Additional Notes: Rain Garden and Stormwater Planter Sizing

These calculators help you size particular BMPs after you have determined the drainage area that the BMP will manage. You will find these calculators at the bottom of Worksheet F1: Porous Pavement (runoff); Worksheet F2: Rain Garden or LID Swale; Worksheet F3: Stormwater Planter; Worksheet F4: Soakage Trench; and Worksheet F5: Drywell after you have calculated the drainage area managed by that BMP (top portion of each worksheet). Below is additional information about the inputs and models associated with these calculators.

General Information:
The calculators are used for modeling runoff from impervious surfaces (called "hardscape areas" in the calculators) of less than 10,000 sq. ft. per each individual BMP. Once you have entered the user inputs, the worksheet will automatically generate a hydrograph for the storm. The hydrograph is generated using a Santa Barbara Urban Hydrograph (SBUH) for different rainfall distributions. **These values are hidden and locked on all calculators.** However, since the Urban Hydrology for Small Watersheds TR-55 model is not applicable for storms under 1 inch and is not very accurate for smaller site-sized areas, this calculator uses the rational method (Q=CIA) within each 10-minute time increment to calculate the peak flow for that interval. Generally, the rational method is not recommended for volume sensitive calculations such as this, but since we are incorporating the shape of the hydrograph from the SBUH into the calculations, this approach will work well to model infiltration facilities.

Calculator Details for Rain Gardens and Stormwater Planters:

USER INPUTS

24 Hour Rainfall Depth [in]: Enter the size of the storm that you are required or wish to infiltrate.

Drainage Area [sf]: This value is automatically set to the value previously calculated for Total Remaining Hardscape Area at the top portion of the form. Note that outside of special circumstances, the drainage area only includes hardscape areas (roofs, roads, pavement, sidewalks, gravel etc.) and not vegetated landscape areas.

Drainage Area Runoff Coefficient: This is the C in Q=CIA of the rational method. Click here to learn more about the rational method and to see typical values if you'd like to model this for all areas, not just impervious areas, draining to the planter (not typical). Choosing the upper end of the range for the particular land cover is safe. For instance, according to the link provided, lawns have a runoff coefficient between 0.05 and 0.35, so enter 0.35. If you're only managing impervious area (typical), then leave this at 0.9.

Design Infiltration Rate of Soil [in/hr]: Enter the infiltration rate of the native soils. This would come from running an infiltration test (see fact sheet "Infiltration Testing") in the location of the infiltration BMP at the depth where the constructed facility intersects with the native uncompacted soil. This number cannot be altered by the design. If the infiltration rate is low, then the facility will have to be bigger, incorporate a rock trench, import soils or use a lined BMP.

Depth of Rock Trench Below Rain Garden/Planter, optional [in]: If the infiltration rate of the native soil is not fast enough to dispose of the desired 24-Hour Rainfall Depth in the available area or a smaller area is desired, then a rock trench could be added below the facility. For this model, the area of the rock trench is assumed to be the same as the footprint of the planter or rain garden, but this not necessarily required in the real world.

Rock Trench Void Porosity [%]: The rock trench is made up of open graded (all almost the same size) rock. The open graded rock provides storage for the additional volume of water that must be stored in the voids between the rocks. The void ratio is the ratio of solid to voids (often 40%), but your rock supplier should be able to tell you. Some jurisdictions require you to assume 30% void ratio to account for fines moving upwards or downwards, which will reduce storage unless you account for this in your design. In the figures below, the rock separation layers (3" coarse sand over 3" crushed gravel) provide protection against fine soil particles moving downward. The non-woven geotextile (aka filter fabric) beneath the uniformly graded storage rock protects against fine soil particles moving up, so no additional factor of safety is needed.

Desired Maximum Ponding Depth: Enter the maximum ponding depth desired, not to exceed 12 inches to protect plant health. The calculator will check to see if the modeled water depth in the BMP ever exceeds this desired maximum ponding depth during the modeled storm to determine if the BMP area is large enough.

Rain Garden/Stormwater Planter Area: To begin testing values, enter any old number smaller than the drainage area. A good place to start guessing is 10% of the drainage area. Now, look at the cell asking "Planter Area Properly Sized?" under the CALCULATED DESIGN CRITERIA area. Does it say "TRUE"? Yes? Good. No? Keep trying different areas until you get a ponding depth less than your maximum desired ponding depth (always must be less than 12”) and all parts of the facility emptying out in 30 hours after the beginning of the 24-hour design storm.

