

Determination of Ideal Parking lot Bioswale Porous Material for South Texas

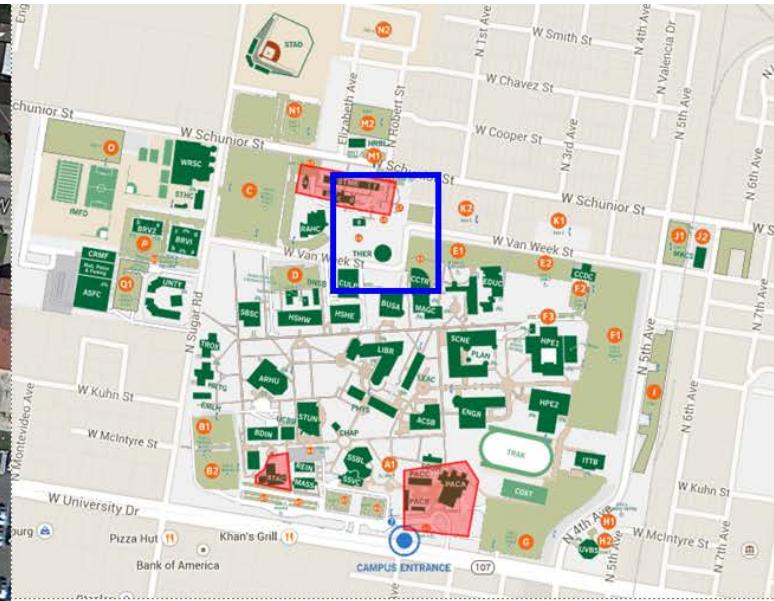
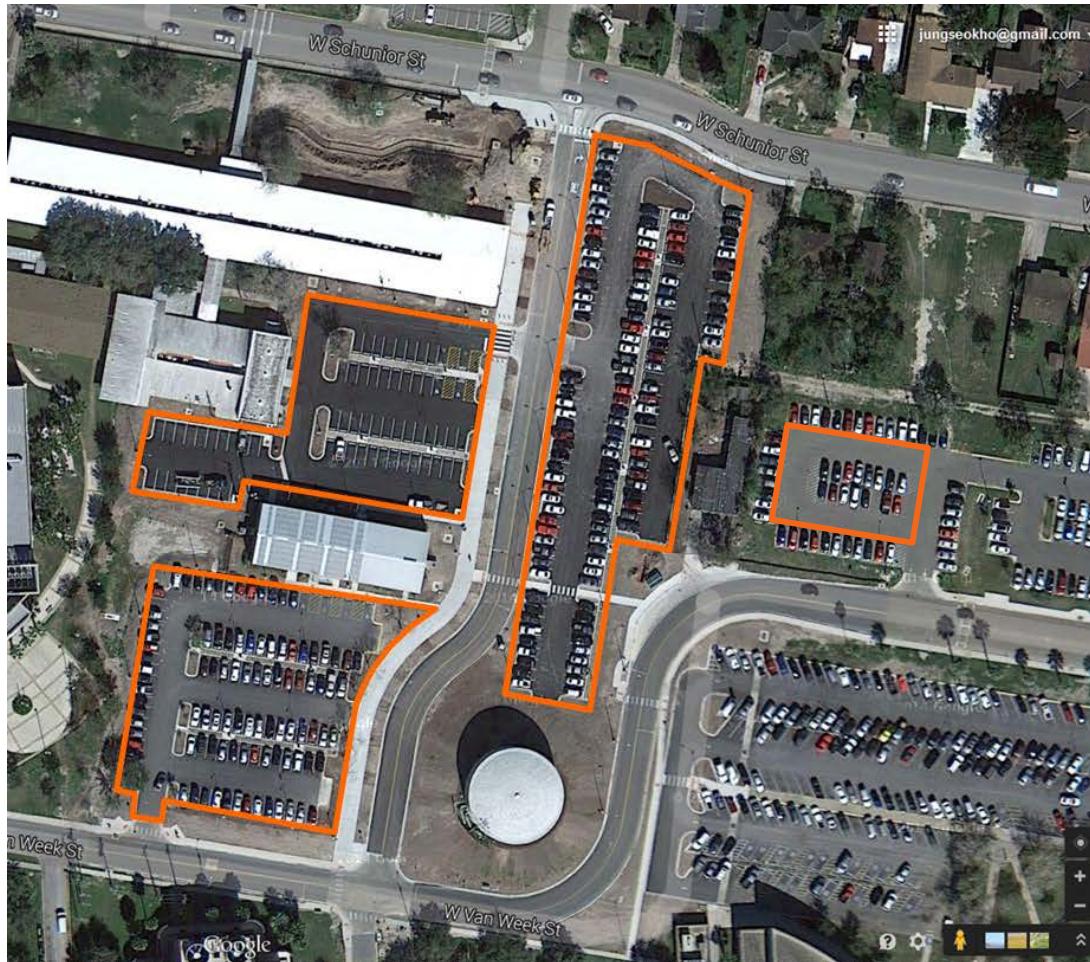
- Border Green Infrastructure Forum, Universidad Technológico de Coahuila, Ramos Arizpe -

Jungseok Ho, Ph.D., P.E.

Civil Engineering Department

University of Texas Rio Grande Valley

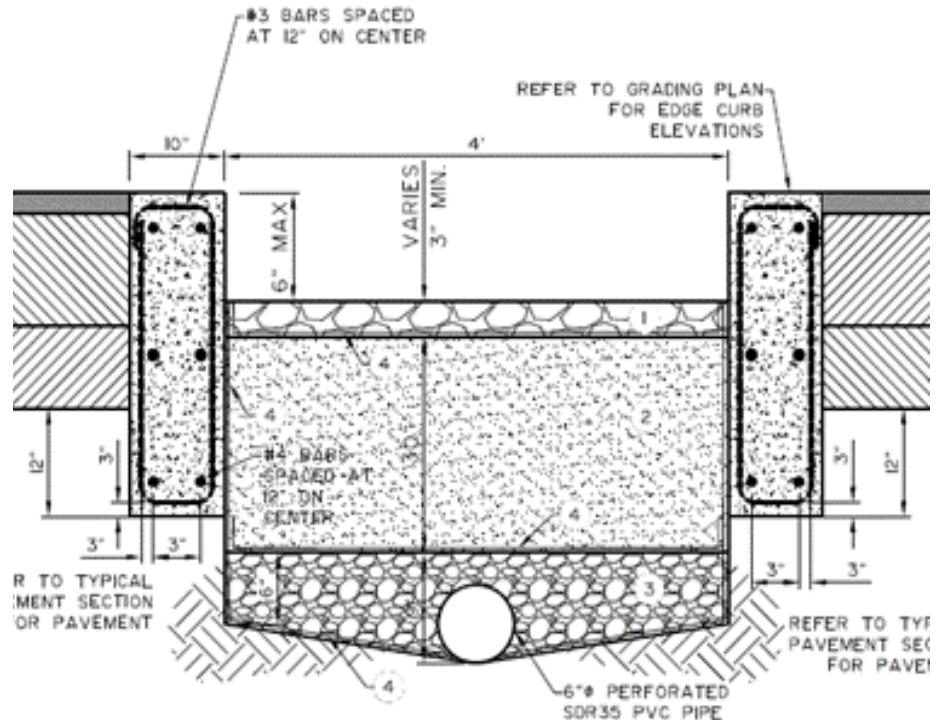
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City of McAllen, TX
City of Edinburg, TX
City of La Feria, TX
City of Harlingen, TX
City of Brownsville, TX
LRGV Stormwater Taskforce

