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# User's Manual

Georgia Stormwater Management Manual (GSMM)  
Stormwater Quality Site Development Review Tool,  
Version 2.2

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## 1.0 Introduction

Following is a User’s Manual for the *Georgia Stormwater Management Manual (GSMM) Stormwater Quality Site Development Review Tool, version 2.0*. Worksheets include:

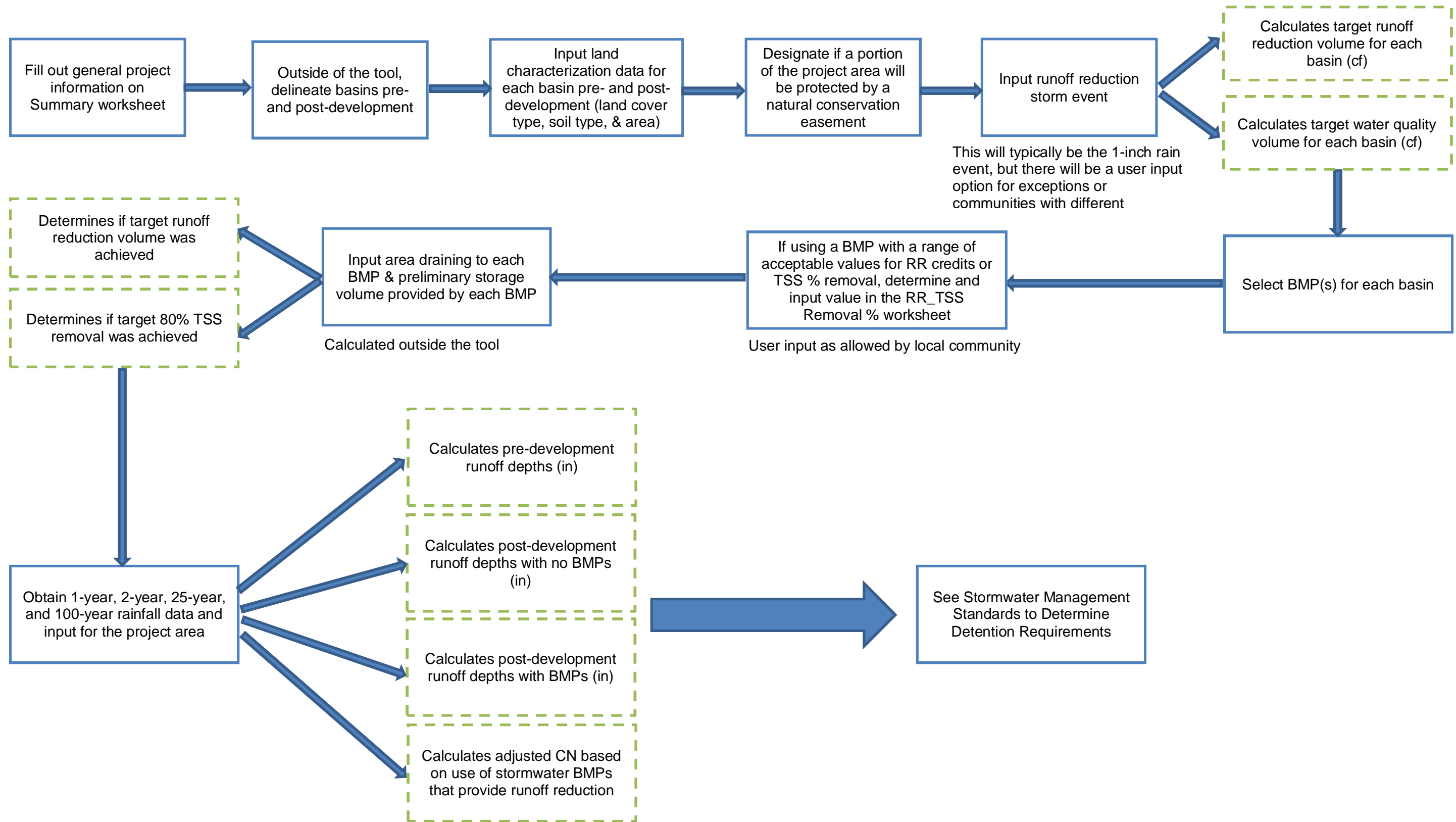
- **Instructions** is a general overview of the Tool. It provides general guidance on the inputs and how to use the Tool.
- **Tool Flowchart** visually represents the step-by-step process to use the Tool. A copy of the flowchart is included on the following page.
- **Summary** is a single sheet that summarizes the project drainage areas and water quality benefits achieved.
- **Runoff Reduction and TSS Removal Efficiencies** includes a table that lists each BMP and its associated runoff reduction and TSS removal efficiencies. It also indicates whether the BMP provides a storage volume for runoff reduction and any drainage area restrictions.
- **Drainage Basins** is where the user’s input the pre- and post-development site information as well as conservation area credits and stormwater BMP information. The worksheet uses these values to calculate water quality criteria met at the basin level. Each drainage basin worksheet includes the following sections:
  - Site Data
  - Select BMPs for Runoff Reduction and Water Quality
  - Channel and Flood Protection Calculations
  - Comments

In the spreadsheet, all cells highlighted in green are user input cells. Cells highlighted in gray are calculation cells, and cells highlighted in yellow are constant values that generally should not be changed. Lastly, cells highlighted orange require input from the local review staff.

Additional guidance is provided below on the worksheets that require user inputs.

**This formatting** indicates a step to be completed by the user when using the Tool.

# BMP Calculation Tool Flowchart



## 2.0 Summary Worksheet

The Summary worksheet is divided into three sections:

- General Information
- Site Summary
- Official Use Only

### 2.1 General Information

The General Information section is the only section in the Summary worksheet with user inputs. The following inputs may be entered: Name of Developer, Development Name, Site Location/Address, Development Type, Date Submitted, Permit Number, Developer Contact, Phone Number, Name of Engineer(s), and Maintenance Responsibility.

#### Enter General Information

1. Input project-specific information in the green fields (*Lines 8-13*), as shown below. Note that the Development Name as entered on this sheet will automatically update on each Drainage Basin worksheet.

The screenshot displays the 'Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool Version 2.2' interface. The 'General Information' section is highlighted in green. The form includes the following fields:

Name of Developer:		Date Submitted:	
Development Name:		Permit Number:	
Site Location / Address:		Developer Contact:	
		Phone Number:	
		Name of Engineer(s):	
Development Type:		Maintenance Responsibility:	

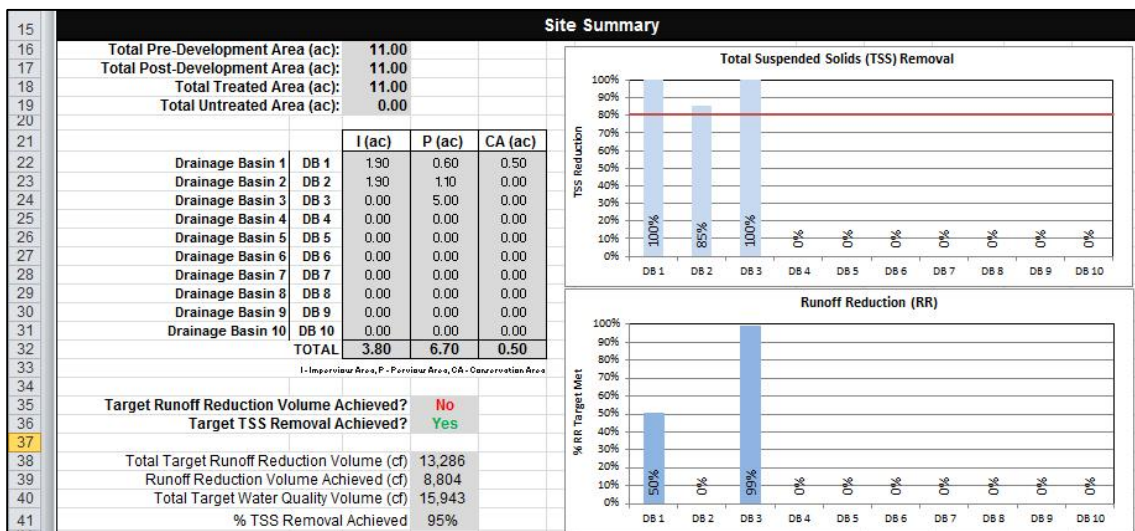
The 'Development Type' dropdown menu is open, showing the following options:

- Agricultural
- Rural Residential
- Low Density Residential
- Medium Density Residential
- High Density Residential
- Office/Professional
- Commercial/Retail
- Office/Distribution/Technology

The 'Site Summary' section is partially visible, showing a bar chart for 'Total Suspended Solids (TSS) Removal' with a scale from 80% to 100%.

### 2.2 Site Summary

The information in the Site Summary section provides a snapshot of the areas and water quality achievements of each drainage basin. It also indicates whether the target runoff reduction volume was achieved and if the target TSS removal was achieved on the project level. These values are automatically calculated based on the inputs in each Drainage Basin worksheet regardless of whether a community requires the water quality standards be met through runoff reduction or water quality treatment. It is the responsibility of the project reviewer, however, to verify the BMPs were sized for the water quality volume (WQv) and the WQv was treated if the project was designed to meet the water quality standard.



### 2.3 Official Use Only

The Official Use Only section helps the local review authority track submittals and reviews. This section is to be completed by the plan reviewer.

Official Use Only	
Tracking #:	Conditions of Approval:
Reviewed By:	
Date Approved:	

#### Outside of the Tool, Delineate Basins Pre- and Post-development

1. Delineate basins pre- and post-development
2. Determine if the outflow from one drainage basin or a portion of one drainage basin is routed to another drainage basin. More information about modeling the outflow from one drainage basin to another is provided in Section 4.4 below.

### 3.0 Runoff Reduction and TSS Removal Efficiencies Worksheet

The Runoff Reduction and TSS Removal Efficiencies worksheet lists each BMP with their corresponding runoff reduction and TSS removal efficiencies. The values are based on published data, and references are included in Volume 2, Chapter 4 of the Manual.

*Column F* indicates whether the BMP provides a **storage** volume or **conveys** runoff. Some of the BMPs are designed to store a volume of water for a certain amount of time prior to runoff being infiltrated or discharged. Examples include bioretention basins and detention basins. Some of the BMPs, on the other hand, convey a volume of stormwater runoff, such as downspout disconnects and grass channels. The designation determines how the amount of runoff reduction achieved is calculated in the individual Drainage Basin worksheets (see Section 4.4).