CALCULATED VALUES

Maximum Ponding Depth: This is the maximum depth to which the design storm will fill the planter/rain garden. Make sure your overflow design actually holds the water back to the depth shown in the Figures below. 12” is considered a maximum for liability reasons. 6” is considered a minimum for optimizing the footprint of the facility. However, for large storms in poorly drained soils, the criteria for emptying the facility may coincide with a shallower ponding depth, which is OK.

Depth of Water Left in Rock Trench After 30 Hours [in]: In some jurisdictions, this will be required to be zero (0) because with our frequency of rain storms, the rule of thumb is that all stormwater facilities should be empty in 30 hours to be ready for the next storm.

Depth of Water Left After 30 Hours [in]: This should be zero (0). No water should be ponded in the planter after 30 hours or the facility will not be ready to infiltrate the next storm.

Rain Garden/Stormwater Planter is Adequately Sized: This cell will check that the Maximum Ponding Depth does not exceed the Desired Maximum Ponding Depths and that the Depth of Water Left in Rock Trench After 30 Hours and Depth of Water Left in Planter/Rain Garden after 30 Hours are both 0. If these criteria are not met, the cell will display “FALSE” and you will need to increase the Rain Garden/Planter Area and/or increase the Depth of Rock Trench Below Planter (optional) until it says “TRUE.” There is a range of numbers that will give a TRUE result, so feel free to experiment with the Rain Garden/Planter Area until you have minimized the footprint of the facility.

OTHER CALCULATED VALUES

Peak Rainfall Intensity [in/hr]: This provides the peak rainfall intensity for the storm entered.

Peak flow overflowing/leaving facility/site: Calculated from the Santa Barbara Urban Hydrograph (SBUH) for different rainfall distribution. Depending on your jurisdiction, this should be 0 (i.e. keeping 100% of stormwater on-site) or at least less than the predeveloped peak flow.

SIZING FACTOR: Ratio of Facility Footprint to Drainage Area: This is provided for agencies who would like to create a SIM form similar to that of the City of Portland. If you look on page 2 of this link to Portland's SIM Form, you'll see what's called a "Sizing Factor". This number was derived in the same way as this Ratio of Planter to Drainage Area and accounts for rainfall patterns (i.e. storm type), 24-hour design storm size, the infiltration rate of the native soils, etc.

Storage Capacity of Rock Trench [cf]: If you are using a rock trench, this will calculate the storage capacity of the voids in the rock based on the Depth of Rock Trench Below Planter (optional) and Void Ratio for Rock Trench values that you entered. If you entered 0, then it doesn't exist, so the storage capacity is 0. This is used to calculate the ponding depth.