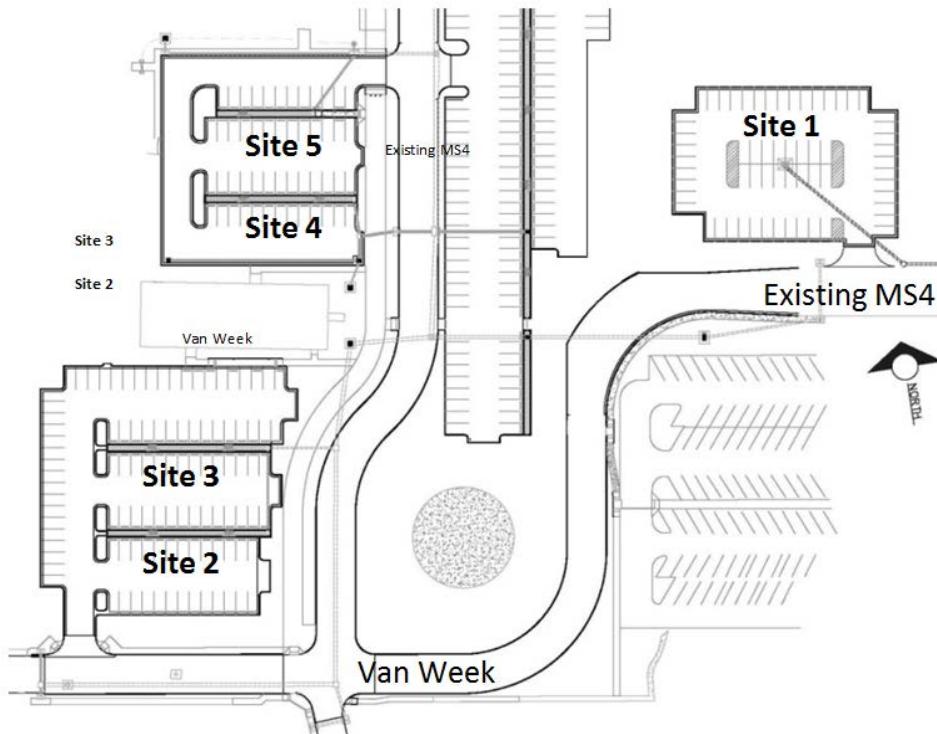


UTRGV Bioswale



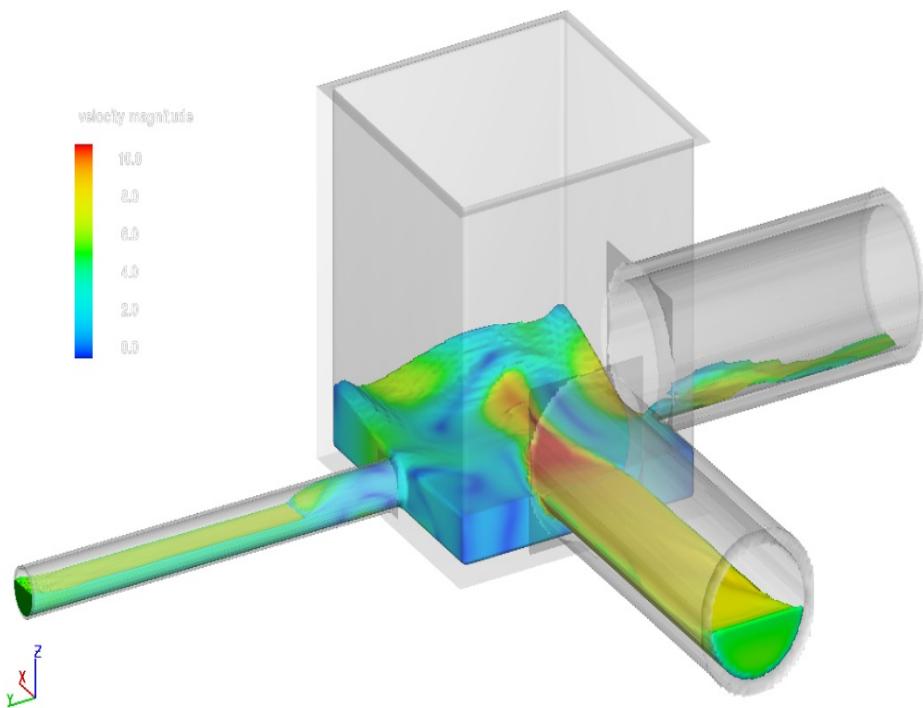
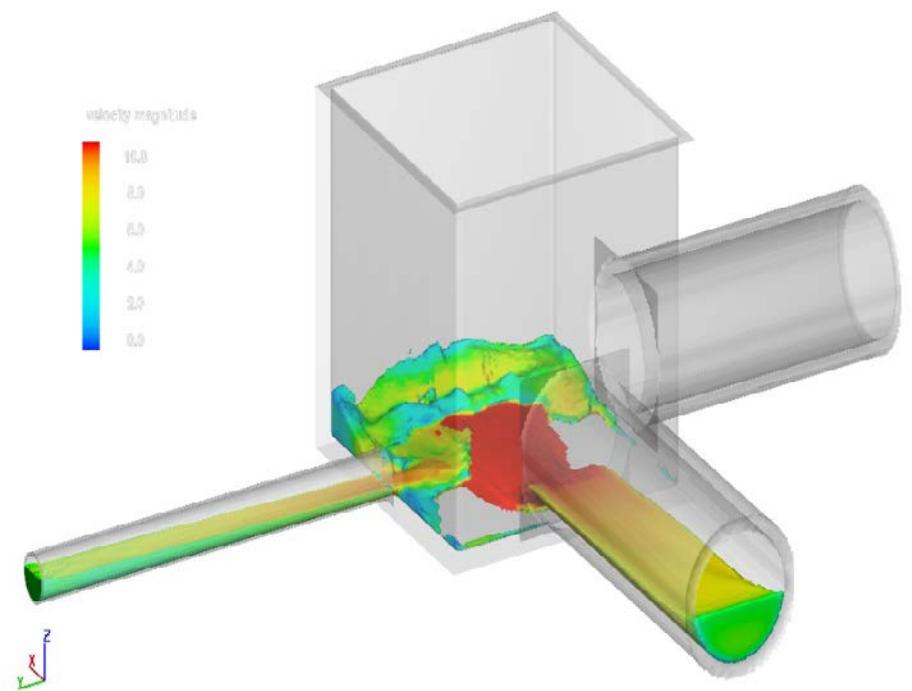
Design by Perez Consulting Engineers

