Flood-Resilient Community Design: Disaster Mitigation, Best Practices for Building New Residential Subdivisions

Presented at:
National Water and Wastewater Conference (November 15, 2016)

Presented by:
Natalia Moudrak
Intact Centre on Climate Adaptation

E-mail: nmoudrak@uwaterloo.ca
Twitter: @nmoudrak

UNIVERSITY OF WATERLOO

INTACT CENTRE ON CLIMATE ADAPTATION

Agenda

INTACT CENTRE
ON CLIMATE ADAPTATION

1. Purpose of the Session
2. Roundtable Leaders Introductions
3. Catastrophic Insurable Losses in Canada Are Increasing
4. Home Owners and Communities Are Vulnerable to Flooding
5. Overview of the Flood-Resilient Community Design Program
6. Facilitated Discussion
7. Next Steps

Purpose of the Session

INTACT CENTRE
ON CLIMATE ADAPTATION

- To introduce the Flood-Resilient Community Design Program, lead by the Intact Centre on Climate Adaptation at the University of Waterloo
- To share the Flood-Resilient Community Design Best Practices (V.1.0) and hear YOUR thoughts on any major:
  - o Additions
  - o Revisions
  - o Deletions
- The ultimate goal of the Program is to develop a Flood-Resilient Community Design Standard(s) for Canada

