GRTS Model Training

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TETRA TECH, INC.

What Will You Learn?

- STEPL model
  1. Create an Excel Model
  2. Use BMP calculator
- R5 model (a simple Excel model not just for Region 5)
- Special discussion
  - BMP Efficiency Estimator
  - Online data server

Part 1: STEPL

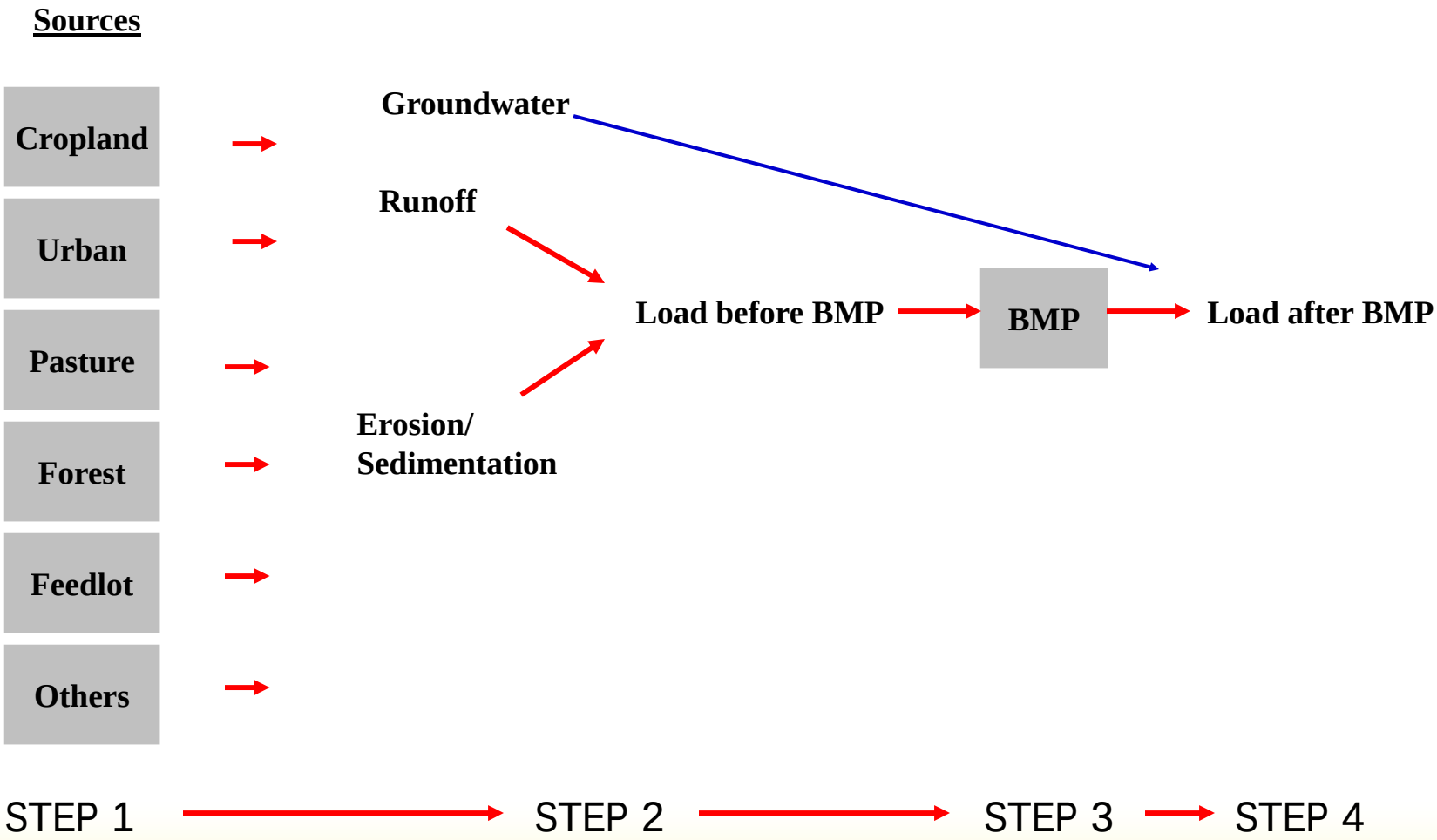
What is STEPL?

- Calculates nutrient (N, P, and BOD pollutants) and sediment loads by land use type and aggregated by watershed
- Calculates load reductions as a result of implementing BMPs
- Data driven and highly empirical
- A customized MS Excel spreadsheet model
  - Simple and easy to use
  - Formulas and default parameter values can be modified by users (optional) with no programming required

STEPL Users?

- Basic understanding of hydrology, erosion, and pollutant loading processes
- Knowledge (use and limitation) of environmental data (e.g., land use, agricultural statistics, and BMP efficiencies)
- Familiarity with MS Excel and Excel Formulas

Process


Sources
Cropland
Urban
Pasture
Forest
Feedlot
Others
Groundwater
Runoff
Erosion/
Sedimentation
Load before BMP
BMP
Load after BMP
STEP 1
STEP 2
STEP 3
STEP 4

STEPL Web Site

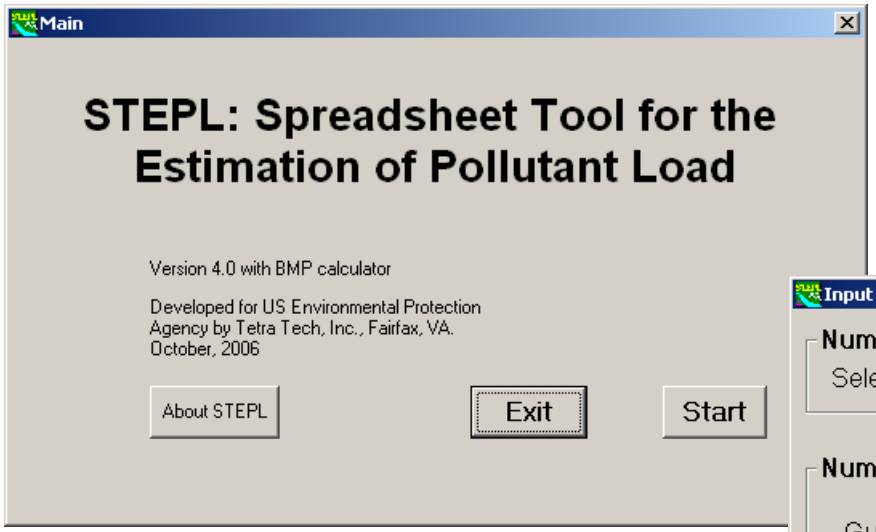
Link to on-line Data server

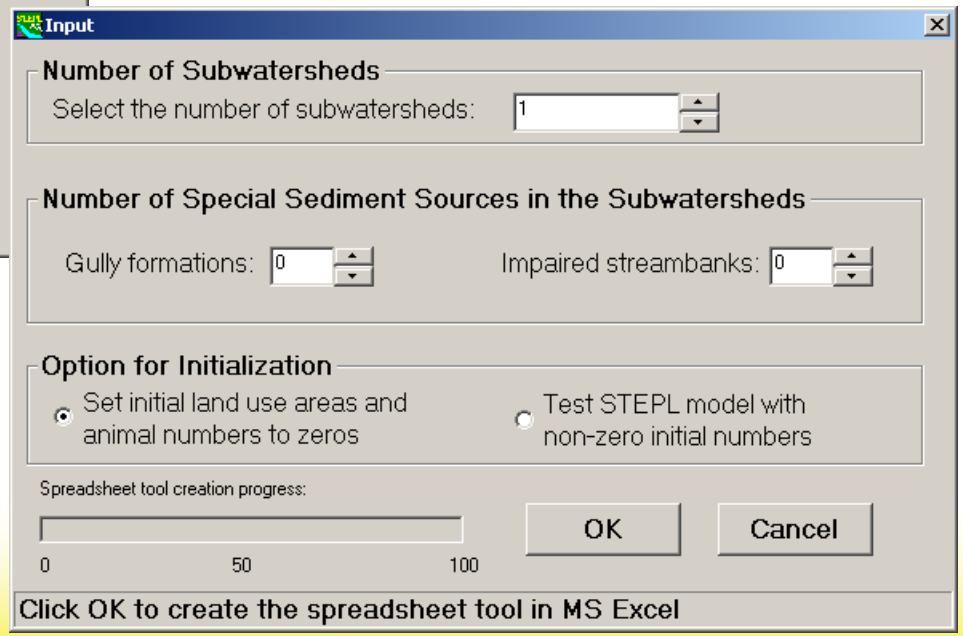
Link to download setup program to install STEPL program and documents

Temporary URL: http://it.tetratech-ffx.com/stepl until moved to EPA server

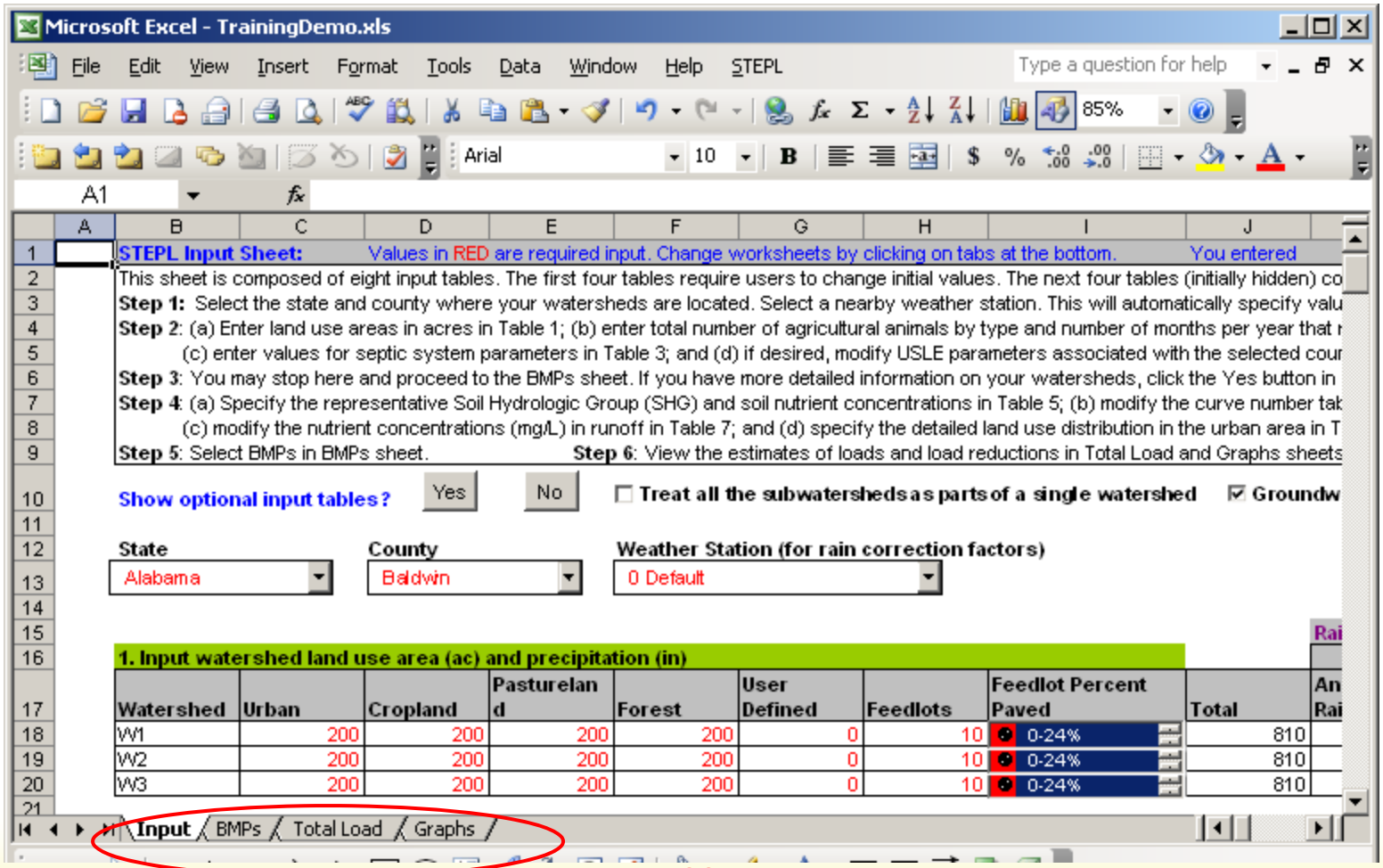
STEPL Main Program

- Run STEPL executable program to create and customize spreadsheet dynamically





STEPL Spreadsheet



Composed of four worksheets

BMPs Worksheet

Urban BMP Tool

Gully and Streambank Erosion

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data

Watershed	Cropland					
	N	P	BOD	Sediment	BMPs	% Area BMP Applied
W1	0.485	0.55	ND	0.405	Contour Farming	100
W2	0.1	0.3	ND	0.35	Diversion	100
W3	0	0	0	0	0 No BMP	100

Each land use type within each watershed can have a separate BMP.
Also it can be partial application.