UTRGV Parking Lot Bioswale Location Map

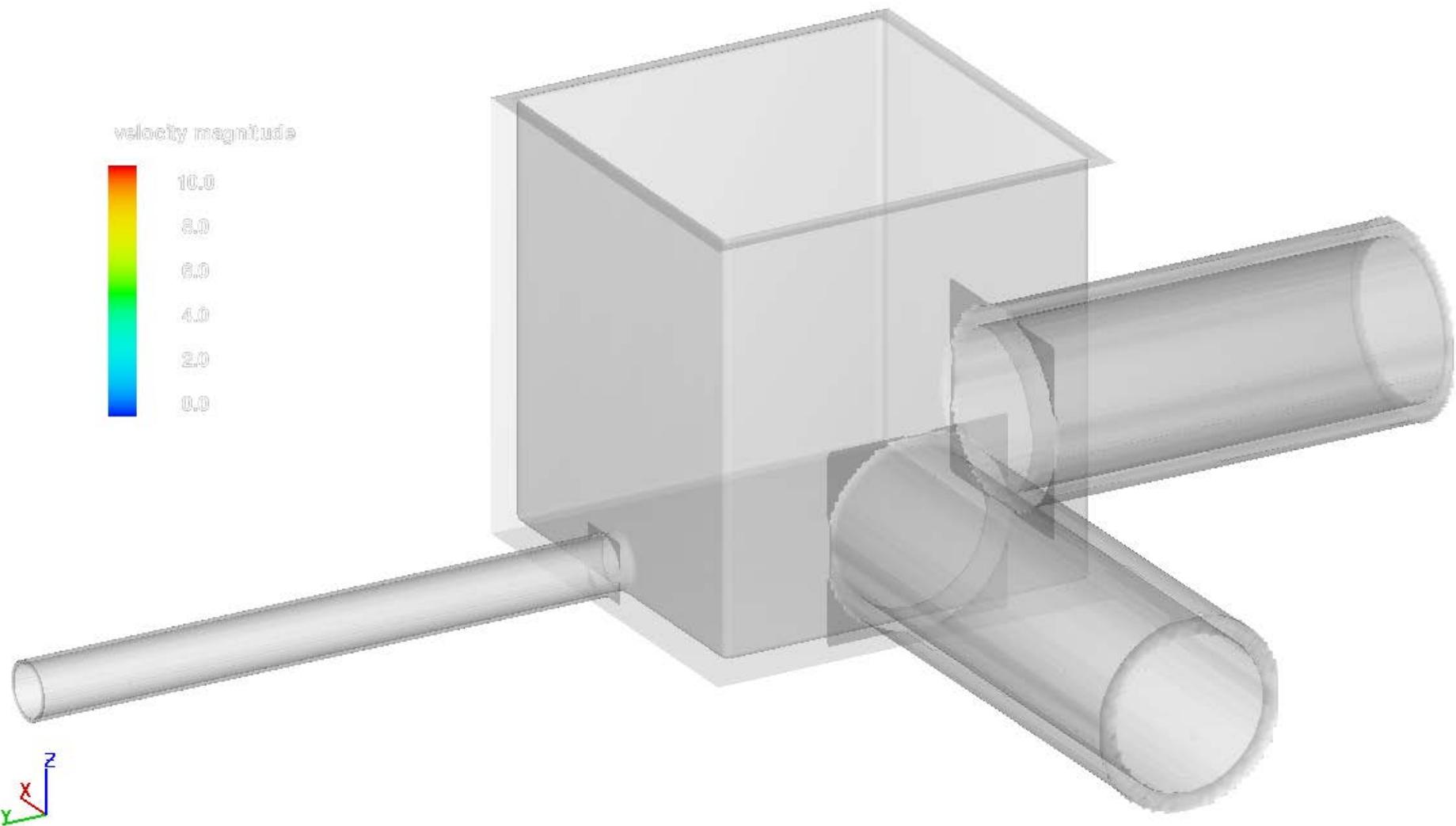


Sites	Bioswale	Materials	Parking lot watershed size (acres)	Remarks
Site 1	No bioswale	No bioswale	0.24	Existing parking lot
Site 2	Bioswale 1	Pumice	0.22	City of Austin, TX
Site 3	Bioswale 2	Manufactured sand	0.23	Sinclair et. al. (2012)
Site 4	Bioswale 3	Recycled crushed glass	0.21	McAllen recycling center
Site 5	Bioswale 4	Medium sand	0.21	City of McAllen, TX

Drain Junction Box CFD Computation



velocity magnitude





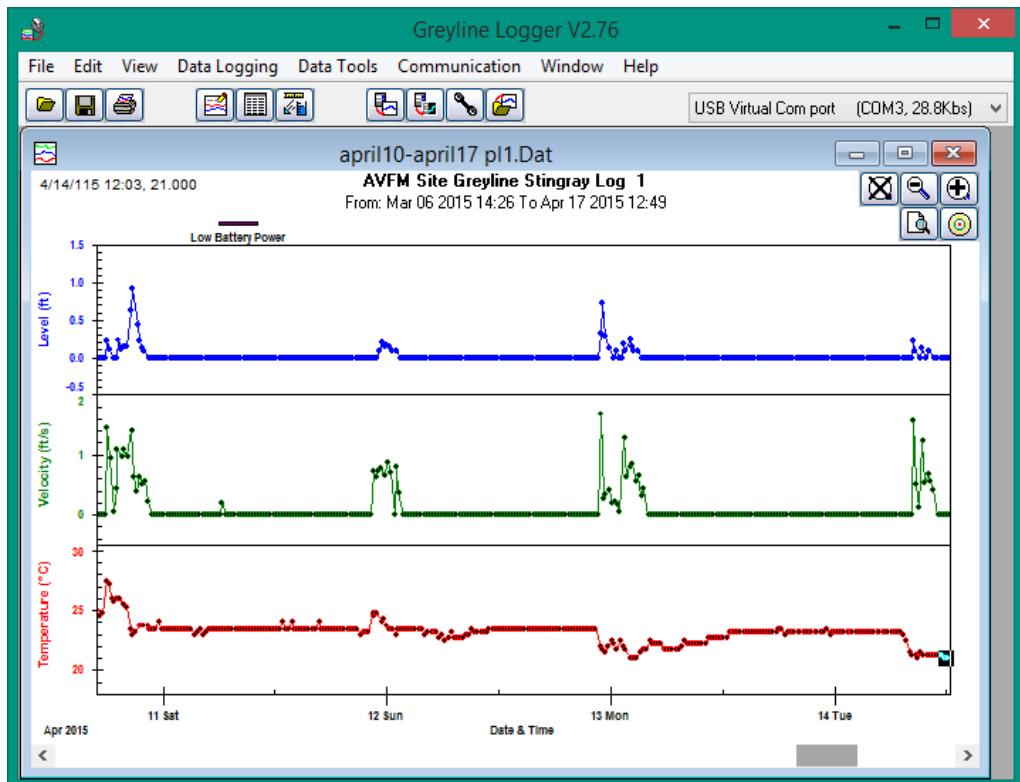
Monitoring Equipment and Set up







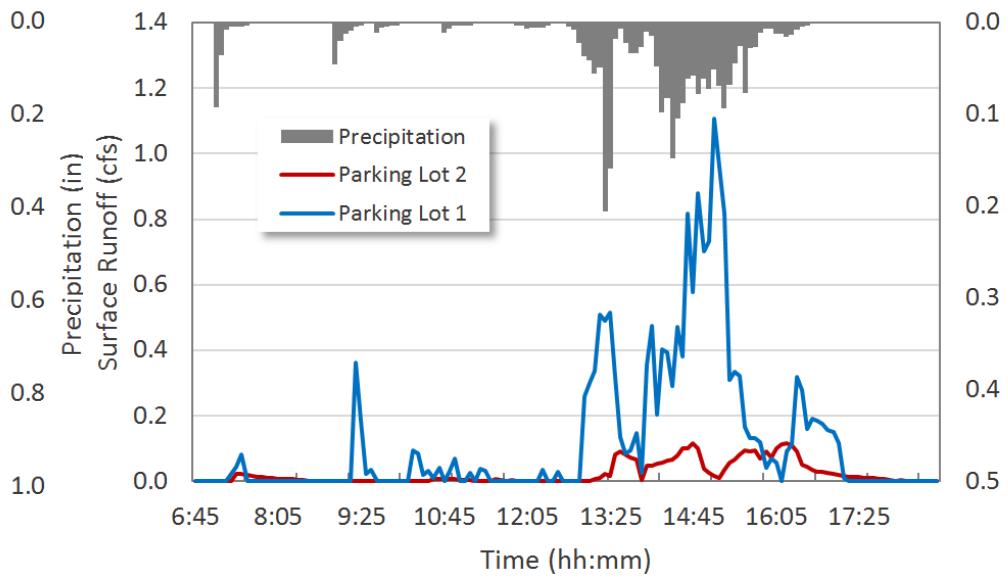
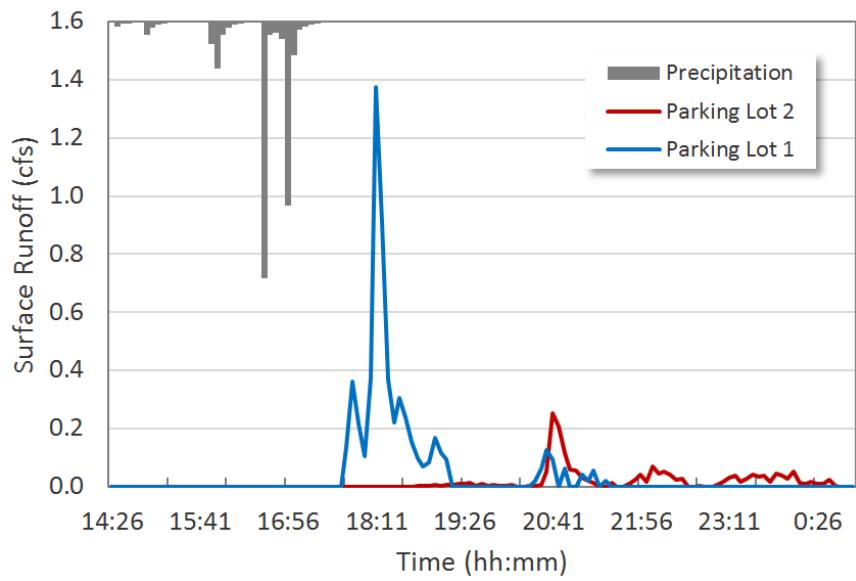
Data logger and Discharge



