WinSLAMM Analysis of Treatment Practices

September 29, 2009

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PV & Associates

&

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WDNR

Outline

- WinSLAMM Purpose
- Model Applications
- Model Strengths and Limitations
- Small Storm Hydrology
- Basic Program Structure
- Treatment Practices
  - Bio-filters
- Upcoming Features

Purpose of the Source Loading and Management Model (SLAMM)

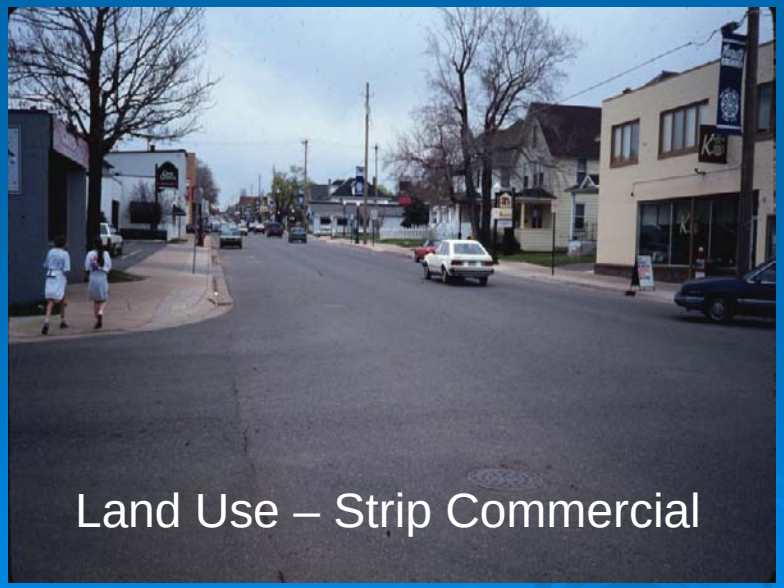
Developed to evaluate the benefits of stormwater treatment practices for both runoff quality and quantity in existing and developing urban areas.

Model Applications

Model Can Be Applied on Multiple Levels –

- Large Scale, City-wide Analysis
- Single Land Use
- Single Source Areas


City-wide - Madison

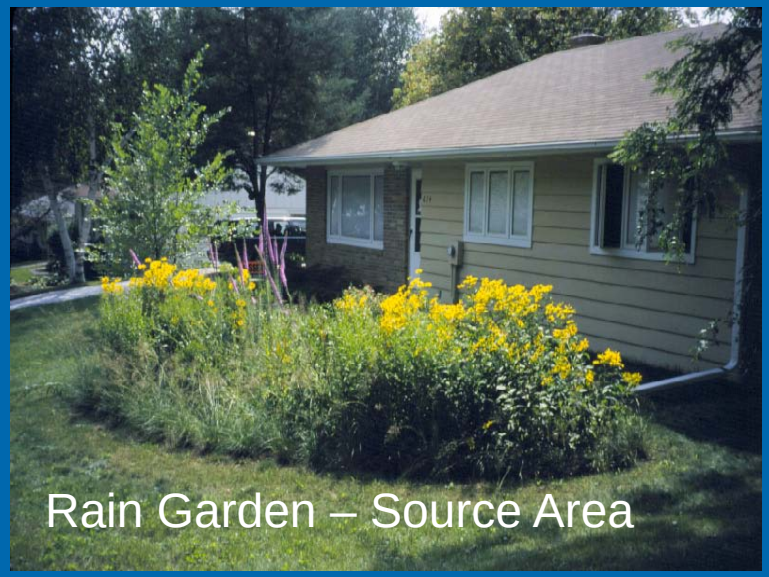

Land Use – Strip Commercial


Source Area

Model Applications

Stormwater Control Practices Can Be Applied on Multiple Levels –

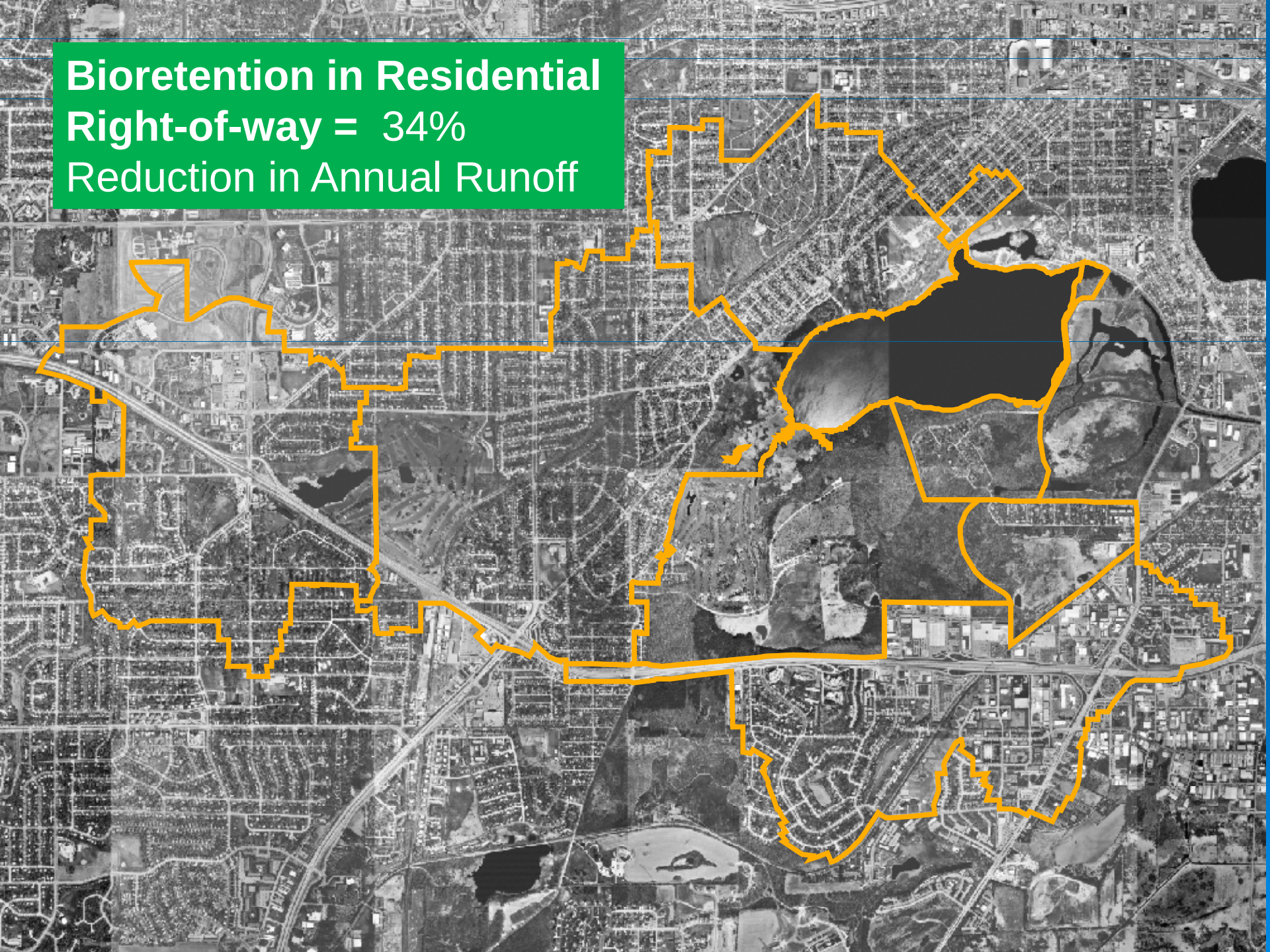
- Source Area
- Conveyance System
- End of Pipe



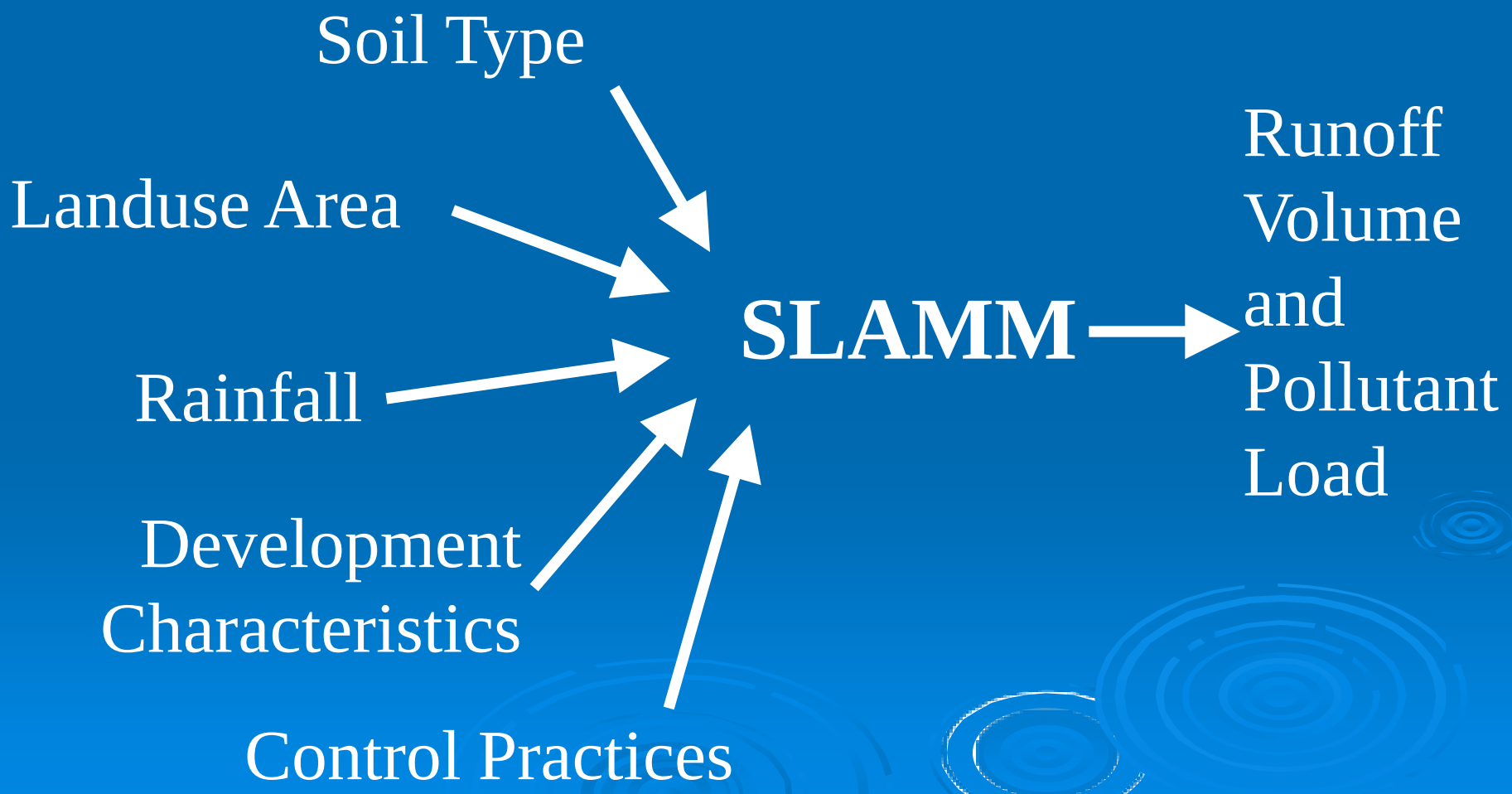
Rain Garden – Source Area

Grass Swale – Conveyance System

Infiltration Basin – End of Pipe


Bioretention in Residential Right-of-way = 34%
Reduction in Annual Runoff

These concepts are incorporated into SLAMM



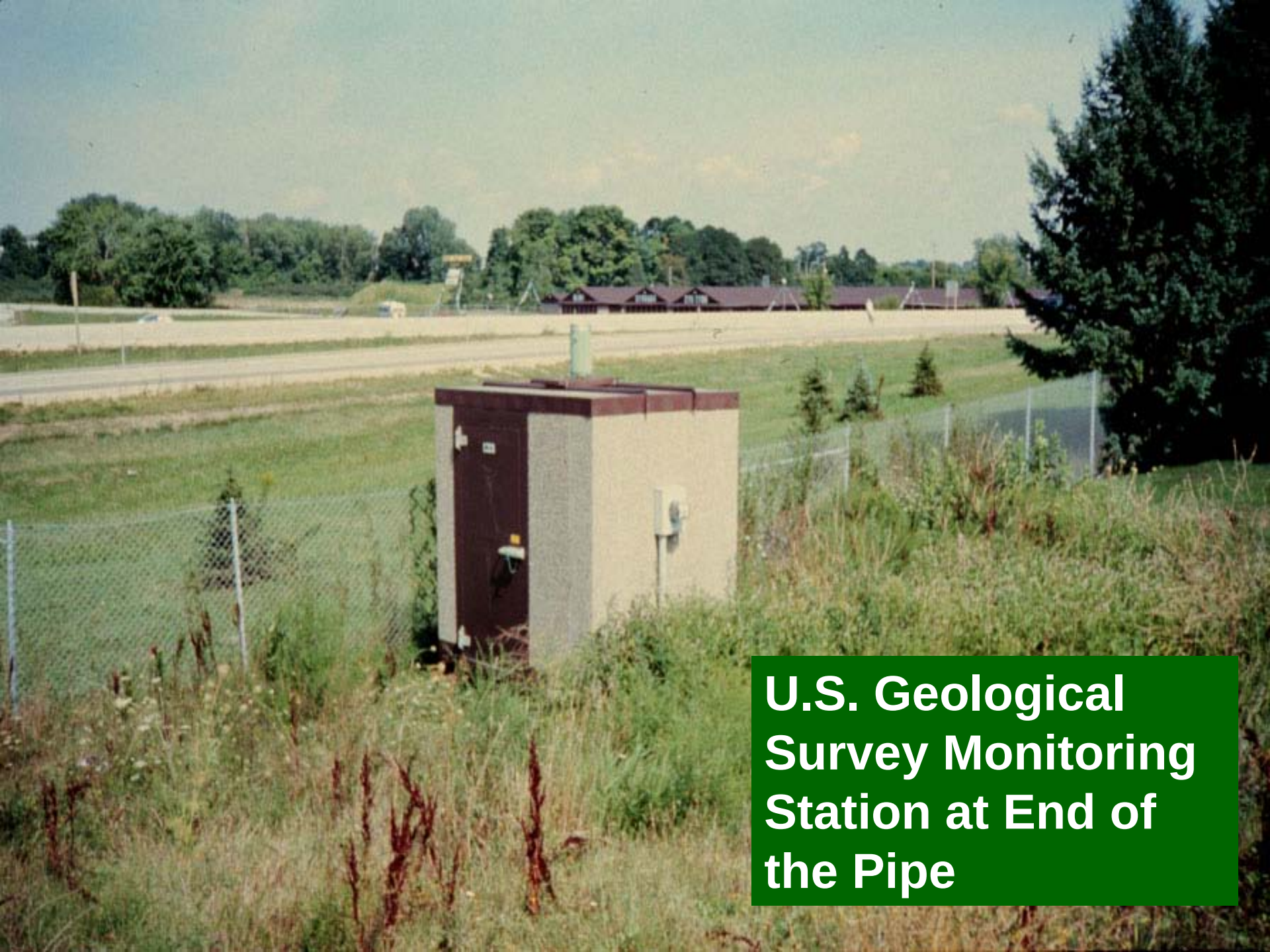
Model Strengths

- Based upon actual field monitoring and data
- Analyzes pollutants at the source area level
- Considers many stormwater controls together, for a long series of rains
- Input data relatively easy to acquire
- Predicts runoff volumes and pollutant loads for long periods

