DCR Runoff Reduction Design Charettes
Overview & Quick Look-Up Tables
February 4, 2009

NOTES ON THE RUNOFF REDUCTION METHOD

- **Total Phosphorus (TP)** is used as the target pollutant for compliance with proposed **Water Quality** criteria (4 VAC50-60-63 through 65). Total Nitrogen (TN) is also calculated and BMP designs address TN removal, as well as the removal of other stormwater pollutants.
- Compliance is based on the overall site; however, stormwater BMP planning can be done on a drainage area basis. The spreadsheet has tabs for multiple drainage areas.
- Each site also has a **Treatment Volume (Tv)**. The method uses post-development land covers (forest and open space, managed turf, impervious cover) to compute the Tv.
- Stormwater BMPs are assigned **Runoff Reduction (RR)** and **Pollutant Removal (PR)** rates. These rates vary based on the "level of design" used. Level 1 designs represent good, current design standards with regard to sizing and BMP features. Level 2 BMPs have design enhancements to boost runoff reduction and pollutant removal performance. Each Level 1 and 2 design has associated design standards and specifications (on the BMP Clearinghouse website) that should be followed to achieve the assigned RR and PR rates.
- There is a tab in the spreadsheet for **Channel and Flood Protection.** This tab is designed to assist users with compliance with the **Water Quantity** part of the proposed regulations (4 VAC50-60-66). The spreadsheet assists users with computing Curve Numbers (CN), runoff volumes, and peak discharges for various design storms. However, the user must also use available hydrologic and hydraulic models and programs to verify compliance with the various conditions of the Water Quantity section. If Runoff Reduction practices are used for Water Quality compliance, then these are given credit for Channel Protection and Flood Control, chiefly by allowing the user to compute an adjusted CN. The designer, with concurrence from the local program authority, may also take other hydrologic "credits" for RR practices, such as increasing the time of concentration (Tc). ***For the purposes of the charette, full hydrologic computations are not possible. The purpose is to get a rough idea of detention requirements for the sample sites.***
- In the spreadsheet, blue boxes require user input; gray boxes are calculation cells, and yellow boxes are constant values. The user should only add values to the blue boxes.

QUICK OVERVIEW OF METHOD

1. Utilize environmental site design (ESD) techniques to reduce impervious cover and maximize forest and open space cover. This will affect the post-development treatment volume and pollutant load. ***Your group should feel free to try different site layouts to try to accomplish this goal.***
2. For the site, measure post-development impervious, managed turf, and forest/open space land cover. Enter these on TAB 1 of the spreadsheet based on hydrologic

soil groups. Guidance on land covers is provided below. More detailed guidance is provided in the documentation and instructions for using the spreadsheet (Document B).

   a. Impervious = roads, driveways, rooftops, parking lots, sidewalks, and surface area of wet ponds, green roofs, and pervious parking (and any other areas of impervious cover)
   b. Managed Turf = land disturbed and/or graded for turf, including portions of yards, rights-of-way, and turf intended to be maintained and mowed within commercial and institutional settings
   c. Forest/Open Space = Land area that will not be disturbed and will be managed in a natural, vegetated state. This can include undisturbed portions of lots, rights-of-way used as filter strips or grass channels, community open space, utility corridors, and the surface area of BMPs (except for wet ponds, green roofs, and pervious parking)

3. The spreadsheet will calculate weighted turf and weighted forest runoff coefficients based on hydrologic soil groups. Combined with impervious cover, the result will be a weighted site runoff coefficient. Based on this, the spreadsheet will calculate post-development TP loading & Treatment Volume for the site on TAB 1.
4. On the DRAINAGE AREA TABS, apply **Runoff Reduction (RR)** Practices for each drainage area to reduce post-development treatment volume and load. The site designer should select the most strategic locations on the site to place RR practices (e.g., drainage areas with the most developed land). This will likely be an iterative process. Runoff reduction "volume credits" are based on the contributing drainage area (CDA) to each selected BMP.
5. Based on the RR practices selected, **Pollutant Removal (PR)** rates will be applied to BMPs that achieve both runoff reduction and pollutant removal functions. This will be shown at the bottom of the DRAINAGE AREA TABS.
6. After applying RR and PR practices to the drainage areas, check the WATER QUALITY COMPLIANCE TAB to see how close you have come to meeting the standard. If there is still a TP load to remove after applying RR and PR credits to the selected BMPs, the designer can:
   a. Select additional **RR** BMPs, and/or
   b. Select additional **PR** BMPs

