Adapting to Climate Change with Low Impact Development/Green Infrastructure

October 5th, 2017

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Presentation Outline

- Monitoring Findings
- Need for Change
- Common Perceptions of LID
- LID Design and Performance
- Draft MOECC LID Requirements
- More Lessons Learned

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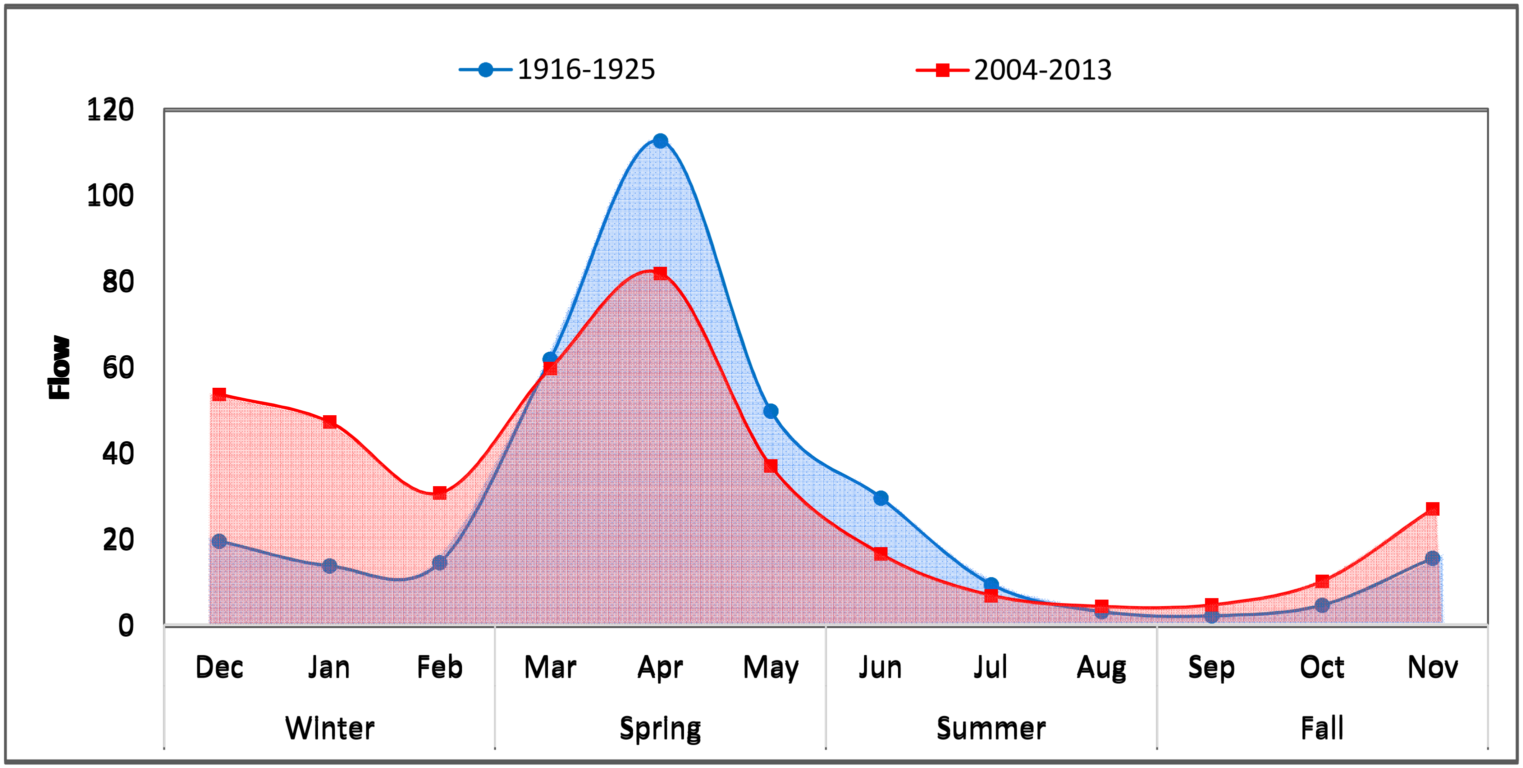
What our Stream Monitoring Shows Us

Rural Hydrology



For Rural Watersheds like the Moira River at Foxboro: winter flows have increased, spring flows have decreased, & summer flows have remained unchanged.

Source: Trevor Dickinson, University of Guelph

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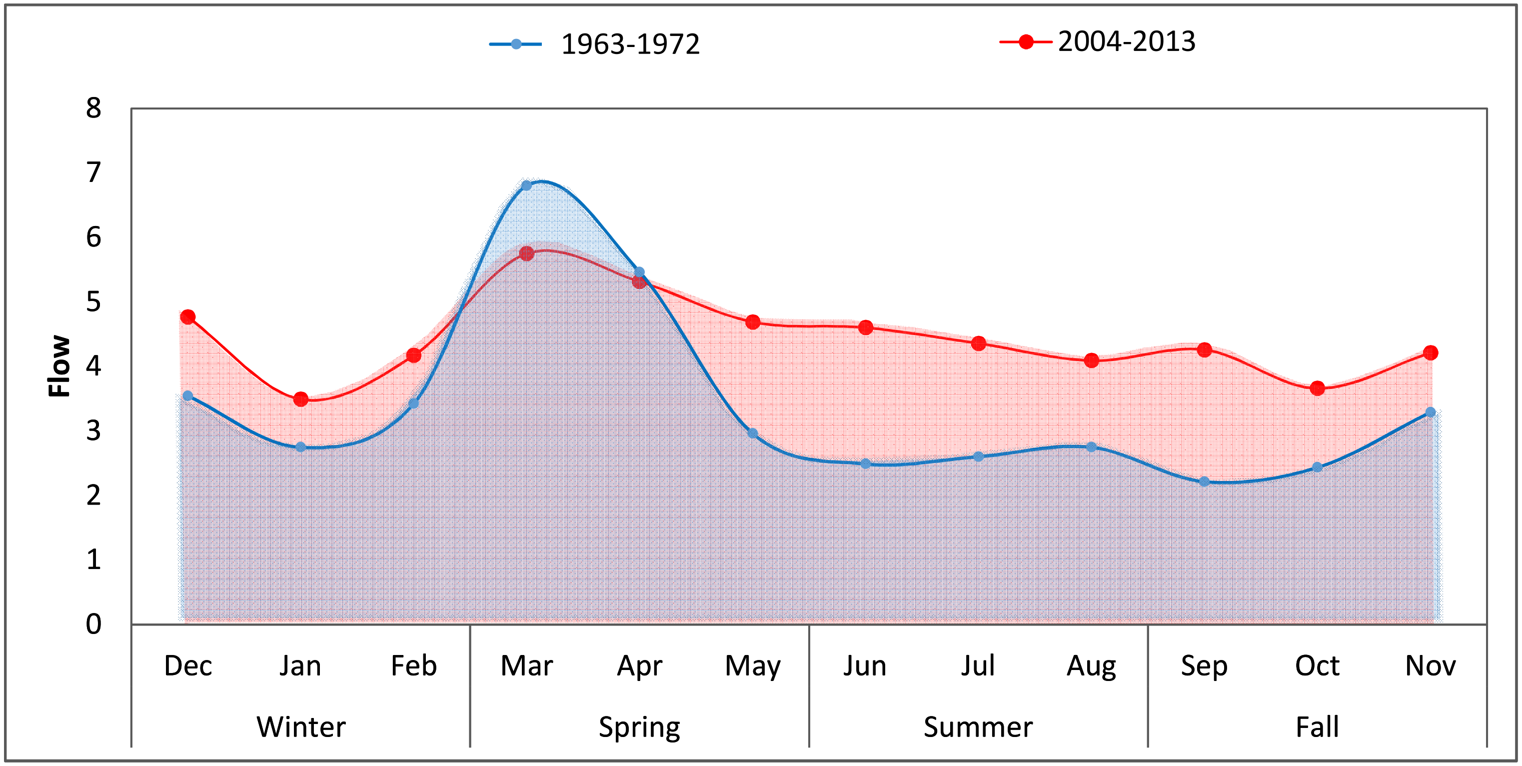
Urban Hydrology



For a highly Urbanized Watershed like the Don River at Todmorden: winter flows have increased, spring flows have decreased, & summer flows have greatly increased.

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Source: Trevor Dickinson, University of Guelph

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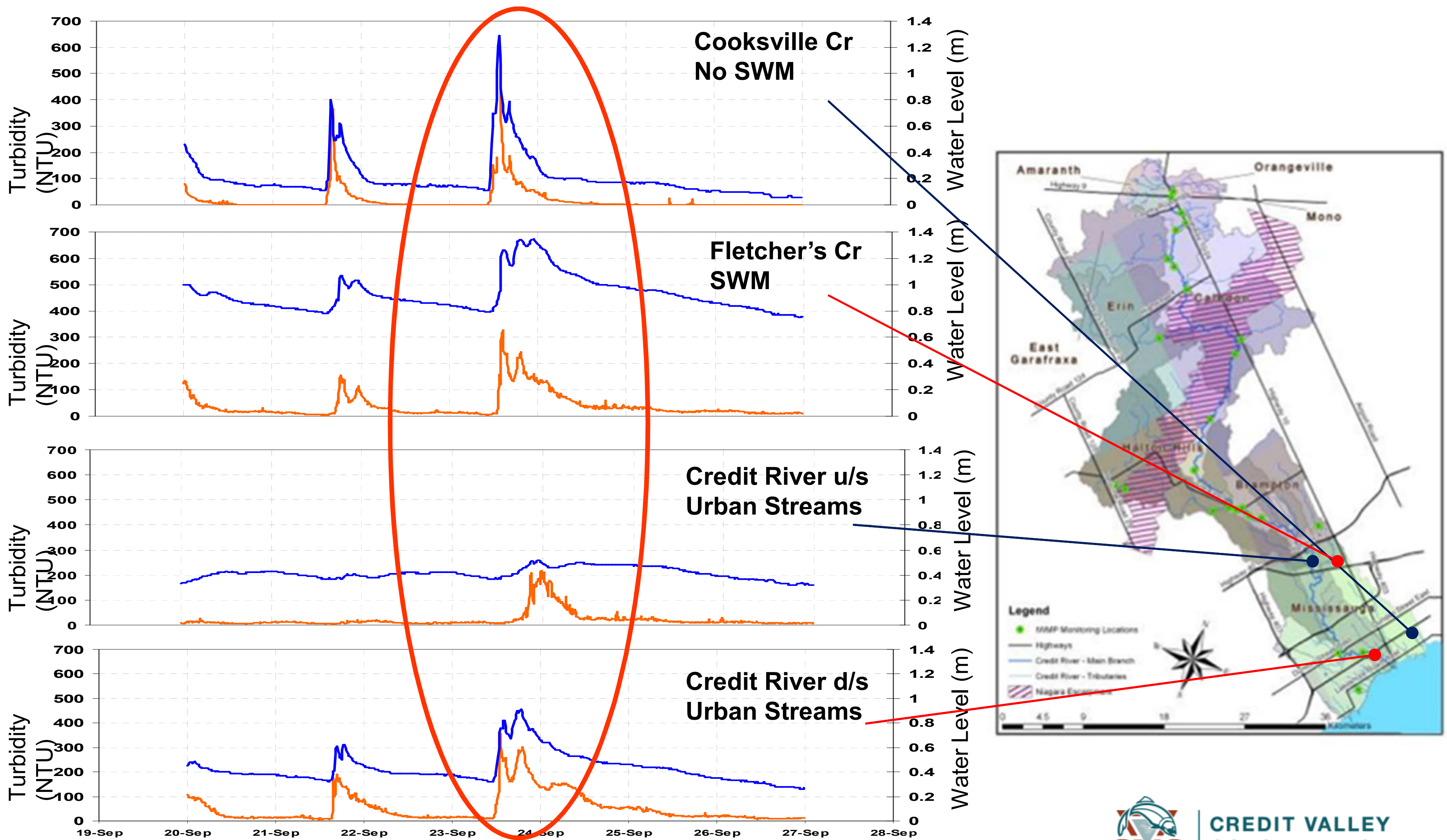
Flow and Turbidity: Sept 23rd Storm (~30mm)



(One Week)

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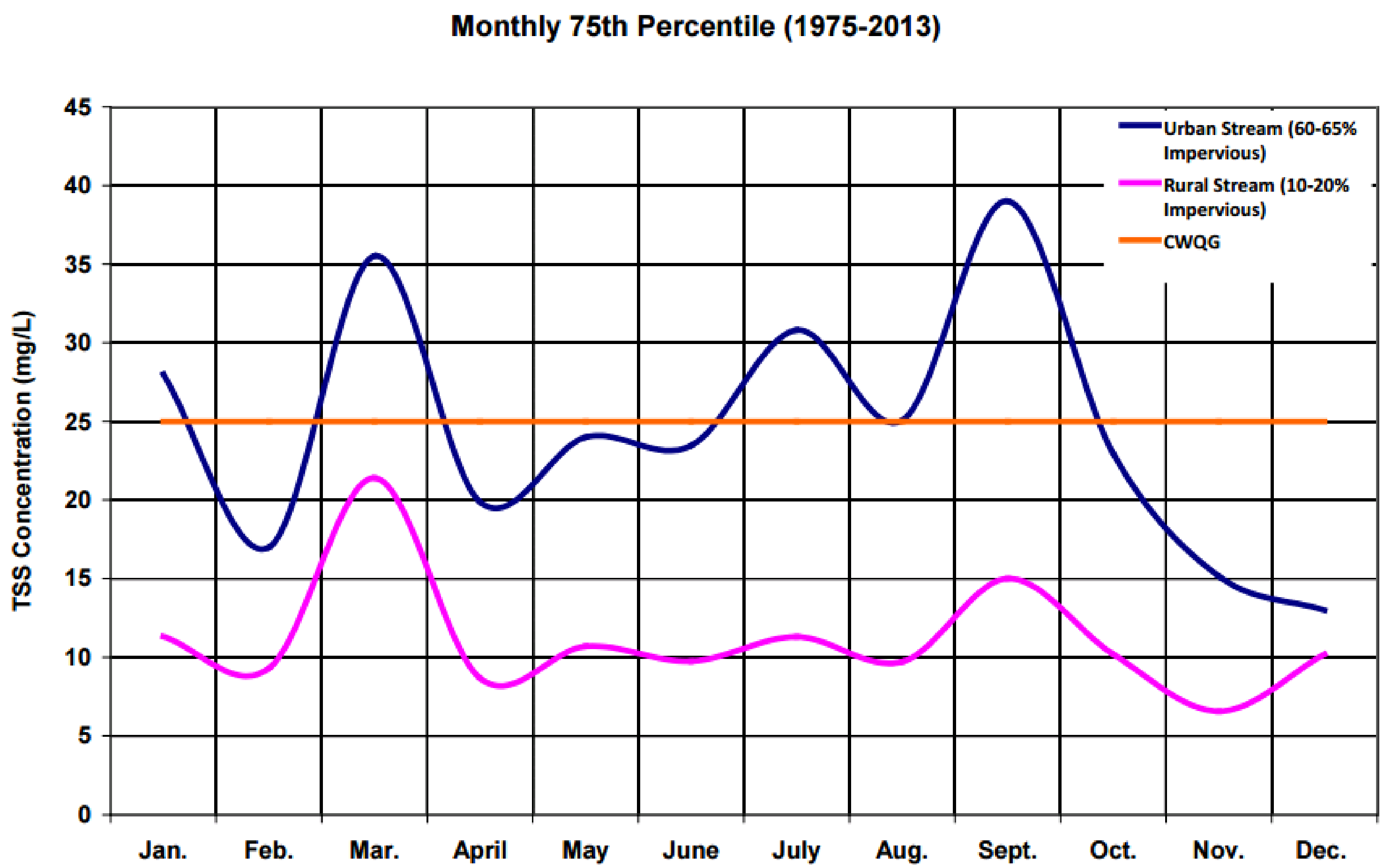
TSS contribution from Urban Vs Rural Subwatersheds



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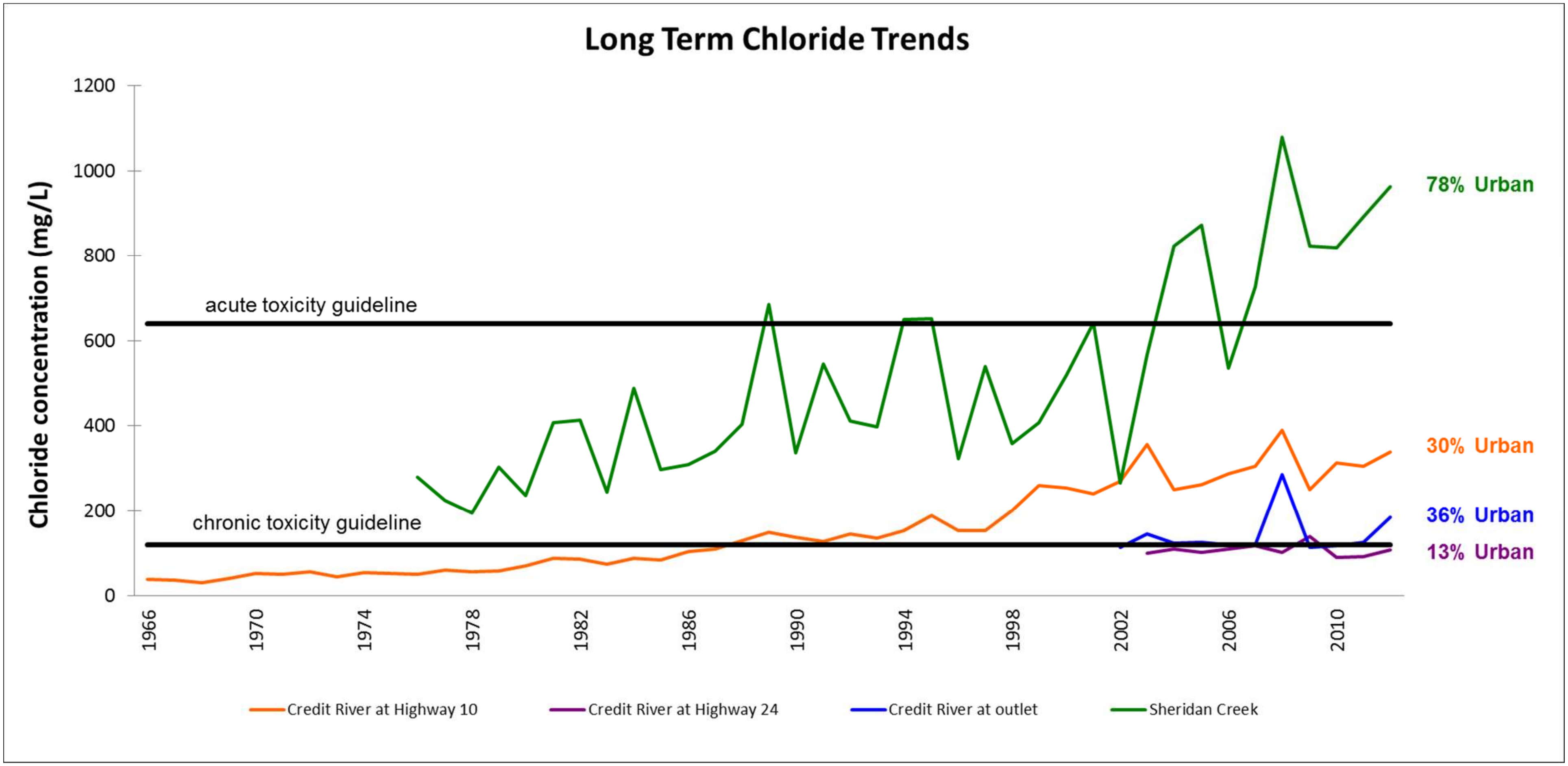
Impact of Warm Winter

