

*Association of Municipalities Ontario*

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# Extreme Weather Resiliency and Climate Adaptation Through Strategic Asset Management & Infrastructure Investments

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# OUTLINE

- 1) Regulations on Resiliency and Level of Service
- 2) Upgrading Historical Service vs. Future Adaptation
- 3) Strategic Flood Resiliency – Where to Act.
- 4) Policies, Programs and Projects for Cost-Effective Resiliency
- 5) Emerging Technology Opportunities and Challenges – Green Infrastructure

# Ontario Drivers for Assessing Climate Change Risks

## Provincial Policy Statement (2014):

“Infrastructure ... shall be provided in a coordinated, **efficient and cost-effective manner that considers impacts from climate change ....**”

## Infrastructure for Jobs and Prosperity Act (2015):

“Infrastructure planning and investment should minimize the impact of infrastructure on the environment ... **should be designed to be resilient to effects of climate change.**”

## Environmental Assessments (2017):

“... proponents to consider measures to adapt to climate change: **How vulnerable might a project be to a changing climate?**”

## Bill 139 (2017) :

“OP shall contain policies that identify goals, objectives and actions to ... **provide for adaptation to a changing climate, including through increasing resiliency.**”

# Ontario Drivers for Assessing Climate Change Risks

## O. Reg. 588/17: ASSET MANAGEMENT PLANNING FOR MUNICIPAL INFRASTRUCTURE

**(July 1, 2019)** “first strategic asset management policy” shall include “the municipality’s commitment to consider, as part of its asset management planning” including “the actions that may be required to address the vulnerabilities that may be caused by climate change”.

**(July 1, 2024)** “Every asset management plan must include the proposed levels of service for core stormwater management assets:

1. Percentage of properties resilient to a 100-year storm.
2. Percentage of stormwater management system resilient to a 5-year storm.

**We have always had flooding**



***And historical level of service 'gaps'***

*... longstanding 'gaps' are challenging.*



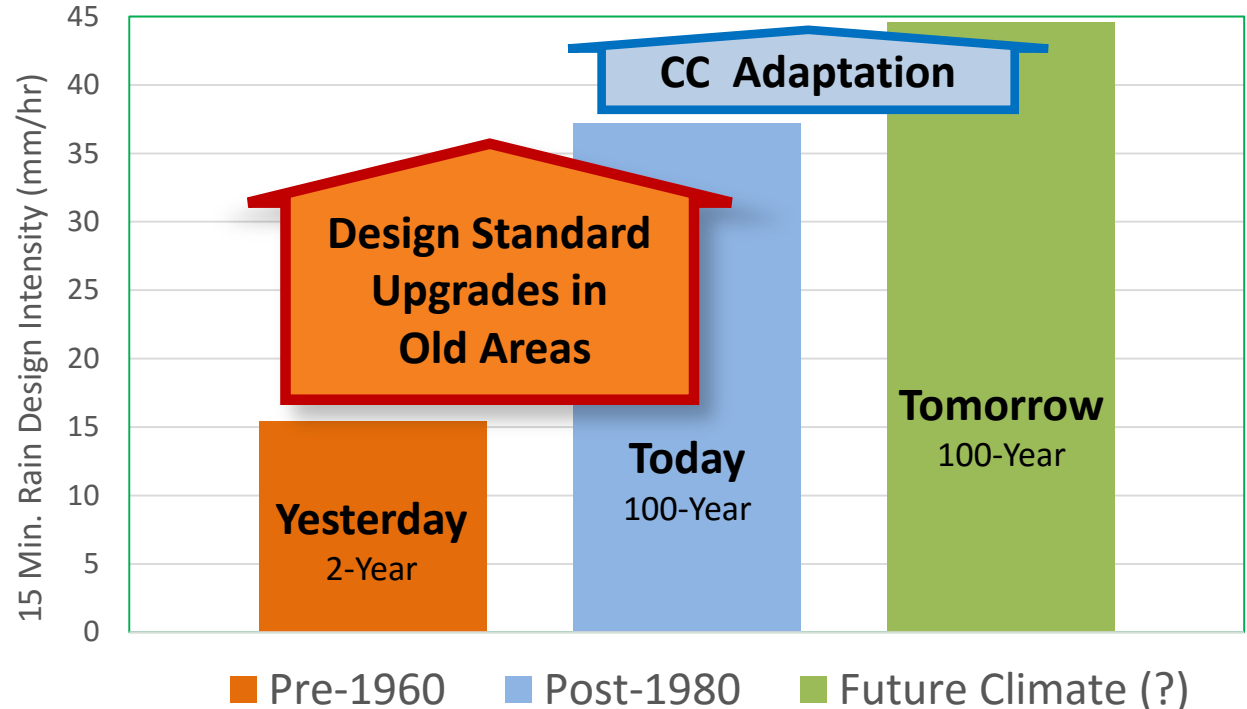
# Repeated operational problems?



