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GREY TO GREEN
Toronto | May 15 & 16, 2018

Design and Performance of Retrofitted Roadside Biofilter Swales, County Court Blvd., Brampton

Presented by:

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Toronto and Region Conservation Authority

STEP Water is a partnership between:

Toronto and Region Conservation for The Living City

Credit Valley Conservation inspired by nature

Lake Simcoe Region conservation authority

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Infrastructure renewal in a changing climate






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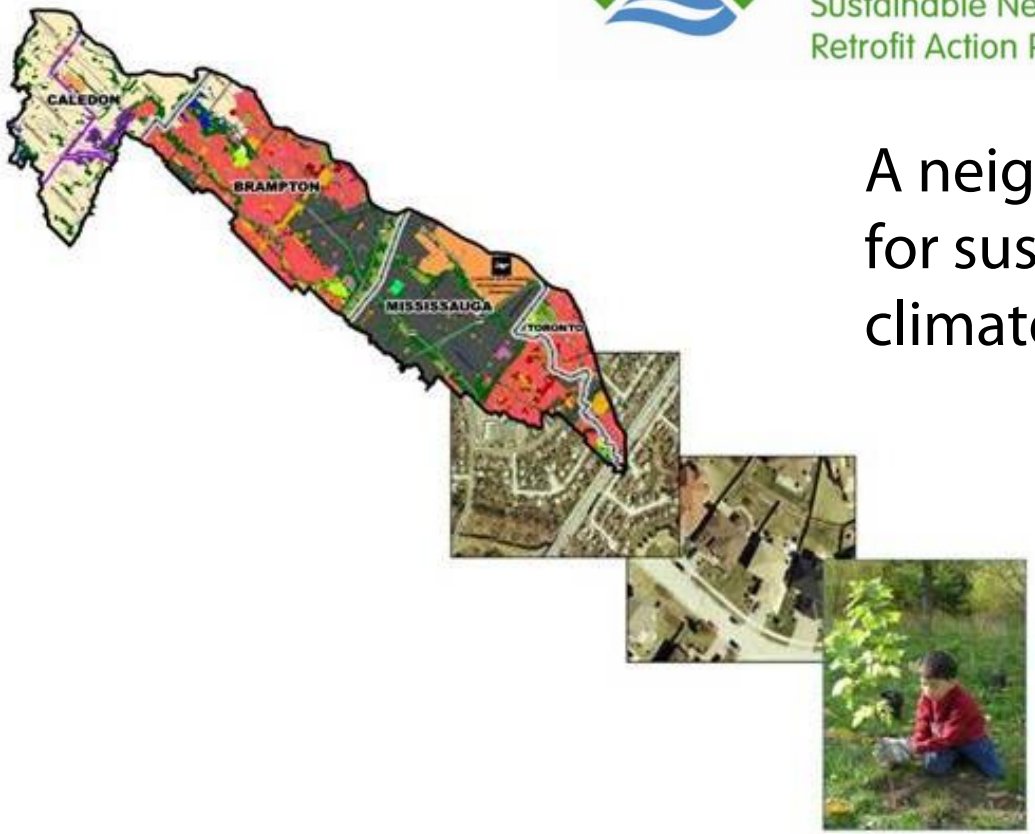
SNAP
Sustainable Neighbourhood Retrofit Action Plan



A neighbourhood-based solution for sustainable urban renewal and climate action.

- ✓ Brings efficiencies
- ✓ Draws strong community support
- ✓ Builds innovative partnerships for implementation

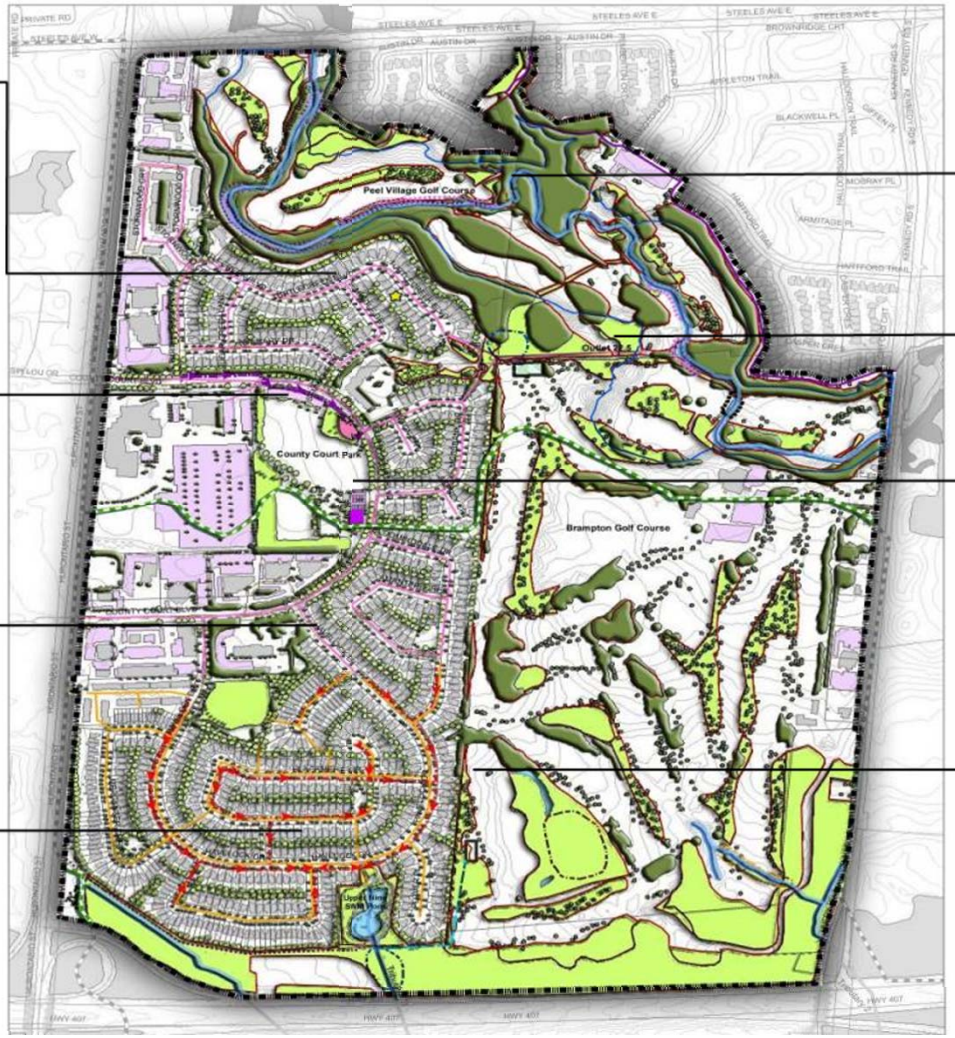
County Court SNAP - Creating a sense of community

Green renovation & landscapes

County Court Park renewal

Bioretention

Upper Nine SW pond transformation



Habitat Restoration

Rainwater harvesting for irrigation

Green parking lots

Urban forest

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County Court Blvd. Biofilter Swales

Demonstrating a strategic financing model and interdepartmental cooperation.

