COMMONWEALTH OF PENNSYLVANIA
DEPARTMENT OF ENVIRONMENTAL PROTECTION
BUREAU OF CLEAN WATER

SCM 3.4.7 SPREADSHEET
GREEN ROOF
INSTRUCTIONS

Draft, September 15, 2026

Introduction

The Department of Environmental Protection (DEP) has developed the SCM 3.4.7 Spreadsheet (Spreadsheet) to calculate volume and water quality management credits when a Green Roof SCM is proposed as part of new land development or as a retrofit to implement Section 3.4.7 of the Pennsylvania Post-Construction Stormwater Management (PCSM) Manual.

The Spreadsheet was designed using the latest version of Microsoft Excel® and is in Excel macro workbook (XLSM) format.

Users should check DEP's website periodically for updates to the spreadsheet and instructions by visiting www.dep.pa.gov/constructionstormwater and selecting "E&S Resources". In general, DEP/CCD will accept older versions of the spreadsheet no more than 6 months following the revision date of the spreadsheet. DEP/CCD also reserves the right to request completion of the latest version of the spreadsheet for any project.

Questions on the use of the spreadsheet can be directed to the Bureau of Clean Water at **RA-EPCHAPTER102@pa.gov**.

General Information

It is important that the user follow these instructions carefully. Omission of data in any cell designed for data entry may result in the failure of important calculations.

If prompted by Excel after opening the spreadsheet, enable editing and macros. *Note that you may need to add additional Trusted Locations in the Trust Center Settings of Excel in order to run the macros*. These locations may include server drives and/or locations where you intend to save the file for use. The following steps may be taken:

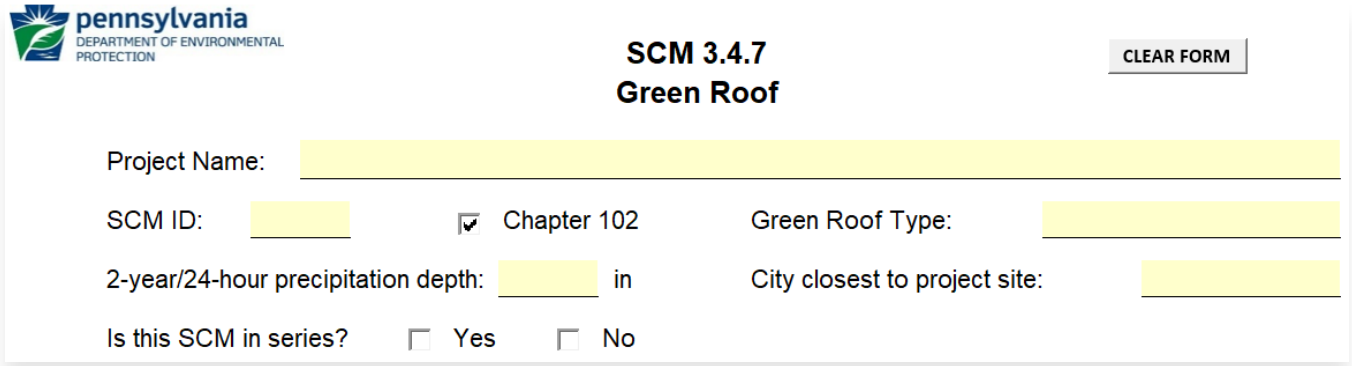
1. Excel Options > Trust Center > Trust Center Settings > Trusted Locations
2. Check the box to "Allow Trusted Locations on my network"
3. Select "Add new location"
4. Browse to select the folder (or server) where the file will be saved, check the "Subfolders of this location are also trusted" box, and then OK.

The top of the worksheet contains a "Clear Form" button. The user may click on the "Clear Form" button at any time to delete **all** data from the current worksheet. All cells available for data entry or selection from a drop-down menu are highlighted. **The user may use the Tab, arrow, or Enter keys to move from cell to cell. Using the mouse to click from cell to cell may result in validation errors**.

Care must be taken to enter the data in the correct order identified in these instructions to avoid potential errors with the calculations and logic. For example, skipping a cell may prevent a calculation or produce an error message. The spreadsheet is protected. Formulas are not visible but are explained in this document. Validation that exists in the spreadsheet is explained in this document.

