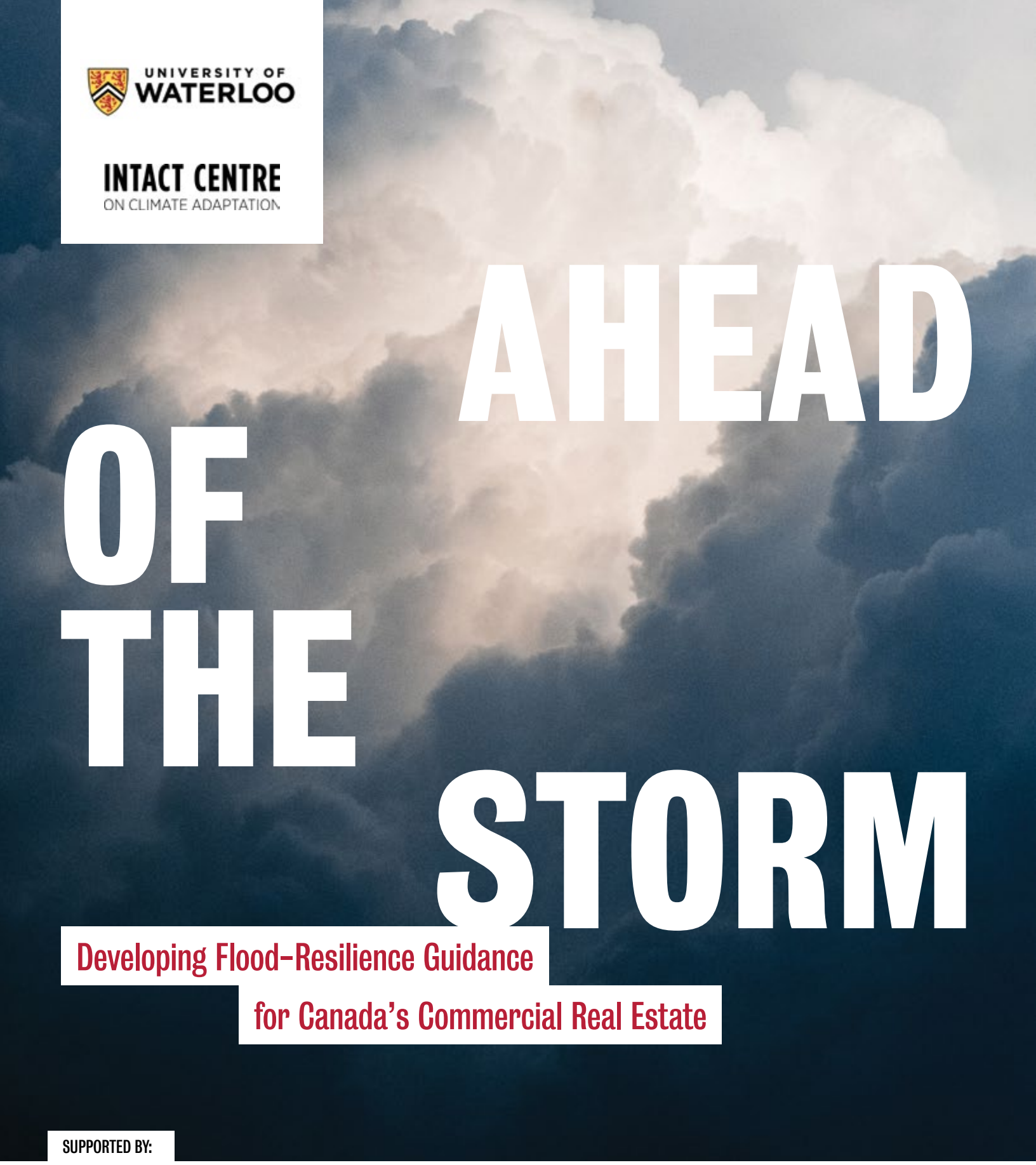


UNIVERSITY OF WATERLOO

INTACT CENTRE
ON CLIMATE ADAPTATION

AHEAD OF THE STORM

Developing Flood-Resilience Guidance for Canada's Commercial Real Estate

SUPPORTED BY:

intact

REALPAC
Real property
Real leadership

BOMA Canada

Natalia Moudrak and Dr. Blair Feltmate
Intact Centre On Climate Adaptation

October 2019



About the Intact Centre on Climate Adaptation

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 additional information, visit: www.intactcentreclimateadaptation.ca.

About the University of Waterloo

The University of Waterloo is Canada's top innovation university. With more than 36,000 students, the university is home to the world's largest co-operative education system of its kind. The university's unmatched entrepreneurial culture, combined with an intensive focus on research, powers one of the top innovation hubs in the world. For additional information, visit: www.uwaterloo.ca.

About REALPAC

The Real Property Association of Canada ("REALPAC") is Canada's senior industry association for owners and managers of investment real estate. Our members include publicly traded real estate companies, real estate investment trusts ("REIT"s), private companies, pension funds, fund managers, banks, and life insurance companies, with cumulative real estate assets under management between $600 Billion and $1 Trillion CAD. The association is further supported by large owner/occupiers and pension fund advisors as well as individually selected investment dealers and real estate brokerages. For additional information, visit: www.realpac.ca.

About BOMA Canada

Comprised of over 3,100 members, BOMA Canada is Canada's oldest commercial real estate industry association. It's members own and/or manage over 2.1 billion square feet of commercial space in Canada and include building owners, managers, developers, facilities managers, asset managers, leasing agents, brokers, investors, vendors and service providers. Together with its eleven chapters, BOMA Canada represents the Canadian commercial real estate industry on matters of national and international concern and provides industry-leading programs such as www.bomabest.org, Canada's principal sustainability certification for commercial real estate. For additional information, visit: www.bomacanada.ca.

About Intact Financial Corporation

Intact Financial Corporation (TSX: IFC) is the largest provider of property and casualty (P&C) insurance in Canada and a leading provider of specialty insurance in North America, with over $10 billion in total annual premiums. The Company has approximately 14,000 full- and part-time employees who serve more than five million personal, business and public-sector clients through offices in Canada and the U.S. In Canada, Intact distributes insurance under the Intact Insurance brand through a wide network of brokers, including its wholly-owned subsidiary BrokerLink, and directly to consumers through belairdirect. In the U.S., OneBeacon Insurance Group, a wholly-owned subsidiary, provides specialty insurance products through independent agencies, brokers, wholesalers and managing general agencies. For additional information, visit: www.intactfc.com.

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FOREWORD

REALPAC and BOMA Canada are pleased to sponsor the Intact Centre on Climate Adaptation's "Ahead of the Storm: Developing Flood-Resilience Guidance for Canada's Commercial Real Estate."

This is Canada's first guideline for improving the flood-resilience of commercial buildings. REALPAC and BOMA Canada's collective membership represent the vast majority of large Canadian commercial real estate companies, which face increasing risk due to climate change.

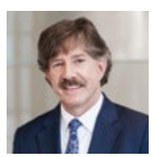
Extreme weather has become the new normal. As we have seen in recent years, flooding, heat waves, extreme heat, and extreme cold events are increasing in frequency and intensity across Canada. Insured losses related to extreme weather averaged $1.8 billion annually between 2009 and 2018. Of these, flooding was the most costly and impactful.

We recognize that climate and resilience are major risk and business issues. Buildings, which persevere through flooding events can eliminate or mitigate risks of physical damage, disrupted business operations and occupant danger. It is therefore imperative that senior leaders recognize the importance of making their buildings as flood-resilient as possible to avoid major future challenges.

Our industry needs to deepen its embrace of proactive adaptation to climate change, rather than simple reaction to the next extreme weather event. This guideline attempts to do just that: equip building owners and managers with best practices they can use to make their buildings more flood-resilient. In doing so, the Intact Centre has consulted numerous stakeholders and experts, including REALPAC and BOMA Canada members, to ensure that this guideline's contents and its recommendations are the most relevant and impactful to industry. We thank the Intact Centre for its leadership in creating this guideline and all stakeholders who contributed to it.

We hope that this document is shared across organizations, from senior leaders to building operators. Resilience needs to be implemented not only in our buildings, but throughout our industry mindset and culture. REALPAC and BOMA Canada look forward to continuing to support the Canadian commercial real estate industry in strengthening its resilience so that our built environment can continue to prosper.

Sincerely,

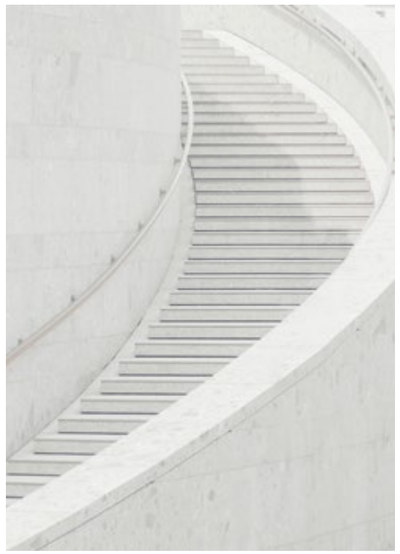


Dr. Michael Brooks
Chief Executive Officer
REALPAC



Benjamin L. Shinewald
President and Chief Executive Officer
BOMA Canada





Letter from Charles Brindamour, Chief Executive Officer, Intact Financial Corporation

Climate change is an environmental and societal issue, as well as an economic challenge. We see the impacts of climate change on our customers and communities every day, which is why Intact is focused on finding practical solutions to build a more climate-resilient society.

Flooding continues to be a pervasive challenge – it's the costliest natural disaster impacting Canadians. Beyond the economic costs of property damage and business disruptions, it takes an emotional toll on those affected. "Ahead of the Storm: Developing Flood-Resilience Guidance for Canada's Commercial Real Estate" is a practical tool for commercial real estate owners and managers to protect people and their assets.

Thank you to the University of Waterloo, REALPAC and BOMA Canada for your leadership, and to the technical advisors for your expertise in building this critical tool.



