Small Storm Hydrology

The Integration of Water Quality and Drainage Design Objectives

Modeling Flow and Pollutant Sources

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Urban Stormwater Hydrology History

ÅEarly focus of urban stormwater was on storm sewer and flood control design using the Rational Method and TR-55 (both single event, ñdesign stormò methods).

ÅThe Curve Number procedure was developed in the 1950s by the (then) SCS as a simple tool for estimating volumes generated by large storm events in agricultural areas, converted to urban uses in mid 1970s (TR55 in SCS 1976). Data based on many decades of observations of large storms in urban areas, at Corps of Engineers monitoring locations. Data available from the Rainfall-Runoff database report prepared by the Univ. of Florida for the EPA.

ÅWater quality focus results form Public Law 92-500, the Clean Water Act, 1972. Stormwater quality research started in the late 1960s, with a few earlier interesting studies. Big push with Nationwide Urban Runoff Program (NURP) in late 70s and early 80s. Most still rely on earlier drainage design approaches.

Many stormwater monitoring configurations used over the years

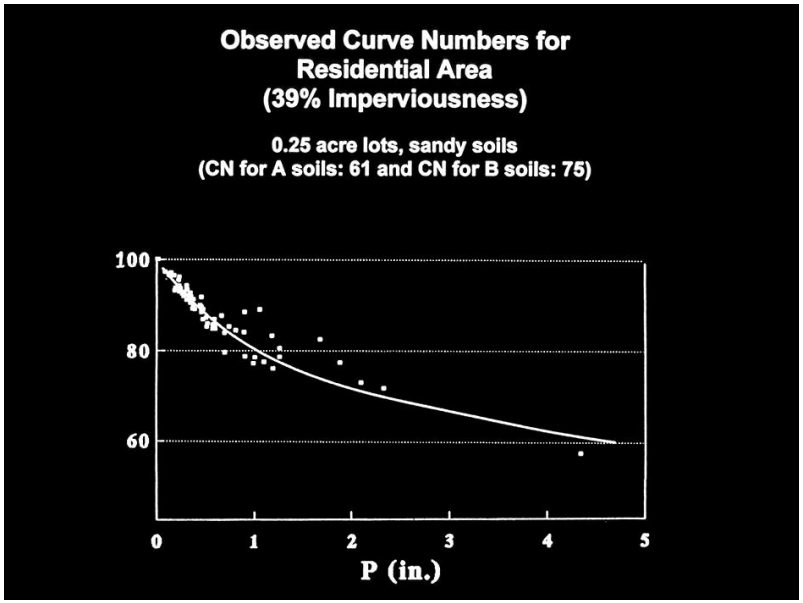
Importance of Site Hydrology in the Design of Stormwater Controls

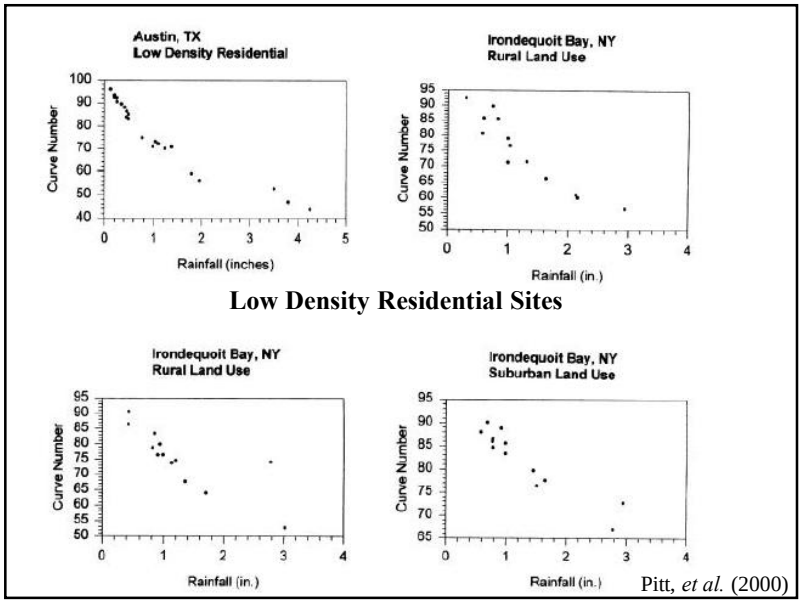
- ÅDesign of stormwater management programs requires knowledge of site hydrology
- ÅUnderstanding of flows (variations for different storm conditions, sources of flows from within the drainage area, and quality of those flows), are needed for effective design of source area and outfall controls.

The following equation can be used to calculate the actual NRCS curve number (CN) from observed rainfall depth (P) and runoff depth (Q), both expressed in inches:

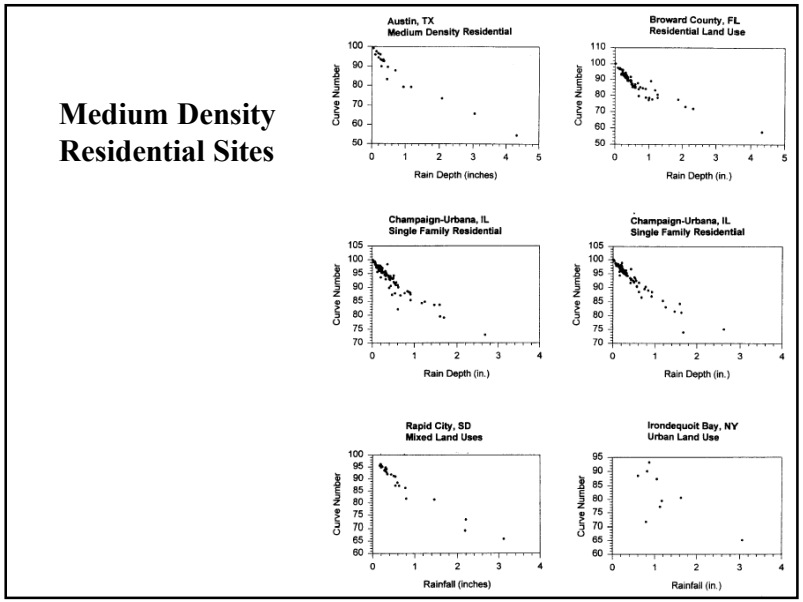
$$CN = 1000/[10+5P+10Q-10(Q^2+1.25QP)^{1/2}]$$

The following plots use rainfall and runoff data from the EPA's NURP projects in the early 1980s (EPA 1983), and from the EPA's rainfall-runoff-quality data base (Huber, *et al.* 1982).

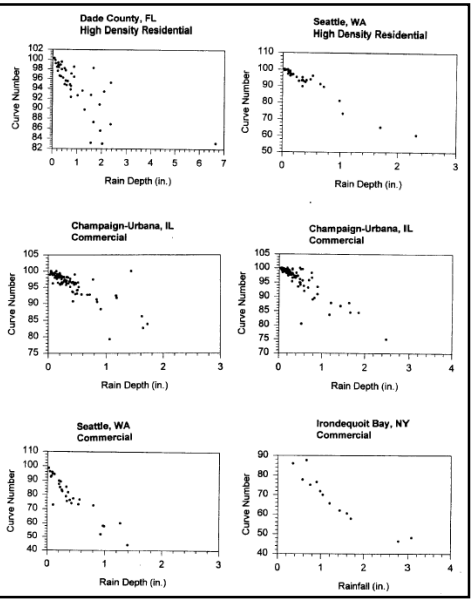


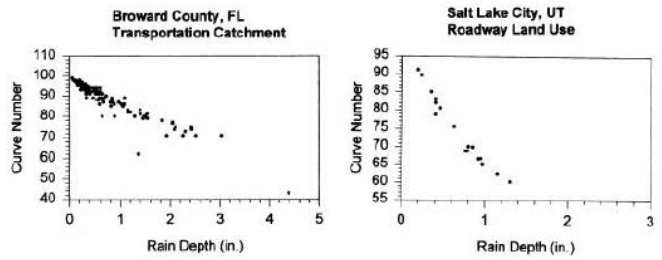


Pitt, *et al.* (2000)

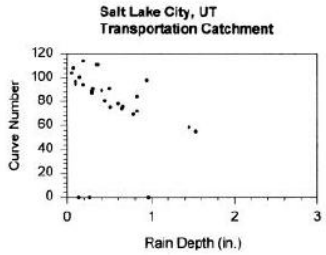


High Density Residential Sites



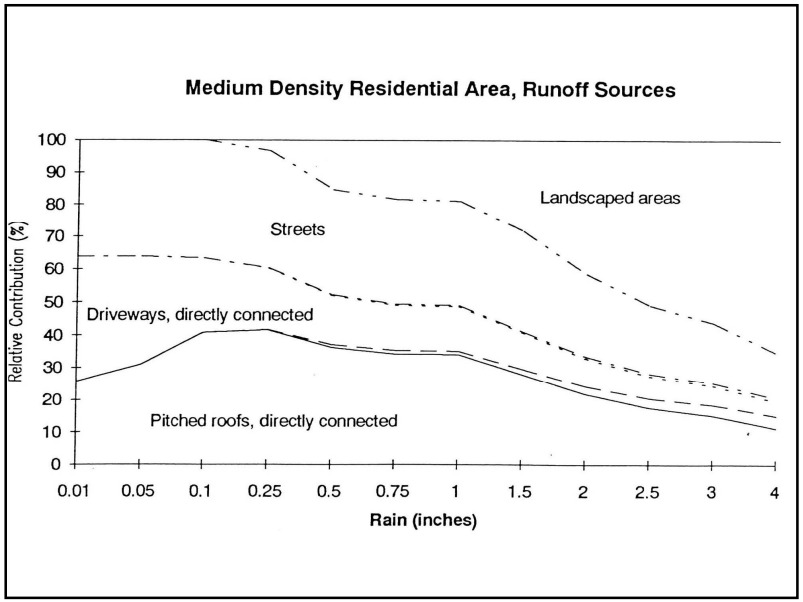


Highway Sites



Knowing the Runoff Volume is the Key to Estimating Pollutant Mass

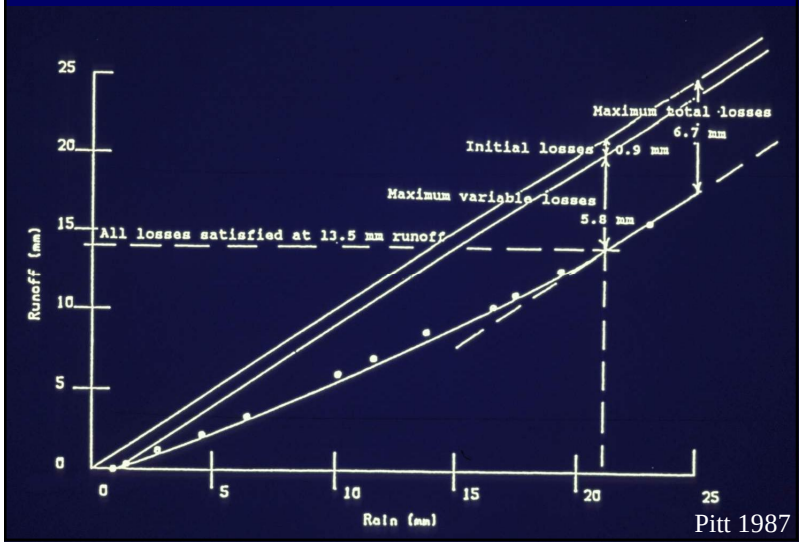
- There is usually a simple relationship between rain depth and runoff depth.
- Changes in rain depth affect the relative contributions of runoff and pollutant mass discharges:
  - Directly connected impervious areas contribute most of the flows during relatively small rains
  - Disturbed urban soils may dominate during larger rains



Source Characteristics of Stormwater Pollutants

- Quality of sheetflows vary for different areas.
- Need to track pollutants from sources and examine controls that affect these sources, the transport system, and outfall.

Runoff response curve for typical residential street, Toronto

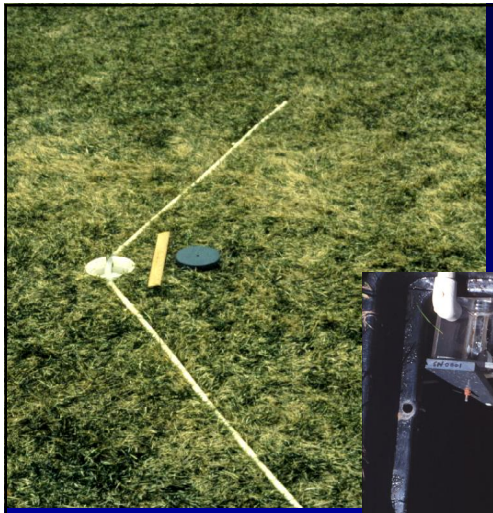


Pitt 1987

Disturbed Urban Soils during Land Development

Road shoulder soil compaction due to parked cars along road.

Soil modifications can result in greatly enhanced infiltration in marginal soils.

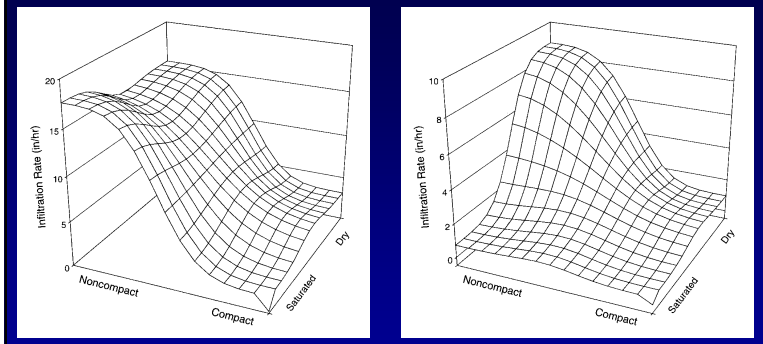


Direct measurements of turf runoff for different soil conditions.

WI DNR Double-Ring Infiltrometer Test Results (in/hr), Oconomowoc (mostly A and B soils)

Initial Rate	Final Rate	Range of Observed Rates
25	15	11 to 25
22	17	17 to 24
14.7	9.4	9.4 to 17
5.8	9.4	0.2 to 9.4
5.7	9.4	5.1 to 9.6
4.7	3.6	3.1 to 6.3
4.1	6.8	2.9 to 6.8
3.1	3.3	2.4 to 3.8
2.6	2.5	1.6 to 2.6
0.3	0.1	0 to 0.3
0.3	1.7	0.3 to 3.2
0.2	0	0 to 0.2
0	0.6	0 to 0.6
0	0	all 0
0	0	all 0

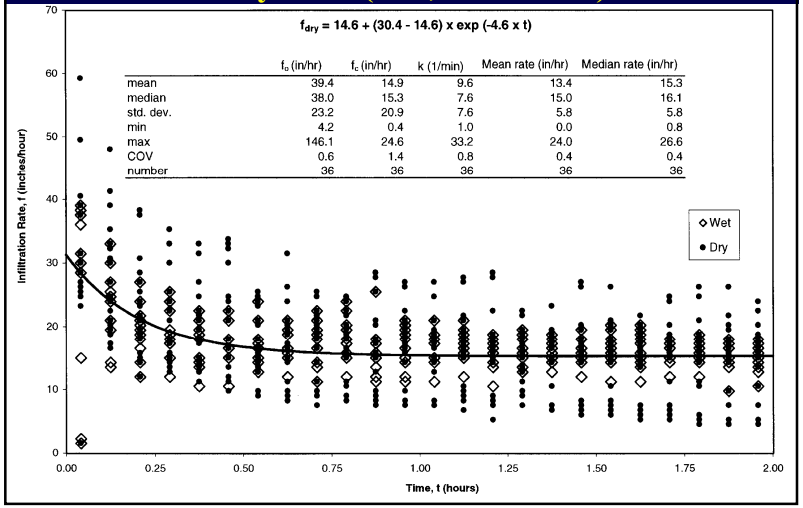
Infiltration Rates in Disturbed Urban Soils (AL tests)



Sandy Soils **Clayey Soils**

Recent research has shown that the infiltration rates of urban soils are strongly influenced by compaction, probably more than by moisture saturation.

