

Stormwater Treatment Monitoring Project

ENSC 22

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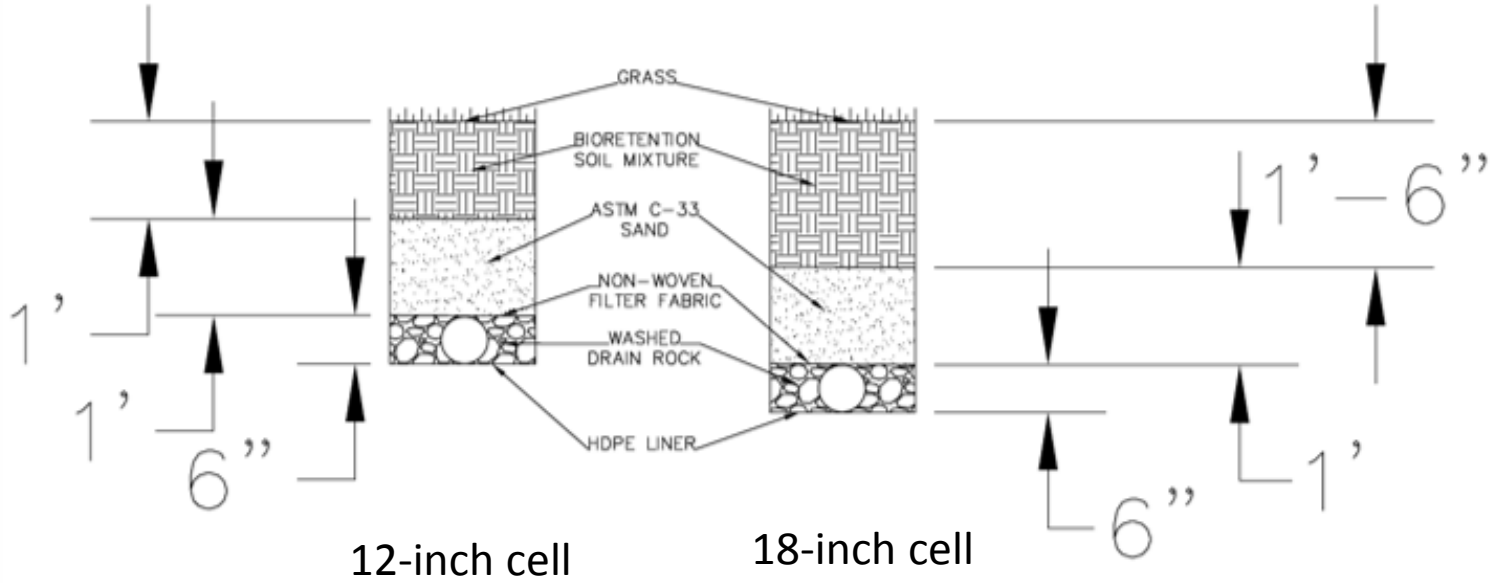


