EVALUATION OF VOLUME IN TWO BIOSWALE

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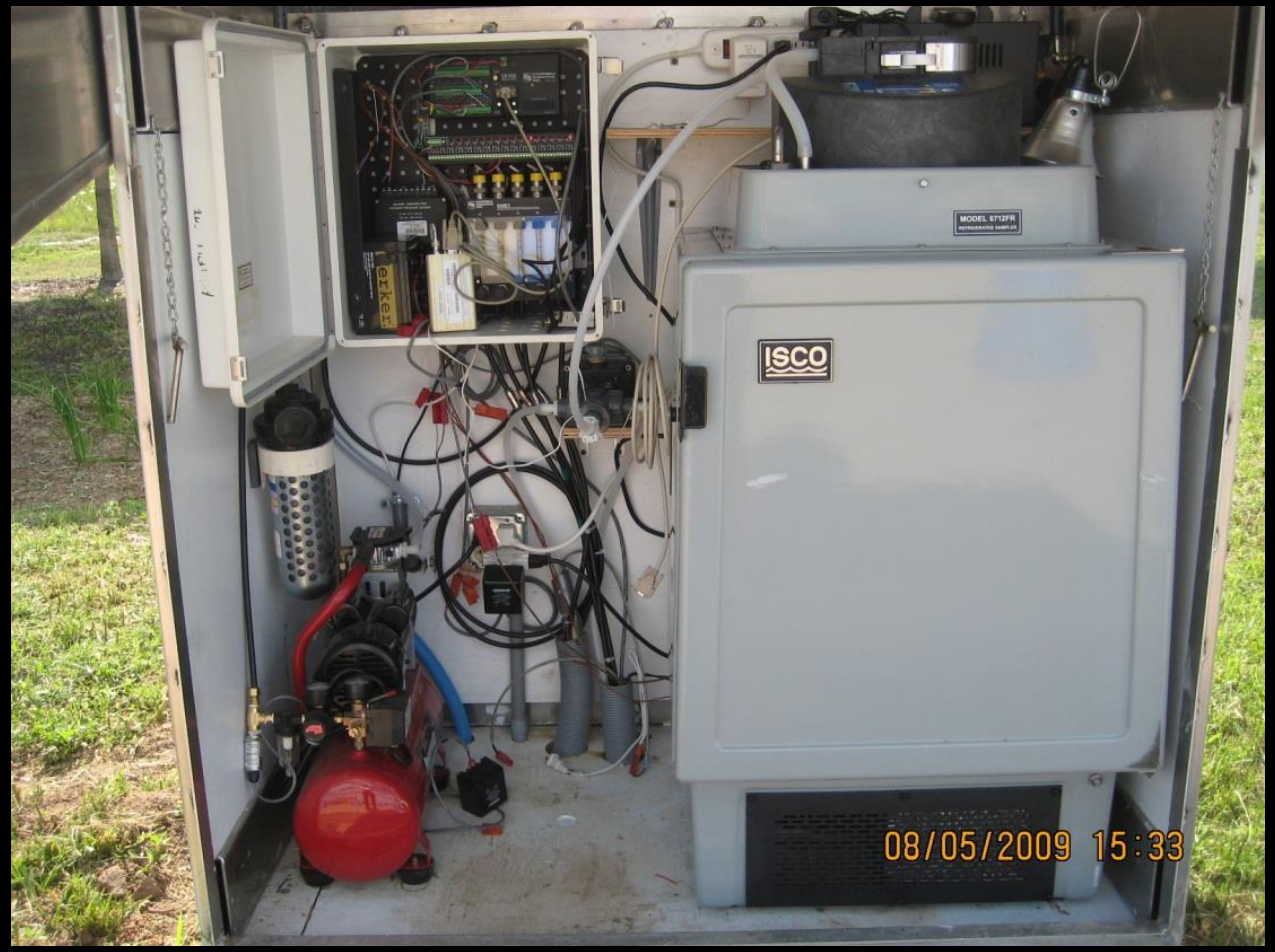
COOPERATORS

- Wisconsin Department of Transportation
- Wisconsin Department of Natural Resources

STUDY DESIGN

- Support Changes to State Technical Standard Bioretention 1004
- Measure Flow and Concentration from Highway VV, WI
- Measure Flow and Concentration from Bioswale Treating Highway VV
- Calibrate and Validate Biofilter Routine in WinSLAMMs (Source Loading and Management Model for Windows)



TODAY'S PRESENTATION

- Changes in Bioretention Technical Standard 1004
- Sites' Description
- Measured Data
- WinSLAMM Modeling

CHANGES IN BIORETENTION1004

Engineered Soil Mix Composition

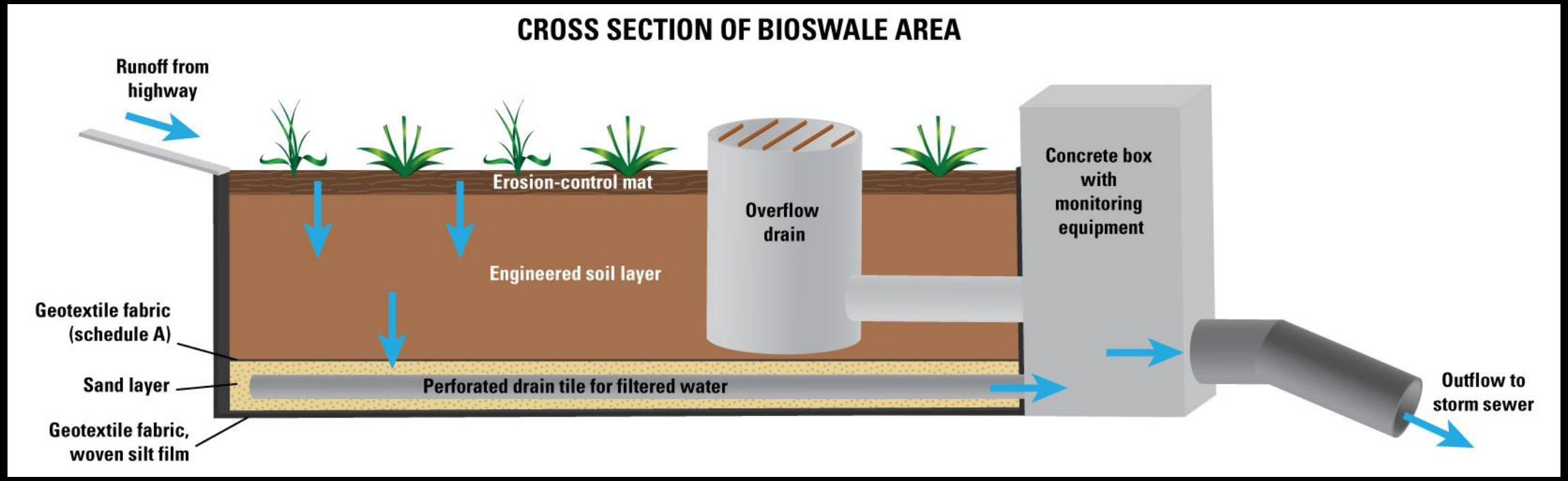
- 50% Sand/ 50% Compost
- 85-75% Sand/ 15-25% Compost

Engineered Soil Thickness

- 3 feet
- 2 feet

BIOSWALE DESIGN

- Linear Bioretention
- Follow Bioretention Design
- Located Along Roadways
- Runoff Enters Through Several Curb Cuts
- Filter Pollutants Through Engineered Soil
- Infiltrate to Native Soil and/or Storm Sewer



Study Site

Two Engineered Mixes:

