TRIECA CONFERENCE

Great Lakes Chapter

Toronto and Region Conservation for The Living City

3rd Annual TRIECA Conference – March 25 & 26, 2014
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WATER SENSITIVE URBAN DESIGN PERFORMANCE MONITORING

Crafting Water-Sensitive Communities in Cold Climate

TRIECA
March 26, 2014

Chris Denich., M.Sc., P.Eng
Aquafor Beech Ltd

Presentation Overview

- Project Goals and Objectives
- Overview of Six (6) sites
  - Trent Street – Victoria, BC;
  - Trumpeter, Edmonton, AB;
  - King Street, Kitchener, ON;
  - Lakeview, Mississauga, ON;
  - Habitation Jean-Mance, Montreal QC,
  - Winston Heights-Mountview, Calgary, AB
- Monitoring Results
- Monitoring Summary

Presentation Overview

Project Goals and Objectives

Project Goal

- This study is to result in the research, monitoring and documentation of six (6) Canadian water sensitive urban design (also known as Low Impact Development or LID) pilot projects in residential/mixed use developments.

Project Goals and Objectives

Project Objective

- To examine:
  1. The technical performance of bioretention and bioswale along streets in regards to:
     - Water quality;
     - Water quantity; and
     - Vegetation health;
  2. Capital and Operation and Maintenance costs as well as cost trade-offs compared to conventional SWM
  3. Regulatory and approvals considerations – examined, compared and summarized.

Monitoring Program

- **Performance Monitoring**
  - Water Quality – 4 season (spring, summer, sinter and fall)
    - Total Kjeldahl Nitrogen (TKN);
    - Total Phosphorous (P);
    - Heavy metals (Full metal scan with emphasis on Copper, Lead, Zinc, Cadmium);
    - Total Suspended Solids (TSS);
    - Oil and Grease (hydrocarbons;
    - Chlorides; and
    - pH
  - Water Quantity (flow)
  - Vegetation Health

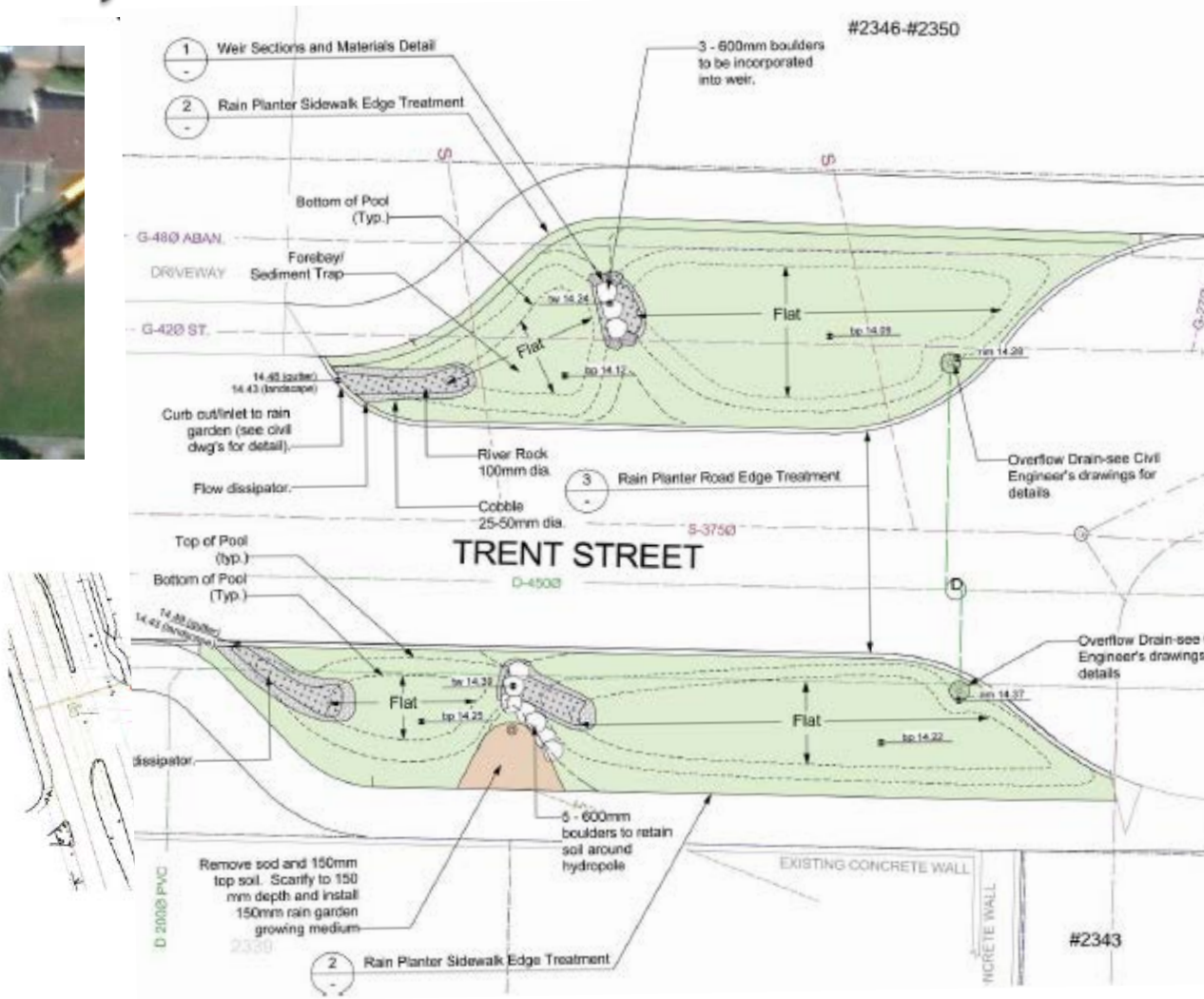
Media Testing

	Kitchener	Montreal		Victoria	Edmonton	Mississauga	Calgary
Infiltration Rate* (mm/hr)	82-116 (Avg. 99mm/hr)	127-128 (Avg. 127.5mm/hr)	80-139 (Avg. 104mm/hr)	49-134 (Avg. 91.5mm/hr)	16-25* (Avg. 21.7mm/hr)	230-249 (Avg. 236mm/hr)	4-144 (Avg. 62mm/hr)
% Sand (2-0.05mm)	69	88	90	79	23	91	52
% Fines (<0.050mm)	31	1.8	10	21	77	9	48
Soil Classification	Sandy Loam	Sandy Loam	Sand	Loamy Sand	Clay	Sand	Sandy Loam
Compost (Organic Matter by Loss On Ignition - LOI)	10.3	22.0	0.9	17.3	7.06	4.02	3.38
% Material smaller than (75 micron)	35.4	1.8	10	1.22	5.53	20.2	n/a
CEC (meq/100g)	31.2	34.1	5.52	14.6	29.6	14.6	18.6
pH	7.22	6.78	7.42	5.26	6.60	7.21	7.5

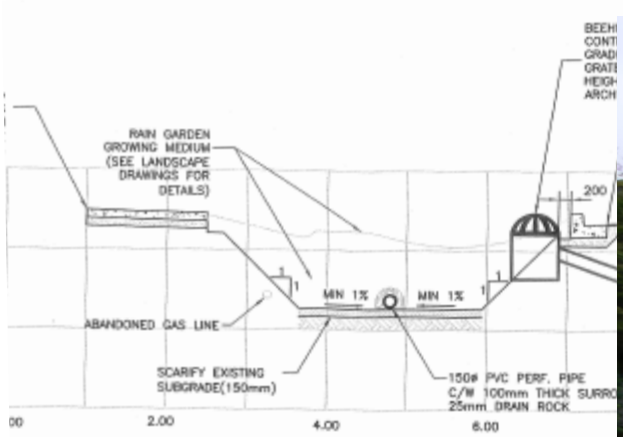
Trent Street, Victoria BC

Trent Street, Victoria BC

- Retrofit in 2009
- DA = 0.16 ha;
- Area = 180-196sqm
- Conventional storm sys
- Outlets to Bowker Creek
- Primarily ICI land-use
- Improved parking issue