As a reference for the designer, this worksheet also includes drainage area restrictions that are associated with each BMP.

The TSS removal efficiency and/or runoff reduction efficiency can vary for the three BMPs listed below. If using one of these BMPs in the project, the user must input the removal percentage value(s). It is recommended that the local review authority require back-up documentation supporting these user inputs.

- Multi-Purpose Detention Basins: TSS Removal Efficiency
- Proprietary Systems: Runoff Reduction and TSS Removal Efficiency
- Rainwater Harvesting: Runoff Reduction and TSS Removal Efficiency

In addition, there are three User Input options in the event a BMP to be used on a project is not included in the dropdown list. It could also be used to designate differences in trapping efficiencies due to slight differences in the design, such as the use of a geomembrane. It is recommended that the local review authority require back-up documentation supporting these user inputs.

#### **Enter BMP Information, if applicable**

1. Enter BMP information if using a Multi-Purpose Detention Basin, Proprietary System, Rainwater Harvesting, or a User Input BMP and compile backup information supporting the data to be submitted with the stormwater report.

<b>Georgia Stormwater Management Manual</b> <b>Stormwater Quality Site Development Review Tool, v2.2</b> <b>Runoff Reduction and TSS Removal Efficiencies</b>						
data input cells		constant values				
	Runoff Reduction %	Effective TSS Removal %	Runoff Reduction Method	Drainage Area Restrictions	Units	Min/Max
Bioretention Basin (w/ underdrain)	50%	85%	Storage	5	acres	Max
Bioretention Basin (w/ upturned underdrain)	75%	85%	Storage	5	acres	Max
Bioretention Basin (w/o underdrain)	100%	100%	Storage	5	acres	Max
Bioslope (A & B hydrologic soils)	50%	85%	Storage	--	--	--
Bioslope (C & D hydrologic soils)	25%	85%	Storage	--	--	--
Downspout Disconnect (A & B hydrologic soils)	50%	80%	Convey	2500	ft <sup>2</sup>	Max
Downspout Disconnect (C & D hydrologic soils)	25%	80%	Convey	2500	ft <sup>2</sup>	Max
Dry Detention Basin	0%	60%	Storage	75	acres	Max
Dry Extended Detention Basin	0%	60%	Storage	--	--	--
Dry Well	100%	100%	Storage	2500	ft <sup>2</sup>	Max
Enhanced Dry Swale (w/ underdrain)	50%	80%	Storage	5	acres	Max
Enhanced Dry Swale (w/o underdrain)	100%	100%	Storage	5	acres	Max
Enhanced Wet Swale	0%	80%	Storage	5	acres	Max
Grass Channel (A & B hydrologic soils)	25%	50%	Convey	5	acres	Max
Grass Channel (C & D hydrologic soils)	10%	50%	Convey	5	acres	Max
Gravity (oil-grit) Separator	0%	40%	Convey	5	acres	Max
Green Roof	60%	80%	Storage	--	--	--
Infiltration Trench	100%	100%	Storage	5	acres	Max
Multi-Purpose Detention Basin	0%		Storage	--	--	--
Organic Filter	0%	80%	Storage	10	acres	Max
Permeable Paver System (w/ underdrain)	50%	80%	Storage	--	--	--
Permeable Paver System (w/ upturned underdrain)	75%	80%	Storage	--	--	--
Permeable Paver System (w/o underdrain)	100%	100%	Storage	--	--	--
Pervious Concrete (w/ underdrain)	50%	80%	Storage	--	--	--
Pervious Concrete (w/ upturned underdrain)	75%	80%	Storage	--	--	--
Pervious Concrete (w/o underdrain)	100%	100%	Storage	--	--	--
Porous Asphalt (w/ underdrain)	50%	50%	Storage	--	--	--
Porous Asphalt (w/ upturned underdrain)	75%	50%	Storage	--	--	--
Porous Asphalt (w/o underdrain)	100%	100%	Storage	--	--	--
Porous Asphalt (OGFC, PEM)	0%	50%	Convey	--	--	--
Proprietary System						
Rainwater Harvesting			Storage			
Regenerative Stormwater Conveyance	0%	80%	Storage	50	acres	Max
Sand Filter	0%	80%	Storage	10	acres	Max
Site Reforestation/Revegetation	0%	0%	Convey	--	--	--
Soil Restoration (can be used to remediate C & D soils)	0%	0%	Convey	--	--	--
Stormwater Planter / Tree Box	50%	80%	Storage	2500	ft <sup>2</sup>	Max
Stormwater Pond	0%	80%	Storage	10-25	acres	Min
Stormwater Wetlands – Level 1	0%	80%	Convey	5	acres	Min
Stormwater Wetlands – Level 2	0%	85%	Convey	5	acres	Min
Submerged Gravel Wetlands	0%	80%	Convey	5	acres	Min
Underground Detention	0%	0%	Convey	--	--	--
Vegetated Filter Strip (A & B hydrologic soils)	50%	60%	Convey	--	--	--
Vegetated Filter Strip (C & D hydrologic soils)	25%	60%	Convey	--	--	--
User Input 1						
User Input 2						
User Input 3						



## 4.0 Drainage Basin Worksheets

The Drainage Basin worksheets are used to provide the land use and stormwater management information for the proposed site. On many sites, there is more than one drainage outlet from the site or it may not be physically possible to treat the runoff from the entire site at a single location. In these cases, the proposed site needs to be evaluated as two or more separate drainage areas, with the information for each area provided on a separate Drainage Basin worksheet. Note that stormwater runoff treatment in every drainage basin is not necessarily required in order to meet the project level water quality requirements. This tool allows a proposed development to be split into ten (10) drainage basins. Each Drainage Basin worksheet is divided into six sections:

- Site Data
- Conservation Area Credits
- Water Quality Goals
- Select BMPs for Runoff Reduction and Water Quality
- Channel and Flood Protection Calculations
- Comments

### Enter Drainage Basin Name

1. Enter the Drainage Basin name in Line 8. This name will be populated in *column A*, rows 22-31 of the Summary worksheet.

	A	B	C	D	E	F	G	H	I	J	K	L
1	Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2											
2												
3												
4												
5												
6												
7	Development Name: <input type="text"/>											
8	Drainage Basin Name: <input style="background-color: #92d050;" type="text"/>											
9												
10												

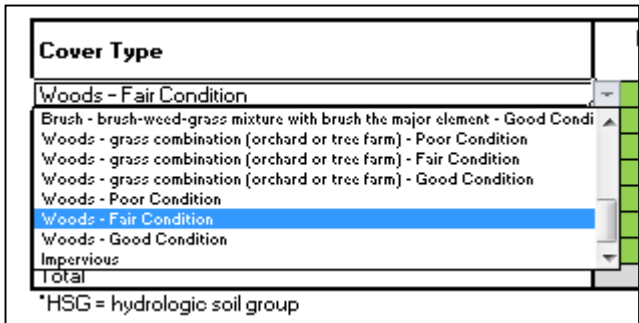
data input cells
calculation cells
constant values

### 4.1 Site Data

The Site Data section is where the user inputs the pre-development and post-development drainage basin characteristics. Characteristics include the amount of area associated with each land cover and soil type. Several pervious cover types and one impervious cover type is included in the drop down box. The curve numbers assume an average moisture condition preceding a storm and will automatically populate based on the land cover and soil type selection.

### Enter Pre- and Post-Development Land Cover

1. Use the drop-down box to select the land cover type(s) and condition for the pre-developed site.



2. Enter the area (acres) associated with each land cover in the appropriate column based on the hydrologic soil group (HSG)<sup>1</sup> of the site.

Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area								
Cover Type	HSG* A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN
Woods - Fair Condition		36	5.00	60		73		79
Select a land cover type...		0		0		0		0
Select a land cover type...		0		0		0		0

3. If the local jurisdiction requires a specific pre-development curve number, use *line 21* to enter the area (acres) associated with each HSG as well as the required curve number.

14 Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area				
	Cover Type	HSG* A (acres)	CN	HSG B (acres)
15				
16	Woods - Good Condition		30	
17	Select a land cover type...		0	
18	Select a land cover type...		0	
19	Select a land cover type...		0	
20	Select a land cover type...		0	
21	Local Jurisdiction Input			
22	Other			
23	Total	0.00		0.00
24	*HSG = hydrologic soil group			

4. If the pre-development land cover type is not provided, use *line 22* to enter the area (acres) associated with each HSG as well as the associated curve number. Overwrite “Other” to indicate the cover type. It is recommended that notes be added at the bottom of the page justifying the cover type and curve number.

<sup>1</sup> **Group A** is sand, loamy sand or sandy loam types of soils. It has low runoff potential and high infiltration rates even when thoroughly wetted. They consist chiefly of deep, well to excessively drained sands or gravels and have a high rate of water transmission.

**Group B** is silt loam or loam. It has a moderate infiltration rate when thoroughly wetted and consists chiefly or moderately deep to deep, moderately well to well drained soils with moderately fine to moderately coarse textures.

**Group C** soils are sandy clay loam. They have low infiltration rates when thoroughly wetted and consist chiefly of soils with a layer that impedes downward movement of water and soils with moderately fine to fine structure.

**Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential. They have very low infiltration rates when thoroughly wetted and consist chiefly of clay soils with a high swelling potential, soils with a permanent high water table, soils with a claypan or clay layer at or near the surface and shallow soils over nearly impervious material.

14 Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area				
	Cover Type	HSG* A (acres)	CN	HSG B (acres)
15				
16	Woods - Good Condition		30	
17	Select a land cover type...		0	
18	Select a land cover type...		0	
19	Select a land cover type...		0	
20	Select a land cover type...		0	
21	Local Jurisdiction Input			
22	Other			
23	Total	0.00		0.00
24	*HSG = hydrologic soil group			

5. Repeat steps 1-4 above for the post-development table.

The volumetric runoff coefficient,  $R_v$ , is automatically calculated in cell K39 using Equation 1 below. This value is used to calculate the water quality and runoff reduction volume. Note that the volumetric runoff coefficient is only calculated for the post-development area. Therefore, the water quality volume is only dependent on the post-development land characteristics.