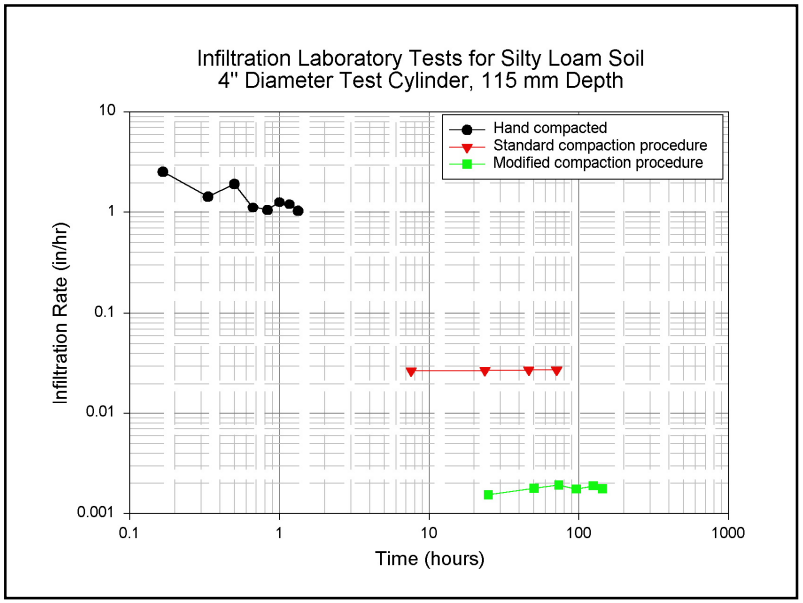
Infiltration Measurements for Noncompacted, Sandy Soils (Pitt, *et al.* 1999)



	f_o (in/hr)	f_c (in/hr)	k (1/min)	Mean rate (in/hr)	Median rate (in/hr)
mean	39.4	14.9	9.6	13.4	15.3
median	38.0	15.3	7.6	15.0	16.1
std. dev.	23.2	20.9	7.6	5.8	5.8
min	4.2	0.4	1.0	0.0	0.8
max	146.1	24.6	33.2	24.0	26.6
COV	0.6	1.4	0.8	0.4	0.4
number	36	36	36	36	36

Infiltration Rates during Tests of Disturbed Urban Soils

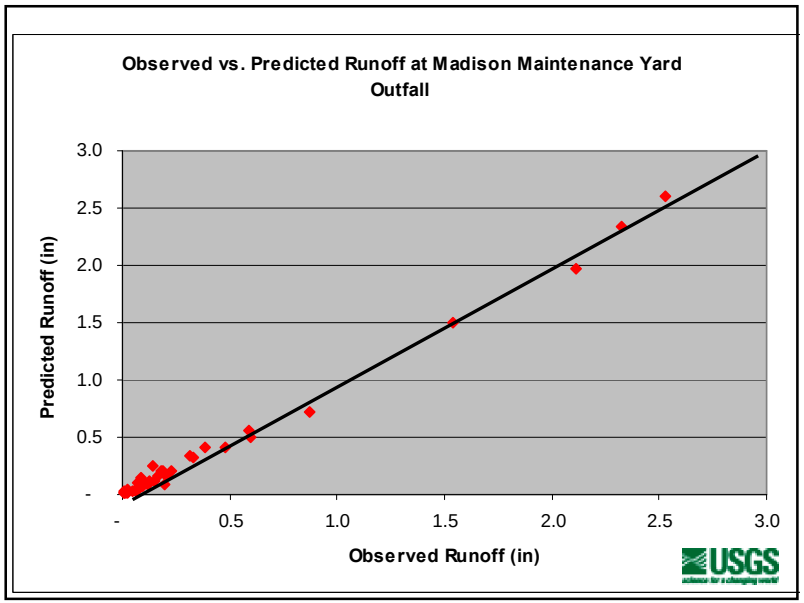
	Number of tests	Average infiltration rate (in/hr)	COV
Noncompacted sandy soils	36	13	0.4
Compacted sandy soils	39	1.4	1.3
Noncompacted and dry clayey soils	18	9.8	1.5
All other clayey soils (compacted and dry, plus all wetter conditions)	60	0.2	2.4



Long-Term Sustainable Average Infiltration Rates (3 of 15 textures tested)

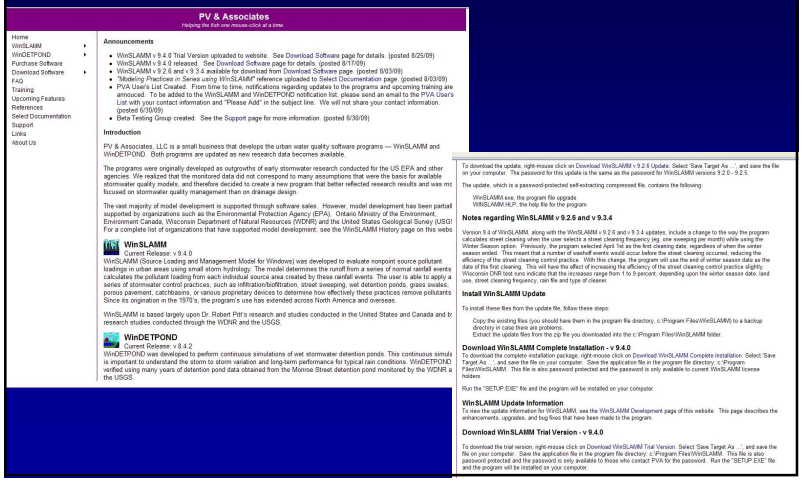
Soil Texture	Compaction Method	Dry Bulk Density (g/cc)	Effects on Root Growth (per NRCS)	Long-term Average Infilt. Rate (in/hr)
Sand	Hand Standard Modified	1.451 1.494 1.620	Ideal Ideal May affect -	Very high Very high 80
Silt	Hand Standard Modified	1.508 1.680 1.740	May affect May affect + Restrict	18 0.9 0.08
Clay	Hand Standard Modified	1.241 n/a n/a	May affect n/a n/a	3.0 0 0

Natural forces and management attempts to increase infiltration in compacted soils. Nature much better at this than we are.

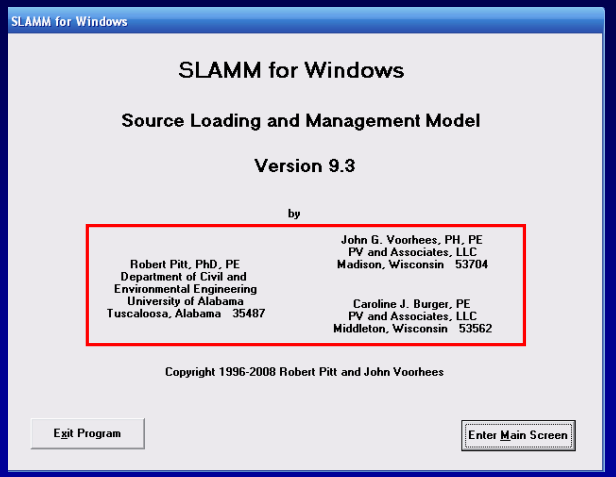


Download WinSLAMM version 9.4

http://www.winslamm.com/



PV & Associates LLC



Installing the program

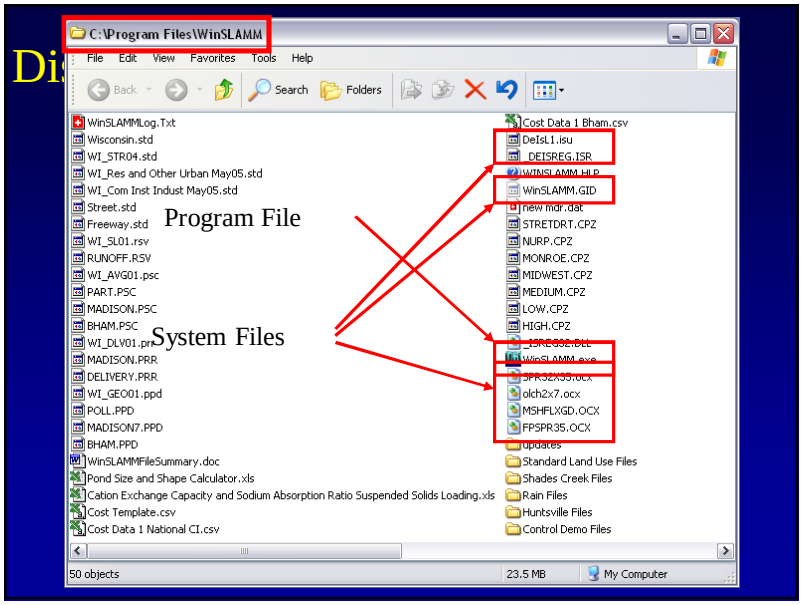
NEW INSTALL

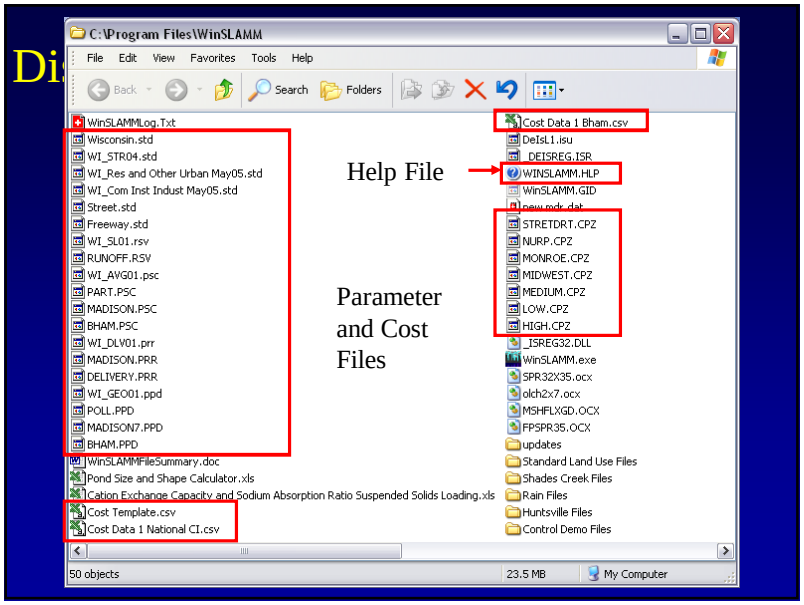
- Place the WinSLAMM CD in your CD Drive
- On your CD drive, go to the ówinSLAMMô Folder
- Double-click on the óSETUP.EXEô file
- The program will install just like any other Windows program
- We recommend that you use the default folder settings when you install the program

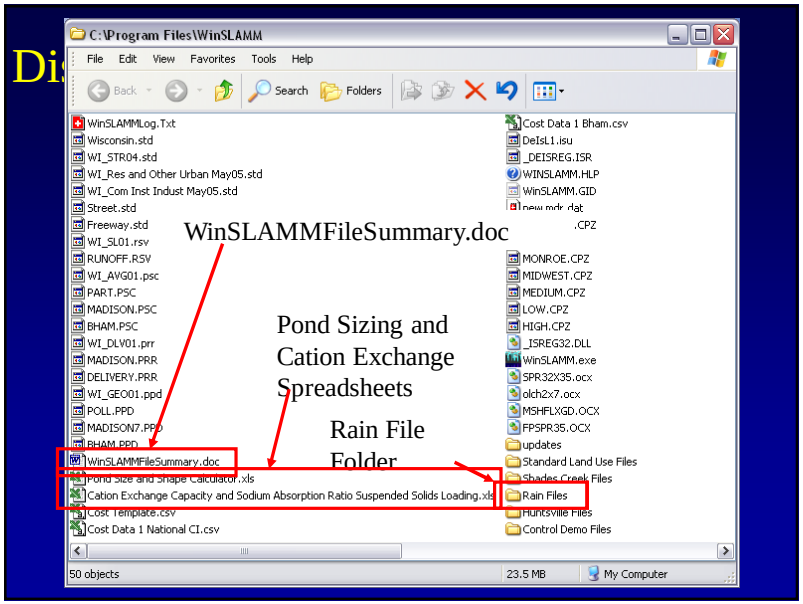
Disk contents and file structure

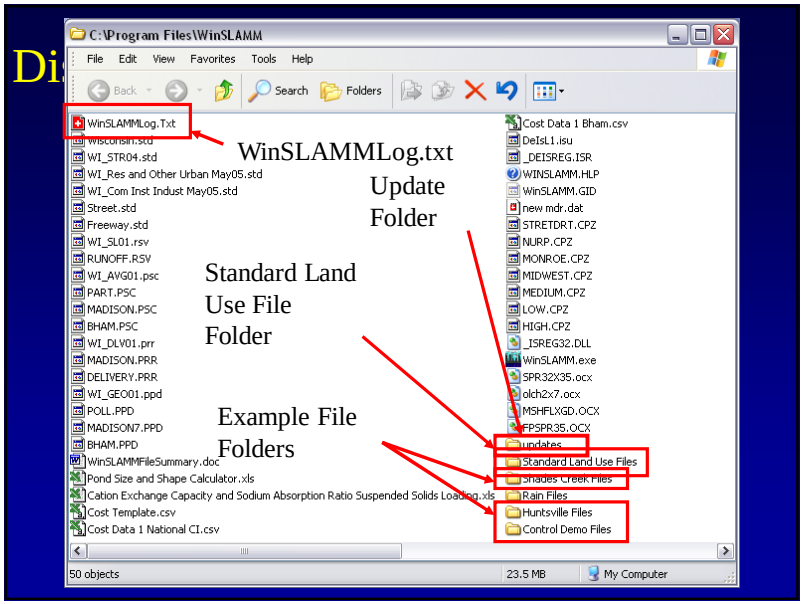
- Executable program (WinSLAMM.exe)
- Miscellaneous System Files
- Parameter and Cost Files
- Help File (WinSLAMM.HLP)
- Documentation
- WinSLAMMFile Summary.doc

- Pond Sizing and Cation Exchange Spreadsheets
- Rain Files
- Example File and Standard Land Use Folders
- Update Folder
- WinSLAMMLog.txt
- Users Guides

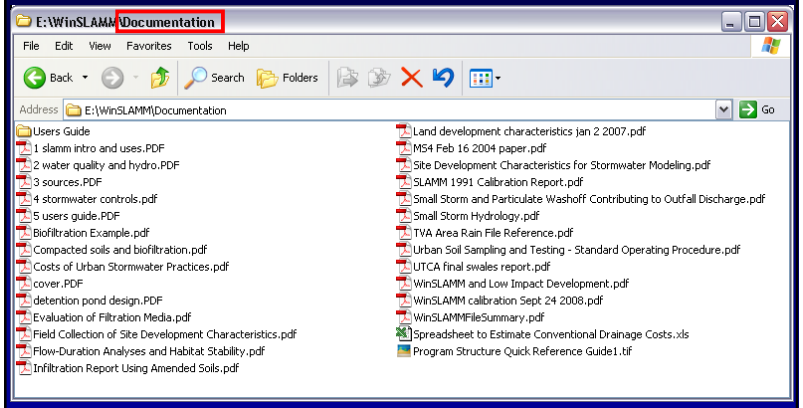

Program File
System Files


Help File
Parameter and Cost Files

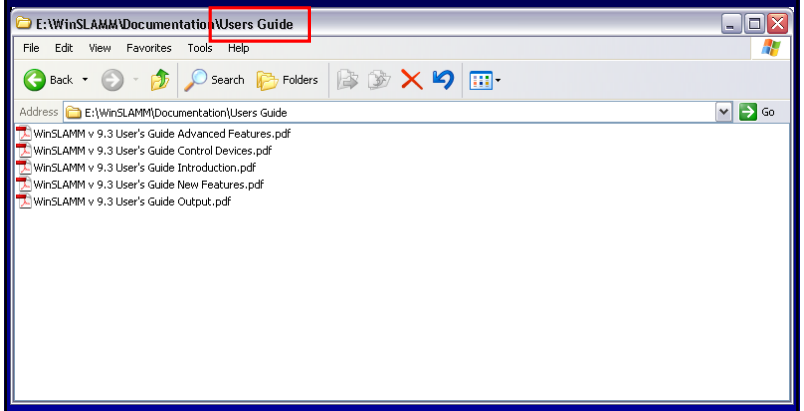

WinSLAMMFileSummary.doc
Pond Sizing and Cation Exchange Spreadsheets
Rain File Folder