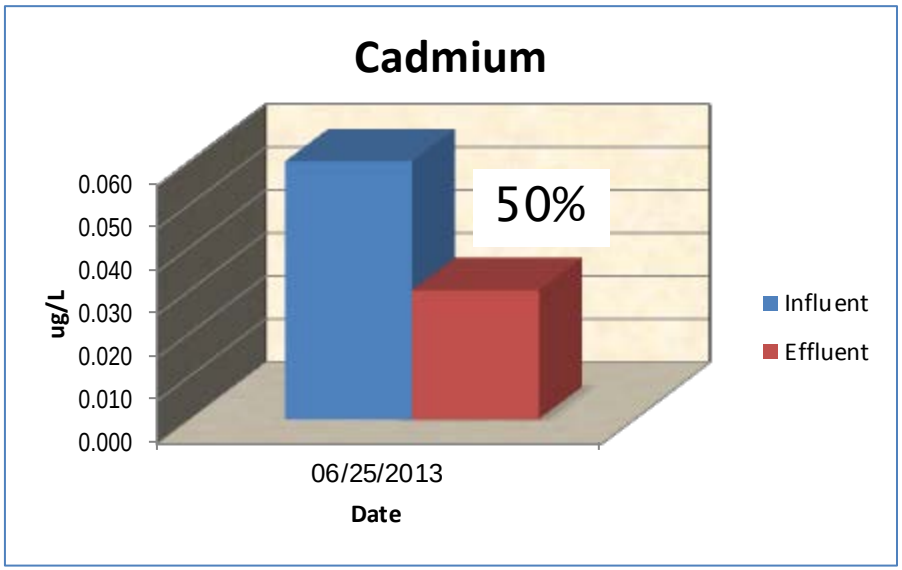


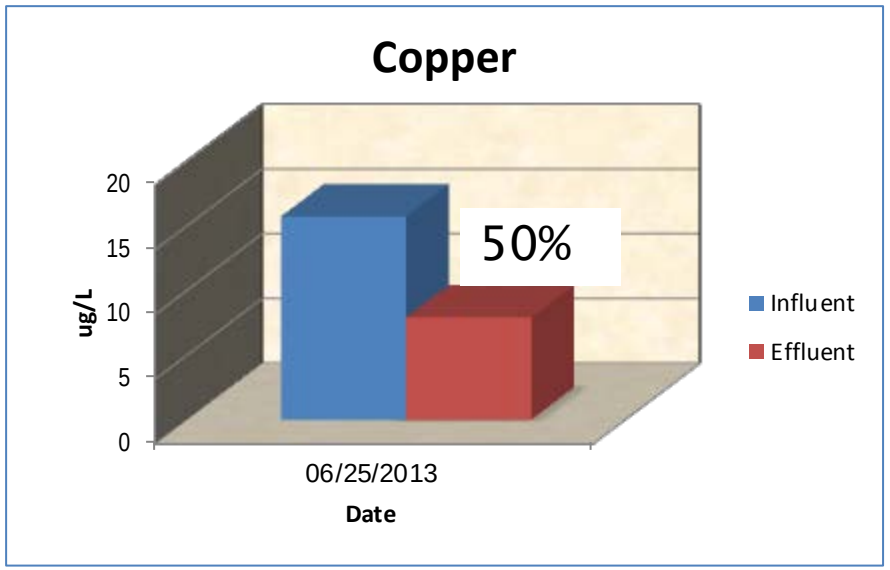
Trent Street, Victoria BC

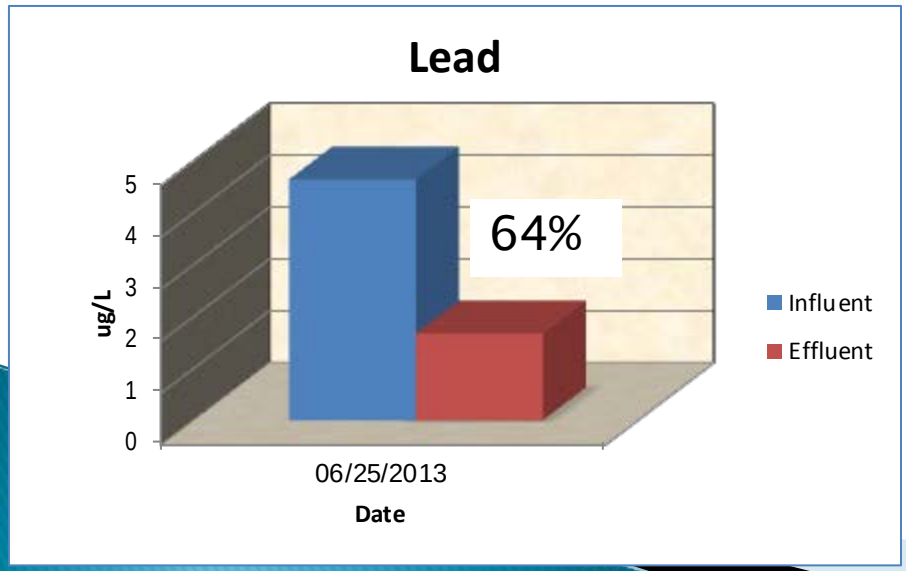


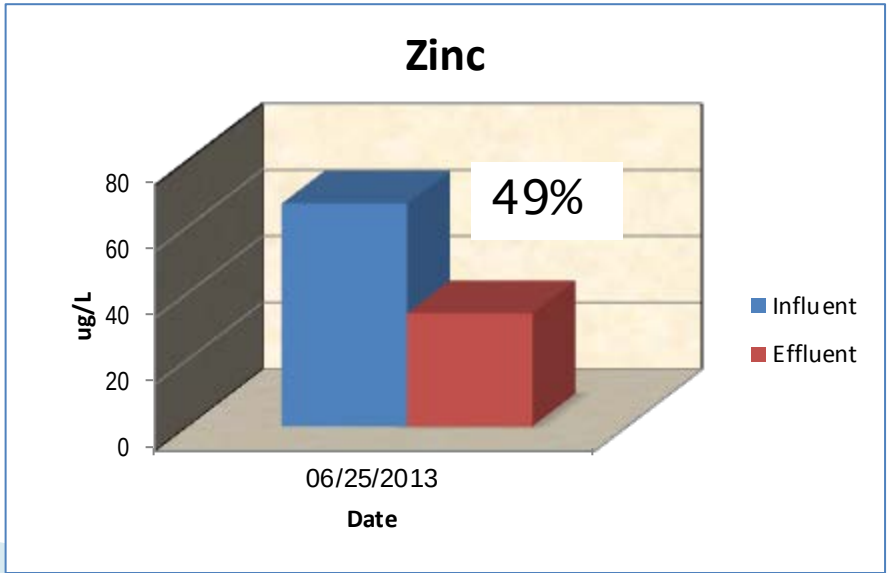
Trent Street, Victoria BC

Heavy Metals



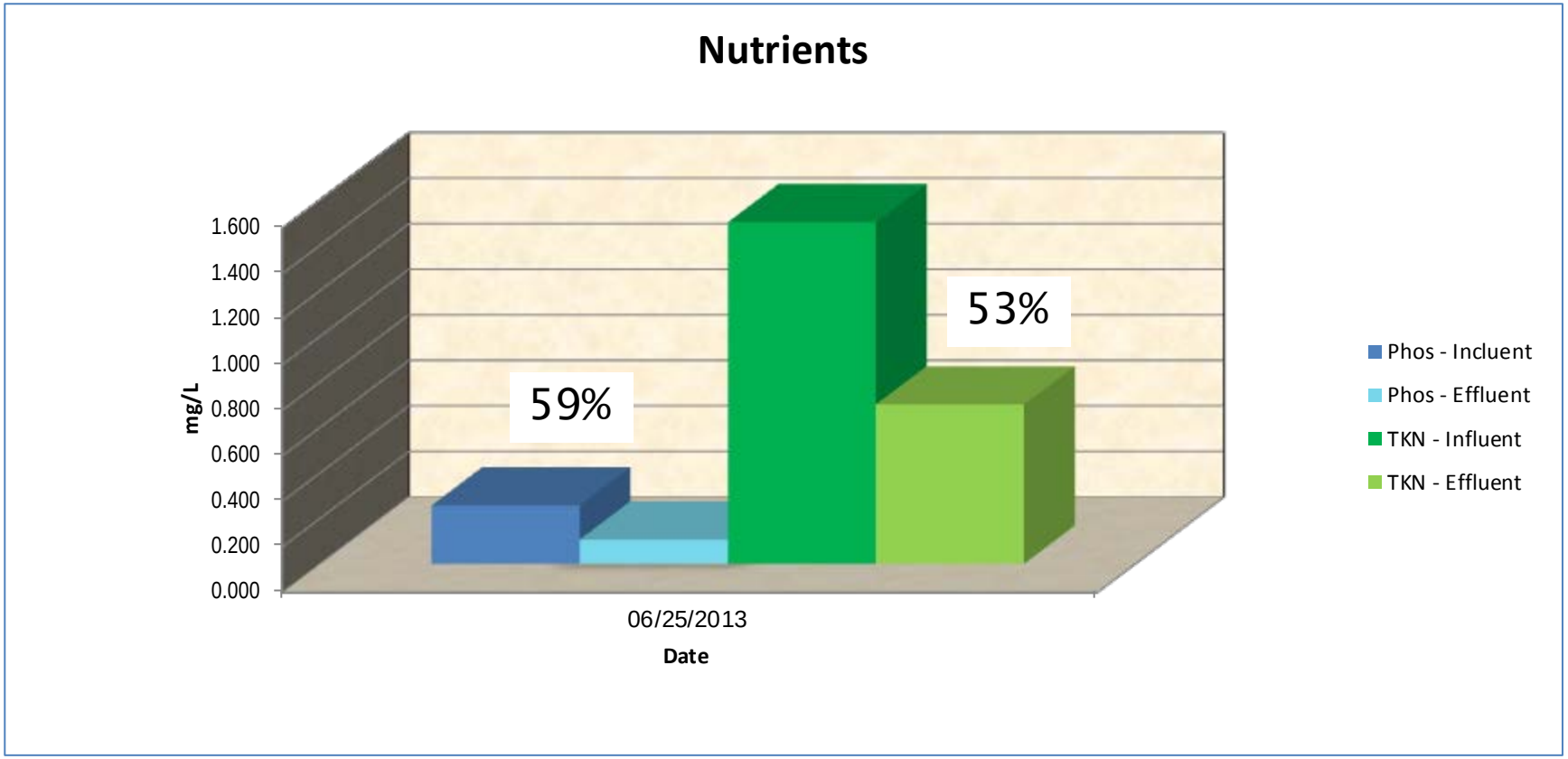






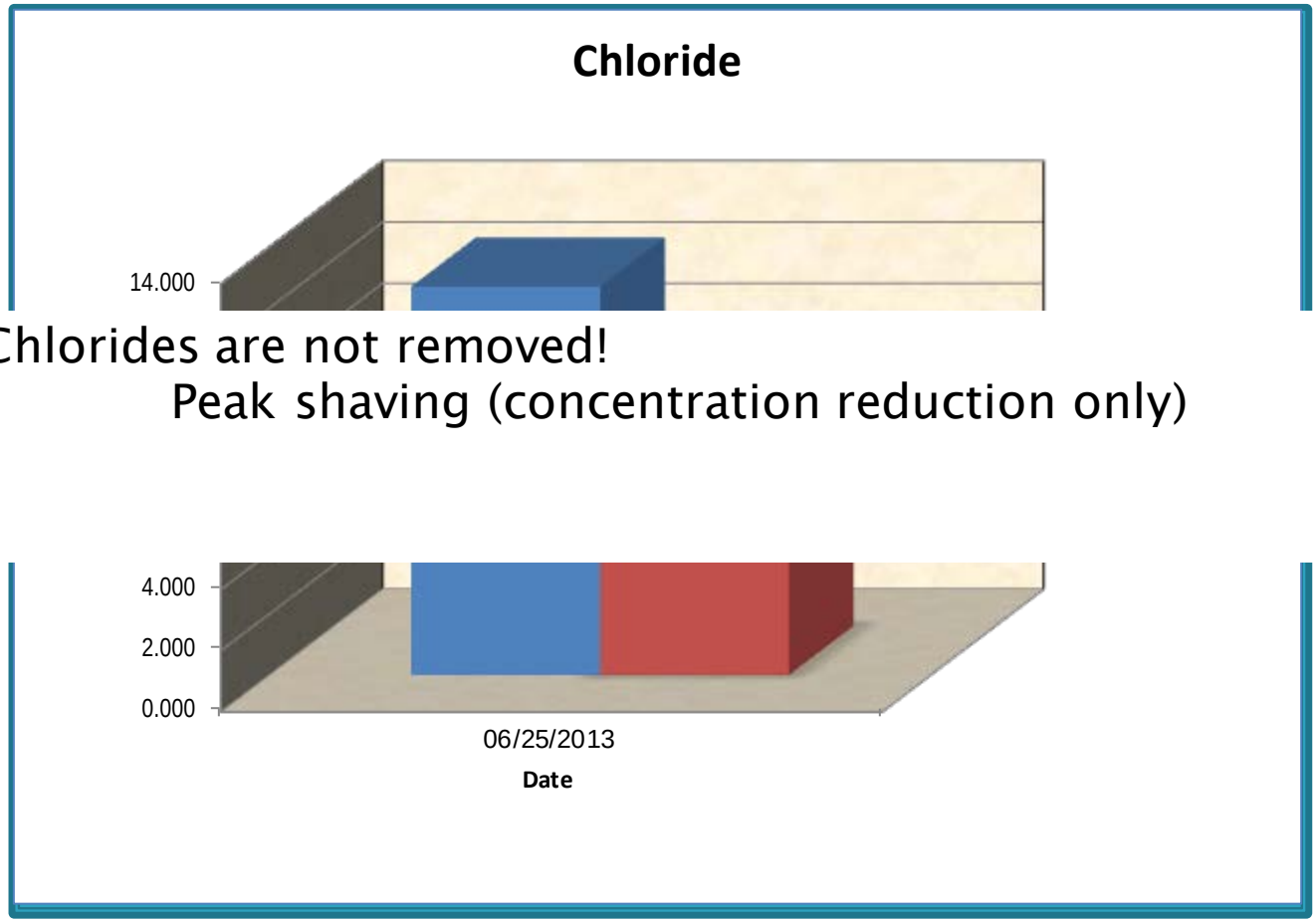
Trent Street, Victoria BC

Nutrients



Trent Street, Victoria BC

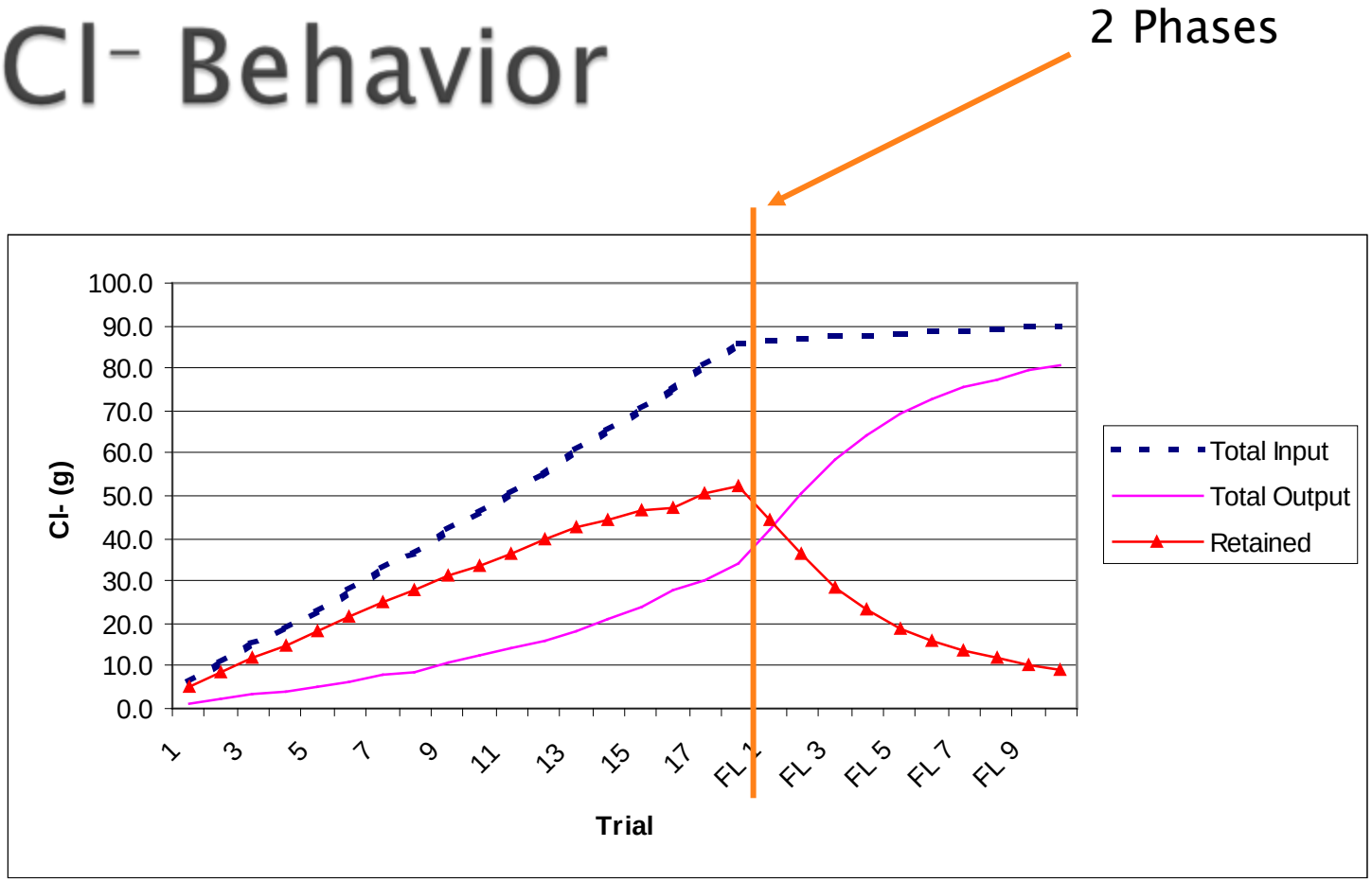
Chloride



Chlorides are not removed!

Peak shaving (concentration reduction only)

Cl^- Behavior

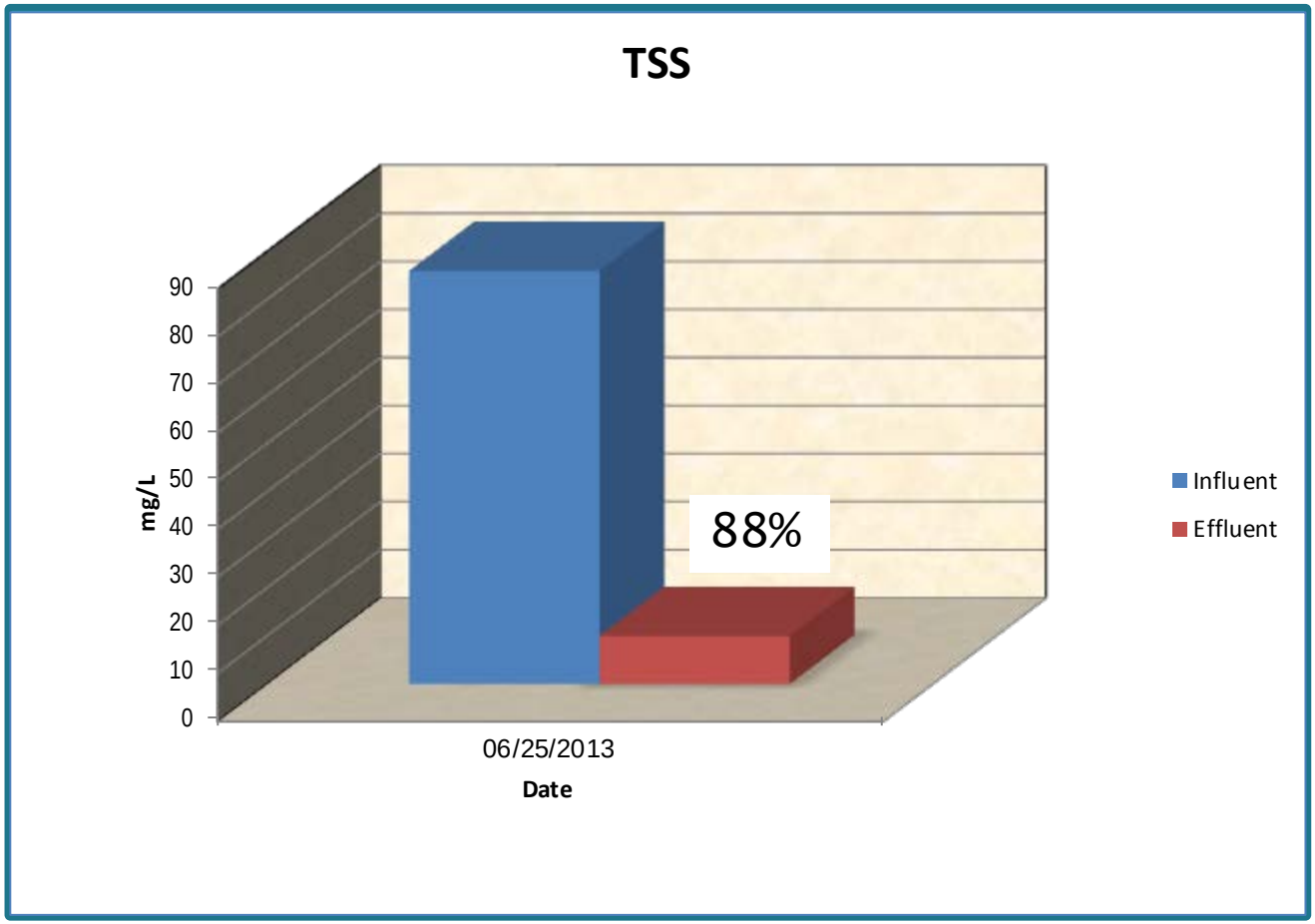


Bioretention: Assessing effects of winter salt and aggregate on plant health, media clogging and effluent quality

Denich. C., et. al., (2014) Water Quality Journal of Canada

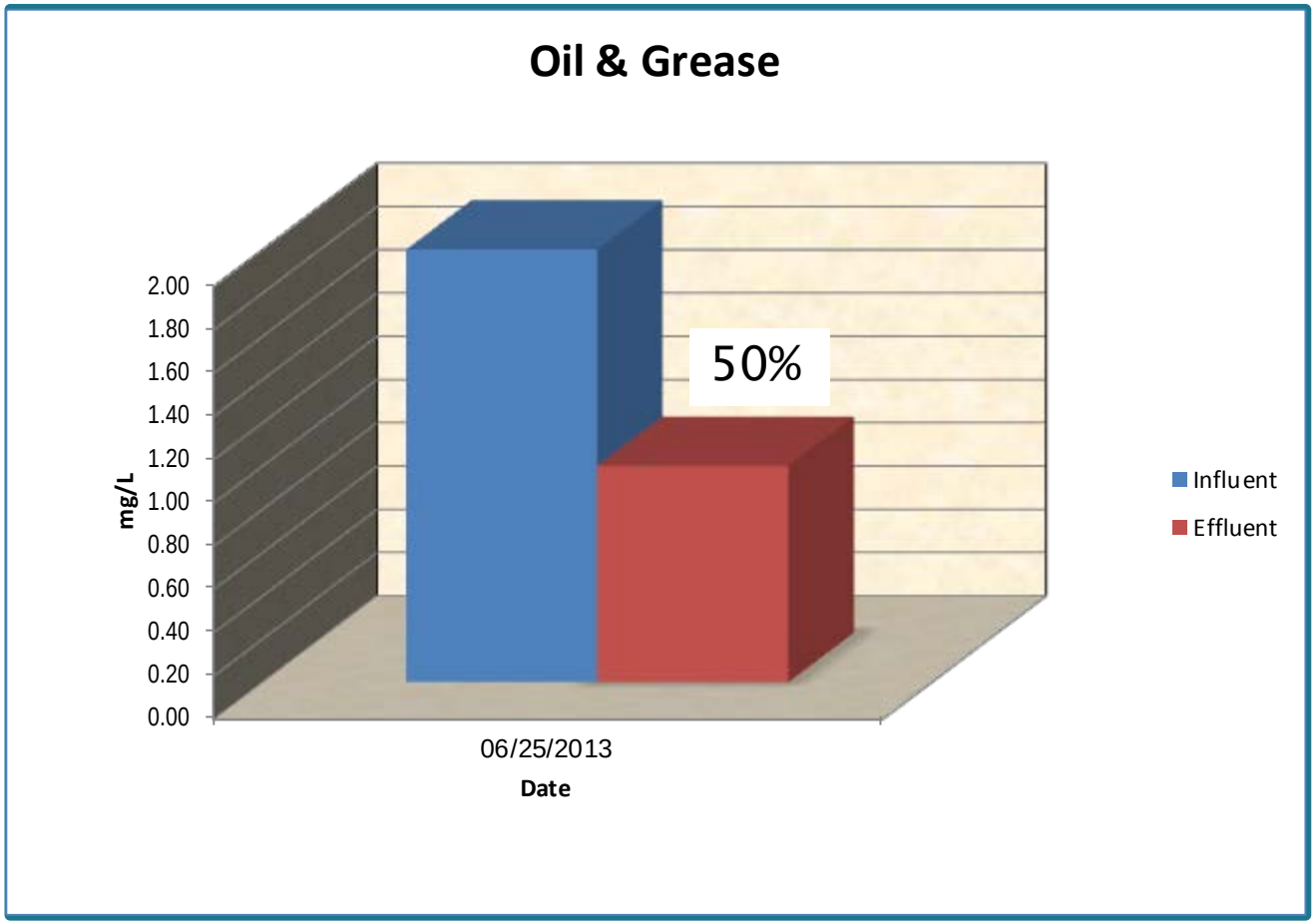
Trent Street, Victoria BC

TSS



Trent Street, Victoria BC

Oil & Grease



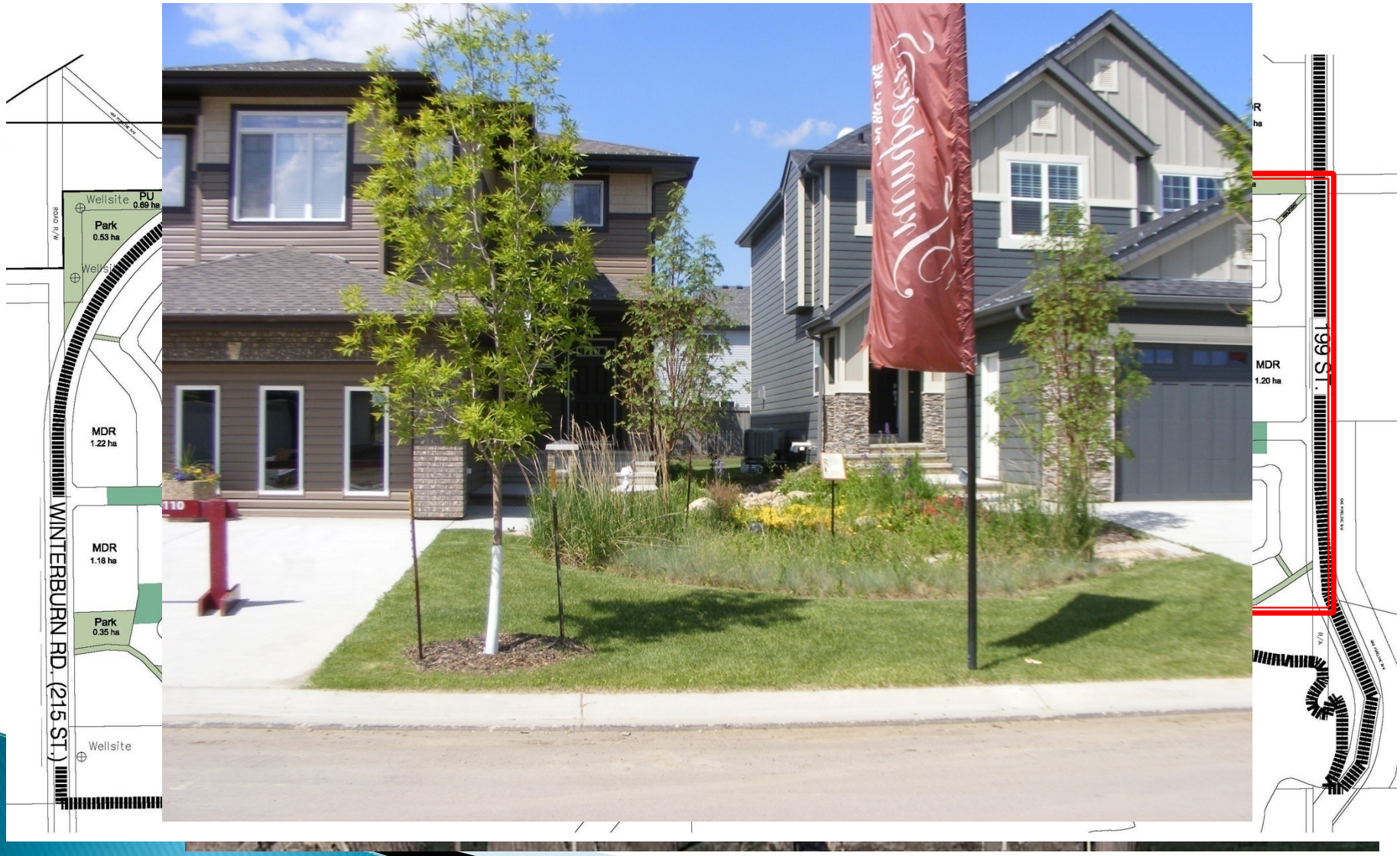
Trent Street, Victoria BC

	Victoria
Infiltration Rate* (mm/hr)	49-134 (Avg. 91.5mm/hr)
% Sand (2-0.05mm)	79
% Fines (<0.050mm)	21
Soil Classification	Loamy Sand
Compost (Organic Matter by Loss On Ignition - LOI)	17.3
% Material smaller than (75 micron)	1.22
CEC (meq/100g)	14.6
pH	5.26