Calibrate SLAMM with Source Area Concentrations

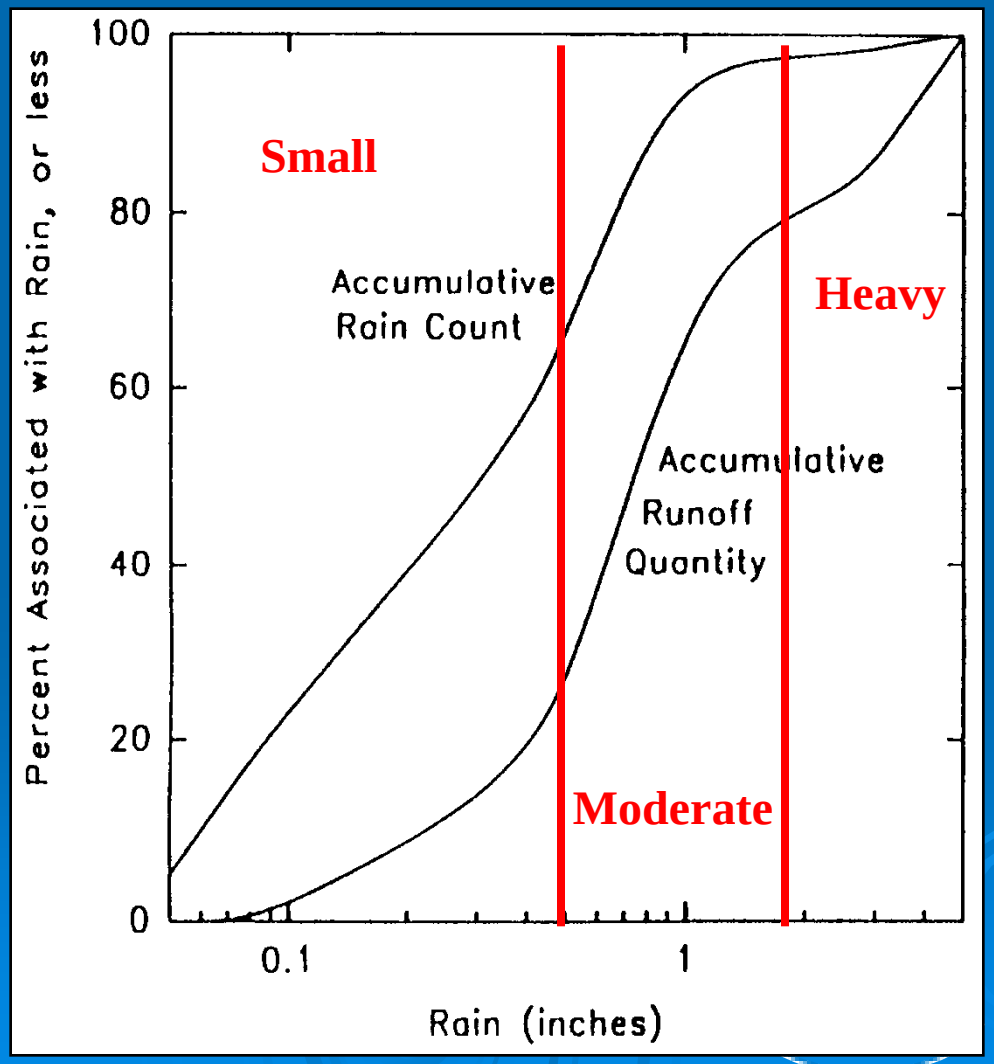
Source Area Sampler for Streets, Parking Lots, Driveways, and Roofs

Source Area Sampler for Lawns

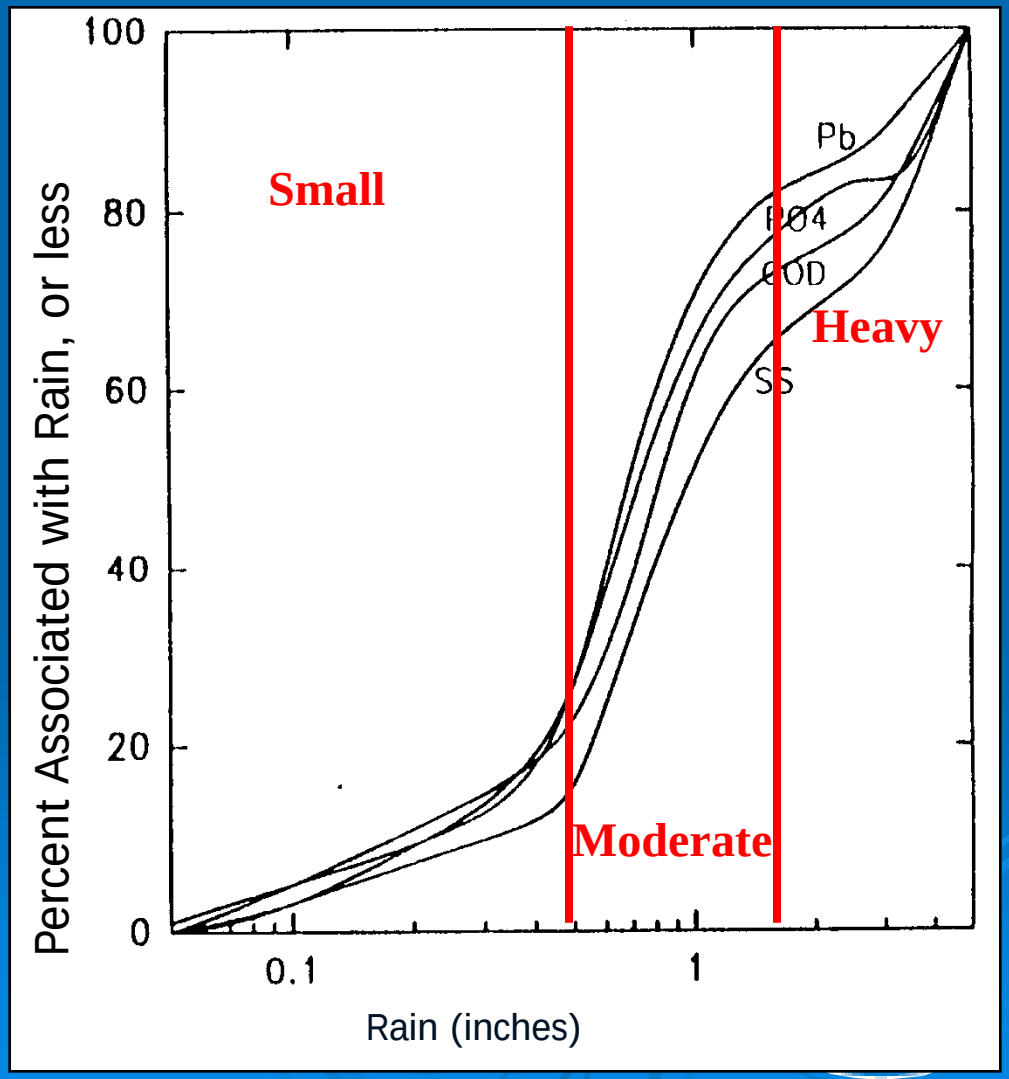

U.S. Geological Survey Monitoring Station at End of the Pipe

For Urban Stormwater Quality, WinSLAMM bases it's analysis on the concept of
Small Storm Hydrology

Milwaukee Rainfall and Runoff Distributions



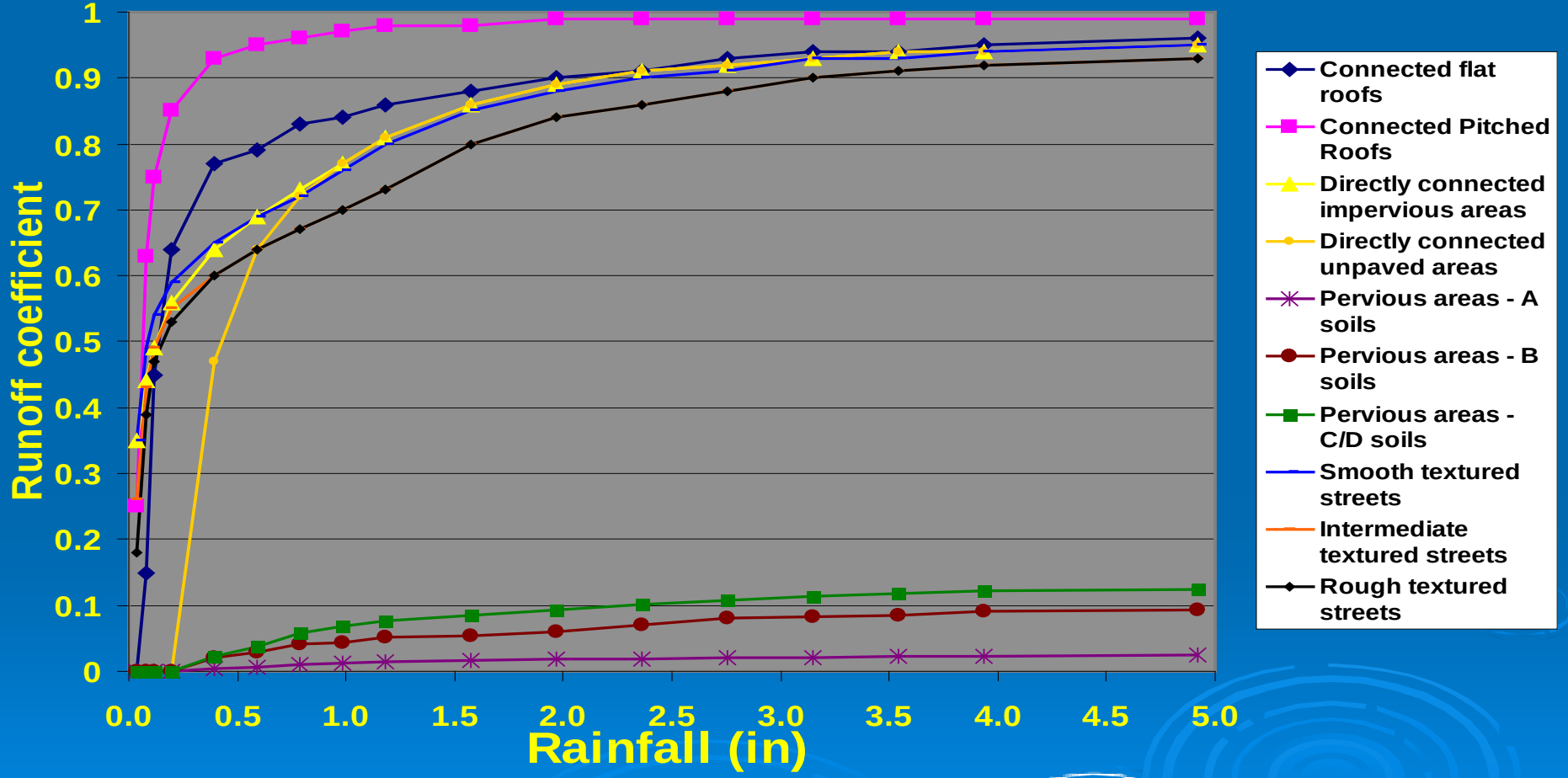
Milwaukee Pollutant Distribution



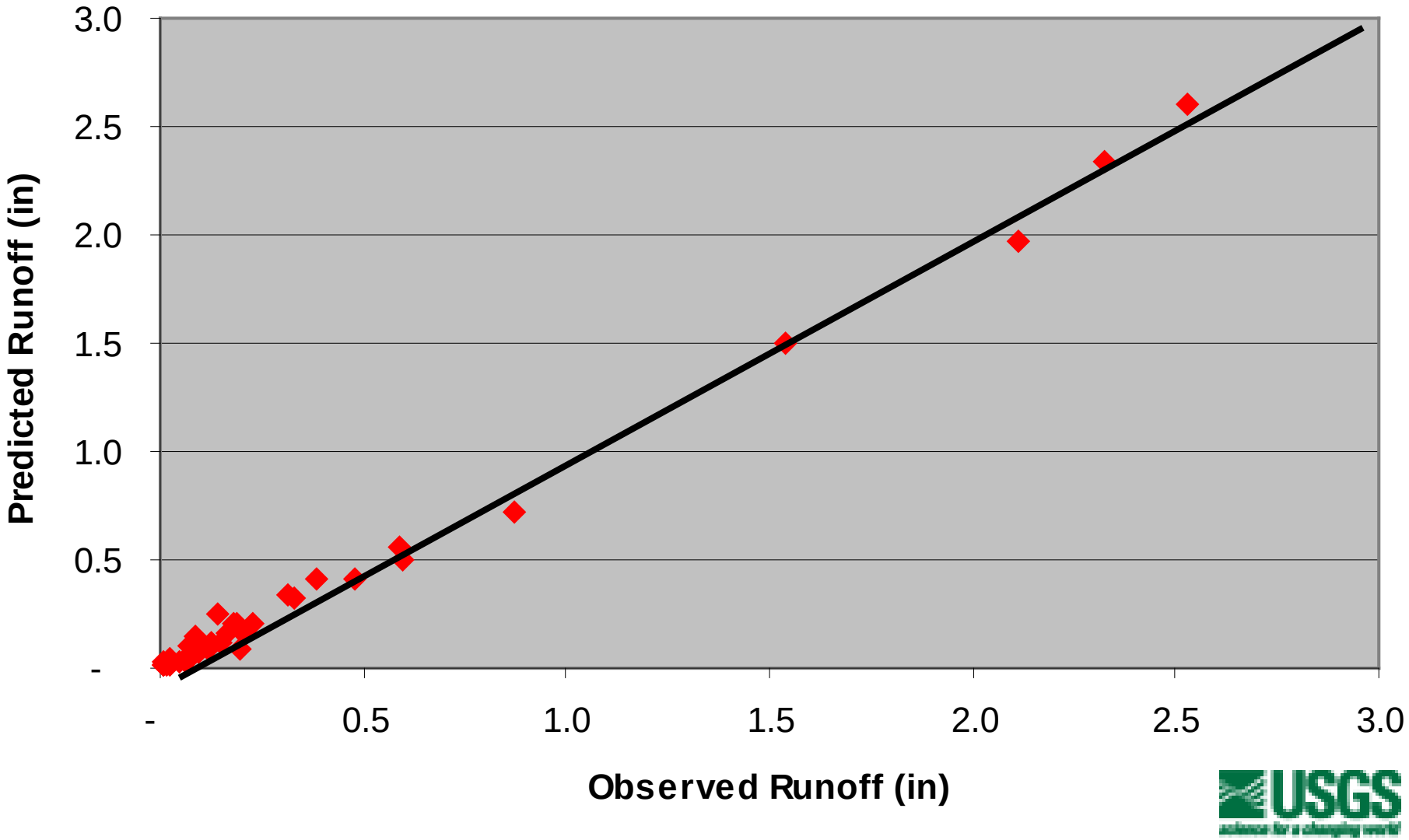
Annual Runoff for Commercial Using SLAMM and TR55

Type of Hydrology	Runoff for < 0.5 in. Rain	Runoff for > 0.5 in. Rain	Total Runoff, inches	Rain Depth, inches
TR55	3.01	14.77	17.99	28.81
SLAMM	4.48	14.81	19.29	28.81