Basis for engaging community and measuring outcomes

County Court Blvd. Biofilter Swales

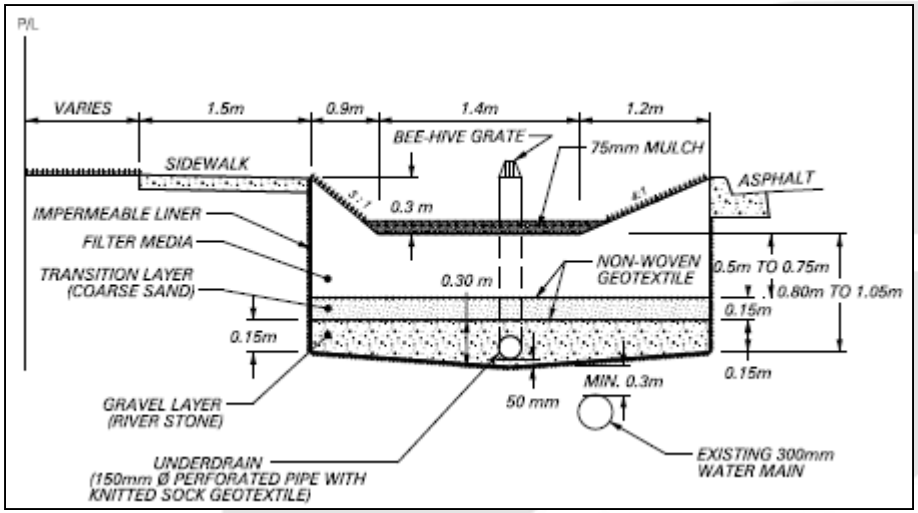
- Two lined bioretention (biofilter) swales, 70 m (West) and 85 m (East) length x 3 m width, constructed in 2014/15 that receives runoff from 1,904 m^2 portion of County Court Blvd.;
- Impervious liner and perforated sub-drain pipe to limit risk of damage to watermain located below swale footprints;
- Construction and routine inspections and 18 mo. performance monitoring by STEP.

Before (2014)

After (2016)

County Court Blvd. Biofilter Swales – Design

- Impervious to pervious area (I:P) ratio of 4:1;
- ~ 1 m deep, vertical walled excavation lined with EPDM (rubber) geomembrane;
- 150 mm dia. perforated pipe sub-drain with filter sock and standpipes;
- 15 cm coarse sand transition layer sandwiched between geotextile;
- 50 to 75 cm depth of filter media (85% sand-sized, 4% O.M.);
- OPSD 605.040 concrete asphalt spillways (2 per bioswale) and simple curb cuts as inlets (5 to 6).



County Court Blvd. Biofilter Swales – Construction

- Vertical excavation destabilized the gravel base of the existing curb, necessitating replacement with wider curb and delaying construction;
- Lab testing of biomedia prior to delivery delayed installation;
- Modified curbs not constructed to OPSD specifications – needed to replace of 4 of 15 with OPSD 605.040 concrete asphalt spillways;
- Missing curb cut inlet u/s of one road catchbasin.

County Court Blvd. Biofilter Swales – Landscaping

- Original planting plan: mix of flowers, herbs and ornamental grasses with shredded mulch cover to create attractive landscaped feature;
- Community planting event in fall 2014;
- Vegetation cover <80% after 2 years – too few plants, lack of watering and mulch, dry spring 2015, road reconstruction in summer 2016 were contributing factors;
- Grass/herb seed mix spread on biomedia in fall 2015 - poor results;
- Added river-run stone cover around surviving plants in 2016.

West Swale - June 2016

West Swale – Oct. 2016

County Court Blvd. Biofilter Swales – Performance Evaluation

- Conducted inspections using visual indicators and test methods recommended in LID I&M Guide (TRCA, 2016);
- Continuous field monitoring to evaluate runoff volume and pollutant load reduction and examine effects on effluent temperature;
- Examine effects of winter operation on treatment performance and maintenance needs;
- Compared bioswale flow volumes, rates & water quality to runoff from an untreated portion of County Court Blvd. (Control catchment);