Parameter	Unit	Influent	Effluent	Removal Efficiency (%)
Cadmium Total	µg/L	0.06	0.03	50.0
Copper Total	µg/L	15.7	7.9	49.7
Lead Total	µg/L	4.64	1.67	64.0
Zinc Total	µg/L	67	34	49.3
Total Suspended Solids	mg/L	86	10	88.4
Phosphorus Total	mg/L	0.256	0.106	58.6
Nitrogen – Total Kjeldahl (TKN)	mg/L	1.5	0.7	53.3
Oil and Grease – Mineral	mg/L	2	1	50.0
Chloride	mg/L	12.7	6.97	45.1

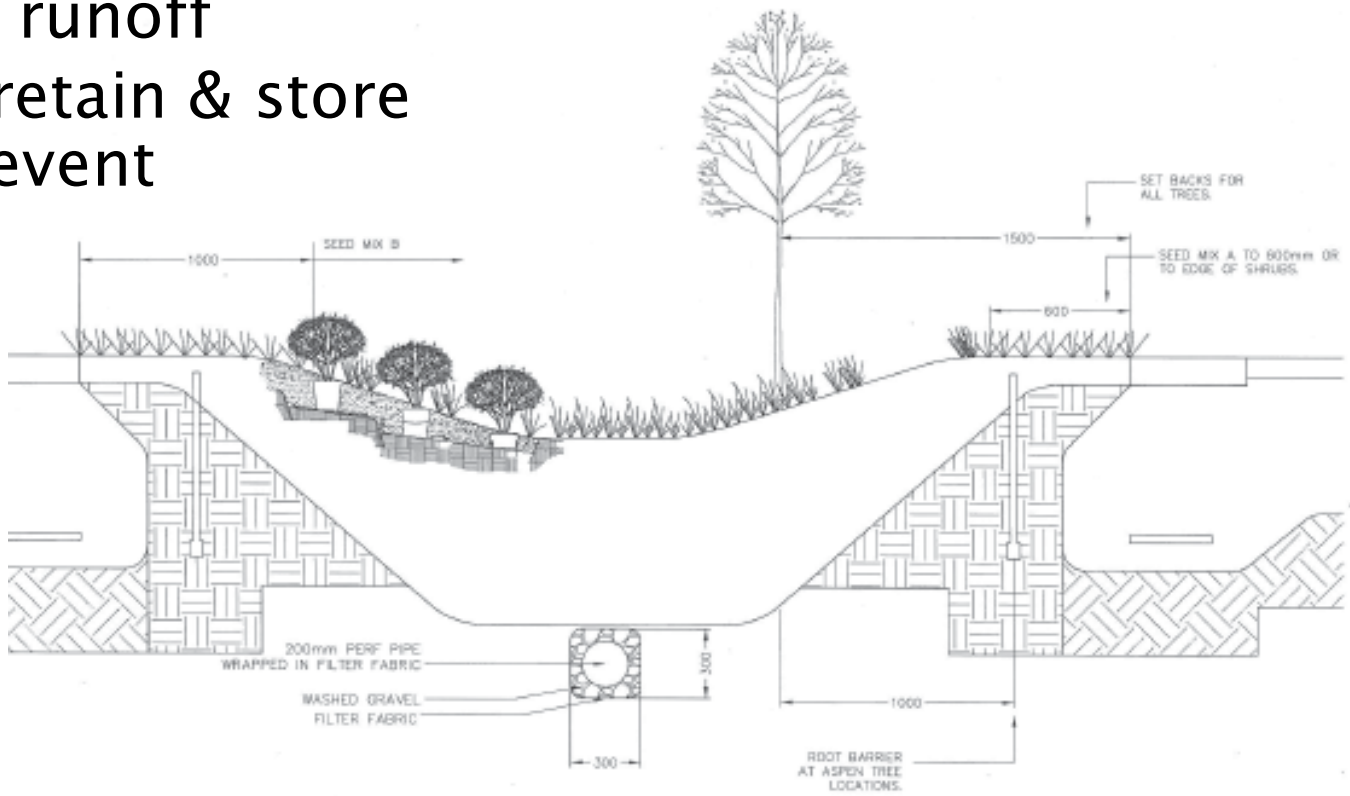
Trumpeter, Edmonton AB

Trumpeter, Edmonton AB



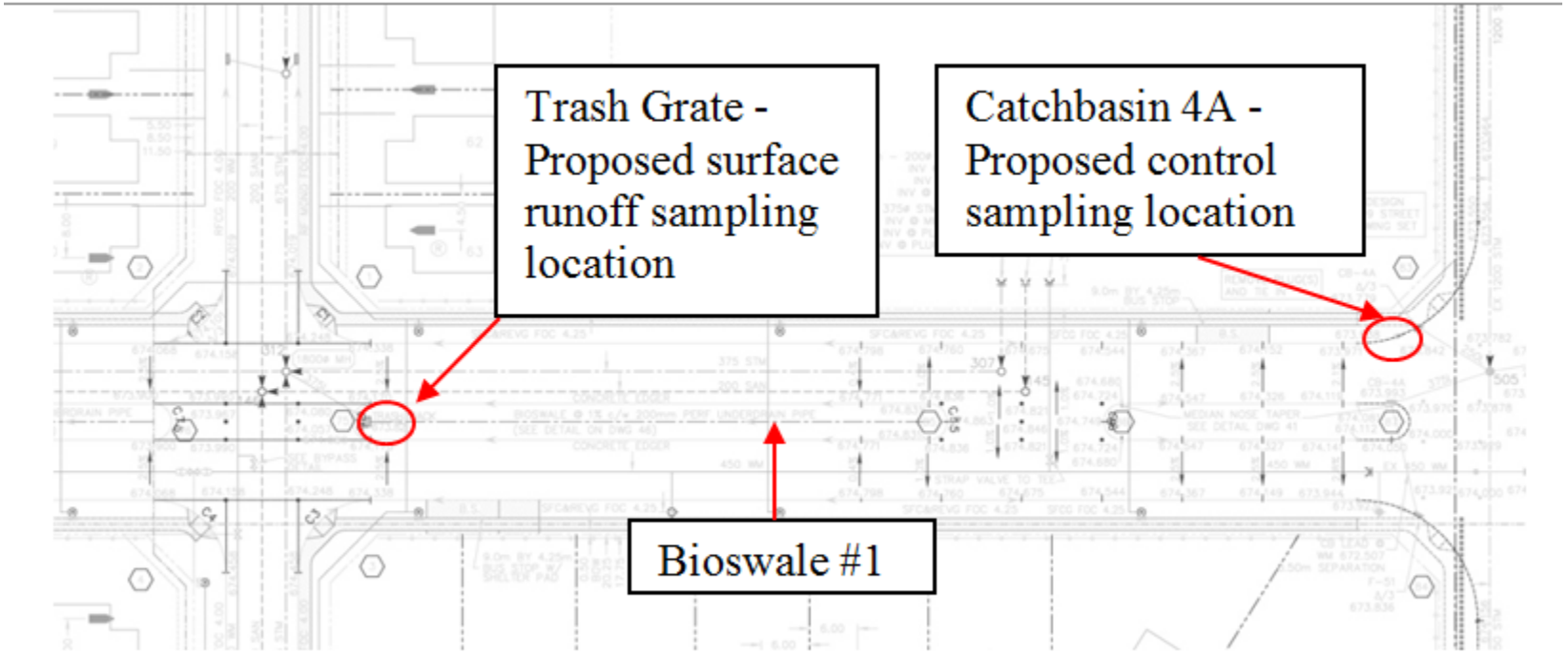
Trumpeter, Edmonton AB

- Multi-phased residential development
- Constructed Fall ‘09
- Accepts road runoff
- Designed to retain & store the 1:5 year event



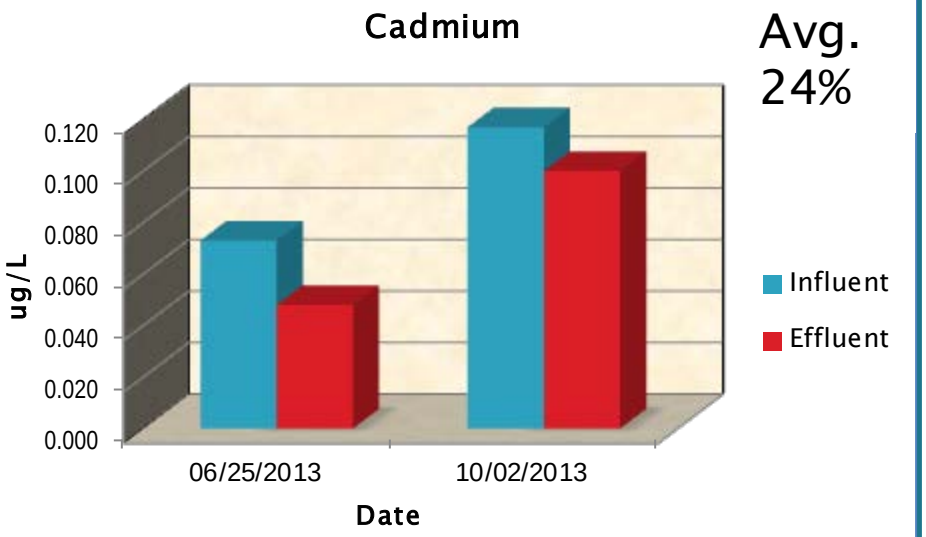
Trumpeter, Edmonton AB

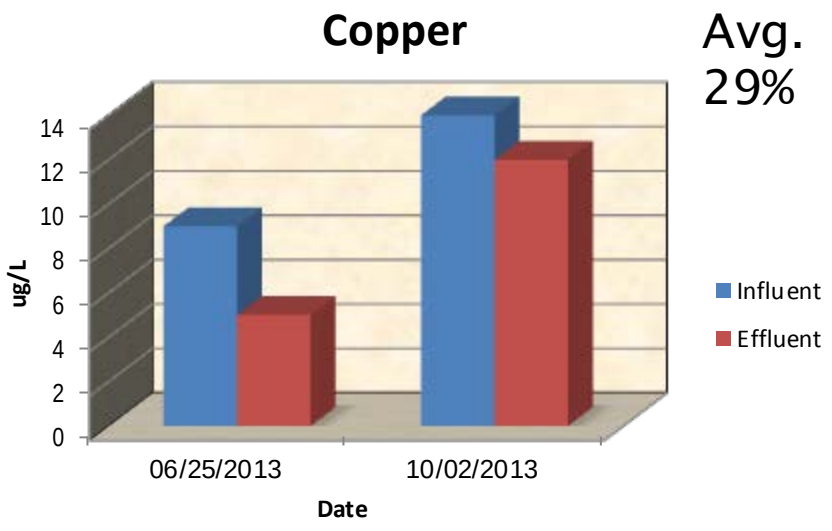
- Water quality and flow monitoring is underway and will continue through 2014