Introduction to the Project



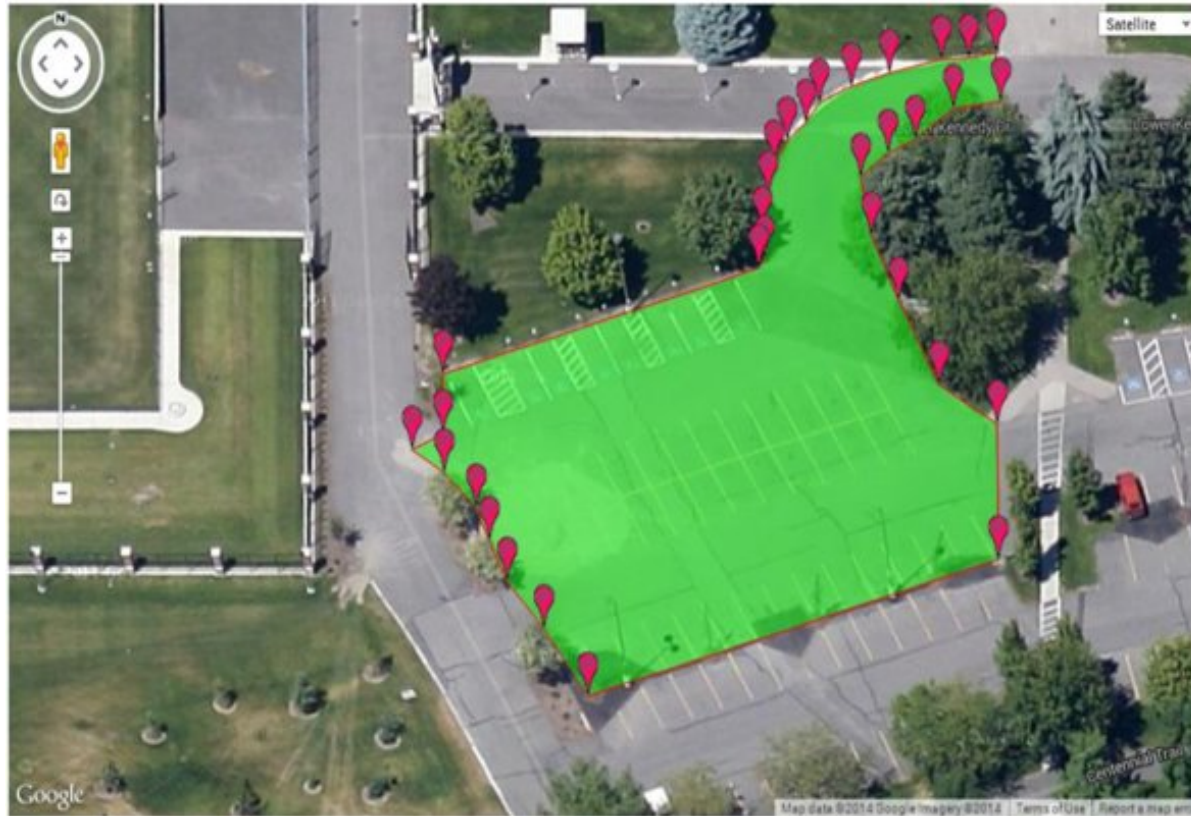
Dual-cell bioretention unit

Introduction to the Project



Cross section of bioretention soil media (BSM)

Introduction to the Project



Contributing drainage area

Introduction to the Project

- Approved in Western Washington:
 - 18-inch BSM depth
 - 60% sand and 40% compost
- Reduces stormwater concentrations of:
 - Total suspended solids (TSS)
 - Dissolved copper
 - Dissolved zinc

Project Goals and Objectives

Goals

Advance an understanding of the treatment performance of:

- 12-inch BSM vs. 18-inch BSM
 - Save on construction costs
- Both cells during cold climate conditions, specifically with deicer

Objectives

- Literature search
- Collect stormwater samples
 - TSS, total phosphorus (TP), dissolved copper & zinc
- Analyze pollutant reduction concentrations
 - Statistical analyses

Literature Search – Pollutants of Concern

○ TSS

- Mechanical filtration
- No removal effect from cold climate
- Increase in influent concentration

○ TP

- Conflicting results in cold climate conditions

○ Dissolved Metals

- Varying results in cold climate conditions

Literature Search – BSM & Hardness

○ BSM

- Cation exchange capacity (CEC)
- Sodium adsorption ratio (SAR)

