WinSLAMM v 10.3
Biofiltration

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We will cover . . .

- Biofilter Design Concepts and Issues
- Biofilter Model Algorithms
- Entering Biofilter Data into the Model

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Modeling Notes

- Control practice used to model:
  - Biofilters
  - Rain Gardens
  - Infiltration Fields
  - Infiltration Trenches

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Modeling Notes

- Biofilter routing is performed using the Modified Puls Storage – Indication Method.
- Time increments are established by the user – default = 6 minutes
- Yield reductions due to runoff volume reduction through infiltration and filtering through engineered soil

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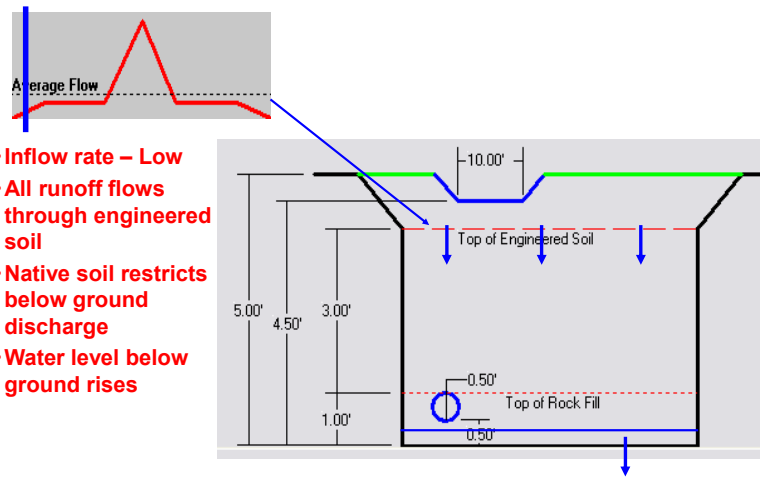
Control Practice Overview



- Inflow rate – Low
- All runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level below ground rises

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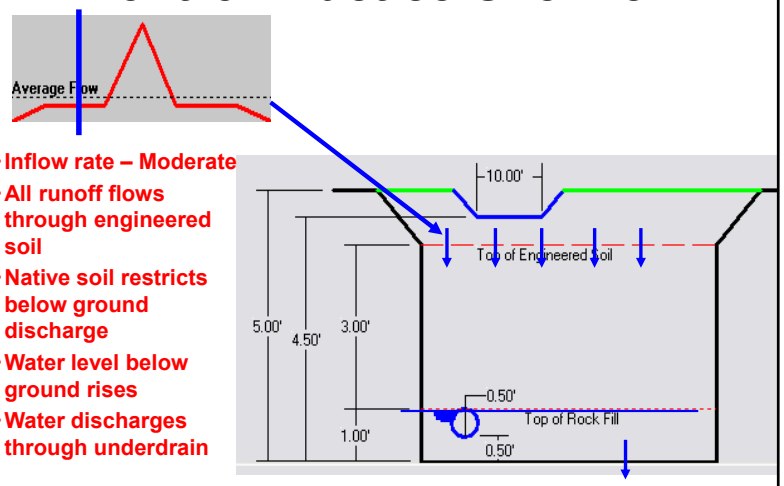
Control Practice Overview



- Inflow rate – Moderate
- All runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level below ground rises
- Water discharges through underdrain

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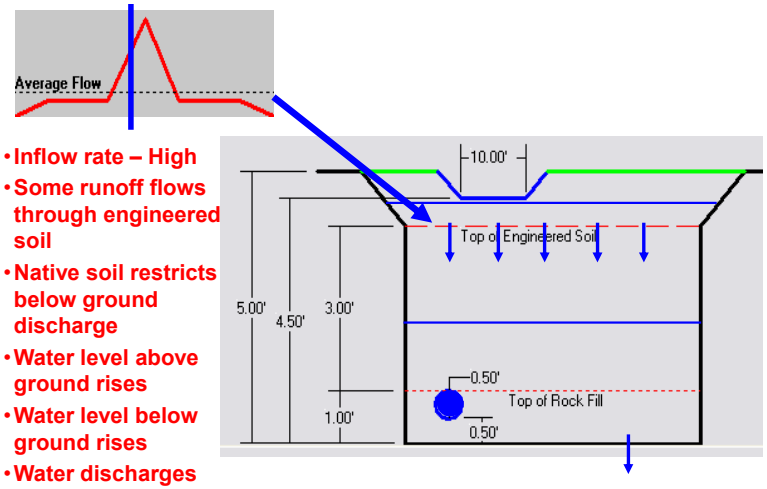
Control Practice Overview



