
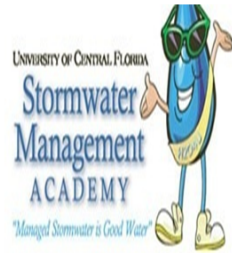




BMPTRAINS Model Updates

Mike Hardin, PhD, PE, CFM

- Geosyntec working on updating model with several new features
 - Fix minor errors and improve general functionality
 - Cost analysis
 - Catchments with multiple land uses
 - FLUCCS Code EMC lookup

Stormwater BMP Treatment Trains [BMPTRAINS@]		CLICK HERE TO START	HELP - INTRODUCTION
		INTRODUCTION PAGE	HELP AND BACKGROUND
Model requires the use of Excel 2007 or newer			1) There is a users manual to help navigate this program and it is available at www.stormwater.ucf.edu
This program is compiled from stormwater management publications and deliberations during a two year review of the stormwater rule in the State of Florida. Input from the members of the Florida Department of Environmental Protection Stormwater Review Technical Advisory Committee and the staff and consultants from the State Water Management Districts is appreciated. The State Department of Transportation provided guidance and resources to compile this program. The Stormwater Management Academy is responsible for the content of this program.			2) This spreadsheet is best viewed at 1280 BY 1080 PIXELS screen resolution. If the maximum resolution of your computer screen is lower than 1280 BY 1080 PIXELS you can adjust the view in the Excel VIEW menu by zooming out to value smaller than 100 PERCENT.
			3) This spreadsheet has incorporated ERROR MESSAGE WINDOWS. Your analysis is not valid unless ALL ERROR MESSAGE WINDOWS are clear.
			4) PRINTING INSTRUCTIONS: Many options. One is to print the page to MICROSOFT OFFICE DOCUMENT IMAGE WRITER (typically the default) or ADOBE PDF, save the page as an image document, then print the document you saved.
			5) Click on the button located on the top of this window titled CLICK HERE TO START to begin the analysis.
<p>Disclaimer: These workbooks were created to assist in the analysis of Best Management Practice calculations. All users are responsible for validating the accuracy of the internal calculations. If improvements are noted within this model, please e-mail Marty Wanielista, Ph.D., P.E. at martin.wanielista@ucf.edu with specific information so that revisions can be made.</p> <p>The authors of this program were Christopher Kuzio, Marty Wanielista, Mike Hardin, and Kienisimma Gogo-Abite. The version 8.0 updates of this program were done by Marty Wanielista (UCF) and Mike Hardin (Geosyntec Consultants). This is version 8.0 of the program, updated on May 1, 2016. Comments are appreciated</p>			
		HELP - HYDROGRAPH AND LEGACY PROGRAMS	
		SMADA ONLINE	

WATERSHED CHARACTERISTICS V 8.0		GO TO STORMWATER TREATMENT ANALYSIS	Blue Numbers = <input type="text"/>	Input data	HELP - LAND USES/EMC
SELECT CATCHMENT CONFIGURATION 5/15/2016		CLICK ON CELL BELOW TO SELECT CONFIGURATION	Red Numbers = <input type="text"/>	Calculated	
CATCHMENT NO.1 NAME: <input type="text"/>		VIEW AVERAGE ANNUAL RUNOFF "C" Factor	VIEW CATCHMENT CONFIGURATION		
CLICK ON CELL BELOW TO SELECT		VIEW EMC & FLUCCS	OVERWRITE DEFAULT CONCENTRATIONS USING:		
Pre-development land use: with default EMCs	CLICK ON CELL BELOW TO SELECT	GO TO GIS LANDUSE DATA	EMC(N): <input type="text"/> mg/L	PRE: <input type="text"/> mg/L	POST: <input type="text"/> mg/L
Post-development land use: with default EMCs	CLICK ON CELL BELOW TO SELECT		EMC(P): <input type="text"/> mg/L		
Total pre-development catchment area:	<input type="text"/>		USE DEFAULT CONCENTRATIONS		
Total post-development catchment or BMP analysis area:	<input type="text"/>		Average annual pre runoff volume:	<input type="text"/>	ac-ft/year
Pre-development Non DCIA CN:	<input type="text"/>		Average annual post runoff volume (note no BMP area):	<input type="text"/>	ac-ft/year
Pre-development DCIA percentage:	<input type="text"/>	%	Pre-development Annual Mass Loading - Nitrogen:	<input type="text"/>	kg/year
Post-development Non DCIA CN:	<input type="text"/>		Pre-development Annual Mass Loading - Phosphorus:	<input type="text"/>	kg/year
Post-development DCIA percentage:	<input type="text"/>	%	Post-development Annual Mass Loading - Nitrogen:	<input type="text"/>	kg/year
Estimated BMP Area (No loading from this area)	<input type="text"/>	AC	Post-development Annual Mass Loading - Phosphorus:	<input type="text"/>	kg/year

