

Appendix A. Compliance Calculator Guidance

A.1 Introduction

The Center for Watershed Protection created the compliance calculator spreadsheet to allow a designer to quickly analyze multiple LID options, and check them against the state water quality requirements. As is clear from the specifications, each LID BMP has different design requirements, equations, and standards that determine its effectiveness. Depending upon the site, it can become difficult to determine which BMP(s) best meets the requirements. With the compliance calculator, it is easier to examine different combinations of BMPs in order to find the best option or set of options. The compliance calculator also can be used by the plan reviewer to quickly verify the compliance status of a plan.

It is important to note that the compliance calculator is not a model, and while it can be used as a design tool, it does not replace the required efforts of a competent designer. The numbers in the spreadsheet do not guarantee that a BMP meets the specifications, is appropriate for its location, or is generally well-designed.

The compliance calculator likely will be a useful tool for many types of development sites. However, there are other tools available that can assist with design of practices, compliance determination, or pollutant removal calculations, some simple, and some much more complex. The applicability of these tools or models will depend upon the characteristics of an individual site and the level of analysis that is desired. Potentially applicable tools include:

SWMM

The EPA Storm Water Management Model (SWMM) is a rainfall-runoff simulation model used mainly in urban areas, often to model complex catchments or watersheds. SWMM models both the generation of runoff from rainfall based upon surface types, and routing through the conveyance system, including pipes, channels, treatment practices, etc. SWMM tracks the quantity and quality of runoff generated within each subcatchment, and the quantity and quality of water conveyed through each pipe and channel throughout each simulation period. More information on SWMM is available at <http://www.epa.gov/nrmrl/wswrd/wq/models/swmm/>.

IDEAL

The Integrated Design, Evaluation, and Assessment of Loadings (IDEAL) model is a water quality model for designing stormwater BMPs and calculating their effectiveness in pollutant removal. The IDEAL model includes a number of available BMPs, including sand filters, detention ponds, bio-retention areas, rainwater harvesting, proprietary practices, and others. Specific BMP details, such as ponding or filter media depths can be input into the model, and runoff can be routed between catchments and BMPs as needed. The IDEAL model was originally designed for coastal South Carolina to help designers meet water quality standards. The IDEAL model can be found at <http://www.stormoppssoftware.com/>.

Green Values National Stormwater Management Calculator

The National Green Values™ Calculator (GVC) is a simple calculator tool intended to allow the user to quickly compare the performance, costs, and benefits of LID BMPs. The GVC looks at an-

nual precipitation values and LID practice performance to determine the benefits of various BMP arrangements. The GVC does not calculate flows or water quality results. Instead, it looks at the runoff reduction benefits of various BMPs, and allows the user to select a runoff reduction goal that matches a site's requirements. The GVC can be found at <http://greenvalues.cnt.org/national/calculator.php>.

A.2 Compliance Calculator Spreadsheet Guidance

The following guidance explains how to use each of the worksheets in the compliance calculator spreadsheet. The spreadsheet is available to download at <http://www.northinlet.sc.edu/LID>.

Note: All cells in the spreadsheet that are highlighted in blue 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.

Site Data Sheet

1. Enter the name of the proposed project on **line 9**.
2. Enter the pre-development land cover areas (in acres) of forest cover, turf cover, and impervious cover on the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in **cells C15-C17, E15-E17, G15-G17, and I15-I17**, respectively.
3. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in **cells D15-D17, F15-F17, H15-H17, and J15-J17**. Default values have been included in these cells, but they can be changed if necessary.
4. Enter the post-development land cover areas (in acres) of forest cover/open space, turf cover, and impervious cover on the site for Natural Resource Conservation Service (NRCS) soil types A, B, C, and D in **cells C24-C26, E24-E26, G24-G26, and I24-I26**, respectively.
5. Verify/enter the NRCS runoff curve numbers for each land use/soil type combination in **cells D24-D26, F24-F26, H24-H26, and J24-J26**. As with the pre-development entries, default values have been included in these cells, but they can be changed if necessary.
6. Answer yes or no to the questions on **lines 29-31** regarding the location of the site. The required water quality volume (**cell C37**), and the mechanism of treatment (**cell E37**), depend on the answers to these questions, as well as the area disturbed on the site (See Figure A.2-1).
7. For sites regulated by the statewide permit only, the water quality volume and treatment mechanism is recorded as "Practice Dependent" and the required volume varies depending on the type of practice (See Table A.2-1). These practice-specific values are recorded in **cells C39-C41**.

