Sustainable Technologies
EVALUATION PROGRAM

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Making green infrastructure mainstream: building the business case for widescale green stormwater infrastructure

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The water component of STEP is a collaborative of:

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature

Toronto and Region Conservation Authority

Overview

STEP is a multi-agency initiative developed to support broader implementation of sustainable technologies and practices within a Canadian context.

The water component of STEP is a conservation authority collaborative. Current partners are:

Lake Simcoe Region conservation authority

Credit Valley Conservation inspired by nature

Toronto and Region Conservation Authority

Our key areas of focus are:

- Low Impact Development
- Erosion and Sediment Control
- Road Salt Management
- Natural Features Restoration

Agenda

- Welcome and introductions
- Project background
- Overview of *Making Green Infrastructure Mainstream*

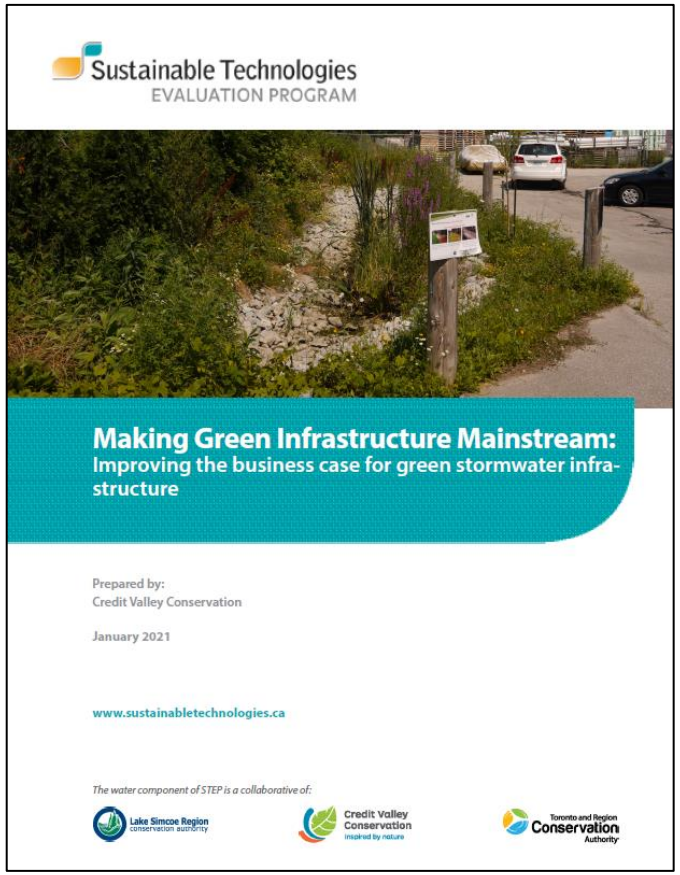
Project Context and Support: Natural Resources Canada (NRCAN) Climate Change Adaptation Fund (2018)

- Objectives:
  - Assess financial and technical feasibility of implementing communal LID systems on aggregated private lands (legacy development)
  - Develop guidance and highlight best practices on improved processes for implementation and business case development for green stormwater infrastructure

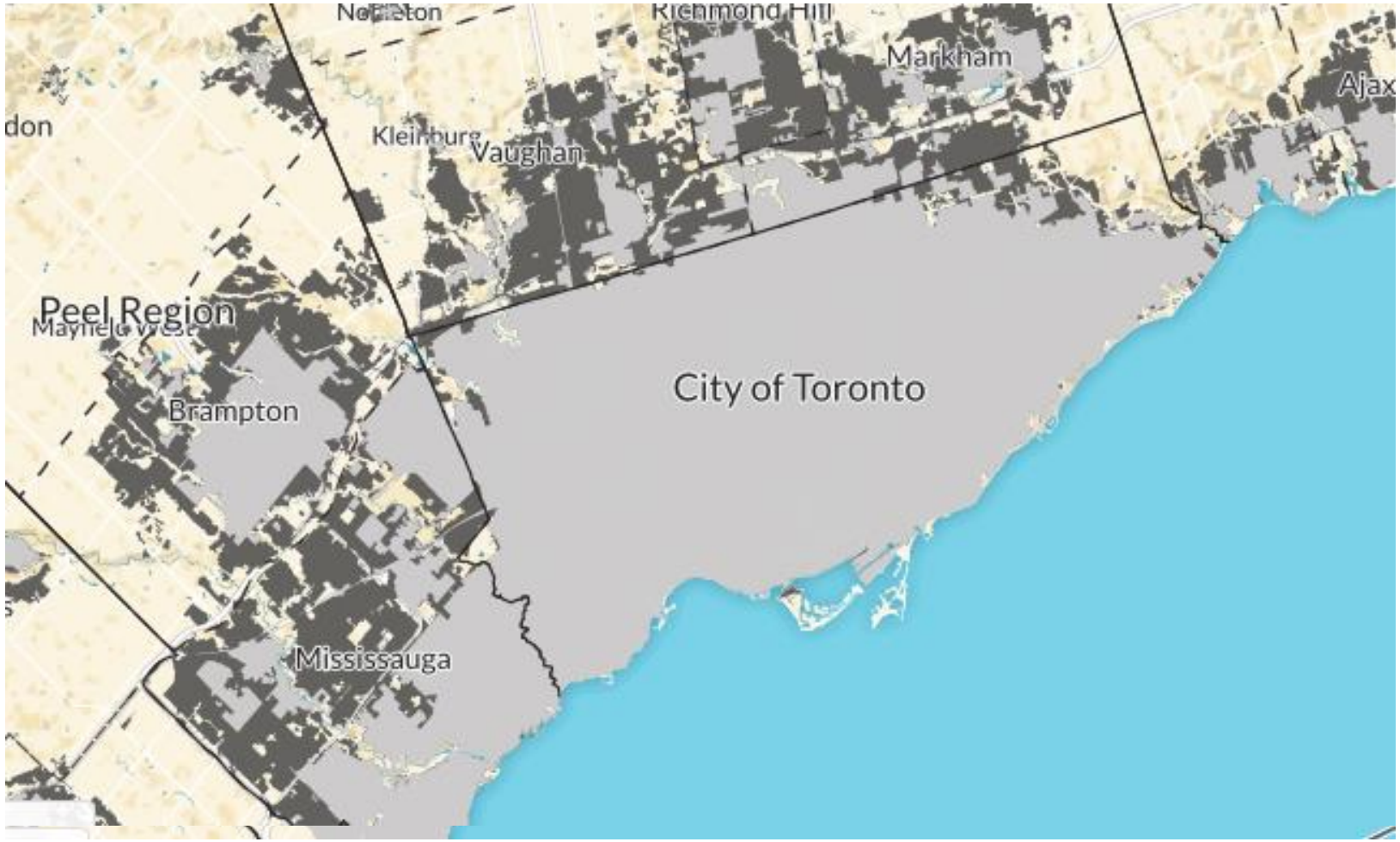
- Outputs:
  - Update to STEP's LID Lifecycle Costing Tool (2019)
  - Recommendations to City of Mississauga's Southdown District Stormwater Servicing and Environmental Management Plan
  - Guidance document: *Making Green Infrastructure Mainstream: improving the business case for green stormwater infrastructure*

Making Green Infrastructure Mainstream

- Features four case studies:
  - City of Kitchener
  - City of Vancouver
  - City of Edmonton
  - Southdown Study



The problem: legacy stormwater infrastructure



Source: Neptis Geoweb (2020)

Outcomes: combined sewer overflows and urban flooding

Credit: Marcel Cretain

Credit: James Matthews

Outcomes: erosion

Outcomes: urban stream syndrome

Symptoms of urban stream syndrome include “a flashier hydrograph, elevated concentrations of nutrients and contaminants, altered channel morphology, and reduced biotic richness, with increased dominance of tolerant species” (Walsh et al., 2005).

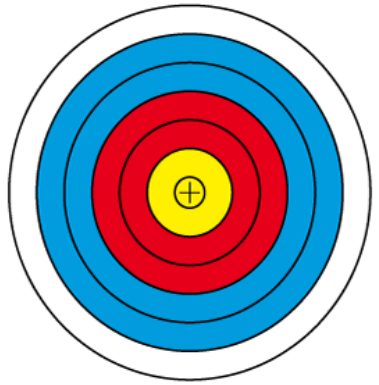
Green Stormwater Infrastructure


Source: USEPA


Source: ADS

Building a business case in the public sector

Business case: a financial, economic, or scientific justification for public investment in a project to realize “specific outcomes in support of a public policy objective” (Government of Canada, 2020).