Fisheries and recreational impacts costing ~$750M - $1.5B annually in lost tourism along GTA shoreline

Water Plant shut down over $400,000 in repair costs



Annual chloride concentration: 1976 to 2012

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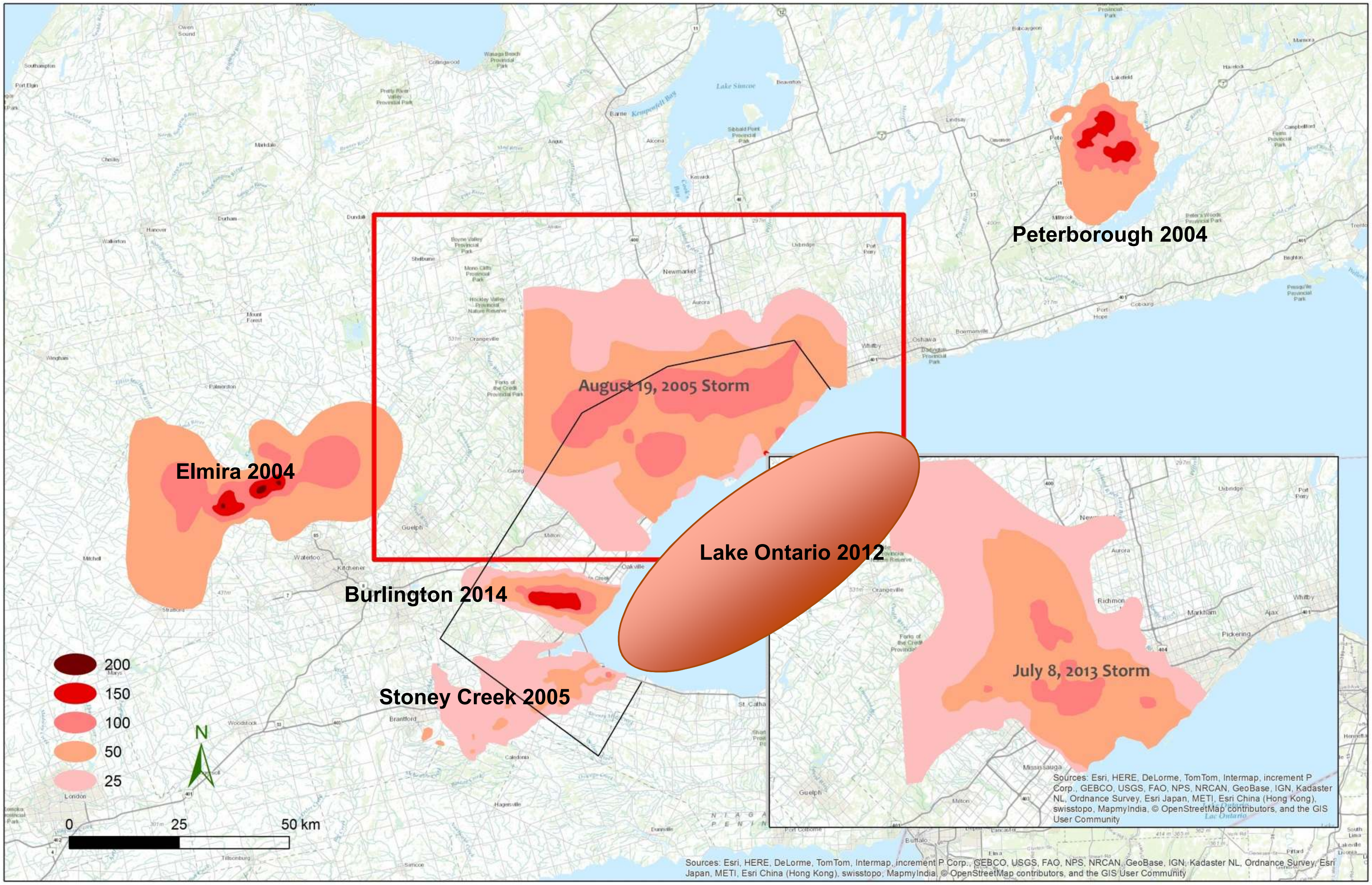
How our Communities have been impacted by Urbanization and Climate Change

The Big Seven (11 years)



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Impact of Extreme Rainfall on Riverine Flooding

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thestar.com

GTA

News / GTA

Mississauga resident living in tent since flood

Ken Hills, 60, is one of hundreds living near Cooksville Creek displaced since last week's storm.

Tweet 32 G+1 0 reddit this!

ALEX NINO GHECIU / TORONTO STAR Order this photo

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https://www.youtube.com/watch?v=NwwnZG0JJ5o

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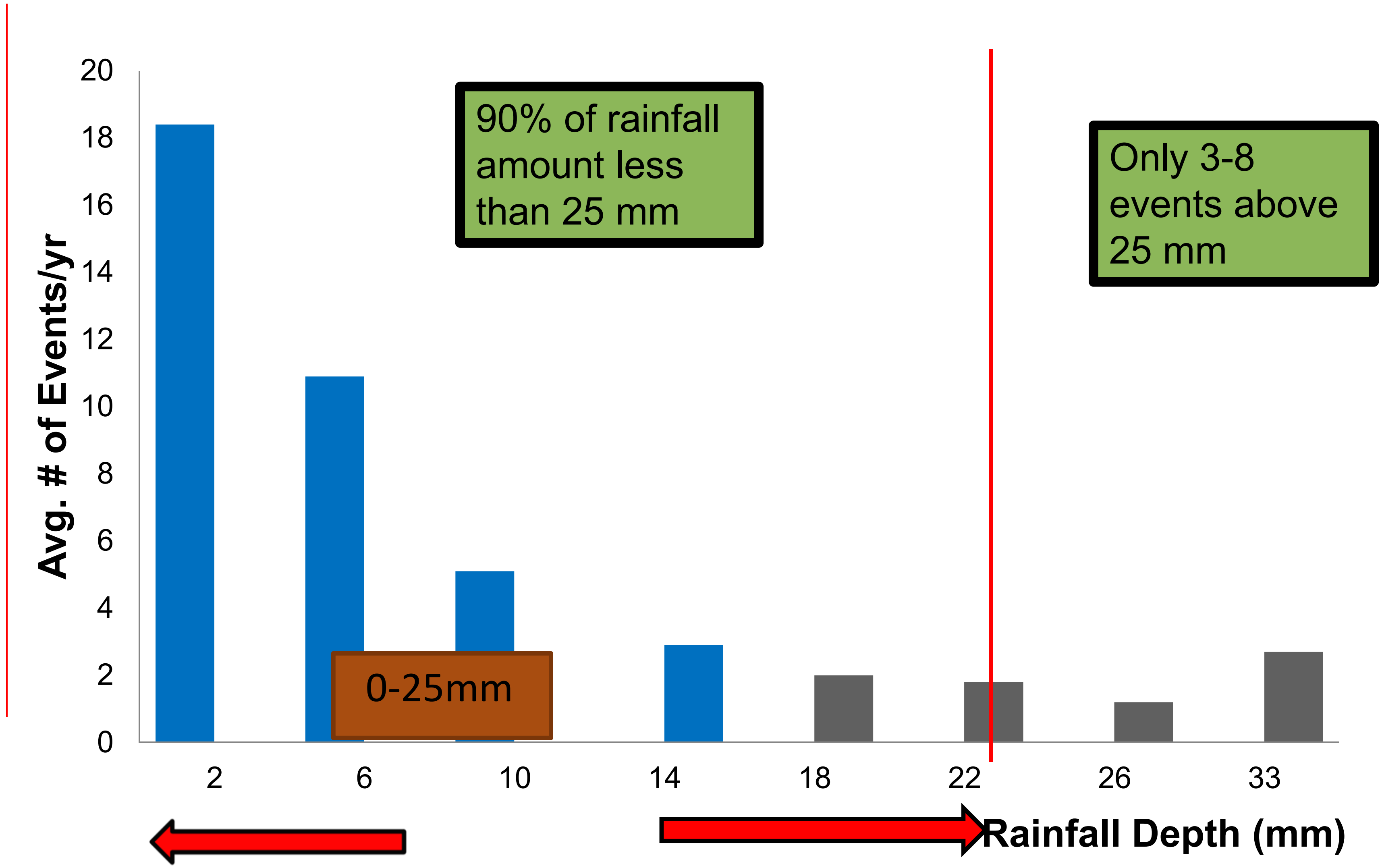
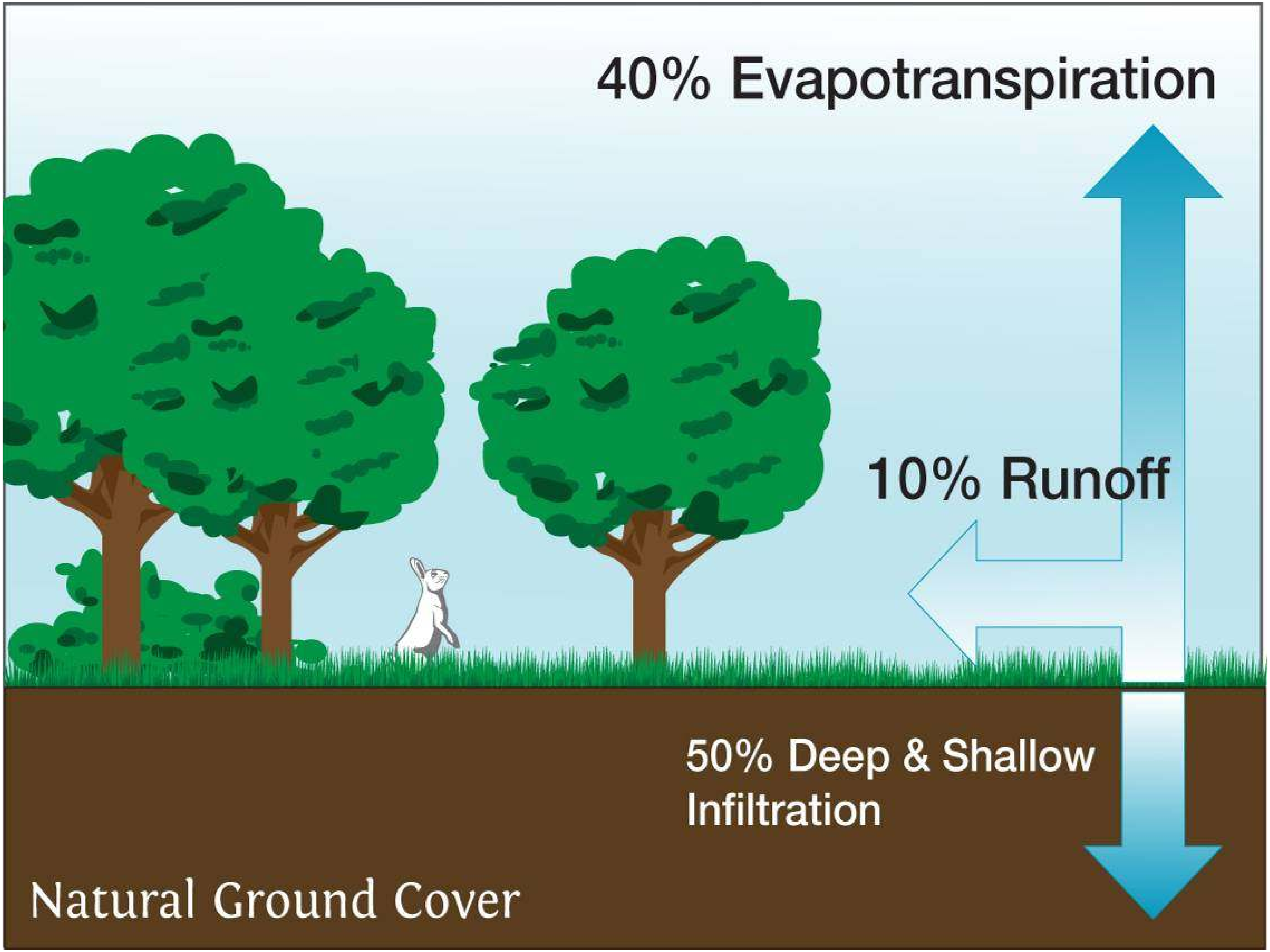
Why is this happening?

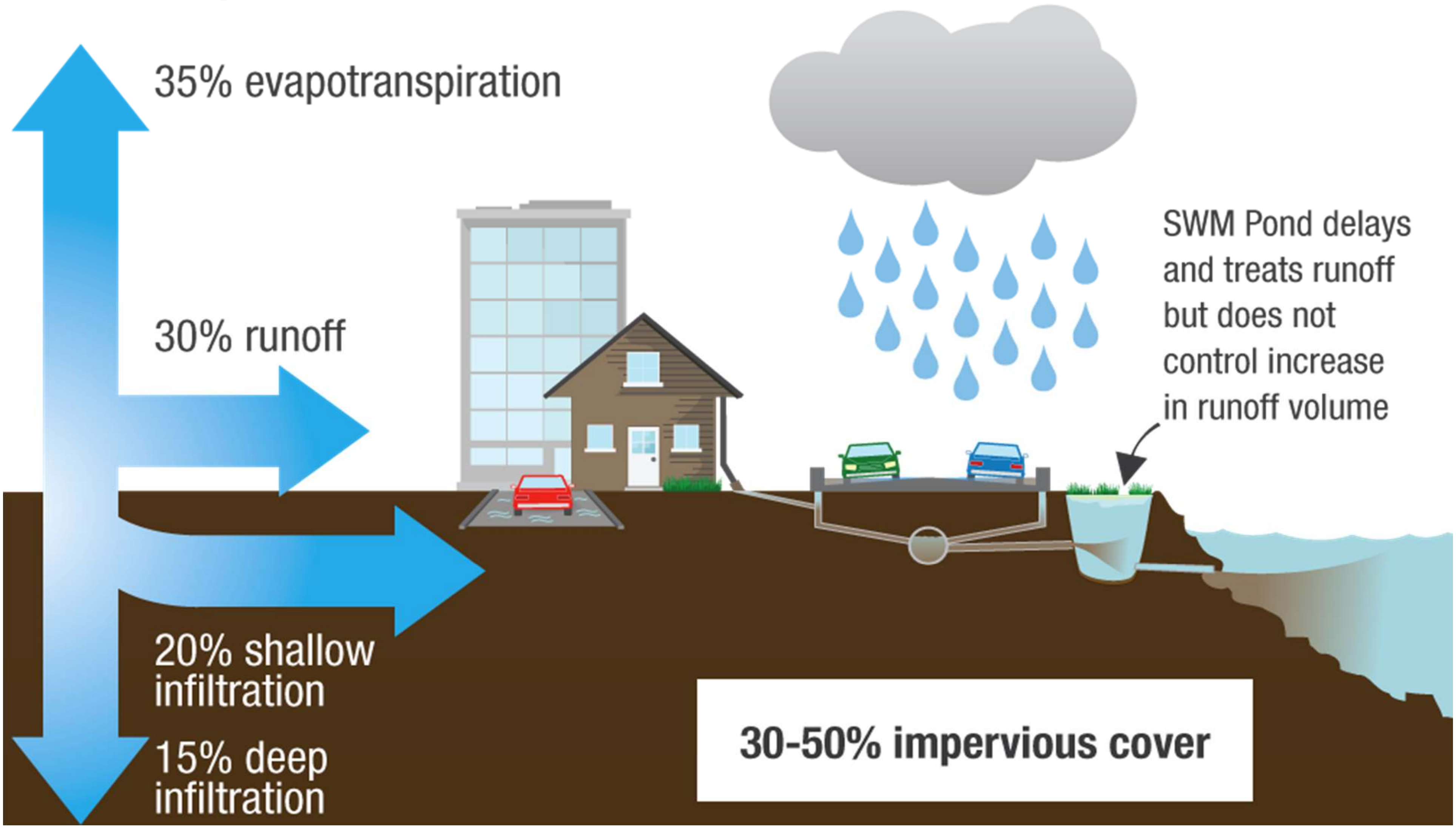
Typical Annual Rainfall Frequency Distribution For Toronto, Ontario




40% Evapotranspiration
10% Runoff
50% Deep & Shallow Infiltration
Natural Ground Cover