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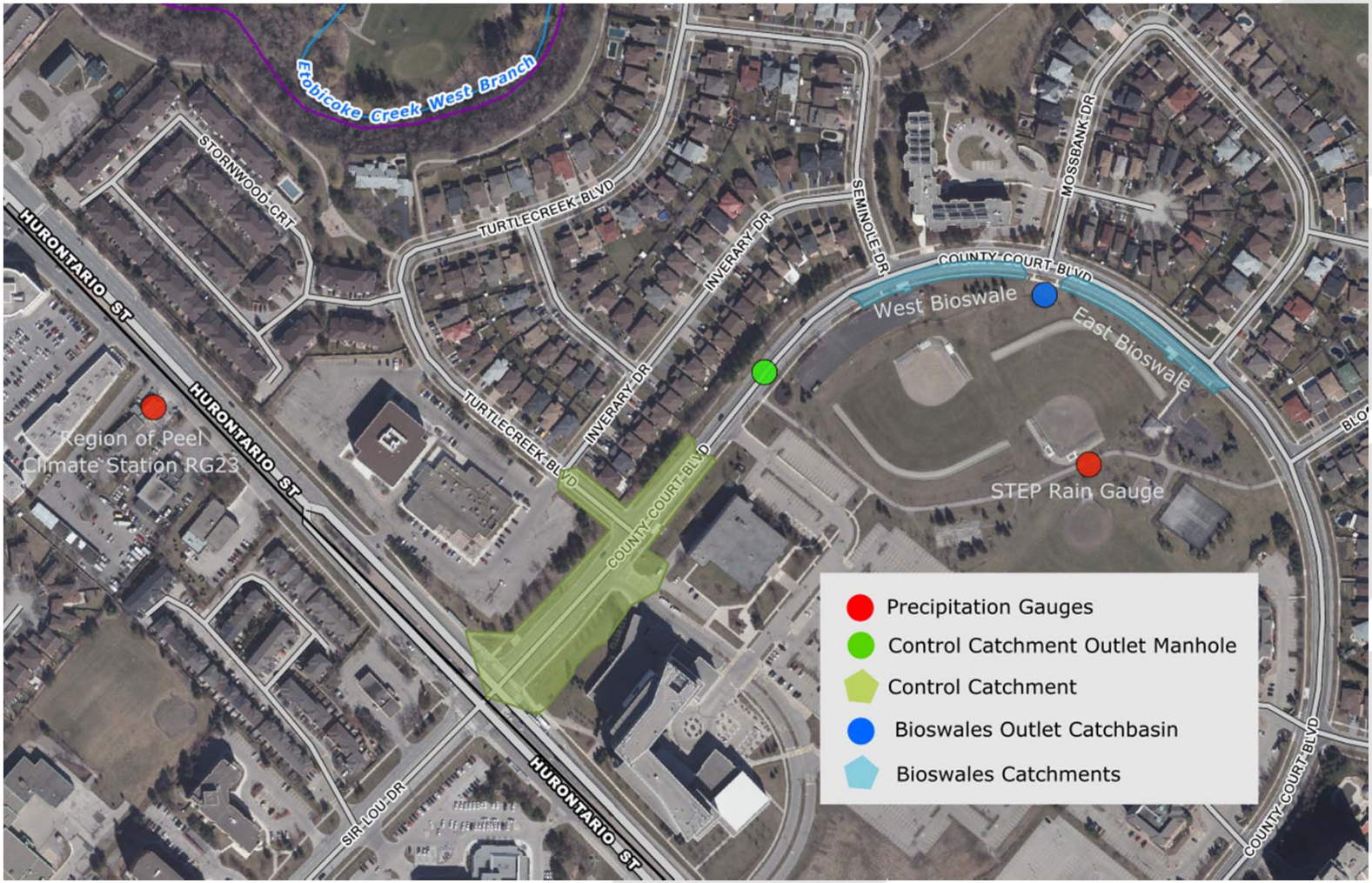
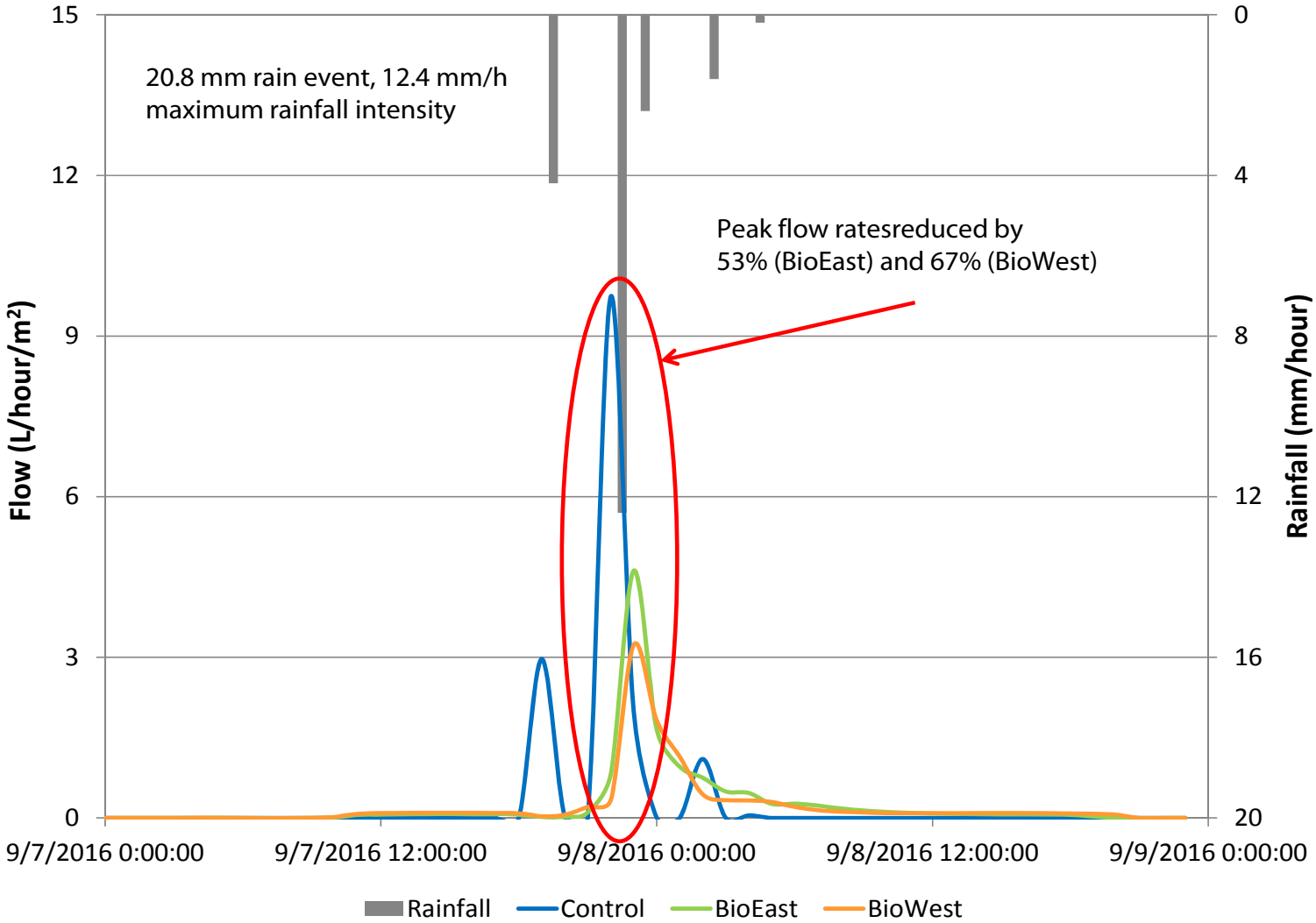
County Court Blvd. Biofilter Swales – Performance Evaluation



County Court Blvd. Biofilter Swales – Performance Evaluation

- Evaluated runoff reduction through continuous flow monitoring during simulated and natural storm events;
- Simulated storm event testing (Nov. 2014) indicated potential to reduce runoff in order of 30% for a 12 mm simulated event on dry soil;
- Biofilter swales with 4:1 I:P ratio can retain all runoff from rainfall events up to 3.0 mm in depth;
- Runoff reduction (2015/16 rain events, n = 80):
  - East Bioswale: 17%
  - West Bioswale: 34%