Common Themes: Key Findings Overview

Systematic Approaches

Flexibility and multi-functional infrastructure

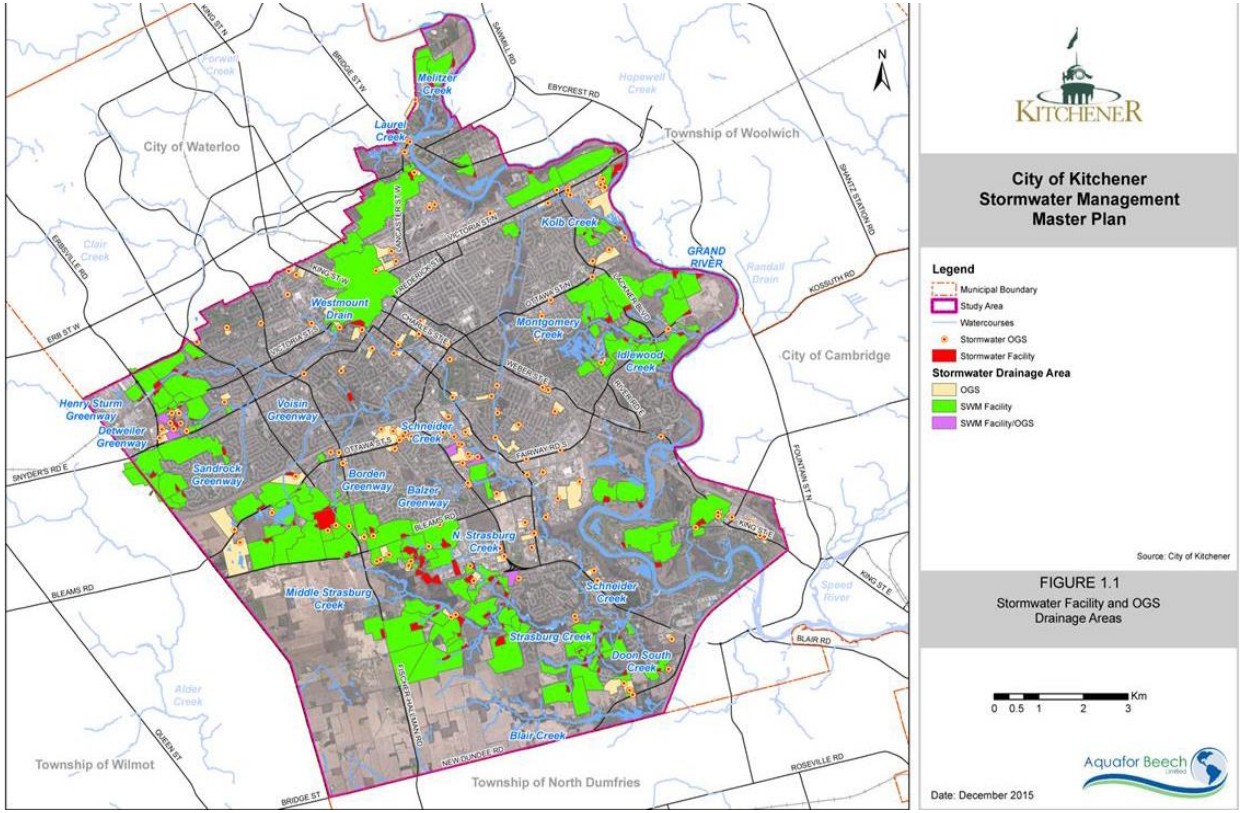
Building Economies of Scale

Bridging Public-Private Divide

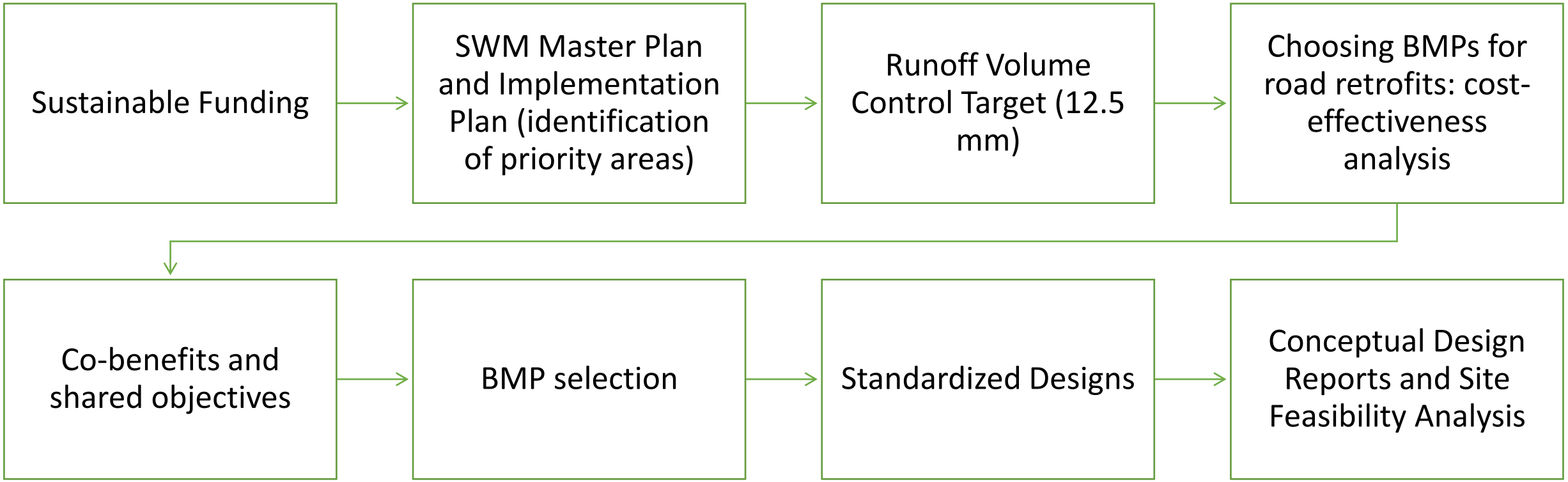
Co-benefits and shared objectives

City of Kitchener

Kitchener Case Study



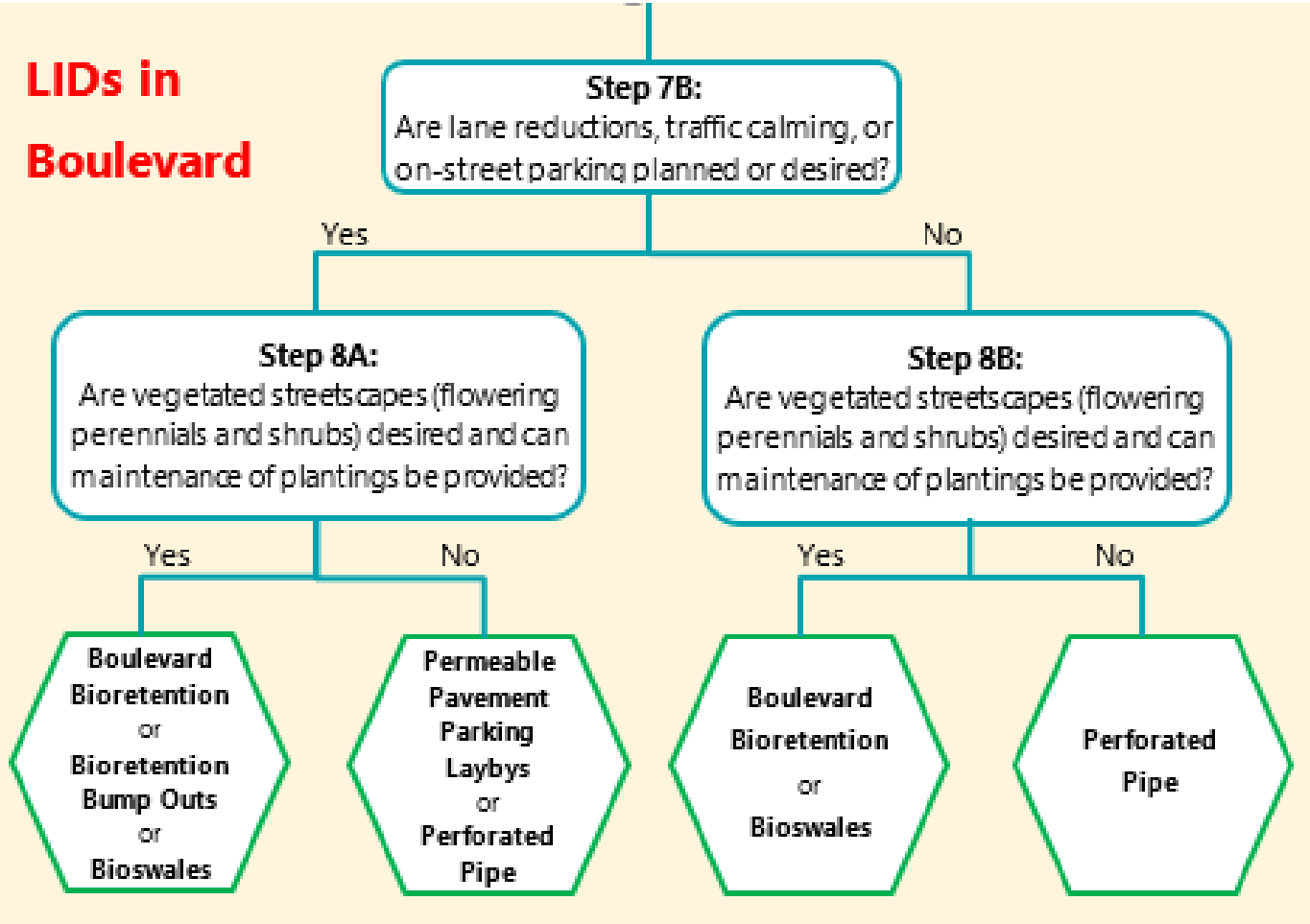
Systematic approach: moving beyond pilot projects

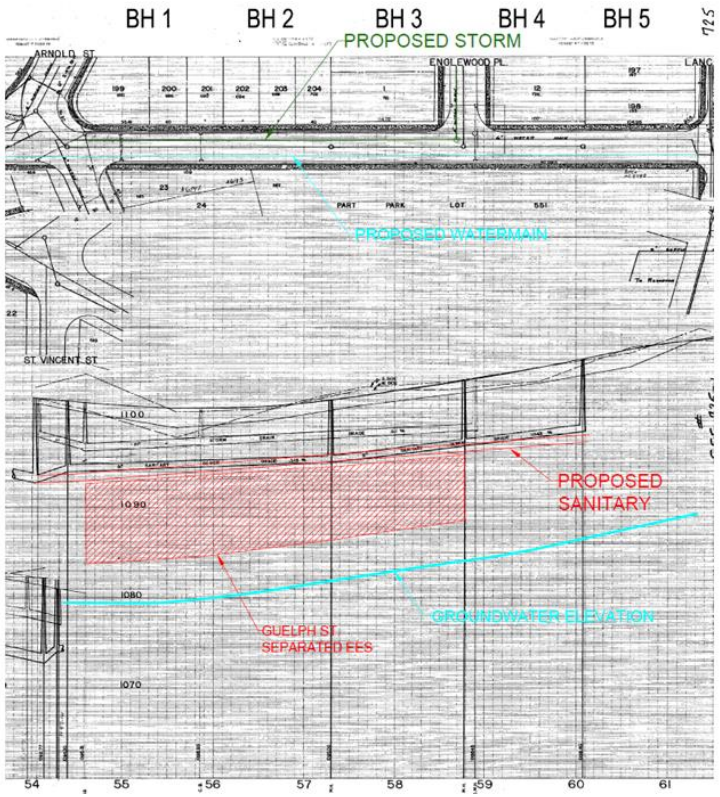


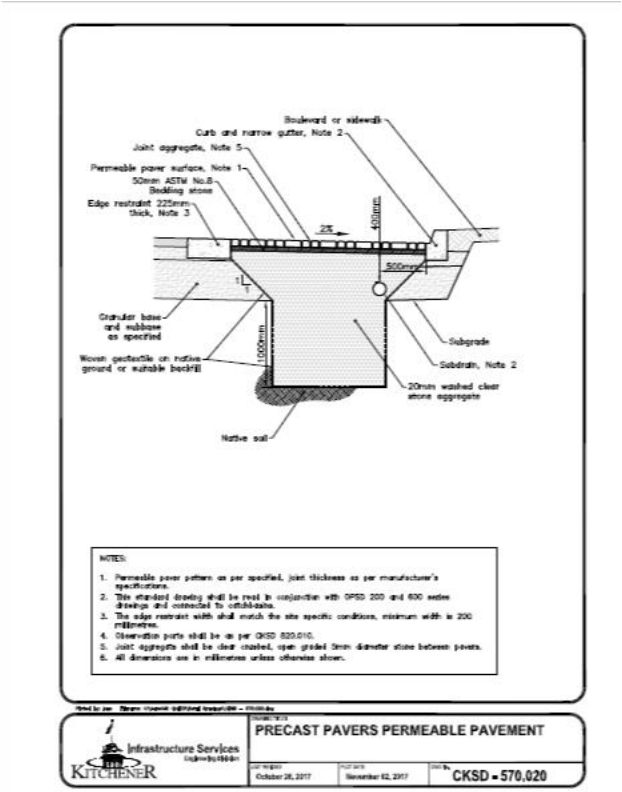
Systematic approach: cost effectiveness analysis