WinSLAMMLog.txt Update Folder
Standard Land Use File Folder
Example File Folders

CD Contents - Documentation

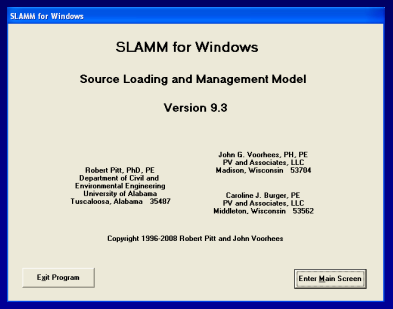


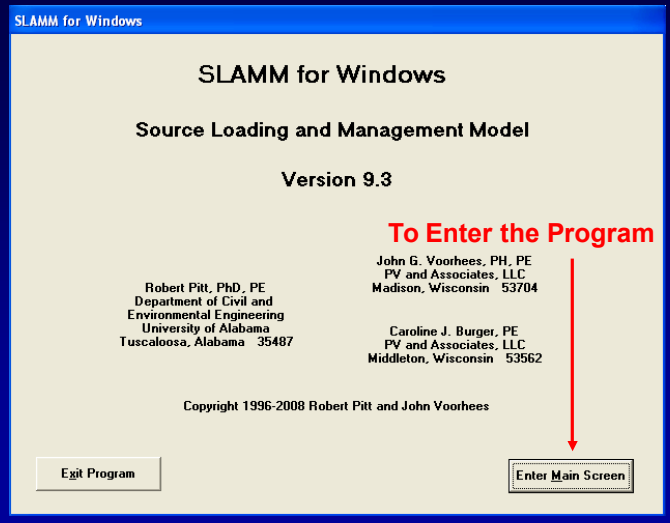
CD Contents ï Users Guides

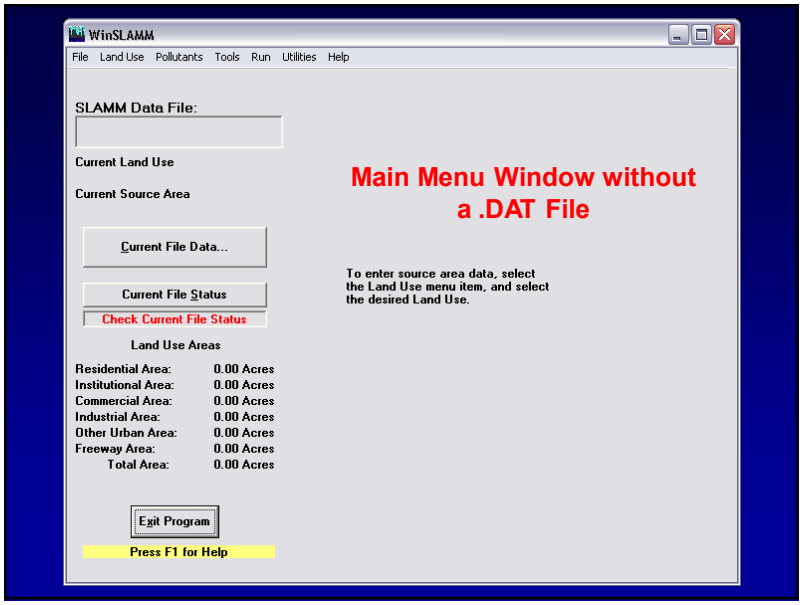


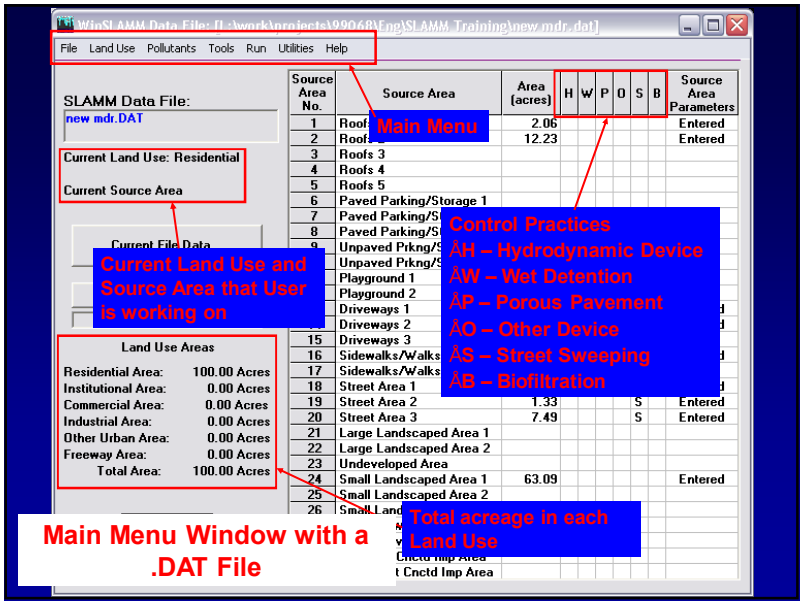
Outline

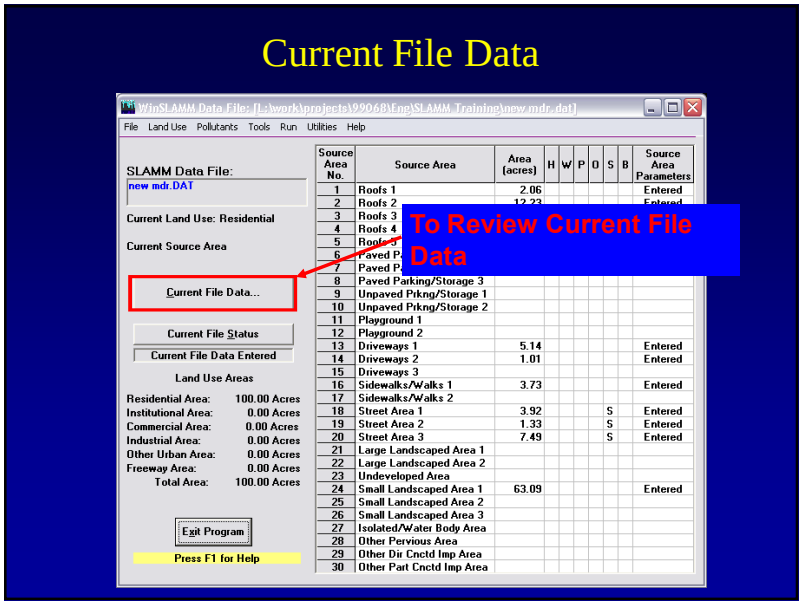
- Main Screen
- Current File Data
- Toolbar Selections
  - File
  - Pollutants
  - Tools
  - Utilities
  - Help
  - Land Use
  - Run
- Land Use
  - Land Uses
  - Control Practices
- Output

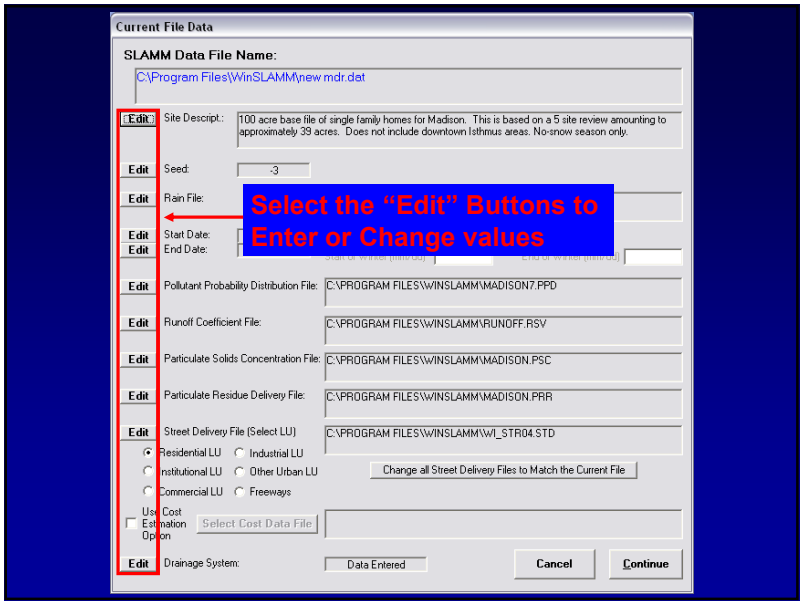


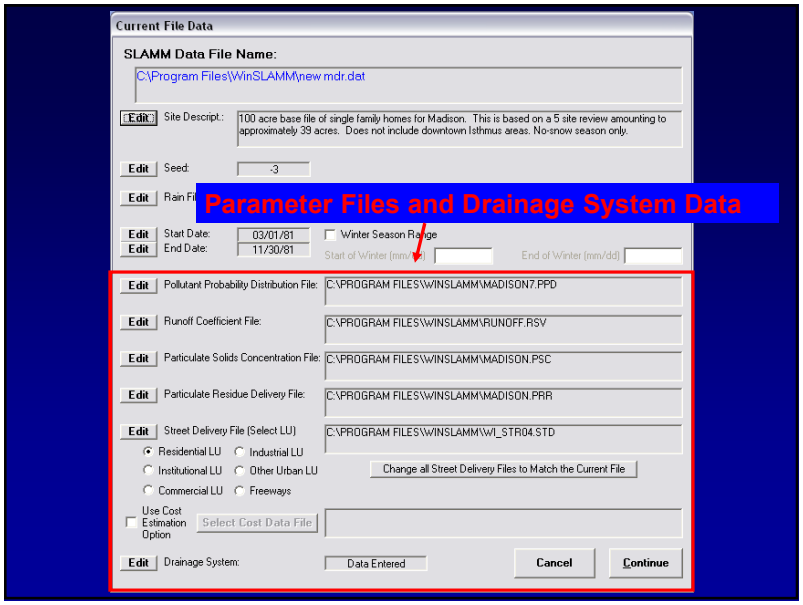



WinSLAMM
File Land Use Pollutants Tools Run Utilities Help
SLAMM Data File:
Current Land Use
Current Source Area
Current File Data...
Current File Status
Check Current File Status
Land Use Areas
Residential Area: 0.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 0.00 Acres
Exit Program
Press F1 for Help
Main Menu Window without a .DAT File
To enter source area data, select the Land Use menu item, and select the desired Land Use.


File Land Use Pollutants Tools Run Utilities Help
SLAMM Data File:
new mdr.DAT
Current Land Use: Residential
Current Source Area
Land Use Areas
Residential Area: 100.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 100.00 Acres
Main Menu
Current Land Use and Source Area that User is working on
Control Practices
AH – Hydrodynamic Device
AW – Wet Detention
AP – Porous Pavement
AO – Other Device
AS – Street Sweeping
AB – Biofiltration
Total acreage in each Land Use
Main Menu Window with a .DAT File


Current File Data
SLAMM Data File:
new mdr.DAT
Current Land Use: Residential
Current Source Area
Current File Data...
Current File Status
Current File Data Entered
Land Use Areas
Residential Area: 100.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 100.00 Acres
Exit Program
Press F1 for Help
To Review Current File Data


Current File Data
SLAMM Data File Name:
C:\Program Files\WinSLAMM\new mdr.dat
Site Descript.:
100 acre base file of single family homes for Madison. This is based on a 5 site review amounting to approximately 39 acres. Does not include downtown Isthmus areas. No-snow season only.
Seed:
Rain File:
Start Date:
End Date:
Pollutant Probability Distribution File:
C:\PROGRAM FILES\WINSLAMM\MADISON7.PPD
Runoff Coefficient File:
C:\PROGRAM FILES\WINSLAMM\RUNOFF.RSV
Particulate Solids Concentration File:
C:\PROGRAM FILES\WINSLAMM\MADISON.PSC
Particulate Residue Delivery File:
C:\PROGRAM FILES\WINSLAMM\MADISON.PRR
Street Delivery File (Select LU)
C:\PROGRAM FILES\WINSLAMM\WI_STR04.STD
Residential LU
Industrial LU
Institutional LU
Other Urban LU
Commercial LU
Freeways
Change all Street Delivery Files to Match the Current File
Use Cost Estimation Option
Select Cost Data File
Drainage System:
Data Entered
Cancel
Continue
Select the “Edit” Buttons to Enter or Change values


Current File Data
SLAMM Data File Name:
C:\Program Files\WinSLAMM\new mdr.dat
Edit
Site Descript.:
100 acre base file of single family homes for Madison. This is based on a 5 site review amounting to approximately 39 acres. Does not include downtown Isthmus areas. No-snow season only.
Seed:
Rain Fi
Parameter Files and Drainage System Data
Start Date:
03/01/81
End Date:
11/30/81
Winter Season Range
Pollutant Probability Distribution File:
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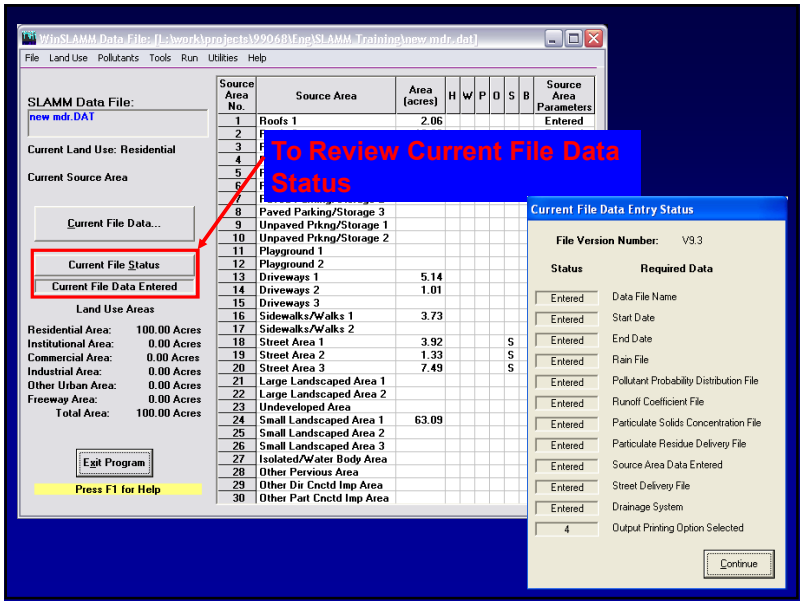
Runoff Coefficient File:
C:\PROGRAM FILES\WINSLAMM\RUNOFF.RSV
Particulate Solids Concentration File:
C:\PROGRAM FILES\WINSLAMM\MADISON.PSC
Particulate Residue Delivery File:
C:\PROGRAM FILES\WINSLAMM\MADISON.PRR
Street Delivery File (Select LU)
C:\PROGRAM FILES\WINSLAMM\WI_STR04.STD
Residential LU
Industrial LU
Institutional LU
Other Urban LU
Commercial LU
Freeways
Change all Street Delivery Files to Match the Current File
Use Cost Estimation Option
Select Cost Data File
Drainage System:
Data Entered
Cancel
Continue