STORMWATER TREATMENT ANALYSIS:		V 8.0	GO TO GENERAL SITE INFORMATION PAGE		Blue Numbers =	Input data
					Red Numbers =	Calculated
If not done, specify pre- and post-development watershed characteristics.				5/15/2016		
GO TO WATERSHED CHARACTERISTICS				<p>SELECT CATCHMENT CONFIGURATION Go to Watershed Characteristics</p>		
<p><u>Total Required Treatment Efficiency:</u></p> <p>Required Treatment Eff (Nitrogen): <input type="text"/> %</p> <p>Required Treatment Eff (Phosphorus): <input type="text"/> %</p>						
Select one of the BMPs below to analyze efficiency or review the summary data.						
RETENTION BASIN	WET DETENTION / MAP	EXFILTRATION TRENCH	RAIN GARDEN	SWALE	USER DEFINED BMP	
PERVIOUS PAVEMENT	STORMWATER HARVESTING	FILTRATION including Up-Flow Filters	View Media Mixes	<p>NOTE !!!: All individual system must be sized prior to being analyzed in conjunction with other systems. Please read instructions in the CATCHMENT AND TREATMENT SUMMARY RESULTS tab for more information.</p>		
GREENROOF	RAINWATER HARVESTING	LINED REUSE POND & UNDERDRAIN INPUT	GO TO COST ANALYSIS WORKSHEET			
VEGETATED NATURAL BUFFER	VEGETATED FILTER STRIP	TREE WELL	CATCHMENT AND TREATMENT SUMMARY RESULTS			

WET DETENTION/ MANAGED AQUATIC PLANTS:

5/15/2016 V 8.0

Also called: FLOATING ISLANDS and includes a wet detention pond:

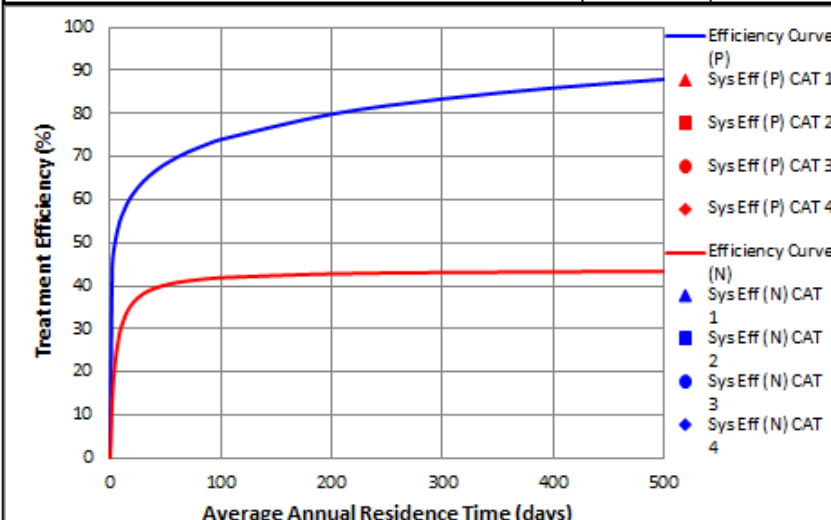
	Catchment 1	Catchment 2	Catchment 3	Catchment 4	
Total pre-development catchment area:	0.000	0.000	0.000	0.000	ac
Total post-development catchment area:	0.000	0.000	0.000	0.000	ac
Average annual residence time (between 1 and 500 days):					days
Littoral Zone or other improvements used?*					
Littoral Zone or other improvement efficiency credit:					%
Floating Wetland or Mats used in the design:					
Floating Wetland or Mats credit:					%
Total Nitrogen removal required:					%
Total Phosphorus removal required:					%
Total Nitrogen removal efficiency:	0.000	0.000	0.000	0.000	%
Total Phosphorus removal efficiency:	0.000	0.000	0.000	0.000	%
Is the wet detention sufficient:					
Average annual runoff volume:					ac-ft/yr
* pond coverage must follow Regulatory Requirements					
Wet Detention Pond Characteristic:					
Minimum Pond Permanent Pool Volume:					ac-ft

