

Storm Water Management of Pleasant Grove, AL

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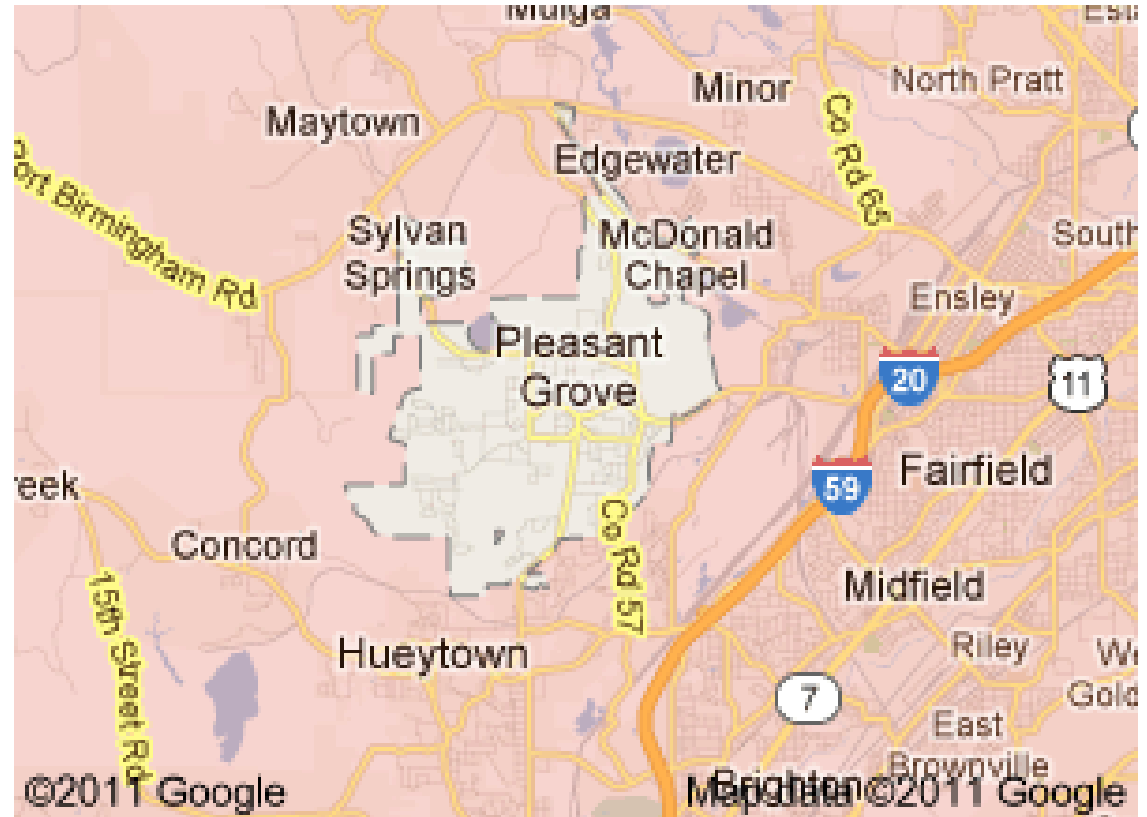
**MEREDITH BAGBY, YOUNG HAN,
ANNA KACHELMAN,
BRYAN LEATH, AND MYLES MCMANUS**



THE UNIVERSITY OF
ALABAMA AT BIRMINGHAM

Background Information

- Small Residential Community
- Population around 10,000
- About 10 miles from the Birmingham City Center