- Inflow rate – High
- Some runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level above ground rises
- Water level below ground rises
- Water discharges through underdrain

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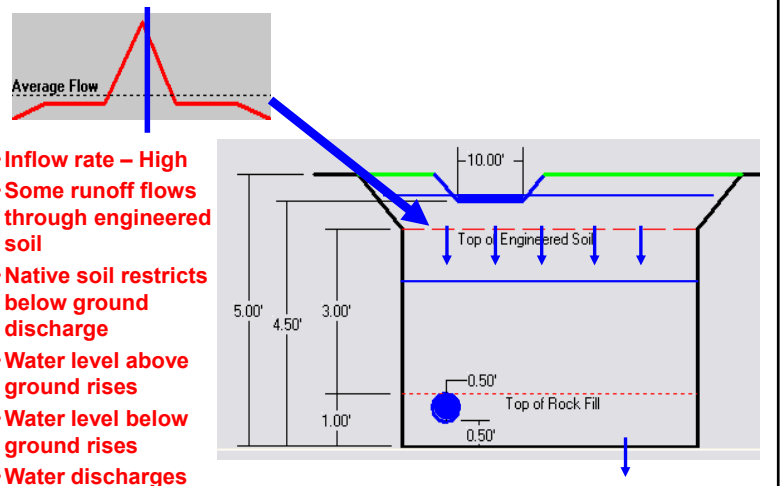
Control Practice Overview



- Inflow rate – High
- Some runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level above ground rises
- Water level below ground rises
- Water discharges through underdrain and above ground

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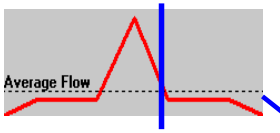
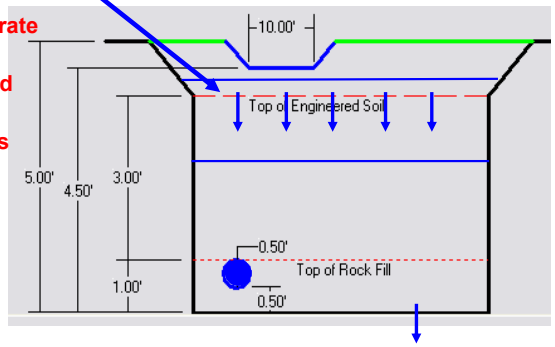
Control Practice Overview



- Inflow rate – Moderate
- Some runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level above ground falls
- Water level below ground falls
- Water discharges through underdrain



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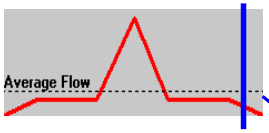
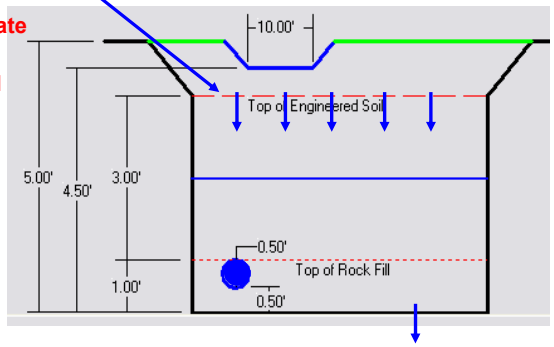
Control Practice Overview



- Inflow rate – Moderate
- All runoff flows through engineered soil
- Native soil restricts below ground discharge
- Water level above ground zeros out
- Water level below ground falls
- Water discharges through underdrain



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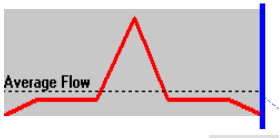
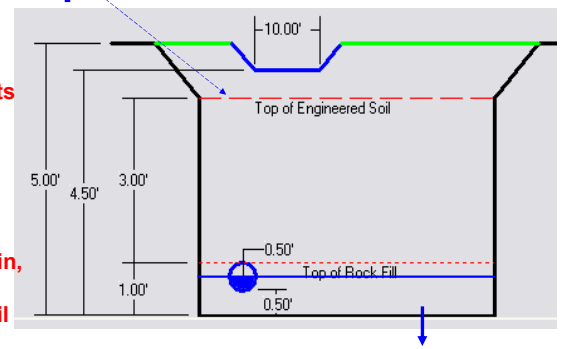
Control Practice Overview



