

Module 5f: Swales in WinSLAMM

Problem Description

You are the stormwater engineer for a commercial site that must reduce its pollution load by 40 percent. The site is fully developed with silty soils. Determine the site's pollution load if swales were used for drainage instead of curb and gutter. Instructions for modifying the file begin on page 2.

How much runoff and pollution does the site generate (Answers to be filled in throughout the example)?

- i. Runoff (cu ft): _____
- ii. TSS (mg/L): _____
- iii. TSS (lbs): _____
- iv. Total Copper (lbs): _____
- v. Particulate Lead (lbs): _____

What is the percent reduction of TSS (lbs)? _____

Steps:

- 1) Fill in the data regarding swales
- 2) Save the file as another name and update the site description
- 3) Enter the swale data
- 4) Run the model
- 5) View the output
- 6) Save the output

Problem

- 1) Fill in the data regarding swales

Change the site's drainage from 100 percent curb and gutter to 100 percent swales. Enter data describing the swale. Assume soil is silt loam and site is classified as Shopping Center Commercial. Follow the steps starting on page 2 to enter the data. Some data has been filled in for you. The answers to (1) can be found on page 2.

Swale infiltration rate (in/hr): _____
 Swale density (ft/ac): _____ (Total Swale Length/Total Area of Site)
 Total Swale Length (ft): _____
 Total Area of Site (ac): _____
 Typical Bottom Width (ft): 3 feet
 Typical Swale Side Slope (H ft / V ft): 3:1
 Typical Longitudinal Slope (ft/ft): 0.01 ft/ft
 Swale Manning's n: 0.027

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Answer

Swale Data

Swale infiltration rate (in/hr): **0.15 inches/hr**
 Swale density (ft/ac): **102 ft/ac**
 Total Swale Length (ft): **757 ft**

Total Area of Site (ac): **7.39 acres**
 Typical Bottom Width (ft): **3 feet**
 Typical Swale Side Slope (H ft : V ft): **3:1**
 Typical Longitudinal Slope (ft/ft): **0.01 ft/ft**
 Swale Manning's n: **0.027**

2) Save the file as another name and update the site description

Save Example 1a as "Example 1b". Save the File in the same location as Example 1a. Click **File**, then **Save As** to save the file with another name.

Click **Current File Data** to enter in swale data

| Source Area No. | Source Area | Area (acres) | I | W | P | O | S | B | Source Area Parameters |
|-----------------|--------------------------|--------------|---|---|---|---|---|---|------------------------|
| 61 | Roofs 1 | 1.48 | | | | | | | Entered |
| 62 | Roofs 2 | | | | | | | | |
| 63 | Roofs 3 | | | | | | | | |
| 64 | Roofs 4 | | | | | | | | |
| 65 | Roofs 5 | | | | | | | | |
| 66 | Paved Parking/Storage 1 | 2.56 | | | | | | | Entered |
| 67 | Paved Parking/Storage 2 | | | | | | | | |
| 68 | Paved Parking/Storage 3 | | | | | | | | |
| 69 | Unpaved Prkng/Storage | | | | | | | | |
| 70 | Unpaved Prkng/Storage | | | | | | | | |
| 71 | Playground 1 | | | | | | | | |
| 72 | Playground 2 | | | | | | | | |
| 73 | Driveways 1 | 2.35 | | | | | | | Entered |
| 74 | Driveways 2 | | | | | | | | |
| 75 | Driveways 3 | | | | | | | | |
| 76 | Sidewalks/Walks 1 | 0.06 | | | | | | | Entered |
| 77 | Sidewalks/Walks 2 | | | | | | | | |
| 78 | Street Area 1 | 0.31 | | | | | | | Entered |
| 79 | Street Area 2 | | | | | | | | |
| 80 | Street Area 3 | | | | | | | | |
| 81 | Large Landscaped Area 1 | | | | | | | | |
| 82 | Large Landscaped Area 2 | | | | | | | | |
| 83 | Undeveloped Area | | | | | | | | |
| 84 | Small Landscaped Area 1 | 0.63 | | | | | | | Entered |
| 85 | Small Landscaped Area 2 | | | | | | | | |
| 86 | Small Landscaped Area 3 | | | | | | | | |
| 87 | Isolated Area | | | | | | | | |
| 88 | Other Pervious Area | | | | | | | | |
| 89 | Other Dir Cnctd Imp Area | | | | | | | | |
| 90 | Other Part Cnctd Imp | | | | | | | | |

