

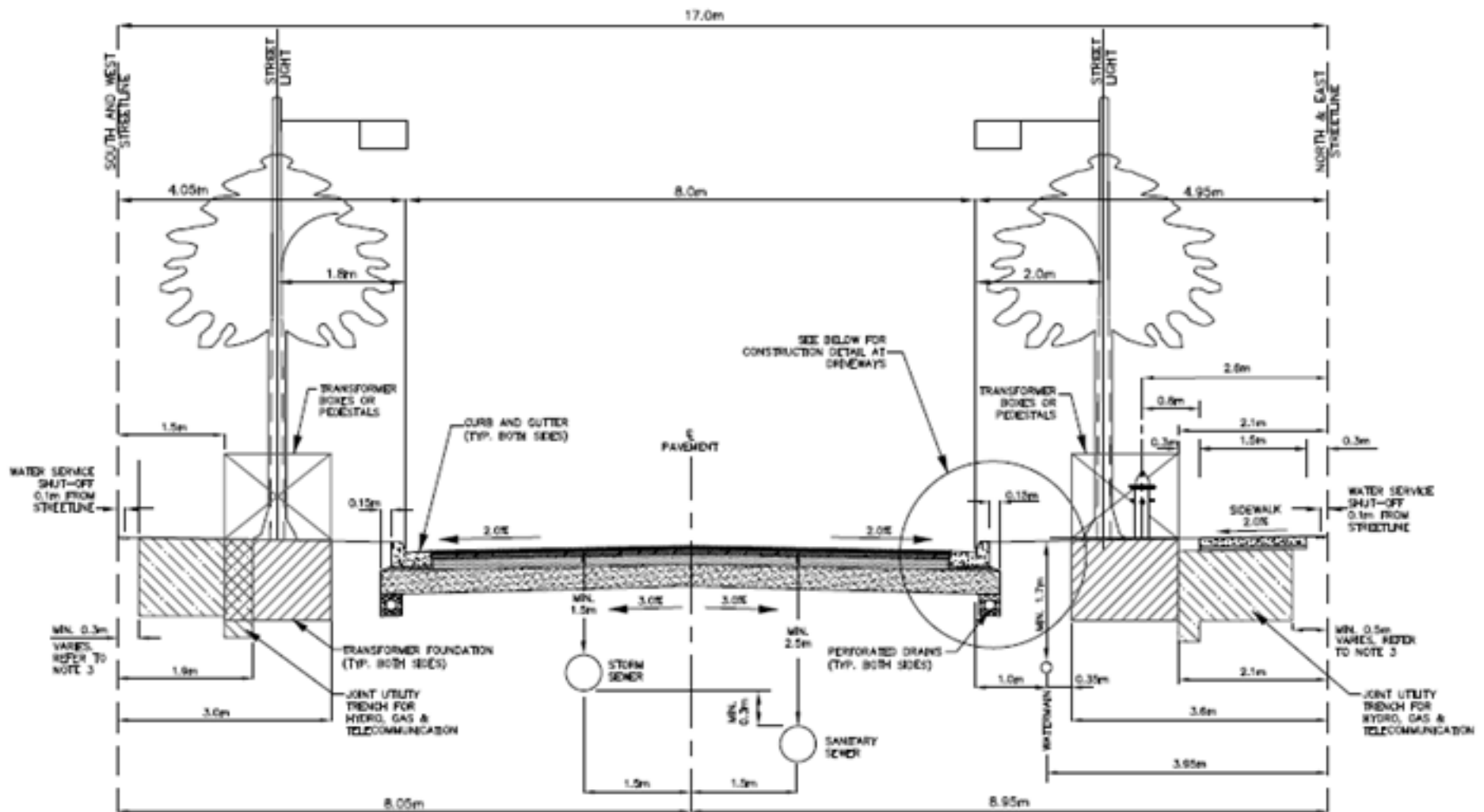


The Business Case for Low Impact Development

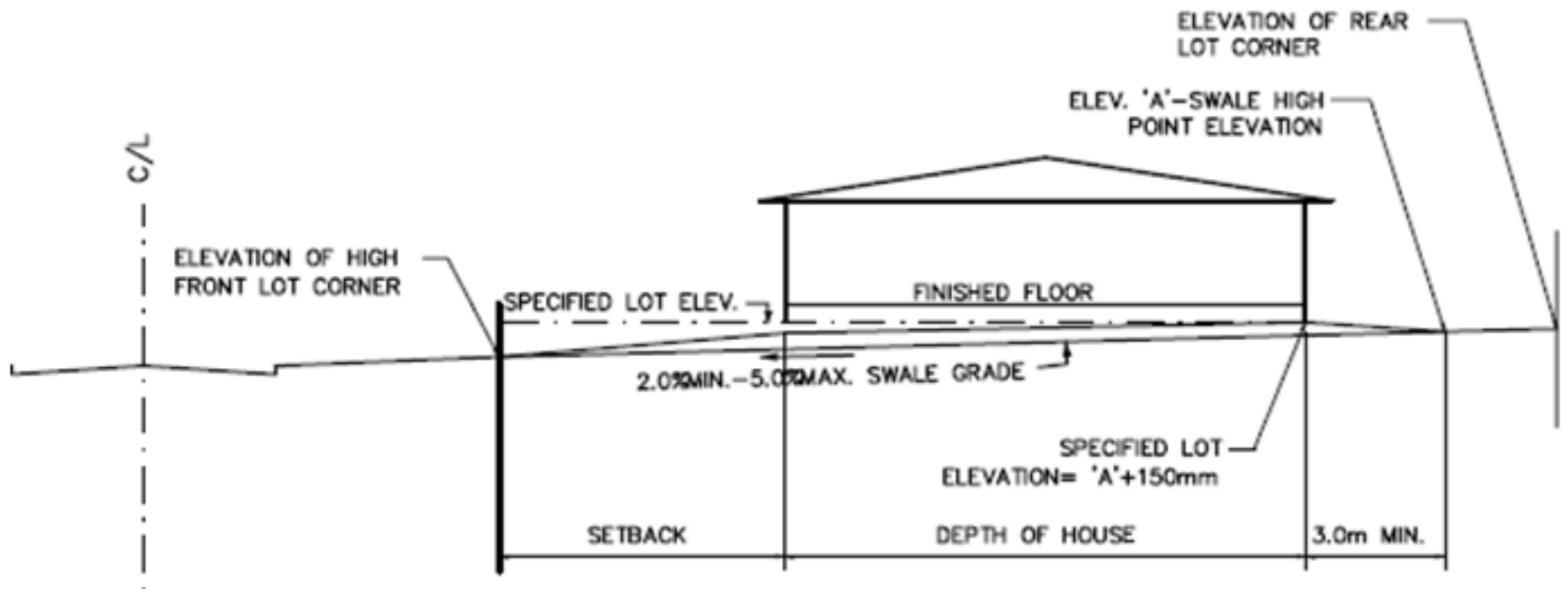
TRIECA 2013 | March 26/27 2013







This drawing is a technical drawing and should be used in accordance with the applicable standards and specifications.