Blue Numbers =
Red Numbers =

Input data
Calculated or Carryover

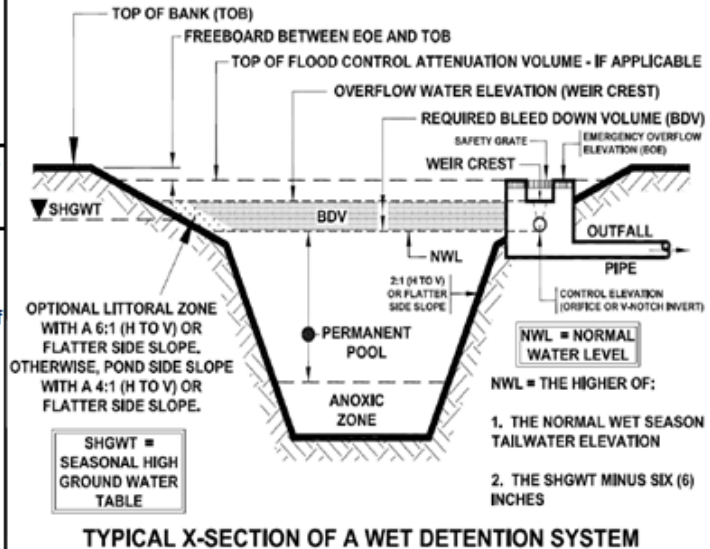
GO TO STORMWATER TREATMENT ANALYSIS

REQUIRED REMAINING TREATMENT EFFICIENCIES OF TREATMENT SYSTEM IN SERIES WITH FLOATING ISLANDS WITH WET DETENTION. USE FOR SIZING OF TREATMENT SYSTEM IN SERIES WITH FLOATING ISLANDS WITH WET DETENTION.



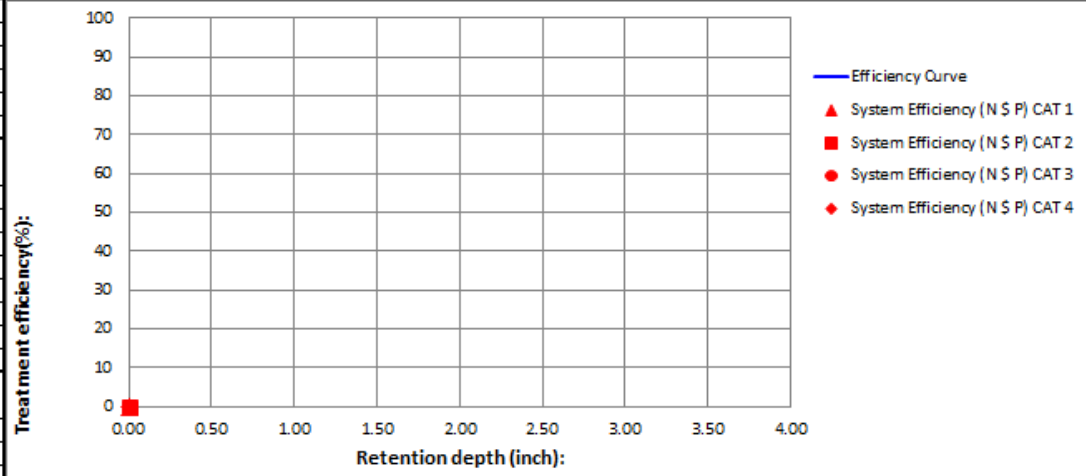
NOTE FOR TREATMENT EFFICIENCY GRAPH:

The purpose of the treatment efficiency graphs is to help illustrate the treatment efficiency of the wet detention system as the function of average annual residence time (and permanent pool volume). The graph illustrates that there is a point of diminished return as the permanent pool volume is substantially increased. Therefore, to provide the most economical BMP treatment system, other alternatives such as "treatment trains" and compensatory treatment should be considered.



