SOURCE TO STREAM 2025 Conference

Canada's Premier Stormwater and Erosion and Sediment Control Conference

Thank you to our sponsors!

EXECUTIVE SPONSORS

ADS — Our reason is water.™
Aquafor Beech Limited
citygreen — Urban Landscape Solutions
CUPOLEX® — Engineering Solutions Inc.
ENVIROPOD™
NEXT STORM
Oldcastle Infrastructure — A CRH Company
PERMACON
Sustainable Technologies Evaluation Program
StormTrap® — Modular Concrete Stormwater Management
terrafix® geosynthetics inc.

MEDIA SPONSOR

Environmental Science & Engineering Magazine

HOSTS

Presented by:

Toronto and Region Conservation Authority

In association with:

Lake Simcoe Region conservation authority

Credit Valley Conservation — inspired by nature

Replacing Ponds with LIDs

Performance of the First LID Subdivision in Brampton

Presenter: Jordan Wiedrick

Date: March 26th, 2025

BRAMPTON

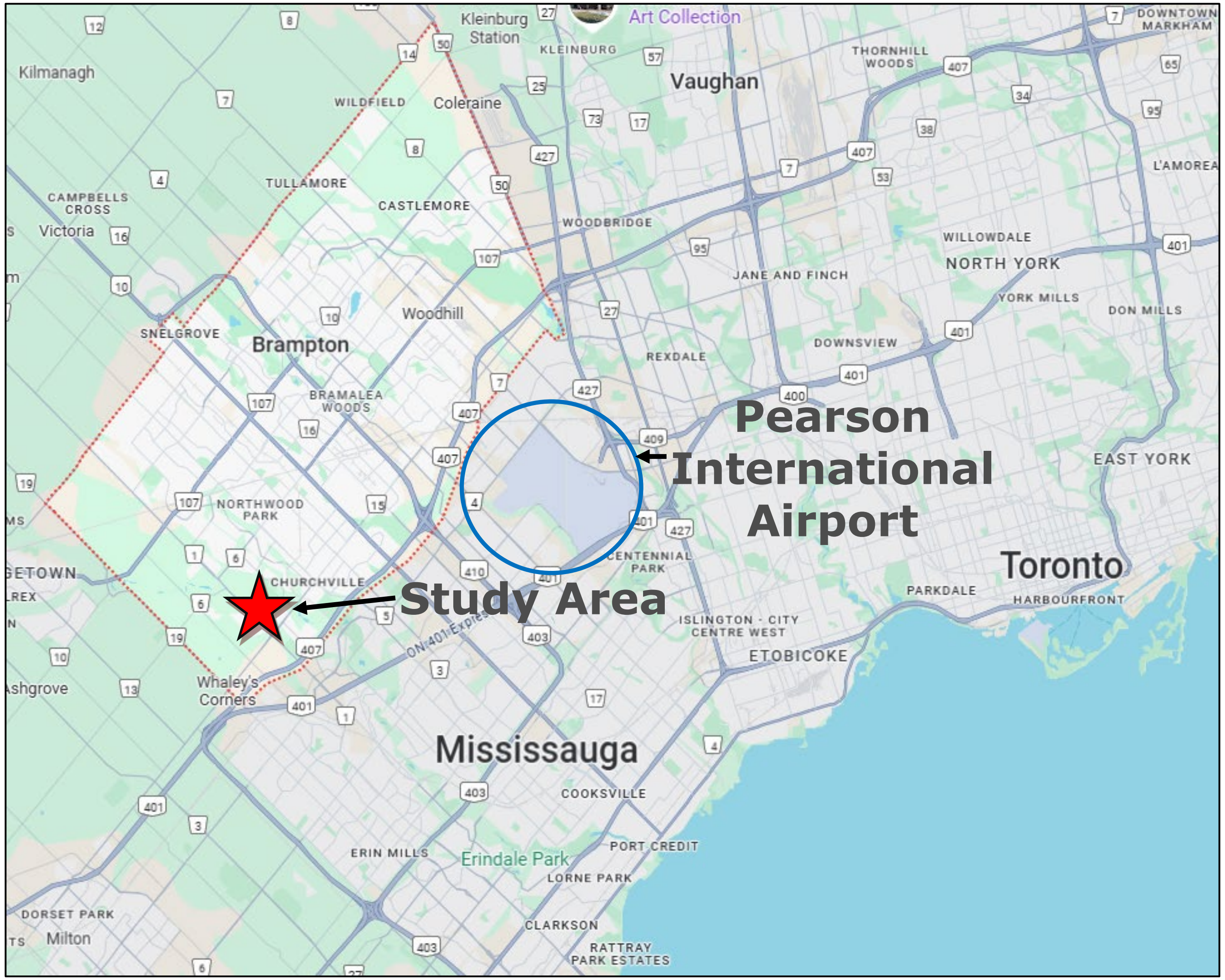
Credit Valley Conservation
inspired by nature

Credit Valley Conservation

Presentation Outline

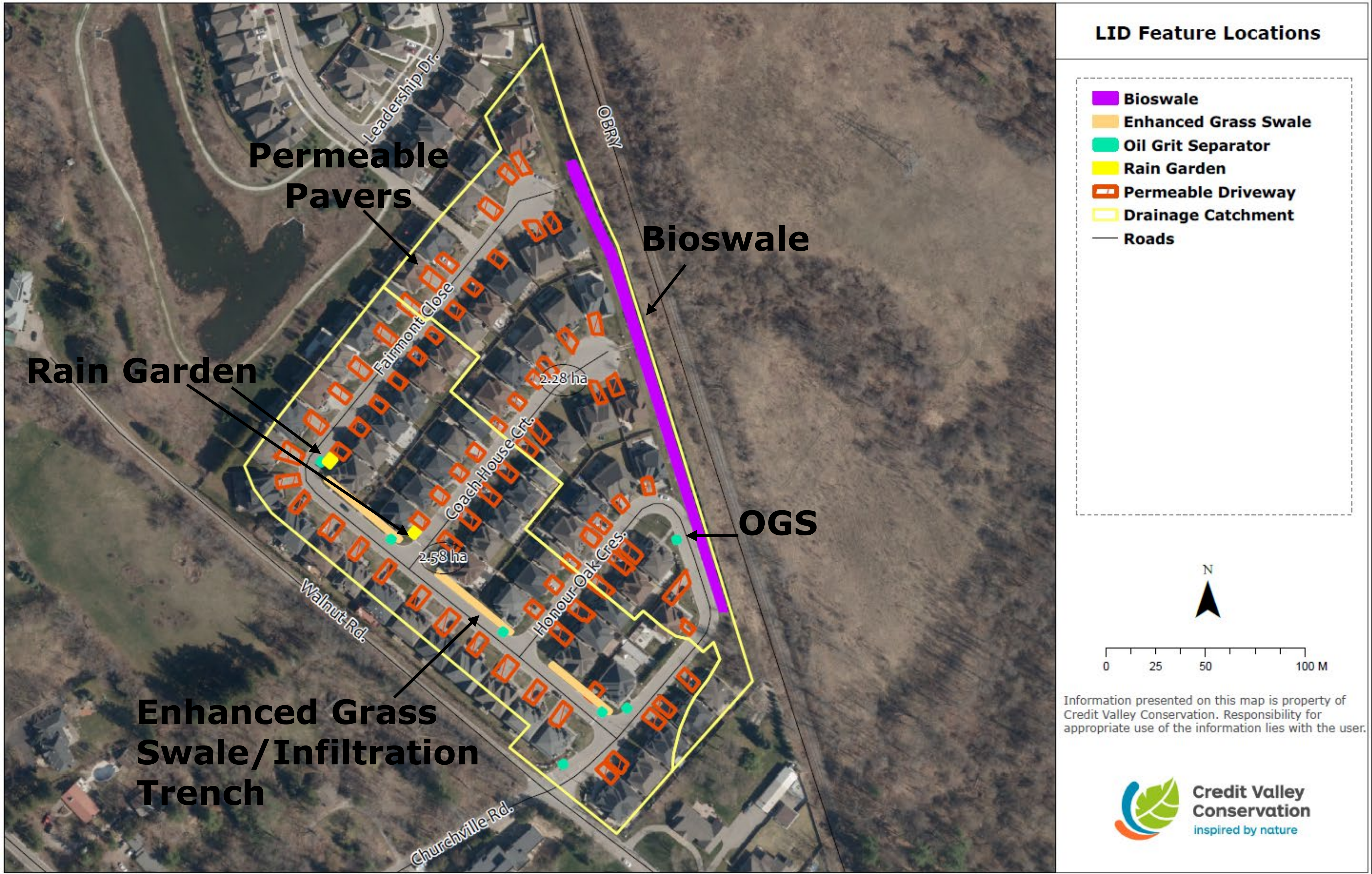
1. Overview of the Wychwood Subdivision
2. Stormwater Management Design Criteria
3. Phase 1: LID Performance Monitoring 2016-2019
4. Phase 2: Groundwater Monitoring Study 2022-2023
    - Groundwater Monitoring Design
    - Study Findings
5. Project Lessons Learned and Best Practices