File Land Use Pollutants Tools Run Utilities Help
SLAMM Data File:
new mdr.DAT
Current Land Use: Residential
Current Source Area
To Review Current File Data Status
Current File Data...
Current File Status
Current File Data Entered
Land Use Areas
Residential Area: 100.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 100.00 Acres
Exit Program
Press F1 for Help
Source Area No.
Source Area
Area (acres)
H W P D S B
Source Area Parameters
1 Roofs 1 2.06 Entered
8 Paved Parking/Storage 3
9 Unpaved Prkng/Storage 1
10 Unpaved Prkng/Storage 2
11 Playground 1
12 Playground 2
13 Driveways 1 5.14
14 Driveways 2 1.01
15 Driveways 3
16 Sidewalks/Walks 1 3.73
17 Sidewalks/Walks 2
18 Street Area 1 3.92 S
19 Street Area 2 1.33 S
20 Street Area 3 7.49 S
21 Large Landscaped Area 1
22 Large Landscaped Area 2
23 Undeveloped Area
24 Small Landscaped Area 1 63.09
25 Small Landscaped Area 2
26 Small Landscaped Area 3
27 Isolated/Water Body Area
28 Other Pervious Area
29 Other Dir Cnctd Imp Area
30 Other Part Cnctd Imp Area
Current File Data Entry Status
File Version Number: V9.3
Status
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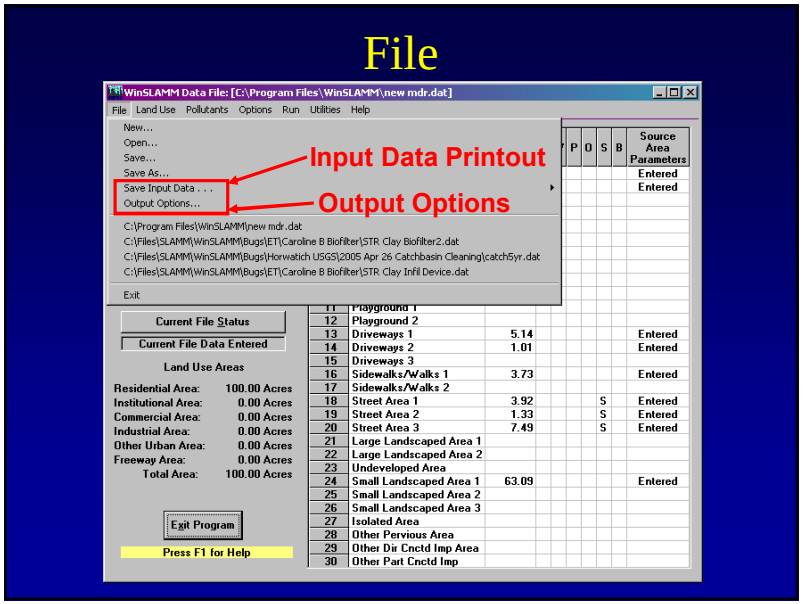
Entered Data File Name
Entered Start Date
Entered End Date
Entered Rain File
Entered Pollutant Probability Distribution File
Entered Runoff Coefficient File
Entered Particulate Solids Concentration File
Entered Particulate Residue Delivery File
Entered Source Area Data Entered
Entered Street Delivery File
Entered Drainage System
4 Output Printing Option Selected
Continue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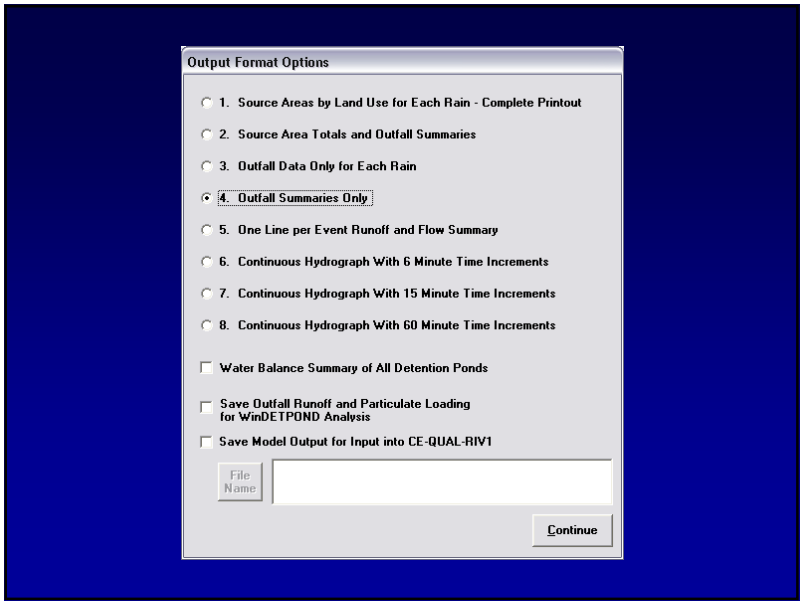
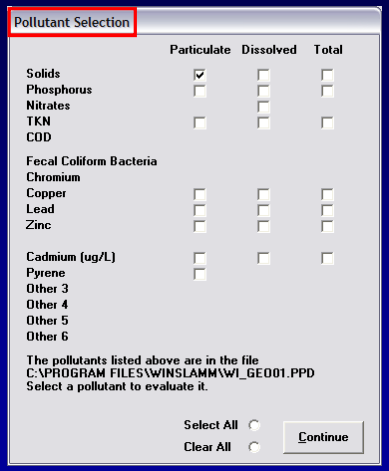
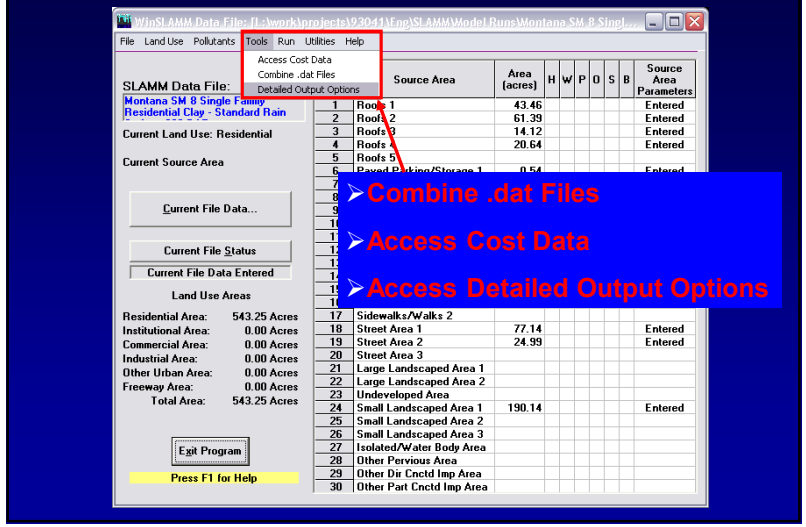
WinSLAMM Data File: [C:\Program Files\WinSLAMM\new mdr.dat]
File Land Use Pollutants Options Run Utilities Help
New...
Open...
Save...
Save As...
Save Input Data . . .
Output Options...
Input Data Printout
Output Options
C:\Program Files\WinSLAMM\new mdr.dat
C:\Files\SLAMM\WinSLAMM\Bugs\ET\Caroline B Biofilter\STR Clay Biofilter2.dat
C:\Files\SLAMM\WinSLAMM\Bugs\Horwatich USGS\2005 Apr 26 Catchbasin Cleaning\catch5yr.dat
C:\Files\SLAMM\WinSLAMM\Bugs\ET\Caroline B Biofilter\STR Clay Infil Device.dat
Exit
Current File Status
Current File Data Entered
Land Use Areas
Residential Area: 100.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 100.00 Acres
Exit Program
Press F1 for Help
Source Area Parameters
11 Playground 1
12 Playground 2
13 Driveways 1 5.14 Entered
14 Driveways 2 1.01 Entered
15 Driveways 3
16 Sidewalks/Walks 1 3.73 Entered
17 Sidewalks/Walks 2
18 Street Area 1 3.92 S Entered
19 Street Area 2 1.33 S Entered
20 Street Area 3 7.49 S Entered
21 Large Landscaped Area 1
22 Large Landscaped Area 2
23 Undeveloped Area
24 Small Landscaped Area 1 63.09 Entered
25 Small Landscaped Area 2
26 Small Landscaped Area 3
27 Isolated Area
28 Other Pervious Area
29 Other Dir Cnctd Imp Area
30 Other Part Cnctd Imp

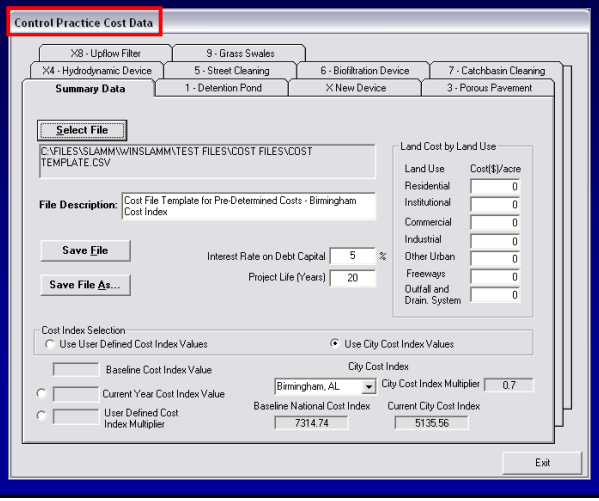

Output Format Options
1. Source Areas by Land Use for Each Rain - Complete Printout
2. Source Area Totals and Outfall Summaries
3. Outfall Data Only for Each Rain
4. Outfall Summaries Only
5. One Line per Event Runoff and Flow Summary
6. Continuous Hydrograph With 6 Minute Time Increments
7. Continuous Hydrograph With 15 Minute Time Increments
8. Continuous Hydrograph With 60 Minute Time Increments
Water Balance Summary of All Detention Ponds
Save Outfall Runoff and Particulate Loading for WinDETPOND Analysis
Save Model Output for Input into CE-QUAL-RIV1
File Name
Continue

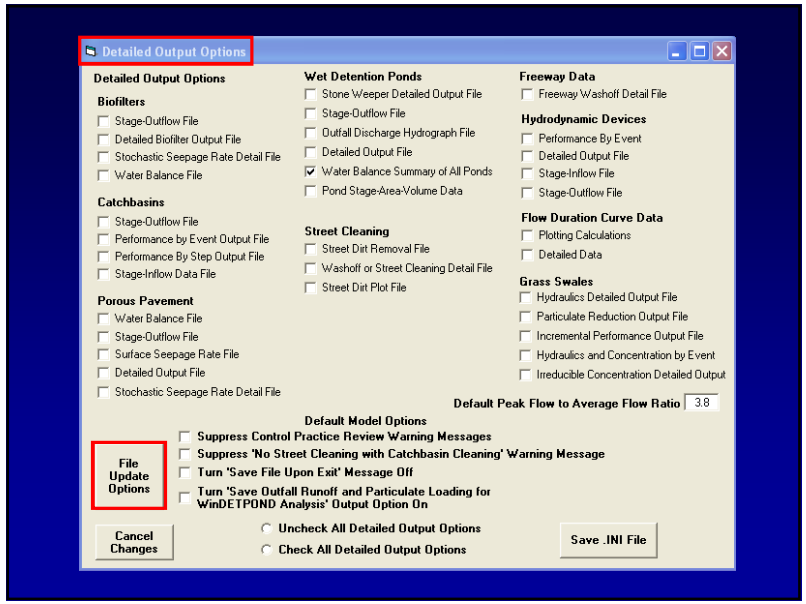
Pollutants



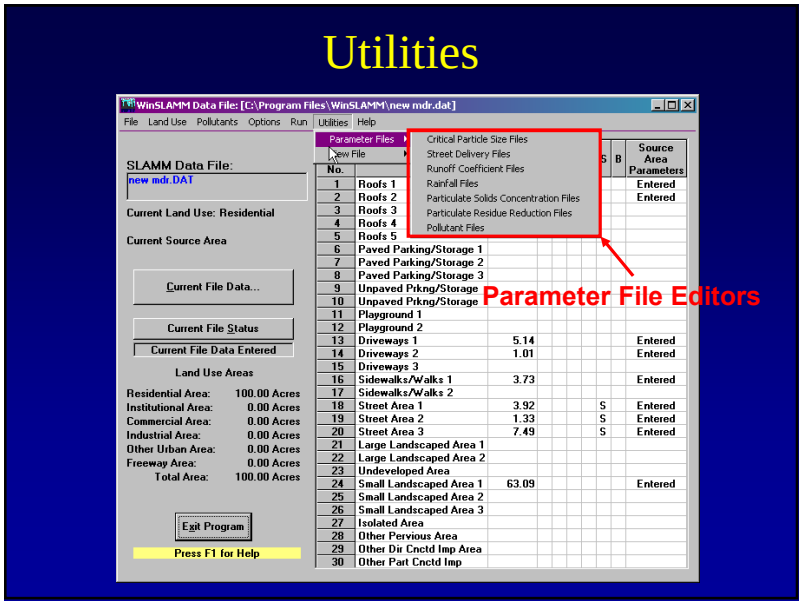
Tools

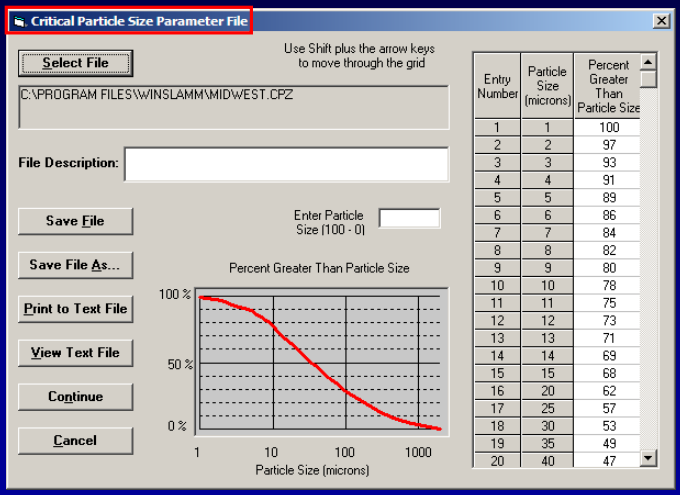


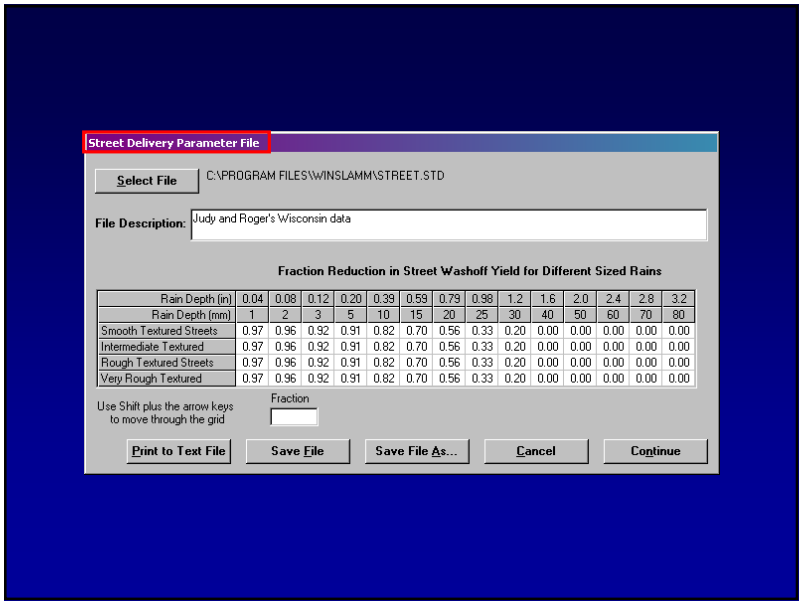


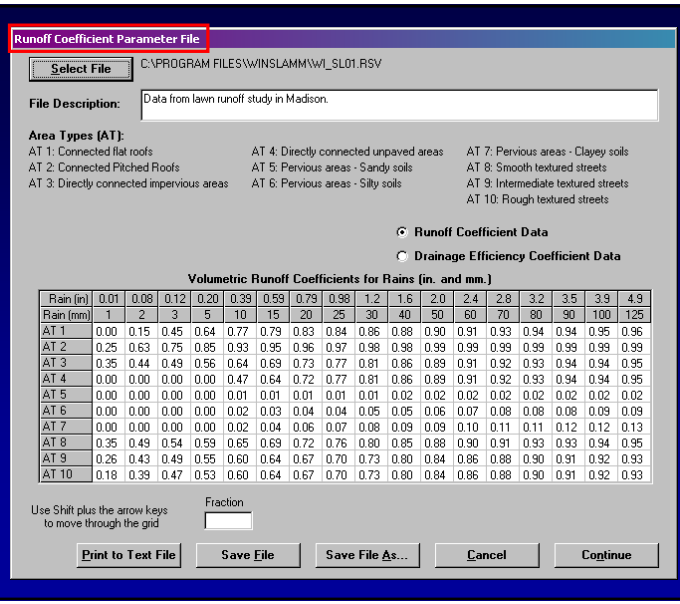


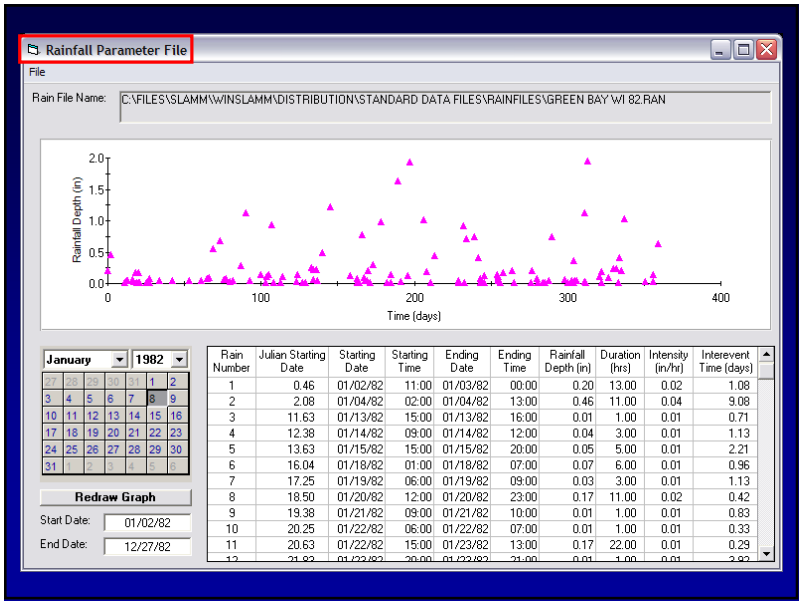
Utilities

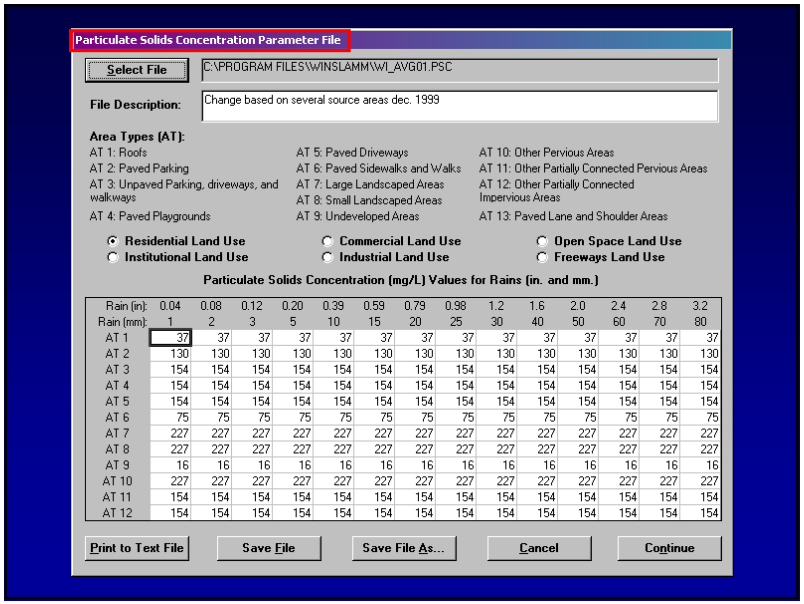

WinSLAMM Data File: [C:\Program Files\WinSLAMM\new mdr.dat]
File Land Use Pollutants Options Run Utilities Help
Parameter Files
New File
Critical Particle Size Files
Street Delivery Files
Runoff Coefficient Files
Rainfall Files
Particulate Solids Concentration Files
Particulate Residue Reduction Files
Pollutant Files
SLAMM Data File:
new mdr.DAT
Current Land Use: Residential
Current Source Area
Current File Data...
Current File Status
Current File Data Entered
Land Use Areas
Residential Area: 100.00 Acres
Institutional Area: 0.00 Acres
Commercial Area: 0.00 Acres
Industrial Area: 0.00 Acres
Other Urban Area: 0.00 Acres
Freeway Area: 0.00 Acres
Total Area: 100.00 Acres
Exit Program
Press F1 for Help
No.
Source Area Parameters
Parameter File Editors