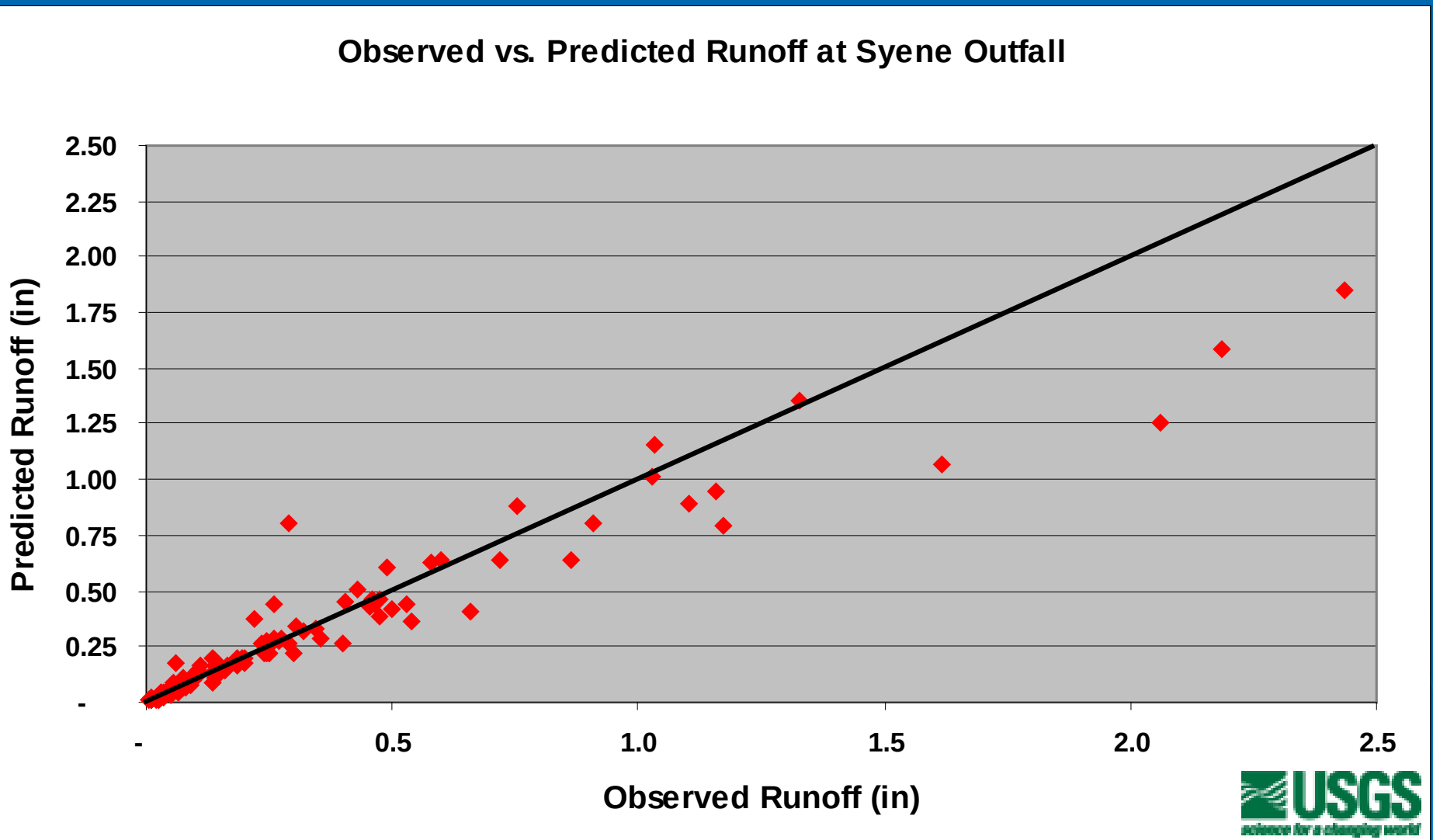
SLAMM runoff coefficient file - .rsv

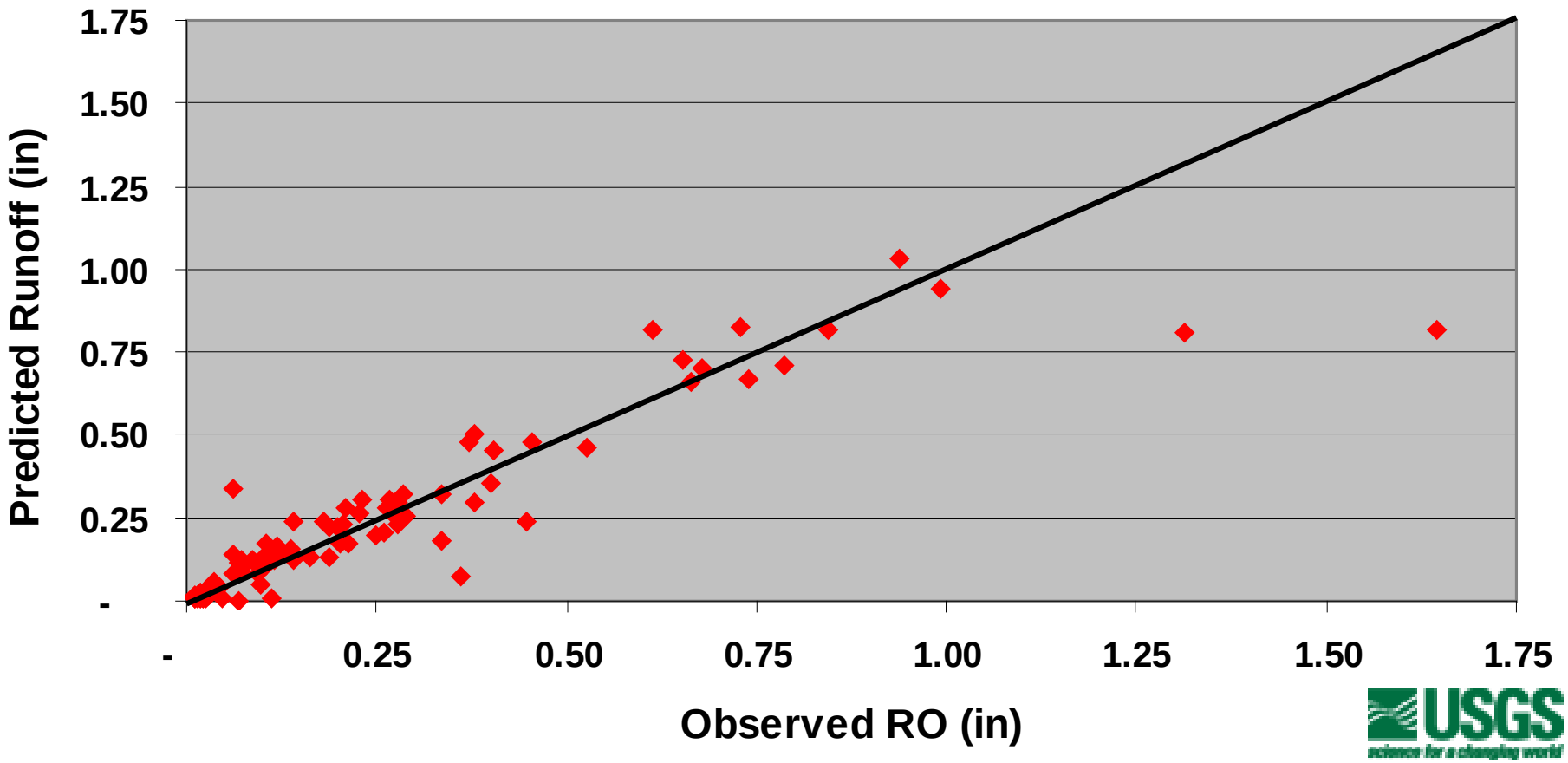


Observed vs. Predicted Runoff at Madison Maintenance Yard Outfall



USGS
science for a changing world


Observed vs. Predicted Runoff at Syene Outfall
Predicted Runoff (in)
2.50
2.25
2.00
1.75
1.50
1.25
1.00
0.75
0.50
0.25
-
-
0.5
1.0
1.5
2.0
2.5
Observed Runoff (in)
USGS
science for a changing world


Observed vs. Predicted Runoff Superior Outfall
Predicted Runoff (in)
1.75
1.50
1.25
1.00
0.75
0.50
0.25
-
-
0.25
0.50
0.75
1.00
1.25
1.50
1.75
Observed RO (in)

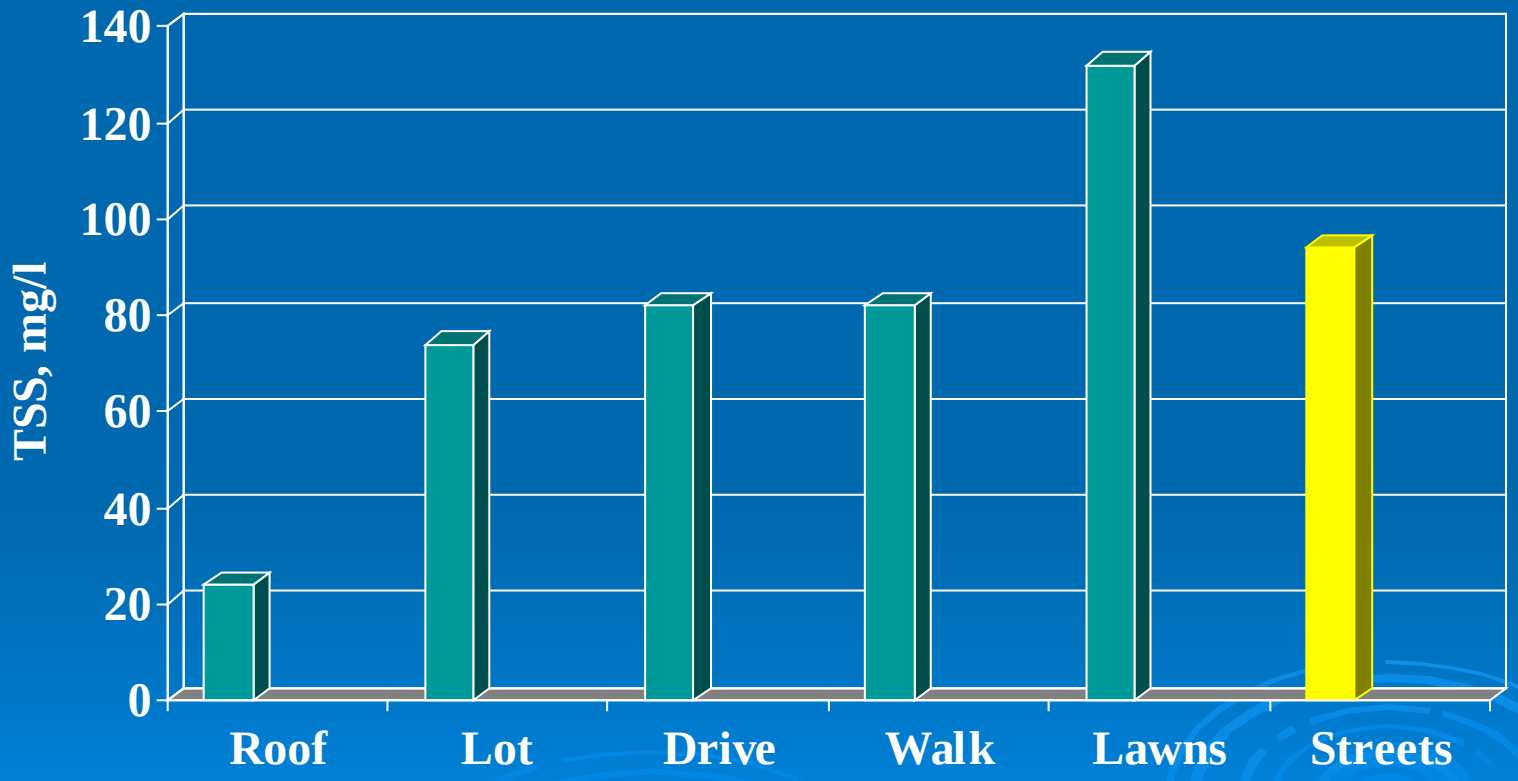
Measured versus Modeled Runoff, inches

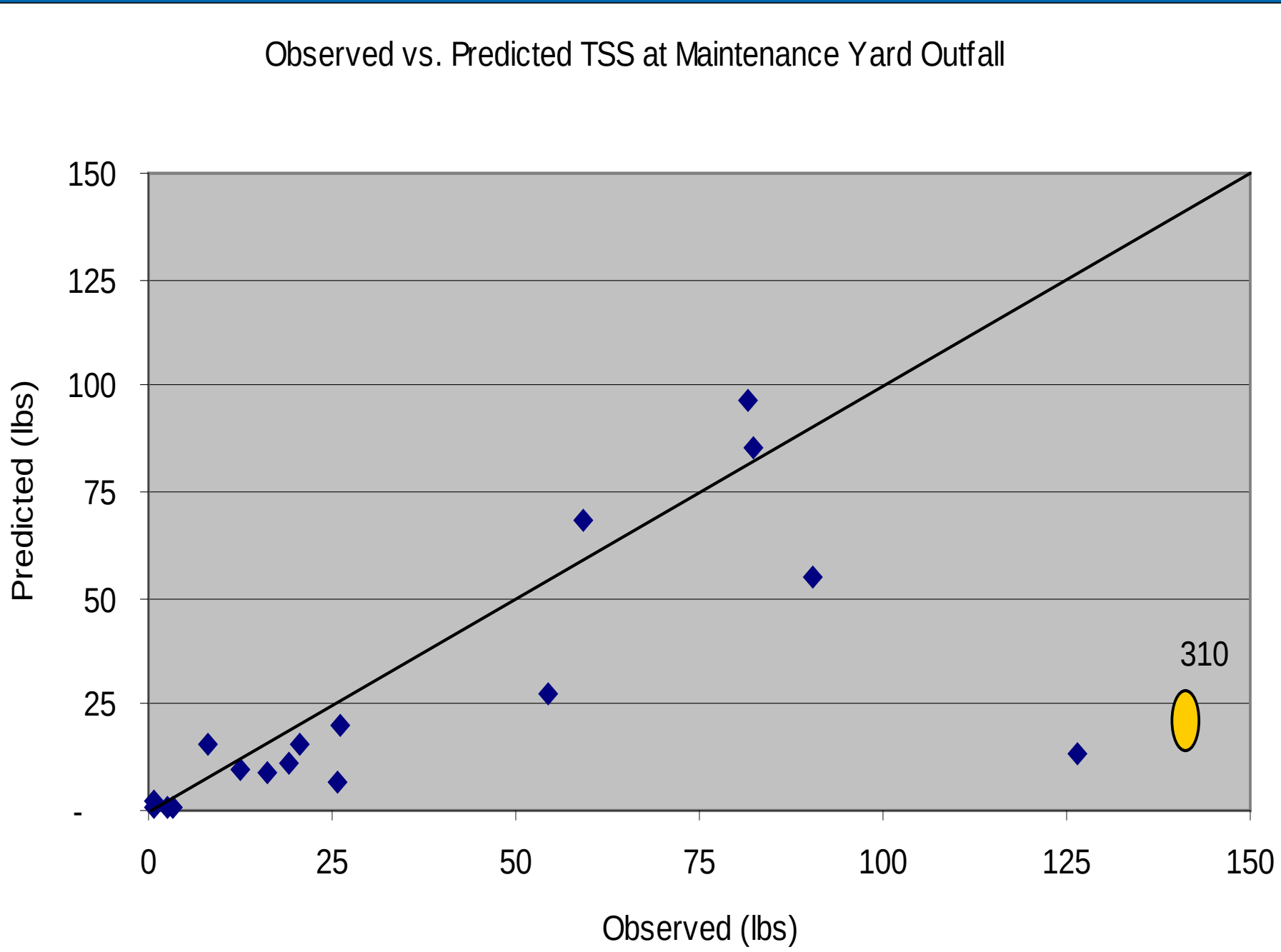
SITE	Total Rain	Measured Runoff	Modeled Runoff	Difference, %
Harper	27.9	7.3	5.3	-27%
Monroe	46.4	8.2	8.8	7%
Canterbury	14.5	5.4	5.9	10%
Marquette	22.1	3.8	4.5	19%
Superior	41.8	22.8	21.8	-4%
Syene	70.5	36.2	33.4	-8%
Badger	17.2	14.9	14.3	-4%