accumulated knowledge

risk

liability

consistency

certainty





**CHANGE
AHEAD**





aging infrastructure
infrastructure deficits

the natural environment





changing climate



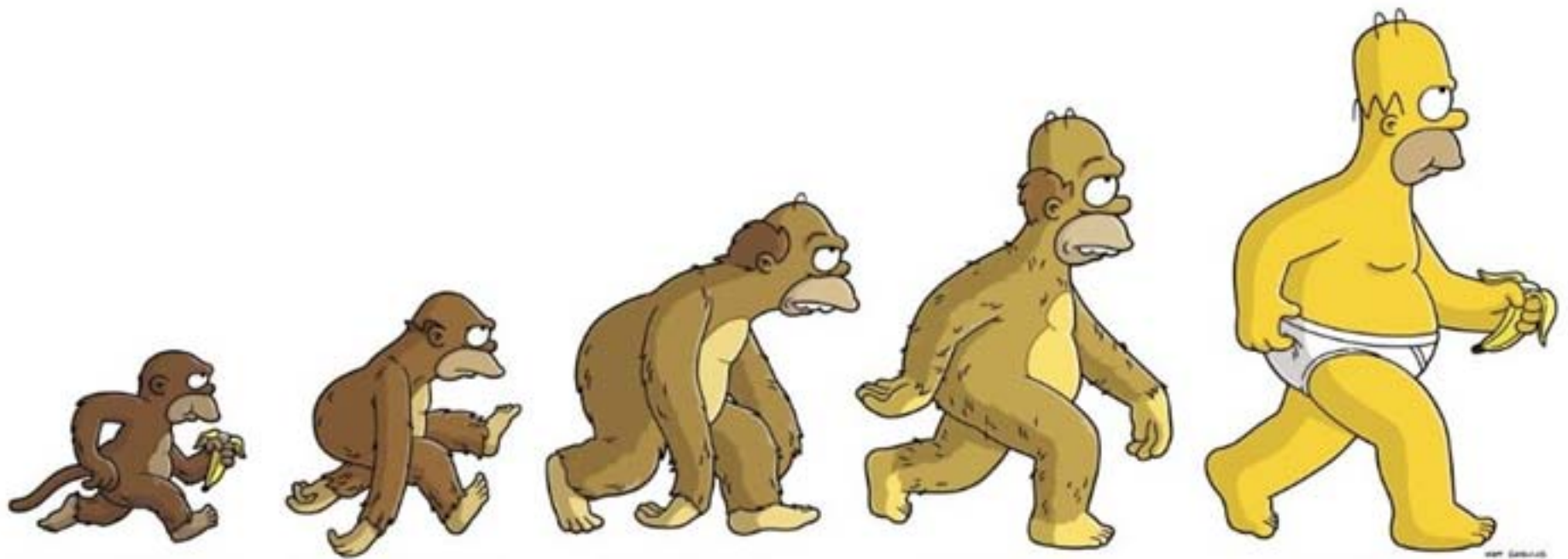
healthy communities ► quality of life



sustainability

stability in the status quo





change is necessary



limited
funds





Nine Rules for Stifling Innovation

by Rosabeth Moss Kanter (Harvard Business Review Blog Network, Jan 15 2013)



2. Invoke history

If a new idea comes up for discussion, find a precedent in an earlier idea that didn't work, remind everyone of that bad past experience. Those who have been around a long time know that **we tried it before, so it won't work this time either.**



5. Stress predictability above all

Count everything that can be counted, and do it as often as possible.
Sweep any surplus into master accounts, and eliminate any slack.

Favor exact plans and guarantees of success. Don't credit people with exceeding their targets because that would just undermine planning.
Insist that all procedures be followed.



7. Act as though punishing failure motivates success

Practice public humiliation, making object lessons out of those who fail to meet expectations. Everyone will know that risk-taking is bad.





unintended consequences





maximize infiltration



maximize evapotranspiration



maximize reuse



minimize impervious cover



north humber extension neighbourhood



**North Humber Extension Development
Kleinburg
Functional Servicing Report
City of VAUGHAN**

Project File: 07115
June 2008



The Municipal Infrastructure Group Ltd.
2300 Steeles Avenue West, Suite 100
Vaughan, Ontario
Canada L4K 5H6
T: 905.738.8700
F: 905.738.8888



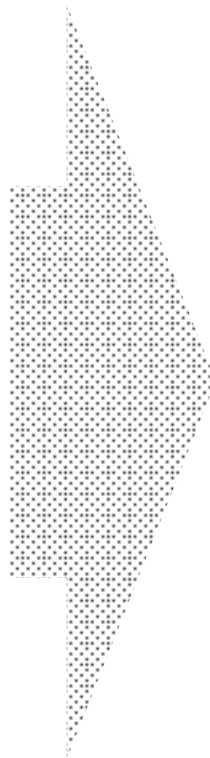
City of Vaughan
**North Humber Extension
 Neighbourhood**
 Low Impact Development
 Evaluation
 Draft - March 2009 - File 28100



The Municipal Infrastructure Group Ltd.
 2700 Steeles Avenue East Suite 100
 Vaughan, ON L4A 1G9
 Tel: 905.709.5700 Fax: 905.709.8075
www.mig.ca



PREPARED FOR:
 Environment Canada
 Toronto Region Conservation
 Authority



RAINWATER HARVESTING
 (BARRELS OR CISTERNS)