Pre-Tornado Stormwater System

Curb and Gutter

to

Culverts

to

Catch Basin



Tornado Path

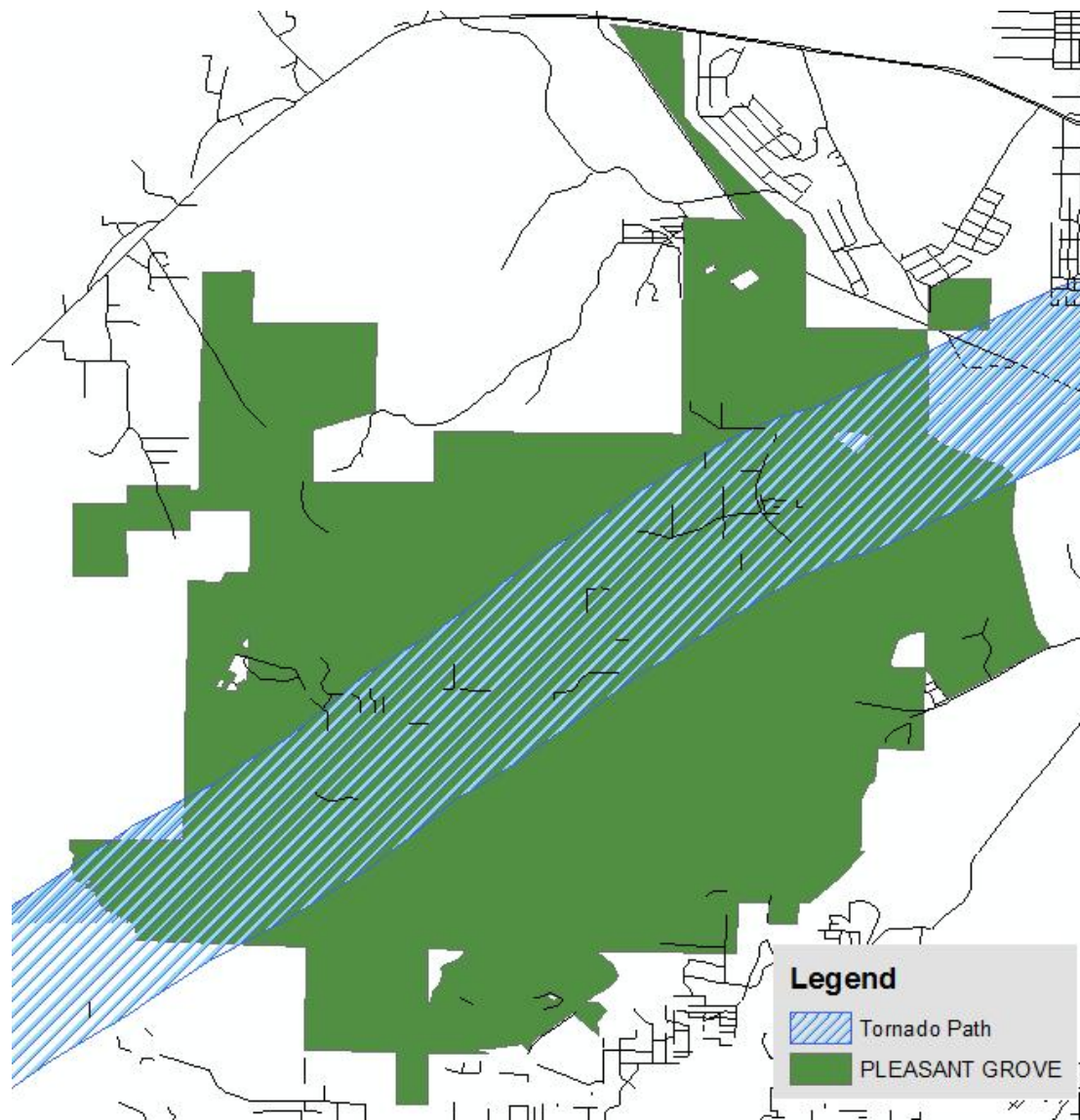
- Tornado

- F-4

- 190 mph

- Total Area Affected

- 435 Acres



Post-Tornado Stormwater System

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Effects of the Tornado

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	Pleasant Grove	Jefferson County	Percentage
Fatalities	10	21	47.6 %
FEMA Registrants	1,645	2,213	74.3 %
Housing Units Likely Affected	700-800	962	78.0 %

Effects of the Tornado

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Curb, Drop Inlet, and Gutter

Total Affected: 275

Normal Condition	169	% Normal	61.45%
Needs Cleanout	61	% Needs Cleanout	22.18%
Broken Lid	31	% Broken Lid	11.27%

Effects of the Tornado

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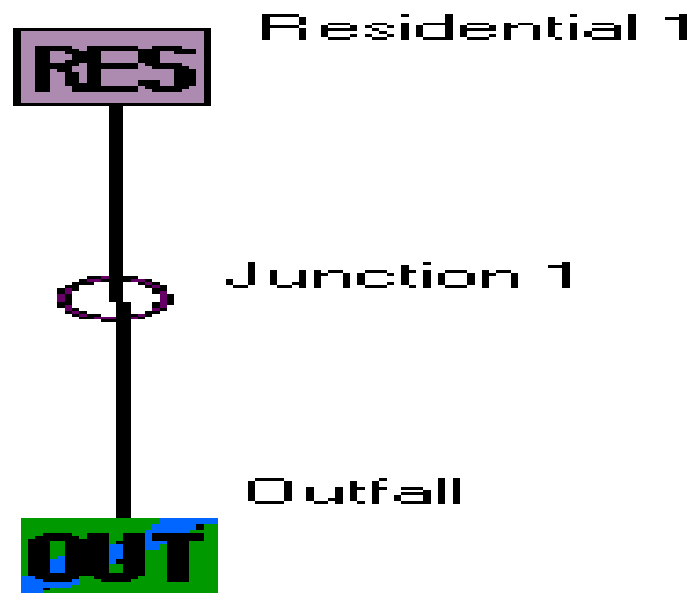
Culvert

Total Affected: 300

Normal Condition	137	% Normal	45.67%
Needs Cleanout	135	% Needs Cleanout	45.00%
Broken Lid	4	% Broken Lid	1.33%
Buried	21	% Buried	7.00%

WinSLAMM Analysis

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WinSLAMM Analysis

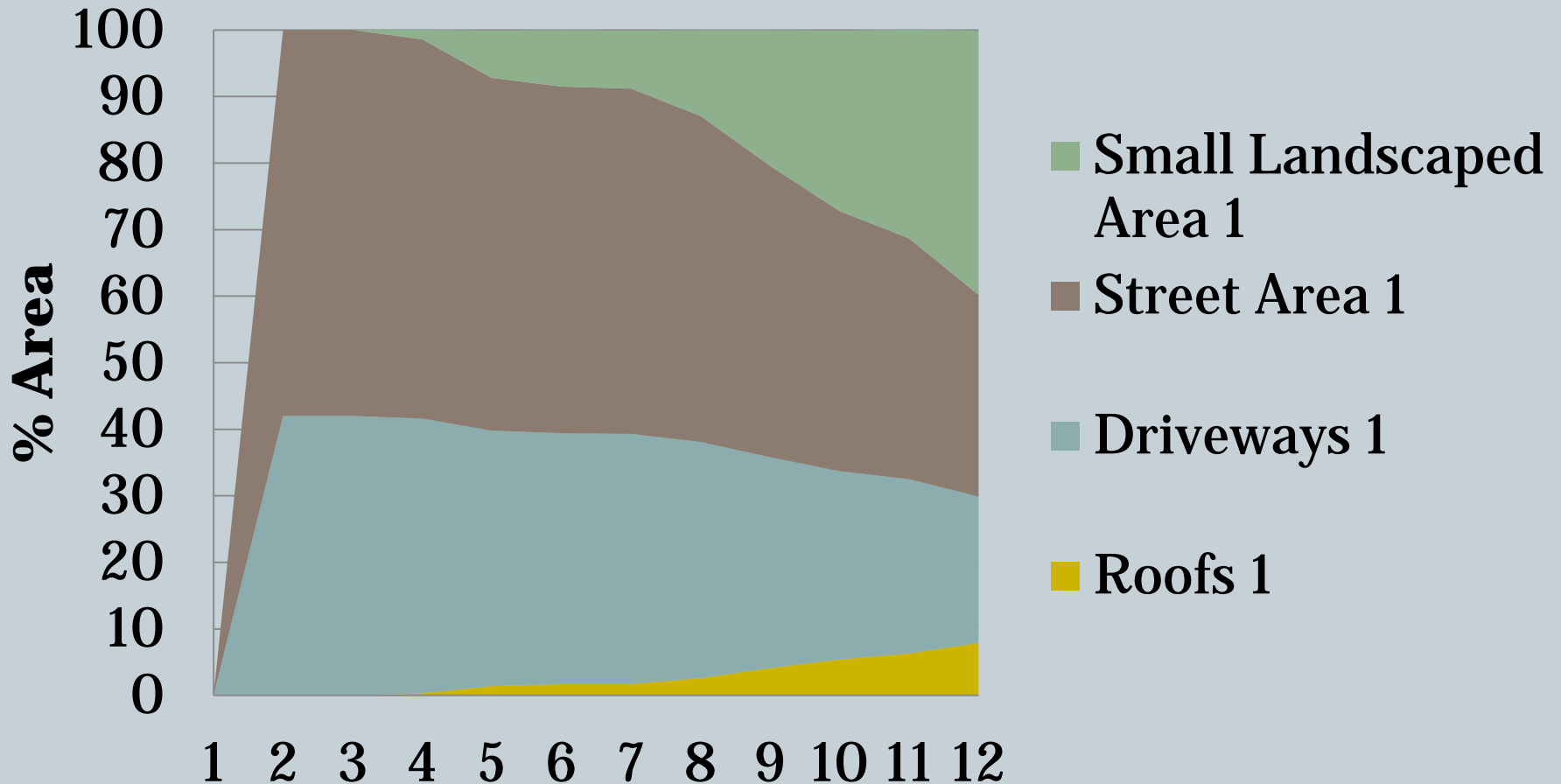
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Pre-Tornado Input Data (ALL Areas in Acres)

