WinSLAMM v 9.3
Grass Swales
Module 7b

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Earth Tech, Inc.

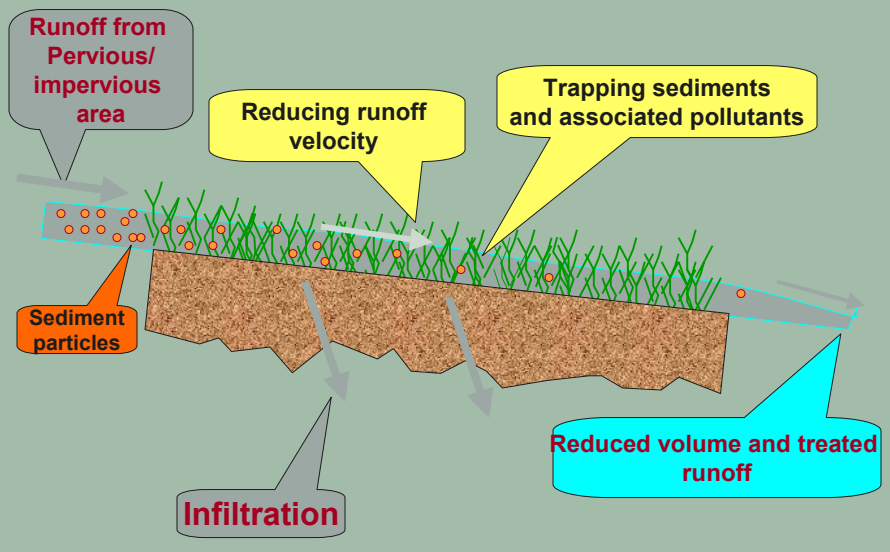
We will cover . . .

- Research Results
- Entering Grass Swale Data into the Model
- Model Output
- Variable Sensitivity

