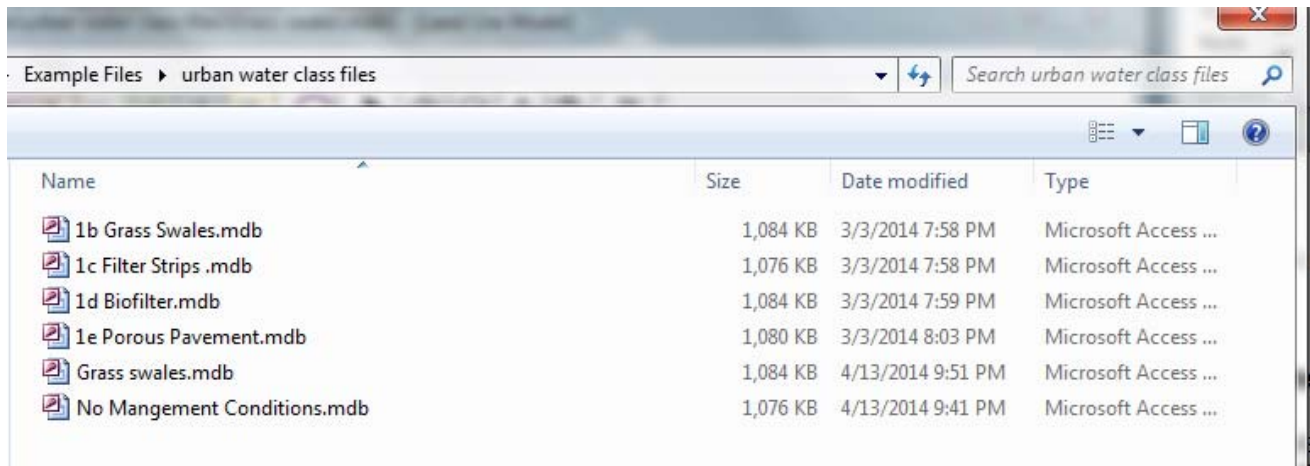


Biofilter Example

Biofilter Example

For this example, we will start with the model file we created for No Controls and add Biofilters. We will assume all of the source areas in the Commercial 1 land use will be routed to the Biofilters.

Open the **No Controls** model file and Save the File with a new name.



Change the Site Description in the Current File Data to reflect the Biofilters.

Biofilter Example

Current File Data

SLAMM Data File Name:
C:\WinSLAMM Files\Example Files\urban water class files\Biofilters.mdb

Site Descript.: Biofilters, commercial development

Edit Seed: -42

Edit Rain File: C:\WinSLAMM Files\Rain Files\AL Birmingham 8799.RAN

Edit Start Date: 01/01/94 ☐ Winter Season Range
Edit End Date: 12/31/98 Start of Winter (mm/dd) End of Winter (mm/dd)

Edit Pollutant Probability Distribution File: C:\WinSLAMM Files\SouthEast April 05 2014.ppd

Edit Runoff Coefficient File: C:\WinSLAMM Files\SouthEast April 05 2014.rsv

Edit Particulate Solids Concentration File: C:\WinSLAMM Files\SouthEast April 05 2014.psc

Edit Street Delivery File (Select LU)
☒ Residential LU ☐ Other Urban LU
☐ Institutional LU ☐ Freeways
☐ Commercial LU
☐ Industrial LU
Change all Street Delivery Files to Match the Current File

Edit Source Area PSD and Peak to Average Flow Ratio File: C:\WinSLAMM Files\PSD source area SSC.csv

☒ Use Cost Estimation Option **Select Cost Data File** C:\WinSLAMM Files\Birmingham Cost Data.csv

Replace Default Values with these Current File Data Values Use Default Values Replace all Particle Size Distribution Files with the Program Default file(s) Cancel Continue

Disconnect the map and add the Biofilter control measure. Reconnect the map to make a contiguous network to the Outfall.