Wychwood Subdivision



- Planning/Design 2010-2012
- Constructed in 2013-2015
- Monitoring started in 2016

Wychwood Subdivision



LID Features at Ground Level

Enhance Grass Swale with Underlying Infiltration Trench


Rain Garden


Permeable Paver Driveways


Bioswale

Credit Valley Conservation

Wychwood Stormwater Management Design Criteria

Stormwater Element	Design Criteria
Water quantity control	Reduce the 2 to 100-year post development flows to pre-development levels.
Water quality control	Enhanced water quality treatment as per the MECP 80% suspended solids reduction.
Water balance	Retain the average annual infiltration depth to pre-development levels.
Erosion control	Erosion control – Manage, detain or reuse ***all*** rainfall events up to 15 mm storm event over the entire site.

Credit Valley Conservation

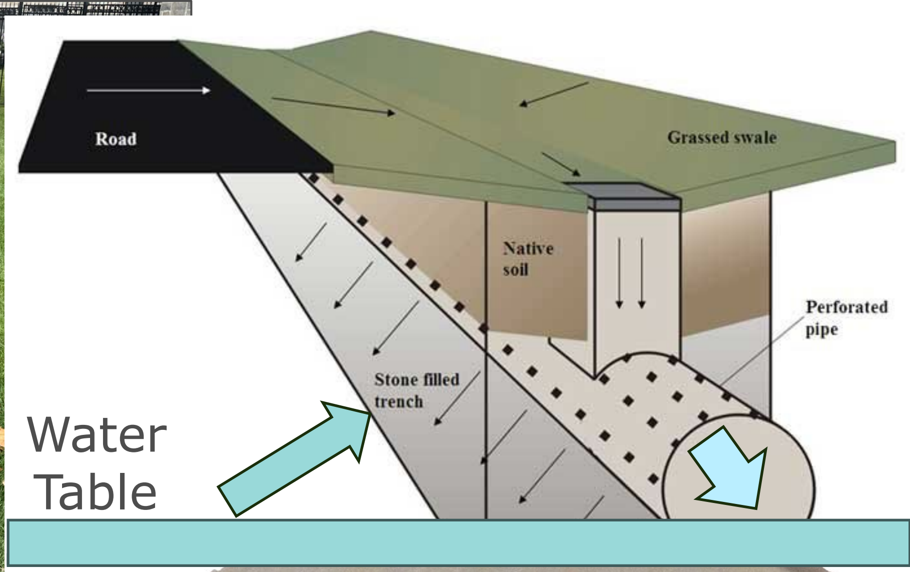
Phase 1: Wychwood LID Feature Performance Monitoring

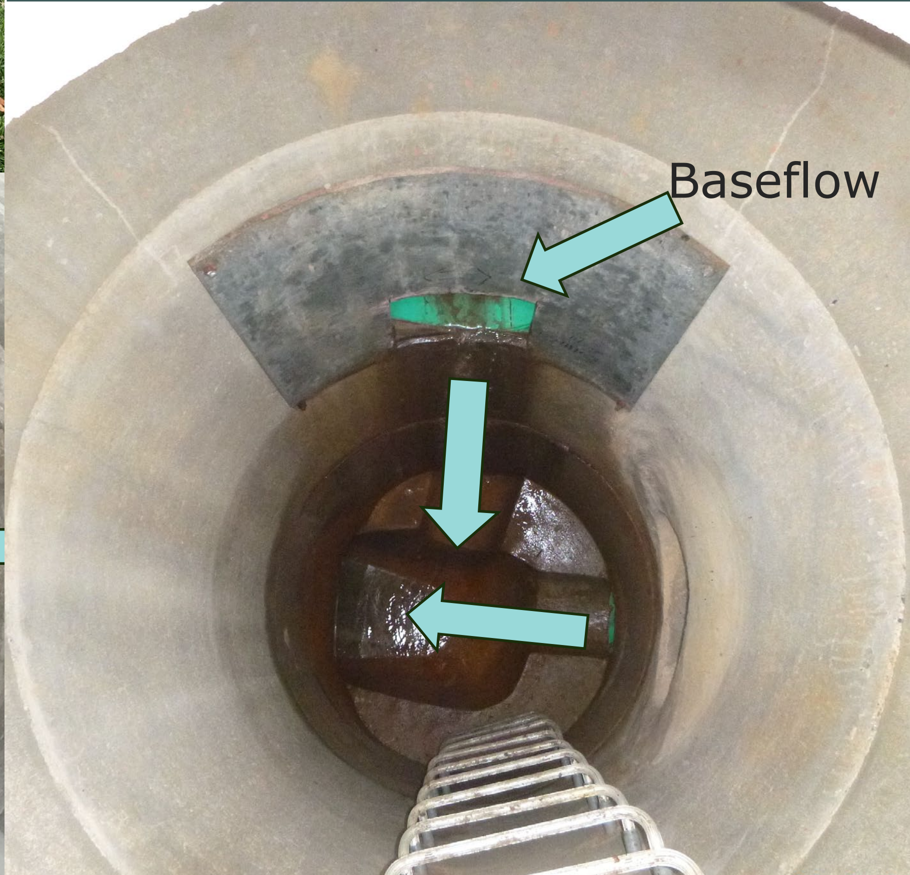
- Multi-Year Study-2016-2019
- 241 Monitored Events (Precipitation and Flow)
- 26 Flow Weighted Water Quality Samples
- 17 Site Inspections
- Monitoring Report Published in 2020 on STEP Water

https://sustainabletechnologies.ca/app/uploads/2020/06/Wychwood-Report.pdf

Baseflow Observed Between Events

- Flow station measuring baseflow for much of the year
- Observed only from infiltration trench outlet