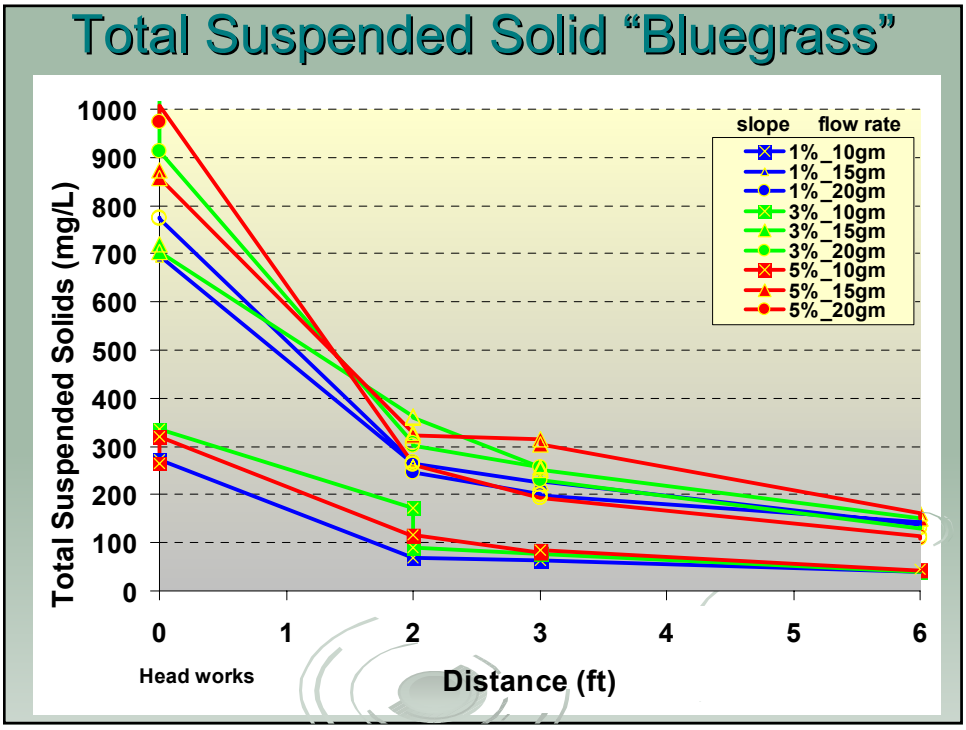
Research Results

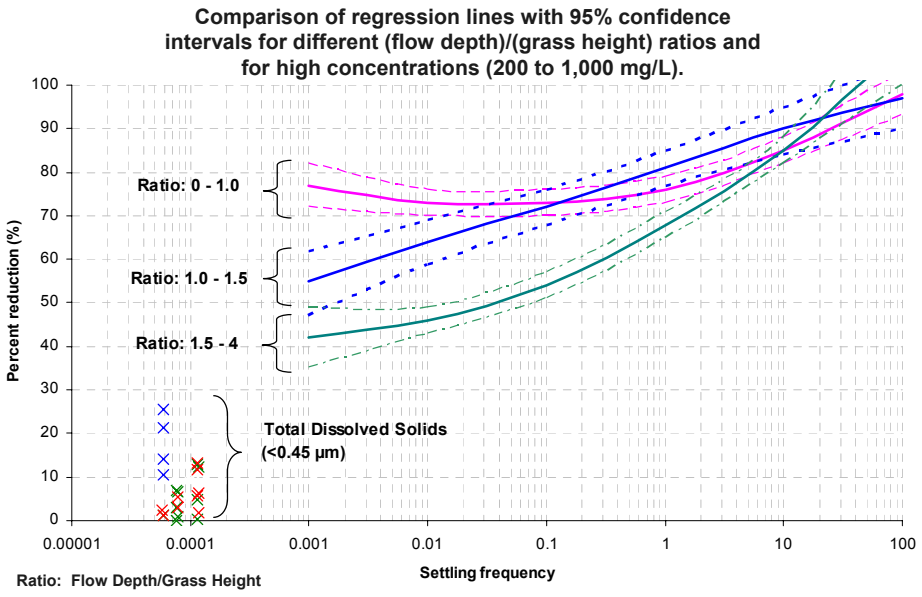
- IJC (1979) found swale drained areas had up to 95% less flows and pollutant yields compared to curb and gutter.
- NURP (1983) found soluble and particulate heavy metals reduced by 50% and COD, nitrate and ammonia nitrogen reduced by about 25%.
- Pitt & McLean (1986) found about 50% reductions in pollutants and runoff volume; for small frequent rains very little runoff was observed
- Current research (Nara 2005) at the Univ. of Alabama identified significant factor affecting particulate transport in grass swales and developed suitable model algorithms. Modeled procedure joins particle settling with swale hydraulics.

Pollutant Control in Grass Swales



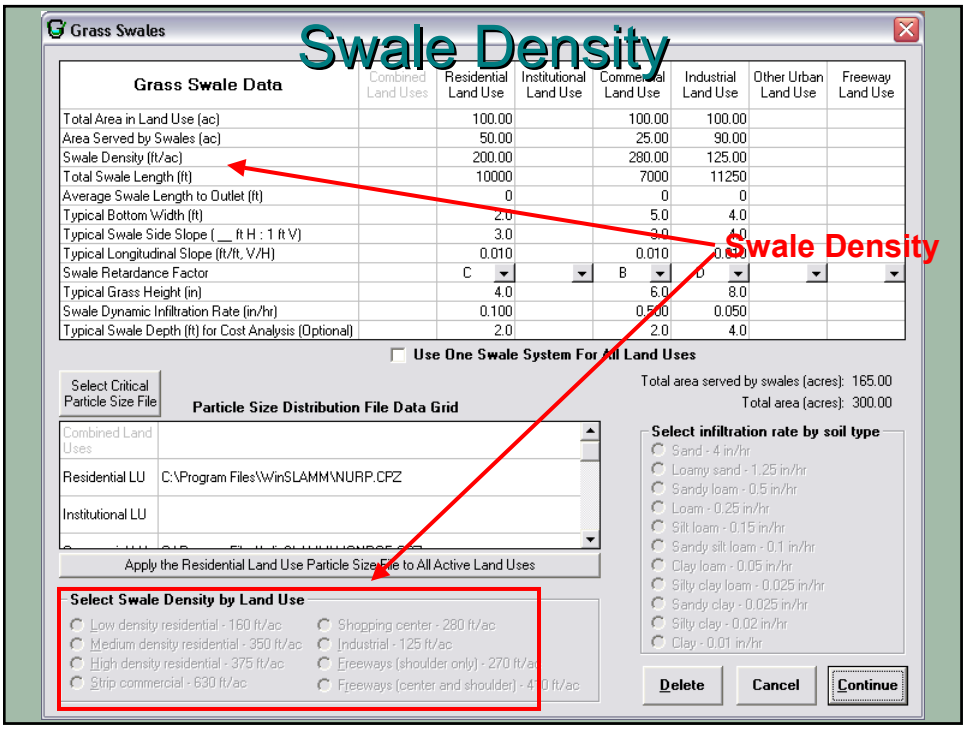

Date: 10/11/2004
116 ft
75 ft
25 ft
6 ft
3 ft
2 ft
Head (0ft)
TSS: 10 mg/L
TSS: 20 mg/L
TSS: 30 mg/L
TSS: 35 mg/L
TSS: 63 mg/L
TSS: 84 mg/L
TSS: 102 mg/L