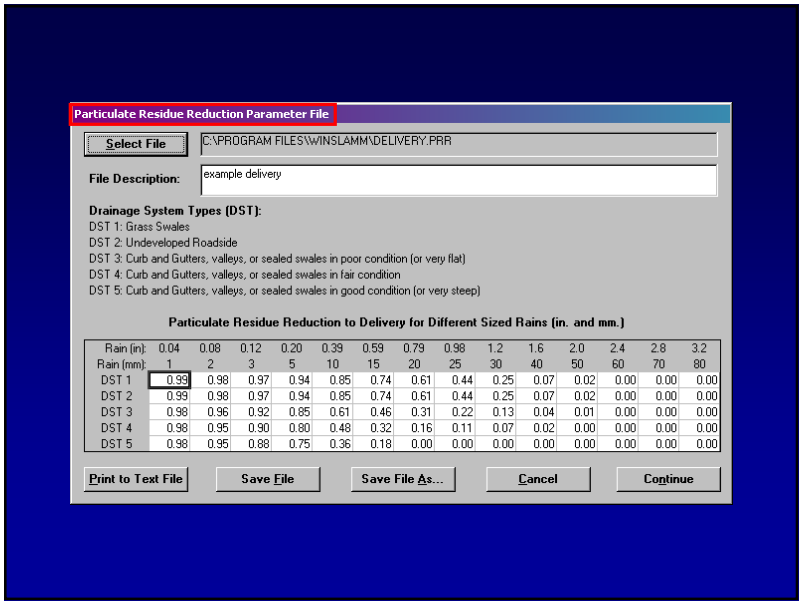

Critical Particle Size Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\MIDWEST.CPZ
Use Shift plus the arrow keys to move through the grid
File Description:
Save File
Save File As...
Print to Text File
View Text File
Continue
Cancel
Enter Particle Size (100 - 0)
Percent Greater Than Particle Size
100 %
50 %
0 %
1
10
100
1000
Particle Size (microns)
Entry Number
Particle Size (microns)
Percent Greater Than Particle Size

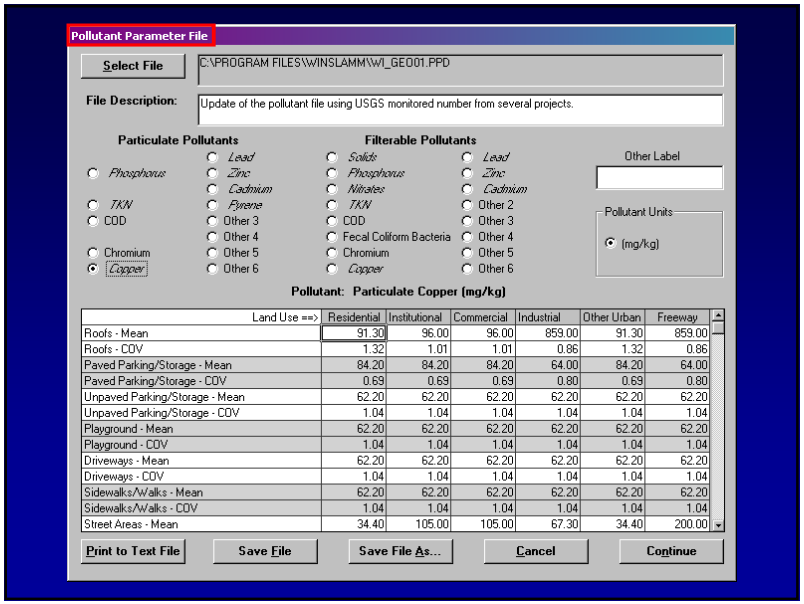

Street Delivery Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\STREET.STD
File Description:
Judy and Roger's Wisconsin data
Fraction Reduction in Street Washoff Yield for Different Sized Rains
Rain Depth (in)
Rain Depth (mm)
Smooth Textured Streets
Intermediate Textured
Rough Textured Streets
Very Rough Textured
Use Shift plus the arrow keys to move through the grid
Fraction
Print to Text File
Save File
Save File As...
Cancel
Continue


Runoff Coefficient Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\WI_SL01.RSV
File Description:
Data from lawn runoff study in Madison.
Area Types (AT):
AT 1: Connected flat roofs
AT 2: Connected Pitched Roofs
AT 3: Directly connected impervious areas
AT 4: Directly connected unpaved areas
AT 5: Pervious areas - Sandy soils
AT 6: Pervious areas - Silty soils
AT 7: Pervious areas - Clayey soils
AT 8: Smooth textured streets
AT 9: Intermediate textured streets
AT 10: Rough textured streets
Runoff Coefficient Data
Drainage Efficiency Coefficient Data
Volumetric Runoff Coefficients for Rains (in. and mm.)
Rain (in)
Rain (mm)
AT 1
AT 2
AT 3
AT 4
AT 5
AT 6
AT 7
AT 8
AT 9
AT 10
Use Shift plus the arrow keys to move through the grid
Fraction
Print to Text File
Save File
Save File As...
Cancel
Continue

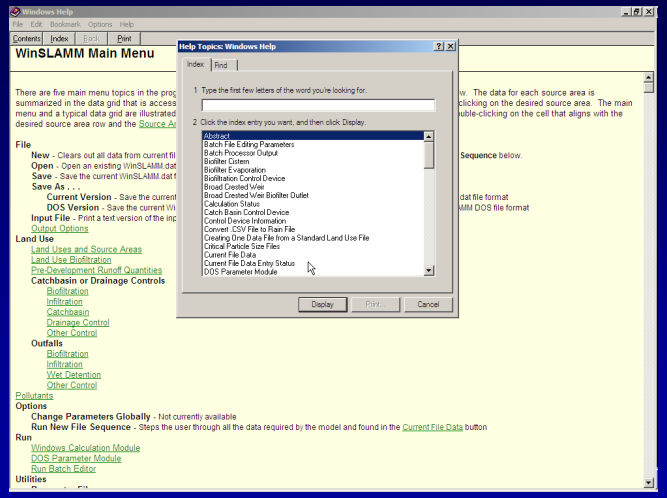

Rainfall Parameter File
File
Rain File Name: C:\FILES\SLAMM\WINSLAMM\DISTRIBUTION\STANDARD DATA FILES\RAINFILES\GREEN BAY WI 82.RAN
Rainfall Depth (in)
Time (days)
January
1982
Redraw Graph
Start Date: 01/02/82
End Date: 12/27/82
Rain Number | Julian Starting Date | Starting Date | Starting Time | Ending Date | Ending Time | Rainfall Depth (in) | Duration (hrs) | Intensity (in/hr) | Interevent Time (days)
1 | 0.46 | 01/02/82 | 11:00 | 01/03/82 | 00:00 | 0.20 | 13.00 | 0.02 | 1.08
2 | 2.08 | 01/04/82 | 02:00 | 01/04/82 | 13:00 | 0.46 | 11.00 | 0.04 | 9.08
3 | 11.63 | 01/13/82 | 15:00 | 01/13/82 | 16:00 | 0.01 | 1.00 | 0.01 | 0.71
4 | 12.38 | 01/14/82 | 09:00 | 01/14/82 | 12:00 | 0.04 | 3.00 | 0.01 | 1.13
5 | 13.63 | 01/15/82 | 15:00 | 01/15/82 | 20:00 | 0.05 | 5.00 | 0.01 | 2.21
6 | 16.04 | 01/18/82 | 01:00 | 01/18/82 | 07:00 | 0.07 | 6.00 | 0.01 | 0.96
7 | 17.25 | 01/19/82 | 06:00 | 01/19/82 | 09:00 | 0.03 | 3.00 | 0.01 | 1.13
8 | 18.50 | 01/20/82 | 12:00 | 01/20/82 | 23:00 | 0.17 | 11.00 | 0.02 | 0.42
9 | 19.38 | 01/21/82 | 09:00 | 01/21/82 | 10:00 | 0.01 | 1.00 | 0.01 | 0.83
10 | 20.25 | 01/22/82 | 06:00 | 01/22/82 | 07:00 | 0.01 | 1.00 | 0.01 | 0.33
11 | 20.63 | 01/22/82 | 15:00 | 01/23/82 | 13:00 | 0.17 | 22.00 | 0.01 | 0.29


Particulate Solids Concentration Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\WI_AVG01.PSC
File Description: Change based on several source areas dec. 1999
Area Types (AT):
AT 1: Roofs
AT 2: Paved Parking
AT 3: Unpaved Parking, driveways, and walkways
AT 4: Paved Playgrounds
AT 5: Paved Driveways
AT 6: Paved Sidewalks and Walks
AT 7: Large Landscaped Areas
AT 8: Small Landscaped Areas
AT 9: Undeveloped Areas
AT 10: Other Pervious Areas
AT 11: Other Partially Connected Pervious Areas
AT 12: Other Partially Connected Impervious Areas
AT 13: Paved Lane and Shoulder Areas
Residential Land Use
Institutional Land Use
Commercial Land Use
Industrial Land Use
Open Space Land Use
Freeways Land Use
Particulate Solids Concentration (mg/L) Values for Rains (in. and mm.)
Rain (in): 0.04 0.08 0.12 0.20 0.39 0.59 0.79 0.98 1.2 1.6 2.0 2.4 2.8 3.2
Rain (mm): 1 2 3 5 10 15 20 25 30 40 50 60 70 80
AT 1 37 37 37 37 37 37 37 37 37 37 37 37 37 37
AT 2 130 130 130 130 130 130 130 130 130 130 130 130 130 130
AT 3 154 154 154 154 154 154 154 154 154 154 154 154 154 154
AT 4 154 154 154 154 154 154 154 154 154 154 154 154 154 154
AT 5 154 154 154 154 154 154 154 154 154 154 154 154 154 154
AT 6 75 75 75 75 75 75 75 75 75 75 75 75 75 75
AT 7 227 227 227 227 227 227 227 227 227 227 227 227 227 227
AT 8 227 227 227 227 227 227 227 227 227 227 227 227 227 227
AT 9 16 16 16 16 16 16 16 16 16 16 16 16 16 16
AT 10 227 227 227 227 227 227 227 227 227 227 227 227 227 227
AT 11 154 154 154 154 154 154 154 154 154 154 154 154 154 154
AT 12 154 154 154 154 154 154 154 154 154 154 154 154 154 154
Print to Text File
Save File
Save File As...
Cancel
Continue

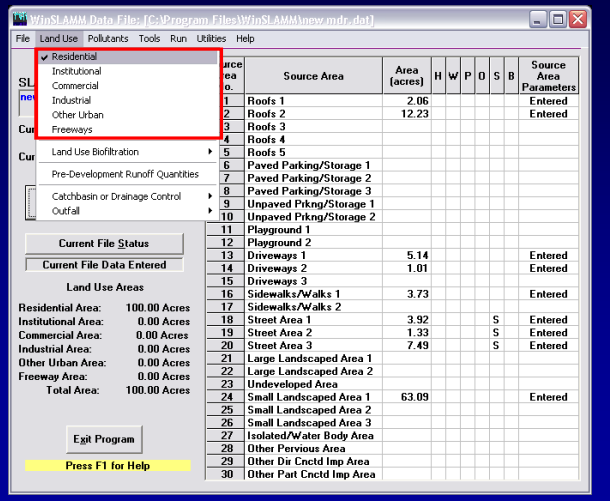

Particulate Residue Reduction Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\DELIVERY.PRR
File Description: example delivery
Drainage System Types (DST):
DST 1: Grass Swales
DST 2: Undeveloped Roadside
DST 3: Curb and Gutters, valleys, or sealed swales in poor condition (or very flat)
DST 4: Curb and Gutters, valleys, or sealed swales in fair condition
DST 5: Curb and Gutters, valleys, or sealed swales in good condition (or very steep)
Particulate Residue Reduction to Delivery for Different Sized Rains (in. and mm.)
Rain (in): 0.04 0.08 0.12 0.20 0.39 0.59 0.79 0.98 1.2 1.6 2.0 2.4 2.8 3.2
Rain (mm): 1 2 3 5 10 15 20 25 30 40 50 60 70 80
DST 1 0.99 0.98 0.97 0.94 0.85 0.74 0.61 0.44 0.25 0.07 0.02 0.00 0.00 0.00
DST 2 0.99 0.98 0.97 0.94 0.85 0.74 0.61 0.44 0.25 0.07 0.02 0.00 0.00 0.00
DST 3 0.98 0.96 0.92 0.85 0.61 0.46 0.31 0.22 0.13 0.04 0.01 0.00 0.00 0.00
DST 4 0.98 0.95 0.90 0.80 0.48 0.32 0.16 0.11 0.07 0.02 0.00 0.00 0.00 0.00
DST 5 0.98 0.95 0.88 0.75 0.36 0.18 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
Print to Text File
Save File
Save File As...
Cancel
Continue

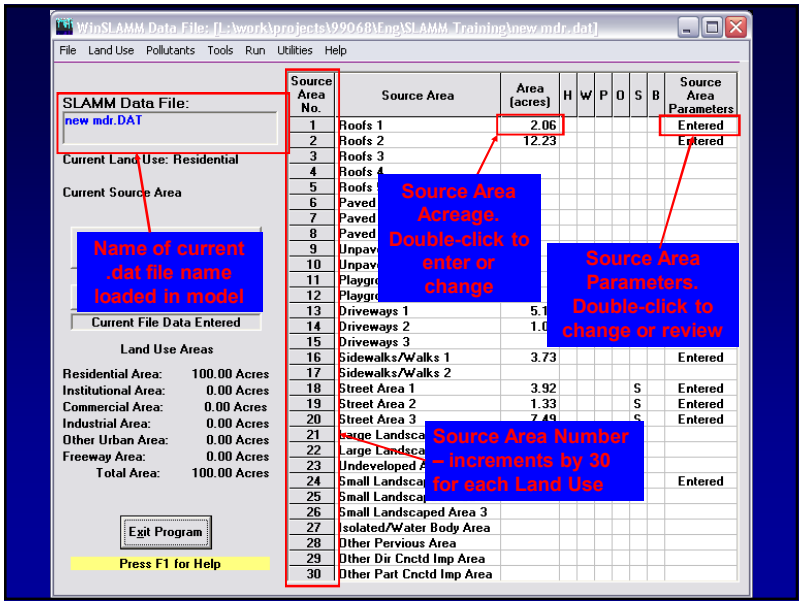

Pollutant Parameter File
Select File
C:\PROGRAM FILES\WINSLAMM\WI_GEO01.PPD
File Description: Update of the pollutant file using USGS monitored number from several projects.
Particulate Pollutants
Phosphorus
TKN
COD
Chromium
Copper
Filterable Pollutants
Solids
Phosphorus
Nitrates
TKN
COD
Fecal Coliform Bacteria
Chromium
Copper
Lead
Zinc
Cadmium
Pyrene
Other 2
Other 3
Other 4
Other 5
Other 6
Other Label
Pollutant Units
(mg/kg)
Pollutant: Particulate Copper (mg/kg)
Land Use ==> | Residential | Institutional | Commercial | Industrial | Other Urban | Freeway
Roofs - Mean 91.30 96.00 96.00 859.00 91.30 859.00
Roofs - COV 1.32 1.01 1.01 0.86 1.32 0.86
Paved Parking/Storage - Mean 84.20 84.20 84.20 64.00 84.20 64.00
Paved Parking/Storage - COV 0.69 0.69 0.69 0.80 0.69 0.80
Unpaved Parking/Storage - Mean 62.20 62.20 62.20 62.20 62.20 62.20
Unpaved Parking/Storage - COV 1.04 1.04 1.04 1.04 1.04 1.04
Playground - Mean 62.20 62.20 62.20 62.20 62.20 62.20
Playground - COV 1.04 1.04 1.04 1.04 1.04 1.04
Driveways - Mean 62.20 62.20 62.20 62.20 62.20 62.20
Driveways - COV 1.04 1.04 1.04 1.04 1.04 1.04
Sidewalks/Walks - Mean 62.20 62.20 62.20 62.20 62.20 62.20
Sidewalks/Walks - COV 1.04 1.04 1.04 1.04 1.04 1.04
Street Areas - Mean 34.40 105.00 105.00 67.30 34.40 200.00
Print to Text File
Save File
Save File As...
Cancel
Continue

