Urban Flooding

Perceptions & Behaviours

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Friday Forum - June 20, 2008
Institute for Catastrophic Loss Reduction

Introduction

- Urban Flooding Background
  - Brief history of stormwater management
  - Urban flooding – causes and impacts
  - Components of urban flooding
  - Urban flood mitigation
- Hazard Perceptions
- Perception & Behaviour – Peterborough, Toronto, Edmonton
- Conclusion

Urban Flooding

- An issue in municipalities across the country
  - 24 of 26 municipalities report frequent basement floods
- Several factors involved:
  - Urbanization/land-use change
  - Infrastructure design & condition
  - Extreme precipitation
  - Design of homes, actions of private individuals
- Stormwater management practices

Allouche & Freure, 2002; Kulkarni, 1999

Stormwater Management

- Impervious area
  - Natural ground cover serves to absorb rainfall
  - Greater urbanization = more roofs, parking lots, roads (land-use change)
  - Increased vulnerability

Waters *et al.*, 2003; MOE, 2003

Stormwater Management

- Storm sewer era: 1880-1970
  - Convey from upstream urban areas to existing surface water – streams, creeks, lakes, etc.
  - 2-10 year design standard – up to 25 years
  - Use of combined sewers
  - Most common method of stormwater management in Canada

Watt *et al*, 2003

Stormwater Management

- Stormwater management era: 1970-1990
  - Major system: overland system
    - Stormwater management ponds, overland flow routes
    - Usually major system (conveyance routes) designed to handle 100 year events
  - Minor system: underground system
    - 2-10 year design standards for minor system
    - 5 year standard common

Watt *et al*, 2003

Stormwater Management

- Best Management Practice era: 1990-current
- Considering stormwater quality along with quantity
  - Addressing rainwater at source
  - Reduce rapid flows, increase infiltration
  - Porous pavements, green roofs, pervious & green areas, vegetation, etc.
  - Environmental Impacts

D'Andrea *et al.*, 2004; Watt *et al*, 2003

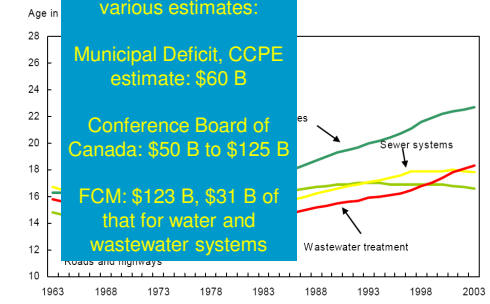
Aging Infrastructure

Infrastructure Deficits – various estimates:

Municipal Deficit, CCPE estimate: $60 B

Conference Board of Canada: $50 B to $125 B

FCM: $123 B, $31 B of that for water and wastewater systems



Flanders *et al.*, 2006

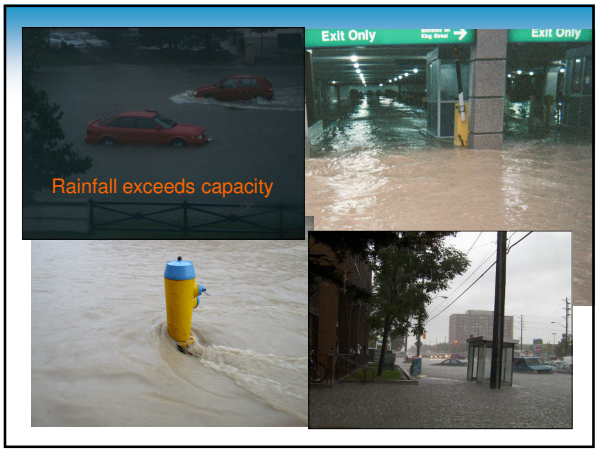
Infrastructure

- Urbanization increases stress on infrastructure
  - Pipes, structures may have been able to handle load when they were built, but increasing urbanisation and impervious surface increases stress on existing infrastructure
  - Impact of infill development

Extreme Precipitation

- Extreme precipitation is often the cause of severe urban flooding events
  - Storm drainage systems designed to handle historical extreme events (e.g., ~1 in 5 year for minor, ~1 in 100 year for major)
  - When extreme precipitation events exceed design capacity, urban flooding can occur

Kulkarni, 2000; Watt et al, 2003; Angel and Huff, 1997



Climate Change

- By 2070, current "20 year" events could occur every 10 years
- Recommendations for increasing design standards to reflect climate change:
  - UBC: consider increasing short duration rainfall in design of infrastructure
  - McMaster: 16% pipe diameter increase
  - Queen's: 15% larger design storm
- Models suggest increase in future heavy rainfall days for Grand, Rideau, Humber and Upper Thames watersheds
  - Greater variability, high and low flows (dry/wet)
  - Increases in insurance claims as a result of heavy rainfall