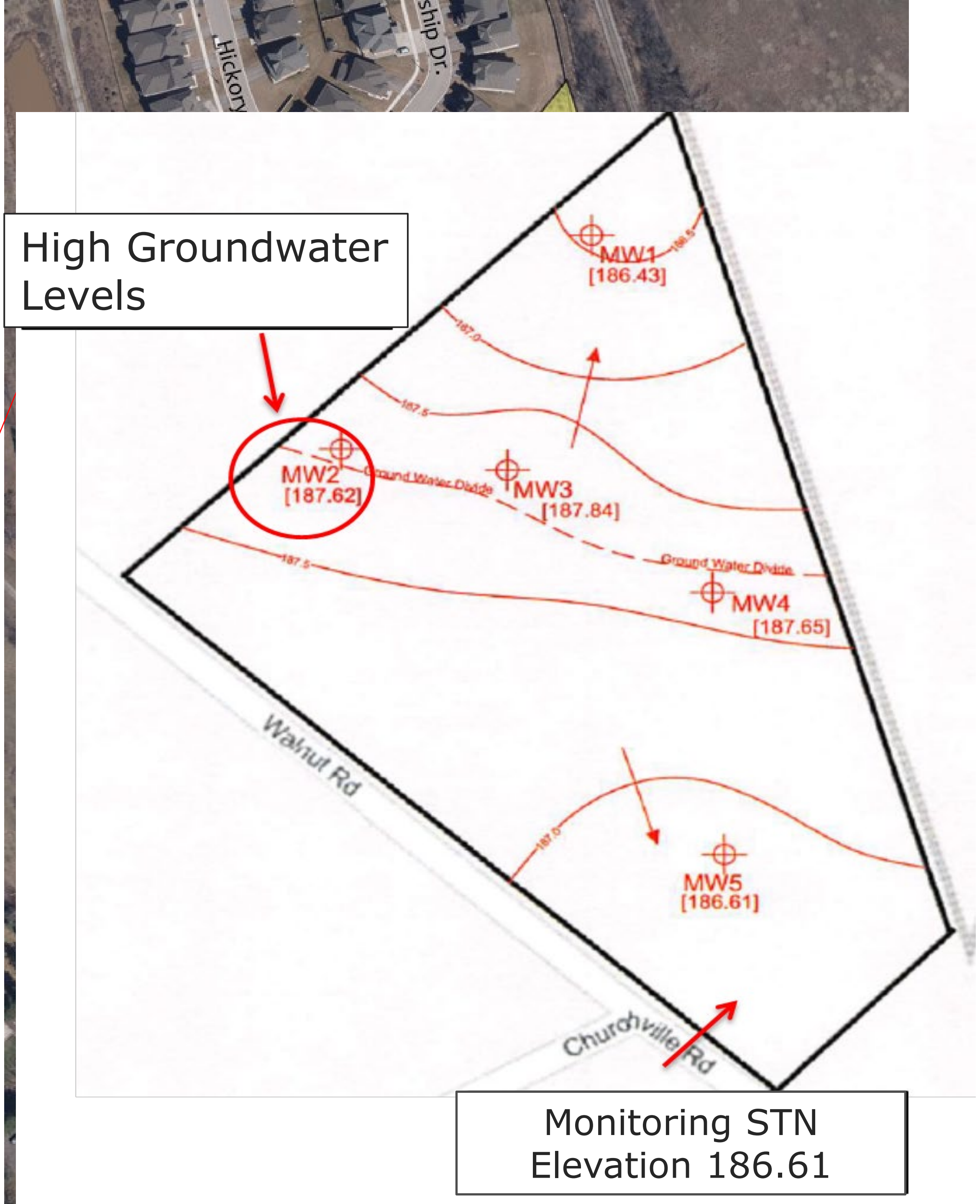




Credit Valley Conservation

Pre-Development Hydrogeological Study

Monitoring Well Location	Depth (mbgl)	Elevation (masl)	Water Level (mbgl) March 10, 2010
MW-1 S	2.24	190.44	Dry
MW-1 D	4.49	190.25	3.82
MW-2 S	2.12	188.38	0.50
MW-2 D	4.59	188.50	0.88
MW-3 S	2.20	190.26	Dry
MW-3 D	4.58	190.14	2.30
MW-4 S	2.11	190.14	Dry
MW-4 D	4.61	189.93	2.28
MW-5 S	2.94	189.94	Dry
MW-5 D	4.46	189.92	3.31



Phase 1: Pre-Development Performance Criteria Results

Stormwater Element	Design Criteria	Criteria Achieved by LID Design (Yes/No)
Water quantity control	Reduce the 2 to 100-year post development flows to pre-development levels.	Yes
Water quality control	Enhanced water quality treatment as per the MECP 80% suspended solids reduction.	Yes, 84% Reduction in TSS loading
Water balance	Retain the average annual infiltration depth to pre-development levels.	Yes, but did not consider groundwater influence
Erosion control	Erosion control – Manage, detain or reuse ***all*** rainfall events up to 15 mm storm event over the entire site.	Partially met: Median of 86% volume control for events <15mm

Credit Valley Conservation

Lingering Question After Phase 1….

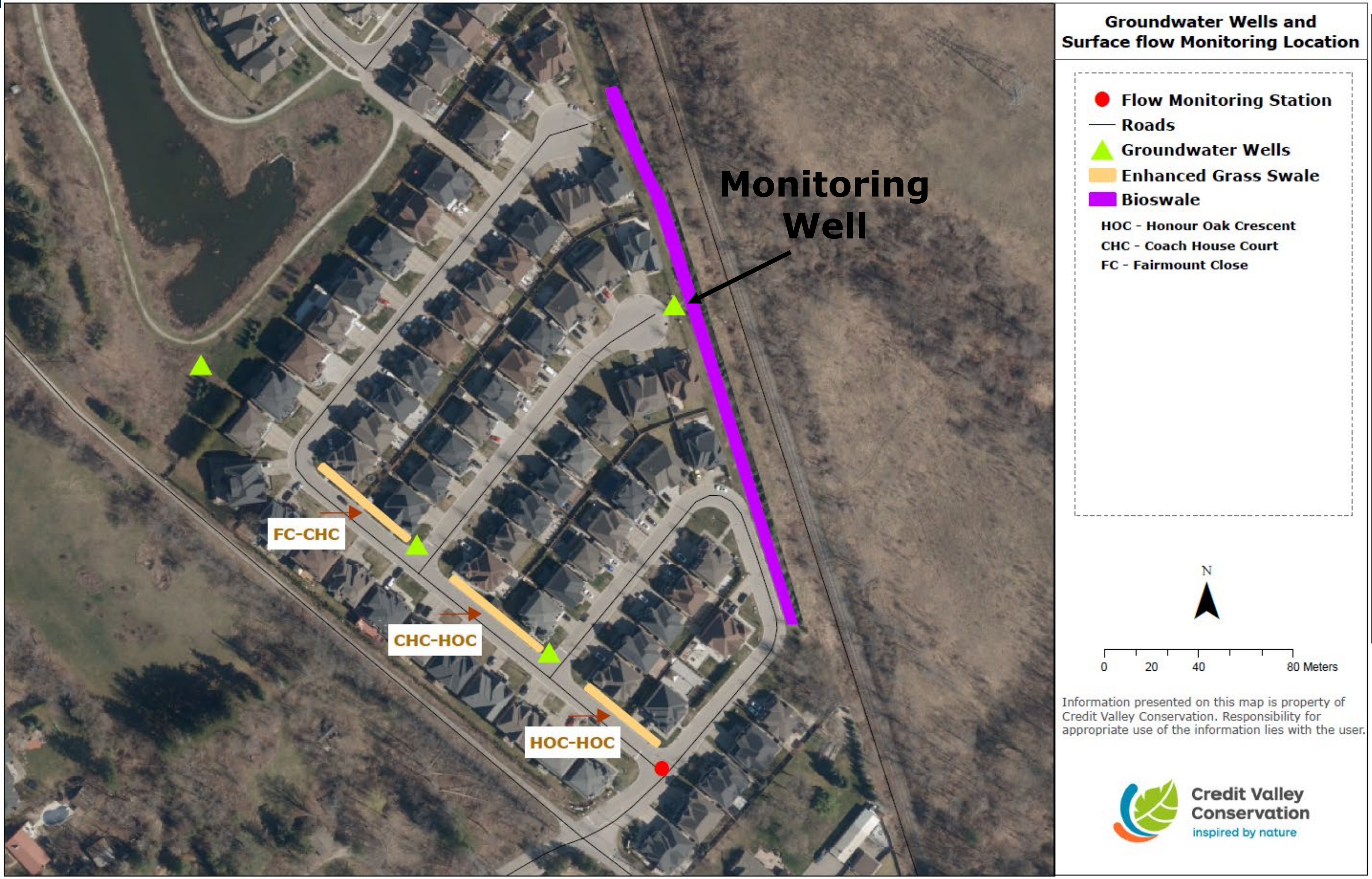
How does the high groundwater table impact the performance of the infiltration trench?