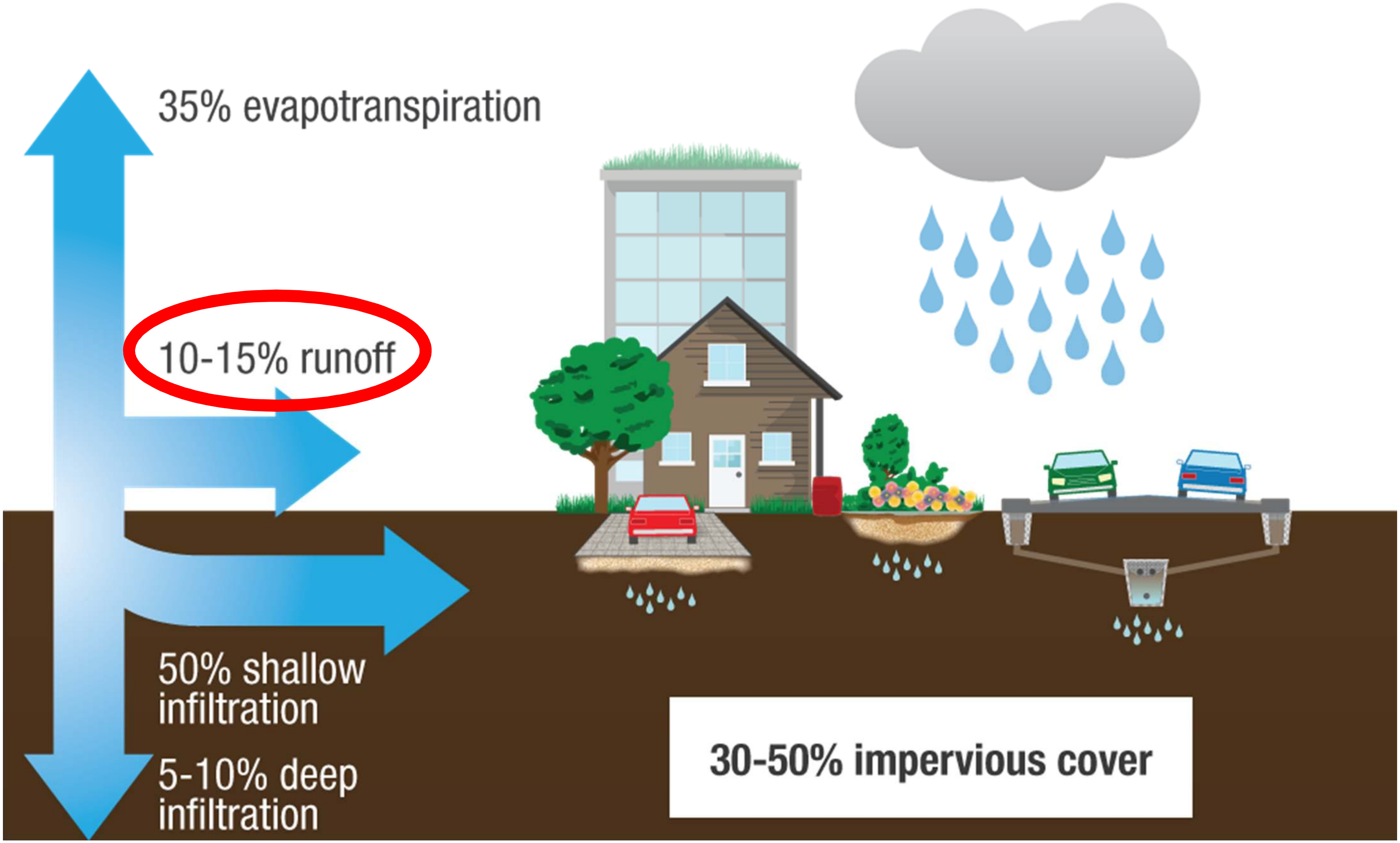
Urban Hydrology

Typical development: Stormwater management using End of Pipe SWM Pond



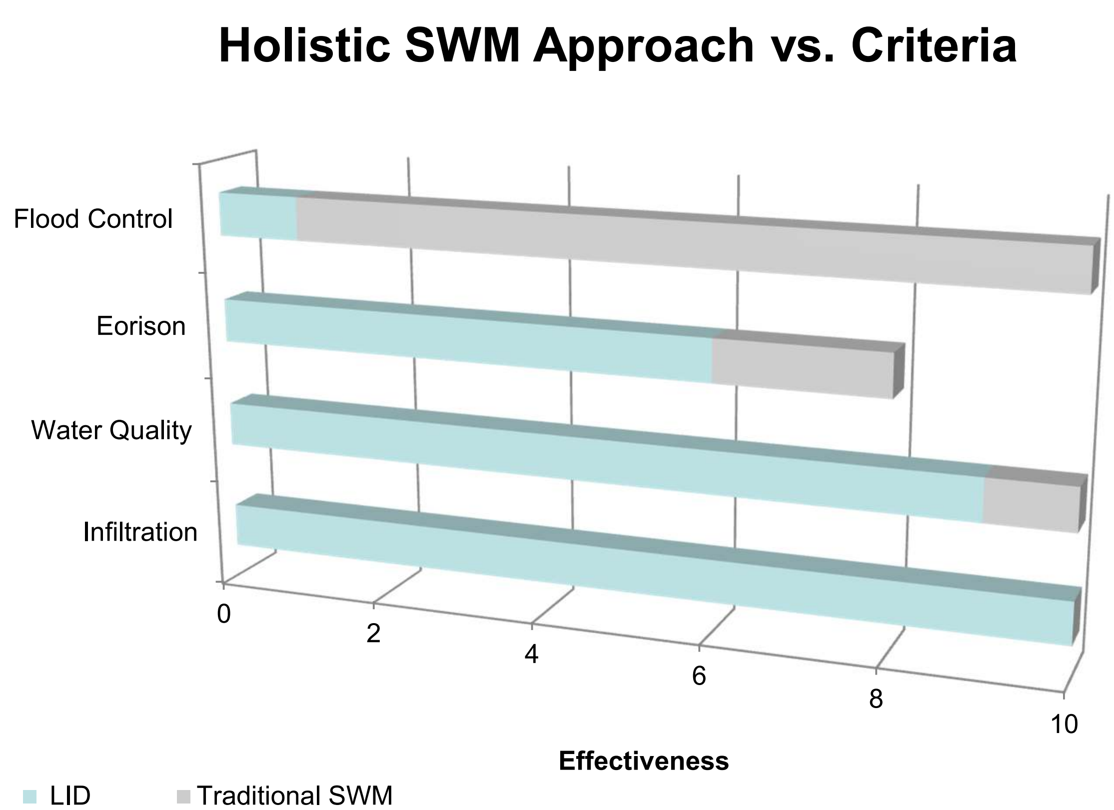
Urban Hydrology

Development with Low Impact Development

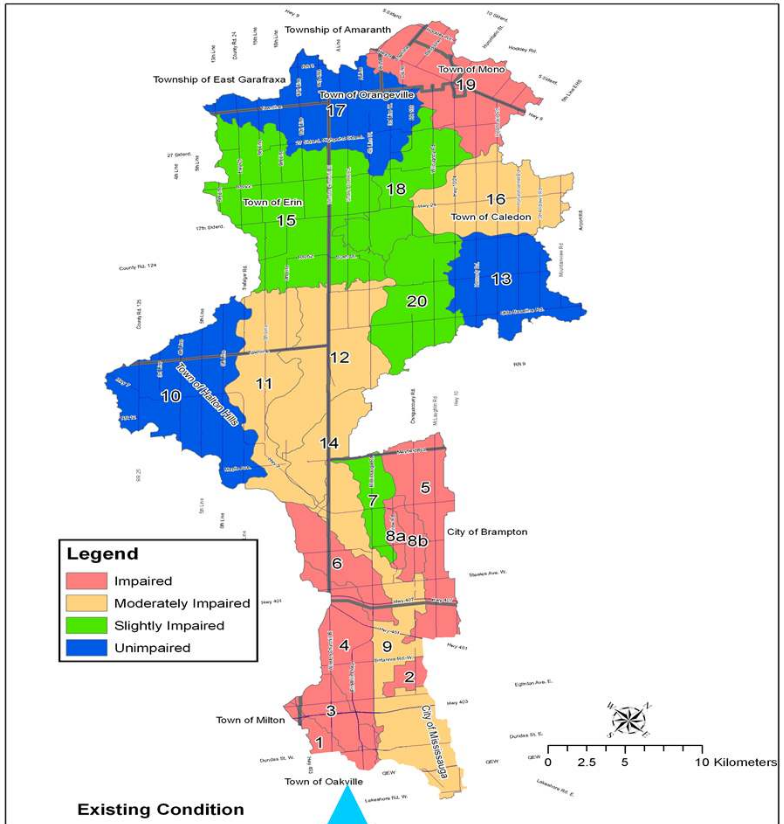


Holistic Approach & Criteria

- When used together

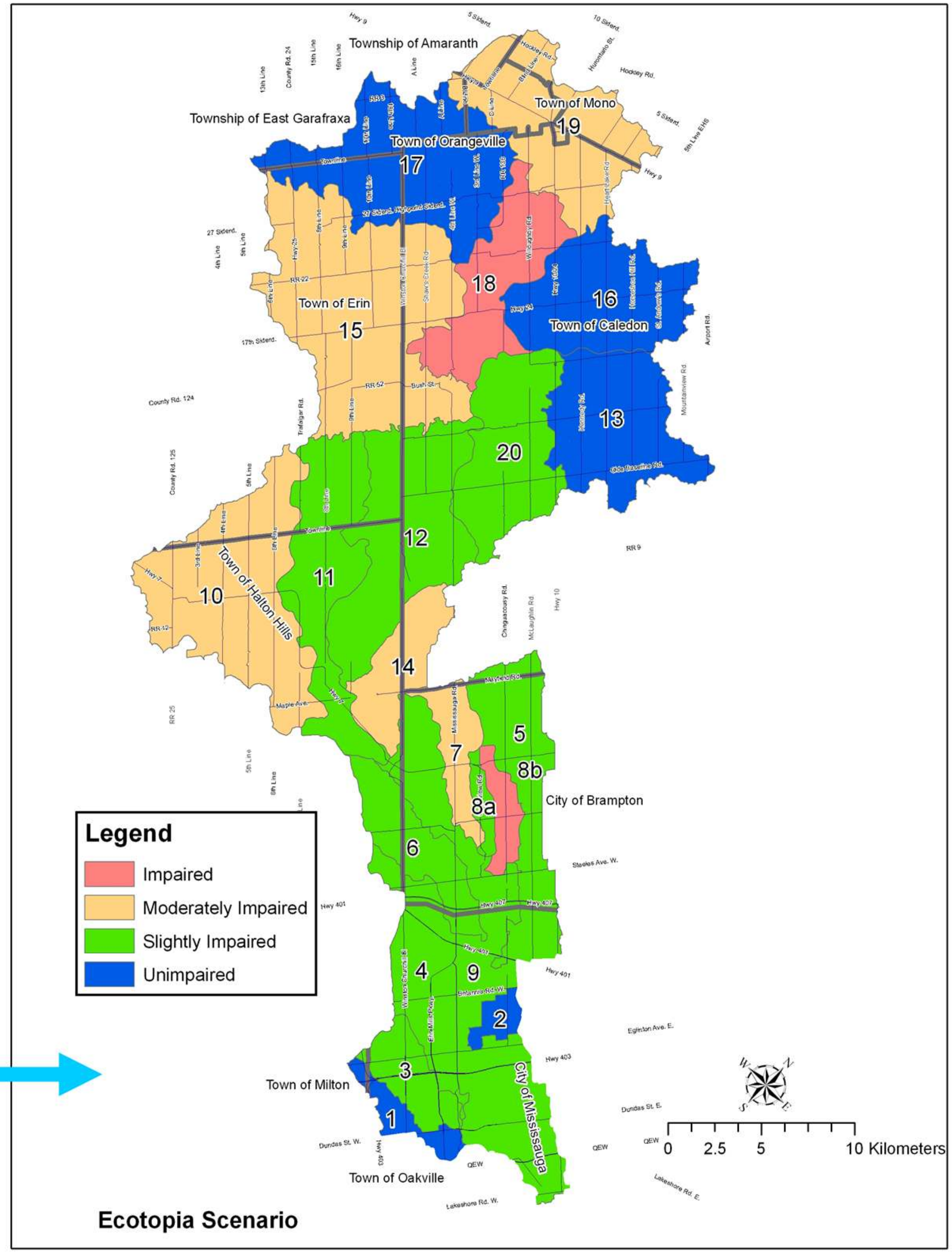


Urban Watershed Study Lessons



EXISTING CONDITIONS (15% URBANIZATION)

PREFERRED MANAGEMENT ALTERNATIVE (25% URBANIZATION)



Watershed Studies in Urban Areas

- Existing urban areas – not all urban watersheds are alike in terms of level of service for stormwater

City of Mississauga
25% receives quantity control
17% receives quality and quantity

Town of Caledon
54% of Bolton settlement area receives quantity control
64% of ponds provide water quality and quantity control

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Watershed Studies in Urban Areas

- Opportunities within urban areas vary in terms of technical feasibility
  - Time to retrofit (E.g., road retrofits with Low Impact Development)
- How to set an appropriate level of service for stormwater? What is feasible, reasonable, and needed? How to integrate Urban targets with Watershed Targets

Interconnected Systems

Storm water

Waste water

Drinking water

Extreme weather

Vulnerable populations

Emergency response

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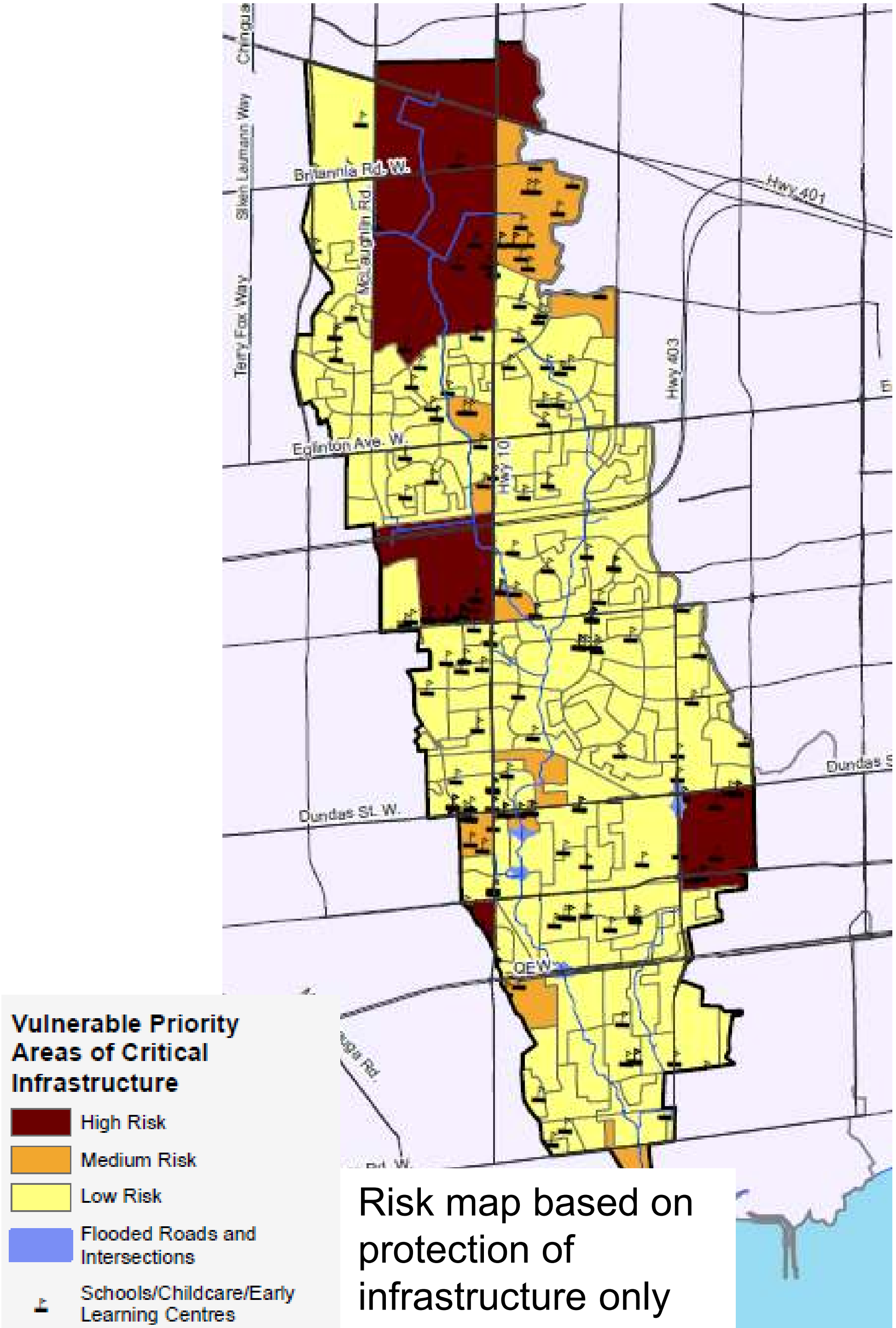
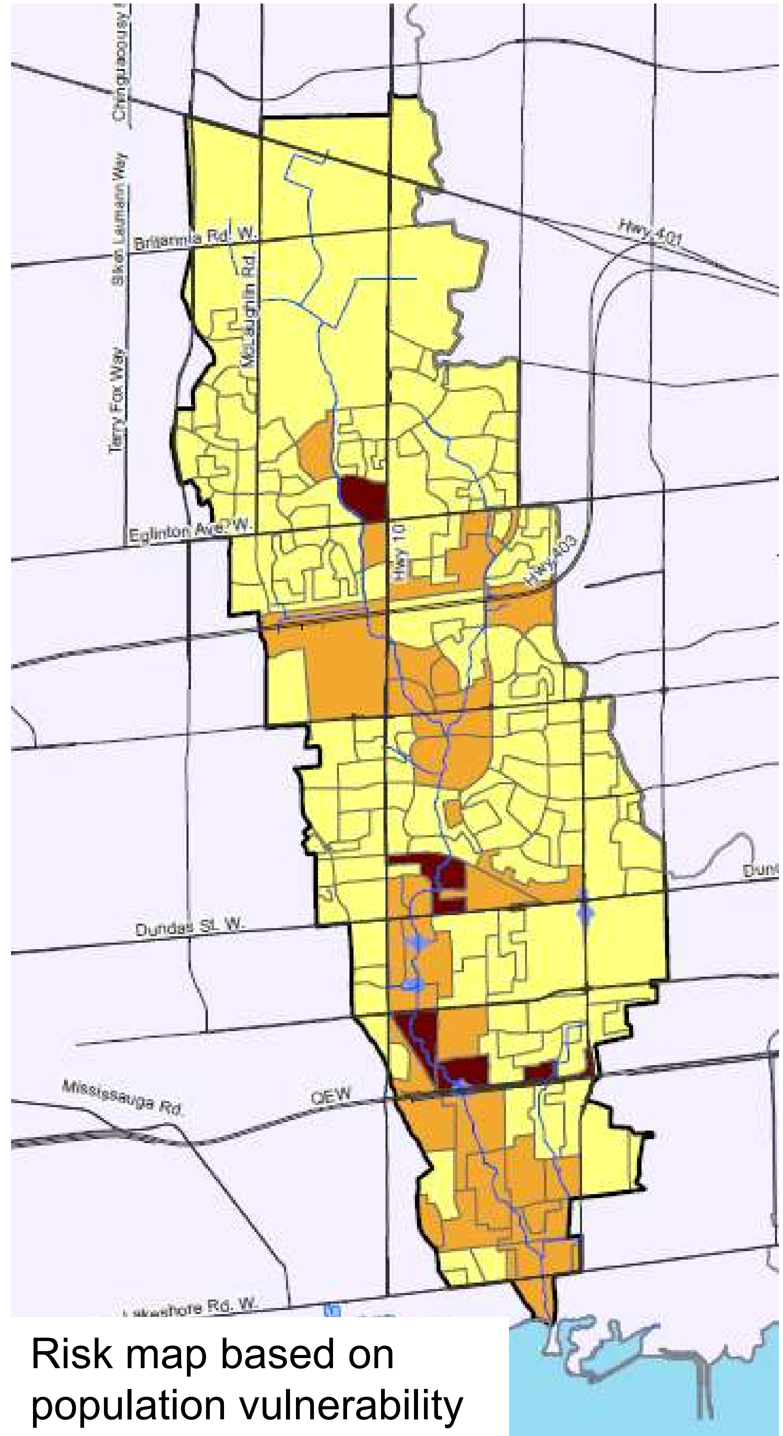
Natural Disasters are a threat to the public, we
need to re-evaluate evacuation plans