Biofilter Example

WinSLAMM v 10 Data File: [C:\WinSLAMM Files\Example Files\urban water class files\Biofilters.mdb] - [Land Use Model]

File Current File Data Pollutants Tools Run Utilities Help

RES INS COM IND UJ FRE CS CB WP BF MF HD OD FS

Land Use:

Commercial 1

Source Area #	Source Area	Area (acres)	Source Area Parameters	First Control Practice	Second Control Practice
39	Streets 3				
40	Streets 4				
41	Streets 5				
42	Streets 6				
43	Streets 7				
44	Streets 8				
Landscaped Areas		3.270			
45	Large Landscaped Areas 1	2.140	Entered	--	--
46	Large Landscaped Areas 2				
47	Large Landscaped Areas 3				
48	Large Landscaped Areas 4				
49	Large Landscaped Areas 5				
50	Large Landscaped Areas 6				
51	Small Landscaped Areas 1	0.630	Entered	--	--
52	Small Landscaped Areas 2	0.500	Entered	--	--
53	Small Landscaped Areas 3				
54	Small Landscaped Areas 4				
55	Small Landscaped Areas 5				
56	Small Landscaped Areas 6				
57	Undeveloped Areas 1				
58	Undeveloped Areas 2				
59	Undeveloped Areas 3				
60	Undeveloped Areas 4				
61	Undeveloped Areas 5				
62	Undeveloped Areas 6				
Other Areas		0.000			
63	Paved Playground 1				
64	Paved Playground 2				
65	Paved Playground 3				
66	Paved Playground 4				
67	Paved Playground 5				

Land Use # Land Use Type Land Use Label Land Use Area (acres)

1	Commercial	Commercial 1	7.290
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CP # Control Practice Type Control Practice Name or Location

1	Biofilter	DS Biofilters # 1
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Current File Data Entered Total Area = 7.290 acres No Upstream Source Areas LU# = 1 Index Number = 1 Remaining Icons = 253 Start Date: 01/01/94 End Date: 12/31/98

Double click on the Biofilter label to access the Biofilter form. All the “Small Landscaped 2” Source Areas will be Biofilters. We will enter the data for a “typical” Biofilter and then enter the number of Biofilters.

Note: when moving through the Biofilter form, press the “Enter” key to move to the next cell, not the “Tab” key.

Biofilter Example

Biofiltration Control Device

Drainage System Control Practice

Device Properties **Biofilter Number 1**

Top Area (sf)	350
Bottom Area (sf)	200
Total Depth (ft)	3.50
Typical Width (ft) (Cost est. only)	10.00
Native Soil Infiltration Rate (in/hr)	0.300
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)	1.00
Rock Fill Porosity (0-1)	0.33
Engineered Media Type	Media Data
Engineered Media Infiltration Rate	13.00
Engineered Media Infiltration Rate COV	N/A
Engineered Media Depth (ft)	2.00
Engineered Media Porosity (0-1)	0.44
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	31

☐ Activate Pipe or Box Storage ☐ Pipe ☒ Box

Diameter (ft)	
Length (ft)	
Within Biofilter (check if Yes)	<input type="checkbox"/>
Perforated (check if Yes)	<input type="checkbox"/>
Bottom Elevation (ft above datum)	
Discharge Orifice Diameter (ft)	

Select Native Soil Infiltration Rate

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

Control Practice #: 1 CP Index #: 1

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)	2.00
Height from datum to bottom of weir opening (ft)	3.40

Add Vertical Stand Pipe

Pipe diameter (ft)	
Height above datum (ft)	

Add Surface Discharge Pipe

Pipe Diameter (ft)	0.25
Invert elevation above datum (ft)	
Number of pipes at invert elev.	