Credit Valley Conservation

Phase 2: Wychwood Groundwater Monitoring

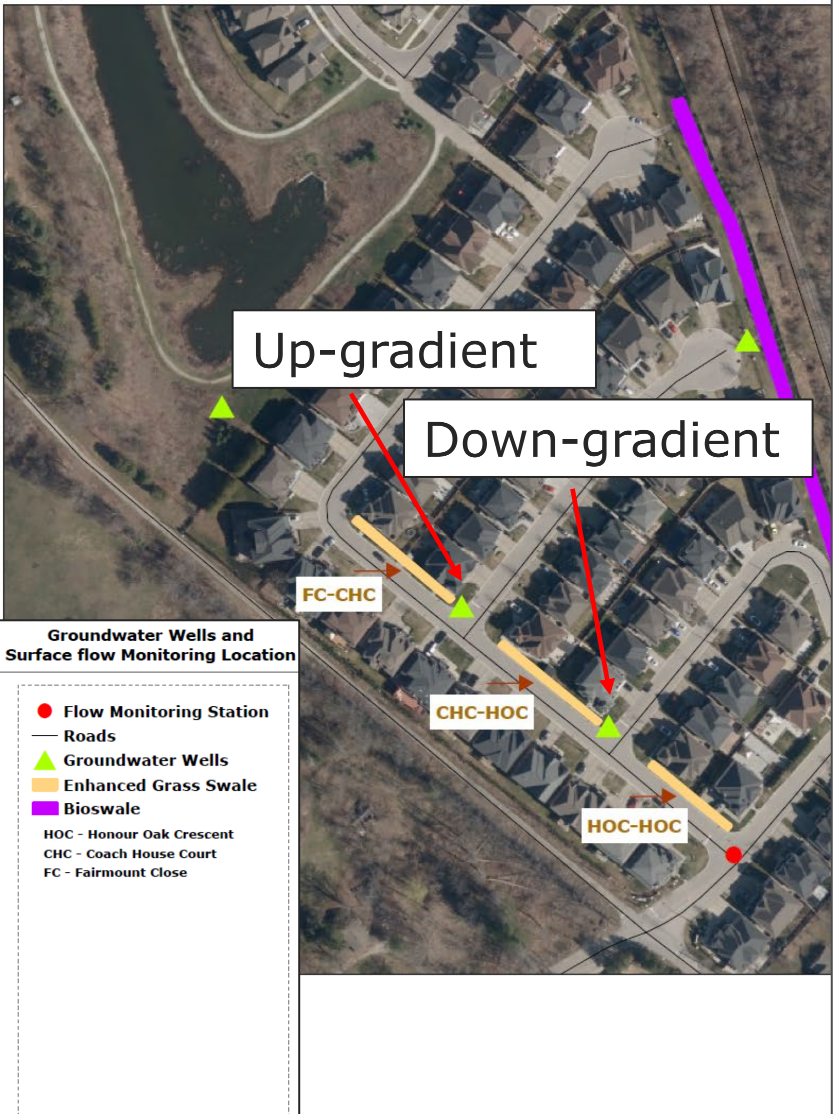
- Groundwater wells installed February 2022
- ~2 yrs of data: March 2022-November 2023
- 4 well nests installed each with 1 shallow and 1 deep well
- Shallow well depth 3.0-3.2m
- Deep Well Depth 6.0-6.7m