Lot Area	Curb- Length (mi)	Street Area	Drive Way Area	Rooftop Area	Landscaped Area
435.00	24.78	60.07	43.50	65.25	326.25

WinSLAMM Analysis

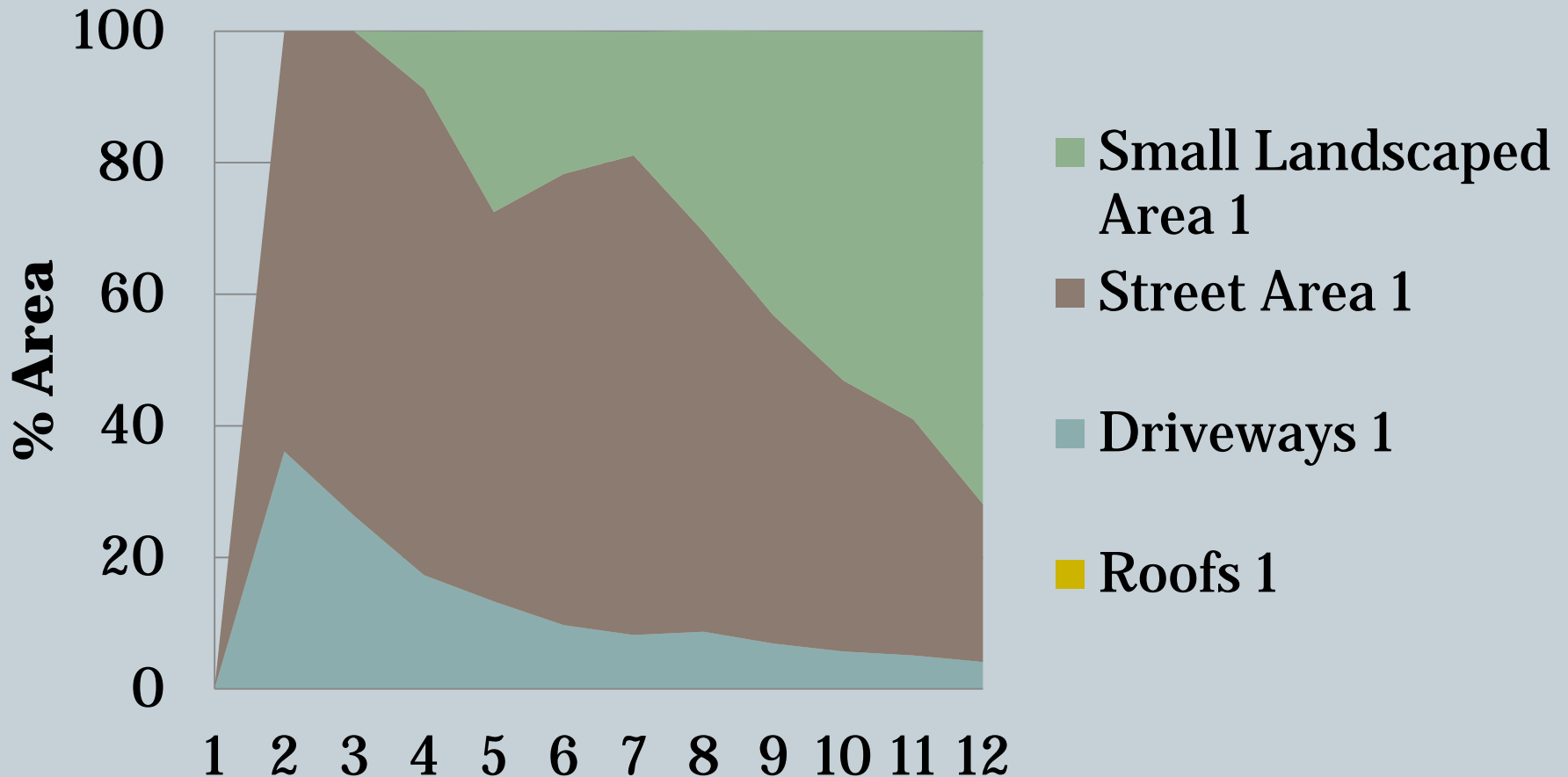
Pre Tornado Storm Water Contribution % Areas



