# TRIECA 2017 CONFERENCE

## Thank you to all of our 2017 sponsors:

### Media Partners

### Hosts

trieca.com | @TRCA_TRIECA

# The Queensway
# Sustainable Sidewalk Pilot Project

6th Annual

## TRIECA Conference

March 22, 2017

Presentation By:

Patrick Cheung, Senior Engineer

Rod Anderton, Stream Restoration Supervisor

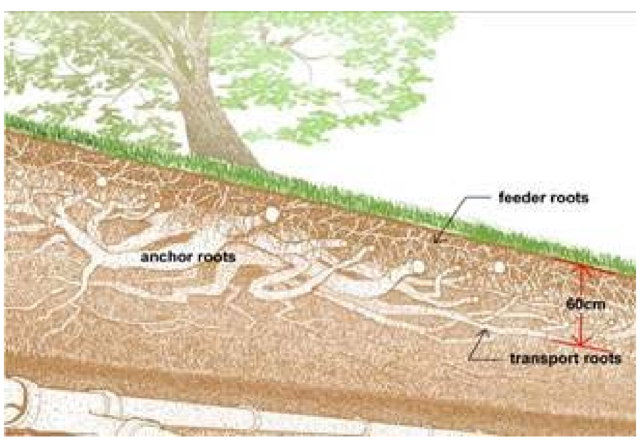
Toronto Water
Water Infrastructure Management

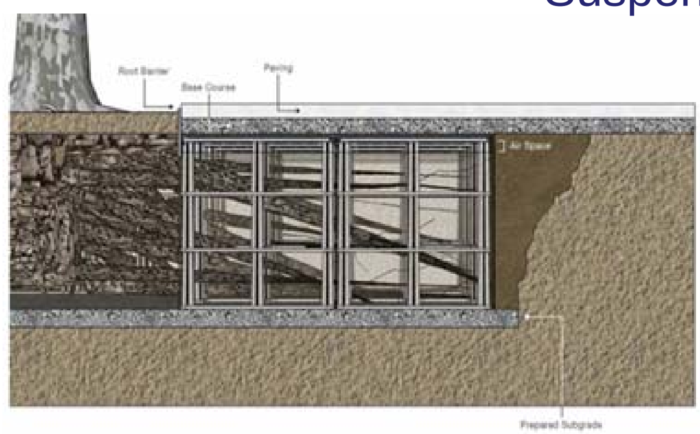
# Sustainable Sidewalk Concept

Led by City Planning with a working group consisting of members from City Planning, Transportation, Forestry, Urban Planning and Toronto Water.

Research into sustainable boulevard designs to:
Reduce utility installation and restoration cost
Reduce time and impact of installations
Promote healthier trees
Increase tree canopy

Suspended Pavement

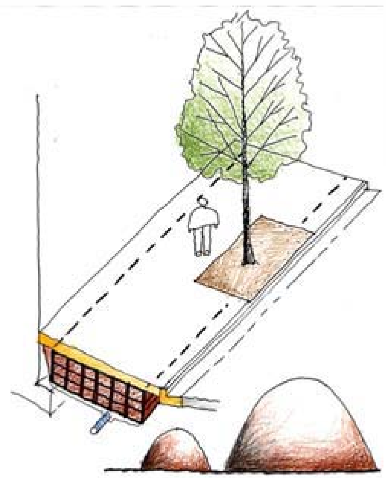




TORONTO Water

# Adding Stormwater Management



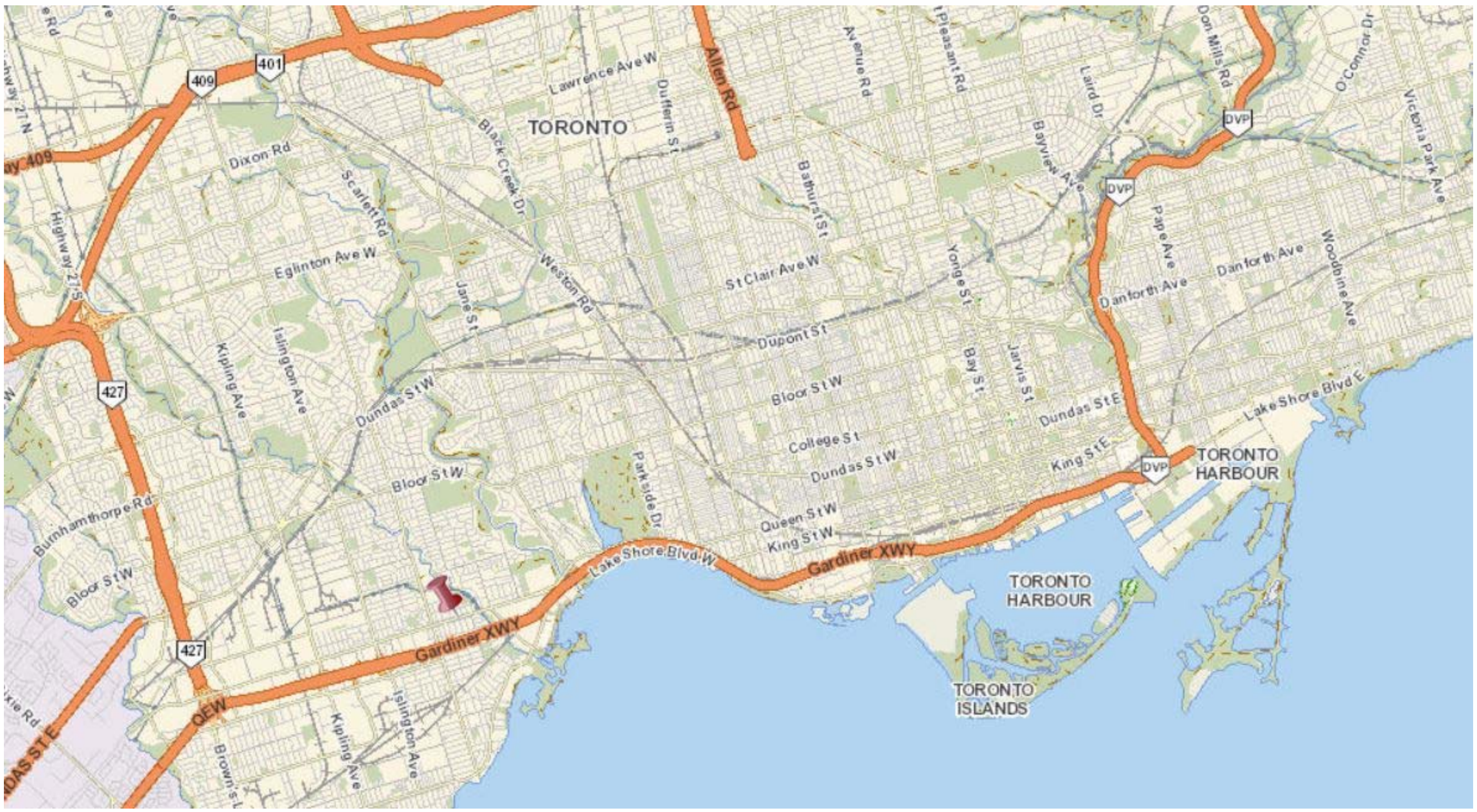
30 cubic meter of un-compacted soil per tree is ideal

15 cubic meter can be shared

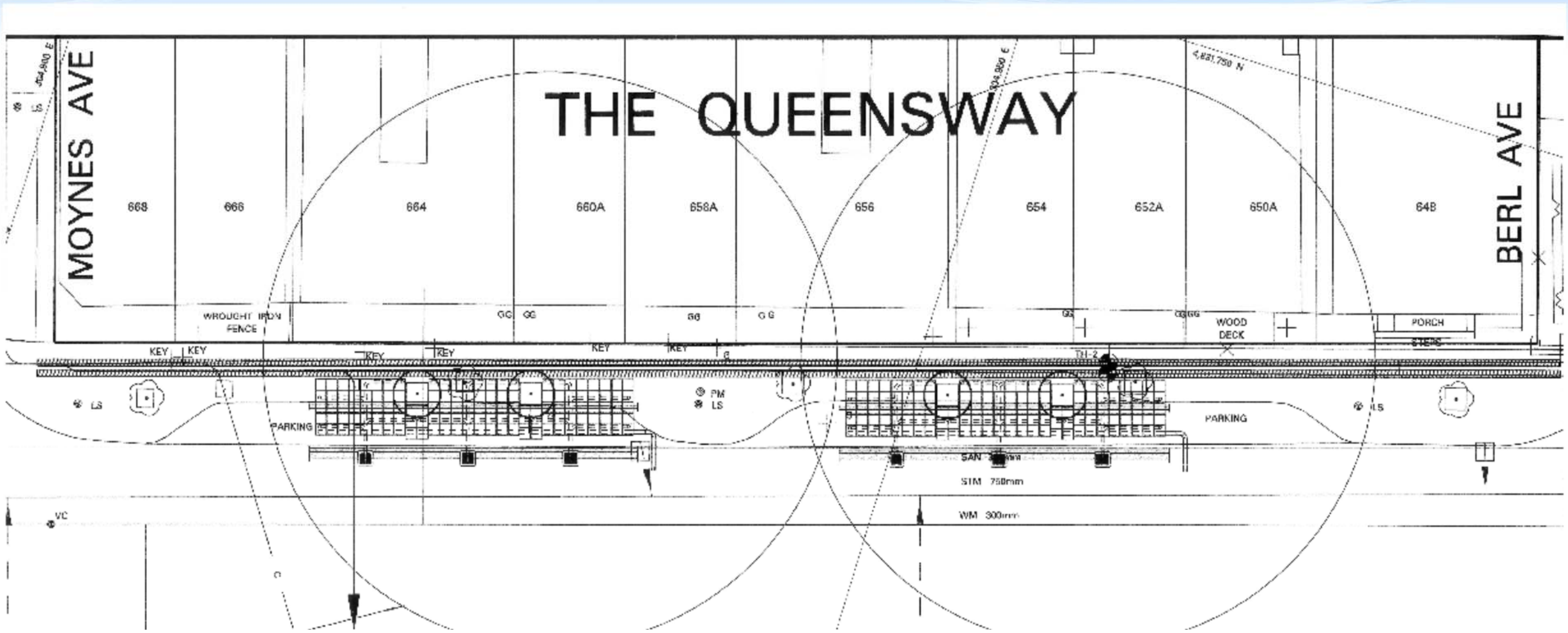
The soil or bio-retention mixture of sand, mulch, natural soils, and clay clumps. The void space is between 10-20% when un-compacted.

**Treat storm run-off from roads**

# Initiated in 2008 on The Queensway (N. side) Toronto, Ontario Canada



# Pilot Project Design




Two set of cells in the parking lay-by on the north side of the street.
The stormwater runoff routed through the easterly set was monitored
The westerly set was used as a control

# Pre-Construction Conditions


The soil cells were installed as part of The Queensway road resurfacing project in October 2008.