**Equation 1: Volumetric Runoff Coefficient,  $R_v$**

$$R_v = 0.009(I) + 0.05$$

Where:

I = Percent impervious area (i.e., for 80% impervious area, use 80, not 0.8)

The pre-development weighted curve number is calculated in cell K25. The post-development weighted curve number is calculated in cell K40. The weighted curve numbers are used to calculate the potential maximum soil retention values.

**Equation 2: Weighted Curve Number,  $CN_{weighted}$**

$$CN_{weighted} = \frac{\sum (CN_i \times A_i)}{A}$$

Where:

$CN_i$  = Curve number associated with land cover i

$A_i$  = Area of land cover i (acres)

A = Total area

The potential maximum soil retention, S, in inches is automatically calculated in cell K26 for the pre-developed area and in cell K41 for the post-developed area. These values are used to calculate the Pre-Development Runoff Volumes (in) in line 110 and Post-Development Runoff Volumes (in) with no BMPs in line 111.

**Equation 3: Potential Maximum Soil Retention, S (in)**

$$S = \frac{1000}{CN_{weighted}} - 10$$

Where:

S = Potential maximum soil retention (in)

$CN_{weighted}$  = Weighted curve number

## 4.2 Conservation Area Credits

The Conservation Area Credits section is where the user has the option to indicate whether a portion of the drainage basin is protected under a conservation easement or equivalent form of protection. There are four scenarios that could qualify for a conservation area credit. If a portion of the drainage basin is protected under one or more of the four scenarios, check the appropriate box and the corresponding area input cell will unlock.

### *Scenario 1: Natural Conservation Area*

Scenario 1 is applicable if a portion of the post-developed area is left in its natural condition and protected, in perpetuity, by a conservation easement or equivalent form of protection. If this scenario is applicable, 100% of the protected natural area will be subtracted from the total site area when calculating the water quality volume. See the GSMM Volume 2, Section 2.3.3.3 for more information on the natural conservation area credit.

### *Scenario 2: Reforestation/Revegetation*

Scenario 2 is applicable if a portion of the post-developed area employs site reforestation/revegetation and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, 50% of the reforested/revegetated area will be subtracted from the total site area when calculating the water quality volume. See the GSMM Volume 2, Section 4.22 for more information.

### *Scenario 3: Soil Restoration*

Scenario 3 is applicable if a portion of the post-developed area employs soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection. If this application is used alone, 50% of the soil restoration area will be subtracted from the total site area when calculating the water quality volume. See the GSMM Volume 2, Section 4.23 for more information on the conservation area credit.

### *Scenario 4: Reforestation/Revegetation & Soil Restoration*

Scenario 4 is applicable if the same portion of the post-developed area employs site reforestation/revegetation as well as soil restoration and is protected, in perpetuity, by a conservation easement or equivalent form of protection. 100% of the acres of development with restored soils in a reforested and revegetated area will be subtracted from the total site area when calculating the water quality volume. See the GSMM Volume 2, Sections 4.22 and 4.23 for more information on the conservation area credit.

If a conservation area credit applies to a drainage basin, a note pops up at the bottom of the Drainage Basin worksheet as well as the Summary worksheet as a reminder that a recorded conservation easement or similar form of protection is required for the project.

### Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool Version 2.2

General Information			
Name of Developer:		Date Submitted:	
Development Name:		Permit Number:	
Site Location / Address:		Developer Contact:	
		Phone Number:	
		Name of Engineer(s):	
Development Type:		Maintenance Responsibility:	

Site Summary			
Total Pre-Development Area (ac):	11.00		
Total Post-Development Area (ac):	11.00		
Total Treated Area (ac):	11.00		
Total Untreated Area (ac):	0.00		

		I (ac)	P (ac)	CA (ac)
Drainage Basin 1	DB 1	1.90	0.60	0.50
Drainage Basin 2	DB 2	1.90	1.10	0.00
Drainage Basin 3	DB 3	0.00	5.00	0.00
Drainage Basin 4	DB 4	0.00	0.00	0.00
Drainage Basin 5	DB 5	0.00	0.00	0.00
Drainage Basin 6	DB 6	0.00	0.00	0.00
Drainage Basin 7	DB 7	0.00	0.00	0.00
Drainage Basin 8	DB 8	0.00	0.00	0.00
Drainage Basin 9	DB 9	0.00	0.00	0.00
Drainage Basin 10	DB 10	0.00	0.00	0.00
<b>TOTAL</b>		<b>3.80</b>	<b>6.70</b>	<b>0.50</b>

I - Impervious Area, P - Pervious Area, CA - Conservation Area

Target Runoff Reduction Volume Achieved?	No
Target TSS Removal Achieved?	Yes
Total Target Runoff Reduction Volume (cf)	13,286
Runoff Reduction Volume Achieved (cf)	6,225
Total Target Water Quality Volume (cf)	15,943
% TSS Removal Achieved	95%

Total Suspended Solids (TSS) Removal

Runoff Reduction (RR)

Official Use Only	
Tracking #:	Conditions of Approval:
Reviewed By:	
Date Approved:	

A RECORDED CONSERVATION EASEMENT OR SIMILAR FORM OF PROTECTION IS REQUIRED FOR THIS PROJECT

### Select Conservation Area Credits, if applicable

- Determine which, if any, of the four scenarios apply to the basin. If a scenario applies, check the associated box.
- Checking the box unlocks the associated user input cell. Enter the area (acres) that is protected by a conservation easement or equivalent form of protection.

Conservation Area Credits			
43	<b>Scenario 1: Natural Conservation Area</b> <small>*See the GSMN Volume 2, Section 2.3.3.3 for more information.</small>	<b>Scenario 3: Soil Restoration</b> <small>*See the GSMN Volume 2, Section 4.23 for more information.</small>	
44			
45	<input checked="" type="checkbox"/> Check the box if a portion of the post-developed area is protected by a conservation easement or equivalent form of protection.	<input type="checkbox"/> Check the box if a portion of the post-developed area employs <b>soil restoration</b> and is protected by a conservation easement or equivalent form of protection.	
46			
47	<b>0.5</b> Area (ac) of development protected by a conservation easement or equivalent form of protection. <span style="color: red; font-size: small;">Note: The green cell will unlock if the Scenario 1 box above is checked</span>	Area (ac) of development with restored soils and protected by a conservation easement or equivalent form of protection. <span style="color: red; font-size: small;">Note: The green cell will unlock if the Scenario 3 box above is checked</span>	
48			
49			
50			
51			
52	<b>Scenario 2: Site Reforestation/Revegetation</b> <small>*See the GSMN Volume 2, Section 4.22 for more information.</small>	<b>Scenario 4: Site Reforestation/Revegetation &amp; Soil Restorati</b> <small>*See the GSMN Volume 2, Section 4.22 and 4.23 for more information.</small>	
53			
54	<input type="checkbox"/> Check the box if a portion of the post-developed area employs <b>site reforestation/revegetation</b> and is protected by a conservation easement or equivalent form of protection.	<input type="checkbox"/> Check the box if the same portion of the post-developed area employs <b>site reforestation/revegetation</b> , <b>and soil restoration</b> , and is protected by a conservation easement or equivalent form of protection.	
55			
56			
57	Area (ac) of development reforested/revegetated and protected by a conservation easement or equivalent form of protection. <span style="color: red; font-size: small;">Note: The green cell will unlock if the Scenario 2 box above is checked</span>	Area (ac) with restored soils in a reforested & revegetated area and protected by a conservation easement or equivalent form of protection. <span style="color: red; font-size: small;">Note: The green cell will unlock if the Scenario 4 box above is checked</span>	
58			
59	<b>Total Conservation Area Credit (acres)</b>		<b>0.50</b>

### 4.3 Water Quality Goals

The Water Quality Goals section summarizes the target water quality goals, i.e., target runoff reduction volume and target water quality volume. Although the water quality standards are not met on the drainage basin level, the standards at the drainage basin level are shown as an indication of the progress made toward the overall goal in each drainage basin.

Water Quality Goals	
71	
72	
73	Target Runoff Reduction Storm (in) <input type="text" value="1.00"/>
74	Total Site Area for Water Quality Volume (acres) <input type="text" value="3.00"/>
75	Target Runoff Reduction Volume (cf) <input type="text" value="6,752"/>
76	Target Water Quality Volume (cf) <input type="text" value="8,102"/>

The Total Site Area for Water Quality Volume (*cell I64*) is equal to the post-development area minus any conservation area credits.

#### Enter the Target Runoff Reduction Storm (in)

1. The default value of *cell C64* is 1 inch, but the user may select a different storm event to set the target runoff reduction volume.

#### Equation 4: Target Runoff Reduction Volume, $RR_v$ ( $ft^3$ )

$$RR_v = \frac{P \times R_v \times A \times 43,560 \text{ ft}^2/\text{acre}}{12 \text{ in}/\text{ft}}$$

Where: P = Target runoff reduction storm (in)  
 $R_v$  = Volumetric runoff coefficient  
 A = Total site area (ac) for water quality volume (post-development area minus conservation area credits)

#### Equation 5: Target Water Quality Volume, $WQ_v$ ( $ft^3$ )

$$WQ_v = \frac{1.2 \times R_v \times A \times 43,560 \text{ ft}^2/\text{acre}}{12 \text{ in}/\text{ft}}$$

Where: 1.2 = 85% storm event (in)  
 $R_v$  = Volumetric runoff coefficient  
 A = Total site area (ac) for water quality volume (post-development area minus conservation area credits)

### 4.4 Select BMPs for Runoff Reduction and Water Quality

This section is where the user inputs the BMPs in each drainage basin. The user must calculate outside the tool the amount of impervious area and disturbed pervious area that drains to each BMP. If using a green roof or permeable pavement system, the area of the green roof or permeable pavement should be included in the impervious cover area. The user may also indicate if there is offsite area draining to a BMP. Please note that no water quality credit is given for treating offsite area; only on-site area routed to a BMP will be used in the runoff reduction and TSS calculations. The Tool compares the total area draining to a BMP with the total post-development area (*cell L37*) and indicates in *row 89* the amount of on-site untreated area in the drainage basin.