Risk map based on protection of infrastructure only



Risk map based on population vulnerability

Striking the Right Balance

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Need to Go from Grey to Green

Industrial & Commercial Lands

Residential Lands

Road Right of Ways

Public Lands

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PERCEPTION:
Storm water infrastructure will take away park lands and recreation

Reality

LID features can be implemented playgrounds with no impact to use

LID Options for Parks

Landscape Alternative

Permeable Pavement

Rain Garden

Bioswales

Dry ponds and infiltration

Rainwater Harvesting

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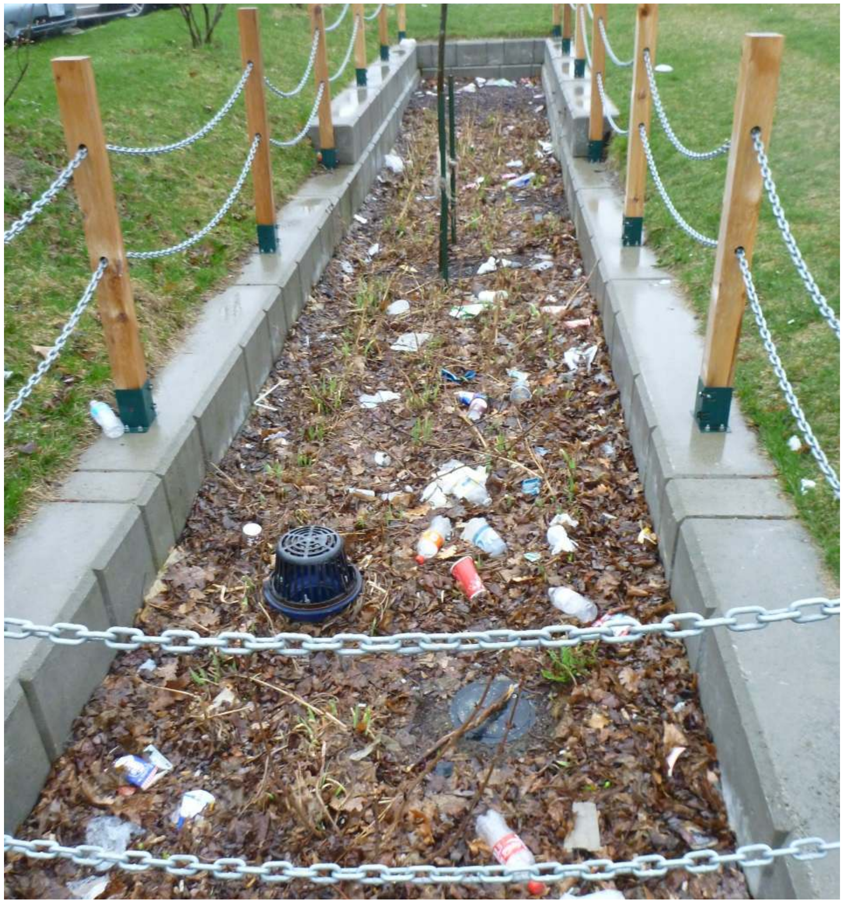
PERCEPTION:
LID costs more to maintain than ponds



Design Matters

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“No additional maintenance is required at parks with LID.”

Tad Makula and Rich Hurren, City of Mississauga

"This project will remedy a number of challenging maintenance issues and reduce our operating costs"

Nancy Cole, IMAX

PERCEPTION: LID does not perform in clay soils

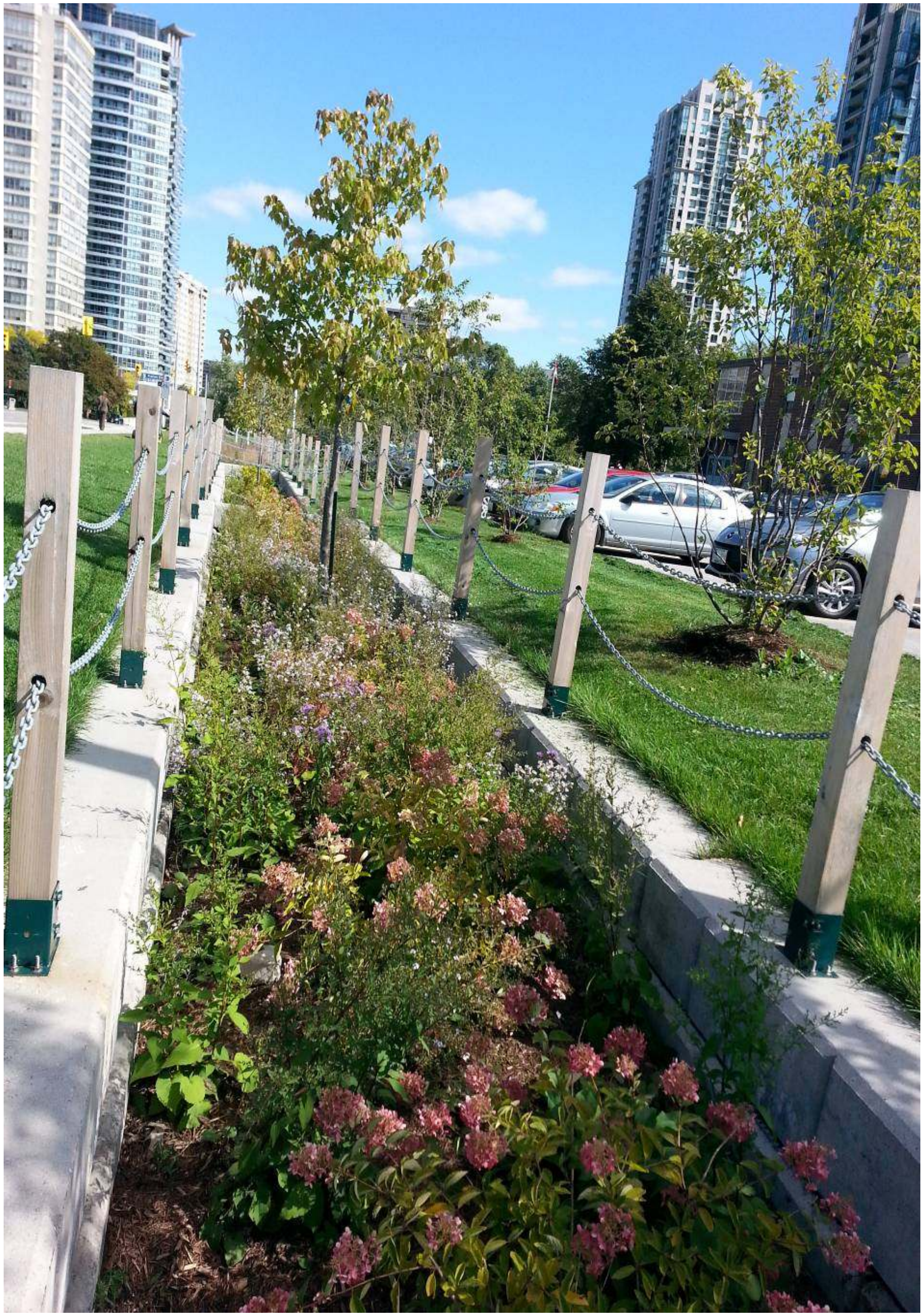
Road Right of Way – Performance Monitoring

- 90% of all rainfall events are absorbed by LID
- Only 3-8 rainfall events produce runoff
- For those 3-8 events, LID removed up to 99% of Total Suspended Solids and 84% Total Phosphorus
- Works during winter thaws

PERCEPTION: LID does not provide flood control

LID Performance

- LID reduced up to 60% of the peak runoff;
- LID reduced volume by 30% (30 mm)
- Delayed the timing of the peak by 20 minutes



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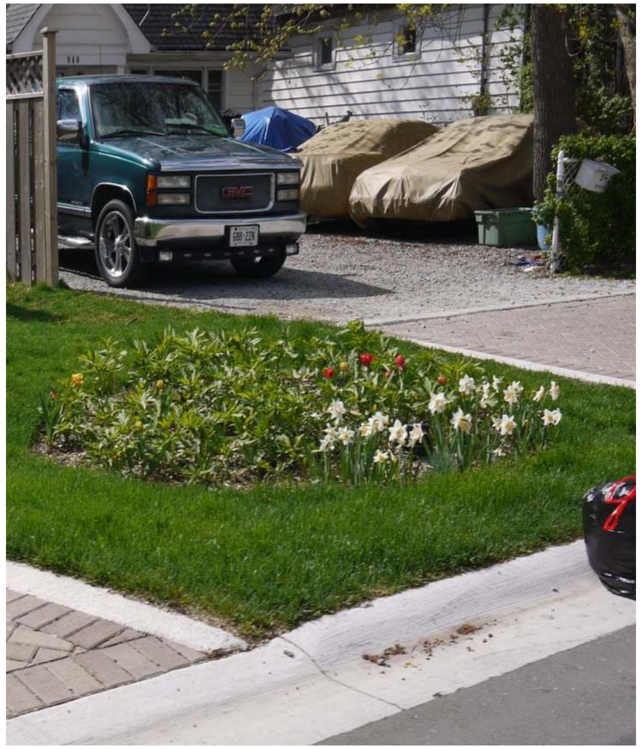
PERCEPTION: Residents won’t maintain the LID

LID Options - Right Design Right Location

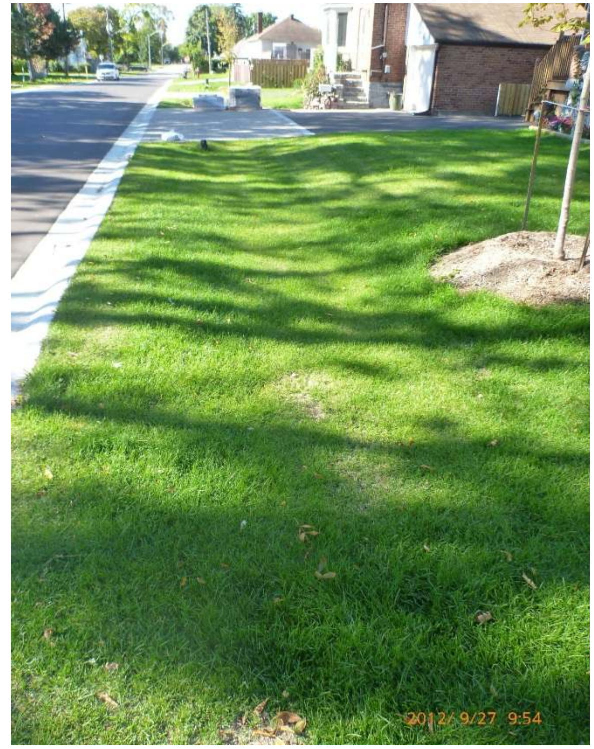
City Centre Showcase Area

Well maintained by city as with other landscaping beds in showcase areas



Neighbourhood with high ownership rate

– will be adopted by owners and maintained

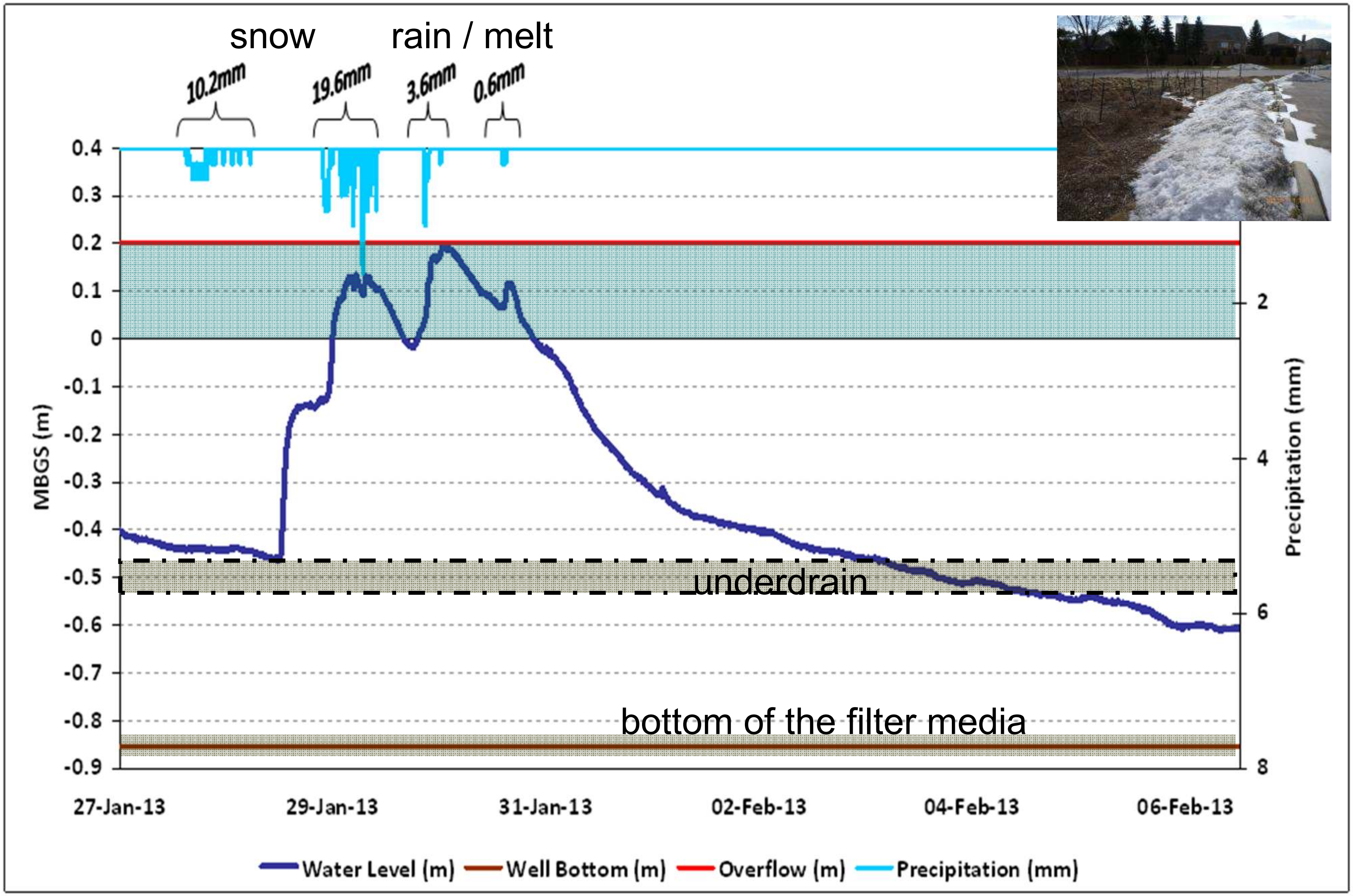


High rental rate / ongoing maintenance concerns

– low maintenance grass option preferred

PERCEPTION: LID does not perform in winter

Do LID Features Work in Winter?