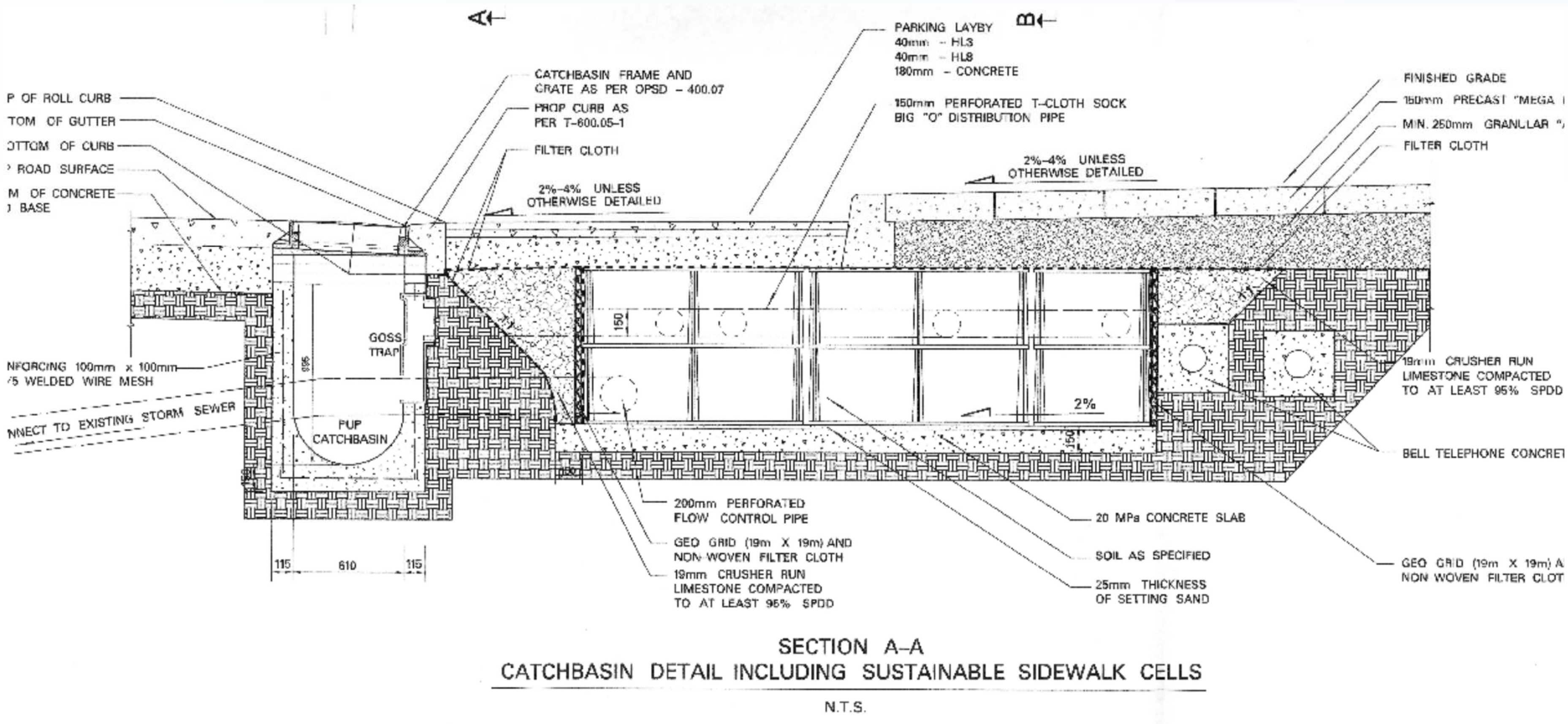
Funding for the pilot project was from several City Divisions:

- Engineering – Transportation Services
- Soil cells – City Planning
- Storm works and monitoring – Toronto Water

# Several options were explored and the Silva Cell system was chosen.

Deep Root Canada Corp.(supplier) has provided technical support throughout the project & peer review of the data.

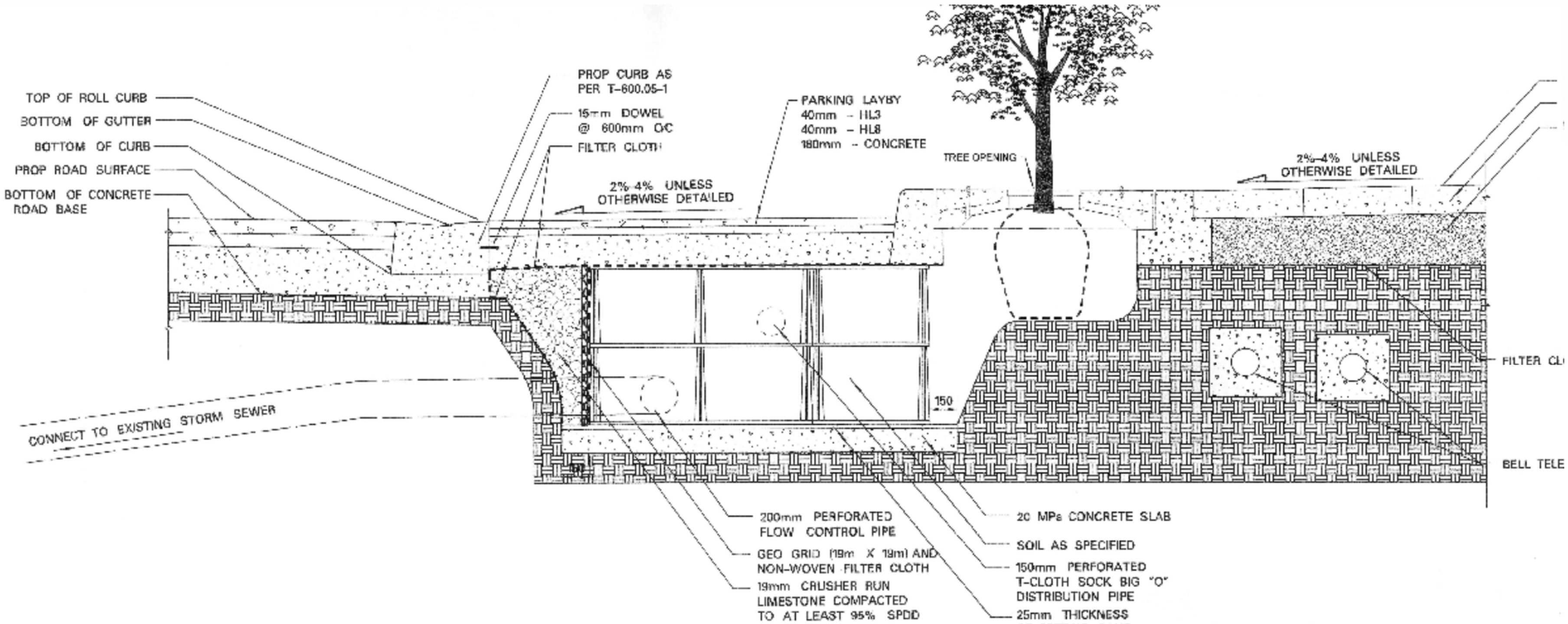
# Cross-section of the cells with the inlet catchbasin




**The Queensway Sustainable Sidewalk Pilot Project**

TORONTO Water

# Cross-Section with the modification to accommodate Bell concrete ducts




SECTION B-B
TREE PIT DETAIL INCLUDING SUSTAINABLE SIDEWALK CELLS

N.T.S.

# Cell were installed around the existing utilities left in place.

# Field Station

- Power and telecommunication
- Data collection hub
- Storage of samples and supplies

- Ryerson University has been assisting the City with data collection, stormwater sampling and submission, review of monitoring results, and reporting;
- A preliminary report was completed in December 2015 and a final report will be completed by the end of 2017.

# Dedicated Rain Gauge

## Precipitation – Heated Tipping-bucket Raingauge:

- New 2015 Hydrological Services TB3 model replaced older unit that was prone to clogging, failure, and calibration issues;
- New 2015 HOBO logging unit and remote access telemetry to replace unreliable initial set-up.



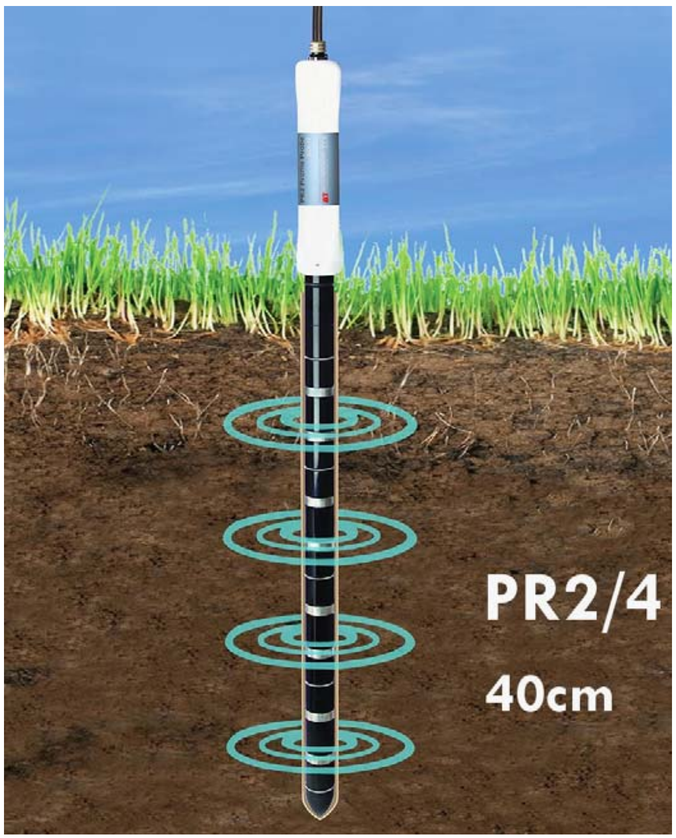


TORONTO Water

# Vertical Moisture Probes

## Soil Moisture – 3 Permanently Installed Profile Sensors:

- 2015 Delta-T Devices PR2 Soil Moisture Profile Probes replaced broken units – sensing elements at 10, 20, 30, & 40 cm depth;
- Replaced unreliable remote logging initial set-up in 2015 with Delta-T Devices hardwired DL6 Soil Moisture Data Loggers.