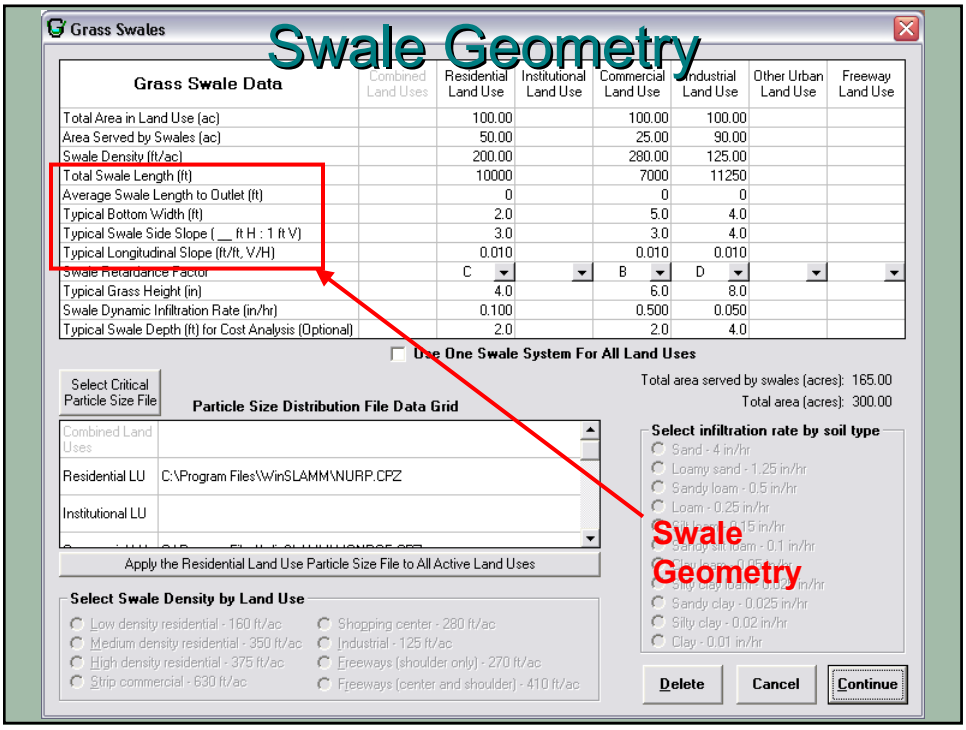

Total Suspended Solid "Bluegrass"
Total Suspended Solids (mg/L)
1000
900
800
700
600
500
400
300
200
100
0
0
1
2
3
4
5
6
Head works
Distance (ft)
slope flow rate
1%_10gm
1%_15gm
1%_20gm
3%_10gm
3%_15gm
3%_20gm
5%_10gm
5%_15gm
5%_20gm



Five Components to Modeling Grass Swales

- Swale Density
- Swale Infiltration Rate
- Swale Geometry
- Grass Characteristics
- Runoff Particle Size Distribution