1. State Standard -75% Sand 25% Compost
2. Growth Layer -18" of Sand Top 6" Compost

MONITORING

Inlet Flows

- Two Curb Cuts Monitored at Each Site
- Extrapolate to Entire Watershed

Outlet Flows

- Drain Tile at Each Site

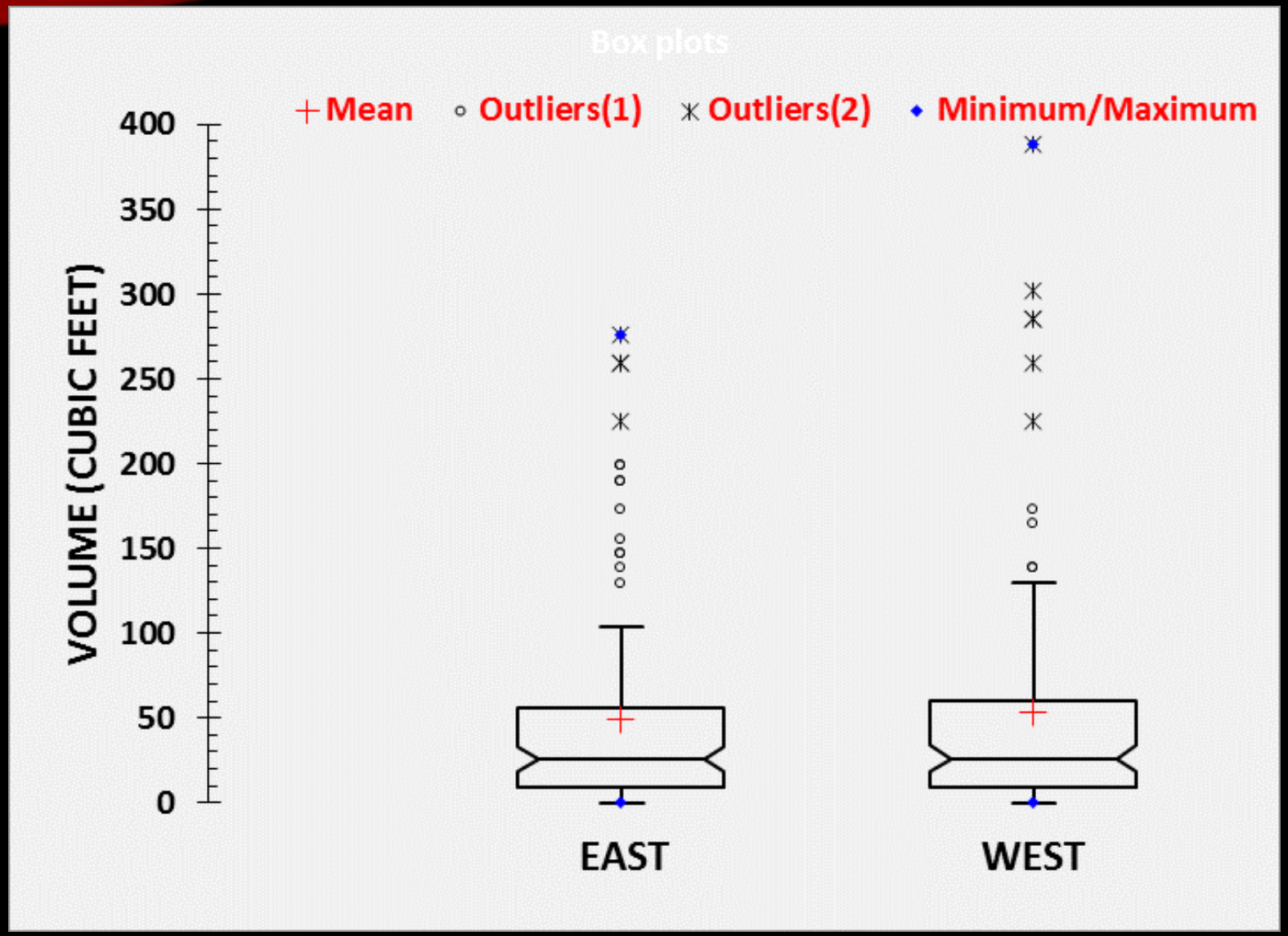
HIGHWAY SITE DESCRIPTION

- Newly Constructed 4-Lane Highway
- 2-Lane Divided Highway into East & West Bound Lanes
- 2 Inner Lanes Slope Towards Median
- Curb-Cuts Drain Highway Runoff into Median (~ 70-ft)

SURFACE AREAS

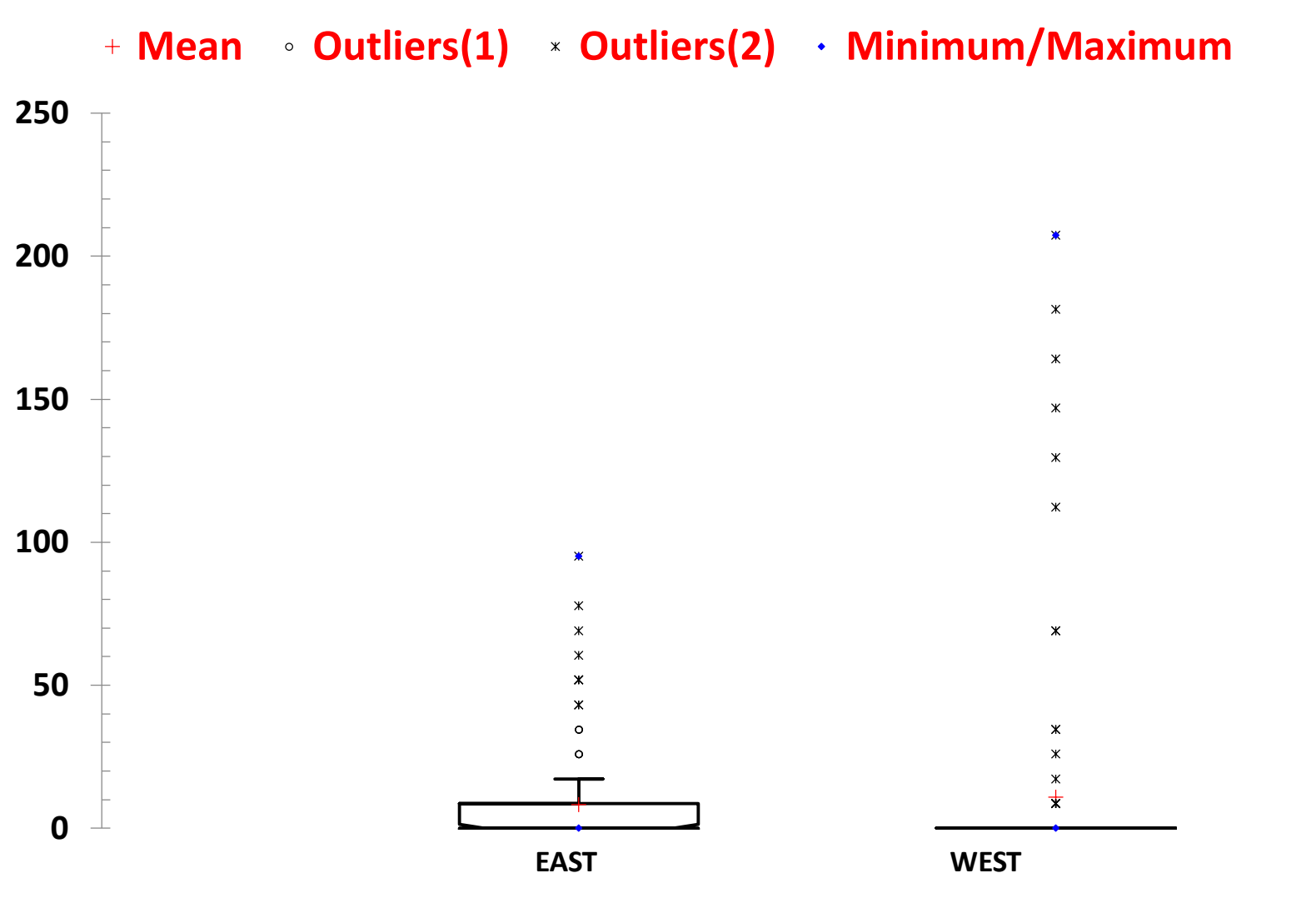
Sites	Number of Curb Cuts	Highway Surface Area (ft^2)	Bioswale Surface Area (ft^2)
East	10	9,540	2,225
West	6	5,920	1,225