As stated in Section 3.0, some of the BMPs are designed to **store** a volume of water for a certain amount of time prior to runoff being infiltrated or discharged. Examples include bioretention basins and detention basins. Some of the BMPs, on the other hand, **convey** a volume of stormwater runoff, such as downspout disconnects and grass channels. This designation affects the runoff reduction achieved calculations. Equations 9a and 9b below indicate how the runoff reduction achieved is calculated with each method.

For the BMPs that have a **storage** volume, the user must calculate its storage volume outside of the tool and enter the value in *column F*. The **storage** volume is equal to the ponding volume plus the void space in the media, if applicable. Guidance on calculating the storage volumes is included in each BMP section of Volume 2, Chapter 4.

If the BMP **conveys** a runoff volume as indicated in the Runoff Reduction and TSS Removal Efficiencies worksheet, the ‘Storage Volume Provided by BMP (cf)’ cell turns black and no value can be entered. The Runoff Reduction Conveyance Volume provided by the BMP (cf) (*column G*) is automatically calculated as the sum of the Runoff Reduction Volume from Direct Drainage (cf) (*column I*) and the Runoff Reduction Volume from Upstream Practices (cf) (*column J*). This value will be equal to the Total Runoff Reduction Volume Received by the BMP (cf) (*column K*).

The user may indicate a treatment train by designating downstream BMPs. Multiple BMPs may be used in a drainage basin without being part of a treatment train. **If the outflow from one drainage basin or a portion of one drainage basin flows to another drainage basin, the basins should be modeled in one worksheet. Name the basin accordingly and provide any comments necessary to communicate the drainage path.**

The Tool will indicate whether the target runoff reduction volume and target TSS removal goal were achieved for the drainage basin.

**Enter the BMP(s) Data**

1. Select the BMPs for the drainage area in *column B*.

77	<b>BMP 1</b>	Downspout Disconnect (C & D hydrologic soils)	0.0
78	<b>BMP 2</b>	Downspout Disconnect (C & D hydrologic soils)	1.1
79	<b>BMP 3</b>	Dry Detention Basin Dry Extended Detention Basin Dry Well	
80	<b>BMP 4</b>	Enhanced Dry Swale (w/ underdrain) Enhanced Dry Swale (w/o underdrain) Enhanced Wet Swale Grass Channel (A & B hydrologic soils)	
81	<b>BMP 5</b>	Select a BMP...	

2. For each BMP, enter the on-site pervious and impervious area as well as offsite area in acres draining to the BMP (*columns C – E*).
3. If the BMP selected provides a storage volume, *column F* will be green. Enter the storage volume provided by the BMP in cubic feet.

		On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)	Storage Volume Provided by BMP (cf)
<b>BMP 1</b>	<b>Bioretention Basin (w/ underdrain)</b>	1.10	1.90	0.00	8,100
<b>BMP 2</b>	Select a BMP_				

4. If the BMP selected does not provide a storage volume, *column F* will be black and the RR Conveyance Volume Provided by the BMP (cf) will be automatically calculated in *column G*. Do not enter a storage volume.

		Area Draining to Each BMP			Storage Volume Provided by BMP (cf)	RR Conveyance Volume Provided by BMP (cf)
		On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)		
<b>BMP 1</b>	<b>Downspout Disconnect (C &amp; D hydrologic soils)</b>	0.00	0.30	0.00		1,035

5. If the drainage basin is using a treatment train, use the dropdown box in *column H* to indicate the downstream BMP. This will direct the remaining Runoff Reduction and TSS units to the practice identified. Note that if there are multiple BMPs in a drainage basin, they do not need to be part of a treatment train. Also, a BMP that is numerically labelled higher in *column A* may be upstream of a BMP that is numerically labelled lower.

75			Area Draining to Each BMP			Storage Volume Provided by BMP (cf)	RR Conveyance Volume Provided by BMP (cf)	Down-stream BMP	RR fr Dra
			On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)				
76									
77	<b>BMP 1</b>	<b>Downspout Disconnect (A &amp; B hydrologic soils)</b>		0.50	0.00		1,724		
78	<b>BMP 2</b>	<b>Bioretention Basin (w/ underdrain)</b>	1.10	1.40					
79	<b>BMP 3</b>	Select a BMP...							
80	<b>BMP 4</b>	Select a BMP...							

### 4.4.1 Runoff Reduction Calculations

The following runoff reduction calculations are completed automatically in columns / through N.



**Equation 6: Runoff Reduction Volume from Direct Drainage,  $RR_{vdirect}$  (ft<sup>3</sup>)**

$$RR_{vdirect} = \frac{\left(0.05 + 0.9 \times \frac{I}{A}\right) \times A \times P \times 43,560 \text{ ft}^2/\text{acre}}{12 \text{ in}/\text{ft}}$$

Where:

P = Target runoff reduction storm (in)

I = On-site impervious cover in BMP drainage area (acres)

A = On-site BMP drainage area (pervious cover plus impervious cover) (acres)

**Equation 7: Runoff Reduction Volume from Upstream Practices (ft<sup>3</sup>)**

Calculated in *column J* and is equal to the sum of the *Remaining RR Volume* (calculated in Equation 10 below) from other practices that are directed to the practice evaluated in this row.

**Equation 8: Total Runoff Reduction Volume Received by BMP (ft<sup>3</sup>)**

$$V_{received} = RR_{vdirect} + RR \text{ Volume from Upstream Practices}$$

**Equation 9a: Runoff Reduction Achieved for BMPs that Provide a Storage Volume,  $RR_{achieved-storage}$  (ft<sup>3</sup>)**

$$RR_{achieved-storage} = BMP \text{ Storage Volume} \times RR\%$$

BMPs may be oversized and receive credit for additional runoff reduction up to the total runoff reduction volume received by the practice (*column K*). The total volume received by the practice includes the runoff reduction volume from direct drainage as well as the volume from upstream practices that was not captured.

**Equation 9b: Runoff Reduction Achieved for BMPs that Convey a Volume,  $RR_{achieved-convey}$  (ft<sup>3</sup>)**

$$RR_{achieved-convey} = Runoff \text{ Reduction Conveyance Volume} \times RR\%$$

**Equation 10: Remaining Volume,  $V_{remaining}$  (ft<sup>3</sup>)**

$$V_{remaining} = V_{received} - RR_{achieved}$$

Runoff Reduction Calculations					
RR Volume from Direct Drainage (cf)	RR Volume from Upstream Practices (cf)	Total RR Volume Received by BMP (cf)	Runoff Reduction %	RR Achieved (cf)	Remaining RR Volume (cf)
1,035	0	1,035	25%	259	776
0	776	776	50%	0	776
0	0	0	10%	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
0	0	0	N/A	0	0
1,035				259	

#### 4.4.2 TSS Removal Calculations

The TSS Removal calculations are hidden in the Tool, but are explained in detail below.

The total TSS in the water quality volume must be established to set a starting point for the TSS removal efficiency calculations. This value can be arbitrarily assigned because the measurement of TSS removal efficiency is a percentage. In the Tool, the TSS in the water quality volume is set equal to the water quality volume; for one cubic foot of water quality volume, there is one “unit” of TSS. The “unit” is not a specific measure of actual TSS in the water quality volume.

The Water Quality Volume from Direct Drainage is automatically calculated for each BMP in *column O* based on the amount of pervious and impervious area draining to each BMP. See Equation 11 below. Because there is one “unit” of TSS associated with one cubic foot of water quality volume, the amount of TSS received by each BMP from direct drainage is equal to the water quality volume from direct drainage.

Similar to the runoff reduction calculations above, the amount of TSS received by each BMP from upstream practices is also calculated. It is equal to the sum of the Remaining TSS from other practices that are directed to the practice evaluated in this row. Adding the TSS received from upstream practices to the TSS from direct drainage provides the total amount of TSS received by the practice.

WQ Calculations	
WQ <sub>v</sub> from Direct Drainage (cf)	Effective TSS Removal %
1,241	80%
5,909	85%
952	50%
0	N/A
0	N/A
0	N/A
0	N/A
0	N/A
0	N/A
0	N/A
0	N/A
8,102	

**Equation 11: Water Quality Volume from Direct Drainage,  $WQ_{vdirect}$  (ft<sup>3</sup>)**

$$WQ_{vdirect} = \frac{(0.05 + 0.9 \times \frac{I}{A}) \times A \times 1.2 \times 43,560 \text{ ft}^2/\text{acre}}{12 \text{ in}/\text{ft}}$$

Where:

1.2 = 85% storm event (in)

I = On-site impervious cover in BMP drainage area (acres)

A = On-site BMP drainage area (pervious cover plus impervious cover) (acres)

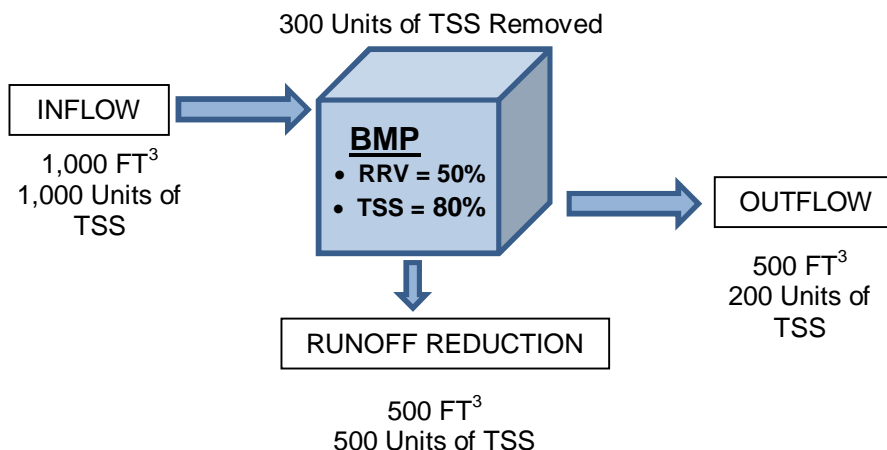
Each BMP is assigned an Effective TSS Removal Efficiency based on accepted, published research, as shown in *column P*. The Effective TSS Removal Efficiency takes into account the total amount of TSS removed by the practice, regardless of the method of removal. For example, if a BMP achieves 80% TSS removal, a portion of that percentage could be achieved through infiltration and a portion through settling. Therefore, the Effective TSS Removal Efficiency takes into account the TSS removed through runoff reduction practices. The Partial Runoff Reduction Approach diagram below illustrates the concept. Equation 12 specifies how the TSS Removal Achieved is calculated.

