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Focusing on Solutions; Kitchener's Advancement in Integrated Stormwater Management

Matt Wilson
Stormwater Utility
City of Kitchener

TRIECA Conference
Track 1
Mar 21, 2019

Agenda



1. Introduction
2. Problem Statement
3. Stormwater Utility – Rates and Credits
4. Storm Water Master Plan / Policy
5. LID Demonstration Projects & Costs
6. LID ROW Projects & Costs
7. LID Site Development & Costs

Problem Statement

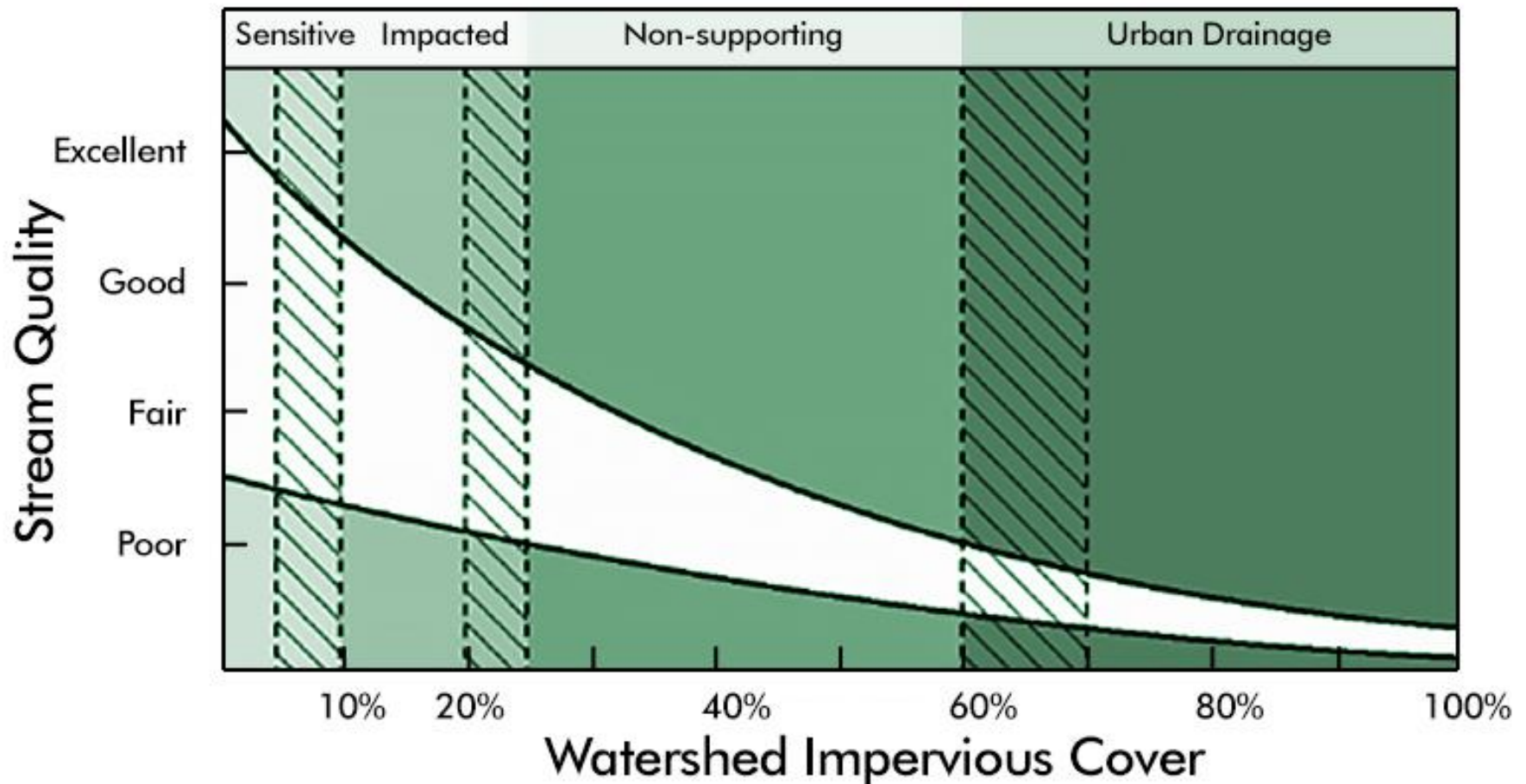
Urbanization impacts the environment in many ways:

- Degraded water quality
- Increased stream temperatures
- Increased sediment loads
- Loss & degradation of habitat
 - Impacts to fisheries biodiversity and abundance
 - Loss of self-supporting populations of coldwater fish
- Flooding (rivers)
- Erosion along watercourses
- Urban flooding



Fairview Mall

Relationship Between Stream Quality and Impervious Area



Kitchener's SWM System



City of Kitchener Stormwater Management Master Plan

Legend

- Municipal Boundary
- Study Area
- Watercourses
- Stormwater OGS
- Stormwater Facility
- Stormwater Drainage Area
- OGS
- SWM Facility
- SWM Facility/OGS

Source: City of Kitchener

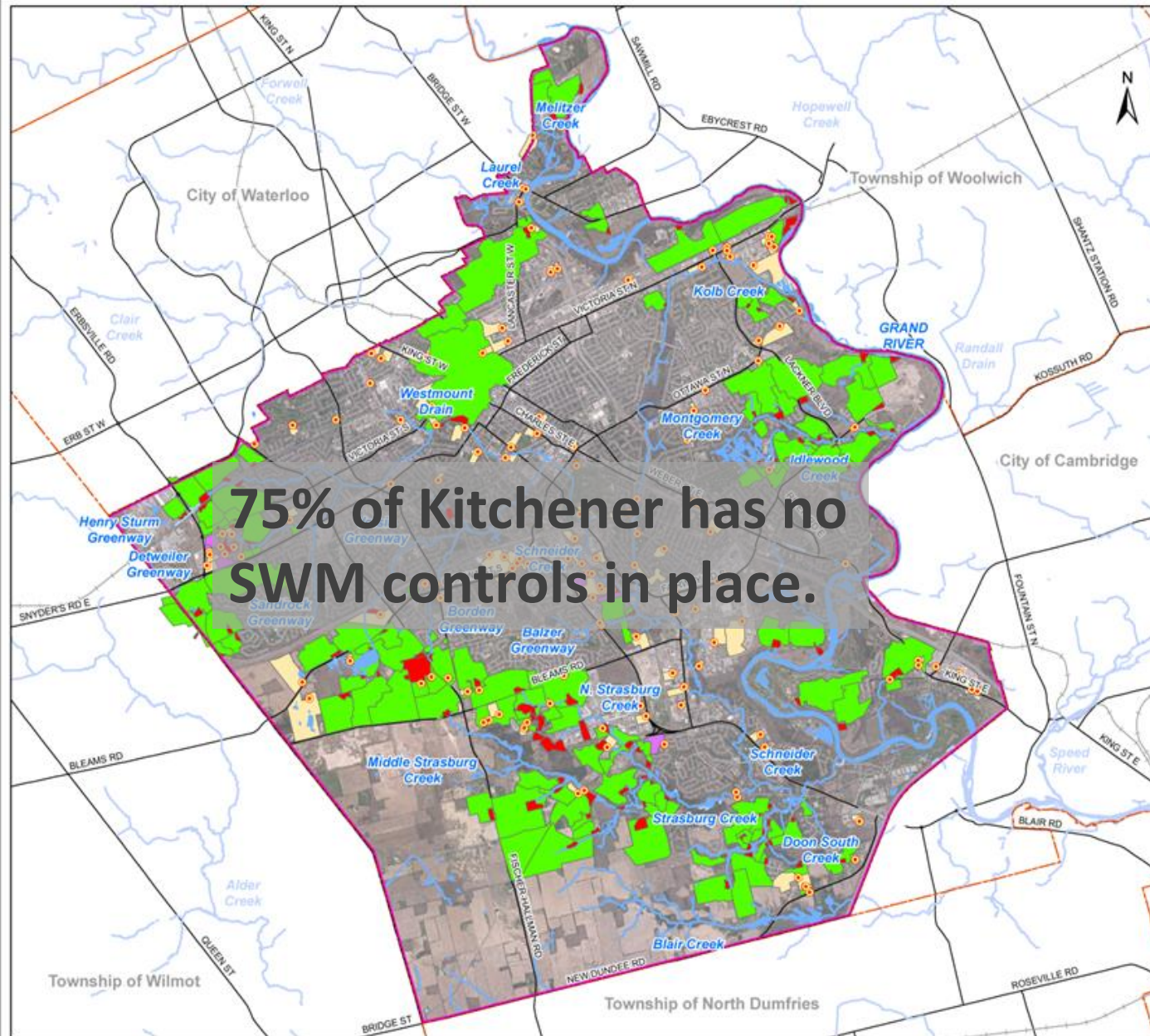
FIGURE 1.1
Stormwater Facility and OGS
Drainage Areas

0 0.5 1 2 3 Km



Date: December 2015

75% of Kitchener has no
SWM controls in place.