Completing the Spreadsheet

General Section



- **Project Name –** Enter the Project (Site) Name as reported on the NOI, application, or plan submitted to DEP/CCD.

- **SCM ID** – Enter the SCM ID as is identified on plan drawings and PCSM Module 2. A legal instrument, easement or other recording will be needed to ensure long-term protection.

- **Chapter 102** – Check the box next to "Chapter 102" if the SCM is being implemented to comply with Chapter 102 PCSM requirements, otherwise uncheck the box.

- **Green Roof Type** – Select Intensive or Extensive for the type of green roof. Where Extensive is selected, the growing medium must be at least 4 inches thick, unless foundation growth media is used (in which case growing medium must be at least 3 inches thick). Where Intensive is selected, the growing medium must be at least 6 inches thick. A selection must be made in order to enter Growing Media depth (see Green Roof Profile section).

- **2-Year/24-Hour Precipitation Depth** – Enter the 90th upper confidence interval statistic for the 2-year/24-hour precipitation depth using NOAA Atlas 14 or other published sources, in inches.

- **City closest to project site** – Select the city from the dropdown list that is closest to the project site. This information is used when a drain restrictor is incorporated into the design and published Potential Evapotranspiration (ET) data from the selected city is used to determine volume management credit.

- **Is this SCM in series?** – Check the appropriate box (Yes or No). If Yes, select whether the SCM ("SCM 1") is upstream or downstream of another SCM ("SCM 2"). Then select the SCM type for "SCM 2". The options are PCSM Objective A, PCSM Objective B, PCSM Objective C, and PCSM Objective D (refer to the PCSM Manual). Then enter the SCM ID for "SCM 2", as identified in the PCSM Plan.

Drainage Area Characterization Section

☑ ***Drainage Area Characterization***

Are there other impervious areas contributing to the Green Roof? ☑ Yes ☐ No

Contributing Impervious Rows: ☑ ***Calculate runoff automatically***

Impervious Cover Type	Area (ac)	HSG	Off-Site	2-Year/24-Hour Runoff (CF)
			☐	

	Post-Construction Values		
	Total	**Off-Site**	**Project Site**
Runoff Volume (CF):			

- **Are there other impervious areas contributing to the Green Roof? –** Check the box next to Yes if impervious roof areas drain to the green roof SCM; otherwise check the box for No if the green roof will receive direct precipitation only (No is checked by default). If Yes is selected a table appears to calculate runoff from the impervious areas.

- **Contributing Impervious** – Select (post-construction) Impervious Cover Types from the dropdown list and enter their areas and HSG Soil Types (or N/A) for the SCM's drainage area to calculate the post-construction 2-year/24-hour runoff volume for the impervious areas. If the area is located outside of the project site boundary check the box in the "Off-Site" column. If the user prefers to calculate runoff for each Land Cover / Soil Type combination separately, uncheck the "Calculate runoff automatically" box and enter the values into the column for "2-Year/24-Hour Runoff (CF)."

  Post-construction runoff volumes are calculated for the total drainage area, any off-site areas, and the project site (the difference between total drainage area and off-site area). Project site runoff (along with direct precipitation) is used as a constraint on volume management credit.

Green Roof Profile Section

☑ ***Green Roof Profile***

No. Layers Comprising Green Roof:

Layer	Description	Depth (in)	Root Accessible?	Sat	FC	WP	RC (gal/SF)
1	Growing Media						
2							
3							

- **No. Layers Comprising Green Roof** – Select the number of distinct layers in the green roof profile, up to 10. Growing media is displayed by default.

- **Profile Table** – Enter information for each layer, starting with the top (Growing Media) layer to the bottom layer.

  - **Description** – Select from the dropdown a description of the layer from the following options: Geotextile / Separation Fabric, Foundation Growth Media, Synthetic Drainage Mat, Granular Drainage Layer, and Synthetic Retentive Layer.

  - **Depth (in)** – Select the depth or thickness, in inches, for the selected layer, up to 48 inches. For Growing Media the Green Roof Type (Intensive or Extensive) must be selected, and the minimum Growing Media depths are 3 inches and 6 inches for Intensive and Extensive green roofs, respectively. For thinner layers such as geotextiles select "< 1" from the list. Round depths to the nearest whole inch.