○ Hardness

- Decreases toxicity of metals
- Not required by Ecology

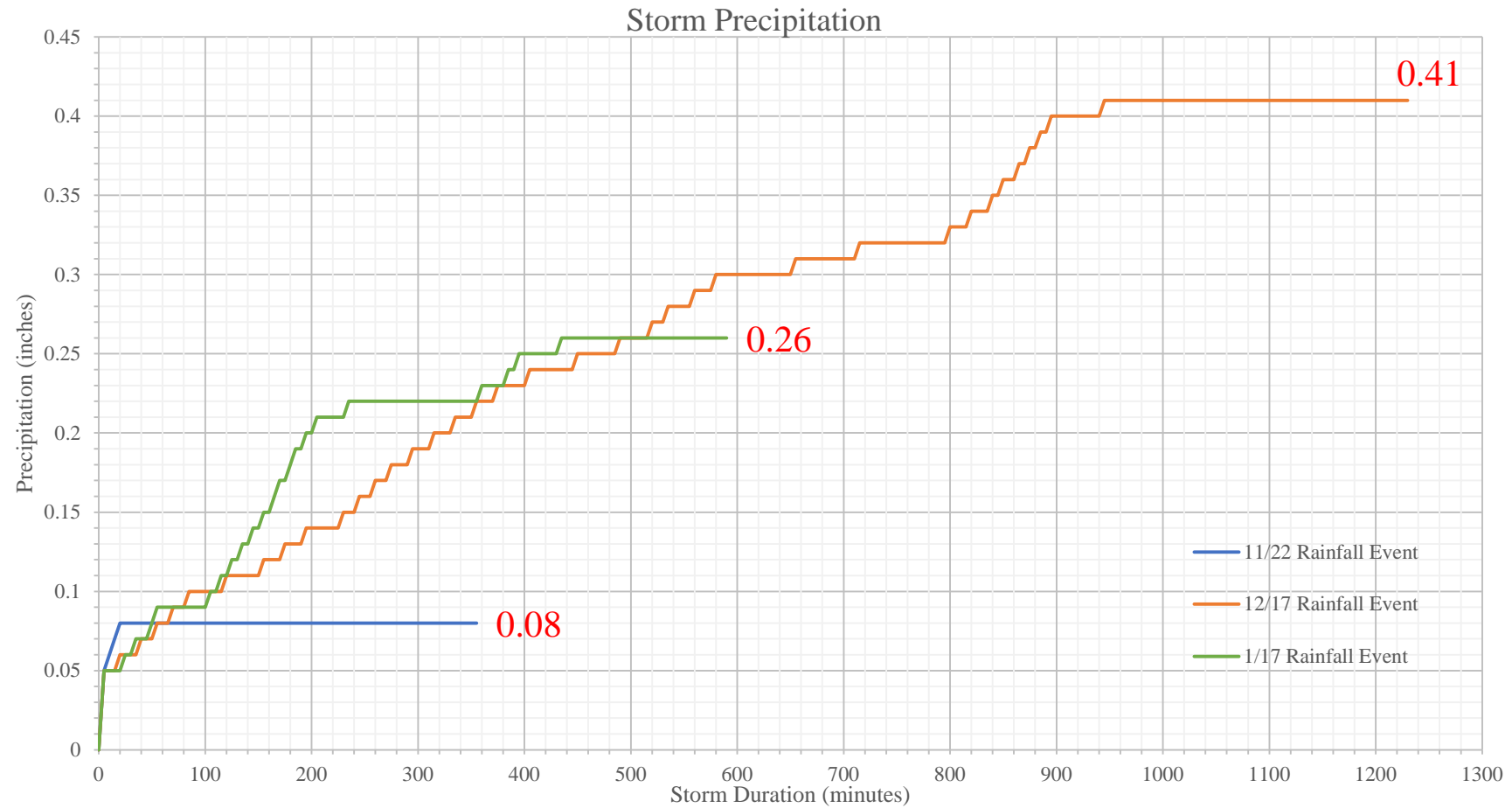
Sampled Events

Date of Sample Collection	Qualification	Samples Collected?	Deicer Applied?
11/22/2018	Non-qualifying ¹	Yes	No
12/11/2018	Qualifying	No ²	Yes
12/17/2018	Qualifying	Yes	No
1/17/2019	Qualifying	Yes	Yes
2/1/2019	Non-qualifying ¹	No ²	Yes

¹The precipitation depth was less than 0.15 inches.

²Temperatures were too cold and the automatic sampler turned off.