How do we pay for SWM?

Stormwater Utility



The City has a funding model in place, the stormwater utility

- Stormwater Charges By-law (2010)
 - All properties in the City are billed a 'stormwater rate' based on the amount of impervious area on the property
 - The city takes in approx. \$15 million annually
 - Sustainable funding mechanism dedicated to recover the costs of stormwater infrastructure:
 - capital costs + repair and replacement
 - planning, maintenance, etc.

Incentives for Private Property Stormwater Credits



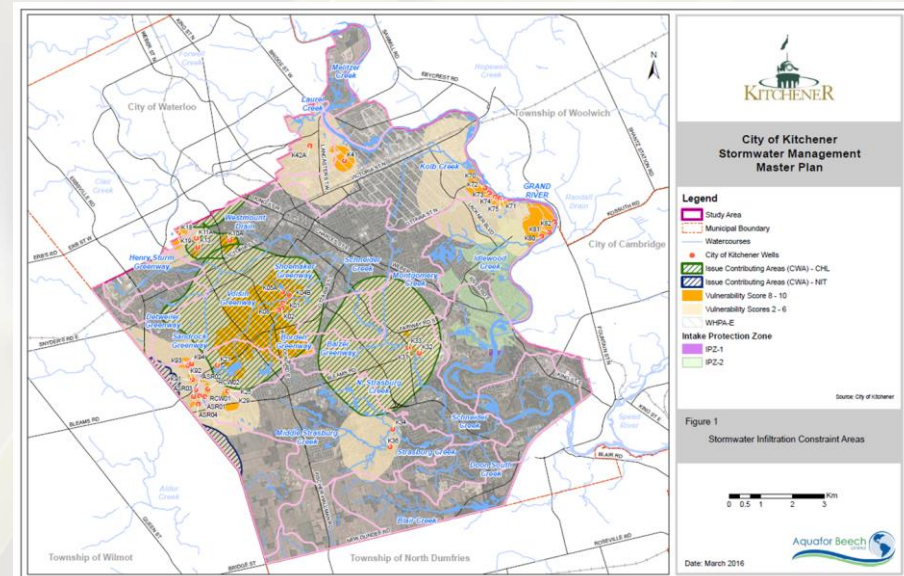
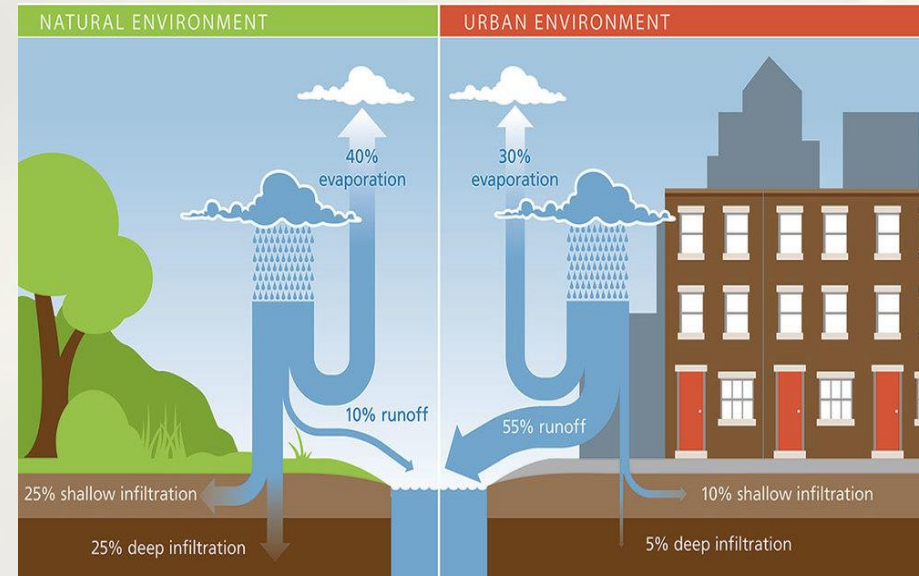
Credit Policy (2012)

- Every property has the opportunity to apply for Stormwater credits to reduce the stormwater charges (up to 45%)
- Residential
 - Rain barrels, Cisterns
 - Infiltration galleries,
 - permeable driveways rain gardens etc.
- Non Residential
 - Water quality measures
 - Water Quantity measures
 - Education



SW Master Plan - SWM for Public Lands

- The Stormwater Master Plan was Approved by Council in 2016 (policy MUN-UTI-2003)
- The SW MP requires a minimum 12.5mm stormwater volume retention of stormwater runoff from all surfaces on the study area as part of:
 - ‘new’ development & redevelopment
 - linear projects i.e. road reconstruction projects
- Our Region is 80% dependent on groundwater for drinking water
- Stormwater Infiltration Constraint Areas were developed (to protect groundwater)



ISMW-MP Low Impact Development Conveyance Controls



Green Infrastructure and Low impact development practices help to reduce runoff and restore natural hydrologic processes and for that reason are critical for maintaining the quality of natural water systems



LID effective for:

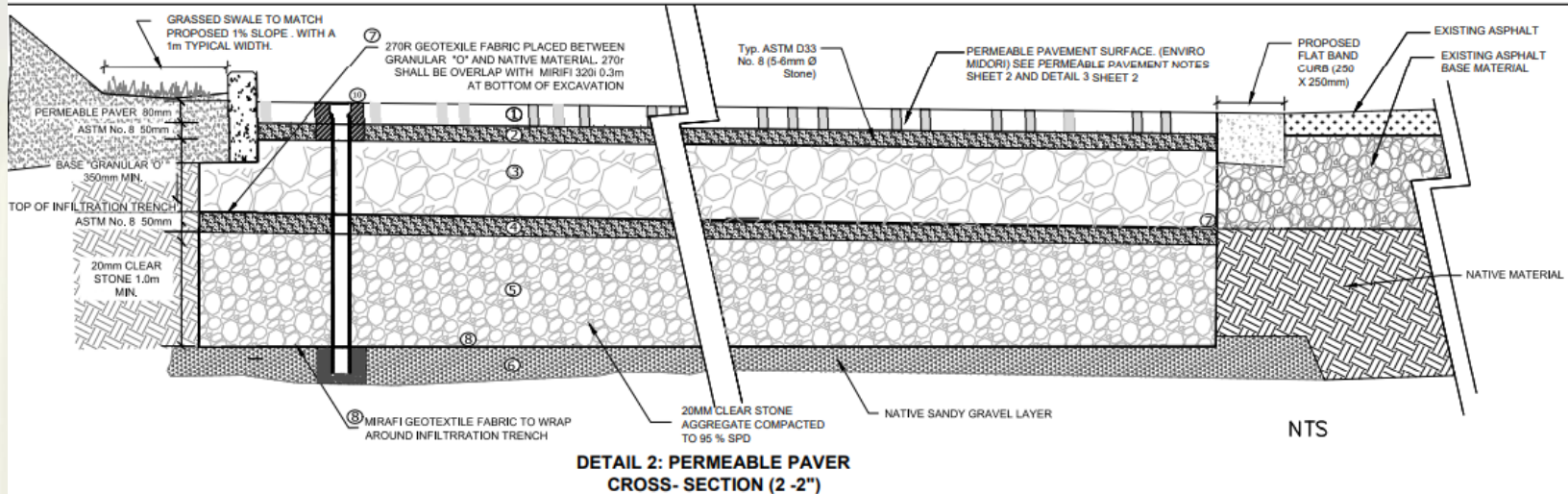
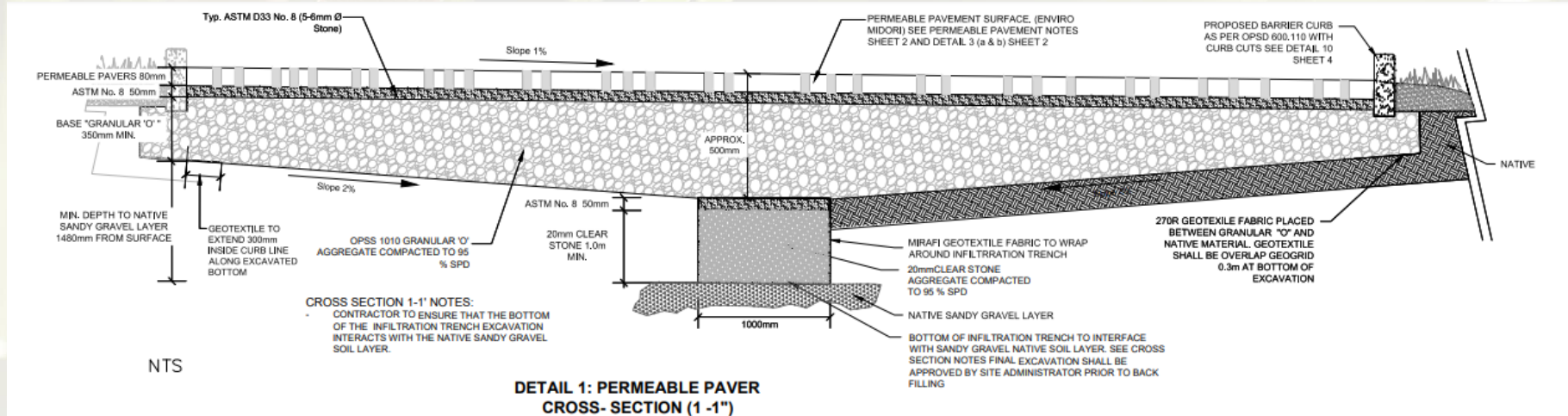
- ? Flood control – design
- ✓ Erosion Control - yes
- ✓ water quality - yes
- ✓ Temperature – yes
- ✓ Groundwater recharge – Yes
- ✓ Baseflow – Yes

