GREATER LAKES

Reconnecting the Great Lakes Water Cycle

GREEN INFRASTRUCTURE OPTIMIZATION TOOL

http://bit.ly/GreenInfrastructureOptimizationTool

USER GUIDE

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INTRODUCTION

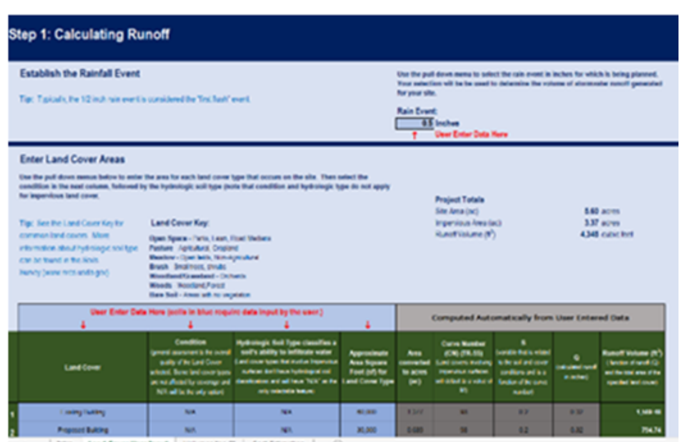
The Greater Lakes Green Infrastructure Optimization Tool, which can be found at http://bit.ly/GreenInfrastructureOptimizationTool, was developed to generate stormwater runoff volumes, identify the areas needed to manage those volumes and then compare the costs of various green management practices to manage the predicted volume. The estimates from the Greater Lakes Green Infrastructure Optimization Tool are for scoping purposes and comparison purposes only and are intended to identify potential retention volumes. Once a management practice approach is selected, there are other tools/calculators that can provide more precision in the estimates prior to proceeding to final design. The results allow the user to make informed decisions, including cost comparisons with traditional detention basin systems when making stormwater management decisions.

Because many, if not most, green infrastructure projects are initiated to manage excessive stormwater, the tool is designed to allow the users to evaluate cost when selecting a green infrastructure solution. The tool is an innovative MS-Excel based tool that utilizes the TR-55 Method to estimate the site specific stormwater volume generated by a “design storm”, and then compares the cost and required areas for a variety of green infrastructure management practices required to effectively manage the volume of stormwater generated on the specific sites. The tool includes several “help features” embedded in the spreadsheet to assist the user with the selection of the input values needed to utilize the tool.

The following steps assist the user with entering the data and provide an explanation of the results.

STEP 1: CALCULATING RUNOFF

The first step to using the tool is to select the “design storm” to input the rain event and calculate the volume of storm runoff to be generated on the site. The user can click on the *Land Cover User Input* tab at the bottom of the page to get started. Data should only be entered into the light blue areas.



At the top of the worksheet, there is a drop-down entry cell to select the design storm. To define the rain event, use the pull down menu to select the desired rainfall event in inches. In general, 0.5” of rain is considered the amount of rain that generates a first flush event.

Once the rain event has been selected, the user can begin to enter the land cover types that occupy the site. The **first column** under the *Enter Land Covers Areas* section has several land cover type selections that are presented in a drop down menu. If 15 selections are not needed, use the blank option in the pull down menu. For examples of the available land uses associated with the land cover, mouse over the *Land Cover Key*.

In the **second column**, the user can select the condition of the land cover type entered in the first column by using the pull down menu. The land cover condition selections include N/A, Good, Fair, and Poor and are based on the most common land cover in the selected subarea. Please note that the land cover condition does not apply for land cover types that involve an impervious surface (i.e., proposed buildings). The user should select the "N/A" option. The user can also "mouse over" the column heading to see the range percentages and select the appropriate condition.

The drop down menu options for the **third column** present the user with selections that pertain to hydrologic soil type. A general description for each hydrologic soil type can be found by hovering the cursor over the column heading. Please note that hydrologic soil types for land cover types that involve an impervious surface (i.e., proposed buildings) are not applicable, and the user should select the "N/A" option. For more information regarding soil type and hydrologic soil groupings, go to the NRCS website at www.nrcs.usda.gov.

In the **fourth column**, the user can input the square footage of the area for the land cover type that was selected in the first column. The tool will automatically convert the area into acres.

The calculated runoff volumes are presented in the last column in white generated using the TR-55 Method by land cover type. The total volume of stormwater for the site is listed under Project Totals, which can be found above the data input table.

Please note that changes to the land cover type selections do not automatically update the selections for the user provided information in the second, third and fourth columns. Changes to these cells will require the user to manually update the information.

STEP 2: GREEN INFRASTRUCTURE PLANNING

With the stormwater runoff volumes calculated, the user is presented with several green infrastructure management practice options based on the land cover types that were specified in Step 1. To begin, select the *Volumes for GI* tab at the bottom of the page.

For each land cover type that was selected on the *Land Cover User Input* table in Step 1, a table will be presented to the user to select management practices that can be potentially incorporated into the site design. The management practice options are restricted based on the land cover type. For example, green and blue roofs can only be selected for proposed and existing buildings; therefore they will not be an available option for land cover types like open space, or existing parking lots.