Remove Drain Tile/Underdrain

Pipe Diameter (ft)	0.25
Invert elevation above datum (ft)	0.75
Number of pipes at invert elev.	1

☐ Use Random Number ☐ Generation to Account for Infiltration Rate Uncertainty

Initial Water Surface Elevation (ft)

Est. Surface Drain Time (hrs)

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)	0.440
Soil field moisture capacity (0-1)	0.157
Permanent wilting point (0-1)	0.029
Supplemental irrigation used?	<input type="checkbox"/>
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	0.50
Plant type	Prairie P ▾ Shrubs ▾ Other G1 ▾
Root depth (ft)	6.0
ET Crop Adjustment Factor	0.50

Evaporation

Month	Evapotranspiration (in/day)	Evaporation (in/day)
Jan	0.05	0.00
Feb	0.06	0.00
Mar	0.10	0.00
Apr	0.13	0.00
May	0.15	0.00
Jun	0.16	0.00
Jul	0.15	0.00
Aug	0.14	0.00
Sep	0.14	0.00
Oct	0.10	0.00
Nov	0.07	0.00
Dec	0.05	0.00

Plant Types

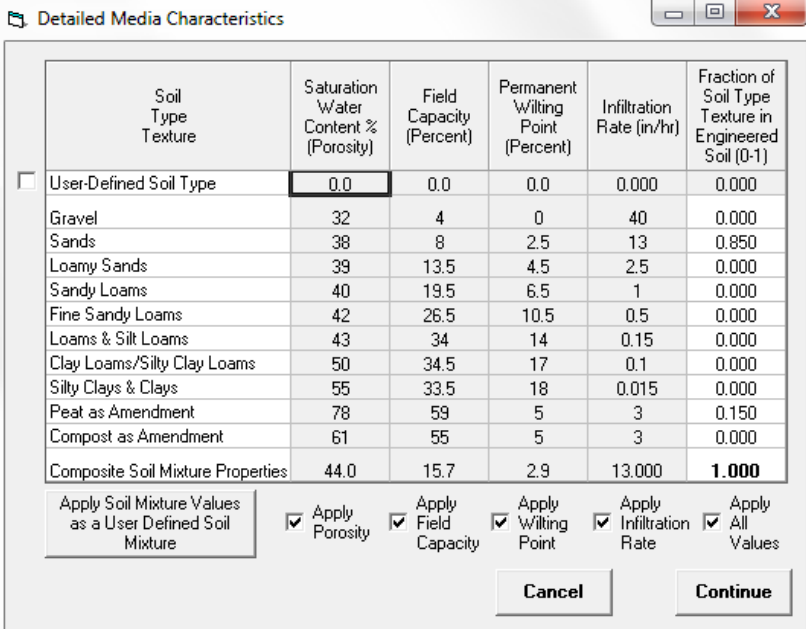
1	2	3	4
0.50	0.25	0.25	0.00
6.0	2.0	1.0	0.0
0.50	0.50	0.55	0.00

Biofilter Geometry Schematic

The information the model needs to evaluate the Engineered Soil, or Media, in the Biofilter can be entered using default values or, as User Defined values.

Enter the fraction for each soil type. Then select "Apply All Values". Select "Continue".

Biofilter Example

Detailed Media Characteristics

Soil Type Texture	Saturation Water Content % (Porosity)	Field Capacity (Percent)	Permanent Wilting Point (Percent)	Infiltration Rate (in/hr)	Fraction of Soil Type Texture in Engineered Soil (0-1)
<input type="checkbox"/> User-Defined Soil Type	0.0	0.0	0.0	0.000	0.000
Gravel	32	4	0	40	0.000
Sands	38	8	2.5	13	0.850
Loamy Sands	39	13.5	4.5	2.5	0.000
Sandy Loams	40	19.5	6.5	1	0.000
Fine Sandy Loams	42	26.5	10.5	0.5	0.000
Loams & Silt Loams	43	34	14	0.15	0.000
Clay Loams/Silty Clay Loams	50	34.5	17	0.1	0.000
Silty Clays & Clays	55	33.5	18	0.015	0.000
Peat as Amendment	78	59	5	3	0.150
Compost as Amendment	61	55	5	3	0.000
Composite Soil Mixture Properties	44.0	15.7	2.9	13.000	1.000

☐ Apply Soil Mixture Values as a User Defined Soil Mixture
 ☒ Apply Porosity
 ☒ Apply Field Capacity
 ☒ Apply Wilting Point
 ☒ Apply Infiltration Rate
 ☒ Apply All Values

When the boxes next to "Apply" are checked, the program will use the calculated values in the Biofilter form. The values will not appear until an Engineered Soil Depth is entered.