- COK budget (ISWM-MP) between \$2 – \$11 million per the works identified in the master plan

Huron Natural Area – Permeable Pavers Demonstration Project (2015 – 2016)



Permeable Paver Design



constructionNORTH

THE POSITION OF THE POLE LINES, C OTHER UTILITIES AND STRUCTURES ARE THE CONTRACT DRAWINGS, AND WHEN POSITION OF SUCH UTILITIES AND STR

BEFORE STARTING WORK
THE CONTRACTOR SHALL CONFIRM TH ALL SUCH UTILITIES, AND SHALL ASS TO THEM MADE DURING THE COURSE

SURVEY
CONDITION SURVEY BY CITY OF K

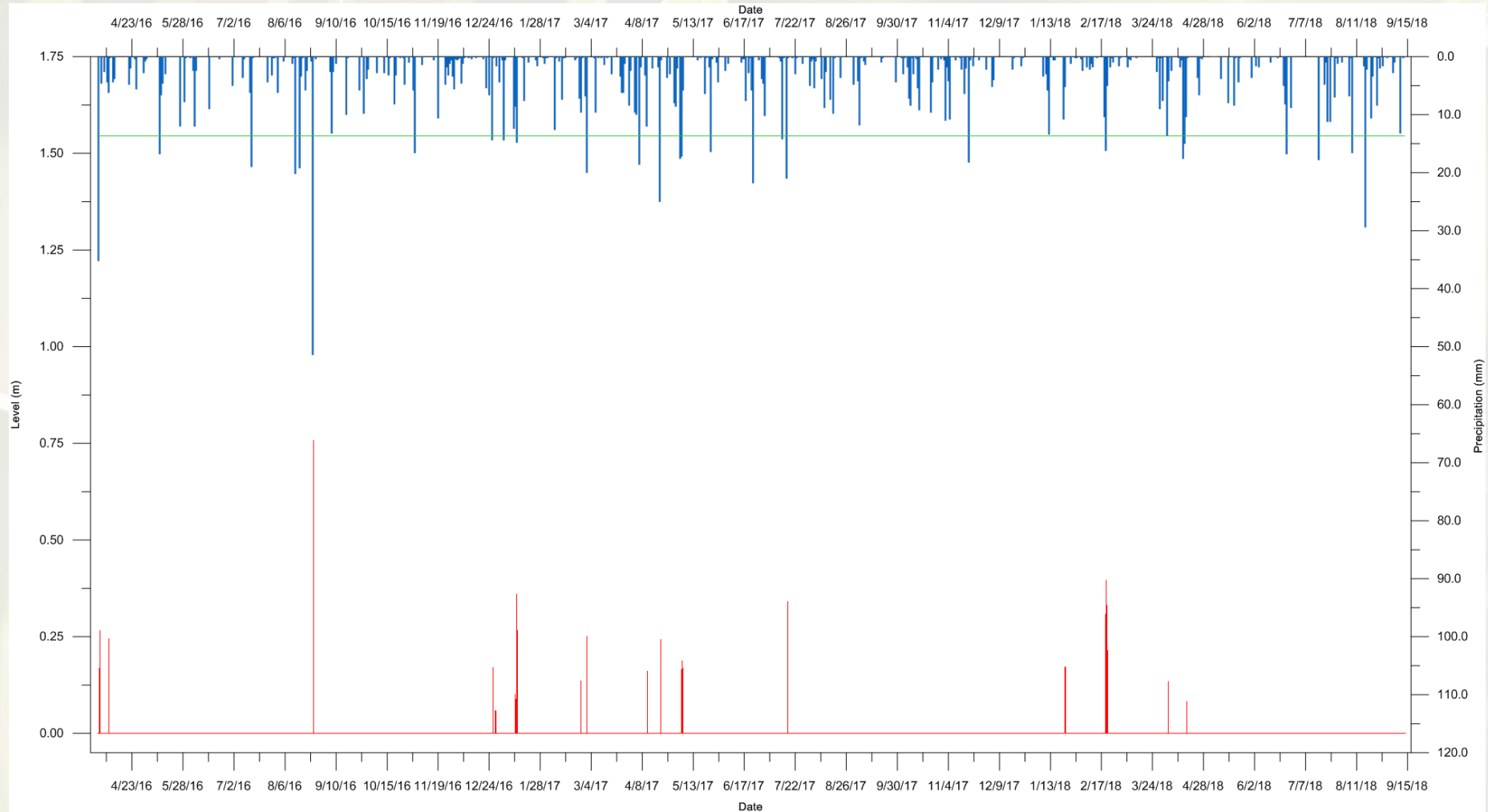
BENCHMARK
BENCHMARK ID:
LOCAL BENCHMARK:

5.	
4.	
3.	
2.	ISSUED FOR TENDER
1.	FOR CITY REVIEW
NO.	REVISION

Monitoring Well



HNA - Monitoring Program



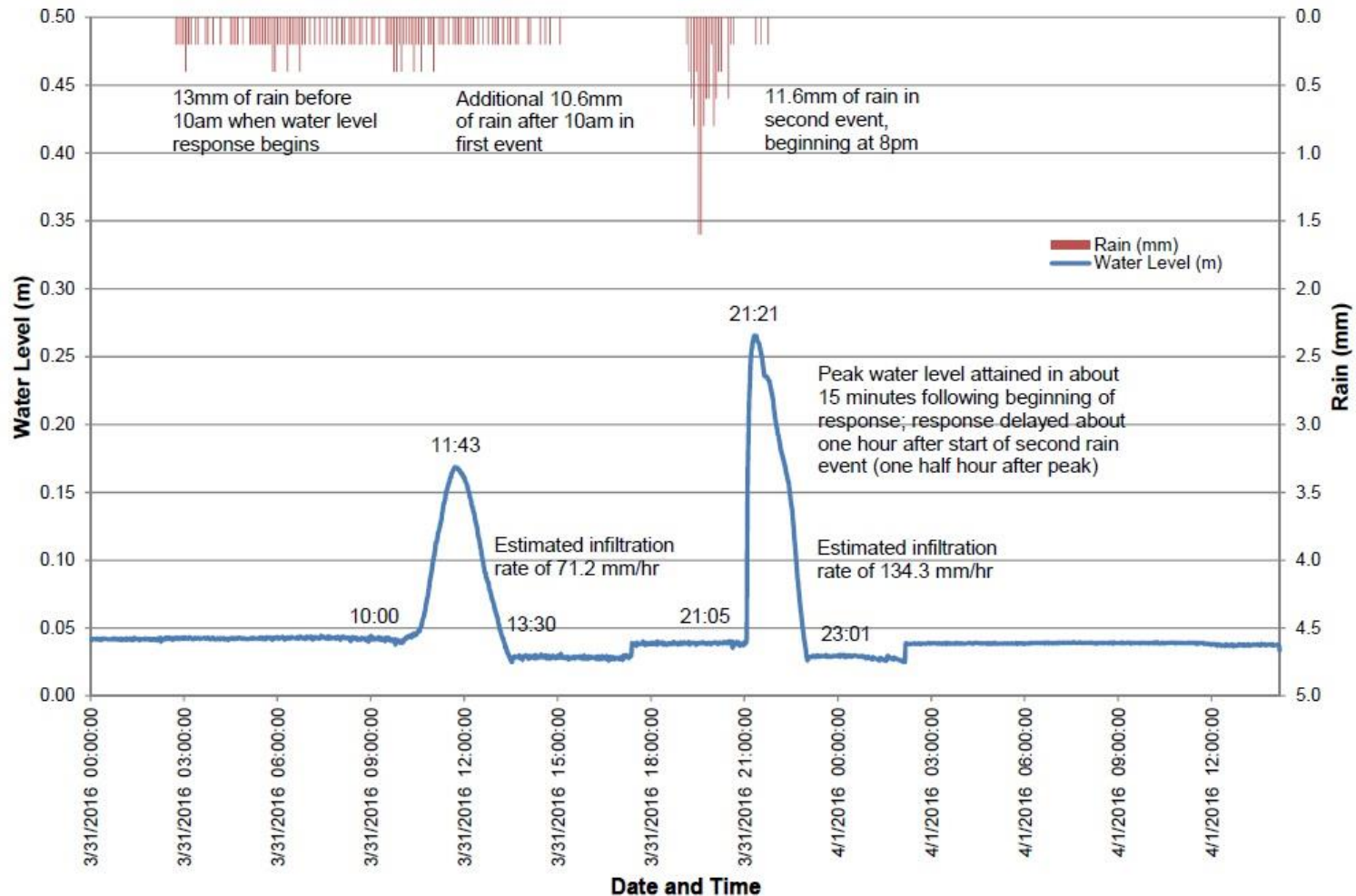
— Level (m)
— Precipitation
— Estimated Parking Lot Elevation

Huron Natural Area Hydrograph
Stormwater Management Monitoring Program 2018
Kitchener 2018 Surface Water Monitoring
Kitchener, Ontario

HNA - Monitoring Program



Huron Natural Area Permeable Paver Lot - March 31 Event Monitoring Log



LID Cost / Ha Suitable metric?