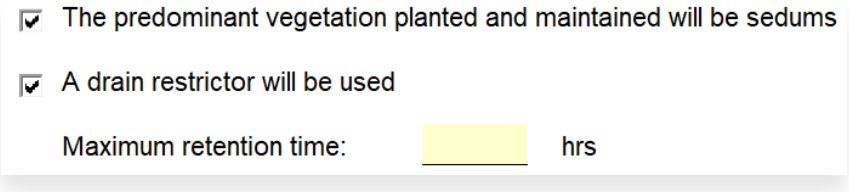
  - **Root Accessible?** – If the layer is intended to be accessible by roots, such that roots may be able to evapotranspire water within the layer, select Yes, otherwise select No.

  - **Saturation Moisture Content (Sat), Field Capacity (FC), and Wilting Point (WP)** – If the cells for "Sat", "FC", and "WP" are highlighted yellow for the layer, enter values for saturation moisture content, field capacity, and wilting point. For manufactured media, mats or layers, this information may be provided by the manufacturer. The value entered for Sat must be greater than FC and WP and not exceed 0.8 (volume/volume); FC must be less than Sat and not exceed 0.6; and WP must be less than Sat and FC (and not exceed 0.5).

    The Sat, FC, and WP cells are applicable (highlighted yellow) and used in volume management credit calculations for 1) Growing Media and 2) when the selected layer is Foundation Growth Media and Yes is selected for "Root Accessible?". They are not used in volume credit calculations (grayed out) in all other scenarios. (Users can type into gray cells but the values are not used).

  - **RC (gal/SF)** – When Synthetic Retentive Layer is selected in the Description column, the cells for Sat, FC, and WP become grayed out and the cell for RC (gal/SF) becomes highlighted yellow. RC is grayed out in all other scenarios. Enter the Retentive Capacity (RC) of the retentive layer in gallons per square foot (gal/SF). RC may be specified by the manufacturer; if not then an estimate of the void space volume per area should be made; a maximum of 5 gal/SF can be entered.

Below the Profile Table additional information is requested:



- **The predominant vegetation planted and maintained will be sedums** – Check the box if sedums (drought-tolerant succulent plants) will be the predominant vegetation planted and maintained on the green roof. This information is used only when a drain restrictor is used (to determine Potential ET).

- **A drain restrictor will be used** – Check the box if water will be held in the green roof growing media through the use of a restrictor. If checked, enter the maximum retention time, in hours, for the 2-year/24-hour storm event. The maximum allowable retention time is 48 hours but may be less due to building codes or ordinances. This information is used to calculate volume management credit.

The following deductions in volume management credit apply to the green roof profile:

- If the Growing Media depth is not at least 3 inches for an extensive green roof with a 1-inch minimum Foundation Growth Media layer, a 25% deduction applies.

- If a Foundation Growth Media layer is provided, it must have a depth of at least 1 inch, otherwise the deduction described above for Growing Media applies.
- If no Geotextile/Separation Fabric layer is provided, a 25% deduction applies.
- If no drainage layer is provided, a 25% deduction applies. At least one of the following must be used to avoid the deduction: Synthetic Drainage Mat or Foundation Growth Media.

Design Standards Section

☑ ***Design Standards***

Parameter	Standard	Design Value
Contributing Impervious : Green Roof Area Ratio, maximum	0.5 : 1	: 1
Green Roof Area (SF)		
Growing Media Saturated Permeability when compacted, minimum (inches/hour)	1.0	
Growing Media meets specifications in PCSM Manual	TRUE	
Geotextile/Separation Fabric meets specifications in PCSM Manual	TRUE	
Foundation Growth Media meets specifications in PCSM Manual	TRUE	
Transmissivity of Drainage Layer, maximum (m^2/s)	0.005	
Transmissivity of Foundation Growth Media, maximum (m^2/s)	0.005	
Height of lowest orifice from SCM bottom (in)		
An underdrain will be installed	FALSE	

- **Contributing Impervious : Green Roof Area Ratio, maximum** – This standard is displayed only when Yes is selected for "Are there other impervious areas contributing to the Green Roof?" above. The total area of impervious is converted to SF and divided by the Green Roof Area in SF. The maximum ratio is 0.5:1 (50%). An allowance of 10% is provided. If the proposed impervious to green roof ratio exceeds 110% of the standard, a deduction in volume management credit applies as follows:

