Reducing Pollutant Discharge into Urban Rivers by Controlling the Retention Time in a Stormwater Pond

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Overview

- Introduction
- Problem Statement
- Objectives
- Materials and Methods
- Results
- Conclusion

Introduction: Concepts
Urban Stormwater Pollutant Concentrations

Average Concentration of Pollutants	
Parameters	**Stormwater** (Adapted from EPA, 1993; Rivard, 1998)
TSS (mg/L)	141-224
Total Nitrogen (mg/L)	3-24
Total Lead (µg/L)	161-204
Total Zinc (µg/L)	140
Total Copper (µg/L)	53*

*Adapted from ASCE and WEF, 1992; Rivard, 1998

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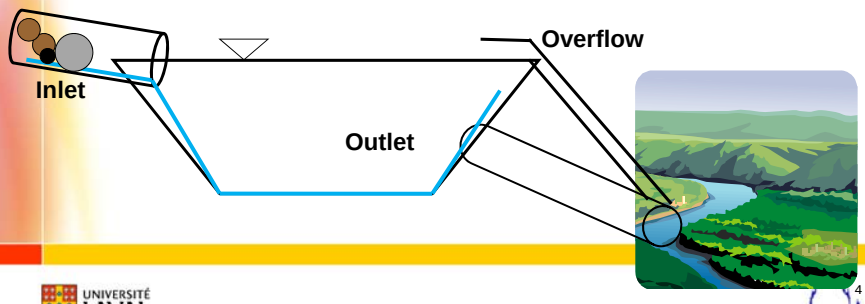
Problem Statement

- No stormwater quality data for Quebec
- 60 % removal efficiency for detention ponds
  (BMPdatabase, 2008)
  - Removal of larger particles with high settling velocities
  - Smaller particles reach receiving waters



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Problem Statement

Particle sedimentation vs absorbed pollutants

	Sedimentation		Pollution
Particle diameter	Settling velocity	Time[1] needed for 1 meter drop	Adsorbed Concentration[2]
µm	m/h		(µg Cu/g TSS)
< 20	0.009	4d	4000
20-40	0.05	21h	700
40-60	0.09	11h	310
60-130	0.5	2h	250
130-400	2.1	0.5h	140
400-4000	19.8	3min	40

1. Adapted from OME, 2000
2. Adapted from Chan et al., 2008

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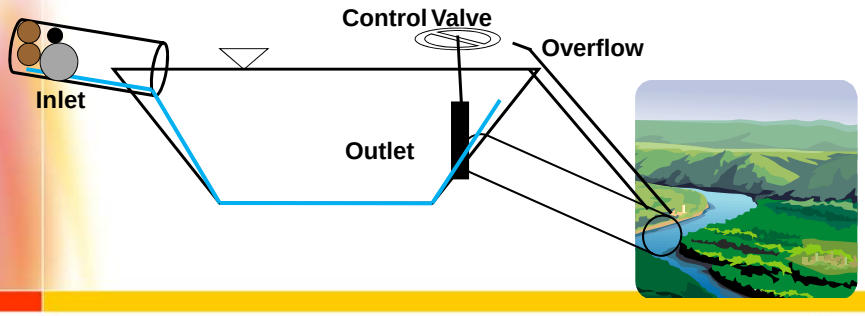
Objectives

- Evaluate stormwater quality in Quebec
- Evaluate impact of stormwater pond outlet control
  - 60-80% Removal efficiency minimum (OMOE, 2003)



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Materials and Methods

- Sampling Inlet/Outlet stormwater detention pond
  - Residential catchment
  - Un-controlled pond
  - Outlet controlled pond
- Step 1 : Find appropriate study site

Materials and Methods
Chauveau Stormwater Pond

Materials and Methods
Chauveau Stormwater Pond

Catchment Area	Detention Pond Volume	Maximum Water Height	Inlet/Outlet Ø
15.1 Ha	~3500 m^3	1.4 m	90/45 cm

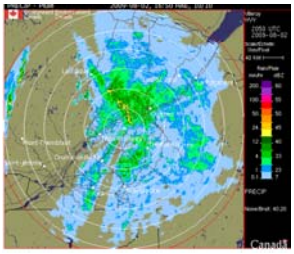
Inlet

Channel

Outlet

Materials and Methods
Measurement Campaign

- «Stormchasing»
- Sampling campaign
  - Grab and composite samples;
  - Inlet/Outlet and inside pond;
    - Suspended solids
      - TSS / VSS
    - Copper, Manganese, Zinc
      - Total and dissolved/particulate fractions
    - Ammonia Nitrogen