HNA Total Project Cost = \$105,831

Drainage Area (parking lot surface area only) = $550\text{m}^2 = 0.055\text{ha}$

Extrapolated Cost to construct 1 ha
= \$1,924,200

Approx 2mil / ha!!

This is really the cost of building a parking lot, road, garden etc.

The incremental cost of the LID relative to a conventional parking lot, road, garden etc. is the metric of interest

Material and Labor Costs: Permeable Pavers vs Asphalt with SWM



HNA LID Material Costs	
Item	Costs (Tender)
Geotextile - Mirafi RS 380i	\$960
Filter Fabric - 270R	\$522
Gran O	\$19,758
ASTM No. 8 (5-6mm Chip Stone)	\$1,755
ASTM No. 57 (20mm Clear Stone)	\$2,430
Excavation	\$7,500
Permeable pavers	\$32,086
LID Cost from Tender (includes labour)	\$65,011

Similar Asphalt Parking Lot with OGS	
Item	Costs (estimated)
Granular A + B	\$9,089
Asphalt (HL3)	\$5,338
Asphalt (HL4)	\$5,569
MH & CB (1)	\$5,500
CB Leads	-
Storm Sewer	\$12,000
Excavation	\$3,750
OGS	\$35,000
Asphalt Cost (estimated)	\$76,247

LID Cost / Ha

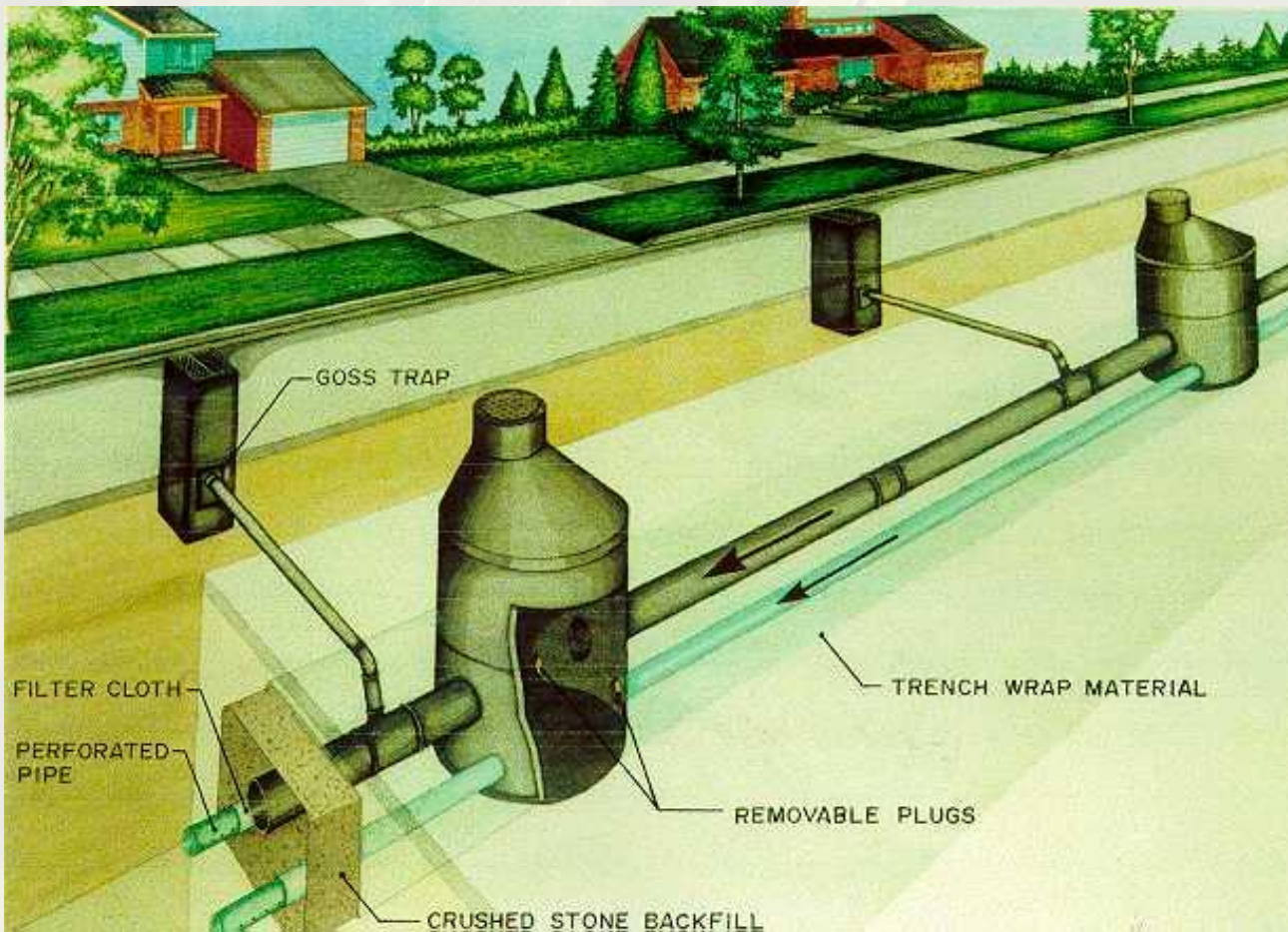


- LID measures can be designed to accept drainage from adjacent impervious surfaces
- The more impervious area that is directed to a BMP the less the cost / ha

Designers should maximize the area draining to an LID to the limit of the recommended I / P ratio to reduce the LID cost / ha

LID type	Hypothetical Cost to Construct 1 ha	Suitable I / P ratio	Acceptable Drainage area (ha)	Cost / ha	Cost %
Permeable pavers	\$2,000,000	close to 1:1	1.25	\$1,600,000	100
Bioretention	\$2,000,000	10:1	10	\$200,000	12.5
Exfiltration trench	\$2,000,000	20:1	20	\$100,000	6.25

