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Innovative subdivision design: performance of a pond with upgradient LIDs

STEP Webinar

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Background

- Meadows in the Glen is the first subdivision in Halton Hills to use a treatment train approach that incorporates both LID practices and a conventional wet pond to manage stormwater
- CVCA has conducted stormwater monitoring at MITG since 2015
  - Measure precipitation, flows and water quality
- Purpose of monitoring is to understand the performance of the stormwater management treatment train as a whole:
  - includes wet pond and upgradient LIDs
- Completed a peer-reviewed technical report, available on the STEP website

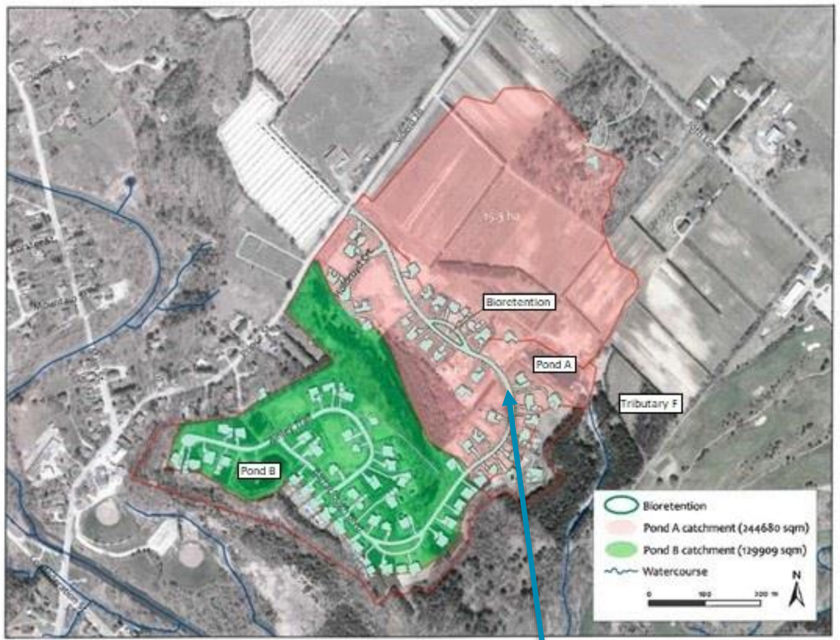
https://sustainabletechnologies.ca/app/uploads/2021/12/rpt_mitgreport_FINAL_20211125.pdf

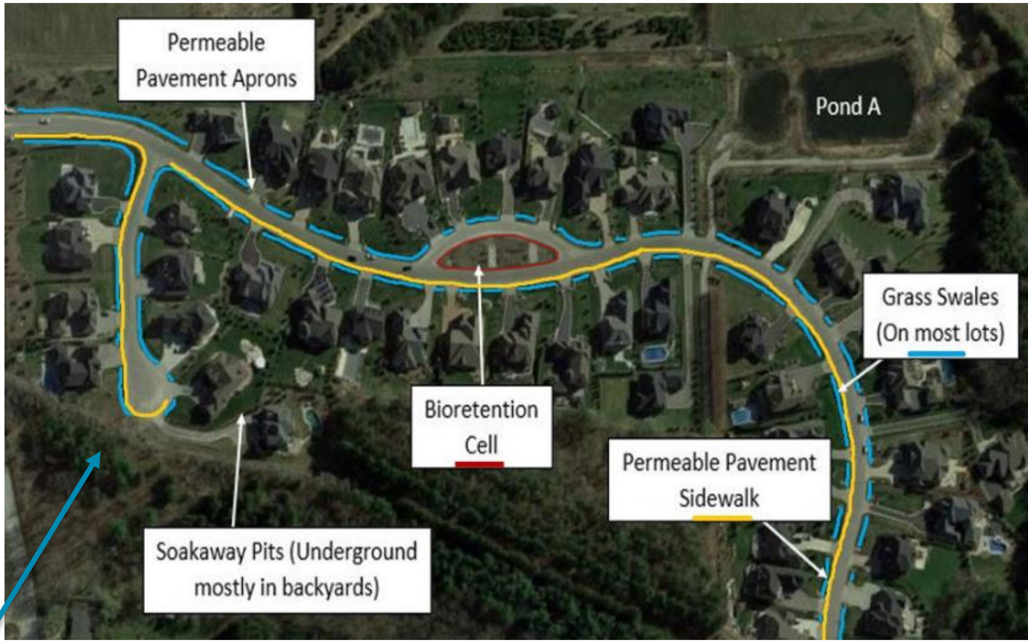
Research Questions

The performance monitoring study aims to answer the following three key questions:

1. Is stormwater management Pond A performing as designed?
2. What is the influence of the upgradient LID practices on the performance of stormwater management Pond A?
3. How can the monitoring results inform asset management at MITG and of stormwater management ponds in treatment train designs?