MEASURED HIGHWAY VOLUMES FROM TWO CURB CUTS



- Medians Identical
- Means within 5 percent

MEASURED OUTLET VOLUME



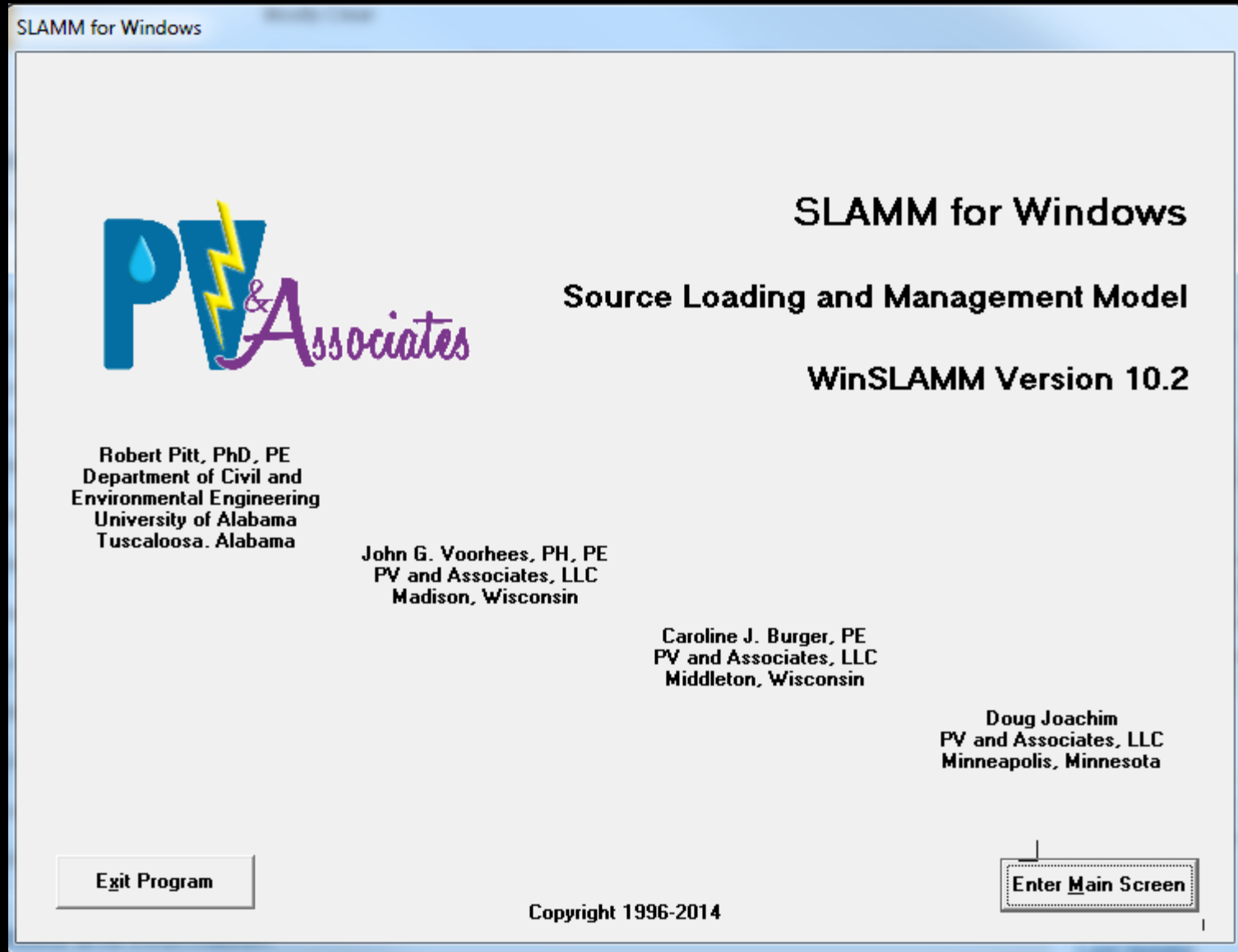
Percent Volume Reduction:

East 97

West 92

CALIBRATE AND VALIDATE BIOFILTER ROUTINE IN WinSLAMM

- Simulate Highway Runoff
- Simulate Bioretention
- Transfer Project Results to WisDOT Future Projects



WinSLAMM PARAMETER FILE

Rainfall

Winter Load

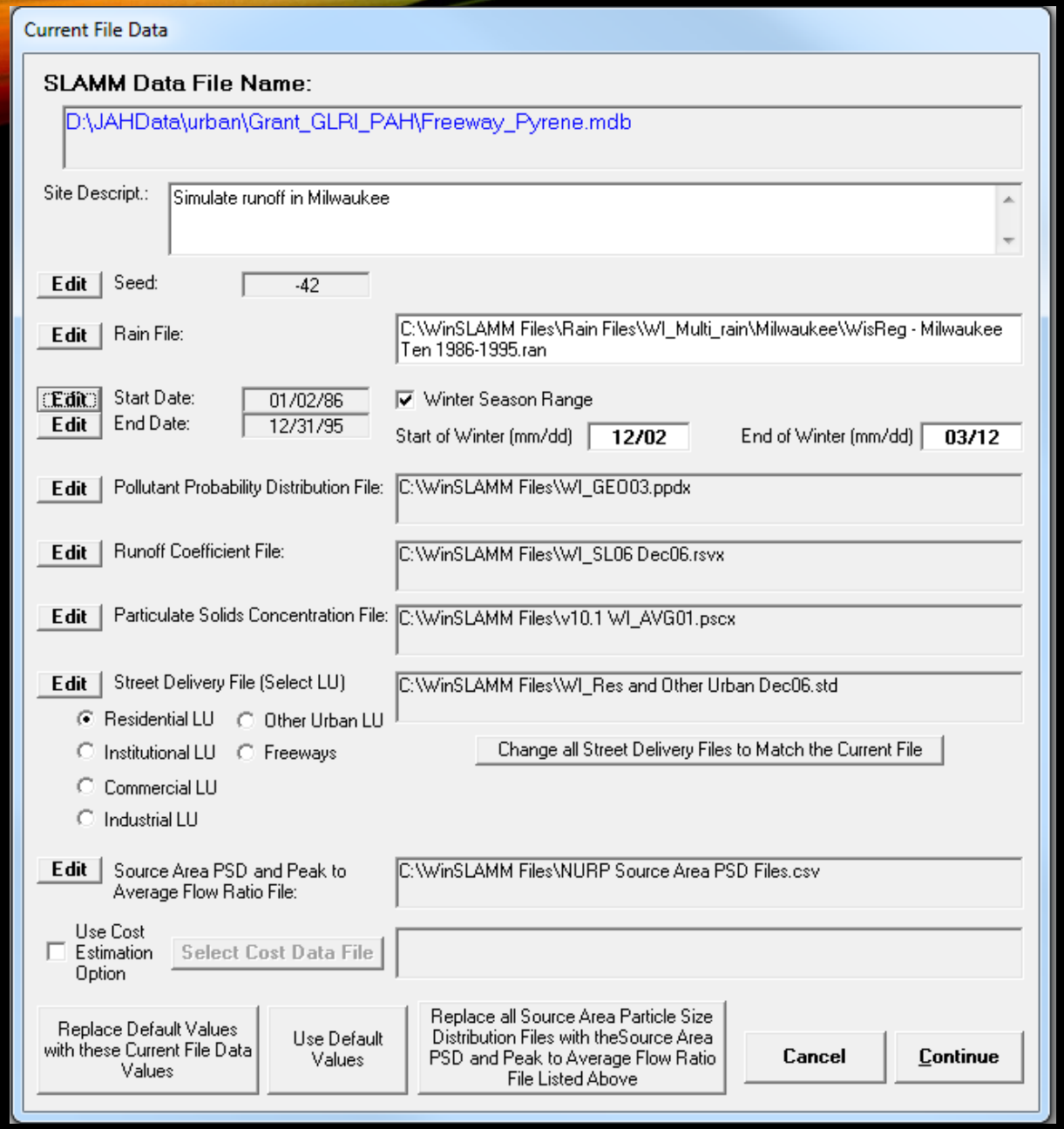
Pollutants

Runoff

Solids Conc.