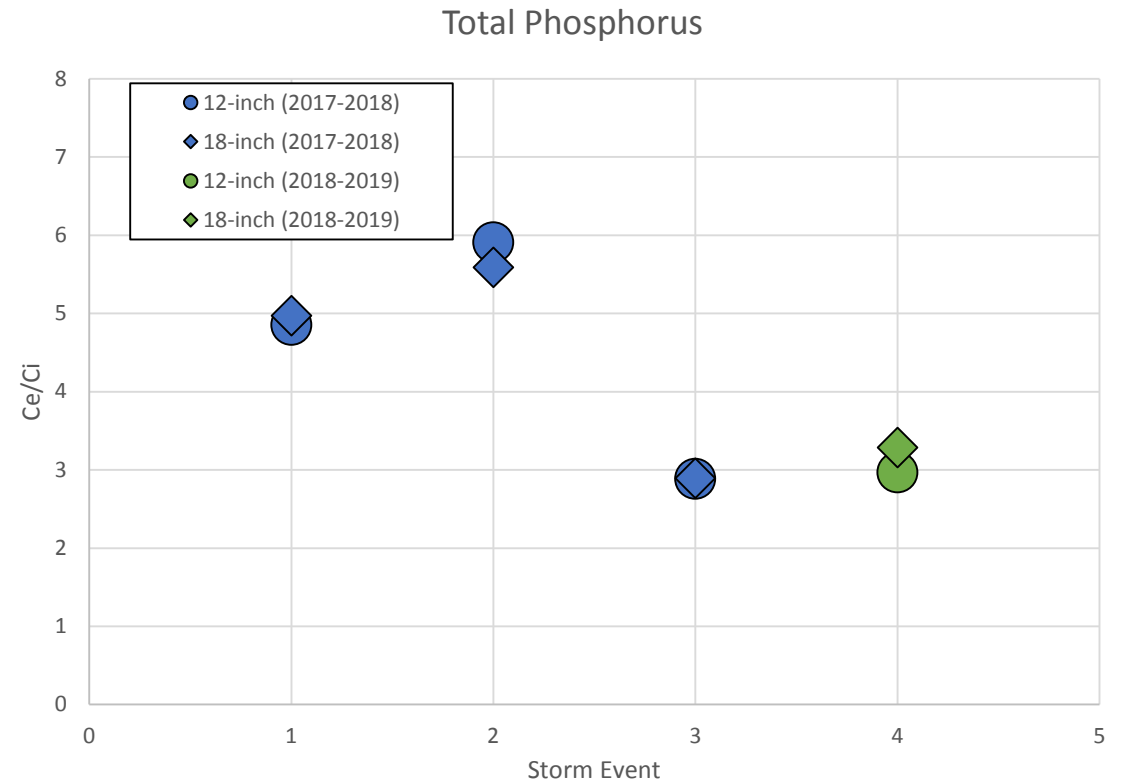
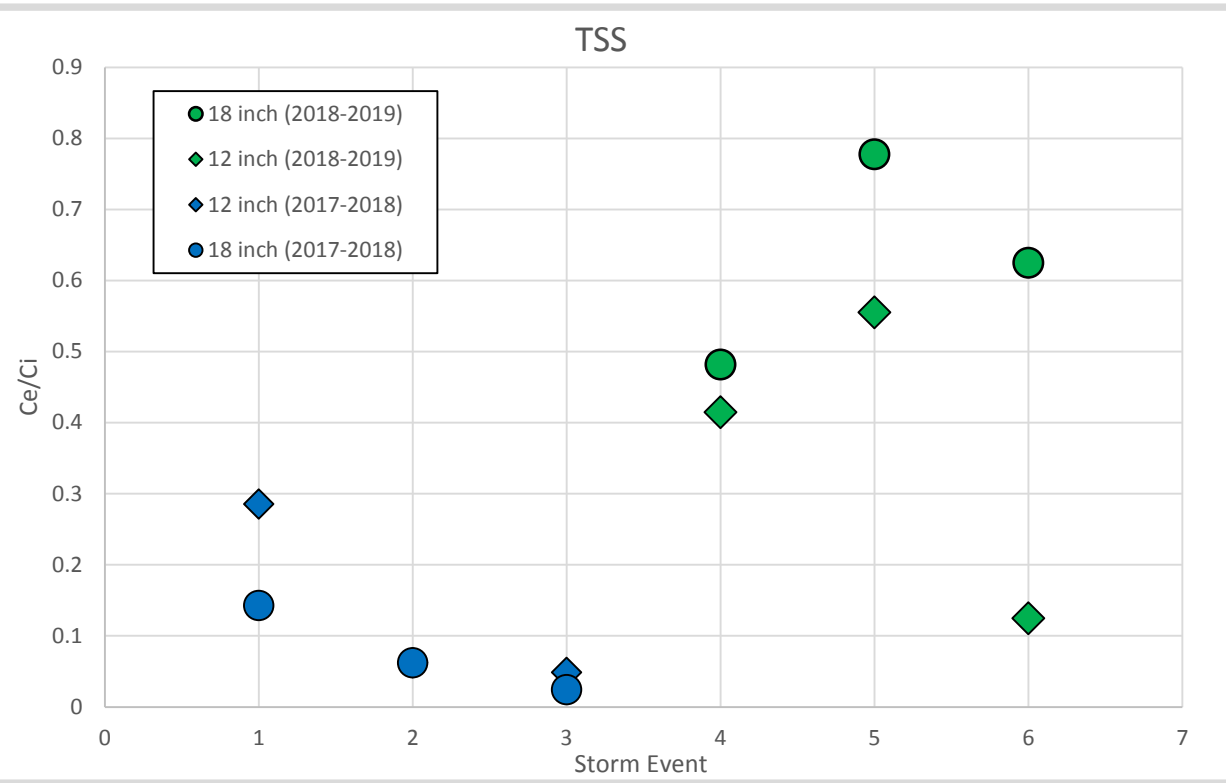
Storm Data