Site Overview





Pond A Catchment
(*indicated in red for image on left*)

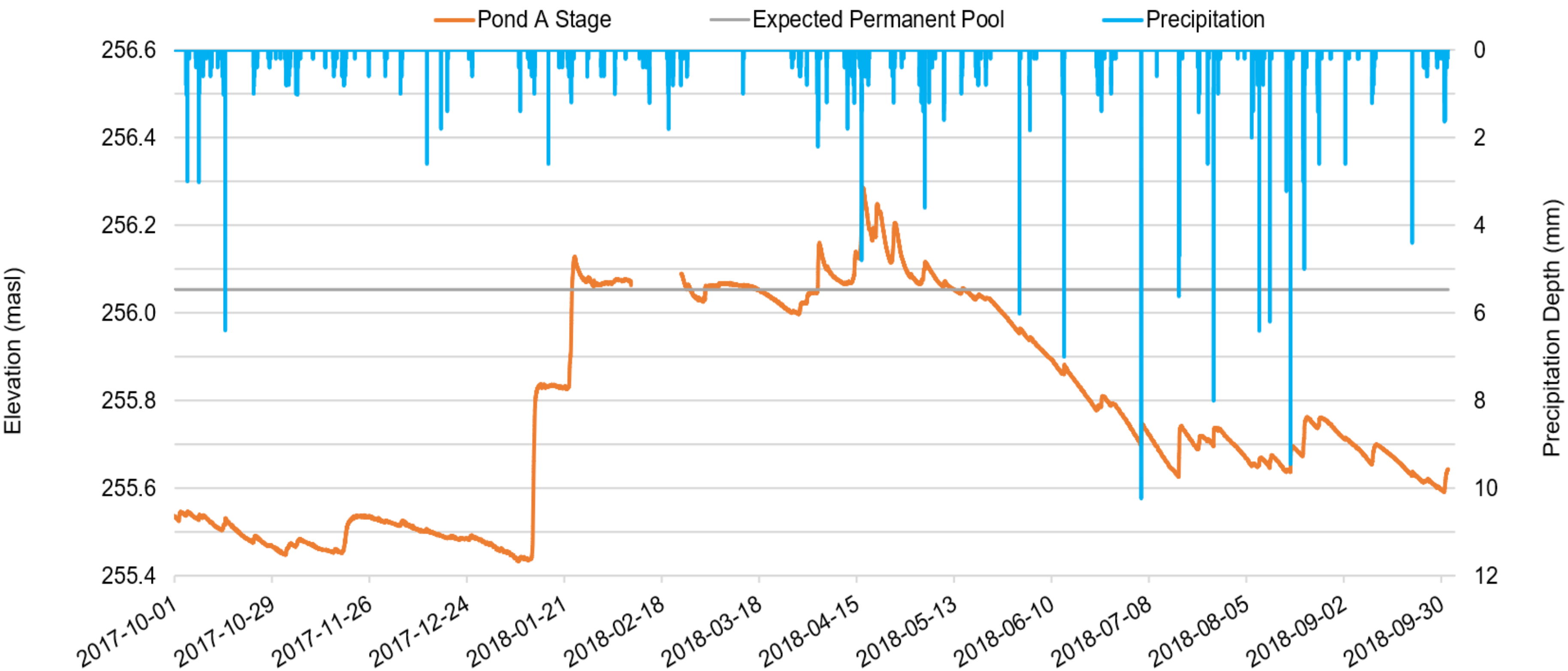
Monitoring Stations

Monitoring Type	Monitoring Purpose
Precipitation and Air Temperature	Determine precipitation amounts.
Continuous Flow	Determine peak flow and runoff volumes entering and leaving the pond.
Continuous Pond A Water Level	Characterize seasonal pond level fluctuations and drawdown times with respect to permanent pool.
Winter Flow	Obtain flow data when there is risk of freezing damage to ISCO 2150 loggers.
Event-Based Water Quality Sampling	Determine water quality and contaminant loads entering and leaving Pond A.
Continuous Conductivity and Temperature	Determine water quality when event-based analysis is not possible.
Continuous Turbidity	Determine water quality when event-based analysis is not possible.
Maintenance Inspections	Track condition of LID features and identify maintenance issues.
Bathymetric Survey	Determine baseline sediment build up in Pond A.
Maintenance Interview	Find out costs of maintenance for developer prior to assumption.