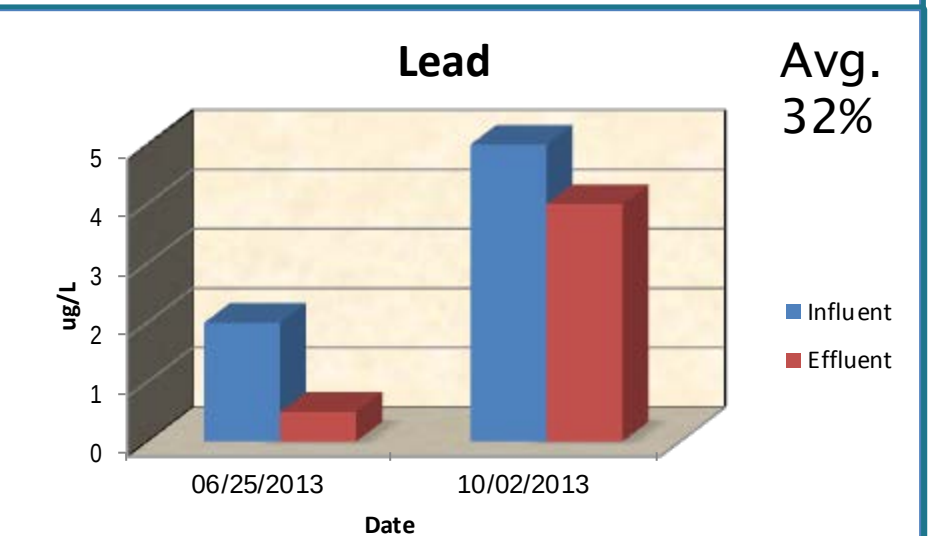


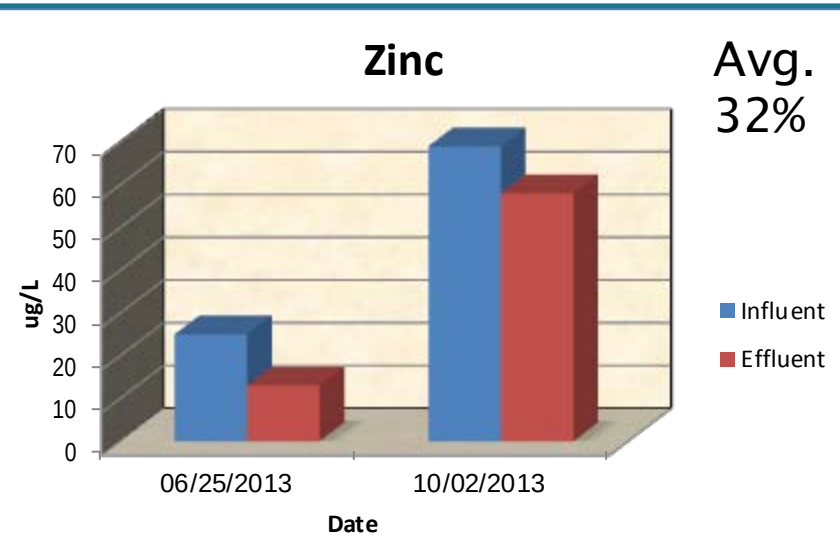
Trumpeter, Edmonton AB

Heavy Metal



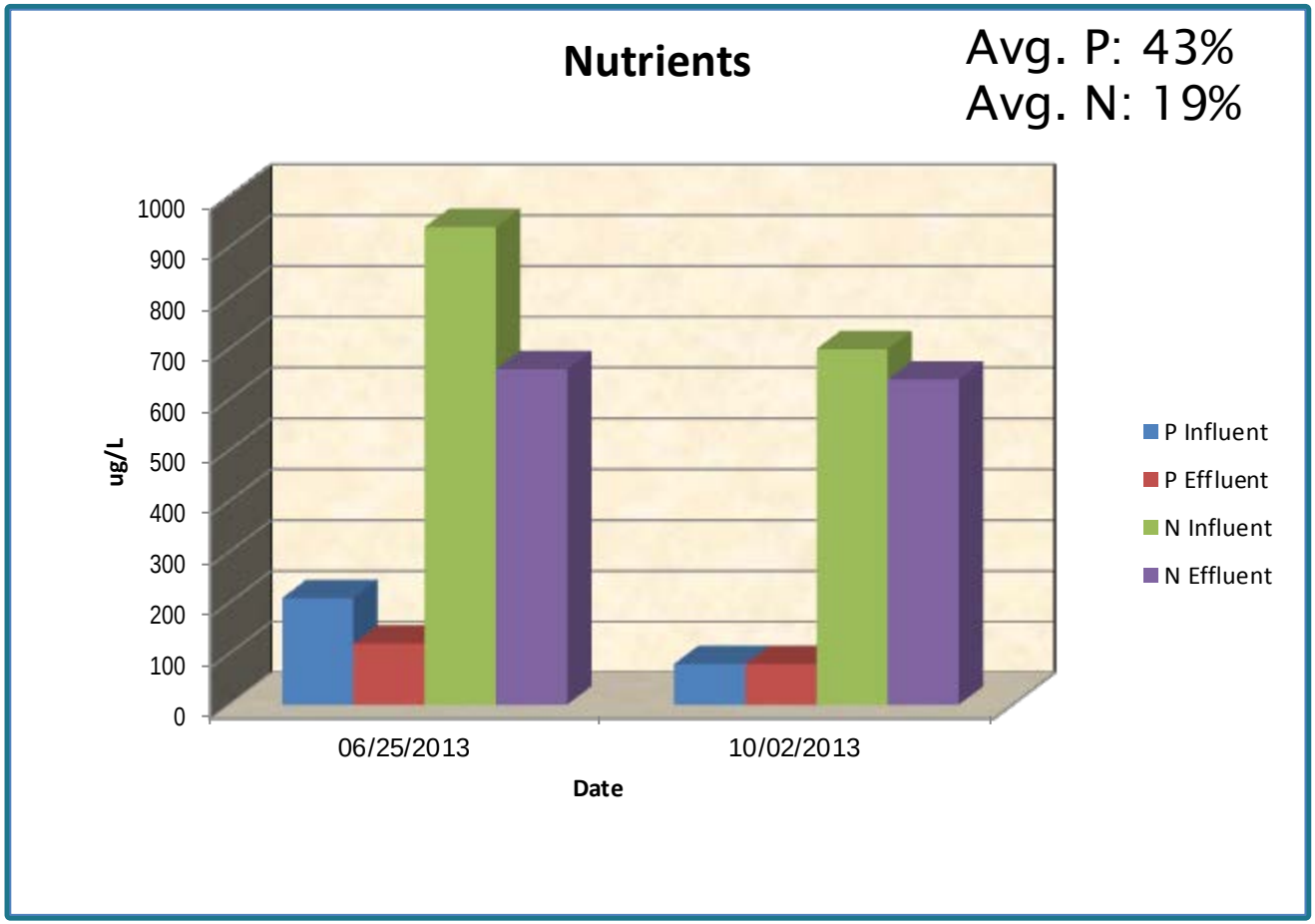






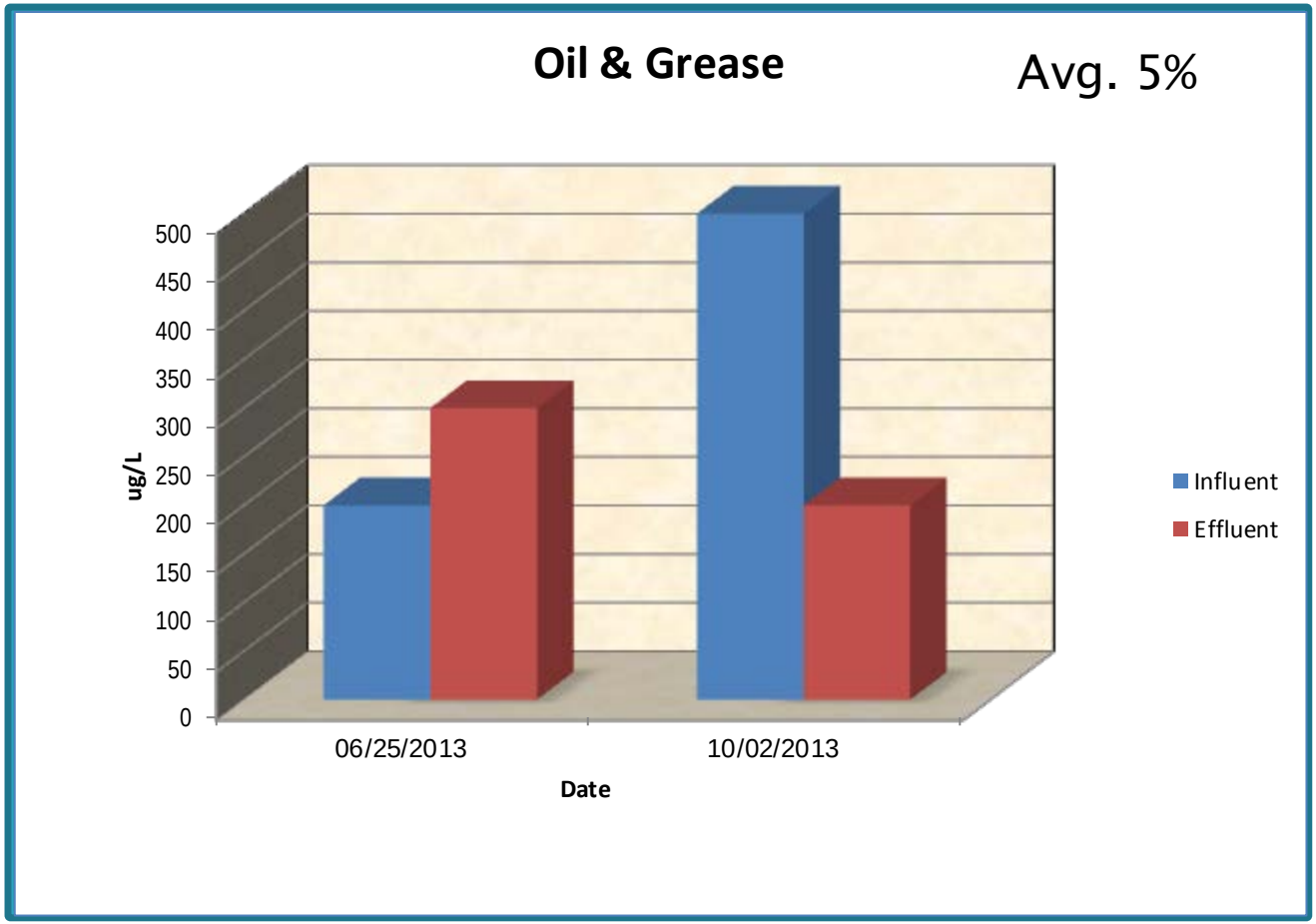
Trumpeter, Edmonton AB

Nutrients



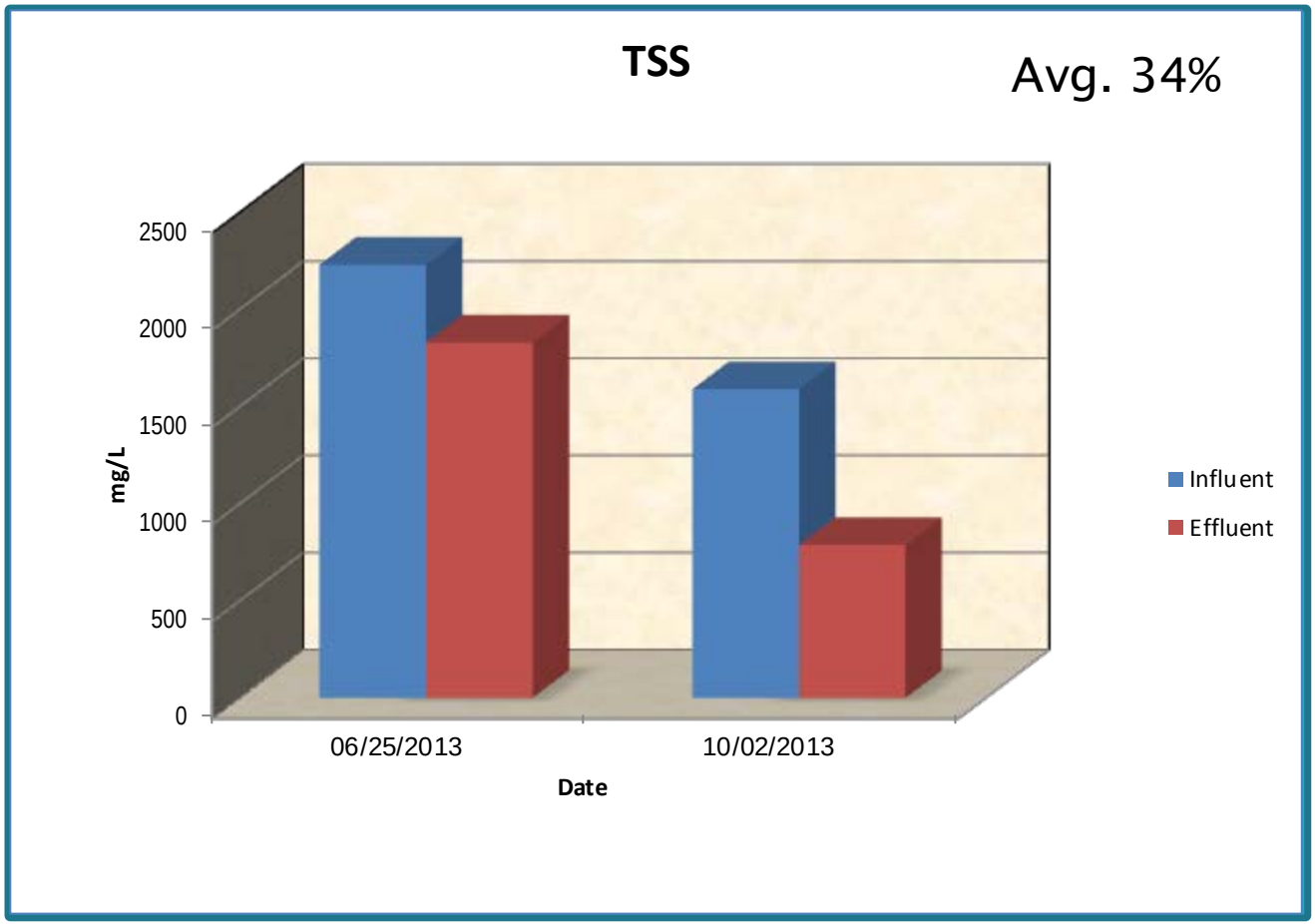
Trumpeter, Edmonton AB

Oil & Grease



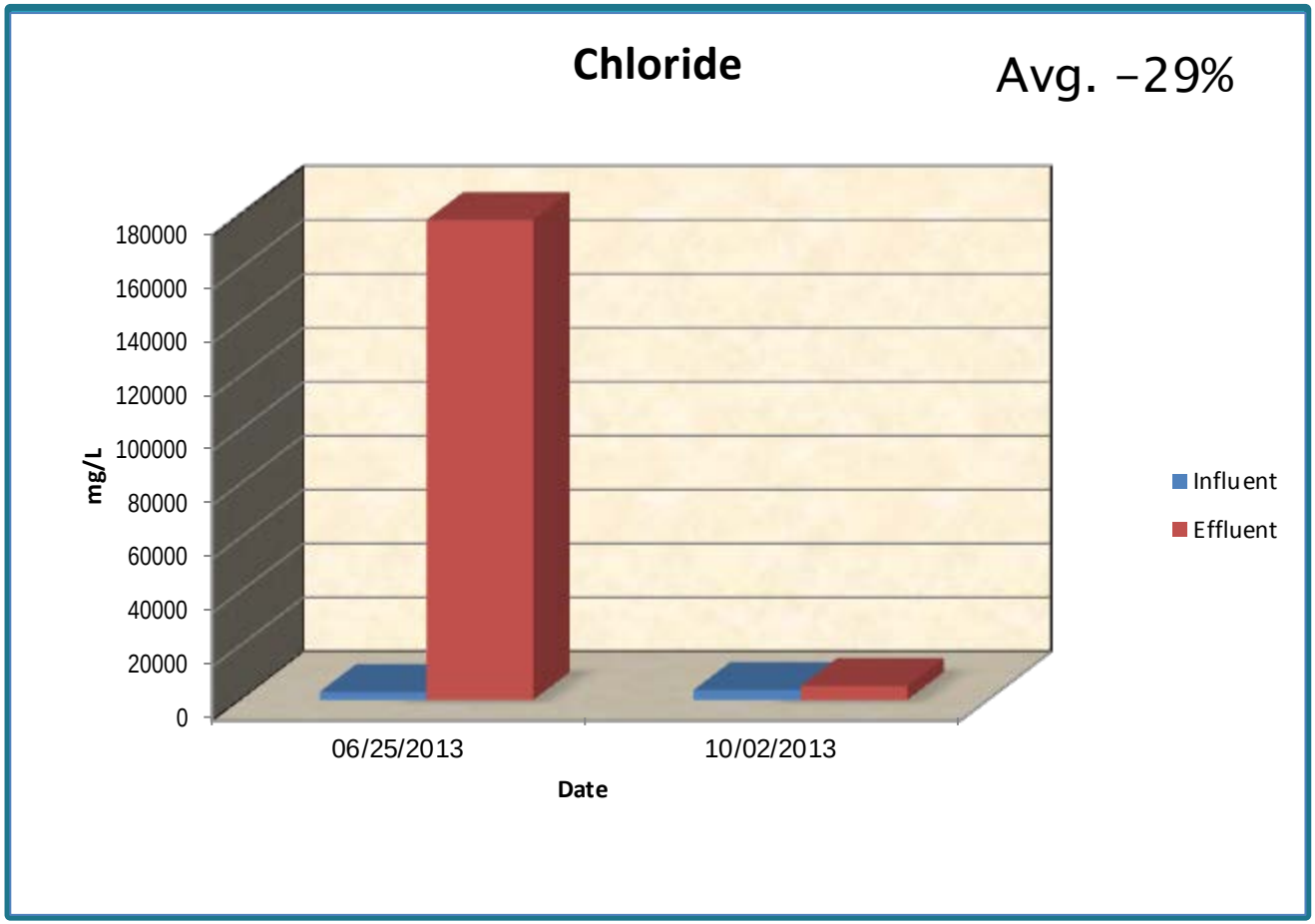
Trumpeter, Edmonton AB

TSS



Trumpeter, Edmonton AB

Chloride



Trumpeter, Edmonton AB

	Edmonton
Infiltration Rate* (mm/hr)	16-25* (Avg. 21.7mm/hr)
% Sand (2-0.05mm)	23
% Fines (<0.050mm)	77
Soil Classification	Clay
Compost (Organic Matter by Loss On Ignition - LOI)	7.06
% Material smaller than (75 micron)	5.53
CEC (meq/100g)	29.6
pH	6.60

Parameter	Unit	Influent	Effluent	Removal Efficiency (%)
Cadmium Total	µg/L	9-14	5-12	0.24
Copper Total	µg/L	2-5	0.5-4	0.29
Lead Total	µg/L	25-69	13-58	0.48
Zinc Total	µg/L	25-69	13-58	0.32
Total Suspended Solids	mg/L	2230-1590	1830-788	0.34
Phosphorus Total	mg/L	210-80	120-80	0.43
Nitrogen - Total Kjeldahl (TKN)	mg/L	940-700	640-660	0.19
Oil and Grease - Mineral	mg/L	200-500	200-300	0.05
Chloride	mg/L	3000-3700	5200-17800	-29.37

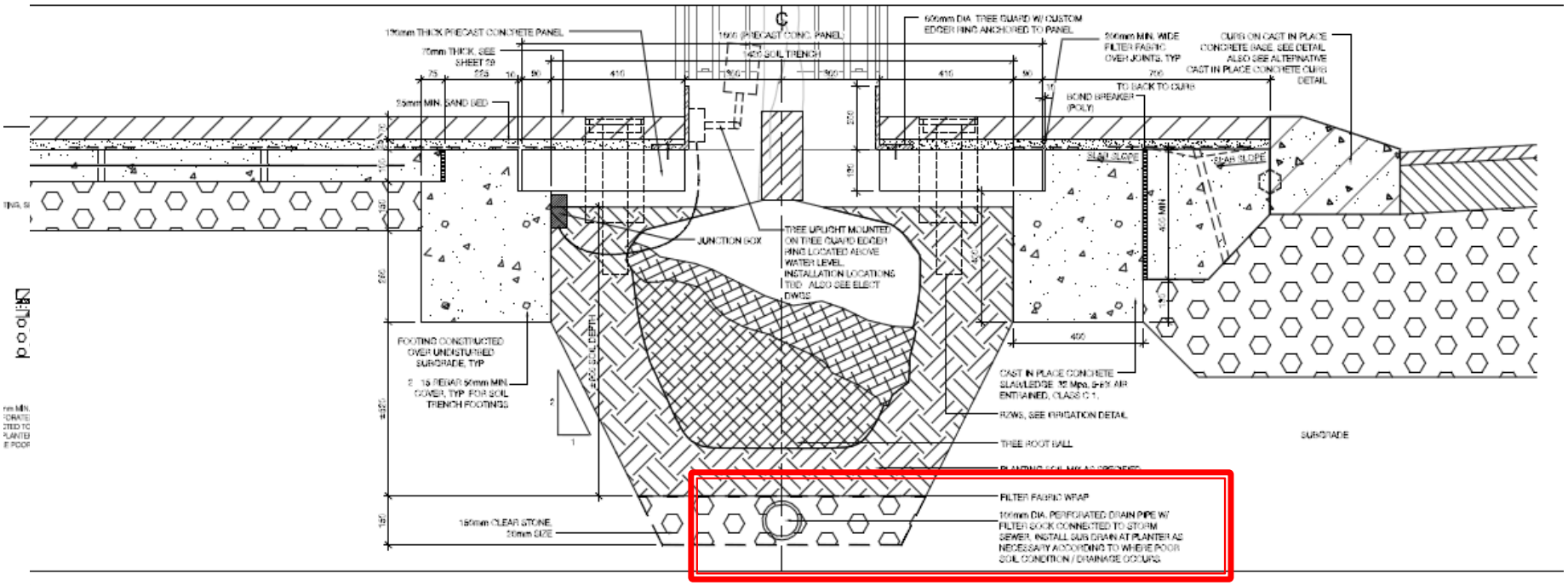
King Street, Kitchener, ON

King Street, Kitchener, ON

King Street, Kitchener, ON

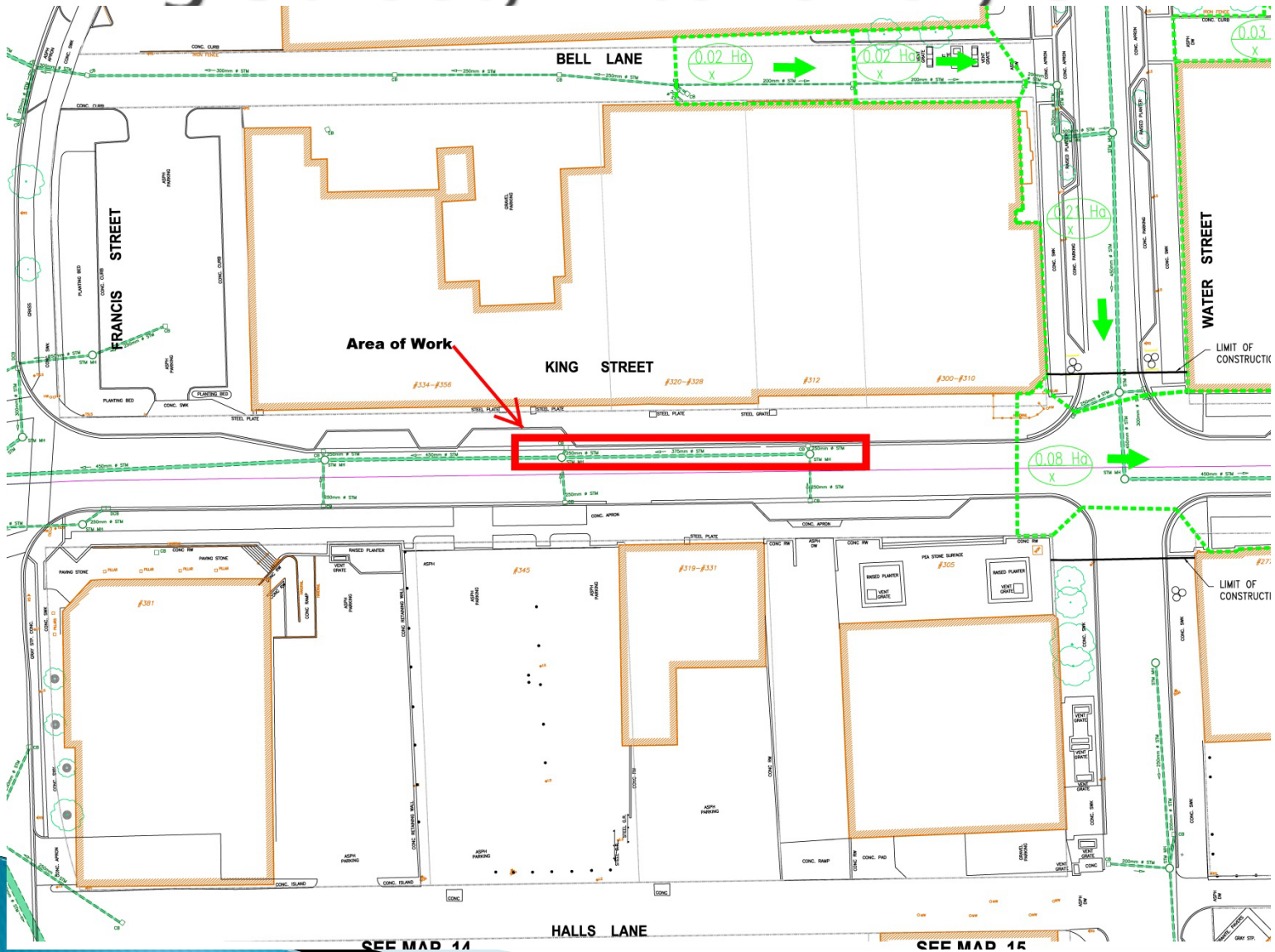
- Constructed in 2009 – City Centre
- Integrates on-street parking, stormwater and aesthetics
- Numerous cells distributed along King St.
- Has unique gate system – prevent chloride introduction

