Module 9: Evaluating Water Quantity Compliance

Module 9 Objectives

After completing this module, you should be able to:

- Review how Curve Numbers are developed and adjusted (from Modules 3 and 5)
- Discuss why and when practitioners may elect to route certain practices
- Describe how the storage at practices can be improved and optimized for quantity control
- Recognize how traditional curve numbers interact with the RRM CNs
- Explain what the Rational Method can be used for

Module 9 Content

9a. Effective Curve Numbers *(review)*

9b. Practice Routing versus CN Adjustment *(practical training)*

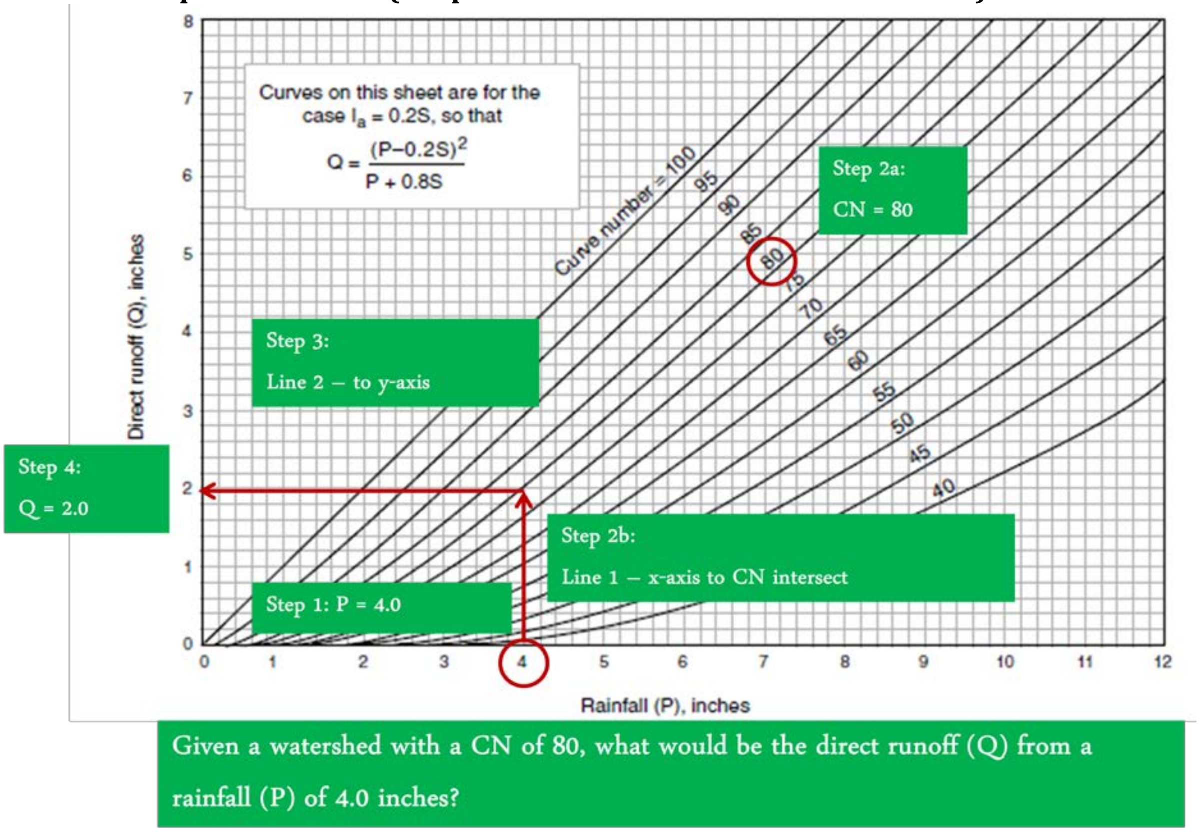
9c. Enhancing Storage at Practices *(practical training)*

9d. Spreadsheet CN versus Traditional Curve Numbers (Discussion Provided Below)

9e. Rational and Modified Rational Method – Applications (review)

Note: Sections 9a, 9b, 9c, and 9e are topics covered in more depth in Modules 3 and 5. They will be discussed during course exercises.

Review – Graphical Solution (see p. 19 in Module 3 and P. 19 in Module 5).