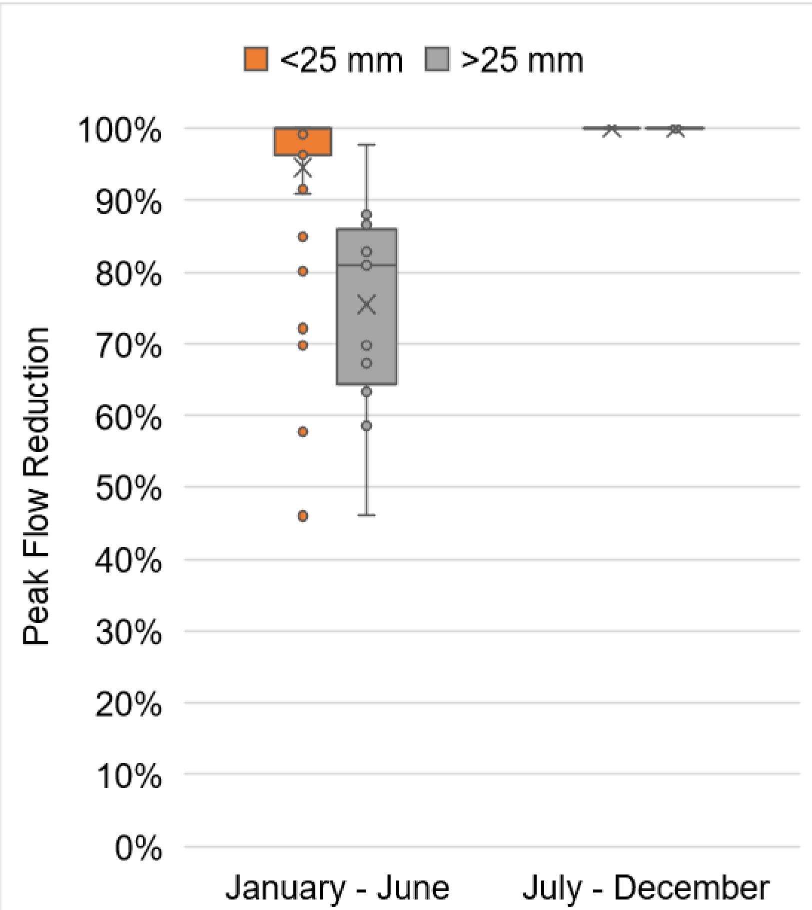
Is stormwater management Pond A performing as designed?

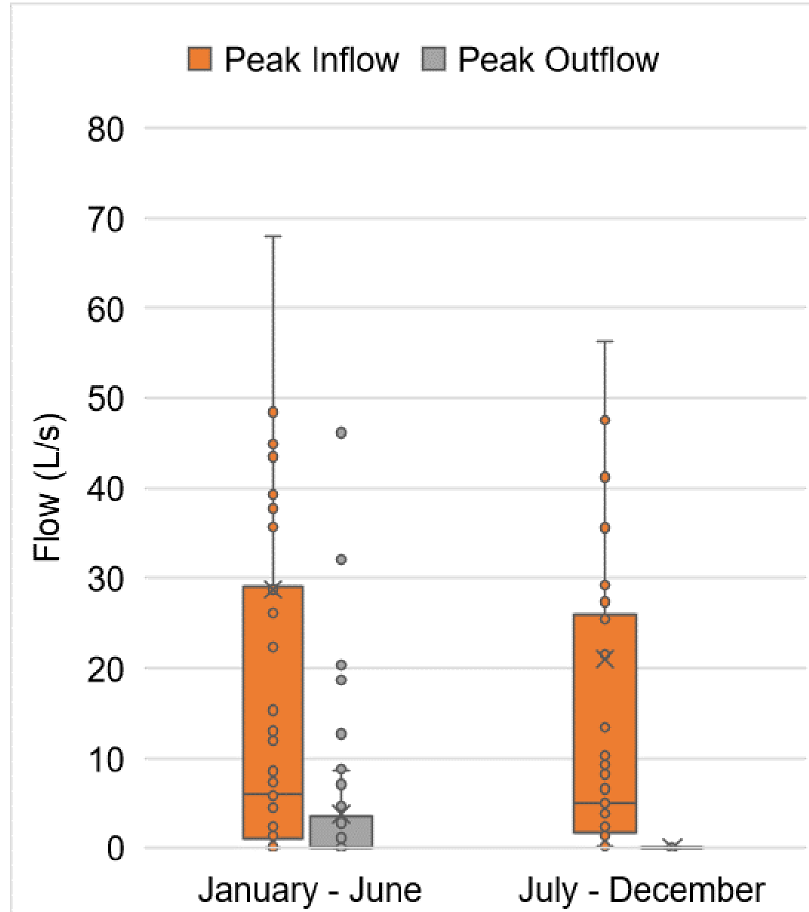
Seasonal Comparison of Pond water levels