Source of Graphic: draft **STORMWATER QUALITY APPLICANT'S HANDBOOK** dated March 2010, by the Department of Environmental Protection, available at: <http://www.dep.state.fl.us/water/wetlands/ep/rules/stormwater>, March 2010

PERVIOUS PAVEMENT:		5/15/2016	V 8.0	0	Blue Numbers =	Input data																																								
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CONTRIBUTING WATERSHED AND PERVIOUS PAVEMENT CHARACTERISTICS:				GO TO STORMWATER TREATMENT ANALYSIS																																										
Pervious Pavement Section Storage Calculator (S)				VIEW TYPICAL PERVIOUS PAVEMENT SYSTEM SCHEMATIC																																										
Catchment 1	Layer	Thickness (in):	Operational Porosity (%):	Storage (in):	Note: There are loadings from this BMP area needing treatment. Contributing catchment area: Required treatment efficiency (Nitrogen): Required treatment efficiency (Phosphorus): Storage provided in specified pervious pavement system: Area of the pervious pavement system: Provided retention over the contributing catchment area: Provided treatment efficiency (Nitrogen): Provided treatment efficiency (Phosphorus):	<table border="1" style="width:100%; text-align: center;"> <tr> <td>Catchment 1</td> <td>Catchment 2</td> <td>Catchment 3</td> <td>Catchment 4</td> <td></td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>ac</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>%</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>in</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>ac</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>in</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>%</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>%</td> </tr> </table>	Catchment 1	Catchment 2	Catchment 3	Catchment 4		0.000	0.000	0.000	0.000	ac					%	0.000	0.000	0.000	0.000	in					ac	0.000	0.000	0.000	0.000	in	0.000	0.000	0.000	0.000	%	0.000	0.000	0.000	0.000	%
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Recycled (crushed) concrete		21.00																																												
BOLD & GOLD™		9.00																																												
Other SubBase																																														
Catchment 2	Layer	Thickness (in):	Operational Porosity (%):	Storage (in):	Remaining treatment efficiency needed (Nitrogen): Remaining treatment efficiency needed (Phosphorus): Remaining retention depth needed if retention:	<table border="1" style="width:100%; text-align: center;"> <tr> <td></td> <td></td> <td></td> <td></td> <td>%</td> </tr> <tr> <td></td> <td></td> <td></td> <td></td> <td>%</td> </tr> <tr> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>0.000</td> <td>in</td> </tr> </table>					%					%	0.000	0.000	0.000	0.000	in																									
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	Pvmt/ SubBase																																													
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	Pvmt Name																																													
Pvmt/ SubBase																																														
#57 rock		21.00																																												



CATCHMENTS AND TREATMENT SUMMARY RESULTS					V 8.0	Blue Numbers = Red Numbers =	Input data Calculated or Carryover																																																																																	
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						<div style="background-color: yellow; padding: 5px; border: 1px solid black; margin-bottom: 5px;"> HELP - SERIES </div> <div style="background-color: yellow; padding: 5px; border: 1px solid black; margin-bottom: 5px;"> HELP - 3 CATCHMENTS </div> <div style="border: 2px solid red; border-radius: 50%; padding: 10px; display: inline-block;"> GO TO COST ANALYSIS WORKSHEET </div>																																																																																		

- New worksheet added which allows for cost analysis
- Can access worksheet from either Stormwater Treatment Analysis sheet or Catchment and Treatment Summary Results worksheet

STORMWATER TREATMENT ANALYSIS: V 8.0		GO TO GENERAL SITE INFORMATION PAGE		Blue Numbers =	Input data																			
If not done, specify pre- and post-development watershed characteristics.		5/15/2016		Red Numbers =	Calculated																			
<p>GO TO WATERSHED CHARACTERISTICS</p> <p><u>Total Required Treatment Efficiency:</u></p> <p>Required Treatment Eff (Nitrogen): <input type="text"/> %</p> <p>Required Treatment Eff (Phosphorus): <input type="text"/> %</p>			<p>SELECT CATCHMENT CONFIGURATION</p> <p>Go to Watershed Characteristics</p>																					
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	Catchment 1	Optional Identification Catchment 2	Catchment 3	Catchment 4																				
BMP Name																								
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<p>Summary Performance of Entire Watershed</p>																								
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- A literature review was performed of published BMP cost data
 - Button will direct users to website with information
- Choose between Capital Cost analysis and Net Present Worth Analysis
- User supplies interest rate
- User supplies duration for analysis
- User supplies cost of water (if relevant)
- As many as 25 different scenarios can be evaluated
- Make sure that the same treatment objective is achieved for each scenario