WinSLAMM Analysis

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Pre Tornado Solids Contribution % Areas



WinSLAMM Analysis

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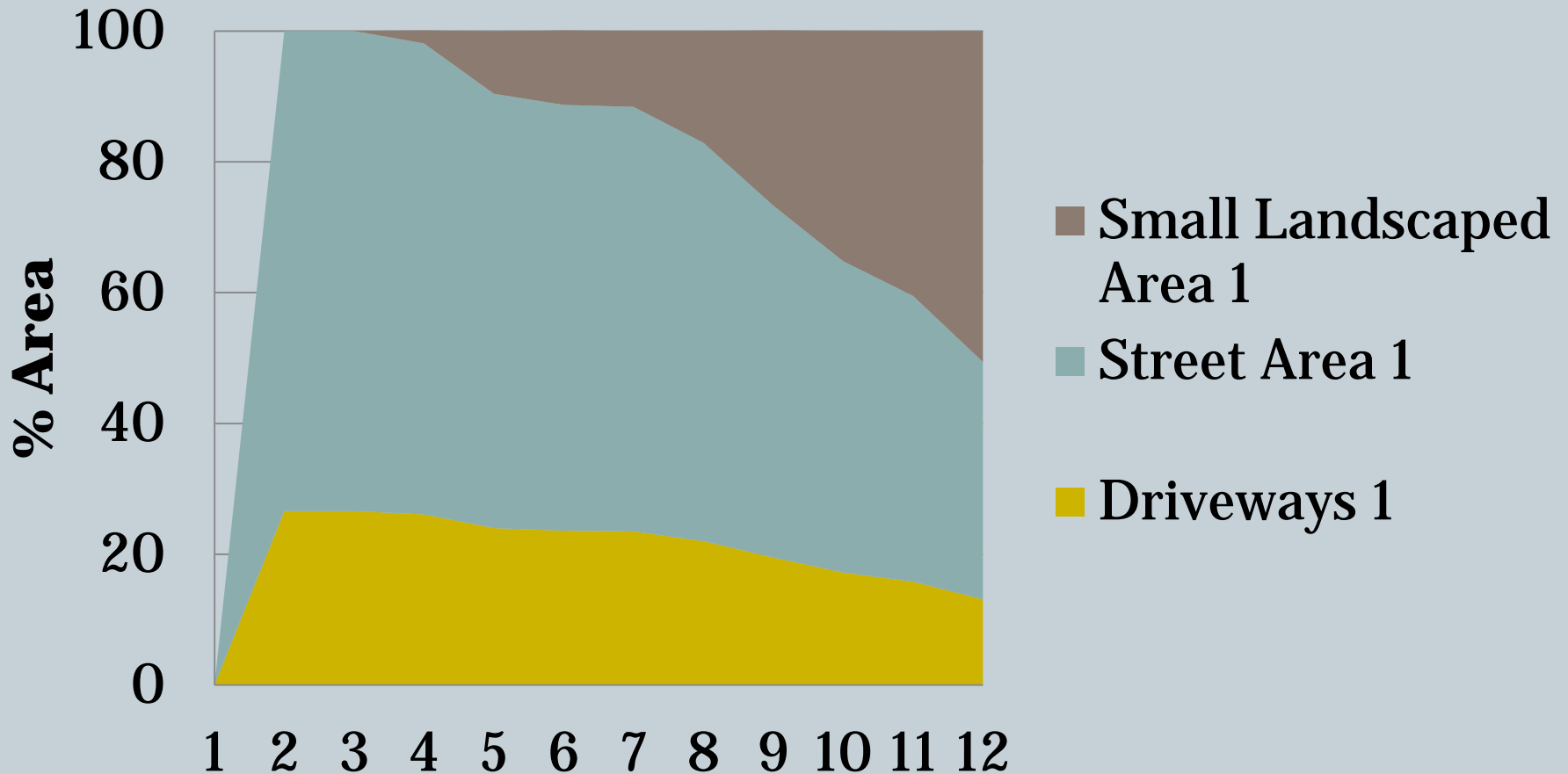
Post Tornado Input Data (ALL Areas in Acres)

Lot Area	Curb- Length (mi)	Street Area	Drive Way Area	Rooftop Area	Landscaped Area
435. 00	24.78	60.07	21.75	0.00	413.25