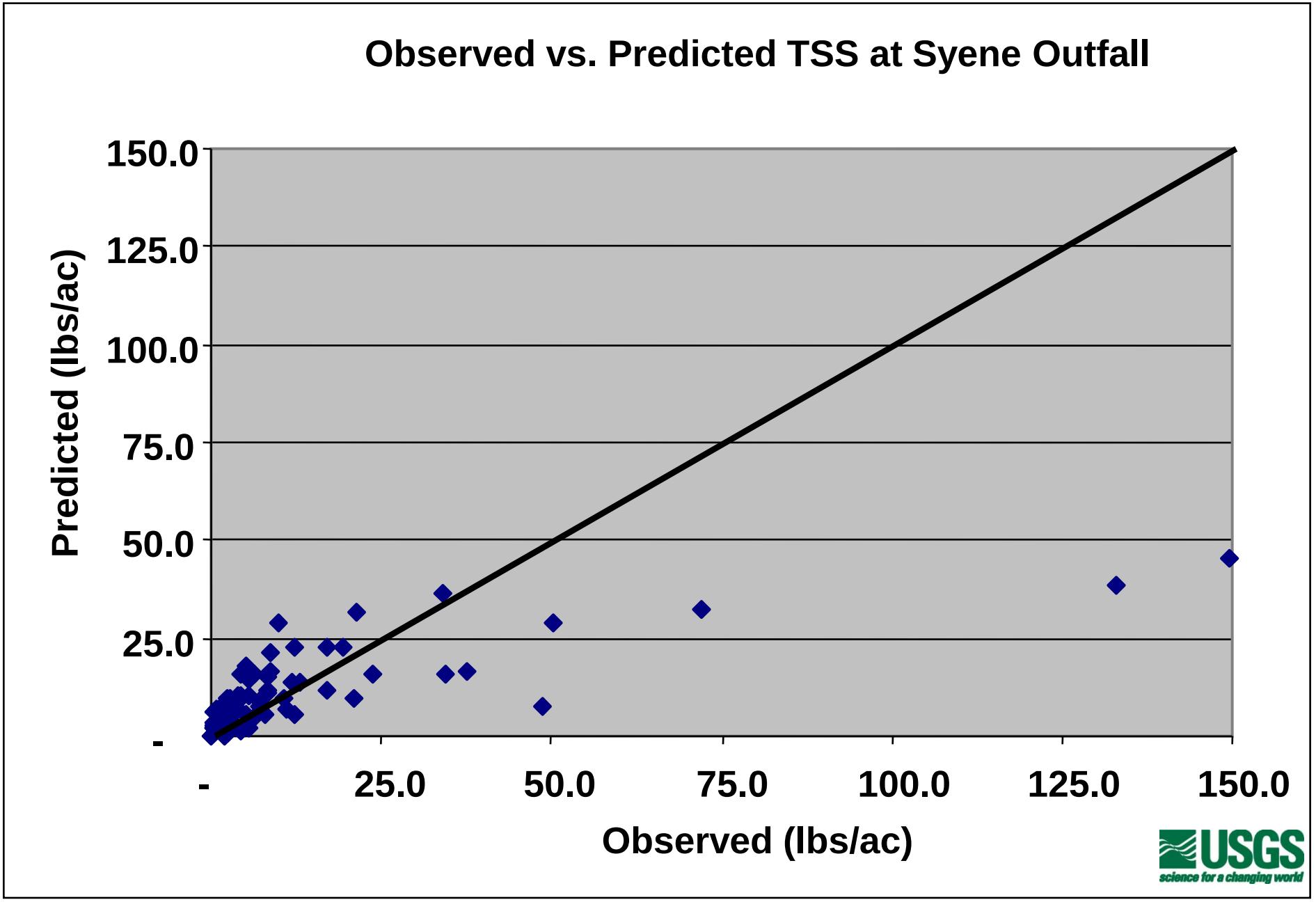
Type of Pollutants

- Suspended Solids
- Total Solids
- Total Phosphorus
- Total Lead
- Total Zinc
- Total Copper
- Dissolved Phosphorus
- Dissolved Lead
- Dissolved Zinc
- Dissolved Copper

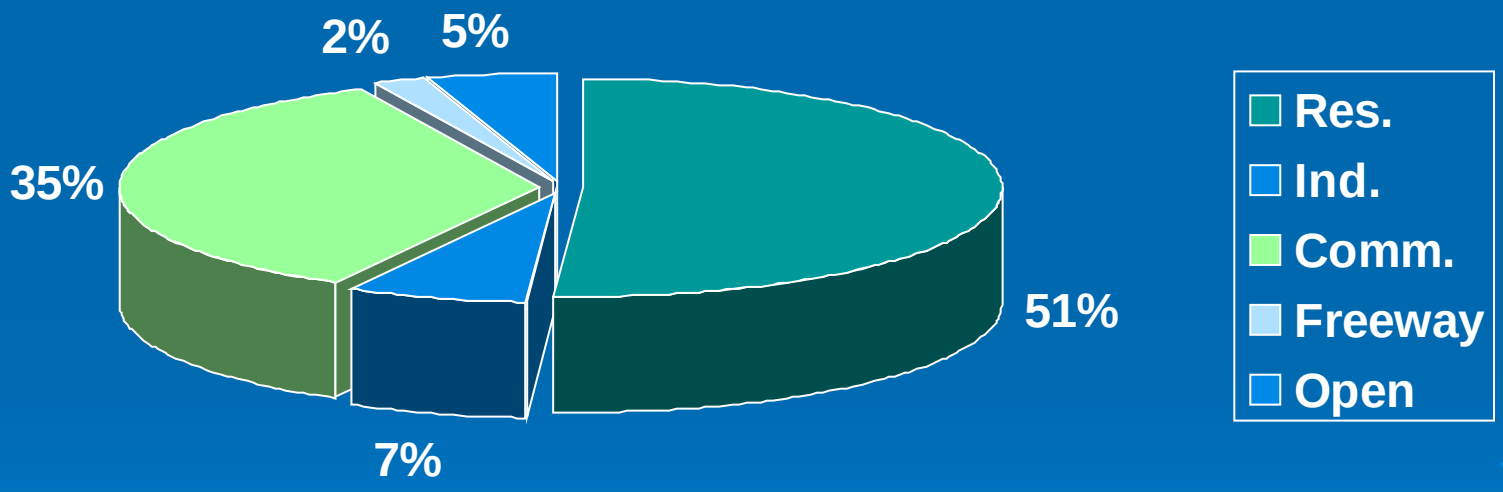
TSS Concentrations Used in SLAMM



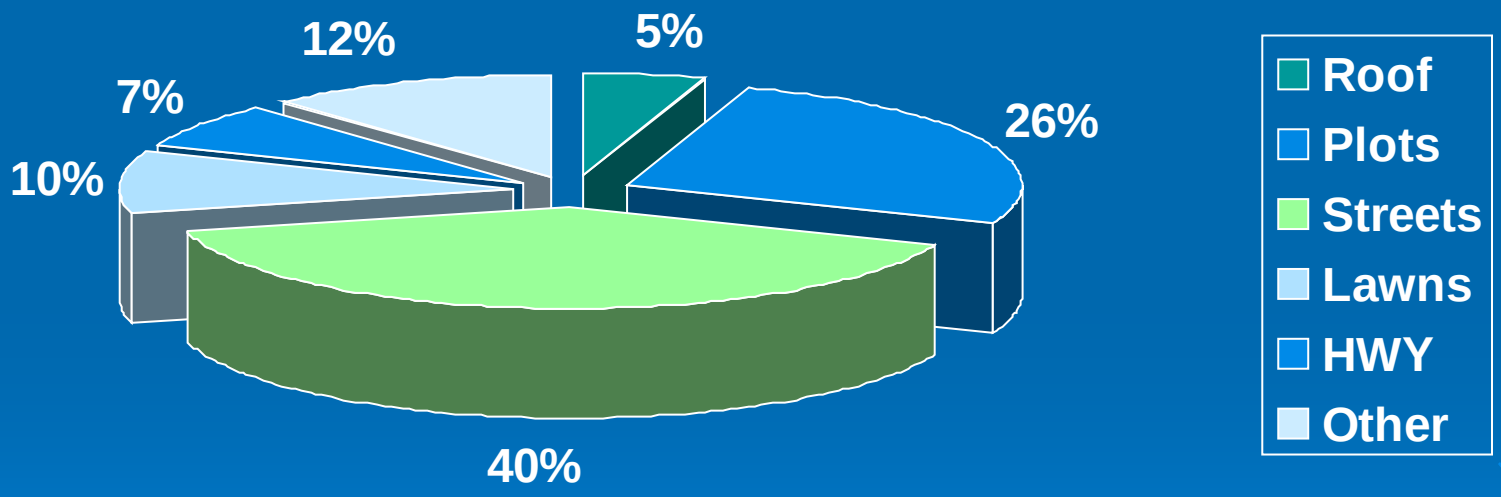

Observed vs. Predicted TSS at Maintenance Yard Outfall
Predicted (lbs)
150
125
100
75
50
25
-
0
25
50
75
100
125
150
Observed (lbs)
310


Observed vs. Predicted TSS at Syene Outfall
150.0
125.0
100.0
75.0
50.0
25.0
-
Predicted (lbs/ac)
-
25.0
50.0
75.0
100.0
125.0
150.0
Observed (lbs/ac)
USGS
science for a changing world

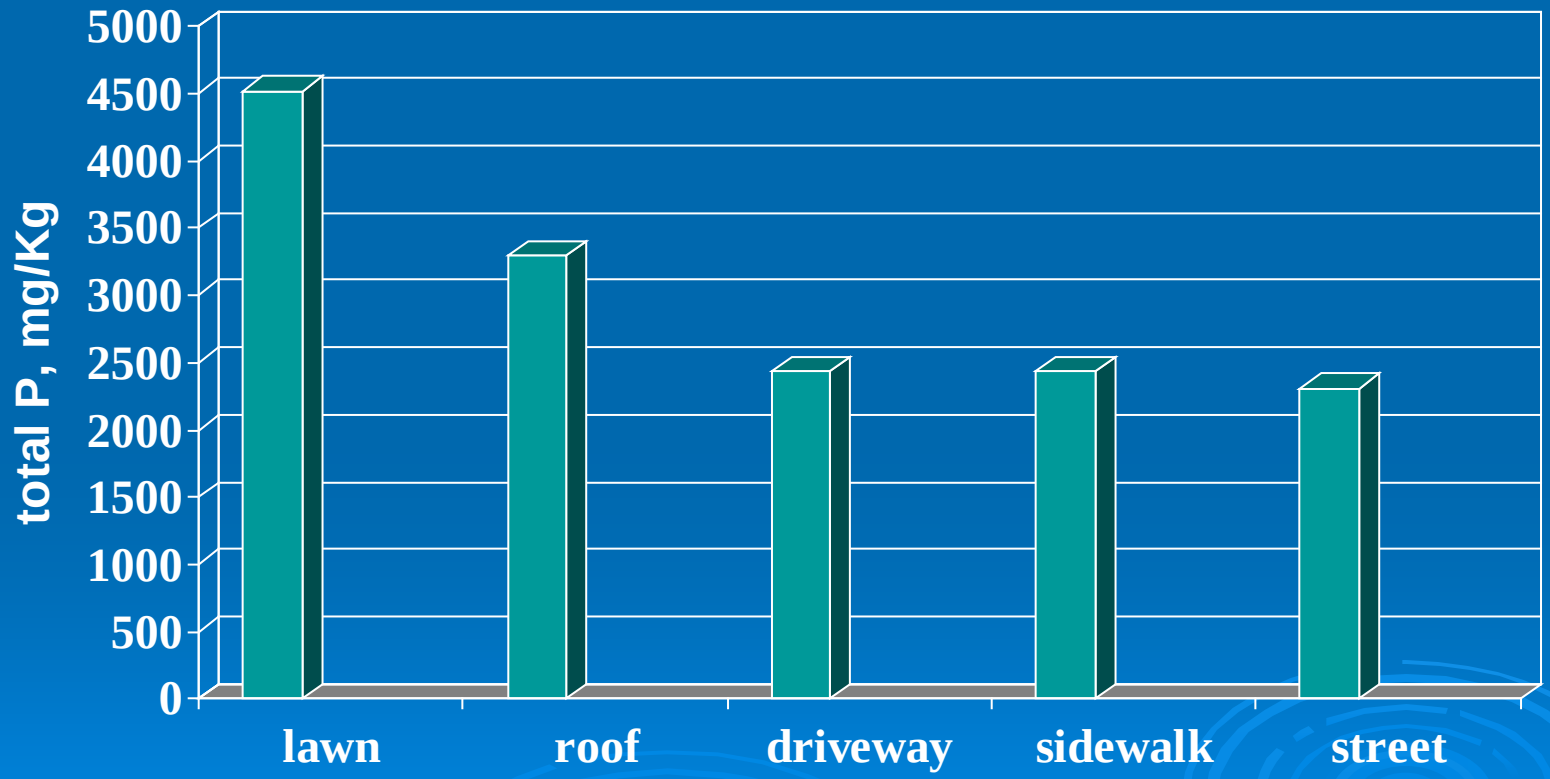
% Suspended Solids Load by Landuse for 4 Subwatersheds