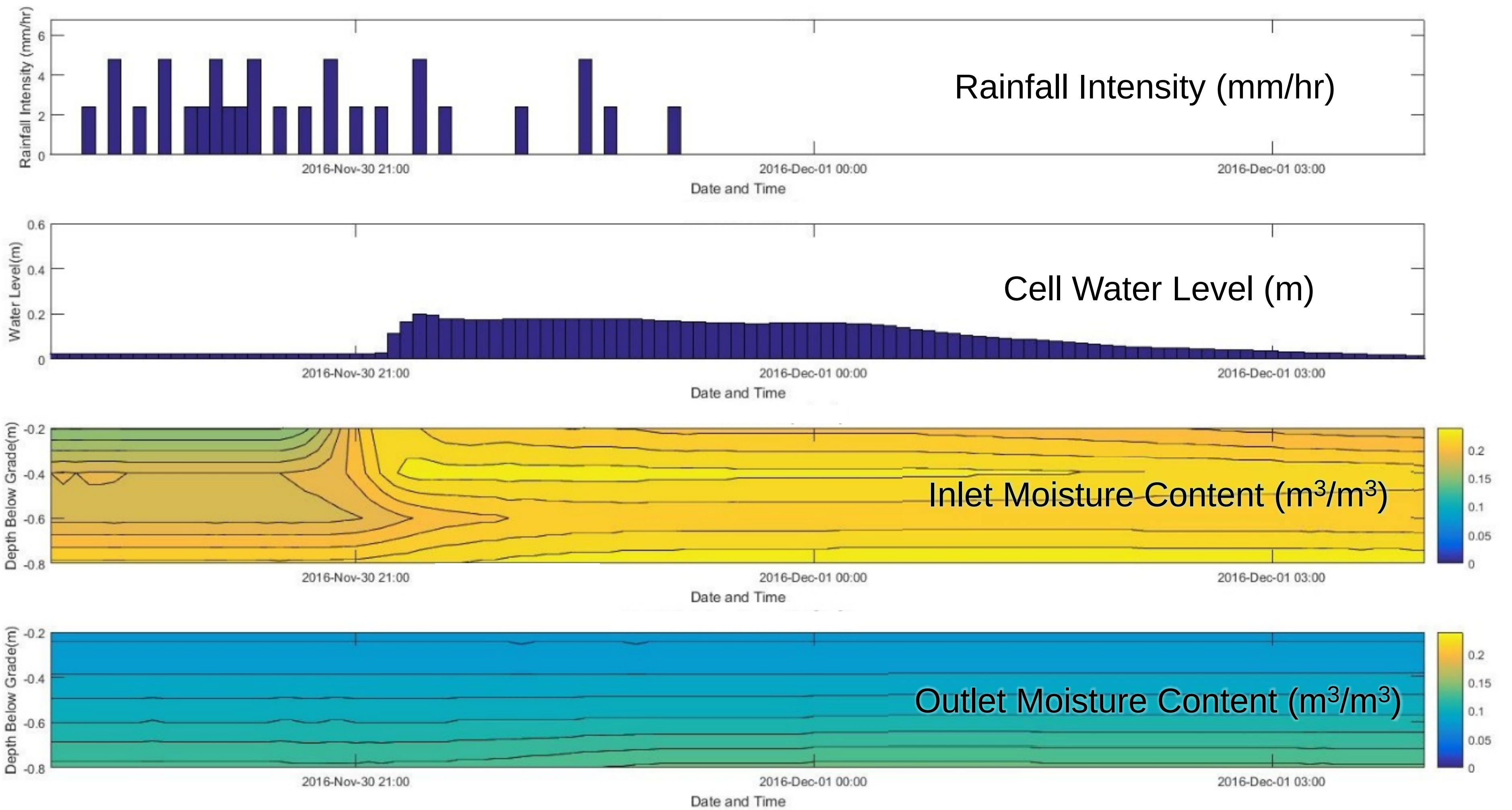


# Water Level Sensors

## Cell Water Level - 2 Permanently Installed Level Sensors

- New 2015 Seametrics PS-9800 Submersible Pressure Transmitters with hardwired HOBO data loggers;
- Replaced older failed level sensors and unreliable remote loggers in 2015 – require manual download for simplicity


# Rainfall Intensity, Cell Water Level & Cell Moisture Plot






TORONTO Water

# Flow Monitoring

## Inlet Catchbasin with Weir:

- 8” Catchbasin Inlet has Thel-Mar $90^{o}$ V-Notch Compound weir;
- Connected to ISCO 730 Bubbler Flow Module (both inlet/outlet).

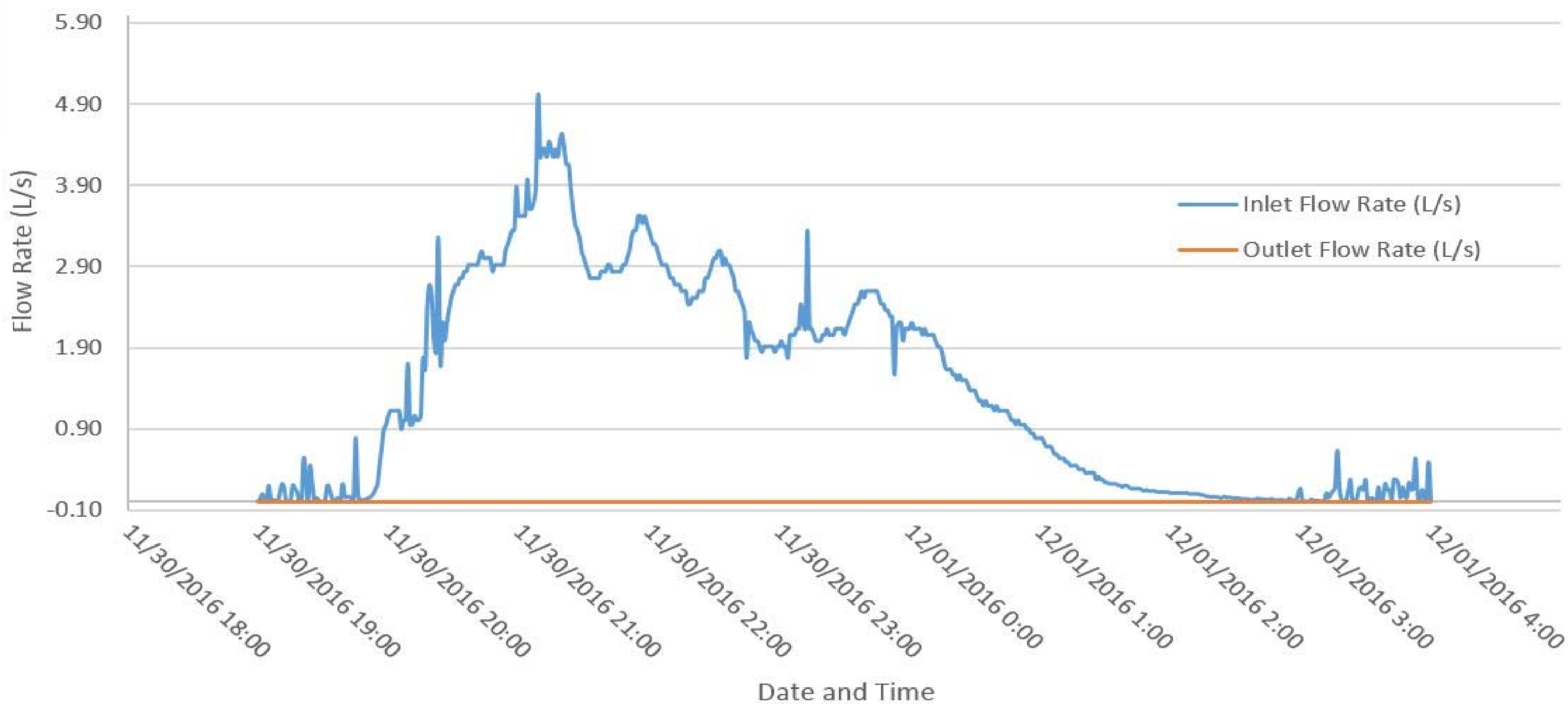

# Flow Monitoring

## Outlet Maintenance Hole with Weir:

- $60^{o}$ V-Notch weir w/ bubbler in 8 inch MH chamber outlet pipe;
- Replaced original install's compound weir as outlet flows rate is far lower.


# Flow Monitoring – Inlet vs Outlet

- Flow restrictor installed on outlet of east cell water collector line;
- Flow reduction, temporary retention, and increased contact time;
- Root Uptake, Media Absorption/Retention, Cell Storage.



# Maintenance and Calibration

- Site Maintenance – Catchbasin Clean-out and Distribution Line Flushing
- Sensor Calibration and System Testing Using Hydrant Water


RA1

# Monitoring Issues

- Outlet MH Chamber Retrofit, Relocate of Flow Weir,
- Sampler Hose Strainer Weir Placement, and Flow Restrictor Installation

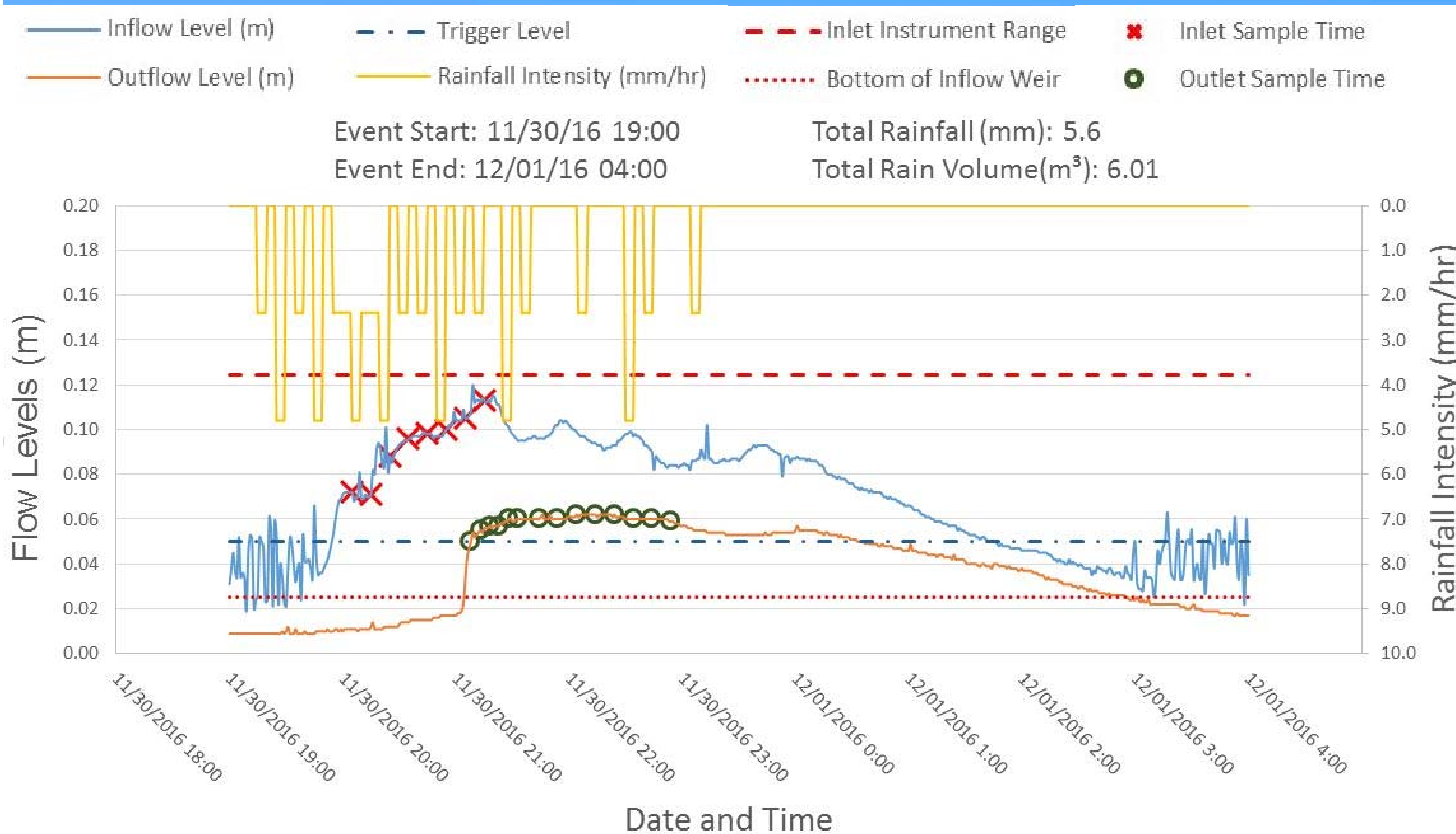
- Frozen Sample Intake Line
- Pinched Bubbler Line
- Melted Sample Intake Line
- Power Outages / Telemetry Failure
- Clogged Intake Strainer
- Plugged Bubbler Nozzle
- Leaking Weirs / Lost Calibration
- Kinked Sample Intake Line
- False Triggering