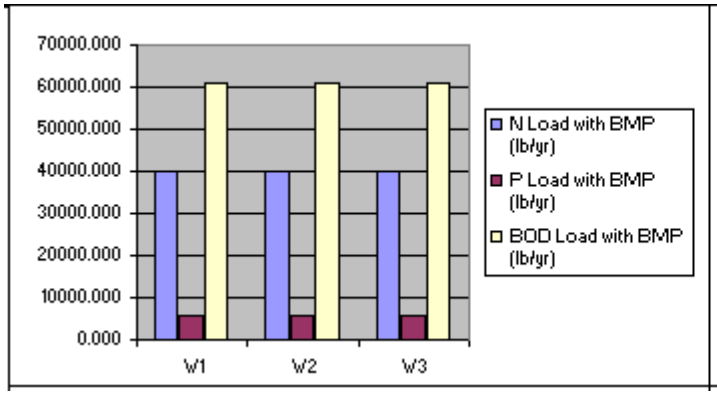
Total Load Worksheet

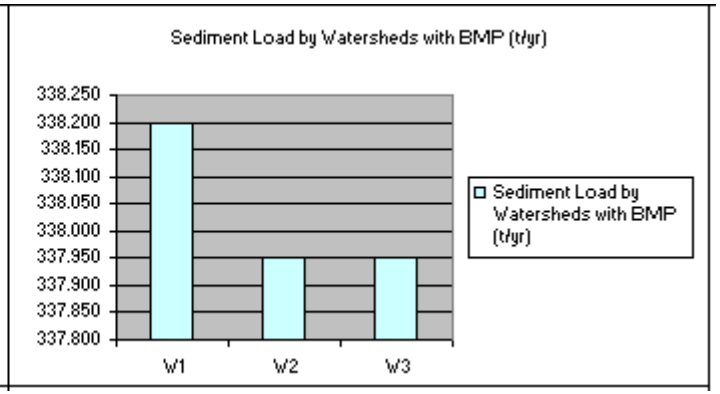
1. Total load by subwatershed(s)

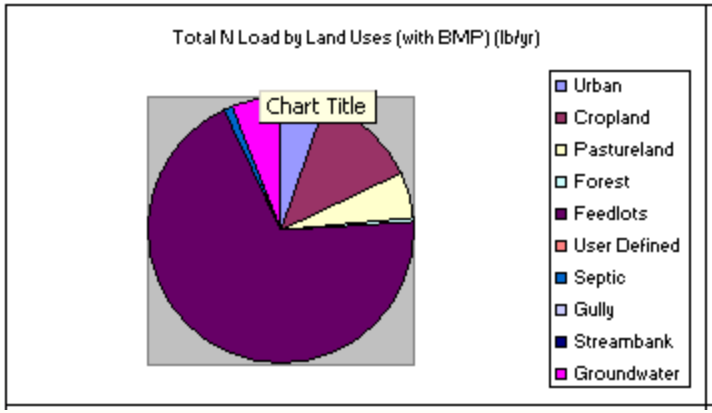
Watershed	N Load (no BMP)	P Load (no BMP)	BOD Load (no BMP)	Sediment Load (no BMP)	N Reduction	P Reduction	BOD Reduction	Sediment Reduction
	lb/year	lb/year	lb/year	t/year	lb/year	lb/year	lb/year	t/year
W1	39888.8	5615.6	60882.3	342.9	8.6	3.3	17.1	4.7
W2	39879.8	5612.2	60864.2	338.0	0.0	0.0	0.0	0.0
W3	39879.8	5612.2	60864.2	338.0	0.0	0.0	0.0	0.0
Total	119648.4	16839.9	182610.8	1018.8	8.6	3.3	17.1	4.7

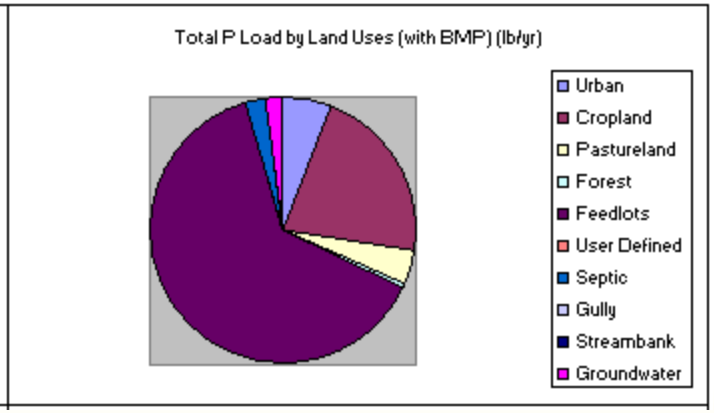
Each row of results corresponds to a different watershed or project.

Graphs Worksheet



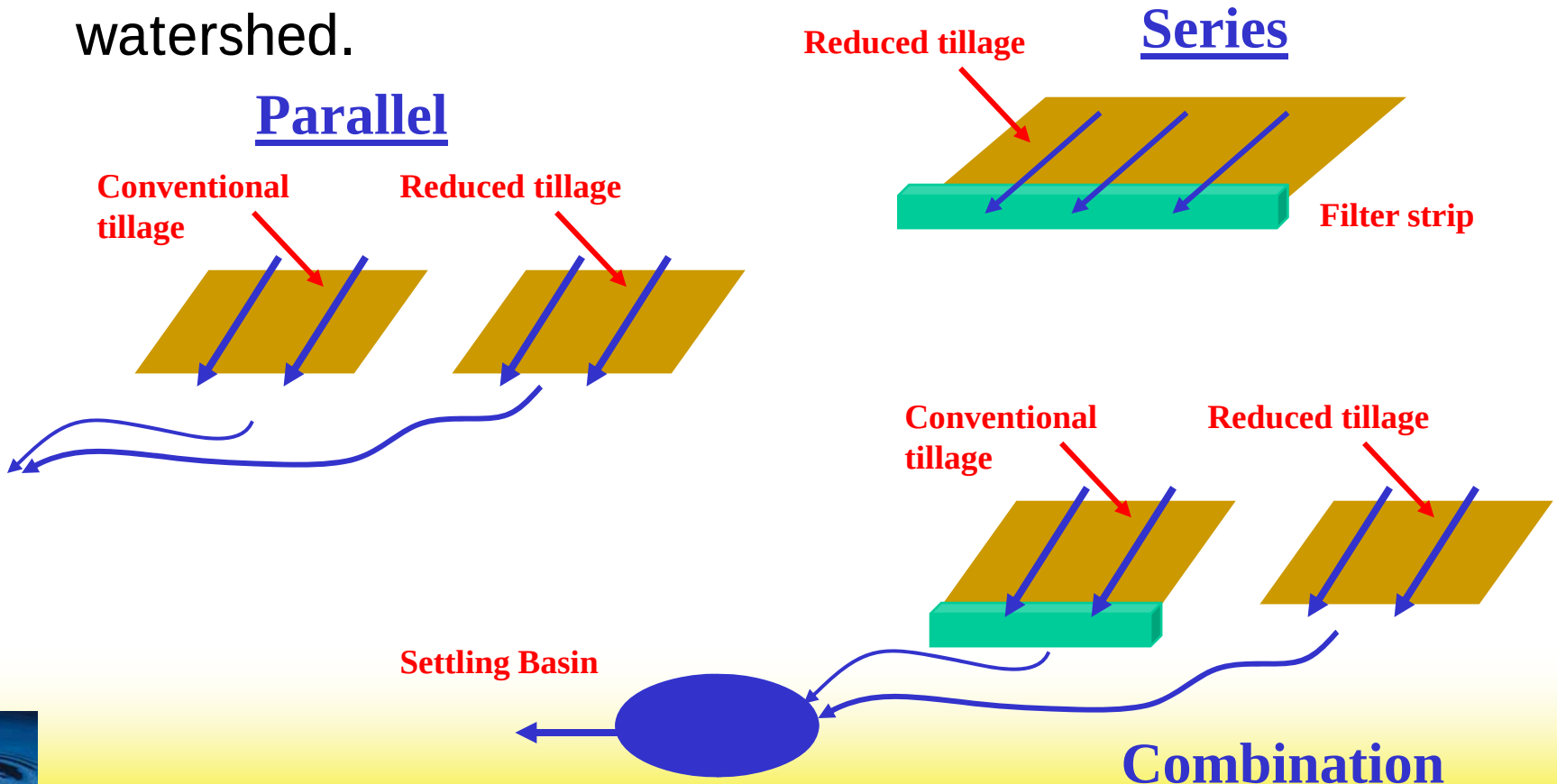




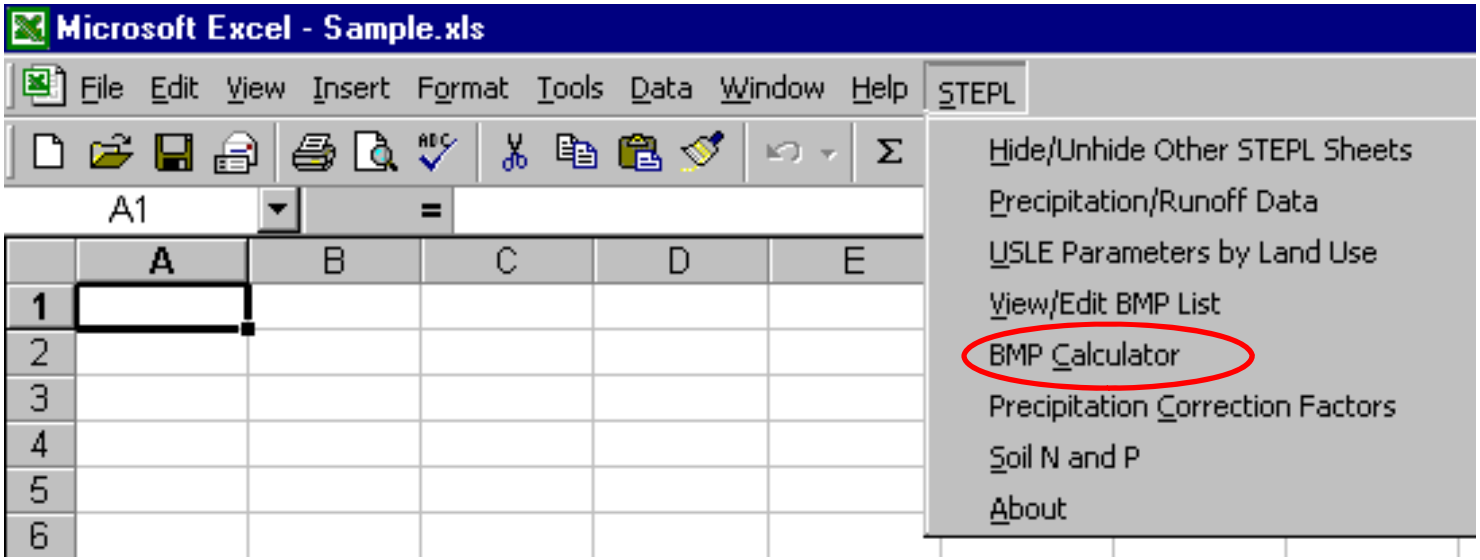


STEPL BMP Calculator

- Calculates combined efficiency of a BMP train for a given land use. The use of BMP calculator requires the understanding of BMPs and their placement in the watershed.



Customized Menu

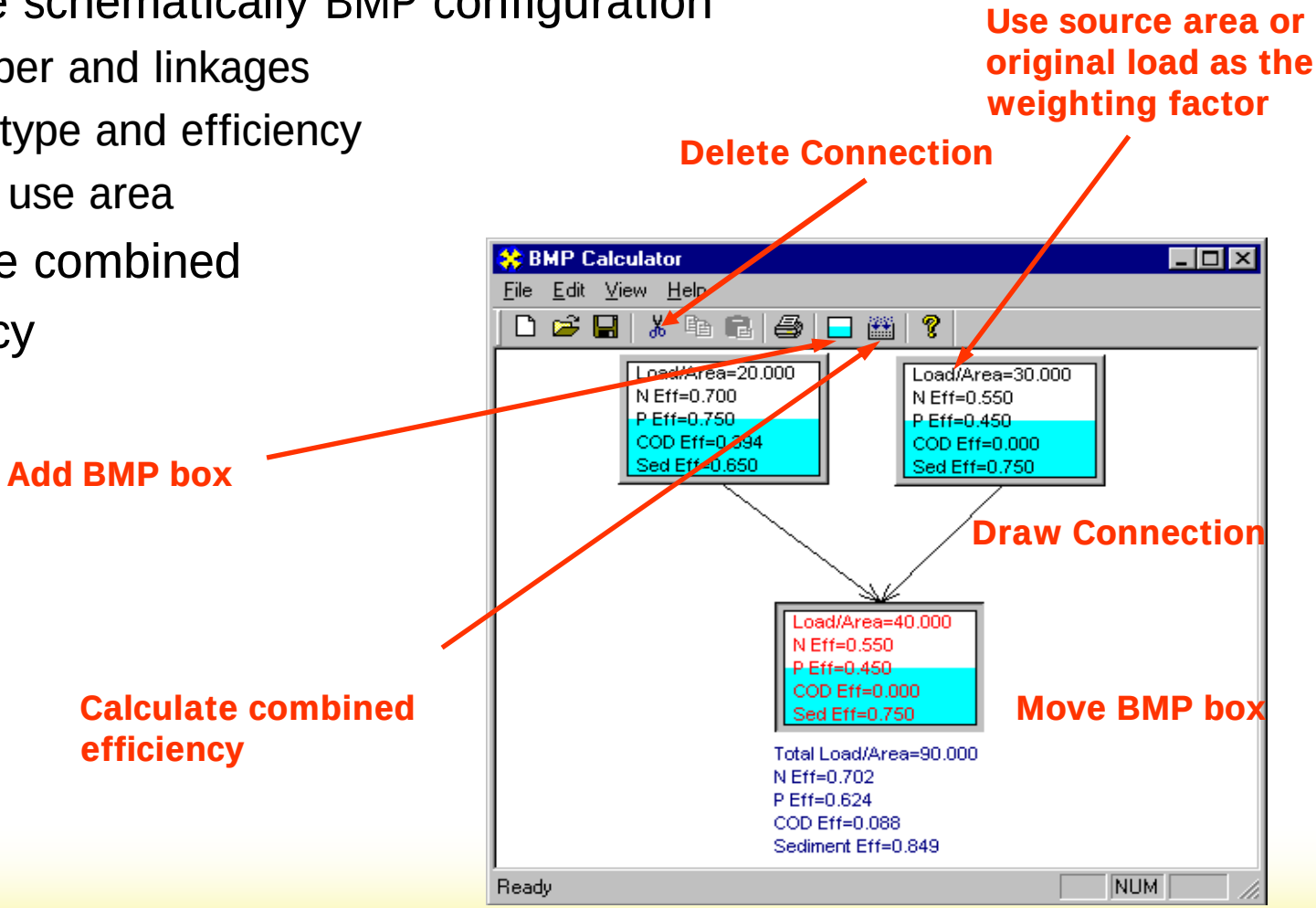


Tip: To ensure that files are linked to the customized menu, set Excel **Default file location** to C\STEPL or D:\STEPL

Step: Tools menu > Options submenu> General tab

STEPL BMP Calculator

- Describe schematically BMP configuration
  - Number and linkages
  - BMP type and efficiency
  - Land use area
- Calculate combined efficiency



New Features in 4.0

- Ability to specify different ways (by Subwatersheds or Individual Project Area vs. the Entire Watershed) to calculate sediment delivery
- Calculation of Gully and stream bank erosion
- Calculation of groundwater and pollutant output

☐ Treat all the subwatersheds as parts of a single watershed ☑ Groundwater load calculation

1. Gully dimensions in the different watersheds

Watershed	Gully	Top Width (ft)	Bottom Width (ft)	Depth (ft)	Length (ft)	Years to Form	BMP Efficiency (0-1)	Soil Textural Class
W1	Gully1	5	5	5	5	1	0.95	Clay

2. Impaired streambank dimensions in the different watersheds

Watershed	Strm Bank	Length (ft)	Height (ft)	Lateral Recession	Rate Range (ft/yr)	Rate (ft/yr)	BMP Efficiency (0-1)	Soil Textural Class
W1	Bank1	5	100	1. Slight	0.01 - 0.05	0.03	0.95	Clay