  Deduction = Design Impervious:Green Roof Ratio – (Standard * 110%) / (Standard * 110%)

- **Green Roof Area (SF)** – Enter the vegetated surface area of the green roof.
- **Growing Media Saturated Permeability when compacted, minimum (inches/hour)** – Enter the saturated permeability of the growing media when compacted, in inches per hour. For engineered media the manufacturer may provide the saturated permeability rate, otherwise it may be determined by following ASTM E2396/E2396M-19, Standard Test Method for Saturated Water Permeability of Granular Drainage Media [Falling-Head Method] for Vegetative (Green) Roof Systems. The standard is greater than or equal to 1.0 inch/hour. An allowance of 10% is provided. If the saturated permeability of the growing media is less than 90% of the standard, a deduction in volume management credit applies as follows:

  Deduction = (Permeability Standard * 90%) – Design Permeability / (Permeability Standard * 90%)

- **Growing Media meets specifications in PCSM Manual** – Select TRUE if the growing media meets the specifications contained in Table 3.4.7-1 of the PCSM Manual; otherwise select FALSE. A 25% deduction in volume management credit is applied if the growing media does not meet the specifications of Table 3.4.7-1.

- **Geotextile/Separation Fabric meets specifications in PCSM Manual** – This standard is displayed if Geotextile/Separation Fabric is selected in the Green Roof Profile Table. Select TRUE if the geotextile/separation fabric meets the specifications contained in Table 3.4.7-1 of the PCSM Manual; otherwise select FALSE. A 25% deduction in volume management credit is applied if the geotextile/separation fabric does not meet the specifications of Table 3.4.7-1.

- **Foundation Growth Media meets specifications in PCSM Manual** – This standard is displayed if Foundation Growth Media is selected in the Green Roof Profile Table. Select TRUE if the foundation growth media meets the specifications contained in Table 3.4.7-1 of the PCSM Manual; otherwise select FALSE. A 25% deduction in volume management credit is applied if the foundation growth media does not meet the specifications of Table 3.4.7-1.

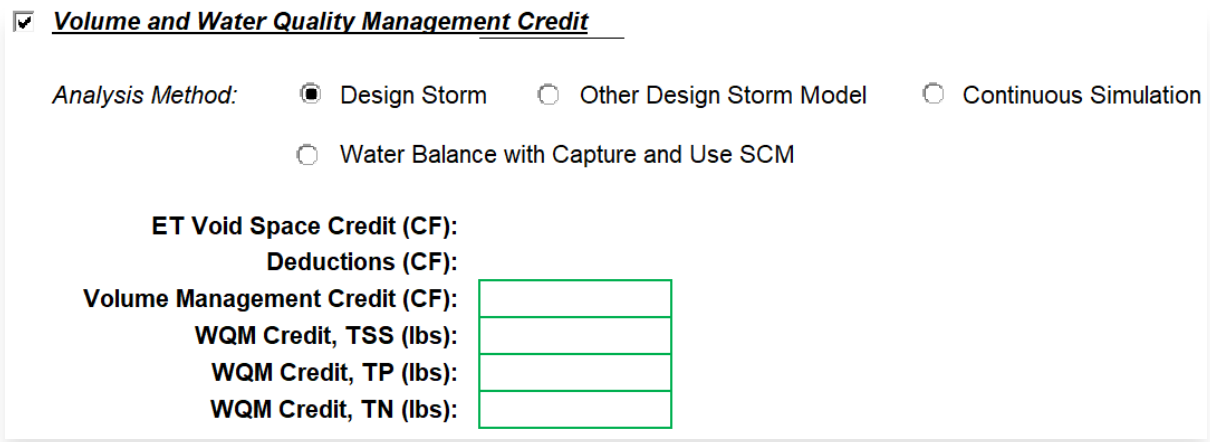
- **Transmissivity of Drainage Layer, maximum (m^2/s)** – This standard is displayed if Synthetic Drainage Mat or Granular Drainage Layer is selected in the Green Roof Profile Table. Enter the transmissivity of the drainage layer, in square meters per second. The standard is 0.005 m^2/s, at maximum. An allowance of 10% is provided. If the transmissivity exceeds 110% of the standard, a deduction applies as described above for Contributing Impervious: Green Roof Area Ratio.