- Inflow rate – Zero
- No runoff
- Native soil restricts below ground discharge
- Water level below ground falls
- Water discharges through underdrain, eventually only through native soil



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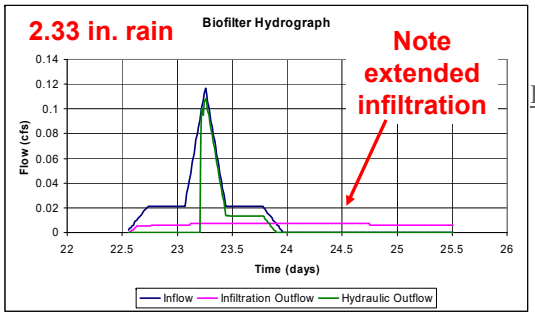
Biofilter Hydrograph Creation

- Flow rate calculated using Complex Triangular Hydrograph (can separate rain into very small increments, if needed, depending on complexity of model run)
  - Runoff Volume calculated from WinSLAMM
  - Runoff Duration = 1.2 times rainfall duration
  - Peak to Average Flow Ratio set by user



Complex Triangular Hydrograph

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Stormwater Constituents that may Adversely Affect Infiltration Device Life and Performance

- Sediment (suspended solids) will clog device
- Major cations (K^+, Mg^{+2}, Na^+, Ca^{+2}, plus various heavy metals in high abundance, such as Al and Fe) will consume soil CEC (cation exchange capacity) in competition with stormwater pollutants.
- An excess of sodium, in relation to calcium and magnesium (such as in snowmelt), can increase the soil's SAR (sodium adsorption ratio), which decreases the soil's infiltration rate and hydraulic conductivity.

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Sodium Adsorption Ratio (SAR)

The sodium adsorption ratio can radically affect the performance of an infiltration device. Soils with an excess of sodium ions, compared to calcium and magnesium ions, remain in a dispersed condition, almost impermeable to rain or applied water. 20 lb/ft^2 gypsum top-dressing as a soil amendment may help reduce SAR problems (used on agricultural fields, but not really shown to be useful at urban sites).

SAR value of 15, or greater, indicates that an excess of sodium will be adsorbed by the soil clay particles. This can cause the soil to:

- **be hard and cloddy when dry**
- **crust badly**
- **take water very slowly**

SAR values near 5 can also cause problems, depending on the type of clay present.

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A new infiltration pond after first winter; receives snowmelt from adjacent salted parking areas (plus sediment from area construction); lost almost all of the infiltration capacity and is rapidly becoming a (poorly designed) wet pond.

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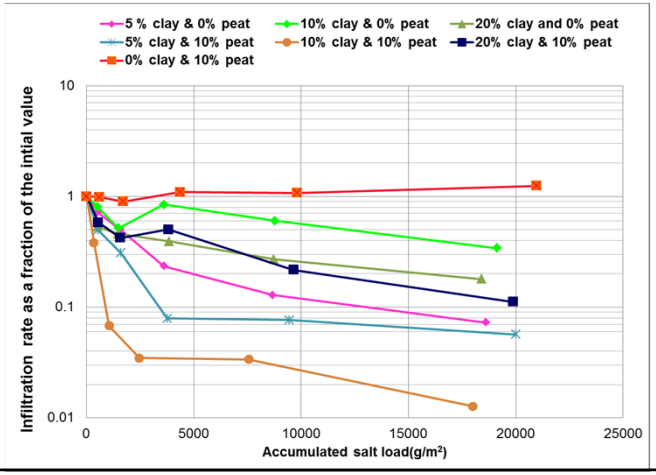
UA Student's Salt Addition Tests of Biofilter Media in Columns:

Lost Infiltration Rates with Clay (above 5%) and with Organic Supplements (peat in this example)



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Ground Water Mounding "Rules of Thumb"

- Mounding reduces infiltration rate to saturated permeability of soil, often 2 to 3 orders of magnitude (100 to 1,000X reductions) lower than dry soil infiltration rate.
- Long narrow system (i.e. trenches) don't mound as much as broad, square/round systems

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Five Components to Modeling Biofilters