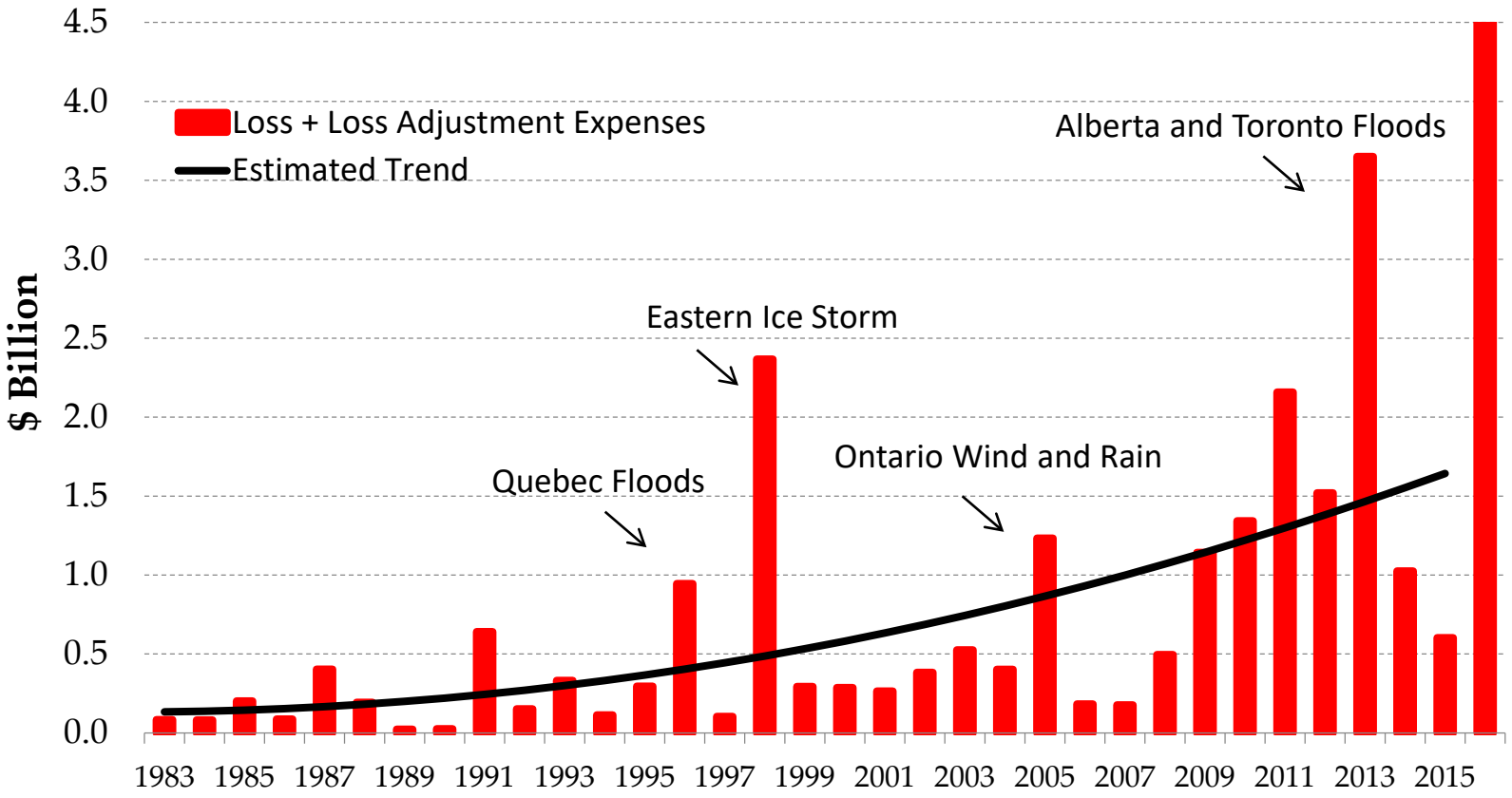
Roundtable Leaders Introductions

INTACT CENTRE
ON CLIMATE ADAPTATION

- **Natalia Moudrak**, Director, Natural Infrastructure Adaptation Program, Intact Centre on Climate Adaptation
- **Hiran Sandanayake**, Senior Engineer, Water Resources, City of Ottawa
- **Mark Palmer**, President and CEO, Greenland Consulting Engineers
- **Robert Muir**, Manager, Stormwater, Asset Management Department, City of Markham
- **Ron Scheckenberger**, Principal Consultant, Amec Foster Wheeler

Catastrophic Insurable Losses in Canada Are Increasing

INTACT CENTRE ON CLIMATE ADAPTATION



Courtesy: Insurance Bureau of Canada
Values are expressed in 2015 CAD
2016 Loss + Loss Adjustment Expenses (up to Q3)

Home Owners and Communities Are Vulnerable to Flooding

INTACT CENTRE ON CLIMATE ADAPTATION

Repeated Flooding ➡ Limited / No Flood Coverage ➡

Rising Debt Levels ➡ Risk of Foreclosures / Mortgage Defaults

CBCnews | Windsor

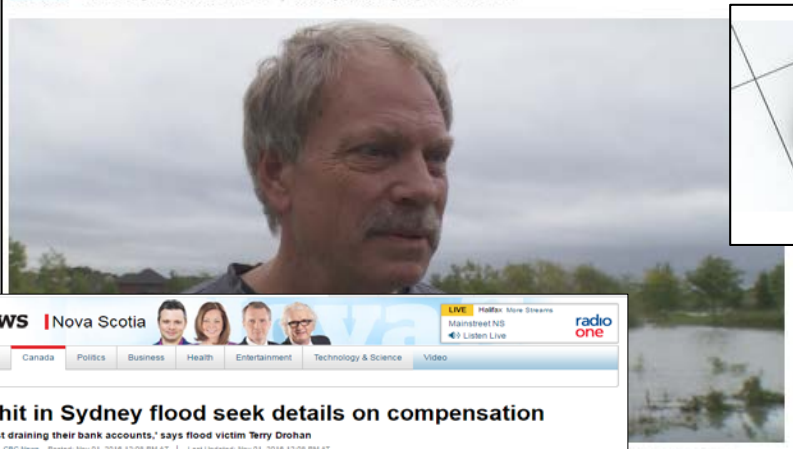
Home | World | Canada | Politics | Business | Health | Entertainment | Technology & Scier