Cheng, *et al.*,2007; Coulibaly & Shi, 2005; Denault *et al*, 2002; Watt *et al.*, 2003; Khairn & Zwiers, 2000; Waters *et al*, 2003

Homeowners

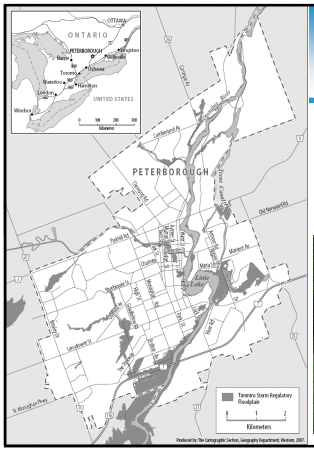
- Contribution of unwanted water to sewer systems
  - Foundation drains, eavestrough downspouts
- Culture of finishing basements, locating expensive property in basements, utilities
- Issues with home design
  - e.g. sunken driveways

Components of Urban Flooding

- Riverine Flooding
  - When river spills onto its floodplain
    - Areas adjacent to water courses
  - Tradition of effective management in Ontario
  - Structures
  - Hazard assessments
    - Flood maps, zoning, management of development
    - Minimum standard (FDRP): 1 in 100 year
    - In Ontario, Timmins Storm and Hurricane Hazel

Riverine Flooding

- Vulnerability is created by developing in floodplain



Risk assessments (maps) used in land-use planning

Components Urban Flooding

- Overland flows caused by extreme rain
  - Caused directly by intense rain
    - e.g., when rain exceeds 100 year capacity of major systems and/or where major systems are poorly defined
  - Occur outside of formally defined floodplain
    - Generally, have not been identified in riverine flood risk maps
  - Usually up to the municipality to identify and plan for risks

Overland Flooding

- Impact of topography – difficulty in defining overland flow routes

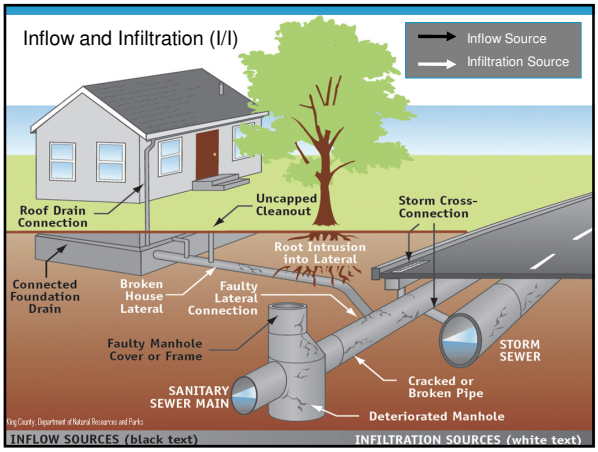
Calgary - June 2007

Components of Urban Flooding

- Infiltration Flooding
  - Water that enters a basement through cracks in walls
  - Factors include:
    - Lot grading
    - Water table level
    - Sewer backup and connection of foundation drains

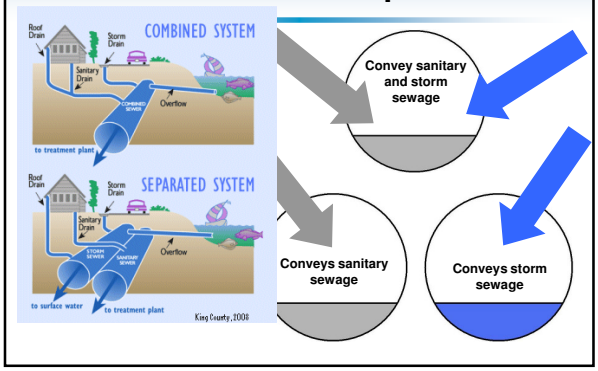
Components of Urban Flooding

- Sewer Backup
  - Surcharge of sanitary or combined sewer, pushing sewage into buildings through sewer lateral (main line) connections
  - Inflow and infiltration
    - Surcharging storm sewers
    - Private connections (eavestroughs, downspouts)
    - Other cross connections
    - Condition of underground pipes (i.e., aging infrastructure/under maintained infrastructure)
    - High water tables
  - Combined sewers increase risk



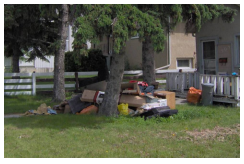
King County Department of Natural Resources and Parks, 2008

Combined vs. Separate



Urban Flood Impacts

- Infrastructure damage
- Business interruption
- Damage to homes
- Environmental impacts



Urban Flood Impacts

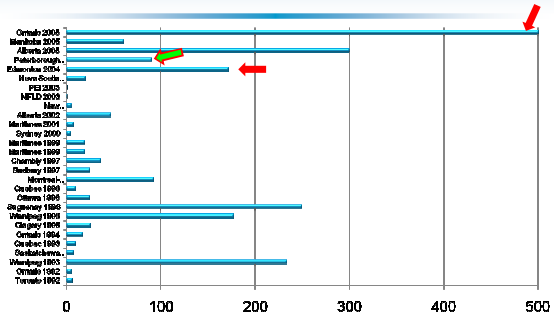
- Environmental Impacts
  - Combined Sewer Overflows (CSOs)
    - Combined sewer surcharge, excess flows are diverted to surface water w/o treatment
    - Protect sewer treatment plants, reduce risk of sewer backup
  - Stormwater surface flows
    - Carry contaminants (oil, animal waste, etc.) from city surfaces to receiving surface water (lakes, streams, etc.)