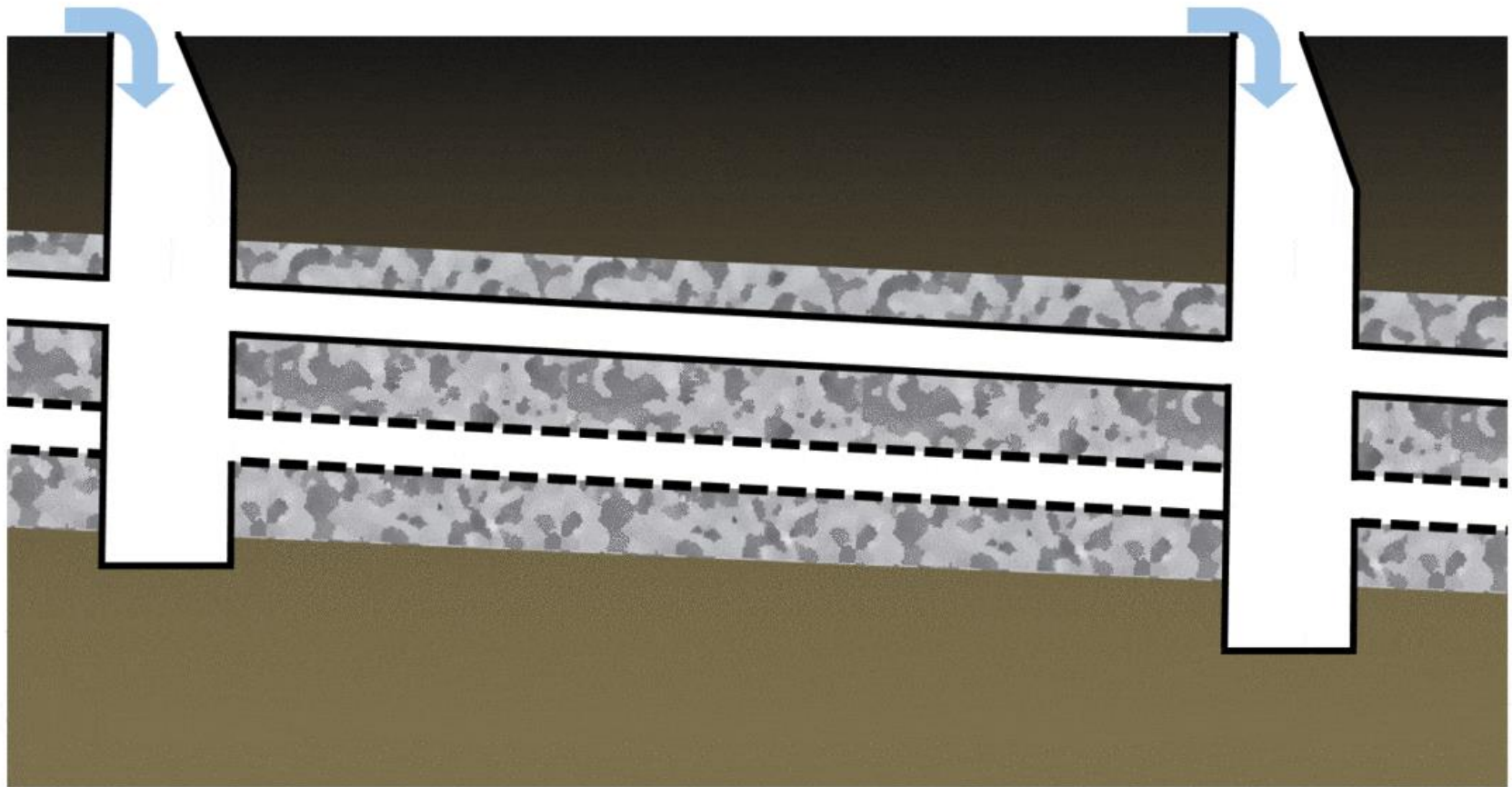
Etobicoke Exfiltration Trench



Exfiltration trench/
perforated pipe has
good performance in
proportion to
construction cost

Cost efficiencies on
road reconstruction
projects (excavation,
site prep. etc.)

Easy to maximize I/P
ratios



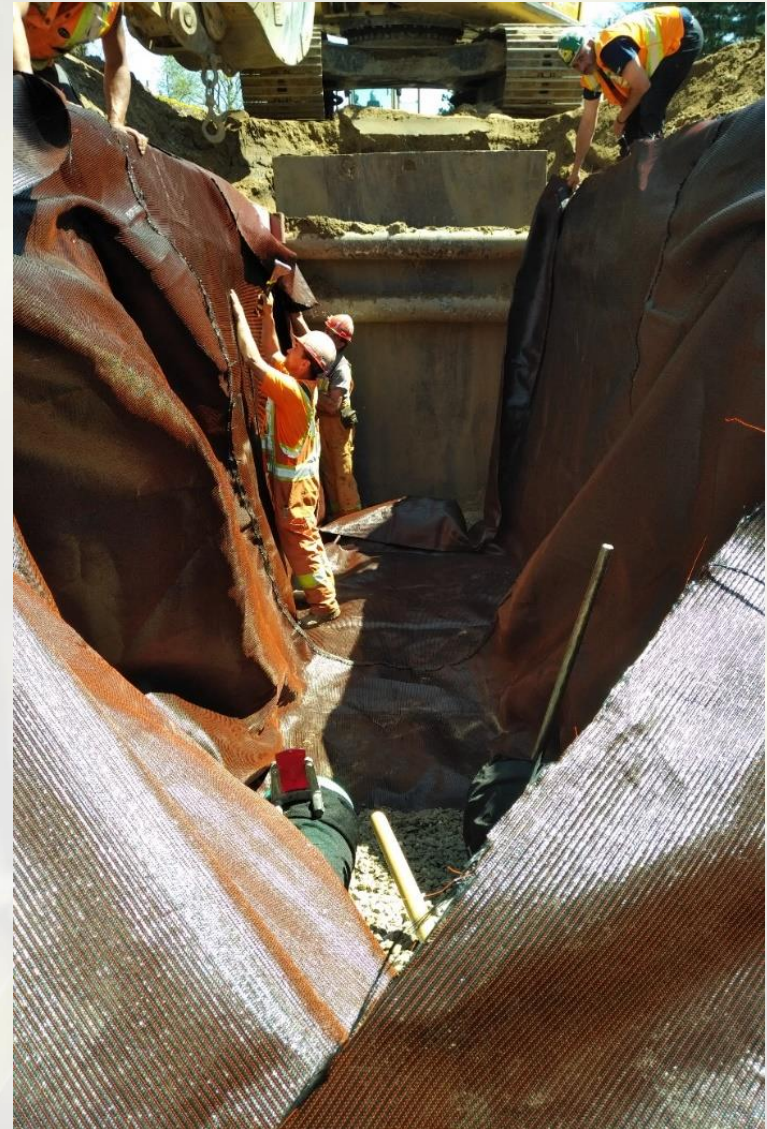
Separated Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



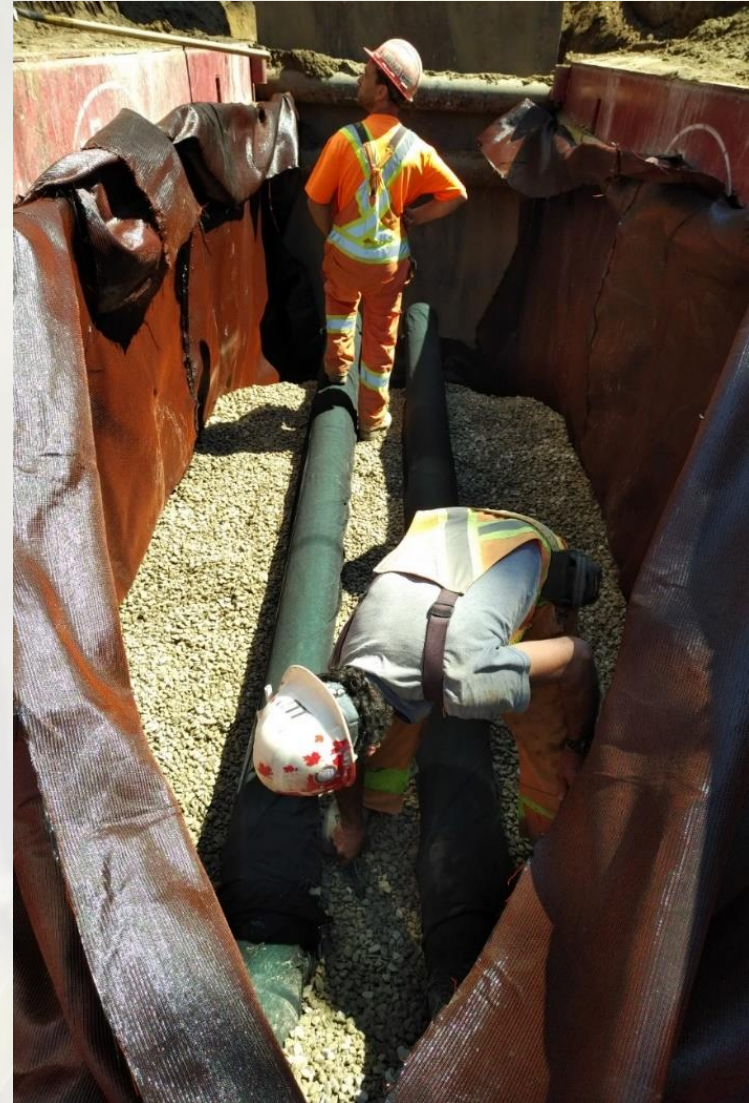
Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