Biofilter Example

Run the model.

Results

Runoff Volume without controls: 3,181,000 ft³ per 5 yrs
Outfall Total with controls: 446,705 ft³ for 1 year (2,223,000 ft³ in 5 years)
Runoff Volume Percent Reduction: 30%
Particulate Solids Concentration (with controls): 18 mg/L
Particulate Solids Yield (with controls): 502 lbs/yr
Particulate Solids Percent Reduction: 81%
Rv (with controls): 0.30
Approx. Urban Stream Classification: Poor
Total Phosphorus Concentration (with controls): 0.58
Total Phosphorus Yield (with controls): 80 lbs/5 yrs
Total Phosphorus Yield Percent Reduction: 69%
Annualized Value of all costs: \$10,005

Land Uses	Junctions	Control Practices	Outfall	Output Summary
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File Name:
C:\WinSLAMM Files\Example Files\urban water class files\Biofilters.mdb

Outfall Output Summary

	Runoff Volume (cu. ft.)	Percent Runoff Reduction	Runoff Coefficient (Rv)	Particulate Solids Conc. (mg/L)	Particulate Solids Yield (lbs)	Percent Particulate Solids Reduction
Total of All Land Uses without Controls	3.181E+06		0.43	67.67	13439	
Outfall Total with Controls	2.223E+06	30.12 %	0.30	17.99	2497	81.42 %

Current File Output: Annualized Total After Outfall Controls: 446705 Years in Model Run: 4.98 501.8

Pollutant	Concentration - No Controls	Concentration - With Controls	Concentration Units	Pollutant Yield - No Controls	Pollutant Yield - With Controls	Pollutant Yield Units	Percent Yield Reduction
Particulate Solids	67.67	17.99	mg/L	13439	2497	lbs	81.42 %
Total Phosphorus	1.294	0.5792	mg/L	257.0	80.36	lbs	68.74 %

Print Output Summary to Text File

Print Output Summary to .csv File

Total Area Modeled (ac)
7.290

Total Control Practice

Capital Cost	\$ 68687
Land Cost	\$ 4981
Annual Maintenance Cost	\$ 4094
Present Value of All Costs	\$ 124696
Annualized Value of All Costs	\$ 10005

Perform Outfall Flow Duration Curve Calculations

Receiving Water Impacts Due To Stormwater

(CWP Impervious Cover Model)

	Calculated Rv	Approximate Urban Stream Classification
Without Controls	0.43	Poor
With Controls	0.30	Poor

Biofilter Example

The pollution reduction reported at the outfall is the overall pollution reduction for the entire site.

To see the pollution reduction from just the Biofilters, select the “Control Practices” tab.