- **Cost data is user defined**
 - Too variable to use fixed values
 - Can use values from literature review
 - Convert to present cost
- **Cost data required**
 - Land cost
 - Fixed cost (mobilization, etc)
 - BMP cost (based on cost per unit treatment volume)
 - Maintenance cost (annual cost)
 - Supplemental water provided (cost benefit, if relevant)
 - BMP life, replacement cost

Life Cycle Cost Comparison Worksheet

What type of analysis would you like to perform?				What Scenario is running? (max 25)		Mass of N removed [kg/yr]		RESET COST ANALYSIS DATA	RESET BMP DATA ONLY
Interest Rate [%]		Project Duration [yrs]		Cost of water [\$ / 1000gal]		Mass of P removed [kg/yr]		GO TO STORMWATER TREATMENT ANALYSIS	GO TO COST ANALYSIS SUMMARY SHEET

	BMP	Treatment volume [ac-ft] ^{2b}	If User Defined BMP, Specify the unit that cost is based on [???] ^c	Cost of Land needed for BMP [\$]	Expected Life [yrs]	BMP Fixed Cost [\$]	BMP Cost [\$ / ac-ft] ^d	BMP Cost [\$]	Estimated Annual BMP Maintenance Cost [\$ / yr]	If User Defined BMP Estimate Annual Difference of Supplemental Water Required and Harvested water supplied [1000 gal/yr]	Estimated Annual Cost Recovery [\$ / yr]	Total Annual Cost [\$ / yr]	Estimated Future Cost of Replacement [\$]	Present Value of Replacement [\$]	Present Worth [\$]
Catchment 1											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
Catchment 2											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
Catchment 3											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
Catchment 4											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	
											\$ -	\$ -		\$0.00	

COST REFERENCE DATA	PERFORM COST ANALYSIS	\$ -
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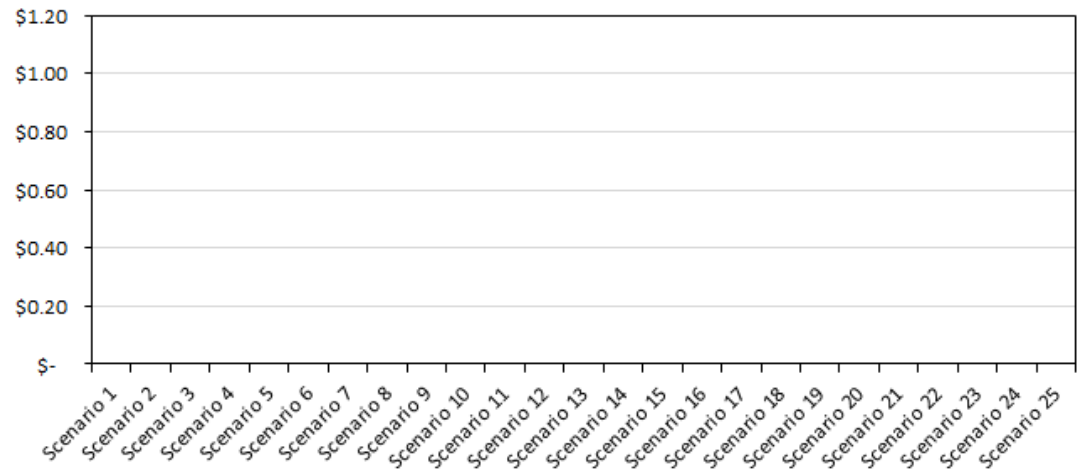
^{2b} If green roof, Vegetated Natural Buffer, or Vegetated Filter Strip the Treatment Area should be used in units of square feet of BMP area
^c If green roof, Vegetated Natural Buffer, or Vegetated Filter Strip the cost should be in \$/sf of BMP area
^d If stormwater harvesting or rainwater harvesting this treatment volume in terms of inches harvested, converted to feet, multiplied by the EIA
^e If Stormwater harvesting or rainwater harvesting this term should be in terms of cost per ac-ft, with the area based on the EIA
^f This is equivalent to the treatment volume specified in column C and could be hours, square foot, ac-ft, or whatever the BMP cost is based on.