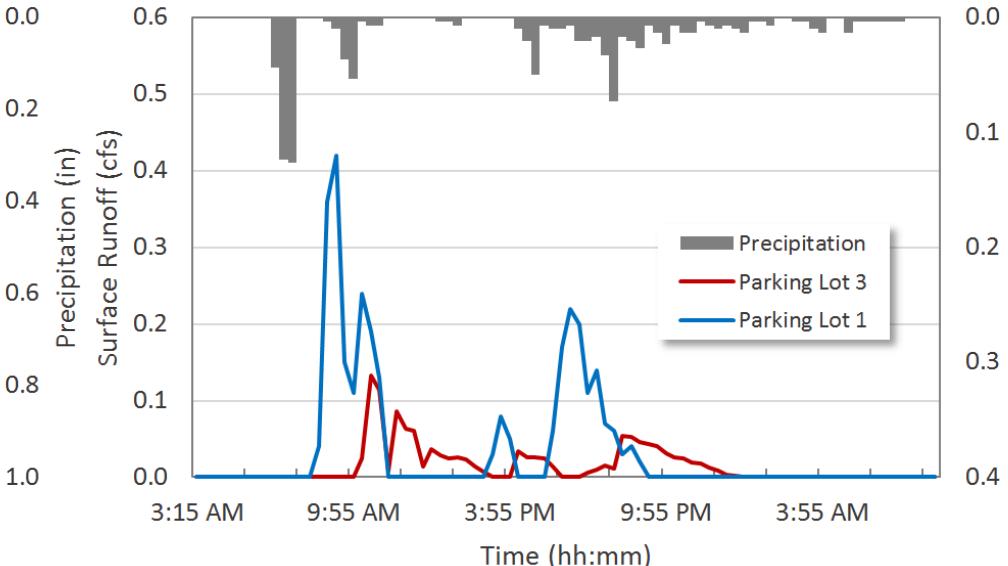
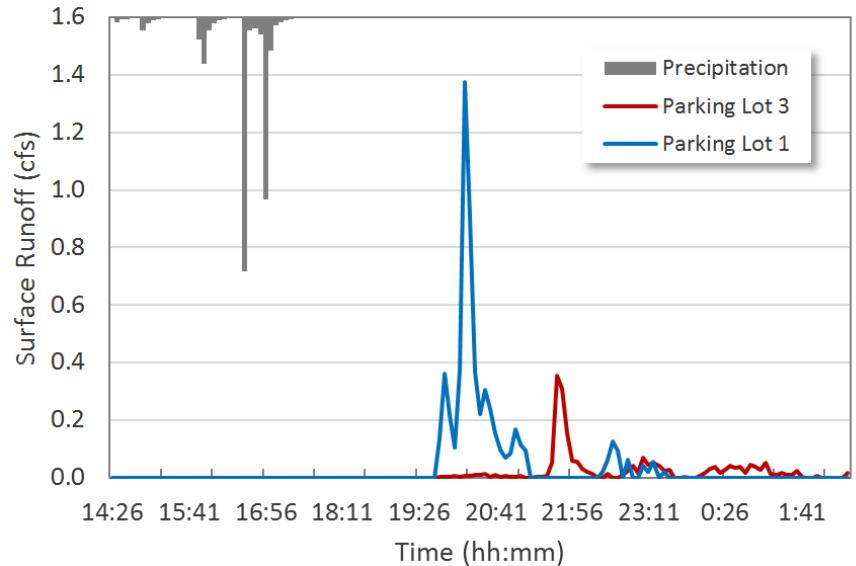
Time	P rate	P (in)	Q (ft ³ /s)	Vol (ft ³)
20:15	0	0		
20:20	0.16	0.013333		
20:25	0.37	0.030833		
20:30	0.38	0.031667		
20:35	0.12	0.01		
20:40	0.06	0.005		
20:45	0.04	0.003333		
20:50		0		
20:55		0	0	0
21:00		0	0.0086	2.58
21:05		0	0.007035	2.1105
21:10		0	0.010006	3.0018
21:15		0	0.005366	1.6098
21:20		0	0.004175	1.2525
21:25		0	0.003496	1.0488
21:30		0	0.004111	1.2333
21:35		0	0.004537	1.3611
21:40		0	0.00307	0.921
21:45		0	0.003393	1.0179
21:50		0	0.002709	0.8127
21:55		0	0.002451	0.7353
	1.13	0.094167	SUM	17.6847

1	Parameter	Symbol	Unit	Data Type	Sites	Method
2	Prototype Parking Lots					
3	Days since last precipitation		days	Observation	1 site	Gage station - underground weather
4	Precipitation hyetograph		in/hr	Observation	1 site	Gage station - underground weather
5	Precipitation depth	P	inches	Observation	1 site	Gage station - underground weather
6	Precipitation beginning time	t _{pb}	time	Observation	1 site	Gage station - underground weather
7	Precipitation duration	t _{pd}	minutes	Observation	1 site	Gage station - underground weather
8	Peak time	t _{pk}	time	Observation	5 sites	Stingray
9	Time to peak	t _{peak}	minutes	Calculation	5 sites	t _{pb} - t _{pk}
10	Calculated runoff volume	V _{calc}	ft ³	Calculation	5 sites	P x Area
11	Measured runoff volume	V _{meas}	ft ³	Measurement	5 sites	Stingray hydrograph x time
12	Computed peak flowrate	Q _{cpeak}	ft ³ /s	Computation	Parking lot 1	Rational method by Civil CAD
13	Measured peak flowrate	Q _{mpeak}	ft ³ /s	Measurement	5 sites	Stingray
14	Computed runoff hydrograph		ft ³ /s	Computation	5 sites	by Civil CAD
15	Measured runoff hydrograph		ft ³ /s	Measurement	5 sites	Stingray
16	Water temperature	Temp	celsius	Measurement	5 sites	Stingray
17	Sampling time	t _{sm}	time	Measurement	5 sites	by sampling
18	Turbidity	t _{b_in} and t _{b_out}	NTU	Measurement	In/Out at 5 sites	Sonde
19	Specific Conductance	sp _{in} and sp _{out}	uS/cm	Measurement	In/Out at 5 sites	Sonde
20	Nitrite	NO2 _{in} & NO2 _{out}	mg/L	Measurement	In/Out at 5 sites	Spectrophotometer
21	Nitrate	NO3 _{in} & NO3 _{out}	mg/L	Measurement	In/Out at 5 sites	Spectrophotometer
22	Ammonia Nitrate	NH3 _{in} & NH3 _{out}	mg/L	Measurement	In/Out at 5 sites	Spectrophotometer
23	Phosphorous	PO4 _{in} & PO4 _{out}	mg/L	Measurement	In/Out at 5 sites	Spectrophotometer
24	pH	pH _{in} and pH _{out}		Measurement	In/Out at 5 sites	Sonde
25	Data Analysis					
26	Calculated volume error	V _{calred}	ft ³	Calculation	4 sites	V _{calc} - V _{meas}
27	Measured volume reduction	V _{meared}	ft ³	Measurement	4 sites	V _{meas_park1} - V _{meas_park2,3,4,5}
28	Measured peak rate reduction	Q _{mpred}	ft ³ /s	Measurement	4 sites	Q _{mpeak_park1} - Q _{mpeak_park2,3,4,5}
29	Peak time attenuation	t _{patt}	minutes	Calculation	4 sites	t _{peak_park2,3,4,5} - t _{peak_park1}
30	Filtration efficiency	η	%	Calculation	4 sites	(t _{b_in} -t _{b_out})/t _{b_in}
31	Laboratory Model Test					
32	Inflow volume	V _{inred}	ft ³	Measurement	Lab model test	Specified inflow volume
33	Outflow volume	V _{outred}	ft ³	Measurement	Lab model test	Measured outflow volume
34	Volume reduction	V _{red}	ft ³	Measurement	Lab model test	V _{inred} - V _{outred}
35	Drain time	t _d	minutes	Measurement	Lab model test	Time for drainage
36						