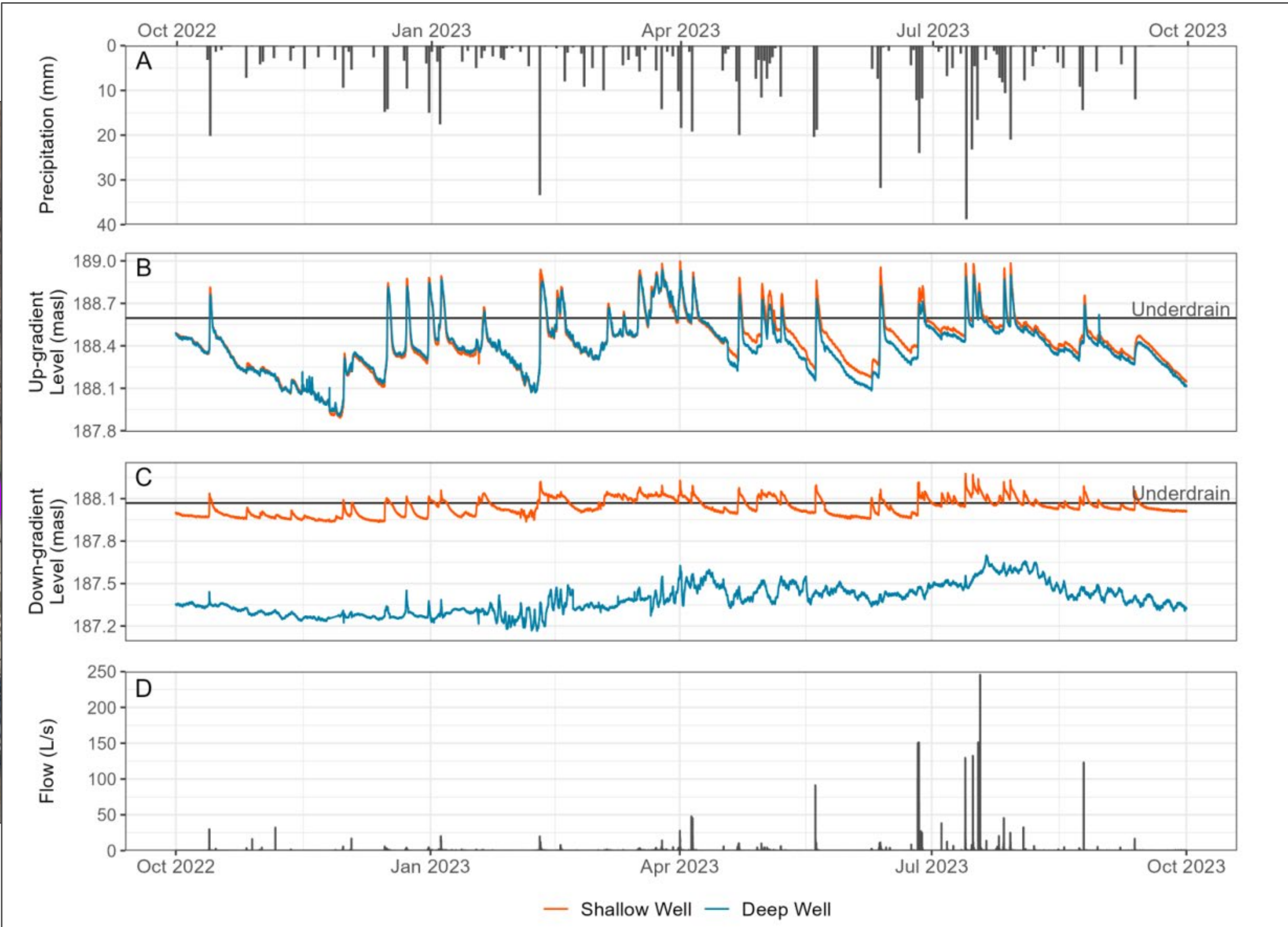
Groundwater Monitoring Well Locations



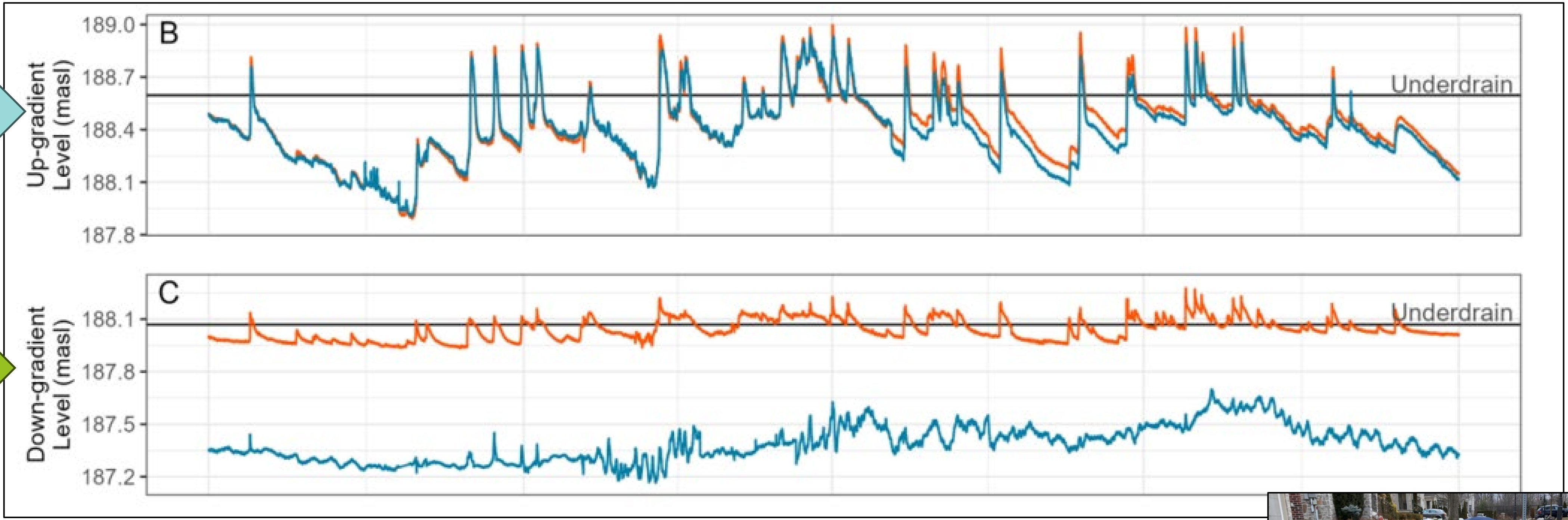
Groundwater well adjacent to enhanced grass swale

Groundwater Levels Adjacent to Infiltration Trench





Hydraulic Conductivity-Slug Testing

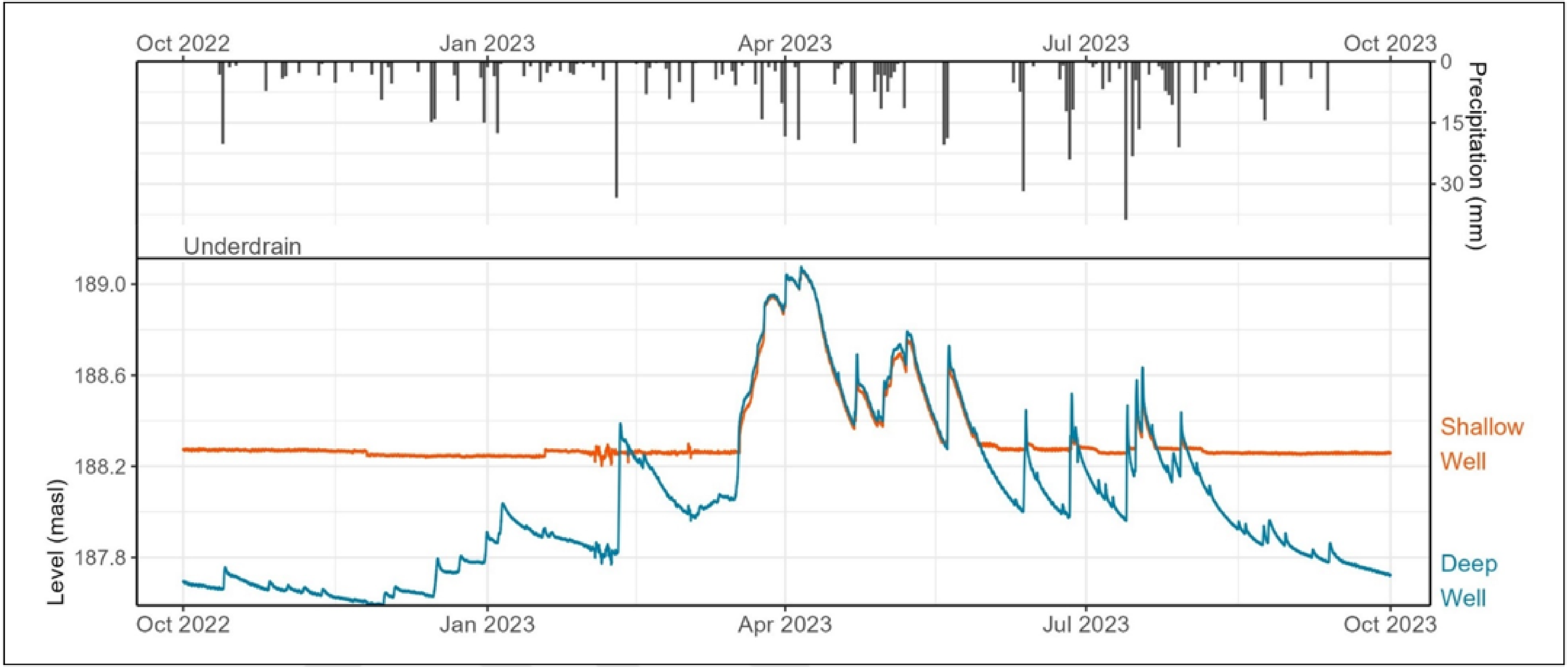


Well Name	Hydraulic Conductivity (meters per second)
Deep up-gradient	9.00E-08
Shallow up-gradient	4.05E-07
Deep down-gradient	2.00E-10
Shallow down-gradient	2.00E-02