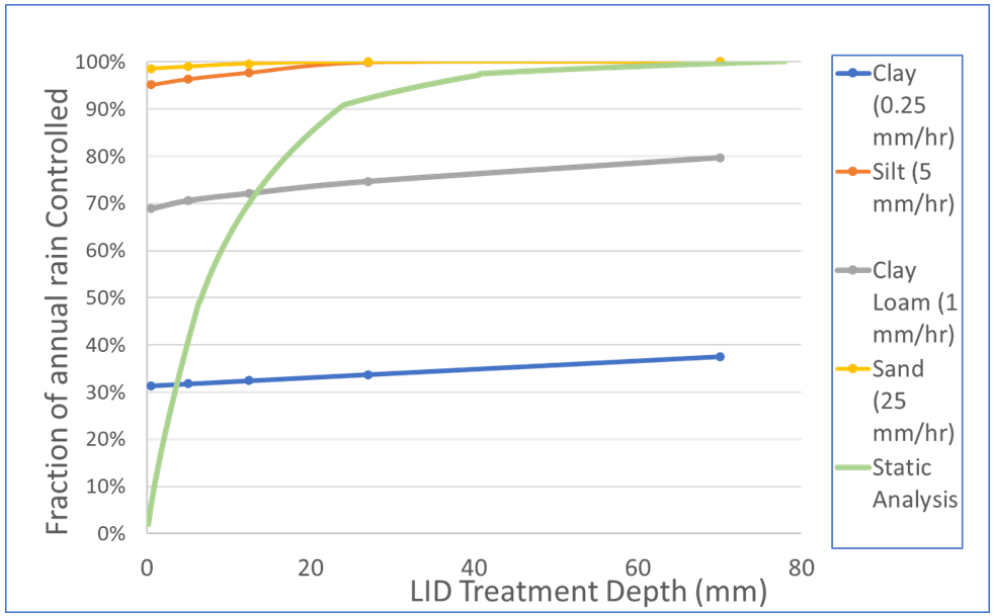
GSI type	Hypothetical cost to construct 1 ha ($ millions)	Suitable I/P ratio	Acceptable drainage area (ha)	Cost per ha ($ millions)	Cost (%)
Permeable pavers	2.0	close to 1:1	1.25	1.6	100
Bioretention	2.0	10:1	10	0.2	12.5
Exfiltration trench	2.0	20:1	20	0.1	6.25

Co-benefits and shared objectives







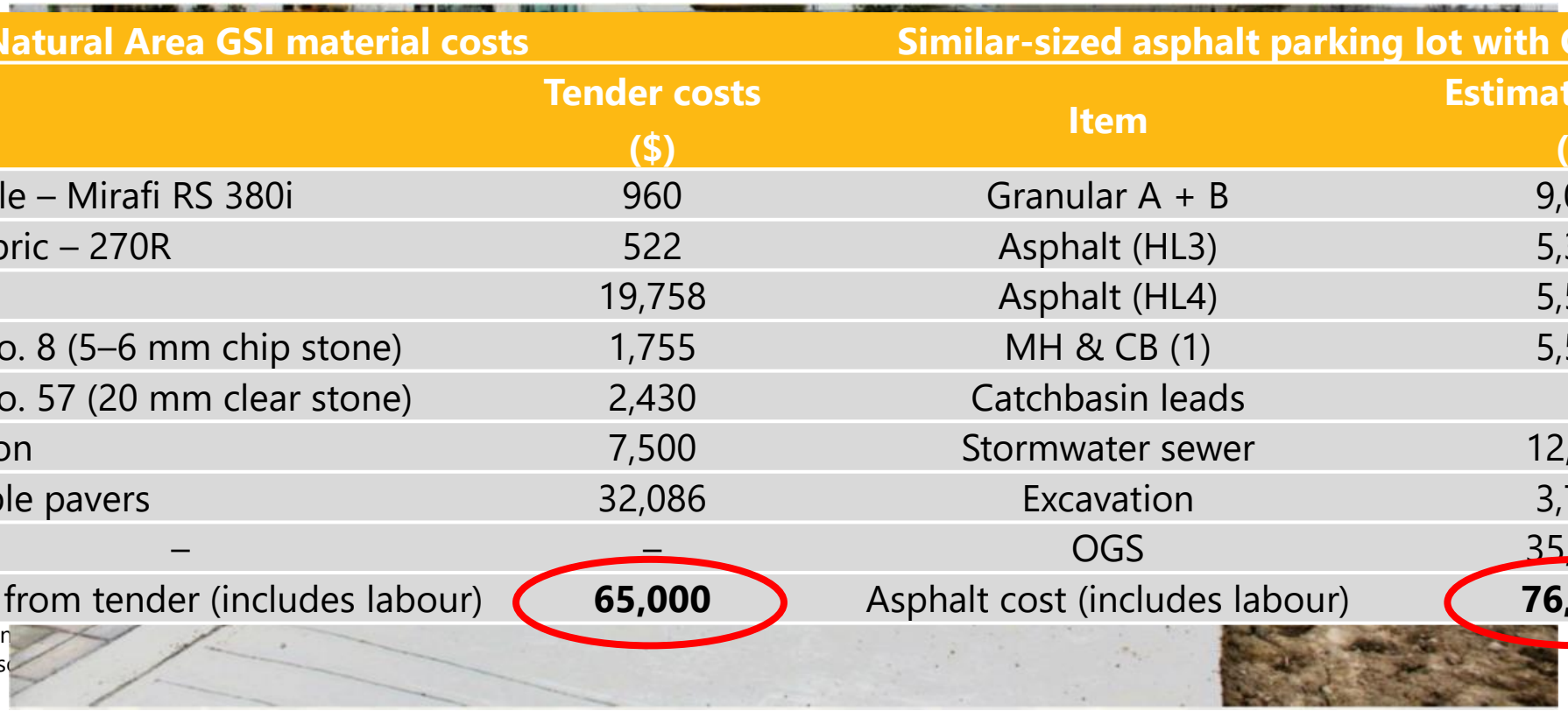


Systematic Approach: Standardized Designs, GSI Sizing, Conceptual Design and Site Feasibility Reports

Flexibility and multi-functional infrastructure: grey vs green

Huron Natural Area GSI material costs		Similar-sized asphalt parking lot with OGS	
Item	Tender costs ($)	Item	Estimated costs ($)
Geotextile – Mirafi RS 380i	960	Granular A + B	9,089
Filter Fabric – 270R	522	Asphalt (HL3)	5,338
Gran O	19,758	Asphalt (HL4)	5,569
ASTM No. 8 (5–6 mm chip stone)	1,755	MH & CB (1)	5,500
ASTM No. 57 (20 mm clear stone)	2,430	Catchbasin leads	–
Excavation	7,500	Stormwater sewer	12,000
Permeable pavers	32,086	Excavation	3,750
–	–	OGS	35,000
GSI cost from tender (includes labour)	**65,000**	Asphalt cost (includes labour)	**76,200**

Abbreviation
Source: Wils



Building economies of scale: incremental cost increases

Road	GSI type	Total cost of road reconstruction ($)	Total GSI cost ($)	Traditional SWM cost ($)	GSI cost (total GSI cost minus traditional SWM) ($)	Cost increase (%)
Guelph	Porous concrete parking lay-bys	3,117,400	119,400	22,000	97,400	**3**
Patricia	Combined exfiltration system	5,566,400	299,000	46,000	253,100	**5**
Hillview	Separated exfiltration system	3,708,600	208,500	28,800	179,700	**5**
Oxford	Combined exfiltration system	2,558,300	90,800	13,000	77,800	**3**
Dieppe	Bioretention boulevard	761,800	40,000	6,000	34,000	**5**
Hett	Combined exfiltration system	825,300	62,000	9,300	52,700	**6**

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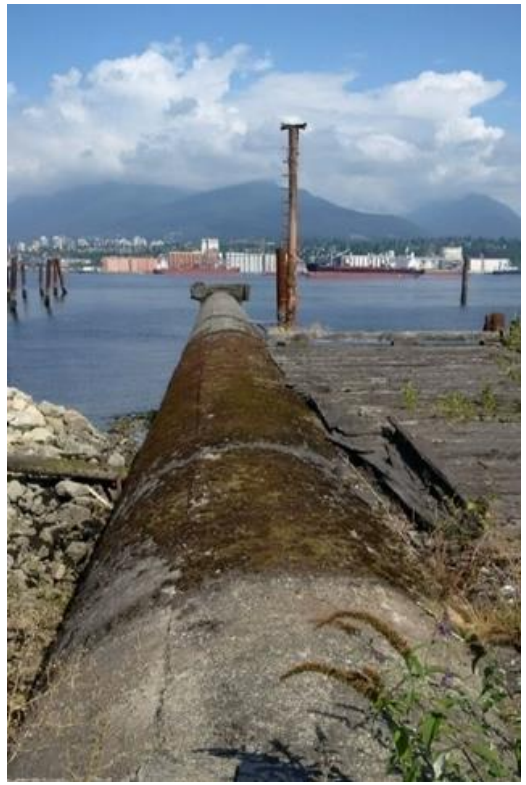
City of Vancouver