*Should not be confused with climate  
change risks*

# Difference Between Increasing Historical Levels of Service & Future Climate Change Adaptation ?

- **Historical upgrades first = very extensive capacity upgrades to meet today's standards.**
- **Next climate adaptation requires +20% more capacity.**





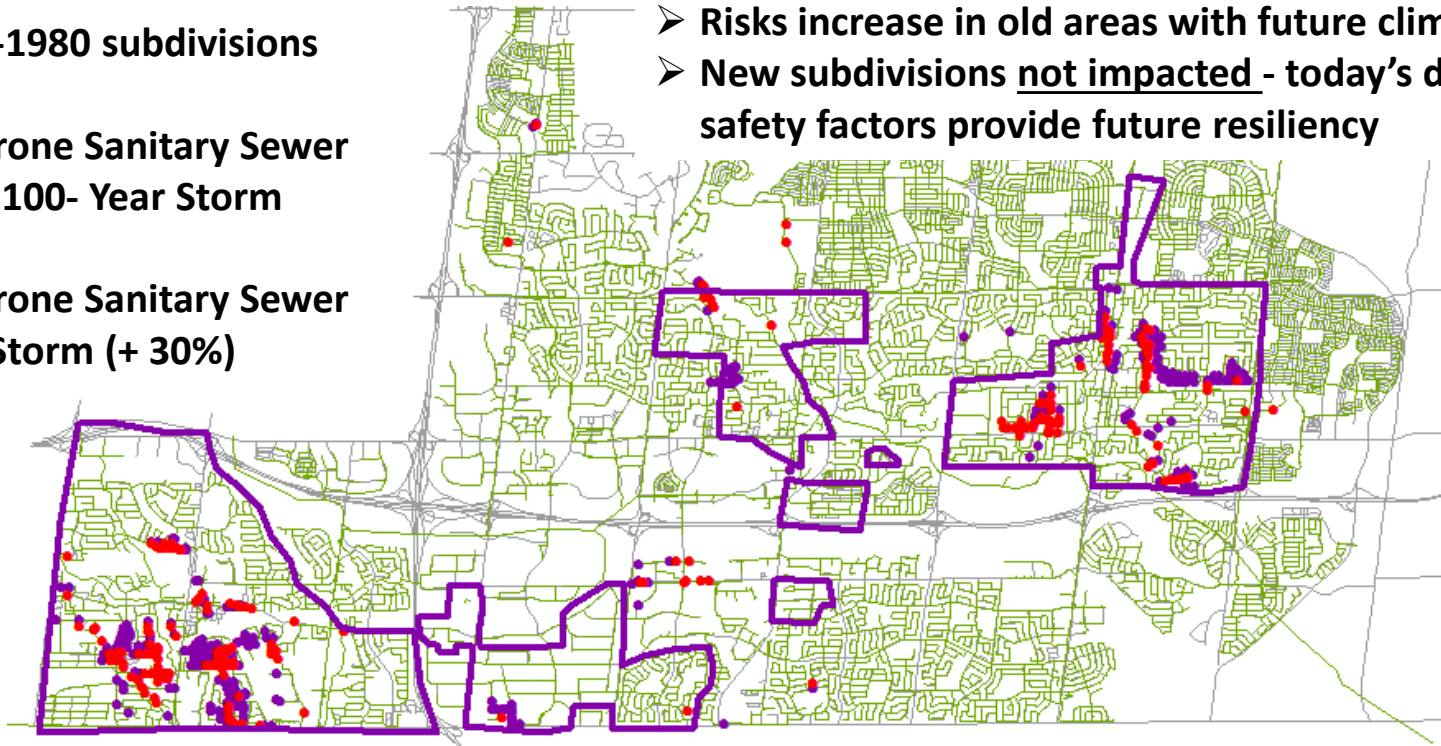
## Strategically Increase Flood Resiliency for Today's Extremes in “Old Areas”