The user can select the preferred management practice by using a drop down menu in the **first column**. Once selected, the design parameters for the management practice will need to be specified in the subsequent columns. These criteria are size, measured by surface area in square feet in **column two**, ponding depth in **column three**, planting media depth in **column four**, and stone base depth in **column five**. With the exception of the size, the design criteria have selectable options available as a drop down menu for each cell. Please note that ponding depth, planting media depth, and stone base depth may not be applicable for some management practices. In these cases, select 0.

1 Existing Building

User Enter Data Here (cells in blue require data input by the user.)

This column calculates the volume of stormwater stored with respect to the management practice selected and design criteria specified by the user.

This column calculates the remaining stormwater volume needed.

Management Practice	Surface Area (sf)	Ponding Depth (in) (if sf is 0, select 0)	Planting Media Depth (in) (if sf is 0, select 0)	Stone Base Depth (in) (if sf is 0, select 0)	Storage Volume (ft^3)	Remaining Unstored Volume (ft^3)	Percent Volume Stored
Green Roof	500	4	6	0	217	1,373	13.6%
Blue Roof	100	4	0	0	33	1,339	2.1%
Green Roof	250	4	6	0	108	1,231	6.8%
						Total Runoff without GI:	1,589
						Total Storage from GI:	358
						Total Remaining Volume:	1,231

Based on the management practices selected, the calculator will automatically calculate a storage volume that can be used to determine how much stormwater can be captured and infiltrated using green infrastructure. In some cases, the total remaining volume may be negative, indicating a surplus of storage. In these cases, the user can adjust the design criteria to balance the sizing of the management practice with the amount of stormwater volume generated on the site. These adjustments will prevent over design and help to prevent increased construction and maintenance costs.

Please note that changes to the management practice selection column will not automatically update the subsequent design criteria columns. The user will have to manually update the information in these cells. For instances where no green infrastructure is desired, input a "0" value in the surface area column. Once completed, select the *Cost Estimation* tab at the bottom of the page to move on to the final step.

STEP 3: COST ANALYSIS

This step provides a cost analysis for implementing green infrastructure management practices in comparison to implementing traditional detention basin systems. The land cover types and management practices that were previously selected are shown with the corresponding construction and annual maintenance cost information. For each land cover type, the management practice shown in the second column in gray (i.e., cistern, or underground storage) represents a gray infrastructure management practice that could potentially be used to capture the balance of the stormwater volume that is not captured by green infrastructure. If the sizing of the green infrastructure management practices is adequate to capture all of the stormwater volume generated, then the required storage volume for gray infrastructure will automatically be set to "0".

Step 3: Cost Analysis

Notes:

For land covers where the management practices selected do not store all of the projected stormwater runoff volume, it is assumed that the balance of the volume will be captured using underground storage or a cistern. It is assumed that underground storage and cisterns will not be implemented for land covers that are not impervious

Cost Comparison:

Cost Comparison			Assumptions
Total Cost without Green Infrastructure:	$	56,220.15	Assumes that no underground storage or cisterns are constructed alternatives to GI on land covers that are not impervious.
Total Cost with Green Infrastructure:	$	101,038.73	
Lowest Cost Option:	$	48,279.14	Cost is generated by using the lowest cost option for each land cover category.

	Land Cover	Management Practice	Size	Unit	Unit Price	Construction Cost	Maintenance Cost (estimated on an annual basis)	Total Cost	Cost Using no GI	Cost Using GI
1	Existing Building	Green Roof	500	SF	$ 15.00	$ 7,500.00	$ 206.00	$ 7,706.00	$ 15,974.29	$ 24,352.04
		Blue Roof	100	SF	$ 4.00	$ 400.00	$ 20.00	$ 420.00		
		Green Roof	250	SF	$ 15.00	$ 3,750.00	$ 103.00	$ 3,853.00		
		Cistern	1,231	CF	$ 10.00	$ 12,311.49	$ 61.56	$ 12,373.04		
2	Proposed Building	Blue Roof	1,000	SF	$ 4.00	$ 4,000.00	$ 200.00	$ 4,200.00	$ 7,987.15	$ 14,365.65
		Green Roof	500	SF	$ 15.00	$ 7,500.00	$ 206.00	$ 7,706.00		
		Blue Roof	-	SF	$ 4.00	$ -	$ -			
		Cistern	245	CF	$ 10.00	$ 2,447.41	$ 12.24	$ 2,459.65		
3	Existing Paved Parking Area	Permeable Pavement	2,000	SF	$ 7.00	$ 14,000.00	$ 320.00	$ 14,320.00	$ 1,867.64	$ 15,223.60
		Pervious Pavers	100	SF	$ 9.00	$ 900.00	$ 3.60	$ 903.60		
		Pervious Pavers	-	SF	$ 9.00	$ -	$ -			
		Underground Storage	-	CF	$ 7.00	$ -	$ -			
4	Proposed Paved Parking Area	Pervious Pavers	200	SF	$ 9.00	$ 1,800.00	$ 7.20	$ 1,807.20	$ 1,867.64	$ 4,119.84
		Permeable Pavement	200	SF	$ 7.00	$ 1,400.00	$ 32.00	$ 1,432.00		
		Permeable Pavement	-	SF	$ 7.00	$ -	$ -			
		Underground Storage	125	CF	$ 7.00	$ 874.40	$ 6.25	$ 880.64		
5	Existing Paved Walkway	Permeable Pavement	1,000	SF	$ 7.00	$ 7,000.00	$ 160.00	$ 7,160.00	$ 280.15	$ 7,160.00
		Permeable Pavement	-	SF	$ 7.00	$ -	$ -			
		Permeable Pavement	-	SF	$ 7.00	$ -	$ -			
		Underground Storage	-	CF	$ 7.00	$ -	$ -			
		Permeable Pavement	-	SF	$ 7.00	$ -	$ -			
		Pervious Pavers	100	SF	$ 9.00	$ 900.00	$ 3.60	$ 903.60		