Change File Description to reflect swale drainage – Select **Edit** next to "Site Descrip:" – Enter swales to reflect drainage system – Click **OK**

Current File Data

Edit SLAMM Data File Name: C:\85086 UW\WinSLAMM\Minn Course\Example 1\Example 1b.dat

Edit Site Descript: **Site Description** (230 characters maximum)

Edit Seed:

Edit Rain File: Example 1a swale

Edit Start Date: 01/01/81 Winter Season Range

Edit End Date: 12/31/81 Start of Winter (mm/dd) End of Winter (mm/dd)

Edit Pollutant Probability Distribution File: C:\Program Files\WinSLAMM\W1_GE001.ppd

Edit Runoff Coefficient File: C:\Program Files\WinSLAMM\W1_SL01.rtv

Edit Particulate Solids Concentration File: C:\Program Files\WinSLAMM\W1_AVG01.psc

Edit Particulate Residue Delivery File: C:\Program Files\WinSLAMM\W1_DLV01.pr

Edit Street Delivery File (Select LU): C:\Program Files\WinSLAMM\W1_Con Inst Indust May05.std

Residential LU Industrial LU

Institutional LU Other Urban LU

Commercial LU Freeways

Use Cost Estimation Option Select Cost Data File

Edit Drainage System: Data Entered

Buttons: Cancel, Continue

3) Enter the swale data

Select **Edit** next to “Drainage System” – Enter “1” by “Grass Swales” and “0” by “Curb and Gutters, Valleys or Sealed Swales in fair condition” – Click **Continue**

Current File Data

Edit SLAMM Data File Name: C:\85086 UW\WinSLAMM\Eng\WinSLAMM Files\Example 1e.dat

Edit Site Descript: Example 1a - Commercial Site, Directly Connected Drainage, Silty Soils, Swale Drainage

Edit Seed:

Edit Rain File:

Edit Start Date:

Edit End Date:

Edit Pollutant Prc:

Edit Runoff Coeff:

Edit Particulate S:

Edit Particulate F:

Edit Street Delivery File (Select LU): C:\Program Files\WinSLAMM\W1_Con Inst Indust May05.std

Residential LU Industrial LU

Institutional LU Other Urban LU

Commercial LU

Drainage System

Enter the fraction of each type of drainage system serving the study area:

| | | |
|--|--|-------|
| 1. Grass Swales | <input checked="" type="checkbox"/> Enter swale data immediately | 1.000 |
| 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 |

The total must equal 1. Total: 1.000

Buttons: Continue, Cancel, Continue

Enter the data describing the swales – Click **Continue** Ignore the “For Cost Analysis Only” section. We will be working with that later in the course.

Grass Swales

1. Swale infiltration rate (in/hr): 2. Swale density (ft/ac):

ENTER WETTED SWALE WIDTH (constant for all events)

3. Wetted swale width (ft):

OR

ENTER TYPICAL SWALE GEOMETRY
(wetted swale width changes for each event based on expected flows)

Typical Swale Geometry

4. Typical Bottom Width (ft): 6. Typical Longitudinal Slope (ft/ft):

5. Typical Swale Side Slope [_ R H : 1 R V]: 7. Swale Manning's n:

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

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

Area served by swales (acres): 7.39

For Cost Analysis Only:

Typical Swale Depth (ft):

Typical Bottom Width (ft):

Click Continue again to get back to the main screen

Current File Data

SLAMM Data File Name:

Site Descript:

Seed:

Rain File:

Start Date: Winter Season Range

End Date: Start of Winter (mm/dd) End of Winter (mm/dd)

Pollutant Probability Distribution File:

Runoff Coefficient File:

Particulate Solids Concentration File:

Particulate Residue Delivery File:

Street Delivery File (Select LU):