Review – Tabular Solution (see p. 20 in Module 3)

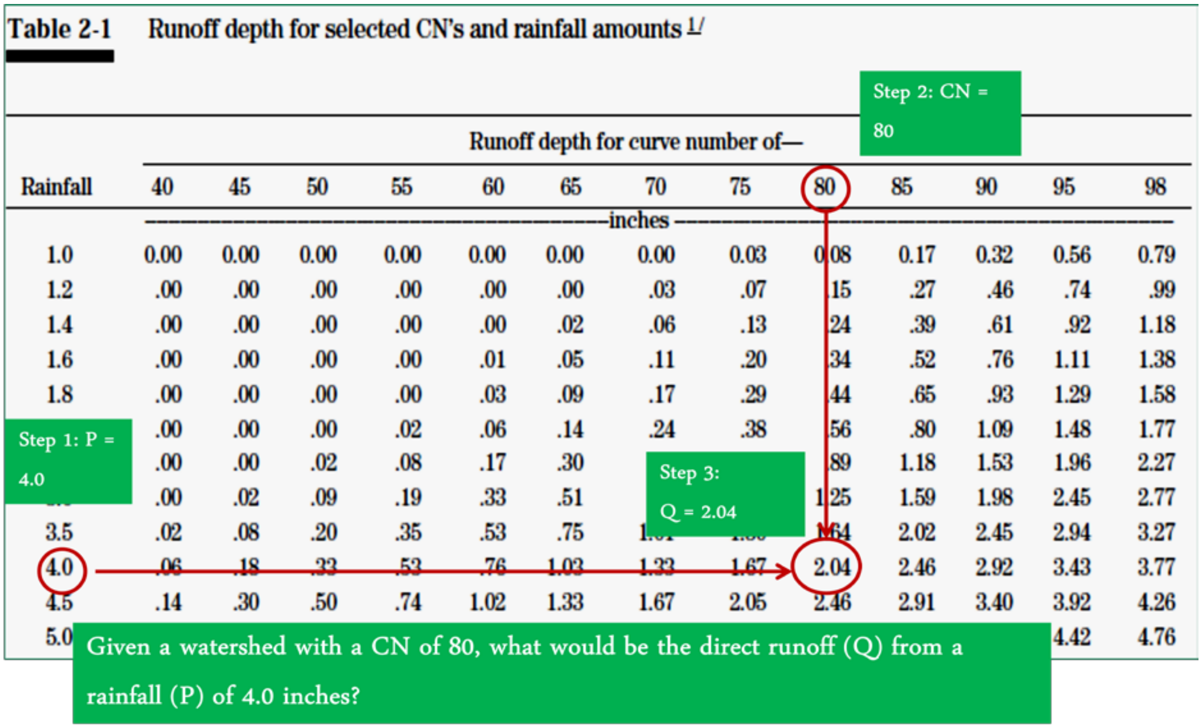
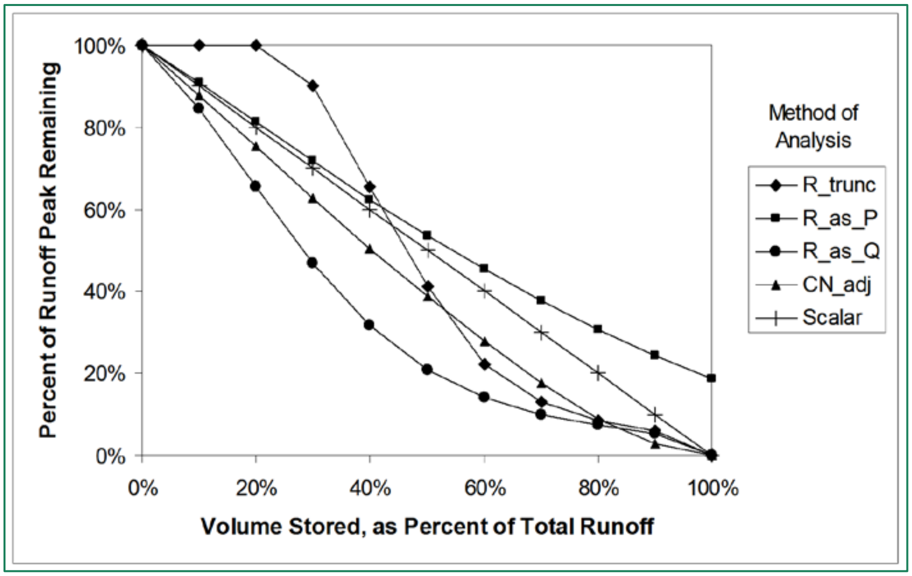