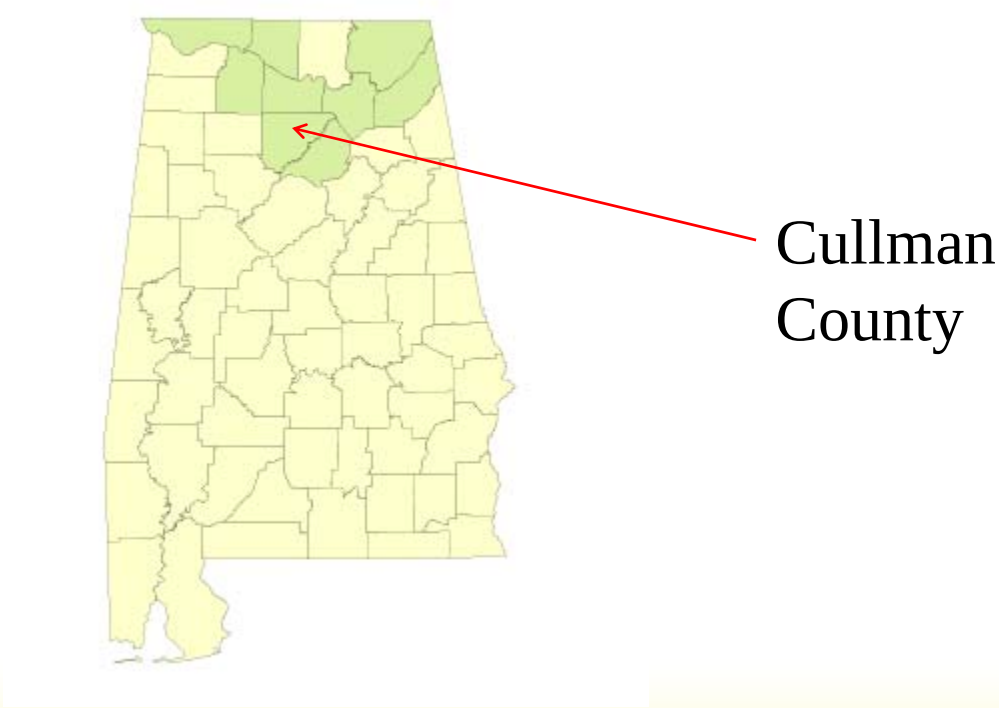
Hands-on Exercises

Sample Problem Exercises

- Exercise #1
  - Estimate total annual load for a specific farm, and total load reduction resulting to implementation of a (single) BMP on croplands
    - Hypothetical watersheds based on Agricultural Statistics and NRCS data
- Exercise #2
  - Similar to Exercise #1 but with multiple BMPs
- Exercise #3
  - Similar to Exercise #1 but BMP trains implemented on croplands, and a single BMP on urban land
- Exercise #4
  - Similar to Exercise #1 but for multiple subwatersheds and BMP trains implemented on croplands, and pasture land
- Exercise #5
  - Hypothetical watersheds for demonstrating gully and streambank erosion

Sample Problem Exercise #1

Estimate total annual load for a farm in Cullman County in Alabama



Agricultural Statistics of Alabama

Summary 2002	
Number of Farms	45126
Acreage of farms	8904387
Average size of farm (ac)	197
Median Size of farm (ac)	90
Total Cropland Number	34073
Totat Cropland Area (ac)	3732751
Harversted Cropland Number	23327
Harversted Cropland Area (ac)	1995139

Animals	
Cattles and calves (farms)	27094
Cattles and calves (number)	1437795
Beef cows (farms)	23558
Beef cows (number)	765901
Milk cows (farms)	223
Milk cows (number)	18939
Hogs and pigs (farms)	576
Hogs and pigs (number)	168013
Sheep and lambs (farms)	445
Sheep and lambs (number)	11374

Based on 2002 Census of Agriculture, USDA National Agricultural Statistics Service

Agricultural Statistics of Cullman County

Land Information		
Average Farm Size (ac)	101	
Average Cropland Size (ac)	64.2	
Animal Information		
Animal	**Total**	**Average**
Beef Cattle	39,018	28.58
Dairy Cattle	1,962	140.14
Swine (Hog)	152	11.69
Sheep	508	25.4
Chicken	1,572,552	14427.08

Based on 2002 Census of Agriculture, USDA National Agricultural Statistics Service

Sample Problem Exercise #1

- Generate a new custom spreadsheet. Note that you may reuse a spreadsheet you created previously for a different project.
  - Click Start button (e.g., normally located at the Windows bottom left corner), then Program, STEPL, and STEPL to run the STEPL main executable program (stepl.exe in /STEPL folder) and display main interface
  - Select options. For Exercise #1, specify the following:
    - Specify number of watershed = 1
    - Select first option under Option for Initialization (default selection – Set initial land use areas and animal numbers to zeros)
  - Click ok to create new spreadsheet
  - Click ok to the following message box
  - Save the spreadsheet using a new file name
    - For this example, you may save it to exercise1.xls
  - When the new spreadsheet is opened, click Ok button to enable stored formulas/equations in the spreadsheet

Sample Problem Exercise #1

- Enter data in the Input Worksheet (numbers in red in spreadsheet)
  - By default, optional tables are not shown. Click yes to show the optional tables (Table 5-8) with their default values. Click no to hide them.
  - Select state = Alabama, and county = Cullman. Notice that initial values for Annual Rainfall and Number of Rain Days are automatically specified in Table 1 as you select a state or county.
  - Select a weather station = Al Birmingham FAA. Notice that correction factors change with the selected weather station.
  - In Table 1, enter the land use areas for your watershed (Refer next slide)
  - Also in Table 1, Select the feedlot percent paved assuming feedlot area is not zero. Default value = 0-24%.

Sample Problem Exercise #1

- Enter data in the Input Worksheet (numbers in red in spreadsheet), cont'd.
  - Also enter data into Tables 2 and 3. Set the number of **months manure applied** to **3**
  - In Table 4, examine the initial USLE parameter values for each land use type which were automatically specified as you selected the state and county.

Table 1	
Cropland	75
Pastureland	20
Feedlots	5

Table 2	
Beef Cattle	10
Dairy Cattle	10
Swine (Hog)	5
Sheep	10
Chicken	100

Table 3	
No. of Septic Systems	5
Population per Septic System	2.38
Septic Failure Rate, %	0.87

You can always change the default and initial data when local data are available.

Sample Problem Exercise #1

- Examine estimated load in Total Load and Graph worksheets and enter the results below:

Total Annual N Load (lb/yr): _____ 4699.1
Total Annual P Load (lb/yr): _____ 1042.7
Total Annual Sediment Load (ton/yr): _____ 428.5

Amount and source with highest annual load contribution:
N load (lb/yr): __2276.2.0 What source: ___ Cropland
P load (lb/yr): __705.6 What source: ___ Cropland
Sediment load (lb/yr): _406.1 What source: ___ Cropland

Note that load reduction = 0 since you have not specified any BMP yet – see next slide

Sample Problem Exercise #1

For the same farm area, estimate total annual load reduction assuming reduced tillage is practiced in cropland areas

- Enter BMP data in BMPs worksheet
  - In Table 1 which is for cropland areas, select Reduced Tillage System under BMP column. Note that initial values of BMP efficiencies are automatically specified with the selected BMP.

Sample Problem Exercise #1

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): _____ 1511.8
Total Annual P Load Reduction (lb): _____467.6
Total Annual Sediment Load Reduction (ton): _____304.6

Source with highest annual load contribution after BMP:
N load (lb): ___2135.9 What source: __Feedlots
P load (lb): ___292.9 What source: __ Feedlots
Sediment load (lb): ___101.5 What source: __Cropland

End of Problem Exercise #1 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #1

- **In the Input worksheet check the box next to Groundwater load calculation**
- Examine estimated load in Total Load and Graph worksheets and enter the results below:

Total Annual N Load (lb/yr): _____ 5221.0
Total Annual P Load (lb/yr): _____ 1065.2
Total Annual Sediment Load (ton/yr): _____ 428.5

Amount and source with highest annual load contribution:
N load (lb/yr): __2135.92 What source: ___ Feedlot
P load (lb/yr): __292.95 What source: ___ Feedlot
Sediment load (lb/yr): _101.52 What source: ___ Cropland

End of Problem Exercise #1 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #2

For the same farm area, estimate total annual load reduction assuming reduced tillage is practiced in cropland areas and Solids Separation Basin BMP on feedlots

- Create a spreadsheet for this project or exercise.
  - Instead of generating a new custom spreadsheet using the STEPL main executable program, you will be using the spreadsheet in the previous exercise.
  - Save the spreadsheet used for Exercise #1 to save recent changes.
  - Save this spreadsheet with a new name (exercise2.xls, be sure to **save the file as *.xls type**). This new spreadsheet will be used for Exercise #2.

Sample Problem Exercise #2

- Enter new data in the Input Worksheet
  - Note that all the input data entered in the previous spreadsheet are still valid
  - Only modification is an additional BMP

Sample Problem Exercise #2

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

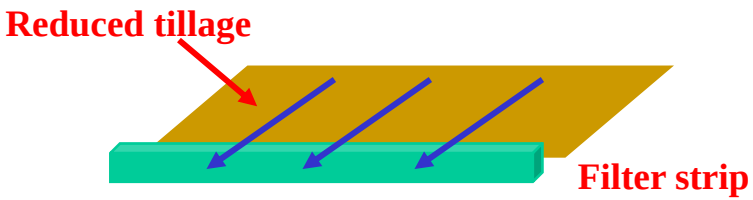
Total Annual N Load Reduction (lb): ____2259.4
Total Annual P Load Reduction (lb): _____ 558.4
Total Annual Sediment Load Reduction (ton): ____ 304.6

Source with highest annual load contribution after BMP:
N load (lb): _1388.3 What source: __Feedlots
P load (lb): _237.97 What source: __Cropland
Sediment load (lb): _101.5 What source: __Cropland

Note that load reductions have been calculated since BMPs have been already specified in the previous exercise. For this exercise, assume that the same BMPs are installed for all cropland and urban areas in the 8-digit watershed.

Sample Problem Exercise #3

Estimate total annual load and load reduction for a watershed that consists more than one farm where all croplands are practicing reduced tillage and filter strips (shown below) and urban open spaces has LID/Bioretention:



Assume all croplands is implementing the above BMP train

Sample Problem Exercise #3

- Create a spreadsheet for this project or exercise.
  - Save the spreadsheet used in Exercise #2 to exercise3.xls.
  - Enter new data in the Input Worksheet

1. Input watershed land use area (ac) and precipitation (in)

Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved
W1	100	500	50	25	0	5	0-24%

2. Input agricultural animals

Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
W1	20	10	0	10	0	2000	0	0	3

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
W1	50	2.38	0.87	0	0

Sample Problem Exercise #3

- Examine estimated load in Total Load and Graph worksheets and enter the results below:

Total Annual N Load (lb): ____17015.2
Total Annual P Load (lb): ____ 4108.5
Total Annual Sediment Load (ton): ___ 1526.7

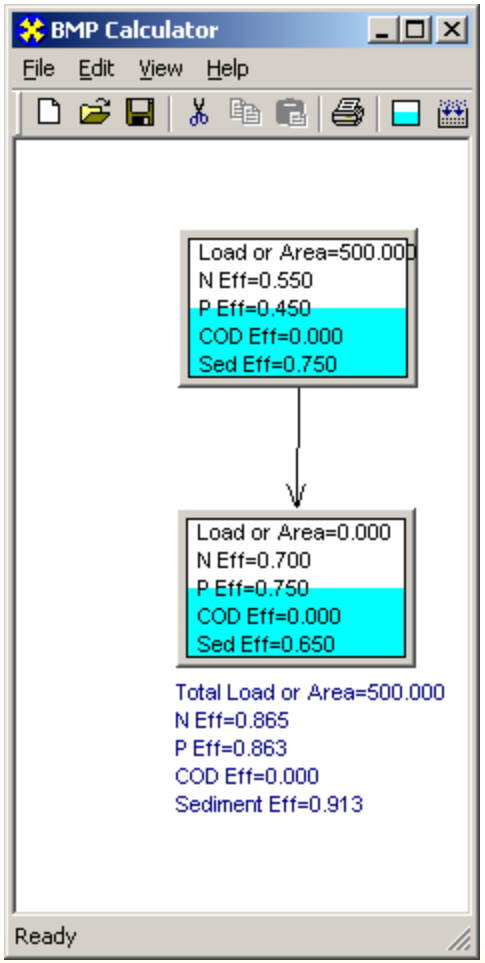
Source with highest annual load contribution:
N load (lb): __11208.3 What source: ___Cropland
P load (lb): __3176.6 What source: ____Cropland
Sediment load (lb): __1467.7 What source: __Cropland

Sample Problem Exercise #3

- Enter BMP data in BMP worksheet
  - In Table 1, which is for cropland areas, select “Combined-BMP calculated” under BMP column to indicate that we have a “Reduced Tillage-Filter Strip” BMP train in croplands.
  - Note that the N, P, BOD, and Sediment BMP efficiencies remained zero. If you have the combined efficiency values for this particular BMP train, enter them in Table 7 (number in red). These values will be reflected in Table 1 and in other tables (i.e., if the same BMP train is implemented for other land uses).
  - If you do not have the values, you may use the BMP calculator (next step)

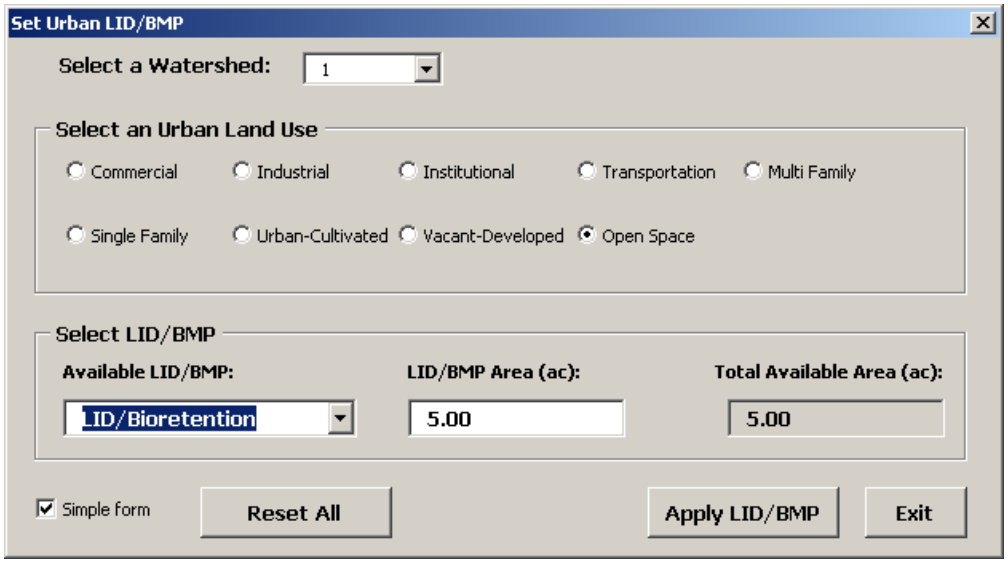
Sample Problem Exercise #3

- Use BMP Calculator to estimate combined efficiencies of the BMP train
  - Run the BMP Calculator by selecting the STEPL/BMP Calculator menu of the STEPL spreadsheet. If the system cannot find the BMP Calculator program, navigate to /STEPL folder and select BMPCalculator.exe
  - Using the BMP Calculator interface, do the following (refer back to slide 13 for steps in using BMP Calculator):
    - Add two BMP boxes (one each for Reduced Tillage, and Filter Strip)
    - Enter BMP information (type, area, etc.) for each BMP box by double-clicking the box (Question: What is the area associated with the filter strip)
    - Specify the connection between the two BMPs (Question: Which BMP should be upstream). You may move the boxes to make them more readable
    - Calculate the combined efficiencies for N, P, BOD, and Sediment (0.865, 0.863, ND, 0.913).
    - Enter the combined efficiencies in Table 7 of STEPL spreadsheet. Note the efficiencies are reflected in Table 1.