   The ultimate goal is to reduce the load to 0.28 pounds/acre.
7. Once you have met the water quality standard, you can use the CHANNEL AND FLOOD PROTECTION TAB to do a quick estimate of what may be required to meet quantity control targets. These are based on actual conditions at the site. You will have to estimate Tc. The spreadsheet will compare the allowable post-development Q to the Q with no detention. Please note that if you used dry ponds, wet ponds, bioretention, or other practices that provide detention to meet the water quality standard (in the Drainage Area Tabs), these can also be used (and sized) to meet the quantity requirements.

Quick Look-Up Tables for Design Exercises

<table>
<tr><th colspan="3">Table 1. Practices Included in the Runoff Reduction Method</th></tr>
<tr><th>Step 1: Environmental Site Design (ESD)*</th><th>Step 2: Runoff Reduction (RR) Practices</th><th>Step 3: Pollutant Removal (PR) Practices</th></tr>
<tr><td>Forest Conservation</td><td>Sheetflow to Conservation Area or Filter Strip</td><td>Filtering Practice</td></tr>
<tr><td rowspan="2">Site Reforestation</td><td rowspan="4">Rooftop Disconnection:
▪ Simple
▪ To Soil Amendments
▪ To Rain Garden or Dry Well
▪ To Rain Tank or Cistern</td><td>Constructed Wetland</td></tr>
<tr><td>Wet Swale</td></tr>
<tr><td rowspan="2">Soil Restoration (combined with or separate from rooftop disconnection, grass channels)</td><td rowspan="2">Wet Pond</td></tr>
<tr><td>Green Roof</td></tr>
<tr><td rowspan="7">Site Design to Minimize Impervious Cover & Soil Disturbance</td><td colspan="2">Grass Channels</td></tr>
<tr><td colspan="2">Permeable Pavement</td></tr>
<tr><td colspan="2">Bioretention</td></tr>
<tr><td colspan="2">Dry Swale (Water Quality Swale)</td></tr>
<tr><td colspan="2">Infiltration</td></tr>
<tr><td colspan="2">Extended Detention (ED) Pond</td></tr>
<tr><td colspan="3">Practices in shaded cells achieve both Runoff Reduction (RR) and Pollutant Removal (PR) functions, and can be used for Steps 2 and 3 depicted in Figure 1. See Appendices B and C for documentation.

* ESD practices are not in the spreadsheet in the drainage area tabs. However, use of these practices decreases the site Rv, treatment volume, and pollutant load (Tab 1).</td></tr>
</table>

Table 2. Comparative Runoff Reduction, TP EMC Removal and Space Required			
Practice	**Runoff Reduction (RR) (%)**	**Pollutant Removal for TP (PR) (%)**	**Shortcut Surface Area (% of Contributing Drainage Area (CDA)**
Green Roof	45 to 60	0	0
Impervious Surface Disconnection	25 to 75	0	5 to 10' wide strip or 5% of CDA
Permeable Pavement	45 to 75	25	0
Grass Channel	10 to 20	15	3 to 5
Dry (Water Quality) Swale	40 to 80	20 to 40	3 to 5
Bioretention	40 to 80	25 to 50	3 to 5
Infiltration	50 to 90	25	3 to 5
Extended Detention	0 to 15	15	2 to 4
Sheetflow to Conservation Area or Filter Strip	50 to 75	0	Combined Area > 0.5 acres
Wet Swale (coastal plain)	0	20 to 40	4 to 6
Filtering Practice	0	60 to 65	3 to 5
Constructed Wetland	0	50 to 75	3 to 6
Wet Pond	0	50 to 75	3 to 5
Range of values is For Level 1 and 2 Designs, respectively, including hydrologic soil group and whether amended soils are used for particular practices			

Table 3 Green Roof Design Guidance	
Level 1 Design (RR: 45 TP: 0)	**Level 2 Design (RR: 60 TP: 0)**
Depth of media four to six inches	Media depth greater than six inches
Soil media not tested for P-index	Soil media with P index less than 10
Sizing: Level 1: 0% of CDA **Level 2:** 0% of CDA	