Monitoring Suggests

- LID offers “quick-win” opportunities in flood prone areas while larger scale SWM measures are being designed, constructed
- Data supports International BMP database (BMPDB) and National Stormwater Quality Database (NSQD), and STEP;
- City of Mississauga passes Resolution to look at all capital roads projects for LID feasibility

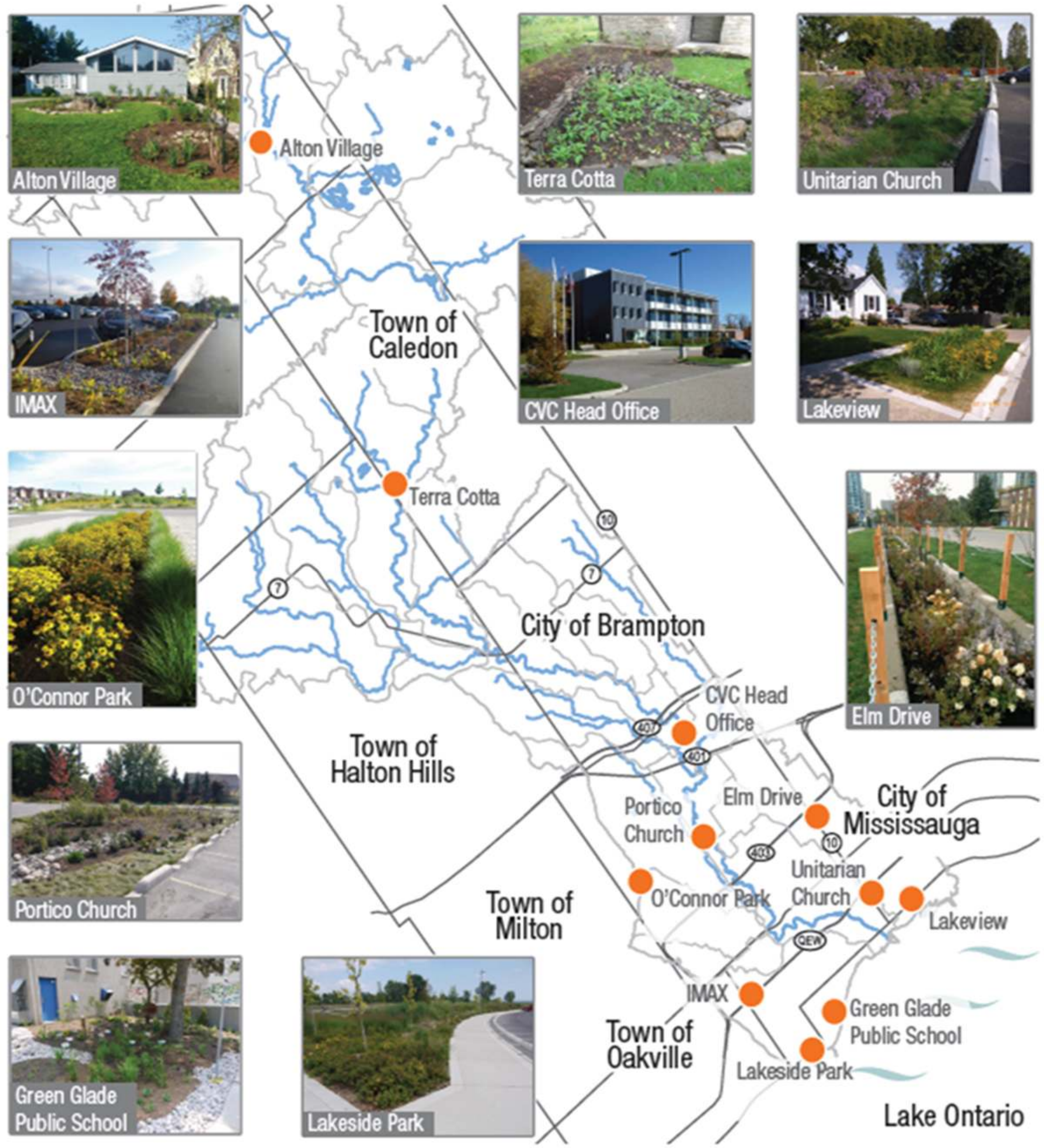


BREAK

LID Design and Performance

With our Municipal Partners:

- 61 LID Sites
- 12 Demonstration Sites
- 19 key performance and maintenance objectives



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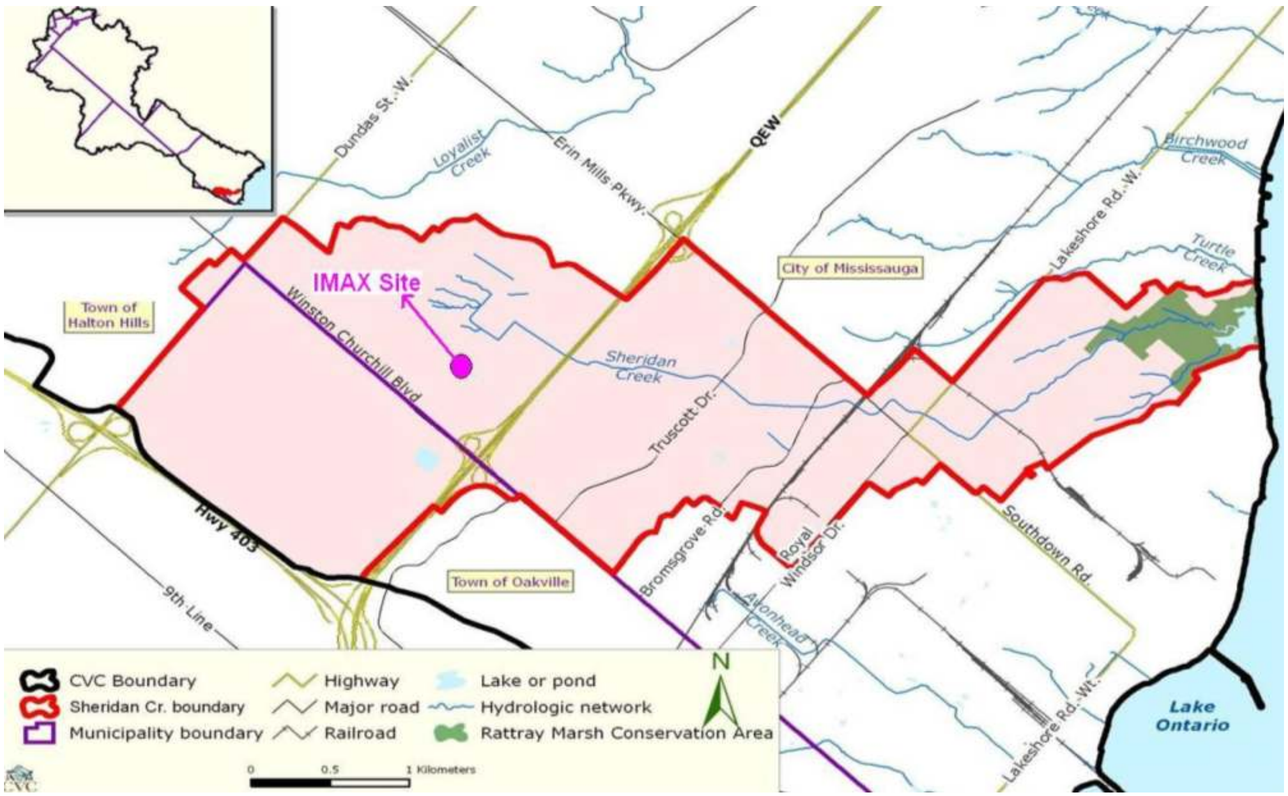
Top Five Stakeholder Objectives

1. Long term maintenance needs and impact on performance;
2. Lifecycle costs (asset management);
3. Water quality and quantity performance of LID design in low infiltration soils;
4. How multiple LIDs treat and manage stormwater;
5. Performance of flood control, erosion control, water quality and natural heritage protection.

IMAX – Industrial Commercial



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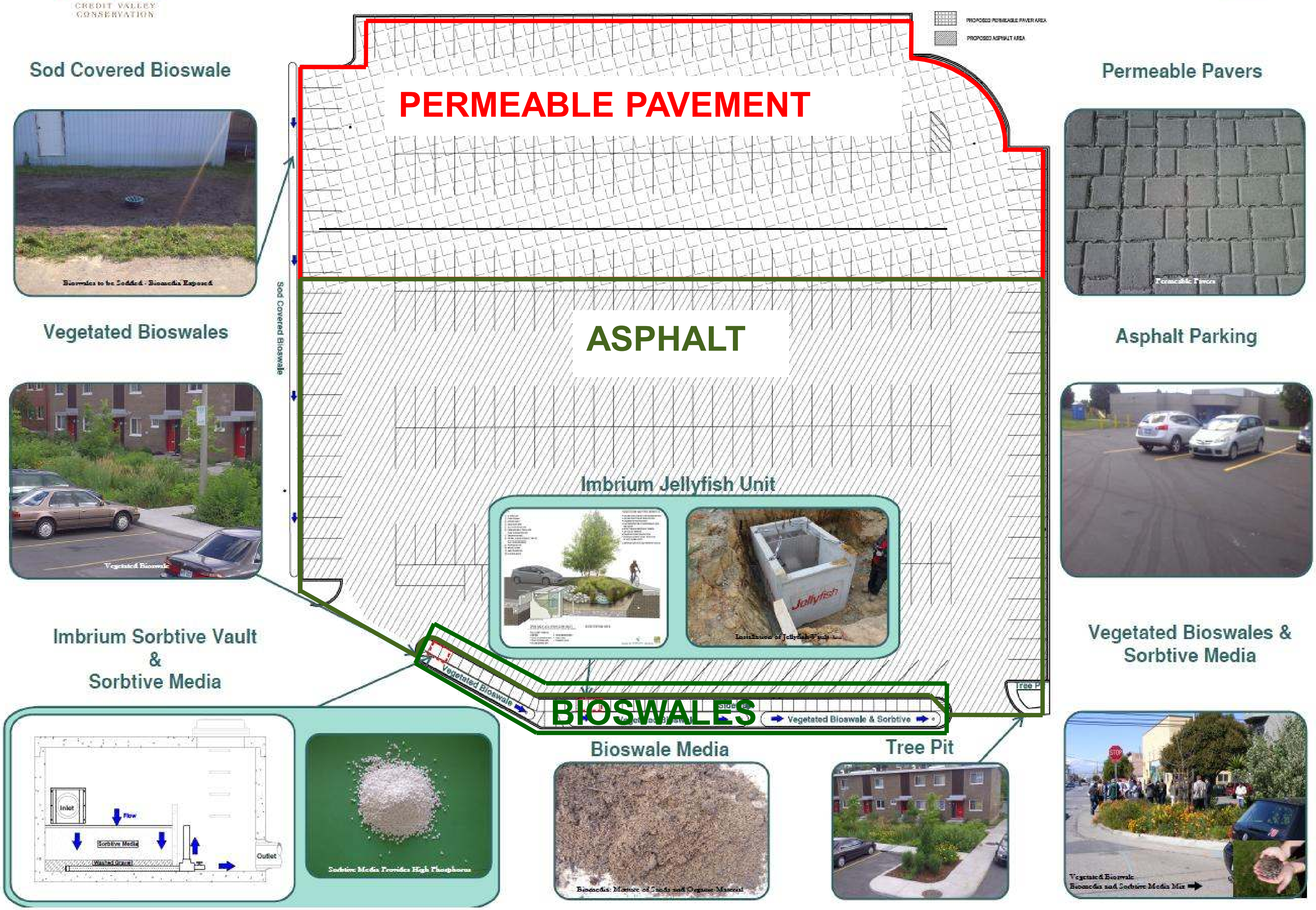
Aquafor Beech Limited

IMAX Corporation
Parking Lot Expansion & Redevelopment



Bioswale Treatments

Bioswale to Sorbtive

Jellyfish to Bioswale

Stand alone Bioswale

Sorbtive® Vault

- Adsorbs and retains dissolved phosphorus

Jellyfish® Filter

- Removes total suspended solids and particulate-bound pollutants

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Bioswale in action!

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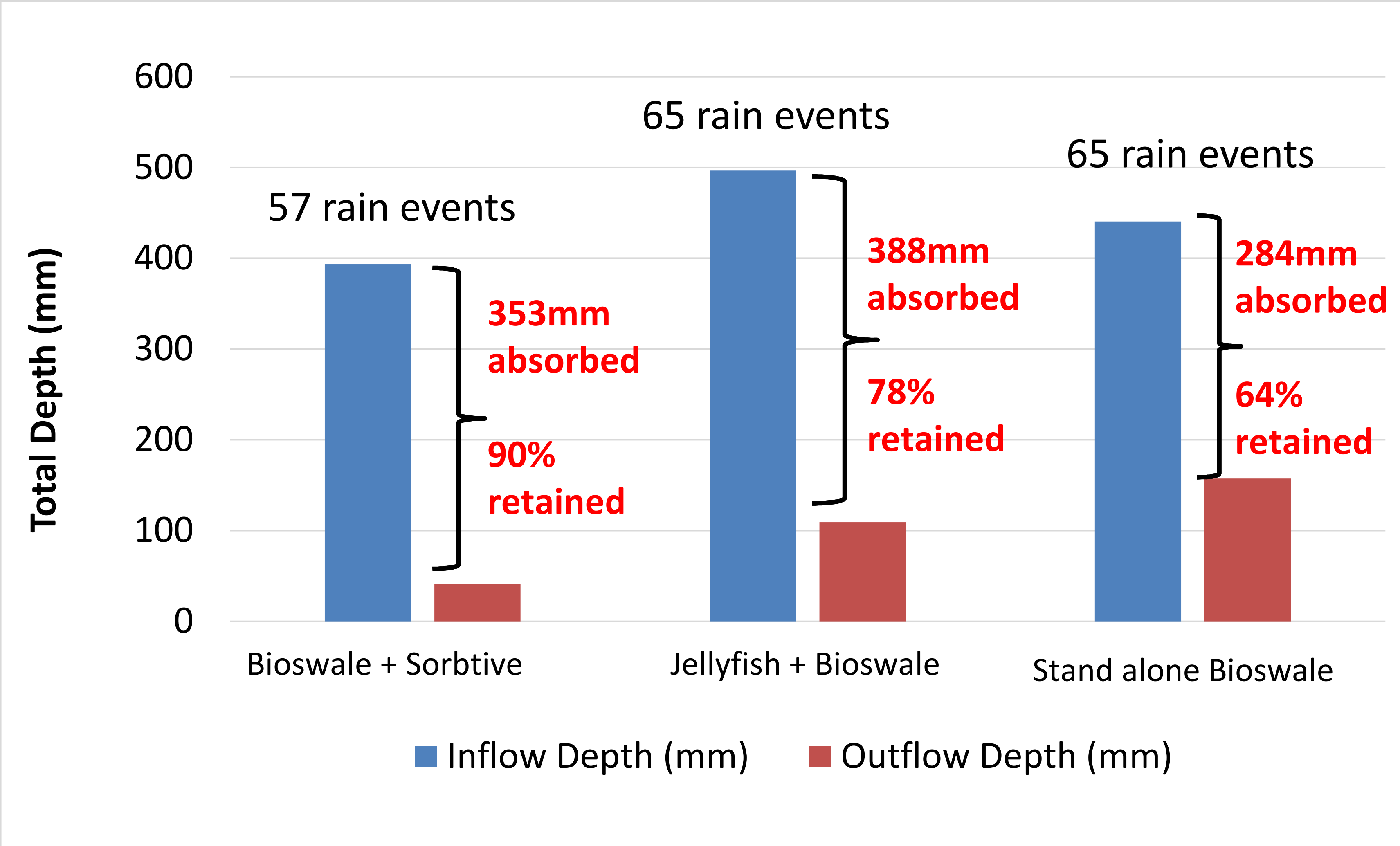
Bioswale Water Quantity



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Bioswale Water Quality

Metric	Criteria	Bioswale + Sorbtive	Jellyfish + Bioswale	Stand Alone Bioswale	SWMP
Runoff Volume Reduction	15 mm	22.4	19.5	16.1	0
TSS Removal	80%	98	99	97	61***
Phosphorous Removal	80% (40%)	90	65*	57*	1.5**

*As-built drainage area constructed almost twice as large as the as-designed
**2010 Stormwater Pond Maintenance and Anoxic Conditions Investigations – Final Report, 2011
*** International Stormwater BMP Database