Sample Problem Exercise #3

- Click Urban BMP Tool
  - Select Open Space under urban land use options->Select LID/Bioretention under Available LID/BMP -> Click Apply LID/BMP



You can always manually change the initial BMP efficiencies if local data are available.

If your BMP is not in the selection list, you may use STEPL-View/Edit BMP List menu to add your BMP to the database (please refer to the user manual)

Sample Problem Exercise #3

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___9929.3
Total Annual P Load Reduction (lb): ____ 2833.4
Total Annual Sediment Reduction (ton): ____ 1340.0

Source with highest annual load contribution after BMP:
N load (lb): __3952.4 What source: __ Feedlot
P load (lb): __658.6 What source: __Feedlot
Sediment load (lb): __127.7 What source: __Cropland

End of Problem Exercise #3 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #4

- Generate a new custom spreadsheet.
  - Similar to exercise 1 create a new spreadsheet, but specify two watersheds this time (Program-> STEPL-> STEPL)
  - Select options. For Exercise #4, specify the following:
    - Specify number of watershed = 2
    - Select first option under Option for Initialization (default selection – Set initial land use areas and animal numbers to zeros)
  - Click ok to create new spreadsheet
  - Click ok to the following message box
  - Save the spreadsheet using a new file name
    - For this example, you may save it to exercise4.xls
  - When the new spreadsheet is opened, click Ok button to enable stored formulas/equations in the spreadsheet

Sample Problem Exercise #4

- Enter data in the Input Worksheet (numbers in red in spreadsheet)
  - Select state = Alabama, and county = Cullman.
  - Select a weather station = Al Birmingham FAA.

Sample Problem Exercise #4

- Enter data in the Input Worksheet (numbers in red in spreadsheet), cont'd

1. Input watershed land use area (ac) and precipitation (in)

Watershed	Urban	Cropland	Pastureland	Forest	User Defined	Feedlots	Feedlot Percent Paved
W1	10	100	50	0	0	0	0-24%
W2	10	200	60	0	0	10	0-24%

2. Input agricultural animals

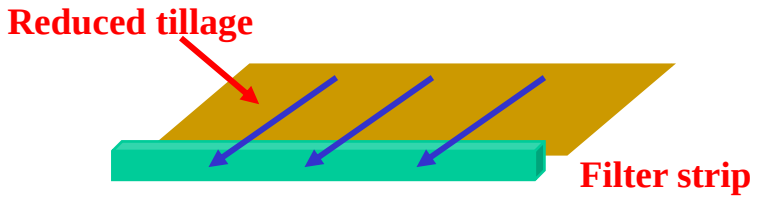
Watershed	Beef Cattle	Dairy Cattle	Swine (Hog)	Sheep	Horse	Chicken	Turkey	Duck	# of months manure applied
W1	10	10	10	10	0	1000	10	0	3
W2	10	10	10	10	0	1000	10	0	3
Total	20	20	20	20	0	2000	20	0	

3. Input septic system and illegal direct wastewater discharge data

Watershed	No. of Septic Systems	Population per Septic System	Septic Failure Rate, %	Wastewater Direct Discharge, # of People	Direct Discharge Reduction, %
W1	10	2.43	2	0	0
W2	10	2.43	2	0	0

Sample Problem Exercise #4

- Cropland in watershed 1 has the same BMP train as in example 2,
- Cropland in watershed 2 has filter strip
- Pastureland in both watersheds has filter strip



Assume all croplands in watershed 1 is implementing the above BMP train

Sample Problem Exercise #4

- Cropland in watershed 1 has the same BMP train as in example 2,
- Cropland in watershed 2 has filter strip
- Pastureland in both watersheds has filter strip

1. BMPs and efficiencies for different pollutants on CROPLAND, ND=No Data

Watershed	Cropland					
	N	P	BOD	Sediment	BMPs	% Area BMP Applied
W1	0.865	0.863	0	0.913	Combined BMPs-Calculated	100
W2	0.7	0.75	ND	0.65	Filter strip	100

7. Combined watershed BMP efficiencies from the BMP calculator

Watershed	Watershed Combined BMP Efficiencies				
	N	P	BOD	Sediment	BMPs
W1-Crop	0.865	0.863	0	0.913	Combined BMPs
W2-Crop	0	0	0	0	Combined BMPs
W1-Pasture	0.7	0.75	0	0.65	Combined BMPs
W2-Pasture	0.7	0.75	0	0.65	Combined BMPs
W1-Forest	0	0	0	0	Combined BMPs
W2-Forest	0	0	0	0	Combined BMPs
W1-User	0	0	0	0	Combined BMPs
W2-User	0	0	0	0	Combined BMPs

Sample Problem Exercise #4

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___ 6909.5
Total Annual P Load Reduction (lb): ____ 1920.5
Total Annual Sediment Reduction (ton): ____ 980.3

Source with highest annual load contribution after BMP:
N load (lb): __2844.1 What source: __ Feedlot
P load (lb): __528.7 What source: __Cropland
Sediment load (lb): __287.6 What source: __Cropland

Sample Problem Exercise #4

- In the Input worksheet, check the box next to ***Treat all the subwatersheds as parts of a single watershed***.
- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___ 6184.3
Total Annual P Load Reduction (lb): ____ 1641.3
Total Annual Sediment Reduction (ton): ____ 753.6

Source with highest annual load contribution after BMP:
N load (lb): __2844.1 What source: __ Feedlot
P load (lb): __483.79 What source: __Cropland
Sediment load (lb): __351.18 What source: __Cropland

End of Problem Exercise #4 – Try adjusting your input data and reexamine the results.

Sample Problem Exercise #5

- Generate a new custom spreadsheet.
  - Similar to exercise 1 create a new spreadsheet, but specify three watersheds this time (Program-> STEPL-> STEPL)
  - Select options. For Exercise #5, specify the following:
    - Specify number of watershed = 3
    - Specify gully formations = 2
    - Specify impaired streambanks = 2
    - Select **second** option under Option for Initialization (Test STEPL model with non-zero initial numbers)
  - Click ok to create new spreadsheet
  - Click ok to the following message box
  - Save the spreadsheet using a new file name
    - For this example, you may save it to exercise5.xls
  - When the new spreadsheet is opened, click Ok button to enable stored formulas/equations in the spreadsheet

Sample Problem Exercise #5

- Enter data in the Input Worksheet (numbers in red in spreadsheet)
  - Select state = Alabama, and county = Cullman.
  - Select a weather station = Al Birmingham FAA.

Sample Problem Exercise #5

- Click Gully and Streambank Erosion button in BMPs Worksheet and enter data in the Gully&Streambank Worksheet (numbers in red in spreadsheet)

1. Gully dimensions in the different watersheds

Watershed	Gully	Top Width (ft)	Bottom Width (ft)	Depth (ft)	Length (ft)	Years to Form	BMP Efficiency (0-1)	Soil Textural Class
W1	Gully1	8	5	5	5	10	0.9	Clay
W3	Gully2	10	5	5	5	5	0.85	Fine Sandy loam

2. Impaired streambank dimensions in the different watersheds

Watershed	Strm Bank	Length (ft)	Height (ft)	Lateral Recession	Rate Range (ft/yr)	Rate (ft/yr)	BMP Efficiency (0-1)	Soil Textural Class
W2	Bank1	5	100	2. Moderate	0.06 - 0.2	0.13	0.95	Clay
W3	Bank2	5	100	3. Severe	0.3 - 0.5	0.4	0.95	Fine Sandy loam

Sample Problem Exercise #5

- Examine estimated load reduction in Total Load and Graph worksheets and enter the results below:

Total Annual N Load Reduction (lb): ___ 20.0

Total Annual P Load Reduction (lb): ____ 7.7

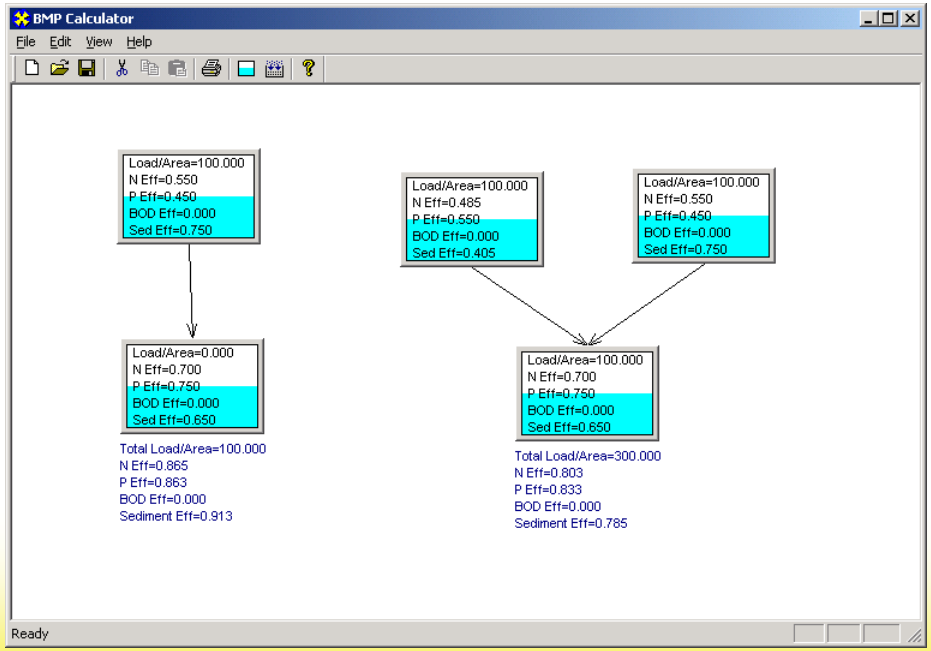
Total Annual Sediment Reduction (ton): ____ 13.8

End of Problem Exercise #5 – Try adjusting your input data and reexamine the results.

BMP Calculator

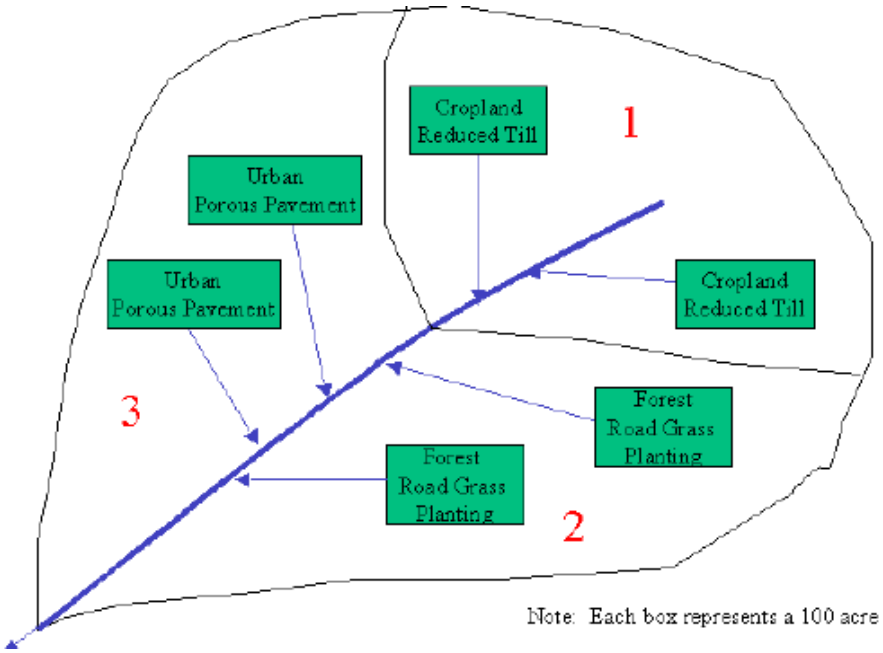
More Exercises for BMP Calculator

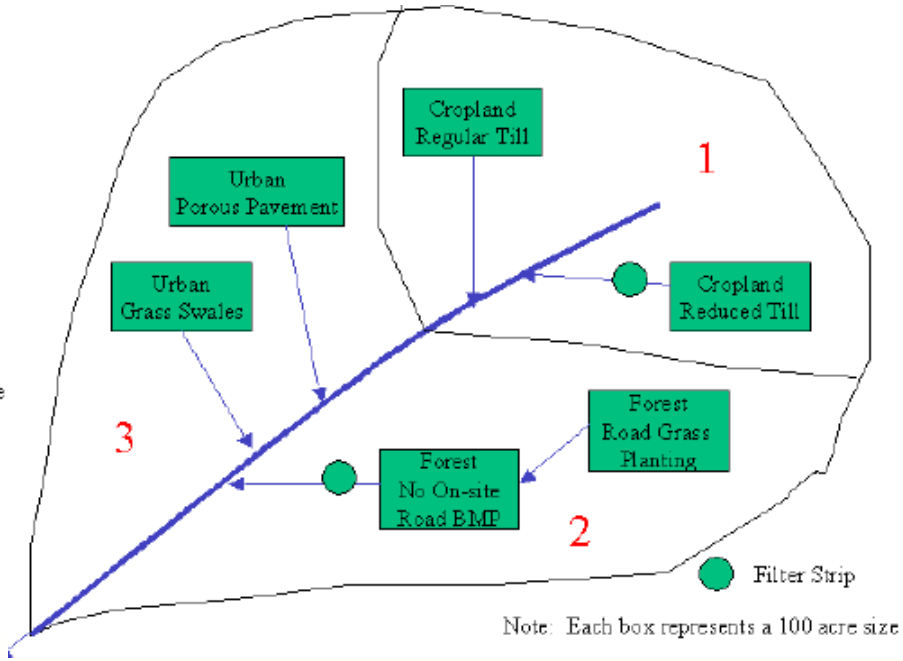
- Try different BMP trains in the BMP Calculator. Note that you may define as many trains as you want and calculate each BMP train's combined efficiency at the same time in the same window. You don't need to open a separate BMP window for each BMP train (see illustration below).



Need of BMP Calculator

- When is BMP Calculator needed?