Canada | Windsor

After Windsor flood, residents learn they don't have insurance

Some residents may not have access to sewer backup coverage, if they live in flood-prone areas

CBC News Posted: Sep 30, 2016 3:46 PM ET | Last Updated: Sep 30, 2016 3:46 PM ET

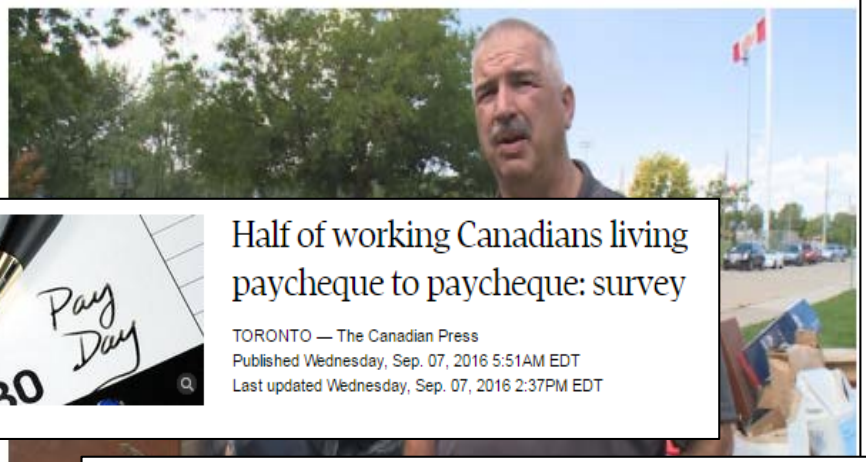


coverage from their insurance provider. Hundreds of residents in Tecumseh and Windsor have flooded basements after Thursday's record-breaking rainfall. (Meg Roberts/CBC)

Provincial assistance won't cover sewer backup damage

Anyone with damages due to sewer backup exclusively will not qualify for financial help

CBC News Posted: Oct 04, 2016 3:51 PM ET | Last Updated: Oct 05, 2016 7:15 AM ET



Half of working Canadians living paycheque to paycheque: survey

TORONTO — The Canadian Press

Published Wednesday, Sep. 07, 2016 5:51AM EDT

Last updated Wednesday, Sep. 07, 2016 2:37PM EDT

CBCnews | Nova Scotia

Home | World | Canada | Politics | Business | Health | Entertainment | Technology & Science | Video

Canada | NS

Worst hit in Sydney flood seek details on compensation

'Everyone's just draining their bank accounts,' says flood victim Terry Drohan

By Peggy MacDonald, CBC News Posted: Nov 01, 2016 12:08 PM AT | Last Updated: Nov 01, 2016 12:08 PM AT

Nearly half of Canadians are within $200 a month of being unable to pay their bills, poll finds

NP The Canadian Press | February 16, 2016 | Last Updated: Feb 17 12:04 PM ET

More from The Canadian Press

Overview of the Flood-Resilient Community Design Program

INTACT CENTRE ON CLIMATE ADAPTATION

Purpose: establish best practices to reduce flood risk in new residential subdivisions.

Process:

Consultations

- Municipal engineers
- Engineering consultants
- Developers / Builders
- Insurers
- Banks
- Credit rating agencies
- Securities commissions

Drafting

- Flood resilient community design characteristics
- Multiple document revisions, based on stakeholder feedback and research

Prioritization

- Urgency of need
- Feasibility (technical and cost)

Result: build a foundation for ***Flood-Resilient Community Design Standard(s) for Canada.***

Overview of the Flood-Resilient Community Design Program (Cont'd)

INTACT CENTRE ON CLIMATE ADAPTATION

Flood-Resilient Community Design Best Practices: Six Broad Categories

1. Basic principles;
2. Overland flow;
3. Storm sewer;
4. Sanitary sewer;
5. Sanitary Infiltration and Inflow; and
6. Natural Infrastructure.