Calgary - June 2007

Impacts on Homes

- Urban flooding Impacts
  - Damage to structure of home
  - General property damage
  - Clean up costs
  - Issues with insurance coverage
  - Mould, dampness and associated health issues
  - Raw sewage intrusion
  - Infiltration flooding

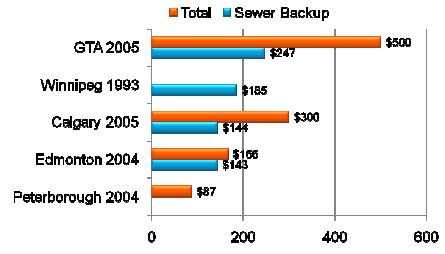
Insurance Claims



$Millions, adjusted to 2005

IBC, 2007

Insurance Claims



$Millions

Litigation

- Litigation against municipalities resulting from damages caused by urban flooding
  - Negligence for inadequate maintenance, construction practices, slow response to complaints
  - Port Alberni, Stratford, Kenora, St. John's, Thunder Bay

Campbell *et al.*,2007

Urban Flood Mitigation

Urban Flood Reduction Measures

Structural Adjustments	Non-Structural Adjustments
•Additional Catch Basins •Relining of pipes •Improving outfalls •Build storage ponds •Re-engineer roadways to better control overland flows, direct flows to catchbasins •Twin pipes/increase pipe sizes •Review and implement new storm drainage design standards •Storage tanks •Seal man-hole covers •Identify (e.g. smoke testing), fix sources of I/I •General maintenance – cleaning, clearing debris, etc. •Riverine flood control structures	•Incorporate use of natural formations •Land-use planning •Increase perviousness •At private property level also •Disconnecting downspouts, foundation drains •Flood proofing private properties •Bylaws •Financial assistance for private homeowners – sumps, BW valves, foundation drain •Public awareness-education •Encouraging homeowners to clear sewer grates of debris •Encourage up-take of flood reduction measures •Emergency preparedness and response •Redistribute losses – Gov't relief, insurance

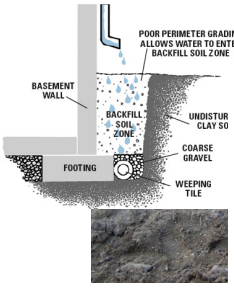
Individual Measures

- Actions at the municipal level (e.g., infrastructure improvements, planning) major stormwater management upgrades are expensive and take time
- Homeowner actions an important part of overall system over the long-term
  - Downspout and foundation drain connections
- Actions at homeowner level are necessary for short-term, medium-term to reduce risk, in long-term to cover residual risk

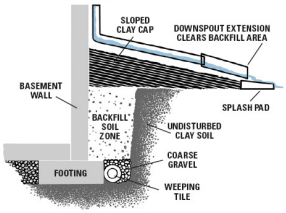
Individual Measures

- Adjustments that reduce risk of damages from overland flows, infiltration flooding and sewer backup
  - Eavestrough extensions
  - Proper backfilling
  - Lot grading
  - Disconnecting downspouts
  - Disconnecting foundation drains (aka weeping tiles)
  - Reducing property at risk
- Adjustments that reduce risk of overland flood damage
  - Window wells, water proof windows and doors (i.e. "dry floodproofing") – generally, above-grade adjustments
- Adjustments that reduce sewer backup risk
  - Backwater valves

Extensions, Lot Grading & Backfill

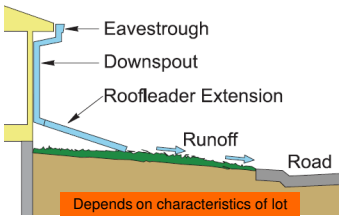


CORRECT DOWNSPOUT EXTENSION WITH SPLASH PAD AND GOOD GRADING



Source: City of Regina, 2004. "Your Guide to Flood Prevention."