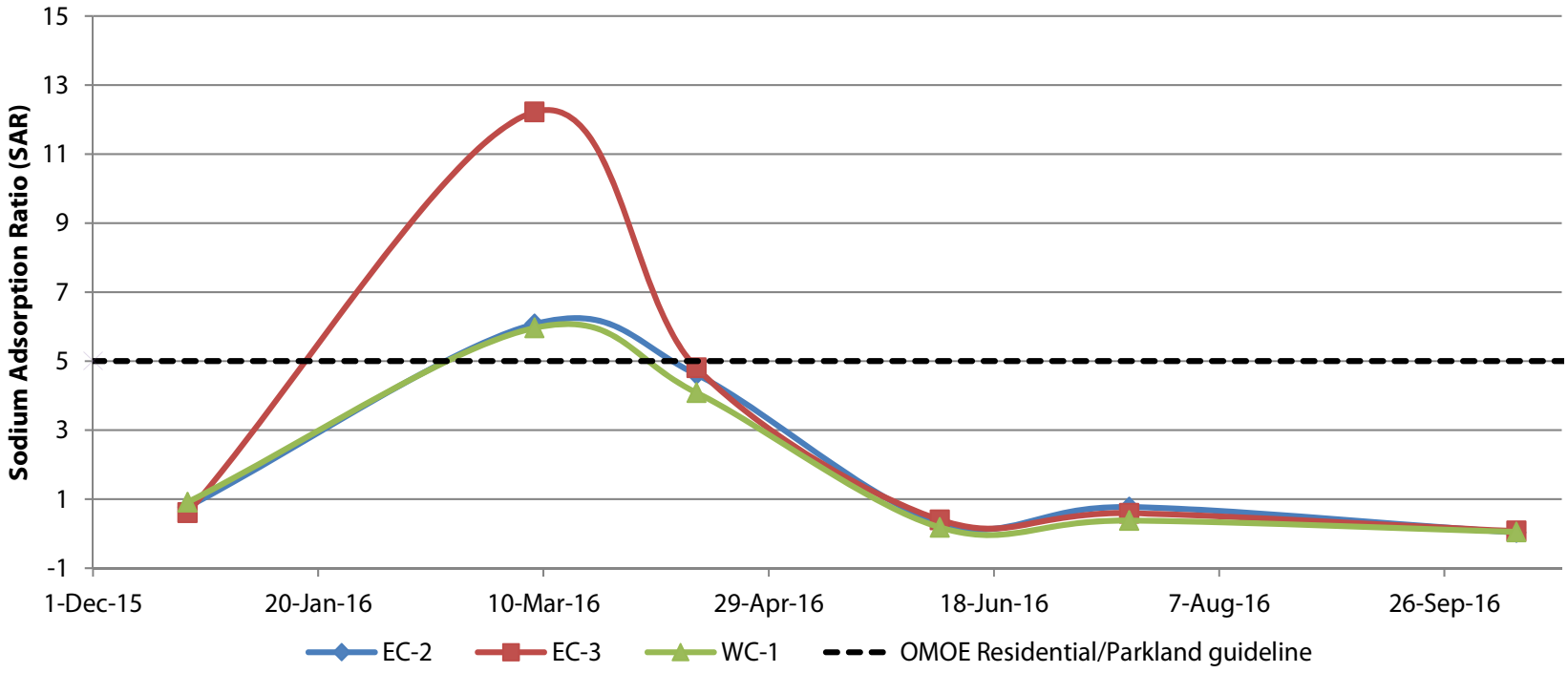
Peak Flow Rate Reduction



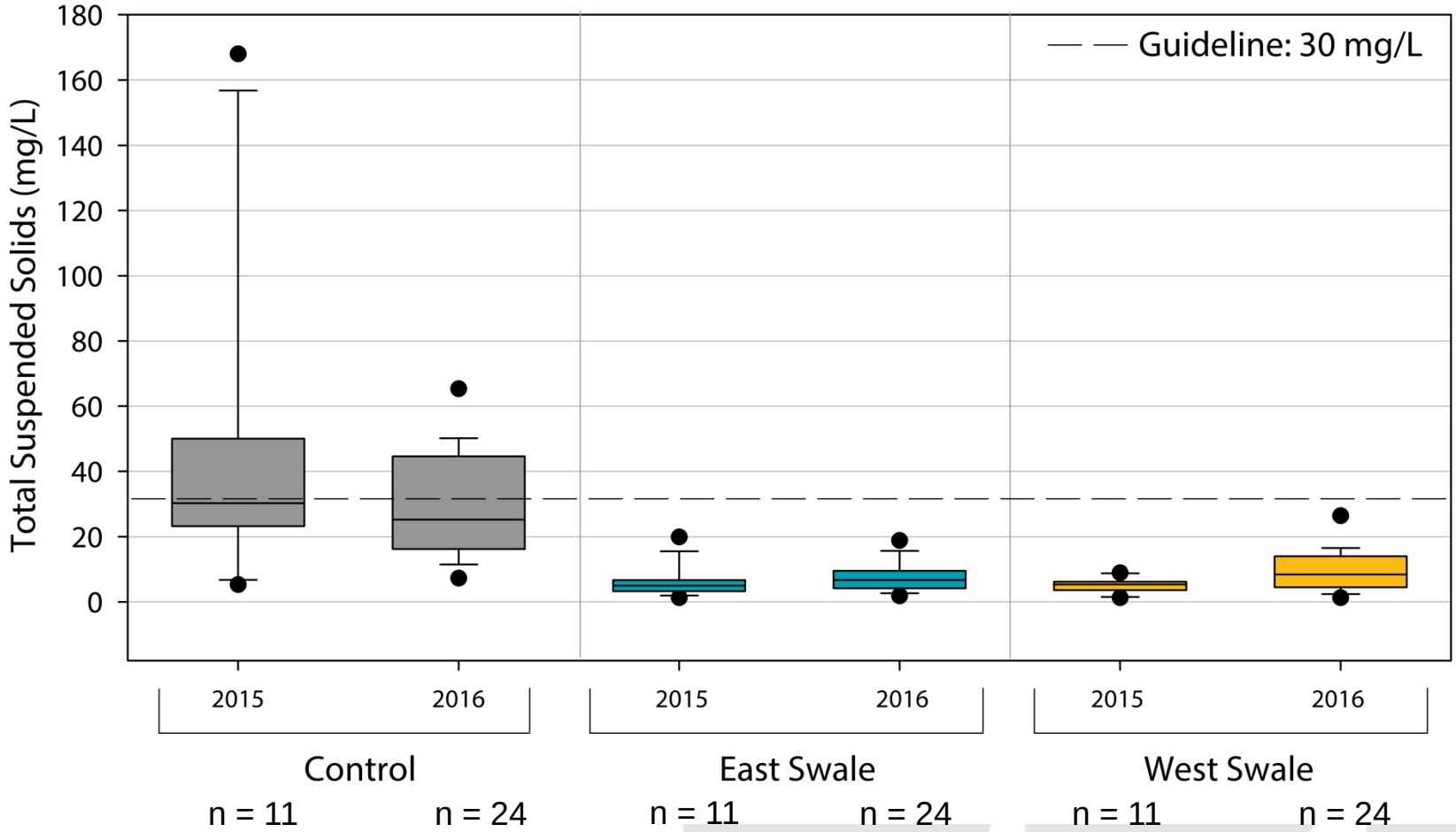
County Court Blvd. Biofilter Swales – Winter Operation

- West Biowale inlets blocked over winter 2016 while East remained on-line;
- Some snowmelt and plowed snow still able to enter West Bioswale;
- Sediment accumulation at inlets ≥5 cm – sediment removal needed annually in early spring;
- Bioswales affected by ingress of salty interflow from surrounding landscapes;
- Biomedia samples at inlets and along centreline showed sodium (SAR) contamination during winter, but back below guideline by end of April.