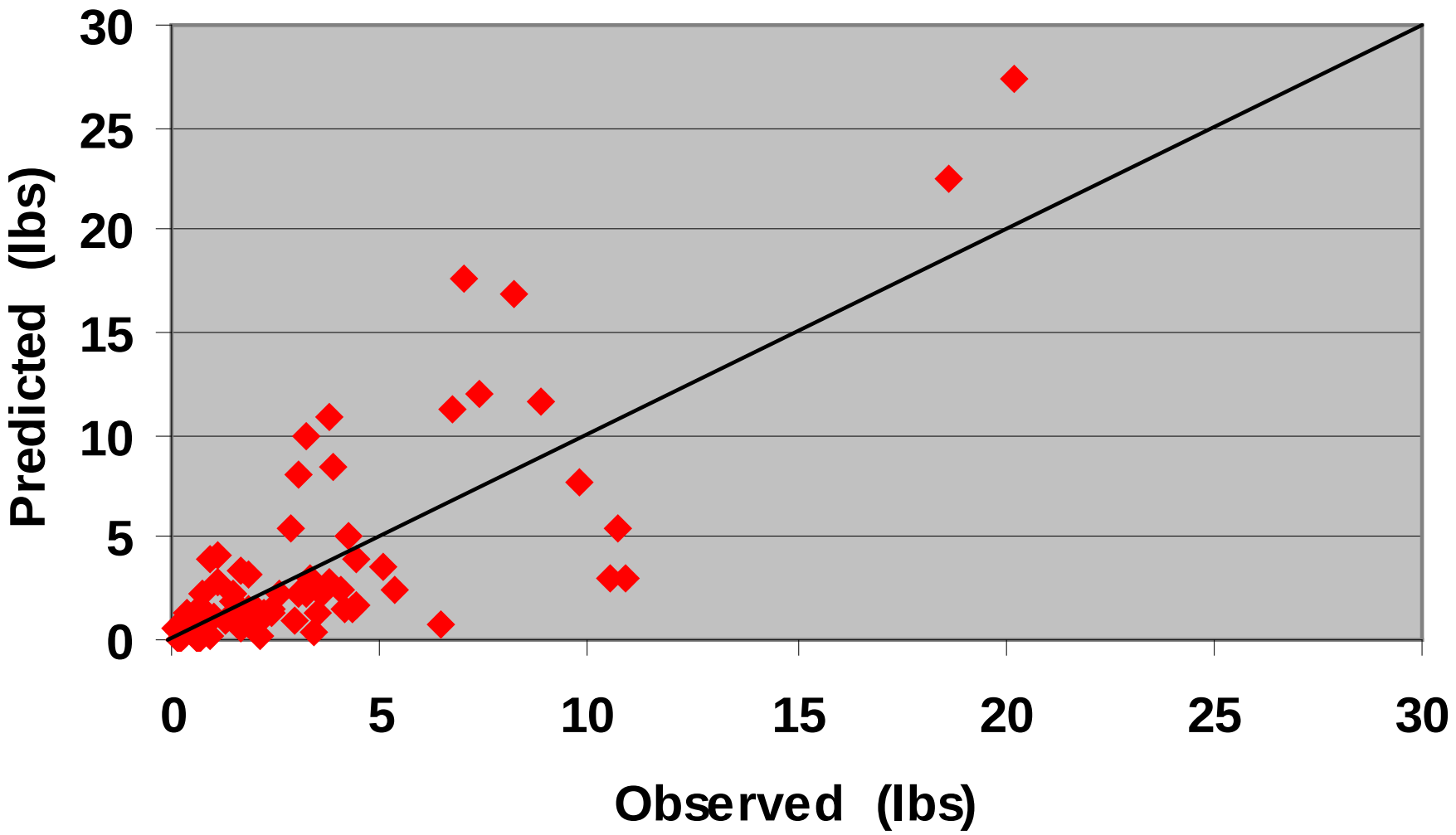


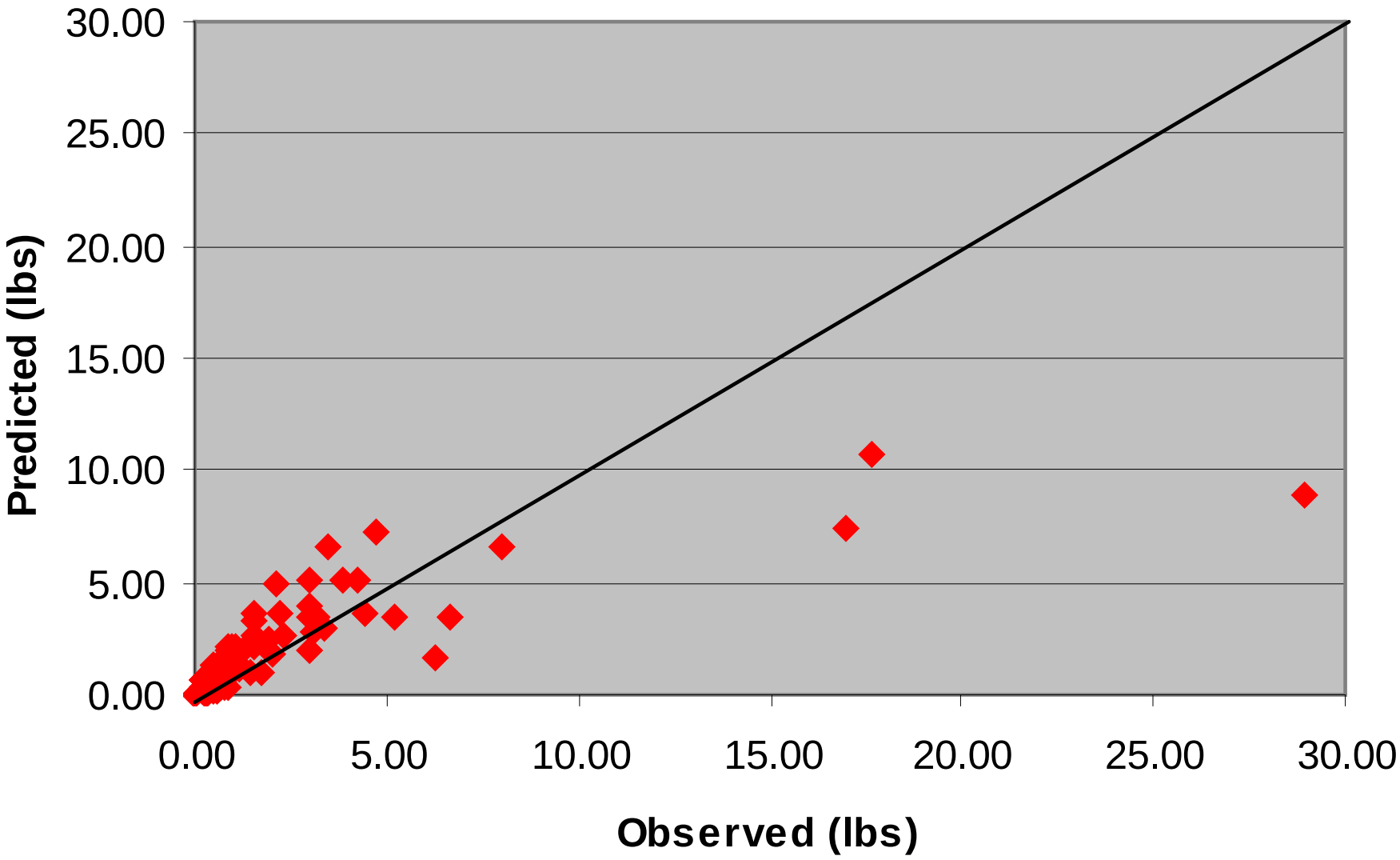
% Suspended Solids Loads from Source Areas in 4 Subwatersheds



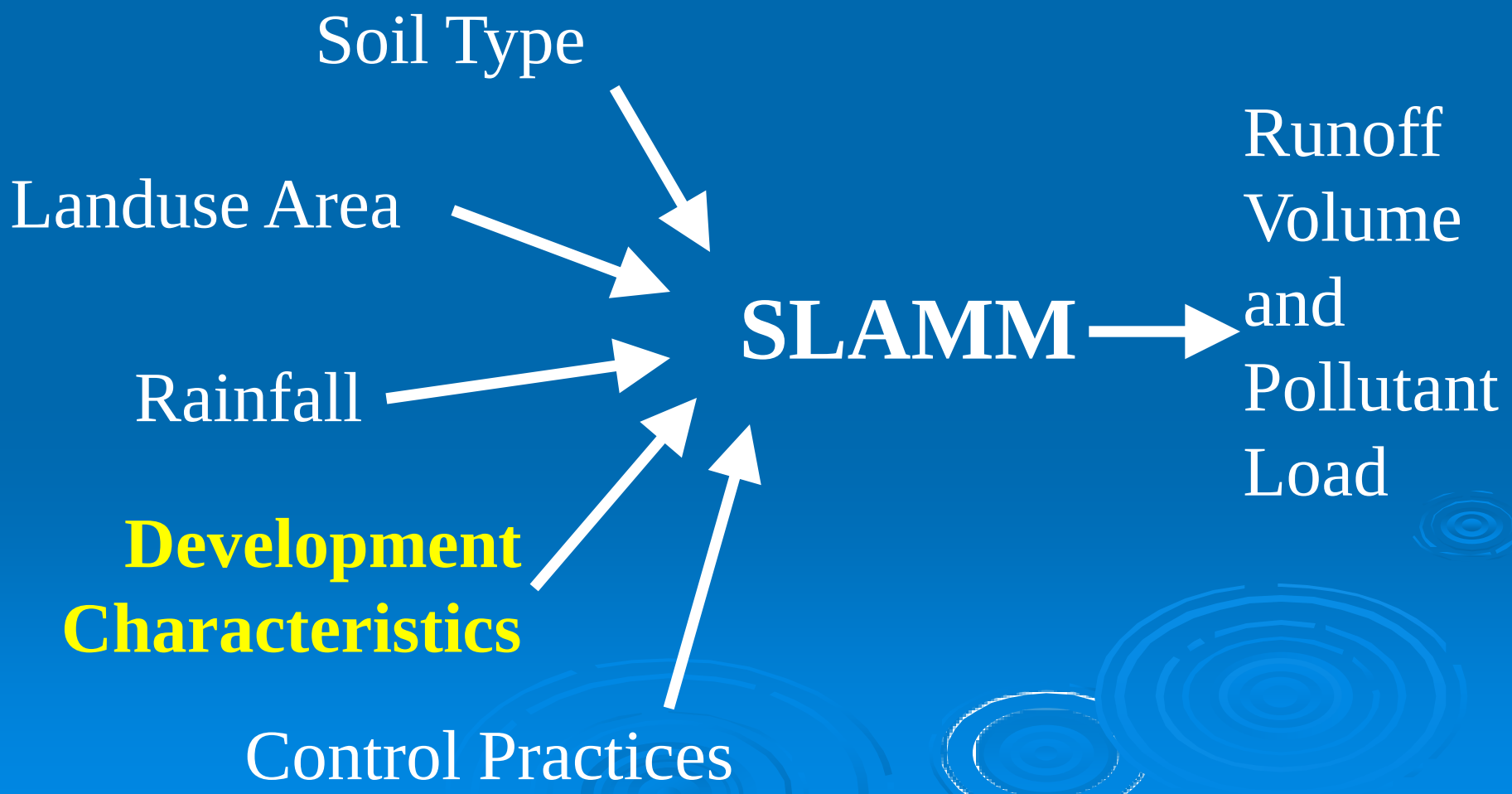
Residential Particulate P Values Used in SLAMM - .ppd




Observed vs. predicted total phosphorus
Monroe St. Outfall
Predicted (lbs)
Observed (lbs)
0
5
10
15
20
25
30


Observed vs. predicted total phosphorus Syene Outfall
30.00
25.00
20.00
15.00
10.00
5.00
0.00
Predicted (lbs)
0.00
5.00
10.00
15.00
20.00
25.00
30.00
Observed (lbs)

These concepts are incorporated into SLAMM



Development Characteristics for Each Source Area

Roofs
- Area
- % Connected
- Pitched or not

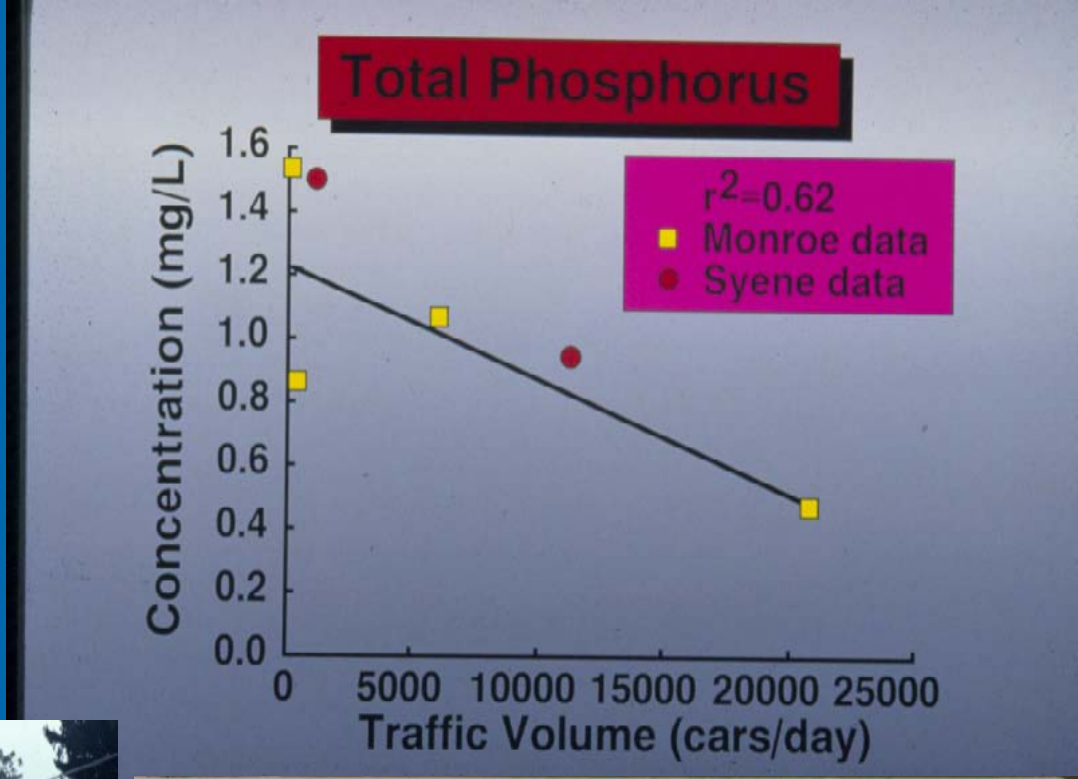
Paved Parking
- Area
- % Connected

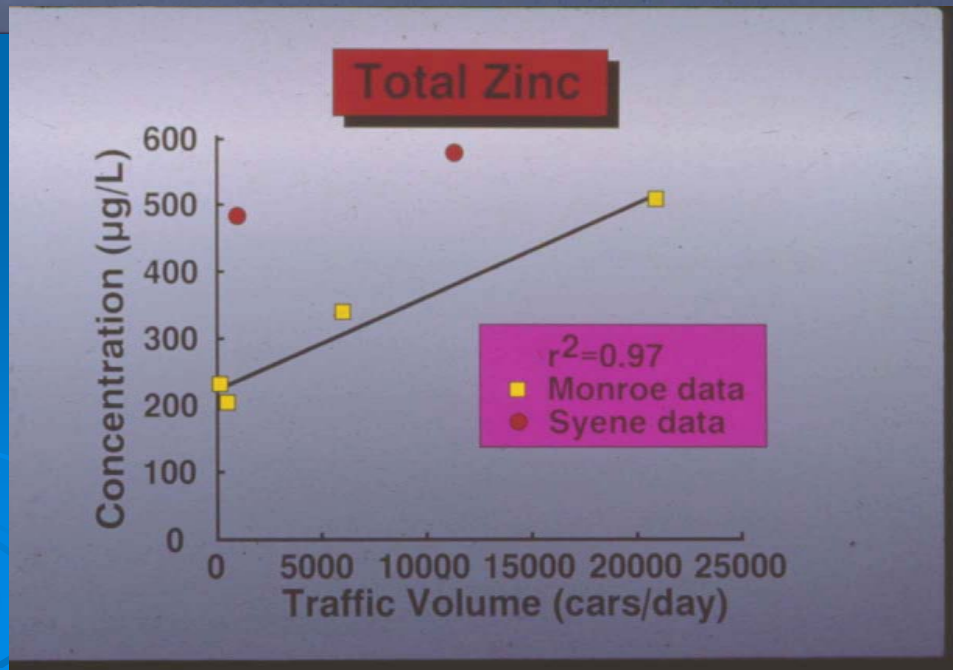
Driveways
- Area
- % Connected

Streets
- Length
- Pavement Texture
- Area
- Alleys

Small Landscape
- Area
- Soil type

Impact of Traffic Volume on Street Runoff Concentrations

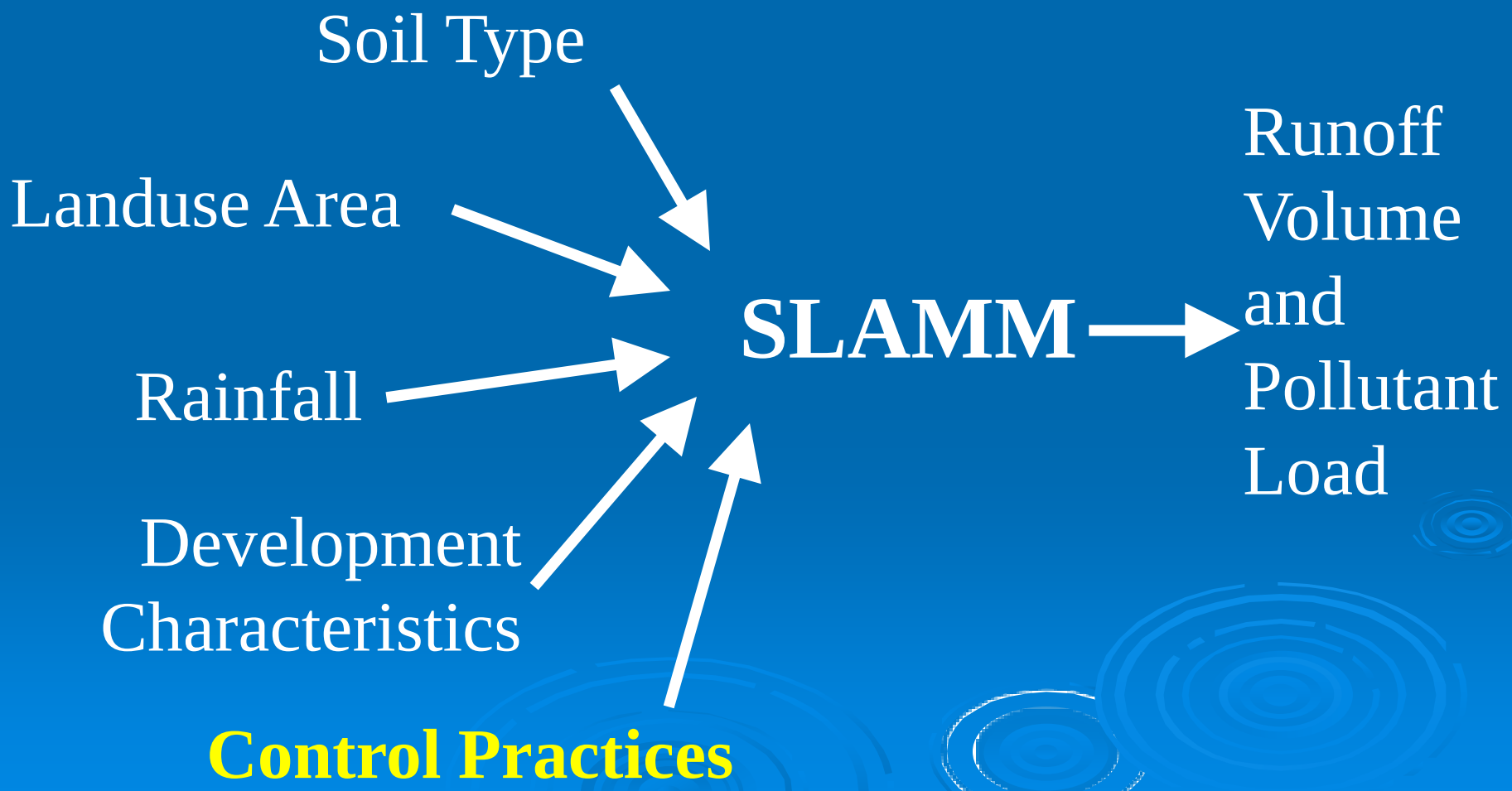




Model Limitations

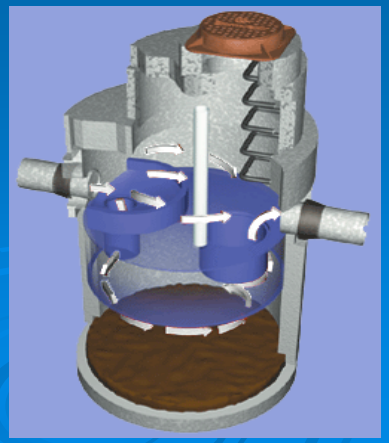
- No snowmelt or baseflow conditions
- Does not consider in-stream processes (but links into receiving water models)
- Has complete routing analyses only for controls and components where hydrograph effects are important
- Does not model construction site erosion losses
- **Not intended for design storm or rural analysis**