# Stormwater Sampling

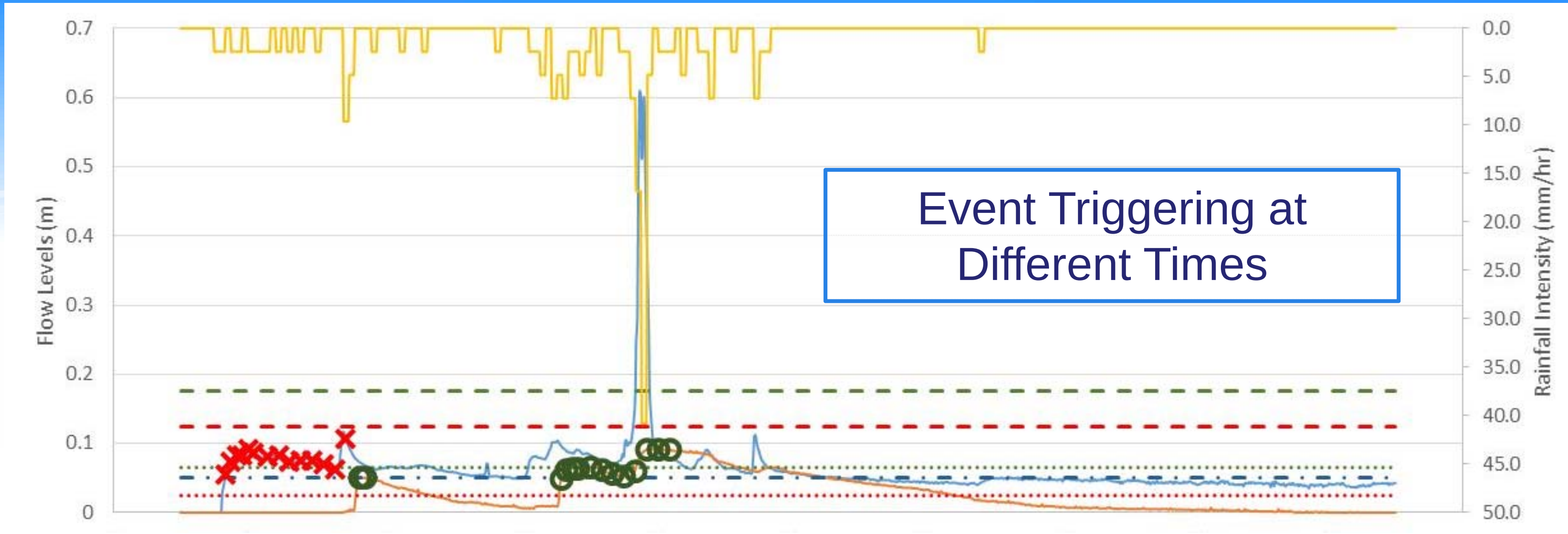
## Inlet and Outlet Autosamplers:

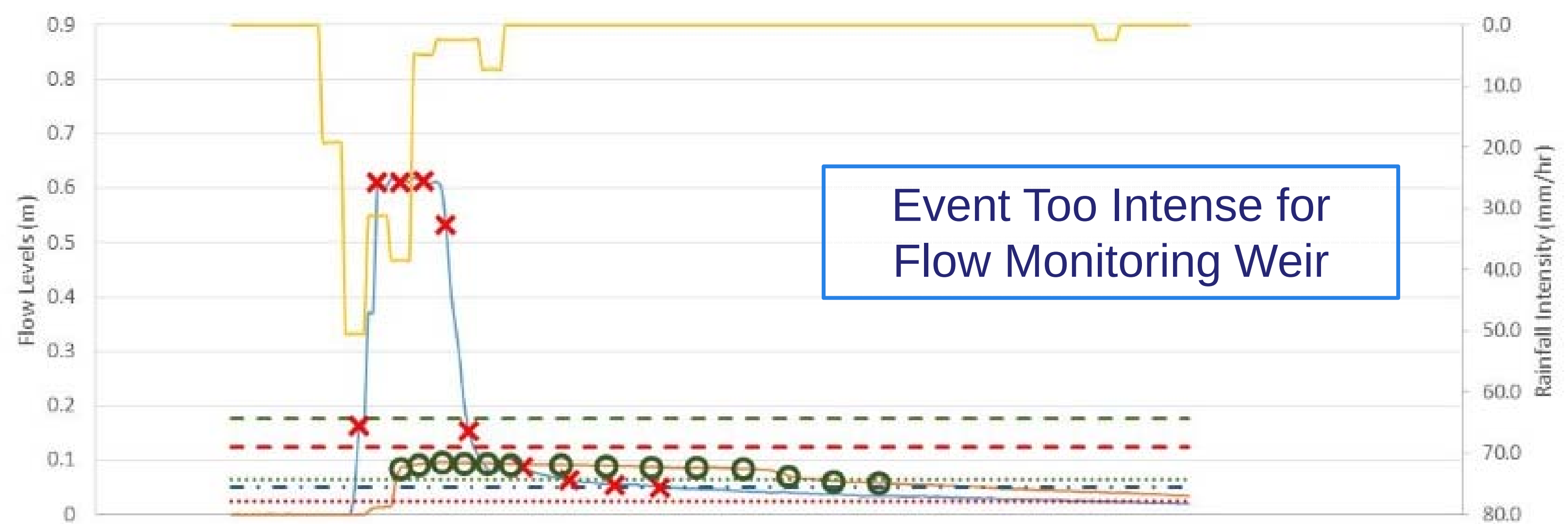
- ISCO Avalanche Portable Refrigerated 14 Bottle Autosamplers;
- Heated huts and sample lines, flow level triggered.