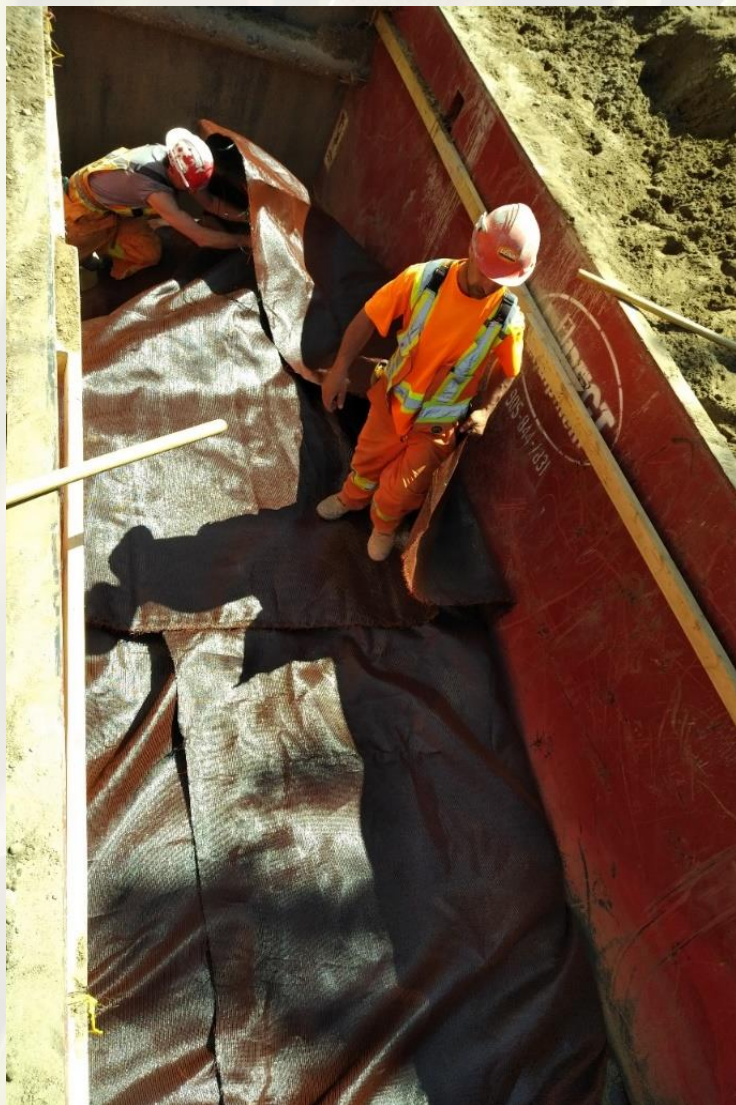
Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



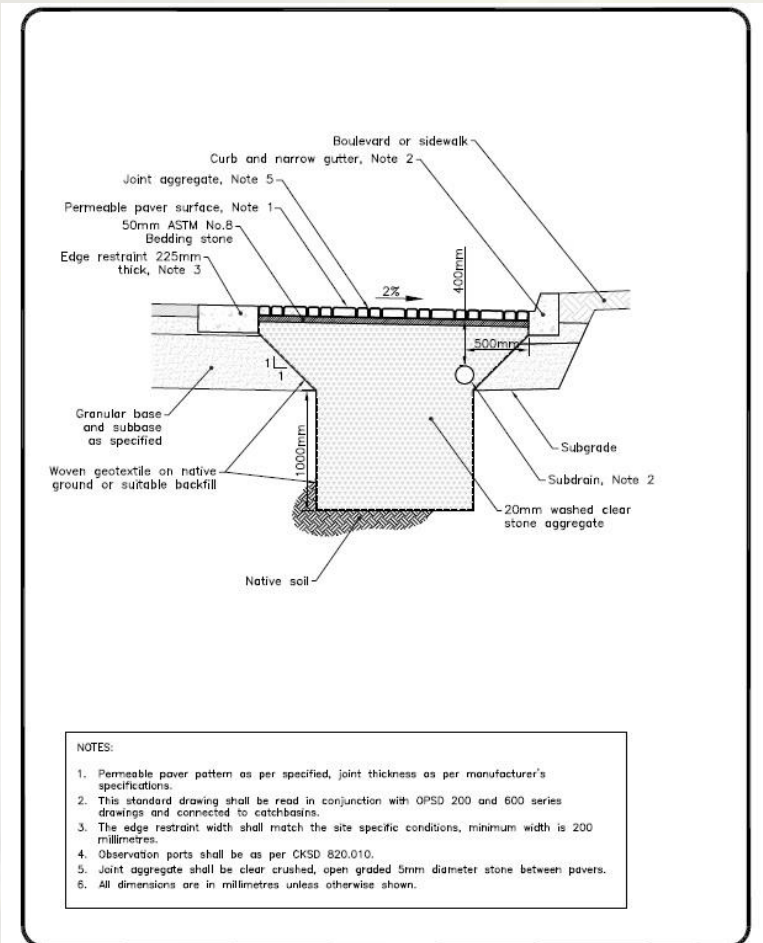
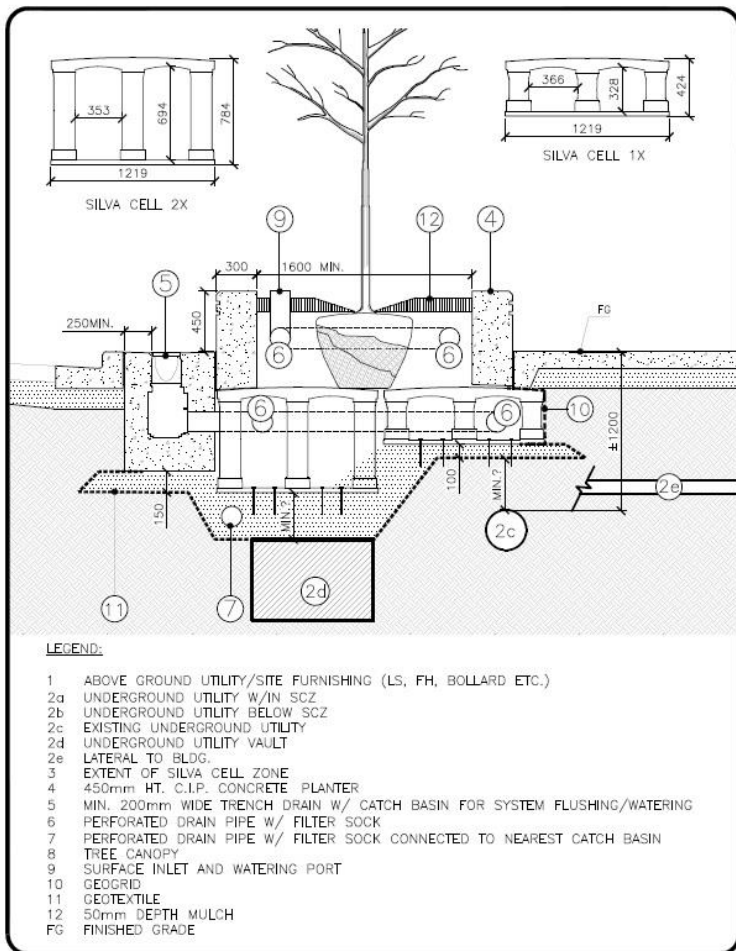
Etobicoke Exfiltration Trench Hill / Hillview / St. Vincent