- **Transmissivity of Foundation Growth Media, maximum (m^2/s)** – This standard is displayed if Foundation Growth Media is selected in the Green Roof Profile Table. Enter the transmissivity of the foundation growth media, in square meters per second. The standard is 0.005 m2/s, at maximum. An allowance of 10% is provided. If the transmissivity exceeds 110% of the standard, a deduction applies as described above for Contributing Impervious: Green Roof Area Ratio.

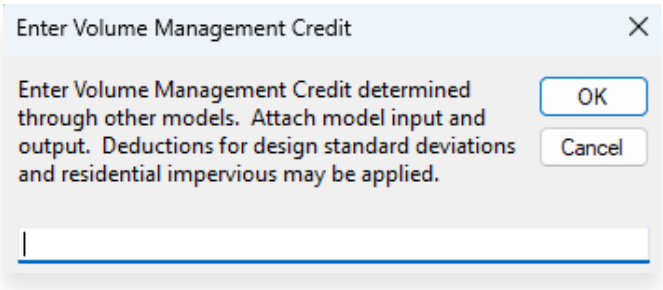
- **Height of lowest orifice from SCM bottom (in)** – Enter the height of the lowest orifice from the bottom of the SCM that is used to drain the SCM. Do not include orifices that are intentionally restricted for a specific period of time (i.e., drain restrictors). Volume management credit is adjusted if the lowest orifice is within the green roof profile. For example, if the total thickness of the profile is 6 inches but the lowest orifice is located 3 inches from the bottom, only one-half of the potential volume management credit will apply.

- **An underdrain will be installed** – Select TRUE if an underdrain will be installed, otherwise select FALSE. There is no credit for a green roof with an underdrain (i.e., a 100% deduction is applied).

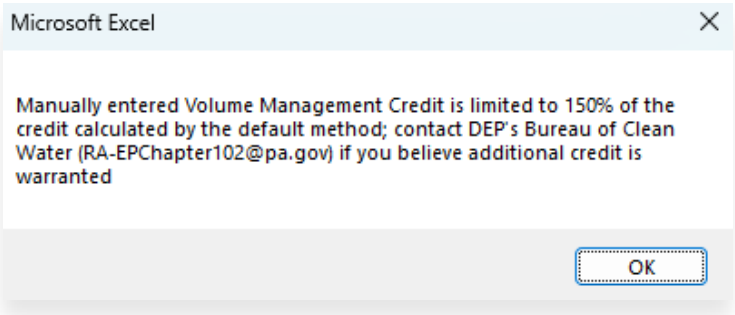
Volume and Water Quality Management Credit Section



- **Analysis Method** – Select the method used to analyze the SCM's performance by checking the appropriate box. If the button for "Default" is clicked, credit calculations are performed in the Spreadsheet using the methods explained below. Click on the button for "Other Design Storm Model" if a different model is used that evaluates a design storm but uses a method that differs from the default (e.g., Green-Ampt, Horton, others). Click on the button for "Continuous Simulation" if a dynamic model is used to evaluate SCM performance through a long-term precipitation data set (e.g., EPA's SWMM). Click on the button for "Water Balance with Capture and Use SCM" if a water balance is completed with a Capture and Use SCM. If a selection is made that is not "Default", *ET Void Space Credit* must be manually entered, which must be supported by the submission of model inputs and outputs. An input box will be displayed for manual entry of the credit determined by modeling:



Enter a valid whole number and click "OK". The entered value will be displayed as ET Void Space Credit. If a number is entered that exceeds 150% of the credit calculated by the default method, a message is displayed and a value equal to 1.5 times the credit calculated by the default method is populated into the ET Void Space Credit cell.