1. **Structure Geometry**
2. **Outlet Information**
3. **Infiltration Data**
4. **Hydrograph and Flow Routing Information**
5. **Particle Size Distribution**

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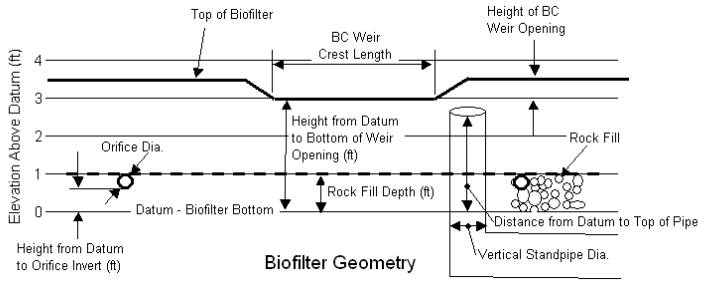
Biofilter Geometry



Biofilter Datum is always zero ft.

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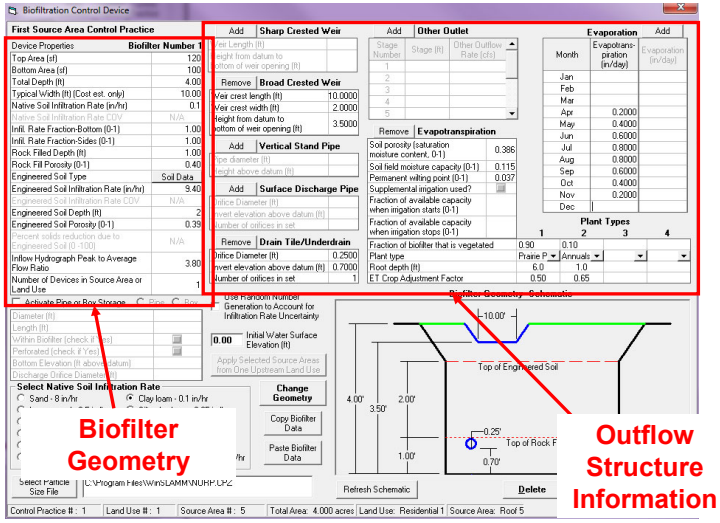
Biofilter Data Entry Form



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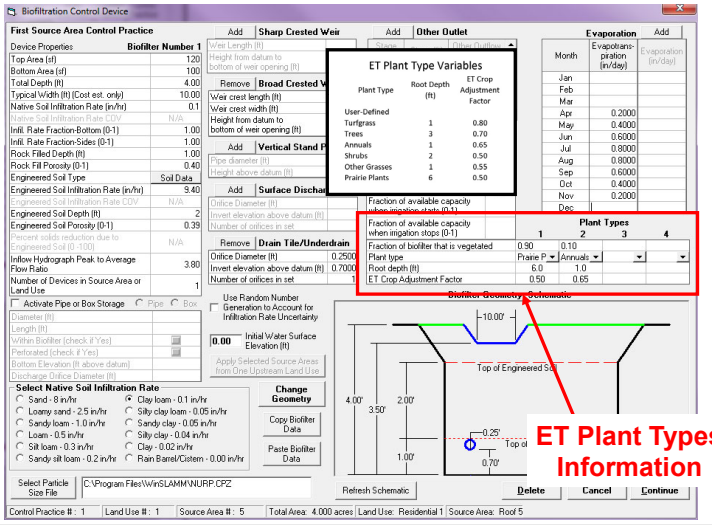
Biofilter Data Entry Form



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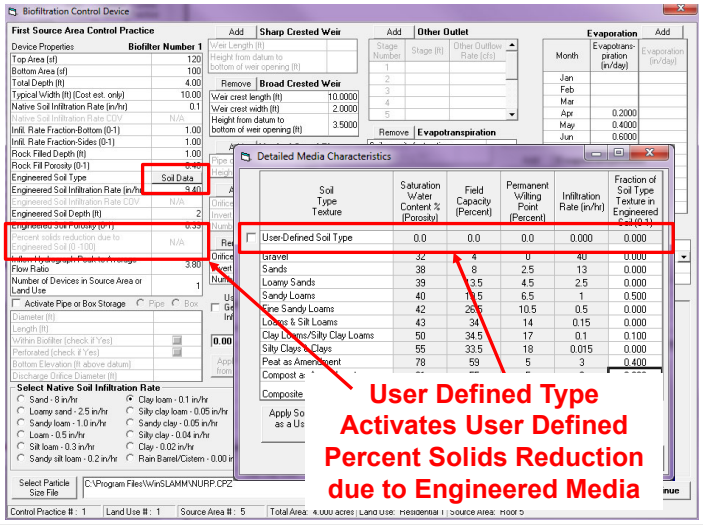
Biofilter Data Entry Form