Environment Canada radar

Materials and Methods
Measurement Campaign

In-pond sampling sites

Materials and Methods
Measurements

Flow In/Out

Rain measurement

Materials and Methods
Measurements

Manual Sampling

Materials and Methods
Outlet Control Structure

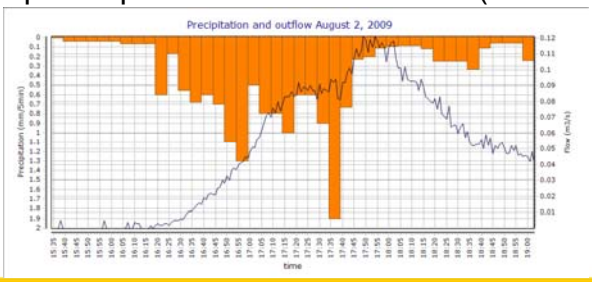
Inside
Open

Side/Front
Closed

Results
Summary of Sampled Storms

	Total Height	Duration	5-min Max Intensity
	mm	(hh:mm)	mm/h
10 storms	1.20 – 33.40	0:38 – 23:59	3.0 – 36.0

- Rapid response time of catchment (15 minutes)



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Results
Concentrations of Composite Samples

Average Concentration of Pollutants		
	Results	
Parameters	IN	OUT
TSS (mg/L)	35-559	13-204
NH4 (mg/L)	0.05-0.63	0.01-0.44
Zinc total (µg/L)	20-150	20-70
Cu total (µg/L)	0-60	0-50

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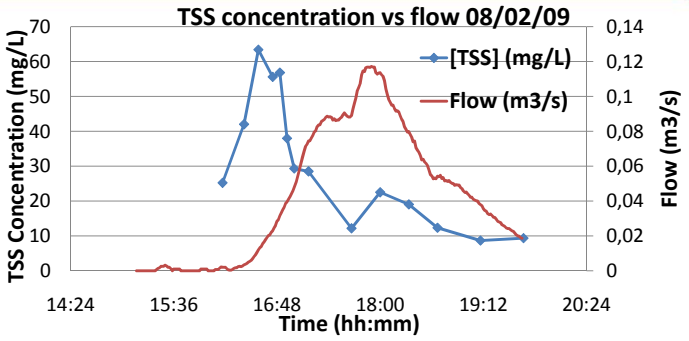
Results
First Flush Effect

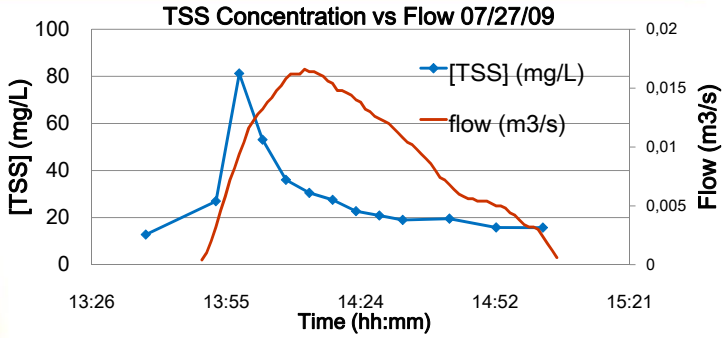
- First flush recognized by lag time between concentration and flow peak measurement

Results
First Flush Effect



Total Height	Duration	5-min Max Intensity
mm	(hh:mm)	mm/h
16.00	3:19	24.0

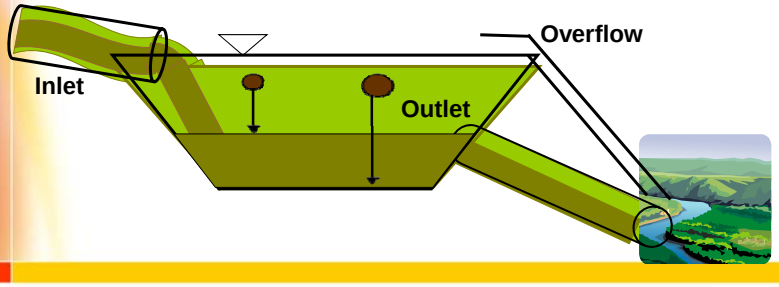
Results
First Flush Effect



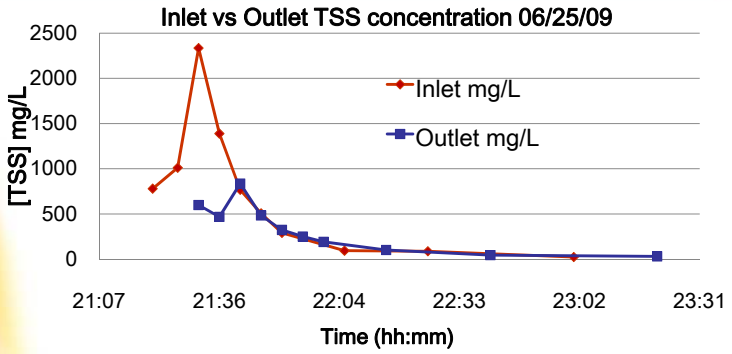
Total Height	Duration	5-min Max Intensity
mm	(hh:mm)	mm/h
1.20	0:38	12.0

Results
First Flush Effect

- **First Flush:** Indicator of possible poor removal efficiencies:
  - Peak pollutant concentration at low flow during beginning of storm event;