Downspout



King County, 2008; Adapted from: City of Edmonton, 2006 "Homeowners Guide to Flood Prevention"

Backwater Valve

- Inline
  - Installed in branch lines
  - Normally closed
  - One installed in each branch line
- Mainline
  - Installed in main sewer line (sewer lateral)
  - Normally open
  - Allows for sewer venting

Reducing Sewer Backup Risk

- Foundation drains disconnected from sanitary sewer
  - Sump pump to remove foundation drain water
    - Drains either on lot or into storm sewer system
- Backwater valve
  - Maintenance
  - Do not use plumbing when valve is closed

Encouraging Homeowner Action

- Edmonton and Toronto – incentives and education
  - Edmonton & Toronto – education programs
    - Meetings associated with EAs
    - Brochures, mass media, flood related meetings
  - Incentive/subsidy programs
    - Provide a considerable cost of installing backwater valves and other adjustments
    - Peterborough provides $800

Encouraging Homeowner Action

- Edmonton
  - Incentive program
    - $975 for preventative plumbing
      - Actual costs average around $1200-$1400 for retrofitting a backwater valve
    - $1400 in the event that backwater valve required a sump pump and pit
    - Possible total of $2375
- Available to all homeowners (2005)

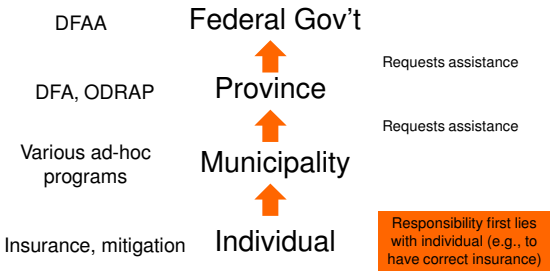
Encouraging Homeowner Action

- Toronto
  - Backwater valve: 80% up to $1000
  - Sump pump: 80% up to $1500
  - Backwater valve + Sump pump: 80% up to $2300
  - Downspout disconnection: 80% up to $500
  - Weeping tile severance and capping: up to $400
  - Possible total of $3200
  - Available to all homeowners as of May, 2007

Cost Sharing

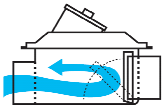
- Insurance
  - Insurance companies do not cover damages caused by overland flooding for private homes in Canada
    - Sewer backup coverage is usually optional
  - Coverage usually available for commercial losses, autos
- Government Relief – for essential items
  - Disaster Financial Assistance Arrangements (DFAA)
  - Provincial programs (e.g., ODRAP)
  - Municipal relief programs – often ad-hoc

Government Relief



Standards and Bylaws

- Lot grading
- Contribution of freshwater to sanitary system
  - Eavestrough
  - Foundation drains
- Backwater valves in all new development
  - Edmonton (since 1989)
  - Winnipeg (since 1979)
- Provincial building codes



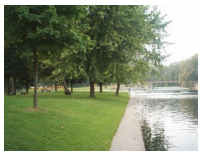
Mainline Backflow Products, 2008

Flood Mitigation

Impacts/Perceptions

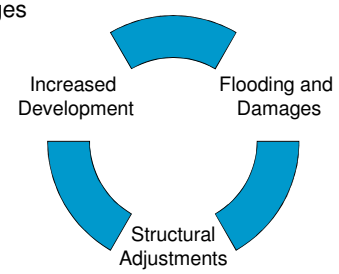
Adjustments

- Range of adjustments:
  - Structural Adjustments
    - Prevent losses through modification of watercourses
    - Dams, floodwalls, levees, etc.
  - Non-structural adjustments
    - Affect human behaviour
    - Modify use of floodplains
    - Flood mapping, land use planning, insurance, etc.
    - Use of natural controls – e.g., wetlands
    - Reduce, redistribute losses, prevent losses



Structures

- Over-reliance on structures increased flood damages



Structural Adjustments

- Various institutional arrangements allowed for cost-sharing with federal government
  - E.g., *Canada Water Conservation Assistance Act* (1953)
  - Allowed for up to 75% cost-sharing, structural adjustments planned and implemented by provincial/municipal governments
  - Enhanced reliance on structural measures

Adjustments

- Mix of structural and non-structural adjustments preferred
  - Manage/restrict new development in flood-prone areas, e.g.:
    - Building practices
    - Homeowner behaviour
    - Educate homeowners
    - Warning
  - Protect existing development
    - Structures

Shrubsole, 2007

Adjustments

- Increasing damages, despite investments in structural adjustments, lead to development of FDRP (1975)
  - Flood Damage Reduction Program
  - Cost-sharing program for flood mapping in Canada
    - Assist with expertise, $ from federal government
  - Factor flood risks into community planning
  - Educate public about flood risk

Perceptions

Perception Studies

- Effectiveness of non-structural flood adjustments partly depends on hazard perceptions
  - Non-structural adjustments affect behaviour
  - Behaviour is dependent on perception

Major Findings in Literature

- Frequent hazard denial, denigration
  - "It won't happen here"
  - Perception of 1 in 100 year storm
    - Belief that random events are self correcting
    - "gambler's fallacy"
- Infrequent adoption of risk reducing adjustments
  - More likely to adopt low cost/low effort adjustments