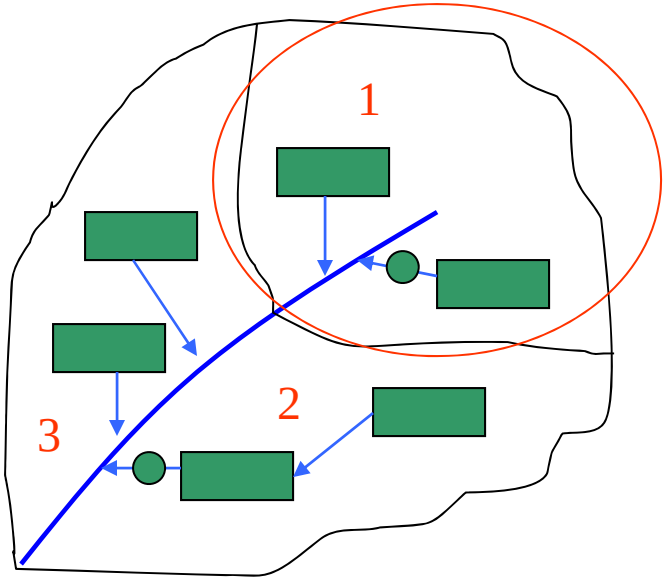




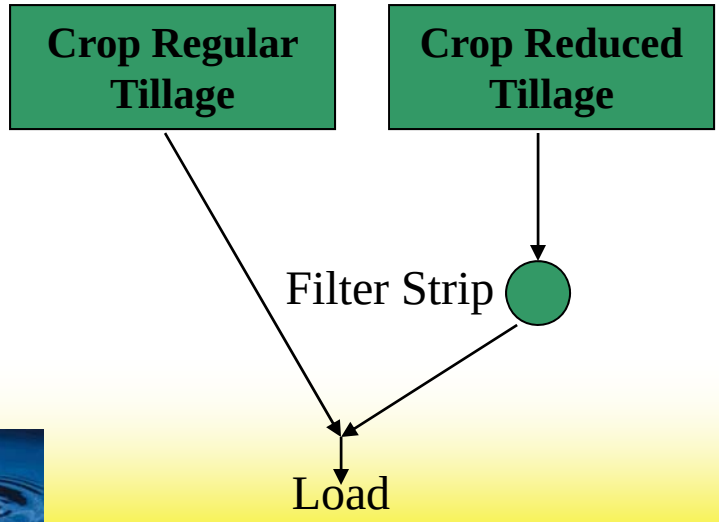
Not needed - No combined efficiency calculation

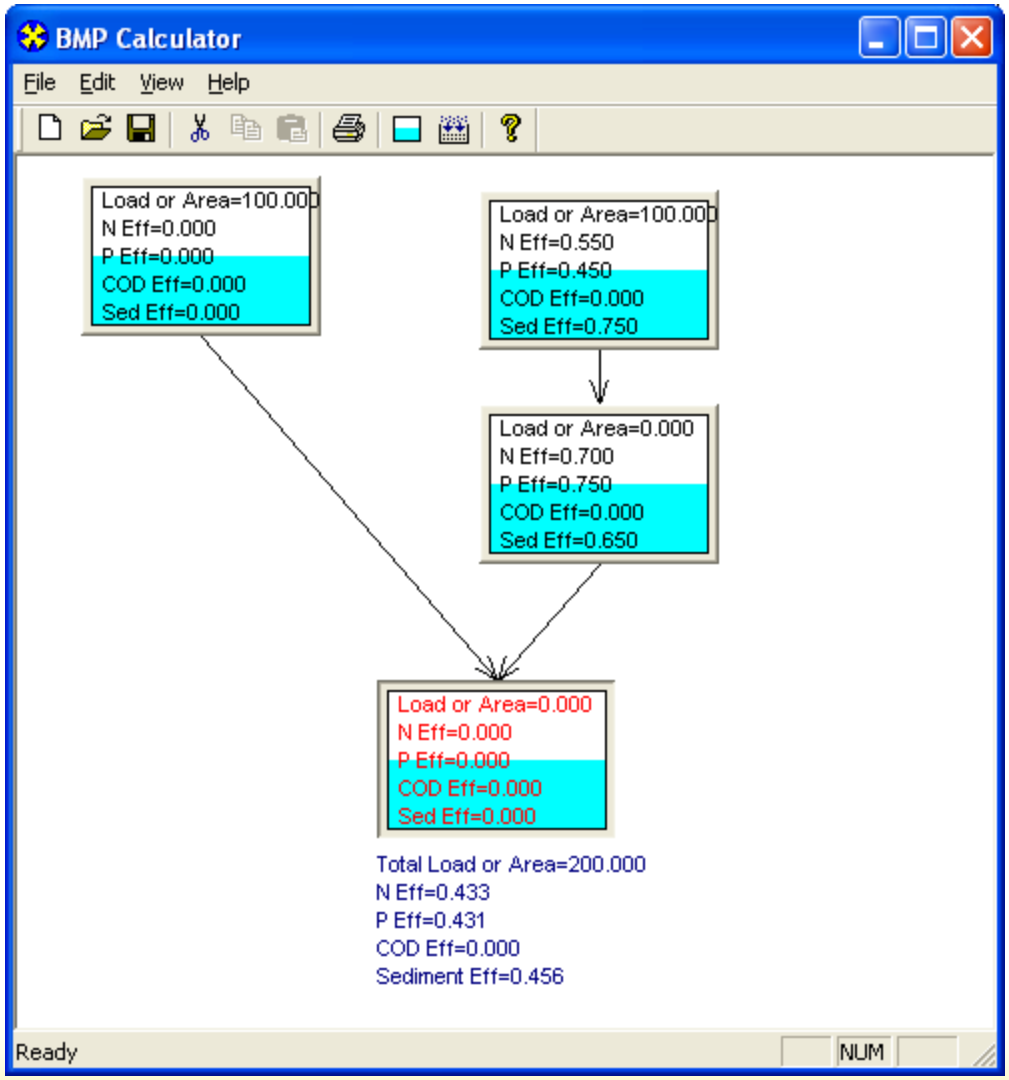
Needed - Each land use type uses more than one type of BMP

BMP Calculator – Example 1

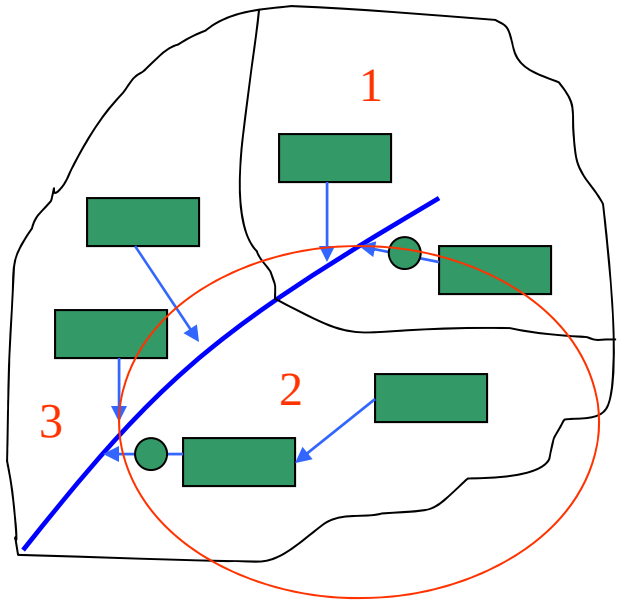


Each box represents 100 ac

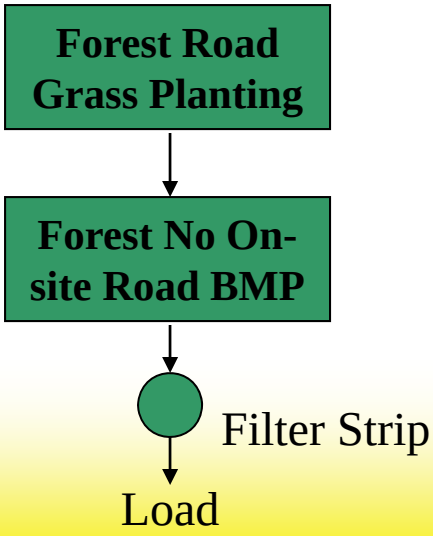


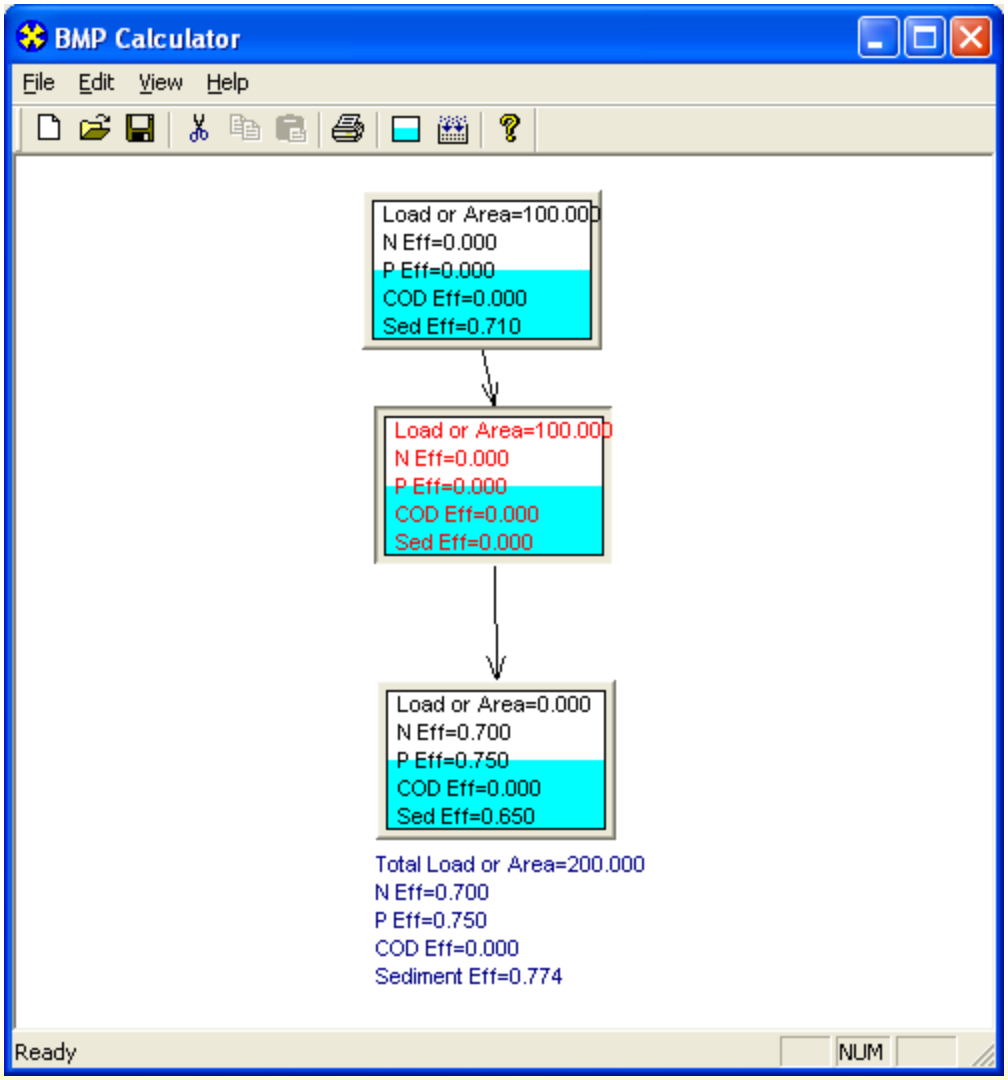


BMP Calculator – Example 2

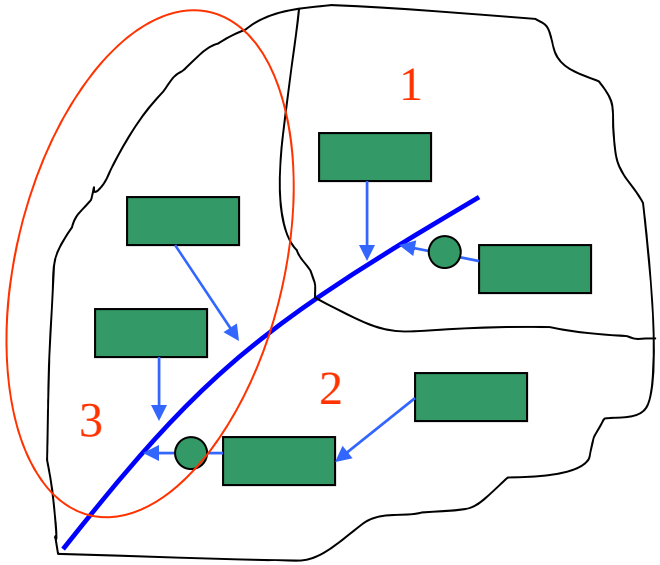


Each box represents 100 ac

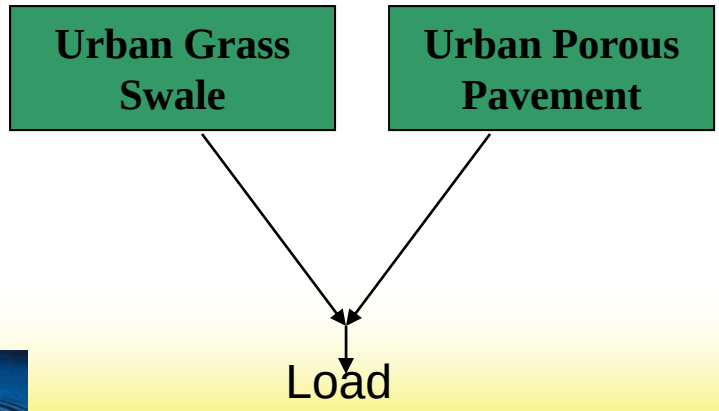


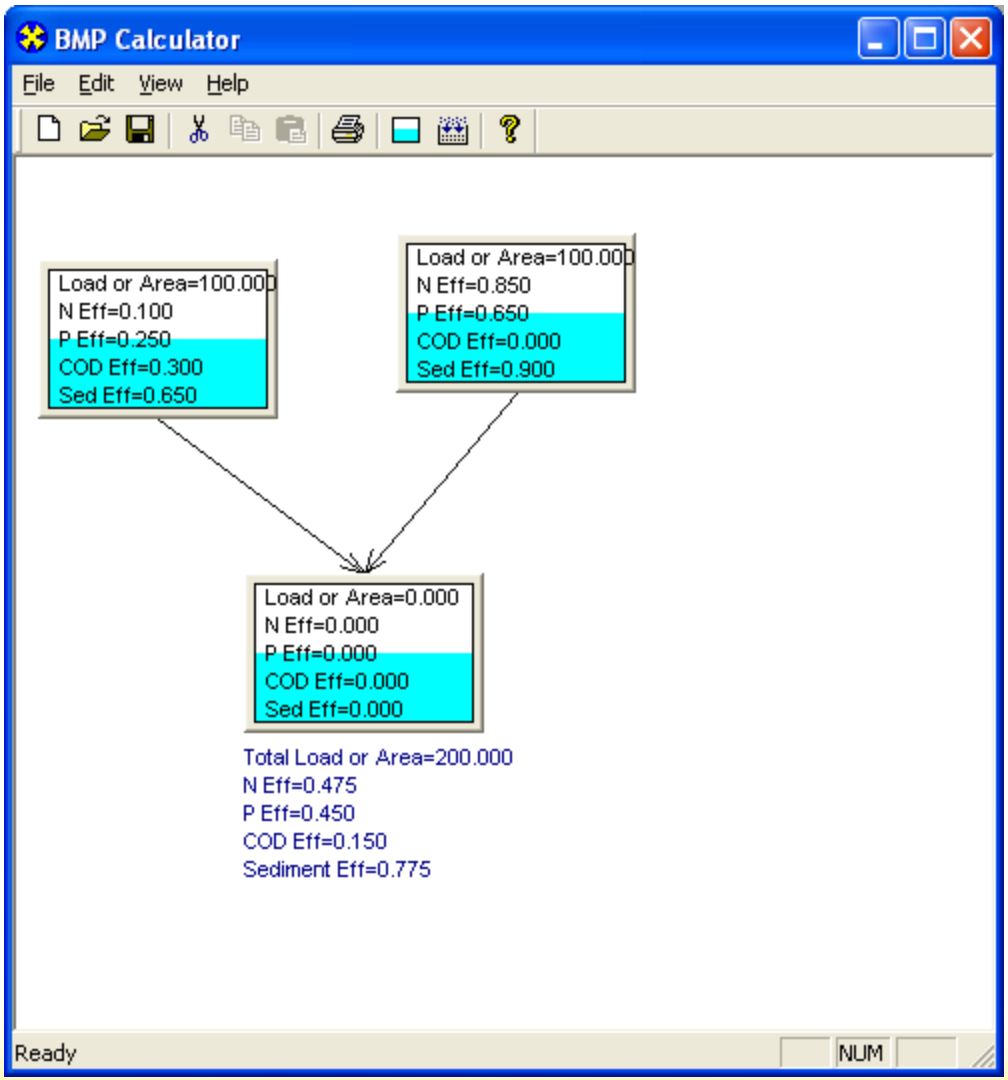


BMP Calculator – Example 3



Each box represents 100 ac

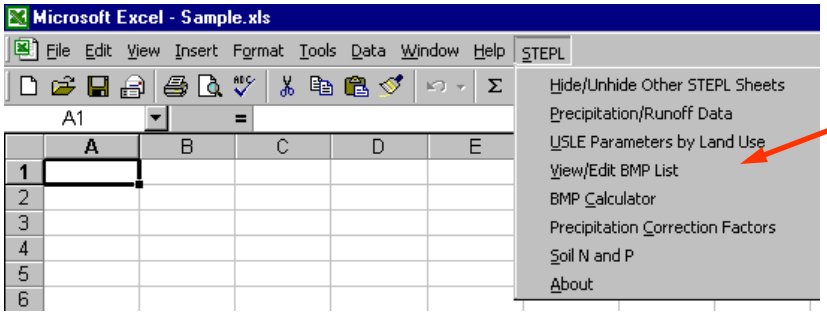




Adding BMP Data

Add New Data to BMP List

- In STEPL customized menu, click “View/Edit BMP List”
- BMPList worksheet is shown, add or delete BMPs