Stormwater Pond A: water level variation through the year



Stormwater Pond A: Peak Flow Reduction





Stormwater Pond A: Comparison with Design Model

Design Model

Return Period	Precipitation Duration (hours)	Precipitation Depth (mm)	Pre-Development Flow Rate (m^3/s)	Flow Rate with Pond (m^3/s)
2-Year	6	39.62	0.55	0.04
5-Year	6	54.11	1.02	0.12
10-Year	6	64.61	1.38	0.27
25-Year	6	77.63	1.86	0.5
50-Year	6	87.58	2.26	0.76
100-year	6	97.07	2.65	1.06

Monitored Events

Date	Return Period Range (year)	Precipitation Duration (hours)	Precipitation Depth (mm)	Peak Precipitation Intensity (mm/hr)	Measured Peak Flow (m^3/s)
2018-07-05	>2<5	0.3	20.2	120	0.000
2016-08-25	>2<5	0.8	26.4	115.2	0.000
2015-08-10	>5<10	7.3	59.0	62.4	0.006
2017-06-22	>5<10	12.6	65.2	129.6	0.013

Stormwater Pond A: Comparison with Design Model

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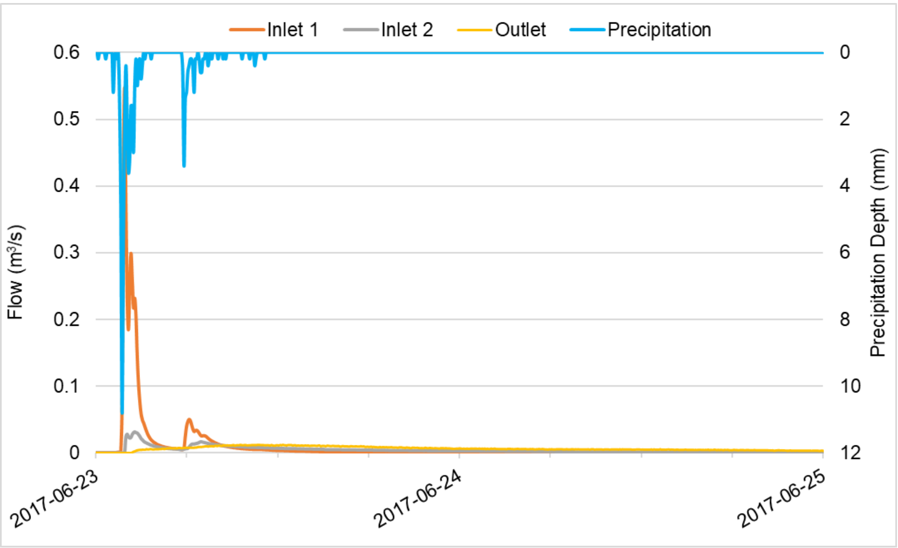
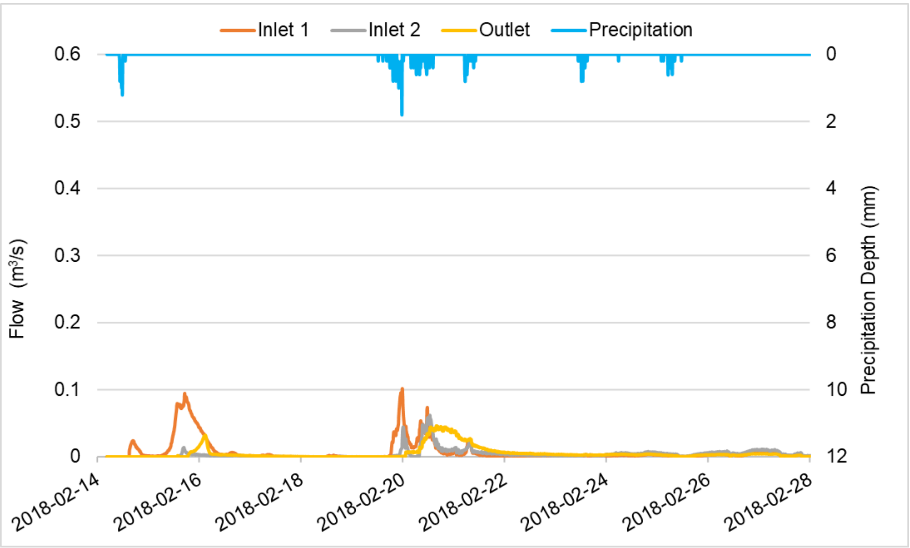
Design Model