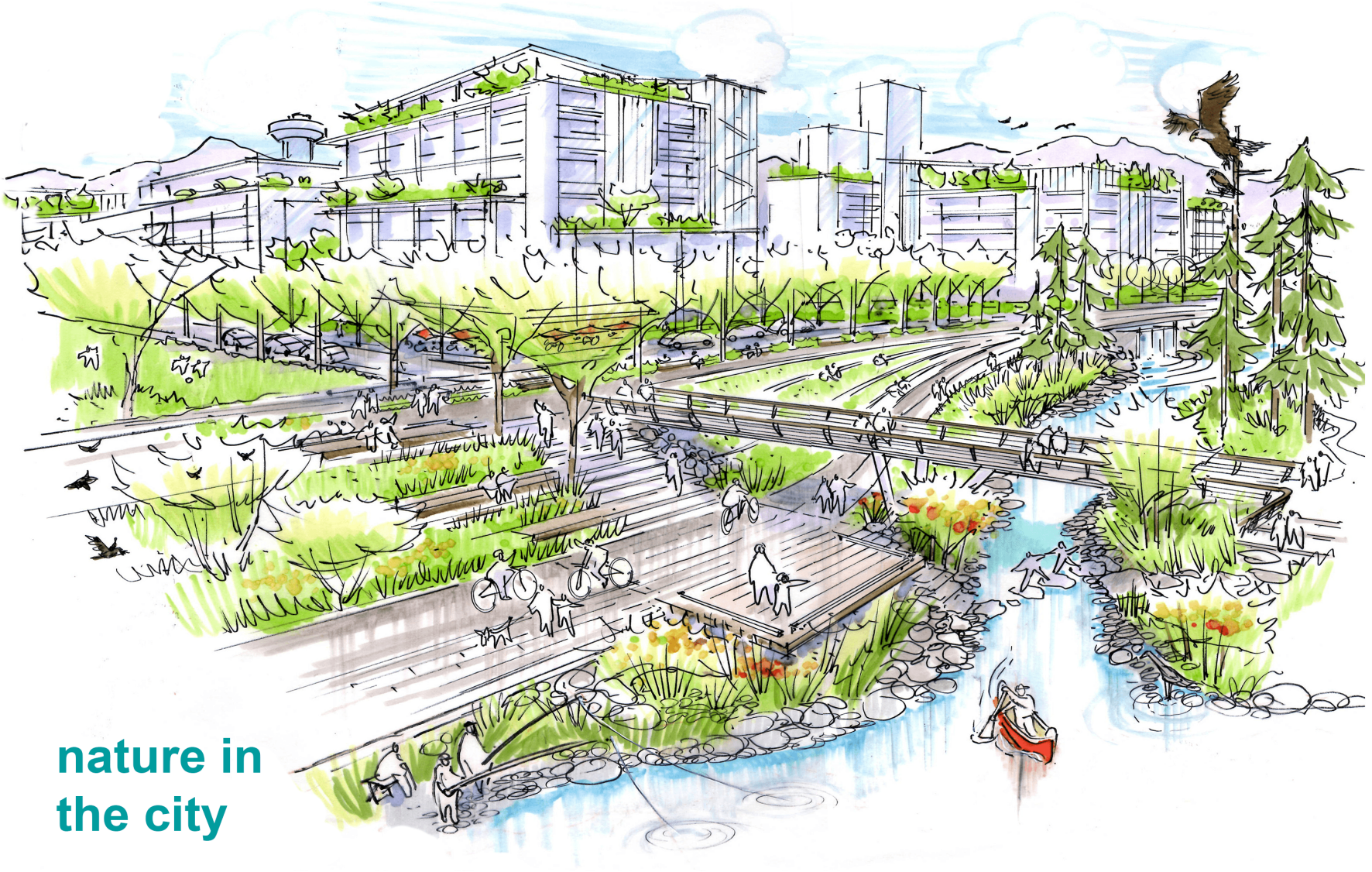
Vancouver Case Study

Highlights:

- Municipal wide 90th percentile RVCT (48 mm)
- Aims to retrofit 40 per cent of Vancouver's impervious surface by 2050
- Primary issue: combined sewer overflows
- $53 M to construct 140 new green infrastructure features between 2019 and 2022 (pre-pandemic)

Aging Infrastructure: billions to Upgrade their Stormwater Infrastructure





nature in
the city

Holistic Approach

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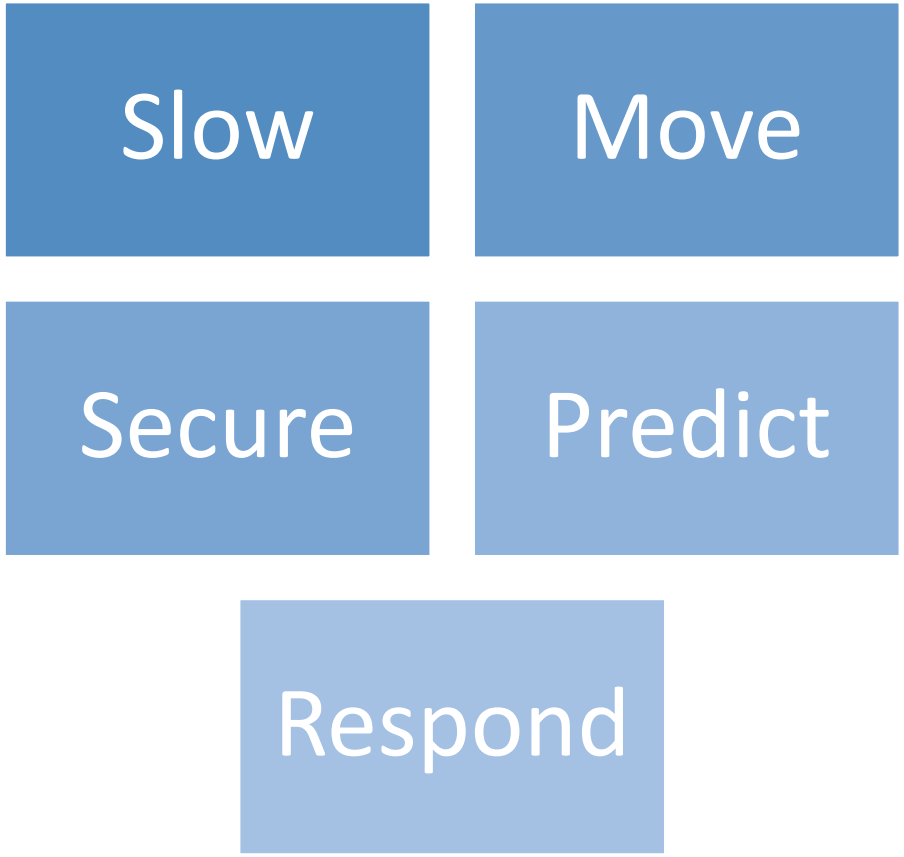
City of Edmonton

EPCOR's Stormwater Integrated Resource Plan (SIRP)

Systematic approaches: SIRP's five themes



- $1.6 billion over 20 years
- $470 million for Green Stormwater Infrastructure

Flexibility of GSI Design and Placement: using GSI for flood-risk mitigation

Photo credit: LSRCA

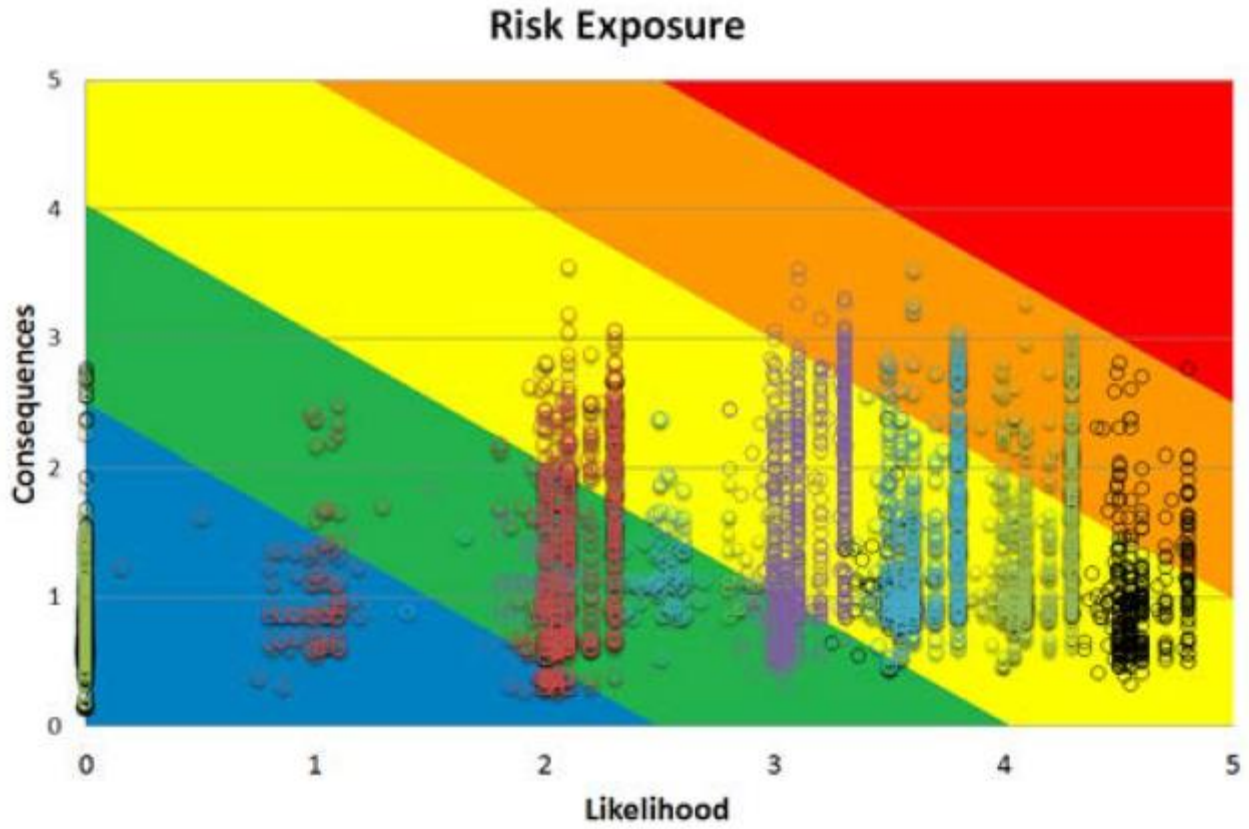
Photo credit: TRCA

Systematic approach: EPCOR's approach to urban food risk assessment

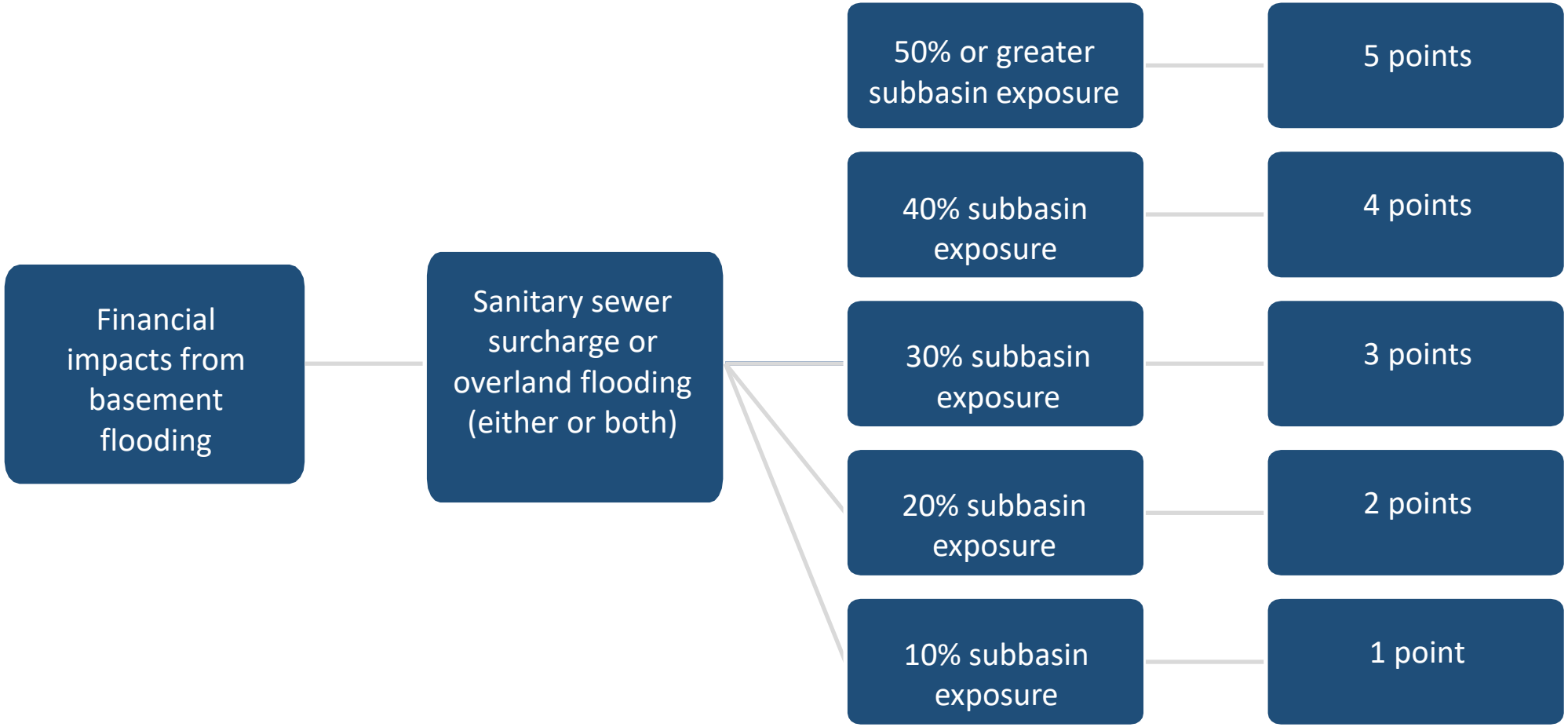
- Purchase of maps from the insurance industry and use of multiple storm scenarios
  - 1:20, 1:50, 1:75, 1:100, 1:200