Charles Brindamour
Chief Executive Officer
Intact Financial Corporation

> **Flooding continues to be a pervasive challenge – it's the costliest natural disaster impacting Canadians."**

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EXECUTIVE SUMMARY

Flooding has emerged as the costliest natural disaster in Canada. According to Public Safety Canada, the cost of the federal Disaster Financial Assistance Arrangements (DFAA) program, which provides funding support to provinces and territories for major natural disasters, will approach one billion dollars annually. Approximately 75% of this cost is attributable to flood events.[i] Flooding is also the lead driver in rising catastrophic insurable losses for the property and casualty insurance sectors in Canada, which experienced over $1.8 billion annually in insured losses from 2009 to 2018, compared to $405 million annually from 1983 to 2008 (this data reflects an adjustment for inflation and wealth accumulation).[ii]

Commercial real estate owners and managers are not immune to the impacts of flooding in Canada. In addition to property damages, their tenants are becoming increasingly concerned with potential business disruptions and loss of life during flood events. This is not surprising – following the 2013 floods in Alberta, between 150,000 to 180,000 people could not access office buildings located in downtown Calgary for approximately two weeks. This resulted in 5.1 million lost work hours, equivalent to half a billion dollars in GDP loss to the province.[iii] In August 2018, when a flash flood occurred in Toronto, Ontario, two individuals almost lost their lives as they got trapped in an elevator of a commercial building and nearly drowned as the elevator was stuck at the basement level, full of water.[iv]

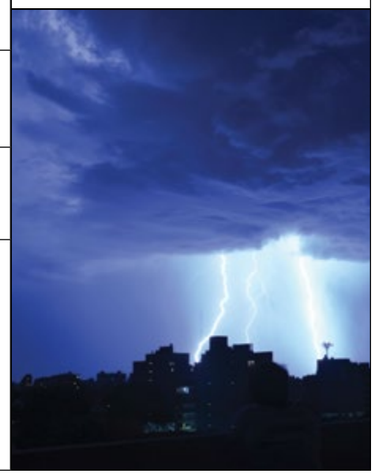
As the commercial real estate industry strives to minimize its exposure to flood risk, this report provides a concise list of flood-resilience measures that can reduce the potential for property damage, business disruptions and potential flood-related injury and loss of life stemming from extreme rain events (Table 1). These measures were developed by a consortium of individuals that reflected a diverse range of flood risk expertise, with support from Intact Financial Corporation, the Real Property Association of Canada (REALPAC) and the Building Owners and Managers Association of Canada (BOMA Canada).

Based on a national consultation with commercial real estate owners, managers, institutional investors, asset management consultants, insurance industry representatives and others, these measures are deemed broadly applicable for implementation across office towers in Canada, with some measures equally applicable to multi-unit residential towers and other commercial and institutional buildings. As such, these measures should be integrated into risk assessment checklists and acquisition and investment questionnaires used by property managers, owners and institutional investors, respectively.

As the National Building Code of Canada is being revised to incorporate climate change impacts, some measures outlined in this report, such as water sensors that prevent elevators from proceeding to flood-inundated levels, should be prioritized for inclusion in code revisions.

The timely deployment of best practices to mitigate flood risk cannot be overstated. The upward curve in insurable losses in Canada, combined with steep increases in DFAA payments, collectively illustrate that if left unattended, the flood risk profile of commercial real estate will increase unless stakeholders adopt the practices profiled in this report.

Table 1: Key Flood-Resilience Measures for Commercial Real Estate (Office Towers), Canada

Plans and Procedures	Equipment & Supplies	Major Retrofits*
PP1. Emergency plans: emergency preparedness and response plans are in place and include flood event procedures.	**ES1. Critical equipment and supplies:** critical equipment and supplies are available onsite to respond to flood emergencies, (e.g., sandbags, sump pumps, portable generators, fuel, portable lights, extension cords, dehumidifiers, protective clothing, etc.).	**MR1. Elevating and flood-proofing critical equipment:** heating, cooling, ventilation, and air conditioning (HVAC) equipment; electrical transformers, switchgear and service panels, as well as communication systems are elevated above expected flood levels. If not feasible to elevate, these systems are flood-proofed (e.g., with equipment elevated off the ground and drains at the lowest points on the floor).
PP2. Practice drills: building operations staff are trained on flood event procedures. Annually, practice drills are performed with tenants and procedures are updated as required.	**ES2. Portable flood barriers and sandbags:** for buildings with critical operations (e.g., buildings housing data centers), portable flood barriers and sandbags are available to protect the building from overland flooding.	**MR2. Protecting server rooms:** server rooms are located on higher floors, preferably on a raised platform, with a sump pump installed at the lowest point. Water sensors are installed for leak detection.
PP3. Emergency funds: dedicated funds are available for emergency operations, including flood events. Designated staff have access to both credit cards and sufficient amounts of cash to be used for emergency operations.	**ES3. Back-up generation:** onsite back-up generation equipment and fuel are available and have the capacity to provide electrical power to at least one elevator, all building sump pumps, heat pumps, boiler, smoke evacuation fans, fire sprinkler and fire alarm systems, stairwell pressurization systems, and emergency lighting equipment for 24-72 hours.	**MR3. Protecting high-voltage and telecommunication pull rooms:** high-voltage and telecommunication pull rooms are waterproofed and equipped with drainage.
PP4. Tenant communication channels: tenant and stakeholder communication channels have been established for emergency situations, including flood events. Tenant contact details are regularly updated.	**ES4. Emergency lighting:** battery-operated emergency lighting is available in critical mechanical and electrical rooms, as well as in emergency exit stairwells for building evacuations, should back-up generation equipment malfunction. A process is in place to regularly test all battery-operated lighting and systems.	**MR4. Isolating electrical circuits:** for multi-level parkades, electrical circuits have been isolated for each parking level.
PP5. Emergency operations centres: designated space is available for building operations staff to use as emergency operations centres. This space is equipped with water, non-perishable food supplies and emergency kits and is located above expected flood levels.	**ES5. Elevator water sensors:** elevators are equipped with water sensors that prevent them from proceeding to flood-inundated levels.	**MR5. Electrical panel upgrades:** electrical panels are equipped with WIFI enabled breakers to allow for remote shut off.
PP6. Emergency response supply contracts: standing orders are in place with fuel suppliers, restoration and landscaping companies to provide goods and services at pre-arranged prices, under set terms and conditions, as required for flood events.	**ES6. Backwater valves:** backwater valves have been installed on storm and sanitary sewer pipes.	
PP7. Emergency contact information: contact information of risk management personnel, insurance adjusters and insurance brokers is maintained and current.	**ES7. Hazardous materials storage:** hazardous materials are protected from flooding (e.g., chemicals used in building operations are stored in sealed containers, or in inflammable cabinets located above expected flood levels). Where hazardous materials are stored, floor drains are protected from spills.	
PP8. Insurance documentation: documentation to access business interruption insurance (e.g., financial statements, lease agreements and inventory counts) is regularly updated, backed-up electronically and stored offsite.		

** These retrofits may be cost-prohibitive to implement post-construction, but they may be warranted for critical sites.*

CHAPTER 1

Introduction

The Need for Flood-Resilience across Commercial Real Estate Properties in Canada

Extreme weather events are on the rise in Canada, bringing ever-increasing cost and disruption to governments, businesses, and ultimately all Canadians.[v] In the past decade, flooding emerged as the most pervasive and costly natural disaster in the country, causing financial and mental distress to those impacted.

To limit the impacts of flooding, all levels of government (Federal, provincial, territorial, municipal and Indigenous governments) are making new infrastructure investments and implementing flood risk reduction strategies.

Flood risk reduction requires a whole of society approach – and this report outlines flood-resilience measures that can be implemented in Canada by commercial real estate (CRE) owners and managers. While the development of this report focused on measures applicable to office towers (high-rise structures, over five stories), many also apply to multi-unit residential towers, retail, industrial, institutional properties and other asset classes.

The report is organized as follows:

- **Chapter 1** examines the need for climate adaptation and presents key drivers for implementing flood-resilience measures across CRE properties in Canada;
- **Chapter 2** outlines flood-resilience measures that should be implemented for existing CRE properties in Canada to reduce the potential for property damage, business disruptions and flood-related loss of life;
- **Chapter 3** provides examples of flood-resilience measures implemented by CRE owners and managers in Canada; and
- **Chapter 4** provides concluding remarks and next steps.

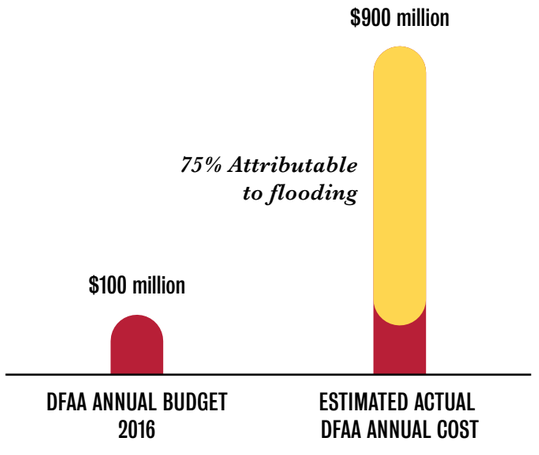


1.1 Escalating Costs of Natural Disasters in Canada

According to Public Safety Canada, the number of natural disasters for which provinces and territories required and obtained federal assistance under the Disaster Financial Assistance Arrangements (DFAA) increased nearly tenfold between 2005 and 2014, compared to the previous decade. Over this 10-year period, the total loss from floods amounted to just over $12.5 billion, the largest expense for the DFAA. Going forward, the annual costs of the DFAA program are expected to average $902 million, with $673 million attributable to flood events. This substantially exceeds the $100 million nominal program budget (Figure 1).[vi]

> **"Annual costs of the DFAA program are expected to average $902 million."**

Figure 1: *Estimate of the Average Annual Cost for Disaster Financial Assistance Arrangements (DFAA) due to Weather Events in Canada*

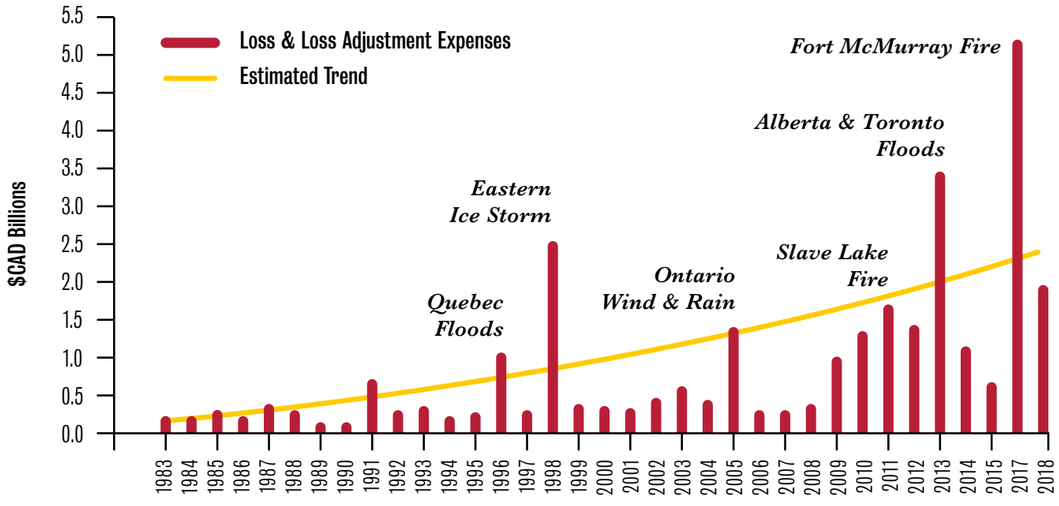


Source: *Parliamentary Budget Officer of Canada. 2016. Estimate of the Average Annual Cost for Disaster Financial Assistance Arrangements due to Weather Events.*



Catastrophic insurable losses[1] in Canada are also on the rise. According to the Insurance Bureau of Canada (IBC), property and casualty insurance payouts from extreme weather averaged $405 million annually from 1983 to 2008 and over $1.8 billion annually from 2009 to 2018 (Figure 2).[vii] Water damage from flooding is the key driver behind these growing costs.