Rising and falling head testing

Conclusion: Localized difference in geology impacts groundwater levels

Groundwater Levels Adjacent to Bioswale



Credit Valley Conservation

EPA-SWMM Design Storm Analysis

Comparison of EPA SWMM Model Results

Return period	Rainfall depth (mm)	Peak flow out (m^3/s)		
		*Original	Updated	Difference
2	50	0.115	0.116	-1%
5	68	0.173	0.182	-5%
10	83	0.252	0.256	-2%
25	95	0.336	0.337	0%
50	107	0.422	0.431	-2%
100	119	0.566	0.57	-1%

*2018 EPA-SWMM model did not account for groundwater interaction

- <u>Modelling results suggest negligible impact on quantity control</u>

EPA-SWMM Water Balance Analysis

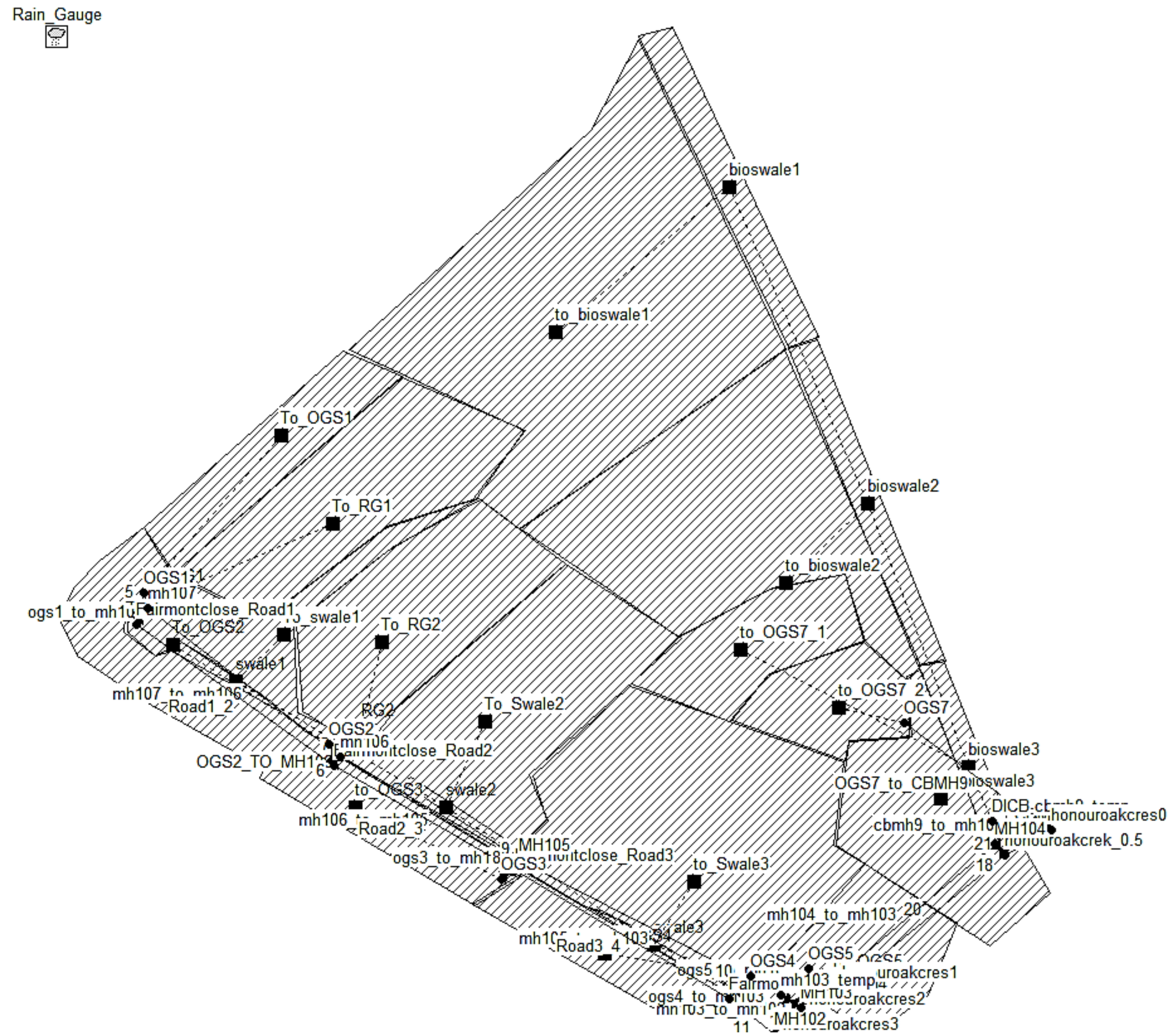
Model	Area (ha)	Precipitation (mm)	Evapotranspiration (mm)	Infiltration (mm)	Runoff (mm)
Original design Pre-Development	5.67	793	443 (56%)	120 (15%)	230 (29%)
Original design Post-Development	5.67	793	335 (42%)	280 (35%)	179 (23%)
As-built calibrated SWMM	4.09	753	334 (44%)	274 (36%)	140 (19%)
Updated SWMM model with groundwater:	**4.09**	**789**	**291 (37%)**	**191 (24%)**	**300 (38%)**

Notes: Runoff for the updated SWMM model includes groundwater discharge to underdrain.

Credit Valley Conservation

EPA SWMM Limitation

- Assumes uni-directional interactions between LID and groundwater
- Cannot model horizontal groundwater flow between sub catchments
- Used a simplified approach



Phase 2: Groundwater Monitoring Findings

Credit Valley Conservation

How does the high groundwater table impacting the performance of the infiltration trench?