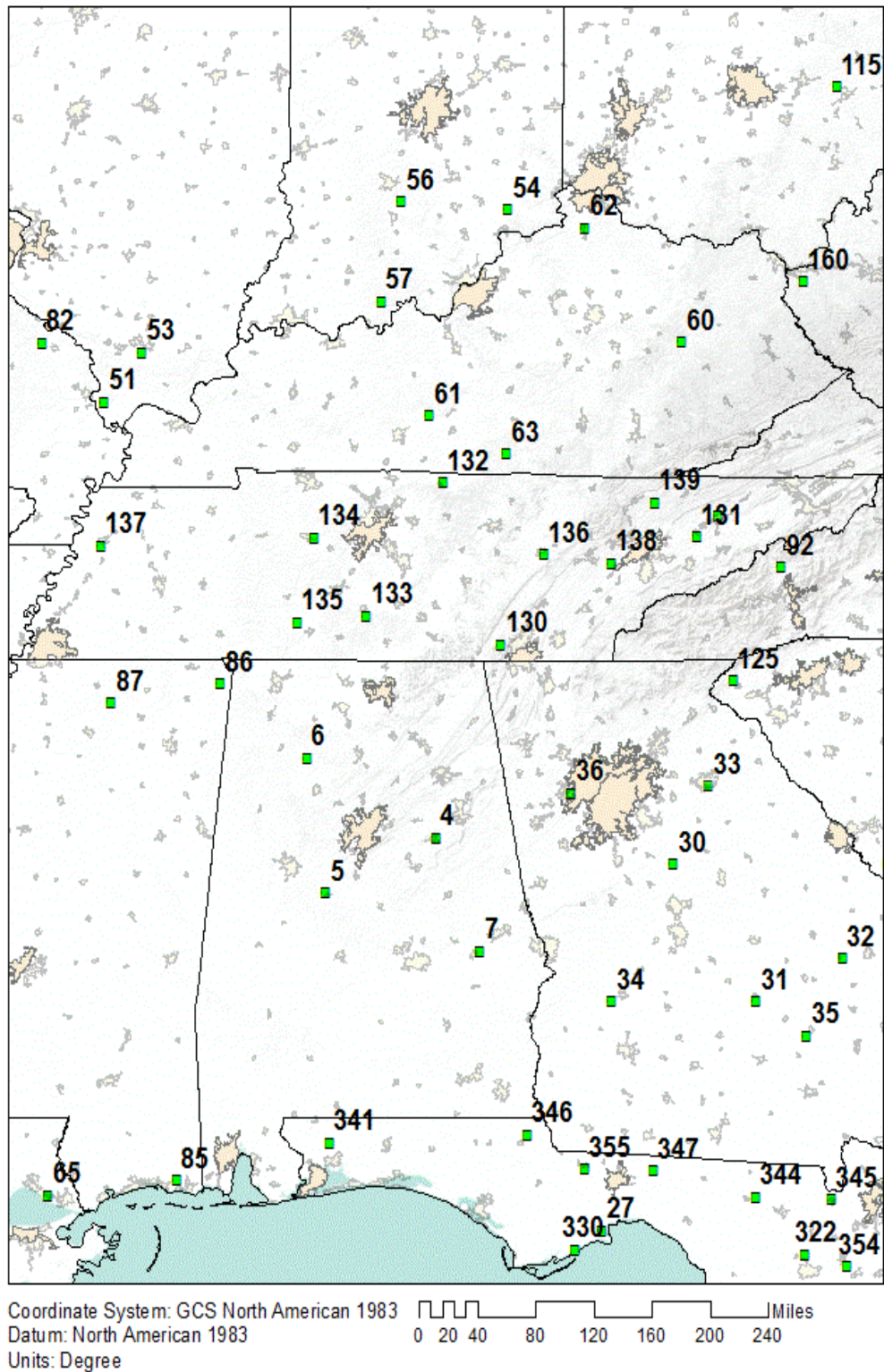
Land Uses			Junctions		Control Practices						Outfall		
Runoff Volume			Part. Solids Yield (lbs)					Part. Solids Conc. (mg/L)					
Data File: C:\w\inSLAMM Files\Example Files\urban water class files\Biofilters.mdb													
Rain File: AL Birmingham 8799.RAN													
Date: 04-13-14 Time: 10:40:04 PM													
Site Description: Biofilters, commercial development													
Control Practice No.	Control Practice Type	Control Practice Name or Location	Total Inflow Volume (cf)	Total Outflow Volume (cf)	Percent Volume Reduction	Total Influent Load (lbs)	Total Effluent Load (lbs)	Percent Load Reduction	Flow Weighted Influent Conc (mg/L)	Flow Weighted Effluent Conc (mg/L)	Percent Conc. Reduction	Influent Median Part. Size (microns)	Effluent Median Part. Size (microns)
1	Biofilter	DS Biofilters # 1	3.181E+06	2.223E+06	30.12	13439	249	81.42	67.67	17.99	73.408	35.17	4.81