These concepts are incorporated into SLAMM



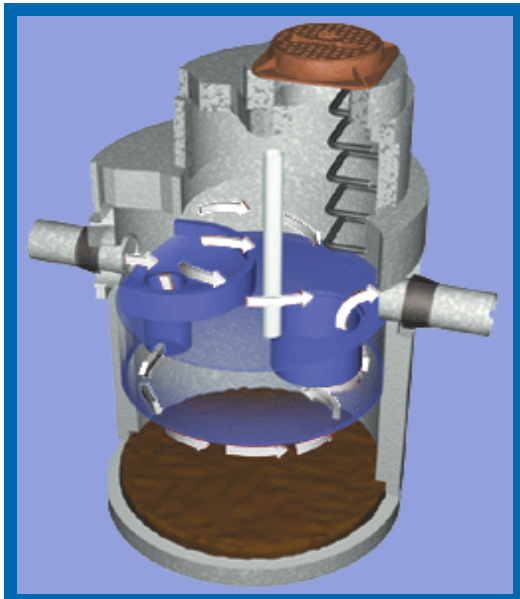
Treatment Practices

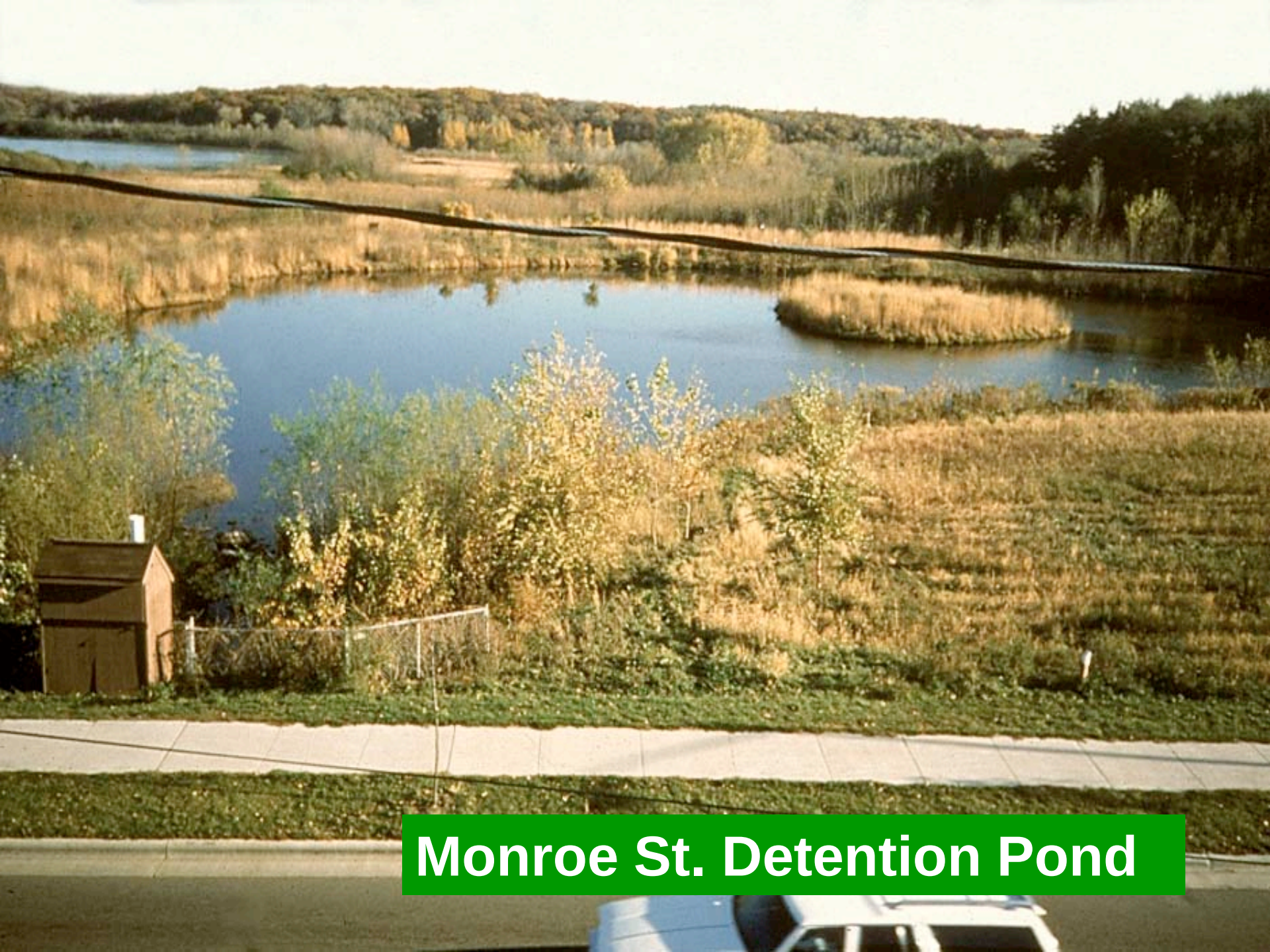
- Hydrodynamic Devices
- Wet Detention
- Porous Pavement
- Street Cleaning
- Catchbasin Cleaning
- Grass Swales
- **Biofiltration/Infiltration**
- Other Device




Evapotranspiration
Volume In
Datalogger
Soil Moisture
Pond Depth
Volume Out
11/3/2003

Comparison of Measured and Modeled TSS Reductions

	**Measured** **TSS Reductions**	**SLAMM / DETPOND** **Estimates with *Measured PSD and Rainfall***
Stormceptor	**5%**	**12%**
Vortechs	**19%**	**19%**


Monroe St. Detention Pond

Productivity Curve for Vacuum Assisted Cleaner

No Change

Y = 0.70 X + 55

Residential; Intermediate Texture; Light Parking; No controls

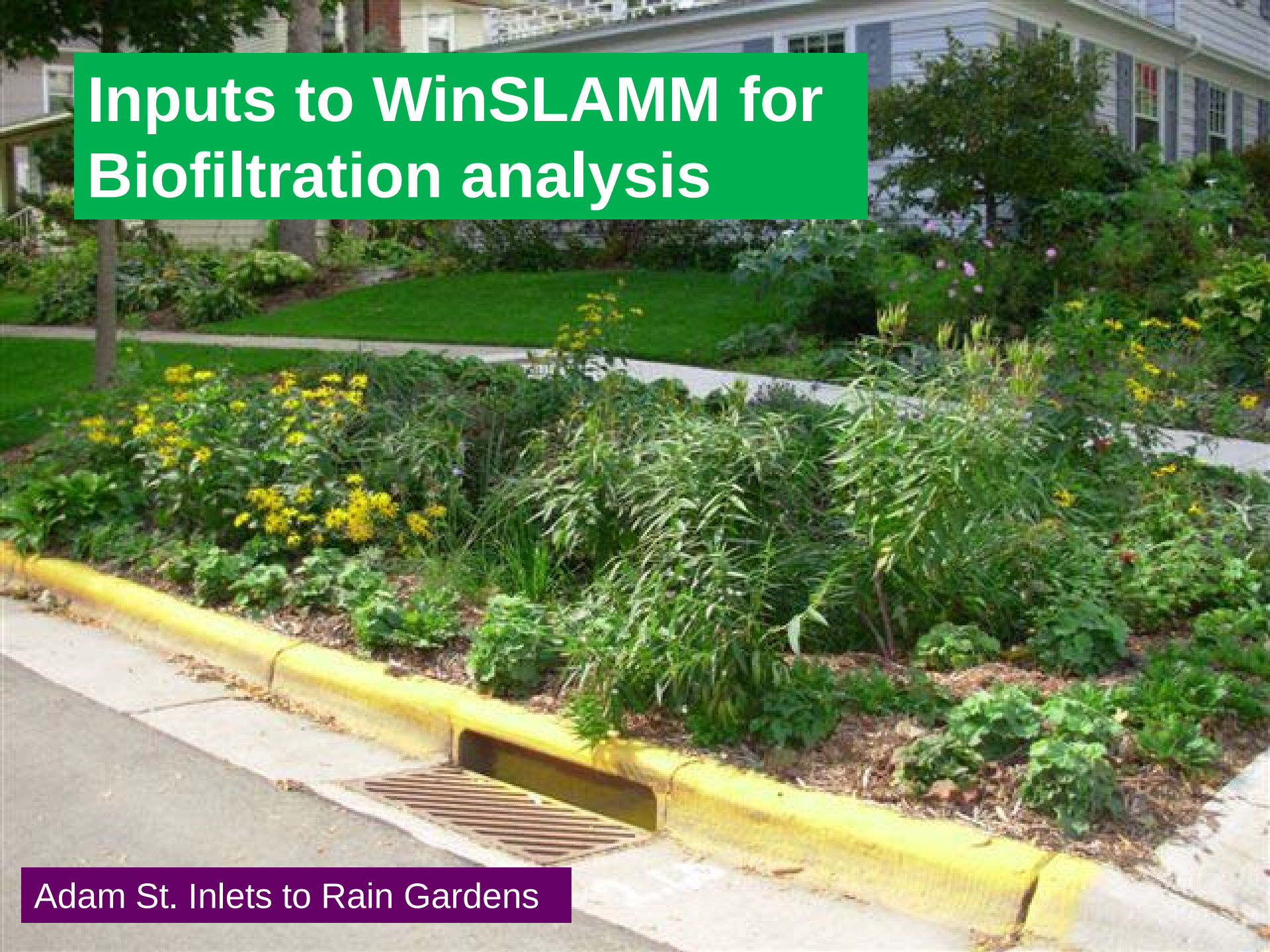
Post-Cleaning Street Loads, lbs\curb mile

0
500
1000
1500
2000
2500
3000
3500

0
500
1000
1500
2000
2500
3000
3500

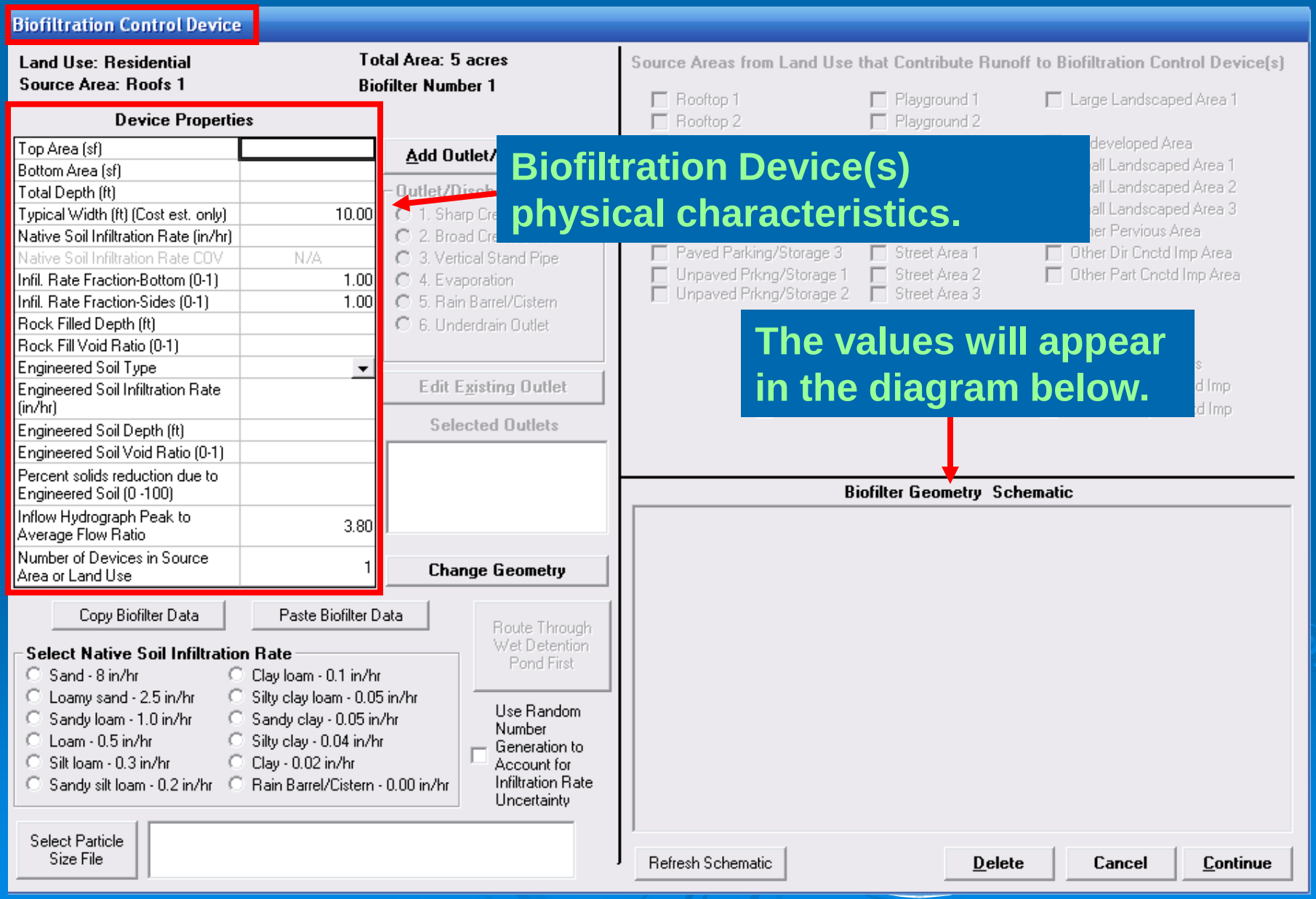
Pre-Cleaning Street Loads, lbs\curb mile