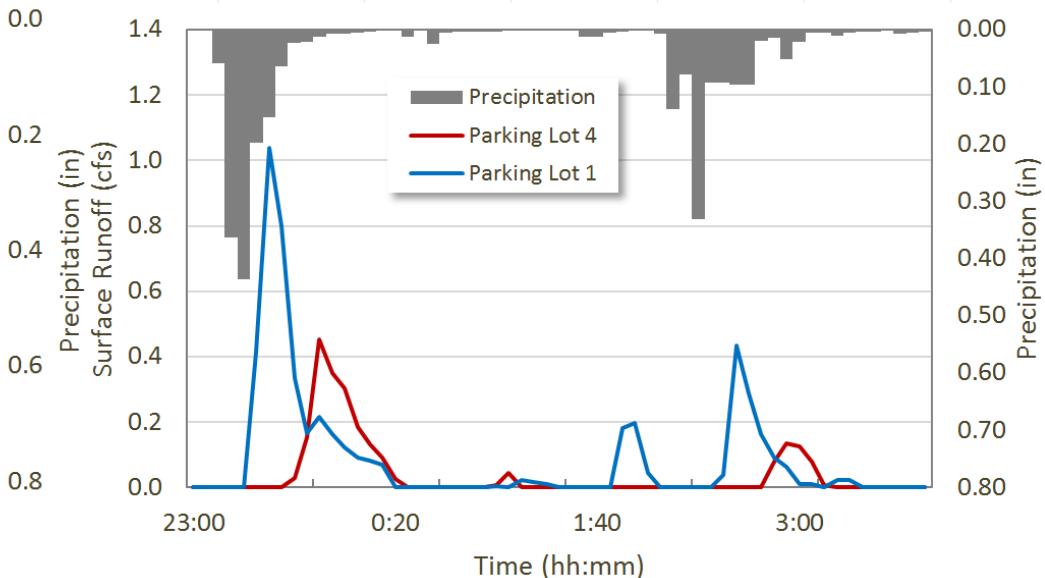
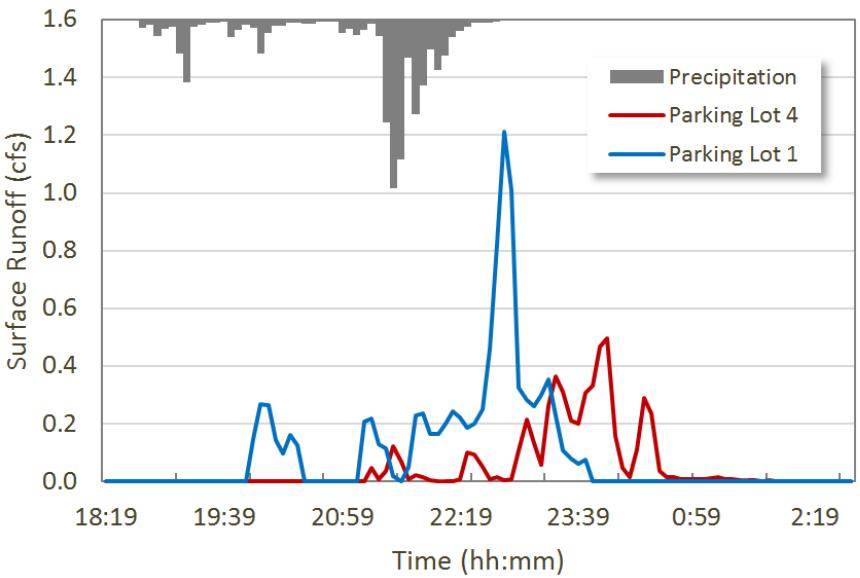
Monitoring Parameters



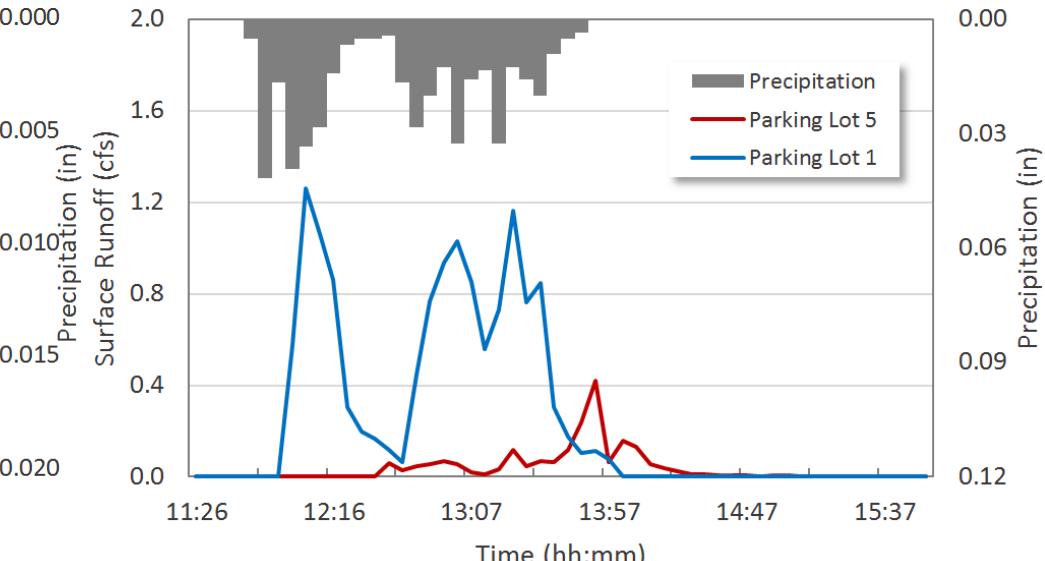
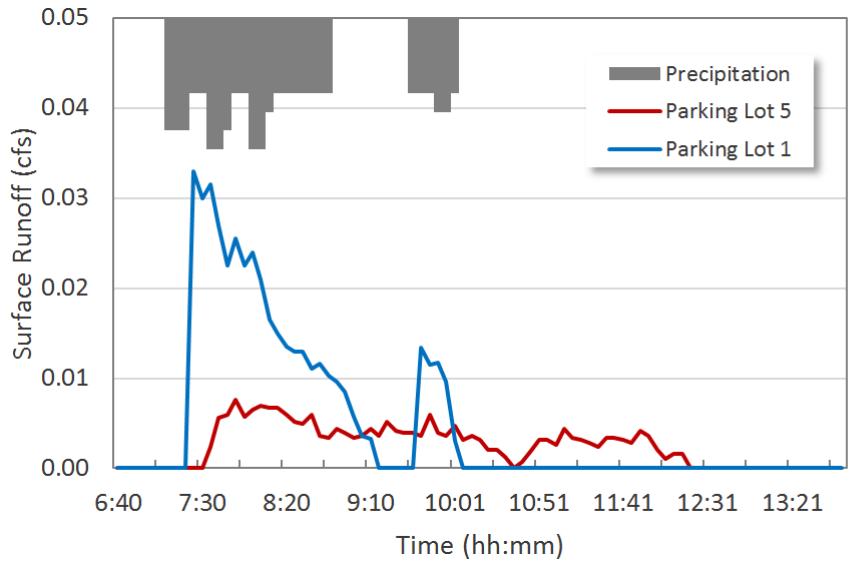
Parking Lot 2 – Pumice