Table 4 Impervious Surface Disconnection Design Guidance
Simple Disconnection to A/B Soils – RR: 50; TP: 0 **Simple Disconnection to C/D Soils – RR: 25; TP: 0** **To Soil Amended Filter Path – RR: 50; TP: 0** **To Rain Garden, Dry Well, French Drain in A/B Soils – RR: 75; TP: 0** **To Rain Garden, Dry Well, French Drain in A/B Soils – RR: 50; TP: 0** **To Rain Barrel, Rain Tank, Cistern – RR: 75% of capture volume (provisional)**
Simple disconnection only allowed for residential lots greater than 6000 square feet
Rooftop area draining to any single discharge point should not exceed 1000 sf and drain continuously through pervious filter until reaching property line ort drainage swale
Slope should be in 2 to 5% range and not cause basement seepage
Sizing: 5 to 10' wide strip or 5% of CDA (see spec for more detail)

Table 5 Permeable Pavement Design Guidance	
Level 1 Design (RR: 45 TP: 25)	**Level 2 Design (RR: 75 TP: 25)**
TV= (Rv)(A)	TV = 1.1(Rv)(A)
Soil Infiltration less than one-inch/hr	Soil infiltration rate exceeds one-inch/hr
Underdrain needed	Underdrain not required or stone sump provided below underdrain
Accepts runoff from non-pervious pavement	CDA = The pervious paver area
Slopes from 2 to 3%	Slopes less than 2%
Sand layer between choker stone and paver blocks, if allowed by manufacturers' specifications (not applicable to porous asphalt or concrete)	Sand layer between choker stone and paver blocks, if allowed by manufacturers' specifications (not applicable to porous asphalt or concrete)

Table 6 - Grass Channel Design Guidance
A/B Soils OR Amended C/D Soils – RR: 20; TP: 15 **C/D Soils – RR: 10; TP: 15**
A maximum residential density of no more than 4 dwelling units per acre
The bottom width of the channel should be between 4 to 8 feet wide.
Channel side-slopes should be no steeper than 3H:1V
5 acre maximum contributing drainage area to any individual grass channel
Length of the grass channel should be equal to or greater than the roadway length
The longitudinal slope of the channel should be no greater than 2%. (Checkdams may be used to break up slopes on steeper swales)
Channel has a maximum flow velocity of less than one foot per second during a one-inch storm event
The dimensions of the channel should ensure that runoff velocity is non-erosive during the two-year design storm event and safely convey the locals design storm (e.g., ten year design event)
Note 1: Runoff reduction can be increased if combined with soil compost amendments (Design Specification No. 4) **Note 2**: Where feasible, the dry swale is always the preferable option due to its greater runoff reduction and pollutant reduction capability

Table 7 - Dry Swale Design Guidance	
Level 1 Design (RR:40; TP:20)	**Level 2 Design (RR:80; TP:40)**
TV= (Rv)(A)	TV= 1.1(Rv)(A)
Swale slopes from <0.5% or >2.0%	Swale slopes from 0.5% to 2.0%
Soil infiltration rates less than 0.5 in/hr	Soil infiltration rates exceed one in/hr
Swale served by underdrain	Lacks underdrain or uses underground stone sump
On-line design	Off-line or multiple treatment cells
Media depth less than 18 inches	Media depth more than 24 inches
Turf cover	Turf cover, with trees and shrubs
All Designs: acceptable media mix tested for phosphorus index	

Table 8 Bioretention Design Guidelines	
Level 1 Design (RR 40 TP: 25)	**Level 2 Design (RR: 80 TP:50)**
WQv= (1.0)(Rv)(A)	WQv = 1.25 (Rv)(A)
SA of filter bed exceeds 3% of CDA	SA of filter bed exceeds 5% of CDA
Filter media at least 24 inches deep	Filter media at least 36 inches deep
One form of accepted pretreatment	Two or more forms of accepted pretreatment
At least 75% plant cover w/ mulch	At least 90% plant cover, including trees.
One cell design	Two cell design
Underdrain needed	Infiltration design or stone storage layer below underdrain pipe
All Designs: Media mix tested for an acceptable phosphorus index	