Grass Swales
Swale Density
Grass Swale Data
Combined Land Uses
Residential Land Use
Institutional Land Use
Commercial Land Use
Industrial Land Use
Other Urban Land Use
Freeway Land Use
Total Area in Land Use (ac) 100.00 100.00 100.00
Area Served by Swales (ac) 50.00 25.00 90.00
Swale Density (ft/ac) 200.00 280.00 125.00
Total Swale Length (ft) 10000 7000 11250
Average Swale Length to Outlet (ft) 0 0 0
Typical Bottom Width (ft) 2.0 5.0 4.0
Typical Swale Side Slope (__ ft H : 1 ft V) 3.0 3.0 4.0
Typical Longitudinal Slope (ft/ft, V/H) 0.010 0.010 0.010
Swale Retardance Factor C B D
Typical Grass Height (in) 4.0 6.0 8.0
Swale Dynamic Infiltration Rate (in/hr) 0.100 0.500 0.050
Typical Swale Depth (ft) for Cost Analysis (Optional) 2.0 2.0 4.0
Swale Density
Use One Swale System For All Land Uses
Select Critical Particle Size File
Particle Size Distribution File Data Grid
Total area served by swales (acres): 165.00
Total area (acres): 300.00
Combined Land Uses
Residential LU C:\Program Files\WinSLAMM\NURP.CPZ
Institutional LU
Select infiltration rate by soil type
Sand - 4 in/hr
Loamy sand - 1.25 in/hr
Sandy loam - 0.5 in/hr
Loam - 0.25 in/hr
Silt loam - 0.15 in/hr
Sandy silt loam - 0.1 in/hr
Clay loam - 0.05 in/hr
Silty clay loam - 0.025 in/hr
Sandy clay - 0.025 in/hr
Silty clay - 0.02 in/hr
Clay - 0.01 in/hr
Apply the Residential Land Use Particle Size File to All Active Land Uses
Select Swale Density by Land Use
Low density residential - 160 ft/ac
Medium density residential - 350 ft/ac
High density residential - 375 ft/ac
Strip commercial - 630 ft/ac
Shopping center - 280 ft/ac
Industrial - 125 ft/ac
Freeways (shoulder only) - 270 ft/ac
Freeways (center and shoulder) - 410 ft/ac
Delete
Cancel
Continue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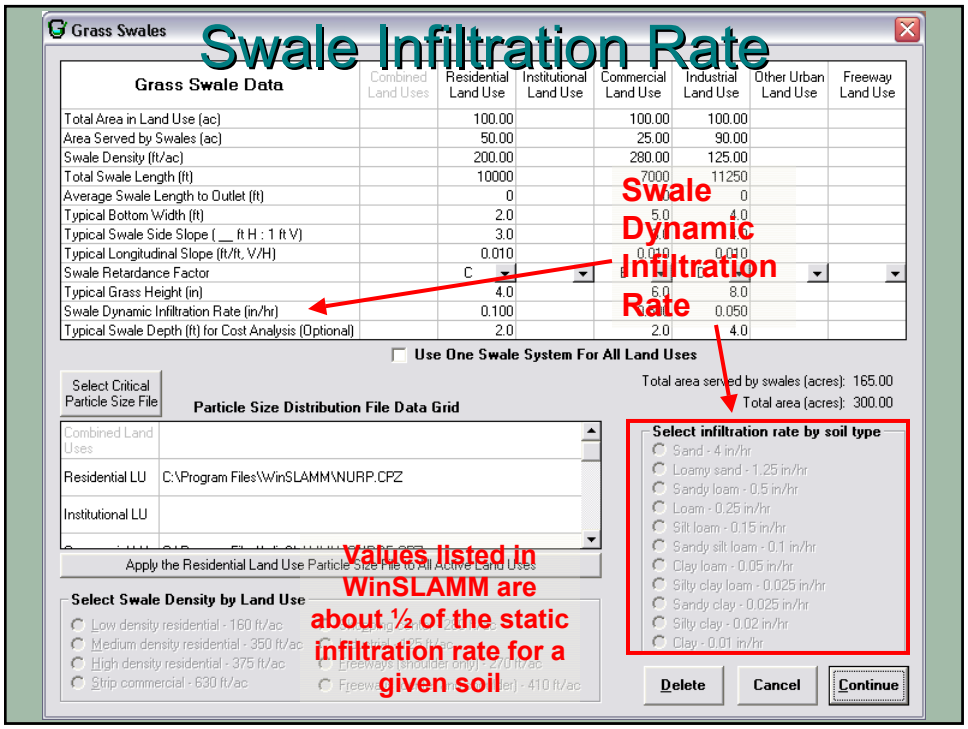
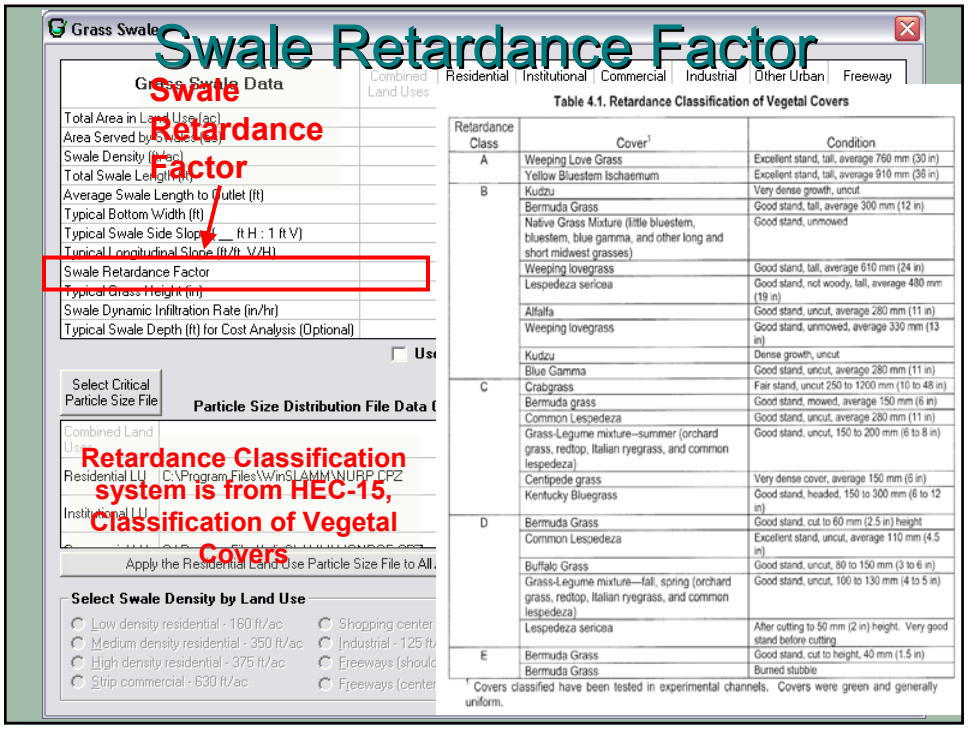
Swale Infiltration Rate