Inputs to WinSLAMM for Biofiltration analysis

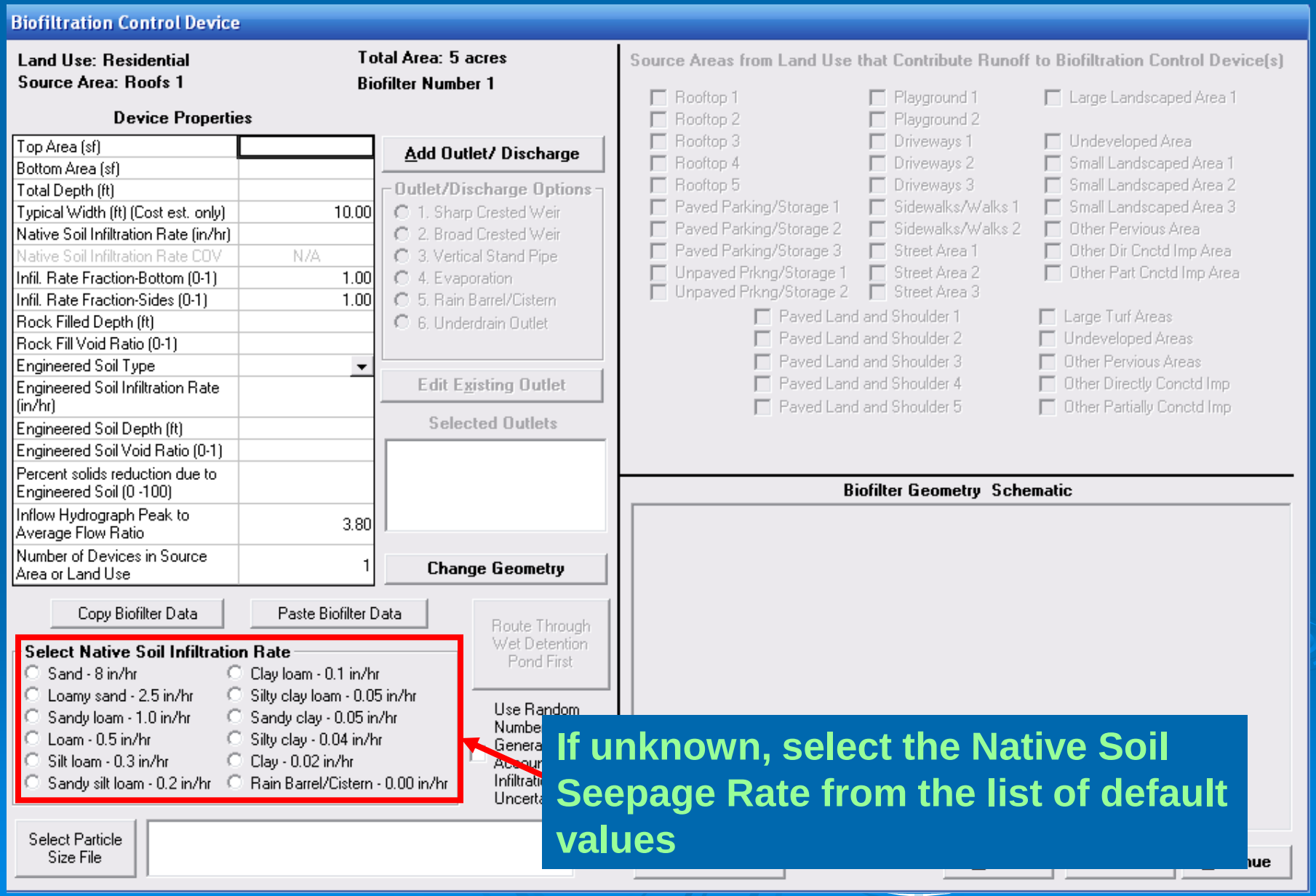


Adam St. Inlets to Rain Gardens

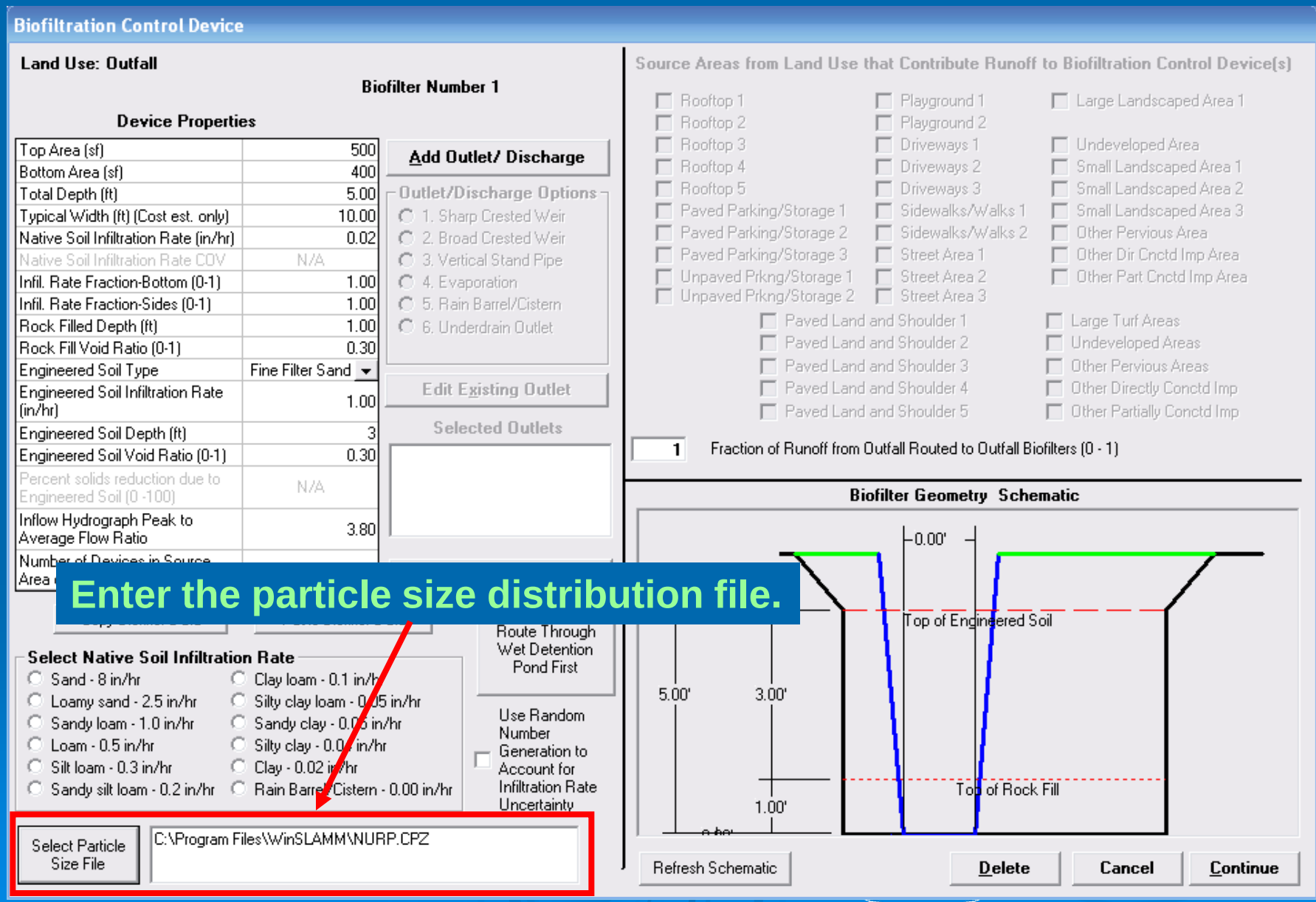
Biofiltration/Infiltration Control Device



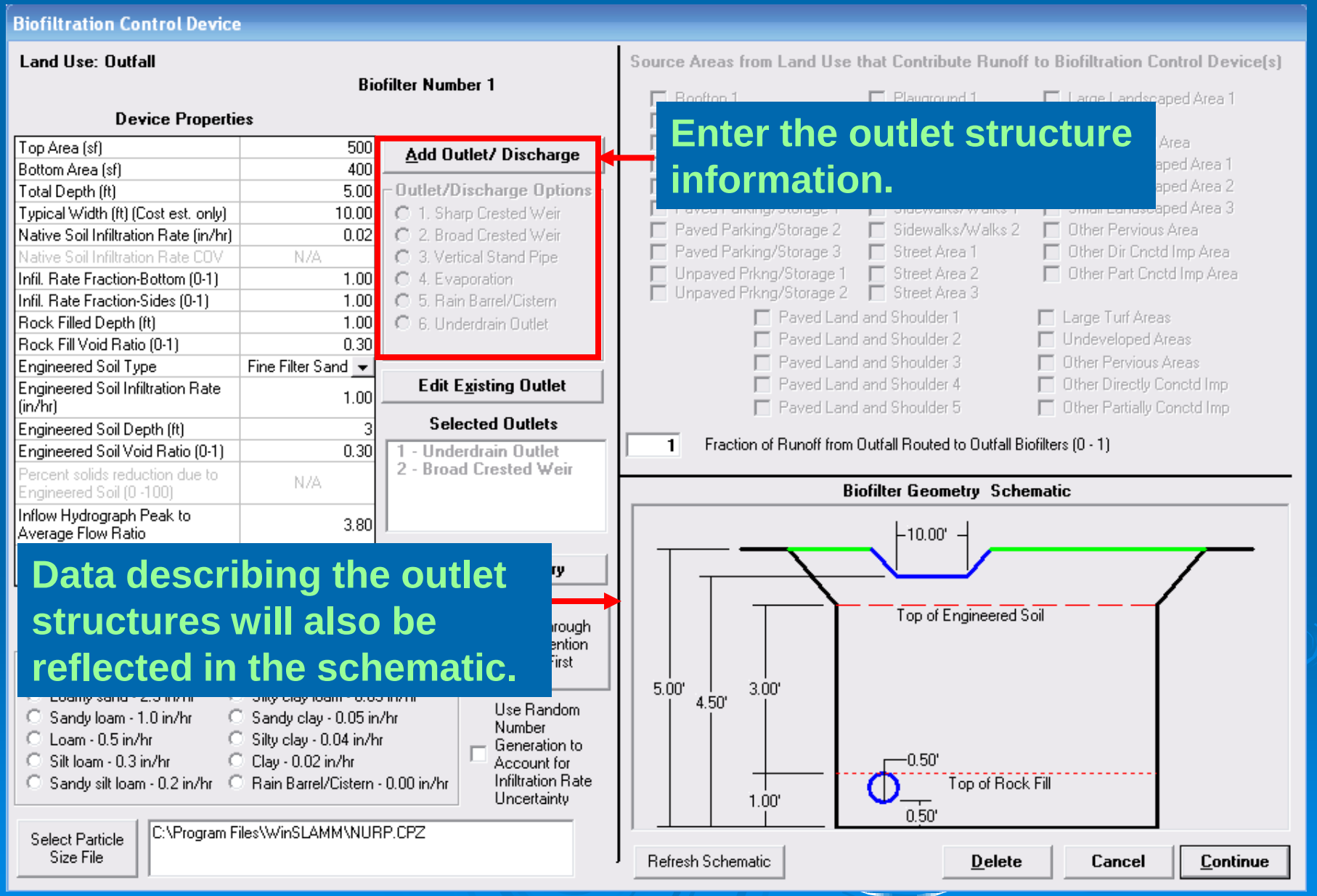
Biofiltration/Infiltration Control Device



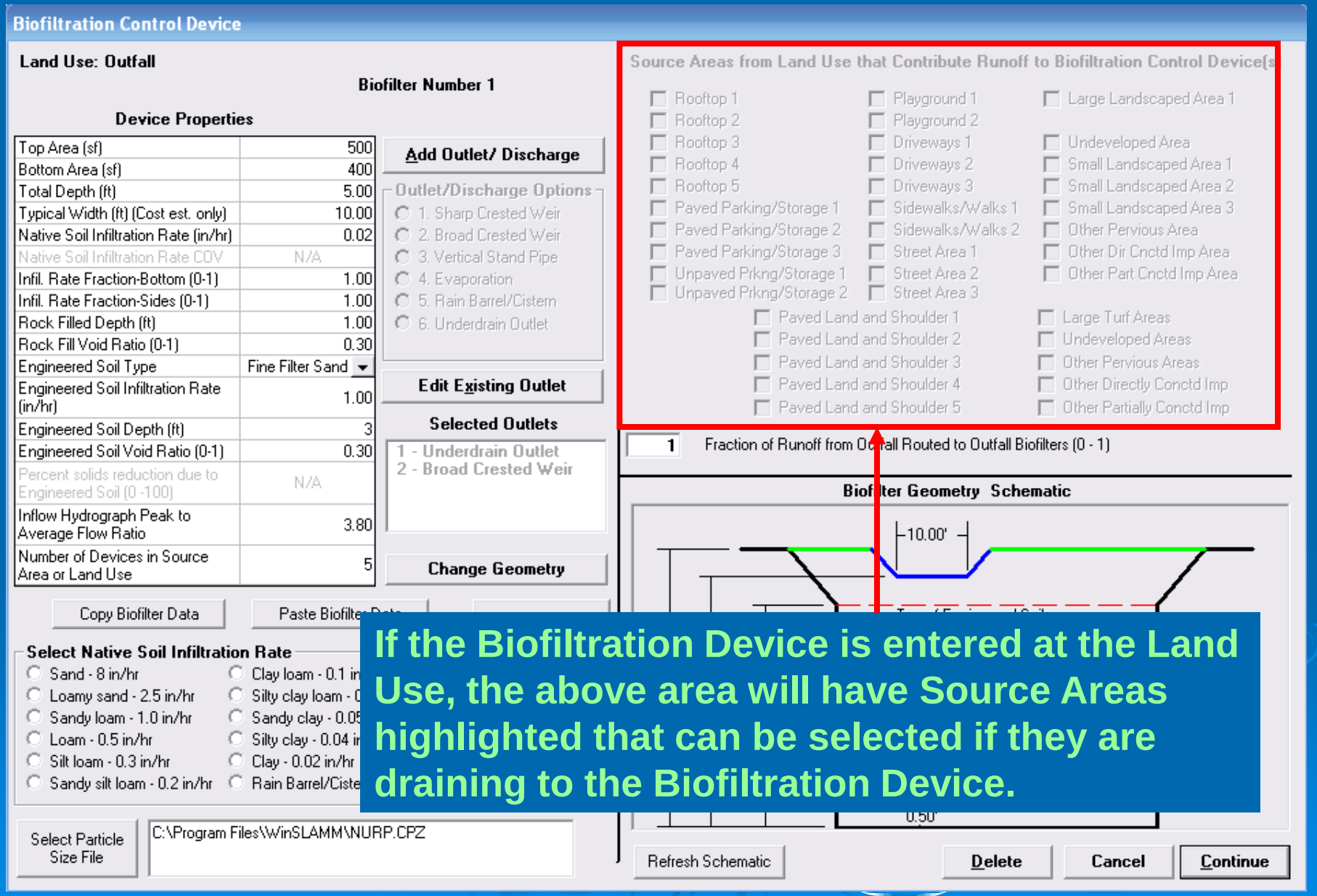
Biofiltration/Infiltration Control Device