**Equation 12: TSS Removal Achieved,  $TSS_{achieved}$**

$$TSS_{achieved} = \text{Total TSS Received by BMP} \times \text{Effective TSS Removal \%}$$

The total TSS received by the practice includes the TSS from direct drainage as well as the TSS from upstream practices that was not captured. BMPs will not be given credit for TSS removal by oversizing the BMP.

Partial Runoff Reduction Approach



### 4.5 Channel and Flood Protection Calculations

The user must input the target rainfall event (in) for the 1-year, 2-year, 25-year, and 100-year, 24-hour storm events. The Tool calculates the adjusted curve number and indicates whether the post-development peak flow is greater than the pre-development peak flow.

Channel and Flood Protection Calculations				
	<b>1-year storm</b>	<b>2-year storm</b>	<b>25-year storm</b>	<b>100-year storm</b>
<b>Target Rainfall Event (in)</b>	3.29	3.69	5.86	7.30
	<b>1-year storm</b>	<b>2-year storm</b>	<b>25-year storm</b>	<b>100-year storm</b>
<b>Pre-Development Runoff Volume (in)</b>	0.44	0.62	1.83	2.82
<b>Post Development Runoff Volume (in) with no BMPs</b>	2.11	2.48	4.53	5.93
<b>Post-Development Runoff Volume (in) with BMPs</b>	1.83	2.20	4.26	5.65
<b>Adjusted CN</b>	<b>85</b>	<b>85</b>	<b>86</b>	<b>86</b>

\*See Stormwater Management Standards to Determine Detention Requirements.

#### Enter the target rainfall events

1. Enter the target rainfall event in inches for the 1-year, 2-year, 25-year, and 100-year, 24-hour storm events. Rainfall data can be found online using the National Oceanic and Atmospheric Administration (NOAA) Precipitation Frequency Data Server database for any location across Georgia (<http://hdsc.nws.noaa.gov/hdsc/pfds/>).

Channel and Flood Protection Calculations				
	<b>1-yr, 24-hr storm</b>	<b>2-yr, 24-hr storm</b>	<b>25-yr, 24-hr storm</b>	<b>100-yr, 24-hr storm</b>
<b>Target Rainfall Event (in)</b>	3.40	4.20	7.90	9.80
	<b>1-yr, 24-hr storm</b>	<b>2-yr, 24-hr storm</b>	<b>25-yr, 24-hr storm</b>	<b>100-yr, 24-hr storm</b>
<b>Pre-Development Runoff Volume (in)</b>	0.95	1.46	4.38	6.05
<b>Post Development Runoff Volume (in) with no BMPs</b>	2.19	2.92	6.48	8.35
<b>Post-Development Runoff Volume (in) with BMPs</b>	2.16	2.90	6.46	8.32
<b>Adjusted CN</b>	<b>88</b>	<b>88</b>	<b>88</b>	<b>88</b>

\*See Stormwater Management Standards to Determine Detention Requirements.

The following values are automatically calculated:

#### Equation 13: Pre-Development Runoff Volume, $Q_{pre}$ (in)

$$Q_{pre} = \frac{(P - 0.2S_{pre})^2}{P + 0.8S_{pre}}$$

Where:

P = Target rainfall event (in)

$S_{pre}$  = Pre-development potential maximum soil retention (in)

#### Equation 14: Post-Development Runoff Volume with no BMPs, $Q_{post}$ (in)

$$Q_{post} = \frac{(P - 0.2S_{post})^2}{P + 0.8S_{post}}$$

Where:

P = Target rainfall event (in)

$S_{post}$  = Post-development potential maximum soil retention (in)

**Equation 15: Post-Development Runoff Volume with BMPs,  $Q_{post-BMP}$  (in)**

$$Q_{post-BMP} = Q_{post} - \frac{Total\ RR_{achieved} \times 12\ in/ft}{A_{post} \times 43,560\ ft^2/acre}$$

Where:

Total  $RR_{achieved}$  = Sum of  $RR_{achieved}$  from all BMPs in the drainage basin ( $ft^3$ ) (cell M89)

$A_{post}$  = Total post-development drainage basin area (acres)

The adjusted curve number is calculated by using lookup tables.

**Equation 16: Adjusted Curve Number,  $CN_{adjusted}$** 

$$CN_{adjusted},\ so\ \frac{(P - 0.2 \times S_{adjusted})^2}{P + 0.8 \times S_{adjusted}} = Q_{post-BMP}$$

Where:

$S_{adjusted} = 1000 / (CN_{adjusted} - 10)$

P = Target rainfall event (in)

#### 4.6 Comments

The Comments section provides the user an opportunity to explain the model or site in more detail. It also provides the reviewer a space to provide comments on the model.

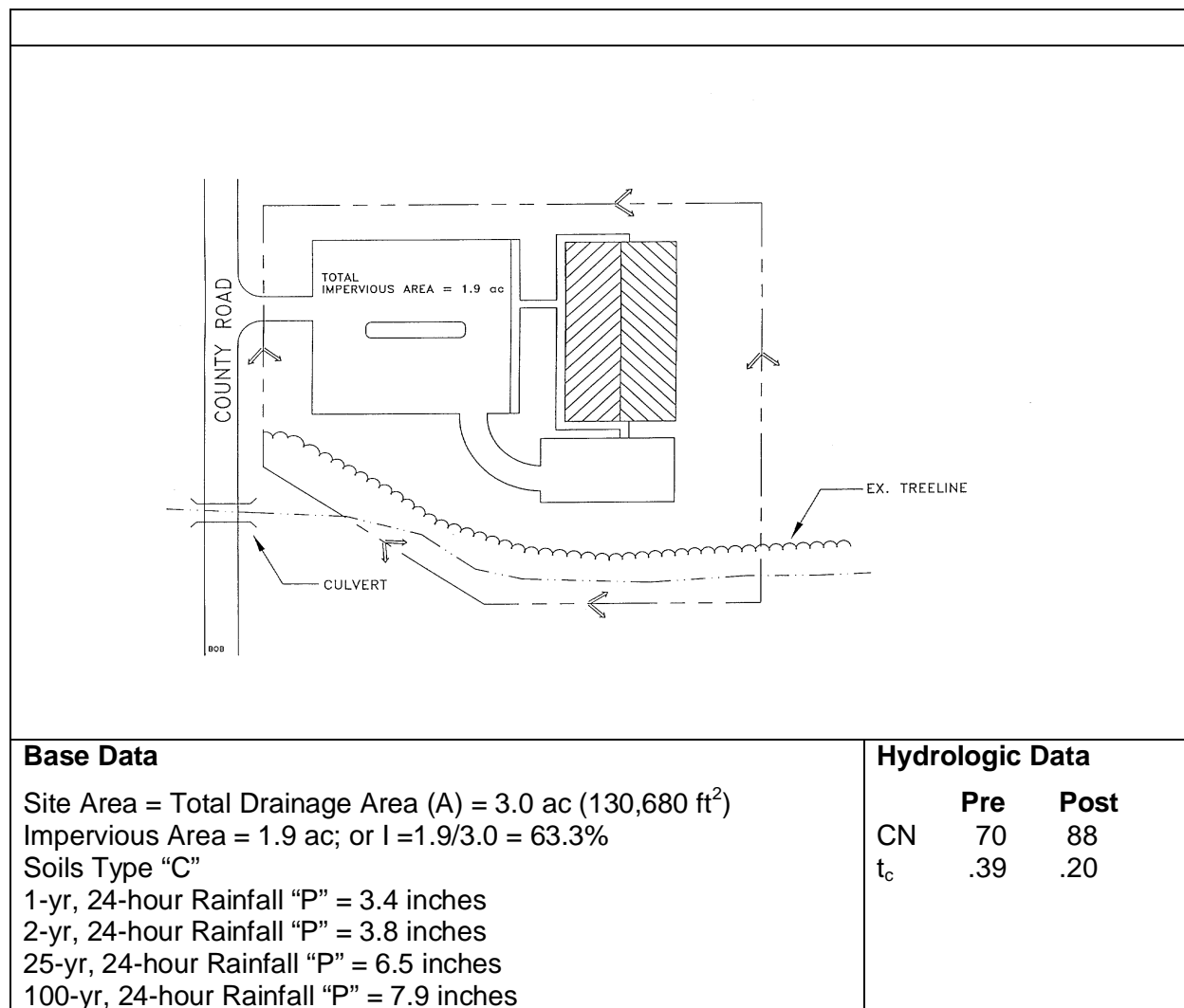
**Provide comments, if necessary**

1. Provide any further explanation in the Comments box.

## 5.0 Examples

### 5.1 Example 1

The first example is based on the GSMM Appendix B2, Bioretention Area example.



The layout of the project is shown above. This example focuses on the design of a bioretention facility to meet the water quality requirements of the site. Due to the Class C soils identified on-site, an underdrain will be provided in this practice that will provide a runoff reduction volume credit of 50%. This example assumes that the local community has adopted the unified stormwater sizing criteria requirements. It was determined by the local municipality that this best management practice would be designed by the runoff reduction volume calculation approach.

The total designed volume of the practice must be provided to retain or remove the stormwater volume associated with the 1.0 inch storm event (this examples target runoff reduction). Runoff reduction credit will then be utilized by the designer through adjusted curve number calculations.

1. **Enter General Information** – complete rows 8 through 13 of the Summary worksheet.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool Version 2.2			
General Information			
Name of Developer:	Georgia Engineers, Inc.	Date Submitted:	3/1/2016
Development Name:	Etowah Recreation Center	Permit Number:	10000
Site Location / Address:	1111 Rec Center Dr. Cityville, GA 12345	Developer Contact:	John Smith
		Phone Number:	111-2222
		Name of Engineer(s):	Joe Jones, PE
Development Type:	Parks, Recreation & Conservation Areas	Maintenance Responsibility:	Cityville, GA

2. **Outside of the Tool, Delineate Basins Pre- and Post-development** – The base data indicates one drainage area that is 3 acres in size. The pre- and post-development curve numbers and times of concentration are provided in the hydrologic data.