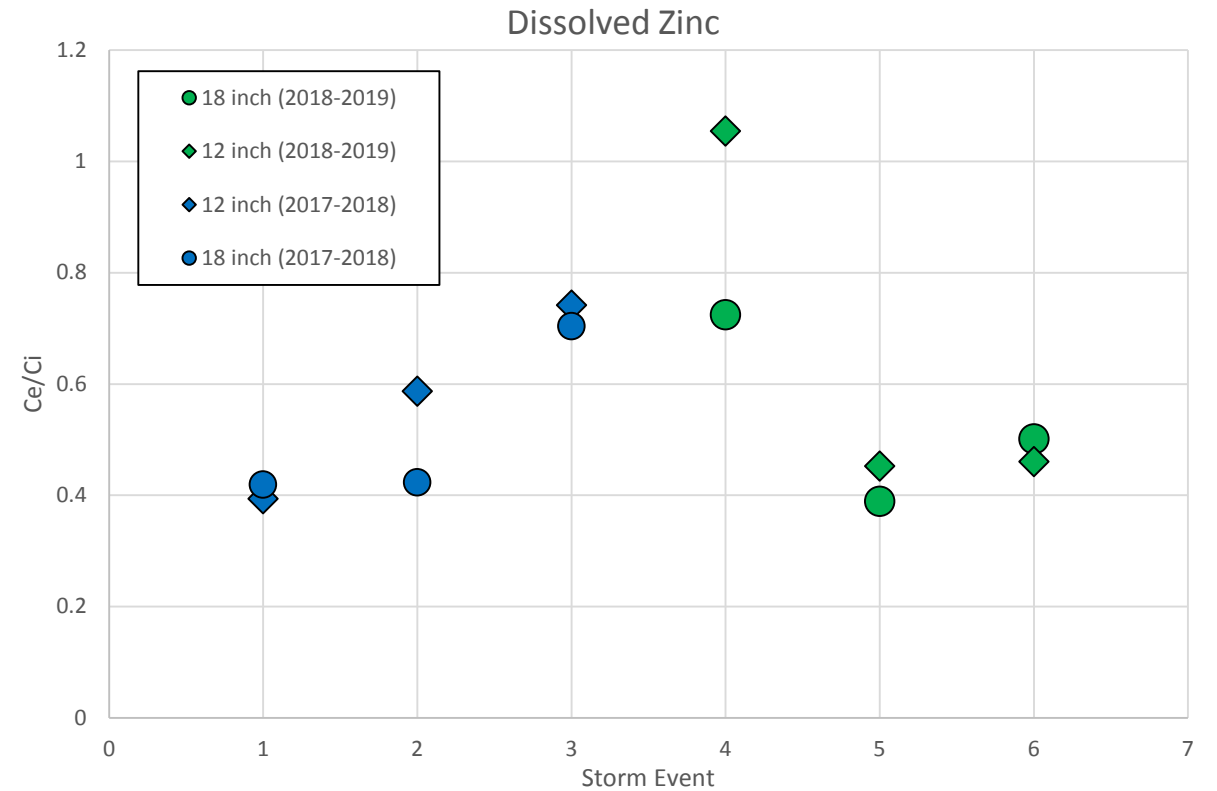
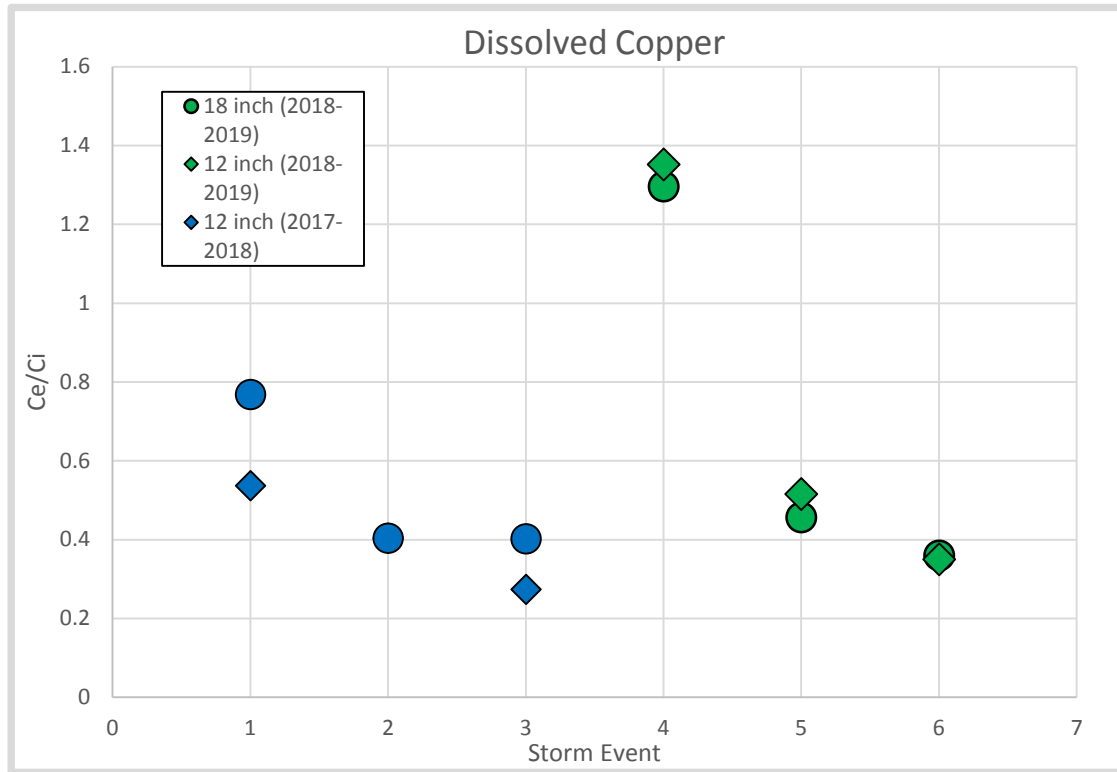
Pollutant Data