Date	Return Period (year)	Precipitation Duration (hours)	Precipitation Depth (mm)	Measured Peak Flow (m^3/s)
2015-06-16	<2	4.4	34.0	0.014
2016-03-31	<2	19.8	32.8	0.019
2017-04-06	<2	16.9	29.8	0.019
2017-05-04	<2	30.3	50.4	0.020
2018-02-14	<2	2.8	7.2	0.032
2018-02-19	<2	26.0	26.8	0.046

Events with Peak Flow exceeding 0.013 m^3/s

Stormwater Pond A: Event Comparison

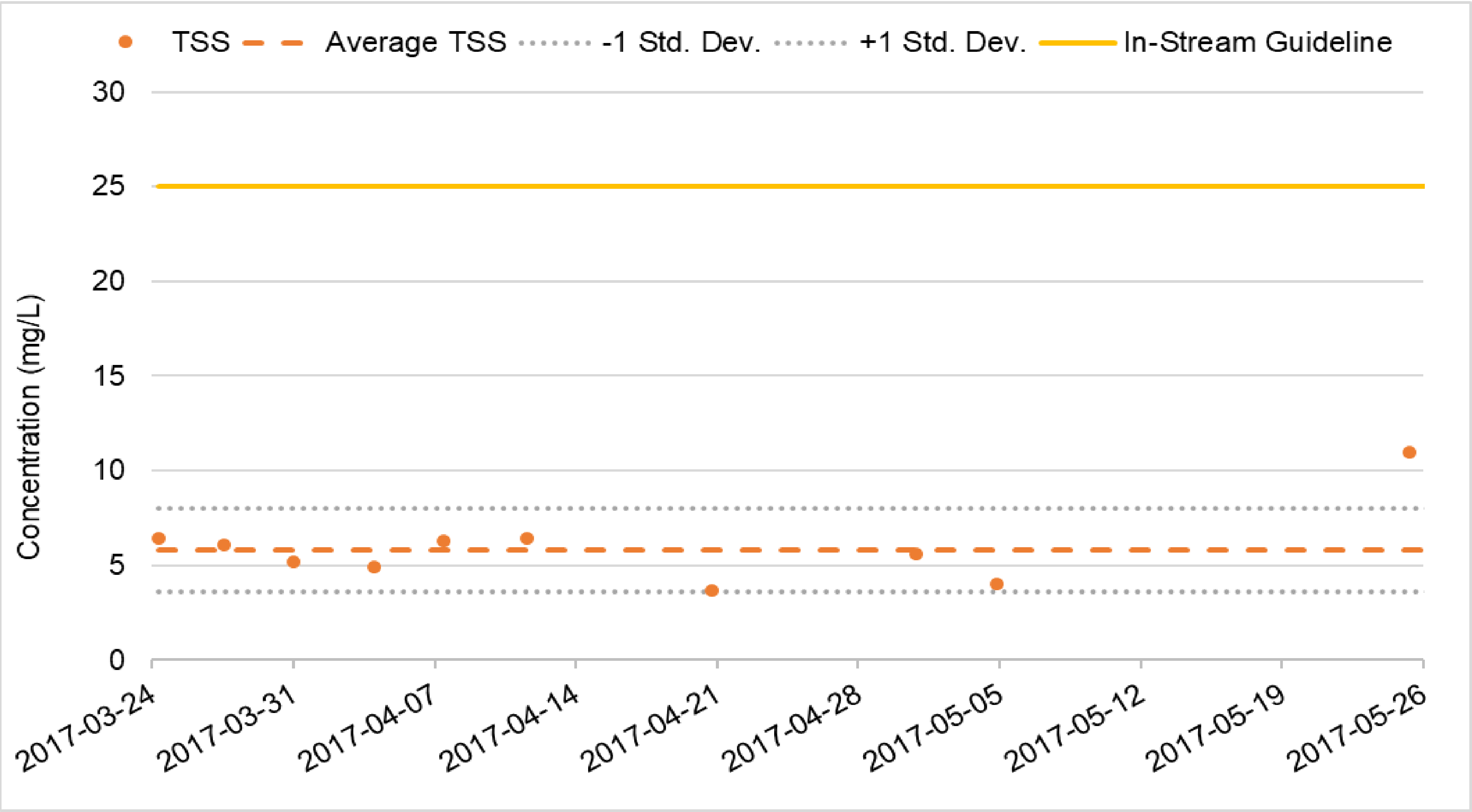




- Early summer event
- High peak intensity and average precipitation intensity >5year return period
- Pond was below permanent pool level prior to event

- Winter event