Figure 2: *Insured Catastrophic Losses for Property and Casualty Insurance Sector, Canada (1983-2018)*



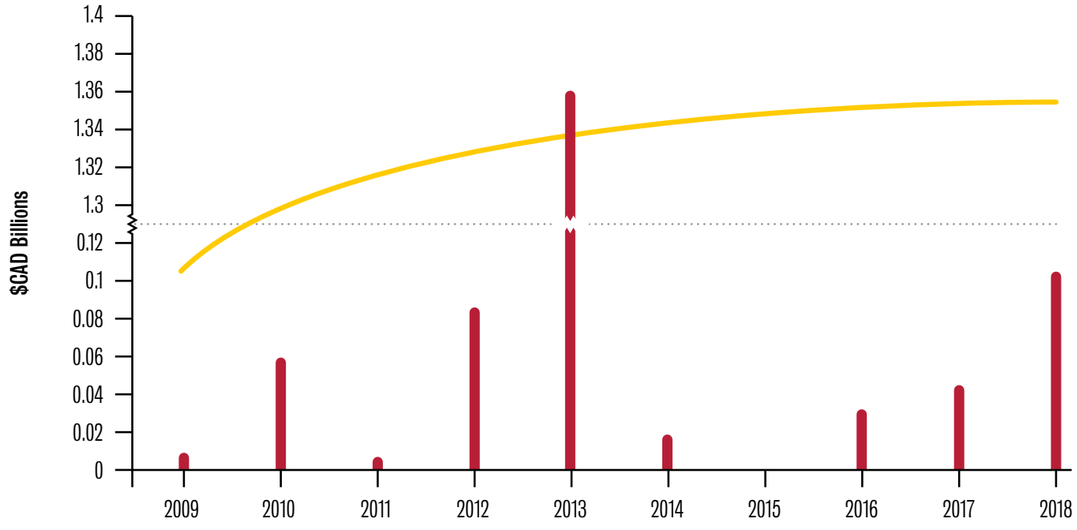
Source: *IBC Facts Book, PCS, CatIQ , Swiss Re, Munich Re & Deloitte. Values are in 2018$ CAN; total natural catastrophe losses normalized by inflation and per-capita wealth accumulation.*

[1] Insured losses for a given disaster are catastrophic when they total $25 million or more per event.

Figure 3 illustrates catastrophic insured losses associated with flood events in Canada that occurred at the level of commercial properties (from 2009 to 2018). There is a spike in losses that occurred in 2013, attributable to $1.37 billion in insured damages associated with the summer floods in Southern Alberta and in the Greater Toronto Area.

In 2018, catastrophic insured losses for severe weather events across Canada exceeded $2 billion, according to IBC. Relative to commercial real estate losses that year, August 2018 flooding in Toronto contributed $113 million in catastrophic insured losses.[viii]

Figure 3: *Insured Catastrophic Losses for Commercial Properties, Property and Casualty Insurance Sector, Flood Events, Canada (2009-2018)*



Source: *Catastrophe Indices and Quantification Inc. (CatIQ). Values for annual commercial loss and loss adjusted expenses, adjusted for inflation to 2018 $CAD.*

> **In 2018, catastrophic insured losses for severe weather events across Canada exceeded $2 billion, according to IBC."**

1.2 Flooding Impacts CRE Tenants

Flooding is not a new phenomenon for CRE tenants in Canada and it is well known that it leads to property damage, business interruptions and lost work hours. For example, following the June 2013 floods in Alberta, between 150,000 to 180,000 people could not access office buildings, located in downtown Calgary, for approximately two weeks. This resulted in 5.1 million lost work hours, equivalent to half a billion dollars in GDP loss to the province.[ix]

More recently, the August 2018 flood in Toronto disrupted business in several buildings including City Hall, Scotia Bank Arena, Union Station, and Rogers Centre.[x] Even more concerning, two tenants were trapped in an elevator of a commercial building and nearly drowned as the elevator was stuck at the basement level, full of water.[xi]

As the number of severe flood events rises, in concert with changing climate, tenants are beginning to ask building managers if their buildings are prepared for extreme weather, and some owners are asking the same of their third-party managers.[xii]

1.3 Flooding Impacts CRE Insurance Rates and Availability

In February 2019, the Office of the Superintendent of Financial Institutions (OSFI) noted that climate change in Canada poses physical, investment and liability risks. It stated that while the insurance industry is "well positioned to manage physical risks in the medium-term, there is growing concern about the potential longer-term impact of climate change. A continued increase in the frequency and magnitude of weather-related claims can create price-setting issues for insurance products."[xiii] OSFI stated that it wants all insurers to quantify their exposure and develop strategic approaches for managing climate risk.[xiv]

Already in some residential areas in Canada, where repeated flooding has occurred, home flood insurance has become more expensive, or the coverage is limited/no longer available.

> "The industry average premium for homeowner insurance has risen by 20-25% over the past five years in Canada. More than half of this increase is directly attributable to water damage and other extreme weather events. The remainder is due to the increase in insured values."
>
> – *Patrick Barbeau, Senior Vice President, Claims at Intact Insurance, March 2019.*

This is a warning sign for CRE owners and managers– even when properties are insurable, premium increases, higher deductibles, and coverage caps may mean that the total amount of potential damage covered by insurance will decline in concert with growing flood risk.[xv]

1.4 Flooding Gives Rise to Lawsuits

Flood-related lawsuits involving homeowners, developers, local governments, Indigenous communities, provinces, and private businesses, are on the rise in Canada. CRE owners and managers are equally exposed to the legal risk associated with flood damages. For example, following a 2009 flood (caused by a leaking pipe) in the building complex now known as Brookfield Place in Toronto, Marsh Canada and other tenants affected by the flood, filed and settled a lawsuit against Centennial Plumbing and Heating Limited. Consequently, Centennial Plumbing sought to be reimbursed by Brookfield Properties Limited, responsible for management of the property, claiming the damage was a result of Brookfield's negligence. While it was ruled that Brookfield was not liable to reimburse Centennial Plumbing in 2017, this case illustrates the potential for lawsuits to arise when flooding impacts commercial tenants.[xvi]

1.5 Flooding Impacts Credit Ratings

In Canada, where flooding is the most common and costly extreme weather risk impacting properties, it is prudent for CRE owners and managers to investigate the degree of flood-preparedness in the cities and provinces they operate. If the creditworthiness of the city is falling due to flood exposure or lack of preparedness to withstand flood events, so might the property values and tenancy rates.

Indeed, global credit rating agencies, including DBRS, Moody's and Standard & Poor's are beginning to examine climate change risks and potential impacts on ratings of tradable assets, including municipal bonds.[xvii] In November 2017, Moody's Investors Service outlined four key credit risks associated with climate change that its analysts consider when examining local and state government risks:

1. Economic disruption (e.g., property loss/damage; lower revenues; business interruption; increased debt; and higher insurance costs);
2. Physical damage (e.g., property loss/damage; loss of utilities, transportation and communication networks);
3. Health and public safety (e.g., loss of life, mental distress, jeopardized critical emergency service provisions); and
4. Population displacement (e.g., short-term displacements and longer-term population migration).[xviii]

Notably, flood risks also comprise a significant focus for climate risk assessment metrics for Moody's, where points three and five below relate directly to flood risk:

1. GDP Coastal Counties per Total State GDP, 2016;
2. Tropical Cyclone Damage (1980–2017) per State GDP, 2016;
3. Coastal Dwelling Units in 100/500 Year Floodplains per Total Coastal Dwelling Units;
4. Damage from Non-Tropical Cyclone Weather Events (1980-2017) per State GDP, 2016;
5. Non-Coastal Dwelling Units in 100/500 Year Floodplains per Total Non-Coastal Dwelling Units; and
6. Agricultural, Forestry, Fishing and Hunting per Total State GDP, 2016.[xix]





1.6 Investors' Attention to Climate Risk and Adaptation

In 2017, the Financial Stability Board's Task Force on Climate-related Financial Disclosures (TCFD) provided recommendations for companies to disclose their climate-related financial risk to investors, lenders, insurers and other stakeholders.[xx] TCFD disclosures are voluntary and include physical, liability and transition risks associated with climate change, which would be material to investors.

In 2018, GRESB, the leading environmental, social, and governance global benchmark for real assets, added a Resilience Module to its long-standing Real Estate and Infrastructure Assessments. The Resilience Module was broadly aligned with TCFD recommendations. As noted by GRESB, "real asset investors are particularly exposed to weather-related disaster issues, as the value of their long-term, often illiquid physical assets is intrinsically linked to energy systems, transportation infrastructure, and social and environmental circumstances." [xxi]

In Canada, Canadian Securities Administrators (CSA) issued a CSA Staff Notice 51-333, Environmental Reporting Guidance in 2010. The notice stipulated that issuers must disclose material information pertaining to environmental matters. As per CSA, "information relating to environmental matters is likely material if a reasonable investor's decision whether or not to buy, sell or hold securities of the issuer would likely be influenced or changed if the information was omitted or misstated." [xxii] A subsequent study by CSA conduced in 2018 (CSA Staff Notice 51-354: Report on Climate Change-Related Disclosure Project), examined climate change-related risk disclosure provided by Canadian issuers. It found that 90% of Canadian issuers disclosed regulatory, policy or legal risks associated with climate change (e.g., impacts of carbon tax on profitability), 43% disclosed physical risks and 33%, 31% and 18% disclosed market, reputation and technology risks, respectively.[xxiii]

With extreme weather events projected to become more severe and frequent, disclosure of physical risks by Canadian issuers will grow in concert with the new climate reality. Pension funds in particular, which take a long view on their real estate investments, are beginning to pay attention to how extreme weather risks may affect returns. For real estate assets located in flood-prone areas, disclosure regarding flood protection and resiliency measures implemented will likely be deemed material.

1.7 Canada's Commitment to Respond to Climate Change, Reduce Flood Risk

Canada has made a number of commitments to respond to the challenge of climate change and to reduce disaster risk, including signing the Paris Agreement [xxiv] and the United Nations' *Sendai Framework for Disaster Risk Reduction* (DRR).[xxv] It also established the Pan-Canadian Framework on Clean Growth and Climate Change (PCF), which aims to both mitigate greenhouse gas emissions and build resilience to extreme weather impacts.

For example, under the PCF, Infrastructure Canada launched the Climate-Resilient Buildings and Core Public Infrastructure (CRBCPI) Project that aims to integrate climate resiliency into building and infrastructure design, guides and codes.[xxvi] As part of this initiative, the Government of Canada invested $42.5 million into research regarding how to factor climate resilience into the design of buildings, roads, bridges, water systems and rail transit in Canada.[xxvii]

Specific to buildings, the National Research Council's Codes Canada division is developing new climate design datasets to incorporate climate change impacts into the National Building Code requirements, including new requirements for building loads from rain, wind and snow due to extreme weather. [xxviii]

Concurrently, the Standards Council of Canada (SCC) identified existing standards referenced in National Model Construction Codes, Provincial and Territorial Regulations and Master Building Specification that need to be updated to include climate change considerations. It also supported the development of new National Standards of Canada that address flood risk reduction at the level of homes and new and existing communities in Canada. [xxiv] [xxx]

CHAPTER 2

Flood-Resilience Measures for Existing CRE Properties in Canada

This chapter outlines flood-resilience measures that can be implemented by CRE owners and managers to better plan, prepare and respond to flood events. The scope of these measures is outlined in Table 2.