Pollutant	Comparison	Percent Removal (%)						Average (All Events, Both Years)	p-value	Statistically Significant? (Y/M/N)
		Last Year Storm Events			This Year Storm Events					
		1	2	3	4	5	6			
TSS	Influent vs. 12-inch	71.43	93.75	95.12	58.5	44.44	87.5	75.12	0.00015	Yes
	Influent vs. 18-inch	85.71	93.75	97.56	51.81	22.22	37.5	64.76	0.00209	Yes
	12-inch vs. 18-inch	-	-	-	-	-	-	-	0.317	No
TP	Influent vs. 12-inch	-397.06	-458.82	-189.56	N/A	-196.61	N/A	-310.51	0.0102	Yes
	Influent vs. 18-inch	-385.31	-490.91	-188.48	N/A	-228.81	N/A	-323.38	0.0096	Yes
	12-inch vs. 18-inch	-	-	-	-	-	-	-	0.339	No
Dissolved Copper	Influent vs. 12-inch	46.35	59.63	72.66	-35.20	48.44	65.02	42.82	0.0226	Yes
	Influent vs. 18-inch	23.18	59.63	59.82	-29.60	54.33	64.04	38.57	0.0246	Yes
	12-inch vs. 18-inch	-	-	-	-	-	-	-	0.407	No
Dissolved Zinc	Influent vs. 12-inch	60.60	41.30	25.80	-5.45	54.74	53.95	38.49	0.00637	Yes
	Influent vs. 18-inch	58.10	57.65	29.62	27.53	61.05	49.83	47.30	0.00029	Yes
	12-inch vs. 18-inch	-	-	-	-	-	-	-	0.182	No