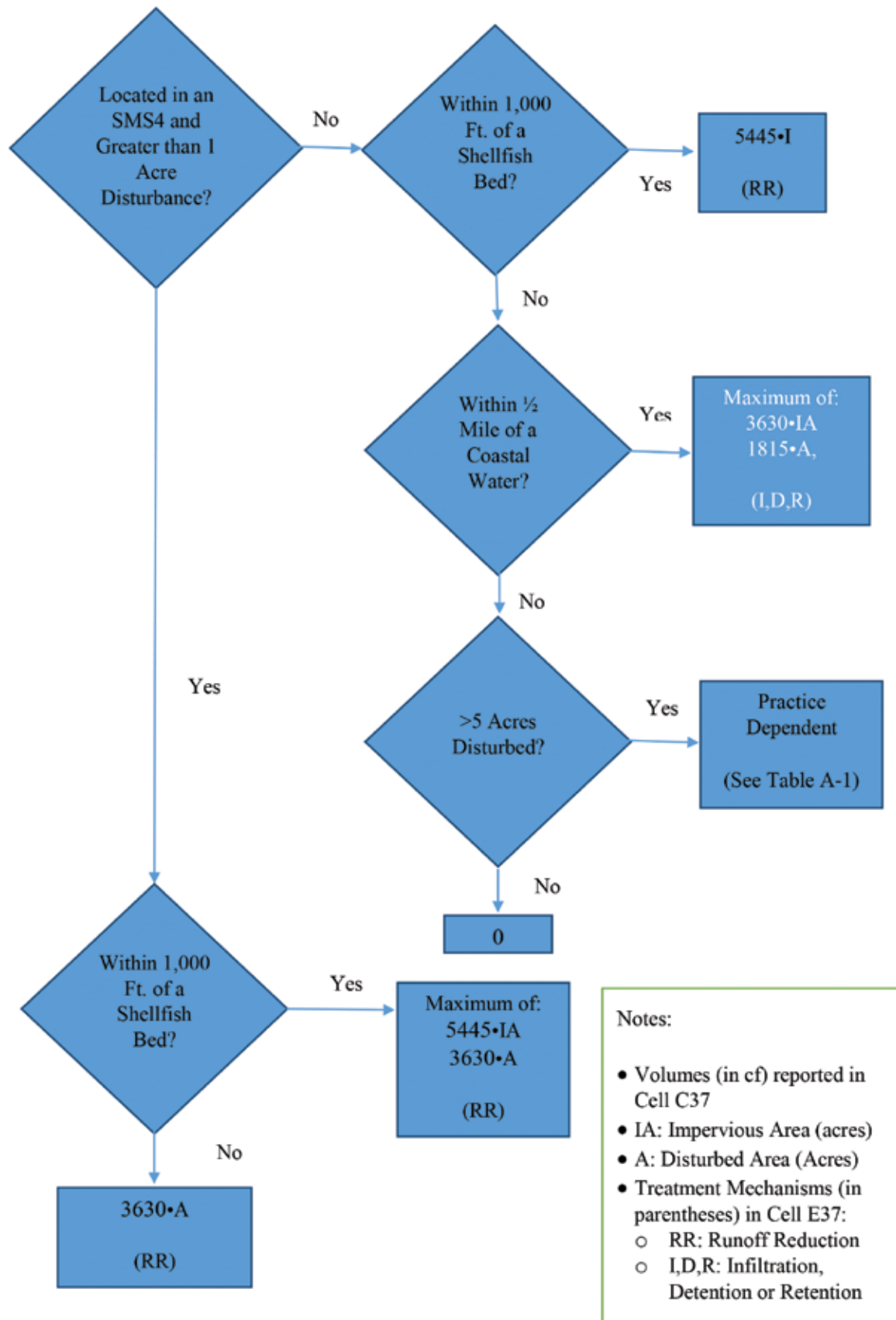


Figure A.2-1. Flowchart to determine stormwater management requirements using the compliance calculator spreadsheet.

Table A.2-1. Practice-Dependent Water Quality Volume and Treatment Mechanisms	
Practice Type	Water Quality Volume (ft³)
LID Practices	3630•IA
Ponds with a Permanent Pool (Wet Swales, Wet Ponds, Wetlands)	1815•A
Ponds without a Permanent Pool (Dry Detention Ponds, Filtration Practices)	3630•A
<i>Note: IA = Impervious Area (acres); A = Disturbed Area (acres)</i>	