Results
TSS Concentration Inlet/Outlet



- First Major Storm of 2009 Summer
- Many Construction Sites on Catchment: «Dirty» Streets

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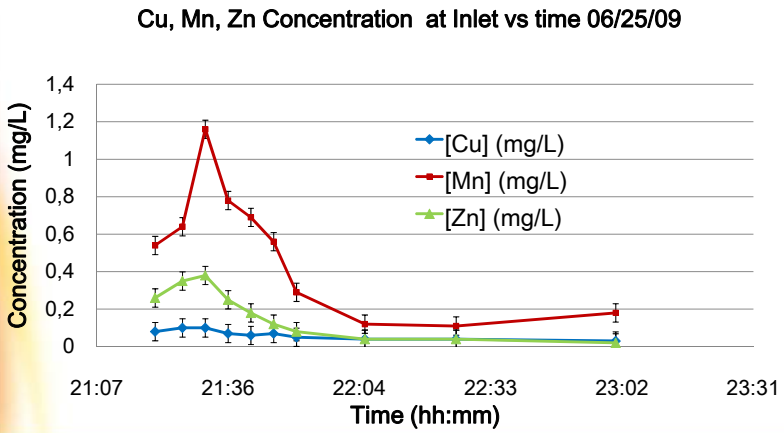
Results
Heavy Metals Cu, Mn, Zn



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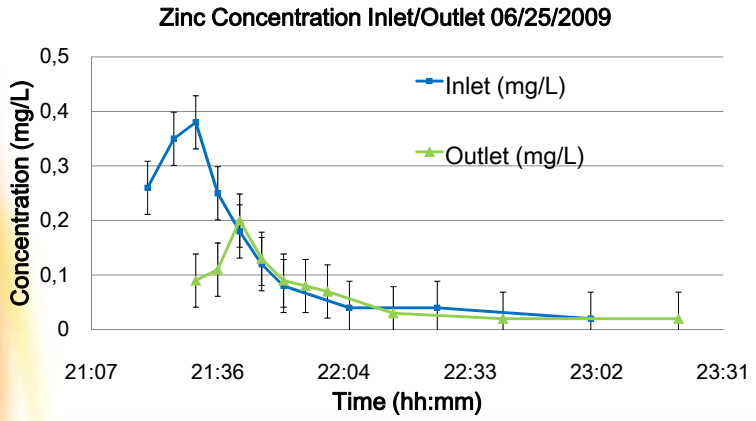
Results
Heavy Metals Zinc Inlet/Outlet



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Results
Sedimentation with controlled outlet

In-pond sampling sites

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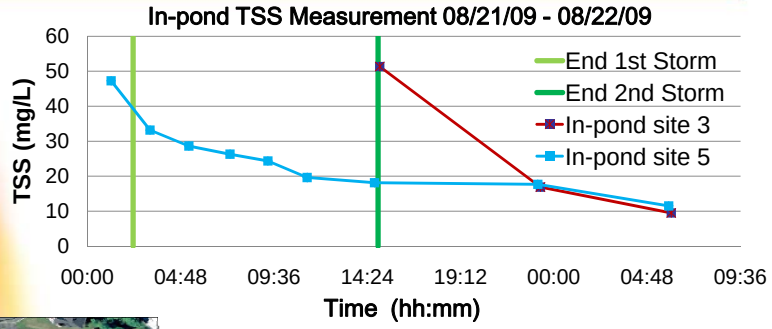
Results
Sedimentation with controlled outlet



	Total Height	Duration	5-min Max Intensity	TSS
	mm	(hh:mm)	mm/h	mg/L
Storm 1	3.40	1:42	11.8	71
Storm 2	4.60	1:15	18.7	74

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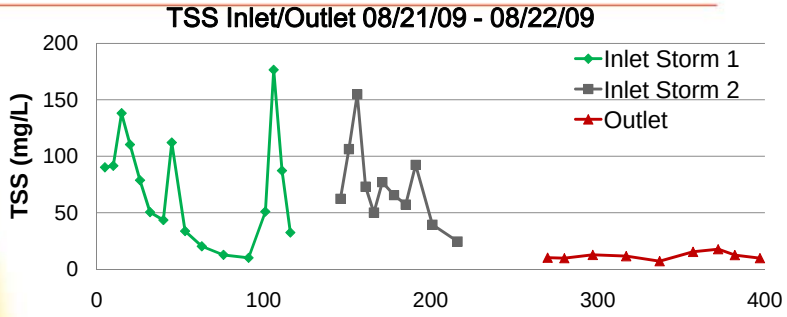
Results
Outlet Control Impact



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Conclusion and Outlook

- Stormwater pond and runoff
  - Pollutant concentrations in accordance with litterature;
- Outlet control

  Increase removal efficiencies of existing stormwater detention ponds;
- Adapt existing infrastructures to stormwater quality management:
  - Dual function of detention ponds
    - Quantity and quality management

Acknowledgements

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«Research is what i'm doing
when I don't know what i'm doing»
-Wernher von Braun