[GO TO COST ANALYSIS WORKSHEET](#)

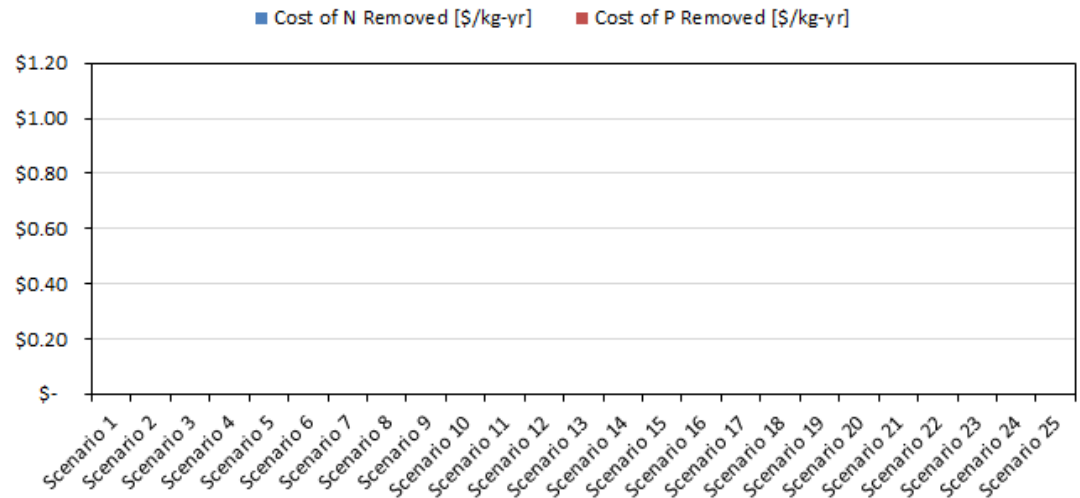
Life Cycle Cost Analysis Summary

	Capital Cost [\$]	Cost of N Removed [\$/kg-yr]	Cost of P Removed [\$/kg-yr]
Scenario 1			
Scenario 2			
Scenario 3			
Scenario 4			
Scenario 5			
Scenario 6			
Scenario 7			
Scenario 8			
Scenario 9			
Scenario 10			
Scenario 11			
Scenario 12			
Scenario 13			
Scenario 14			
Scenario 15			
Scenario 16			
Scenario 17			
Scenario 18			
Scenario 19			
Scenario 20			
Scenario 21			
Scenario 22			
Scenario 23			
Scenario 24			
Scenario 25			

Life Cycle Cost Analysis Summary Capital Cost [\$]



Life Cycle Cost of N and P Removed [\$/kg-yr]



- Cost analysis results presented
 - Total project cost
 - Cost per lb of TN removed
 - Cost per lb of TP removed
 - Presented in both tabular and graphical form
- Reset BMP data button
- Reset cost data button
- Go to Stormwater Treatment Analysis button
- Go to Cost Summary Analysis button
- Perform Cost Analysis button
- Cost Reference Data button

Multiple Land Use Catchments and FLUCCS Code EMC look up

- New worksheet added which allows for calculation of composite EMC for multiple land use catchments
- Can access worksheet from Watershed Characteristics