WinSLAMM Analysis

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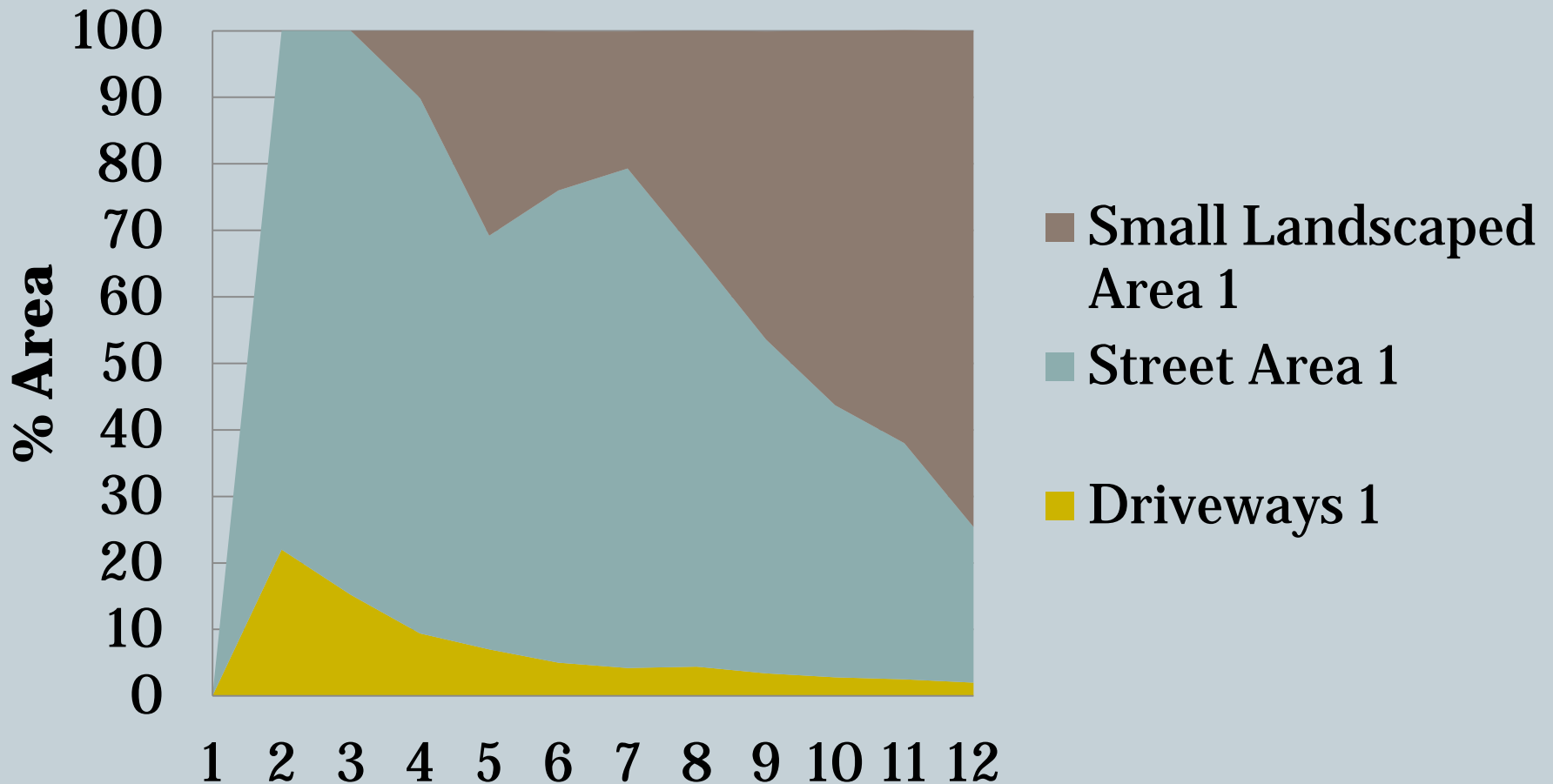
Post Tornado Storm Water Contribution % Areas



WinSLAMM Analysis

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Post Tornado Solids Contribution % Areas



Street Cleaning

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Pre Tornado Street Cleaning Results

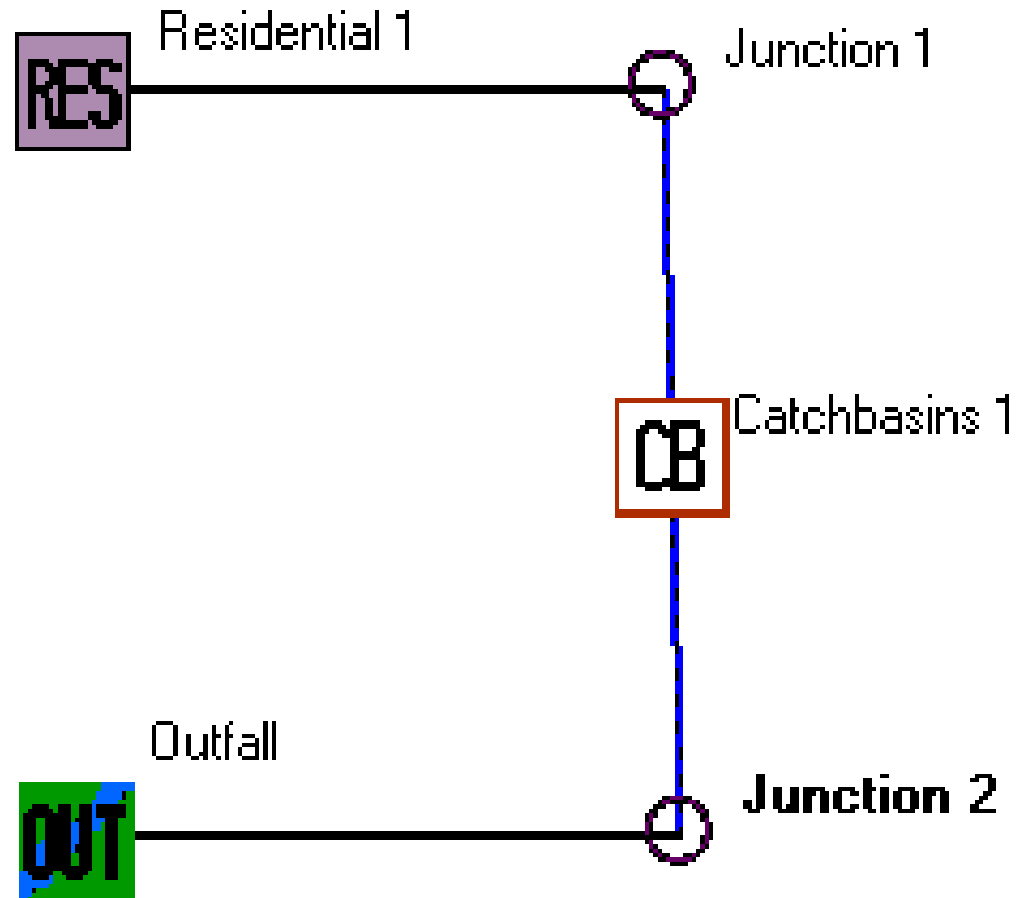
Total Influent Load (lbs)	Total Effluent Load (lbs)	Percent Load Reduction	Total Influent Conc (mg/L)	Total Effluent Conc (mg/L)	Percent Conc. Reduction
18845	18215	3.343	105.9	102.3	3.343