Control Practices			Outfall			Output Summary							
Part. Solids Yield (lbs)			Part. Solids Conc. (mg/L)					Summary Table					
Maximum Stage (ft)	Hydraulic Volume Out (cf)	% of Clogging Factor	Maximum Surface Ponding Time (hrs)	Maximum Subsurface Ponding Time (hrs)	Volume Infiltrated (cf)	Underdrain Discharge Vol. (cf)	Evapo-Transpir. Vol. (cf)	Minimum Soil Moist. (frac)	Surface Discharge Bypass Vol. (cf)	Evap. Vol. (cf)	Volume Supplmt. Irrig.(cf)	Surface Ponding Events >72 hrs (Count)	Runoff Producing Events/ Ttl. Rains
3.46	2202303		5.8	13.70	894087.50	2115745	49445.32		83943.55			0	289/511

The Biofilters are reducing the runoff volume by 30% and the TSS load by 81% from the source areas in the Commercial 1 land use. The underdrain short-circuits the infiltration potential (relatively low for this site) but provides substantial filtering of the stormwater before it is discharged.



Biofilter Example



ET monitoring stations example (from Pitt, et al. 2009).
(use Station 5 (Oakmulgee, AL) for Birmingham and Tuscaloosa and station 6 (Bankhead, AL) for Huntsville)