# Sampling - Event Summary Plot



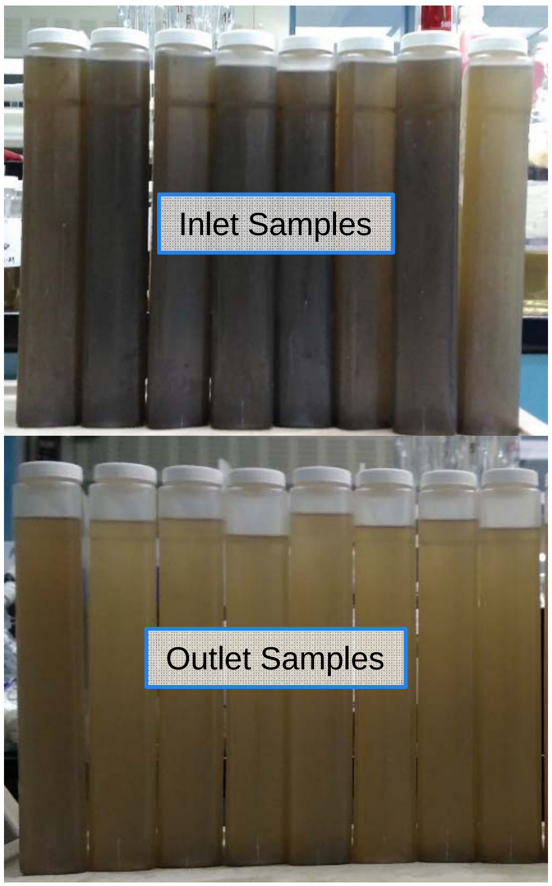
# Concerns and Issues

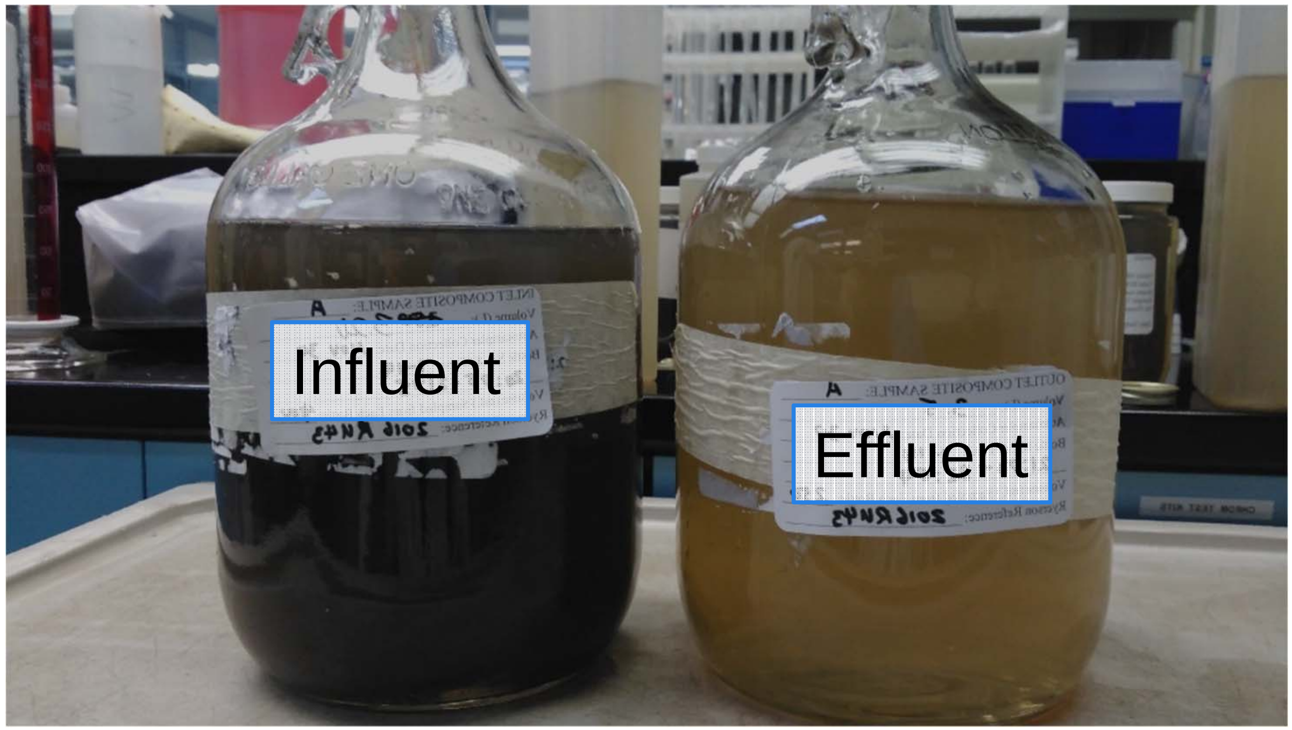


# Stormwater Sampling

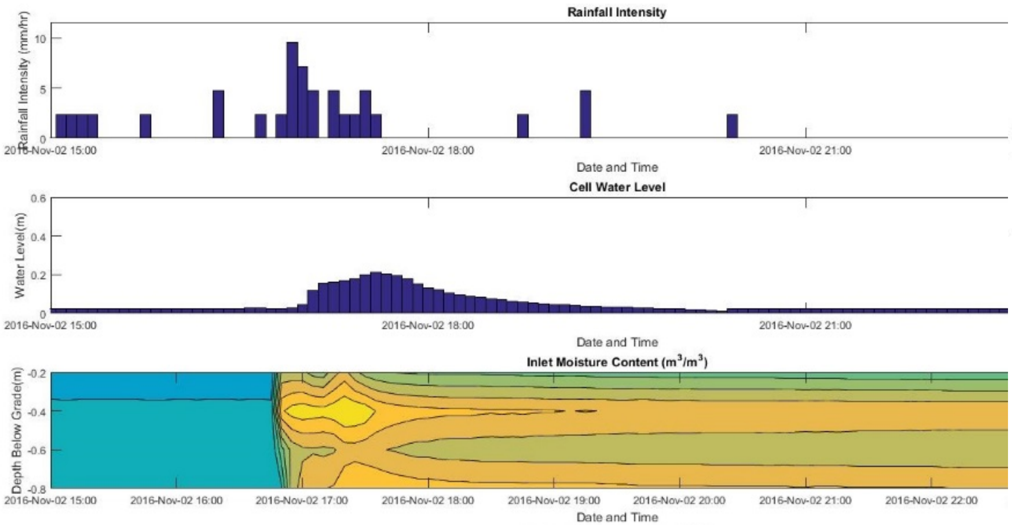
- Flow triggered with set minimum flow level to avoid sampling minor events;
- First 25 minutes of event captured in 6 bottles at 5 minute sampling intervals;
- Next 80 minutes of event collected in last 8 bottles at 10 minute intervals;
- Composite samples analyzed (not flow proportioned);

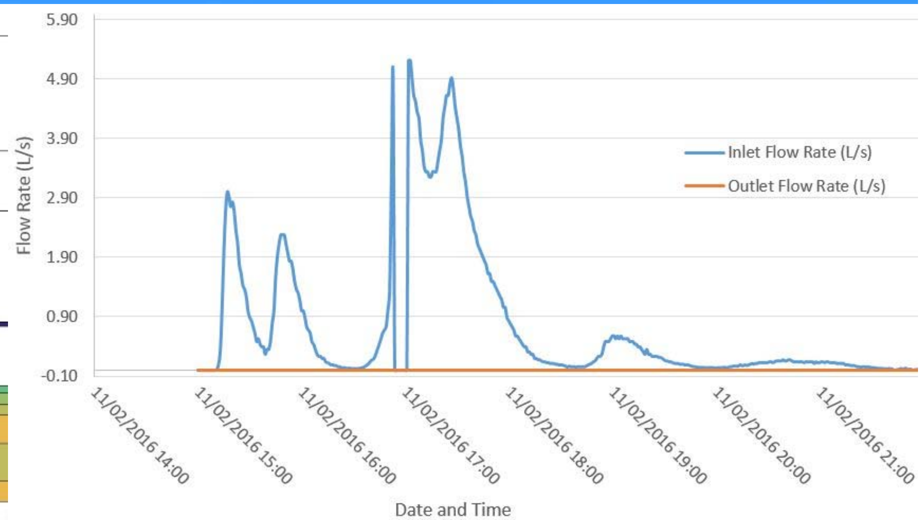


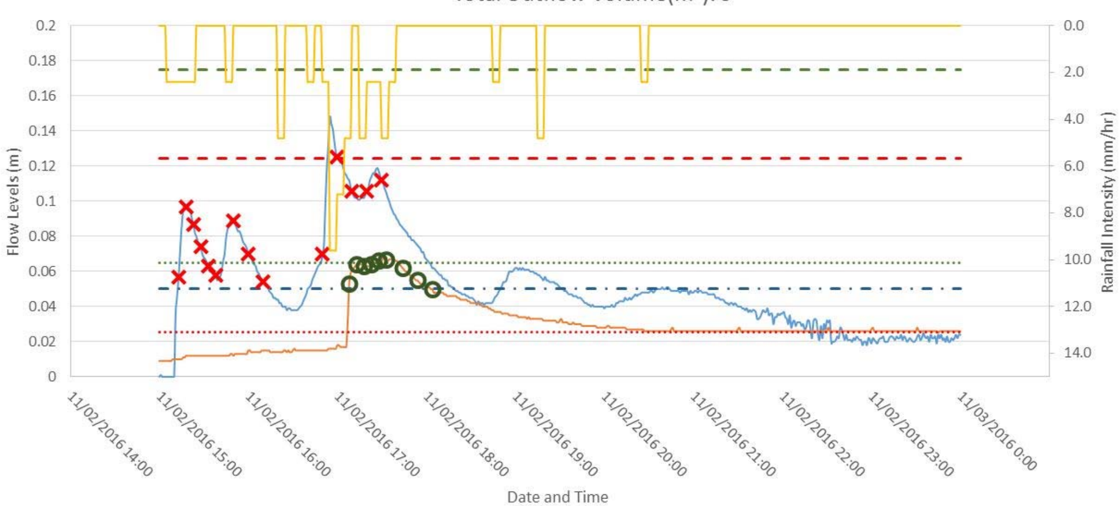

- Over 50 events sampled with both inlet and outlet samples collected for water quality comparison.

# November 2, 2016 Event and Sample Collection




Event Start: 11/02/16 15:00
Event End: 11/03/16 00:00
Total Rainfall (mm): 5.8 | Total Rain Volume(m³): 6.23
Total Inflow Volume(m³): 18.83
Total Outflow Volume(m³): 0




# Water Quality Improvement

| November 2, 2016 Sample | | | |
|---|---|---|---|
| Parameter | Influent (mg/L) | Effluent (mg/L) | Percent Reduction |
| Aluminium | 0.853 | 0.138 | **83.8%** |
| Arsenic | 0.000654 | 0.000287 | **56.1%** |
| BOD | 63.00 | 18 | **71.4%** |
| Chloride | 25.9 | 21.5 | **17.0%** |
| Chromium | 0.0079 | 0.00166 | **79.0%** |
| Copper | 0.0302 | 0.0144 | **52.3%** |
| Iron | 2.43 | 0.287 | **88.2%** |
| Lead | 0.00584 | 0.00064 | **89.0%** |
| Manganese | 0.175 | 0.013 | **92.6%** |
| Nickel | 0.00383 | 0.00316 | **17.5%** |
| Potassium | 8.59 | 4.47 | **48.0%** |
| Total Phosphorus | 0.607 | 0.082 | **86.5%** |
| Total Suspended Solids | 58 | 2 | **96.6%** |
| Zinc | 0.106 | 0.025 | **76.4%** |

# Small and Large Event Sample Results

| Storm Event Characteristics | Small Event | Large Event |
|---|---|---|
| Date | June 12, 2015 | June 22-23, 2015 |
| Total Rainfall Depth (mm) | 4.20 (on-site rain gauge), | 19.40 (on-site rain gauge), |
| Total Rainfall Volume ($m^3$) | 1.62 (on-site rain gauge), | 7.47 (on-site rain gauge), |
| Rain Duration (min) | 289 | 336 |
| Peak Intensity (mm/hr) | 12.24 | 76.20 |

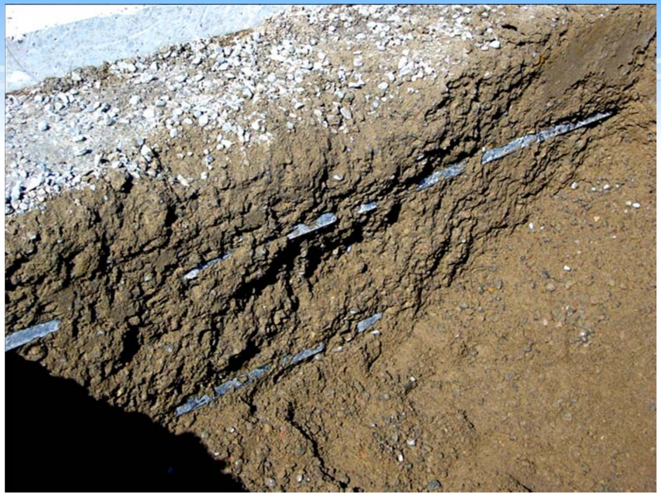
## Small Event – June 12, 2015 Sample

| **Name** | **Influent Concentration (mg/L)** | **Effluent Concentration (mg/L)** | **Concentration Reduction (%)** |
|---|---|---|---|
| Total Phosphorus | 0.178 | 0.0843 | **52.64** |
| Chloride | 5.10 | 8.70 | **-70.59** |
| Nitrate (as N) | 0.30 | 0.46 | **-53.33** |
| TSS | 40 | 2 | **95.00** |
| Aluminium | 0.969 | 0.110 | **88.65** |
| Zinc | 0.0586 | 0.025 | **57.34** |
| Lead | 0.00752 | 0.000606 | **91.94** |
| Nickel | 0.00184 | 0.000777 | **57.77** |
| Copper | 0.0169 | 0.00946 | **44.02** |
| Iron | 1.19 | 0.136 | **88.57** |
| BOD | 12 | 2 | **83.33** |