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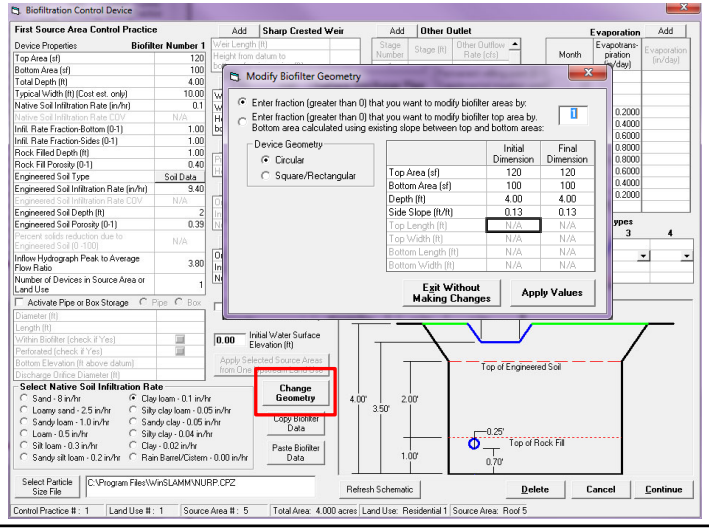
Biofilter Data Entry Form



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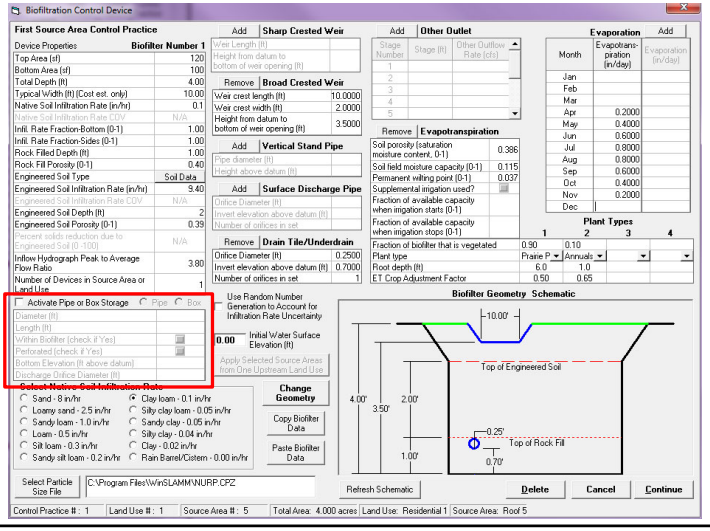
Biofilter Data Entry Form



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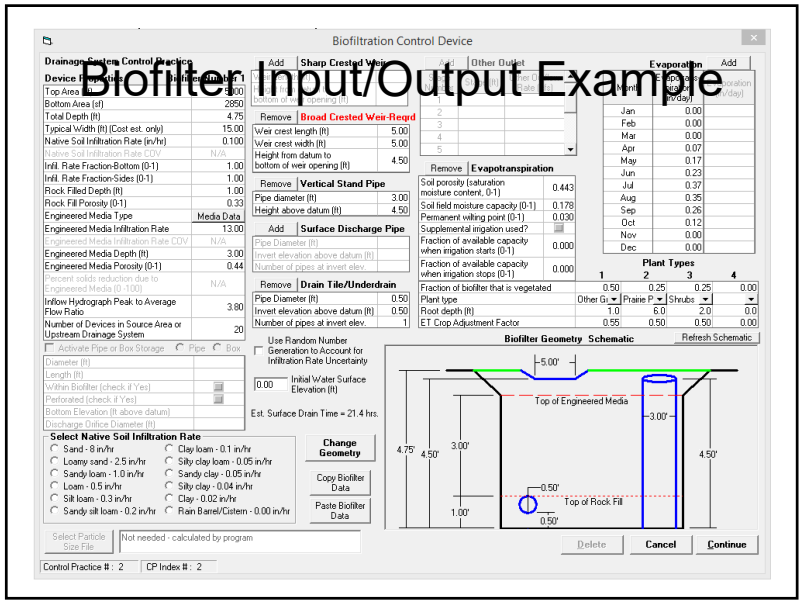
Tab 4-G: Biofilter Control Practice