GREEN ROOFS



DOWNSPOUT DISCONNECTS
 / INCREASED TOPSOIL



PERMEABLE PAVEMENT



VEGETATED FILTER STRIPS



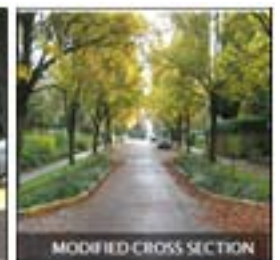
SOIL AMENDMENTS



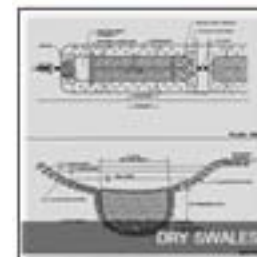
SWAGWAY PITS



BIORETENTION / TREE
 CLUSTERS



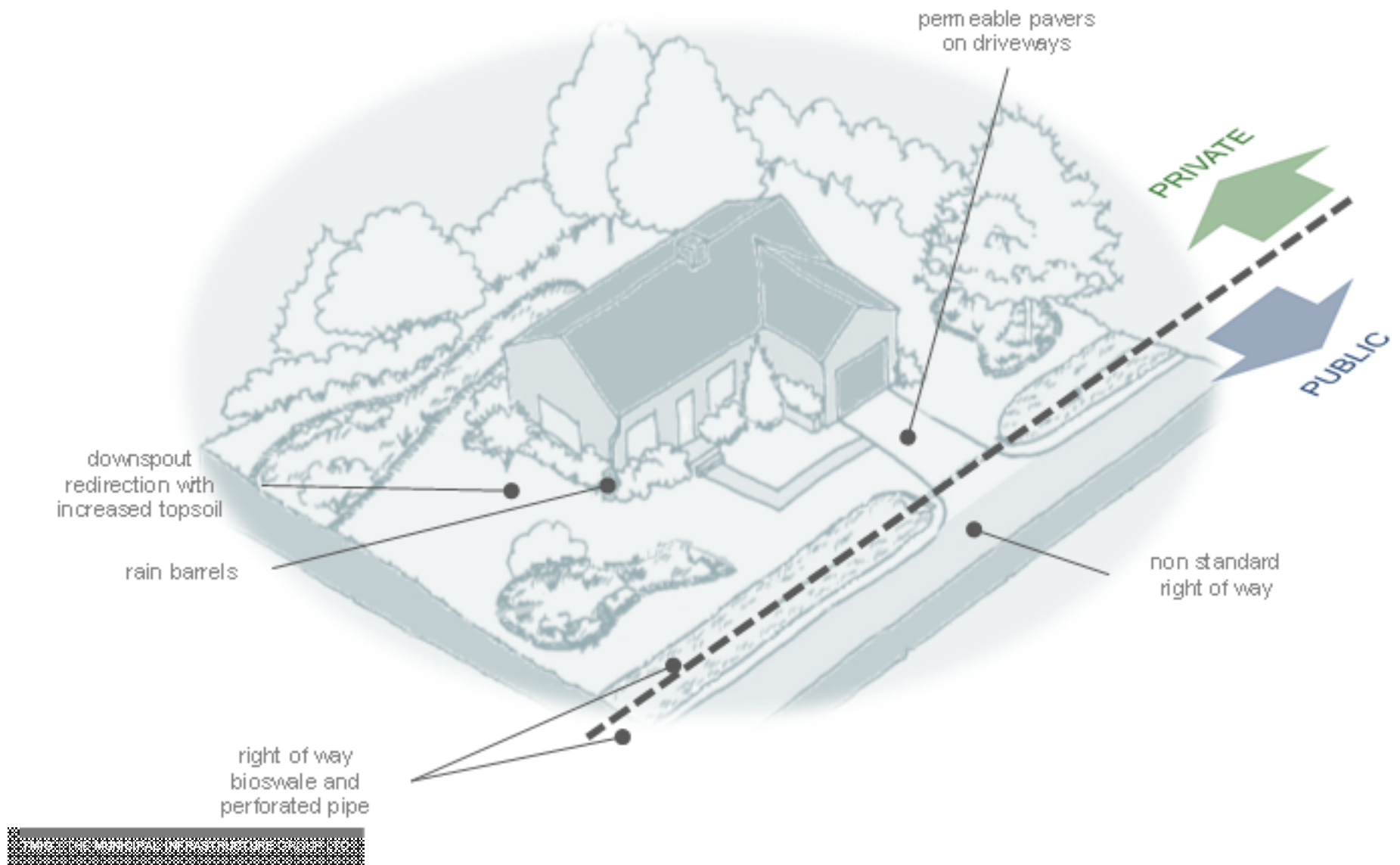
MODIFIED CROSS SECTION



DRY SWALES



GRASS SWALES



overall project
estimated as 30%
less than
conventional design





redundancy

systems spanning
conventional
boundaries



nimbyism



“... I can think of better
uses for our funding ...”

		conventional	alternative
money	capital costs		
	operating costs		
	maintenance costs		
	replacement costs		
	integrated design savings		
not money	improved water / air quality		
	resilience to changing conditions		
	healthy communities		
	liability / risk		
total ► dollars + “quality of life” index		x	y





The Business Case for Low Impact Development: Where are the Savings?

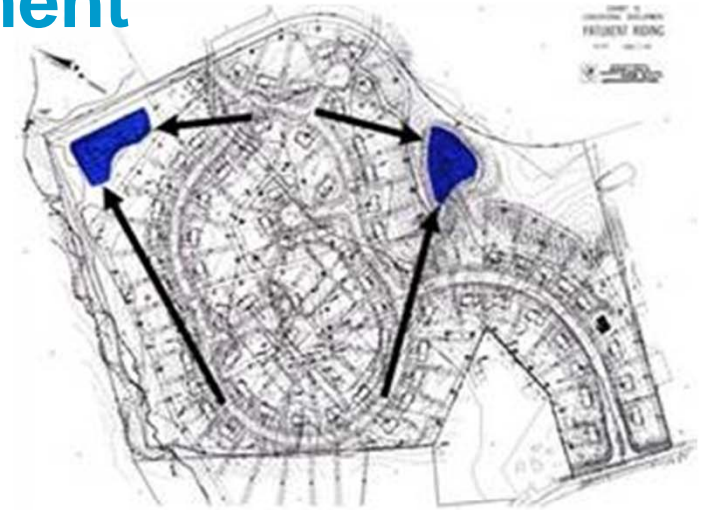
Tim Van Seters
TRIECA Conference
March 27, 2013