Table 2-1 Runoff depth for selected CN's and rainfall amounts [1/]

Rainfall	Runoff depth for curve number of—												
	40	45	50	55	60	65	70	75	80	85	90	95	98
	inches												
1.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.17	0.32	0.56	0.79
1.2	.00	.00	.00	.00	.00	.00	.03	.07	.15	.27	.46	.74	.99
1.4	.00	.00	.00	.00	.00	.02	.06	.13	.24	.39	.61	.92	1.18
1.6	.00	.00	.00	.00	.01	.05	.11	.20	.34	.52	.76	1.11	1.38
1.8	.00	.00	.00	.00	.03	.09	.17	.29	.44	.65	.93	1.29	1.58
[illegible]	.00	.00	.00	.02	.06	.14	.24	.38	.56	.80	1.09	1.48	1.77
[illegible]	.00	.00	.02	.08	.17	.30	[illegible]	[illegible]	.89	1.18	1.53	1.96	2.27
[illegible]	.00	.02	.09	.19	.33	.51	[illegible]	[illegible]	1.25	1.59	1.98	2.45	2.77
3.5	.02	.08	.20	.35	.53	.75	[illegible]	[illegible]	1.64	2.02	2.45	2.94	3.27
4.0	.06	.18	.33	.53	.76	1.03	1.33	1.67	2.04	2.46	2.92	3.43	3.77
4.5	.14	.30	.50	.74	1.02	1.33	1.67	2.05	2.46	2.91	3.40	3.92	4.26
5.0	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4.42	4.76

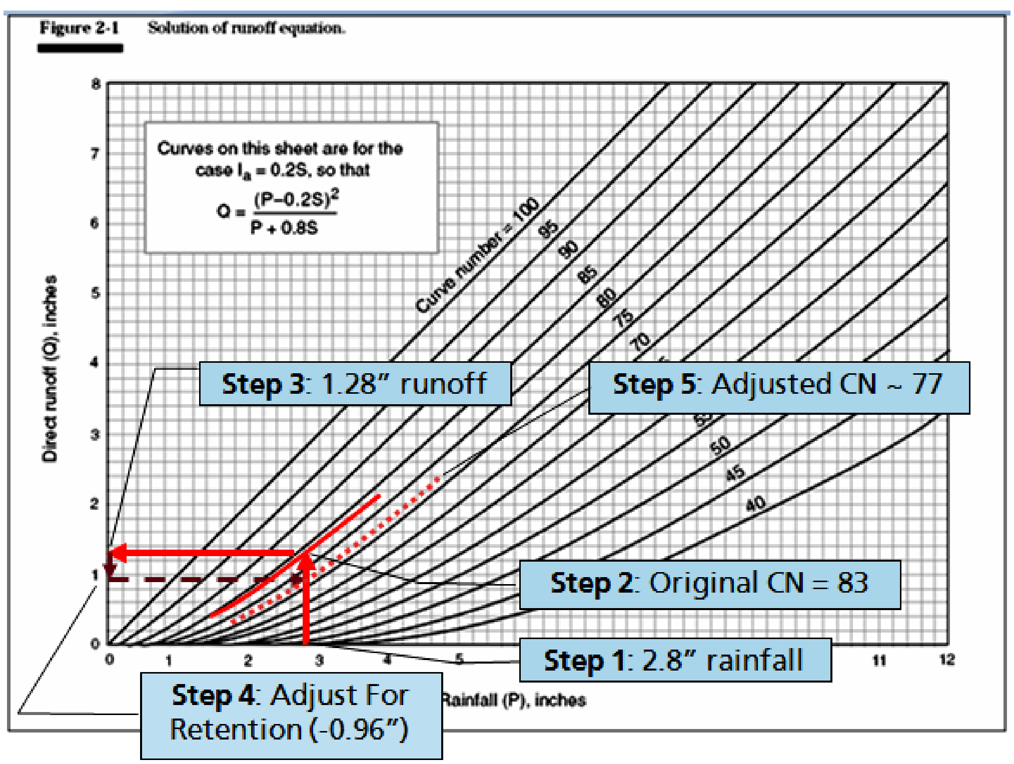
9b. Practice Routing versus CN Adjustment *(practical training)*

Why are CN adjustments useful?