3. **Enter BMP Information in the Runoff Reduction and TSS Removal Efficiencies, if applicable** – This step is not applicable because a bioretention basin with an underdrain has been specified for this project, and this BMP does not require any user inputs.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2 Runoff Reduction and TSS Removal Efficiencies						
data input cells		constant values				
	Runoff Reduction %	Effective TSS Removal %	Runoff Reduction Method	Drainage Area Restrictions	Units	Min/Max
Bioretention Basin (w/ underdrain)	50%	85%	Storage	5	acres	Max
Bioretention Basin (w/ upturned underdrain)	75%	85%	Storage	5	acres	Max
Bioretention Basin (w/o underdrain)	100%	100%	Storage	5	acres	Max

4. **Enter Drainage Basin Name** – In the Drainage Basin worksheet, enter a specific drainage basin name

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2	
Development Name: Etowah Recreation Center	data input cells
Drainage Basin Name: Basin 1	calculation cells
	constant values

5. **Enter Pre- and Post-Development Land Cover** – complete the Pre- and Post-Development Land Cover and Runoff Curve Numbers in the Site’s Disturbed Area tables. As indicated above, the soil is HSG C for this project.

Site Data											
<b>Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area</b>											
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover	
Brush - brush-weed-grass mixture with brush the major element - Fair Condition	35		56		3.00		70		77	3.00	100%
Select a land cover type...	0		0		0		0		0	0.00	0%
Select a land cover type...	0		0		0		0		0	0.00	0%
Select a land cover type...	0		0		0		0		0	0.00	0%
Select a land cover type...	0		0		0		0		0	0.00	0%
Local Jurisdiction Input									0.00	0.00	0%
Other									0.00	0.00	0%
<b>Total</b>	<b>0.00</b>		<b>0.00</b>		<b>3.00</b>		<b>0.00</b>		<b>3.00</b>	<b>3.00</b>	<b>100%</b>
*HSG = hydrologic soil group											
									Impervious (ac)	0.00	
									Weighted CN	70	
									Potential Max Soil Retention, S <sub>pot</sub> (in)	4.29	
<b>Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area</b>											
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover	
Impervious	98		98		1.90		98		98	1.90	63%
Woods - Good Condition	30		55		0.10		70		77	0.10	3%
Open space - Good condition (grass cover > 75%)	39		61		0.50		74		80	0.50	17%
Brush - brush-weed-grass mixture with brush the major element - Fair Condition	35		56		0.50		70		77	0.50	17%
Select a land cover type...	0		0		0		0		0	0.00	0%
Local Jurisdiction Input									0.00	0.00	0%
Other									0.00	0.00	0%
<b>Total</b>	<b>0.00</b>		<b>0.00</b>		<b>3.00</b>		<b>0.00</b>		<b>3.00</b>	<b>3.00</b>	<b>100%</b>
									Impervious (ac)	1.90	
									Rv	0.62	
									Weighted CN	88	
									Potential Max Soil Retention, S <sub>post</sub> (in)	1.31	

6. **Select Conservation Area Credits, if applicable** – There are no conservation area credits for this site.

7. **Enter the Target Runoff Reduction Storm (in)** – The default value in cell C64 is one inch, which is the correct target runoff reduction storm for this project.

Water Quality Goals	
Target Runoff Reduction Storm (in)	1.00
Total Site Area for Water Quality Volume (acres)	3.00
Target Runoff Reduction Volume (cf)	6,752
Target Water Quality Volume (cf)	8,102

8. **Enter the BMP(s) Data** – See Appendix B2 of the Manual for sizing steps. As stated above, this example is using the runoff reduction approach, so the total designed volume of the practice must be provided to retain or remove the stormwater volume associated with the 1.0 inch storm event. The target runoff reduction volume is calculated to be 6,752 ft<sup>3</sup>. Because the bioretention basin with an underdrain only receives 50% runoff reduction credit, the minimum volume of the practice must be twice the target runoff reduction volume.

		Area Draining to Each BMP			Storage Volume Provided by BMP (cf)	RR Conveyance Volume Provided by BMP (cf)	Down-stream BMP
		On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)			
BMP 1	Bioretention Basin (w/ underdrain)	1.10	1.90	0.00	13,504		



Runoff Reduction Calculations						WQ Calculations	
RR Volume from Direct Drainage (cf)	RR Volume from Upstream Practices (cf)	Total RR Volume Received by BMP (cf)	Runoff Reduction %	RR Achieved (cf)	Remaining RR Volume (cf)	WQ <sub>v</sub> from Direct Drainage (cf)	Effective TSS Removal %
6,752	0	6,752	50%	6,752	0	8,102	85%

The Tool indicates that the target runoff reduction goal has been met.

Target Runoff Reduction Volume (cf)	6,752
Target Achieved?	Yes!
Remaining Runoff Reduction Volume (cf)	0
Target Water Quality Volume (cf)	8,102
% TSS Removal Achieved	85%
Target Achieved?	Yes!
Remaining TSS Removal %	0%

9. **Enter the target rainfall events** – The target rainfall events were provided in the project information. Enter the values in row 106.

Channel and Flood Protection Calculations				
	1-yr, 24-hr storm	2-yr, 24-hr storm	25-yr, 24-hr storm	100-yr, 24-hr storm
Target Rainfall Event (in)	3.40	3.80	6.50	7.90
	1-yr, 24-hr storm	2-yr, 24-hr storm	25-yr, 24-hr storm	100-yr, 24-hr storm
Pre-Development Runoff Volume (in)	0.95	1.20	3.21	4.38
Post Development Runoff Volume (in) with no BMPs	2.21	2.58	5.15	6.52
Post-Development Runoff Volume (in) with BMPs	1.59	1.96	4.53	5.90
Adjusted CN	80	81	83	83

\*See Stormwater Management Standards to Determine Detention Requirements.

Utilize the adjusted curve number and the modified TR-55 approach to compute the channel protection storage volume (CP<sub>v</sub>) and Overbank Flood Protection Volume (Q<sub>p25</sub>).

10. **Provide comments** – No additional comments are necessary for this project.

## 5.2 Example 2

A developer is proposing the development of a new public institution and associated amenities including parking, playground, and multi-purpose field.

### Pre-Developed Conditions

The pre-developed basin consists of 11.08 acres, 7.41 acres on-site and the remainder off-site.

The existing site consists of a completely pervious area. The site is broken into the following land covers:

<b>Pre-Developed Runoff (HSG B)</b>		
<b>Basin</b>	<b>Land Use</b>	<b>Area (acres)</b>
On-site Basin A	Original land use (natural wooded/grassed area)	7.41
Offsite Basin 1	Composite mixture of pervious and impervious surfaces	2.09
Offsite Basin 2	Offsite road basin	0.48
Offsite Basin 3	Composite mixture of pervious and impervious surfaces	1.10
Combined	All above basins combined at analysis point	11.08

There is also a 0.23 acre farm pond that sits on the northwest portion of the property that is proposed to be removed prior to the start of construction. Currently, the water from the project area surface flows to this existing pond and then discharges to an off-site creek.

#### Post-Developed Conditions

In the post-developed condition, the existing farm pond is removed and a storm sewer system is introduced to the site. The proposed storm sewer system will collect surface water from around the building, the building roof, and the parking lot. This system then conveys water to a dry extended detention basin. The water stored in the detention basin discharges to an adjacent creek off-site through a 30" HDPE outlet pipe. The post-developed condition contains one drainage basin with the study point located at the outlet control structure of the stormwater detention facility.

<b>Post-Developed Runoff (HSG B)</b>		
<b>Basin</b>	<b>Land Use</b>	<b>Area (acres)</b>
On-site Basin A	Composite mixture of pervious (5.25 acres) and impervious surfaces (2.16 acres)	7.41
Offsite Basin 1	Composite mixture of pervious and impervious surfaces	2.09
Offsite Basin 2	Offsite road basin	0.48
Offsite Basin 3	Composite mixture of pervious and impervious surfaces	1.10
Combined	All above basins combined routed through dry extended detention basin	11.08

The following is the rainfall data for the area:

- 1-year, 24-hour: 3.29 inches
- 2-year, 24-hour: 3.69 inches
- 25-year, 24-hour: 5.86 inches
- 100-year, 24-hour: 7.30 inches

1. Enter General Information – complete rows 8 through 13 of the Summary worksheet.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool Version 2.2			
General Information			
Name of Developer:	Georgia Engineers, Inc.	Date Submitted:	3/1/2016
Development Name:	Etowah Recreation Center	Permit Number:	10000
Site Location / Address:	1111 Rec Center Dr. Cityville, GA 12345	Developer Contact:	John Smith
		Phone Number:	(333) 111-2222
		Name of Engineer(s):	Joe Jones, PE
Development Type:	Institutional, Public & Semi Public	Maintenance Responsibility:	Cityville, GA

2. Outside of the Tool, Delineate Basins Pre- and Post-development – The base data indicates one on-site drainage basin that is 7.41 acres in size and three offsite basins. The pre- and post-development land covers are included in the project information.

3. Enter BMP Information in the Runoff Reduction and TSS Removal Efficiencies, if applicable – This step is not applicable because a dry extended detention basin has been specified for this project, and this BMP does not require any user inputs.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2 Runoff Reduction and TSS Removal Efficiencies						
	Runoff Reduction %	Effective TSS Removal %	Runoff Reduction Method	Drainage Area Restrictions	Units	Min/Max
Bioretention Basin (w/ underdrain)	50%	85%	Storage	5	acres	Max
Bioretention Basin (w/ upturned underdrain)	75%	85%	Storage	5	acres	Max
Bioretention Basin (w/o underdrain)	100%	100%	Storage	5	acres	Max
Bioslope (A & B hydrologic soils)	50%	85%	Storage	--	--	--
Bioslope (C & D hydrologic soils)	25%	85%	Storage	--	--	--
Downspout Disconnect (A & B hydrologic soils)	50%	80%	Convey	2500	ft <sup>2</sup>	Max
Downspout Disconnect (C & D hydrologic soils)	25%	80%	Convey	2500	ft <sup>2</sup>	Max
Dry Detention Basin	0%	80%	Storage	75	acres	Max
Dry Extended Detention Basin	0%	60%	Storage	--	--	--
Dry Well	100%	100%	Storage	2500	ft <sup>2</sup>	Max

4. Enter Drainage Basin Name – In the Drainage Basin worksheet, enter a specific drainage basin name.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2	
Development Name: Etowah Recreation Center	<div style="display: flex; justify-content: space-between;"> <span>data input cells</span> <span>calculation cells</span> </div> <div style="display: flex; justify-content: space-between;"> <span>constant values</span> </div>
Drainage Basin Name: Basin A	

5. Enter Pre- and Post-Development Land Cover – complete the Pre- and Post-Development Land Cover and Runoff Curve Numbers in the Site’s Disturbed Area tables. As indicated above, the soil is HSG B for this project.