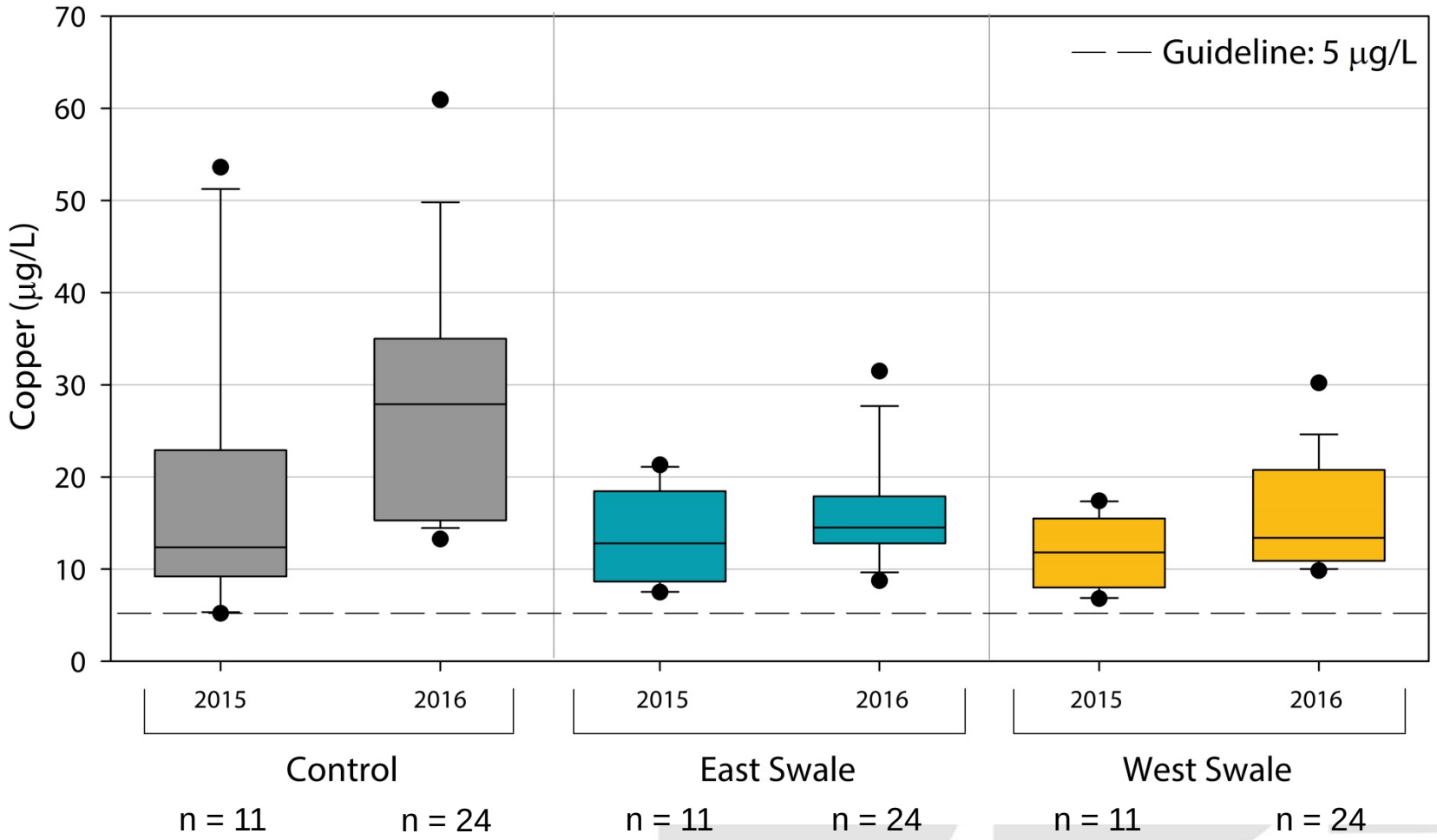
County Court Blvd. Biofilter Swales – Sodium Adsorption Ratio in Biomedia



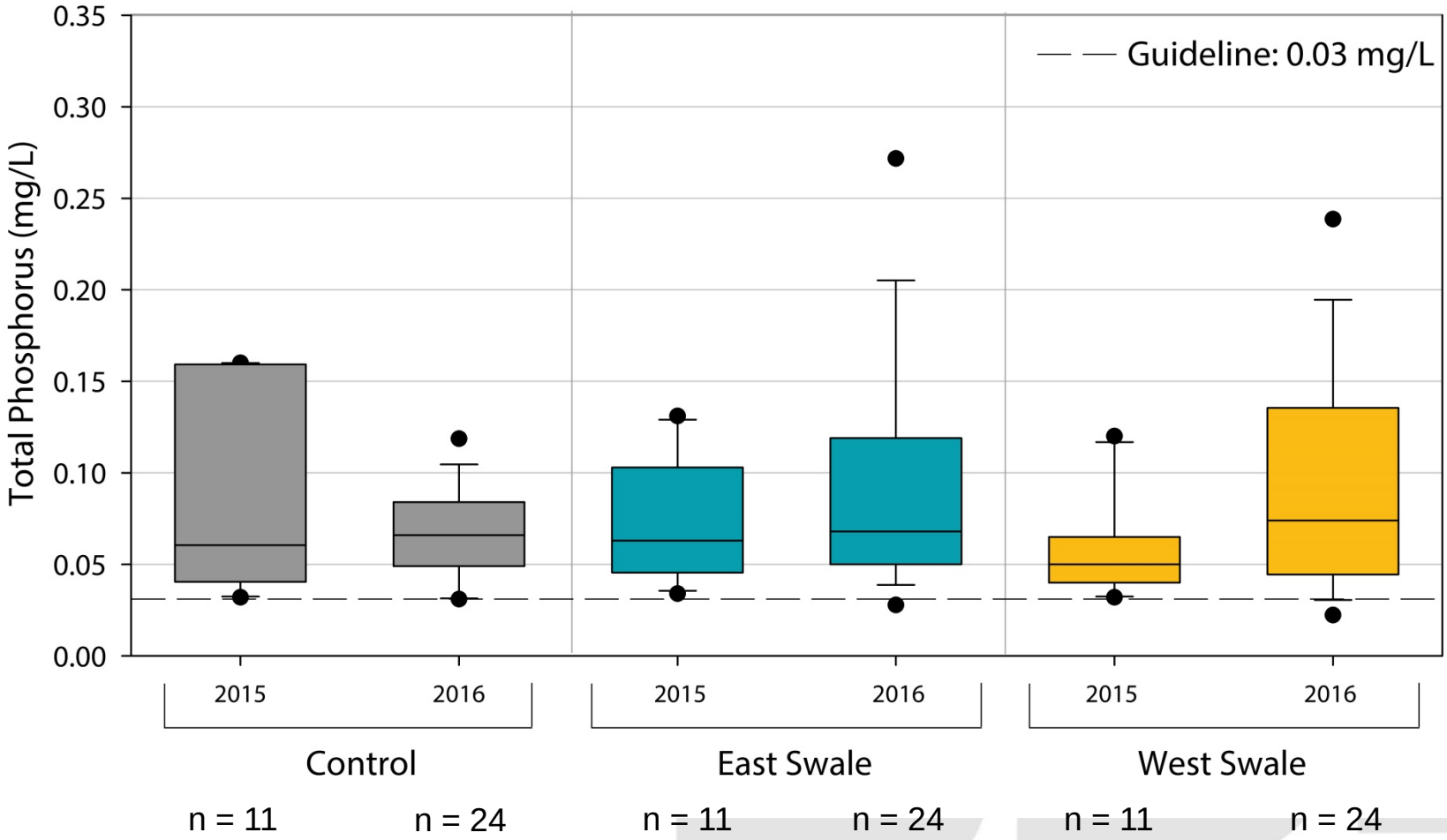
County Court Blvd. Biofilter Swales – Suspended Solids, Total