Street Washoff

Particle Size



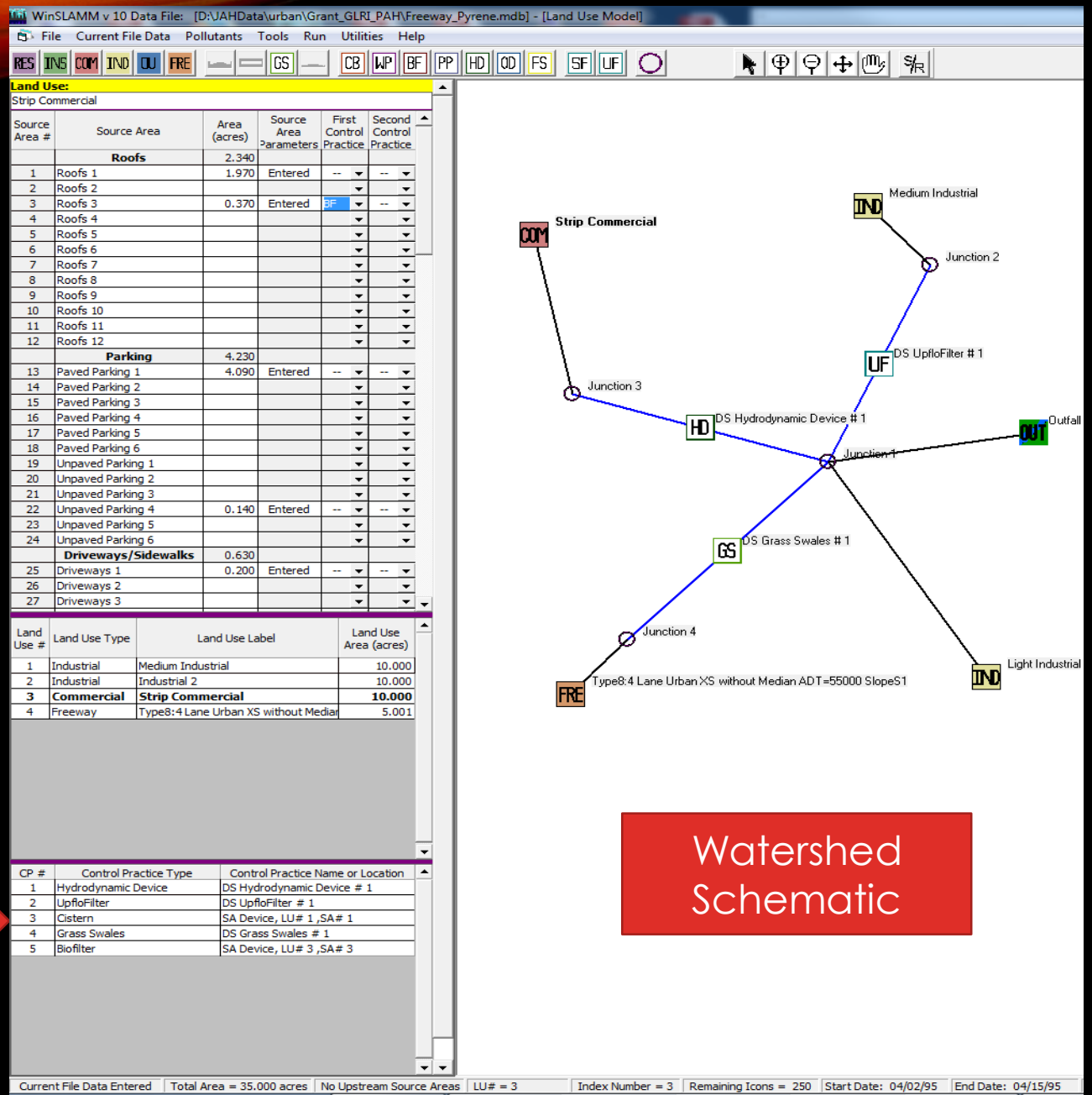
- Wisconsin Files
- Based on Measured Data
- Calibrated for Flow and Concentration
- Validated for Numerous Sites

WinSLAMM INTERFACE

Source Areas

Landuse

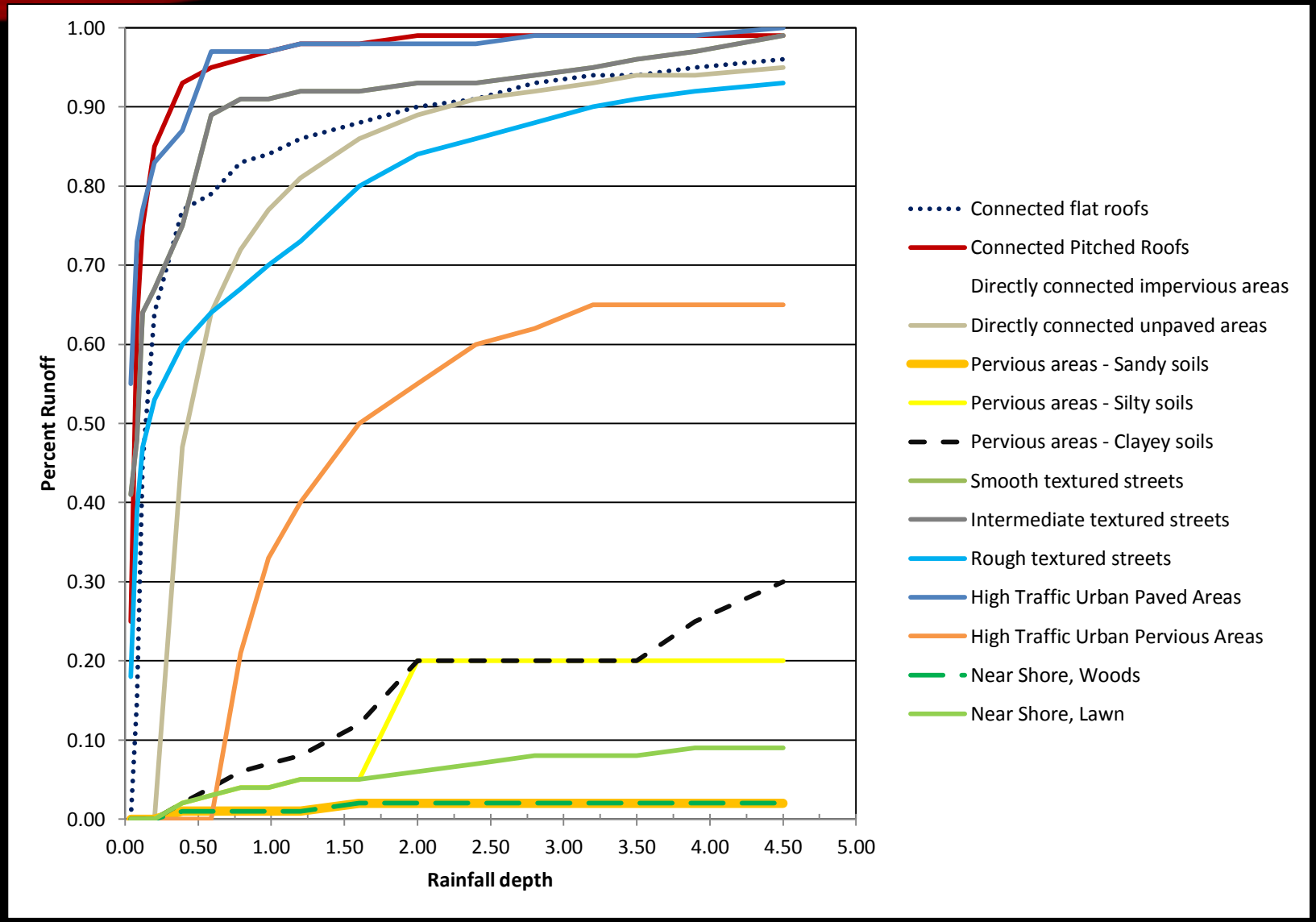
Management Practices



Watershed Schematic

- Characterize Stormwater By Source Areas and Landuses
- Source Area and Regional Management Practices