## Large Event – June 22 -23, 2015 Sample

| **Name** | **Influent Concentration (mg/L)** | **Effluent Concentration (mg/L)** | **Concentration Reduction (%)** |
|---|---|---|---|
| Total Phosphorus | 0.282 | 0.108 | **61.70** |
| Chloride | 36.2 | 5.88 | **83.76** |
| Nitrate (as N) | 0.02 | 0.68 | **-1.32** |
| TSS | 65 | 15 | **76.92** |
| Aluminium | 0.908 | 0.499 | **45.04** |
| Zinc | 0.104 | 0.0300 | **71.15** |
| Lead | 0.00525 | 0.00102 | **80.57** |
| Nickel | 0.00434 | 0.000929 | **78.59** |
| Copper | 0.0315 | 0.0118 | **62.54** |
| Iron | 2.53 | 0.381 | **84.94** |
| BOD | 68 | 5 | **92.65** |

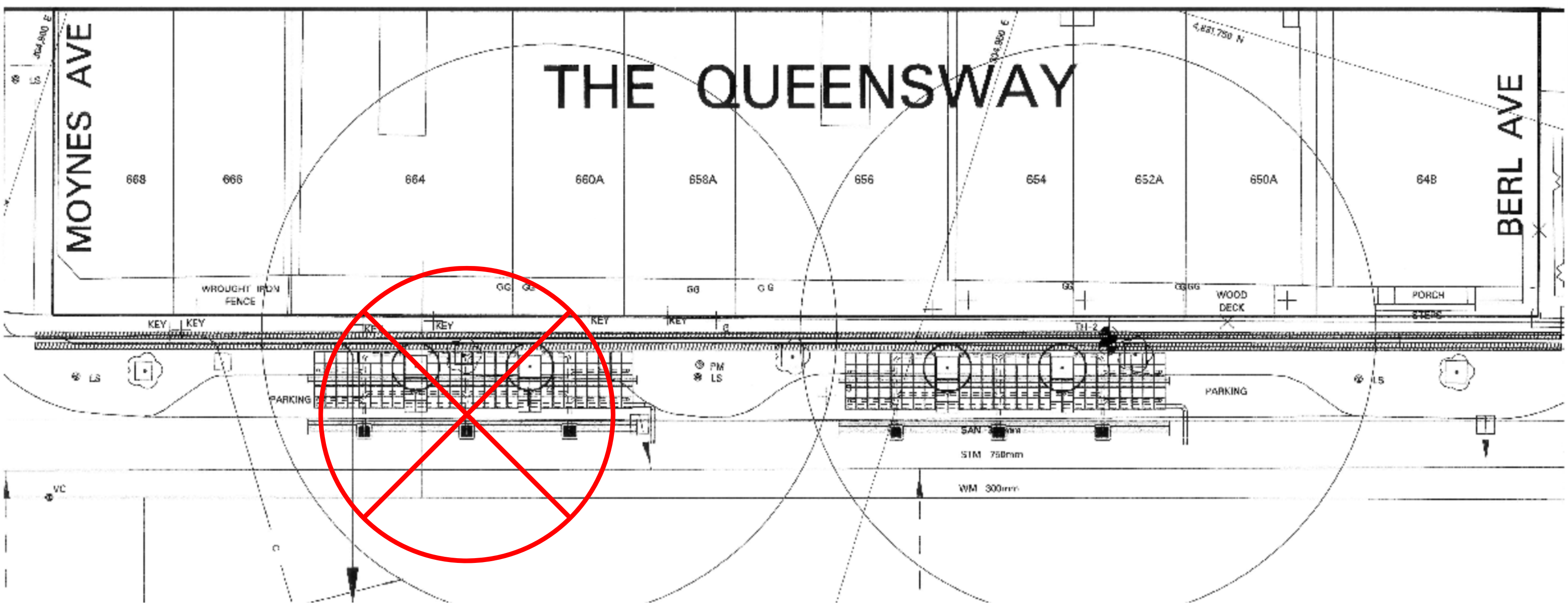
# Nashdene Yard
# Water Service Break Repair Simulation
# What we learned?



Clean cut through Un-Shrinkable Fill.

- Emergency repairs will cost marginally more compare to other treed area.
- Definite added cost if we go back and restore root conductivity.
- Planned work will cost more if we want to retain root system in cells.
- How much more?

# Catchbasin top was later covered over to create a control and test scenario






TORONTO Water

# Years Later

Originally anticipate that discernible and conclusive results may not be available until over five years. However, there are signs of very healthy growth at this time.



Without Water (Fall, 2014) With Water

# Co-Benefits

- Water quality
- Water detention
- Water retention (balance) via evapo-transpiration
- Reduction in heat island effect
- Increase in shade
- Air quality improvement
- Support Bio-diversity
- Carbon sequestration

Potential

- Increase in retail/commercial foot traffic
- Increase in property value

# Moving Forward

Quality – material, volume of soil vs drainage area, plants (root system), flow rates through the system, infiltration

Water Balance – volume of soil and moisture content, evaporation rate (plants), infiltration rate

Attenuations – volume of soil and voids, additional storage options, selection of release rates (too high and contact time for quality maybe too short).

Cost Benefit –Triple Bottom Line

Other Studies – S. Carolina, United States; Sheffield, England; Mississauga, Canada

# Future Street Network
# Six Points Project


Courtesy of HDR, Inc.



Toronto Water

# The Queensway Sustainable Sidewalk Pilot Project


Presentation By:

Patrick Cheung, Senior Engineer
Patrick.Cheung@toronto.ca

Rod Anderton, Stream Restoration Supervisor
Rod.Anderton@toronto.ca

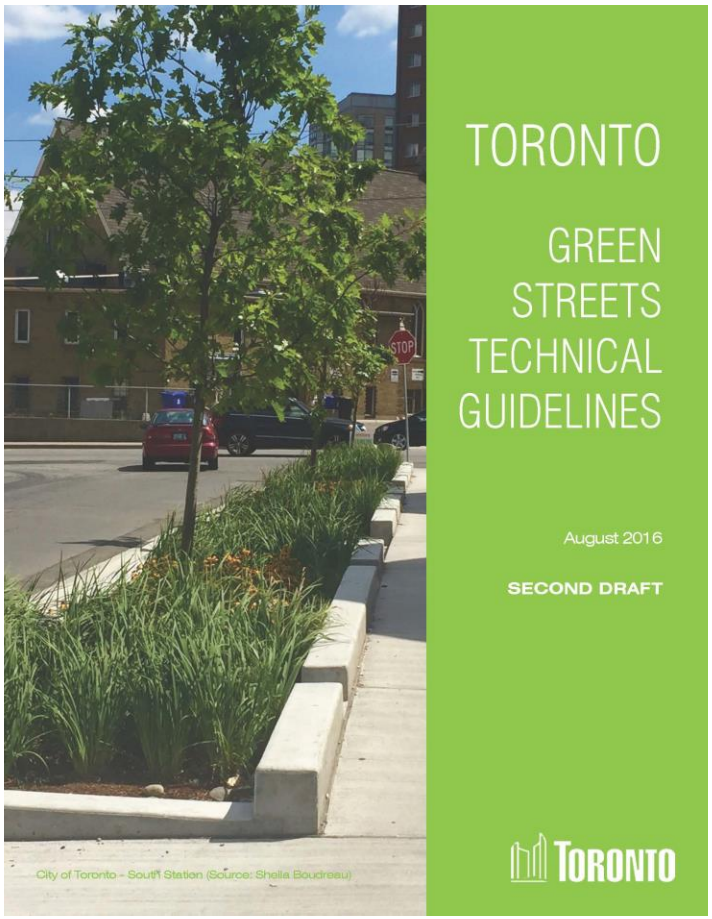
Toronto Water
Water Infrastructure Management



Thanks and acknowledgments for their effort and assistance throughout the Project go to:
Ryerson University Staff: James Li, Darko Joksimovic
Ryerson University Graduate Students: Marija Eric, Leo Chen; Kay Kang, Carol Haiyue Liu
Toronto Water Laboratory
Toronto Water Operations & Maintenance
Toronto Water Divisional Operations Services


TORONTO Water

# Green Streets Technical Guidelines(GSTG)




6th Annual

## TRIECA Conference

March 22, 2017

Presentation By:
Patrick Cheung, Senior Engineer
Toronto Water
Water Infrastructure Management

TORONTO Water

# The Core Team


**Patrick Cheung, P.Eng., Senior Engineer**
Patrick.Cheung@toronto.ca
Toronto Water, Water Infrastructure Management, Policy & Program Development Unit

**Shayna Stott, Planner**
Shayna.Stott@toronto.ca
City Planning, Strategic Initiatives, Policy & Analysis, Policy

**Sheila Boudreau, OALA, CSLA (with Seal), Urban Designer**
Sheila.boudreau@toronto.ca
City Planning, Urban Design, Civic Design

**Kate Nelischer, Senior Public Consultation Coordinator**
Kate.Nelischer@toronto.ca
Policy, Planning, Finance and Administration, Public Consultation Unit

TORONTO Water

# How we got started

## City of Toronto Council Directive, Oct. 2013:

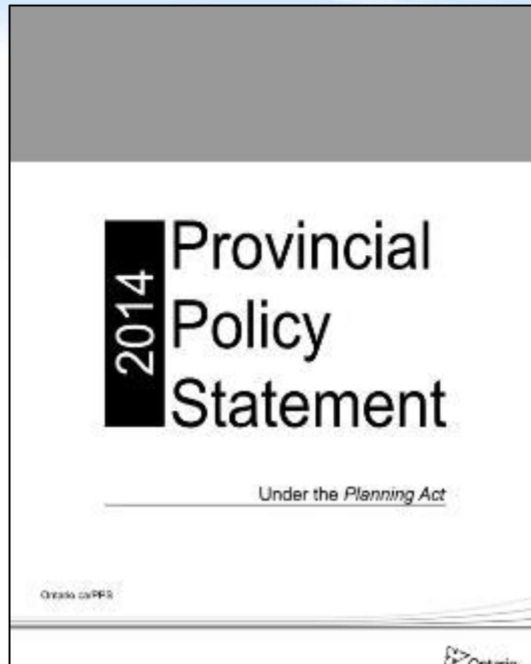
"…to **develop 'green infrastructure' standards** for the public right-of-way for implementation in Transportation Services and Toronto Water capital projects…"