County Court Blvd. Biofilter Swales – Copper



County Court Blvd. Biofilter Swales – Phosphorus, Total



Statistical Significance - concentrations

Pollutant	Control vs. East (ANOVA 2015-2016)	Control vs. West (ANOVA 2015-2016)	East vs. West (ANOVA 2015-2016)
Chloride	C < E	C < W	Not sig.
Suspended Solids	C > E	C > W	Not sig.
Nitrogen, Total	Not sig.	Not sig.	Not sig.
Phosphorus, Total	Not sig.	Not sig.	Not sig.
Phosphate	C < E	C < W	Not sig.
Oil and Grease	C > E	C > W	Not sig.
Hardness	C < E	C < W	Not sig.
Chromium	C > E	C > W	Not sig.
Copper	C > E	C > W	Not sig.
Sodium	C < E	C < W	Not sig.
Zinc	C < E	Not sig.	Not sig.

Effluent Pollutant Concentrations

Control catchment concentrations low to being with

Int'l SWM BMP Database:

Parameter	Unit	Guideline	Control	East Bioswale		West Bioswale	
			Effluent conc. (median)	Effluent conc. (median)	Removal Efficiency (%)	Effluent conc. (median)	Removal Efficiency (%)
Chloride	mg/L	120/640	32.1	149	-364	81.35	-153
Solids, suspended	mg/L	25	27.8	5	82	5.4	81
Nitrogen, Total	mg/L	n/a	1.11	0.81	2		23
Nitrogen; NH_3+NH_4	mg/L	0.019	0.246	0.034	8		88
Nitrogen, nitrite (NO_2)	mg/L	0.060	0.055	0.008	85	0.01	82
Nitrogen, NO_2+NO_3	mg/L	n/a	0.373	0.297	20	0.31	17
Phosphorus, Total (TP)	mg/L	0.03	0.066	0.059	11	0.05	24
Phosphorus, Phosphate	mg/L	n/a	0.018	0.041	-1		67
Oil & Grease	mg/L	n/a	1.85	0.5	7		73
Aluminum	ug/L	75	180	130	28	95.5	47
Boron	ug/L	1500/2900	13.5	46	-241	47	-248
Chromium	ug/L	9.9	11.8	2.5	79	2.5	79
Copper	ug/L	5	21.3	13.6	36	12.05	43
Iron	ug/L	300	360	190	4		50
Sodium	ug/L	n/a	22.6	135	-4		349
Zinc	ug/L	20	85.7	95.5	-1		-2