Biofiltration/Infiltration Control Device

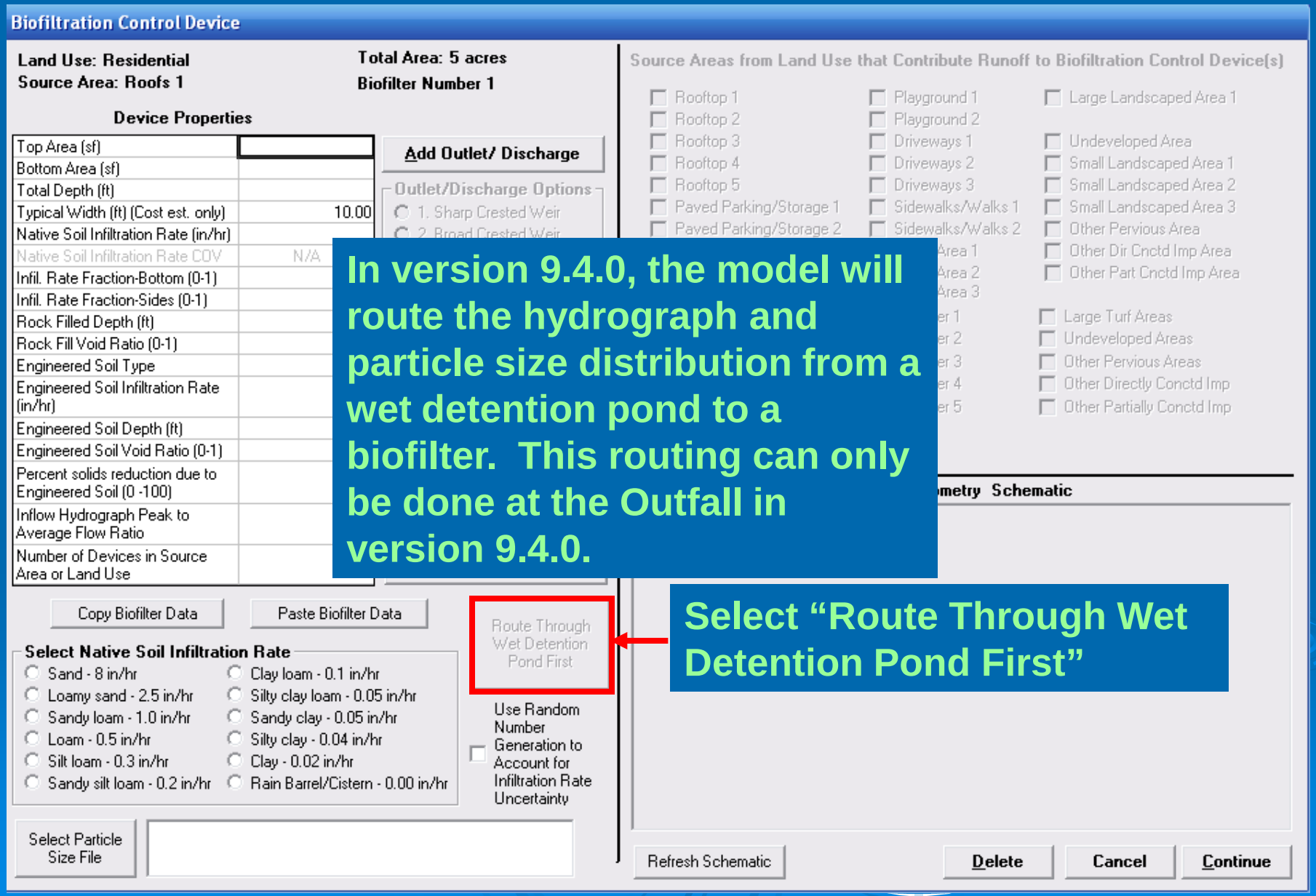


Biofiltration/Infiltration Control Device



If the Biofiltration Device is entered at the Land Use, the above area will have Source Areas highlighted that can be selected if they are draining to the Biofiltration Device.

Biofiltration/Infiltration Control Device



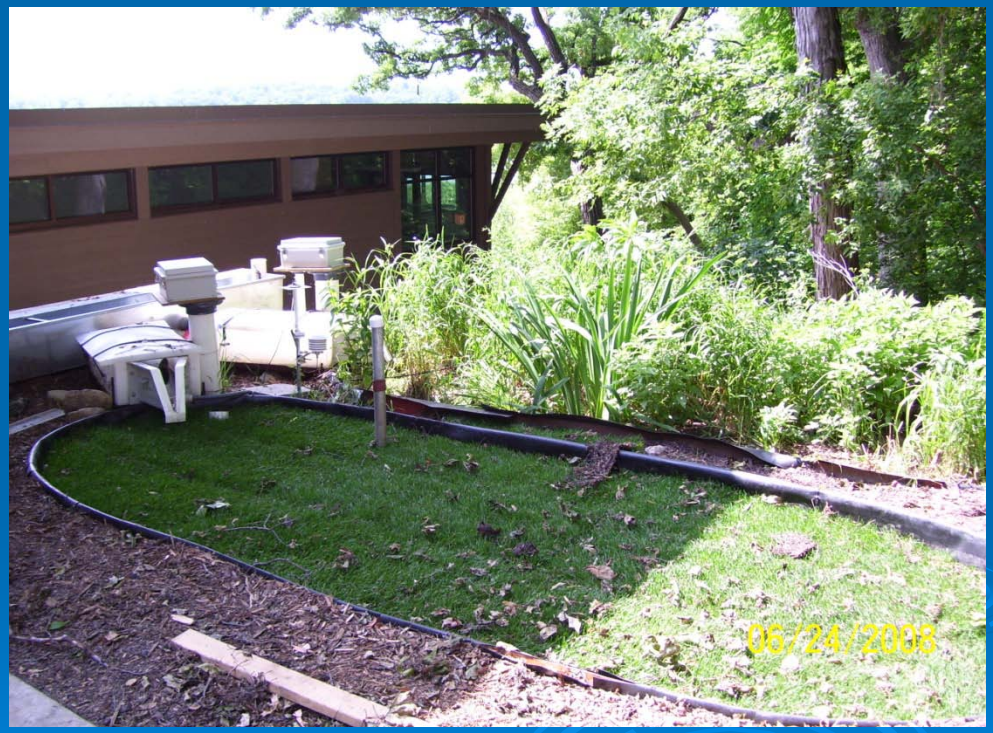
In version 9.4.0, the model will route the hydrograph and particle size distribution from a wet detention pond to a biofilter. This routing can only be done at the Outfall in version 9.4.0.

Select "Route Through Wet Detention Pond First"

Upcoming Features

Sneak Peak

- Evapotranspiration
- Cisterns
- Filter Strips
- Green Roofs
- Version 10



Edgewood College Bioretention Systems - Evapotranspiration

Evapotranspiration

- Added as outlet for Biofiltration/Infiltration Devices
- Currently undergoing testing through the USGS, WDNR, and City of Madison
- Will be available in version 9.4.1 or 10.0

Monteverde Cloud Forest, Costa Rica

Cisterns

Cistern Control Device

Land Use: Institutional
Source Area: Paved Parking/Storage 3

Total Area: 3 acres
Cistern Number = 1

Device Properties

Cistern Area (sf)	
Cistern Depth (ft)	
Rock Filled Depth (ft)	
Rock Fill Porosity (0-1)	
Inflow Hydrograph Peak to Average Flow Ratio	
Number of Devices in Source Area or Land Use	

Copy Cistern Data

Paste Cistern Data

Water Use Rate

Month	Water Use Rate (gal/day)
January	
February	
March	
April	
May	
June	
July	
August	
September	
October	
November	
December	

Delete **Cancel** **Continue**

Grass Filter Strips

Filter Strip Control Device

Land Use: Commercial
Source Area: Roofs 3

Device Properties

Total Area in Source Area (ac)	
Area Served by Filter Strips (ac)	
Total Filter Strip Length (ft)	
Effective Width (ft)	
Native Soil Infiltration Rate (in/hr)	
Native Soil Infiltration Rate COV	
Typical Longitudinal Slope (0-1)	
Typical Grass Height (in)	
Grass Retardance Factor	
Rock Fill Porosity (0-1)	
Grass Retardance Factor	
Number of Devices in Source Area or Land Use	

Select Particle Size File

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

Copy Filter Strip Data | Paste Filter Strip Data

Delete | Cancel | Continue

Ledgebrook Lane in Southbury, CT

Green Roofs

Green Roof Control Device

Land Use: Residential
Source Area: Roofs 5

Total Area: 4 acres
Green Roof Number 1

Device Properties

Top Area (sf)	550
Bottom Area (sf)	550
Total Depth (ft)	1.00
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	
Native Soil Infiltration Rate COV	N/A
Infil. Rate Fraction-Bottom (0-1)	1.00
Infil. Rate Fraction-Sides (0-1)	1.00
Rock Filled Depth (ft)	0.30
Rock Fill Porosity (0-1)	0.40
Engineered Soil Type	Loam Soil
Engineered Soil Infiltration Rate (in/hr)	0.15
Engineered Soil Depth (ft)	.6
Engineered Soil Porosity (0-1)	0.40
Percent solids reduction due to Engineered Soil (0 -100)	N/A
Inflow Hydrograph Peak to Average Flow Ratio	3.80
Number of Devices in Source Area or Land Use	1

Add Outlet/ Discharge

Outlet/Discharge Options
- 1. Sharp Crested Weir
- 2. Broad Crested Weir
- 3. Vertical Stand Pipe
- 4. Evaporation
- 5. Underdrain Outlet
- 6. Evapotranspiration

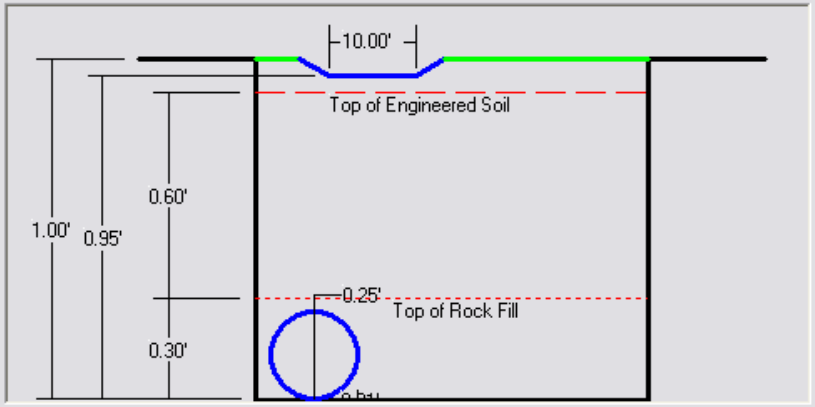
Edit Existing Outlet

Selected Outlets

Change Geometry

Copy Data | Paste Data

Green Roof Geometry Schematic



Refresh Schematic

Select Particle Size File

C:\Program Files\WinSLAMM\NURP.CPZ

Use Random Number Generation to Account for Infiltration Rate Uncertainty

Delete | Cancel | Continue

School of Art, Design and Media at Nanyang Technological University, Singapore

The Calhoun School, New York, NY

Version 10

WinSLAMM - [Land Use Model]

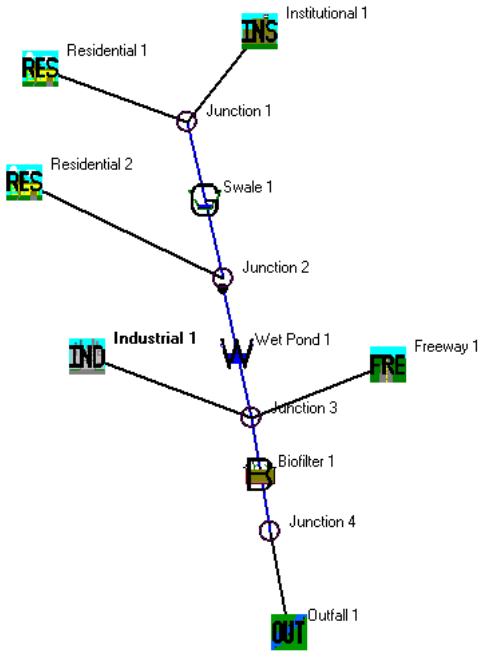
File Pollutants Tools Run Utilities Help

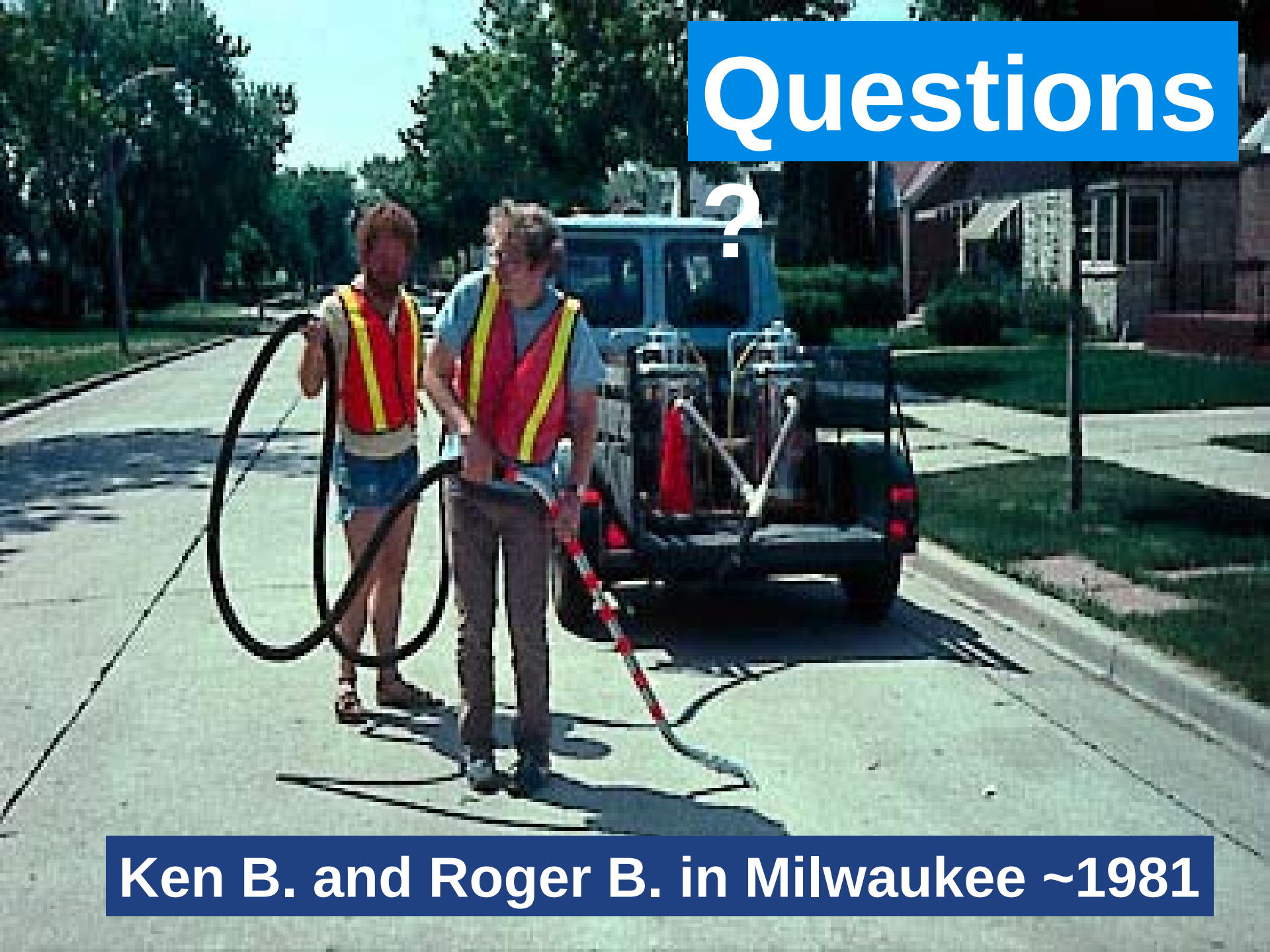
Land Use:
Industrial 1

Source Area #	Source Area	Area (acres)	Control Practice	Source Area Parameters
	Roofs	12.300		
1	Roofs 1			
2	Roofs 2	12.300	HD	Entered
3	Roofs 3			
4	Roofs 4			
5	Roofs 5			
6	Roofs 6			
7	Roofs 7			
8	Roofs 8			
9	Roofs 9			
10	Roofs 10			
11	Roofs 11			
12	Roofs 12			
	Parking	2.200		
13	Paved Parking 1			
14	Paved Parking 2			
15	Paved Parking 3	2.200		Entered
16	Paved Parking 4			
17	Paved Parking 5			
18	Paved Parking 6			
19	Unpaved Parking 1			
20	Unpaved Parking 2			
21	Unpaved Parking 3			
22	Unpaved Parking 4			
23	Unpaved Parking 5			
24	Unpaved Parking 6			
	Driveways/Sidewalks	0.000		
25	Driveways 1			
26	Driveways 2			

Land Use #	Land Use Type	Land Use Label	Land Use Area (acres)
1	Residential	Residential 1	8.700
2	Residential	Residential 2	14.200
3	Institutional	Institutional 1	101.500
4	Industrial	Industrial 1	14.500
5	Freeway	Freeway 1	0.000

CP #	Control Practice Type	Control Practice Name
1	Wet Pond	Wet Pond 1
2	Biofilter	Biofilter 1




Questions
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Ken B. and Roger B. in Milwaukee ~1981