The results of the cost analysis provide the user with two options. The first costing option, shown in the **ninth column**, labeled *Cost using no GI,* shows the cost of managing the stormwater volume using traditional stormwater detention methods. The second costing option shown in the **tenth column**, labeled *Cost using GI*, provides the estimated costs incorporating the use of green infrastructure management practices (and gray infrastructure as applicable). Both costs are comprised of the initial construction cost, and the maintenance cost for one year after construction – the most costly maintenance year for most green infrastructure solutions. The unit costs are provided in the table for consideration by the user.

Since use of green infrastructure management practices may not be cost feasible in every case, a *Cost Comparison* analysis is presented above the management practice cost table. This analysis presents the total costs to manage stormwater with and without using green infrastructure management practices, as well as providing the lowest cost option. The lowest cost option determines which option is the most cost feasible by land cover type and then provides a total cost.

Appendix A – Other Public Domain Models/Tools for Use in Green Infrastructure Analysis

A number of agencies and organizations have developed stormwater and green infrastructure calculators to assist design professionals in stormwater management and green infrastructure planning, costing and comparison of various best management practices. Commonly used models that are typically utilized for large, diverse watersheds are listed below:

1. BASINS

BASINS is a flexible GIS based program which allows users to remain flexible if implementing a large scale program. It requires less calibration than SWAT while also including modeling capabilities not easily replicated in a spreadsheet model.

2. HEC-HMS

HEC-HMS is often viewed as a compromise between BASINS and more detailed programs but takes a significant amount of time to set up. If BASINS is viewed as too flexible and less specific, HEC-HMS can be appropriate. However, another pollutant model is typically required to support pollutant reduction questions.

3. TR-20

TR- 20 is an "old reliable" simple spatial modeling program similar to TR-55 but for larger watersheds. It remains a fairly course model that only takes into account the land cover and runoff with no pollution component. It is also a single event model, which makes it a bit too focused for most purposes.

4. SWMM

SWMM is a commonly used model when estimating runoff and pollutant loadings from urban areas. It includes hydraulic routing and hydrologic routing, which would be unnecessary for many analyses.

5. SWAT

SWAT is often seen as a very difficult and temperamental model to use and it can sometimes take months to effectively calibrate

6. Other Tools and Calculators

There are also a number of other tools that aid decision makers when evaluating green infrastructure. An industrial group, Uni-Group USA, maintains a summary of the most readily available green infrastructure calculators from the U.S. Environmental Protection Agency, Center for Neighborhood Technologies, Sustainable Technologies Evaluation Program and the Water Environment Research Foundation as well as state, regional or municipal calculators and programs by educational institutions (http://www.uni-groupusa.org/calculators.html). Some of the most popular include:

The National Green Values™ Calculator (http://greenvalues.cnt.org/) was developed to demonstrate the ecological and economic gains that result from implementing green infrastructure practices. The Center for Neighborhood Technology (CNT) collaborated with the US EPA Office of Wetlands, Oceans, and Watersheds (OWOW), Assessment and Watershed Protection Division, Non-Point Source Branch to develop a green infrastructure evaluation tool. It compares green infrastructure performance, costs, and benefits to conventional stormwater practices. The tool provides a quantified analysis of environmental benefits including reduced runoff volume and maintenance savings, in addition to carbon sequestration, reduced energy use, and groundwater recharge.

The Minimal Impact Design Standards (MIDS) best management practice (BMP) calculator (http://stormwater.pca.state.mn.us/index.php/MIDS_calculator) is a tool used to determine stormwater runoff volume and pollutant reduction capabilities of various green infrastructure management practices. The MIDS calculator estimates the stormwater runoff volume reductions for various management practices based on the MIDS performance goal (1.1 inches of runoff off impervious surfaces) and annual pollutant load reductions for total phosphorus and total suspended solids (TSS). The MIDS calculator is designed in Microsoft Excel with a graphical user interface (GUI), packaged as a windows application, and used to organize input parameters. The Excel spreadsheet conducts the calculations and stores parameters, while the GUI provides a platform that allows the user to enter data and presents results in a user-friendly manner.