- Use of four impact categories: health and safety, social, financial, and environmental

Risk ranking Edmonton's 1300 sub-basins



Systematic approach: sample risk ranking methodology: financial category



Public survey: determining priorities

Social

- “Agencies that support homeless or vulnerable citizens are temporarily displaced for upwards of a year and unable to get enough essential services they need such as food, shelter, or addiction/mental health support.”

Environmental

- “The ecosystem (vegetation, insects, and wildlife) in the North Saskatchewan River is killed due to a large amount of chemical pollutant or sewage spilling into it.”

Systematic approach: grey vs green

Climate hazard	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Urban flooding	1:100 year storm impacting 20 km^2	1:100 year storm impacting 5 km^2	1:50 impacting 20 km^2	1:50 impacting 5 km^2
Cost to upgrade (in billions, over 80 years)	$4.6	$2.6	$3.4	$2.2

- $1.6 billion over 20 years
- $470 million for Green Stormwater Infrastructure

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Southdown Study

Implementing Green Infrastructure (GI) on Private Property in Existing Urban Areas

This project is exploring the technical and financial feasibility of implementing communal stormwater management systems on private property

Barriers - Stormwater Management on Private Property

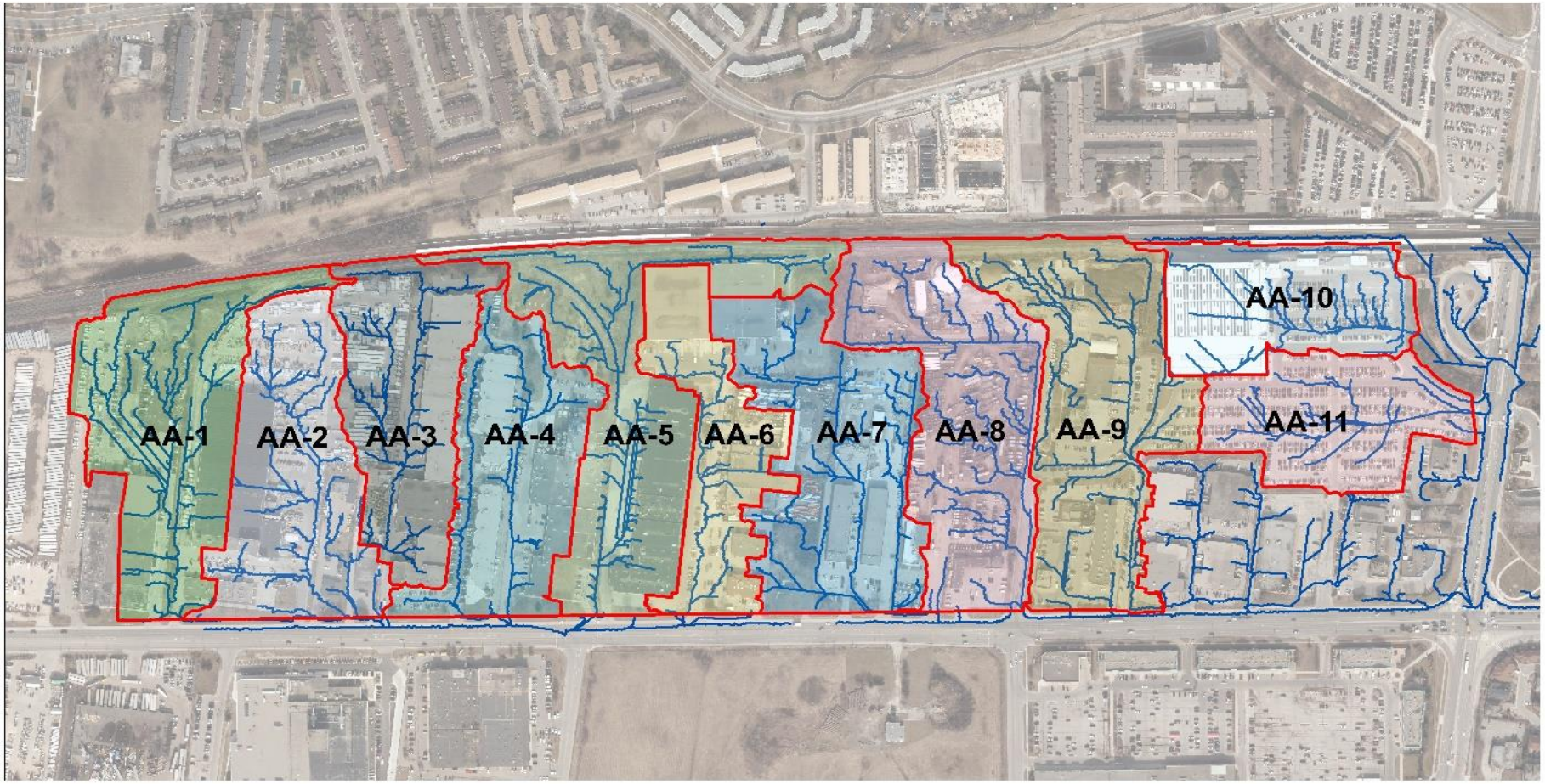
Private Property Owner Barriers

- Cost
- Pay back period for SWM retrofits is poor

Municipal Barriers

- Protecting asset from damages
- Ensuring features are maintained

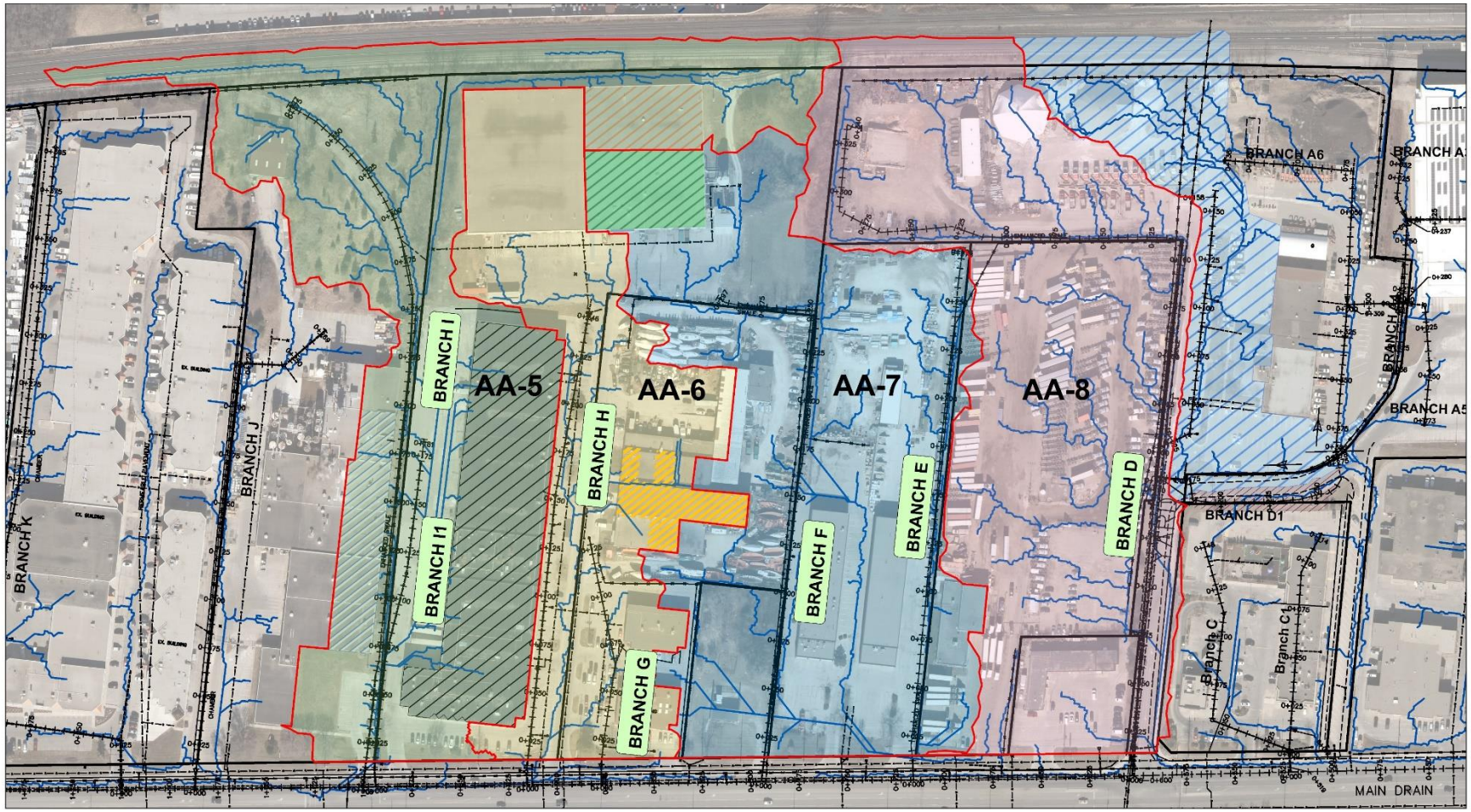
Study Area


AA-1
AA-2
AA-3
AA-4
AA-5
AA-6
AA-7
AA-8
AA-9
AA-10
AA-11
Legend
Major Subcatchment
Overland flow routes
0 50 100 200 Meters

Applying the Drainage Act Process to Southdown Area

- Site Survey/Characterization/Modelling
- Conceptual Design
- Estimating Total Cost
  - Construction, Engineering & Admin, Net HST
  - Allowances (Compensation for existing and proposed assets)
- Types of Assessments (Who is Benefitting?)
- Assessment Schedules (Dividing up the costs)
- Future Operation & Maintenance Schedules
- Engineer's Report (Adopted under By-law)