Caveats:

- Program focused on best practices for greenfield development;
- Consideration of fluvial and pluvial flood risks; coastal flood risks are not included in the current program scope; and
- Primary focus is on Canadian provinces; Yukon, Northwest Territories and Nunavut are not included in the current program scope.

Overview of the Flood-Resilient Community Design Program (Cont'd)

INTACT CENTRE ON CLIMATE ADAPTATION

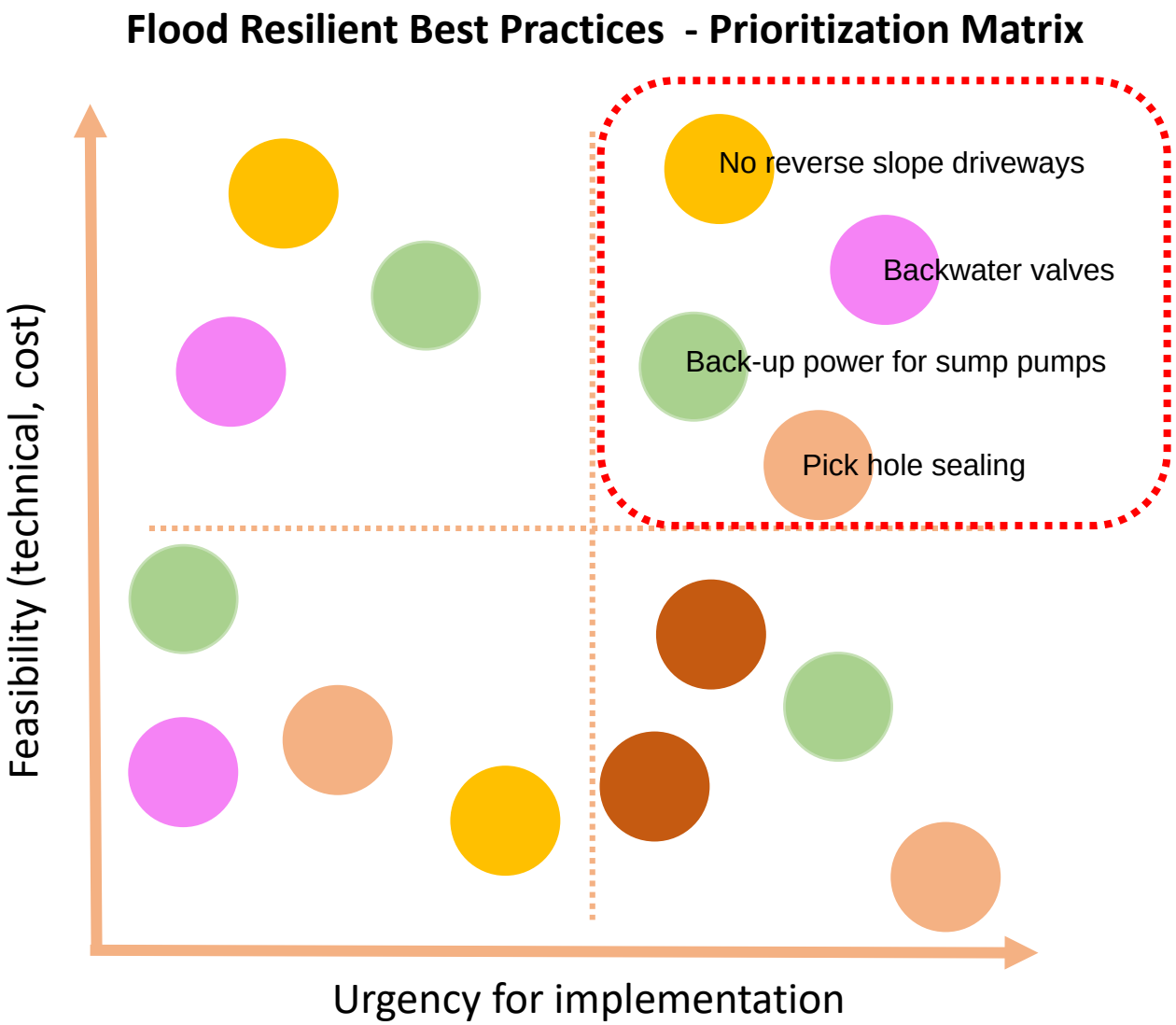


ILLUSTRATION PURPOSE ONLY

Best Practice Considerations:

- Overland Flow
- Storm Sewer
- Sanitary Sewer
- Sanitary Infiltration and Inflow
- Natural Infrastructure

Facilitated Discussion

Discussion Questions:

1. Do you see any best practices that should be deleted from the projected list?
2. Do you see any best practices that should be added to the projected list?
3. Are there major revisions required to any of the projected best practices?

Basic Principles

SOME TERMINOLOGY

“major system standard event ”: 1-in-100, Regional storm

“minor system standard event”: 1-in-2, 1-in-5 year event

B. P. 1. New development should not be permitted within the floodplains of watercourses, as determined using best science and practices. For new development adjacent to the floodplain, the sewer analysis should have regard for the flood levels at the outlet based on a hydraulic grade line (HGL) determination.

B. P. 2. Fully separated storm and sanitary sewer systems should be maintained as a basic requirement.

B. P. 3. Comprehensive watershed, sub-watershed studies and master drainage plans should guide modelling and sizing of stormwater infrastructure for new subdivisions. These studies should address a broad range of flood-resilience issues, at minimum including consideration of seasonal stresses, extreme weather and long-term land use projections.

B. P. 4. Intensity-Duration-Frequency (IDF) curves should be reviewed over a suitable timeframe (e.g., every 5 years) and updated if material differences in values outside of the confidence limits of the current IDF curves are identified. If a decreasing trend is observed, the IDF values should be maintained to remain conservative (and reviewed again at the suitable timeframe).

B. P. 5. Modelling tools should use the adjusted IDF curves and other climate factors to account for changes in performance over the life-cycle of stormwater management infrastructure (e.g., storm sewers and facilities).

B. P. 6. In the absence of defined local climate factors, stressor meteorological events (e.g., IDF +20%, significant historical events, etc.) should be used for drainage assessments to understand the potential of the stormwater system to withstand associated risks.

B. P. 7. Development of critical infrastructure should account for potential changes in flood plains in the future as a result of climate factors (e.g., including additional freeboard for pumping stations outside the current flood plain; elevating roadways that lead to hospitals and places of refuge).

Overland Flow

O. F. 1. Overland flow routes should provide for effective conveyance of runoff from storm events in excess of the minor system away from properties and towards acceptable overland flow outlets. Overland flow routes include:

- All roads and streets; and
- Designated conveyance routes.

O. F. 2. The major and minor system modelling / analysis should demonstrate that overland flow water surface stays below property line elevations for the major system standard event and below the lowest building opening for conditions identified for B. P. 5 and B. P. 6. (i.e. the stressor meteorological events).

- The public right of way (ROW) grading should provide for effective conveyance of major overland flow away from private property to an acceptable overland flow outlet location.
- Where analyses cannot demonstrate the desired level of service, modelling should be used having regard for the capture efficiency at inlets, the hydraulics of major system and minor system components, the accumulation of flows at road sags, the HGL in downstream SWM facilities and system outlets, as well as the HGL in the storm sewer system and the major system.

O. F. 3. Maximum runoff depths on roads during the major system standard event should meet the requirements for emergency access and passenger vehicle safety. Emergency access routes shall be identified on the subdivision design plans.

O. F. 4. Reverse slope / depressed driveways should not be allowed.

O. F. 5. Property owners having designated overland flow routes from their properties and others directed towards public lands and ROWs (i.e. swales with storm sewer connections) should be educated in and responsible for their maintenance. These overland flow routes should be protected through easement agreements.