WinSLAMM SMALL STORM HYDROLOGY



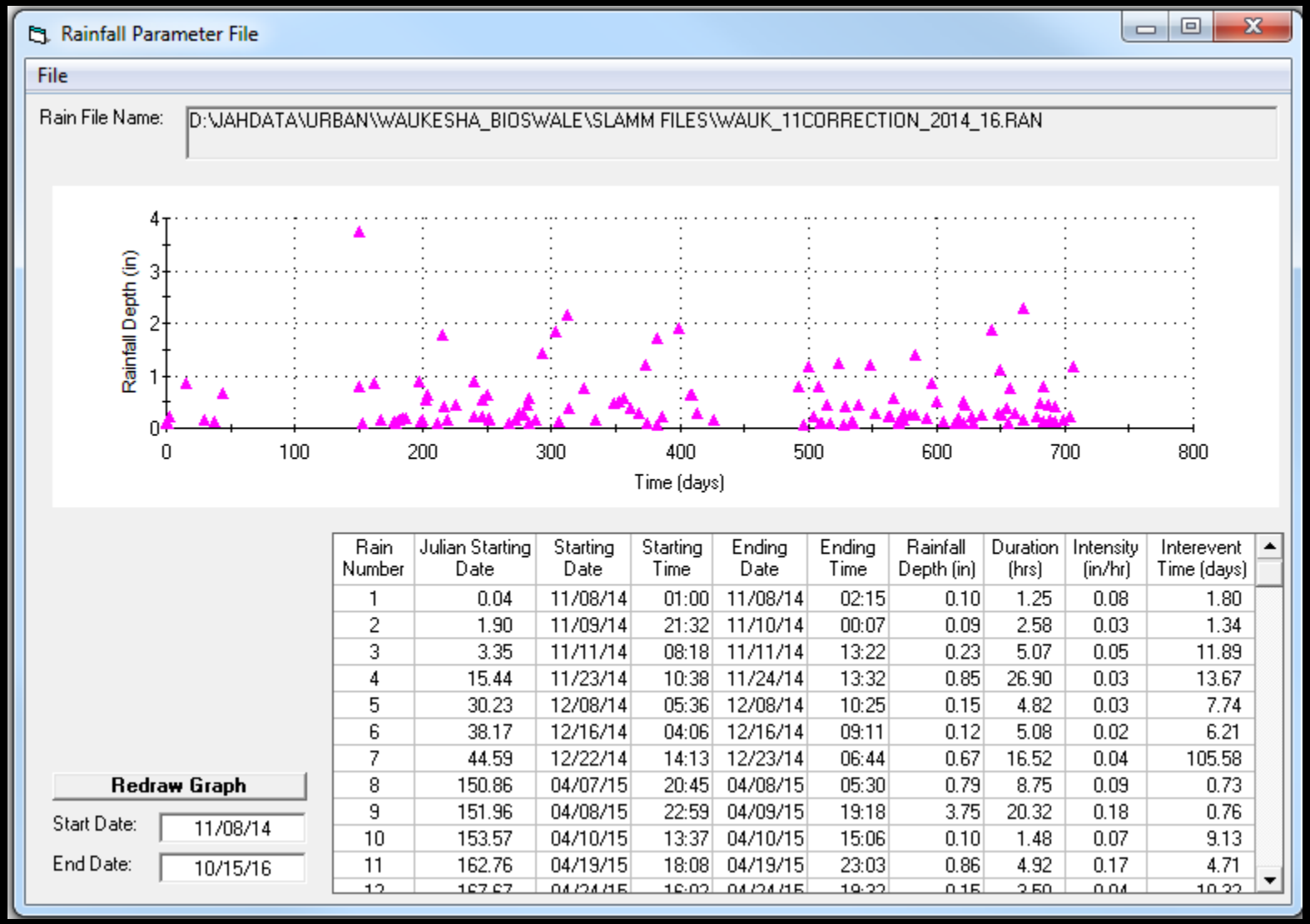
- Runoff Coefficient (Rv) Curves for at Least 14 Source Area
- Conducts a Continuous Water Mass Balance for Every Event

ASSESS BIOSWALE IN WinSLAMM

Model Steps

1. Create Rainfall File Using Measured Values
2. Assess Runoff Inlet Event Volumes– Measured vs Modeled
3. Assess Biofilter Event Volumes – Measured vs Modeled

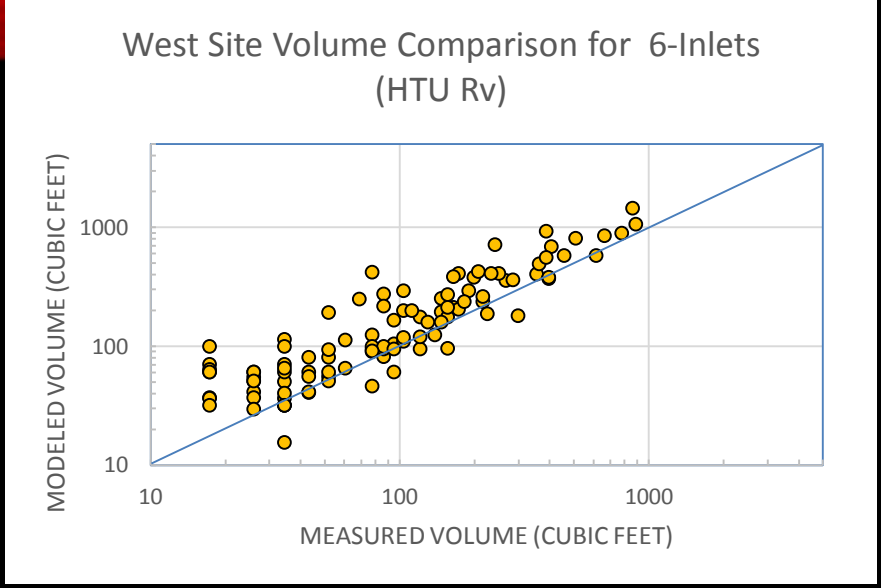
EVALUATION OF WinSLAMM

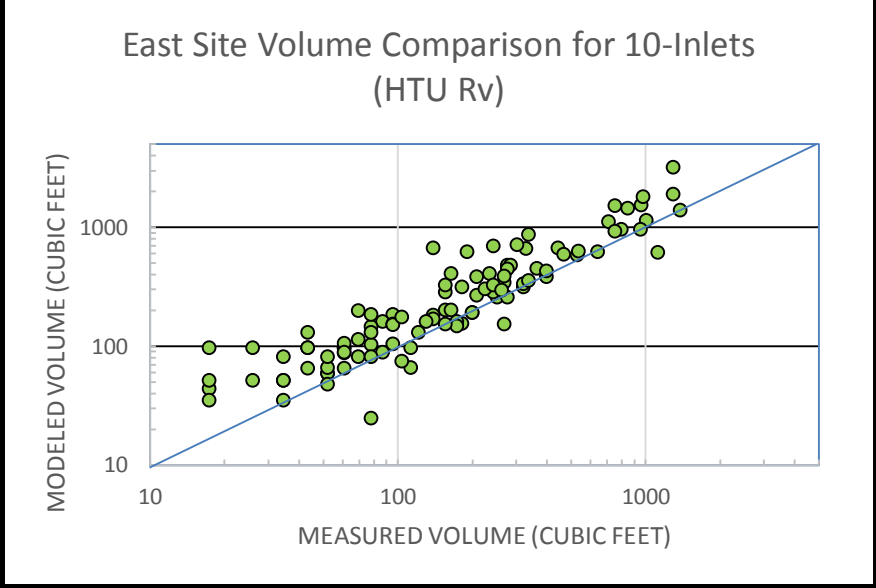


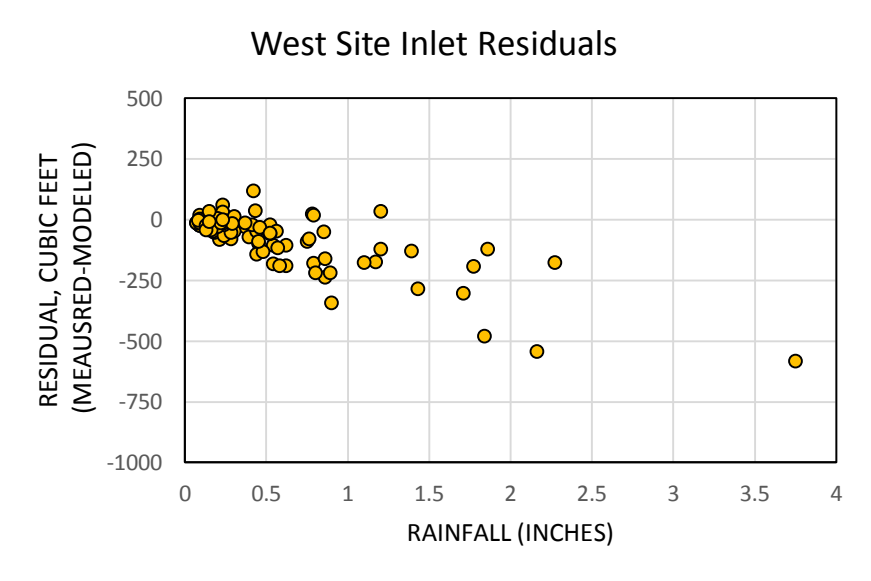
Rain Number	Julian Starting Date	Starting Date	Starting Time	Ending Date	Ending Time	Rainfall Depth (in)	Duration (hrs)	Intensity (in/hr)	Interevent Time (days)
1	0.04	11/08/14	01:00	11/08/14	02:15	0.10	1.25	0.08	1.80
2	1.90	11/09/14	21:32	11/10/14	00:07	0.09	2.58	0.03	1.34
3	3.35	11/11/14	08:18	11/11/14	13:22	0.23	5.07	0.05	11.89
4	15.44	11/23/14	10:38	11/24/14	13:32	0.85	26.90	0.03	13.67
5	30.23	12/08/14	05:36	12/08/14	10:25	0.15	4.82	0.03	7.74
6	38.17	12/16/14	04:06	12/16/14	09:11	0.12	5.08	0.02	6.21
7	44.59	12/22/14	14:13	12/23/14	06:44	0.67	16.52	0.04	105.58
8	150.86	04/07/15	20:45	04/08/15	05:30	0.79	8.75	0.09	0.73
9	151.96	04/08/15	22:59	04/09/15	19:18	3.75	20.32	0.18	0.76
10	153.57	04/10/15	13:37	04/10/15	15:06	0.10	1.48	0.07	9.13
11	162.76	04/19/15	18:08	04/19/15	23:03	0.86	4.92	0.17	4.71
12	167.67	04/24/15	16:02	04/24/15	19:32	0.15	3.50	0.04	10.22