Parking Lot 3 – Manufactured Sand

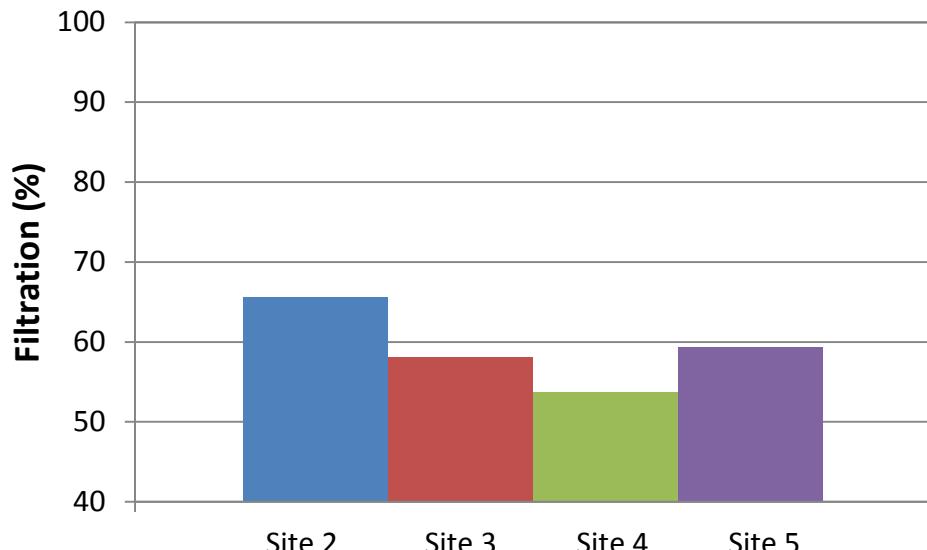
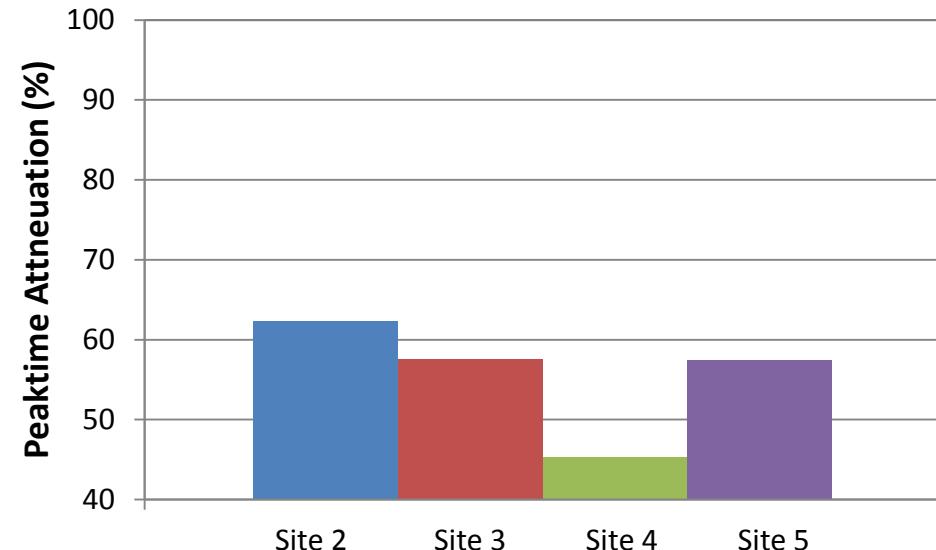
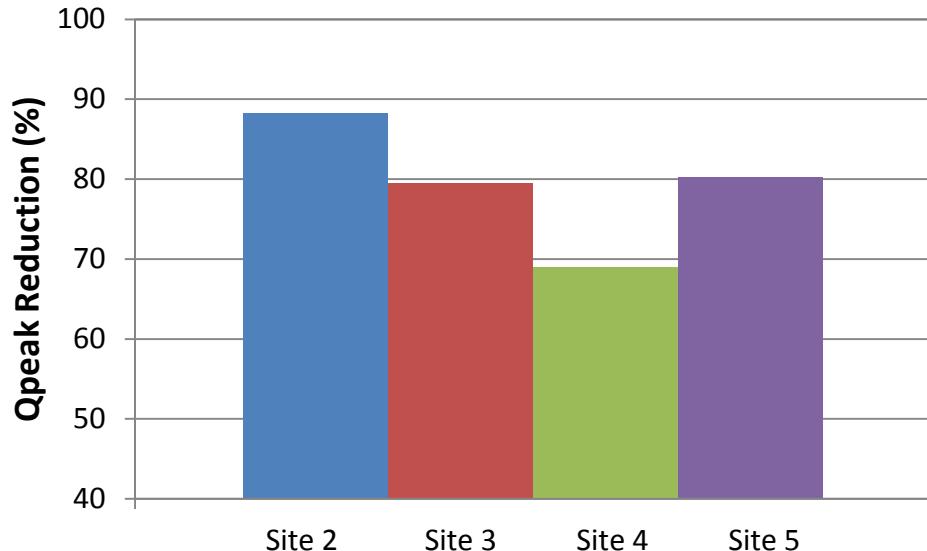
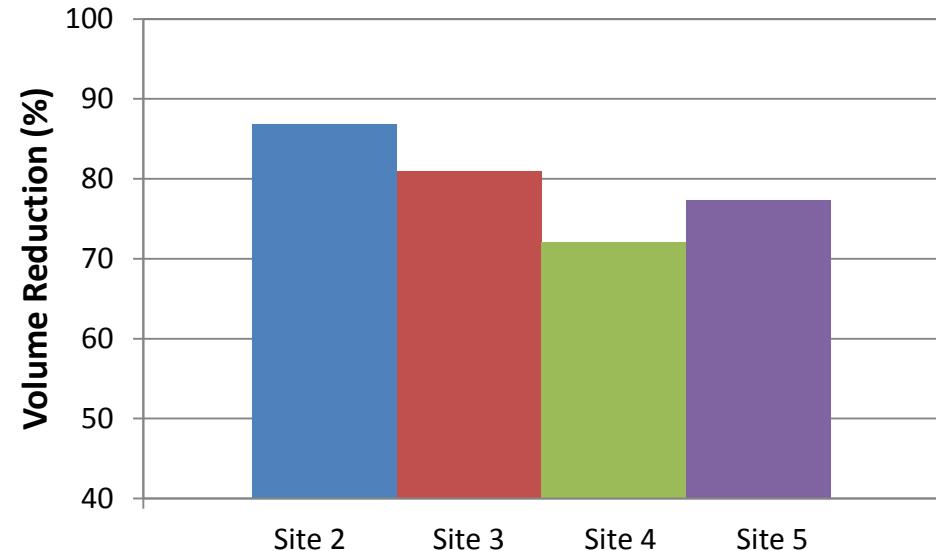