Low Impact Development Approach

- Manage runoff volumes and water quality using decentralized controls
- Preserve or reproduce pre-development water balance
- Preserve natural drainage features
- Simple low tech, low cost practices that detain, infiltrate and evapotranspire



Conventional approach



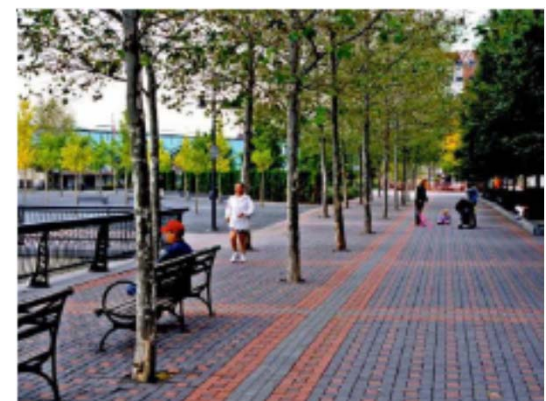
LID approach



Low Impact Development Practices

Detain - infiltrate - evapotranspire - capture and use

- Reduced impervious surfaces
- Permeable pavements
- Bioretention
- Infiltration trenches
- Swales, terraces, and check dams
- Rain barrels and cisterns
- Green roofs
- Trees and tree boxes
- Amended soils
- etc..





Economic Benefits of LID: Private and Public

LID Function	Property Owner	Community
Stormwater Management	Satisfies Stormwater Policy Requirements Long term effectiveness and O&M	Lower Stream Erosion Reduced Flood Risk Less Infrastructure Damage Fewer Combined Sewer Overflows and Beach Closures Improved Water Quality
Water Conservation	Lower Water Bills through reduced water use	Delays need for expensive water treatment infrastructure expansion Reduces municipal water pumping/treatment costs



Economic Benefits of LID: Private and Public

LID Function	Property Owner	Community
Green Roof Insulation Tree shade Tree wind breaks	Lower Energy Costs	Urban Cooling Improved Air Quality Carbon Capture
Naturalized Landscaping Reduced impervious cover	Increased Property values due to improved aesthetics	Improved habitat and biodiversity Improved air quality More green space and recreational opportunities



Grey versus Green: Where are the Savings?

- Preserves open space
- Reduces impervious cover
 - Narrower streets, alternative urban form
 - Shorter driveways, smaller parking stalls, etc
- Avoided Costs
 - Less site grading and preparation
 - Eliminate or reduce downstream infrastructure
 - Larger buildable area
 - Fewer pipes and inlets
 - Smaller culverts
 - Less curbs and gutters
 - Less paving
 - Simpler long term maintenance

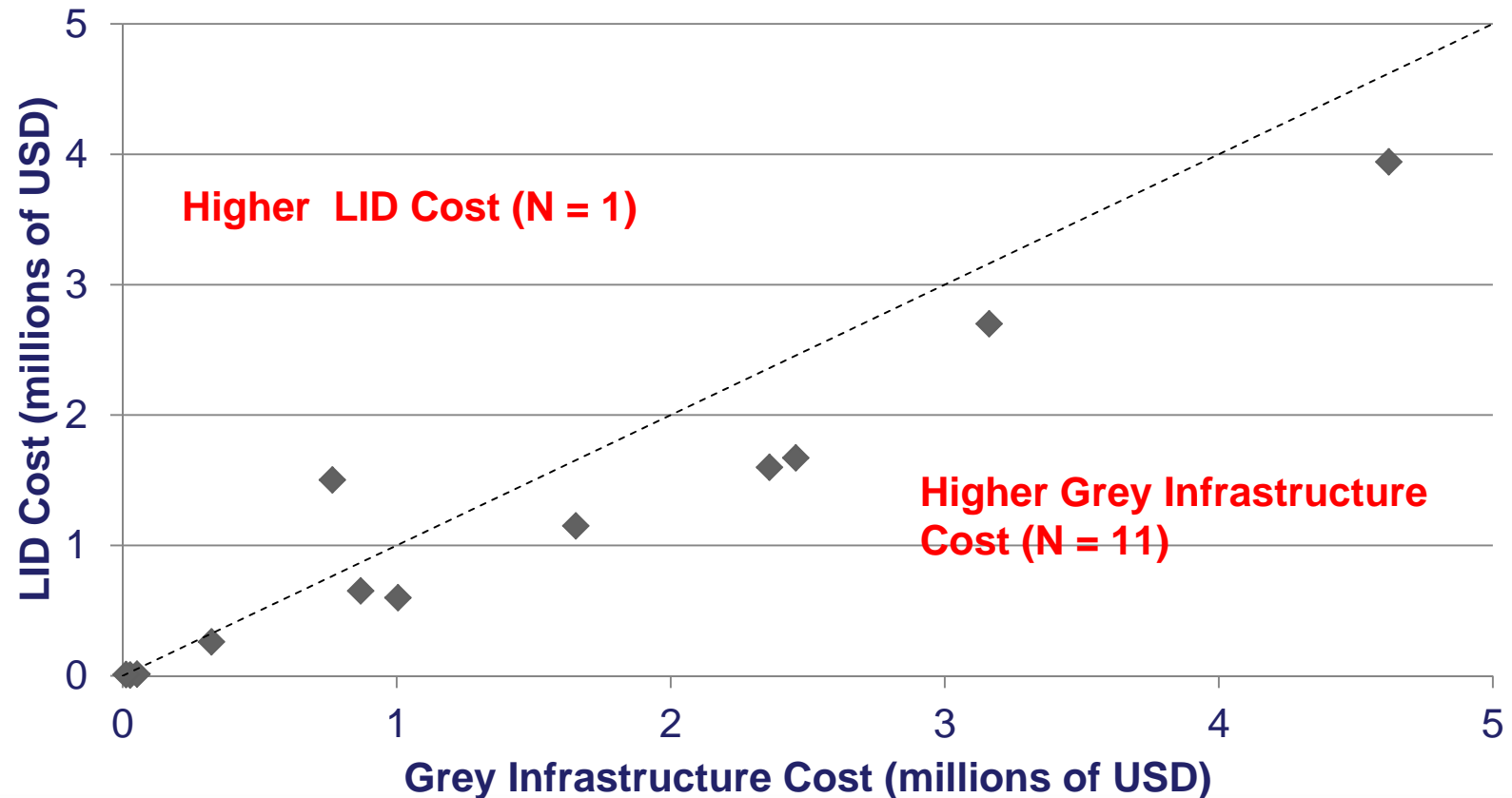


Source: StormTech



Potential for Savings is Real

USEPA study in 2007 showed lower LID costs for 11 of 12 projects relative to grey infrastructure





Context will influence potential for savings...