O. F. 6. Major system flow that accumulates on public property and ROWs should not be routed through private property.

Storm Sewer

S. S. 1. Storm sewers should be modelled / analyzed together with the overland flow network to determine their required capacity / size.

S. S. 2. Storm system inlets should be sized to balance the requirements of the minor system HGL, the major system flow depths, water surface elevation and extent.

S. S. 3. If foundation drains are connected to the storm sewer, the HGL in the storm sewer should be maintained below the basement slab for the major system standard design event.

- Freeboard between the HGL and the basement slab is preferred for the major system standard event.

If foundation drains connect to sump pumps, storm sewers can be allowed to surcharge, but not to the road surface for the minor system design event.

S. S. 4. Basements should be set above the seasonal high groundwater table, unless flood mitigation measures are in place. Homeowners should be informed of the responsibilities, risks and costs associated with such systems.

S. S. 5. Where sump-pumps are required, they should have back-up power supply systems. Homeowners should be educated about sump-pump maintenance and operations.

S. S. 6. Directing sump pump discharge to the sanitary system should not be allowed.

S. S. 7. Roof leaders/downspouts should not be connected to the sanitary sewer or to the storm sewer system and should discharge to a pervious area appropriately graded away from the building.

Sanitary Sewer

Sa. S. 1. Backwater valves should be installed on sanitary sewer laterals. Homeowners should be educated about backwater valve maintenance.

Sa. S. 2. Resiliency design factors for sanitary pumping stations should be included such as redundant pumping capacity (e.g., design flow met with largest pump out of service).

Sa. S. 3. Emergency backup power should be able to support wastewater pumping and SCADA controls in an electrical outage for a minimum of 24 hours.

Sanitary Inflow and Infiltration (I&I)

I. I. 1. Sanitary sewer property leads should be certified for water tightness upon municipal assumption.

I. I. 2. Inlet and outlet pipes should be joined to sanitary manholes with a flexible watertight gasket connection. For jurisdictions that allow Moduloc risers between manholes and their covers, risers should be sealed with a watertight membrane.

I. I. 3. Pick holes and frames on low lying sanitary manholes should be sealed in areas where runoff accumulation is expected to occur during the major system standard event to minimize I&I, with consideration given to access and ventilation.

I. I. 4. Trench seals (e.g. clay seals) should be used where there is a potential for groundwater to migrate preferentially through the sanitary sewer or water main trench bedding and backfill.

Natural Infrastructure

N. I. 1. Natural infrastructure elements (e.g., existing, naturally occurring wetlands, depression areas and open watercourses) should be evaluated from the standpoint of their flood attenuation capacity.

N. I. 2. Where green infrastructure and Low Impact Development Best Management Practices (LID BMPs) are considered for water quality and erosion control objectives, they also can be considered in the analysis of drainage system performance during frequent flooding events.

Next Steps

INTACT CENTRE ON CLIMATE ADAPTATION

1. Feedback gathered will be incorporated into the Flood-Resilient Community Design Best Practices Best Practices (V.2.0)
2. Prioritization exercise (urgency and feasibility for implementation) will occur in Spring 2017.
3. Public webinar to share final results will be held in Summer 2017.
4. Please sign up to be involved! nmoudrak@uwaterloo.ca

Thank You All Attendees & Roundtable Leaders!

Mark Palmer, President and CEO, Greenland Consulting Engineers

Hiran Sandanayake, Senior Engineer, Water Resources, City of Ottawa

Ron Scheckenberger, Principal Consultant, Amec Foster Wheeler

Robert Muir, Manager, Stormwater, Asset Management Department, City of Markham

Natalia Moudrak
Director, Intact Centre on Climate Adaptation
Faculty of Environment, University of Waterloo
200 University Avenue West
Waterloo, ON, N2L 3G1
+1 226 339 3506
nmoudrak@uwaterloo.ca