Drainage Act Convention



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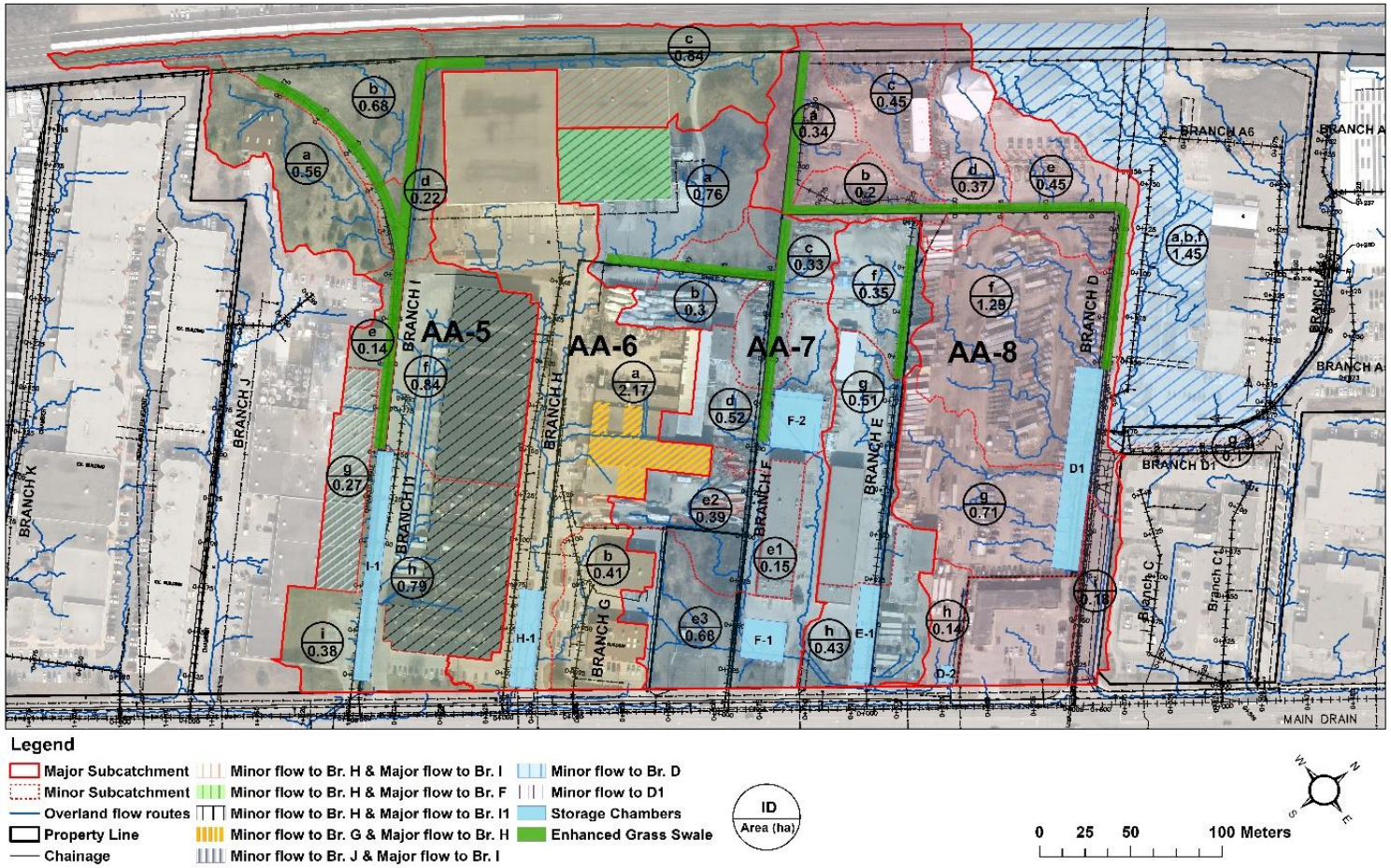
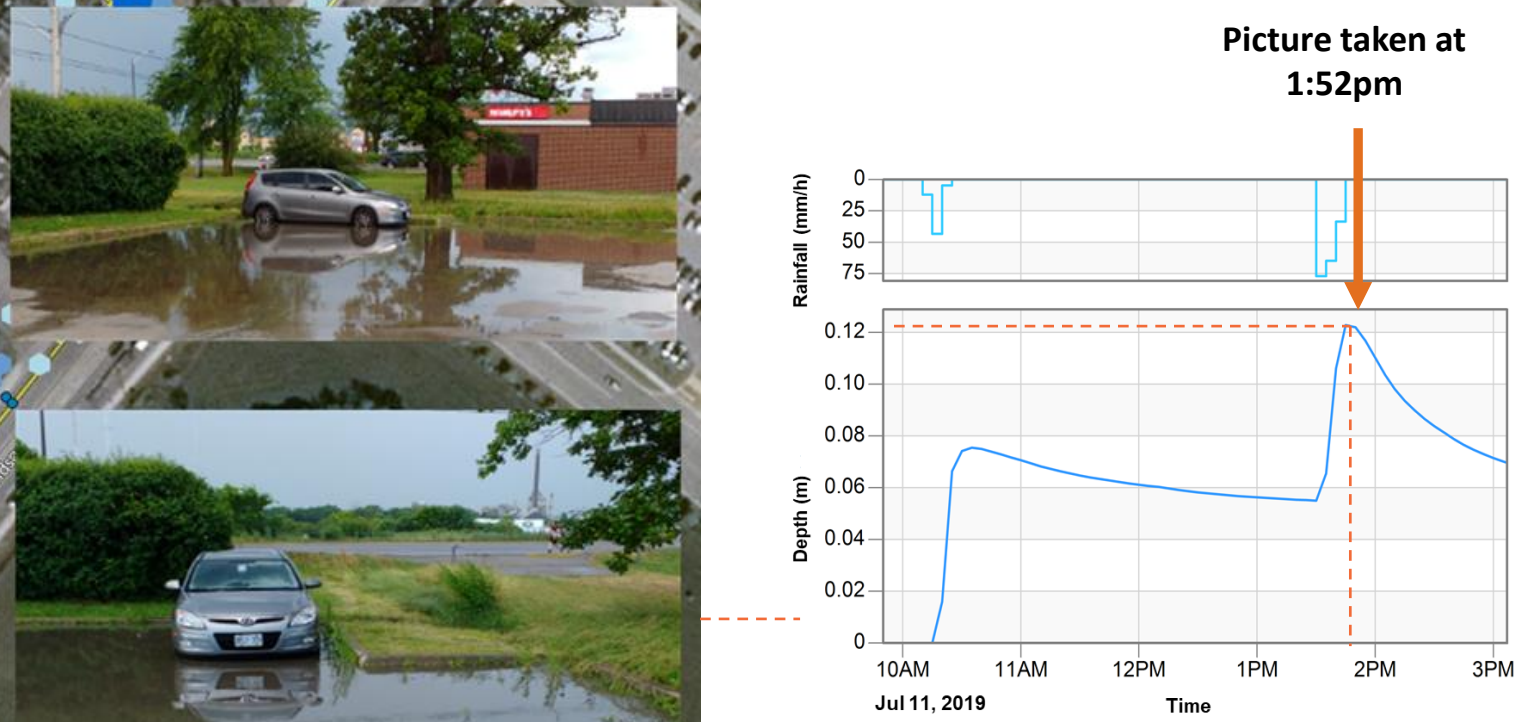
Technical Assessment - Model



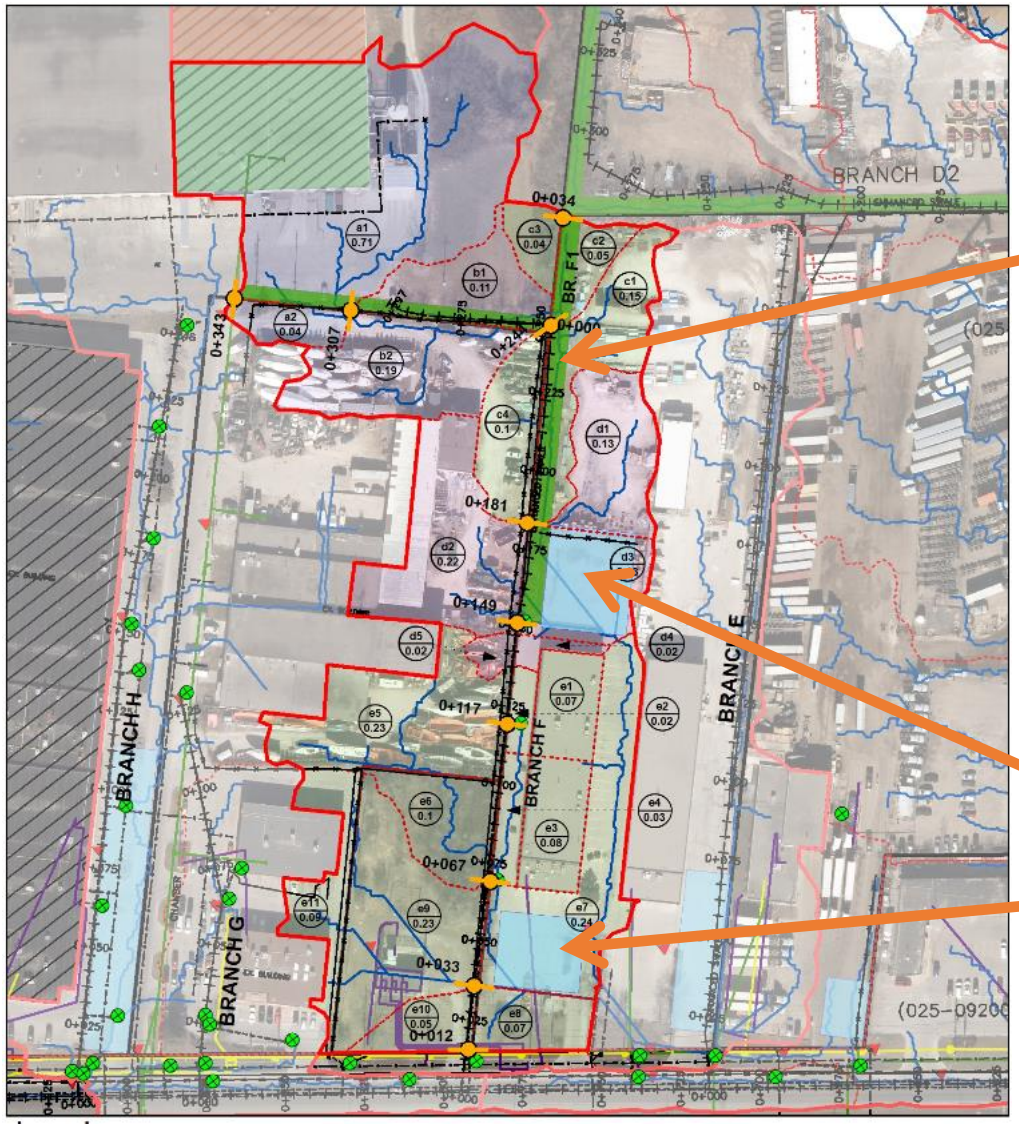
- Pre-development Conditions
- Existing Conditions
- Communal GSI to achieve 50% SWM credit
- End of Pipe