Site Data										
Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area										
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover
Woods - Good Condition	30		7.41	55		70		77	7.41	100%
Select a land cover type...	0		0	0		0		0	0.00	0%
Select a land cover type...	0		0	0		0		0	0.00	0%
Select a land cover type...	0		0	0		0		0	0.00	0%
Select a land cover type...	0		0	0		0		0	0.00	0%
Local Jurisdiction Input									0.00	0%
Other									0.00	0%
Total	0.00		7.41		0.00		0.00		7.41	100%
*HSG = hydrologic soil group										
									Impervious (ac)	0.00
									Weighted CN	55
									Potential Max Soil Retention, S <sub>pre</sub> (in)	8.18
Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site's Disturbed Area										
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover
Impervious	98		2.16	98		98		98	2.16	29%
Open space - Good condition (grass cover > 75%)	39		5.25	61		74		80	5.25	71%
Select a land cover type...	0		0	0		0		0	0.00	0%
Select a land cover type...	0		0	0		0		0	0.00	0%
Select a land cover type...	0		0	0		0		0	0.00	0%
Local Jurisdiction Input									0.00	0%
Other									0.00	0%
Total	0.00		7.41		0.00		0.00		7.41	100%
									Impervious (ac)	2.16
									Rv	0.31
									Weighted CN	72
									Potential Max Soil Retention, S <sub>post</sub> (in)	3.93

6. **Select Conservation Area Credits, if applicable** – There are no conservation area credits for this site.

7. **Enter the Target Runoff Reduction Storm (in)** – The default value in cell C64 is one inch, which is the correct target runoff reduction storm for this project.

Water Quality Goals			
Target Runoff Reduction Storm (in)	1.00	Total Site Area for Water Quality Volume (acres)	7.41
		Target Runoff Reduction Volume (cf)	8,402
		Target Water Quality Volume (cf)	10,082

8. **Enter the BMP(s) Data** – See Volume 2, Chapter 4 of the Manual for sizing steps. Complete the Select BMPs for Runoff Reduction and Water Quality table.

		Area Draining to Each BMP			Storage Volume Provided by BMP (cf)	RR Conveyance Volume Provided by BMP (cf)	Down-stream BMP
		On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)			
BMP 1	Dry Extended Detention Basin	5.25	2.16	3.67	80,000		

Runoff Reduction Calculations						WQ Calculations	
RR Volume from Direct Drainage (cf)	RR Volume from Upstream Practices (cf)	Total RR Volume Received by BMP (cf)	Runoff Reduction %	RR Achieved (cf)	Remaining RR Volume (cf)	WQ <sub>v</sub> from Direct Drainage (cf)	Effective TSS Removal %
8,402	0	8,402	0%	0	8,402	10,082	60%

Because the dry extended detention basin has a 0% runoff reduction removal efficiency and BMPs cannot receive TSS trapping efficiency credit for oversizing above the WQ<sub>v</sub>, this layout does not meet the water quality requirements.

Target Runoff Reduction Volume (cf)	8,402
Target Achieved?	No
Remaining Runoff Reduction Volume (cf)	8,402
Target Water Quality Volume (cf)	10,082
% TSS Removal Achieved	60%
Target Achieved?	No
Remaining TSS Removal %	20%

**9. Reevaluate the selected BMP or combination of BMPs.**

**5.3 Example 3**

A developer is proposing the development of a new public institution and associated amenities including parking, playground, and multi-purpose field.

Pre-Developed Conditions

The pre-developed basin consists of 11.08 acres, 7.41 acres on-site and the remainder off-site. The existing site consists of a completely pervious area. The site is broken into the following land covers:

Pre-Developed Runoff (HSG B)		
Basin	Land Use	Area (acres)
On-site Basin A	Original land use (natural wooded/grassed area)	6.24
On-site Basin B	Original land use (natural wooded/grassed area)	1.17
Offsite Basin 1	Composite mixture of pervious and impervious surfaces	2.09
Offsite Basin 2	Offsite road basin	0.48
Offsite Basin 3	Composite mixture of pervious and impervious surfaces	1.10

There is also a 0.23 acre farm pond that sits on the northwest portion of the property that is proposed to be removed prior to the start of construction. Currently, the water from On-site Basin A surface flows to this existing pond and then discharges to an off-site creek. Water from On-site Basin B surface flows to an adjacent wooded area. Water from the offsite basins is routed to the existing pond.

Post-Developed Conditions

In the post-developed condition, the existing farm pond is removed and a storm sewer system is introduced to the site. The proposed storm sewer system will collect surface water from around the building and the building roof. This system then conveys water to a multi-purpose detention basin. In Basin A, 0.5 acres will be conserved as woods and protected under a conservation easement. On-site Basin B will be completely paved with a parking lot and sidewalks. Runoff

from the parking lot will be collected in an enhanced dry swale with an underdrain, which will then be routed to the multi-purpose detention basin. The water stored in the detention basin discharges to a creek off-site through a 30” HDPE outlet pipe. The post-developed condition study point is located at the outlet control structure of the stormwater detention facility.

Post-Developed Runoff (HSG B)		
Basin	Land Use	Area (acres)
On-site Basin A	Composite mixture of pervious (4.75 acres) and impervious surfaces (0.99 acres), Wooded conservation area (0.5 acres)	6.24
On-site Basin B	Impervious surfaces	1.17
Offsite Basin 1	Composite mixture of pervious and impervious surfaces	2.09
Offsite Basin 2	Offsite road basin	0.48
Offsite Basin 3	Composite mixture of pervious and impervious surfaces	1.10
Combined	All above basins combined routed through dry extended detention basin	11.08

The following is the rainfall data for the area:

- 1-year, 24-hour: 3.29 inches
- 2-year, 24-hour: 3.69 inches
- 25-year, 24-hour: 5.86 inches
- 100-year, 24-hour: 7.30 inches

1. **Enter General Information** – complete rows 8 through 13 of the Summary worksheet.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool Version 2.2			
General Information			
Name of Developer:	Georgia Engineers, Inc.	Date Submitted:	3/1/2016
Development Name:	Etowah Recreation Center	Permit Number:	10000
Site Location / Address:	1111 Rec Center Dr. Cityville, GA 12345	Developer Contact:	John Smith
		Phone Number:	(333) 111-2222
		Name of Engineer(s):	Joe Jones, PE
Development Type:	Institutional, Public & Semi Public	Maintenance Responsibility:	Cityville, GA

2. **Outside of the Tool, Delineate Basins Pre- and Post-development** – The base data indicates one on-site drainage basin that is 7.41 acres in size, one on-site drainage basin that is 1.17 acres in size, and three offsite basins. The pre- and post-development land covers are included in the project information.

3. **Enter BMP Information in the Runoff Reduction and TSS Removal Efficiencies, if applicable** – This step is applicable because a multi-purpose detention basin has been selected for this project, and it requires a user input for its effective TSS removal.

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2 Runoff Reduction and TSS Removal Efficiencies						
	Runoff Reduction %	Effective TSS Removal %	Runoff Reduction Method	Drainage Area Restrictions	Units	Min/Max
Bioretention Basin (w/ underdrain)	50%	85%	Storage	5	acres	Max
Bioretention Basin (w/ upturned underdrain)	75%	85%	Storage	5	acres	Max
Bioretention Basin (w/o underdrain)	100%	100%	Storage	5	acres	Max
Bioslope (A & B hydrologic soils)	50%	85%	Storage	--	--	--
Bioslope (C & D hydrologic soils)	25%	85%	Storage	--	--	--
Downspout Disconnect (A & B hydrologic soils)	50%	80%	Convey	2500	ft <sup>2</sup>	Max
Downspout Disconnect (C & D hydrologic soils)	25%	80%	Convey	2500	ft <sup>2</sup>	Max
Dry Detention Basin	0%	60%	Storage	75	acres	Max
Dry Extended Detention Basin	0%	60%	Storage	--	--	--
Dry Well	100%	100%	Storage	2500	ft <sup>2</sup>	Max
Enhanced Dry Swale (w/ underdrain)	50%	80%	Storage	5	acres	Max
Enhanced Dry Swale (w/o underdrain)	100%	100%	Storage	5	acres	Max
Enhanced Wet Swale	0%	80%	Storage	5	acres	Max
Grass Channel (A & B hydrologic soils)	25%	50%	Convey	5	acres	Max
Grass Channel (C & D hydrologic soils)	10%	50%	Convey	5	acres	Max
Gravity (oil-grit) Separator	0%	40%	Convey	5	acres	Max
Green Roof	60%	80%	Storage	--	--	--
Infiltration Trench	100%	100%	Storage	5	acres	Max
Multi-Purpose Detention Basin	0%	60%	Storage	--	--	--
Organic Filter	0%	80%	Storage	10	acres	Max

4. Enter Drainage Basin Name – In the Drainage Basin worksheet, enter a specific drainage basin name

Georgia Stormwater Management Manual Stormwater Quality Site Development Review Tool, v2.2	
Development Name: Etowah Recreation Center	
Drainage Basin Name: Basin A and Basin B	

5. Enter Pre- and Post-Development Land Cover – complete the Pre- and Post-Development Land Cover and Runoff Curve Numbers in the Site’s Disturbed Area tables. As indicated above, the soil is HSG B for this project.