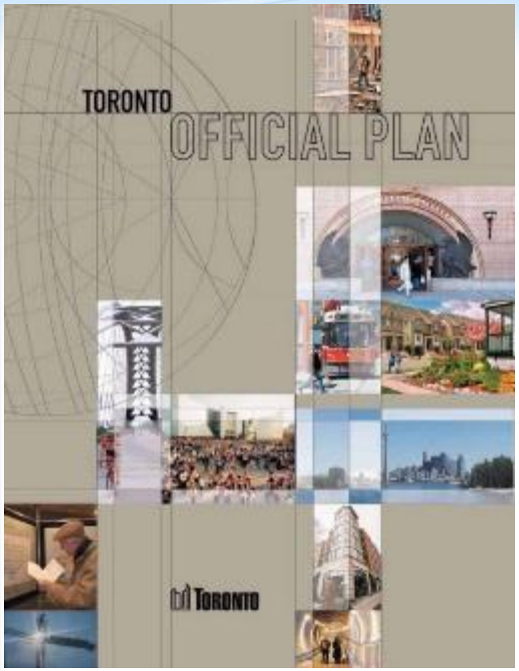
# Defining the Green Infrastructure

Min. of Municipal Affairs & Housing

**2014 PPS Definition**
**Green Infrastructure:**

*"…natural and human-made elements that provide ecological and hydrological functions and processes"*



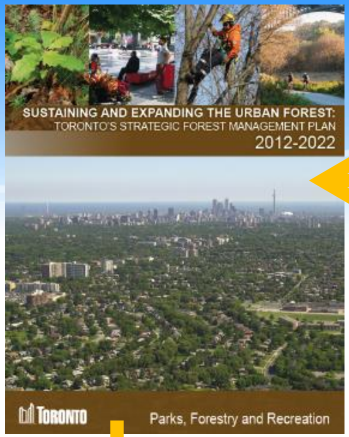



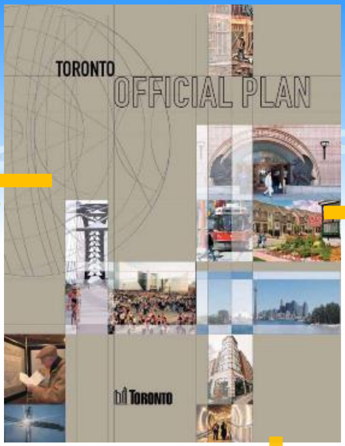

http://www.mah.gov.on.ca/Page14980.aspx#Infrastructure:+Sewage+and+Water+(Policy+1.6.6)

**Green Streets** is about:
**Integrating Green Infrastructure into the Right–of-way**

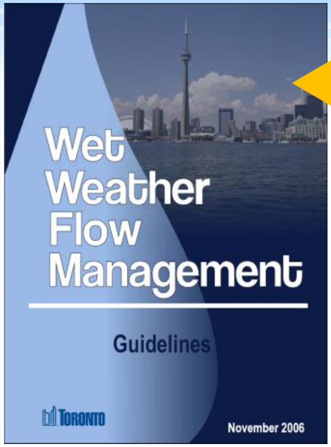
TORONTO Water

# Linking to Other Requirements



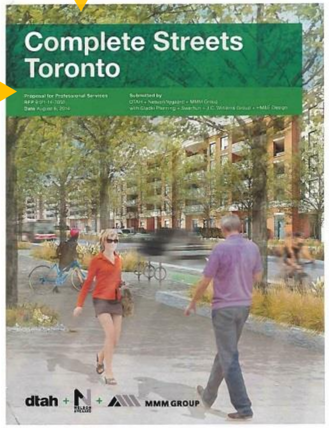


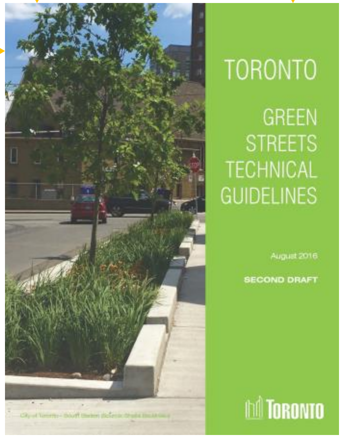



New MOECC
LID Guidelines
And Criteria

Toronto and Region Conservation for The Living City

LID Guidelines

# Objectives for Greens Streets

1. Enhance the extent and longevity of the urban forest
2. Mitigate urban heat island effect
3. Manage stormwater runoff to mitigate flooding and enhance water quality
4. Promote infiltration to sustain shallow groundwater systems and maintain inflow patterns
5. Enhance air quality
6. Moderate microclimate
7. Conserve / generate energy

TORONTO Water

# Defining the Green Infrastructure

Core Group
    Organization

Working Group
    Internal Stakeholders

Advisory Group
    External Stakeholders

Tech. Advisory Group
    Subject Matter Experts

Schollen & Company Inc.
Mark Schollen,
Landscape Architect

with
The Municipal Infrastructure Group (TMIG)
Bousfields Inc.,
Urban Forest Innovations Inc. (UFI)
DPM Energy Inc.

TORONTO Water

# Purpose of the Document

The GSTG is a tool that will assist City Staff, developers and consultants in:

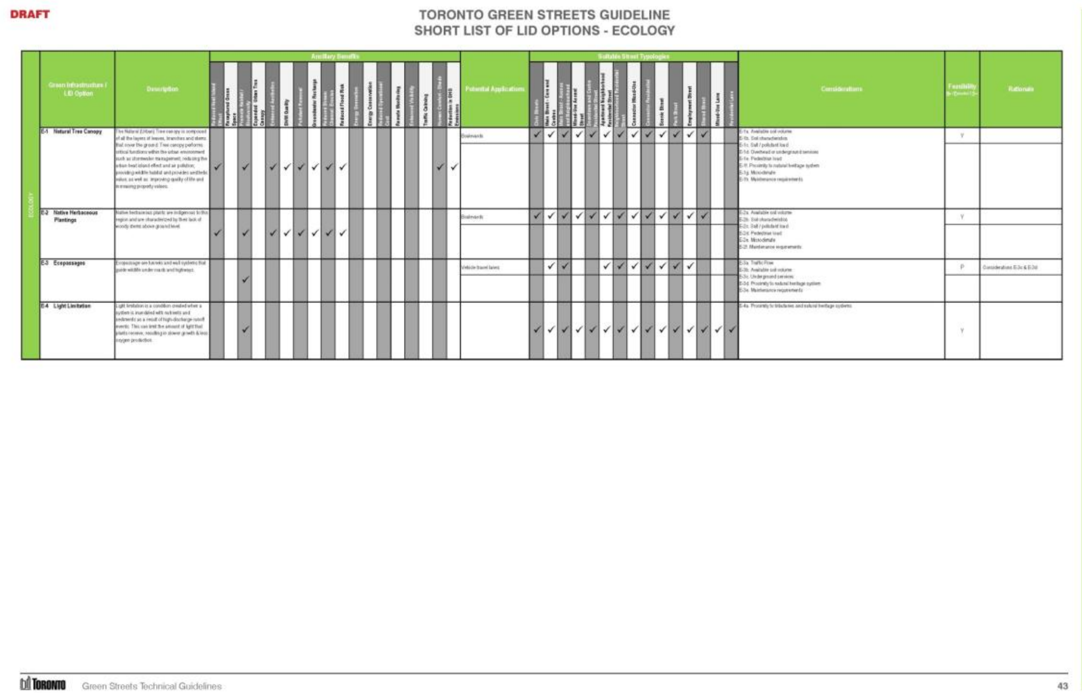
- understanding sustainable stormwater planning & practices,
- selecting appropriate LID options to be integrated as part of street retrofit/rehabilitation or new/ reconstruction projects; and,
- ensuring that green street designs are beautiful, functional and appropriate to their urban context.

Applicability

- New / Reconstruction Projects
- Rehabilitation / Retrofit Projects

TORONTO Water

# Determining Appropriate LID Techniques


- Long list of LID Options
- Categorization | According to TGS Priorities
- Short List of LID Options | Selection Tool (y-axis)

TORONTO Water

# Green Streets Techniques & Technical Guidance



**DRAFT**

**The following Green Street Options are designed to promote Water Quality, Quantity and Efficiency within Toronto's streets.**

## 3.2.14| Bioretention

Bioretention is an LID practice that is designed to provide temporary storage, filtration and infiltration of stormwater runoff. Although the physical design of a bioretention facility can be flexible, the profile generally consists of a gravel storage cell, choker (optional), bioretention media, mulch and vegetation layers.

Proper design of the drainage system will depend on the infiltration rate of existing native soils. Sites with highly permeable soils (>15mm/hr) can facilitate bioretention practices that are designed with no underdrain to provide full infiltration. Bioretention facilities designed for sites with less permeable soils (<15mm/hr) will require an underdrain for partial infiltration. In cases where contaminated soils exist or where the water table is high, an impermeable liner and underdrain can be integrated into the bioretention cell to create a facility designed for filtration only. This type of bioretention facility is also known as a biofilter.

Bioretention practices are designed to capture and treat runoff from small storm events. The maximum ponding depth after a storm event should be 150 - 250 mm with larger events handled by an overflow/bypass. Bioretention facilities can also serve as areas for snow storage and snowmelt treatment.

The physical form of bioretention practices can vary to provide a complementary aesthetic within any street typology from the rural to the ultra-urban contexts. Types of bioretention facilities include:

- Bioretention Planters
- Bioretention/Stormwater Curb Extensions/Bump-outs
- Bioretention Cells
- Rain Gardens


Source: xx


Source: xx


Source: xx



**DRAFT**

### 3.2.14.1| Bioretention /Stormwater Planters

Bioretention Planters are formalized structures with vertical sidewalls. They are often narrow and rectangular in shape and can be installed in close proximity to utilities, driveways, trees, light standards and other street features. Bioretention Planters receive road runoff through curb inlets and overland flows from the surrounding sidewalk and other paved surfaces.

They are well suited for urban street typologies and can be adapted to fit within Furnishing Zones and Medians. Because they can be used within the ultra-urban context, bioretention planters require hardy, aesthetically pleasing plant materials that tolerate harsh urban conditions and winter maintenance protocols.

Bioretention Planters are often located in higher pedestrian traffic areas, therefore design solutions should consider planting, curb or railing options that will keep pedestrians from inadvertently stepping into a planter bed.

Stormwater Planters are similar to Bioretention Planters in their form and function, however Stormwater Planters typically located within the Frontage Zone or directly adjacent to a building. They can be designed to receive runoff from downspouts and surrounding sidewalks.

Due to the risk of seepage, stormwater planters should either be located a minimum of 4m from the foundation of any building or they should be designed with an impervious liner and underdrain.