Residential LU Industrial LU

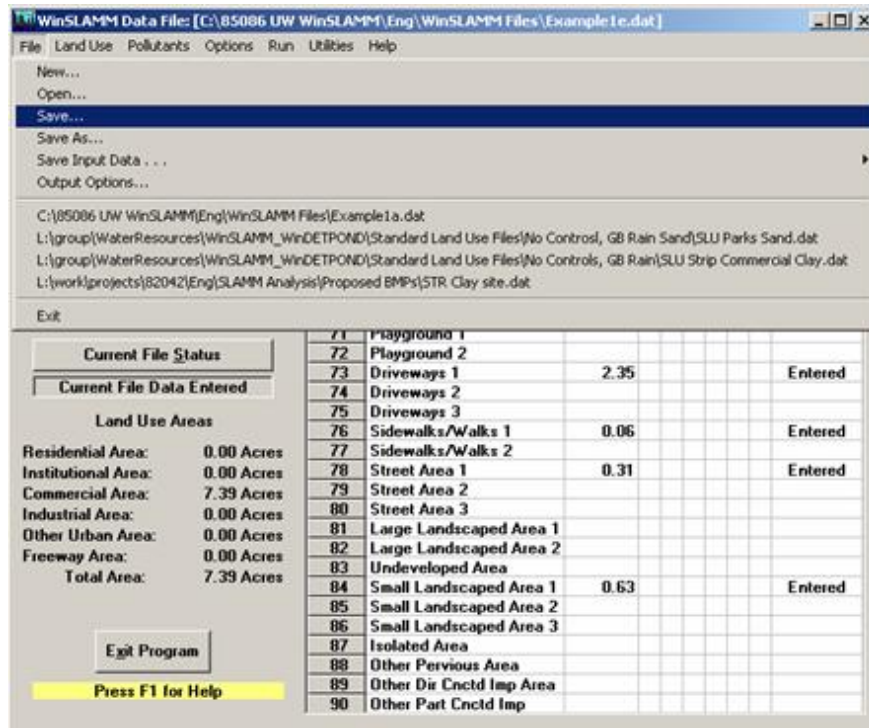
Institutional LU Other Urban LU

Commercial LU Freeways

Use Cost Estimation Option

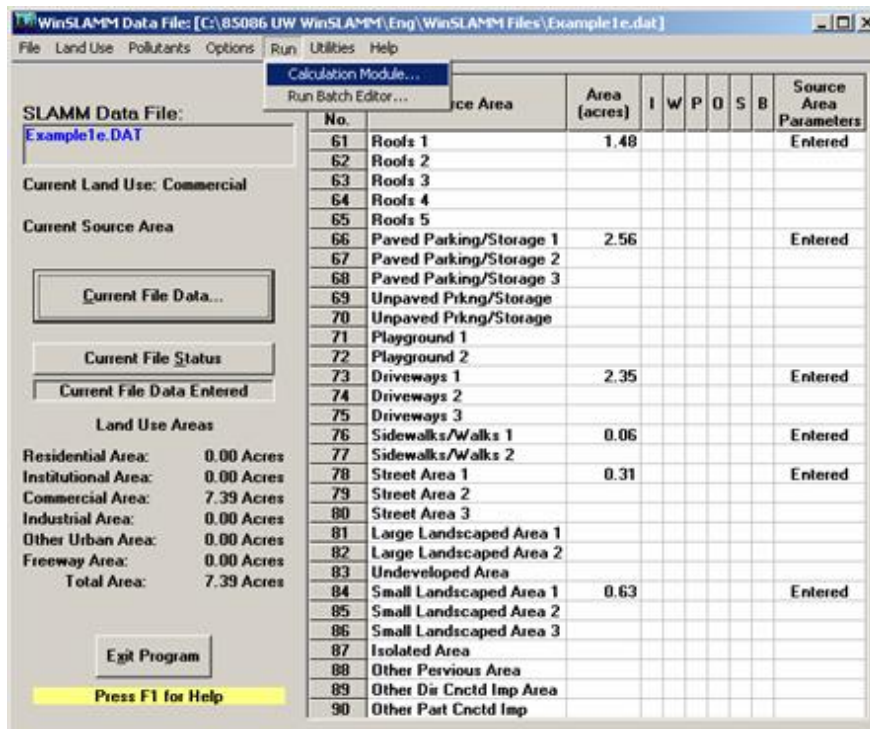
Drainage System:

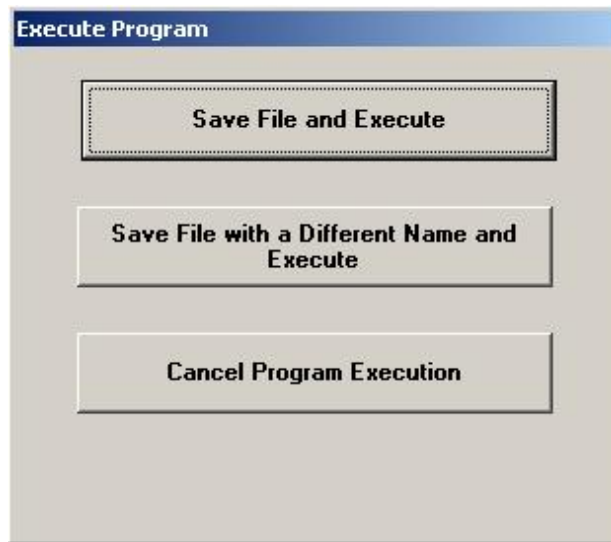
Save your changes



4) Run the model

Run the file





5) View the output

How much runoff and pollution does the site generate (fill in summary table on page 1)?

WinSLAMM Model Output

File View

Runoff Volume Particulate Solids Pollutants **Output Summary**

File Name: C:\85086 UW\WinSLAMM\Minn Course\Example 1\Example 1b.dat

| | Runoff Volume (cu. ft.) | Percent Runoff Reduction | Particulate Solids Conc. (mg/L) | Particulate Solids Yield (lbs) | Percent Particulate Solids Reduction |
|------------------------------|-------------------------|--------------------------|---------------------------------|--------------------------------|--------------------------------------|
| Total Before Drainage System | 561484 | Base | 125.3 | 4390 | Base |
| Total After Drainage System | 540579 | 3.72 % | 124.4 | 4195 | 4.44 % |
| Total After Outfall Controls | 540579 | 3.72 % | 124.4 | 4195 | 4.44 % |

Total Area Modeled (ac) 7.39

Total Control Practice Costs

| | |
|-------------------------------|-----|
| Capital Cost | N/A |
| Land Cost | N/A |
| Annual Maintenance Cost | N/A |
| Present Value of All Costs | N/A |
| Annualized Value of All Costs | N/A |

Print Output Summary to Comma Separated Value File

Print Output Summary to Text File

- i. Runoff (cu ft): **540,579 cu. ft.**
- ii. TSS (mg/L): **124.4 mg/L**
- iii. TSS (lbs): **4,195 lbs**

WinSLAMM Model Output

File View

Runoff Volume Particulate Solids **Pollutants** Output Summary

| | Concentration | Yield (lbs) | | | Percent SA Contribution |
|--|---------------------|------------------------------|-----------------------------|------------------------------|-------------------------|
| Data File: Example 1b.DAT | | | | | |
| Rain File: MSN1981.RAN | | | | | |
| Date: 09-05-05 Time: 1:26:33 PM | | | | | |
| Site Description: Example 1e swales | | | | | |
| Total Area, with Drainage and Outfall Controls - Yield of TOTAL COPPER (lbs) | | | | | |
| Summary of Runoff Producing Events | | | | | |
| | Rain Total (inches) | Total Before Drainage System | Total After Drainage System | Total After Outfall Controls | |
| Minimum: | 0.01 | 6.691E-06 | 5.258E-06 | 5.258E-06 | |
| Maximum: | 2.59 | 0.06604 | 0.06583 | 0.06583 | |
| Fl\wt Ave: | | 0.02668 | 0.02699 | 0.02699 | |
| Total: | 32.10 | 0.6765 | 0.6605 | 0.6605 | |
| Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE LEAD (lbs) | | | | | |
| Summary of Runoff Producing Events | | | | | |
| | Rain Total (inches) | Total Before Drainage System | Total After Drainage System | Total After Outfall Controls | |
| Minimum: | 0.01 | 5.156E-06 | 1.034E-05 | 1.034E-05 | |
| Maximum: | 2.59 | 0.1098 | 0.1090 | 0.1090 | |
| Fl\wt Ave: | | 0.04444 | 0.04457 | 0.04457 | |
| Total: | 32.10 | 1.128 | 1.081 | 1.081 | |