King Street, Kitchener, ON



SOIL TRENCH ALONG ROAD SOIL TRENCH/TREE PIT OPENING ALONG ROAD, TYP.
NTS

King Street, Kitchener, ON



King Street, Kitchener, ON

- Water quality monitoring not possible;
- Flow monitoring is ongoing
  - Ultrasonic device and weir installed Nov, 2012

<u>Flow Monitoring</u>

Off-line condition (gates closed)

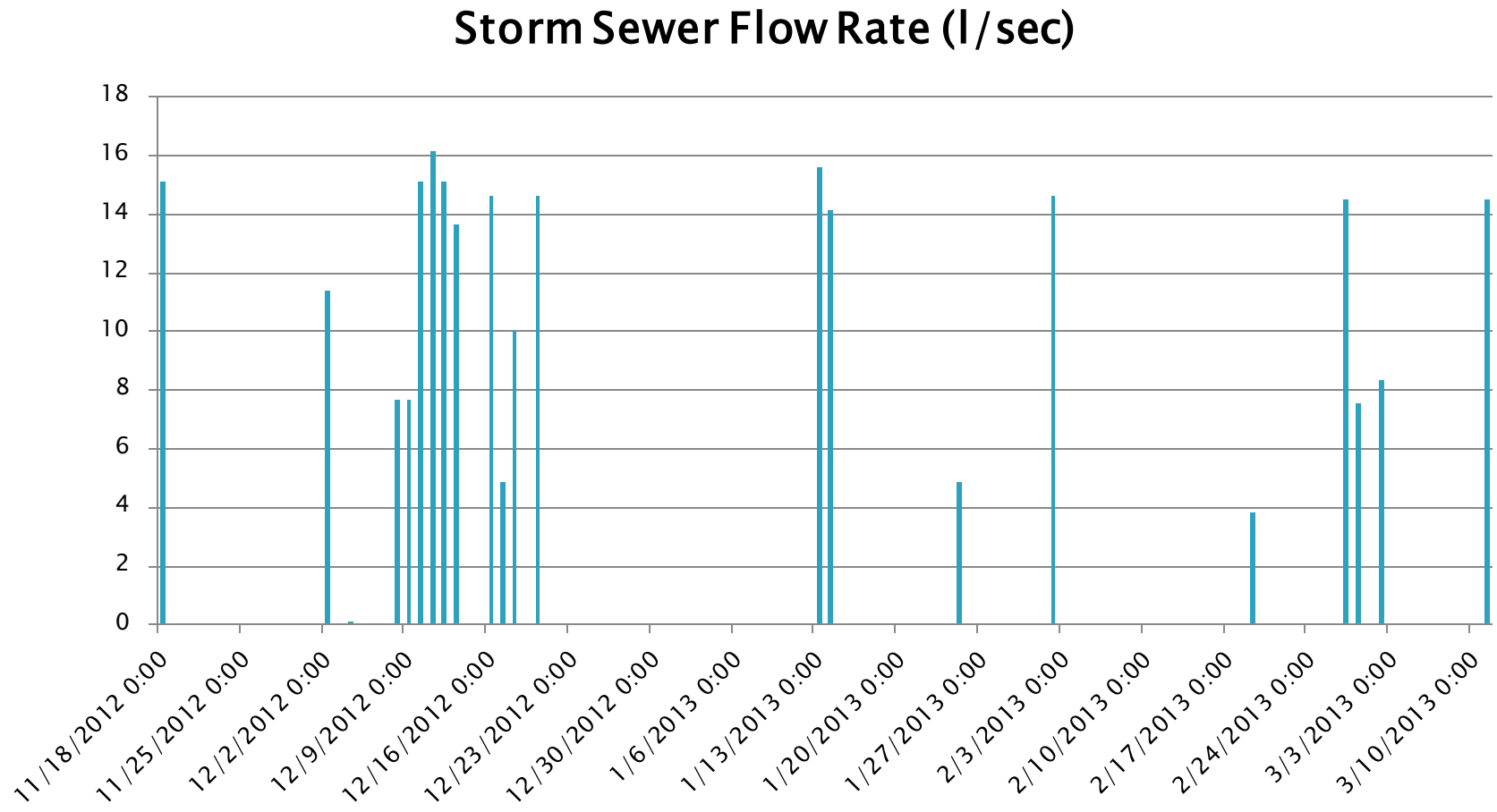
- November 18, 2012 to June 9, 2013

On-line condition – May 2013

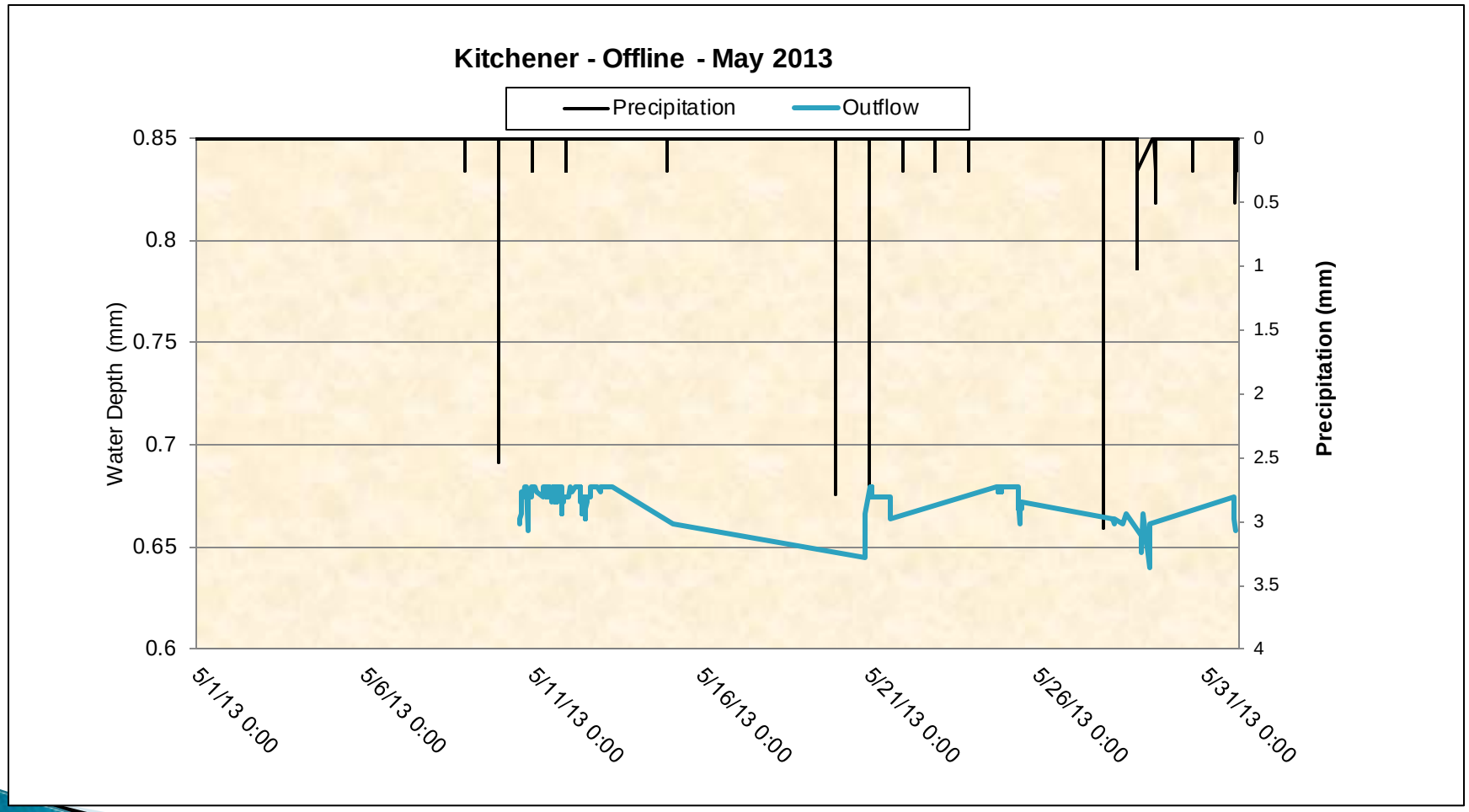
- June 10, 2013 to November 12, 2013

Results normalized/mm rainfall

King Street, Kitchener, ON



King Street, Kitchener, ON



King Street, Kitchener, ON

Flow Conditions	Total Rainfall (mm)	Peak Outflow L/s/mm	Avg. L/s/mm
Offline	12.954	0.88	0.31
	9.398	0.03	
	5.08	0.04	
Online	17.53	0.03	0.03
	5.08	0.04	
	15.748	0.05	
	8.128	0.01	
	24.384	0.02	

Habitation Jeanne-Mance, Montreal QC

Habitation Jeanne-Mance, Montreal QC

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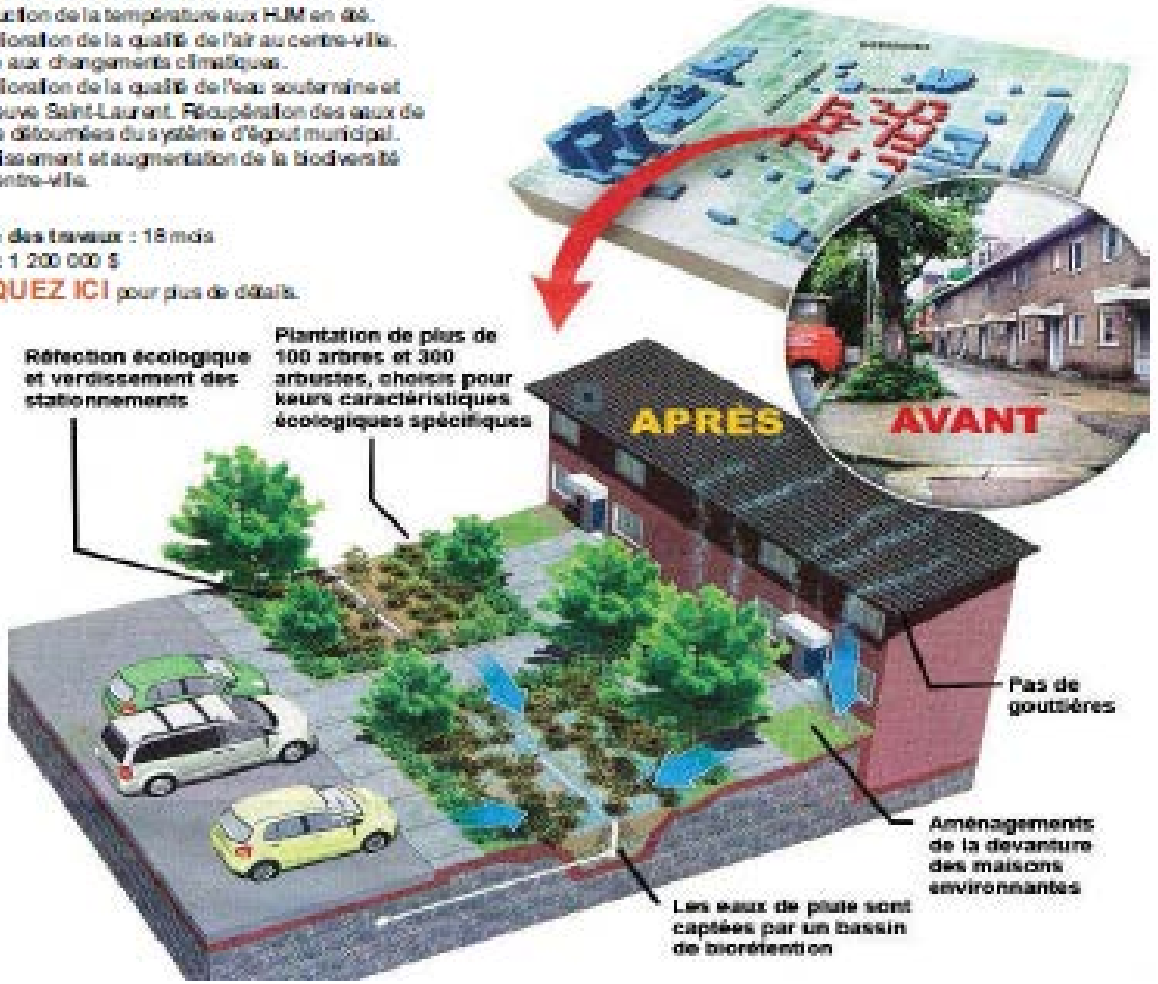
Habitation Jeanne-Mance, Montreal QC

Stationnements écologiques aux Habitations Jeanne-Mance [hs4]

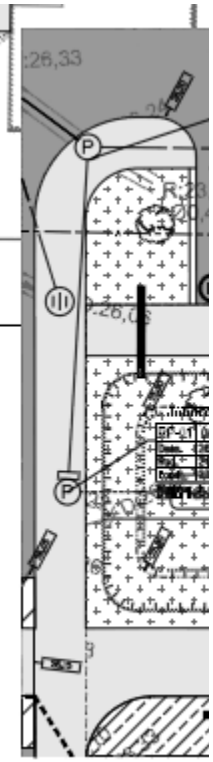
Voici le tout premier stationnement écologique à Montréal. Ce projet sera réalisé aux Habitations Jeanne-Mance et vise à lutter contre les îlots de chaleur urbains, et gérer les eaux de pluie.

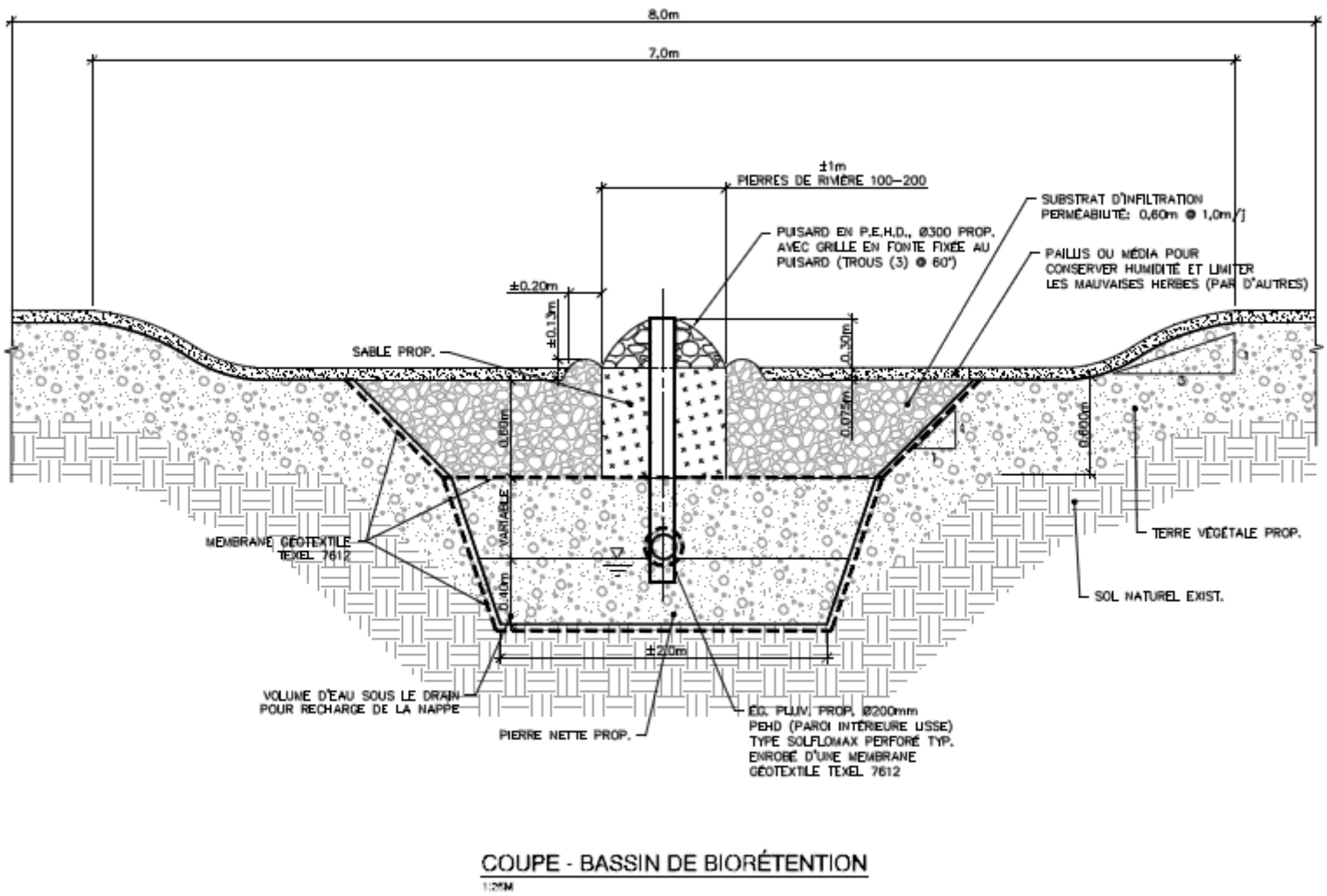
Objectifs environnementaux :
- Réduction de la température aux HJM en été.
- Amélioration de la qualité de l'air au centre-ville.
- Lutte aux changements climatiques.
- Amélioration de la qualité de l'eau souterraine et du fleuve Saint-Laurent. Récupération des eaux de pluie détournées du système d'égout municipal.
- Verdissement et augmentation de la biodiversité au centre-ville.