Source: xx


Source: xx

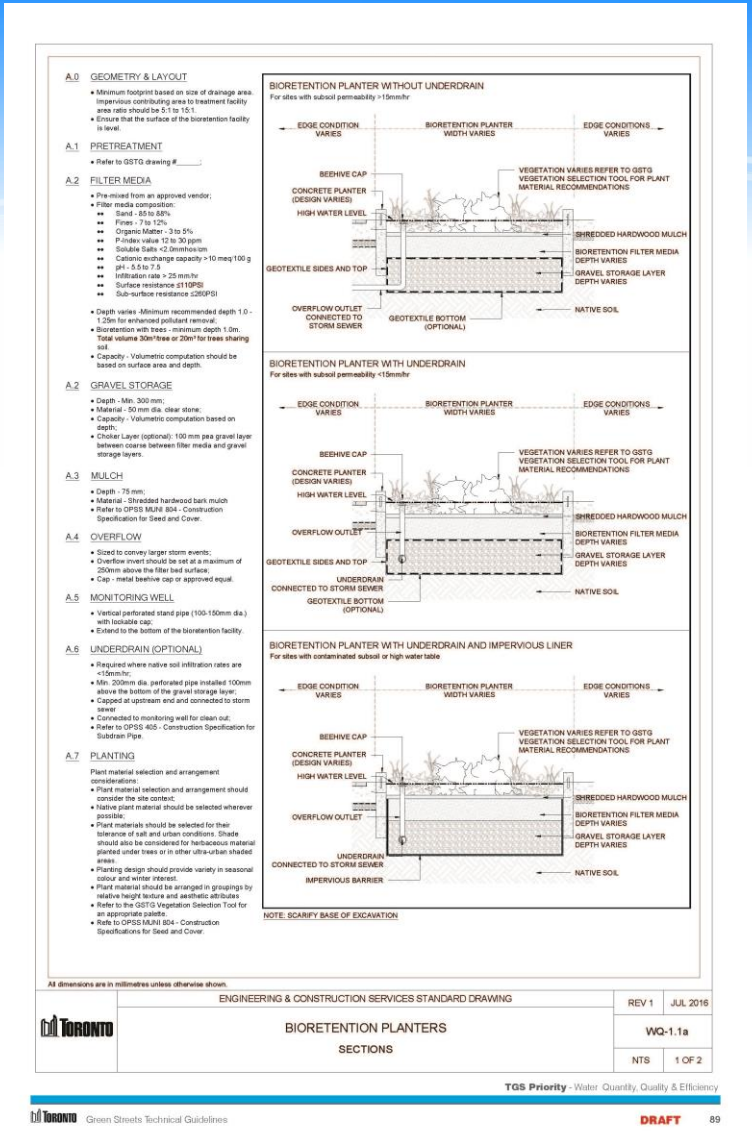
### 3.2.14.2 | Bioretention Curb Extension/Bump-Outs

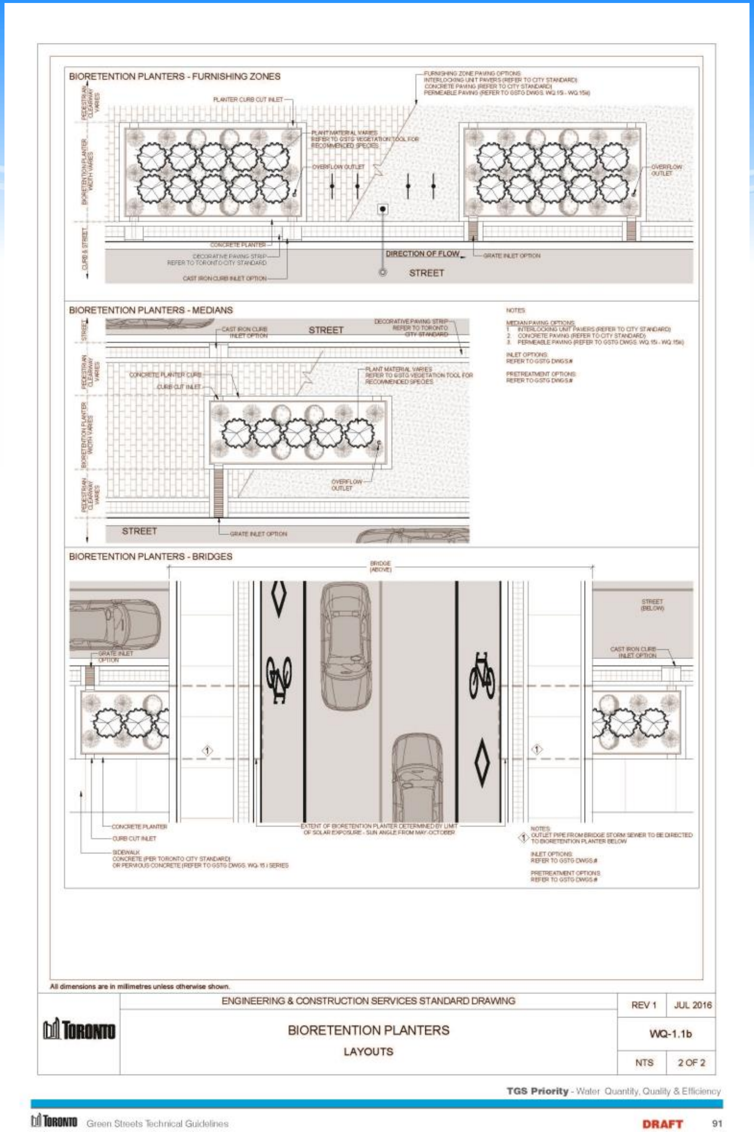
Curb Extensions and Bump-Outs provide another design variation of the bioretention practice. They can be located at intersections, mid-block and at transit stops within the "In-Between Zone" of various street typologies. In addition to stormwater management functions, bump-outs and curb extensions can also enhance biodiversity, offer visual appeal and provide traffic calming benefits. Bump-Outs and Curb Extensions are ideal for street retrofit projects as they can be installed within the limits of existing street cross-sections.

Curb Extensions and Bump-Outs are typically on-line stormwater management practices, which means that they are in the direct flow of runoff flowing along the curb. This is an important consideration as it will affect the pretreatment design and maintenance considerations for these practices.


Source: xx

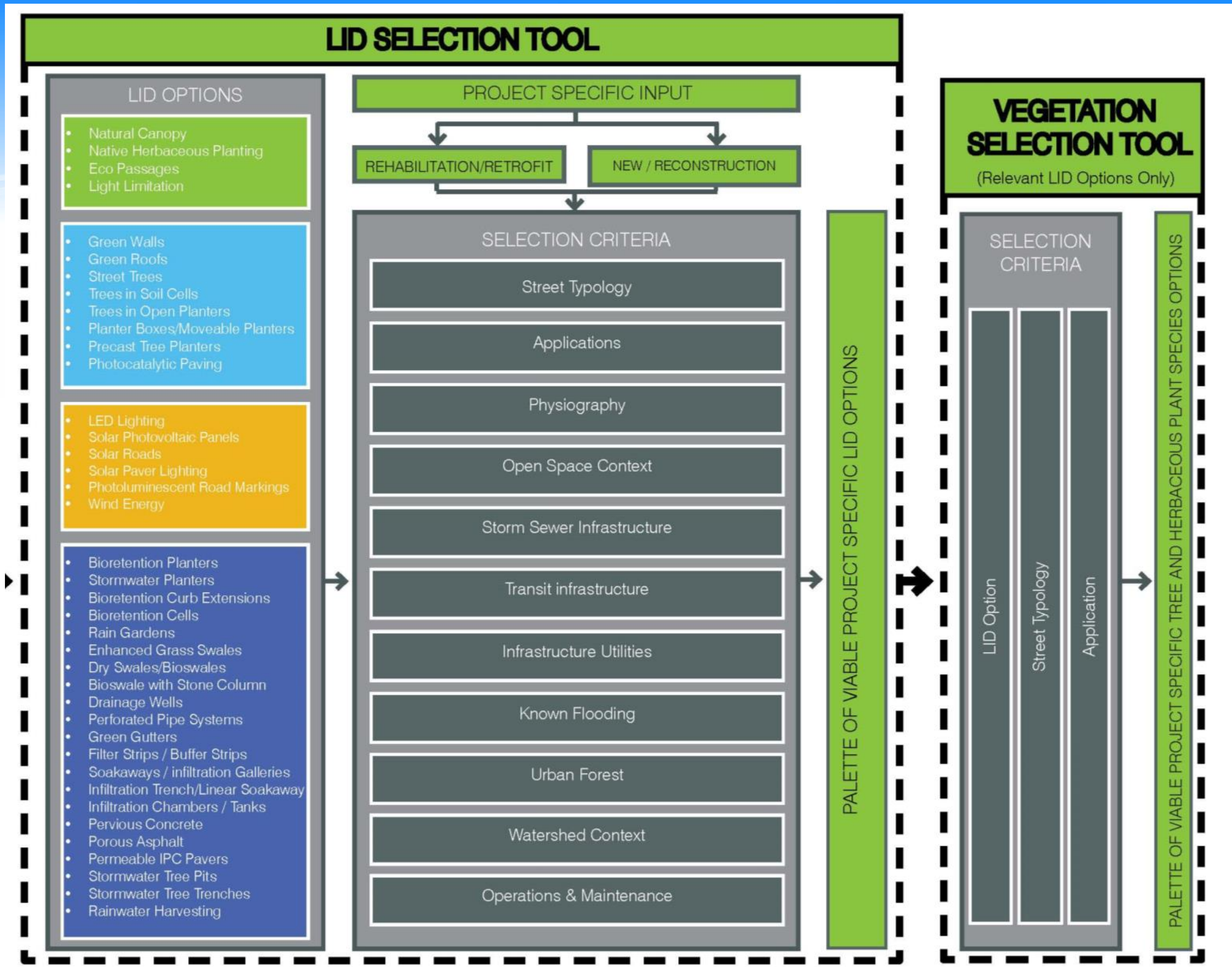
# Guideline Drawings




TORONTO Water

# Description of The Selection Tool




TORONTO Water

# Selection Parameters

- Street Typology
- Applications
- Physiography
- Open Space Context
- Storm Sewer Infrastructure
- Transit infrastructure
- Infrastructure Utilities
- Known Flooding
- Urban Forest
- Watershed Context
- Operations & Maintenance

→ Coordinated with Complete Streets

→ Coordinated with Complete Streets

TORONTO Water

# Parting Thoughts

**Green Streets requires a multi-discipline approach that needs to be incorporated at the project concept stage with adequate information.**

**Think co-benefits.**

**Don’t work in silos!**

**Thank you organizers of TRIECA for inviting us to present at this conference.**