Parking Lot 4 – Recycled Crushed Glass



Parking Lot 5 – Medium Sand

Hydrologic Performance



Hydrologic Performance & Design Flow

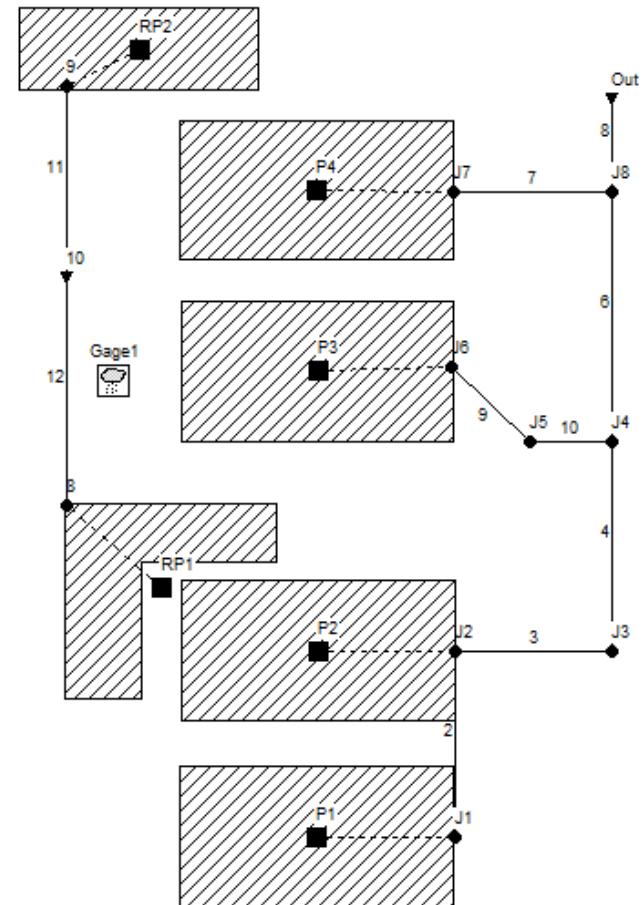
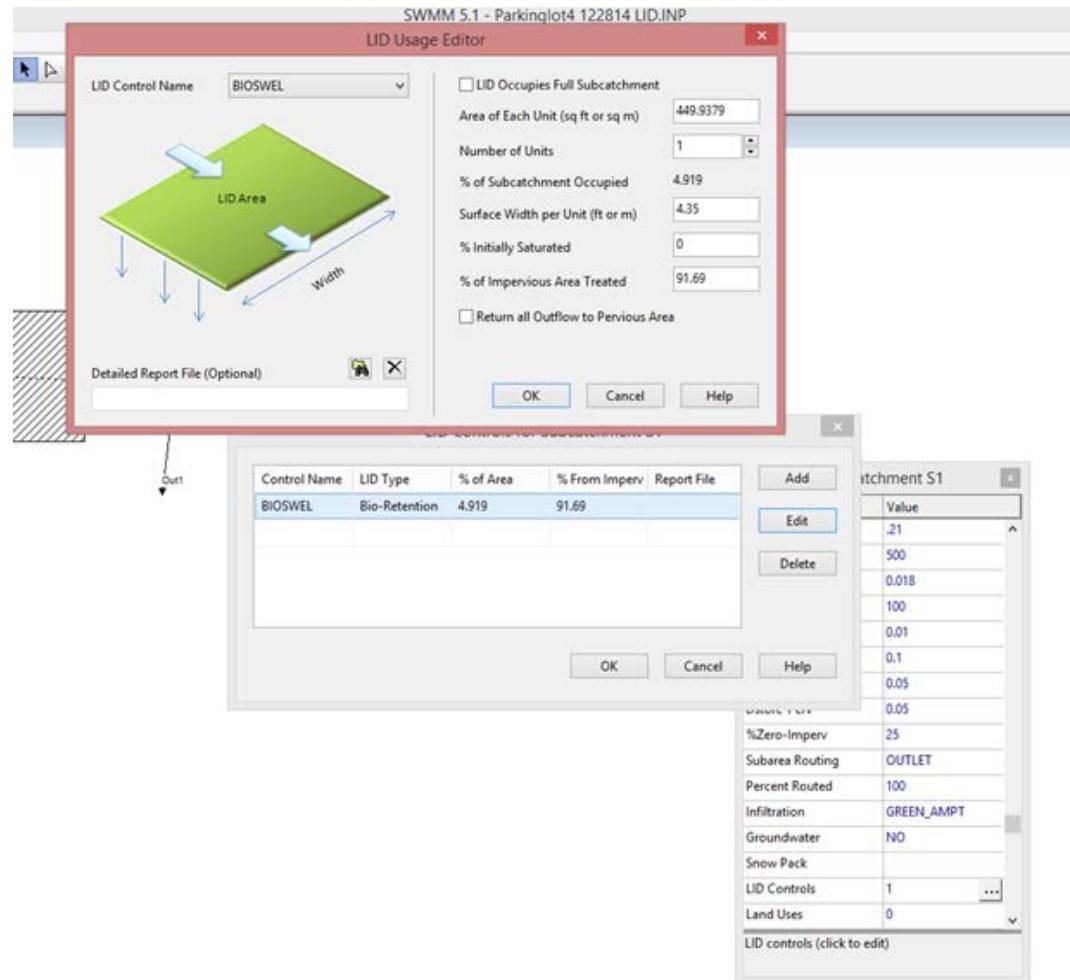


Storm event August 16, 2016

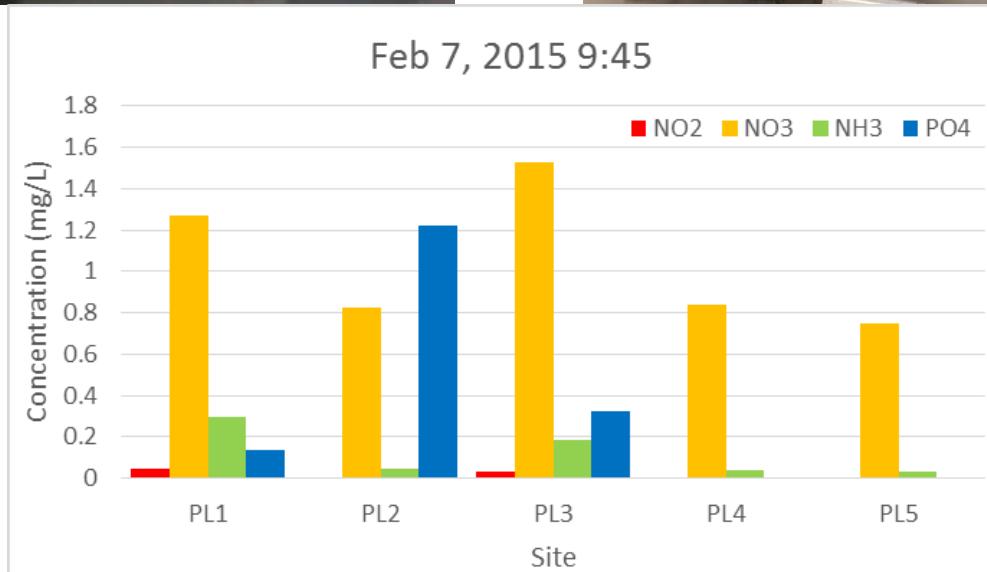
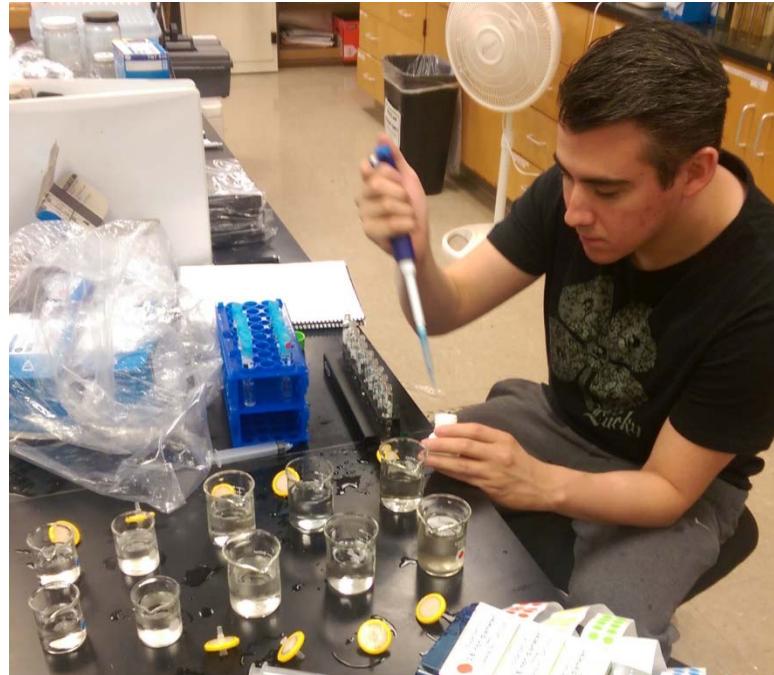