Durée des travaux : 18 mois
Coût : 1 200 000 $
CLIQUEZ ICI pour plus de détails.

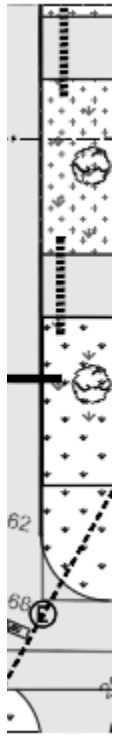


Habitation Jeanne-Mance, Montreal QC





COUPE - BASSIN DE BIORÉTENTION



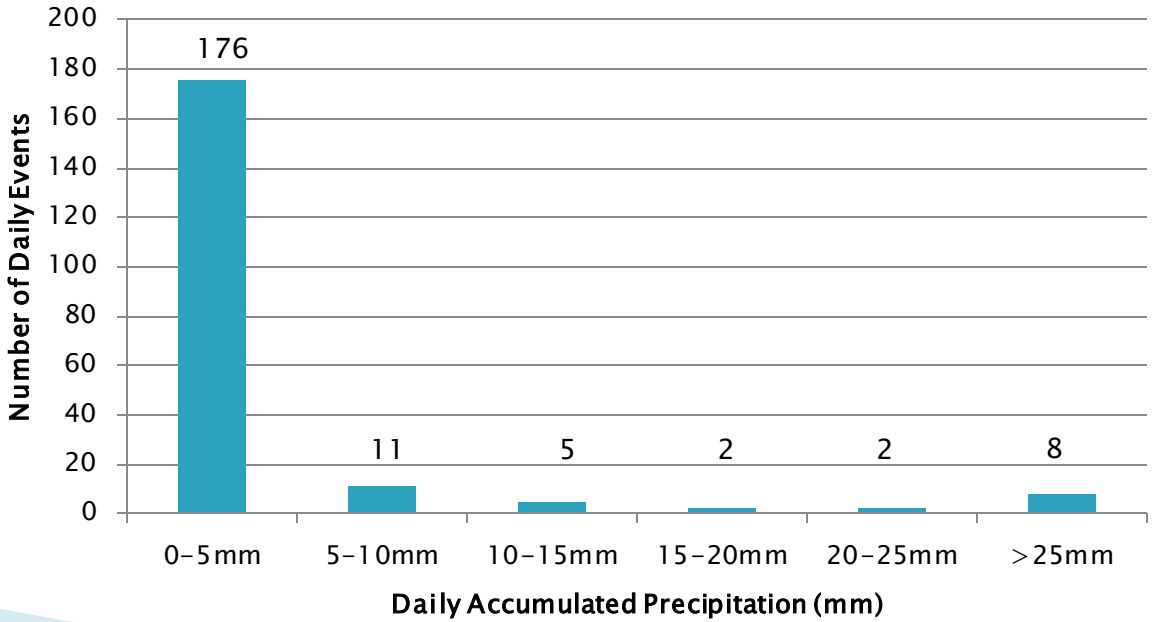
Media: Heavy Metal & Chloride Accumulation

Upper Media Profile Chemical Characteristics Summary for HJM, Montreal, QC

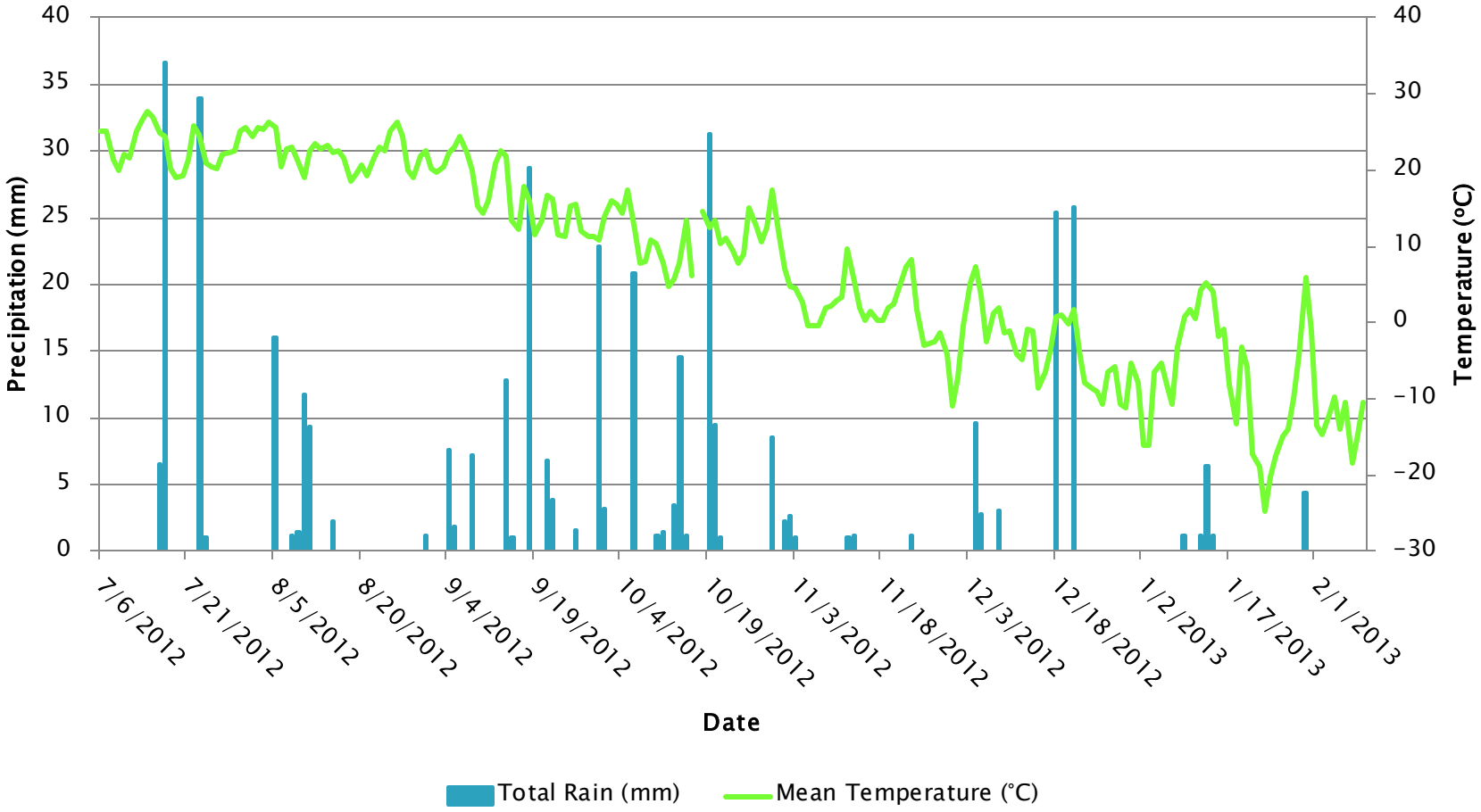
Parameter	Result
Chloride	<2 µg/g
Sodium	113 µg/g
Heavy Metals	
Arsenic	1 µg/g
Cadmium	<0.5 µg/g
Copper	11 µg/g
Lead	6 µg/g
Zinc	33 µg/g
Oil and Grease	
Animal/ Vegetable	800 µg/g
Mineral	580 µg/g

Habitation Jeanne-Mance, Montreal QC

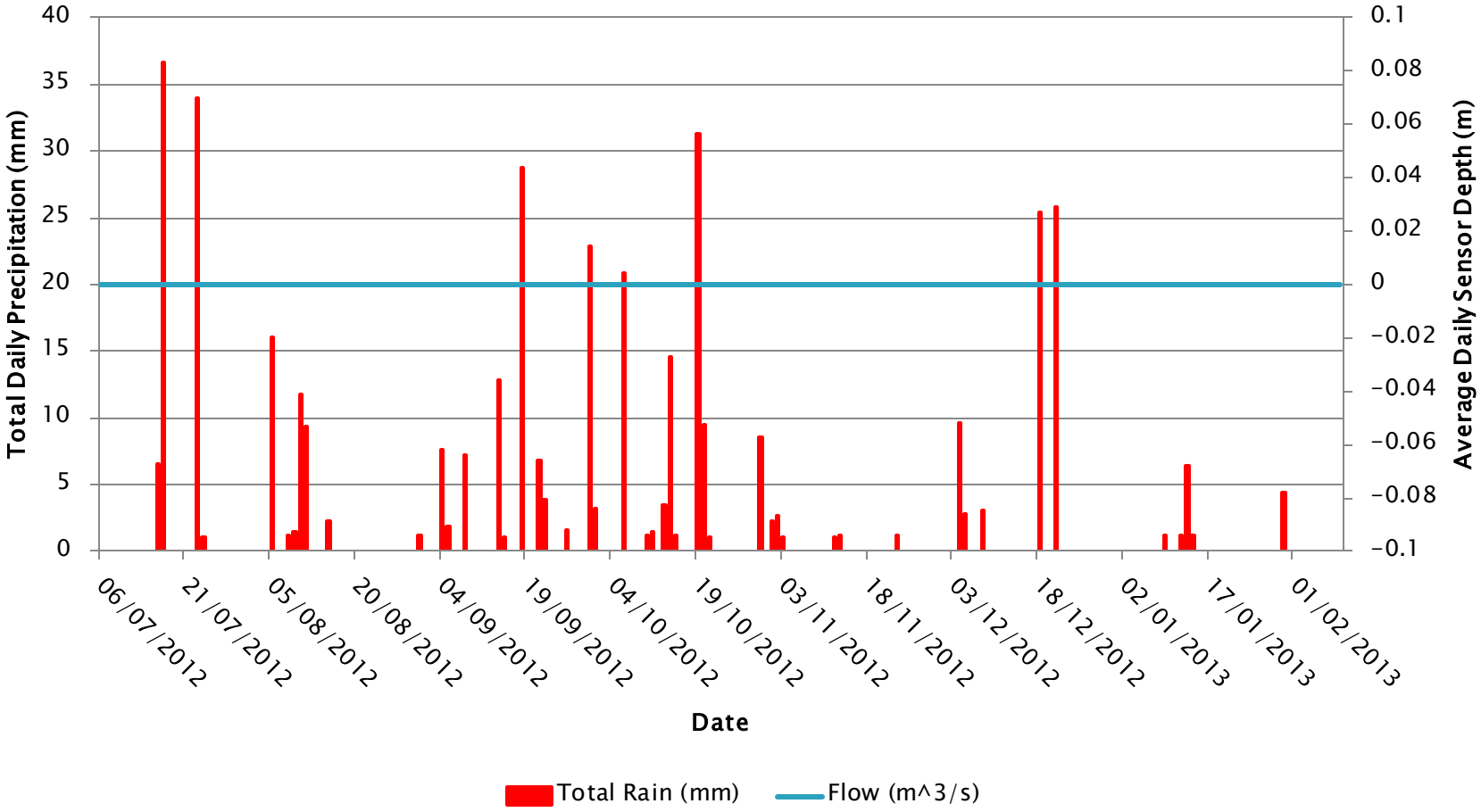
- Flow monitoring completed
  - Pressure transducer and weir installed July, 2012 – Feb 2013
  - 204 events – Maximum event 38.9mm