Bioretention 78%
Enhanced Swale 47%

Bioretention -28%
Enhanced Swale -72%

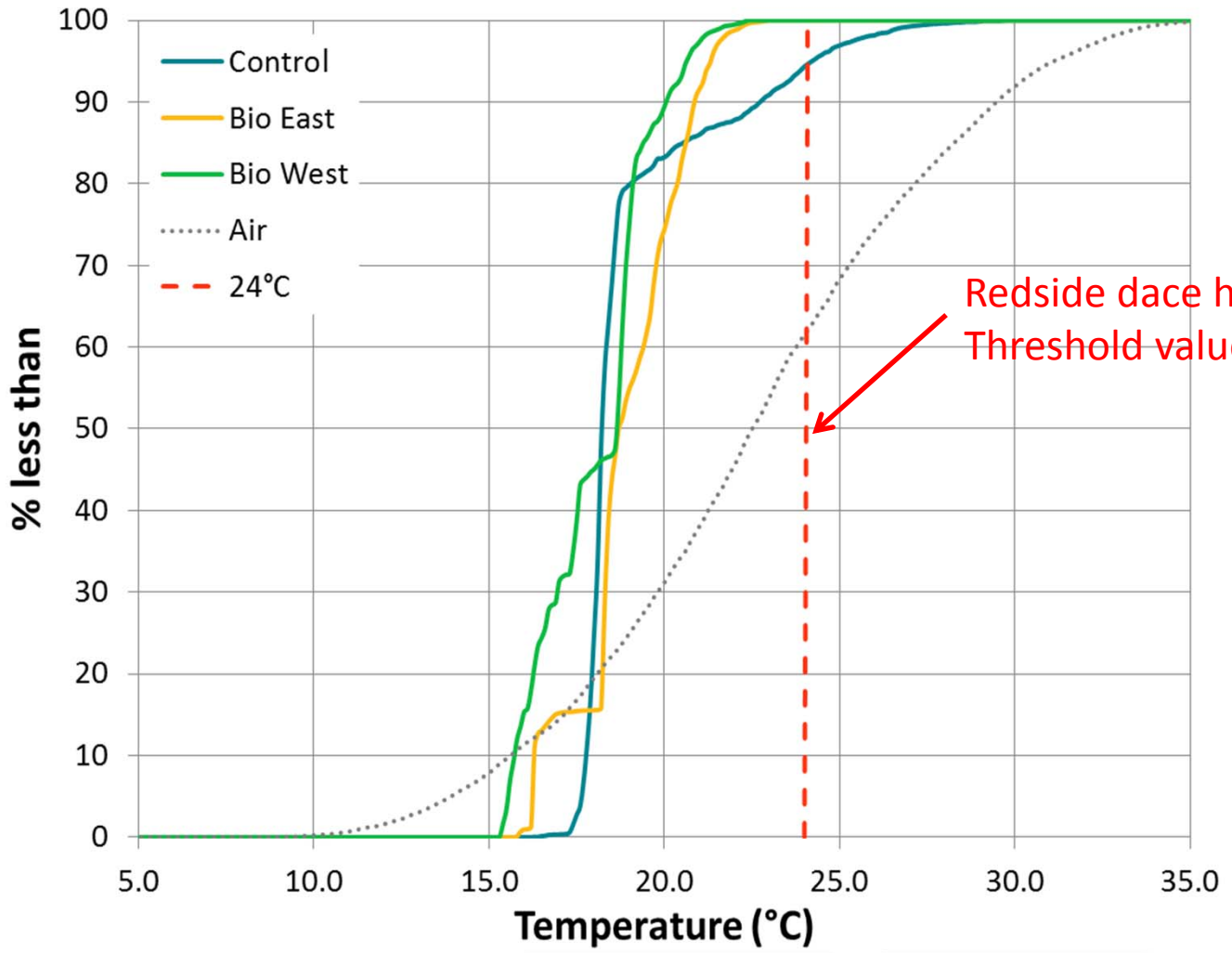
Bioretention 36%
Enhanced Swale 37%

County Court Blvd. Biofilter Swales – Pollutant Load Removal Efficiency (%)

Parameter	East	West	Parameter	East	West
Suspended Solids, Total	64	52	Aluminum	-129	-138
Oil and Grease	65	73	Chloride	-309	-311
Phosphorus, Total	-90	-96	Chromium	76	78
Phosphorus, Phosphate	-275	-264	Copper	5	13
Nitrogen, Ammonia + Ammonium	77	73	Iron	-48	-48
Nitrogen, Nitrate + Nitrite	-8	-1	Sodium	-624	-507
Nitrogen, Total	4	-1	Zinc	-46	-37

*Results based on event mean water quality sampling results from 2015 & 2016 (combined), measured outflow volumes from East and West Bioswales and modelled control catchment outflow volumes for 35 paired rain events.