Permeable Concrete Guelph Street



COK Standard LID Drawings

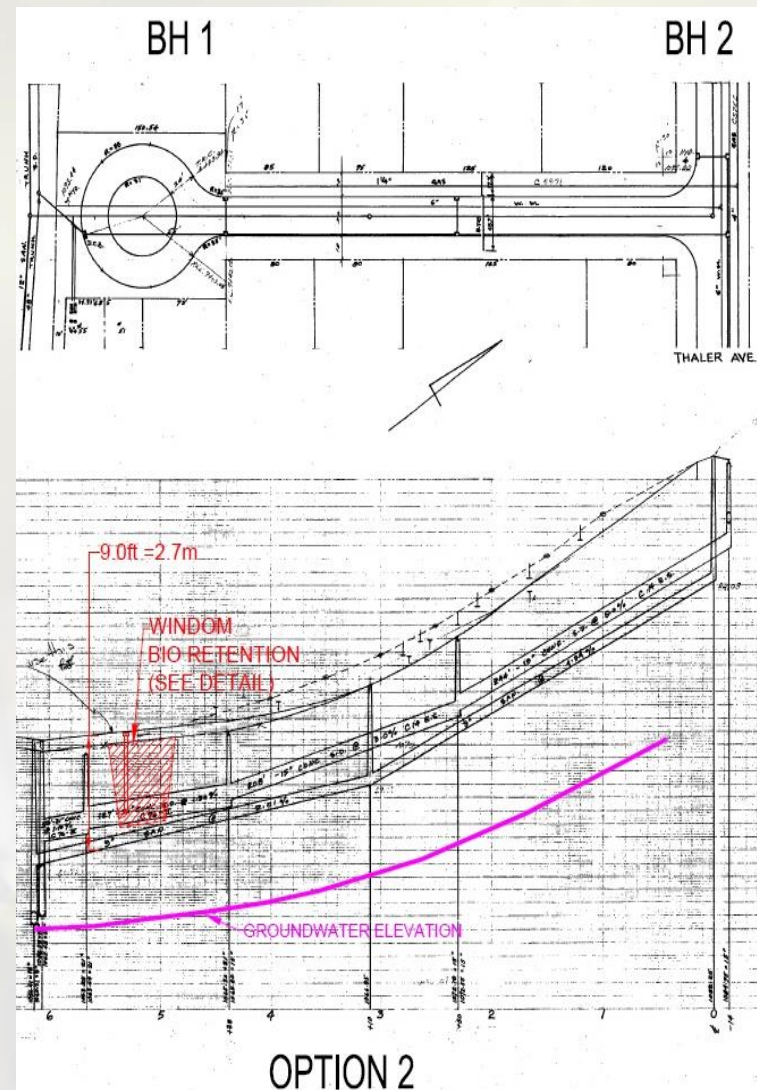
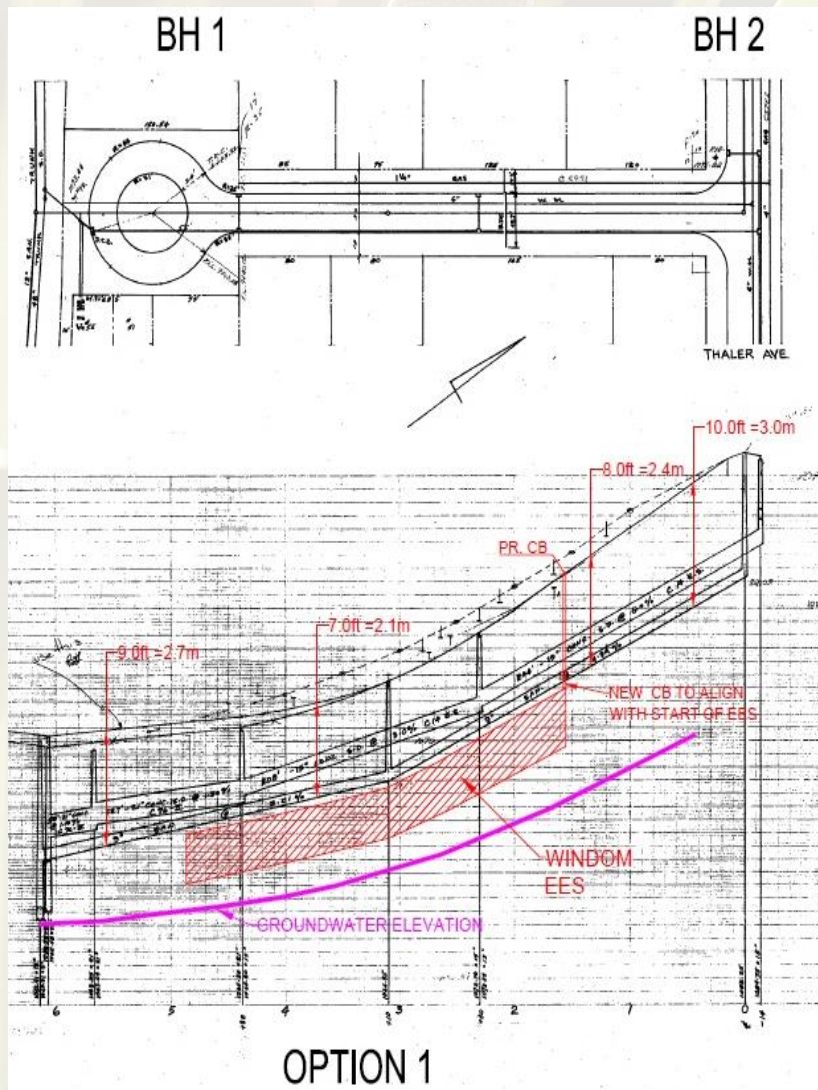


Kitchener Right of Way LID projects (year of construction)

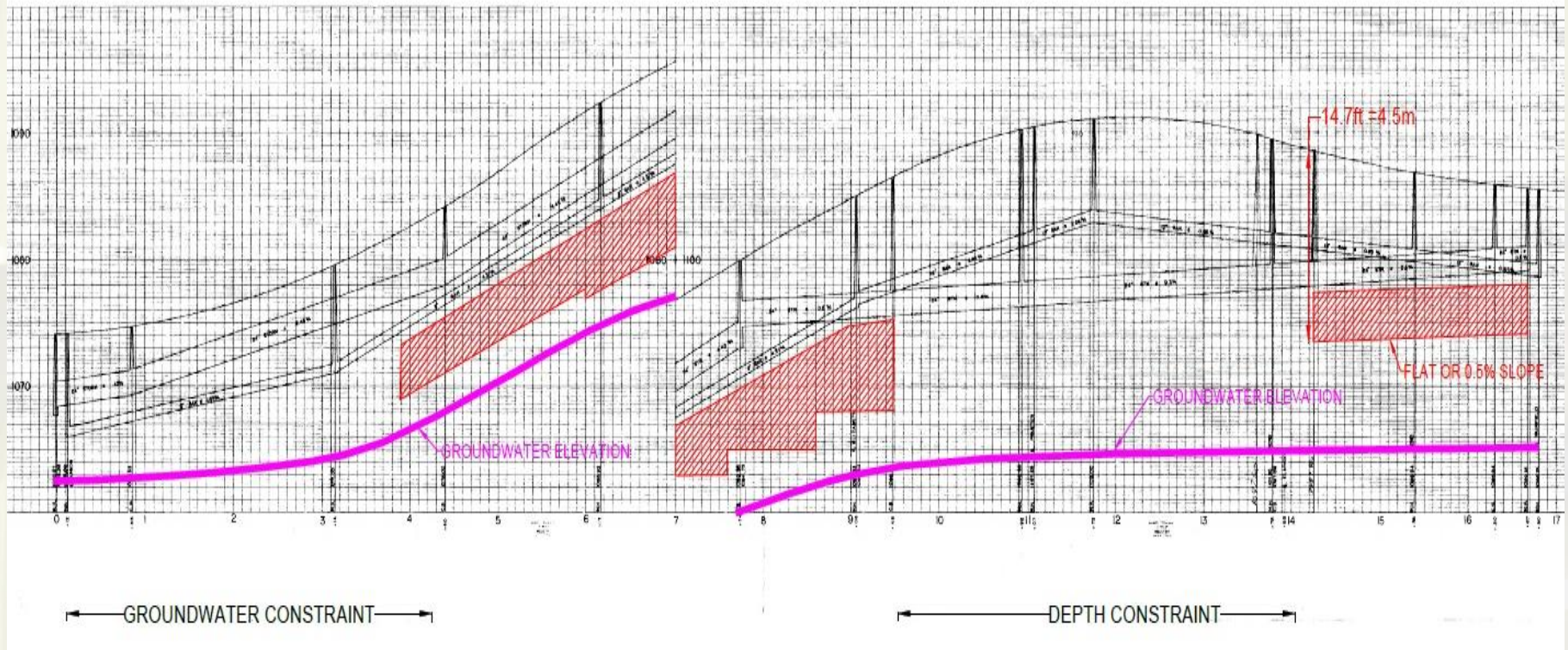


2017 / 2018 (Constructed)	2019	2020	2021 (In house LID Feasibility and Conceptual Design Reports)
Adelaide / Patricia / Talbot (Combined EES)	Ahrens Street (Silva Cells)	Heiman St / Mill (Design 2019)	Becker St
Oxford / Elizabeth / Bond (Combined EES)	Franklin	Hebel/Peter (Design (2019)	Boehmer / Valewood (EES and Bioretention)
Hill / Hillview / St. Vincent (Separated EES)	Dunham st	Hoffman (Design 2019 - Boulevard Exfiltration)	Cambridge St
Dieppe / Hett (Boulevard Bioretention)	Sheldon Ave	Ephraim / Ethel	Wayne Dr
Guelph St (Porous Concrete Laybys)	Krug st	Centerville (Separated EES and Boulevard Exfiltration)	Delta / Sydney / Maurice
	Fairmount	Shantz Lane	Fergus Ave
			Floyd St
			Pattandon Ave
			Thaler / Windom (EES and bioretention)
			Englewood / Guelph St
			Sydney