Storm event May 14, 2016

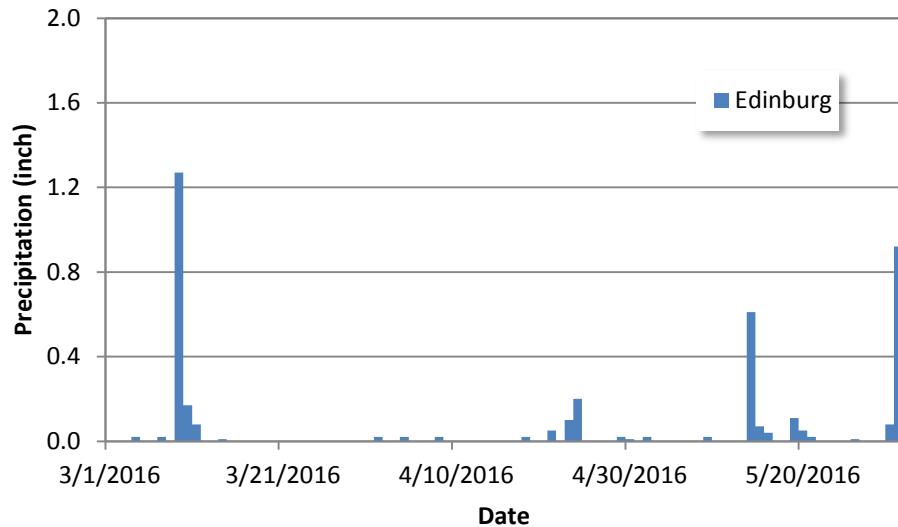
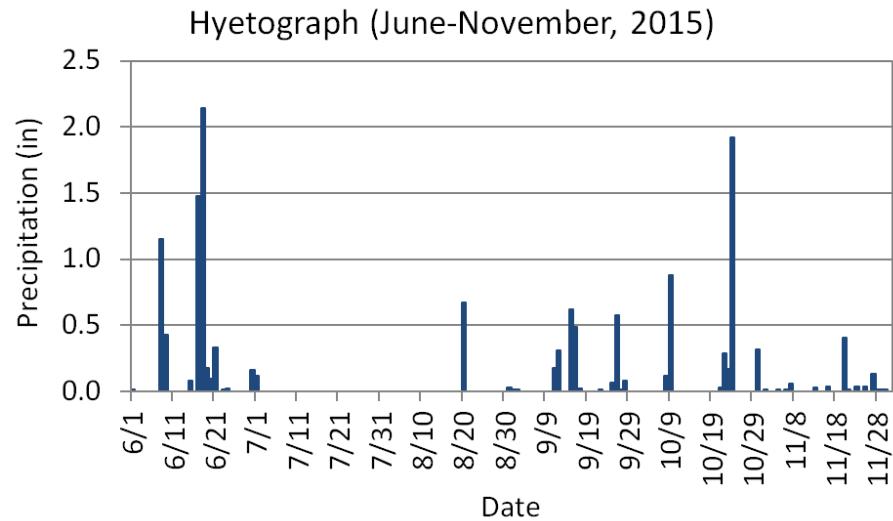
SWMM LID Function Modeling



Nutrient Analysis using Spectrophotometer



More Tasks and Timeline



Jordan Sindair, Francisco Chapa, Oziel Bautista & Dr. Jungseok Ho
Civil Engineering Program, The University of Texas-Pan American

Abstract

Bioswales are landscape elements consisting of a raised drainage channel with permeable sides and are filled with vegetation. They are used to manage stormwater runoff, such as those that contribute to the breakdown of certain pollutants. Our study will focus on permeable media from local soil in the Rio Grande Valley to determine its efficiency. Since the infiltration rate and the infiltration of these media is currently unknown, we will test and compare permeable media improvements in water quality by means of infiltration. The USGS has found that permeable media tested is found to provide adequate performance conducive to a bioswale, which can be attributed to existing permeable media in the market. This study aims to prove that to improve water quality as per TCEQ standards, it is significantly more cost effective than permeable media.

Introduction

Bioswales are becoming more largely implemented across the United States, however only Austin really has derived and studied appropriate media for the purposes of bioswales. Bioswales are a cost effective way to manage stormwater, but no one else other than the Austin area, the costs of using infiltration as a means of filtering water runoff in the Rio Grande Valley is very high.

This research is dedicated to discovering local, readily available materials that can be used in the construction of bioswales that are cost effective. The media must be able to trap contaminants from easily entering the storm water system, but enough for these particles to be removed without much waste as been done.

The bioswale must not be enough waste so that it becomes a burden to the environment in the long run. We will use the principles of bioswales using media we already have, and we designed for Parking Lot #10 of the University of Texas-Pan American in



Precipitation rates were tested by pouring two liters of water over the area for one hour of rainfall to be recorded. The volume of test volume was chosen by calculation of assumed density of the sample media.

The infiltration method was used to calculate porosity.

Permeability was calculated using Darcy's Law.

Results & Analysis

Parking Lot #10 and its existing infiltration channels were measured to find the total area covered with a ruler and tape measure. The area of the parking lot and volume of the channels were calculated using the uploaded data on AutoCAD. With these measurements, the volume of water produced by a 25mm rain event.

Darcy's Law was used to calculate infiltration rates and the infiltration performance of each media sample. Samples were filtered and washed to improve the precision of our results.

Porosity was calculated by dividing the amount of water retained into the mass and the original sample weight. The percent porosity was measured using a water quality testing device called the Hydrosil Counter.

Verification of the test was done by repeating each set of runs two more times.

Materials used and processes

Water quality analysis

Depth velocity analysis

Accuracy analysis

Process analysis

Retention analysis

Porosity analysis

Permeability analysis

Volume analysis

Weight analysis

Water analysis

Accuracy analysis

Process analysis

Retention analysis

Porosity analysis

Permeability analysis

Volume analysis

Weight analysis

Water analysis

Accuracy analysis

Process analysis

Retention analysis

Porosity analysis

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Retention analysis

Porosity analysis

Permeability analysis

Volume analysis

Weight analysis

Water analysis

Accuracy analysis

Process analysis

Retention analysis

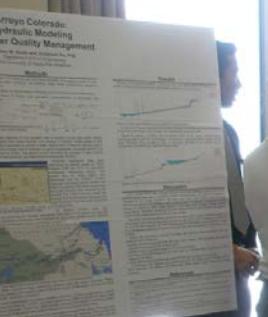
Porosity analysis

Permeability analysis

Volume analysis

Weight analysis

Water analysis



Bioswale Porous Material Unit Price

	\$Price (dollars)	Bioswale Site 2	Bioswale Site 3	Bioswale Site 4	Bioswale Site 5	
Pumice (ton)	62	67	N/A	N/A	N/A	Innovative Block
Manufactured-Sand (ton)	44.2	N/A	53	N/A	N/A	Deltal Aggregate and Lanscape
Crush-Glass (ton)	40	N/A	N/A	23	N/A	Mcallen Recycling Center
Clean-Sand (ton)	11.6	N/A	N/A	N/A	31	Deltal Aggregate and Lanscape
2-3-inch-rock (ton)	44.2	13.4	13.4	12.4	7.8	Deltal Aggregate and Lanscape
3-5-inch-rock (ton)	44.2	12.5	12.5	13.27	8.4	Deltal Aggregate and Lanscape
Perforated-Pipe(LF)	1.89	121	121	112	71	Average retail price
R.C-Wall/(LF)	21.25	250	250	232	150	

Border 2020 Grant

Activity	Outputs	Outcomes	Assessment
Existing parking lot runoff monitoring	Runoff flow rate, turbidity, and peak time from conventional parking lot with no bioswale system	Bioswale hydrologic performances: peak flow attenuation, filtration, peak time reduce	Comparison to theoretical calculation of runoff flow rate
New parking lot with bioswale system runoff monitoring	Runoff flow rate, turbidity, and peak time from parking lot with bioswale system	Best performing bioswale porous media material available in the Valley and South Texas	Comparison with the guidelines and criteria in South Texas
Laboratory bioswale model	Hydrologic performance test results of bioswale porous media mixture	Best performing bioswale porous media mixture and ratio	Comparison to independent testing of soil permeability