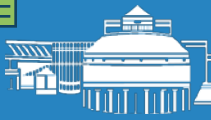
 Old pre-1980 subdivisions

 Flood Prone Sanitary Sewer  
Today's 100- Year Storm

 Flood Prone Sanitary Sewer  
Future Storm (+ 30%)

- Risks increase in old areas with future climate
- New subdivisions not impacted - today's design safety factors provide future resiliency





## Cost- Effective Policies, Programs & Capital Works Projects

- **Policies / Design Standards (prevention):**
  - Land use planning / floodplain mgmt.
  - Engineering standards

60 Times  
Reduction in  
Flood Density
- **Programs (low cost remediation)**
  - Sanitary downspout disconnection
  - Plumbing protection / backwater valves

Double Sanitary  
Capacity with  
Lower Storm Flows
- **Capital Works Projects (high cost remediation)**
  - Sewer capacity upgrades (grey)
  - Storage facilities (grey)
  - Low impact development (green ?)

Is it cost effective ?  
Do Benefits exceed  
Costs (ROI) ?

# Green Infrastructure – Recent Local Tender Costs

City / Town	LID Type (Project Name)	Capital + Soft Cost (\$)	Service Area (ha)	Cost / Hectare (\$ / ha)
Markham	Bioswale & Infiltration Trench (Green Rd)	\$783,602	1.9	\$412,422
Markham	Rain Garden (Glencrest Park)	\$216,000	1.6	\$135,000
Brampton	Bioswale (County Court SNAP)	\$130,514	0.2	\$652,570
Whitchurch-Stouffville	Various Measures (Coultic Park & CC P. Lot)	\$106,671	0.11	\$969,741
Ottawa	Bioretention (Sunnyside / Road)	\$282,887	0.464	\$609,670
Ottawa	Bioswale (Stewart / Road)	\$363,452	2.01	\$180,821
Ajax	Rain Garden (Lake Driveway)	\$350,000	0.14	\$2,500,000
Mississauga	Bioswale & Pavers (Elm Drive)	\$226,000	0.633	\$357,030
Mississauga	Bioswale (Lakeview)	\$420,900	1.6	\$363,063
Mississauga	Bioswale/Permeable S.Walk (Alpha Mills Rd)	\$148,521	0.3	\$495,070
Newmarket	Bioswale/Biofilter/Rain Grd (Forest Glenn Rd)	\$431,000	1.16	\$371,552
London	Rain Garden & Infiltration Trench (Oakridge Phase 1)	\$108,765	0.22	\$500,068
London	Rain Garden & Infiltration Trench (Oakridge Phase 2)	\$88,400	0.30	\$290,312
London	LID 540 sq.m (Waterloo Street)	\$448,955	0.81	\$554,266
London	LID 1550 sq.m (Sarnia Road)	\$441,105	2.33	\$189,692
London	LID 580 sq.m (Commissioners Road)	\$334,656	0.87	\$384,662
London	LID 1440 sq.m (Southwest Community Centre)	\$223,708	2.16	\$103,569
London	LID 150 sq.m (No. 11 Fire Station)	\$63,708	0.23	\$283,147
Newmarket	Enhanced Swale (Woodland Court)	\$37,860	0.02	\$1,892,985
East-Gwillimbury	P.Pavement/Bioswale (Municipal Office)	\$155,433	0.23	\$665,949
Bradford West-Gwillimbury	P.Pavement/Bioswale (LID Parking Lot)	\$471,385	0.29	\$1,625,467
Uxbridge	Bioswale (Recreation Complex)	\$85,087	1.67	\$50,951
Aurora	Permeable Pavement, Rain Garden (Recreation Complex Roof and Parking)	\$339,005	1.98	\$171,215
Innisfil	Permeable Pavement, Rain Garden (Fire Station Parking Lot and Roof)	\$84,003	1.98	\$42,426

Approximately \$600,000 per hectare in capital cost.