- Retrofit sites where infrastructure already exists
- Stormwater criteria, credit programs and incentives
- Space constraints and cost of buildable area
- Provincial and municipal standards
- Site specific constraints or opportunities

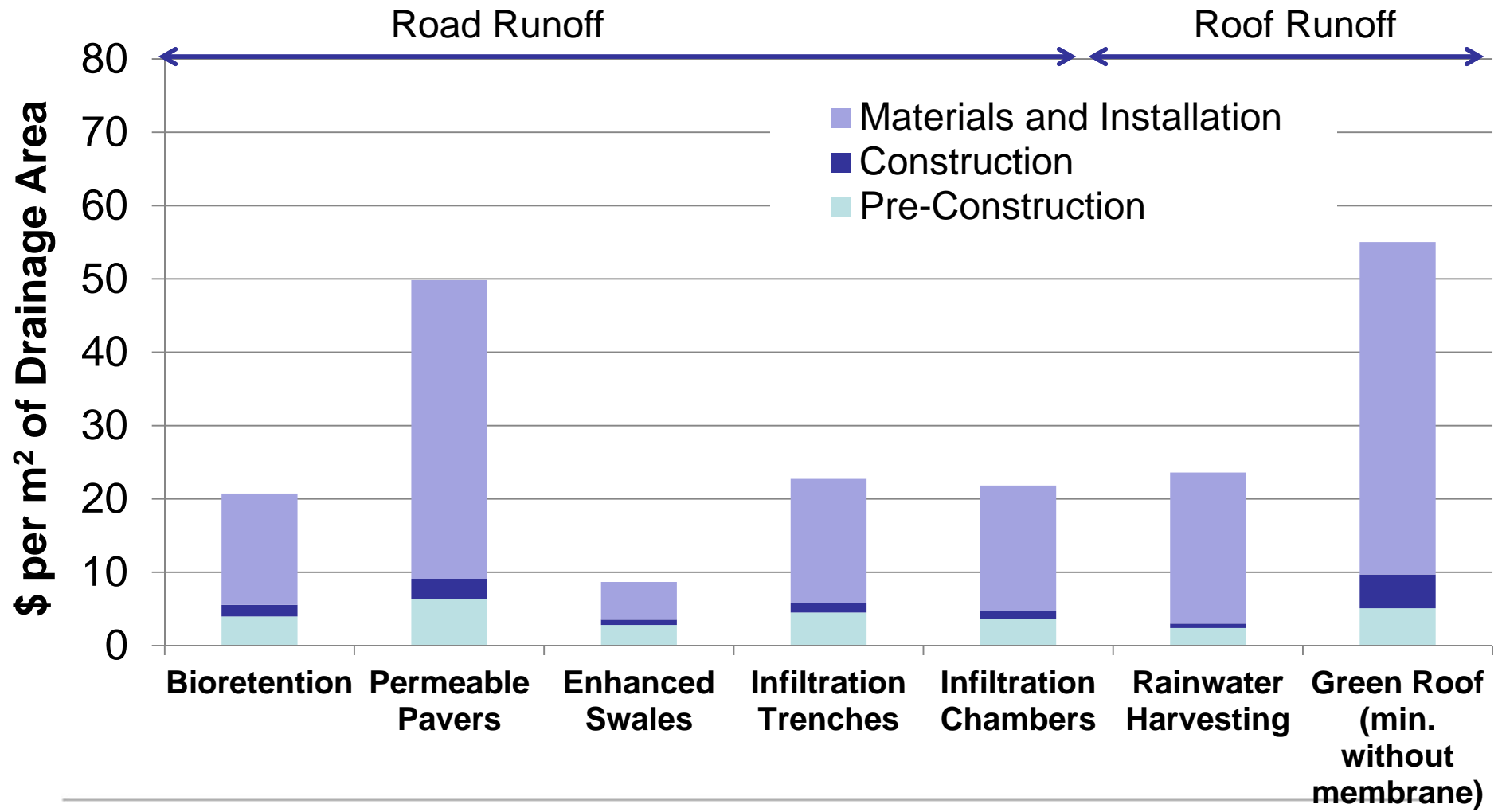


LID Life Cycle Cost Study and Tool

- Collaborative project with University of Toronto
 - Mariko Uda and Chris Kennedy - Civil Engineering Department
- Evaluates **capital** and **life cycle** costs over 50 years based on:
 - Local input costs from RS means and industry surveys
 - Practice maintenance requirements in Ontario
 - LID designs from local guides
- LID Capital and **Life Cycle Costing Tool** for preliminary scoping