Customized menu

Landuse	BMP & Eff	N	P	BOD	Sediment
Cropland					
Cropland	0 No BMP	0	0	0	0
Cropland	Combined	0	0	0	0
Cropland	Contour Fa	0.485	0.55	ND	0.405
Cropland	Diversion	0.1	0.3	ND	0.35
Cropland	Filter strip	0.7	0.75	ND	0.65
Cropland	Reduced T	0.55	0.45	ND	0.75
Cropland	Streambar	0.75	0.75	ND	0.75
Cropland	Terrace	0.2	0.7	ND	0.85
Pastureland					
Pasturelan	0 No BMP	0	0	0	0
Pasturelan	Combined	0	0	0	0
Pasturelan	User Defin	0.5	0.5	0.5	0.75

Example: New data inserted here

STEPL: Add New Data to BMP List

A	B	C	D	E	F	G
Landuse	BMP & Efficiency	N	P	BOD	Sediment	
Cropland						<Don't Delete
Cropland	0 No BMP	0	0	0	0	<Don't Delete
Cropland	Combined BMPs-Calculated	0	0	0	0	
Cropland	Contour Farming	0.485	0.55	ND	0.405	
Cropland	Diversion	0.1	0.3	ND	0.35	
Cropland	Filter strip	0.7	0.75	ND	0.65	
Cropland	Reduced Tillage Systems	0.55	0.45	ND	0.75	
Cropland	Streambank stabilization and fencing	0.75	0.75	ND	0.75	
Cropland	Terrace	0.2	0.7	ND	0.85	
Pastureland						<Don't Delete
Pastureland	0 No BMP	0	0	0	0	<Don't Delete
Pastureland	Combined BMPs-Calculated	0	0	0	0	
Pastureland	User Defined	0.5	0.5	0.5	0.75	
Forest						<Don't Delete
Forest	0 No BMP	0	0	0	0	<Don't Delete

Instruction:
1. Do not delete the greyed rows.
2. BMP efficiencies should be <=1.
3. If you add a row for a new BMP, you must specify landuse, BMP name, and pollutant removal efficiencies.
4. Type "ND" for no data.
5. Click "Update BMP Data" to update selection boxes on the BMPs sheet.
6. Click "Save Updates" to save the BMP list to external text files in the STEPL/Support folder.

Update BMP Data

Update BMP button (BMPList worksheet)

New BMP added!

New BMP added! (BMPs worksheet)

2. BMPs and efficiencies for different pollutants on pastureland, ND=No Data					
Watershed	Pastureland				
	N	P	BOD	Sediment	BMPs
W1	0.5	0.5	0.5	0.75	User Defined

- Click “Update BMP Data” button to update the BMP selections in the BMPs worksheet
- Click “Save Updates” to save changes to text files (comma delimited)
  - C:or D:\Stepl\Support\AllBMPstepl.csv
  - C: or D:\Stepl\Support\AllBMP.csv

Part 2: Region 5 Model

R5 model is not limited to Region 5

If controls of the model does not work, set EXCEL > Tools > Macro >Macros >Security to Medium

Region 5 model has five functional worksheets.

Estimating Load Reductions For Agricultural and Urban BMPs

This workbook uses the "Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual" (Michigan Department of Environmental Quality, June 1999) to provide a gross estimate of sediment and nutrient load reductions from the implementation of agricultural BMP The methodology for the gross estimate of sediment and other constituent load reductions from the implement urban BMPs is based on reduction efficiencies and calculations developed by Illinois EPA.

Please note: This workbook uses many simplifying assumptions to provide a general ESTIMATE of pollutant load reductions through BMP implementation. More accurate results of pollutant load reductions may be obtained through direct monitoring and/or a more detailed modeling application. In addition, this workbook does not estimate pollutant load reductions for dissolved constituents.

The workbook is divided into worksheets (see bottom of the Window). Each worksheet is specific to a particular source. In some cases, multiple practices may take place for a specific site, then the various worksheets will all need to be completed; one worksheet must be completed for each BMP. The following are the worksheets and what practices they cover:

Worksheet	Possible Practices
Gully Stabilization	Grade Stabilization Structure
	Grassed Waterway
	Critical Area Planting in areas with gullies
	Water and Sediment Control Basins
Bank Stabilization	Animal Trails and Walkways
	Stream Channel Stabilization
	Streambank Protection
Agricultural Fields	Prescribed Grazing
	Residue Management, Mulch Till
	Conservation Crop Rotation
	Conservation Cover
	Cover and Green Manure
	Critical Area Planting
	Stripcropping, Contour
	Stripcropping, Field

Instructions | Gully Stabilization | Bank Stabilization | Ag Fields & Filter Strips | Feedlots | Urban Runoff

Region 5 Load Estimation Model

- Introduction
  - Provide a general estimate of pollutant reduction at the source level
  - Initially developed by Indiana Department of Environmental Management (IDEM) based on Michigan DEQ's pollution control manual for section 319 watersheds.

Source	BMP
Gully	Gully Stabilization
Streambank	Streambank Stabilization
Agricultural Fields	Field Management Practices and Filter Strips
Feedlot	Animal Waste System
Urban Runoff	Various BMPs

Gully Erosion: Calculate Load Reduction

- Select a soil texture (e.g. sand, loamy sand)
- Enter gully dimensions and the number of years since the gully formed

Please fill in the gray areas below:

Parameter	Gully	Example
Top Width (ft)	13	**15**
Bottom Width (ft)	2	**4**
Depth (ft)	1.5	**5**
Length (ft)	300	**20**
Number of Years	5	**5**
Soil Weight (tons/ft3)	0.0425	**0.05**
Soil P Conc (lb/lb soil)* USER	0.0005	**0.0005** *
Soil N Conc (lb/lb soil)* USER	0.001	**0.001** *

* If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations

Estimated Load Reductions

	BMP Efficiency*	Gully	Example
Sediment Load Reduction (ton/year)	1.0	28.7	**10**
Phosphorus Load Reduction (lb/year)		28.7	**8**
Nitrogen Load Reduction (lb/yr)		57.4	**16**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

Gully Stabilization

- Load

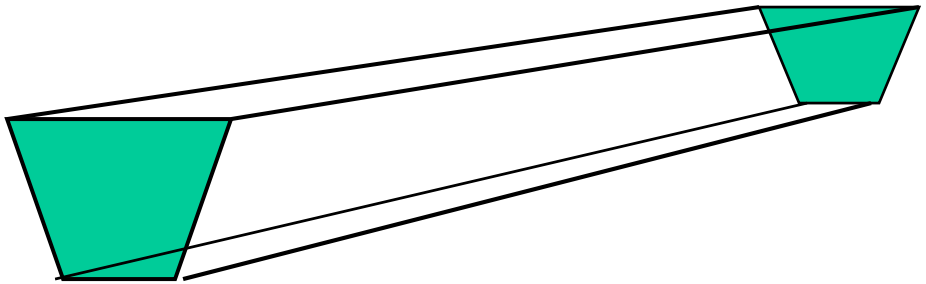
  Average annual erosion during the life of the gully (t/y)

  = Volume x Soil Weight / Years

  Nutrient load

  = Annual Erosion x Soil Nutrient Conc. x Correction Factor

- Load Reduction after implementing gully stabilization
  - Specify reduction efficiency (100% efficiency by default)
  - Reduction is equal to annual erosion x user-specified efficiency



Volume = (Top Width +Bottom Width) x Depth x Length / 2

Gully Erosion: Nutrient Correction Factor

- Correction Factor
  - Smaller soil particles -> larger aggregated surface area -> more nutrients attached

Soil Texture	Nutrient Correction Factor
Clay	1.15
Silt	1.00
Sand	0.85
Peat	1.50

Stream Bank Erosion—Calculation

- Select a soil texture (e.g. silty clay)
- Enter the dimensions of the eroding stream banks

Please fill in the gray areas below:

Parameter	Bank #1	Bank #2	Example
Length (ft)	500	500	**500**
Height (ft)	10	10	**15**
Lateral Recession Rate (ft/yr)*	0.2	0.2	**0.5**
Soil Weight (tons/ft3)	0.0425	0.0425	**0.04**
Soil P Conc (lb/lb soil)** USER	0.0005	0.0005	**0.0005** **
Soil N Conc (lb/lb soil)** USER	0.001	0.001	**0.001** **

** If not using the default values, users must provide input (in red) for Total P and Total N soil concentrations
*Lateral Recession Rate (LRR) is the rate at which bank deterioration has taken place and is measured in feet per year. This rate may not be easily determined by direct measurement. Therefore best professional judgement may be required to estimate the LRR. Please refer to the narrative descriptions in Table 1.

Estimated Load Reductions

	BMP Efficiency* Bank #1	BMP Efficiency* Bank #2	Bank #1	Bank #2	Example
Sediment Load Reduction (ton/year)	1.0	1.0	42.5	42.5	**150**
Phosphorus Load Reduction (lb/year)			42.5	42.5	**150**
Nitrogen Load Reduction (lb/yr)			85.0	85.0	**300**

* BMP efficiency values should be between 0 and 1, and 1 means 100% pollutant removal efficiency.

Stream Bank Erosion

- Load (Channel Erosion)
  = Length * Height * Lateral Recession rate * Soil weight
- Load Reduction
  = Load * Load reduction efficiency

Determining Lateral Recession Rate by Field Observation

Lateral Recession Rate (ft/yr)	Category	Description
0.01 – 0.05	Slight	Some bare bank, no exposed roots
0.06 – 0.2	Moderate	Bank is mostly bare
0.3 – 0.5	Severe	Bank is bare with exposed roots
0.5+	Very Severe	Bank is bare with fallen trees

Agricultural Practices—Usage

- Check BMPs: Agricultural field practices and filter strips (check both)
- Select a state and a county for default USLE parameter values
- Modify the default USLE parameter values for local conditions, especially the cover factor C and the supporting practice factor P to reflect the before and after treatment effects

Please check which BMPs apply:

☑ Agricultural Field Practices

☑ * Filter Strips

Please select a state and a county, and default USLE parame

Users should use the local USLE parameter values if available!

State: Alabama

County: Autauga

Please fill in the gray areas below:

USLE or RUSLE	Before Treatment	After Treatment	Example **Before Treatment**	Example **After Treatment**
Rainfall-Runoff Erosivity Factor (R)	374.69	374.69	**120**	**120**
Soil Erodibility Factor (K)	0.20	0.20	**0.35**	**0.35**
Length-Slope Factor (LS)	0.29	0.29	**0.44**	**0.44**
Cover Management Factor (C<=1.0)*	0.20	0.04	**0.7**	**0.5**
Support Practice Factor (P<=1.0)*	0.99	0.99	**0.775**	**0.11**
Predicted Avg Annual Soil Loss (ton/acre/year)	4.21	0.84	**10.03**	**1.02**

* User must use the local C and/or P values (in red) to obtain the reduction due to the field practices.

Agricultural Practices—Usage 2

- Enter contributing areas (e.g. 50 acres)
- Select a soil texture (e.g. silt)

Estimated Load Reductions for Agricultural Field Practices

	Treated	Example
Sediment Load Reduction (ton/year)	97	**85**
Phosphorus Load Reduction (lb/year)	118	**100**
Nitrogen Load Reduction (lb/yr)	236	**200**

Estimated Additional Load Reductions through Filter Strips

	Filter-Strip Efficiency	Filter-Strip Treated	Example
Sediment Load Reduction (ton/year)	0.65	16	**92**
Phosphorus Load Reduction (lb/year)	0.75	34	**114**
Nitrogen Load Reduction (lb/yr)	0.70	63	**227**

Total Estimated Load Reductions

	Total	Example
Sediment Load Reduction (ton/year)	113	**177**
Phosphorus Load Reduction (lb/year)	152	**214**
Nitrogen Load Reduction (lb/yr)	298	**427**

Note: This worksheet is also applicable to other cases (mining, construction sites) when USLE is used.

Feedlot Pollution Reduction

- Load
  - Enter a contributing area (e.g. 1.74 acre)
  - Specify the percentage of paved area (e.g. 75-100%)
  - Select state and a county (Pennsylvania, Lycoming)
  - Select Weather Station (NY New York Central Park)
  - Enter animal count for each type

Animal Numbers	Animal Type	Design Weight*
0	Slaughter Steer	1,000
0	Young Beef	500
100	Dairy Cow	1,400
30	Young Dairy Stock	500
0	Swine	200
0	Feeder Pig	50
0	Sheep	100
0	Turkey	10
0	Chicken	4
0	Duck	4
0	Horse	1,000

Feedlot Pollution Reduction

- Load Reduction
  - Select a feedlot best management practice (e.g. waste management system)
  - System calculates load reduction using pre-assigned (BOD, P, N) efficiencies for the selected BMP

Estimated Load and Load Reductions

Pollutants	Load before BMP	Load Reduction	Load after BMP
Biochemical Oxygen Demand load (lbs/yr)	8,598	NA	NA
Phosphorus load (lbs/yr)	848	763	85
Nitrogen load (lbs/yr)	7,239	5,791	1,448

Urban Pollution Reduction

- Load
  - Enter size (acres) of storm water sewered and unsewered areas for each urban land use subclass
  - System calculates load using default unit loads for each land use sub class

Please enter landuse of contributing/drainage area in acres:

	Sewered	Unsewered
Commercial	100	10
Industrial	100	10
Institutional	50	10
Transportation	50	0
Multi-Family	100	10
Residential	200	10
Agriculture	0	20
Vacant	20	0
Open Space	250	250

Note: Storm sewers

Urban Pollution Reduction

- Load Reduction
  - Select BMP
  - System calculates load using default BMP efficiencies for the selected BMP

	Pre-BMP Loading (lbs/yr)		Post-BMP Loading (lbs/yr)		Load Reduction (lbs/yr)
BOD	30,640		13,482		17,158
COD	234,750		U		U
TSS	681,250		126,031		555,219
LEAD	531		U		U
COPPER	102		U		U
ZINC	785		U		U
TDS	1,210,084		U		U
TN	7,850		U		U
TKN	4,293		U		U
DP	363		U		U
TP	928		450		478
CADMIUM	6		U		U

U = Removal Efficiency for the particular BMP and constituent unavailable.