BMP Sheet

1. Apply BMPs to the drainage area to address the required water quality volume by indicating the area in square feet of turf cover and impervious cover to be treated by a given BMP in **Columns B and C**. This likely will be an iterative process. The available BMPs include the following:
 - Bioretention - Enhanced
 - Bioretention - Standard
 - Permeable Pavement - Infiltration
 - Permeable Pavement - Standard
 - Infiltration
 - Green Roof
 - Rainwater Harvesting
 - Disconnection to A/B or Amended Soils
 - Disconnection to Forest Cover/Open Space
 - Grass Channel in A/B or Amended Soils
 - Grass Channel in C/D Soils
 - Dry Swale
 - Wet Swale
 - Regenerative Stormwater Conveyance (RSC)
 - Filtration
 - Dry Detention Practice
 - Wet Detention Pond
 - Wetland
2. Enter the BMP storage volume (ft³) in **Column D**.
3. The volume from direct drainage to the BMP is calculated and reported in **Column E**, using the flowchart provided in Figure A.2-1. Note that the total disturbed area is

reflected as the sum of impervious cover (**column B**) and turf cover (**column C**) draining to the practice.

4. If more than one BMP will be employed in series, any overflow from upstream BMPs (V_{US}) will be accounted for in **column F**.
5. The total volume captured by the practice (V_{CAP}) is reported in **column G** and is equal to the following:

$$V_{CAP} = \text{Maximum of } (Sv, V_{US} + V_{DD})$$

where:

V_{CAP}	=	Water Quality Volume captured by the practice (ft ³)
Sv	=	Storage Volume (ft ³)
V_{US}	=	Volume of runoff from upstream practice (ft ³)
V_{DD}	=	Volume of runoff from direct discharge (ft ³)

6. The Treatment Mechanism (from **cell E37** on the **Site Data Tab**) is reported in **Column H**.
7. The Credit (%) for each treatment mechanism (from Table A.2-2) is reported in **Columns I-K**.
8. The Water Quality Volume Credited is calculated in **Column L**, and is equal to the following:
- 9.

$$WQv_{CR} = \text{Minimum of } (Sv \times CR, V_{CAP})$$

where:

WQv_{CR}	=	Water Quality Volume Credited (ft ³)
Sv	=	Storage Volume (ft ³)
CR	=	Credit (fraction)
V_{CAP}	=	Volume Captured by the Practice (ft ³)

10. The Remaining Water Quality Volume (**column M**) is calculated as:

$$WQv_R = V_{US} + V_{DD} - WQv_{CR}$$

where:

WQv_R	=	Water Quality Volume Remaining (cf)
---------	---	-------------------------------------

V_{US} = Volume from Upstream Practices (cf)

V_{DD} = Volume from Direct Drainage (cf)

11. Any runoff volume remaining can be directed to a downstream BMP by selecting a practice from the pull-down menu in **column N**. Selecting a BMP from the menu will automatically direct the runoff volume remaining to **column F** for the appropriate BMP.
12. The Target Water Quality Volume (WQV_T) is reported in **Cells B31-B35**, from corresponding **Cells C37-C41** on the **Site Data Tab** as follows:
 - For sites where the volume is not practice dependent (i.e., regulated by a rule other than the Statewide Stormwater Rule), the target is reported in **Cell D31** and is equal to the value on **Cell D37** on the **Site Data Tab**.
 - For sites where the volume is practice dependent (i.e., regulated by the Statewide Stormwater Rule only), the target volumes are specific to each practice, and reported in **Cells C33-C35**, which are taken from corresponding **Cells C39-C41** on the **Site Data Tab**.

Table A.2-2. Water Quality Credit for Each Treatment Mechanism			
Practice Type	Treatment Mechanism		
	Runoff Reduction	Infiltration, Retention, or Detention	Practice Dependent
Bioretention - Enhanced	100%	100%	100%
Bioretention - Standard	60%	100%	60%
Permeable Pavement - Infiltration	100%	100%	100%
Permeable Pavement - Standard	50%	100%	50%
Infiltration	100%	100%	100%
Green Roof	100%	100%	100%
Rainwater Harvesting	100%	100%	100%
Disconnection to A/B or Amended Soils	50%	100%	50%
Disconnection to C/D Soils	25%	25%	25%
Disconnection to Forest Cover/Open Space	75%	75%	75%
Grass Channel in A/B or Amended Soils	20%	20%	20%
Grass Channel in C/D Soils	10%	10%	10%
Dry Swale	60%	100%	60%
Wet Swale	0%	100%	100%
Regenerative Stormwater Conveyance (RSC)	100%	100%	100%
Filtration	0%	100%	100%
Dry Detention Practice	0%	0%	100%
Wet Detention Pond	0%	100%	100%
Wetland	0%	100%	100%