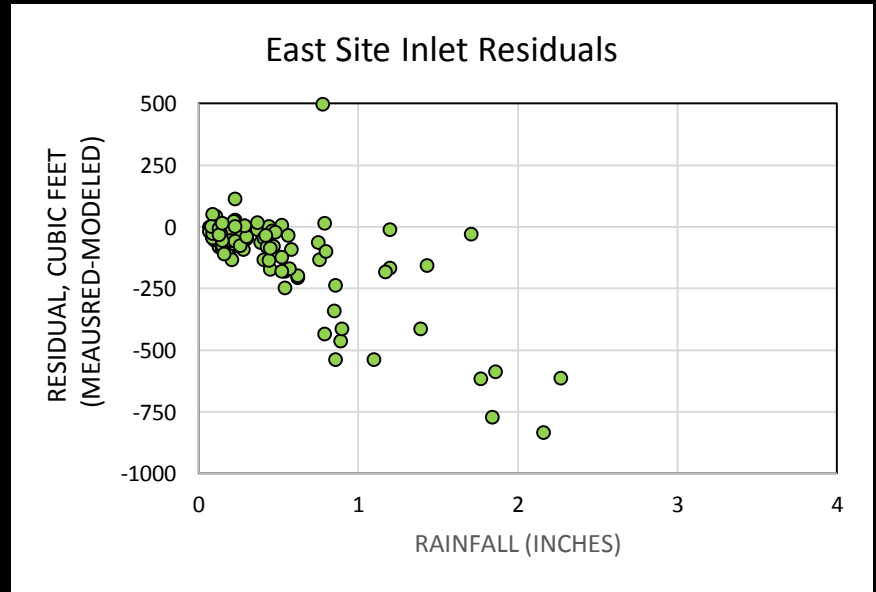
Create Rainfall File Using Measured Values

INLET VOLUME COMPARISON —MEASURED VS. MODELED USING DEFAULT HIGH-TRAFFIC URBAN Rv









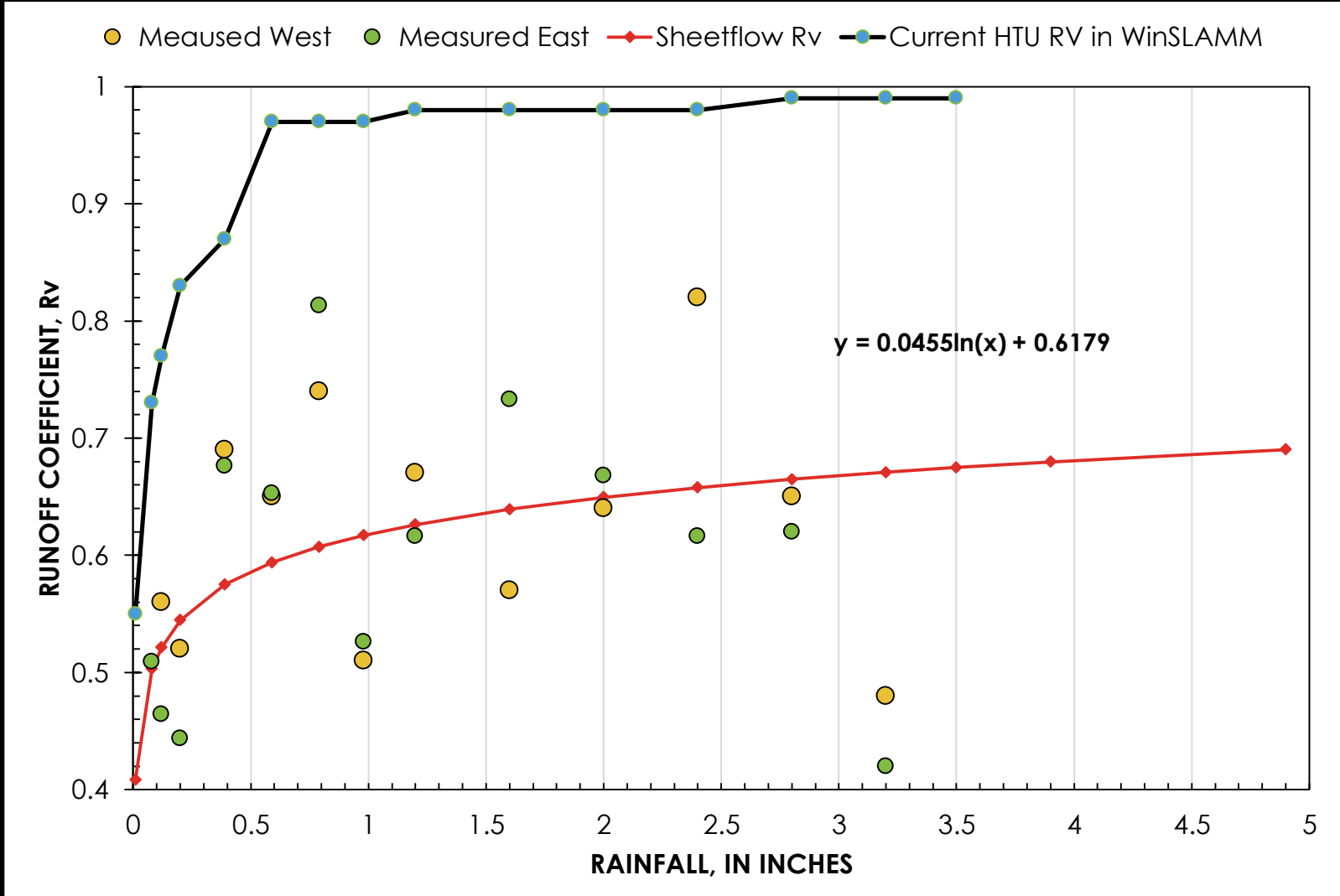
For Both Sites WinSLAMM is Over-Estimating Event Volumes ~50 percent

DEVELOP A NEW RUNOFF COEFFICIENT (R_v)