Model Verification



Picture taken at 1:52pm

Branch F



Meet minimum requirements to achieves 50% credit

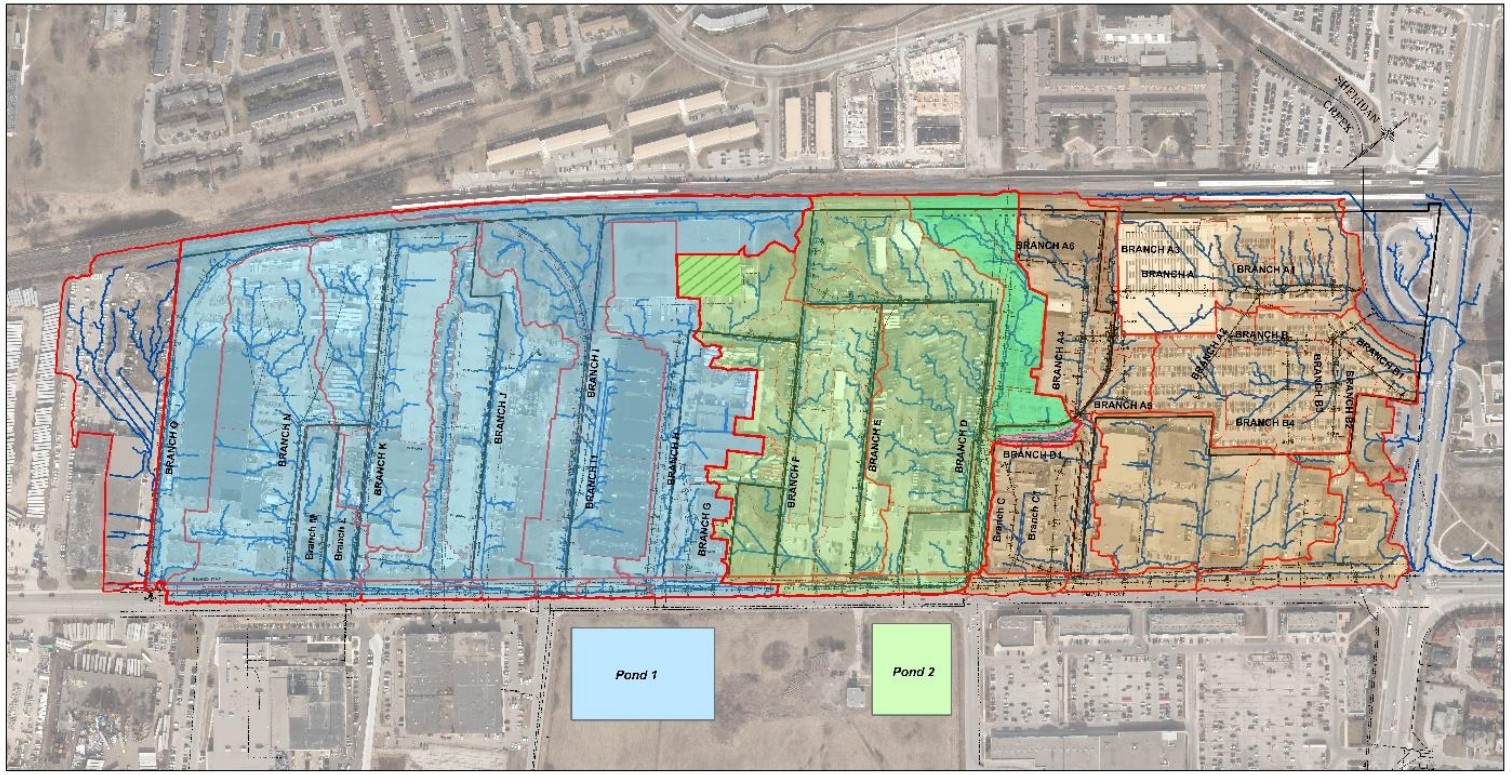
Enhanced Grass Swale + OGS

Underground Storage

Technical and Financial Performance

- 100% Peak Flow Control
- >80% TSS Removal, 40% TP Removal
- 5mm of infiltration over 48 hrs
- $274,000/ha

End of Pipe - Public property scenario



Legend

- Lakeside Creek - Pond 1
- Sheridan Creek - Pond 2
- Major Subcatchment
- Minor Subcatchment
- Overland flow routes
- Property Line
- Chainage
- Minor to Br. H & Major to Br. F
- Minor to Br. D
- Minor to D1

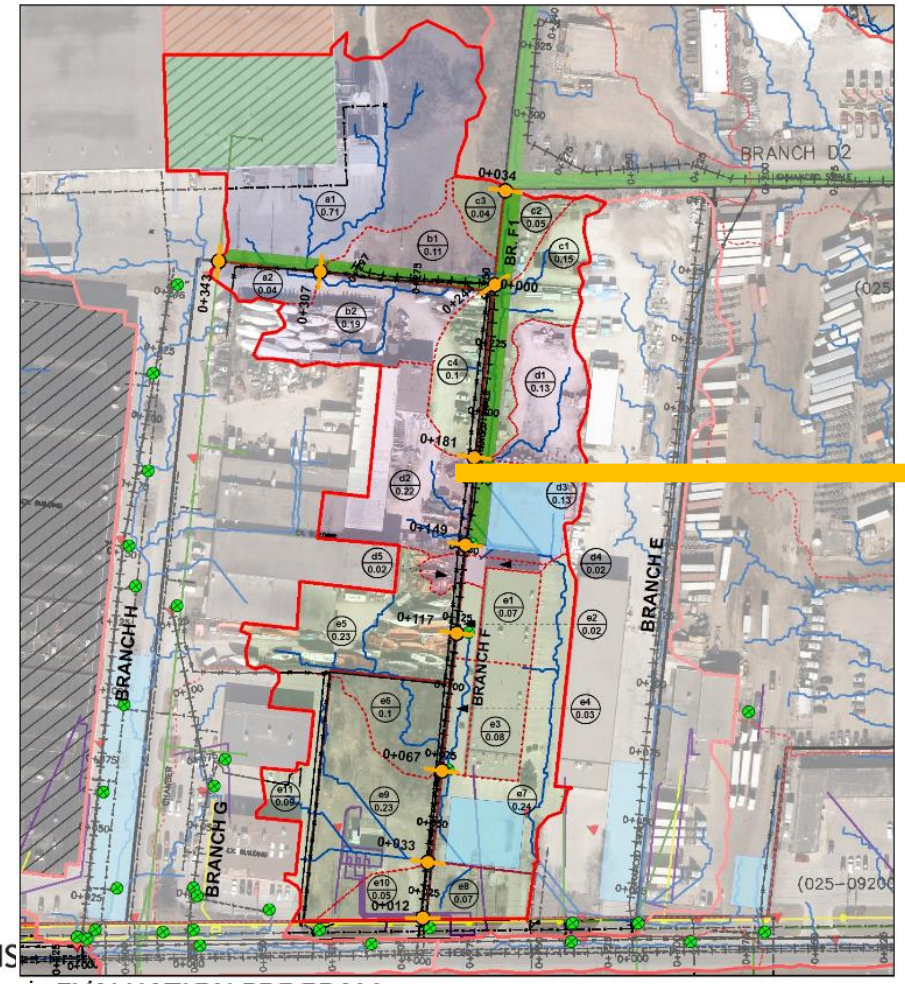
Southdown Project Area

0 50 100 200 Meters

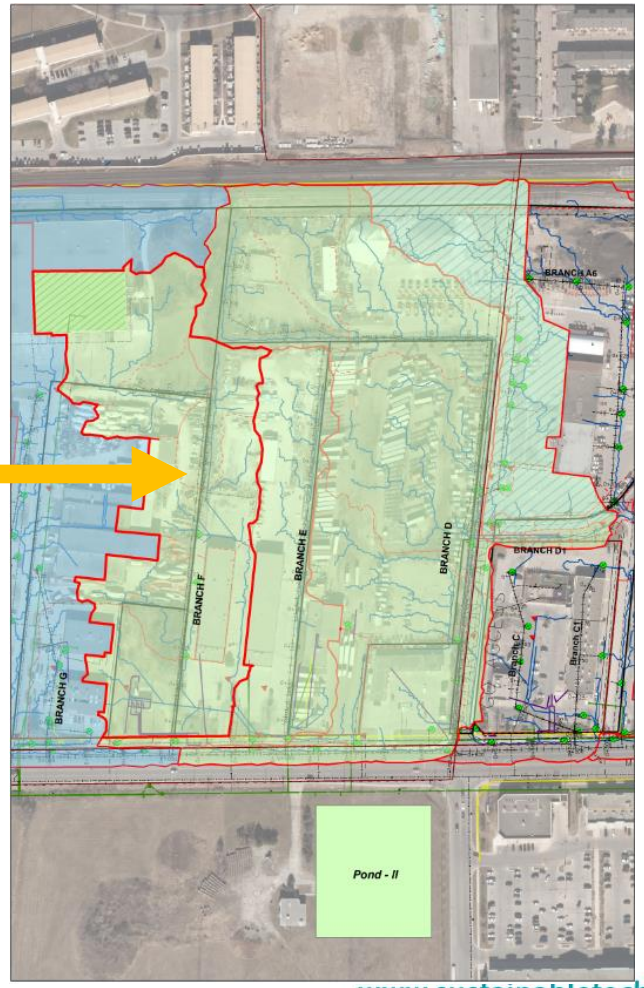
Communal GSI on Private Property

VS

End of Pipe on Public Property



Apples to Apples Comparison



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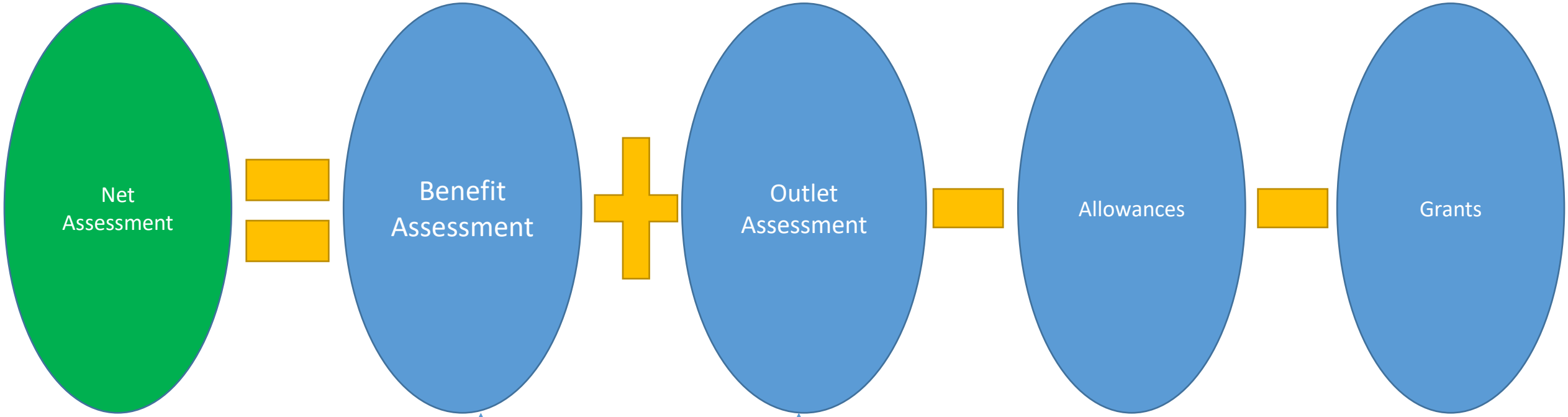
Stormwater criteria	Private Property	Public property
Mitigates riverine flood risk	Yes	Yes
Mitigates urban flood risk	Yes	No
Improves water quality: remove 80 per cent of total suspended solids	Yes	Yes
Improves water quality: thermal mitigation	Yes	No
Erosion control	Yes	Yes
Improve water balance / reduce runoff volume	Yes	No
Cost	**$274,000/ha**	**$320,000/ha**