13. The Water Quality Volume Provided (WQv_p), is calculated in **Cells D31-D35**, as follows:

- For sites where the volume is not practice dependent (i.e., regulated by a rule other than the Statewide Stormwater Rule), the volume provided is reported in **Cell D31** and is equal to the value in **Cell L26**, which sums the water quality volume credited for all practices in **Column L**.
- For sites where the volume is practice dependent (i.e., regulated by the Statewide Stormwater Rule only), the target volumes are specific to each practice, also from **Column L**. The value calculated in **Cell D33** is the summation of the WQv_p provided in all LID practices (i.e., practices with greater than 0% Runoff Reduction in Table A.2-2). The value calculated in **Cell D34** is equal to the WQv_p provided in all ponds with a permanent pool (wet swales, wet ponds and wetlands), and the value calculated in **Cell D35** is equal to the WQv_p provided in all ponds without a permanent pool (filtration practices and dry ponds).

14. The fraction of target achieved (either by practice or by the entire site as appropriate) is calculated in **Cells F31-F35**). The % of target achieved is calculated as follows:

$$T = \left(\frac{WQv_p}{WQv_T}, 1 \right)$$

where:

T	=	Treatment (fraction)
WQv_p	=	Water Quality Volume Provided (cf)
WQv_T	=	Water Quality Volume Target (cf)

15. **Cell I31** determines if the site target has been reached as follows:

- For sites where the volume is not practice dependent (i.e., regulated by a rule other than the Statewide Stormwater Rule), the target volume is achieved if the Target % in **Cell F31** is 100%.
- For sites where the volume is practice dependent (i.e., regulated by the Statewide Stormwater Rule only), the target volumes is achieved if:
 - The Total % achieved in **Cells F32-F35** is at least 100%, *and*
 - The Total Turf treated is at least equal to the site turf area, *and*
 - The Total Impervious Cover treated is at least equal to the site impervious cover.

Channel and Flood Protection

This sheet assists with calculation of Adjusted Curve Numbers that can be used to calculate peak flows associated with the 2-year storm, 10-year storm, or other storm events.

1. Indicate the appropriate depths for the 2-year, 10-year, 25-year, and 100-year 24-hour storms (or other storms as needed) on **line 5**.
2. The Total Site Area (from the **Site Data** Tab), is reported in **Cell C7**.
3. Detention Storage Volume (cf) is calculated in **Cell C8**, and refers to the total storage provided in all LID practices using the following equation:

$$V_{DS} = \sum_{LID\ BMPs} Sv_{BMP} \times IRD_{BMP}$$

where:

V_{DS} = Volume in Site Detention Storage (cf)

Sv_{BMP} = Storage Volume Provided in Each BMP (cf)
(from **Column D** of the **BMPs** Tab)

IRD_{BMP} = Infiltration, Retention or Detention Credit for Each BMP
(from **Column J** of the **BMPs** Tab)

Note that, while other practices such as ponds provide detention, it is assumed that design engineers will explicitly account for this detention in a Pond Routing program.

4. As indicated in the Site Data sheet, each cover type is associated with a NRCS curve number. **Cells D15–G20** show the pre-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G22**.
5. **Cells D27–G32** show the post-development land cover areas and curve numbers that were indicated on the Site Data Sheet. Using these curve numbers, a weighted curve number is calculated in **cell G39**.
6. Using NRCS methodology, **line 38** calculates the pre-development runoff volume (inches) for the various storm events.

Potential Abstraction:

$$S = \frac{1,000}{(CN - 10)}$$

where:

S = potential abstraction (inches)

CN = weighted curve number

Runoff Volume:

$$Q = \frac{(P - 0.2S)^2}{(P + 0.8S)}$$

where:

- Q = runoff volume (in.)
- P = precipitation depth for a given 24-hour storm (in.)
- S = potential abstraction (in.)

7. Line 39 calculates the post-development runoff volume based solely on land cover (without regard to the BMPs selected on the BMP sheet). **Line 40** then subtracts the runoff reduction volume provided by BMPs, from **Cell C8**.
8. Based upon the reduced runoff volumes calculated in line 40, the spreadsheet then calculates corresponding reduced curve numbers for each storm event. This Adjusted Curve Number is reported on **line 41**.
9. Line 42 compares the pre-development runoff volume in line 38 with the post-development (with BMPs) runoff volume in line 40. If the post-development volume (with BMPs) is less than or equal to the pre-development volume for a given storm event, then it is assumed that detention will not be required. If the post-development volume (with BMPs) is greater than the pre-development volume for a given storm event, then detention will be necessary, and the Adjusted Curve Numbers from line 41 should be used to calculate the post-development peak runoff rates.