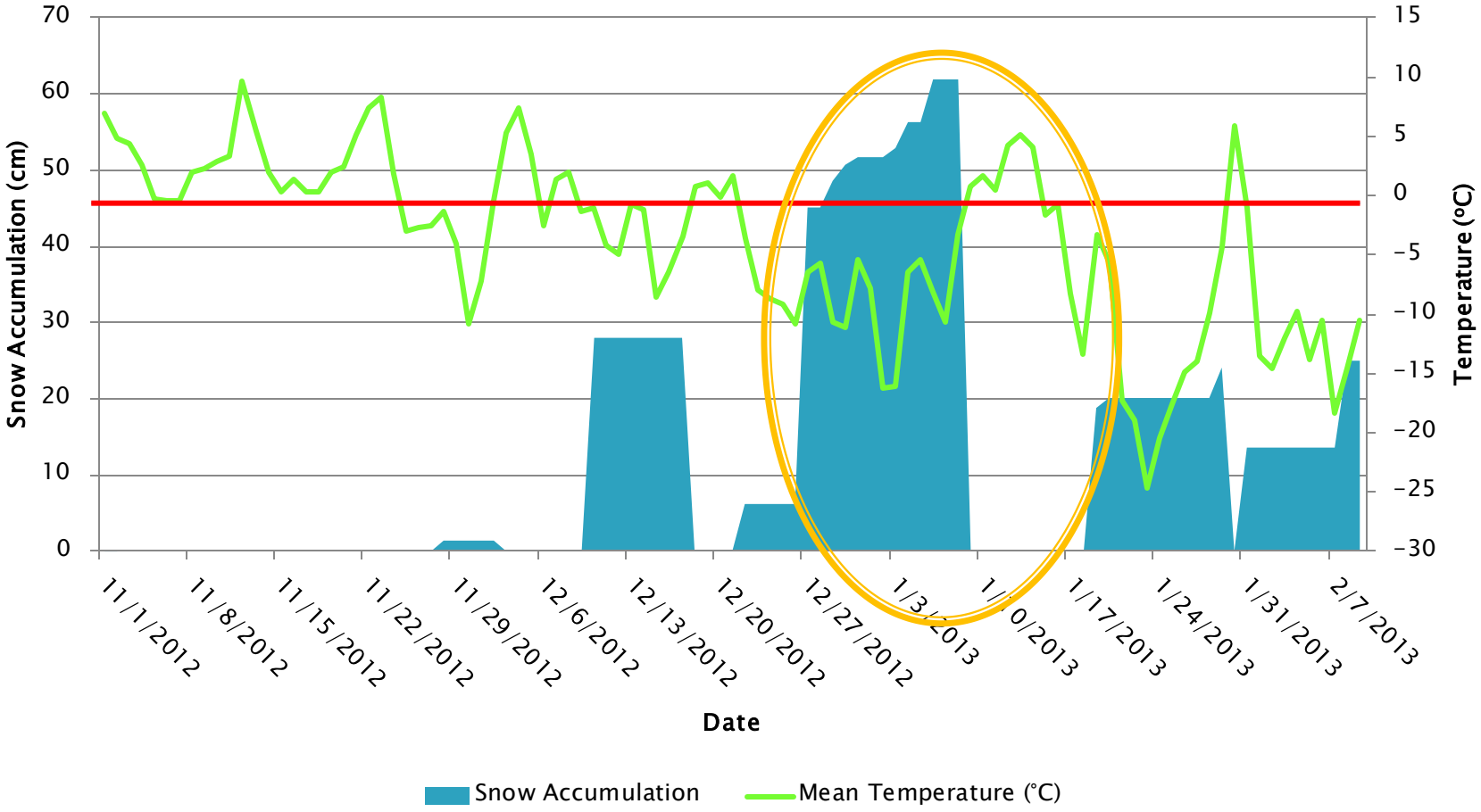
Habitation Jeanne-Mance, Montreal QC



Habitation Jeanne-Mance, Montreal QC

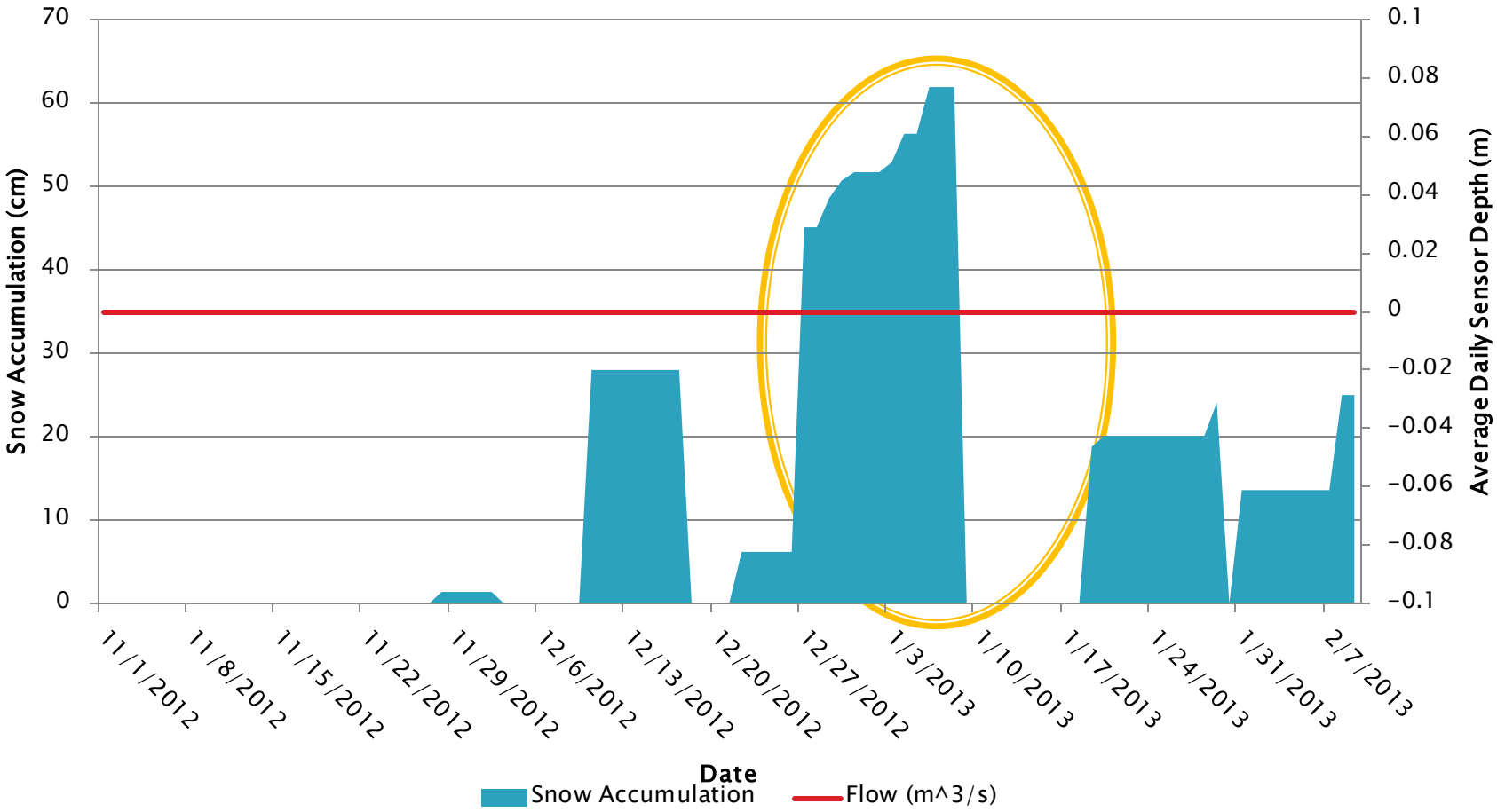


Habitation Jeanne-Mance, Montreal QC



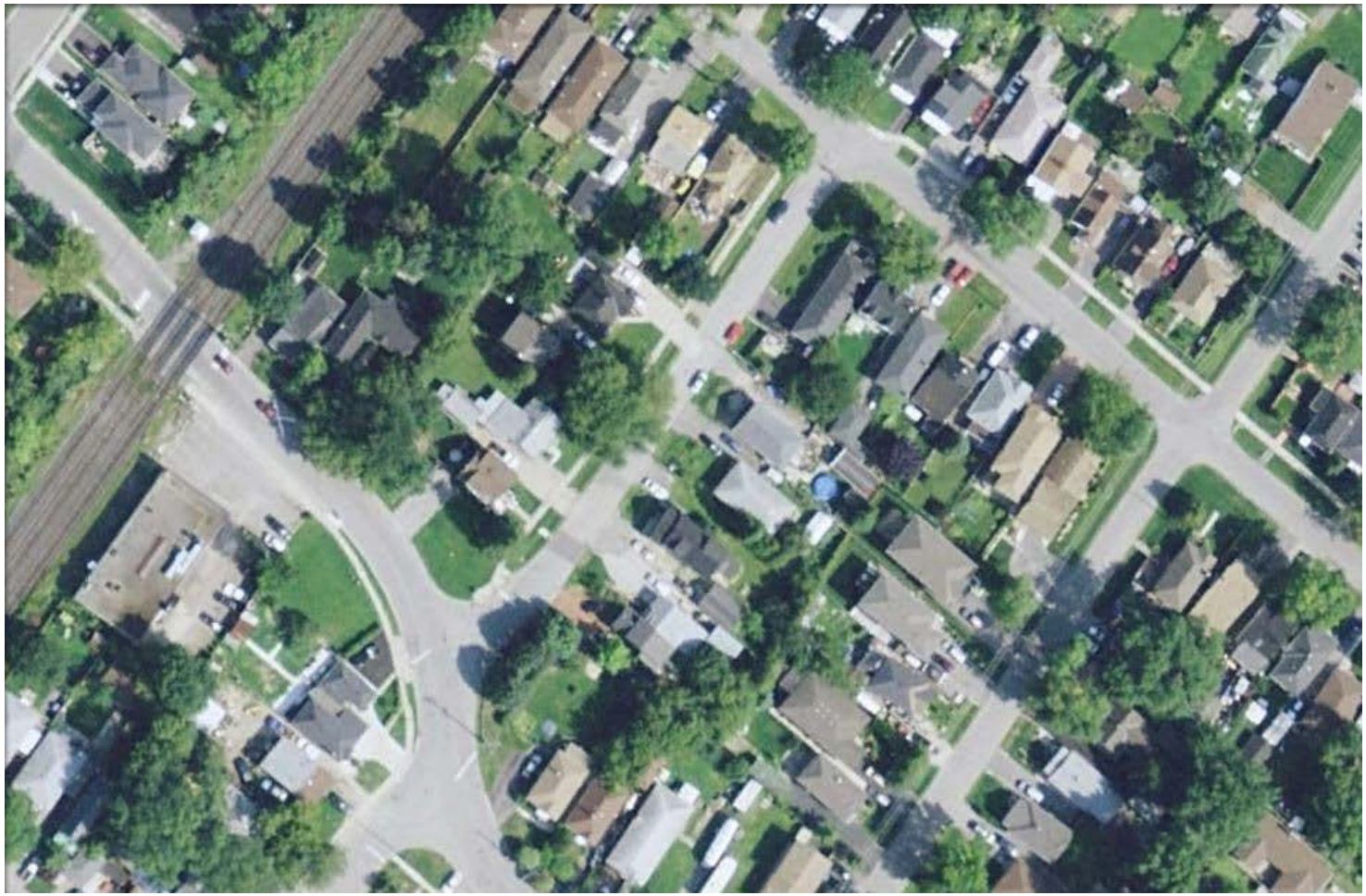

INEMA

Habitation Jeanne-Mance, Montreal QC



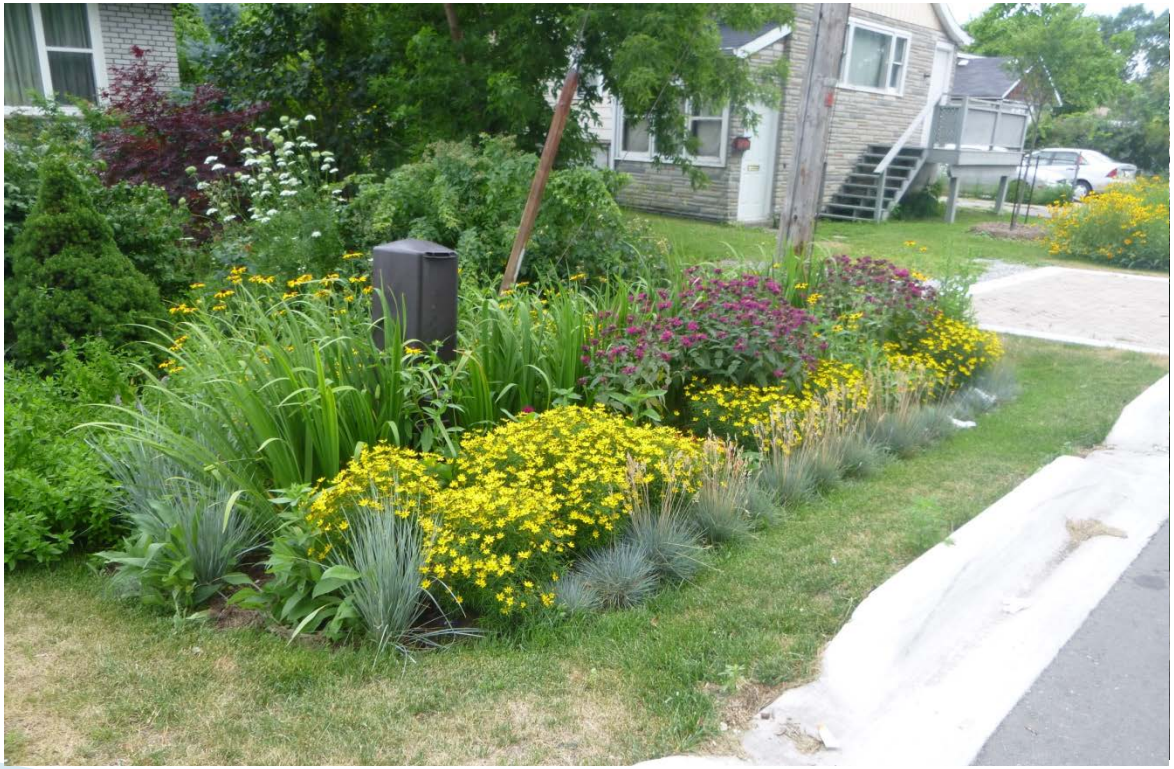
Lakeview, Mississauga ON

Lakeview, Mississauga ON



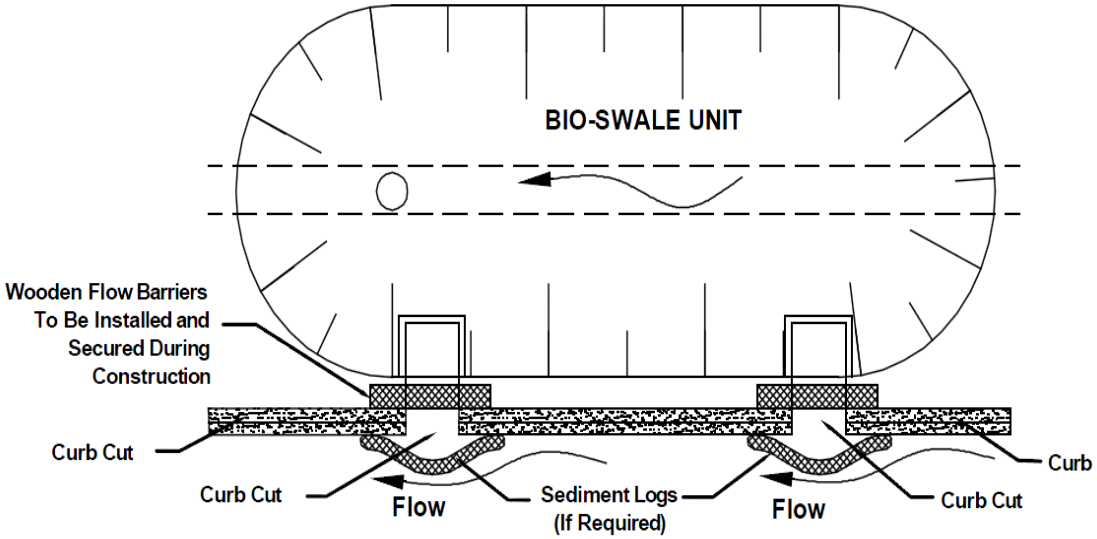
Lakeview, Mississauga

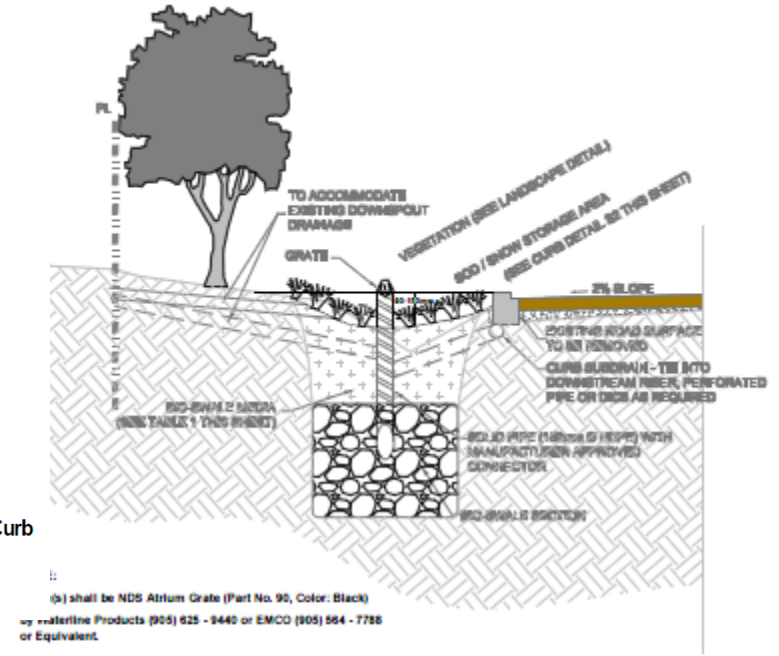
- Lakeview District (Mississauga)
  - Residential ROW utilizing bioswales and permeable pavement



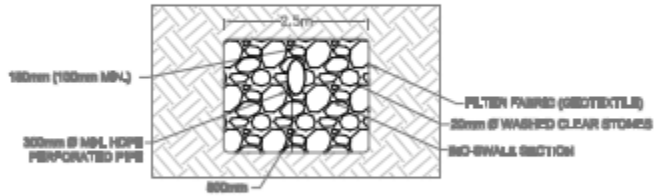
Lakeview, Mississauga

Lakeview, Mississauga ON





BIO-SWALE DETAIL



N.T.S.

UNDERDRAIN DETAIL

DETAIL S3B

BIO-SWALE TYPICAL CROSS-SECTION

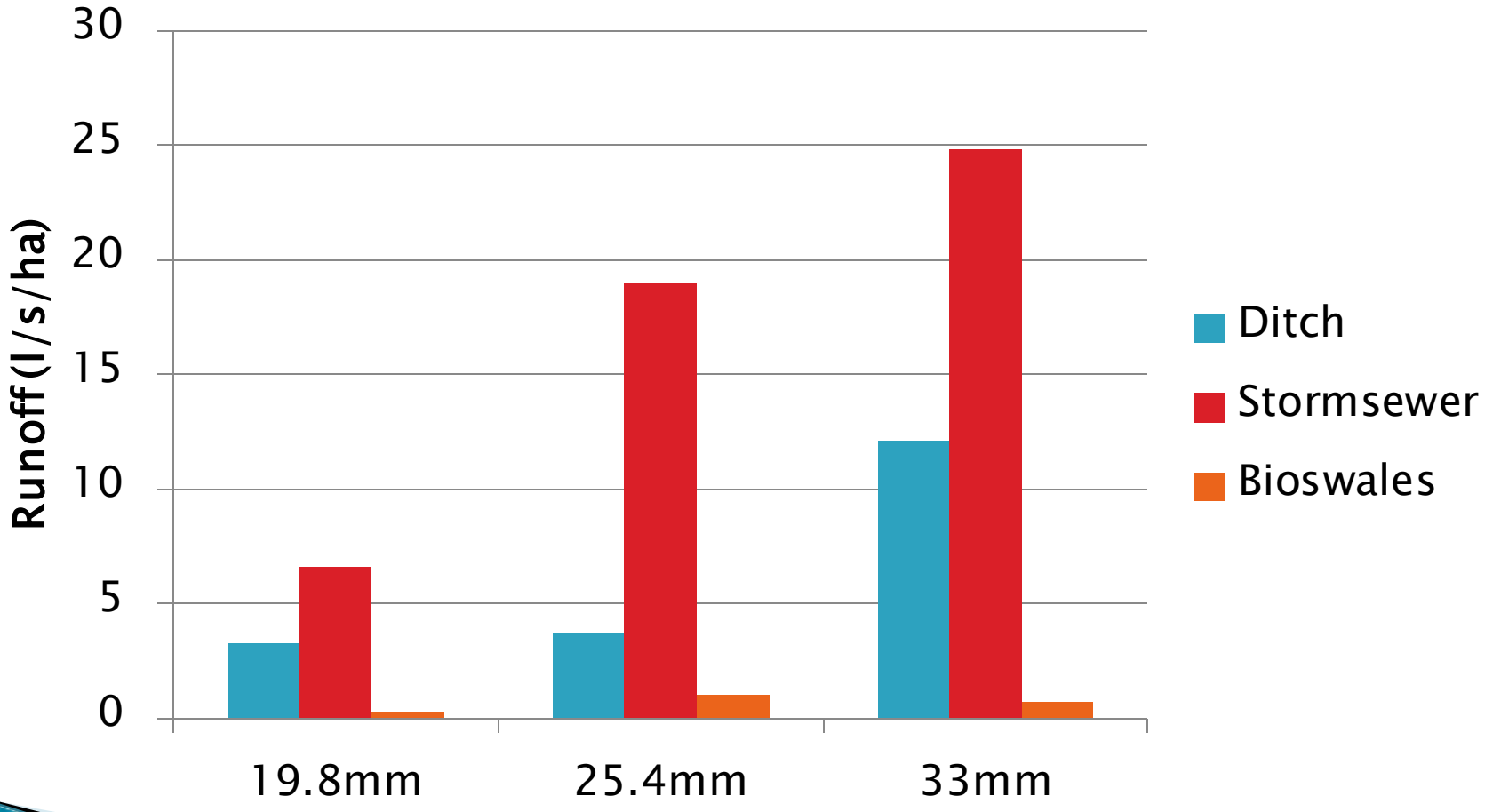
Lakeview, Mississauga ON

- Monitoring both pre and post construction by CVC;
- Precipitation, flow and water quality;