LID Practice Capital Costs





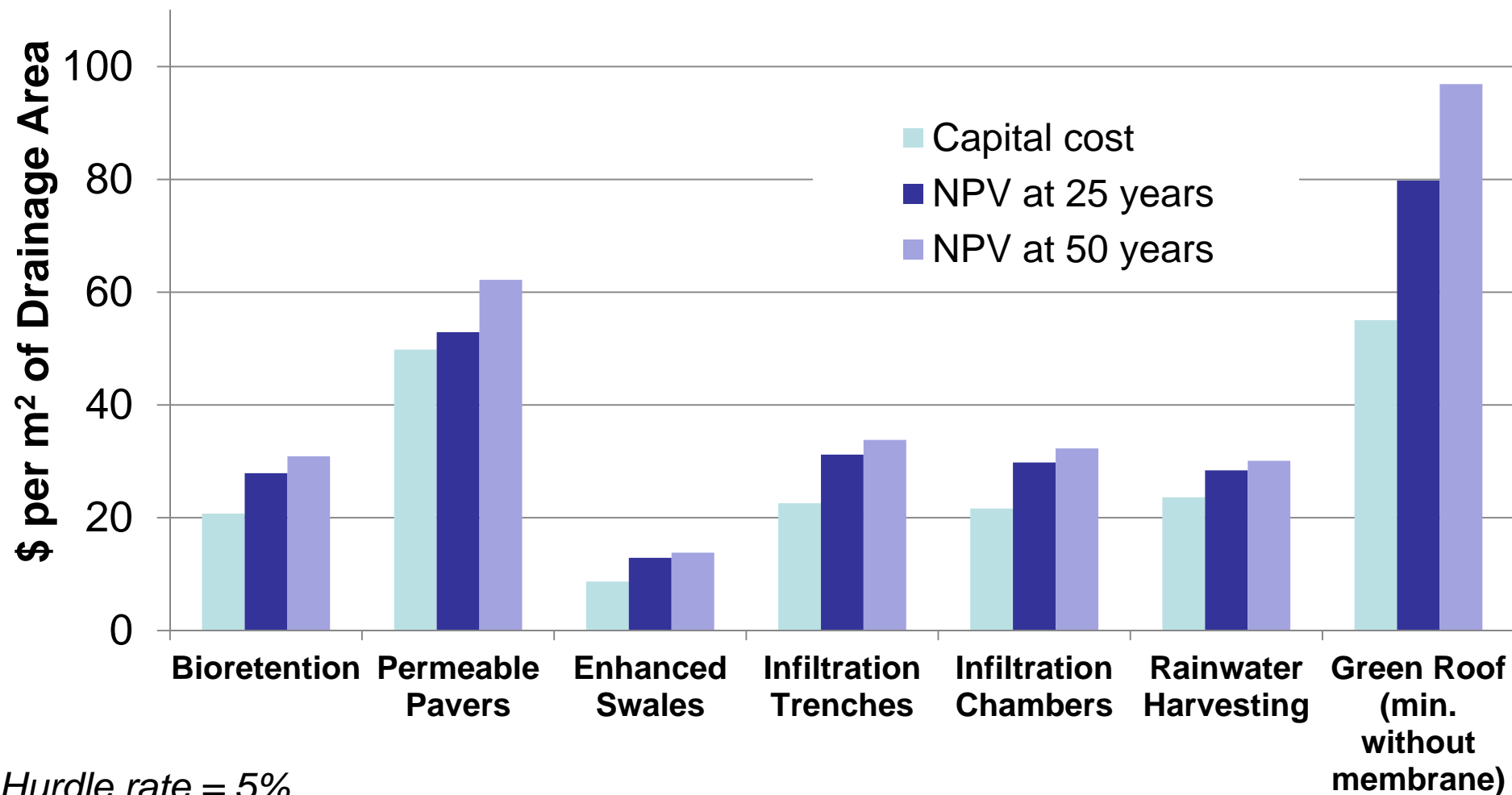
Life Cycle Operation, Maintenance and Rehabilitation Costs

- Typical routine activities: *inspection, sediment removal, vegetation maintenance, mowing, watering, vac. clean out etc ...*
- Higher **initial establishment** costs for vegetative practices
- Periodic **rehabilitation** or replacement costs

	Operation, Maintenance and Rehabilitation Costs										Total PV
Bioretention	\$\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$	\$\$\$\$\$	\$\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$28,670
Perm. Pavers	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$	\$41,819
Enhanced Swale	\$\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$\$\$	\$	\$	\$	\$	\$	\$10,292
Infil. Chamber	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$30,563
Infil. Trench	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$32,276
Rain Water H.	\$\$\$	\$\$\$\$	\$\$\$	\$\$\$\$	\$	\$\$\$\$	\$	\$\$\$\$	\$	\$	\$18,851
Green Roof Min	\$\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$	\$\$\$\$\$	\$\$\$\$	\$\$\$	\$182,228
	5	10	15	20	25	30	35	40	45	50	
Member of Conservation Ontario	Years										TORONTO AND REGION CONSERVATION AUTHORITY