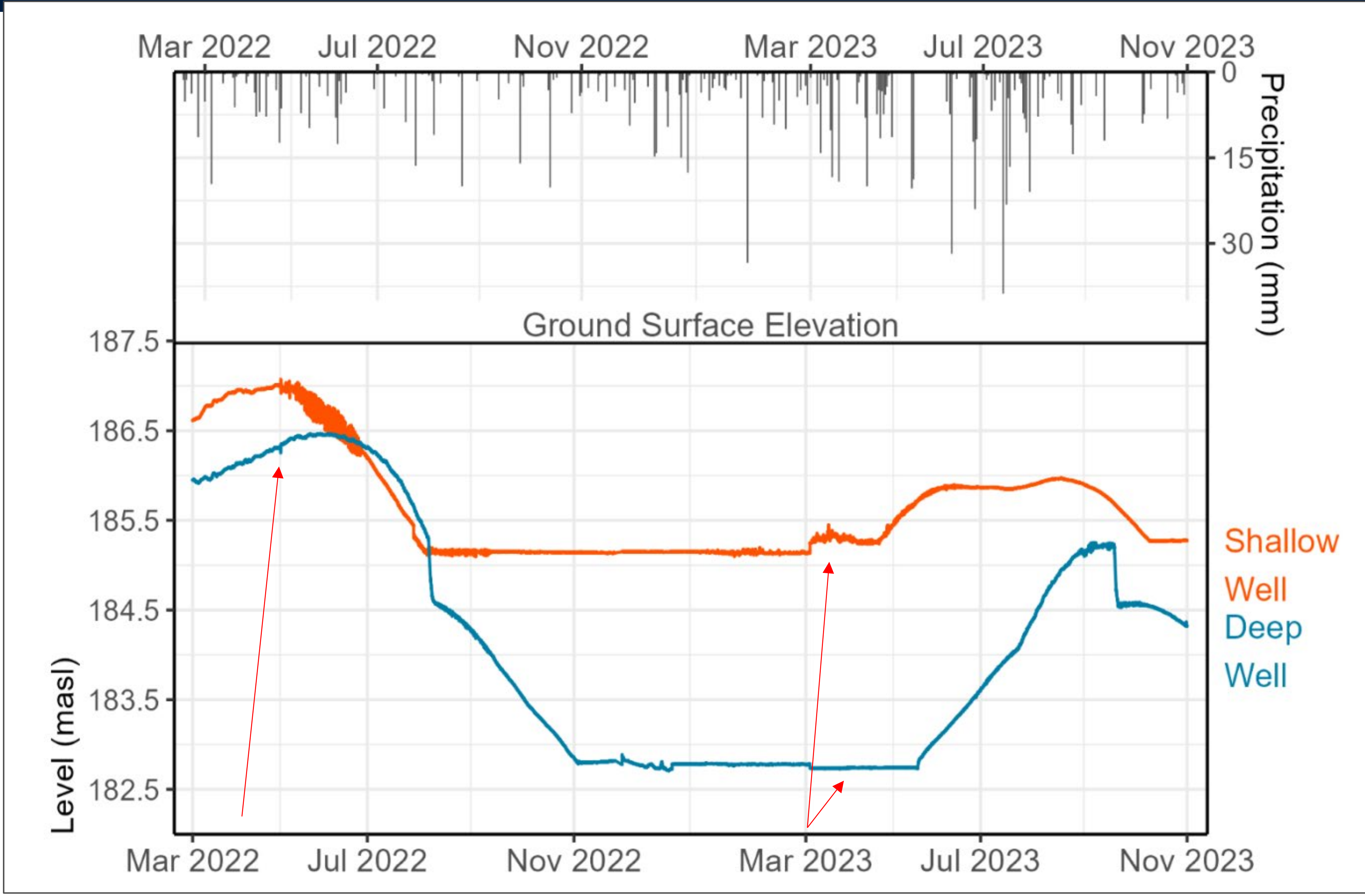
Infiltration Trench	Entire Subdivision
• Limited infiltration due to groundwater interaction within infiltration trench • Lack of storage volume impacts contribution to erosion protection target • Groundwater interaction limits the ability of the infiltration trench contribution to water balance • Inspection/maintenance in late Nov-Dec	• Less infiltration than post-development design estimation but greater infiltration relative to pre-development–Water Balance ✓ • Groundwater has a negligible impact on quantity control for 2-100 yr design storm ✓ • Enhanced Water Quality per MECP >80% criteria achieved ✓ • Bioswale and other features are not impacted by high groundwater levels and storage capacity is unaffected ✓ • Erosion control-86% median volume control for event ~ 15mm 👍

Overall, a successful implementation of LID!

Stormwater Element	Design Criteria	Criteria Achieved by LID Design (Yes/No)
Water quantity control	Reduce the 2 to 100-year post development flows to pre-development levels.	Yes
Water quality control	Enhanced water quality treatment as per the MECP 80% suspended solids reduction.	Yes, 84% Reduction in TSS loading
Water balance	Retain the average annual infiltration depth to pre-development levels.	Yes, avg annual infiltration increased from 19% to 24%
Erosion control	Erosion control – Manage, detain or reuse ***all*** rainfall events up to 15 mm storm event over the entire site.	Partially met: Median of 86% volume control for events <15mm

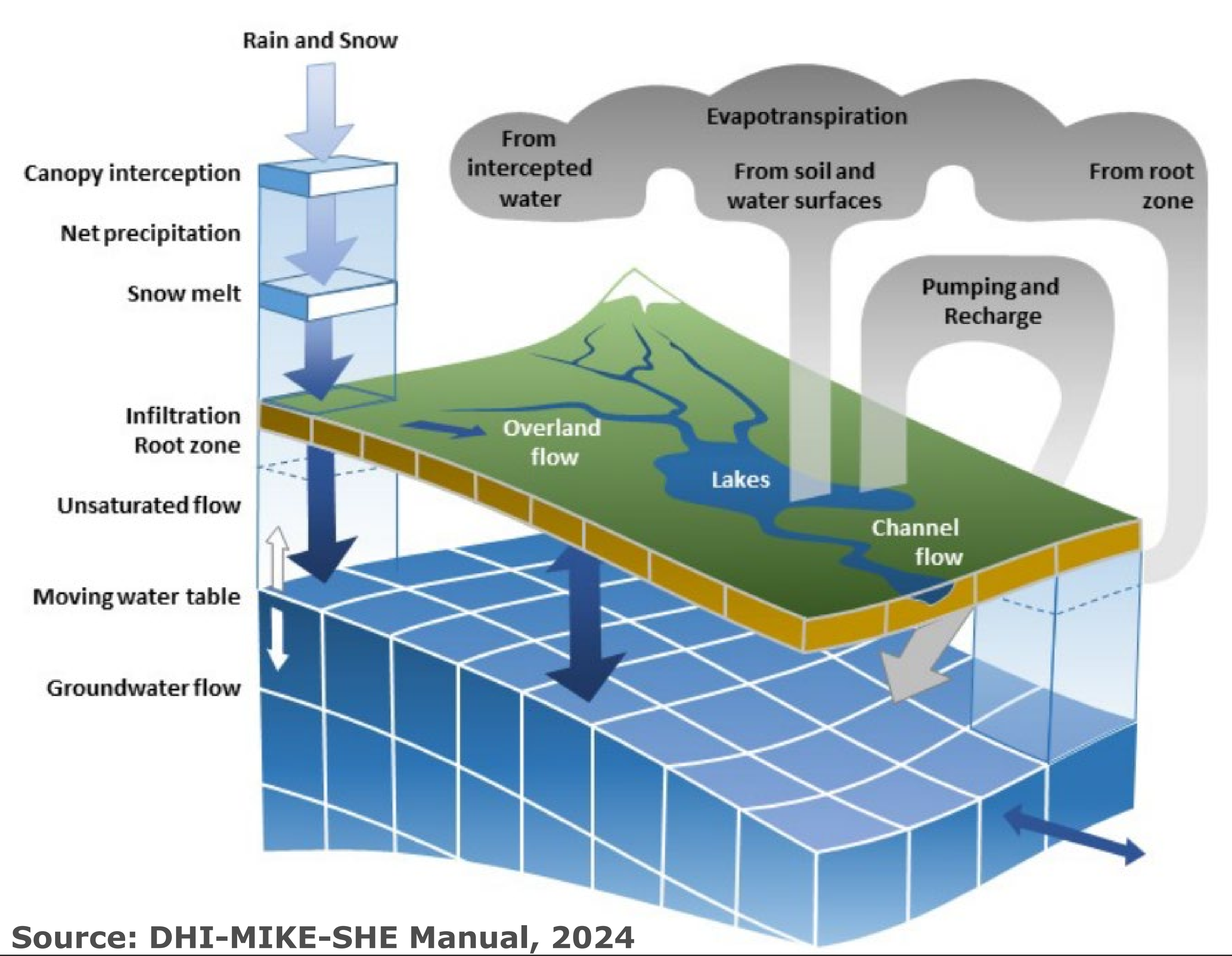
Lessons Learned: Pre-Development Investigation Best Practices