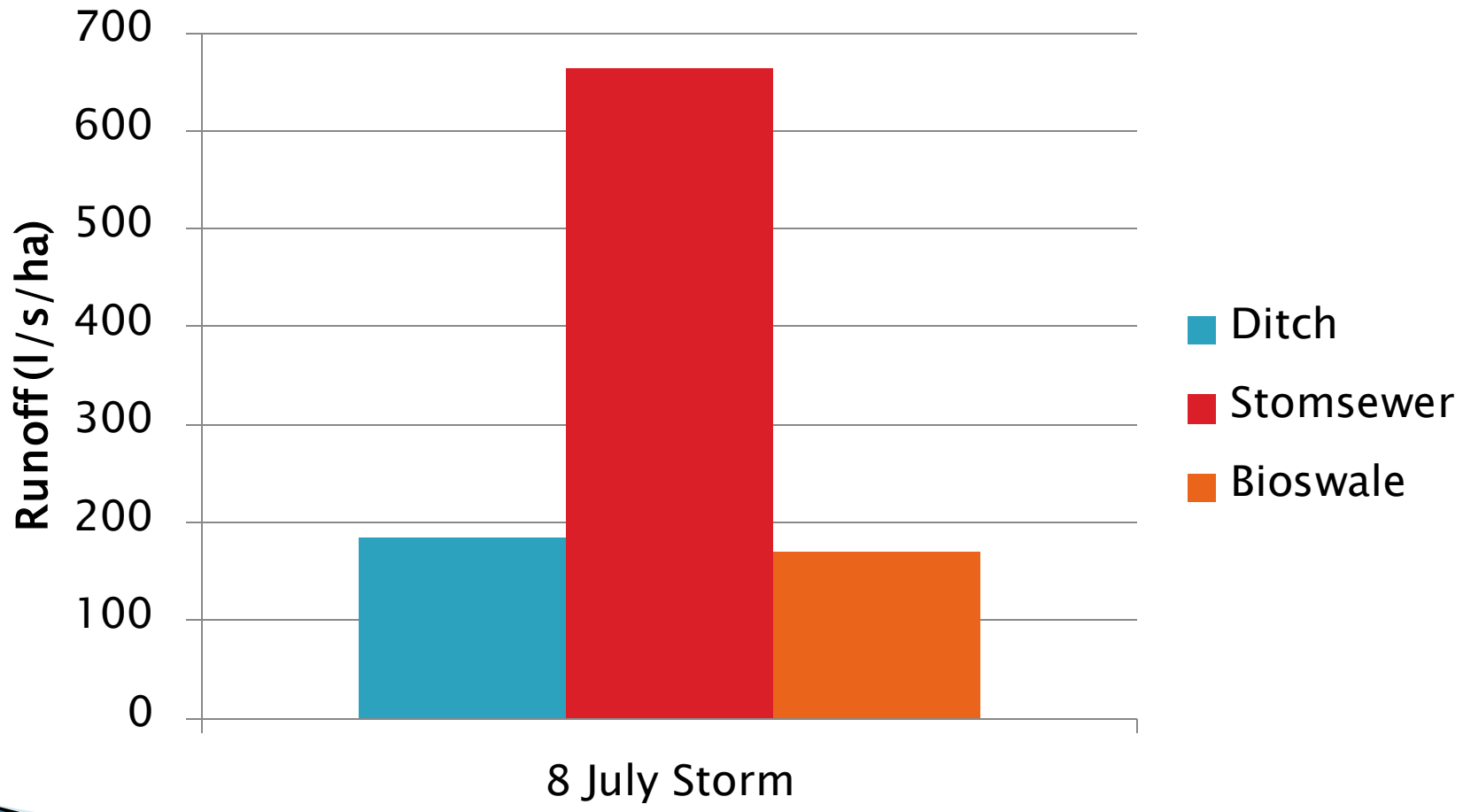
Event Response: 20 – 78mm

Road	9 April 7-hr storm, 19.8 mm			10 April 10-hr storm, 25.4 mm			10 June 20-hr storm, 33 mm			8 July 2-hr storm, 78 mm		
	Peak flow (cms)	Peak flow (l/s/ha)	Lag to peak time	Peak flow (cms)	Peak flow (l/s/ha)	Lag to peak time	Peak flow (cms)	Peak flow (l/s/ha)	Lag to peak time	Peak flow (cms)	Peak flow (l/s/ha)	Lag to peak time
Ditch (Eastmount)	0.007	3.3	5 hrs	0.008	3.7	6.5 hrs	0.026	12.1	12.5 hrs	0.397	185.5	30 min
Stormsewer (Northmount)	0.008	6.6	5 hrs	0.023	19.0	6.5 hrs	0.03	24.8	12.5 hrs	0.804	664.5	40 min
Bioswale (First St.)	0.0001	0.2	12 hrs	0.0004	1.0	6.5 hrs	0.0003	0.7	16.5 hrs	0.07	170.7	40 min

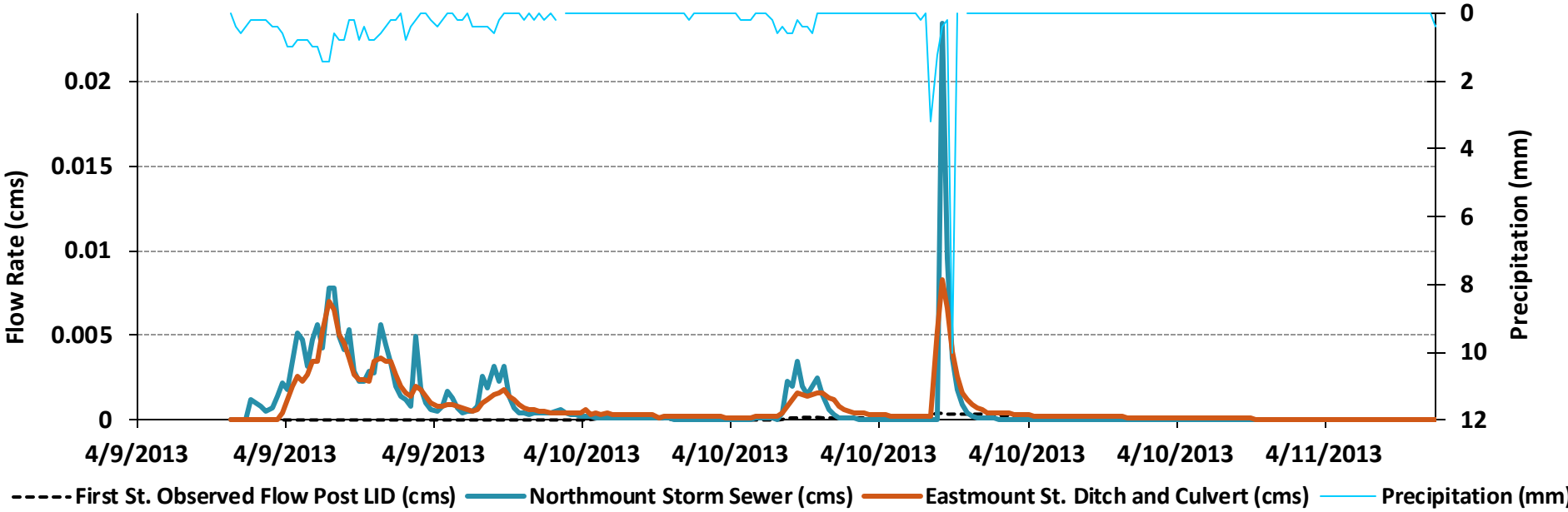
Event Response: 19-33mm



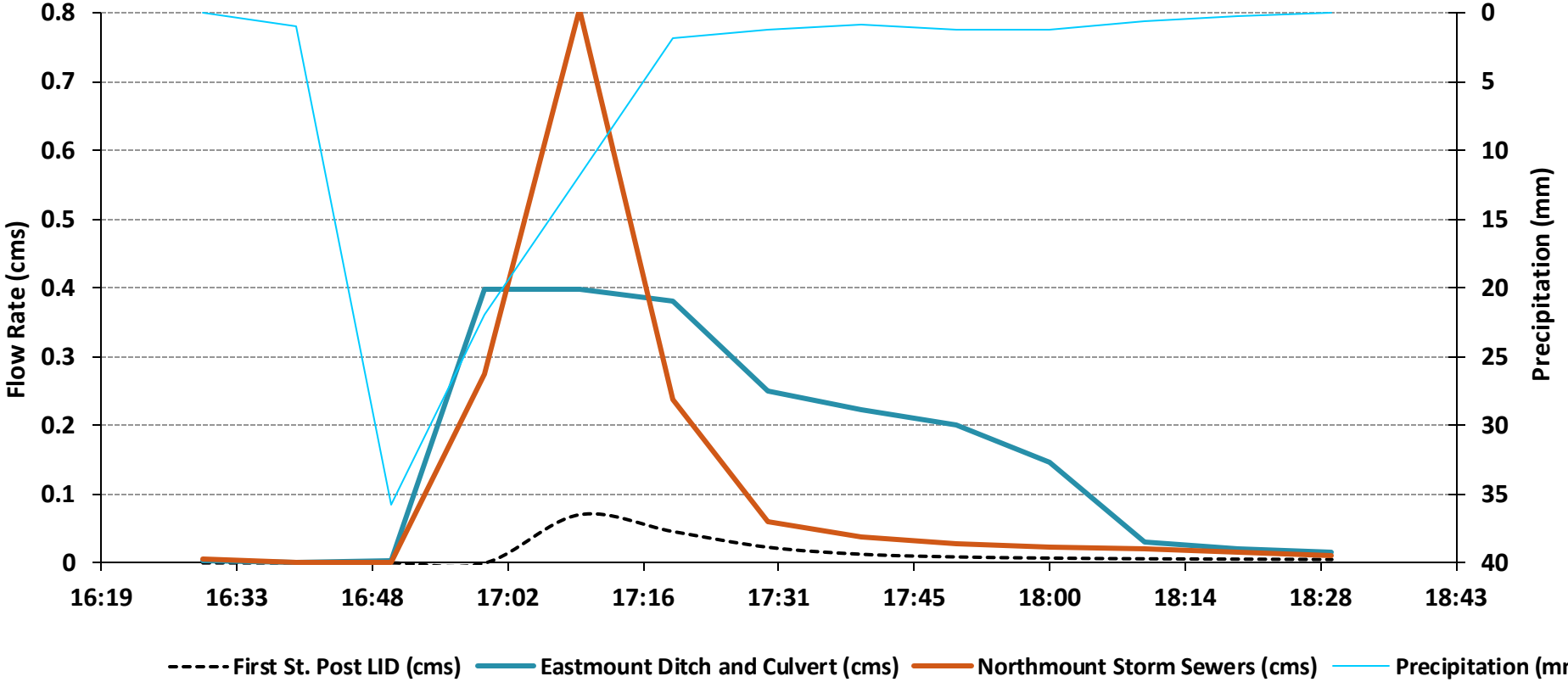
Event Response: 78mm



65 mm 9 –12 April 2013
Two consecutive storms
– 7–hr storm, 19.8 mm (9 April)
– 10–hr storm, 25.4 mm (10 April)



8 July 2013 (2 hrs)
78 mm



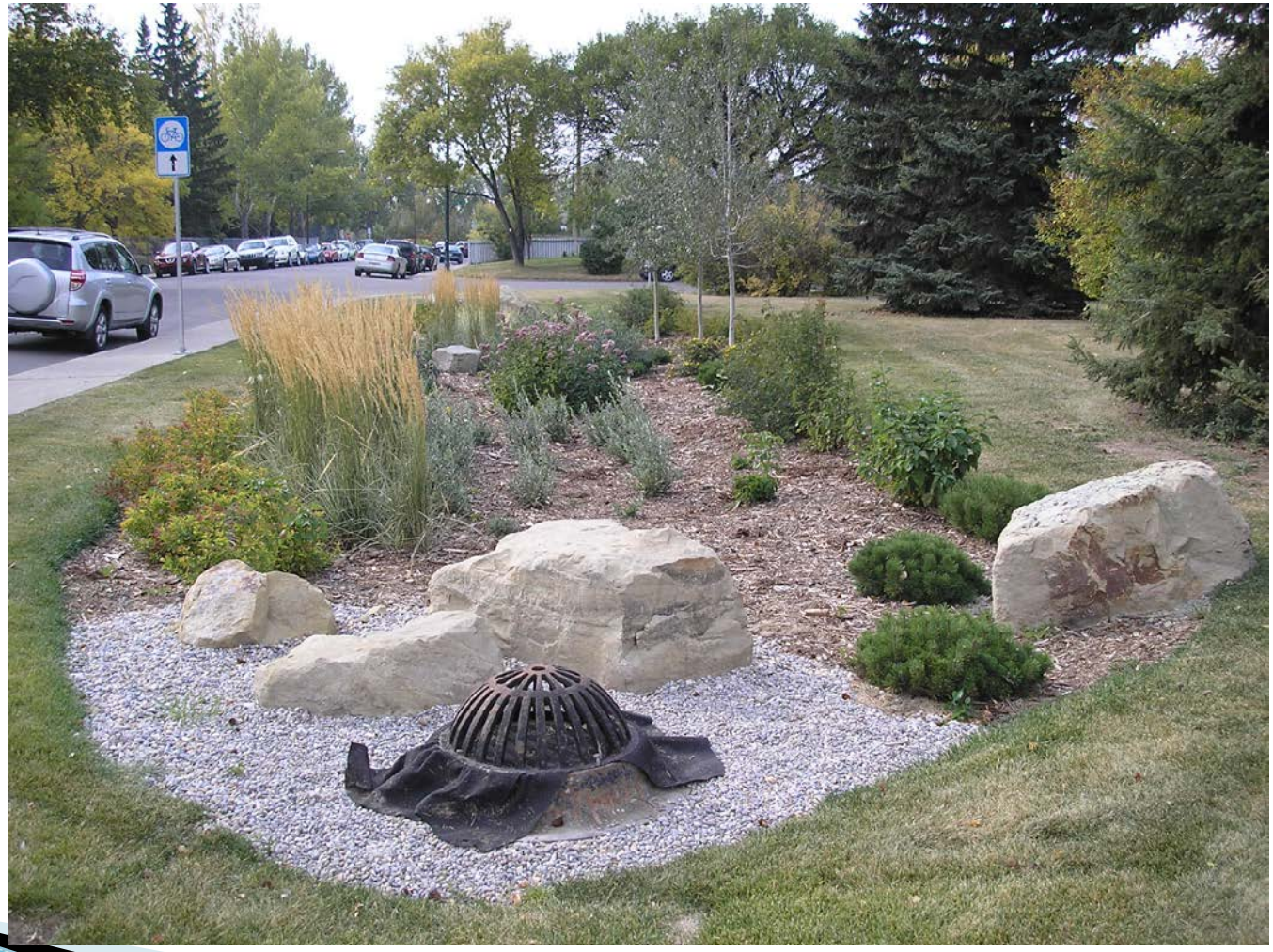
Water Quality Composite samples (mg/L) LV1: Stormsewers, LV2: Ditch, 1st: Bioswales

	10 April (10-hr storm 25.4 mm)			10 June (20 hr-storm, 33 mm)			8 July (2 hr-storm, 78 mm)			Influent (mg/l) (Residential Land use from Literature)
	LV2	LV1	1st	LV2	LV1	1st	LV2	LV1	1st	
Total Phosphorus	0.6	0.37	0.29	0.28	0.48	0.35	0.36	0.4	0.76	0.50
Total Suspended Solids	270	160	10	85	59	23	85	170	60	273
Copper (Cu)	0.027	0.029	0.018	0.014	0.014	0.016	0.013	0.024	0.026	0.015
Zinc (Zn)	0.19	0.188	0.014	0.058	0.065	0.016	0.055	0.113	0.026	0.10

Removal (%)
LV1: Stormsewer, LV2: Ditch, 1st: Bioswale

Storm	10 April (10-hr storm 25.4 mm)			10 June (20 hr-storm, 33 mm)			8 July (2 hr-storm, 78 mm)			Influent (mg/l) (Residential Land use from Literature)
Road	LV2	LV1	1st	LV2	LV1	1st	LV2	LV1	1st	
Total Phosphorus	No removal	26.0	42.0	44.0	4.0	30.0	28.0	20.0	No removal	0.50
Total Suspended Solids	1.1	41.4	96.3	68.9	78.4	91.6	68.9	37.7	78.0	273
Copper (Cu)	No removal	No removal	No removal	6.7	6.7	No removal	13.3	No removal	No removal	0.015
Zinc (Zn)	No removal	No removal	86.0	42.0	35.0	84.0	45.0	No removal	74.0	0.10

Winston Heights – Mountview, Calgary AB



Photo; Courtesy of the City of Calgary

Winston Heights – Mountview, Calgary AB

Winston Heights – Mountview, Calgary AB

Photo; Courtesy of the City of Calgary

Photo; Courtesy of the City of Calgary

Before

After

Winston Heights – Mountview, Calgary AB

- Constructed in 2011
- City of Calgary initiative – part of the City's Broader SWM Strategy
- The majority of Winston heights flows to Nose Creek untreated
- Community Engagement – Winston Heights Community Association
- Maintained by the City of Calgary

Photo; Courtesy of the City of Calgary

Winston Heights – Mountview, Calgary AB

- **Monitoring is ongoing by the City of Calgary:**
  - 2 year program (May- Sept)
  - Flow out of the systems;
  - Water quality (automated)
    - Goal – 10 samples/yr
    - TSS, TP, Ammonia-N, TKN, NO2/NO3, pH, Anions & cations, Conductivity and total metals
    - 1/year – pesticides, E.coli, total coliforms and dissolved metals

Photo; Courtesy of the City of Calgary

Monitoring Program

- **Coordinated Site Inspections;**
  - Infiltration testing (Guelph P);
  - Physical inspection of media profile (soil coring)
  - Media samples;
    - Grain size analysis (% weight sands (2 to 0.05mm ø)
    - % weight fines (<0.050mm ø)
    - % weight organics
    - pH
    - Cation Exchange capacity (CEC)

Monitoring Summary

Site	Water Quality	Water Quantity (Flow)	Infiltration Testing	Media Composition (Lab analysis)	Vegetation Assessment
King St (Kitchener, ON)	N/A	Completed	Completed	Completed	Completed
Trent St (Victoria, BC)	Underway	Underway	Completed	Completed	Completed
Habitation Jeanne-Mance (Montreal, QC),	N/A No systems outflows	Completed	Completed	Completed (Soil chemical analysis also performed)	Completed
Trumpeter (Edmonton, AB)	Underway	Underway	Completed	Completed	Completed
Lakeview Neighborhood (Mississauga, ON)	Underway by Credit Valley Conservation	Underway by Credit Valley Conservation	Completed	Completed	Completed
Winston Heights (Calgary, AB).	Underway by City of Calgary	Underway by City of Calgary	Completed	Completed	Completed

Project Deliverables

Deliverables

- Monitoring Results;
- Capital vs. long-tern cost comparisons;
- Regulatory approvals considerations;
- Six case studies; and
- Research report and highlights document.

Expected completion date - Summer 2014

QUESTIONS ?

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