Site Data										
Indicate Pre-Development Land Cover and Runoff Curve Numbers in the Site’s Disturbed Area										
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover
Woods - Good Condition	30		7.41	55			77		7.41	100%
Select a land cover type...	0			0			0		0.00	0%
Select a land cover type...	0			0			0		0.00	0%
Select a land cover type...	0			0			0		0.00	0%
Select a land cover type...	0			0			0		0.00	0%
Local Jurisdiction Input									0.00	0%
Other									0.00	0%
Total	0.00		7.41		0.00		0.00		7.41	100%
*HSG = hydrologic soil group							Impervious (ac)	0.00		
							Weighted CN	55		
							Potential Max Soil Retention, S <sub>pot</sub> (in)	8.18		
Indicate Post-Development Land Cover and Runoff Curve Numbers in the Site’s Disturbed Area										
Cover Type	HSG A (acres)	CN	HSG B (acres)	CN	HSG C (acres)	CN	HSG D (acres)	CN	Total	% Cover
Impervious	98	2.16	98	98		98		98	2.16	29%
Open space - Good condition (grass cover > 75%)	39	4.75	61	74		80		80	4.75	64%
Woods - Good Condition	30	0.50	55	70		77		77	0.50	7%
Select a land cover type...	0			0		0		0	0.00	0%
Select a land cover type...	0			0		0		0	0.00	0%
Local Jurisdiction Input									0.00	0%
Other									0.00	0%
Total	0.00		7.41		0.00		0.00		7.41	100%
							Impervious (ac)	2.16		
							Rv	0.31		
							Weighted CN	71		
							Potential Max Soil Retention, S <sub>post</sub> (in)	4.01		



**6. Select Conservation Area Credits, if applicable** – There is a 0.5-acre conservation area credit associated with this project because 0.5 acres is being left in its natural condition, and a conservation easement has been issued for the area. Select the Scenario 1 box and input 0.5 in the input cell (cell A50).

Conservation Area Credits			
<b>Scenario 1: Natural Conservation Area</b> *See the GSMM Volume 2, Section 2.3.3.3 for more information. <input checked="" type="checkbox"/> Check the box if a portion of the post-developed area is protected by a conservation easement or equivalent form of protection. 0.5 Area (ac) of development protected by a conservation easement or equivalent form of protection. <b>Note: The green cell will unlock if the Scenario 1 box above is checked</b>		<b>Scenario 3: Soil Restoration</b> *See the GSMM Volume 2, Section 4.23 for more information. <input type="checkbox"/> Check the box if a portion of the post-developed area employs <u>soil restoration</u> a conservation easement or equivalent form of protection. Area (ac) of development with restored soils and protected by a conservation easement or equivalent form of protection. <b>Note: Scenario 3</b>	
<b>Scenario 2: Site Reforestation/Revegetation</b> *See the GSMM Volume 2, Section 4.22 for more information. <input type="checkbox"/> Check the box if a portion of the post-developed area employs <u>site reforestation/revegetation</u> and is protected by a conservation easement or equivalent form of protection. Area (ac) of development reforested/revegetated and protected by a conservation easement or equivalent form of protection. <b>Note: The green cell will unlock if the Scenario 2 box above is checked</b>		<b>Scenario 4: Site Reforestation/Revegetation &amp; Soil Restoration</b> *See the GSMM Volume 2 for more information. <input type="checkbox"/> Check the box if the same portion of the post-developed area employs <u>site reforestation/revegetation and soil restoration</u> , and is protected by a conservation easement or equivalent form of protection. <b>Note: Scenario 4</b>	
Total Conservation Area Credit (acres) 0.50			

**7. Enter the Target Runoff Reduction Storm (in)** – The default value in cell C64 is one inch, which is the correct target runoff reduction storm for this project.

Water Quality Goals	
Target Runoff Reduction Storm (in) <input type="text" value="1.00"/>	Total Site Area for Water Quality Volume (acres) <input type="text" value="6.91"/>
	Target Runoff Reduction Volume (cf) <input type="text" value="7,835"/>
	Target Water Quality Volume (cf) <input type="text" value="9,402"/>

**8. Enter the BMP(s) Data** – See Appendix B2 of the Manual for sizing steps. Complete the Select BMPs for Runoff Reduction and Water Quality table.

		Area Draining to Each BMP			Storage Volume Provided by BMP (cf)	RR Conveyance Volume Provided by BMP (cf)	Downstream BMP
		On-site Pervious Area (acres)	On-site Impervious Area (acres)	Offsite Area (acres)			
BMP 1	Multi-Purpose Detention Basin	5.25	0.99	3.67	75,000		
BMP 2	Enhanced Dry Swale (w/ underdrain)		1.17		4,040		BMP 1

Runoff Reduction Calculations						WQ Calculations	
RR Volume from Direct Drainage (cf)	RR Volume from Upstream Practices (cf)	Total RR Volume Received by BMP (cf)	Runoff Reduction %	RR Achieved (cf)	Remaining RR Volume (cf)	WQ <sub>v</sub> from Direct Drainage (cf)	Effective TSS Removal %
4,367	2,015	6,382	0%	0	6,382	5,240	60%
4,035	0	4,035	50%	2,020	2,015	4,842	80%



The Tool indicates that the target water quality goal has been met.

Target Runoff Reduction Volume (cf)	7,835
Target Achieved?	No
Remaining Runoff Reduction Volume (cf)	5,815
Target Water Quality Volume (cf)	9,402
% TSS Removal Achieved	81%
Target Achieved?	Yes!
Remaining TSS Removal %	0%

9. Enter the target rainfall events – The target rainfall events were provided in the project information. Enter the values in row 106.

Channel and Flood Protection Calculations				
	1-yr, 24-hr storm	2-yr, 24-hr storm	25-yr, 24-hr storm	100-yr, 24-hr storm
Target Rainfall Event (in)	3.29	3.69	5.86	7.30
Pre-Development Runoff Volume (in)	0.28	0.41	1.44	2.32
Post Development Runoff Volume (in) with no BMPs	0.95	1.21	2.82	4.02
Post-Development Runoff Volume (in) with BMPs	0.88	1.13	2.75	3.94
Adjusted CN	70	70	71	71

\*See Stormwater Management Standards to Determine Detention Requirements.

Utilize the adjusted curve number and the modified TR-55 approach to compute the channel protection storage volume ( $CP_v$ ) and Overbank Flood Protection Volume ( $Q_{p25}$ ).

10. Provide comments – Suggest indicating references to the conservation easement and multi-purpose detention basin TSS Removal % in the stormwater report.

Comments
Back-up information supporting a TSS removal efficiency of 60% for the multi-purpose detention basin is included in Appendix C of the Stormwater Report. Proof of the conservation easement is included in Appendix D.

## 6.0 Frequently Asked Questions

### What does “Impervious Cover” mean?

Impervious cover refers to land cover that is impermeable to runoff, and includes all paved surfaces. In addition, any surface that supports vehicle traffic, such as a gravel road or parking lot, is considered impervious.

### Are Green Roofs and Permeable Pavement pervious or impervious?

Green roofs and permeable pavement are *partially impervious*. These practices act as a runoff reduction and stormwater treatment practice, so that the ultimate runoff from these surfaces is reduced. For the purposes of the Tool, however, the area of permeable pavement and green roofs should be included as impervious area.

### Can I direct additional impervious drainage to permeable pavement?

While the worksheet allows the user to enter a drainage area greater than the pavement area, the GSMM does not recommend this practice and it is discouraged. Doing so in practice could increase maintenance burden and/or lead to failure of the permeable pavement system.

### How should I use the “Channel and Flood Protection Calculations” section?

The “Channel and Flood Protection Calculations” section generates revised curve numbers that account for the benefits of runoff reduction practices. Detention is typically not needed if the revised curve number is lower than the pre-developed curve number. If detention is needed, a hydrologic and hydraulic analysis will be needed to properly size and route flow through the practice.

### As a reviewer, what are some key cells I should look at to ensure that the submitted worksheet is accurate?

Some checks that can help to act as a “first screen” to ensure that the spreadsheet has been used correctly include the following:

#### Runoff Reduction and TSS Removal Efficiencies Worksheet

- 1) Verify user input values, if applicable. Backup information should be provided by the user to support their inputs.

#### Drainage Basin Worksheets

- 2) Thoroughly check the Conservation Area Credit section. Verify that the area is protected by a conservation easement or equivalent form of protection.
- 3) Check drainage areas to each BMP and their storage volumes, if applicable, to ensure that practices capture the design volume. For each drainage basin the total of the pervious and impervious area draining to BMPs should be less than or equal to the total drainage basin pervious and impervious area.
- 4) For permeable pavement and bioretention, ensure that the designer has selected “underdrained” if an underdrain is needed.
- 5) Review the site plan to ensure that the pathway of practices in series from the “Downstream BMP” (*column H*) corresponds to the actual conditions.

### Why don’t I need to enter a storage volume for some practices?

Some practices, such as bioretention basins, are credited based on their storage volume. Other practices, such as rooftop disconnection, receive credit based on meeting a minimum design standard that conveys a runoff volume.

**How should I credit underground storage?**

The default Underground Detention BMP does not provide any runoff reduction or TSS removal credits. If it does not provide infiltration it will not provide treatment or runoff reduction, and will act as a detention practice only. If underground storage is designed, however, to provide infiltration, it can act as an infiltration practice. This can be input into the tool as a User Input, if necessary.

**How do I account for BMPs that have an upturned underdrain if it is not listed in the Runoff Reduction and TSS Removal Efficiencies worksheet?**

The three User Input options at the bottom of the table in the Runoff Reduction and TSS Removal Efficiencies table can be used to account for BMPs that have an upturned underdrain and are not already included in the worksheet.

**Does the worksheet allow me to do anything that is inconsistent with the guidance in the GSMM?**

Yes. The worksheet is only intended as a tool to quantify the runoff reduction and treatment volume provided on site, and does not have limits on design parameters. For example, drainage areas are not limited, and practices that may require an underdrain on C or D soils can be applied on sites that have only C and D soils. When doing anything that is or appears to be inconsistent with the GSMM, consult the local jurisdiction for further guidance.

**I have a pond that captures drainage from several upstream practices. For the drainage area to the pond, should I enter the *entire* drainage area, or only the land that has not been captured by other practices?**

Only enter the remaining drainage area. The overflow from upstream practices will be accounted for as the “Volume Received by Upstream Practices.”

**Are runoff volumes generated from off-site areas allowed in the volume runoff reductions?**

Because off-site areas can change over time with no input from the owner/developer of the property in question, volumes generated from off-site areas can be routed through a BMP, but no water quality credits will be achieved for the off-site volumes.

**How are these “drainage basin” areas defined in terms of areas used in water quality, channel protection, and peak flows? Do the drainage basin areas treat areas outside the site differently?**

In terms of water quality, a drainage basin in the Tool only takes into account the on-site area. The channel protection volume and peak flows are dependent on the specific conditions of the site and where the analysis point is located.