- Average precipitation intensity <2 year return period
- Pond was at or above permanent pool level prior to event
- Multiple low intensity events in succession, including rain on snow

Stormwater Pond A: Effluent TSS



Performance of Stormwater Pond A

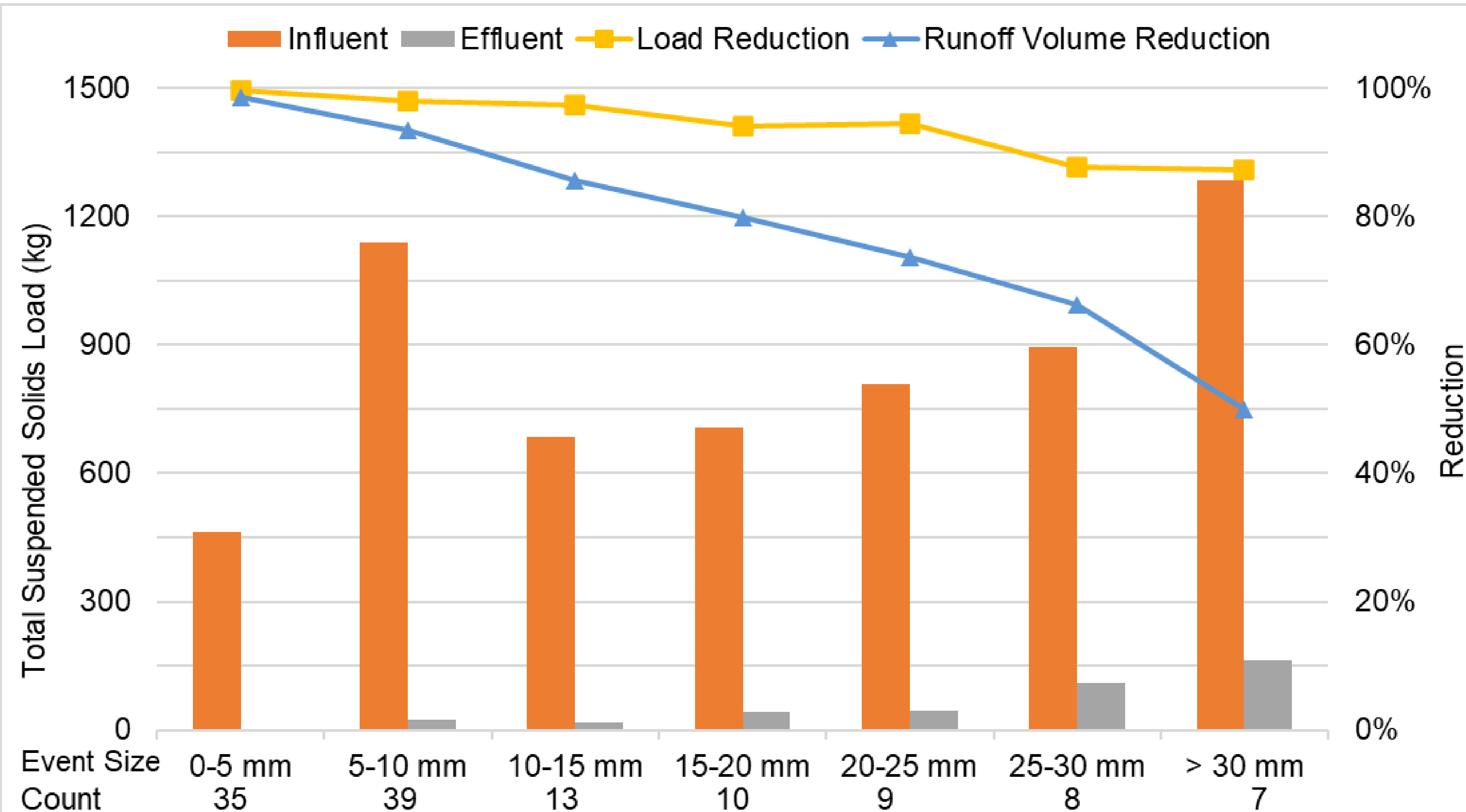
- Not performing quite as expected but in some ways exceeding design
  - Summer and Fall peak flow reduction seems to exceed design
  - Pond doesn’t stabilize at expected permanent pool
  - For the most part flows only occur in Winter and Spring
  - Effluent water quality pretty good in terms of TSS