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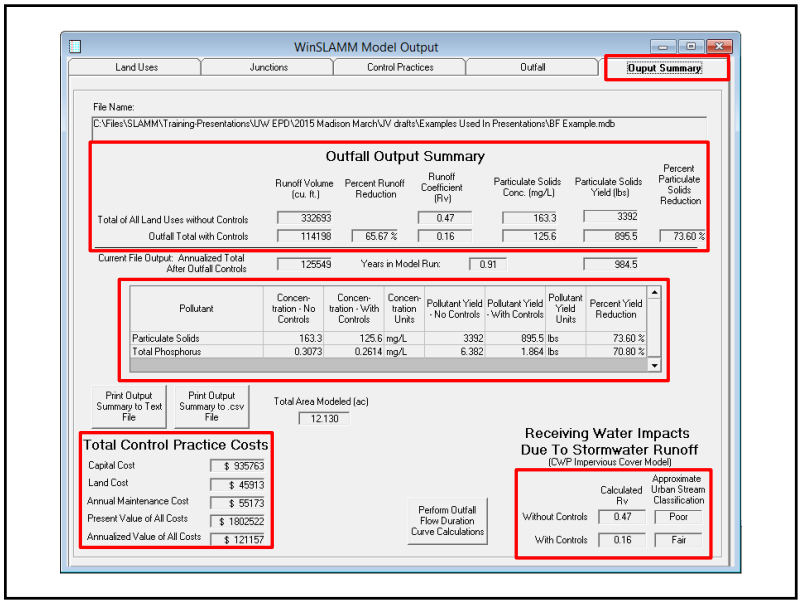

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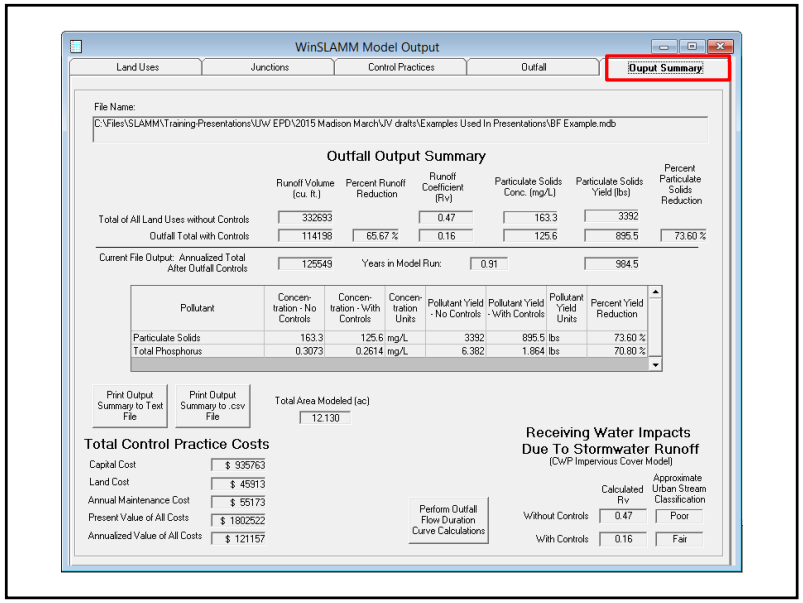

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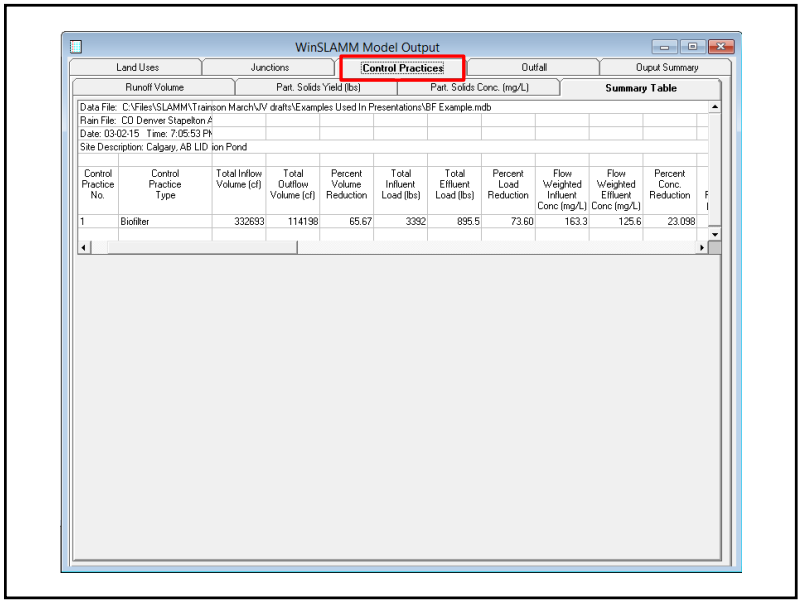