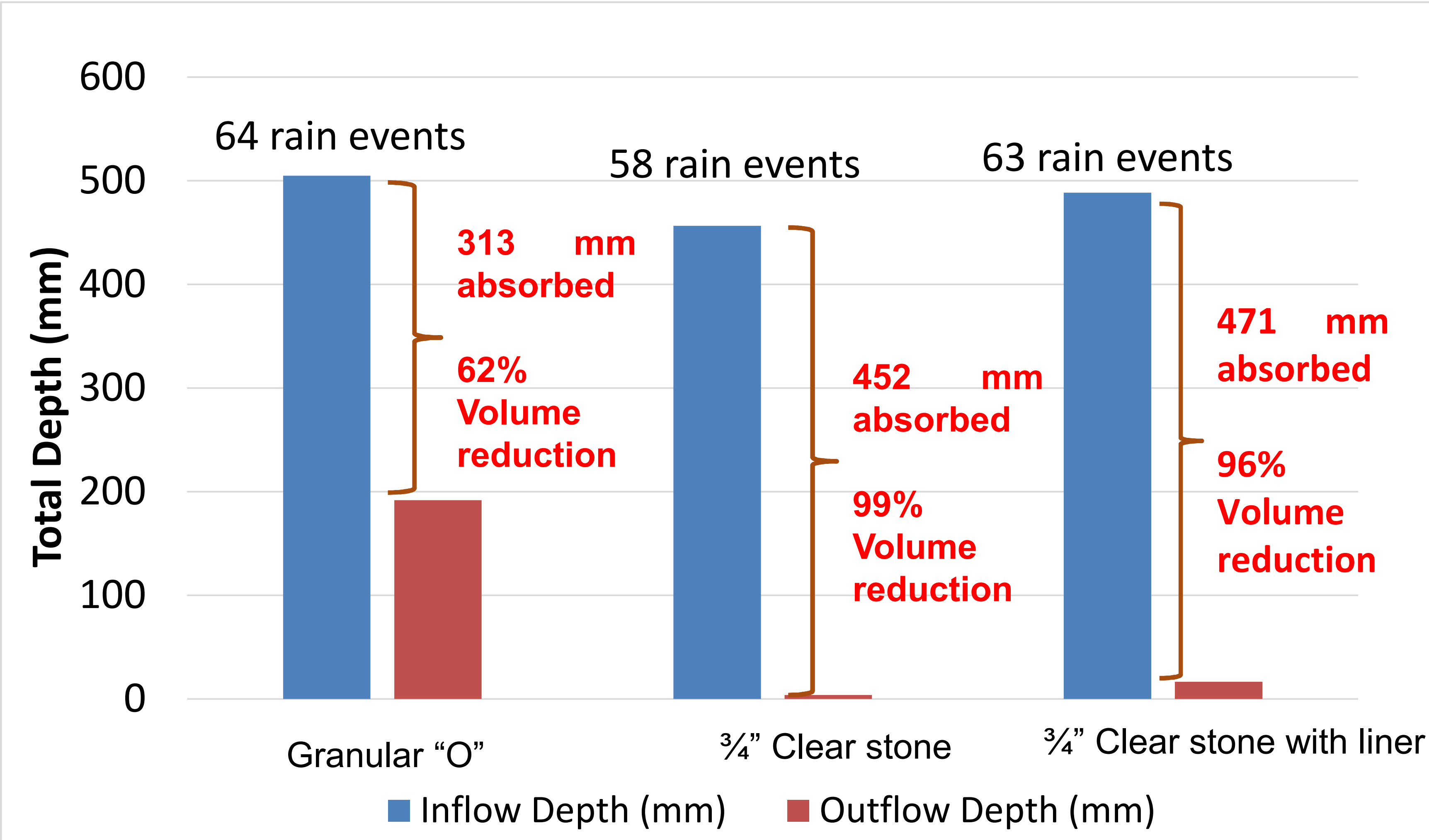
Permeable Pavement Treatments

Granular "O" aggregate

¾" Clearstone aggregate

¾" Clearstone aggregate with geosynthetic clay liner

Permeable Pavement Water Quantity



Permeable Pavement Water Quality

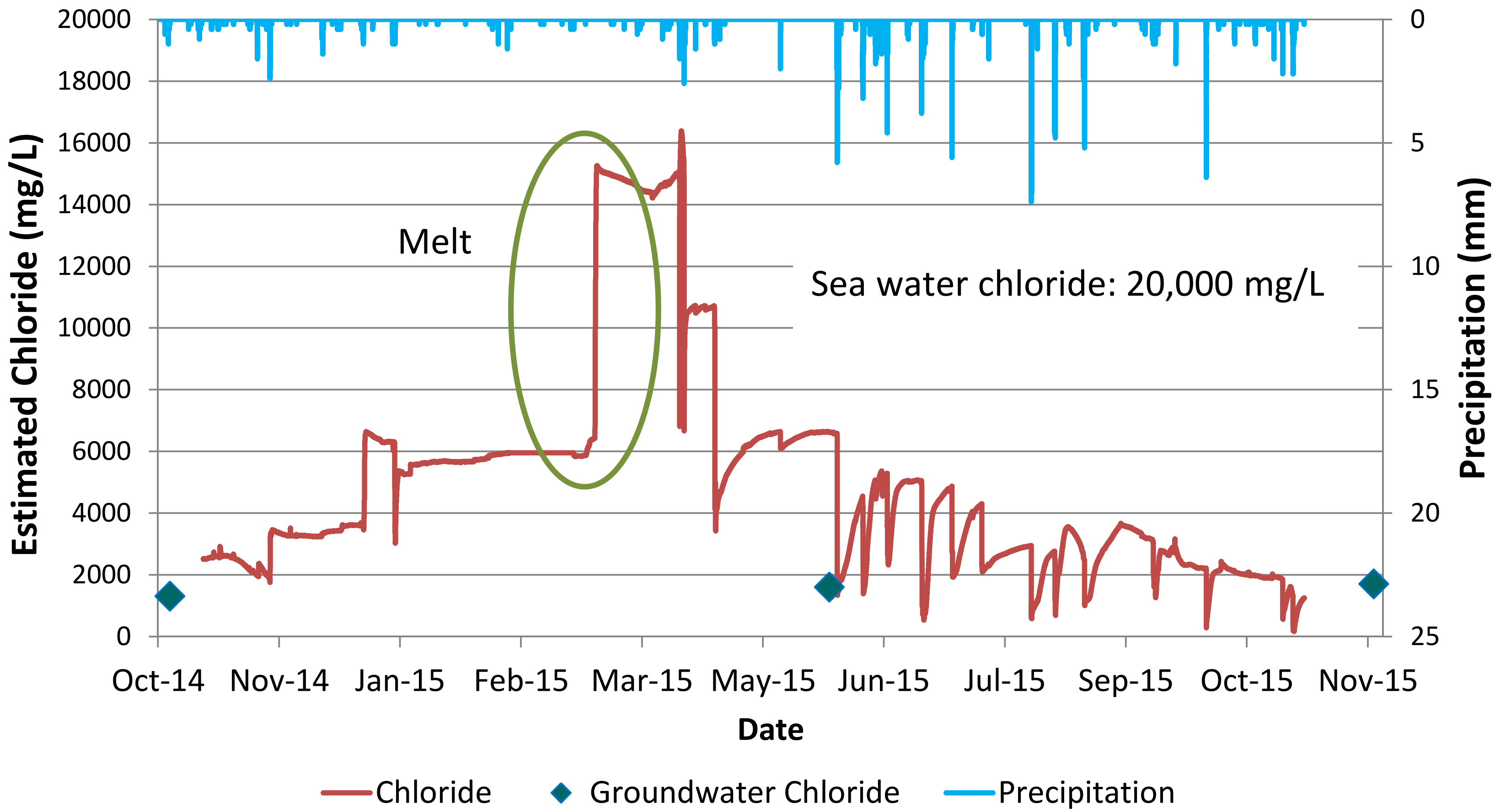
Metric	Criteria	Granular "O"	¾" Clear stone	¾" Clear stone with liner	SWMP
Runoff Volume Reduction	15 mm	15.5	24.8	24.2	0
TSS Removal	80%	93	100	97	**61*** **
Phosphorous Removal	80% (40%)	92	100	99	**1.5****

*As-built drainage area constructed almost twice as large as the as-designed

**2010 Stormwater Pond Maintenance and Anoxic Conditions Investigations – Final Report, 2011

*** International Stormwater BMP Database

Permeable Pavement with Liner Chloride Monitoring



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Elm Drive – Road Right of Way

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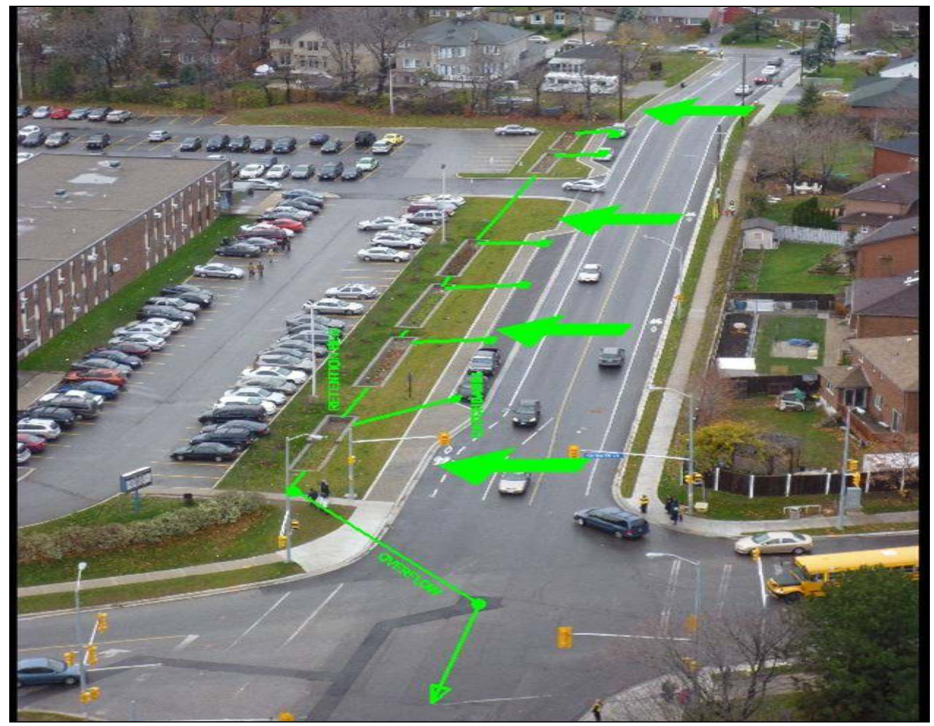
<u>Before:</u>

Split road drainage

No sidewalks

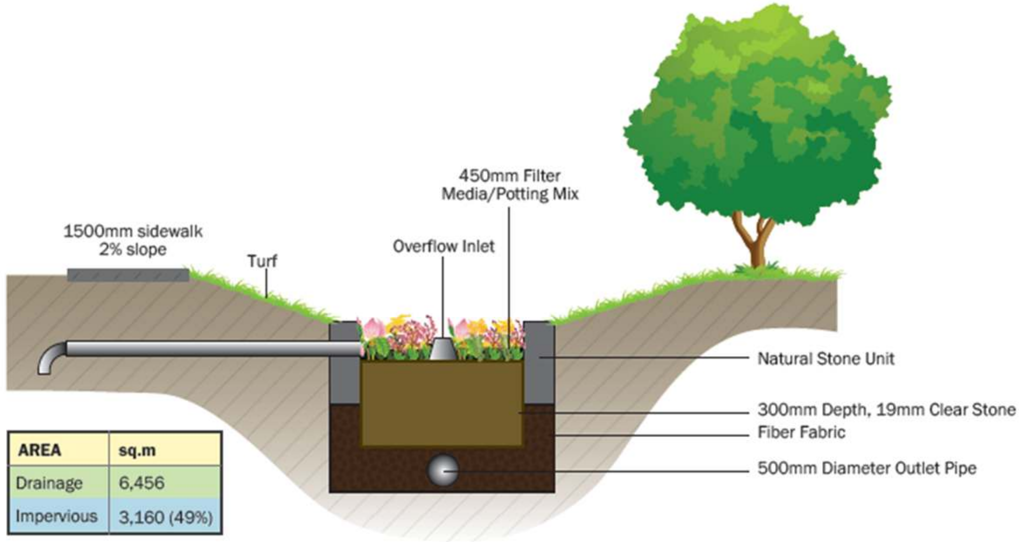
Aesthetically unappealing



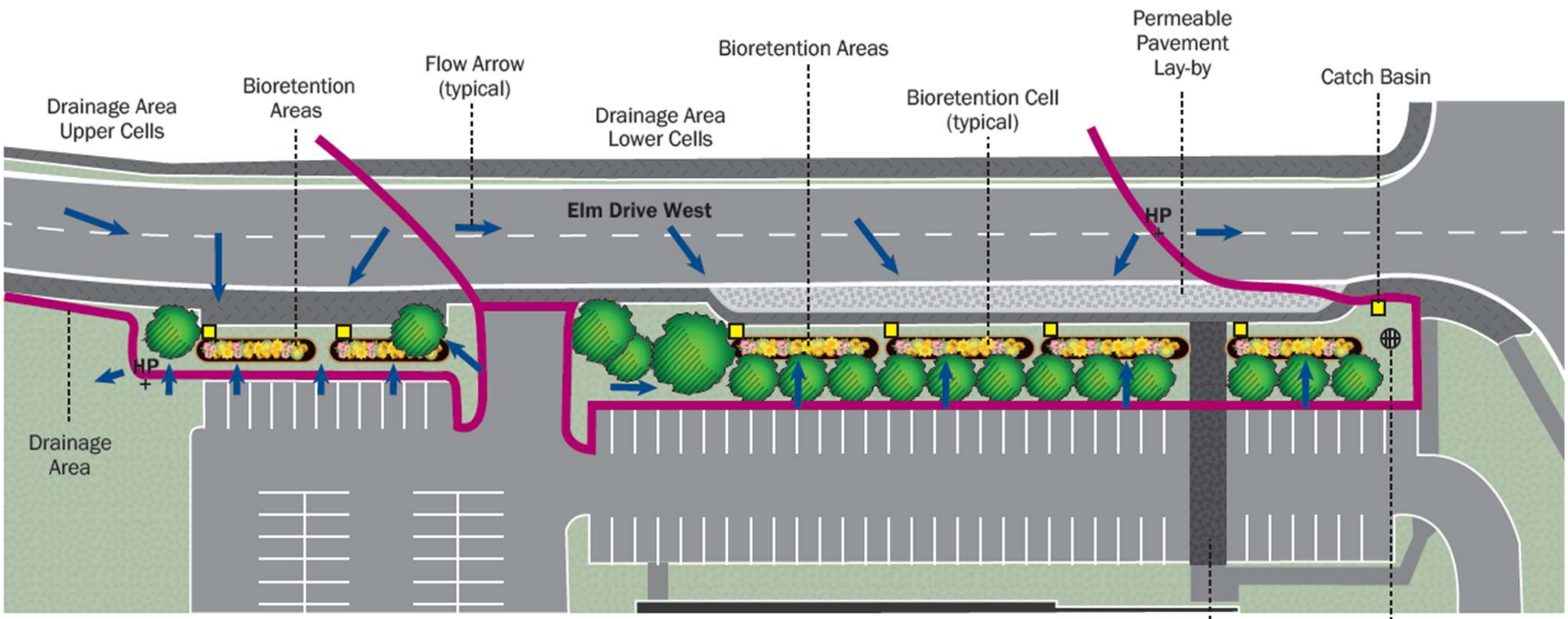
<u>After:</u>

Road re-graded so all runoff goes to the LID facility

Tight native soils: infiltration rate of **7.5 mm/h**

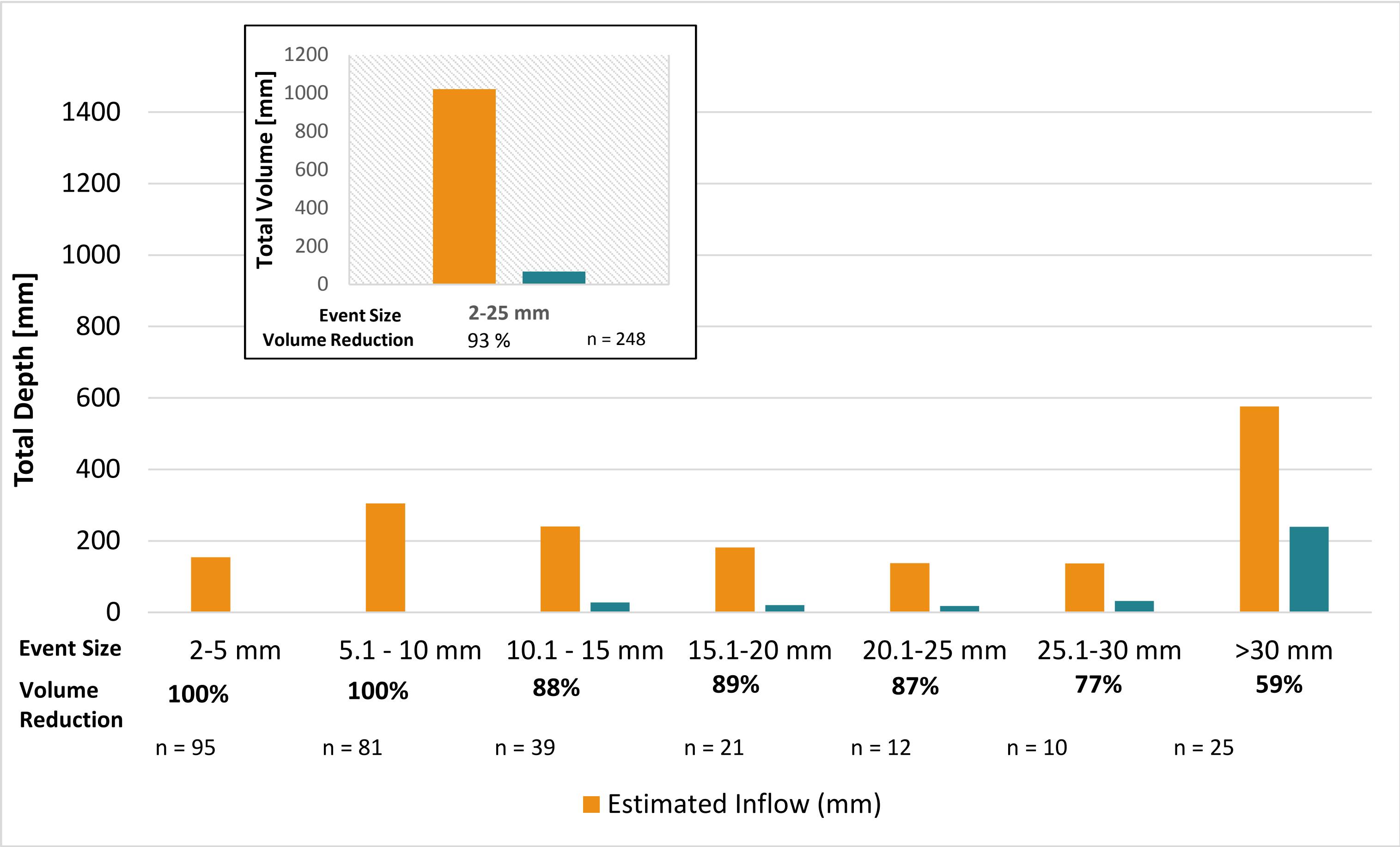


AREA	sq.m
Drainage	6,456
Impervious	3,160 (49%)



Elm Drive Low Impact Development Retrofit

Quantity Performance: Volume



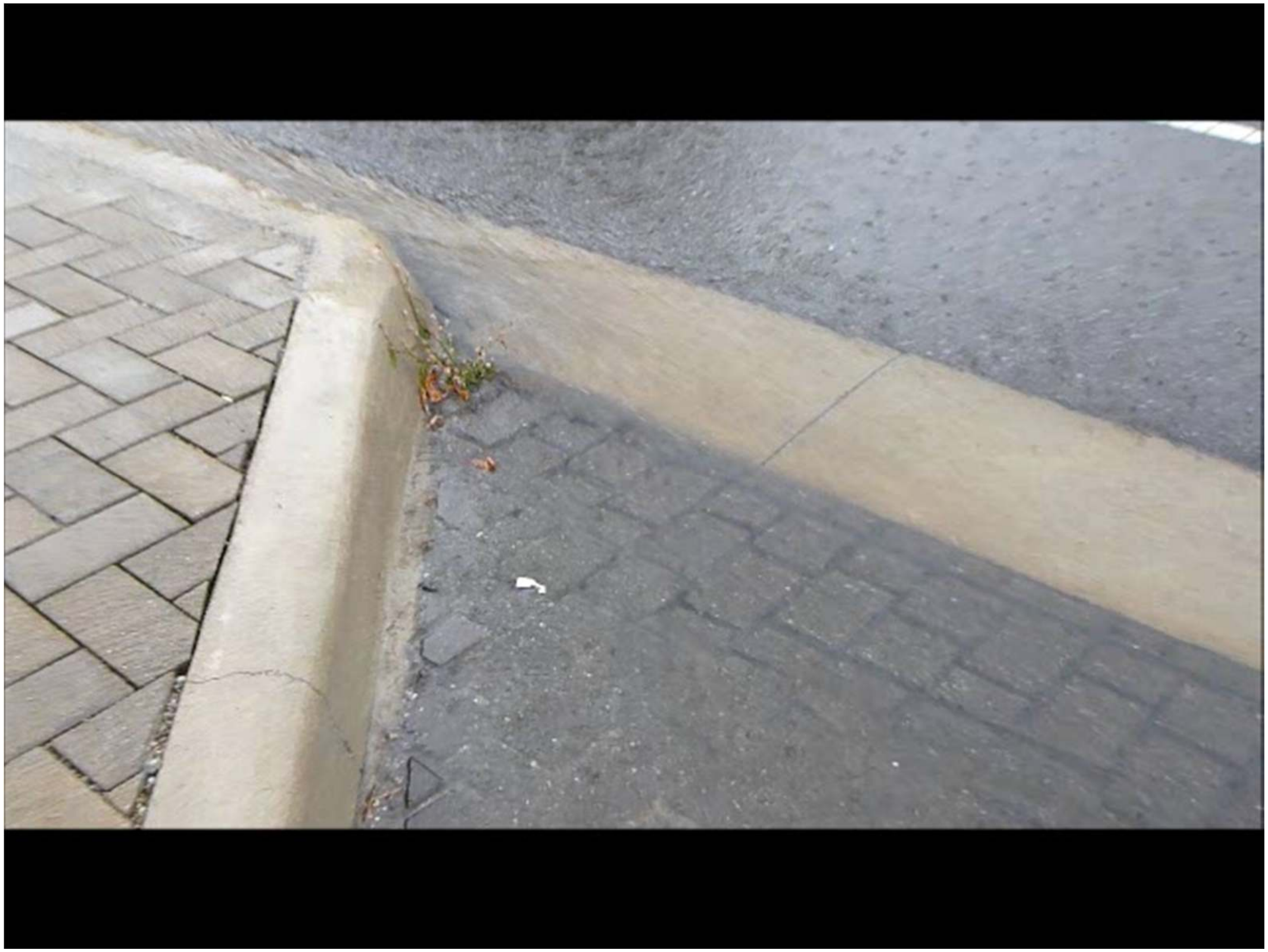
Note: Data is an aggregation of monitoring results from 2011 to 2015 (inclusive)