iv. Total Copper (lbs): **0.6605 lbs**

WinSLAMM Model Output

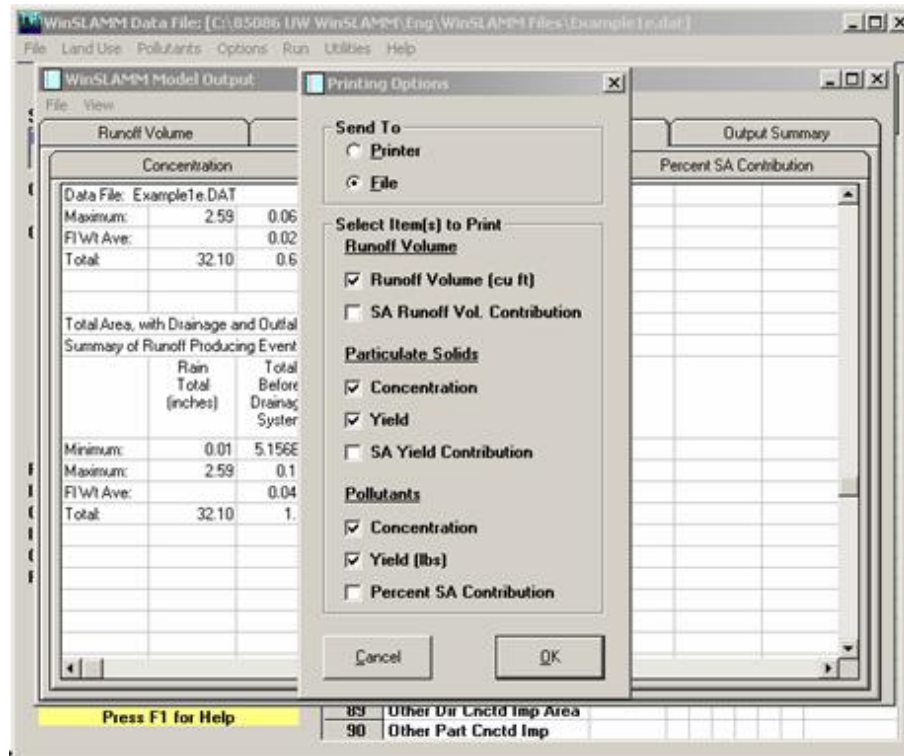
File View

Runoff Volume Particulate Solids **Pollutants** Output Summary

| | Concentration | Yield (lbs) | | | Percent SA Contribution |
|--|---------------------|------------------------------|-----------------------------|------------------------------|-------------------------|
| Data File: Example 1b.DAT | | | | | |
| Rain File: MSN1981.RAN | | | | | |
| Date: 09-05-05 Time: 1:26:33 PM | | | | | |
| Site Description: Example 1e swales | | | | | |
| Total Area, with Drainage and Outfall Controls - Yield of TOTAL COPPER (lbs) | | | | | |
| Summary of Runoff Producing Events | | | | | |
| | Rain Total (inches) | Total Before Drainage System | Total After Drainage System | Total After Outfall Controls | |
| Minimum: | 0.01 | 6.691E-06 | 5.258E-06 | 5.258E-06 | |
| Maximum: | 2.59 | 0.06604 | 0.06583 | 0.06583 | |
| Fl\wt Ave: | | 0.02668 | 0.02699 | 0.02699 | |
| Total: | 32.10 | 0.6765 | 0.6605 | 0.6605 | |
| Total Area, with Drainage and Outfall Controls - Yield of PARTICULATE LEAD (lbs) | | | | | |
| Summary of Runoff Producing Events | | | | | |
| | Rain Total (inches) | Total Before Drainage System | Total After Drainage System | Total After Outfall Controls | |
| Minimum: | 0.01 | 5.156E-06 | 1.034E-05 | 1.034E-05 | |
| Maximum: | 2.59 | 0.1098 | 0.1090 | 0.1090 | |
| Fl\wt Ave: | | 0.04444 | 0.04457 | 0.04457 | |
| Total: | 32.10 | 1.128 | 1.081 | 1.081 | |

v. Particulate Lead (lbs): **1.081 lbs**

6) Save the output



What is the percent reduction from swales of TSS(%)? **4.44 %**

Alternative Scenarios (if available time)

- a. Question: You have chosen to use engineered soil with an infiltration rate of 2 in/hr. What happens to the runoff and pollution results? Why?

Answer: Runoff and pollution are decreased. The engineered soil has a higher infiltration rate than the native soil, thus allowing additional runoff to infiltrate.

- b. Question: You have chosen to increase the swale bottom width by 2 feet using the native soil. What happens to the runoff and pollution results? Why?

Answer: Runoff and pollution are decreased. The wider swale allows for more surface area for runoff to spread out and infiltrate. The decrease is not a linear relationship because the smallest storms are infiltrated completely – only the slightly larger storms and above are affected by the wider bottom width.