Life Cycle Costs





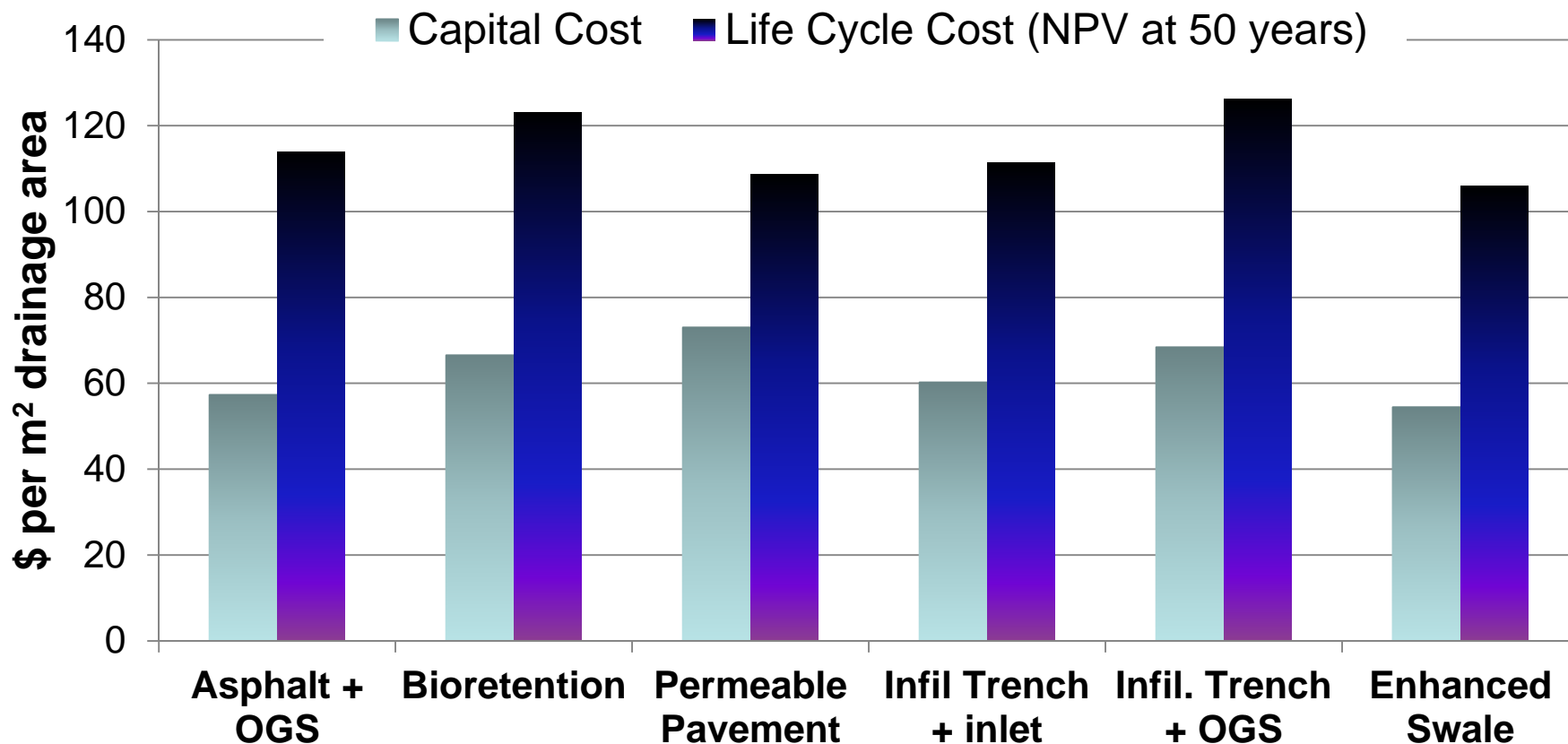
Scenarios

- **Asphalt with:**
 1. **Oil Grit Separator** treatment
 2. **Bioretention** with underdrain
 3. **Permeable Pavement** (50% of drainage area)
 4. **Infiltration trench** with pretreatment via gravel inlet
 5. **Infiltration trench** with pretreatment via OGS
 6. **Enhanced swale**





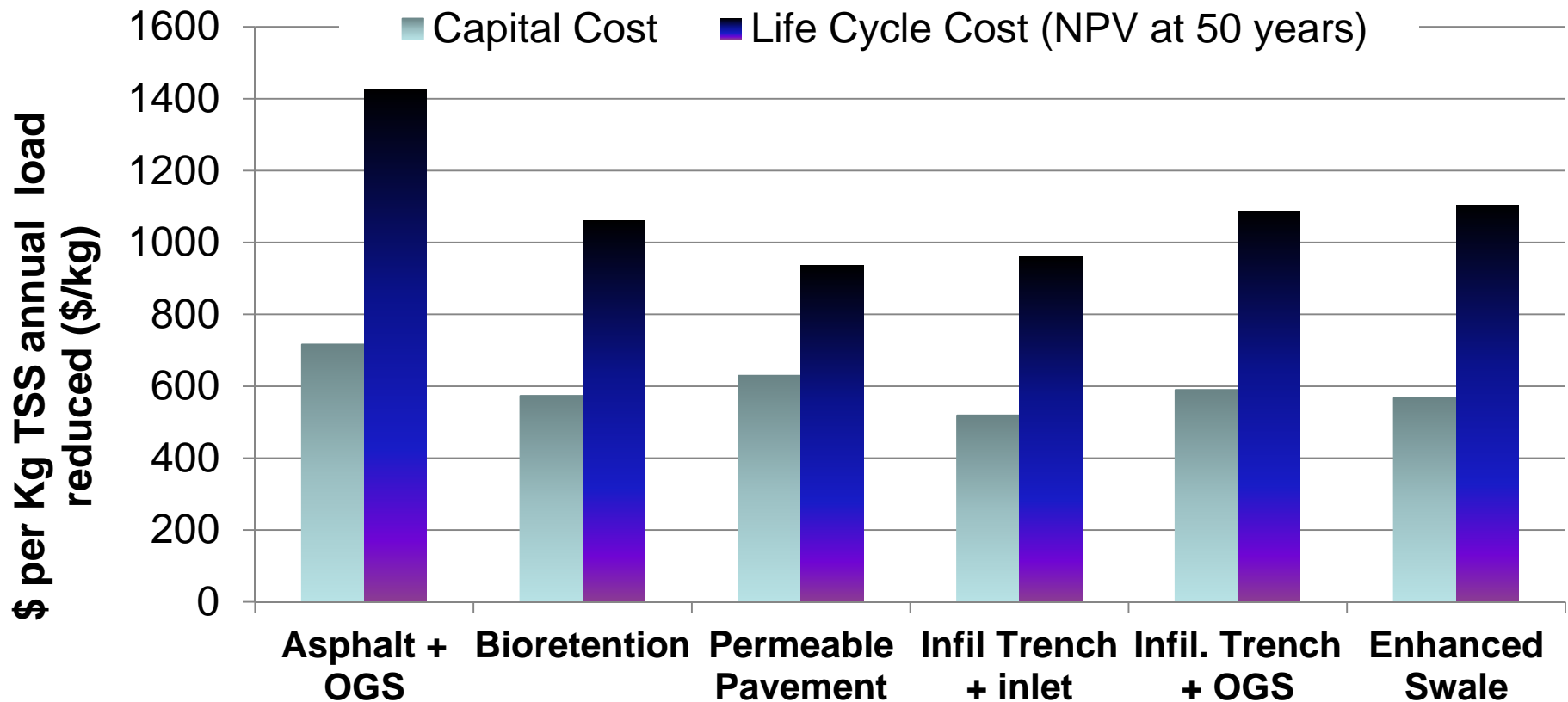
Scenario Cost Estimates



....But conventional treatment does not reduce runoff volumes



Costs by TSS Load Reduced



For simplicity, assumes annual rainfall of 800 mm, all practices reduce influent TSS (200 mg/L) by 50%, runoff volume reductions as per LID Guide



Life Cycle Costing Tool

- Spreadsheet decision support tool
- Facilitate selection of LID practices
- User enters site characteristics, and can modify default practice design and maintenance parameters
- Tool provides capital, maintenance and life cycle costs
- Inflation factor can be applied to update costs to current year





Design Information and Capital Costs

STEP LID Toolxism [Read-Only]

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BIORETENTION

Design & Costs Information

What is bioretention?

Bioretention temporarily stores, treats and infiltrates runoff. Depending on native soil infiltration rate and physical constraints, the system may be designed without an underdrain for full infiltration, with an underdrain for partial infiltration, or with an impermeable liner and underdrain for filtration only. The primary component of a bioretention practice is the filter bed which is a mixture of sand, fines and organic material. Other important elements include a mulch ground cover and plants adapted to the conditions of a stormwater practice. Pretreatment, such as a settling forebay, vegetated filter strip, or stone diaphragm, often precedes the bioretention to remove particles that would otherwise clog the filter bed. Bioretention is designed to capture small storm events or the water quality storage requirement. An overflow or bypass is necessary to pass large storm event flows.