Biofilter Example

Map ID	State	Lat	Long	Elev	Station Name	Years of Data	ASCE Standardized Reference Evaporation Equation (ET _o) ($\frac{in}{day}$)											
							Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	AK	64.84	-147.62	454	Fairbanks Alaska													
2	AK	61.08	-149.73	1480	Rabbit Creek Alaska													
3	AK	57.8	-135.13	450	Hoonah Alaska													
4	AL	33.44	-86.081	600	Talladega Alabama	5	0.04	0.08	0.11	0.15	0.16	0.16	0.16	0.15	0.14	0.12	0.07	0.05
5	AL	32.96	-87.171	363	Oakmulgee Alabama	7	0.05	0.06	0.10	0.13	0.15	0.16	0.15	0.14	0.14	0.10	0.07	0.05
6	AL	34.14	-87.362	804	Bankhead Alabama	7	0.04	0.08	0.11	0.17	0.16	0.17	0.16	0.16	0.14	0.12	0.07	0.05
7	AL	32.45	-85.641	283	Tuskegee Alabama	5	0.05	0.08	0.12	0.16	0.17	0.18	0.17	0.15	0.15	0.12	0.08	0.04
8	AR	34.76	-90.722	253	Marianna Arkansas	3	0.04	0.06	0.11	0.15	0.16	0.20	0.18	0.17	0.14	0.10	0.07	0.04
9	AR	34.27	-92.393	270	Sheridan Arkansas	6	0.04	0.07	0.12	0.08	0.19	0.20	0.21	0.19	0.17	0.11	0.08	0.04
10	AR	36.07	-93.357	2365	Compton Arkansas	2	0.04	0.06	0.11	0.16	0.17	0.22	0.18	0.19	0.15	0.15	0.09	0.05
11	AR	35.87	-94.297	1633	Strickler Arkansas	6	0.06	0.06	0.13	0.17	0.16	0.19	0.21	0.22	0.17	0.13	0.11	0.06
12	AZ	32.4	-110.27	4175	Muleshoe Ranch AZ	13	0.07	0.13	0.17	0.24	0.28	0.30	0.24	0.22	0.23	0.20	0.12	0.08
13	AZ	35.15	-111.68	7000	Flagstaff Arizona	10	0.04	0.07	0.11	0.16	0.20	0.24	0.22	0.18	0.17	0.13	0.07	0.04
14	AZ	32.32	-110.81	3100	Saguaro Arizona	8	0.09	0.14	0.17	0.24	0.28	0.29	0.25	0.22	0.24	0.19	0.13	0.08
15	AZ	34.2	-112.14	2960	Sunset Point Arizona	13	0.13	0.17	0.29	0.29	0.36	0.40	0.42	0.44	0.42	0.30	0.19	0.14
16	CA	37.79	-122.14	1095	Oakland South CA	5	0.05	0.07	0.11	0.15	0.18	0.21	0.22	0.19	0.16	0.12	0.07	0.05
17	CA	34.13	-118.41	1260	Beverly Hills California	6	0.07	0.08	0.10	0.14	0.14	0.15	0.12	0.12	0.10	0.08	0.08	0.07
18	CA	34.46	-119.65	1500	Montecito California	6	0.08	0.08	0.11	0.15	0.17	0.19	0.18	0.18	0.15	0.12	0.11	0.07
19	CA	32.69	-116.97	425	San Miguel California	5	0.07	0.09	0.11	0.15	0.16	0.17	0.18	0.18	0.14	0.12	0.08	0.06
20	CA	34.29	-118.81	914	Simi Valley California	9	0.10	0.09	0.11	0.15	0.15	0.17	0.20	0.17	0.16	0.13	0.10	0.08
21	CO	39.48	-105.21	8725	Waterton North CO	9	0.04	0.07	0.10	0.15	0.17	0.20	0.19	0.18	0.16	0.13	0.07	0.04
22	CO	40.57	-105.23	6082	Redstone Colorado	11	0.04	0.04	0.06	0.07	0.13	0.15	0.16	0.13	0.13	0.05	0.05	0.03
23	CO	38.66	-104.85	6700	Ft. Carson Colorado	10	0.05	0.08	0.11	0.16	0.18	0.22	0.21	0.18	0.17	0.13	0.08	0.05
24	DE	38.74	-75.415	50	Redden Delaware	6	0.04	0.05	0.11	0.14	0.18	0.18	0.18	0.15	0.13	0.10	0.08	0.06
25	FL	25.63	-80.58	5	Chekika Florida	8	0.11	0.14	0.17	0.21	0.20	0.18	0.16	0.16	0.16	0.16	0.13	0.11
26	FL	29.11	-81.63	61	Central Florida	6	0.08	0.12	0.15	0.19	0.18	0.18	0.16	0.16	0.15	0.14	0.10	0.08
27	FL	30.01	-84.424	50	St. Marks (West) Florida	7	0.10	0.11	0.13	0.14	0.14	0.15	0.15	0.13	0.13	0.12	0.10	0.10
28	GA	30.92	-81.429	25	Stafford-CUIS Georgia	5	0.07	0.09	0.13	0.19	0.17	0.17	0.16	0.14	0.14	0.13	0.09	0.07
29	GA	32.1	-81.083	10	Savannah NWR SC	6	0.06	0.09	0.13	0.17	0.19	0.18	0.17	0.14	0.14	0.12	0.08	0.06
30	GA	33.21	-83.714	476	Oconee #1 Georgia	9	0.04	0.09	0.10	0.14	0.17	0.17	0.17	0.14	0.11	0.11	0.08	0.06
31	GA	32.01	-82.9	250	McRae Georgia	6	0.06	0.09	0.12	0.17	0.18	0.18	0.16	0.15	0.15	0.13	0.08	0.06
32	GA	32.39	-82.037	99	Metter Georgia	7	0.06	0.09	0.12	0.16	0.17	0.18	0.18	0.15	0.16	0.12	0.08	0.06
33	GA	33.9	-83.366	675	Watkinsville Georgia	6	0.06	0.07	0.11	0.12	0.14	0.18	0.18	0.16	0.15	0.12	0.08	0.05
34	GA	32.01	-84.33	526	Plains/Sumter Georgia	6	0.07	0.09	0.13	0.16	0.17	0.17	0.17	0.15	0.14	0.12	0.10	0.07
35	GA	31.71	-82.388	109	Baxley Georgia	7	0.06	0.09	0.12	0.14	0.17	0.18	0.16	0.14	0.14	0.12	0.08	0.06

Biofilter Example

ASCE Standardized Reference ETo (in/day)

Month	Station 5 (Oakmulgee, AL)	Station 6 (Bankhead, AL)
January	0.05	0.04
February	0.06	0.08
March	0.10	0.11
April	0.13	0.17
May	0.15	0.16
June	0.16	0.17
July	0.15	0.16
August	0.14	0.16
September	0.14	0.14
October	0.10	0.12
November	0.07	0.07
December	0.05	0.05