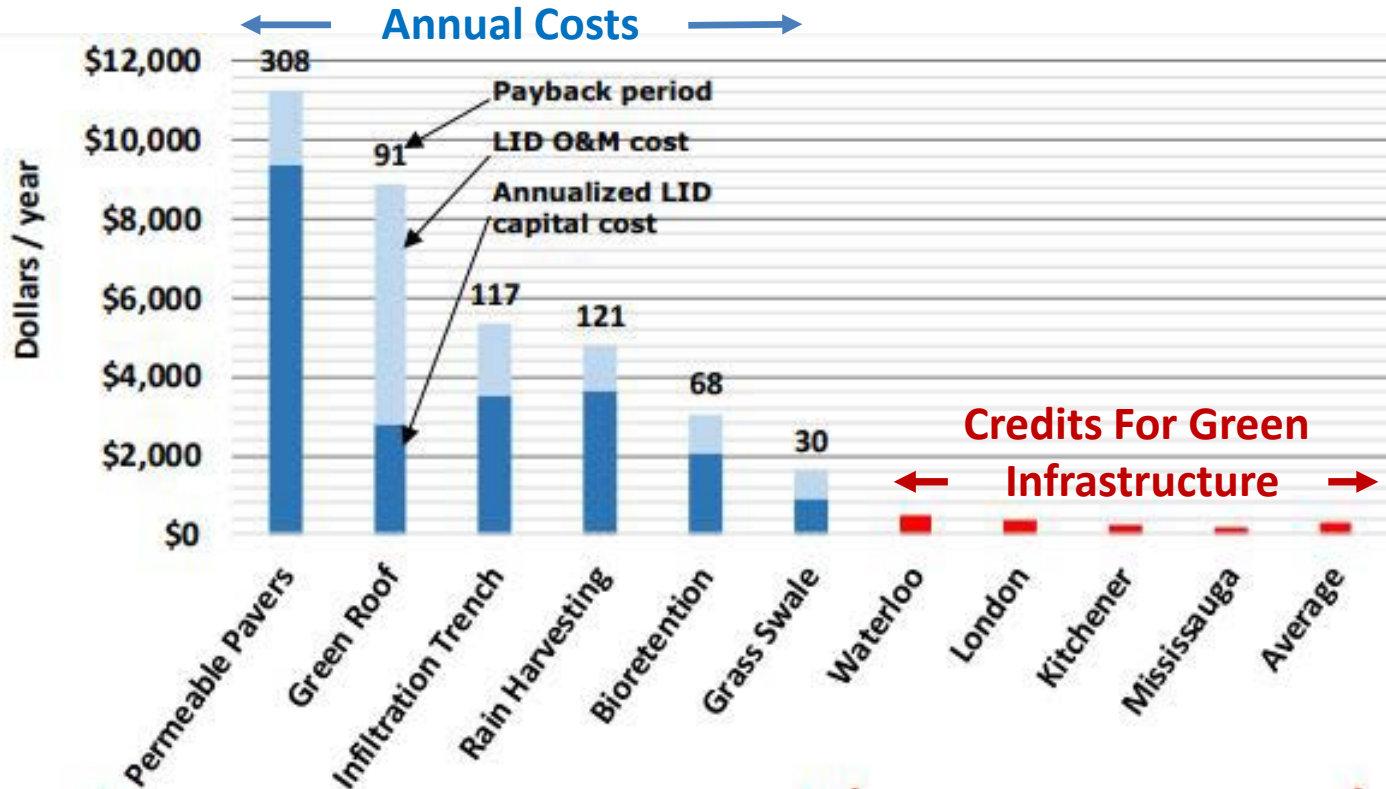
Retrofitting Ontario's 852,000 urban hectares would cost about **half a trillion dollars**.

US costs of \$860,000 per impervious hectare give cost of **\$360 billion**.