WATERSHED CHARACTERISTICS V 8.0		GO TO STORMWATER TREATMENT ANALYSIS	Blue Numbers = Input data	Red Numbers = Calculated	HELP - LAND USES/EMC
SELECT CATCHMENT CONFIGURATION 5/15/2016		CLICK ON CELL BELOW TO SELECT CONFIGURATION			
CATCHMENT NO.1 NAME:		VIEW AVERAGE ANNUAL RUNOFF "C" Factor	VIEW CATCHMENT CONFIGURATION		
Pre-development land use: with default EMCs		CLICK ON CELL BELOW TO SELECT	OVERWRITE DEFAULT CONCENTRATIONS USING:		
Post-development land use: with default EMCs		CLICK ON CELL BELOW TO SELECT	EMC(N):	PRE: mg/L	POST: mg/L
Total pre-development catchment area:			EMC(P):	mg/L	mg/L
Total post-development catchment or BMP analysis area:			USE DEFAULT CONCENTRATIONS		
Pre-development Non DCIA CN:					
Pre-development DCIA percentage:					
Post-development Non DCIA CN:					
Post-development DCIA percentage:					
Estimated BMPArea (No loading from this area)					
CATCHMENT NO.2 NAME:					
Pre-development land use: with default EMCs					
Post-development land use: with default EMCs					
Total pre-development catchment area:					
Total post-development catchment or BMP analysis area:					
Pre-development Non DCIA CN:					
Pre-development DCIA percentage:					
Post-development Non DCIA CN:					
Post-development DCIA percentage:					
Estimated BMPArea (No loading from this area)					
CATCHMENT NO.3 NAME:					
Pre-development land use: with default EMCs					
Post-development land use: with default EMCs					
Total pre-development catchment area:					
Total post-development catchment or BMP analysis area:					
Pre-development Non DCIA CN:					
Pre-development DCIA percentage:					
Post-development Non DCIA CN:					
Post-development DCIA percentage:					
Estimated BMPArea (No loading from this area)					

- Up to 4 different catchments
- Uses FLUCCS codes to look up EMC values
 - EMC values based on Harper, 2007 data and 2013 IRL report
- Handles pre- and post separately
- Can overwrite TN and/or TP for any entry
- Computes flow weighted average EMC
 - $$EMC = \frac{\sum_{i=1}^n CN_i \times A_i \times EMC_i}{\sum_{i=1}^n CN_i \times A_i}$$
- Computes area weighted average CN
 - $$CN = \sum_{i=1}^n \frac{CN_i \times A_i}{A_i}$$

Multiple Land Use Catchments and FLUCCS Code EMC look up

IMPORT GIS LAND USE DATA

V 8.0

Instructions: The data required for this analysis is as follows; Basin ID, FLUCCSCODE, Soils Hydro Group, CN, and Area. This data is typically derived by using the ArcGIS geoprocessing tool intersect and performing an intersect on the basins of interest, soils polygons, and land use polygons. The resulting attribute table can then be exported to Excel where any final data formatting and processing can be done to get it ready to copy into this spreadsheet. Data must be sorted by Basin ID for this table to work properly. The user can use up to four catchments for this analysis. The user may overwrite any EMC by manually entering in a value in the first two columns. All this must be done for both the pre and post development conditions when this tool is used.

Note: Soil hydrologic groups should be single class. For example, A/D would be assigned B, B/D would be assigned C, and C/D would be assigned D. This is due to the fact that this is an annual average analysis and the soils will behave as drained during part of the year and not drained during other parts of the year. To assume D would artificially increase runoff. Additionally, it is recommended that, due to compaction, the soil hydrologic group remain consistent in the pre and post development conditions for these dual class soils.

[GO TO WATERSHED CHARACTERISTICS](#)

[VIEW EMC & FLUCCS](#)

Pre-Development EMC Calculation Table

EMC Overwrite		Basin ID	FLUCCSCODE	FLUCSDESC	HYDROGRP	CN	Area [acres]	Compressed Land Use	Area [acres] (for CN)	CN*Area	EMC's Based on		CN*Area * TN _{EMC}	CN*Area * TP _{EMC}	New Basin?	Subbasin		Basin ID	Basin Area [acres]	Basin CN [area weighte]
TN [mg/L]	TP [mg/L]										TN [mg/L]	TP [mg/L]				TN [mg/L]	TP [mg/L]			
									0	0										
									0	0										
									0	0										
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									0	0										

Summary

Basin ID	Basin Area [acres]	Pre-Development			Pre-Development		
		TN [mg/L]	TP [mg/L]	CN	TN [mg/L]	TP [mg/L]	CN

Post-Development EMC Calculation Table

EMC Overwrite		Basin ID	FLUCCSCODE	FLUCSDESC	HYDRO GRP	CN	Area [acres]	Compressed Land Use	Area [acres] (for CN)	CN*Area	EMC's Based on		CN*Area * TN _{EMC}	CN*Area * TP _{EMC}	New Basin?	Subbasin		Basin ID	Basin Area [acres]	Basin CN [area weighte]
TN [mg/L]	TP [mg/L]										TN [mg/L]	TP [mg/L]				TN [mg/L]	TP [mg/L]			
									0	0										
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