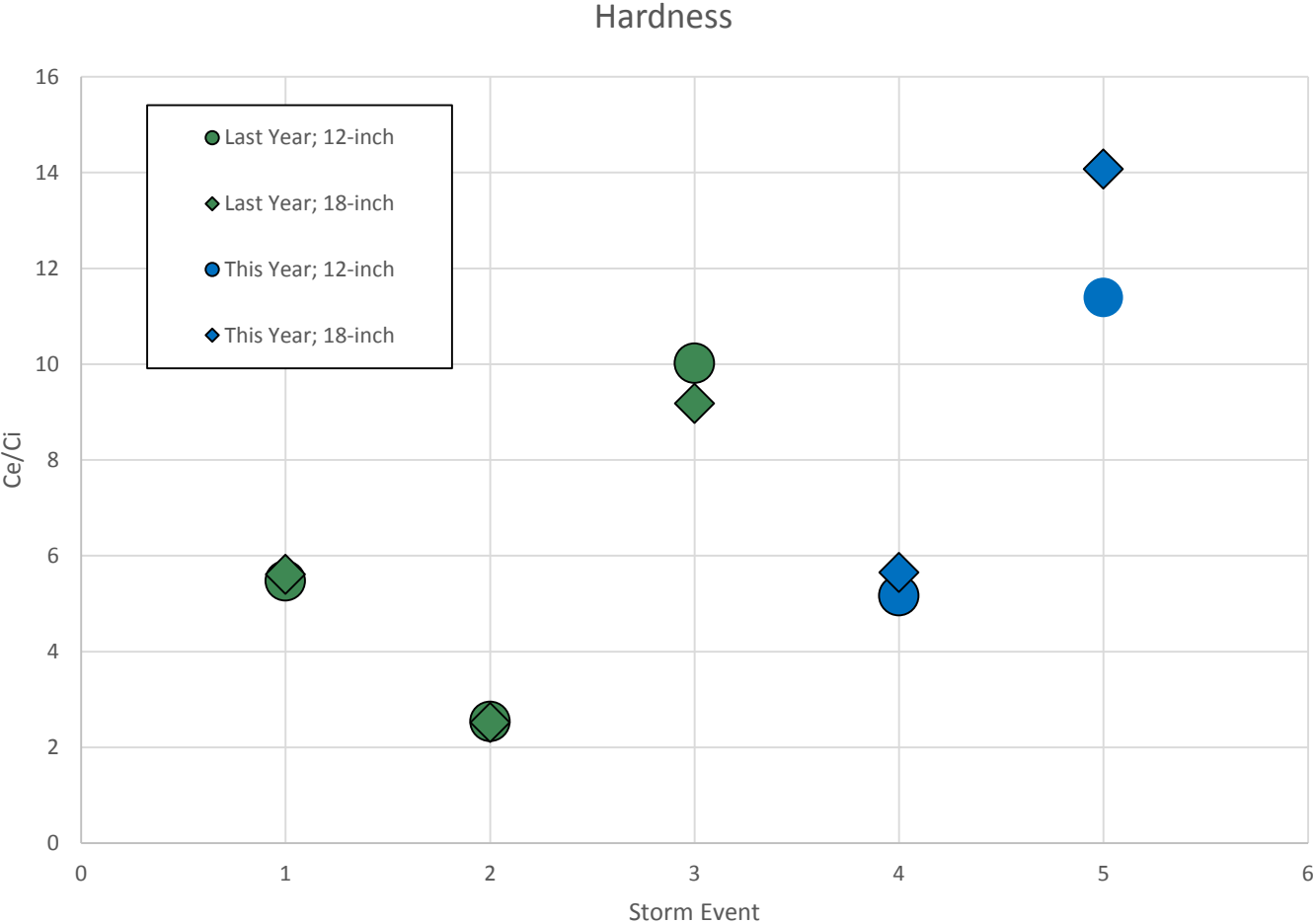
Concentration Effluent / Concentration Influent Graphs