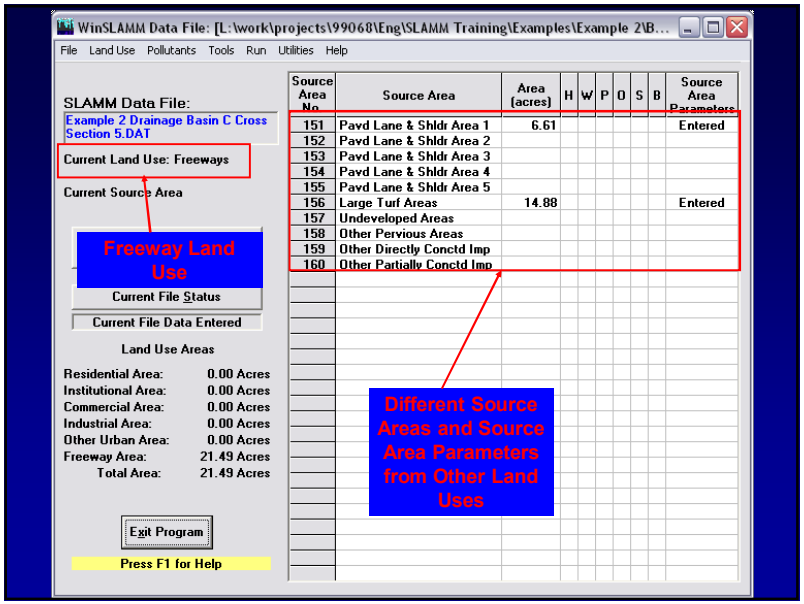
Help



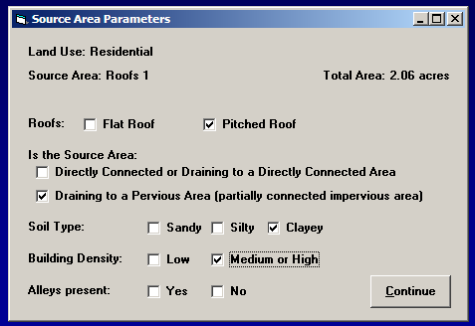
Land Use

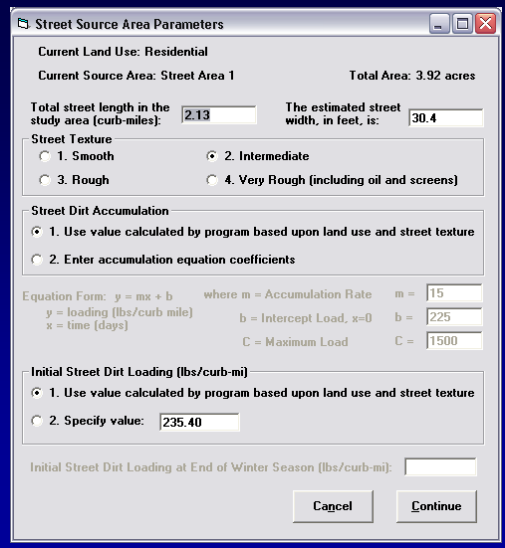


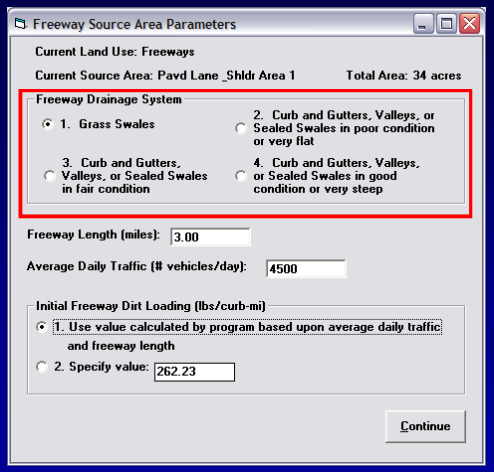




Source Area Parameters

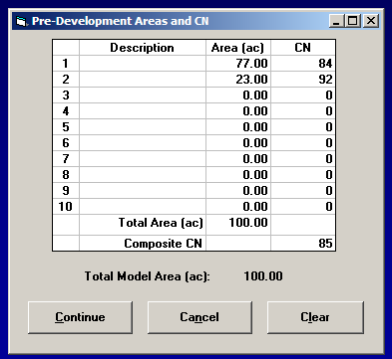


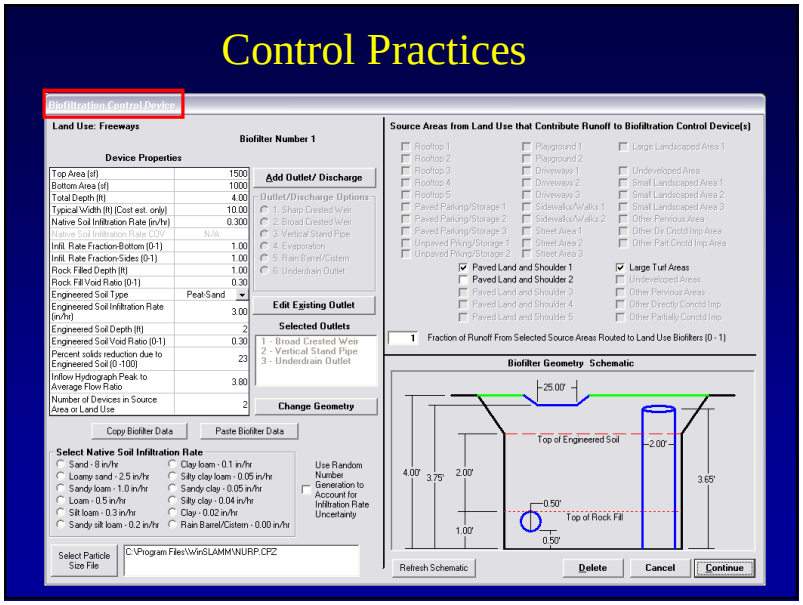


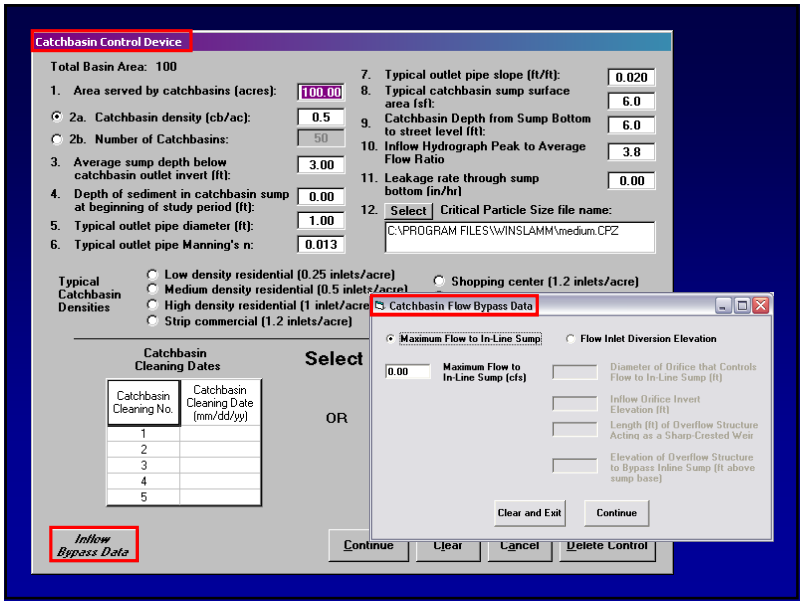


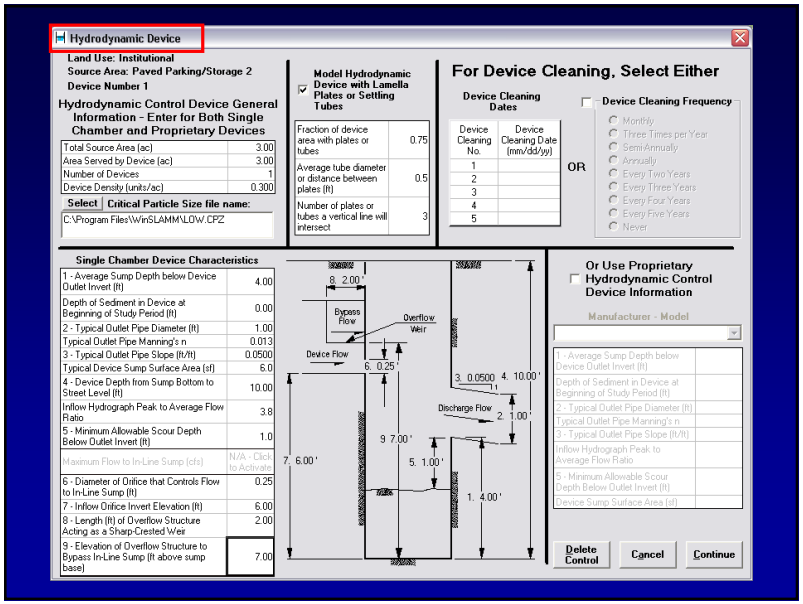
Used to Apply Freeway Delivery File Values

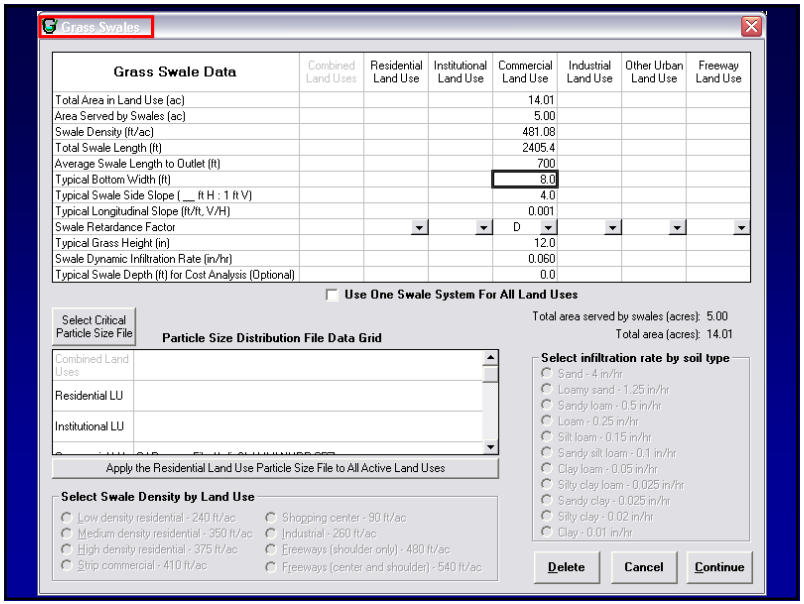
Pre-Development Areas and Curve Numbers (CN)



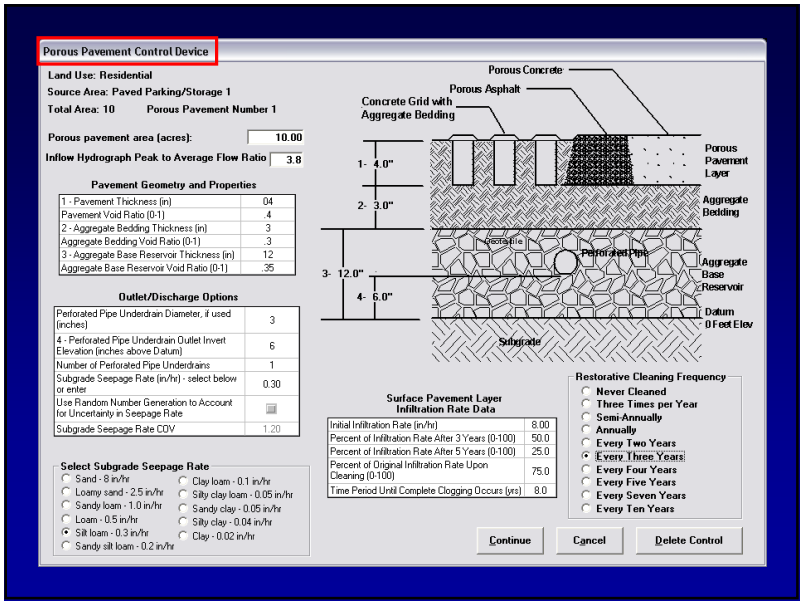

Control Practices
Biofiltration Control Device
Land Use: Freeways
Biofilter Number 1
Device Properties
Add Outlet/ Discharge
Edit Existing Outlet
Change Geometry
Copy Biofilter Data
Paste Biofilter Data
Select Native Soil Infiltration Rate
Source Areas from Land Use that Contribute Runoff to Biofiltration Control Device(s)
Biofilter Geometry Schematic
Select Particle Size File
C:\Program Files\WinSLAMM\NURP.CPZ
Refresh Schematic
Delete
Cancel
Continue

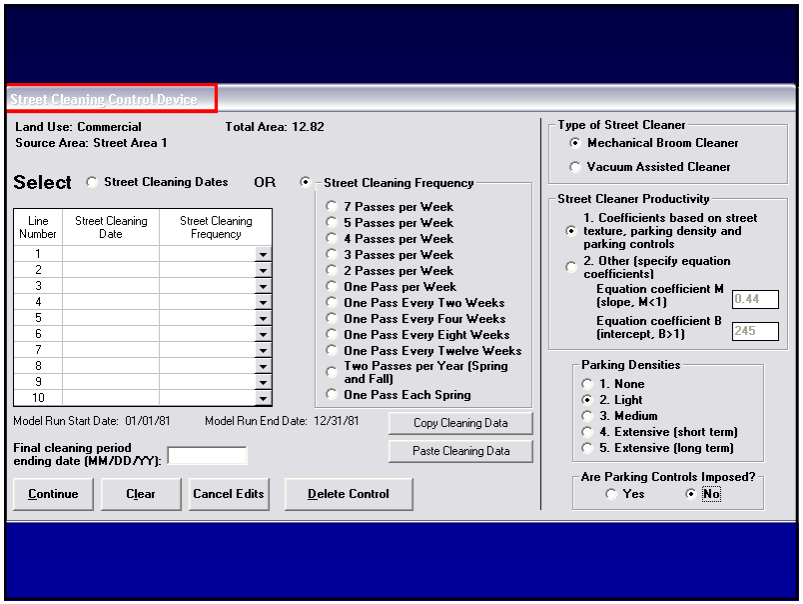

Catchbasin Control Device
Total Basin Area: 100
1. Area served by catchbasins (acres): 100.00
2a. Catchbasin density (cb/ac): 0.5
2b. Number of Catchbasins: 50
3. Average sump depth below catchbasin outlet invert (ft): 3.00
4. Depth of sediment in catchbasin sump at beginning of study period (ft): 0.00
5. Typical outlet pipe diameter (ft): 1.00
6. Typical outlet pipe Manning's n: 0.013
7. Typical outlet pipe slope (ft/ft): 0.020
8. Typical catchbasin sump surface area (sf): 6.0
9. Catchbasin Depth from Sump Bottom to street level (ft): 6.0
10. Inflow Hydrograph Peak to Average Flow Ratio 3.8
11. Leakage rate through sump bottom (in/hr) 0.00
12. Select Critical Particle Size file name:
C:\PROGRAM FILES\WINSLAMM\medium.CPZ
Typical Catchbasin Densities
Low density residential (0.25 inlets/acre)
Medium density residential (0.5 inlets/acre)
High density residential (1 inlet/acre)
Strip commercial (1.2 inlets/acre)
Shopping center (1.2 inlets/acre)
Catchbasin Cleaning Dates
Select
OR
Catchbasin Flow Bypass Data
Maximum Flow to In-Line Sump
Flow Inlet Diversion Elevation
Maximum Flow to In-Line Sump (cfs)
Clear and Exit
Continue
Inflow Bypass Data
Continue
Clear
Cancel
Delete Control

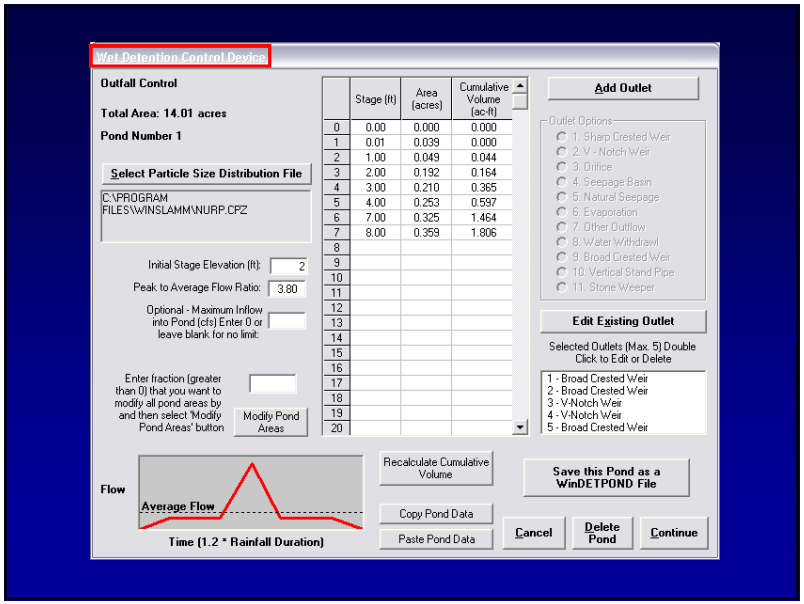

Hydrodynamic Device
Land Use: Institutional
Source Area: Paved Parking/Storage 2
Device Number 1
Hydrodynamic Control Device General Information - Enter for Both Single Chamber and Proprietary Devices
Model Hydrodynamic Device with Lamella Plates or Settling Tubes
For Device Cleaning, Select Either
Device Cleaning Dates
OR
Device Cleaning Frequency
Select Critical Particle Size file name:
C:\Program Files\WinSLAMM\LOW.CPZ
Single Chamber Device Characteristics
Or Use Proprietary Hydrodynamic Control Device Information
Manufacturer - Model
Delete Control
Cancel
Continue