Post Tornado Street Cleaning Results

Total Influent Load (lbs)	Total Effluent Load (lbs)	Percent Load Reduction	Total Influent Conc (mg/L)	Total Effluent Conc (mg/L)	Percent Conc. Reduction
18845	15640	17	105.9	87.86	17

Catch Basins

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Catch Basins

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Pre Tornado Catch Basin Results

Total Influent Load (lbs)	Total Effluent Load (lbs)	Percent Load Reduction	Total Influent Conc (mg/L)	Total Effluent Conc (mg/L)	Percent Conc. Reduction
35615	0	100	80.03	0	100

Post Tornado Catch Basin Results

Total Influent Load (lbs)	Total Effluent Load (lbs)	Percent Load Reduction	Total Influent Conc (mg/L)	Total Effluent Conc (mg/L)	Percent Conc. Reduction
35615	0	100	80.03	0	100

Wet Pond Design: Pre-Tornado Design Inputs

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Pond Number 1

Drainage System Control Practice

Select Particle Size Distribution File

C:\Program Files\WinSLAMM v10\NURP.CPZ

Initial Stage Elevation (ft):

Peak to Average Flow Ratio:

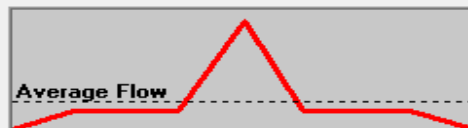
Enter fraction (greater than 0) that you want to modify all pond areas by and then select 'Modify Pond Areas' button

Modify Pond Areas

	Stage (ft)	Area (acres)	Cumulative Volume (ac-ft)
0	0.00	0.0000	0.000
1	0.50	0.1900	0.048
2	1.00	0.9700	0.338
3	1.50	2.0100	1.083
4	2.00	3.4700	2.453
5	2.50	5.6600	4.735
6	3.00	9.3100	8.478
7	3.25	16.6100	11.718
8	3.50	23.9000	16.781
9	3.75	38.4900	24.580
10	4.00	82.2700	39.675
11			
12			
13			
14			
15			
16			
17			

Recalculate Cumulative Volume

Flow



Time (1.2 * Rainfall Duration)

Copy Pond Data

Paste Pond Data

Save this Pond as a WinDETPOND File

Cancel

Delete Pond

Continue

Add **Sharp Crested Weir**

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

Remove **V-Notch Weir**

Weir Angle (<180 degrees)	45
Height from datum to bottom of weir opening (ft)	0.25
Number of V-Notch weirs	5

Remove **Orifice Set 1**

Orifice Diameter (ft)	5.50
Invert elevation above datum (ft)	0.25
Number of orifices in set	5

Add **Orifice Set 2**

Orifice Diameter (ft)	
Invert elevation above datum (ft)	
Number of orifices in set	

Add **Orifice Set 3**

Orifice Diameter (ft)	
Invert elevation above datum (ft)	
Number of orifices in set	

Add **Stone Weeper**

Width at bottom of weeper (ft)	
Weeper side slope [H:1V]	
Upstream side slope [H:1V]	
Downstream side slope [H:1V]	
Horizontal flow path length at top of weeper (ft)	
Average rock diameter (ft)	
Distance from bottom to top of weeper (ft)	
Height from datum to bottom of weeper (ft)	

Add **Vertical Stand Pipe**

Pipe diameter (ft)	
Height above datum (ft)	

Add Add

Month	Evaporation (in/day)	Water Withdraw Rate (ac-ft/day)
Jan	0.00	0.000
Feb	0.00	0.000
Mar	0.00	0.000
Apr	0.00	0.000
May	0.00	0.000
Jun	0.00	0.000
Jul	0.00	0.000
Aug	0.00	0.000
Sep	0.00	0.000
Oct	0.00	0.000
Nov	0.00	0.000
Dec	0.00	0.000

Add Add

Stage (ft)	Natural Seepage Rate (in/hr)	Other Outflow Rate (cfs)
0.50	0.00	0.000
1.00	0.00	0.000
1.50	0.00	0.000
2.00	0.00	0.000
2.50	0.00	0.000
3.00	0.00	0.000

Add **Broad Crested Weir**

Weir crest length (ft)	
Weir crest width (ft)	
Height of weir opening (ft)	
Height from datum to bottom of weir opening (ft)	

Add **Seepage Basin**

Infiltration rate (in/hr)	
Width of device (ft)	
Length of device (ft)	
Invert elevation of seepage basin inlet above datum (ft)	

Wet Pond Design Results

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Iteration	Inflow Vol. (cf)	Outflow Vol. (cf)	% Vol. Reduced	Influent Load (lbs)	Effluent Load (lbs)	% Load Reduced	Orifice Dia. (ft)	No. of Weirs
1	2.04E+07	0	100	117246	0	100	5.50	1
2	2.04E+07	2.04E+07	0	117246	115314	1.647	0.55	1
3	2.04E+07	2.04E+07	0	117246	115831	1.207	1.23	1
4	2.04E+07	325552	98.41	117246	1324	98.87	1.24	1
5	2.04E+07	7.22E+06	64.65	117246	43509	62.89	1.23	13

Wet Pond Design: Post Tornado Wet Pond Design Inputs

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Pond Number 1
Drainage System Control Practice

Select Particle Size Distribution File
 C:\Program Files\WinSLAMM v10\NURP.CPZ

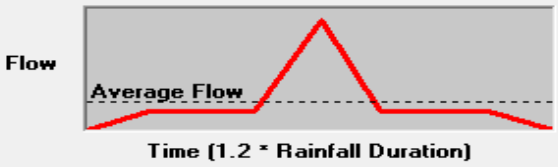
Initial Stage Elevation (ft):
 Peak to Average Flow Ratio:

Enter fraction (greater than 0) that you want to modify all pond areas by and then select 'Modify Pond Areas' button