Design Guidance

- Bioretention cells work best for smaller drainage areas. Typical drainage areas are between 100 m² to 0.5 hectares. The maximum recommended drainage area to one bioretention facility is approximately 0.8 hectares. Typical ratios of impervious drainage area to bioretention cell area range from 5:1 to 15:1.
- Bioretention can be designed to fit into many locations and shapes, the geometric design is dictated by other elements of the landscape such as building, sidewalks, utility corridors, retaining walls, etc. Narrow or narrow sections can concentrate flow and
- The filter bed surface should be level to encourage stormwater to spread out evenly to reduce localized sedimentation and

Ready

STEP LID Toolxism [Read-Only] - Microsoft Excel

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Clipboard Font Alignment Number

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BIORETENTION

USERS: Please enter information into dark coloured cells, DO NOT LEAVE BLANK
* Medium coloured cells are model defaults and can be changed by the user. All light coloured cells are locked.

Design

Site & Design Information		
Drainage area		m ²
Native soil infiltration rate		mm/hr
Design type ¹		Unitless
Drainage Period		hours
Ponding Depth		m
Safety Factor		Unitless
Void Ratio		%
Filter Media Depth		m
Mulch Depth		m
Pea Gravel		m
Underdrain Diameter		m
Gravel Storage Layer		m
Cell Depth		m
Cell Length		m
Cell Width		m
Surface Area		m ²
Drainage area/Surface area ²		Unitless
Adjust sizing using drainage area: surface area?	No	(Y/N)

Capital Costs

Costs are 2010 data, apply inflation rate (%)

PRE-CONSTRUCTION	Select	Unit	Cost	Remove Cost?
Test pits		pits	\$0.00	No
Infiltration tests		tests	\$0.00	No
Stakeout of utilities	1	visit	\$0.00	No
Erosion and sediment controls:				
2" Submersible gas pump		days	\$0.00	No
Silt sack in catch-basin		each	\$0.00	No
Silt fence around excavation		m	\$0.00	No
Add additional costs if necessary				
EXCAVATION				
Excavator		m ³	\$0.00	No
Loading	15	% of excavation cost	\$0.00	No
Hauling		hours	\$0.00	No
Safety fencing		m	\$0.00	No
Pipe to sewer travelling		m	\$0.00	No
Add additional costs if necessary				
MATERIALS				
Impermeable membrane		m ²	\$0.00	No
Underdrain (200 mm)		m	\$0.00	No
Clean out pipes (150 mm)		m	\$0.00	No
Overflow pipes (200 mm)		m	\$0.00	No
Pipe to sewer (200 mm)		m	\$0.00	No
Monitoring pipes (150 mm)		m	\$0.00	No
Delivery charges		\$	\$0.00	No
Fittings (materials & labour)		units	\$0.00	No
Manhole adaptor (200 mm)		each	\$0.00	No
Stone (50 mm clear)		Cm ³	\$0.00	No
Pea gravel		m ³	\$0.00	No
Geotextile		m ²	\$0.00	No
Filter media (includes delivery)		Lm ³	\$0.00	No
Backfill excavation		m ³	\$0.00	No
Curb & gutter with curb inlets		m	\$0.00	No
Vegetation		m ²	\$0.00	No
Wood mulch		m ²	\$0.00	No
Stone inlets (50 mm clear)		m ²	\$0.00	No
Add additional costs if necessary				
TOTALS				
Sub-total			\$0.00	
Overhead	10	%	\$0.00	
Other	0	%	\$0.00	
TOTAL			\$0.00	

Reset to defaults

Ready



Maintenance and Life Cycle Costs

STEP LID Toolxism [Read-Only]

PERMEABLE INTERLOCKING CONCRETE PAVERS

Maintenance and Life Cycle Costs

Maintenance and Life Cycle Costs are 2010 data, apply inflation rate (%)

MAINTENANCE OPTIONS	Occurrence	Frequency (years)	Annual Cost
Surface vacuum	Annually	2	\$594
Replace pavers	Annually	8	\$58
Clean out pipes	Annually	10	\$40
Restriping	Annually	3	\$469
Add additional options	n/a	n/a	\$0
Add additional options	n/a	n/a	\$0
Add additional options	n/a	n/a	\$0

Life Cycle Costing Inputs

Inflation Rate (%)	0
Discount Rate (%)	0
Construction Costs	\$99,709.93
Rehabilitation	\$74,087
Year rehabilitation required	30
50 YEAR EVALUATION PERIOD	
Average annual maintenance	\$1,918
25 YEAR EVALUATION PERIOD	
Average annual maintenance	\$445

Reset to Defaults

Notes:
* Maintenance costs scaled based on surface area or underdrain length.

User Notes:

Ready

STEP LID Toolxism [Read-Only] - Microsoft Excel

PERMEABLE INTERLOCKING CONCRETE PAVERS

Cost Summary

Grand total for this project	
	\$99,709.93
Total costs by area	
Pre-construction	\$3,599
Excavation	\$5,636
Materials	\$81,410
Other	\$9,065

Retrofit Cost	
Percentage of total cost	16%
Total	\$15,954

Life Cycle Totals	
50 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	\$95,920
PV of all costs	\$195,630
25 YEAR EVALUATION PERIOD	
PV of maintenance & rehabilitation	\$11,131
PV of all costs	\$110,841

82%

Pre-construction Excavation Materials Other

Ready



Next Steps

- Final Report and Tool will be available in April at:
 - www.sustainabletechnologies.ca
- Modifications will be made based on user feedback



Rainwater Cistern in Parking Garage





Project Partners

- Government of Canada's Great Lakes Sustainability Fund
- City of Toronto
- York Region
- Region of Peel
- University of Toronto
- National Science and Research Council Industrial Postgraduate Scholarship



Thank You

Tim Van Seters

Phone: 289-268-3902

Email: tvanseters@trca.on.ca

STEP website:

www.sustainabletechnologies.ca

Innovative Stormwater Interactive Map

www.iswm.ca



Toronto and Region
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Sustainable Technologies
Evaluation Program