What is the influence of the upgradient LID practices on the performance of stormwater management Pond A?

LID Performance: Volume Reduction

Month	Count	Estimated Runoff (m^3)	Measured Discharge from LID Treatment Train (m^3)	Volume Reduction (%)
June	28	12500	4244	66
July	16	5031	995	80
August	26	9960	2813	72
Summer	70	27491	8051	71
September	20	6570	950	86
October	17	5947	1104	81
November	14	4252	837	80
Autumn	51	16770	2891	83

LID Performance: Load Reduction



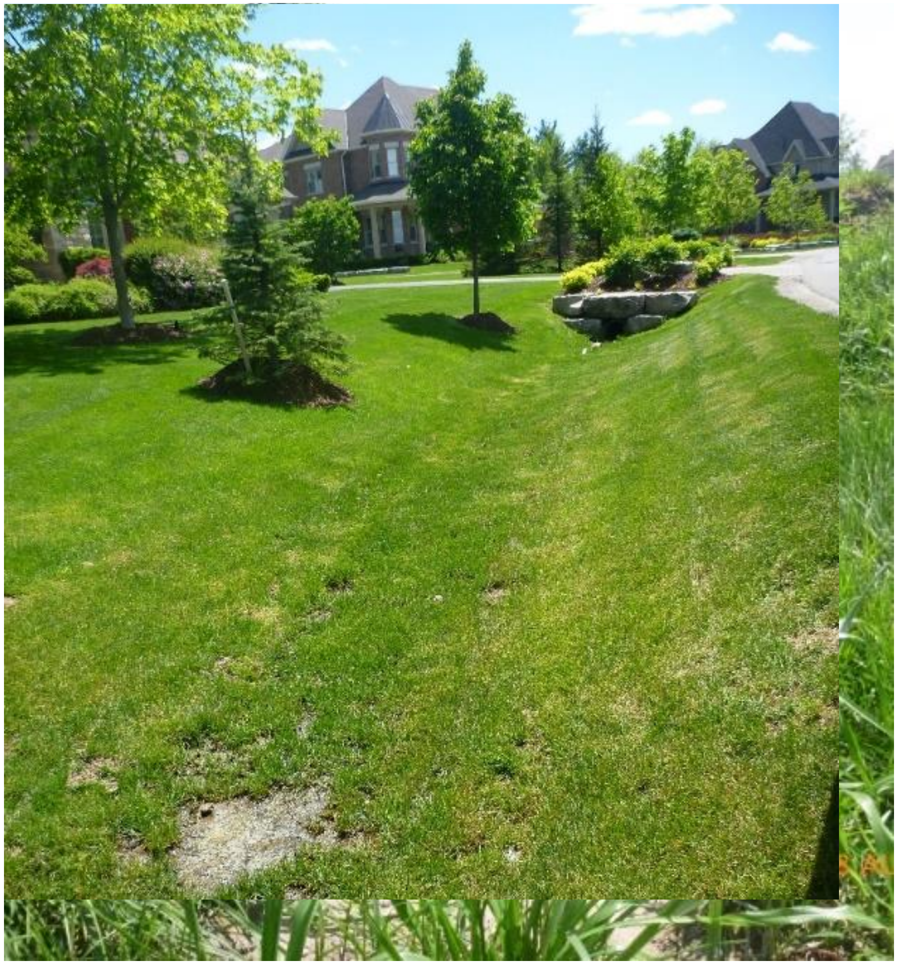
Influence of LIDs

- Volume reductions
  - Contributes to performance of pond
  - LIDs could have been considered when sizing pond
- Load reductions
  - Reduced contaminants entering pond
  - LIDs will require maintenance to provide ongoing treatment

How can the monitoring results inform asset management at MITG and of stormwater management ponds in treatment train designs?