Grass Swales
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)
Area Served by Swales (ac)
Swale Density (ft/ac)
Total Swale Length (ft)
Average Swale Length to Outlet (ft)
Typical Bottom Width (ft)
Typical Swale Side Slope (__ ft H : 1 ft V)
Typical Longitudinal Slope (ft/ft, V/H)
Swale Retardance Factor
Typical Grass Height (in)
Swale Dynamic Infiltration Rate (in/hr)
Typical Swale Depth (ft) for Cost Analysis (Optional)
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): 5.00
Total area (acres): 14.01
Select infiltration rate by soil type
Apply the Residential Land Use Particle Size File to All Active Land Uses
Select Swale Density by Land Use
Delete
Cancel
Continue

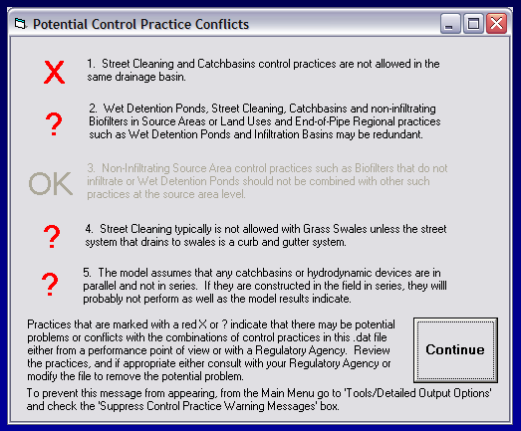

Drainage System
Drainage System
Enter the fraction of each type of drainage system serving the study area:
1. Grass Swales
0.000
Enter swale data immediately
Note: The grass swale drainage system fraction is calculated from the areas of the drainage system that are served by swales. These areas are entered in the Grass Swale control practice
2. Undeveloped Roadside:
0.000
3. Curb and Gutters, Valleys, or Sealed Swales in poor condition or very flat
0.000
4. Curb and Gutters, Valleys, or Sealed Swales in fair condition
0.000
5. Curb and Gutters, Valleys, or Sealed Swales in good condition or very steep
0.000
Continue
The total must equal 1. Total: 0.000
The balance left is: 1.000


Porous Pavement Control Device
Land Use: Residential
Source Area: Paved Parking/Storage 1
Total Area: 10
Porous Pavement Number 1
Porous pavement area (acres):
10.00
Inflow Hydrograph Peak to Average Flow Ratio
3.8
Pavement Geometry and Properties
1 - Pavement Thickness (in) 04
Pavement Void Ratio (0-1) .4
2 - Aggregate Bedding Thickness (in) 3
Aggregate Bedding Void Ratio (0-1) .3
3 - Aggregate Base Reservoir Thickness (in) 12
Aggregate Base Reservoir Void Ratio (0-1) .35
Outlet/Discharge Options
Perforated Pipe Underdrain Diameter, if used (inches) 3
4 - Perforated Pipe Underdrain Outlet Invert Elevation (inches above Datum) 6
Number of Perforated Pipe Underdrains 1
Subgrade Seepage Rate (in/hr) - select below or enter 0.30
Use Random Number Generation to Account for Uncertainty in Seepage Rate
Subgrade Seepage Rate COV 1.20
Select Subgrade Seepage 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
Porous Concrete
Porous Asphalt
Concrete Grid with Aggregate Bedding
1- 4.0"
2- 3.0"
3- 12.0"
4- 6.0"
Porous Pavement Layer
Aggregate Bedding
Perforated Pipe
Aggregate Base Reservoir
Datum 0 Feet Elev
Subgrade
Surface Pavement Layer Infiltration Rate Data
Initial Infiltration Rate (in/hr) 8.00
Percent of Infiltration Rate After 3 Years (0-100) 50.0
Percent of Infiltration Rate After 5 Years (0-100) 25.0
Percent of Original Infiltration Rate Upon Cleaning (0-100) 75.0
Time Period Until Complete Clogging Occurs (yrs) 8.0
Restorative Cleaning Frequency
Never Cleaned
Three Times per Year
Semi-Annually
Annually
Every Two Years
Every Three Years
Every Four Years
Every Five Years
Every Seven Years
Every Ten Years
Continue
Cancel
Delete Control

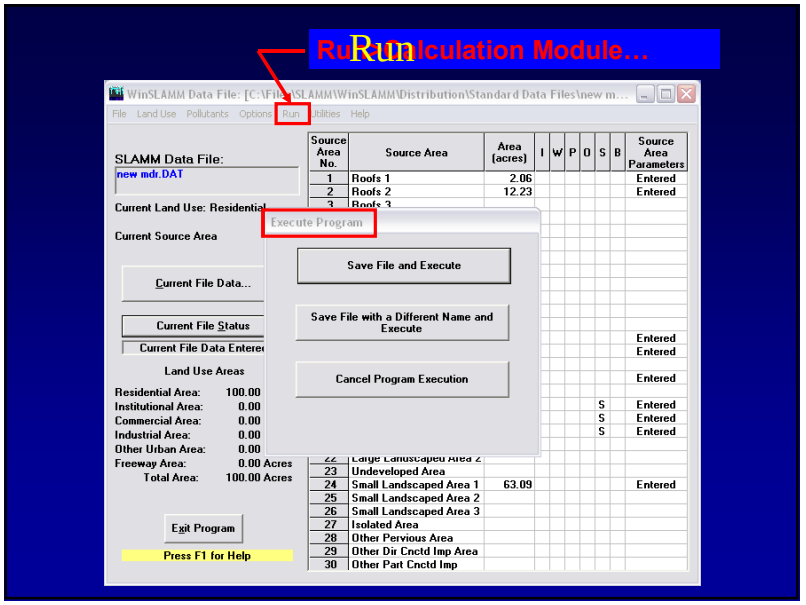

Street Cleaning Control Device
Land Use: Commercial
Source Area: Street Area 1
Total Area: 12.82
Select
Street Cleaning Dates
OR
Street Cleaning Frequency
Line Number
Street Cleaning Date
Street Cleaning Frequency
7 Passes per Week
5 Passes per Week
4 Passes per Week
3 Passes per Week
2 Passes per Week
One Pass per Week
One Pass Every Two Weeks
One Pass Every Four Weeks
One Pass Every Eight Weeks
One Pass Every Twelve Weeks
Two Passes per Year (Spring and Fall)
One Pass Each Spring
Model Run Start Date: 01/01/81
Model Run End Date: 12/31/81
Copy Cleaning Data
Paste Cleaning Data
Final cleaning period ending date (MM/DD/YY):
Continue
Clear
Cancel Edits
Delete Control
Type of Street Cleaner
Mechanical Broom Cleaner
Vacuum Assisted Cleaner
Street Cleaner Productivity
1. Coefficients based on street texture, parking density and parking controls
2. Other (specify equation coefficients)
Equation coefficient M (slope, M<1)
0.44
Equation coefficient B (intercept, B>1)
245
Parking Densities
1. None
2. Light
3. Medium
4. Extensive (short term)
5. Extensive (long term)
Are Parking Controls Imposed?
Yes
No


Wet Detention Control Device
Outfall Control
Total Area: 14.01 acres
Pond Number 1
Select Particle Size Distribution File
C:\PROGRAM FILES\WINSLAMM\NURP.CPZ
Initial Stage Elevation (ft):
2
Peak to Average Flow Ratio:
3.80
Optional - Maximum Inflow into Pond (cfs) Enter 0 or leave blank for no limit:
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)
Add Outlet
Outlet Options
1. Sharp Crested Weir
2. V - Notch Weir
3. Orifice
4. Seepage Basin
5. Natural Seepage
6. Evaporation
7. Other Outflow
8. Water Withdrawl
9. Broad Crested Weir
10. Vertical Stand Pipe
11. Stone Weeper
Edit Existing Outlet
Selected Outlets (Max. 5) Double Click to Edit or Delete
1 - Broad Crested Weir
2 - Broad Crested Weir
3 - V-Notch Weir
4 - V-Notch Weir
5 - Broad Crested Weir
Flow
Average Flow
Time (1.2 * Rainfall Duration)
Recalculate Cumulative Volume
Copy Pond Data
Paste Pond Data
Save this Pond as a WinDETPOND File
Cancel
Delete Pond
Continue

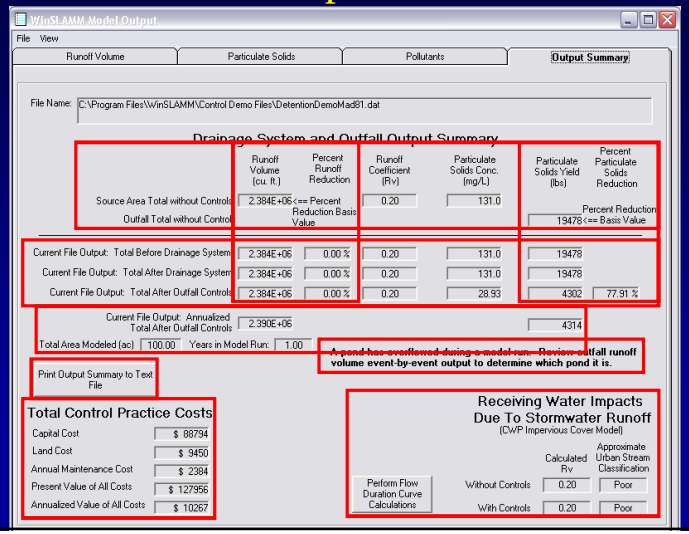
Warning Messages



Run

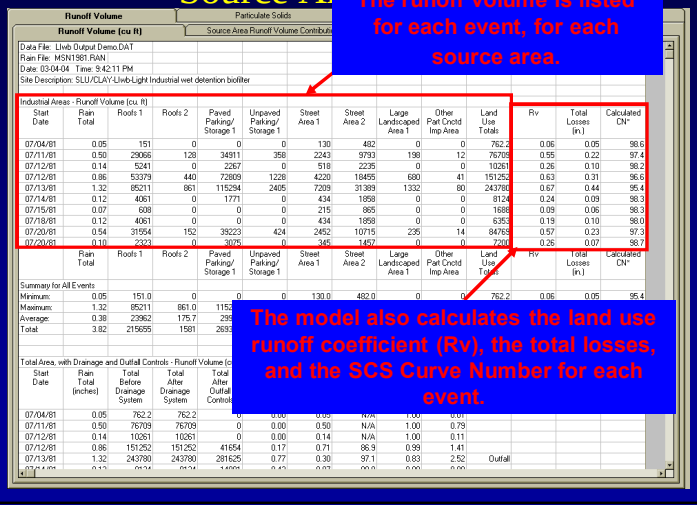


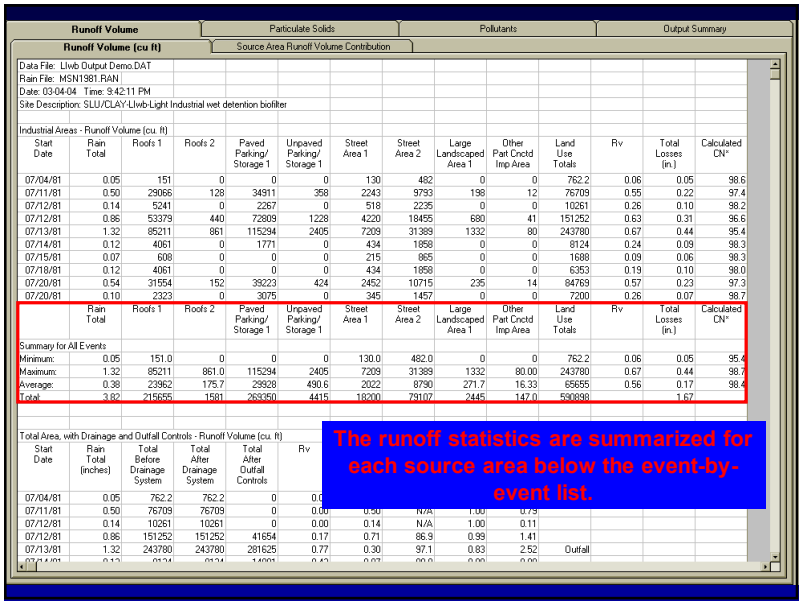
Output

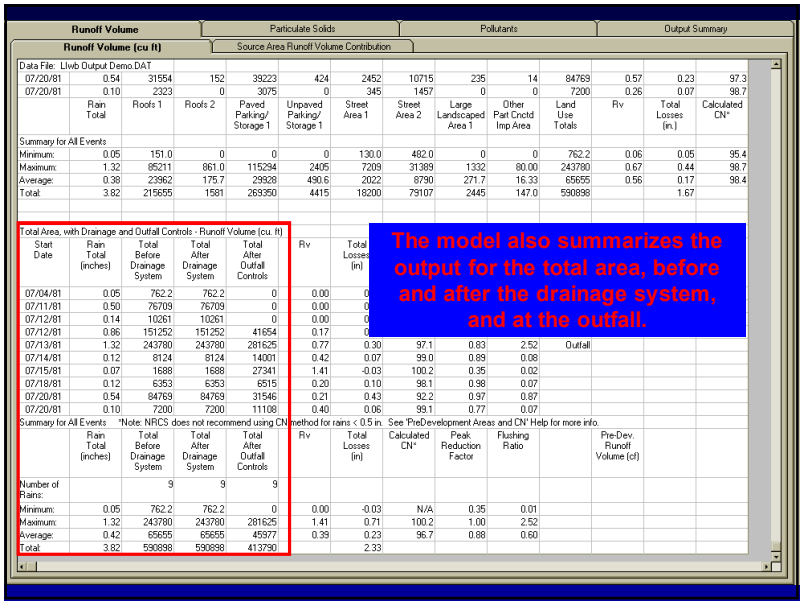


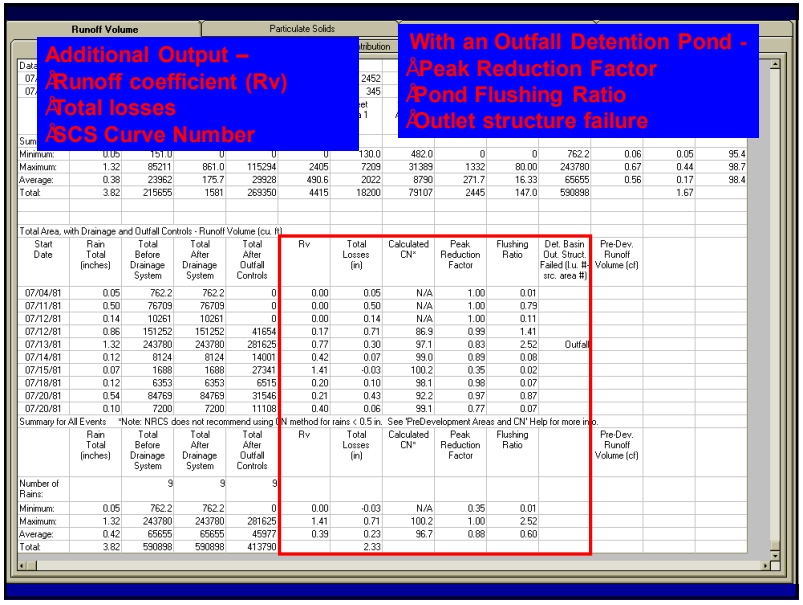
Runoff Volume Tab

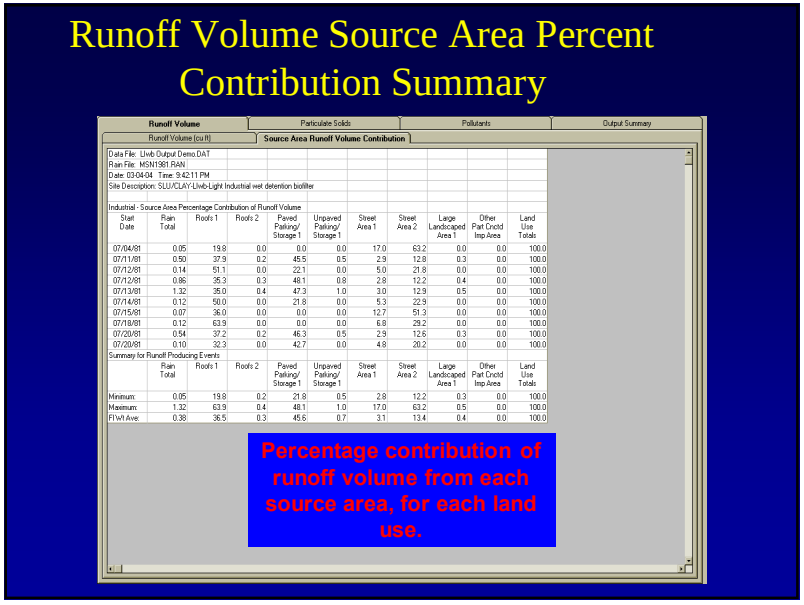
Source A



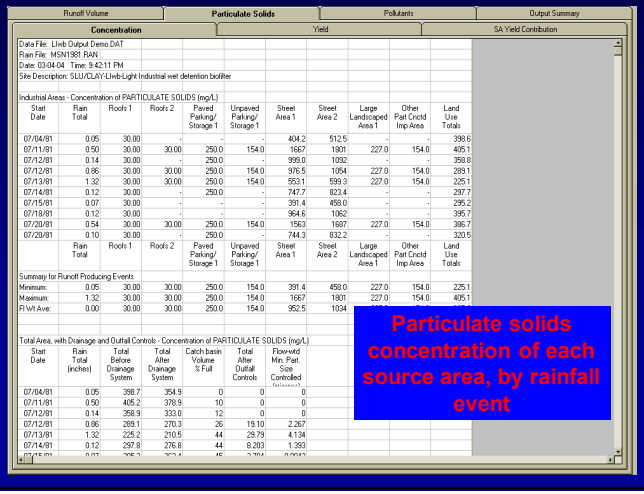

Runoff Volume
Particulate Solids
Pollutants
Output Summary
Runoff Volume (cu ft)
Source Area Runoff Volume Contribution
The runoff statistics are summarized for each source area below the event-by-event list.