## Green Infrastructure - Costs Far Exceed Revenues

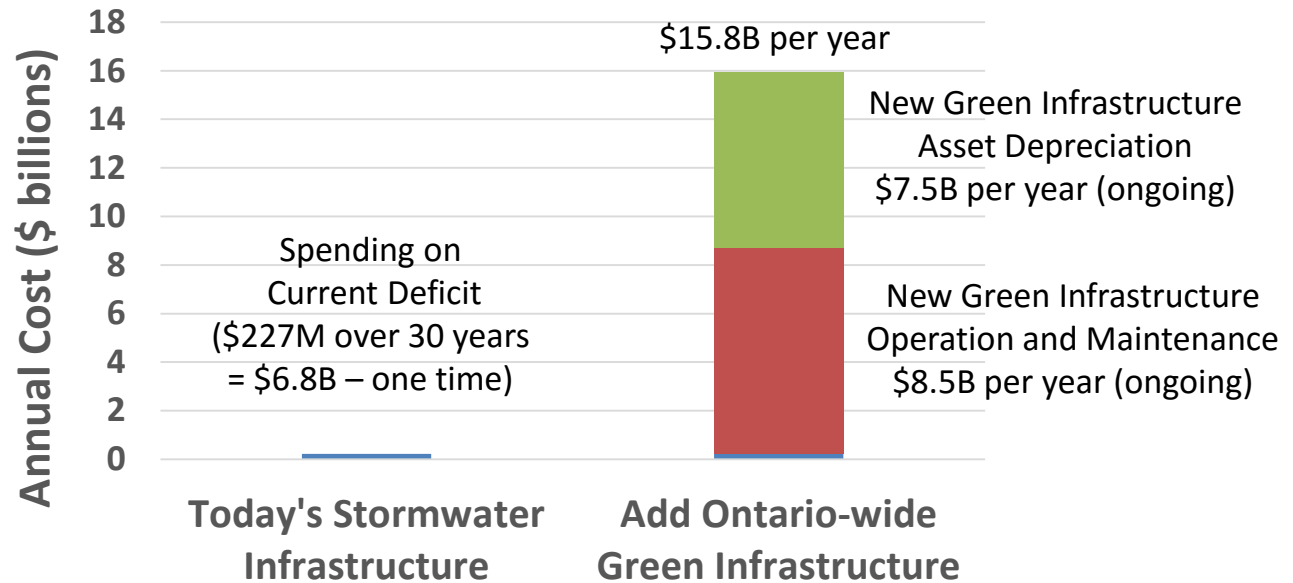
- Permeable Pavers have a **308 year payback period**.
- Grassed Swales have **30 year payback**.
- **Limited return on investment** for green infrastructure.



## Green Infrastructure – Ontario Lifecycle Cost Impacts

- Annual lifecycle costs for Ontario-wide implementation would **double the current Ontario stormwater infrastructure deficit each year.**

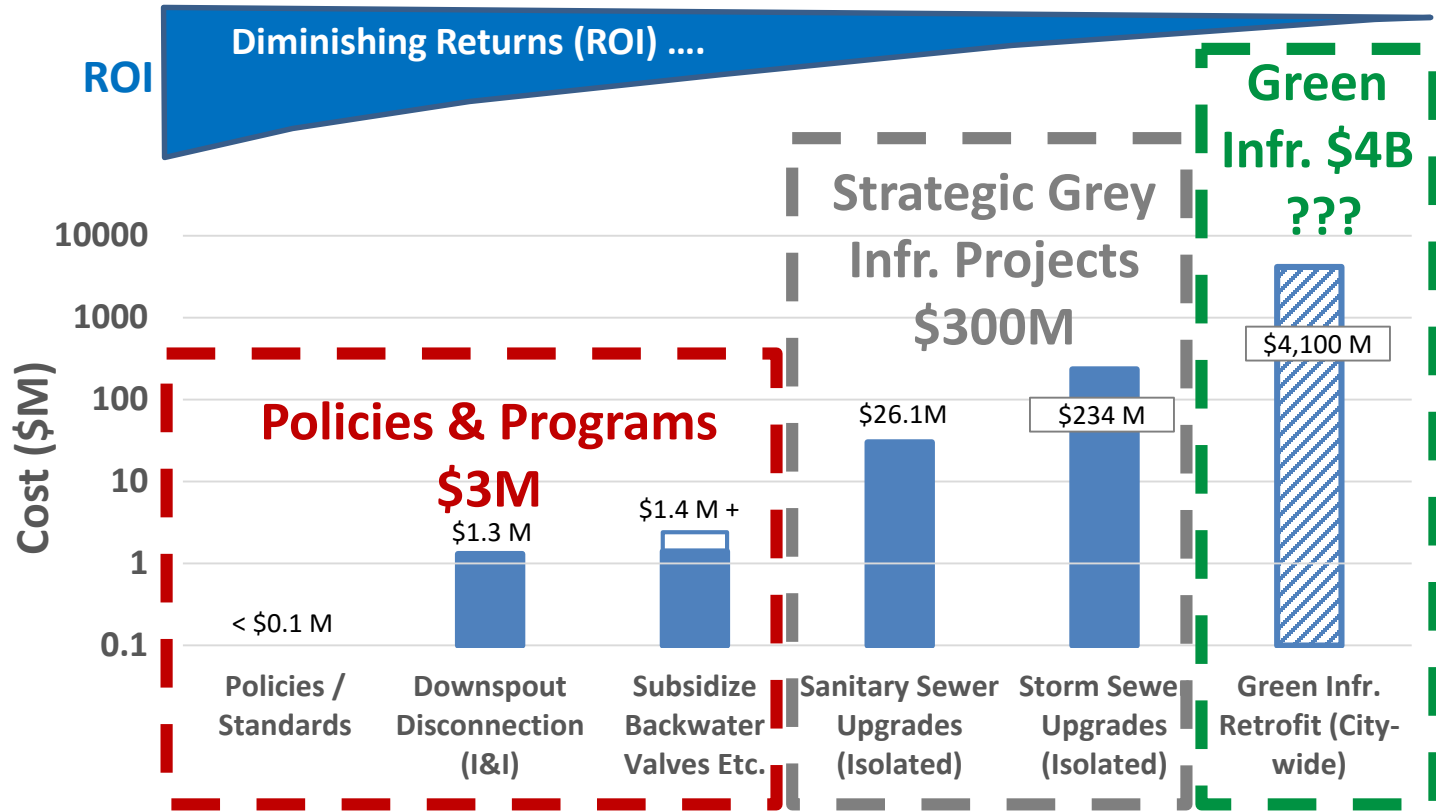
Retrofit Green Infrastructure Costs vs. Spending on Current Deficit