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Control Practice Summary Table

Data File: C:\Files\SLAMM\Training-Presentations\UW EPD\2015 Madison March\JV drafts\Examples Used In Presentations\BF Example.mdb
Rain File: CO Denver Stapelton AP 4899.RAN
Date: 03-02-15 Time: 7:05:53 PM
Site Description: Calgary, AB LID Example, with Biofilters and Wet Detention Pond

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)
1	Biofilter	DS Biofilters # 1	332693	114198	65.67	3392	895.5	73.60	163.3	125.6

Data File: C:\Files\SLAMM\Train
Rain File: CO Denver Stapelton A
Date: 03-02-15 Time: 7:05:53 PM
Site Description: Calgary, AB LID I

Control Practice No.	Control Practice Type	Percent Conc. Reduction	Influent Median Part. Size (microns)	Effluent Median Part. Size (microns)	Notes	Maximum Stage (ft)	Hydraulic Volume Out (cf)	% of Clogging Factor	Maximum Surface Ponding Time (hrs)	Maximum Subsurface Ponding Time (hrs)	Volume Infiltrated (cf)	Ur Di V
1	Biofilter	23.098	7.80	5.55	No Biofilter Overflows	4.01	110421		0.0	24.66	134066.30	

Data File: C:\Files\SLAMM\Train
Rain File: CO Denver Stapelton A
Date: 03-02-15 Time: 7:05:53 PM
Site Description: Calgary, AB LID I

Control Practice No.	Control Practice Type	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 Supplemtl. Irrig.(cf)	Surface Ponding Events >72 hrs (Count)	Runoff Producing Events/ Ttl. Rains
1	Biofilter	24.66	134066.30	107362	119531.50		0.00			0	9/55

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Control Practice Detail Tables

Runoff Volume | Part. Solids Yield (lbs)

Data File: C:\Files\SLAMM\Training-Presentations\UW EPD\2015 Madison March\JV drafts\
Rain File: CO Denver Stapelton AP 4899.RAN
Date: 03-02-15 Time: 7:05:53 PM
Site Description: Calgary, AB LID Example, with Biofilters and Wet Detention Pond

Control Practice Type ==> CP# 1 - Biofiltration/Infiltration
Control Practice Name/Location ==> DS Biofilters # 1

Rain Number	Start Date	Rain Total (in)	Influent Runoff Vol.(cf)	Effluent Runoff Vol.(cf)	Runoff Vol. Percent Reduction
484	03/30/55	-	0	0	0
485	04/11/55	0.48	11059	0	100.00
486	05/08/55	0.02	83.39	0	100.00
487	05/09/55	0.11	1626	0	100.00
488	05/16/55	0.12	1881	0	100.00
489	05/18/55	1.75	53245	25056	52.94
490	05/22/55	0.07	763.9	0	100.00
491	05/25/55	0.40	8965	1.337	99.99
492	06/04/55	0.43	9738	0	100.00
493	06/05/55	0.14	2316	0.04611	100.00
494	06/08/55	0.03	187.6	1.789E-04	100.00
495	06/08/55	0.01	20.85	2.112E-05	100.00
496	06/13/55	0.19	3557	0	100.00
497	06/14/55	0.13	2094	0.06578	100.00
498	06/16/55	0.11	1626	0.001842	100.00
499	06/16/55	0.23	4504	0.05530	100.00
500	06/18/55	0.07	763.9	0.02714	100.00
501	06/20/55	0.02	83.39	2.932E-04	100.00
502	06/25/55	0.03	187.6	0	100.00
503	07/04/55	0.02	83.39	0	100.00
504	07/10/55	0.01	20.85	0	100.00
505	07/12/55	0.02	83.39	0	100.00
506	07/20/55	0.16	2786	0.1940	99.99