Table 2: *Scope of Flood-Resilience Approaches for Existing Commercial Real Estate Properties in Canada*

In Scope	Out of Scope
Property-Level Measures: • Emergency response procedures • Flood preparedness activities • Physical building improvements	• Climate risk assessments • Broader resilience plans
Geography: • All of Canada	**Geography:** • Permafrost communities
Flood Hazards: • Riverine • Overland • Sanitary sewer back up • Storm sewer back up	**Flood Hazards:** • Water damage due to burst pipes, sink overflows, fire system failures • Storm surge and sea level rise • Tidal flooding, dam failures and other unique flood hazards
Property Types: • Commercial (primary focus is on office towers)	**Property Types:** • Industrial, institutional and multi-unit residential buildings (MURB)*

** Some flood-resilience measures identified for CRE properties may also apply to industrial, institutional, MURB properties and other asset classes.*

Notably, the assumption made in this report is that CRE property owners and managers would use the results of climate risk assessments to identify properties that are the most vulnerable to flooding and have the greatest need of flood protection (e.g., high value properties, critical facilities, heritage sites and properties housing vulnerable populations).

Climate risk assessments can be conducted internally, or through utilizing external expertise. Guidance documents, such as BOMA Canada's *Resilience Brief*[xxxi] and the Urban Land Institute's *Guide for Assessing Climate Change Risk* [xxxii] can aid with internal assessments. External assessments can be provided by insurance and re-insurance companies (e.g., AON, MunichRE and SwissRE), engineering firms (e.g., AECOM, Stantec, WOOD), risk modelling and advisory firms (e.g., Bloomberg, DNVGL, Four Twenty Seven, JBA, Mantle314, Quinn & Partners Inc., Risk Nexus, RMS, WSP, XDI) and others.

Relative to flood, risk assessments typically include determining property-level exposure to fluvial (i.e., riverine) and pluvial (i.e., urban) flood hazards to understand what flood levels are probable (e.g., 100-year flood) and what flood levels are possible (e.g., 500-year flood). These risk assessments should take into account current and future climate projections.

The flood-resilience measures outlined in Section 2.1.1 and 2.1.2 are broadly applicable and should be considered for implementation across all CRE properties in Canada. Detailed, site-specific analysis is required to determine relevant major flood-resilience retrofits outlined in Section 2.1.3.

> "Climate risk assessments can be conducted internally, or through utilizing external expertise."

2.1 Measures to Enact Before the Flood

2.1.1 Plans and Procedures

1. **Emergency plans:** emergency preparedness and response plans are in place and include flood event procedures.
2. **Practice drills:** building operations staff are trained on flood event procedures. Annually, practice drills are performed with tenants, and procedures are updated as required.
3. **Emergency funds:** dedicated funds are available for emergency operations, including flood events. Designated staff have access to both credit cards and sufficient amounts of cash to be used for emergency operations.
4. **Tenant communication channels:** tenant and stakeholder communication channels (mass notification systems and social media channels) have been established for emergency situations, including flood events. Tenant contact details are regularly updated.
5. **Emergency operations centres:** designated space is available for building operations staff to use as emergency operations centres. This space is equipped with water, non-perishable food supplies and emergency kits and is located above expected flood levels.
6. **Emergency response supply contracts:** standing orders are in place with fuel suppliers, restoration and landscaping companies to provide goods and services at pre-arranged prices, under set terms and conditions, as required for flood events. Consideration should be given to developing a list of secondary suppliers, if the primary suppliers are not available.
7. **Emergency contact information:** contact information of risk management personnel, insurance adjusters and insurance brokers is maintained and current.
8. **Insurance documentation:** documentation to access business interruption insurance (e.g., financial statements, lease agreements, inventory counts, etc.) is regularly updated, backed-up electronically and stored offsite.

2.1.2 Equipment and Supplies

1. **Critical equipment and supplies:** critical equipment and supplies are available onsite to respond to flood emergencies, such as reusable sandbags, submersible sump pumps, portable generators, fuel, portable lights, extension cords, air dryers, air moisture sensors, dehumidifiers, protective clothing, two-way radios, batteries and medical supplies. A satellite phone is available in the event of internet and cell tower outage.

2. **Portable flood barriers and sandbags:** for buildings with critical operations, portable flood barriers and sandbags are available to protect the building from overland flooding.

3. **Back-up generation:** onsite back-up generation equipment and fuel are available and have the capacity to provide electrical power to at least one elevator, all building sump pumps, heat pumps, boiler, smoke evacuation fans, fire sprinkler and fire alarm systems, stairwell pressurization system, and emergency lighting equipment for 24-72 hours.

4. **Emergency lighting:** battery-operated emergency lighting is available in critical mechanical and electrical rooms, as well as in emergency exit stairwells for building evacuations, should back-up generation equipment malfunction. A process is in place to regularly test all battery-operated lighting and systems.

5. **Elevator water sensors:** elevators are equipped with water sensors that prevent them from proceeding to flood-inundated building levels.

6. **Backwater valves:** backwater valves have been installed on storm and sanitary sewer pipes.

7. **Hazardous materials storage:** hazardous materials are protected from flooding (e.g., chemicals used in building operations are stored in sealed containers, or in inflammable cabinets located above expected flood levels). Where hazardous materials are stored, floor drains are protected from spills.

2.1.3 Major Retrofits

While most measures below may be cost-prohibitive to implement post-construction, they may be warranted for critical sites, or during major building retrofits:

1. **Elevating and flood-proofing critical equipment:** heating, cooling, ventilation, and air conditioning (HVAC) equipment; electrical transformers, switchgear and service panels, as well as communication systems are elevated above expected flood levels. If not feasible to elevate, these systems are flood-proofed (e.g., with equipment elevated off the ground and drains at the lowest points on the floor).

2. **Protecting server rooms:** server rooms are located on higher floors, preferably on a raised platform, with a sump pump installed at the lowest point. Water sensors are installed for leak detection.

3. **Protecting high-voltage and telecommunication pull rooms:** high-voltage and telecommunication pull rooms are waterproofed and equipped with drainage.

4. **Isolating electrical circuits:** for multi-level parkades, electrical circuits have been isolated for each parking level.

5. **Electrical panel upgrades:** electrical panels are equipped with WIFI enabled breakers to allow for remote shut off.

It is also important to note how site design considerations can be critical for property-level flood-resilience. For example, a major issue for CRE properties during flash flood events is overland water entering underground parking lots through intake and exhaust vents. Accordingly, when designing a new site, it is critical to elevate parking garage intakes and exhaust vents above grade and cover them with a canopy, where possible. Similarly, landscape design features such as berms, swales, rain gardens and permeable pavements can provide a range of benefits, including flood attenuation, biodiversity improvements and aesthetic benefits. The SITES framework and certification system can guide landscape architects, designers, engineers, planners, developers and others to align land development with sustainable design considerations.[xxxiii] Care should be taken to ensure that such features do not present an obstacle to the disabled. The Rick Hansen Foundation *Accessibility Certification* can guide professionals in this regard.[xxxiv]

Although the focus of this report was on identifying preventative measures to reduce flood risk, some examples of what needs to be done "during" and "immediately after" flood events are also provided on the next page.

2.2 Measures to Enact During the Flood

- Follow emergency procedures and instructions from local authorities. If evacuation orders are issued, all tenants and building operation staff must leave the premises immediately.
- Prohibit tenants and building operations staff from entering floodwaters (one foot of water can sweep away a vehicle and hazardous materials can enter the water easily)
- Procedures are in place to shutdown equipment that may be affected by the flood. This includes shutting off electrical equipment and flammable liquid lines at the source (except for emergency generators and fire pumps). Do not energize until a licensed electrician inspects this equipment for damage.
- Fill up fuel tanks for emergency generators and fire pumps.
- Protect building doors and windows from overland flooding and debris damage (e.g., by setting up boards and sandbags).
- Protect onsite waste disposal and collection facilities from floodwater entry (e.g., through locking waste disposal bins).
- Secure outdoor items (e.g., outdoor furniture landscape items, waste containers and other equipment) that can be swept away by the flood waters.
- Move machinery, equipment and valuables to higher levels (above expected inundation).
- Take photos of impacted areas for insurance claims process.
- Provide regular updates to tenants and building operation staff.



2.3 Measures to Enact Immediately After the Flood

Once the flood waters subside, the following steps should be considered:

- Check for downed power lines and fuel spills caused by the storm, report damages to the utility providers.
- Engage qualified gas fitters and boiler service technicians to restart boilers, advising jurisdictional authorities as necessary.
- Extract water from premises as soon as possible to reduce damage and contamination.
- Remove damaged contents and furniture; disposing of it in accordance with regulations.
- Assess structural damage through visual inspections, moisture meters, and thermal imaging to detect all moisture.
- Check for contamination to determine the required levels of cleaning and sanitation (typically this assessment is performed by an external environmental consultant).
- Clean and sanitize the property, once dried, to industry standards and scope provided by an external environmental consultant.
- Initiate drying and dehumidification process and keep daily moisture logs to measure progress.
- Test electrical, mechanical, fire protection, alarms and other building systems; repair as required.

It should be noted that there could be a wide range of illness and injury due to floods. These adverse health effects include "physical injuries such as cuts and abrasions; infections due to contact with contaminated flood water and contaminated surfaces; exposure to non-biological contaminants such as carbon monoxide, heavy metals, and pesticides, which can lead to health impacts; allergic or asthmatic episodes triggered by exposures to mold; and emotional trauma and post-traumatic stress." [xxxv] Accordingly, careful attention needs to be paid as buildings go through clean up and restoration phases following flood events.



ELEVATORS:

An In-Depth Look At Flood-Resilience Measures

Elevator flooding is usually a reportable event in most provinces in Canada. This typically means once a flood occurs, the Authority Having Jurisdiction (AHJ) must be notified to ensure the elevator(s) affected are inspected by the AHJ prior to returning to service.

There are two common types of elevators used at CRE buildings in Canada: traction elevators and hydraulic elevators.

Traction elevators function with the help of a rope that passes over an electrically-powered pulley or wheel. [xxxvi] This wheel is attached to an electric motor and when the motor is powered, the wheel is set in motion, pulling the rope and in turn lifting the elevator car to the desired floors. [xxxvii] The wheel is usually placed in the machine room, constructed on the highest floor of the building. [xxxviii]

Hydraulic elevators utilize a piston, placed at the bottom of the elevator and controlled by an electrically-powered pump. Hydraulic elevators are typically used in smaller buildings (5-6 stores high), serving a vertical rise of up to 60 feet. The elevator pump, oil tank and controls are housed within a common space, usually located at the bottom landing served by the hydraulic elevator.