Bollens *et al.*, 1988; Burton *et al.*, 1993; 1978; 1968; Kates, 1962; Kreutzwiser *et al.*, 1994; Laska, 1986; McPherson & Saarinen, 1977; Shrubsole *et al.*, 1997; Wong & Zhao, 2001; Yoshida & Deyle, 2005

Major Findings in Literature

- Preference for structural adjustments
  - Belief that governments are responsible for flood prevention
  - Preference to continue to live in hazard prone areas, but be protected by structures
    - Dams, dykes, flood walls, sewer systems, etc.
  - Lack of understanding of non-structural adjustments

Bollens *et al.*, 1988; Burton *et al.*, 1993; 1978; 1968; Kates, 1962; Kreutzwiser *et al.*, 1994; Laska, 1986; McPherson & Saarinen, 1977; Shrubsole *et al.*, 1997; Wong & Zhao, 2001; Yoshida & Deyle, 2005

Structural Adjustments

- "Levee Effect"
  - People trust structures
    - Increased complacency, reduced preparedness
      - Governments and individuals
    - An incentive to build on structurally protected lands
      - Lands are "safe"
    - When structures fail, damages are extreme

Structural Adjustments

- Resistance to non-structural adjustments is common
  - Experience in flood-mapping efforts in Ontario
    - Fear of property devaluation
    - Fear of regulating development/property improvements – perception of infringement on personal rights

Shrubsole, 2000

Factors Affecting Perception

- Hazard experience
  - Generally accepted as most powerful influence
  - Severity of experience
  - Frequency of experience
- Length of time lived in community
- Socioeconomics sometimes a factor

Burton & Kates, 1964; Burton *et al.*, 1978; Burton *et al.*, 1968; Kates, 1962; Kreutzwiser *et al.*, 1994; McPherson & Saarinen, 1977; Parker & Penning-Roswell, 1982; Payne & Pigram, 1981; Penning-Roswell, 1976; Schiff, 1977

Factors Affecting Behaviour

- Hazard Experience
  - May increase or decrease mitigative behaviour – depends on nature of experience
- Perception of Hazard
  - Risk – recurrence in the future, severity of damages
  - Past experience – severity of damages, emotional stress
- Education programs – depends on nature of program
- Awareness of available actions

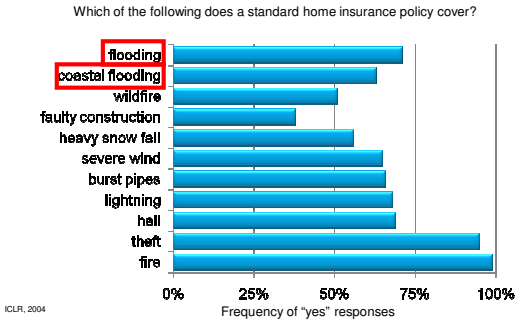
Burton & Kates, 1964; Burton *et al.*, 1978; Burton *et al.*, 1968; Kates, 1962; Kreutzwiser *et al.*, 1994; McPherson & Saarinen, 1977; Parker & Penning-Roswell, 1982; Payne & Pigram, 1981; Penning-Roswell, 1976; Schiff, 1977

Institutional Arrangements

- Can have an impact on perception and behaviour
  - E.g., cost-sharing programs
  - Share costs with taxpayers through gov't relief
    - Not a mechanism to reduce risk
      - Return to "pre-disaster condition" is written into federal/provincial disaster assistance guidelines
  - Expectation of government relief has been identified as a inhibitor to flood mitigation, purchase of insurance

Crichton, 2007; Winter & Fried, 2000

Perceptions of Insurance Coverage



ICLR, 2004

Perception of Natural vs. Technological Hazards

Overland Flooding	Sewer Backup
Natural	Technological
▪ Forces of nature, "Acts of God" ▪ Humans have limited control ▪ Have occurred throughout the history of humankind	▪ Caused by human-made systems ▪ Systems not designed to fail ▪ Humans *had* control ▪ Point of blame

Baum *et al.*, 1983; Burton *et al.*, 1993; Zeigler *et al.*, 1983

Perception and Behaviour

Peterborough, Edmonton & Toronto

Peterborough

- Historical occurrences of urban flooding
  - 1980, 1996, 2002, 2004
  - 1 in 100 year event in 2002

Peterborough 2004

- July 14-15, 2004
- Approximately 8,000 homeowner ODRAP and insurance claims
- Many businesses affected

Peterborough 2004

- State of emergency declared on July 15, remained until July 29
- July 21: province declared Peterborough a disaster area, qualifying city for ODRAP
- DFAA has provided funds to Ontario twice:
  - 1998 ice storm
  - 2004 Peterborough flood