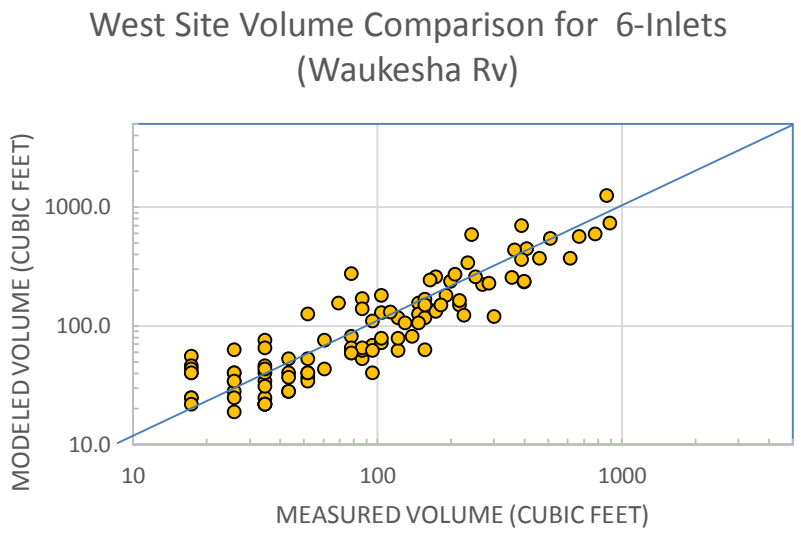
Split Dataset

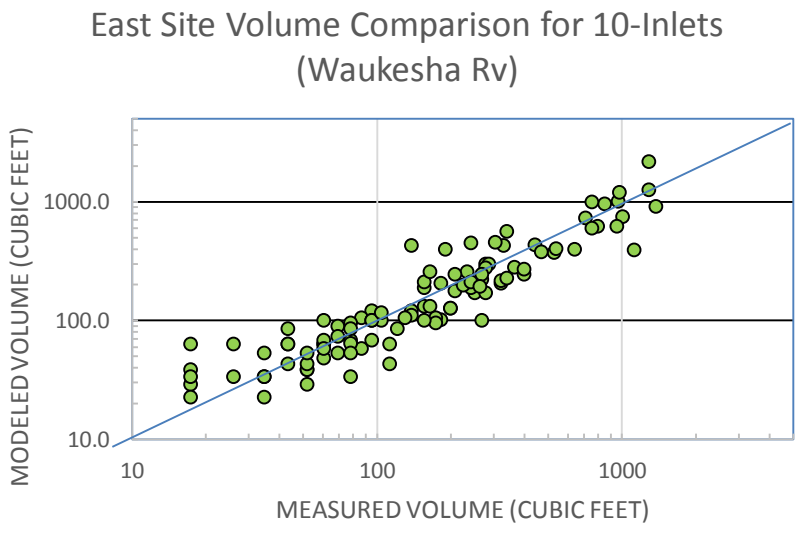
- West Site Calibration
- East Site Validation

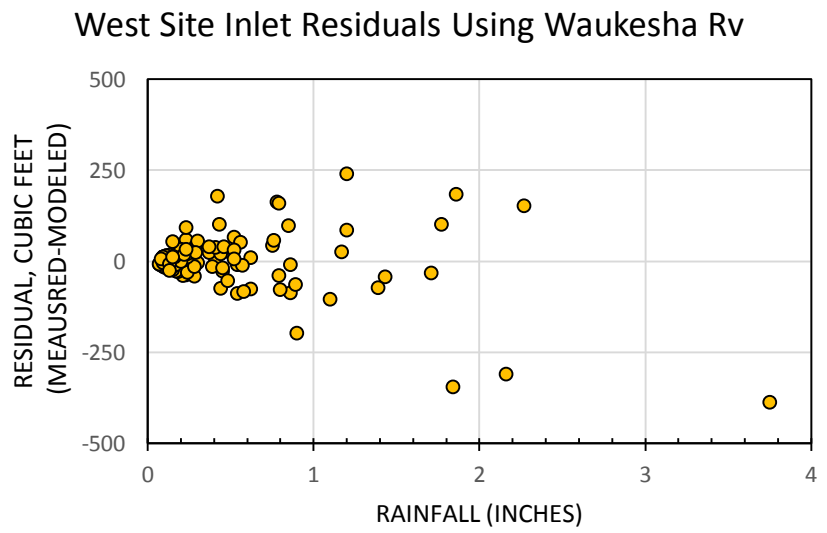
- Calibration
  - ✓ Determine New Rv using Rainfall
  - ✓ Extend Rv to Larger Events not Measured

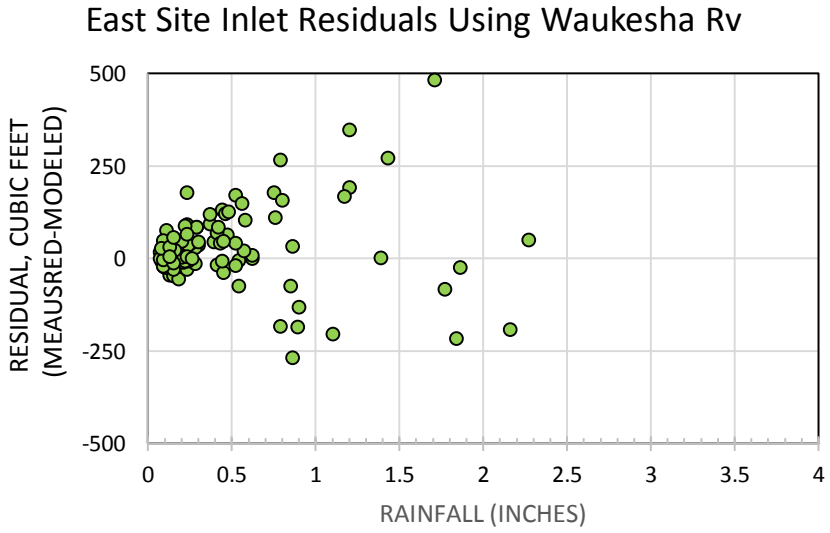


INLET VOLUME COMPARISON OF MEASURED TO MODELED HWY-VV Rv









Percent Error

West 1

East 7

BIOSWALE

- Modeling Biofilters

Biofiltration Control Device

Drainage System Control Practice

Device Properties — Biofilter Number 1

Top Area (sf)	1300
Bottom Area (sf)	122
Total Depth (ft)	5.00
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	0.020
Native Soil Infiltration Rate COV	N/A
Infil. Rate Fraction-Bottom (0.001-1)	1.000
Infil. Rate Fraction-Sides (0.001-1)	1.000
Rock Filled Depth (ft)	1.25
Rock Fill Porosity (0-1)	0.33
Engineered Media Type	Media Data
Engineered Media Infiltration Rate	10.00
Engineered Media Infiltration Rate COV	N/A
Engineered Media Depth (ft)	2.00
Engineered Media Porosity (0-1)	0.27
Percent solids reduction due to Engineered Media (0 -100)	N/A
Inflow Hydrograph Peak to Average Flow Ratio	3.80
Number of Devices in Source Area or Upstream Drainage System	1

Activate Pipe or Box Storage — Pipe — Box

Diameter (ft)	
Length (ft)	
Within Biofilter (check if Yes)	
Perforated (check if Yes)	
Bottom Elevation (ft above datum)	
Discharge Orifice Diameter (ft)	

Select Native Soil Infiltration Rate

- Sand - 8 in/hr
- Loamy sand - 2.5 in/hr
- Sandy loam - 1.0 in/hr
- Loam - 0.5 in/hr
- Silt loam - 0.3 in/hr
- Sandy silt loam - 0.2 in/hr
- Clay loam - 0.1 in/hr
- Silty clay loam - 0.05 in/hr
- Sandy clay - 0.05 in/hr
- Silty clay - 0.04 in/hr
- Clay - 0.02 in/hr
- Rain Barrel/Cistern - 0.00 in/hr

Select Particle Size File — Not needed - calculated by program

Add — Sharp Crested Weir

Weir Length (ft)	
Height from datum to bottom of weir opening (ft)	

Remove — Broad-Crested Weir-Reqrd

Weir crest length (ft)	24.00
	1.00
Height from datum to bottom of weir opening (ft)	4.75

Remove — Vertical Stand Pipe

Pipe diameter (ft)	2.00
Height above datum (ft)	3.26

Add — Surface Discharge Pipe

Pipe Diameter (ft)	
Number of pipes at invert elev.	