Flood-resilience measures that are applicable to both traction and hydraulic elevators include:

- Installing a back-flow preventer in the drain line between the sump pit and the elevator pit to reduce the risk of elevator pit flooding if the sump pump fails;
- Ensuring that the elevator sump pumps are provided with emergency power so they can remain operational during power outages; and
- Waterproofing elevator lobby vestibule doors to reduce floodwater incursion into the hoistway.

Flood-resilience measures that are specific to traction elevators include:

- Installing water sensors that trigger the elevator operations program to move elevator cars to a level high enough in the building to ensure that critical elevator equipment (e.g., travelling cables, car safeties, car bottom roller guides, wiring junction boxes, etc.) are above the water line.

In buildings where an elevator pit does not have a drain:

- Securing portable pumps and required equipment (e.g., extension cords) to be deployed in a flood event.
- Installing water sensors in the elevator pit and connecting these to the central alarm system or BMS to provide immediate notification to building operators of a flood occurring within the elevator's pit space.
- Retrofitting electrical components in the elevator pit to meet National Electrical Manufacturers Association (NEMA) 4 protection requirements (including waterproofing of elevator receptacles, switches and light fixtures).

Flood-resilience measures that are specific to hydraulic elevators include:

Sealing the borehole's annulus space to prevent groundwater seeping up into the elevator pit through this unprotected opening. This is particularly important for properties located in areas with seasonally high water tables.

Prepared by: Clifford Ayling, Director, Elevating Devices, PCL Constructors Canada Inc.

2.4 Engagement with Local Governments on Climate Resilience

Although CRE owners and managers should make every effort to improve flood-resilience of their properties, this could be negatively impacted if the underlying infrastructure to service these properties fails. As noted in the 2019 study *Climate Risk and Real Estate Investment Decision-Making* by the Urban Land Institute (ULI) and Heitman, it is critical for CRE owners and managers to investigate the degree to which local governments are proactive in mitigating climate risks.

ULI and Heitman surveyed global real estate investors and managers and found that "local governments' preparedness for climate change influenced their decisions regarding whether to invest long-term in those markets."[xxxix] Some CRE investment managers surveyed by ULI and Heitman noted that they meet with elected city officials to discuss climate resilience plans and to signal to them that major asset owners are thinking about this issue and want to see action taken.[xl]

The Intact Centre notes the following areas as critical to assessing relative to local and provincial/territorial government flood preparedness:

- Availability of updated and forward-looking flood risk mapping;
- Land use planning guidance, which takes into account current and future climate projections;
- Proactive maintenance of drainage, storm, water and wastewater infrastructure systems; and
- Emergency preparedness and response including coordination with agencies in charge of transportation and electricity supply to remain functional during flood emergencies.[xli]

As it relates to ageing infrastructure, large water main breaks can cause localized floods, leading to property damage and building closures. Some cities and utilities have begun to implement monitoring solutions, such as installing acoustic fiber optic cables to continuously monitor the integrity of pipes and provide notifications to trained personnel if potential problems are detected, helping prevent major pipe bursts.[xlii] CRE owners and managers need to take note of these broader efforts that local governments make to manage flood risk, as they affect property-level resilience.

If the local governments and provinces are not stepping up to the challenge to prepare and respond to climate change and flood threats proactively, the risk is passed on to everyone else. CRE industry is well positioned to drive adaptation efforts within jurisdictions where they operate. As noted by the ULI survey respondents, a good place to start is to have a conversation with elected officials regarding their climate risk management plans.

> **"If the local governments and provinces do not step up to the challenge to prepare and respond to climate change and flood threats proactively, the risk is passed on to everyone else."**

CHAPTER 3

Examples of Flood-Resilience Measures Implemented

This chapter presents case studies of flood-resilience measures implemented at CRE properties across Canada to illustrate the practicality of measures outlined in Chapter 2. While the databank of flood-resilience case studies in Canada is a "work in progress," in the US, ULI's report *Returns on Resilience: The Business Case,* highlights real estate development projects that employ best practices in resilient design (including flood-resilience) and show demonstrable returns on investment.[xl]

BGIS: Flood-Resilience Retrofit for a Financial Client

In 2018, BGIS worked with a financial client to identify and implement flood-resilience measures for select branch locations across Canada exposed to urban flood risk. Based on the assessment conducted by BGIS, the following measures were implemented to help the client limit flood damage from severe precipitation events and plumbing failures:

- Installation of sump pump alarms to trigger notification alerts in case sump pits are at risk of overflow (estimated cost of alarm installation is $1,000, annual alarm monitoring fee is $500);
- Installation of backflow valves to reduce the risk of sewer back-up flooding (estimated cost of installation is $3,500);
- Installation of water sensors in server rooms (estimated cost of installation is $10,000 or higher, depending on the room size and monitoring equipment); and
- Installation of heat tracers on interior and exterior water pipes to keep them from freezing and subsequently bursting (estimated cost of installation is $1,000 or higher, depending on the required length).

In addition, BGIS team biannually (in the spring and in the fall) cleans out roof drains and downspouts at the branch properties to avoid water pooling on the roof, which can cause leaks and damage.



Evergreen Brick Works is located in the flood plains of the Don River in Toronto, Ontario.

Evergreen Brick Works: Flood Management by Design and by Protocol

Evergreen Brick Works is a hub – a place where the world can experience sustainable practices that enable flourishing cities of the future. In 2010, Evergreen transformed a collection of deteriorating heritage buildings into a global showcase for green design and an award-winning public space. Open year-round, Evergreen Brick Works welcomes more than 500,000 visitors annually to experience its public markets, participate in conferences and events, enjoy outdoor learning and nature play, and explore public art in the heart of Toronto's ravine system.

As an organization, Evergreen Brick Works acknowledges that "*Flooding at Evergreen Brick Works Is Not a Matter of If, It Is a Matter of When*." Therefore, Evergreen Brick Works embeds flood resiliency knowledge and education into its work culture in all of its day to day activities and operations.

Unlike many other CRE properties, Evergreen Brick Works faces a unique set of various activities that make dealing with flood emergencies complicated. Evergreen Brick Works has tenants, who operate within normal office hours, but also hosts events, programs and community engagement functions that happen after hours, on weekends and holidays.

At any point of time, Evergreen Brick Works could have a large number of people on site. This makes flood risk management a paramount priority. In particular, evacuation procedures and communication protocols are critical to have in place in instances where the facilities staff may need to shut down a high-profile function due to a flood emergency.

Since 2013, Evergreen Brick Works has experienced three major riverine flood events. Each event has turned the 11 acre site into a lake. By developing a comprehensive flood management plan, Evergreen Brick Works managed to reduce the recovery time and cost significantly from millions of dollars to below one hundred thousand dollars. Evergreen Brick Works has a goal to reduce future flood recovery costs to below $30,000.

To achieve flood-resiliency, Evergreen Brick Works has focused its efforts on an approach that was coined *"Flood Management by Design & by Protocol"*.

Relating to "Flood Management by Design", Evergreen Brick Works has implemented the following actions:

- Installed all electrical outlets above the 10-year flood line
- Located all major electrical and mechanical rooms on the 2nd floor or higher
- Ensured new walls and floors are made of solid dense concrete to be easily washable and resistant to mold
- Across locations where a framed wall needed to be installed, removable cement boards have been used to be easily washed and dried
- Reprogrammed elevators to park on the 2nd floor when not in use
- Used hollow plastic structures called "Cupolex" to raise the floor above 10-year floodline while reducing the quantity of required concrete
- Installed flood gates at all entry points around the buildings perimeter
- Installed permeable concrete pavement to reduce water runoff from parking lots
- Installed green roofs to reduce water runoff from roofs
- Built cages and platforms for merchandise display in retail stores, so that the items are always displayed above the 10-year flood line
- At the children's program area, built closets and benches for placing backpacks and other items above the 10-year flood line
- Installed 14 rain water cisterns that each retain approximately 20,000 liters of water, or more than 250,000 liters of rainwater that could be used for pressure washing after the flood

Relating to "Flood Management by Protocol," Evergreen Brick Works implemented the following actions:

- Developed a comprehensive flood management plan, which includes procedures for weather watch, flood watch, flood alerting, evacuation and recovery
- Developed a customized weather widget with centralized weather information and flood gauges that pulls the data from available sources in a central location for analysis and action by facilities staff
- Integrated flood preparation checklist into daily standing orders for each activity taking place at Evergreen Brick Works
- Implemented "flood walk" program to communicate key findings about the status of flood readiness of various spaces to staff and tenants
- Procured an inventory of flood equipment (e.g., sump pumps, hoses, pressure washers, sanitizer sprays and large fans)
- Designated a place of refuge on higher floors, equipped with drinking water and food
- Partnered with a nearby church in higher elevation up the adjacent hill to shelter children and others if necessary
- Developed a confidential staff and tenants phone tree as well as critical contacts
- Developed Flood Management, Flood Response and Floor Recovery teams including volunteers
- Established partnerships with watershed authorities (TRCA) and their flood duty officers
- Included a flood risk clause in the tenants' agreements, as well as third party events' agreements to ensure they are aware of the risk and they take their own measures in addition to the site's efforts
- Informed every new hire about the site's flood risk and their possible engagement in flood recovery and provided online and in-person health and safety training for cleanup assistance as part of the orientation package

Fiera Properties: Addressing Flood-Resilience at an Office Complex

The City of Richmond in British Columbia is situated below sea level and relies on pumping stations to reduce and maintain seawater levels. Seasonally, the city is exposed to extreme high tides (i.e., "king tides") and, at times, city storm drains are over capacity and storm drains located in low-lying areas backflow.

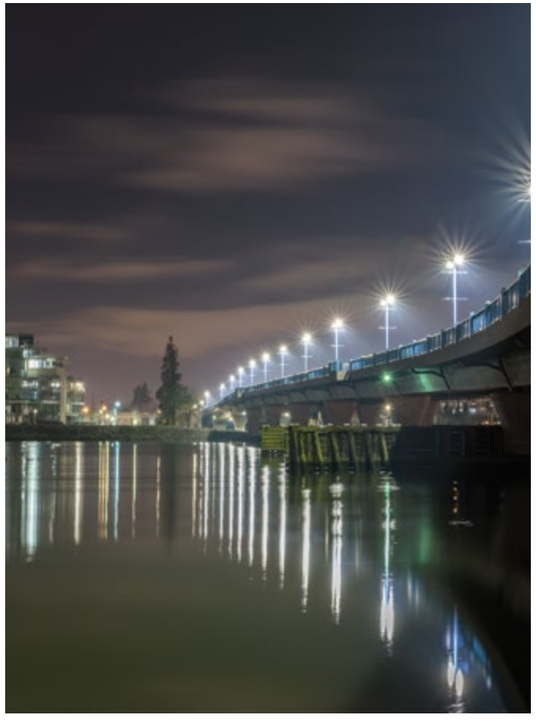
The Office Complex, managed by Fiera Properties, is comprised of 13 buildings that span 707,000 square feet, located on a 35-acre land parcel. Portions of the parcel are located in the designated flood plain. Three of these buildings are particularly vulnerable to flooding, as they have parking and service rooms (including main electrical services and telecommunications data rooms) located on the ground floor, where storm drains are below the elevation of the city storm drains. There is no ability to relocate or elevate critical equipment located in these rooms.