Swale Dynamic Infiltration Rate

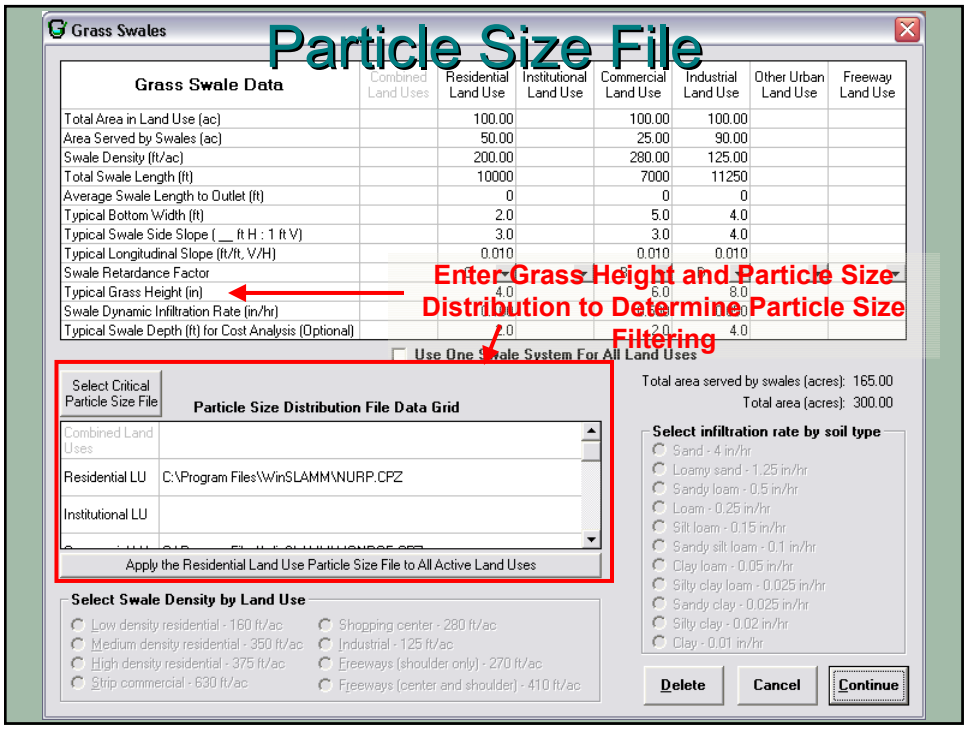
Values listed in WinSLAMM are about ½ of the static infiltration rate for a given soil