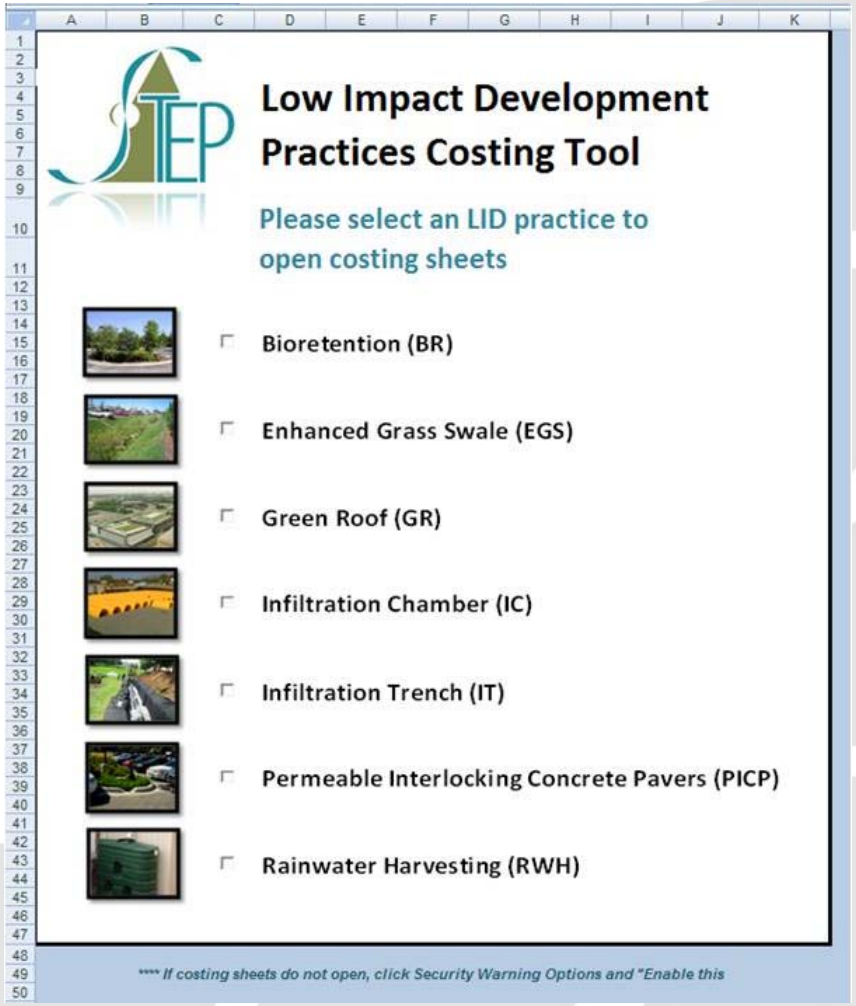
Effect on Effluent Temperature



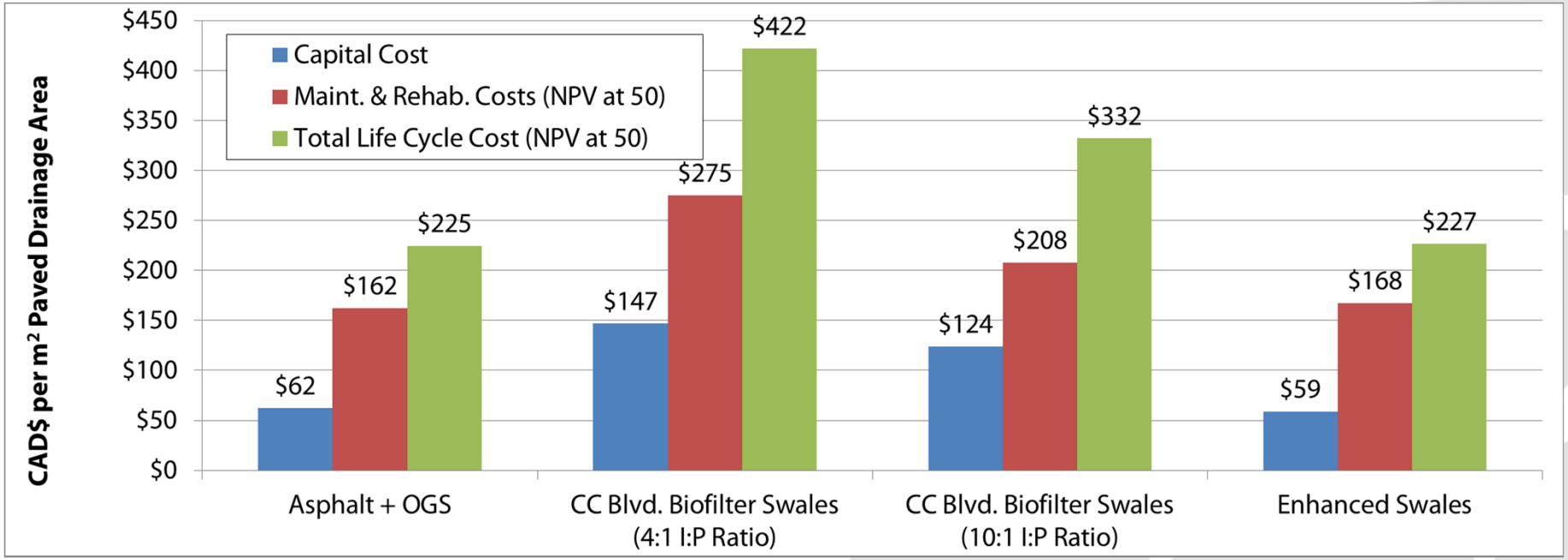
LID BMP Life Cycle Costing Tool

- User enters site characteristics, and can modify default design and maintenance parameters;
- Tool provides capital, maintenance, inspection and rehabilitation cost estimates;
- Inflation factor can be applied to update costs to current year;
- Version 1.1 free to download;
- Version 2.0 coming soon!

https://sustainabletechnologies.ca

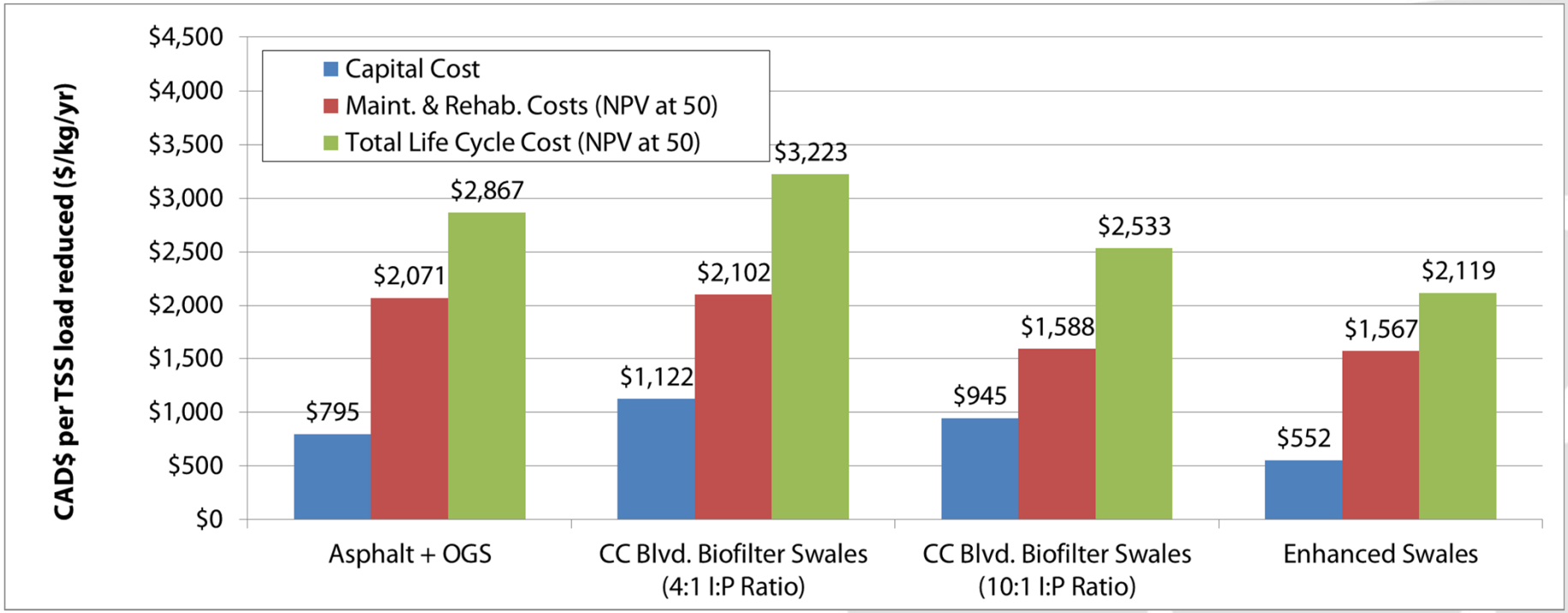


Life cycle cost per paved drainage area



But OGS and enhanced swales provide less treatment…

Life cycle cost per pollutant load removal



Biofilter swales still more expensive to construct and operate than enhanced swales…

Lessons Learned – Partner Feedback

Barriers	Enablers
Concern that projects could be more expensive and time-consuming than 'business-as-usual"	• Community engagement builds excitement and support; • Business cases to show project achieves greater outcomes;
Different tolerances for risk versus optimism among partners	• Use SNAPs to pilot new projects; • Prepare contingency plans as a group and share experience/risk;
Inflexible permitting processes	• Early engagement with permitting agencies;
Unforeseen issues	• Build a buffer into project timeline; • Keep focused on key objectives.

Lessons Learned - Implementation

- Construction supervision, rigorous inspection and testing prior to assumption and routine maintenance (annual to biannual) is critical;
- Landscaping plan needed further consideration of context and available resources/capacity for maintenance – choose easy to maintain plants tolerant to wet, dry and salt; plants need watering during 1st growing season (biweekly for 1st 2 months in absence of rain) & maintain 5 to10 cm shredded wood mulch cover.

Conclusions

- Planned infrastructure renewal projects can be leveraged to achieve greater impact by taking an integrated, multi-objective approach;
- Biofilter swales are effective at reducing runoff volume, attenuating peak flow rate, removing some pollutants and reducing thermal loading relative to the control catchment.
- Weak removal efficiencies for nutrients and some metals – biomedia specifications for lined, filtration-only bioswales should include additive(s) to enhance removal;
- Life cycle cost of suspended solids removal for biofilter swales estimated to be favorable to HDS/OGS units but slightly higher than enhanced swales;

Conclusions (cont'd)

- Operation during winter 2016 had no significant effects on biofilter swale treatment performance;
- Biomedia showed sodium contamination within the top 10 cm at inlets during winter months; SAR declined to below Ontario parkland/residential guideline of 5 by end of April.
- Despite efforts to dam inlets, monitoring results show that substantial quantities of snowmelt and plowed snow enters the bioswales over the curb (and past dams/sandbags?);
- In contexts where BMPs are to be taken out of service during winter, inlets should be designed with sluice gates or other flow diversion devices.

Project supporters

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Thank you

For more information:

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