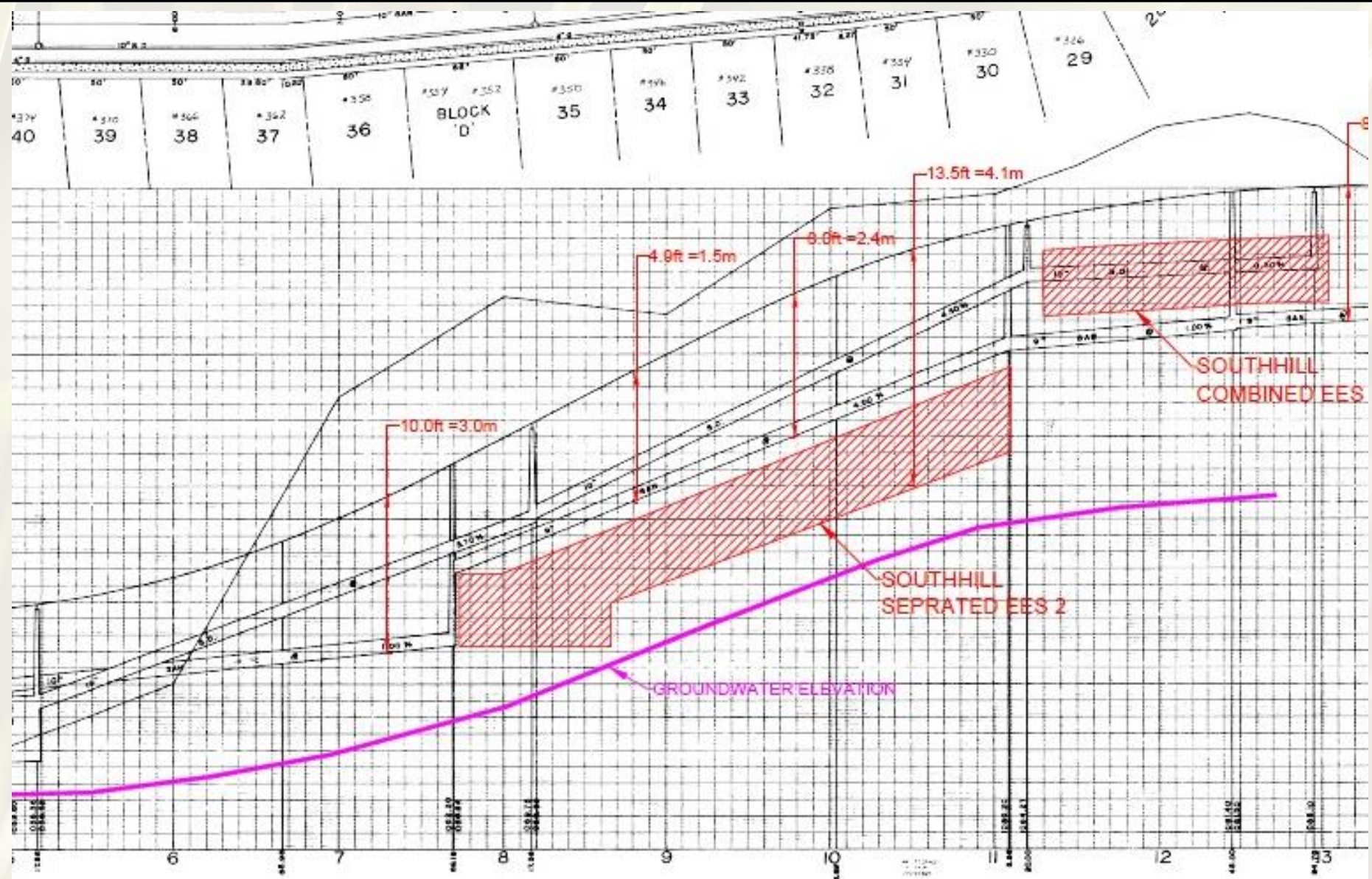
Thaler / Southill / Windom LID Feasibility and Conceptual Design Report



Boehmer / Valewood LID Feasibility and Conceptual Design Report



Combined vs Separated EES



2018 LID Costs for ROW Projects



Road	LID type	LID length (m)	Total LID Cost (\$)	Savings (\$)	Unit Costs (\$/m)
Guelph	Porous parking laybys	225m of parking bay	119,408	22,002	433
Patricia	Exfiltration system	393m of perf. pipe	299,072	46,015	640
Hillview	Exfiltration system	257 m of perf. pipe	208,511	28,780	700
Oxford	Exfiltration system	171 m of perf. pipe	90,830	13,008	455
Dieppe	Bioretention Boulevard	6 bio cells (210m)	40,000	6,000	171
Hett	Exfiltration system	171 m of perf. pipe	61,984	9,297	308

2018 LID Costs for ROW Projects



Road	LID Type	Total Road Reconstruction Cost (\$)	LID Cost (\$)	Incremental Cost (%)
Guelph	Porous concrete parking laybys	3,117,444	100,081	3
Patricia	Combined Exfiltration system	5,566,372	253,056	5
Hillview	Separated Exfiltration System	3,708,587	179,730	5
Oxford	Combined Exfiltration system	2,558,311	77,822	3
Dieppe	Bioretention Boulevard	761,834	36,000	5
Hett	Combined Exfiltration System	825,320	52,687	6

2018 LID Costs for ROW Projects



Road	Drainage area to LID (ha)		Cost / Ha Treated (\$)	
	ROW	Total Area	ROW only	Total Area
Guelph	0.375	0.99	\$266,882	\$101,091
Patricia	1.7	12.7	\$150,000	\$20,000
Hillview	0.59	3.09	\$304,627	\$58,156
Oxford	0.11	0.99	\$707,472	\$78,608
Dieppe	0.167	0.666	\$215,568	\$54,054
Hett	0.096	0.456	\$550,000	\$115,541

Summary of 2018 LID Costs for road reconstruction Projects



- City of Kitchener LID implementation costs on road reconstruction projects:
 - \$400/m
 - 3-5% of a road reconstruction project
 - \$250,000/ha ROW area treated
 - \$75,000/ha total area treated (not full treatment)
 - LID costs will come down over time
 - Cost SWM Ponds: \$20k to \$60K / ha of land treated

Private Development Stormwater Development Charges



- SWM Control Fee previously applied to water quality targets:
 - Started in 2001 at \$15,000/ha
 - 2009 study determined \$25,000/ha too low
 - Fee increased by 25% until 2016
 - Current fee is \$98,605/ha
- SWM Control Fee now applied separately to both water quality and retention targets
 - Evolution in the application of the fee for large sites, small projects etc.

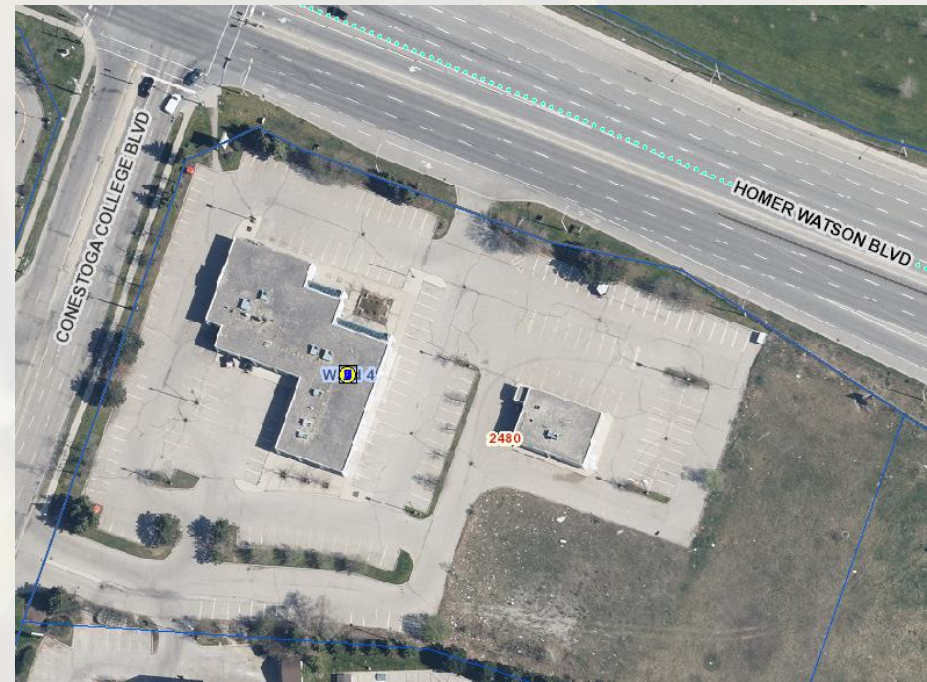
Homer Watson Site Redevelopment



- Re-Development: Addition to existing restaurant, new gas station, restaurant and retail building (1.77 ha site area)
- OGS sized to achieve water quality criteria: SWM fee not required for water quality
- Rooftop infiltration galleries provided 8.75mm of treatment for the site area (12.5mm required by COK policy) : SWM fee required for retention

SWM Fee calculations:

- SWM Fee (Retention only) = \$96,670 / ha
- $\$96,670 \times 1.77 \text{ ha} = \$171,106$
- $8.75\text{mm}/12.5\text{mm} = 0.7$
- 70% of the retention target achieved
- so 30% of the SWM fee required
- $\$171,106 \times 0.3 = \$51,332$
- SWM fee reduced by = \$119,774
- Cost to build infiltration gallery = ~\$85,000



Concluding Remarks



- City of Kitchener has a Council Approved line item for LID integration into road reconstruction projects
- Budget constraints - full lifecycle costs of LID integration are unknown
- Pilot projects will help to determine these
- Standard drawings, specifications, tender quantities for LID have largely been developed
- When compared to conventional stormwater practices alone an integrated stormwater management approach will:
 - Improve environmental conditions
 - Be more cost effective
 - Have lower maintenance burdens
 - Protect property and infrastructure during extreme storms

Thank you!



*The more you pave...
the more you pay*

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