Modify Pond Areas

	Stage (ft)	Area (acres)	Cumulative Volume (ac-ft)
0	0.00	0.0000	0.000
1	1.00	0.1540	0.077
2	1.50	1.8500	0.578
3	2.00	2.9810	1.786
4	2.50	4.3950	3.630
5	3.00	6.2120	6.282
6	3.50	8.6360	9.994
7	4.00	12.0280	15.160
8	4.50	17.1170	22.446
9	5.00	25.5980	33.125
10	5.25	42.5610	41.644
11	5.50	59.5230	54.405
12	5.75	93.4490	73.526
13	6.00	195.2240	109.611
14			
15			
16			
17			

Recalculate Cumulative Volume



Copy Pond Data
 Paste Pond Data

Save this Pond as a WinDETPOND File

Cancel Delete Pond Continue

Add **Sharp Crested Weir**

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

Remove **V-Notch Weir**

Weir Angle (<180 degrees)
 Height from datum to bottom of weir opening (ft)
 Number of V-Notch weirs

Remove **Orifice Set 1**

Orifice Diameter (ft)
 Invert elevation above datum (ft)
 Number of orifices in set

Add **Orifice Set 2**

Orifice Diameter (ft)
 Invert elevation above datum (ft)
 Number of orifices in set

Add **Orifice Set 3**

Orifice Diameter (ft)
 Invert elevation above datum (ft)
 Number of orifices in set

Add **Stone Weeper**

Width at bottom of weeper (ft)
 Weeper side slope [H:1V]
 Upstream side slope [H:1V]
 Downstream side slope [H:1V]
 Horizontal flow path length at top of weeper (ft)
 Average rock diameter (ft)
 Distance from bottom to top of weeper (ft)
 Height from datum to bottom of weeper (ft)

Add **Vertical Stand Pipe**

Pipe diameter (ft)
 Height above datum (ft)

Month	Evaporation (in/day)	Water Withdraw Rate (ac-ft/day)
Jan	0.00	0.000
Feb	0.00	0.000
Mar	0.00	0.000
Apr	0.00	0.000
May	0.00	0.000
Jun	0.00	0.000
Jul	0.00	0.000
Aug	0.00	0.000
Sep	0.00	0.000
Oct	0.00	0.000
Nov	0.00	0.000
Dec	0.00	0.000

Stage (ft)	Natural Seepage Rate (in/hr)	Other Outflow Rate (cfs)
1.00	0.00	0.000
1.50	0.00	0.000
2.00	0.00	0.000
2.50	0.00	0.000
3.00	0.00	0.000
3.50	0.00	0.000

Add **Broad Crested Weir**

Weir crest length (ft)
 Weir crest width (ft)
 Height of weir opening (ft)
 Height from datum to bottom of weir opening (ft)

Add **Seepage Basin**

Infiltration rate (in/hr)
 Width of device (ft)
 Length of device (ft)
 Invert elevation of seepage basin inlet above datum (ft)

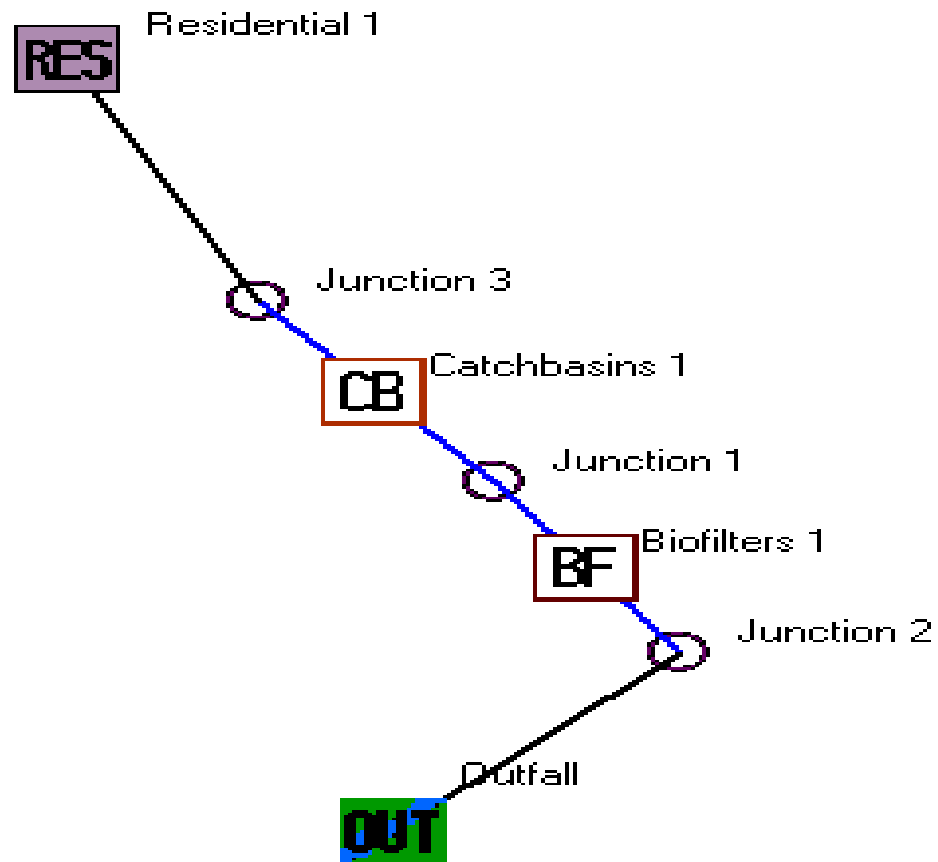
Wet Pond Design: Post Tornado Outputs

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Iteration	Inflow Vol. (cf)	Outflow Vol. (cf)	% Vol. Reduced	Influent Load (lbs)	Effluent Load (lbs)	% Load Reduced	Orifice Dia. (ft)	No. of Weirs
1	1.75E+07	0	100	131079	0	100	8.47	1
2	1.75E+07	1.75E+07	0	131079	129600	1.129	1	5
3	1.75E+07	1.75E+07	0	131079	129779	0.9918	1.4	1

Bio-filter Design

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Bio-filter Design: Pre-Tornado Inputs

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Drainage System Control Practice