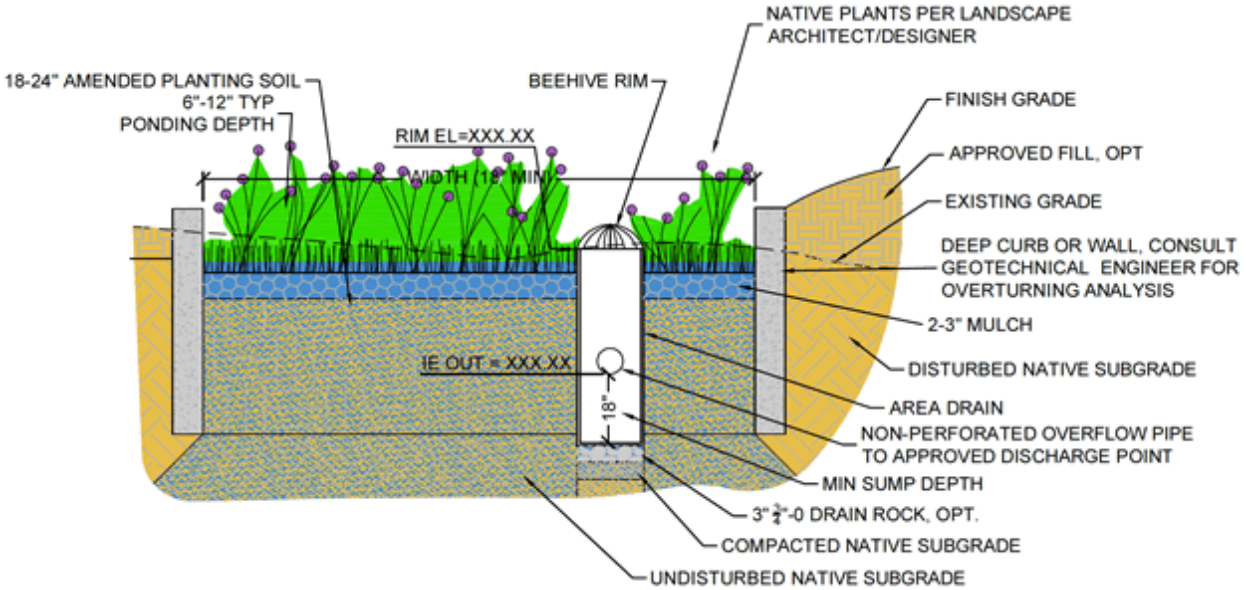

Figure 1: Infiltration Stormwater Planter with Planting Soil

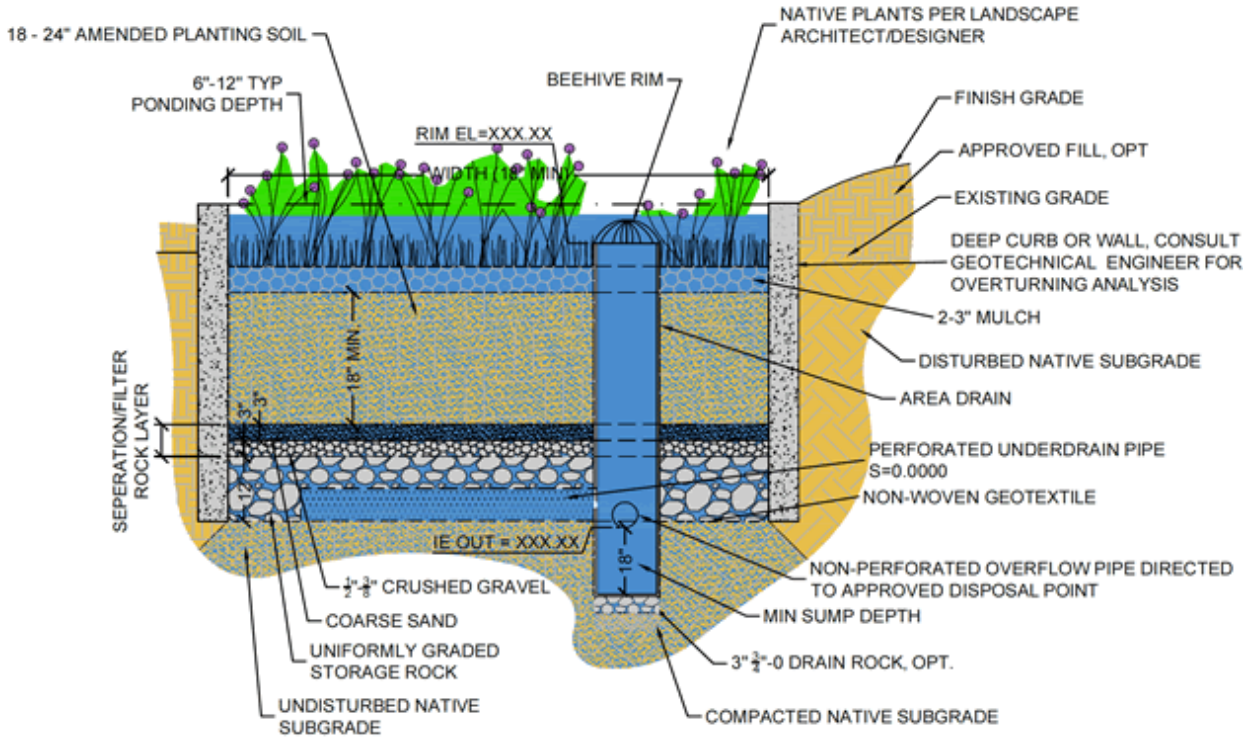

Figure 2: Infiltration Stormwater Planter with Planting Soil & Rock Trench