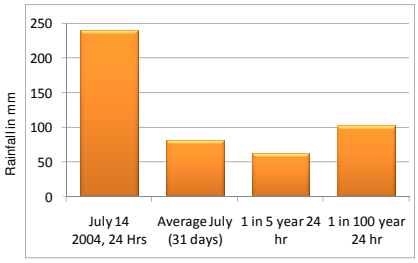
Klassen & Seifert, 2006

Extreme Rainfall

- Unprecedented since recording began in 1866
- 150 - 250mm over July 14-15, depending on location within the city
- Trent University: 239 mm, 3X normal rainfall for entire month of July (1971-2000)
- Rainfall in days preceding extreme event, saturating soil

Klassen & Seifert, 2006

Extreme Rainfall



Rainfall measured at Trent U

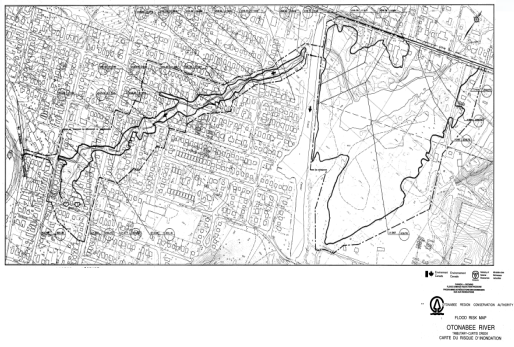
Klassen & Seifert, 2006; UMA, 2005

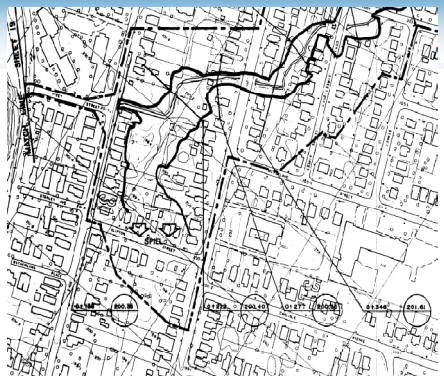
Peterborough, 2004

- Overland flow routes did not efficiently direct flows to the storm sewer system
  - Lack of curbs, not enough catch basins, catch basins clogged with debris (major system)
- Inappropriate lot grading
- Many pipes not designed to current 5-year standard
  - 80% of analyzed storm pipes met 2-year standard
- Development in the floodplain

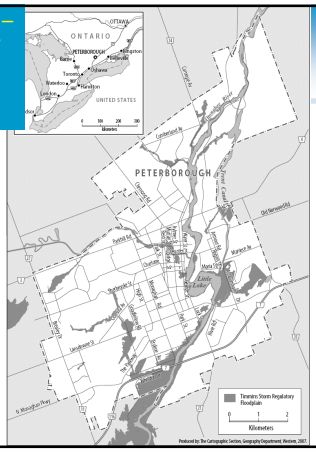
UMA, 2005

Peterborough





Intense Rainfall – Overland Flow Routes Vs. Riverine Flooding



Sewer Backup

- Unwanted water getting into sanitary sewer
  - Infiltration and inflow
    - Damaged pipes, inflow through manholes, etc.
  - Legal connection of foundation drains to sanitary sewer until 1991
  - Downspout connections to sanitary sewer
- On July 15, 5 times normal flows at sewage treatment plant

Klassen & Seifert, 2006; UMA, 2005

Edmonton and Toronto

- Extreme rainfall
  - Recent events (Edmonton 2004, Toronto 2005)
  - Exceeding capacity – well over 1 in 100 year events
- Infiltration and Inflow
  - Foundation drains, downspout connections
- Combined sewers
  - In Toronto Aug 2005 event, most damage occurred in area with separated sewers

Edmonton

- 2 severe rainfall events in July, 2004
  - July 2 - 75 mm
  - July 11 - 150 mm (~1 in 200 year event)
- 9,500 insurance claims for sewer backup
  - $143 M for sewer backup
  - Total of $166 M for all damages
- Other historical events, one of the few cities in Alberta with remaining combined sewers

(IBC, 2006; Klassen & Seifert, 2006)

Toronto

- Aug. 19, 2005
  - 150 mm of rainfall
  - 13,011 sewer backup claims in GTA, $247 M
  - Total insured damages in GTA: $500 M
- Several storm events in May 2000
  - 3,000 flood complaints to city
- Other events, including 2003 blackout

Methods

- Peterborough
  - Survey – 750 self administered
  - 76 responses
    - 58 sewer backup
    - 46 overland flood
  - Confidential interviews
    - 14 professionals and experts from various sectors
- Toronto and Edmonton – Sewer backup only
  - ~800 Respondents, Phone-based survey
  - 200 SB+/SB- in Edmonton and Toronto

Results

Peterborough

- 89% OF, 90% SB respondents unaware of risk when they moved into their home
  - Most homes damaged were not in floodplain
- 61% of overland flood respondents perceived hazard recurrence
- 59% of sewer backup respondents perceived hazard recurrence
  - Expert respondents perceived recurrence