Bioretention Water Quality

Metric	Criteria	Performance at Elm*	SWMP
Runoff Volume Reduction	15 mm	24 mm	0
TSS Removal	80%	88%	**61*** **
Phosphorous Removal	80%	91%	**1.5****

*As-built drainage area constructed almost twice as large as the as-designed
**2010 Stormwater Pond Maintenance and Anoxic Conditions Investigations – Final Report, 2011
*** International Stormwater BMP Database

Performance Evaluation: Precipitation Video



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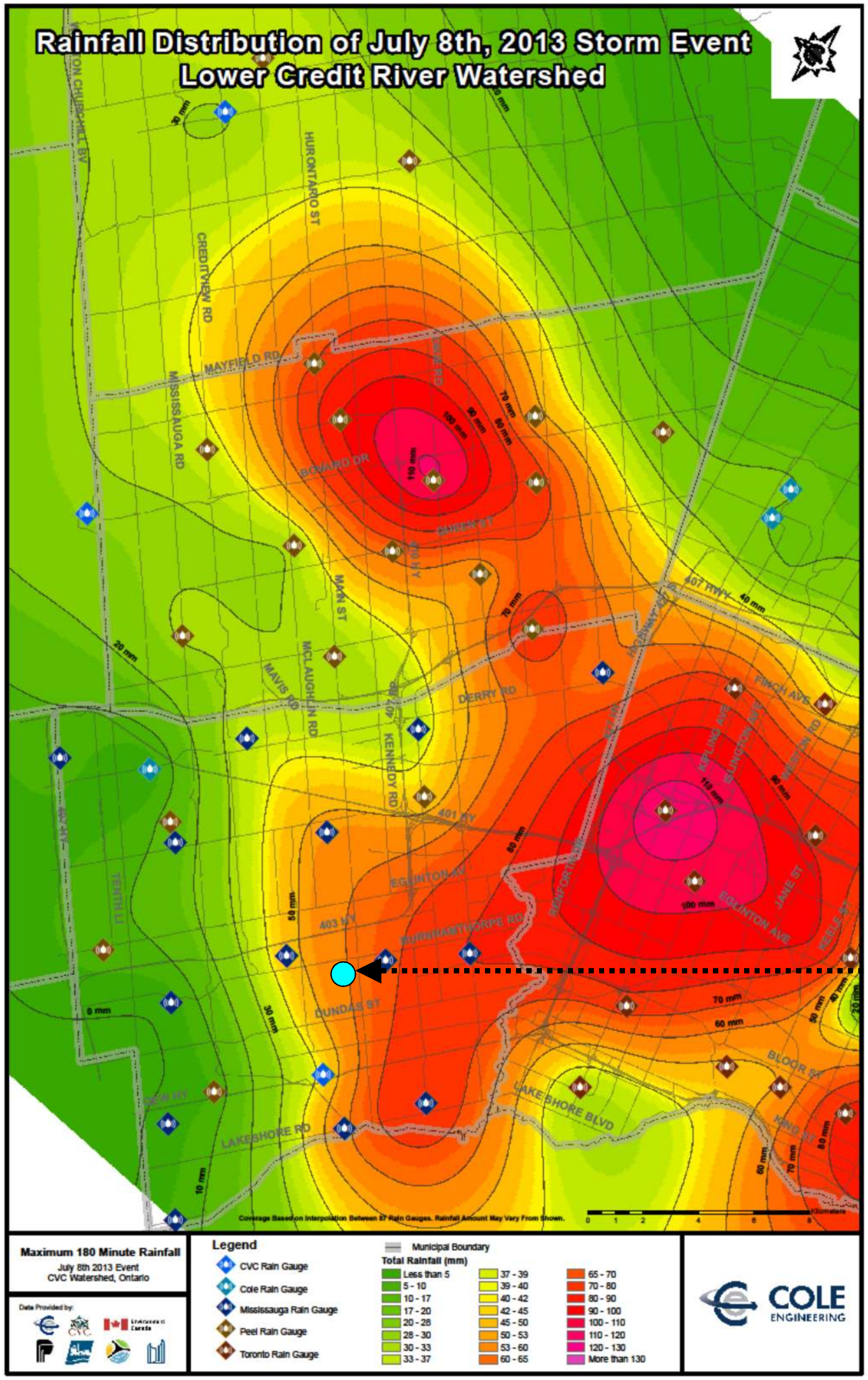
July 8th 2013 – Elm Drive Performance



Event greater than 100 year design storm

105 mm in 5 hours, 242 mm/hr intensity

- ~20 minute lag time
- ~30% volume reduction
- ~60% peak flow reduction

Elm Drive LID Site

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Meadows in the Glenn – Residential

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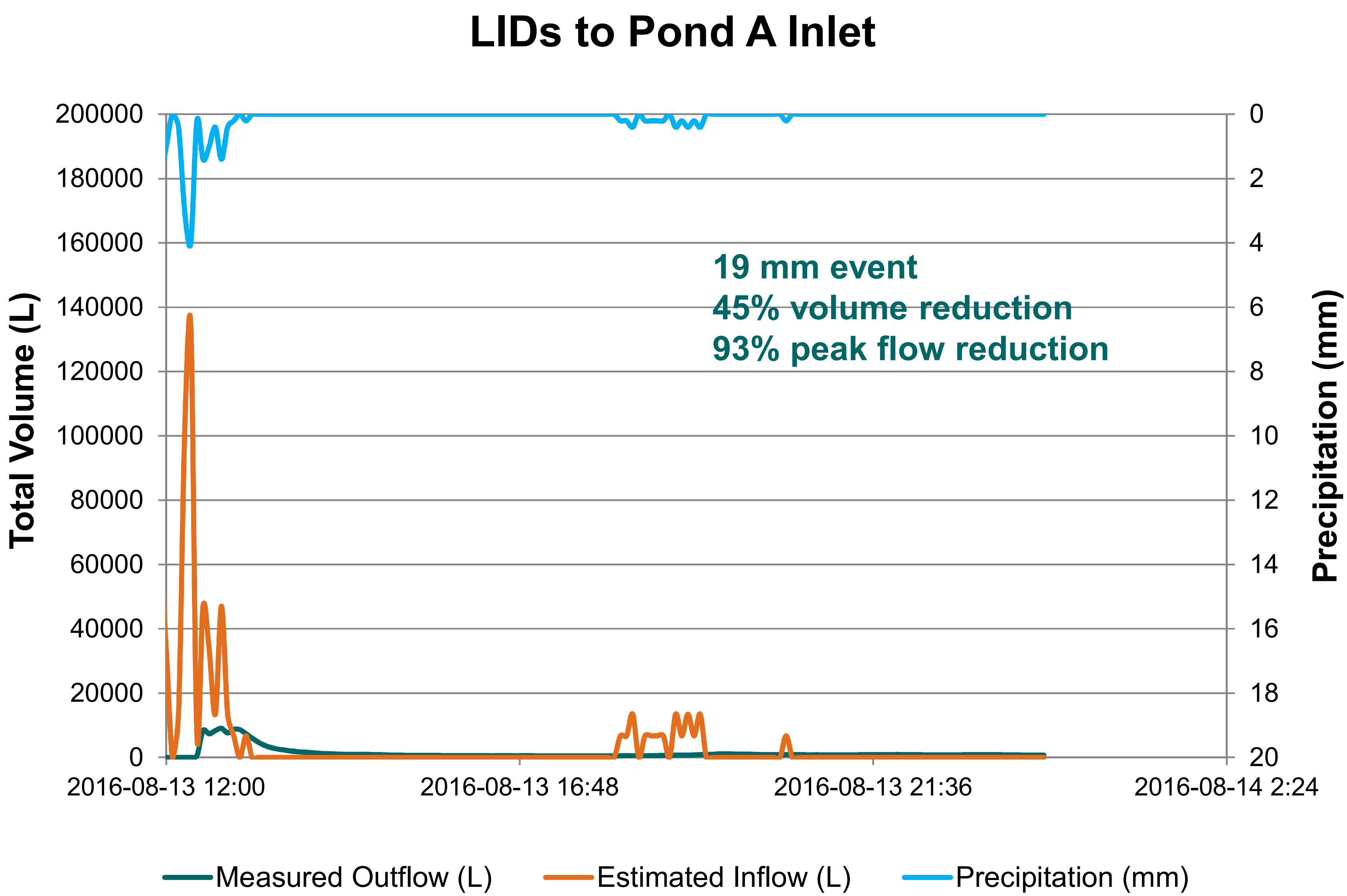
LID features at Meadows in the Glen

1. Swale drainage
2. Biofilters or bioretention cells
3. Soakaway pits
4. Rain gardens
5. Permeable Pavement Driveways



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MITG: Low Pond Levels in Summer Months

Wychwood Residential Subdivision

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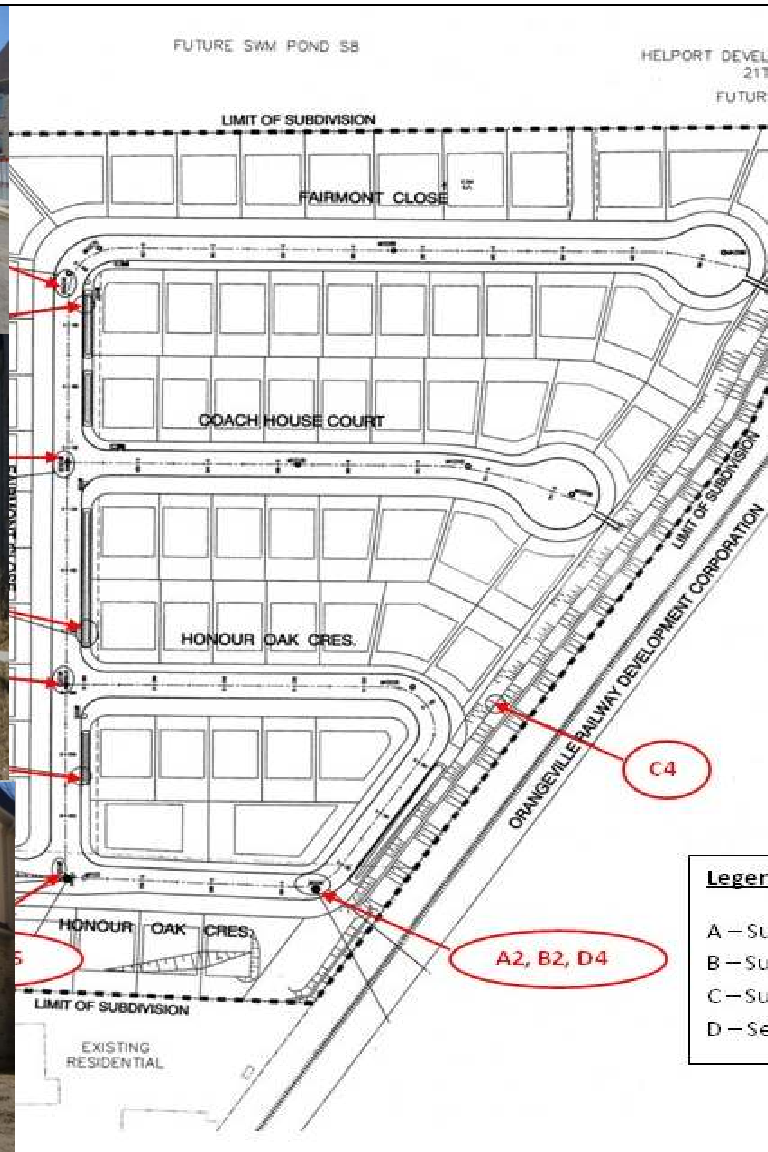
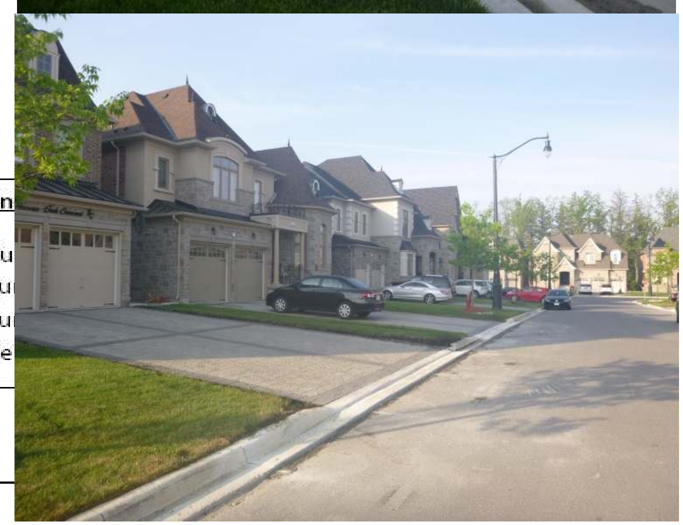
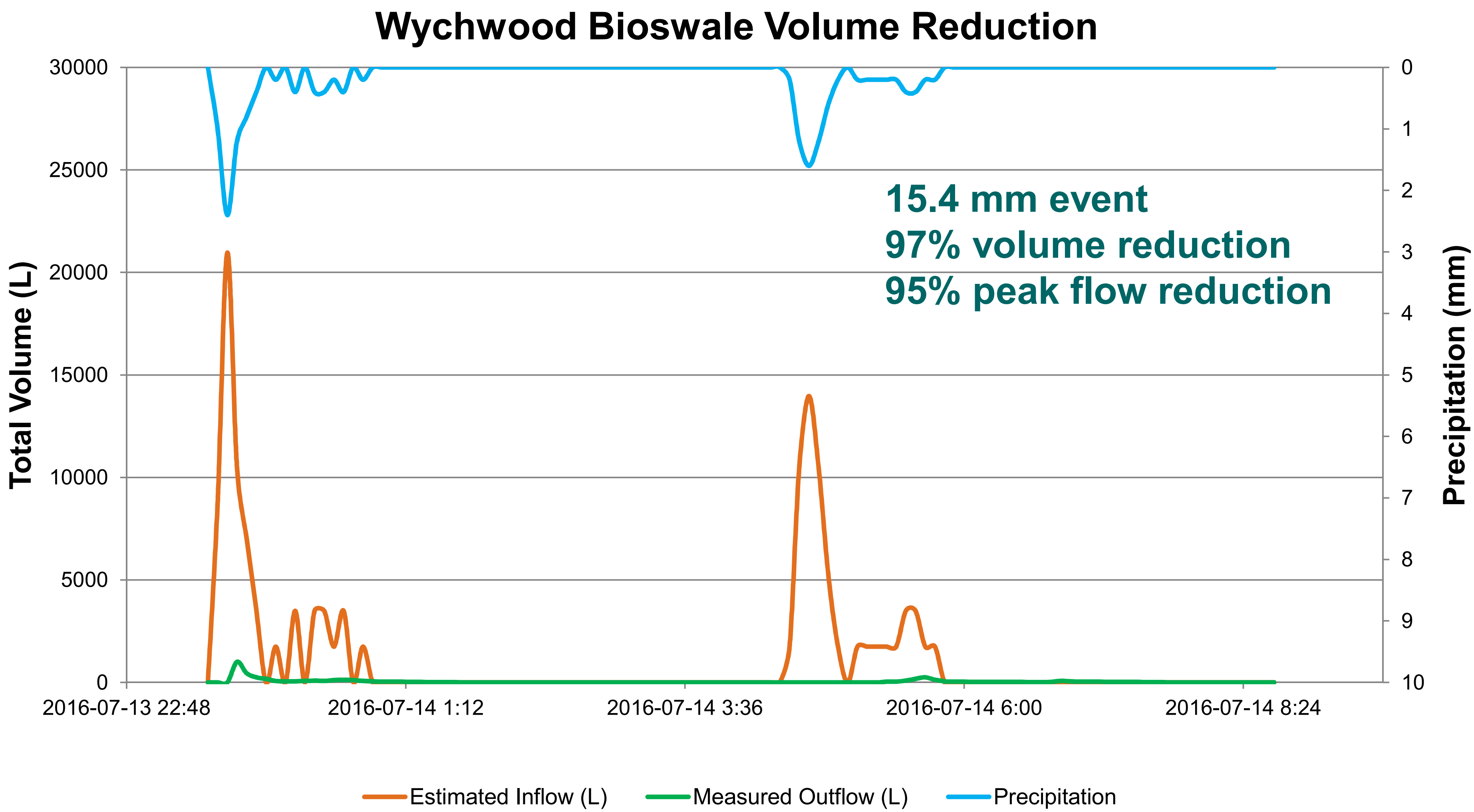
Site Layout





FUTURE SWM POND SB
LIMIT OF SUBDIVISION
FAIRMONT CLOSE
COACH HOUSE COURT
HONOUR OAK CRES.
LIMIT OF SUBDIVISION
ORANGEVILLE RAILWAY DEVELOPMENT CORPORATION
C4
A2, B2, D4
HONOUR OAK CRES.
LIMIT OF SUBDIVISION
EXISTING RESIDENTIAL