To address flood-resilience, Fiera Properties implemented the following property-level protocols across the three most vulnerable buildings:

- Installed automatically-activated sump systems to reduce rising water levels;
- Installed two gas-powered pumps and secured fuel supplies for emergency response;
- Set up an "incident command center", which is equipped with a first aid room, emergency tools and supplies;
- Trained onsite staff and mobile security on emergency response procedures, including flood response; and
- Instructed the onsite staff and mobile security to inspect low elevation levels for flooding during high precipitation events.

Fiera Properties further plans to enhance flood-resilience at the Office Complex through implementing the following measures:

- Inspect all buildings for the presence of backwater valves to reduce potential storm and sanitary backflow events / where backwater valves are missing initiate installation;
- Ensure City of Richmond and water pumping trucks (McRaes Environmental) emergency contact information are readily available for emergency response teams;
- Ensure all emergency equipment (e.g., utility hole cover removal tools, hoses, pumps, extra fuel, electrical cords, etc.) are properly stored and are ready for use;
- Stockpile sand on site for sandbags if required for a flooding event;
- Develop emergency shut down procedures for main electrical service in catastrophic flooding events; and
- Revisit tenant communications / evacuation protocols to exercise for flood events.



> "The incident command centre is equipped with a first aid room, emergency tools and supplies."

FirstOnSite: Emergency Preparedness for Critical Telecommunications Sites

Several critical telecommunications sites are at risk of flooding in Western Canada. These sites are impractical to relocate or redesign. Accordingly, flood tube barriers and pumps have been purchased for rapid deployment in the event of overland flooding. Standby generators and diesel tanks have been raised. The estimated cost of implementing these measures was $175,000 per site. Notably, natural gas has been approved as a fuel source for emergency standby power in many jurisdictions where these sites are located. Costs to retrofit vary, however the benefits of using natural gas for emergency standby power include:

- Reliable fuel source without the need to resupply diesel tanks;
- No risk of diesel spills;
- Lower emissions;
- Less maintenance required than diesel;
- Extended run times; and
- Natural gas does not have to be stored so it does not degrade over time.

FirstOnSite: Flood Retrofit for a Condominium Complex

A 180-unit condominium complex in High River, Alberta, which was heavily damaged by the floods in 2013, elevated all the hot water tanks and furnaces from grade upon replacement. The estimated cost of this retrofit was $20,000, with retrofit work conducted by a local HVAC contractor.



Healthcare of Ontario Pension Plan: Climate Risk and Resilience Assessment

In collaboration with Quinn & Partners and AON, the Healthcare of Ontario Pension Plan (HOOPP) undertook a climate change risk and resilience assessment on its global $14 billion commercial real estate portfolio. HOOPP used historical extreme weather and flood risk data, predicted climate change risk parameters and a property survey to inform the creation of a risk and resilience matrix. The matrix helps HOOPP to identify properties at a high risk of extreme weather events and relates this risk information to a property's degree of preparedness (resilience).

The climate change risk and resilience assessment clarified that for HOOPP's real estate portfolio the main climate risk is flooding. HOOPP is now focusing its flood-resilience planning and flood-protection investments on high-risk properties. HOOPP is also including property-level resilience practices in their investment and asset management checklists to reduce climate change-related risks.

Across HOOPP's 190-property portfolio, the cost of the climate change risk and resilience assessment was approximately $500 per property. This cost included access to forward-looking climate risk data, resilience survey, analysis and development of recommendations.

> "The climate change risk and resilience assessment clarified that for HOOPP's real estate portfolio the main climate risk is flooding."

Infrastructure Ontario / CBRE: Weather Service Predictor

To make provincial buildings more resilient to extreme weather, automated warnings based on forecasted weather and Environment Canada Public Weather Alerts go out to any impacted buildings within the Infrastructure Ontario portfolio. An extreme weather event may be a heavy snowfall, intense rain, high winds, or a period of extreme heat or cold. A set of prescriptive measures appropriate to the type of weather event are sent to field staff. Measures can include validating building systems and supplies, communicating with staff and tenants, or checking building access points. Sending these alerts to field staff in advance of the weather event allows them to take precautionary measures to mitigate risks of incidents impacting the building.

Infrastructure Ontario: Computer Rooms Flood Protection

In its Design Guidelines (which must be followed for the commissioning of any building retrofit), Infrastructure Ontario specifies that water detection sensors should be installed under the raised floor of a computer room, whenever air conditioners are being installed. If flooding occurs, sensors will trigger the water leak detection alarm. The Building Automation System (BAS) sends alarm notifications, by email or other means, to the building operators/facility managers. The building operators can then decide what measures need to be taken to ensure occupant and building equipment safety.

Menkes: Social Media Tenant Outreach Strategy

As a way to engage occupants in an influential way, Menkes departed from traditional CRE industry methods, such as posters and flyers, and used social media to form the basis of its outreach strategy. Using platforms like Twitter, Facebook, and Instagram, Menkes leveraged its diversified social media presence as a direct channel to engage building occupants. Various messages are posted on these accounts, including flood warnings and emergency communication.

Building	Instagram	Twitter
One York Street	@OneYorkStreet	@OneYorkStreet
25 York Street	@25YorkStreet	@25YorkStreet
4711 Yonge	@4711Yonge	@4711Yonge
Aero Centre	@AeroCentre	@AeroCentre_GTA

Menkes realized the benefits of having a direct channel to communicate with building occupants during several events in Toronto. For example, in 2018 there was a daylong power outage caused by a Toronto Hydro equipment failure at a Menkes managed property. As occupants did not have access to their emails and company servers were down, traditional tenant email notifications were not getting through to the occupants. However, the occupants were able to follow live updates about the power outage on the social media channels. These live updates were also critical during the April 23, 2018 North York City Centre van attack, as occupants needed safety information, as well as information about road closures and building operating schedules.

> **Sending these alerts to field staff in advance of the weather event allows them to take precautionary measures to mitigate risks of incidents impacting the building.”**



Tridel: Preparing Property Managers to Respond to Flood Emergencies

Tridel, the largest builder of condominiums in the Toronto area, provides property management staff (e.g., superintendents, concierges and cleaners) with emergency management training, emergency kits and ladders. As part of the training, property management staff are instructed on flood response, with a significant focus on leak containment. The staff are trained on reading valve charts and drawings, which indicate valve locations and which water flows each valve controls (e.g., domestic water supply systems, hydronic systems used for heating and cooling, fire protection systems and storm and sanitary sewer systems). In case of a leak, the staff are able to perform shut off procedures, reducing property damage. Emergency kits that are provided to staff include screwdrivers, drywall knives, garbage bags, gloves, goggles, flashlights, adjustable wrenches, duct tape, clamps, pens, note pads, etc. Tridel conducts emergency drills annually with the onsite property management staff. An emergency drill log is maintained, listing the type of drill, the time conducted and any additional training required.

Triovest: Flood-Resilience Retrofits Following a Major Flood Event

Following 2013 Alberta floods, Triovest set up a permanent flood room at the Keynote Office Tower in Calgary. The room stores critical equipment and supplies, including portable flood barriers, sand bags, submersible sump pumps, portable generators, fuel, portable lights, extension cords, protective clothing, etc.

As well, **Triovest purchased the Watergate flood barrier system, which can be set up in less than an hour and covers the perimeter of the city block where the tower is located.** The Watergate flood barrier system (with sections of it spanning from 0.6 to 1 meter in height) cost approximately $165,000. It is stored in movable carts located in the flood room.

Triovest also worked with Fujitec Canada to retrofit elevators with water sensors in its four-story Customs House building in Calgary, Alberta. Fujitec specialists installed water sensors at the bottom of the building’s elevator pits. The sensors automatically return elevators to ground or higher floors should there be flooding in the basement of the building (i.e., if the elevator pit is full of water). The cost of retrofit, including equipment and labour, was approximately $5,000 per elevator.

CHAPTER 4

Conclusion and Next Steps

Climate change and extreme weather events will continue to challenge the stability of returns from real estate investments. As noted in this report, the time is now for institutional investors and commercial real estate owners and managers to revisit their risk assessment models and to assess their exposure to the most costly natural disaster in Canada – flooding.

Relative to commercial real estate assets, flood-resilience measures outlined in this report can reduce the potential for property damage, business disruption and flood-related loss of life stemming from extreme precipitation events. The focus of these measures is on proactive planning and preparedness activities that can be executed across office towers in Canada.

It is important to acknowledge that flood damage can arise in the absence of extreme precipitation events, for example due to city infrastructure failures (e.g., water main breaks), domestic water and hydronic system leaks. Appendix A, prepared by Global Construction and Infrastructure Group, Aon Risk Solutions, outlines emerging technologies that can help address these broader water-related challenges.

To be effective, many of the flood-resilience measures outlined in this report rely on regular maintenance activities. To this end, inspections, testing and documentation processes comprise an important part of risk management activities. Qualified professionals who are responsible for inspections and testing must therefore receive training on flood risk assessment and resilience measures, such as the ones outlined in this report.

The commendable leadership of REALPAC and BOMA Canada to establish the flood mitigation practices presented in this report is self-evident.

The next step for commercial real estate – the formidability of which should not be underestimated – will be the timely deployment of these practices in anticipation of bigger storms that have yet to come.

APPENDIX A

Aon Flood & Water Damage Resilience Technology Profiles

Aon's Commercial Risk Solutions
Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Doxel's autonomous robots scans and captures images of the asset as it is being built and is able to detect defects, inspect quality and measure progress through a robust artificial intelligence system. This enables Doxel to identify micro issues that could turn into macro flood and water damage events.

Product Description

Doxel is an artificial intelligence solution for construction productivity. It uses autonomous devices to monitor a site every day, both outdoors and indoors, with LIDAR and HD cameras. Their proprietary artificial intelligence algorithm then processes the data, inspects installation quality, and quantifies how much material has been installed correctly.

Their cloud-based dashboard then provides project managers with real-time feedback on productivity, as well as how actual costs and time spent are comparing to the original budget and schedule. As a result, managers can better control outcomes and keep their projects on time and on budget. Benefits include:

Budget — AI measures installed quantities and calculates earned value for thousands of line items, telling you exactly how much you owe for a day's work.

Schedule — Doxel keeps you updated with real-time progress reports, measured production rates and project completion forecasts.

Quality — Doxel detects errors with superhuman accuracy through their AI engine, instantly letting you know if field installations are installed per the plan.