# Markham Policy, Program & Project Cost Comparison

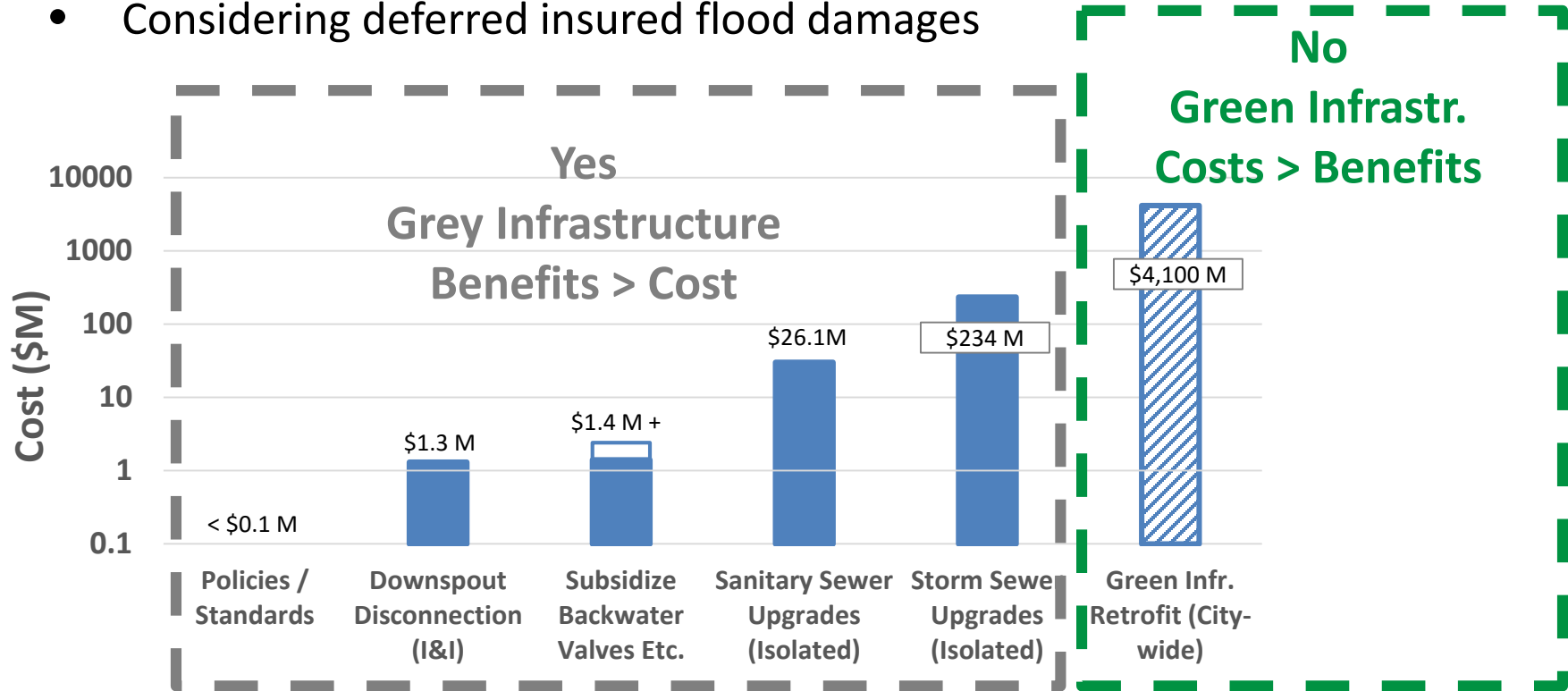
- City-wide green infrastructure retrofits could cost **100 times** sanitary sewer upgrades and **10 times** storm sewer upgrades – need strategic approach.