Runoff Volume | Part. Solids Yield (lbs)

Data File: C:\Files\SLAMM\Training-Presentations\UW EPD\2015 Madison March\JV d
Rain File: CO Denver Stapelton AP 4899.RAN
Date: 03-02-15 Time: 7:05:53 PM
Site Description: Calgary, AB LID Example, with Biofilters and Wet Detention Pond

Control Practice Type ==> CP# 1 - Biofiltration/Infiltration
Control Practice Name/Location ==> DS Biofilters # 1

Rain Number	Start Date	Rain Total (in)	Influent Part. Sol. Yield(lbs)	Effluent Part. Sol. Yield(lbs)	Part.Yield Percent Reduction
484	03/30/55	-	0	0	0
485	04/11/55	0.48	109.2	0	100.00
486	05/08/55	0.02	1.125	0	100.00
487	05/09/55	0.11	17.42	0	100.00
488	05/16/55	0.12	19.59	0	100.00
489	05/18/55	1.75	552.3	199.6	63.86
490	05/22/55	0.07	9.439	0	100.00
491	05/25/55	0.40	88.02	0.01313	99.99
492	06/04/55	0.43	95.83	0	100.00
493	06/05/55	0.14	23.77	4.732E-04	100.00
494	06/08/55	0.03	2.531	2.413E-06	100.00
495	06/08/55	0.01	0.2812	2.849E-07	100.00
496	06/13/55	0.19	35.36	0	100.00
497	06/14/55	0.13	21.65	6.800E-04	100.00
498	06/16/55	0.11	17.42	1.973E-05	100.00
499	06/16/55	0.23	44.52	5.466E-04	100.00
500	06/18/55	0.07	9.439	3.353E-04	100.00
501	06/20/55	0.02	1.125	3.955E-06	100.00
502	06/25/55	0.03	2.531	0	100.00
503	07/04/55	0.02	1.125	0	100.00
504	07/10/55	0.01	0.2812	0	100.00
505	07/12/55	0.02	1.125	0	100.00
506	07/20/55	0.16	28.21	0.001964	99.99

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Additional Output

Biofilter Event by Event Output

Biofilter Water Balance Performance Summary, by Event

BioF Source Area Number	Rain Number	Rain Depth (in)	Time (Julian Date)	Maximum BioF Stage (ft)	Minimum BioF Stage (ft)	Event Inflow Volume (ac-ft)	Event Hydr Outflow (ac-ft)	Event Infil Outflow (ac-ft)	Event Evap Outflow (ac-ft)	Event Cistern Outflow (ac-ft)	Event Orifice Outflow (ac-ft)	Event Total Outflow (ac-ft)	Event Flow Balance (ac-ft)	Volume Reduction Fraction	Solids Reduction Fraction
7	1	0.01	0	0.12	0	0	0	0	0	0	0	0	0	1	0
7	2	0.05	31	0.57	0	0.007	0	0.001	0	0	0.006	0.007	0	0.183	0
7	3	0.1	59	0.71	0	0.015	0	0.002	0	0	0.013	0.015	0	0.095	0
7	4	0.25	90	1.2	0	0.042	0	0.002	0	0	0.041	0.042	0	0.043	0
7	5	0.5	120	2.03	0	0.084	0	0.002	0	0	0.082	0.084	0	0.024	0
7	6	0.75	151	2.46	0	0.125	0	0.002	0	0	0.122	0.125	0	0.018	0
7	7	1	181	2.5	0	0.165	0.007	0.002	0	0	0.156	0.165	0	0.014	0
7	8	1.5	212	2.52	0	0.249	0.034	0.003	0	0	0.213	0.249	0	0.01	0
7	9	2	243	2.52	0	0.335	0.066	0.003	0	0	0.266	0.335	0	0.008	0
7	10	2.5	273	2.53	0	0.416	0.087	0.003	0	0	0.326	0.416	0	0.008	0
7	11	3	304	2.52	0	0.497	0.097	0.004	0	0	0.396	0.497	0	0.008	0
7	12	4	334	2.53	0	0.661	0.149	0.004	0	0	0.507	0.661	0	0.007	0

Other Output Options

- Time step detail
- Irreducible concentration
- Particulate reduction
- Stage outflow
- Stochastic seepage rates
- Water Balance
- Evapotranspiration

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