Risks Treated

Key risks mitigated by the Doxel system include:

1. Defects (design/ workmanship)
2. Loss in Productivity (construction)
3. Contractor Default
4. Property Damage (own, others)
5. Bodily Injury (own, others)
6. Schedule & Cost Overrun

DOXEL

Company Profile

Doxel
3250 Ash Street
Palo Alto, CA, USA

CEO:
Saurabah Ladha

Category:
Artificial Intelligence, Scanning/ Reality Capture

Website:
www.doxel.ai/

Location:
North America

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Site 1001's comprehensive building platform combines the use of sensors, IoT devices and AI to stop leaks, flooding and monitor the overall health of the building before there is a chance of a risk occuring.

Product Description

A cloud-based software platform that combines a building's core information (design models, floorplans, asset details, warranty information, etc.), its maintenance and service records, and live data feeds from building systems, sub-sensors, and IoT devices, to create a continuously updated record of the building's operational health and performance. Building owners, operators and managers enjoy the following benefits of Site 1001:

Operations & Maintenance — Helps identify operational anomalies and prevent building system failures. Mitigates risks from previously unnoticed and undetected issues such as mold and water leaks by automatically detecting and notifying before the issue becomes a problem.

Quality — Continuously monitors building comfort, safety, and performance, while creating a continuously updated record of the state of the building for all in the building's ecosystem.

Budget — Reduce costs associated with maintenance and repair delays by delivering diagnostics, parts and maintenance details at the point of service.

Risks Treated

Key risks mitigated by the Site 1001 system include:

1. Property Damage (resultant damage, own, others)
2. Bodily Injury (own, others)
3. Defects (design workmanship)
4. Delays in claims discover
5. Brand Impact
6. Warranty

site 1001

Company Profile

Site 1001
1001 Locust Street, 4th Floor,
Kansas City, MO 64106

CEO:
Cleve Adams

Category:
Smart Buildings

Website:
https://site1001.com/

Location:
Global

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
With Upbrella's innovative way to construct high-rise buildings, many of the traditional risks of water damage are eliminated due to its sheltered construction method and best practices.

Product Description

Upbrella works to bring sheltered conditions to high-rise construction projects by using roof-lifting technology that envelops the structure and provides a protective enclosure that supports the floor-by-floor construction of high buildings.

Safety
Industry leading worker health and safety environment due to weather sheltered enclosure that allows 80% of the work to be performed at worker's height with no tower cranes required.

Budget
Offers direct costs savings by eliminating lost time and productivity due to weather as well as temporary set ups and reduces waste management.

Schedule
Faster delivery vs traditional construction can reduce project schedule by 20% - 25%.

Risks Treated

Key risks mitigated by Upbrella include:

1. Bodily Injury (own, others)
2. Property Damage (resultant damage, own, others)
3. Defect (workmanship)
4. Weather

upbrella CONSTRUCTION

Company Profile

Upbrella
9160 boulevard Leduc, Bureau 310,Brossard, QC, Canada, J4Y 0E3

CEO/Founder:
Joey Larouche

Category:
Engineering Solutions

Website:
www.upbrella.com

Location:
North America

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Arx Pax's Self Adjusting Floating Environment (SAFE) Foundation System provides a consistent building surface regardless of site location. It provides scalable, repeatable foundations ideal for poor soils, floods and earthquake hazards.

Product Description

Arx Pax unlocks "unbuildable" land. The SAFE (Self Adjusting Floating Environment) Foundation System is a modular, pre-cast concrete foundation system that provides a consistent building surface regardless of site location. SAFE adapts and integrates well proven technology to provide a scalable, repeatable foundation ideal for poor soils, flood and earthquake hazards. Ultimately, SAFE provides greater margins and less risk per unit of development and will disrupt real estate development models worldwide. Instead of spending billions on rebuilding after disasters, we can now build responsibly and sustainably to last for generations. Benefits include:

Budget
The cost of SAFE is comparable to traditional pier-based foundation systems required in poor soils. Land price is significantly reduced therefore reducing overall development cost.

Schedule
Known SAFE Foundation System structural load capacity allows for the predesign of buildings independent of site geotechnical conditions allowing building predesign or structural duplication.

Safety
To protect people, property and communities from natural disasters is our mission. Factory production of foundations will increase worker safety and reduce jobsite hazards.

Risks Treated

Key Risks mitigated by the ArxPax system include:

1. Property Damage (resultant damage, own, others)
2. Weather
3. Loss in Productivity (operations)
4. Bodily Injury (own)

ARX PAX

Company Profile

Arx Pax Labs, Inc.
20 S. Santa Cruz Avenue, Suite 102, Los Gatos, California 95030

CEO/Founder:
Greg Henderson, AIA

Category:
Construction Technology, Resiliency

Website:
www.arxpax.com

Location:
California HQ, Global solution

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Using the "Weather of Things" approach, ClimaCell is innovating the way we forecast weather. Through new and exciting methods of providing weather nowcasts and forecasts, weather risks can be mitigated and managed more efficiently to reduce risk exposure.

Product Description

ClimaCell is pioneering an approach we call the "Weather of Things" — where we use existing infrastructure like cell signal interference, connected cars and airplane sensors to generate millions of proprietary weather observations around the globe, each day. By assimilating these IoT data points into proprietary forecasting models and combining them with traditional weather sources like government radars, we output street-level, highly granular nowcasts and forecasts, updated minute-by-minute. We call this MicroWeather — which we deliver to operations-focused clients through a web-based user interface (HyperCast) and to data-focused clients via API.

Productivity

Automatic logging of weather conditions into the daily log via ClimaCell's API saves a manual task and functions as the one source of weather truth across projects, for example in solving Liquidated Damages disputes.

Safety

Lightning, high winds, precipitation and extreme temperatures can create job-site hazards for crews and equipment. ClimaCell's weather alerting system helps operators mitigate and manage these risks with advance warnings at the site level.

Budget

Labor makes up 20–30% of project costs, which can be stretched into significant overrun due to delays. HyperCast gives the granularity to make binary "go-no go" shift decisions, avoiding mistaken cancellations and minimizing missed shifts due to faulty forecasts.

Risks Treated

Key risks impacted by ClimaCell include:

1. Property Damage (resultant damage, own, others)
2. Bodily Injury (own, other)
3. Schedule & Cost Overrun
4. Loss in Productivity (construction, operations)
5. Weather

climacell

Company Profile

ClimaCell
280 Summer Street
Boston, MA 02210

CEO/Founder
Shimon Elkabetz (CEO, co-founder), Rei Goffer (Chief Strategy Officer, Co-founder), Itai Zlotnik (Chief Customer Officer)

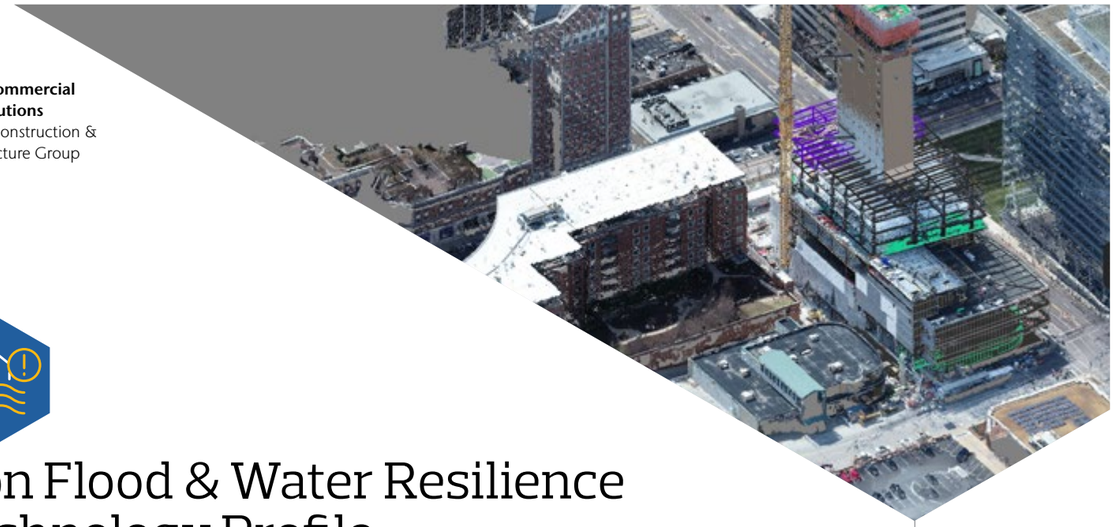
Category
IoT Wireless sensors, Machine Learning

Website
https://www.climacell.co/

Location
We are a global company with offices in the US (Boston, MA and Boulder, CO) and Tel Aviv, Israel

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Reconstruct provides a visual command center for construction projects and their 3D timelines. By integrating schedules, building information models (BIM) and reality capture into a single platform, Reconstruct enables proactive and actionable insights for all stakeholders through quantified and visual analytics.

Product Description

Reconstruct provides a visual command center for construction projects and their 3D timelines. By integrating schedules, building information models (BIM), and reality capture into a single unified view, Reconstruct creates actionable insights for all stakeholders including owners, project executives, project managers, superintendents, field engineers, and trade forepersons. Reconstruct's quantified and visual analytics enable proactive, strategic decisions. The Wall Street Journal describes Reconstruct as a 'time machine' that reconstructs the past while simultaneously predicting future risk. Benefits Include:

Enlighten

Reconstruct's web platform overlays 3D reality with BIM and schedule to keep everyone on the same page with a single version of the truth.

Anticipate

Reconstruct's predictive analytics identify work locations most at risk for future delays so that project teams can fix problems before they occur.

Collaborate

With integrated progress reports, at-risk reports, weekly reports, and visuals as-built reports project teams coordinate to maximize the project execution efficiency, safety, and profitability.

Risks Treated

Key risks mitigated by the Reconstruct system include:

1. Defects (design, workmanship)
2. Loss in Productivity (construction)
3. Contractor Default
4. Property Damage (own, others)
5. Bodily Injury (own, others)
6. Schedule & Cost Overrun

RECONSTRUCT

Company Profile

Reconstruct, Inc.
Development Headquarters:
Champaign, Illinois

Business Headquarters:
Menlo Park, California

CEO/Founder:
Zak MacRunnels

Category:
Visual Command Centers for Construction Projects & Their 3D Timelines; Augmented Reality; Robotics; Artificial Intelligence; Remote Connectivity; Scanning/ Reality Capture; Virtual Reality

Website:
www.reconstructinc.com

Location:
US, North America, Global

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Pillar's moisture sensing technology can identify early stage water incidents, thereby mitigating potential for greater damage.

Product Description

Wirelessly connected, battery powered sensors that monitor key metrics like temperature, pressure, humidity, smoke and dust. Once in place Pillar's sensor technology and monitoring platform provides multiple benefits to all project stakeholders including:

Safety
The sensors provide real time, constant protection of the job site helps prevent events such as fire and water damage. Also, it acts as an early warning system to all stakeholders and can also link emergency response resources.

Budget
It can reduce insurance claims and deductibles by pushing alerts that allow contractors to pinpoint problem areas before damage occurs. Also Pillar helps gain insight into what did happen during construction that may have led to post construction defect claims.

Productivity:
Pillar provides site wide data to gain improved insight into what is happening on the job site in real time, providing a construction site nervous system that improves productivity and risk management.