## Do Deferred Flood Damage Benefits Justify Costs?

- Considering deferred insured flood damages



## Green Infrastructure – Strategic Approach?

- MOECC proposed Ontario-wide green infrastructure, LID for new development & retrofits.
- **Ontario Society of Professional Engineers** has expressed caution due to:
  - capital costs ([Bill 139 comments](#)),
  - flood control limitations ([Watershed Planning Guidance comments](#)),
  - lack of full lifecycle cost accounting ([Ontario's 2017 LTIP comments](#)).
- **WEAO** and several municipalities expressed concerns with retrofit applications & impacts to existing utilities (wastewater infiltration, watermain corrosion/contamination).
- **AMO, MEA, RPWCO** proposed a phased approach:
  - Phase 1 focused on new development and larger municipalities with greater stormwater impacts (risk-based approach)
  - Phase 2 voluntary implementation for retrofits according to City-approved plans (e.g., Kitchener).



## Conclusions

- **New regulations and guidelines require design and actions to adapt to future climate:**
  - Resiliency gaps are in historical service areas under existing climate and today's extreme weather stresses.
  - Improving existing infrastructure levels of service (first step) has a climate adaptation co-benefit.
- **Standards, programs and capital works increase resiliency with varying degrees of cost-effectiveness:**
  - Policies/standards and low cost programs offer effective and timely flood risk reduction.
  - Conventional grey and modern green infrastructure require assessment of cost effectiveness for flood remediation.
- **Green infrastructure lifecycle costs are a concern:**
  - Precludes standard practice in retrofits.
  - Implementation must be strategic / focused & avoid infiltration impacts.

# Thank You Questions ?

## **More Rob :**

Blog: [www.CityFloodMap.com](http://www.CityFloodMap.com)

Podcast: [Open During Construction](#) on iTunes

Twitter: [@RobertMuir\\_PEng](#)

## **More City of Markham :**

Web: [www.markham.ca](http://www.markham.ca)

Twitter: [@CityofMarkham](#)



# Resources On Resiliency and Flood Risks

- **Observed rain intensities decreasing in S. Ontario (Environment Canada data):**
  - <https://www.chijournal.org/C449>
  - <http://www.cityfloodmap.com/2018/07/decrease-in-southern-ontario-design.html>
- **Design rain intensities not increasing (engineering studies):**
  - <https://www.cityfloodmap.com/2018/03/extreme-rainfall-and-climate-change-in.html>
- **Predicted lower rainfall intensities in Ontario:**
  - <http://www.cityfloodmap.com/2018/04/climate-models-predict-decreasing.html>
- **Urbanization affects flood risk:**
  - <https://www.cityfloodmap.com/2016/08/urbanization-and-runoff-explain.html>
- **Historical design standards affect flood risk:**
  - <https://www.cityfloodmap.com/2018/03/construction-era-infrastructure.html>
- **Operational risk factors vs climate change risks (GO Train):**
  - <https://www.cityfloodmap.com/2015/12/toronto-go-train-flood-avoidable-july-8.html>
- **Lake Ontario levels in 2017 barely above historical extremes:**
  - <https://www.cityfloodmap.com/2017/09/toronto-island-flooding-2017-were-lake.html>
- **Green infrastructure lifecycle costs:**
  - <https://www.cityfloodmap.com/2018/07/green-infrastructure-capital-and.html>