Remove — Drain Tile/Underdrain

Pipe Diameter (ft)	0.50
Invert elevation above datum (ft)	1.25
Number of pipes at invert elev.	1

Add — Other Outlet

Stage Number	Stage (ft)	Other Outflow Rate (cfs)
1		
2		
3		
4		
5		

Add — Evapotranspiration

Soil porosity (saturation moisture content, 0-1)	
Permanent wilting point (0-1)	
Supplemental irrigation used?	
Fraction of available capacity when irrigation starts (0-1)	
Fraction of available capacity when irrigation stops (0-1)	

Evaporation — Add

Month	Evapotranspiration (in/day)	Evaporation (in/day)
Jan		
Feb		
Mar		
Apr		
May		
Jun		
Jul		
Aug		
Sep		
Oct		
Nov		
Dec		

Plant Types

	1	2	3	4
Fraction of biofilter that is vegetated				
ET Crop Adjustment Factor				

Use Random Number Generation to Account for Infiltration Rate Uncertainty

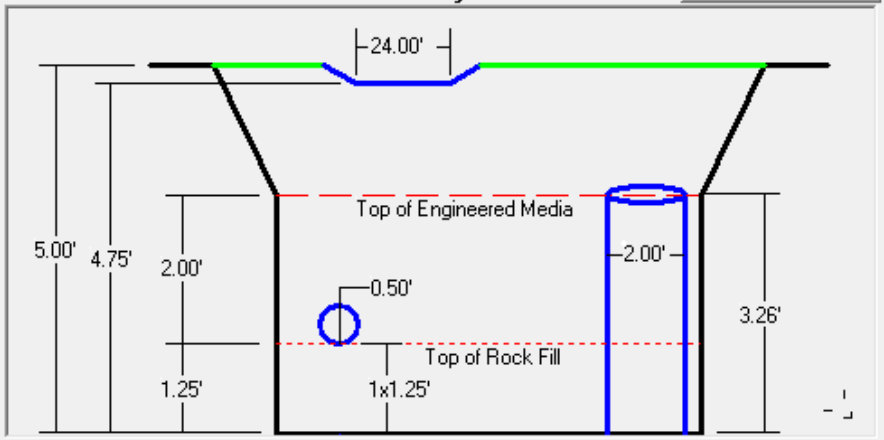
0.00 Initial Water Surface Elevation (ft)

Est. Surface Drain Time = 248.2

Copy Biofilter Data

Paste Biofilter Data

Biofilter Geometry Schematic — Refresh Schematic



Press 'F1' for Help — Delete — Cancel — Continue

Control Practice # : 1 — CP Index # : 1

Area

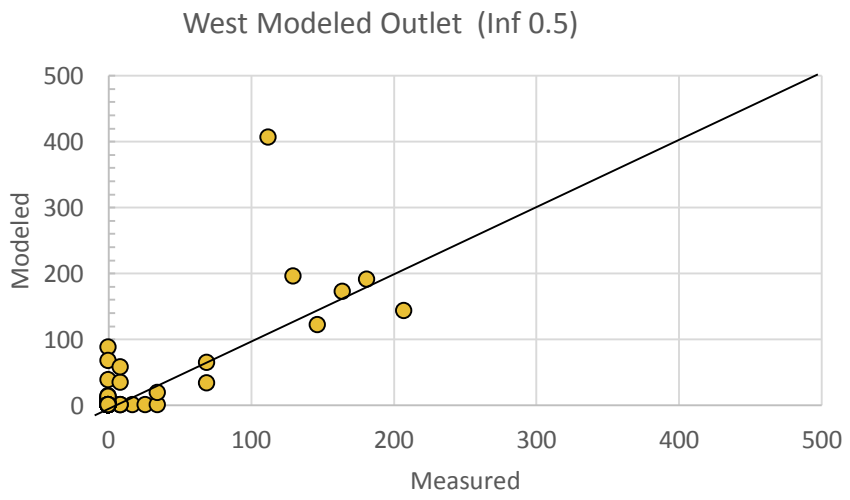
Inf Rate

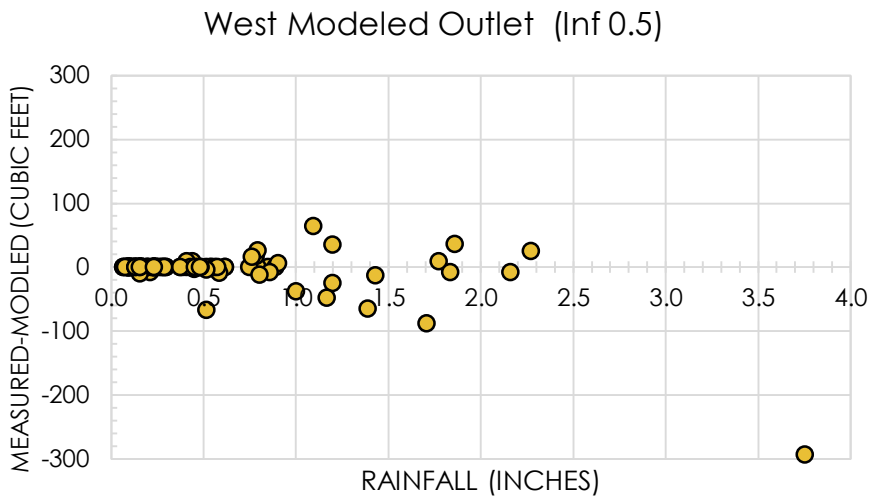
Overflow

Thickness

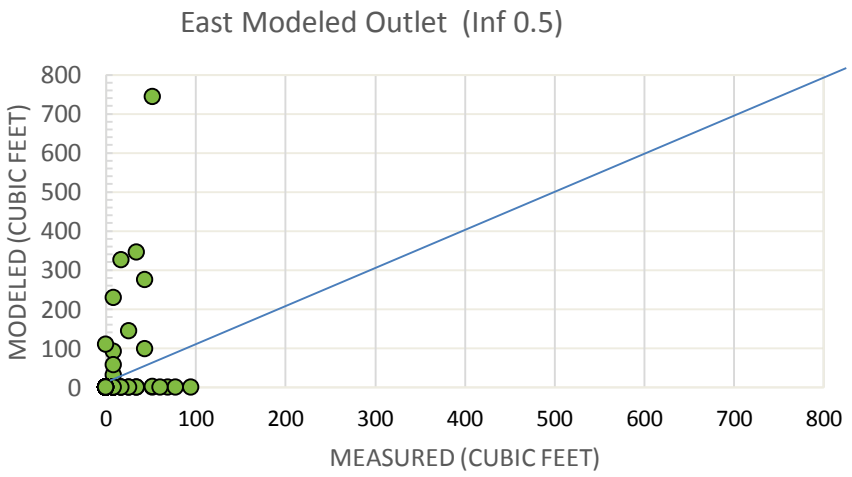
Drain Tile

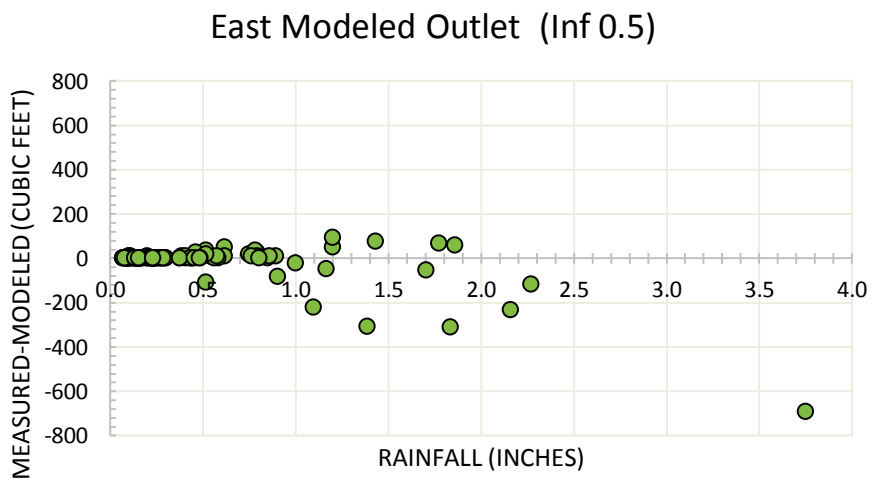
OUTLET VOLUME COMPARISON OF MEASURED TO MODELED





West	Measured	Modeled
Percent Reduction	92	91
Number of Event With Volume	12	18





West	Measured	Modeled
Percent Reduction	97	95
Number of Event With Volume	15	11

VOLUME COMPARISON MEASURED VS MODELED

West	Measured (cf)	Modeled (cf)	Percent Difference	Infiltration Rate (in/hr)
Inlet	16,300	16,200	1	-
Outlet	1,240	1,700	37	0.5
Outlet	1,240	1,300	5	0.6

East	Measured (cf)	Modeled (cf)	Percent Difference	Infiltration Rate (in/hr)
Inlet	28,300	26,200	7	-
Outlet	950	2,500	158	0.5
Outlet	950	1,770	86	0.6

CONCLUSION

- Bioswales Very Effective Along Highways
- WinSLAMM Modeled Results Match Measure Data
- WisDOT Achieving Reduction Goals