2004 Damages - Peterborough

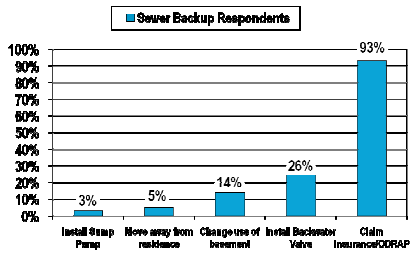
Overland Flood

Type of Damage Experienced	% of respondents
Structural damage to home	27%
Personal property	73%
Irreplaceable items	58%
Mould	29%

Sewer Backup

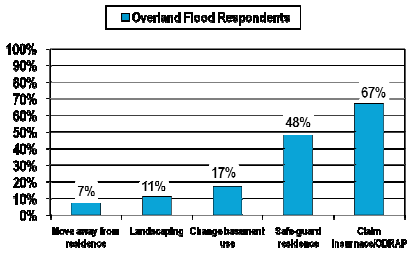
Type of Damage Experienced	% of respondents
Structural damage to home	31%
Personal property	97%
Irreplaceable items	72%
Mould	43%

Peterborough



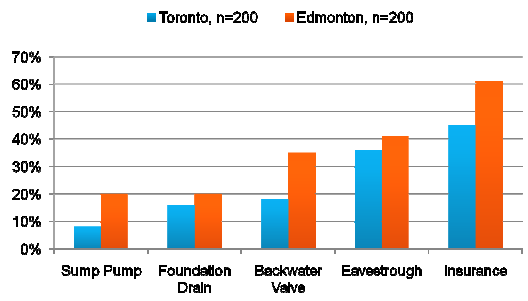
Sewer Backup Mitigation Adjustments

Peterborough

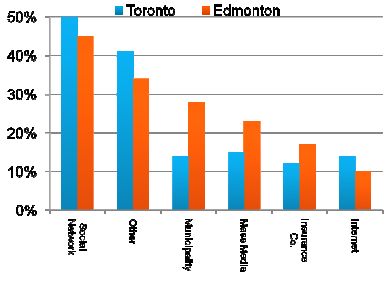


Overland Flood Mitigation Adjustments

Edmonton/Toronto – Sewer Backup

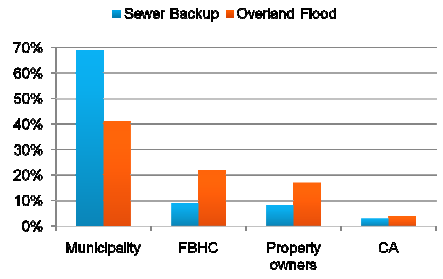


Information Source Edmonton and Toronto



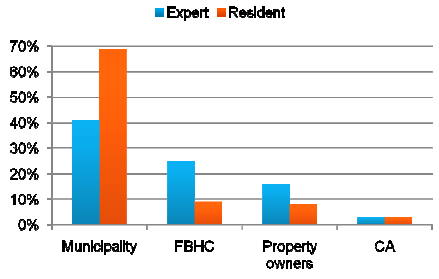
Where did you learn of what to do?

Resident's AOR Peterborough



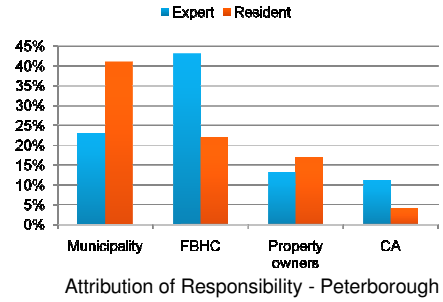
Attribution of Responsibility - Peterborough

Expert vs Resident AOR, SB



Attribution of Responsibility - Peterborough

Expert vs Resident AOR, OF



Attribution of Responsibility - Peterborough

Peterborough

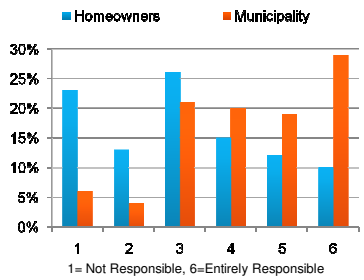
Overland Flood

Adjustment	Rank
Maintenance, increasing sewer system capacity	1
Improve overland drainage	2
Retain natural formations to control high water	3
Regulate new development	4
Structural controls on overland water courses	5

Sewer Backup

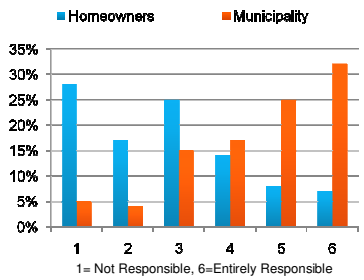
Adjustment	Rank
Maintenance, increasing sewer system capacity	1
Regulate new development	2
Retain natural formations to control high water	3
Flood proof homes (including backwater valves)	4
Public education about sewer backup	5