Risks Treated

Key risks impacted by Pillar Technologies system include:

1. Property damage (own, others)
2. Defects (design/ workmanship)
3. Delays in Claims Discovery
4. Weather

PILLAR TECHNOLOGIES

Company Profile

Pillar Technologies
335 Madison Avenue,
New York, NY 10017

CEO:
Alex Schwarzkopf

Category:
IoT/Wireless Sensors

Website:
http://pillar.tech/

Location:
North America

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Eddy Solutions is an innovative manufacturer of smart water metering products and related technologies. Their intelligent suite of products continually track and monitor the water environments of buildings and homes to identify issues, monitor usage, and ensure that water damage is mitigated.

Product Description

Eddy Solutions is committed to empowering property owners with Intelligent Water Management tools that identify issues, monitor usage and mitigate water damage. Eddy's comprehensive, award-winning technology provides real time data and insights and enables remote and automatic water shutoff when necessary to protect and control water in all property types. Eddy's system includes IoT enabled sensors, smart meters and shutoff valves, all connecting to a Homeowner App or Property Management dashboard to protect against water damage and improve overall risk management.

Benefits

3 key benefits associated with Eddy Solutions include:

Protection
Protection against water damage that originates within a structure – internal plumbing leaks, burst pipes, appliance failures, heating and cooling issues, and bathroom fixture leaks.

Data
Real time data – The Eddy system collects, normalizes, and analyzes data on water damage and end user consumption habits on an individual and aggregate level.

24/7 Monitoring
Eddy's highly trained experts have a deep understanding of water usage for each profile and provide remediation coordination.

Risks Treated

Key risks mitigated by Eddy Solutions include:

1. Property Damage (resultant damage, own)
2. Loss in Productivity (operations)
3. Ability to Prove Impact Costs
4. Delays in Claims Discovery
5. Warranty
6. Brand Impact

Eddy SOLUTIONS

Company Profile

Eddy Solutions
5255 Yonge Street
Suite 900
Toronto, ON M2N 6P4

CEO and President
Travis Allan

Category
IoT/Wireless Sensors,
Remote Connectivity

Website
www.eddysolutions.com

Location
Canada and the US

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk

FullStack's fully integrated modular solution for design, manufacturing and construction offers an efficient, quality driven alternative to traditional construction. With complete weather protection, 80% of construction occurs off-site and at ground level, resulting in fewer deliveries, safer working conditions and reduced weather impact.

Product Description

FullStack Modular seeks to revolutionize the building process through manufacturing pre-fabricated components for high-rise multifamily, hospitality and student housing sectors. Their fully integrated modular solution for design, manufacturing and construction enables a higher level of control, predictability and scalability for development projects.

Fire

There is no welding or sweating of pipes on site. All connections are bolted, press fit or Victaulic connections and the sprinkler standpipe can be extended within 1 hour in the stairwells which get stacked alongside the mods.

Water

The facades are installed in the factory and checked with aerospace accuracy to ensure perfect seal on site. Additionally, all mods are temporarily weather wrapped and receive a temporary EPDM roof to protect mod during transport and stacking.

Safety

All the SMEP including connection pieces are shipped in the mods from the factory, no other deliveries are made to the site. Eliminates the need for scaffolding and our solution allows us to use the elevator shaft for people transport, eliminating the need for an exterior hoist.

Risks Treated

Key risks mitigated by the FullStack Modular include:

1. Bodily Injury (own, others)
2. Property Damage (resultant damage, own, others)
3. Defects (design, workmanship)
4. Loss in Productivity (construction)
5. Weather
6. Warranty

FullStack Modular

Company Profile

FullStack Modular LLC
63 Flushing Avenue-Unit # 63;
Brooklyn, NY 11205

CEO:
Roger Krulak

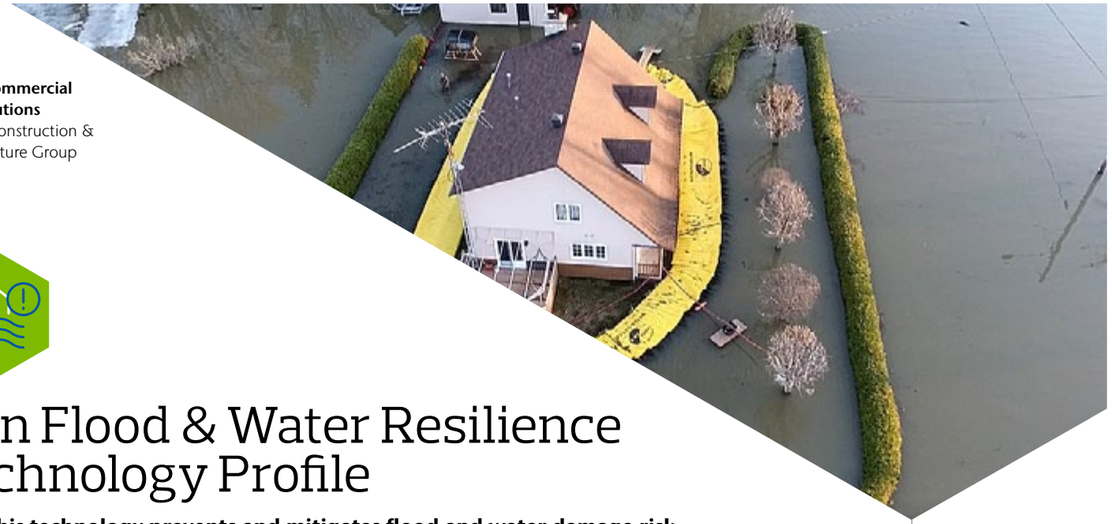
Category:
Full Volumetric Modular Design, Manufacture and Construct

Website:
www.fullstackmodular.com

Location:
U.S.

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk

The MegaSecur Water-Gate barrier is a turnkey solution that was designed to provide a rapid, reliable and safe solution in an emergency situation. Built for flooding, cofferdams, spill, fire water reservoirs and submerged areas, the Water-Gate water barrier is made out of a polymer canvas that automatically expands open as it collects excess water.

Product Description

The MegaSecur Water-Gate Barrier allows for the rapid, reliable and safe deployment of a water containment barrier that can be used in emergency situations. The concept of the Water-Gate is simple: it's the weight of the water that stops the water. Its simple and unique design makes it possible for the FM certified polymer canvas to collect excess water, while instantaneously stabilizing the barrier to protect against water related emergencies. The Water-Gate Barrier can be used for short or long durations of time without impacting its efficiency and durability, as it is resistant to corrosion and toxic materials.

Safety

MegaSecur allows for the safe and rapid deployment of water containment barriers. Its simple, unique design collects excess water, while instantaneously stabilizing the barrier.

Budget

The Water-Gate Barrier eliminates the need to use and dispose of hazardous sandbags, which are expensive to get rid of and can have a negative effect on the environment.

Quality

The Water-Gate Barrier is made from materials that are FM certified, flexible, durable and environmentally friendly.

Risks Treated

Key risks impacted by MegaSecur include:

1. Property Damage (resultant damage, own, others)
2. Bodily Injury (own, other)
3. Schedule & Cost Overrun
4. Loss in Productivity (construction, operations)
5. Weather

MegaSecur
SECURITY ENVIRONMENT

Company Profile

MegaSecur
940A Pierre-Roux East Blvd,
Victoriaville (QC) G6T 2H6

President & Founder:
Daniel Dery

Category:
Public Safety/First Response in Security Environment; Product Manufacturing

Websites:
www.megasecur.com
www.water-gate.com

Locations:
Global

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Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
The Tiger Dam™ system is a specifically placed flood containment system that enables the control of large volumes of flood water. To avoid business interruption and mass flooding, the Tiger Dam™ system was designed to act as a temporary emergency rapid deployment system that consists of elongated flexible tubes that can be virtually any length and take any shape.

Product Description

The Tiger Dam System is a rapid deployable and re-usable containment bladder that is used in overland and flash flooding, oil spill containment and wildfire applications. Tiger Dam alleviates the need to use and dispose of hazardous sandbags, which are dangerous to the environment and expensive to get rid of. When deployed properly, the Tiger Dam System may divert up to 100% of floodwaters. Having your community or business equipped with a certified and engineered Tiger Dam for their next emergency is key, as it's not a matter of if, but when.

Quality
Tiger Dams are designed to take any shape and are the only engineered system that can be joined from sections into dams hundreds of miles long.

Safety
Tiger Dam is FM approved with a platinum level certification (top level) for flood abatement.

Budget
Tiger Dams are 1/5 the overall cost of sandbags on their first use. Each dam replaces 500 sandbags.

Risks Treated

Key risks mitigated by the Tiger Dam System include:

1. Property Damage (resultant damage, own, others)
2. Bodily Injury (own, others)
3. Schedule & Cost Overrun
4. Loss in Productivity (construction, operations)
5. Weather

Company Profile

Tiger Dam
#300, 530 8th Ave SW
Calgary, Alberta

CEO and President
Paul Vickers

Category
Flood Mitigation, Oil Spill Containment, Wildfire Applications, Emergency Response

Website
www.canadafloodcontrol.com

Location
Global

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Aon's Commercial Risk Solutions
Global Construction & Infrastructure Group



Aon Flood & Water Resilience Technology Profile

How this technology prevents and mitigates flood and water damage risk
Pontarolo's Cupolex solution bring projects a set of ecological, social and municipal benefits by integrating risk-reducing functions, such as storm water capture and management, structural soil cells for flood mitigation and green infrastructure to combat urban heat.

Product Description

Pontarolo Engineering®, with its patented Cupolex structural void space technologies and applications, converts risk-driving impervious spaces into resilient assets. By manipulating the geometry of concrete through Cupolex's form-based approach, Pontarolo Engineering's design and engineering approach brings a unique set of additional performance functions to any construction project with limitless applications. Next to cost-benefits for our clients, Cupolex projects bring a set of ecological, social and municipal benefits by integrating risk-reducing functions, such as storm water capture and management, structural soil cells for flood mitigation and green infrastructure to combat urban heat.

Urban Resilience
Pontarolo Engineering converts impervious spaces into resilient assets. From parking lots to plazas, sidewalks to highways, Pontarolo gives these spaces additional resilient performance qualities.

Resilient Infrastructure
Pontarolo Engineering reduces risk of transportation assets (LRT, airports and BRT, bike lanes), by integrating Cupolex in lines, streets, parking areas and sidewalks.

Sustainable Construction
Cupolex structural void space construction solutions bring significant cost savings by using less concrete, gravel and aggregates, reduces GHGs emissions and increase implementation times.

Risks Treated

Key risks mitigated by Pontarolo's Cupolex solutions include:

1. Property Damage (resultant damage, own, others)
2. Loss in Productivity (construction, operations)
3. Weather
4. Schedule & Cost Overrun
5. Brand Impact

Company Profile

Pontarolo Engineering Inc.
55 Administration Rd.
Concord, ON
Canada L4k 4G9

CEO/Founder
William J. Cannizzaro

Category
Engineering Solutions

Website
www.cupolex.com

Location
Global

Empower Results®

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