Swale Retardance Factor



Swale Retardance Factor

Retardance Classification system is from HEC-15, Classification of Vegetal Covers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Enter Grass Height and Particle Size Distribution to Determine Particle Size Filtering
Use One Swale System For All Land Uses
Select Critical Particle Size File
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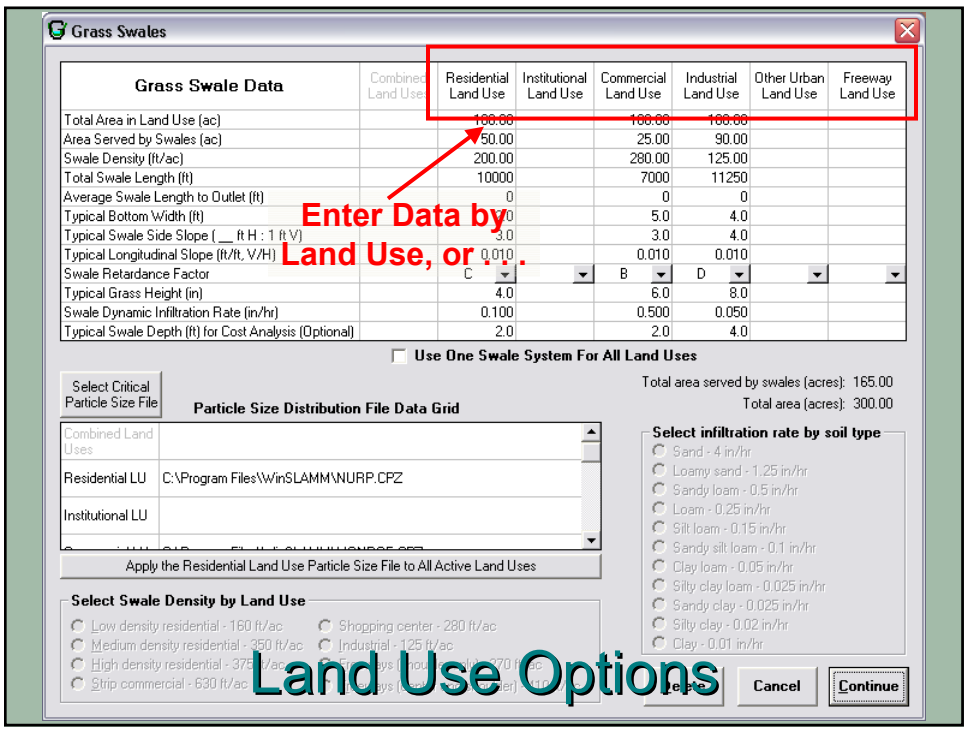
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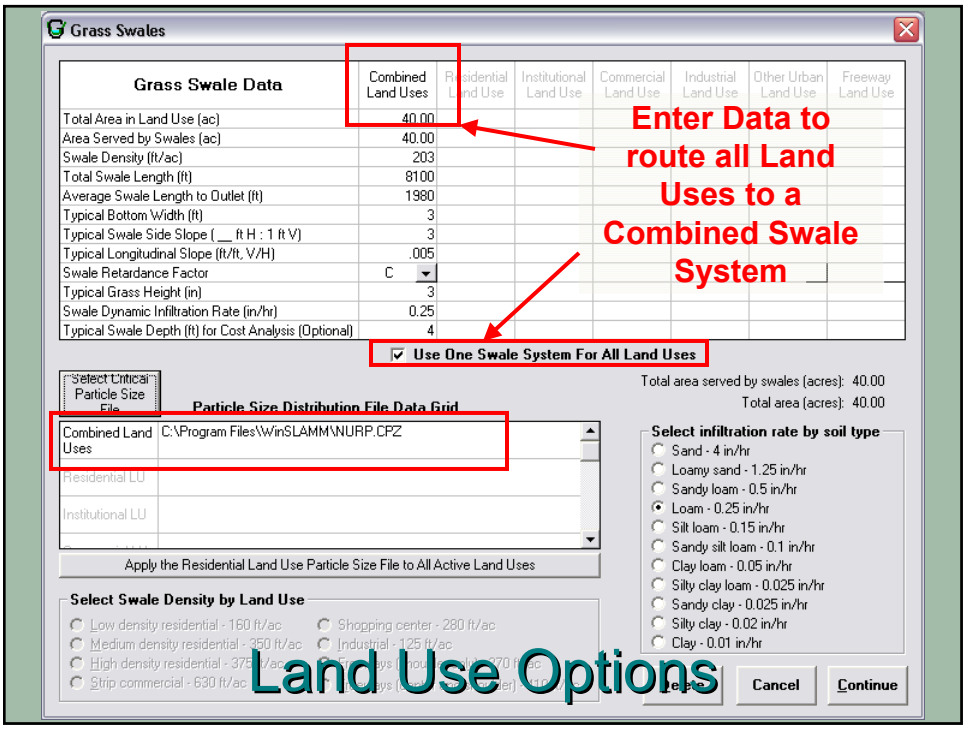
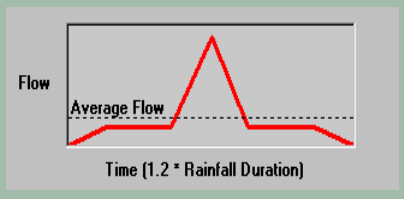
Land Use Options