Volume Management Credit – Default Method

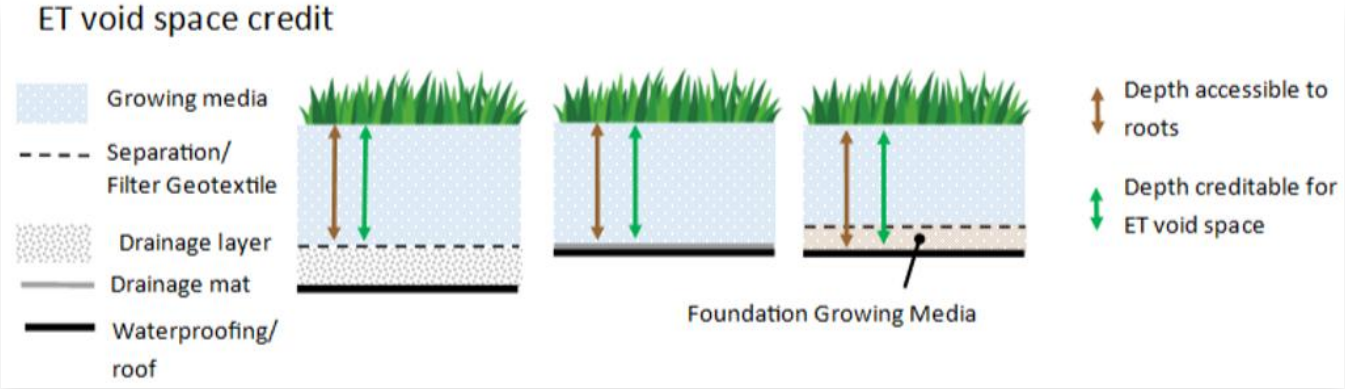
There are three mechanisms that provide volume management credit for green roofs using the default method:

1. **ET Void Space Credit** – ET Void Space Credit is the difference between FC and WP for growing media depth and foundation growing media depth, as long as roots can access the media (see figure below). ET Void Space Credit does not apply to Synthetic Drainage Mats, but may apply to other types of drainage layers if roots will access those layers.

   Example – A green roof is comprised of a 4-inch deep growing media on top of a geotextile and a 2-inch deep foundation growth media. Roots will access the foundation growth media. The FC of the growing media and foundation growth media are 0.35 and 0.4, respectively. The WP of the growing media and foundation growth media are 0.15 and 0.2, respectively. The ET Void Space Credit is:

$$ET\ void\ space\ credit\ (in) = (0.35 - 0.15) * 4\ in * \left(\frac{1\ ft}{12\ in}\right) + (0.4 - 0.2) * 2\ in * \left(\frac{1\ ft}{12\ in}\right) = 0.1\ in$$

The 0.1 inch of ET Void Space Credit is then multiplied by the area of the green roof to determine credit in terms of cubic feet (CF).

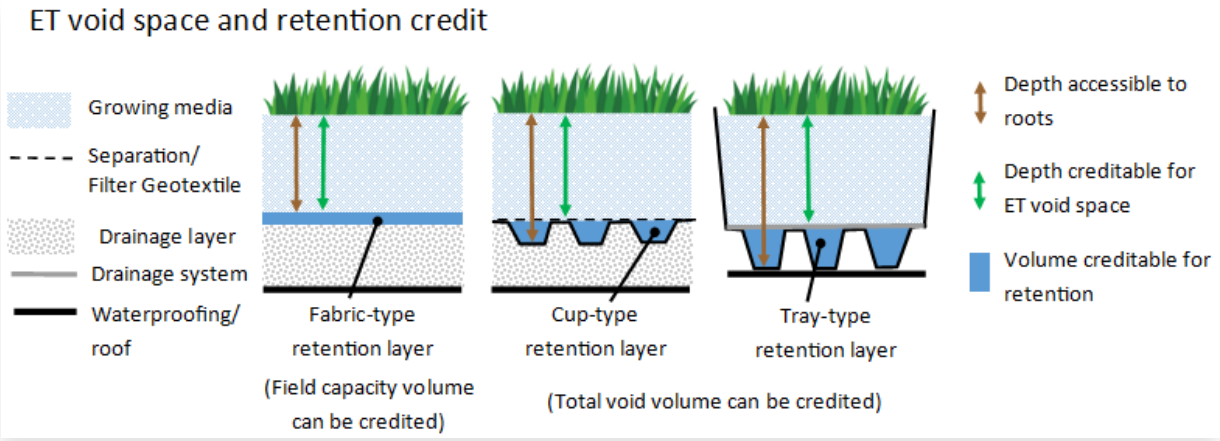


2. **Retention Credit** – Retention Credit may apply when there is a synthetic retentive layer with or without media and roots can access the retentive layer. An assumption is made that all of the retained void space water in the layer will be evapotranspired. See figure below.