Region 5 model vs. STEPL 1

- Region 5 model
  - Calculates load at the source level
  - Sources are independent (no relationship between worksheets)
- STEPL
  - Calculates load for different sources at source and watershed level
  - Sources are related in watershed
  - User can specify and update BMP list
  - BMP calculator for complex BMP arrangements

Part 3: Special Discussion

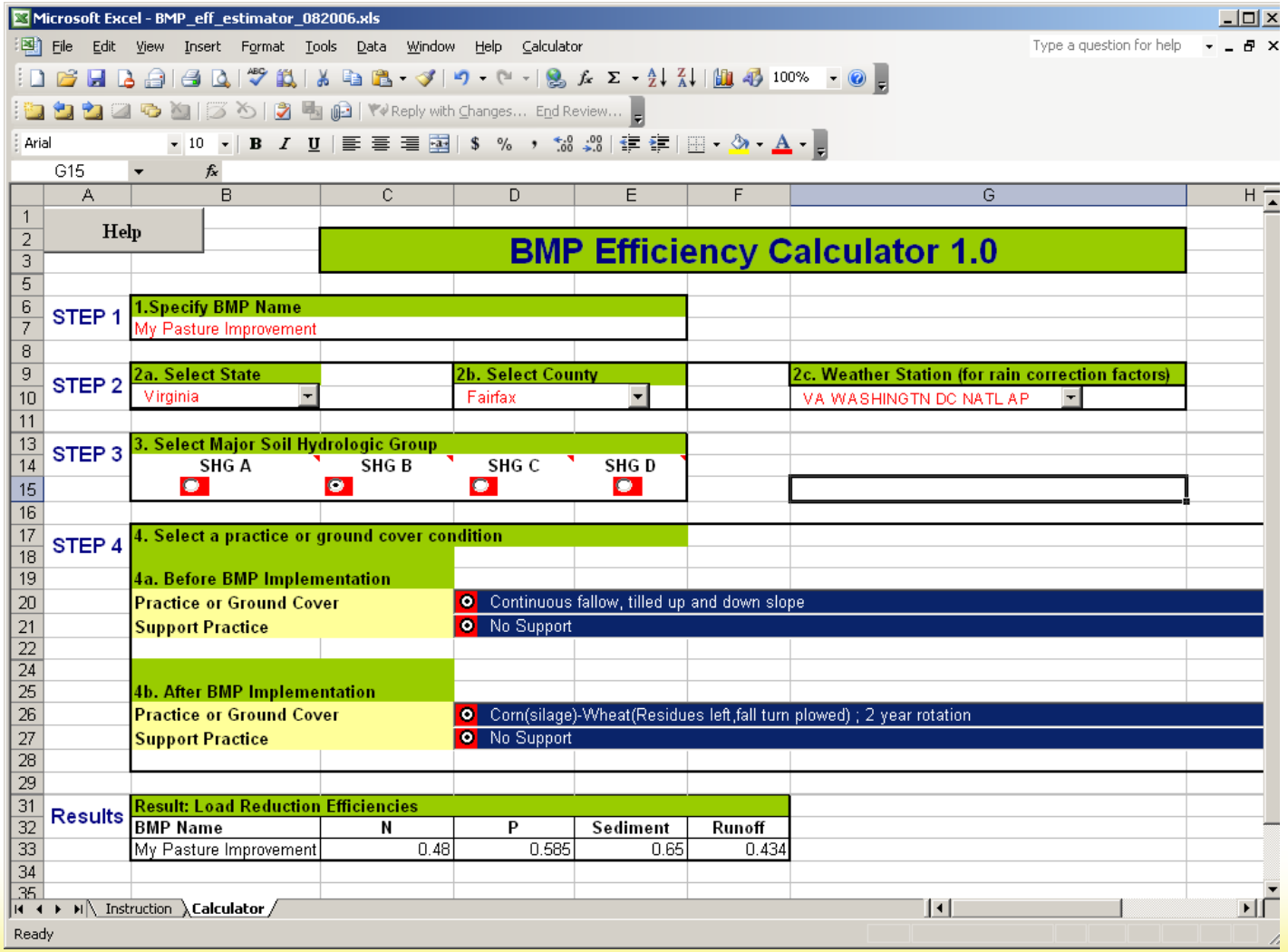
BMP Efficiency Estimator

- Simple calculator to estimate BMP efficiency for non structural BMP
- Estimates efficiency due tochanges in cropping patterns or soil support practices

Models and Documentation

- **BMP Efficiency Calculator (New)**
  (Last updated: 09/24/2008. Please send your comments to STEPL support.)
  - BMP Efficiency Calculator 1.0 Package 

BMP Efficiency Estimator – contd.



Other Alternative Load Models - Simple

Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Simple							
Simple Method	Watershed	Urban	N, P	Event		Low	Low
FHWA	Both	Urban	N, P	Event		Low	Low
SLOSS/ PHOSPH	Both	Rural	P, Sed	Event		Low	Low
Watershed	Both	Both	P	Event	Simple	Medium	Medium

Reference: List of alternative load and load reduction models, STEPL Web site.

Other Alternative Load Models – Mid Range

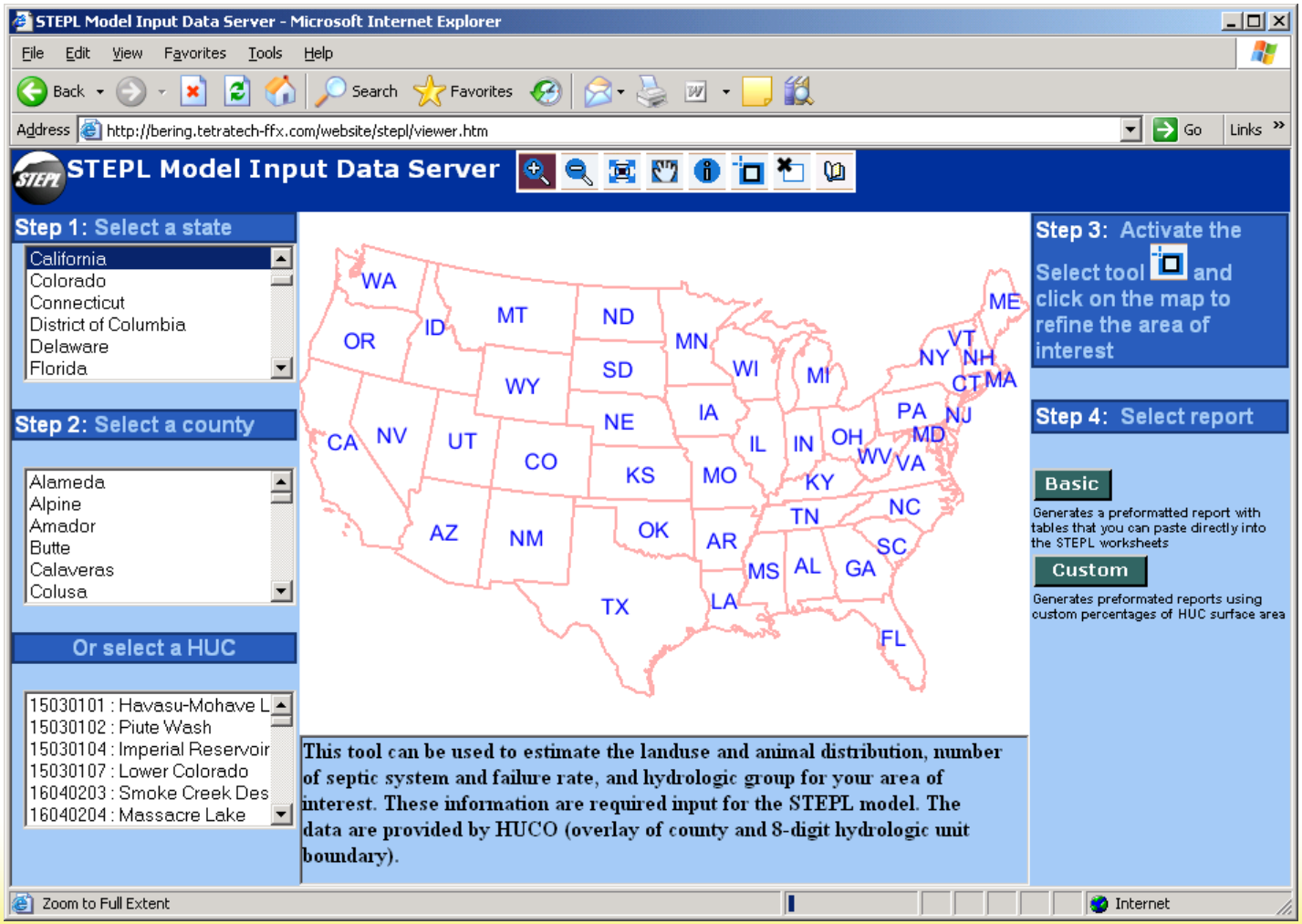
Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Mid Range							
AGNPS	Both	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
GWLF	Both	Both	N, P, Sed	Both	Simple	Low to Medium	Low to Medium

Other Alternative Load Models - Detailed

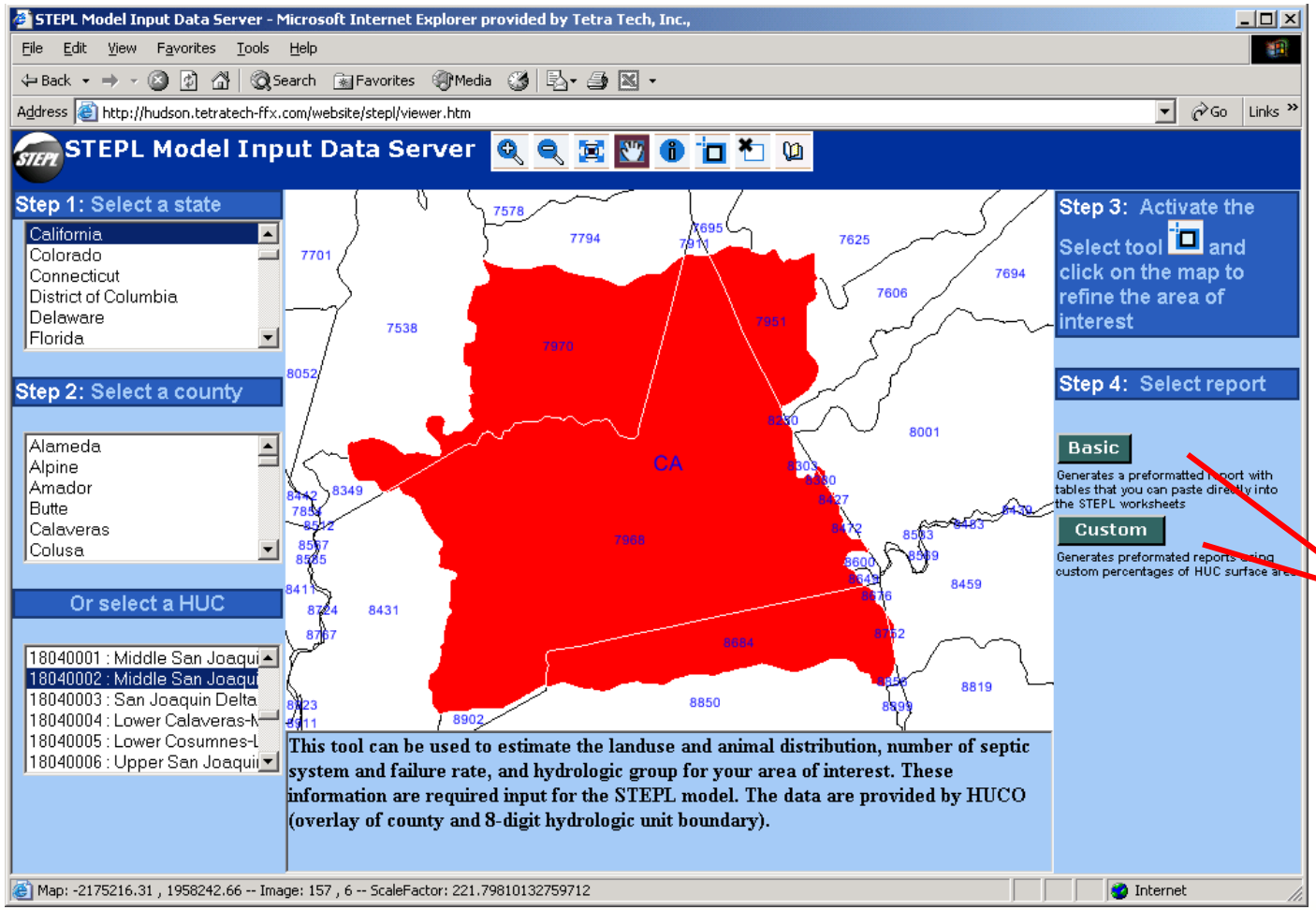
Model	Field or Watershed	Land Use	Pollutant	Event or Continuous	BMP	Data Reqt's	Level of Effort
Detailed/Complex							
ANSWERS	Both	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
GLEAMS	Field	Rural	N, P, Sed	Both	Detailed	Medium to High	Medium to High
HSPF	Both	Both	N, P, Sed	Both	Detailed	Medium to High	Medium to High
SWAT	Both	Rural	N, P, Sed	Both	Detailed	Medium	Medium
SWMM	Both	Both	N, P, Sed	Both	Detailed	High	High
WEPP	Both	Rural	Sed	Continuous	Detailed	Low to High	Low to High

STEPL Online Input Data Server

ONLY FOR PRACTICE!!