Dynamic Wetted Width Calculation

- Calculate event volume
- Convert volume to flow with:
  - Runoff duration = 1.2 times rainfall duration
  - Complex triangular hydrograph peak to average ratio = 3.8

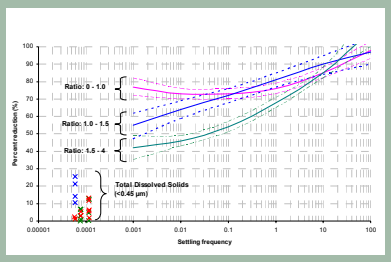


- Flow rate calculated for each six minute interval
- Calculate the wetted width from the flow rate and swale geometry using Manning's open channel flow equation
  - Width
  - Side slope
  - Slope
  - Manning's n from Retardance Factor

Particulate Removal Calculations

For each time step -

- Calculate flow velocity, settling velocity and flow depth
- Determine flow depth to grass height, for particulate reduction for each particle size increment using Nara & Pitt reference
- Check particle size group limits
  - Not exceed irreducible concentration value
  - No filtering for particles less than 50 microns



Additional Output

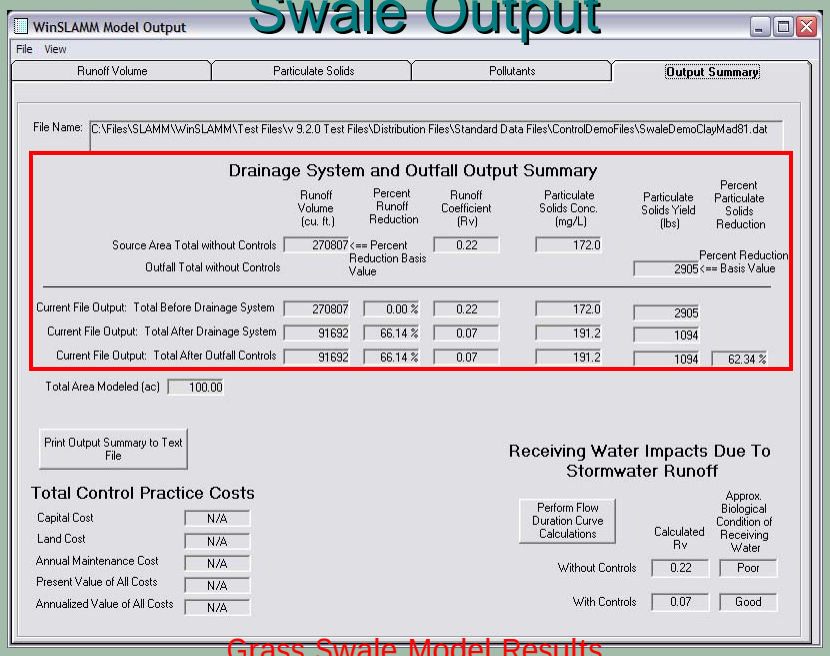
Rain No.	Rainfall Depth (in)	Step Count	Qln	QCalc	Diff	h	Wetted Perimeter	Swale Vol Reduction	Runoff Vol Before Swales	Runoff Vol After Swales
39	0.21	1	0.659558	15.88515	15.22559	0.5				
39	0.21	2	0.659558	3.332024	2.672466	0.25				
						0.125				
						5625				
						5313				
						4141				
						3623				
						6975				
						4116				
							2.525232	0.673294	10497.38	3429.561
40	0.3	1	0.43074	15.88515	15.45441	0.5				
40	0.3	2	0.43074	3.332024	2.901284	0.25				
40	0.3	3	0.43074	0.796467	0.365727	0.125				
40	0.3	9	0.43074	0.481597	5.09E-02	0.186899				
40	0.3	10	0.43074	0.453293	2.26E-02	0.181059				
40	0.3	11	0.43074	0.426746	3.99E-03	0.183888				
40	0.3	12	0.43074	0.439498	8.76E-03	0.182451				
40	0.3	13	0.43074	0.432998	2.26E-03	0.181026				
40	0.3	14	0.43074	0.426599	4.14E-03	0.181733				
40	0.3	15	0.43074	0.429767	9.73E-04	0.182443				
40	0.3						2.153869	0.761577	15996.33	3813.894

GrassSwaleHydraulicsAndConcDetailed.csv
GrassSwaleHydraulicsAndConcByEvent.csv
GrassSwaleIncPerformance.csv
GrassSwaleIrreducibleConc.csv
GrassSwalePartRed.csv