Device Properties	Biofilter Number 1
Top Area (sf)	14211450
Bottom Area (sf)	8509850
Total Depth (ft)	5.00
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	0.470
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)	2.00
Rock Fill Porosity (0-1)	0.40
Engineered Media Type	media Data
Engineered Media Infiltration Rate	0.47
Engineered Media Infiltration Rate COV	N/A
Engineered Media Depth (ft)	2.00
Engineered Media Porosity (0-1)	0.46
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 Land Use	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 Clay loam - 0.1 in/hr
 Loamy sand - 2.5 in/hr Silty clay loam - 0.05 in/hr
 Sandy loam - 1.0 in/hr Sandy clay - 0.05 in/hr
 Loam - 0.5 in/hr Silty clay - 0.04 in/hr
 Silt loam - 0.3 in/hr Clay - 0.02 in/hr
 Sandy silt loam - 0.2 in/hr Rain Barrel/Cistern - 0.00 in/hr

Select Particle Size File: C:\Program Files\WinSLAMM v10\NURP.CPZ

Add Sharp Crested Weir

Weir Length (ft) _____

Height from datum to bottom of weir opening (ft) _____

Remove Broad Crested Weir

Weir crest length (ft) 10.00

Weir crest width (ft) 1.00

Height from datum to bottom of weir opening (ft) 4.75

Add Vertical Stand Pipe

Pipe diameter (ft) _____

Height above datum (ft) _____

Add Surface Discharge Pipe

Orifice Diameter (ft) _____

Invert elevation above datum (ft) _____

Number of orifices in set _____

Add Drain Tile/Underdrain

Orifice Diameter (ft) _____

Invert elevation above datum (ft) _____

Number of orifices in set _____

Use Random Number Generation to Account for Infiltration Rate Uncertainty

0.00 Initial Water Surface Elevation (ft)

Apply Selected Source Areas from One Upstream Land Use

Change Geometry

Copy Biofilter Data

Paste Biofilter Data

Add Other Outlet

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

Remove Evapotranspiration

Soil porosity (saturation moisture content, 0-1) 0.463

Soil field moisture capacity (0-1) 0.328

Permanent wilting point (0-1) 0.089

Supplemental irrigation used?

Fraction of available capacity when irrigation starts (0-1) 0.000

Fraction of available capacity when irrigation stops (0-1) 0.000

Fraction of biofilter that is vegetated _____

Plant type: Annuals ▾, Prairie P ▾, Shrubs ▾

Root depth (ft): 1.0, 6.0, 2.0, 0.0

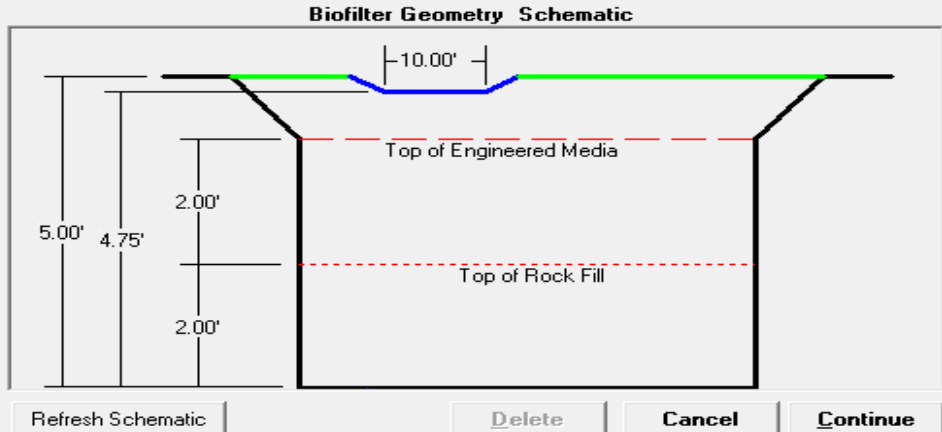
ET Crop Adjustment Factor: 0.65, 0.50, 0.50, 0.00

Evaporation

Month	Evapotranspiration (in/day)	Evaporation (in/day)
Jan	0.00	
Feb	0.00	
Mar	0.00	
Apr	0.00	
May	0.00	
Jun	0.00	
Jul	0.00	
Aug	0.00	
Sep	0.00	
Oct	0.00	
Nov	0.00	
Dec	0.00	

Plant Types

	1	2	3	4
Fraction of biofilter that is vegetated	0.50	0.25	0.25	0.00
Plant type	Annuals ▾	Prairie P ▾	Shrubs ▾	▾
Root depth (ft)	1.0	6.0	2.0	0.0
ET Crop Adjustment Factor	0.65	0.50	0.50	0.00



Bio-filter Design: Pre-Tornado Results

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Iteration	Total Inflow Vol. (cf)	Total Outflow Vol. (cf)	Percent Vol.Reduction	Total Influent Load (lbs)
1	3.04E+07	0	100	0
2	3.04E+07	609630	97.99	0
3	3.04E+07	2.02E+07	33.6	0
4	3.04E+07	4.68E+06	84.58	0

Bio-filter Design: Post-Tornado Results

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Iteration	Total Inflow Vol. (cf)	Total Outflow Vol. (cf)	Percent Vol. Reduction	Influent Load (lbs)
1	1.75E+07	0	100	0
2	1.75E+07	8.35E+06	52.19	0
3	1.75E+07	1.16E+07	33.31	0

Conclusion

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Proposed Plan

- Clean up remaining debris and sediment
- Repair existing storm water infrastructure
- Add additional catch basins
- Add additional bio-filters

Results

- Efficient water removal
- Efficient pollution removal

A green frog is sitting behind a piece of brown cardboard. The frog's front legs are resting on the top edge of the cardboard. The word "QUESTIONS?" is printed in a bold, black, sans-serif font across the middle of the cardboard. The background is dark and out of focus, suggesting an outdoor setting at night or in low light. The ground appears to be dark gravel or sand.

QUESTIONS?