- Water level at well outside the subdivision perimeter fluctuates by almost 4 meters over the course of one year
- Recommend a minimum of 12 months of continuous level monitoring to characterize the groundwater system's highs and lows



Lessons Learned: Pre-Development/Design Best Practices

- Use an integrated surface/groundwater model
  - Existing surface water and groundwater flow paths
  - Average and seasonal groundwater levels
  - Vertical and horizontal hydraulic gradients
  - Infiltration and recharge capacity
  - Water quality impacts



Source: DHI-MIKE-SHE Manual, 2024

Lessons Learned: LID Design Considerations

Location with potential for GW interaction

- Consider designs where flow is directed to the surface-utilize shallow storage and ET
- Consider alternative location, deeper groundwater
- Consider an impermeable liner
- Include 1 meter buffer between bottom of feature and seasonal high groundwater level

General best practices:

- Consider localized geology where LIDs are proposed
- Select correct LID for the site constraints

Lessons Learned: LID Design Considerations:

LID/BMP Selection Screening Tools

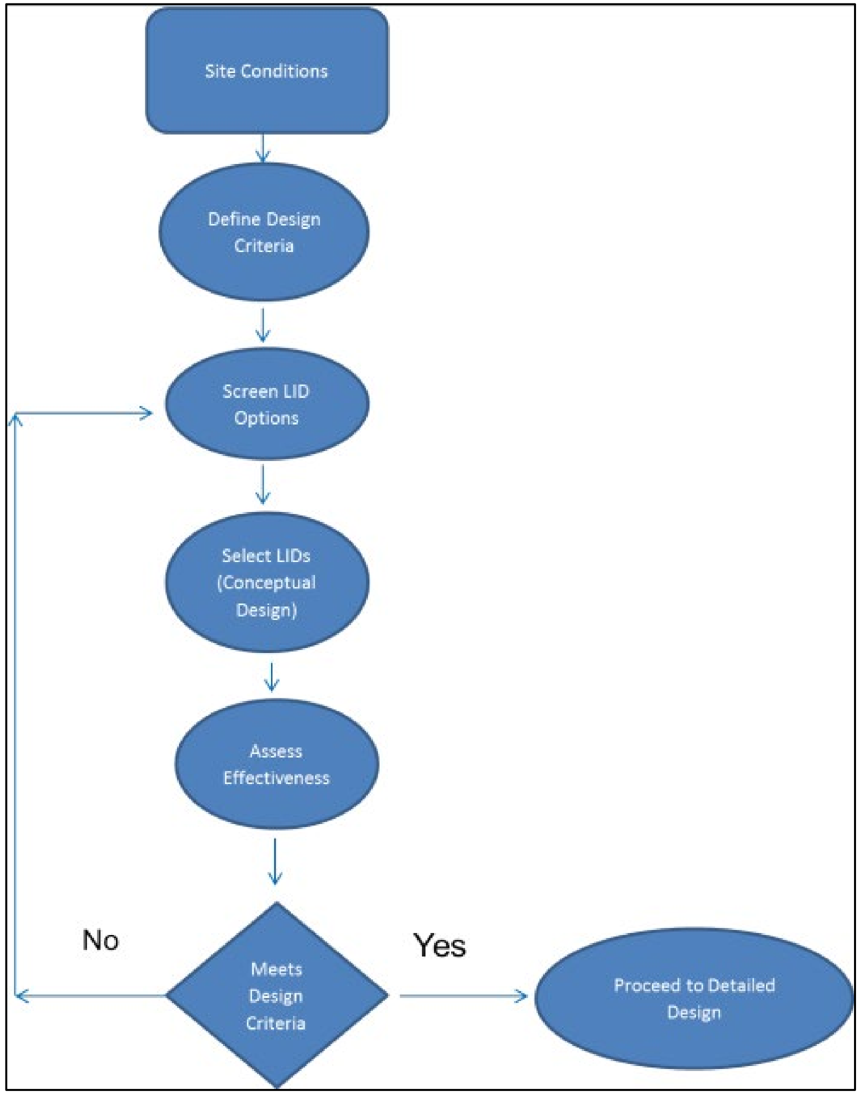
Scoring Matrix for Low Impact Development Best Management Practices

	PARAMETERS	Infiltration Basin	Infiltration Chambers	Boulevard bioretention units	Bioretention curb extensions	Bio-retention Planters	Bioswales	Perorated Pipe	Enhanced grass swales	Prefabricated modules
COST	Construction Cost	5	5	5	5	1	5	5	10	1
	Fiscal Responsibility	10	10	1	1	1	5	1	5	1
	Asset Management	5	5	10	5	1	1	5	1	10
	Lifecycle Cost	5	5	5	5	1	5	10	10	5
	Land Requirements	1	10	1	1	1	1	10	5	10
ENVIRONMENTAL	Erosion Control Measures	5	1	10	10	10	10	10	5	5
	Protecting Water Quantity	10	10	5	5	5	5	5	1	1
	Protecting Water Quality	10	10	10	10	10	10	5	5	5
	Groundwater Recharge	10	5	10	10	10	10	10	5	1
	Climate Change	10	10	5	5	5	5	5	5	5
SOCIAL	Aesthetics	10	10	5	10	10	5	1	5	10
	Green Infrastructure	1	10	5	5	5	5	5	5	1
	Urban Tree Canopy	10	1	5	1	10	1	1	1	1
	Community Engagement	5	1	10	10	10	10	1	1	5
	TOTAL	97	93	87	83	80	78	74	64	61

COST	
Low	10
Moderate	5
High	1

ENVIRONMENTAL	
Significant Impact	10
Medium Impact	5
Low Impact	1

SOCIAL	
High	10
Moderate	5
Low	1



Credit: Civica Infrastructure Inc, 2024. STEP Wiki, 2025: https://wiki.sustainabletechnologies.ca/wiki/Screening_LID_options

Credit Valley Conservation

Our Partners in Conservation

Credit Valley Conservation inspired by nature

Credit Valley Conservation FOUNDATION

Toronto and Region Conservation Authority

Conservation ONTARIO Natural Champions

GREENBELT Possibility grows here.

MISSISSAUGA

BRAMPTON

TOWN OF CALEDON

TOWN OF HALTON HILLS

OAKVILLE

Orangeville Historic Charm Dynamic Future

MILTON

TOWN OF MONO

TOWNSHIP OF EAST GARAFRAXA

TOWNSHIP OF AMARANTH

TOWN OF ERIN

Credit Valley Conservation

Questions?

SOURCE TO STREAM 2025 Conference

Canada's Premier Stormwater and Erosion and Sediment Control Conference

Thank you to our sponsors!

EXECUTIVE SPONSORS

ADS — Our reason is water.
Aquafor Beech Limited
citygreen — URBAN LANDSCAPE SOLUTIONS
CUPOLEX® ENGINEERING SOLUTIONS INC.
ENVIROPOD™
NEXT STORM
Oldcastle Infrastructure — A CRH COMPANY
PERMACON
Sustainable Technologies EVALUATION PROGRAM
StormTrap® — MODULAR CONCRETE STORMWATER MANAGEMENT
terrafix® geosynthetics inc.

MEDIA SPONSOR

Environmental Science & Engineering MAGAZINE

HOSTS

Presented by:

Toronto and Region Conservation Authority

In association with:

Lake Simcoe Region conservation authority

Credit Valley Conservation — inspired by nature