Runoff Volume
Particulate Solids
Pollutants
Output Summary
Runoff Volume (cu ft)
Source Area Runoff Volume Contribution
The model also summarizes the output for the total area, before and after the drainage system, and at the outfall.

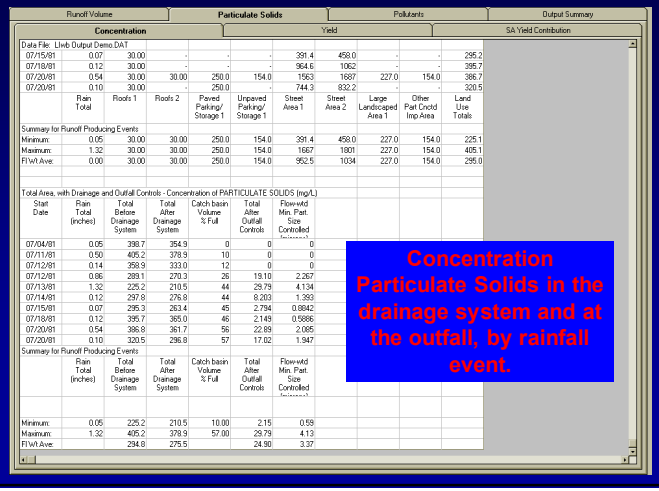

Runoff Volume
Particulate Solids
Additional Output –
Runoff coefficient (Rv)
Total losses
SCS Curve Number
With an Outfall Detention Pond -
Peak Reduction Factor
Pond Flushing Ratio
Outlet structure failure


Runoff Volume Source Area Percent Contribution Summary
Runoff Volume
Particulate Solids
Pollutants
Output Summary
Runoff Volume (cu ft)
Source Area Runoff Volume Contribution
Percentage contribution of runoff volume from each source area, for each land use.

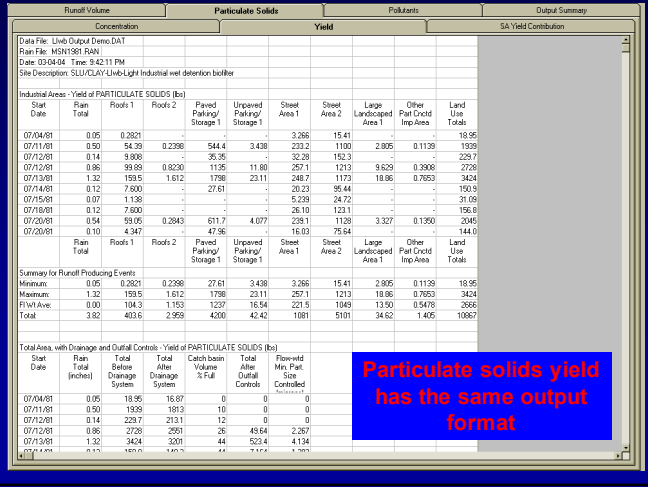
Particulate Solids Concentration Tab Source Areas



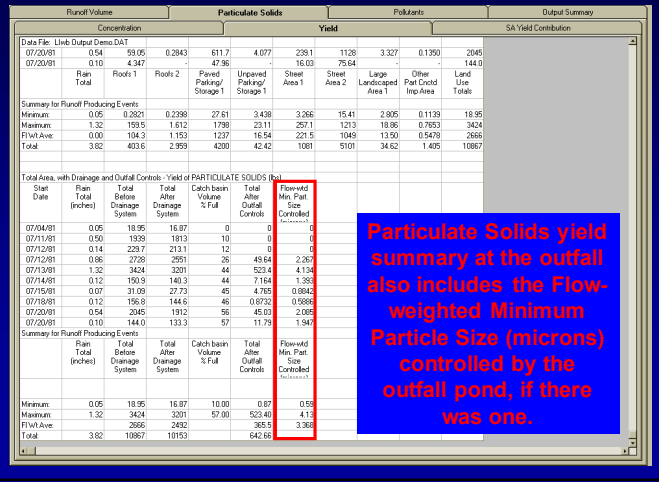
Particulate Solids Concentration Tab Outfall



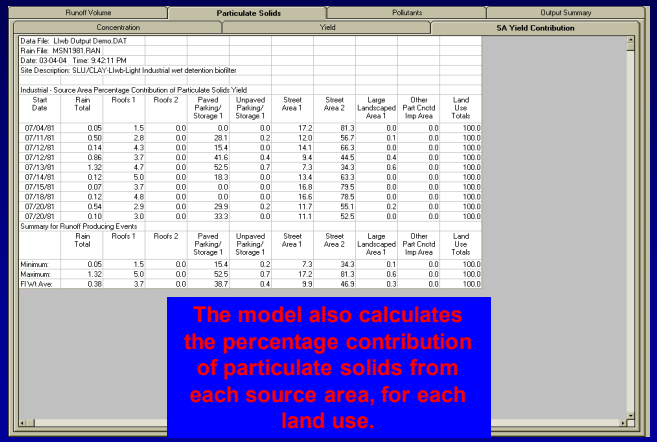
Particulate Solids Yield Tab Source Areas



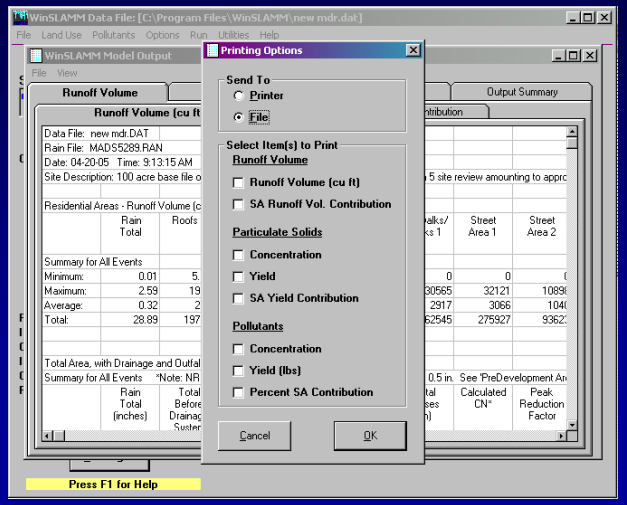
Particulate Solids Yield Tab Outfall



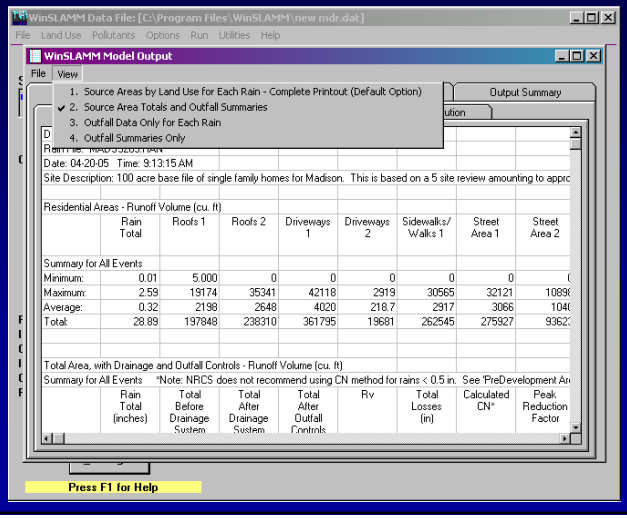
Particulate Solids Yield Source Area Percent Contribution Summary



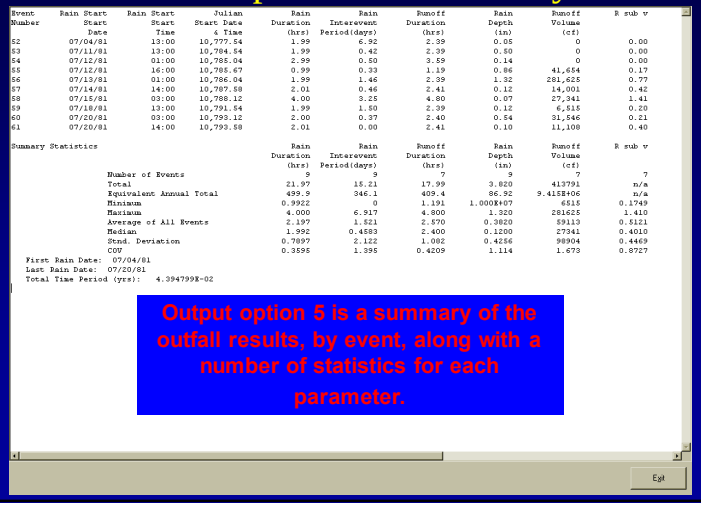
Print Detailed Output



Change Output View



Output Option 5
One Line per Event Summary



WinSLAMM Parameter Files for Alabama
(based on regional model calibration and verification)

Particle Solids Concentrations:
- BHAM_PSC_CALIB_June07.psc

Pollutant Probability Distributions:
- BHAM_PPD_CALIB_June07.ppd

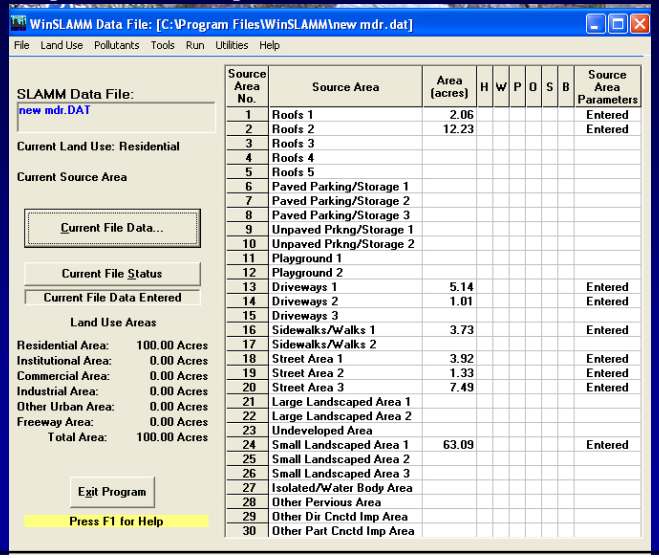
Drainage System Solids Delivery:
- Delivery_BHAM.prr

Cost Analysis File:
- Bham Cost Data.csv

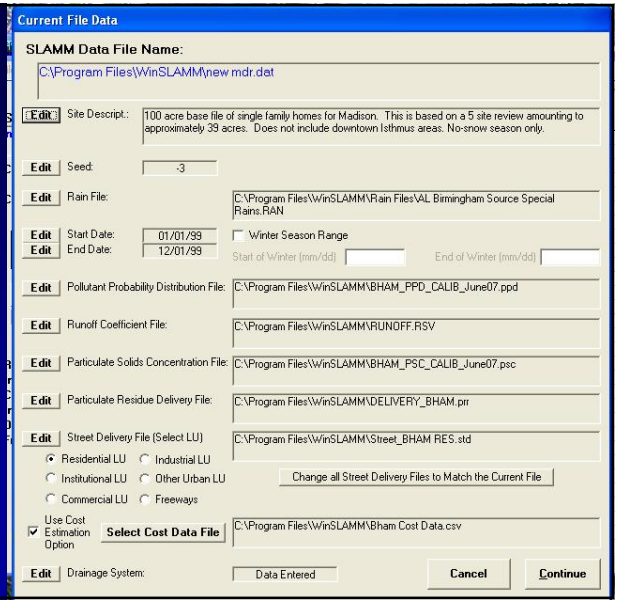
Runoff Coefficient File:
- Runoff.rsv

Street Particulate Delivery Files (by land use):
- Street_BHAM RES.std
- Street_BHAM INST and OTHER URBAN.std
- Street_BHAM COM and IND.std
- Freeway_BHAM.std

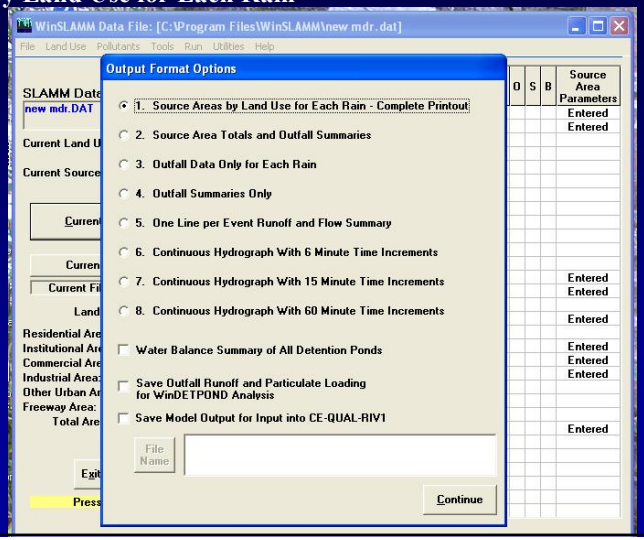
Example Land Development Conditions for a Residential Area



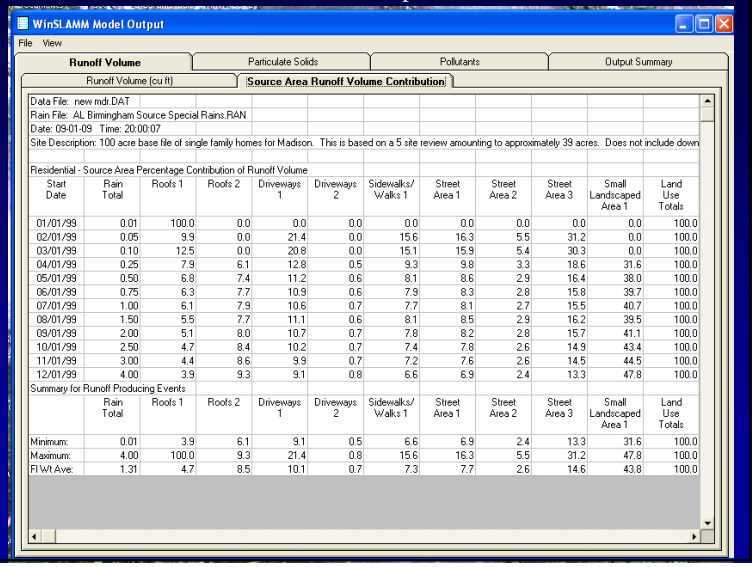
Parameter Files for Alabama Conditions (note rain file for special source area calculations)



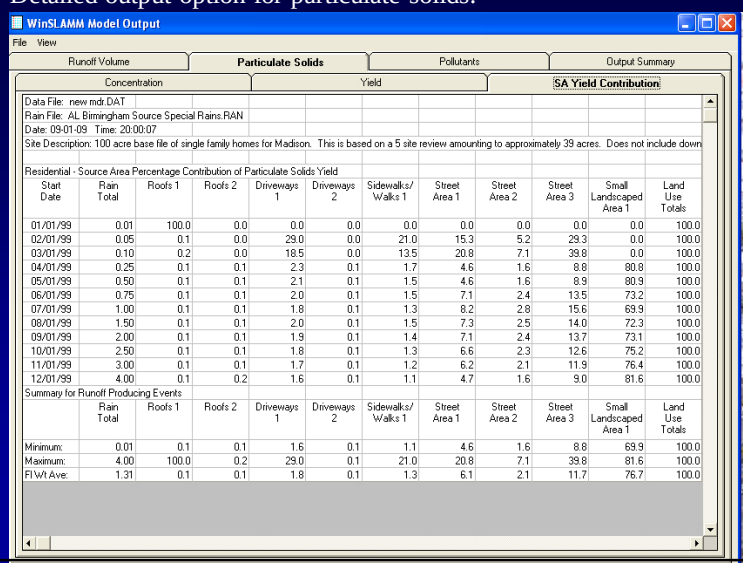
Change output format options (under “file”) to option 1) Source Areas by Land Use for Each Rain



After ñRunò Select Detailed Model Output:



Detailed output option for particulate solids:



You can then plot the data in Excel (after copying output to file and then importing the data into Excel) and label the most significant sources. Look for which source areas most important for different rain ranges of most interest. Can also do for other pollutants contained in the *.ppd file, but start with runoff volume and solids.