   Example – A green roof is comprised of a 4-inch deep growing media on top of a synthetic retentive layer (cup-type) without media that are accessible to roots, with a drainage layer underneath the retentive layer. The volume in the cups is approximately 1 gallon per SF. ET Void Space Credit can be claimed for the 4-inch growing media. In addition, a Retention Credit is provided as follows:

$$Retention\ credit\ (in) = \frac{1\ gal}{SF} * \frac{CF}{7.48\ gal} = 0.134\ in$$

   The 0.134 inch of Retention Credit is then multiplied by the area of the green roof to determine credit in terms of cubic feet (CF).



3. **Potential ET (PET)** – When a drain restrictor is used to retain water for a specific period of time, a volume management credit based on PET applies. The PET rate for the city closest to the project site (as selected in the General Section, based on Appendix D, Table D-2 of the PCSM Manual) is multiplied by the retention period, in days.

   Example – A green roof in Scranton (PET of 0.07 in/day) will include a drain restrictor that will retain water for 18 hours (0.75 day). The predominant vegetation will not be sedums. The PET credit would be:

$$PET\ credit\ (in) = \ 0.070\ \left(\frac{in}{day}\right) * 0.75\ (day) = 0.053\ in$$

The 0.053 inch of PET Credit is then multiplied by the area of the green roof to determine credit in terms of cubic feet (CF). Note that if the predominant vegetation is sedums, the PET credit is reduced by 50% since sedums are generally not as capable of evapotranspiration as other vegetation.

However, PET credit must be compared against the volume of water that is capable of being drained or the difference between saturation moisture content and field capacity of the growing media and any other layer that receives ET Void Space Credit. For a growing media of 4 inches with a Sat value of 0.35 and FC value of 0.15, the depth of drainage available is:

$$Drainage\ available\ volume\ (in) = \ (0.35 - 0.15) * \ 4 * \ \left(\frac{1\ ft}{12\ in}\right) = 0.067\ in$$

Since the PET Credit is less than drainage available volume, PET Credit is limiting and applies (otherwise drainage available volume could be credited).

Volume management credit is the sum of #1, #2, and #3, as applicable. All 3 credits are combined and shown in the ET Void Space Credit cell. This credit cannot exceed volume routed to the SCM and average PET for 7 days.

- **Deductions (CF)** – If there are any deductions as described in the Green Roof Profile and Design Standards Sections, the magnitude of the deductions is displayed.

- **Volume Management Credit** – If the default method is used, Volume Management Credit is ET Void Space Credit (or volume routed to SCM or PET for 7 days, whichever is less) minus Deductions. If a method other than the default is used, Volume Management Credit is the manually entered ET Void Space Credit (up to 150% of the default credit) minus Deductions.

Water Quality Management Credit

WQM Credit only applies to green roofs proposed for projects under Chapter 102 that will receive contributing impervious flows and are either not in series with another SCM or are in series with a downstream PCSM Objective D SCM (i.e., rate control SCM). The following steps are taken to determine WQM Credit:

1. Land cover-based loads for Total Suspended Solids (TSS), Total Phosphorus (TP) and Total Nitrogen (TN) are calculated as follows:

Event Mean Concentration (EMC) for post-construction land cover and pollutant (see Appendix G, Table G-2 of the **PCSM Manual**) x runoff volume per land cover at 2-year/24-hour storm x 6.24 x 10^{-5} (conversion factor)

2. Total Volume Management Credit is subtracted from Total Volume Routed to SCM (i.e., direct precipitation at the 2-year/24-hour storm and contributing impervious minus off-site runoff, if applicable) to determine the SCM outflow volume.

3. The pollutant loads associated with the outflow volume are determined as follows:

SCM Outflow Volume x Median Outflow Concentration (MOC) (i.e., 23 mg/L, 0.23 mg/L, and 1.27 mg/L for TSS, TP and TN, respectively for the Green Roof SCM) x 6.24 x 10^{-5} (conversion factor)

4. The difference between land cover-based loads and outflow loads represents the pollutant load captured and treated by the SCM, i.e., WQM Credit.

The user of the spreadsheet should enter their name and company after reading the certification statement.

Revision History

Date	Version	Revision Reason
9/15/2026	1.0	Original Draft