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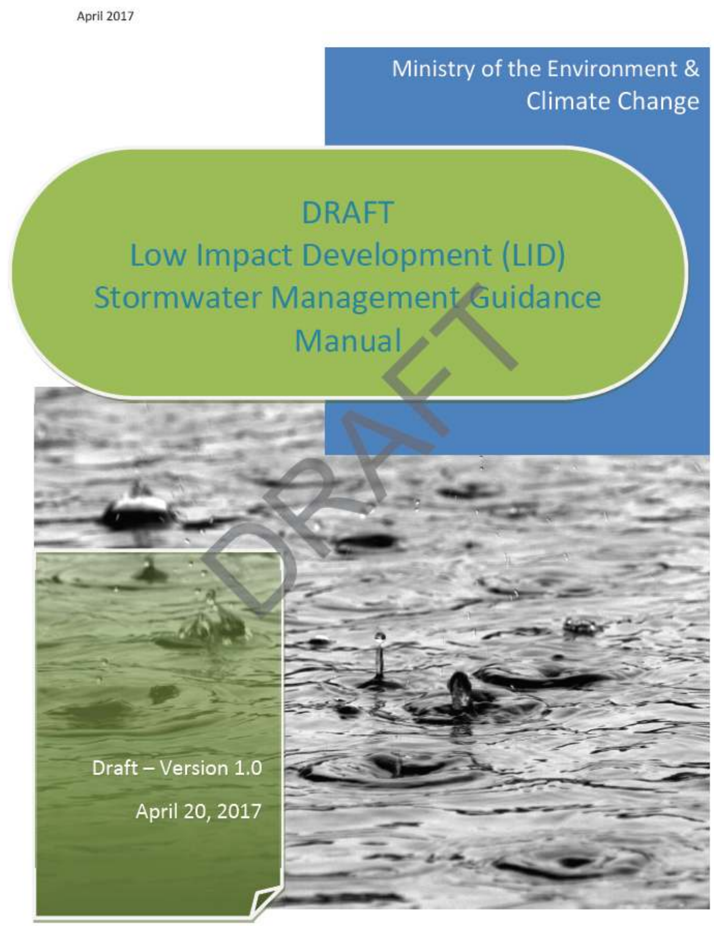
DRAFT MOECC LID Manual Requirements, 2017

Hierarchy (MOECC, 2017)

- Begin with better site design
- Utilize natural systems and preserve existing natural systems;
- Create multifunctional landscapes that achieve goals and objectives beyond stormwater management to include broader community goals of livability and sustainably as well as environmental protection objectives;
- Contribute to water sustainability across the watershed to reduce the use of resources including potable water; and
- Provides climate change co-benefits (contributes to both climate change mitigation and adaptation, it is a climate co-benefit)



Draft MOECC LID Requirements (MOECC, 2017)

Mandatory Runoff Volume Control Targets (RVC_T) Hierarchy

If site restrictions prevent the implementation of the hierarchy, provide justification and refer to the **alternative requirements

Priority 1: Maintain pre-development water balance. 100% retention (if possible)

Of total rainfall event of the 90th percentile for the area (See Graphic)

Priority 2: Capture and release

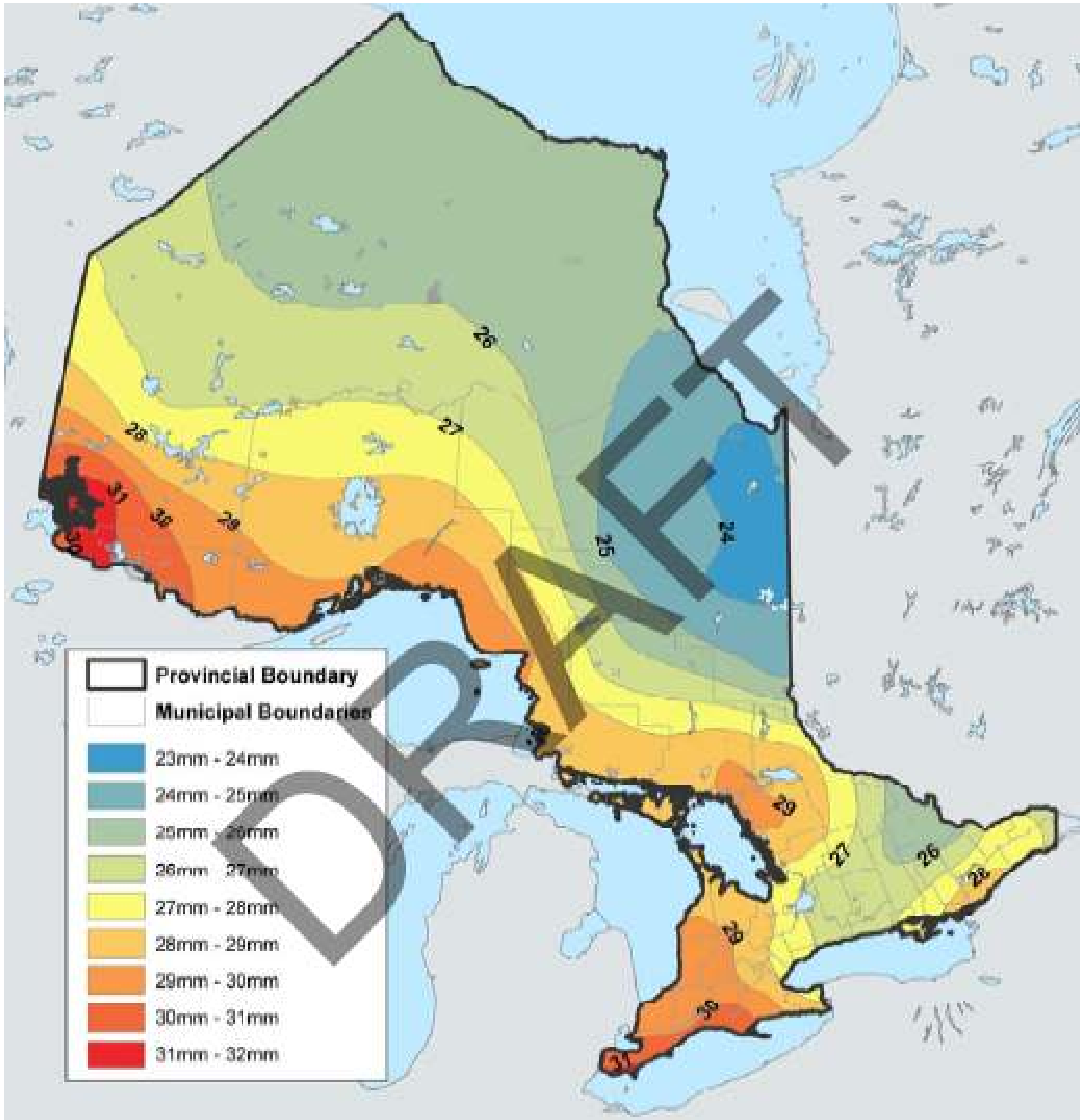
Runoff volume not retained must be filtered and released back into the system at a reduced rate

Priority 3: Other volume detention and release

Any “still remaining” runoff volume not detained or treated must use other stormwater technologies i.e.: end of pipe facilities to detain and treat runoff and release back into the system at a reduced rate

Regionally Specific 90^{th} Percentile RVC_T Requirements for Ontario

Source: MOECC, 2017



Draft Alternative Requirements (MOECC, 2017)

- Two (2) alternatives are identified for sites with restrictions (i.e. constraints). These constraints may include:
  - shallow bedrock
  - high groundwater table
  - contaminated soils
  - swelling clays or unstable sub-soils
  - high risk site activities including spill prone areas.

Sites with Restrictions/Constraints

Alternative 1: Reduced Runoff Volume Control Target (RVC_T)

- 75% reduction of the 90th percentile rainfall event for the area
- Relocation of features as needed to meet the target

Alternative 2: Maximum Extent Possible

- XX% (site specific) of volume reduction
- Relocation of features as needed to meet target

Direct Discharge of Stormwater to Watercourses or Wetlands (MOECC, 2017)

- Reduced pollutant loads
- 100% retention of the 90th percentile event for storm sewers discharging directly to a water course or wetland,
- Alternatives #1 and #2, will not be considered.

Location: Cooksville Creek, Mississauga ON

Source: AOTU, 2018. http://angelsoftheunderground.ca/drains/cooksville-creek/rusty-bucket/index.html

Does Elm Drive meet the Draft RVC_T Hierarchy? …the answer is yes…

Mandatory Runoff Volume Control Targets (RVC_T) Hierarchy

Priority 1: Maintain pre-development water balance. 100% retention (if possible)

***90th percentile for the area = 25 mm**

LID treatment train retains a 24 mm event

Examine outflow data for events between the range of 2-25 mm to determine 100% retention.

Priority 2: Capture and release

No overflow for events up to 25 mm.

Examine well data within bioswales to determine if any 25 mm events create untreated SW bypass

Priority 3: Other volume detention and release

No other volume detention is available nor needed

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CVC TRCA LSRCA Treatment Train Tool

- Designed to help you meet MOECC requirements with respect to Low Impact Development
- Assist Conservation Authorities and Municipalities provide approvals
- Next Training Session Details: **November 17th, 2017 9:30 am to 3:00 pm**
  CVC Board Room; 1255 Old Derry Road, Mississauga, L5N 6R4
- More training sessions to be announced in 2018. For more information, please visit: http://www.sustainabletechnologies.ca/wp/events/lid-treatment-train-tool-mississauga/

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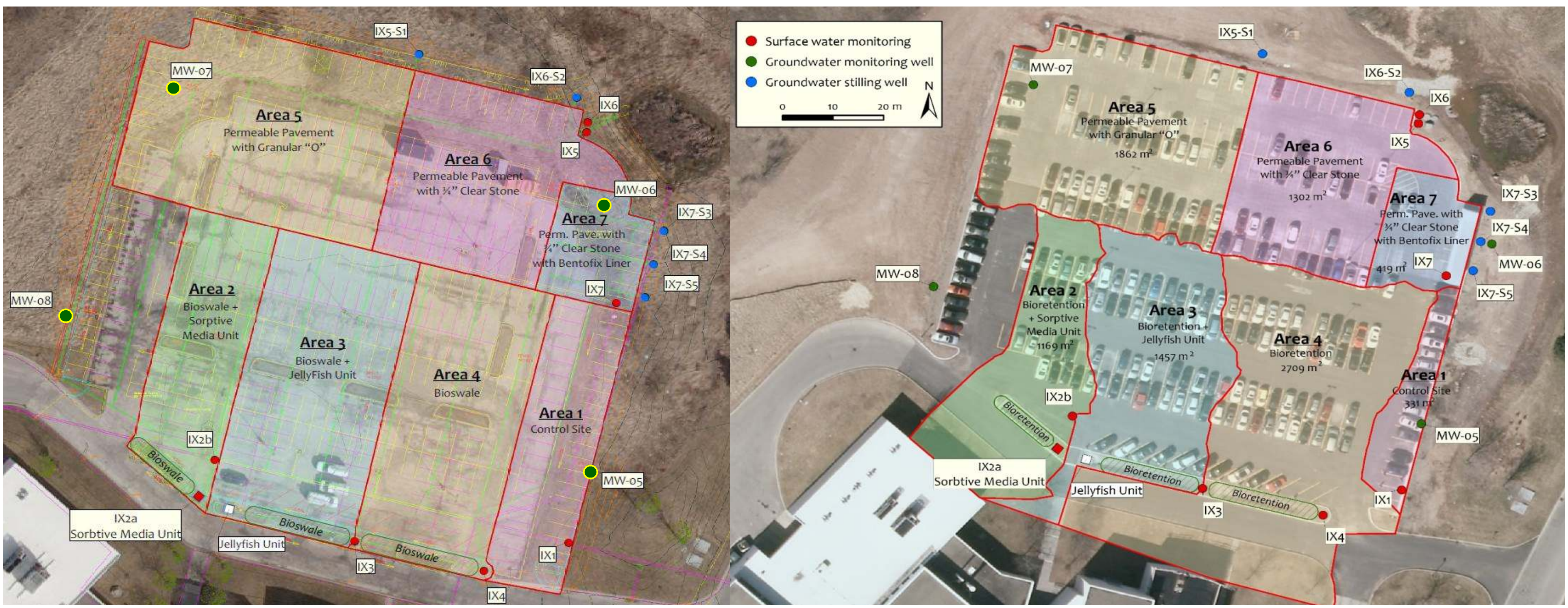
More Lessons Learned

Lessons Learned – Drainage Areas/Slopes

- 2% slope vs. 0.50%
- Impervious Drainage Area to Bioretention Surface Area ratio should be between 5:1 and 15:1

Bioretention Area/Detail	Bioswale to Sorbtive	Jellyfish to Bioswale	Bisowale alone
As-designed Treatment Area (m^2)	1125	1350	1566
As-built Treatment Area (m^2)	1407	1491	3166
Catchment Area : BMP Area	35:1	24:1	44:1
Event Size Retained/Treated (mm)	22.4	19.5	16.1



Test Soils BEFORE They arrive onsite

Lesson Learned – Groundwater Flow Paths

Lessons Learned: Snow Storage & Removal

Lesson Learned: Right Design for Land Use

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Lessons Learned: Protecting Infiltration Areas During Construction

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Lesson Learned – Importance of Grading and Inlet Design

Blocked Inlet Video

Proper Inlet Design

IMAX Bioswale

Wychwood Bioswale

Share Lessons Learned: Case Studies

Case Study

CVC

Elm Drive

Location: Mississauga
Constructed: May 2011

Road Right-of-Way Retrofit

Project Objectives, Design and Performance

- Road retrofit comprised of six bioretention planters and permeable pavement that treats and infiltrates road runoff on adjacent school property.
- Retrofit aimed at improving stormwater management within the Cooksville Creek watershed by providing enhanced erosion control, quantity control, and water balance.
- Ongoing performance assessment had found that LID practices are exceeding all design expectations, providing 99% total suspended solids removal and reducing peak flows for 2-year events by 70-100%.

Overcoming Barriers and Lessons Learned

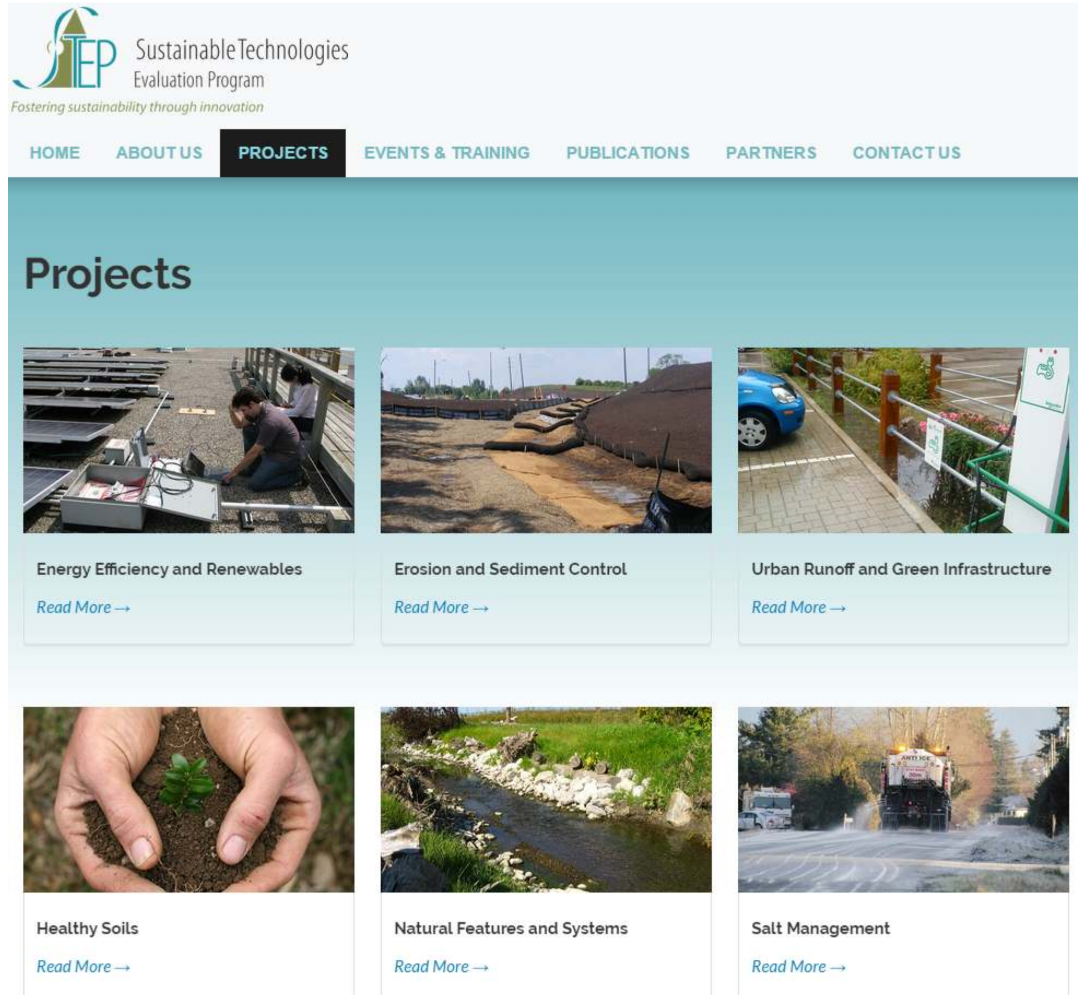
- To provide additional clarity and reduce the potential for error, drawings should include a profile view of the storm services through the bioretention cells, and detailed dimensions of any non-standard items.
- Warranty provisions need to be more specific with respect to LID features (i.e. plant watering and weeding) and need to be adhered to by all parties.
- Aesthetics are key - original landscaping had to be supplemented with additional plantings, including trees, to improve aesthetics and add seasonal variety to cells.

Practices Implemented

Bioretention
Permeable Pavement

Barriers & Issues Encountered

Design
Construction & Comissioning
Operation & Maintenance



http://www.creditvalleyca.ca/

http://www.sustainabletechnologies.ca/wp/


why
when
who
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where
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QUESTIONS
why
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what
how
when

CREDIT VALLEY CONSERVATION

Together, it's our nature to conserve and our future to shape.