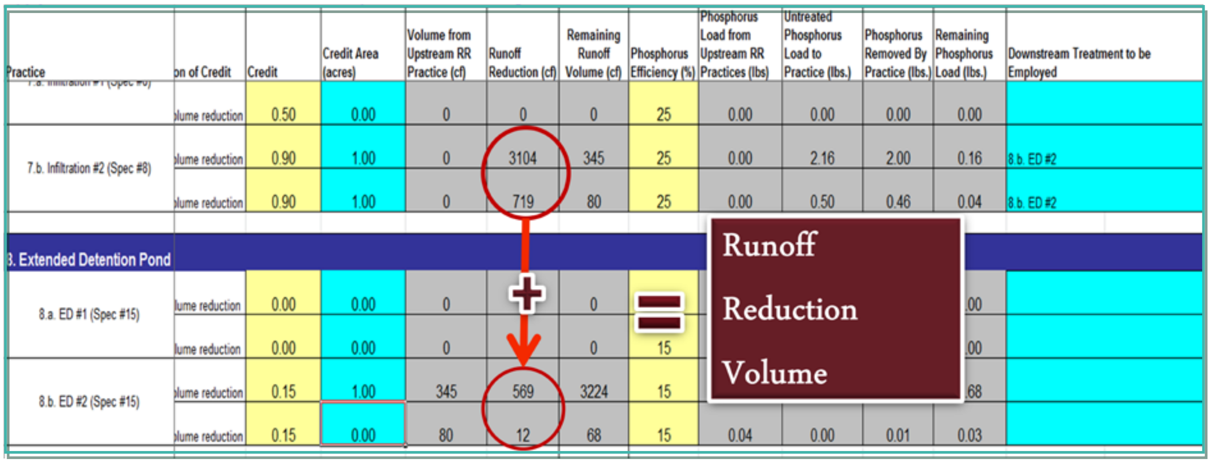
Excerpted from work by Paul R. Koch, Ph.D., P.E.

- Simplified way of reflecting small storage amounts distributed on the landscape
- Helps to reduce amount of complex modeling



How does the spreadsheet determine (retention) storage?

- Residual volume from upstream BMP contributes to next BMP in treatment train for sizing



Practice	on of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice (cf)	Runoff Reduction (cf)	Remaining Runoff Volume (cf)	Phosphorus Efficiency (%)	Phosphorus Load from Upstream RR Practices (lbs)	Untreated Phosphorus Load to Practice (lbs.)	Phosphorus Removed By Practice (lbs.)	Remaining Phosphorus Load (lbs.)	Downstream Treatment to be Employed
[illegible]	lume reduction	0.50	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
7.b. Infiltration #2 (Spec #8)	lume reduction	0.90	1.00	0	3104	345	25	0.00	2.16	2.00	0.16	8.b. ED #2
	lume reduction	0.90	1.00	0	719	80	25	0.00	0.50	0.46	0.04	8.b. ED #2
3. Extended Detention Pond												
8.a. ED #1 (Spec #15)	lume reduction	0.00	0.00	0		0					.00	
	lume reduction	0.00	0.00	0		0	15				.00	
8.b. ED #2 (Spec #15)	lume reduction	0.15	1.00	345	569	3224	15				.68	
	lume reduction	0.15	0.00	80	12	68	15	0.04	0.00	0.01	0.03	

What does that volume mean?

- That volume is the estimated fraction of the runoff volume that is reduced annually
- Multiplied by a 1-inch rainfall

What are the limitations?