AOR Edmonton



1= Not Responsible, 6=Entirely Responsible

AOR Toronto



1= Not Responsible, 6=Entirely Responsible

Cost Sharing – Peterborough

- Insurance
  - 5154 insurance payouts
  - $87 M
  - Average ~$17,000 per payout
  - 4573 payouts for sewer backup damages
- ODRAP
  - 2783 claims paid to private homeowners
  - $5.8 M for homeowners
  - Average ~$2,000 per homeowner
  - Total: $25 M for all damages

ODRAP

- Ontario Disaster Relief Assistance Program
  - Covers **90%** of assessed value of ***essential items***
  - Allows risk taker to carry some costs, reduces burden on taxpayers
  - A "last resort"
    - Avenues of insurance, litigation must be exhausted
- Those who receive it do not have to pay into it directly
  - Share costs with:
    - ODRAP – Ontario Taxpayers
    - DFAA – Canadian Taxpayers

Insurance

- Average insurance payouts
  - GTA ~$19,000
  - Edmonton ~$15,000
  - Peterborough ~$15,000-$17,000
- In Peterborough, average ODRAP payout
  - ~$2,000

ODRAP - Peterborough

- Positive perceptions
  - People had enough time to apply
  - Forms easily understood, easy to fill out
- Negative perceptions
  - Few people felt well informed of the ODRAP process
  - Perception that ODRAP should cover total cost
  - Lack of overall satisfaction with ODRAP

Insurance

- Some dissatisfaction – Peterborough
  - 59% of claimants feared cancellation
  - Insurance caps and cancellations, lack of payouts for overland flooding

"Insurance companies are a joke, they take your money and pay out little if any"

"now limited to $10,000 coverage regardless of loss if the problem arises again"

Insurance

- General satisfaction with insurance in Peterborough
  - Enough $ to cover damages
  - Customer service
  - Fairly priced sewer backup coverage
  - In very few cases, insurance covered damages from overland flooding

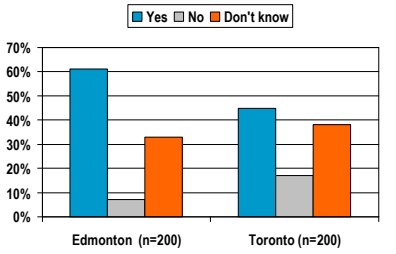
Insurance

- Edmonton and Toronto:
  - Few insurance claims for most recent events
    - 37% Edmonton
    - 32% Toronto
    - Compared to 93% in Peterborough 2004
  - Making a claim associated with severity of damages
  - Of those who did have it and claimed insurance:
    - Generally very satisfied with how claim was handled

Insurance

- Insurance most popular adjustment for sewer backup damages – Peterborough, Edmonton, Toronto
  - Lack of awareness of the role of insurance
    - People think that their overland flood damages will be covered by insurance

Insurance



Do you have insurance coverage for sewer backup damages?

Sewer backup positive respondents

Identifying Affected Homes

- Those who sustain damages may not notify municipality
- 9,500 claims in Edmonton in 2004
  - City estimated 4,000 flooded basements
- Identified as an issue in Hamilton
- Low level of insurance claims in Edmonton-Toronto
  - E.g. only about a third reported last SB event
- Issues with identifying who has been affected
  - Implications for information on where there are flooding issues

Incentive Programs

- Public notified by information mailings, etc.
  - Generally, low uptake in both cities
  - Toronto:
    - In 2005, 5000 applications mailed, 2000 returned, 1000 approved for funding
  - Edmonton:
    - Notified by mailings in 2004
      - Half of those who received mailings applied
      - ¾ of those who applied received funding

Targeting Information

- Increasing risk?
  - Aging infrastructure, increasing urbanization
  - Climate change and extreme rainfall events
  - Lack of uptake of necessary homeowner actions
  - Increasing wealth, value of property
- There exists a need to identify people at risk
  - Including those who had minor damages and who may not have reported them

Conclusions

- Respondents have similar perceptions, responses to hazards
  - Recurrence, adoption of adjustments, perception of adjustments
- Attribution of responsibility
  - Differs depending on type of hazard experienced

Conclusions

- Responsibility placed on municipality
  - Perception that gov't should cover all uninsured damages
- Reliance on municipality for implementing sewer system improvements
  - Short- and medium-term adjustments necessary, as infrastructure improvements completed over long-term
  - Property-level actions important part of the overall system

Conclusions

- Mould
  - Frequent reports of mould damage
  - Implications for recovery education
- Insurance
  - Transfer burden/increase reliance on government relief programs – in case of cancellations
  - A role for education/encouragement of risk-reducing adjustments
  - Awareness of water damage coverage

Thank You

Dan Sandink, M.A.
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