Table 9 Infiltration Design Guidelines	
Level 1 Design (RR:50; TP:25)	**Level 2 Design (RR:90; TP:25)**
TV= (Rv)(A)	TV= 1.1(Rv)(A)
Maximum CDA of one acre	Max CDA of 0.5 acre, nearly 100% IC
At least two forms of pretreatment	At least three forms of pretreatment
Soil infiltration rate of 0.5 to 1.0 in/hr	Soil infiltration rates of 1.0 to 4.0 in/hr
Underdrain needed due to soils	No underdrain utilized, although elevated underdrain may be used on C and D
All Designs: are subject to hotspot runoff restrictions/prohibitions	

Table 10 - Extended Detention (ED) Pond Guidance	
Level 1 Design (RR:0; TP:15)	**Level 2 Design (RR:15; TP:15)**
TV=(1.0) (Rv)(A)/12	TV = 1.25(Rv) (A)/12
At least 15% of TV in permanent pool	More than 40% of TV in deep pool or wetlands
Flow path at least 1:1	Flow path at least 1:5 to 1
Average ED time of 24 hours or less	Average ED time of 36 hours
Vertical ED fluctuation exceeds 4 feet	Maximum vertical ED limit of 4 feet
Turf cover on floor	Trees and wetlands in the planting plan
Forebay and micropool	Additional cells or treatment methods (e.g., sand filter or biotretention on pond floor)
CDA less than ten acres	CDA greater than ten acres

Table 11 Sheetflow to Conservation Area
RR: 75% for A and B Soils **RR: 50%** for C and D Soils **PR: O**
Conservation Area must be at least 0.5 acres in size and protected by easement, covenant, or similar restriction
Maximum contributing sheet flow path from adjacent pervious areas is 150 feet
Maximum contributing sheet flow path from adjacent impervious areas is 75 feet
Slopes cannot be steeper than 6 - 8%

Table 12 - Wet Swale Design Guidance	
Level 1 Design (RR:0; TP:20)	**Level 2 Design (RR:0; TP:40)**
TV= (Rv)(A)	TV= (1.25)(Rv)(A)
Swale slopes more than 1%	Swale slopes less than 1%
On-line design	Off-line swale cells
No planting	Wetland planting within swale cells
Turf cover in buffer	Planting trees within swale cells
Note: Generally recommended only for flat coastal plain conditions with high water table. Linear wetland always preferred to wet swale	

Table 13 - Filtering Practice Design Guidance	
Level 1 Design (RR:0; TP:60)	**Level 2 Design (RR:0 ; TP:65)**
TV= (1.0)(Rv)(A)/12	TV= 1.25 (Rv)(A) /12
One cell design	Two cell design
Sand media	Sand media with organic layer
CDA contains pervious area	CDA is nearly 100% impervious
Not a confirmed stormwater hotspot	Site is a confirmed stormwater hotspot
[1] **may** be increased to up to 50% if second cell is used for infiltration	

Table 14 Constructed Wetland Design Criteria	
Level 1 Design (RR:0; TP:50)	**Level 2 Design (RR:0; TP:75)**
TV= (Rv)(A)	TV = 1.5(Rv) (A)
Single cell (with forebay)	Multiple cells or pond/wetland design
ED wetland	No ED in wetland
Uniform wetland depth	Diverse microtopography
Mean wetland depth more than one foot	Mean wetland depth less than one foot
Wetland SA/CDA ratio less than 3%	Wetland SA/CDA ratio more than 3%
Flow path 1:1 or less	Flow path 1.5:1 or more
Emergent wetland design	Mixed wetland design

Table 15 - Wet Pond Design Guidance	
Level 1 Design (RR:0; TP:50)	**Level 2 Design (RR:0; TP:75)**
TV= (1.0)(Rv)(A)/12	TV = 1.5 (Rv) (A) /12
Single Pond Cell (with forebay)	Wet ED or Multiple Cell Design
Pool Depth Range of 3 to 12 feet	Pool Depth Range of 4 to 8 feet
Flow path = 1:1 or less	Flow path = 1.5:1 or more
Pond intersects with groundwater	Adequate water balance
CDA less than 15 acres	CDA greater than 15 acres