Grass Swales: Observations

- Trash accumulation after waste collection days
- Sediment accumulates in culverts
- Appear to be well maintained by residents
- Some swales are consistently wet at bottom, may erode more readily



Bioretention Cell: Observations

- Overgrown vegetation could impede sightlines and be a safety problem
  - This was a comment from residents

Permeable Pavers: Observations

- Clogging of permeable pavers in topographic low near the pond
  - this would be where flow paths converge possibly resulting in higher loads

Pond A: Observations

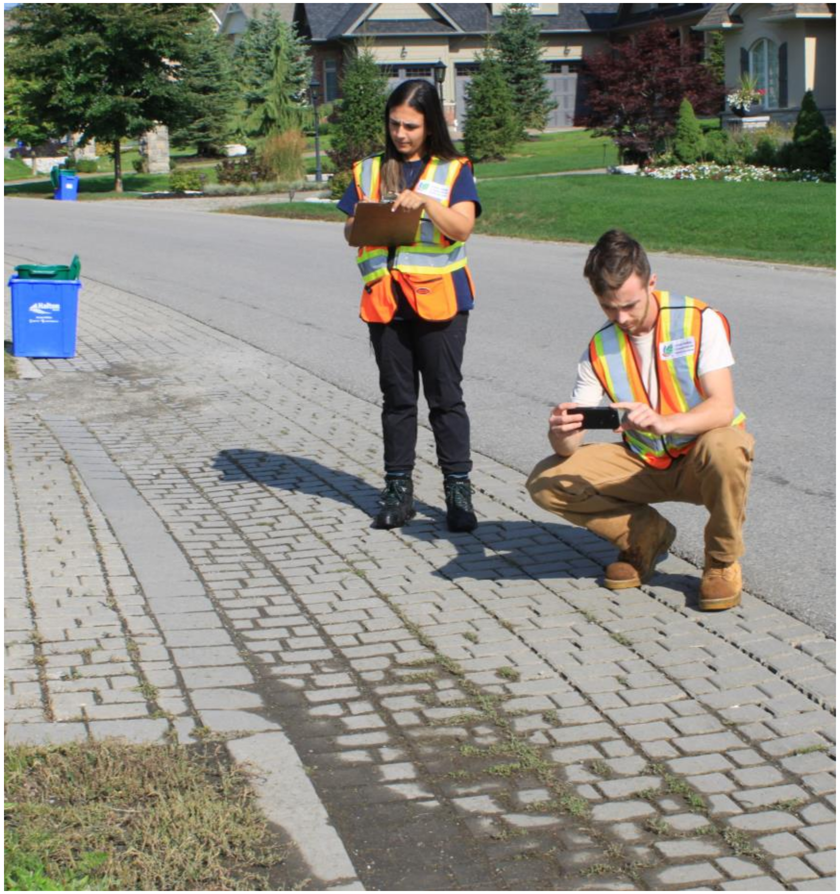
- Volume reduction from LIDs may reduce sediment load entering pond
- Stagnant for a long time, might be encouraging algae growth and mosquitoes
- Invasive plant species present

General Observations

- Costly remediation during establishment period
  - Beneficial for Municipality to have clear assumption protocols so the developer will cover these expenses
  - Construction inspections can help ensure that design and sediment and erosion control is implemented properly

Asset Management Conclusions

- Maintenance of all stormwater features is crucial to ensure ongoing performance
- Maintenance needs are localized based on spatial distribution of sediment loading
- Low water levels in the pond may result in special maintenance considerations.



Lessons Learned

- Be prepared to adapt monitoring plans to local conditions and apply different approaches to monitoring and analysis, for example, focusing on event-based analysis may not be appropriate for all study sites.
- Winter monitoring
- Incorporate pond water level measurement for future monitoring plans
- Whenever possible monitor influent quantity and quality directly to allow for greater accuracy in volume and load reductions.

Conclusions

- It is suspected that volume reductions provided by upgradient LID features influence water balance
- Contaminant load reductions by the LID features improve water quality in the pond.
- LID features could have been taken into consideration when sizing the pond, while still meeting design objectives.
- Strictly Event-Based Modelling approaches might not be best way to understand peak flows in this setting
- Regular maintenance is very important to ensure ongoing treatment is provided by the LIDs and the pond

questions?

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