Cost Sharing



Based on how much each property benefits from the system

Based on how much water each property outlets to the system

Net Assessment Schedules

Schedule A - Total Net Assessment

Con	Lot	Roll No.	Owner	Total Ha Affected	Benefit ($)	Outlet ($)	Total ($)	General Grants ($)	Allow-ances ($)	NET ASSESS. ($)	Cost to Manage Br F using End of Pipe Controls [2, 3]	Savings to Municipality [4] ($)
		21-05-020-221	Landowner 1	0.86	3,568	62,445	66,013		40,981	25,032		
		21-05-020-222	Landowner 2	0.89	7,582	49,012	56,593		0	56,593		
		21-05-020-223	Landowner 3	0.38	36,245	7,245	43,490		0	43,490		
		21-05-020-224	Landowner 4	1.00	143,376	35,975	179,351		155,136	24,215		
		Road Allowance	Municipality		456,912		456,912			456,912	1,257,443.27	800,531.03
Total Assessments for Branch F				3.13	647,683	154,677	802,360	0	196,117	606,243		

Note: This example is to help illustrate how the process works and the process of arriving at the net assessment.

It is the engineer's responsibility to fairly assess benefits and the landowners have the ability to appeal their assessment if they don't agree.

Ongoing Operation & Maintenance of Infrastructure on Private Property

Clearing invasive species

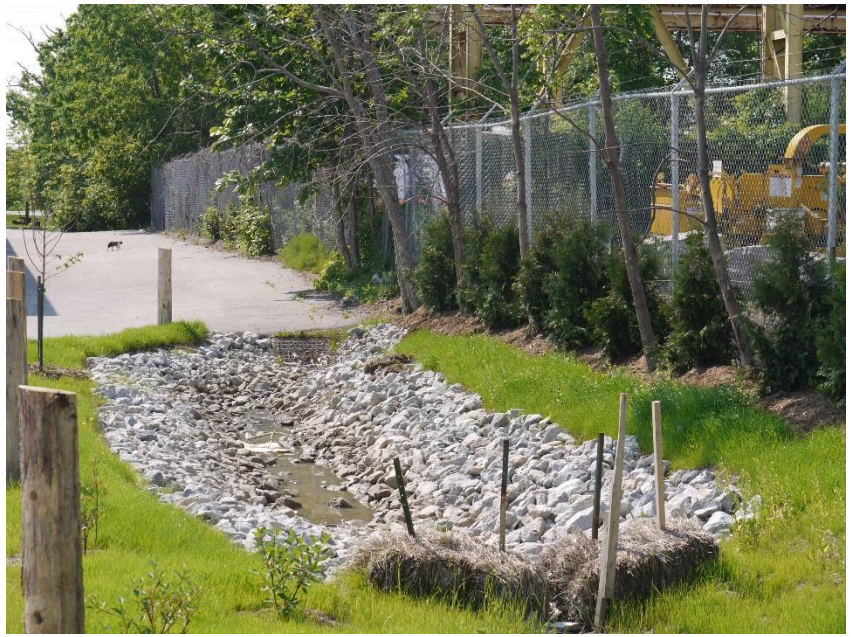
Replacing dead plants

Vacuuming out chambers

- Drainage act process ensures ongoing maintenance is carried out

Operation & Maintenance Schedules

- The engineer is required to consider how the costs of future maintenance and repair will be addressed
- The cost of future maintenance and repair and minor improvements to a drain may be assessed to properties as defined by the engineer in the report.
- Drainage Superintendent oversees the ongoing O&M of the infrastructure for municipality and private landowners

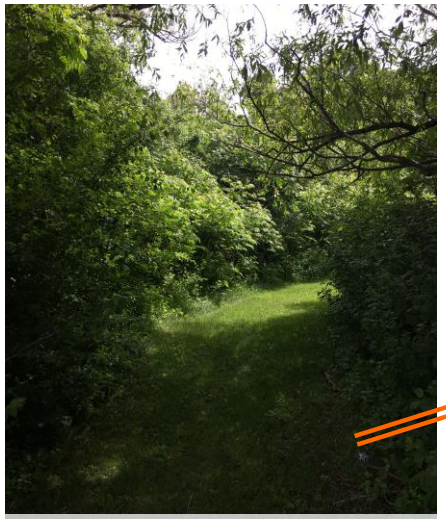


O&M Schedule

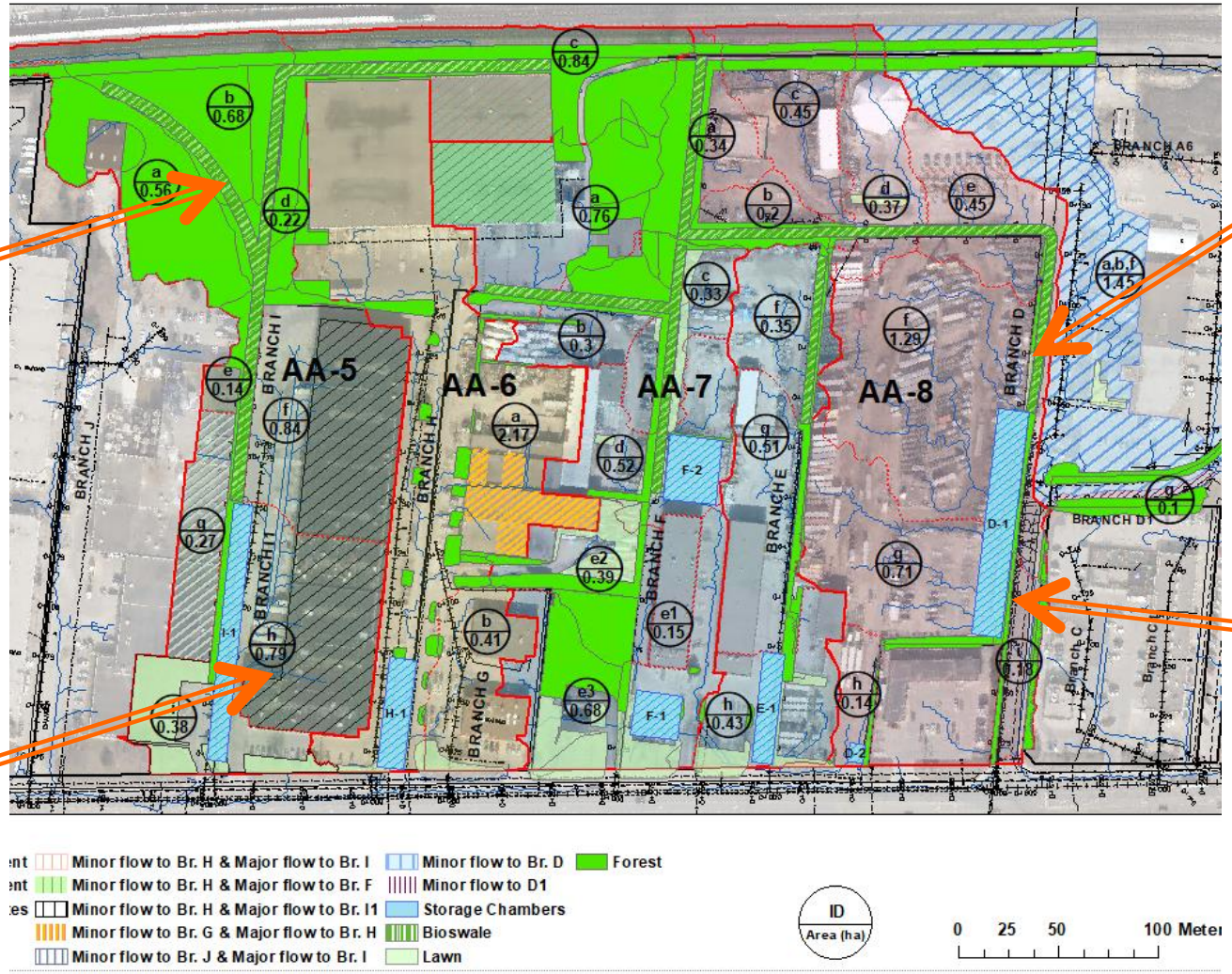
Schedule B - Schedule of Assessments for Future Maintenance

Roll No.	Owner	Interval 5 Chamber & Enhanced Sta 0+149 $	to 0+181 %	Interval 6 Enhanced Grass Swale Sta 0+181 $	to 0+244 %	Interval 7 Enhanced Grass Swale Sta 0+244 $	to 0+307 %	Interval 8 Enhanced Grass Swale Sta 0+307 $	to 0+343 %
73-06-020-050-902-10	Kyle's Green Roof Systems	1000.00	20%	800.00	40%	1100.00	55%	975.00	65%
73-06-020-050-902-11	R.Hakimi Industries	1000.00	20%	300.00	15%	300.00	15%	75.00	5%
73-06-020-050-902-12	A.Bhatti Enterprises	500.00	10%	0.00	0%	0.00	0%		
73-06-020-050-902-13	S.Malloy Inc.	1000.00	20%	300.00	15%	0.00	0%		
Municipality		1500.00	30%	600.00	30%	600.00	30%	450.00	30%
TOTAL O&M Costs		5,000.00	1.00	2,000.00	1.00	2,000.00	1.00	1,500.00	1.00

‘One Water’ Scenario



Natural Assets - Forest



Bioswale

Communal Rainwater Harvesting

Underground Storage with infiltration trench

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Conclusions/Recommendations

- Develop and implement a stormwater master plan supported by a municipal stormwater charge and runoff volume control target (RVCT).
- Incentivize communal GSI retrofits on private property.
- Use GSI on private and public property to augment or replace existing grey infrastructure systems. A less costly way to improve water quality and reduce flood risk and CSOs.
- Combat urban flooding by augmenting existing stormwater infrastructure with GSI to lower urban flood risk.

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