STEPL Online Input Data Server



Data is available at HUC and county intersection (HUCO Polygon)

Generate data summaries

Note: Zoom in further to display polygon IDs

STEPL Online Input Data Server: Basic Report

Data is summarized by HUCO polygon

Polygon ID	Urban/Transportation	Cropland	Pasture/Rangeland	Forest	User Defined	Feedlots	Water	Others
7951	1000.00	200.00	58800.00	20600.00	0.00	1.22	1000.00	200.00
7968	61900.00	273100.00	267400.00	5500.00	0.00	349.00	10300.00	43300.00
7970	31100.00	133500.00	31400.00	1400.00	0.00	55.94	3600.00	10800.00
8290	0.90	0.00	81.72	0.00	0.00	0.00	0.00	0.00
8380	67.11	0.00	6107.11	0.00	0.00	0.03	0.00	0.00
			)31.88	0.00	0.00	0.01	0.00	0.00
			79.29	0.00	0.00	0.00	0.00	0.00
			4600.00	0.00	0.00	48.16	2000.00	4300.00
			00	0.00	0.00	0.00	0.00	0.00
			31299.97	27500.00	0.00	454.38	16900.00	58600.00

Polygon ID	Beef Cattle	Dairy Cattle	Swine(Hog)	Sheep	Horse	Chicken	Turkey	Duck
7951	1873	0	11	165	104	110	D	1
7968	28569	113759	16339	1871	2540	3223938+D	1056600	60
7970	7159	22697	503	5781	930	1254374	D	13
8290	D	D	0	0	0	0	2	0
8380	D	D	0	0	0	0	218	0
8427	D	D	0	0	0	0	72	0
8568	D	D	0	0	0	0		
8684	4656	21874	921	1693	170	D		
8752	8	0				D		
Total	42265	15				4478422		

Polygon ID	Hydrological Group
7951	D
7968	B
7970	B
8290	D
8380	D
8427	D
8568	D
8684	B
8752	D

Polygon ID	No. of Septic Systems	Population per Septic System	Septic Failure Rate,%
7951	1479	1.67	0.38
7968	18862	2.81	0.38
7970	6823	2.89	0.38
8290	0	1.92	0.38
8380	5	1.92	0.38
8427	1	1.92	0.38
8568	0	1.92	0.38
8684	1628	3.05	0.38
8752	5	1.86	0.38
Total	28803	2.78	0.38

STEPL: Discussion

- Watershed vs. subwatershed
  - STEPL model is not limited to subwatershed (can apply to farms, scenarios, etc.)
  - Watershed size (make the subwatershed small enough to reflect BMP effectiveness.
  - You want to know the reduction at the local subwatershed level (Sum of loads from subwatersheds ≠ load at the watershed outlet because of the transport loss in the main stem.)
- Local weather data
- How to use the user-defined land use?
- Septic failure rate clarification
- Add new BMPs to the list
- Small treated area vs. large watershed
- R5 100% efficiency assumptions
- Estimate BMP efficiencies using USLE tables

Some useful data!

Estimate BMP Efficiency Using USLE C Value Table I

Generalized Values of Cover and Management Factor (C) for Field Crops East of the Rocky Mountains (Stewart et al 1975).

	Crop, rotation & management b/ (Please use the abbreviation table below!)	Productivity a/ High	Moderate
Continuous fallow, tilled up and down slope		1.00	1.00
CORN			
1	C, RdR, fall TP, conv (1)	0.54	0.62
2	C, RdR, spring TP, conv (1)	0.50	0.59
3	C, RdL, fall TP, conv (1)	0.42	0.52
4	C, RdR, wc seeding, spring TP, conv (1)	0.40	0.49
5	C, RdL, standing, spring TP, conv (1)	0.38	0.48
6	C, fall shred stalks, spring TP, conv (1)	0.35	0.44
7	C(silage)-W(RdL,fall TP) (2)	0.31	0.35
8	C, RdL, fall chisel, spring disk, 40-30% re (1)	0.24	0.30
9	C(silage), W wc seeding, no-till p1 in c-k W (1)	0.20	0.24
10	C(RdL)-W(RdL, spring TP) (2)	0.20	0.28
11	C, fall shred stalks, chisel p1, 40-30% re (1)	0.19	0.26
12	C-C-C-W-M, RdL, TP for C, disk for W (5)	0.17	0.23
13	C, RdL, strip till row zones, 55-40% re (1)	0.16	0.24
14	C-C-C-W-M-M, RdL, TP for C, disk for W (6)	0.14	0.20
15	C-C-W-M, RdL, TP for C, disk for W (4)	0.12	0.17
16	C, fall shred, no-till pl, 70-50% re (1)	0.11	0.18
17	C-C-W-M-M, RdL, TP for C, disk for W (5)	0.087	0.14
18	C-C-C-W-M, RdL, no-till pl 2nd & 3rd C (5)	0.076	0.13
19	C-C-W-M, RdL, no-till pl 2d C (4)	0.068	0.11
20	C, no-till pl in c-k wheat, 90-70% re (1)	0.062	0.14
21	C-C-C-W-M-M, no-till p1 2d & 3rd C (6)	0.061	0.11
22	C-W-M, RdL, TP for C, disk for W (3)	0.055	0.095
23	C-C-W-M-M, RdL, no-till pl 2d C (5)	0.051	0.094
24	C-W-M-M, RdL, TP for C, disk for W (4)	0.039	0.074
25	C-W-M-M-M, RdL, TP for C, disk for W (5)	0.032	0.061
26	C, no-till pl in c-k sod, 95-80% re (1)	0.017	0.053

Estimate BMP Efficiency Using USLE C Value Table II

Generalized Values of Cover and Management Factor (C) for Field Crops East of the Rocky Mountains (Stewart et al 1975).

	Crop, rotation & management b/ (Please use the abbreviation table below!)	Productivity a/ High	Moderate
COTTON /c			
27	Cot, conv (western plains) (1)	0.42	0.49
28	Cot, conv (south) (1)	0.34	0.40
MEADOW (HAY)			
29	Grass & legume mix	0.004	0.01
30	Alfalfa, lespedeza or sericia	0.020	-
31	Sweet clover	0.025	-
SORGHUM, GRAIN (western plains)			
32	RdL, spring TP, conv (1)	0.43	0.53
33	No-till pl in shredded 70-50% re	0.11	0.18
SOYBEANS /c			
34	B, RdL, spring TP, conv (1)	0.48	0.54
35	C-B, TP annually, conv (2)	0.43	0.51
36	B, no-till pl	0.22	0.28
37	C-B, no-till pl, fall shred C stalks (2)	0.18	0.22
WHEAT			
38	W-F, fall TP after W (2)	0.38	-
39	W-F, stubble mulch, 500 lb re (2)	0.32	-
40	W-F, stubble mulch, 1000 lb re (2)	0.21	-
41	Spring W, RdL, Sept TP, conv (ND,SD) (1)	0.23	-
42	winter W, RdL, Aug TP, conv (KS) (1)	0.19	-
43	Spring W, stubble mulch, 750 lb re (1)	0.15	-
44	Spring W, stubble mulch, 1250 lb re (1)	0.12	-
45	Winter W, stubble mulch, 750 lb re (1)	0.11	-
46	Winter W, stubble mulch, 1250 lb re (1)	0.10	-
47	W-M, conv (2)	0.054	-
48	W-M-M, conv (3)	0.026	-
49	W-M-M-M, conv (4)	0.021	-

Estimate BMP Efficiency Using USLE C Value Table III

Values of Cover and Management Factor (C) for Pasture and Woodland (Novotny & Chesters, 1981).

Cover	**Value**
Permanent pasture, idle land, unmanaged woodland	
95-100% ground cover	
as grass	0.003
as weeds	0.01
80% ground cover	
as grass	0.01
as weeds	0.04
60% ground cover	
as grass	0.04
as weeds	0.09
Managed woodland	
75-100% tree canopy	0.001
40-75% tree canopy	0.002-0.004
20-40% tree canopy	0.003-0.01

For example: Increase ground cover from 60% to 80% will reduce erosion about 75%

Estimate BMP Efficiency Using USLE C Value Table IV

Generalized Values of Cover and Management Factor (C) for Field Crops East of the Rocky Mountains (Stewart et al 1975).

Notes and Abbreviations

a/. High level exemplified by long-term yield averages greater than 75 bu/ac corn or 3 ton/ac hay or cotton management that regularly provides good stands and growth.

b/. Numbers in parentheses indicate numbers of years in the rotation cycle. (1) indicates a continuous one-crop system.

c/. Grain sorghum, soybeans or cotton may be substituted for corn in lines 12,14,15, 17-19, 21-25 to estimate values for sod-based rotations.

Abbreviations:

B	soybeans	F	fallow
C	corn	M	grass & legume hay
c-k	chemically killed	pl	plant
conv	conventional	W	wheat
cot	cotton	wc	winter cover
lb re	pounds of residue per acre remaining on surface after new crop seeding		
% re	percentage of soil surface covered by residue mulch after new crop seeding		
xx-yy% re	xx% cover for high productivity, yy% for moderate		
RdR	residues (corn stover, straw, etc.) removed or burned		
RdL	residues left on field (on surface or incorporated)		
TP	turn plowed (upper 5 or more inches of soil inverted, covering residues		

Estimate BMP Efficiency Using USLE P Value Table

Values of Supporting Practice Factor (P) (Stewart et al 1975).

Practice Slope(%):	1.1-2	2.1-7	7.1-12	12.1-18	18.1-24
No support practice	1.00	1.00	1.00	1.00	1.00
Contouring	0.60	0.50	0.60	0.80	0.90
Contour strip cropping					
R-R-M-M /a	0.30	0.25	0.30	0.40	0.45
R-W-M-M	0.30	0.25	0.30	0.40	0.45
R-R-W-M	0.45	0.38	0.45	0.60	0.68
R-W	0.52	0.44	0.52	0.70	0.90
R-O	0.60	0.50	0.60	0.80	0.90
Contour listing or ridge planting	0.30	0.25	0.30	0.40	0.45
Contour terracing /b	$0.6/n^{½}$	$0.5/n^{½}$	$0.6/n^{½}$	$0.8/n^{½}$	$0.9/n^{½}$

a/. R = row crop, W = fall-seeded grain, M = meadow. The crops are grown in rotation and so arranged on the field that row crop strips are always separated by a meadow or winter-grain strip.

b/. These factors estimate the amount of soil eroded to the terrace channels. To obtain off-field values, multiply by 0.2. n = number of approximately equal length intervals into which the field slope is divided by the terraces. Tillage operations must be parallel to the terraces.

For example: Contouring will reduce sediment by 10-40% depending on slope

Estimate Runoff Changes Using Curve Number

Runoff Curve Numbers (Antecedent Moisture Condition II) for Cultivated Agricultural Land (Soil Conservation Service, 1986).

Land Use/Cover		Hydrologic Condition	A	B	C	D <- Soil Hydrologic Group
Fallow Bare Soil		-	77	86	91	94
Crop residue cover (CR)		Poor *	76	85	90	93
		Good	74	83	88	90
Row Crops	Straight row (SR)	Poor	72	81	88	91
		Good	67	78	85	89
	SR+CR	Poor	71	80	87	90
		Good	64	75	82	85
Contoured (C)		Poor	70	79	84	88
		Good	65	75	82	86
	C+CR	Poor	69	78	83	87
		Good	64	74	81	85
Contoured & terraced (C&T)		Poor	66	74	80	82
		Good	62	71	78	81
C&T + CR		Poor	65	73	79	81
		Good	61	70	77	80
Small	SR	Poor	65	76	84	88
Grains		Good	63	75	83	87
	SR+CR	Poor	64	75	83	86
		Good	60	72	80	84
	C	Poor	63	74	82	85
		Good	61	73	81	84
	C+CR	Poor	62	73	81	84
		Good	60	72	80	83
	C&T	Poor	61	72	79	82
		Good	59	70	78	81
	C&T + CR	Poor	60	71	78	81
		Good	58	69	77	80
Close-	SR	Poor	66	77	85	89
seeded or		Good	58	72	81	85
broadcast	C	Poor	64	75	83	85
legumes or		Good	55	69	78	83
rotation	C&T	Poor	63	73	80	83
meadow		Good	51	67	76	80

Estimate Runoff Changes Using Curve Number II

Runoff Curve Numbers (Antecedent Moisture Condition II) for Other Rural Land (Soil Conservation Service, 1986).

Land Use/Cover	Hydrologic Condition	Soil Hydrologic Group	A	B	C	D
Pasture, grassland or range		Poor/a	68	79	86	89
- continuous forage for grazing		Fair	49	69	79	84
		Good	39	61	74	80
Meadow – continuous grass, protected from grazing, generally mowed for hay		-	30	58	71	78
Brush - brush/weeds/grass mixture		Poor/b	48	67	77	83
with brush the major element		Fair	35	56	70	77
		Good	30	48	65	73
Woods/grass combination		Poor	57	73	82	86
(orchard or tree farm) /c		Fair	43	65	76	82
		Good	32	58	72	79
Woods		Poor/d	45	66	77	83
		Fair	36	60	73	79
		Good	30	55	70	77
Farmsteads – buildings, lanes, driveways and surrounding lots		-	59	74	82	86

a) Poor: 50% ground cover or heavily grazed with no mulch; Fair: 50 to 75% ground cover and not heavily grazed; Good: > 75% ground cover and lightly or only occasionally grazed.

b) Poor: < 50% ground cover; Fair 50 to 75% ground cover; Good: > 75% ground cover.

c) Estimated as 50% woods, 50% pasture.

d) Poor: forest lifter, small trees and brush are destroyed by heavy grazing or regular burning; Fair: woods are grazed but not burned and some forest lifter covers the soil; Good: Woods are protected from grazing and litter and brush adequately cover the soil.

Estimate Runoff Changes Using Curve Number III

Runoff Curve Numbers (Antecedent Moisture Condition II) for Arid and Semiarid Rangelands (Soil Conservation Service, 1986).

Land Use/Cover	Hydrologic Condition	Soil Hydrologic Group	A	B	C	D
Herbaceous - grass, weeds & low-growing brush; brush the minor component		Poor /a	-	80	87	93
		Fair	-	71	81	89
		Good	-	62	74	85
Oak/aspen - oak brush, aspen, mountain mahogany, bitter brush, maple and other brush	Poor		-	66	74	79
		Fair	-	48	57	63
		Good	-	30	41	48
Pinyon/juniper - pinyon, juniper or both; grass understory		Poor	-	75	85	89
		Fair	-	58	73	80
		Good	-	41	61	71
Sagebrush with grass understory		Poor	-	67	80	85
		Fair	-	51	63	70
		Good	-	35	47	55
Desert scrub - saltbush, greasewood, creosotebrush, blackbrush, bursage, palo verde, mesquite and cactus		Poor	63	77	85	88
		Fair	55	72	81	86
		Good	49	68	79	84

a. Poor: < 30% ground cover (litter, grass and brush overstory); Fair: 30 to 70% ground cover; Good: 70% ground cover.

Estimate Runoff Changes Using Curve Number IV

Runoff Curve Numbers (Antecedent Moisture Condition II) for Urban Areas (Soil Conservation Service, 1986).

Land Use/Cover	Hydrologic Condition	Soil Hydrologic Group	A	B	C	D
Open space (lawns, parks, golf courses, cemeteries, etc.):						
Poor condition (grass cover < 50%)			68	79	86	89
Fair condition (grass cover 50-75%)			49	69	79	84
Good condition (grass cover> 75%)			39	61	74	80
Impervious areas:						
Paved parking lots, roofs, driveways, etc.)			98	98	98	98
Streets and roads:						
Paved with curbs & storm sewers			98	98	98	98
Paved with open ditches			83	89	92	93
Gravel			76	85	89	91
Dirt			72	82	87	89
Western desert urban areas:						
Natural desert landscaping (pervious areas, only)			63	77	85	88
Artificial desert landscaping (impervious weed barrier, desert shrub with 1-2 in sand or gravel mulch and basin borders)			96	96	96	96