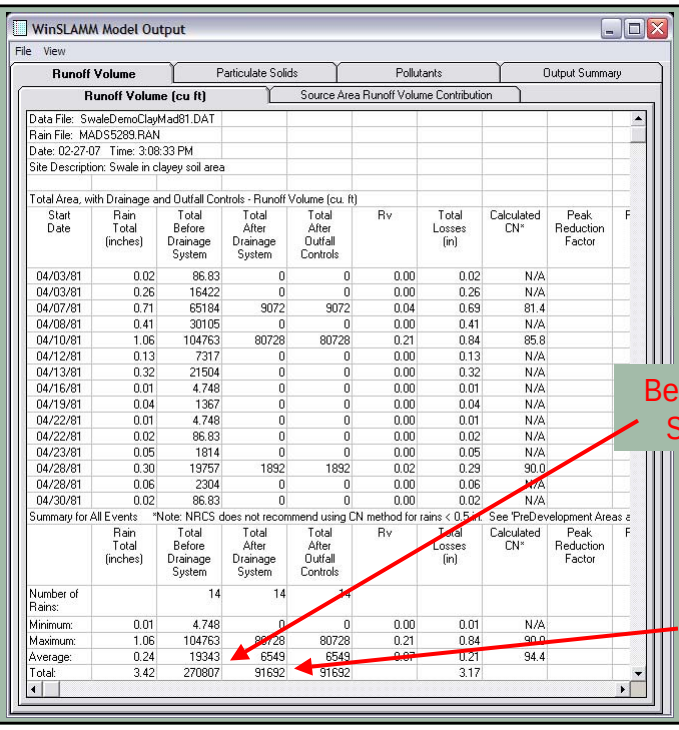
Iterative calculation to determine swale height and wetted perimeter for each runoff event

SwaleQ = 1.486 / n * (h * BottomWidth + SideSlope * h ^ 2) ^ (5 / 3) / (BottomWidth + h * Sqr(SideSlope * SideSlope + 1) * 2) ^ (2 / 3) * Sqr(LongSlope)

Swale Output



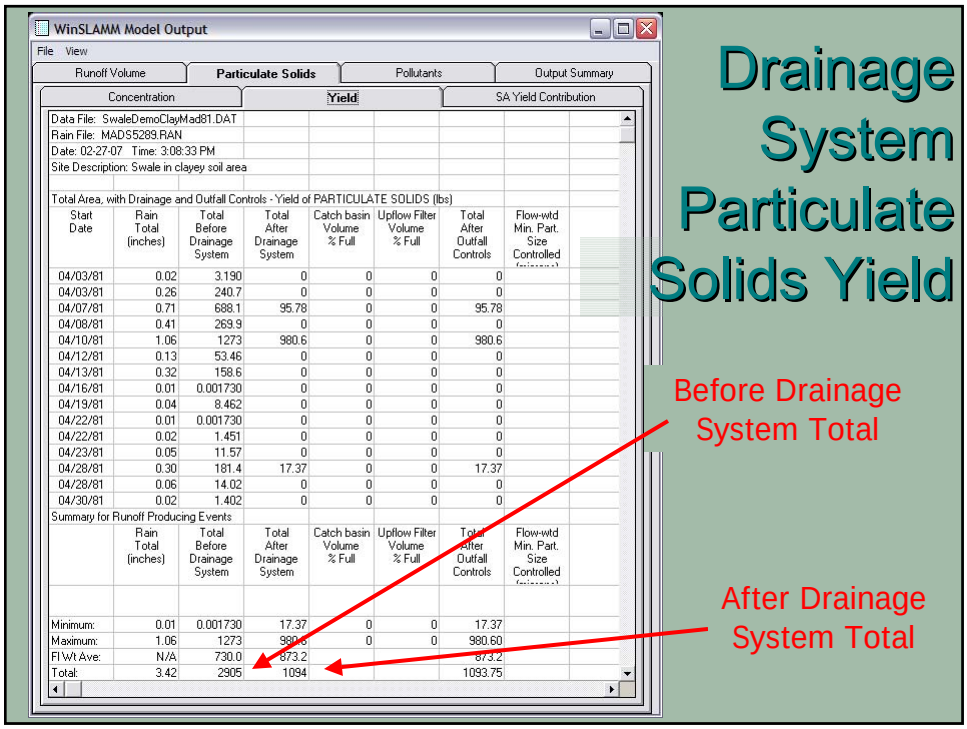
Grass Swale Model Results



Drainage System Runoff Volume

Before Drainage System Total

After Drainage System Total



Drainage System Particulate Solids Yield

Before Drainage System Total

After Drainage System Total

Questions?