Ce/Ci Graphs



Hardness



Column Test

- Hardness Concentration
- Deionized water = influent
- Influent < 1 mg CaCO_3/L
- 12" BSM = 112 mg CaCO_3/L
- 18" BSM = 146 mg CaCO_3/L



Schematic of Column Test



Sample Collection

BSM Testing

Soil Parameters	Test Method
Saturated Paste: pH, Ca, Mg, Na, P	S-1.10
Saturated Paste: SAR	S-1.60
CEC (meq/100g)	S-10.10
Organic Matter (OM)	S-9.20
Total Elements: Cu, Zn, Mg, Ca	EPA 3050A & 6010B



Soil Sample Collection

BSM Testing Results

Parameter	Unit	Uninstalled	12-inch BSM	18-inch BSM
Copper	mg/kg	17.3	16.1	16.8
Zinc	mg/kg	57.7	82.6	86.4
Magnesium	meq/L	3.68	9.18	8.30
Calcium	meq/L	5.25	3.74	3.05
CEC	meq/100 g	9.9	10.7	9.6
Sodium	meq/L	0.47	12.77	17.76
SAR	-	0.27	5.02	7.49
pH	-	7.3	7.0	6.9
Organic Material	%	5.0	6.2	4.5%

Washington State Department of Transportation : 5 meq/100 g dry soil

BSM Testing Results

	Percent Reduction (%)	
Parameter	12-inch BSM	18-inch BSM
Copper	6.94	2.89
Zinc	-43.15	-49.74
Magnesium	-6.71	-3.04
Calcium	28.76	41.90
Cation Exchange Capacity	-8.08	3.03
Sodium	-2617.02	-3678.72
Sodium Adsorption Ratio	-1759.26	-2662.96

Next Steps and Recommendations

- Further research on:

- Hardness
- TP
- Total nitrogen (TN)
- Total petroleum hydrocarbons (TPH)

Conclusion

- Influent vs. Effluent
 - Statistically significant difference
- 12-inch BSM vs. 18-inch BSM
 - Not statistically significant
- Did not meet TAPE and Ecology performance goals
 - TP
 - Dissolved Zn
 - Dissolved Cu

Ecology Treatment Performance Goals

Performance Goal	Pollutant	Influent Concentration Range	Treatment Performance Criteria
Basic Treatment	TSS	100-200 mg/L	80% Reduction
Dissolved Metals Treatment	Dissolved Copper	5.0-20.0 µg/L	30% Reduction
	Dissolved Zinc	20-300 µg/L	60% Reduction

TAPE Treatment Performance Goals

Performance Goal	Influent Range	Criteria	Required Water Quality Parameters
Basic Treatment	20-100 mg/L TSS	Effluent goal ≤ 20 mg/L TSS	TSS
	>100 mg/L TSS	> 80% TSS removal	
Dissolved Metals Treatment	Dissolved copper 0.005 – 0.02 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as > 30% dissolved copper removal	TSS, hardness, total and dissolved Cu and Zn
	Dissolved zinc 0.02 – 0.3 mg/L	Must meet basic treatment goal and better than basic treatment currently defined as > 60% dissolved zinc removal	
Phosphorus Treatment	TP 0.1 to 0.5 mg/L	Must meet basic treatment goal and exhibit \geq 50% TP removal	TSS, TP, orthophosphate