- For *storage-based* practices
  - Volume is often much smaller than the actual storage provided
  - Designers may also customize the storage characteristics to reduce flows (more than the spreadsheet can account)

Bioretention Level 1 – Example:

Given:

- Level 1 bioretention
- B type soils
- 2 Acre DA (50% Imp, 50% Turf)

Sizing:

- Tv = volume
- Surface area is 1 Tv divided by storage depth
- Storage depth ~ 1.4 ft. (typical)

Size:

- Tv = 4,175 *ft*^{3}
- SA = 4,175/1.4 = 2,982 *ft*^{2}
- RR "Credit" = 1,379 + 290 = 1,669 *ft*^{3}
  - 40% of the volume draining to the facility

6. Bioretention								
6.a. Bioretention #1 or Urban Bioretention (Spec #9)	impervious acres draining to bioretention	40% runoff volume reduction	0.40	1.00	0	1379	2069	25
	turf acres draining to bioretention	40% runoff volume reduction	0.40	1.00	0	290	436	25
6.b. Bioretention #2 (Spec #9)	impervious acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50
	turf acres draining to bioretention	80% runoff volume reduction	0.80	0.00	0	0	0	50

		1-year storm	2-year storm	10-year storm
arget Rainfall Event (in)		2.60	3.60	4.60
rainage Area A				
rainage Area (acres)	2.00			
unoff Reduction Volume (cf)	1,670			
rainage Area B				
rainage Area (acres)	0.00			
unoff Reduction Volume (cf)	0			
rainage Area C				
rainage Area (acres)	0.00			
unoff Reduction Volume (cf)	0			
rainage Area D				
rainage Area (acres)	0.00			
unoff Reduction Volume (cf)	0			
rainage Area E				
rainage Area (acres)	0.00			
unoff Reduction Volume (cf)	0			

ased on the use of Runoff Reduction practices in the selected drainage areas, the spreadsheet calculates an adjusted $RV_{Developed}$ and adjusted Curve Number.

Drainage Area A		A soils	B Soils	C Soils	D Soils
Forest/Open Space -- undisturbed, protected forest/open space or reforested land	Area (acres)	0.00	0.00	0.00	0.00
	CN	30	55	70	77
lanaged Turf -- disturbed, graded for yards or other turf to be mowed/managed	Area (acres)	0.00	1.00	0.00	0.00
	CN	39	61	74	80
Impervious Cover	Area (acres)	0.00	1.00	0.00	0.00
	CN	98	98	98	98

Weighted CN	S
80	2.50

	1-year storm	2-year storm	10-year storm
$RV_{Developed}$ (in) with no Runoff Reduction	0.96	1.72	2.55
$RV_{Developed}$ (in) with Runoff Reduction	0.73	1.49	2.32
Adjusted CN	75	77	77

Interim Summary:

Practice is calculated to reduce:

1 year storm volume

From: 0.96 in

To: 0.73 in

For the 2 acre catchment

0.96 x 2 x 43,560/12 = 6,970 ft^3

0.72 x 2 x 43,560/12 = 5,227 ft^3

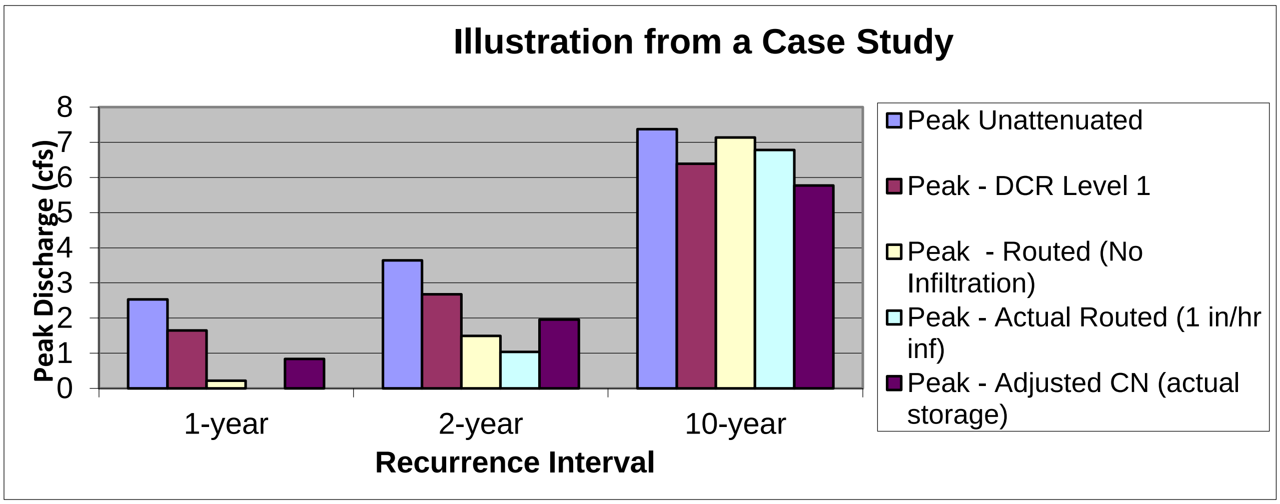
Given total runoff 1-yr = 6,970 ft^3

Actual storage greater than 4,175 ft^3

Credit is only 1,669 ft^3

What does this mean?

- Often practices that are *storage-based* generate **much lower discharges than the CN adjustment**, if routed
- Expect that designers will route these practices
- CN Reduction for the given practice **AND** Routing are **not** allowed
  - Be careful to discount the routed practice from CN adjustments **<u>ONLY</u>**

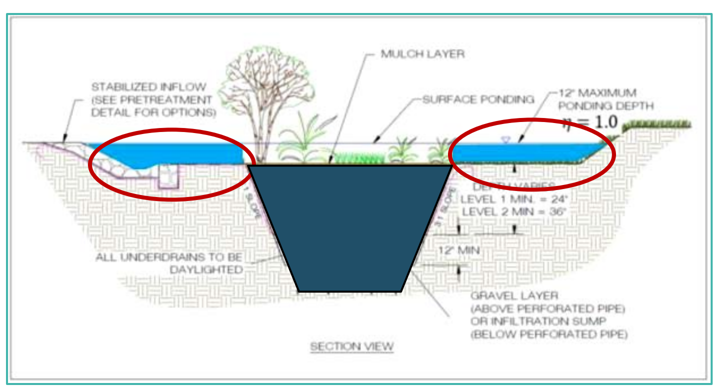


Storage Optimization

Storage can also be customized to reduce discharges for water quantity design. Examples for bioretention customization include:

- Increasing media thickness
- Increasing sump depth
- Increasing ancillary surface storage

Bioretention (Specification No. 9): Optimization and Storage



9d: Spreadsheet CN versus Traditional Curve Numbers

Terminology Alert!!		
VRRM	**:**	**TR-55**
Managed Turf	=	Open Space
Open Space	=	Woods
It is very important to recognize that TR-55 and the VRRM use the term *Open Space* differently (discussed in Module 4b)		

The VRRM considers ***Managed Turf*** to be equivalent to TR-55 ***Open Space***:

- Lawns, parks, golf courses, and cemeteries, with a *CN* equivalent to pasture/grassland in good hydrologic condition.
- This generally represents lawn areas that have been cleared and/or graded to accommodate development.

The VRRM considers ***Open Space*** to be equivalent to TR-55 ***Woods***:

- Protected undisturbed (or restored) land, be it forested or undisturbed meadow, with a CN equivalent to *woods* in good hydrologic condition.
- This generally represents wooded areas as well as protected undisturbed or restored areas of the site with defined operational management criteria.

The VRRM definition of what can be considered *Forest/Open Space* is provided in **Module 4** and includes land that will remain undisturbed OR that will be restored to a hydrologically functional state; as well as land that will be subject to minimal operational and management activities so as to minimize the compaction of soils, the application of fertilizers, and other impacts. In all cases, the designation of lands as *Forest/Open Space* will require some form of a protective covenant.

This is intended to incentivize the minimization of disturbance and the protection and preservation of open space. Combined with the management conditions, these land covers are considered to be functionally equivalent to the TR-55 land cover; however, it is intended to be used in the application of the VRRM for crediting purposes and the design of stormwater management structures.

Plan reviewers should be aware of this nomenclature and ensure the correct use in the design of the stormwater management strategy versus hydrologic analyses related to other requirements.

9e: Rational and Modified Rational Method

For drainage areas ≤ 200 acres

- VSMP authority can allow use of Rational Method for evaluating peak discharges
- VSMP authority can allow use of Modified Rational Method for evaluating volumetric flows to stormwater conveyances
- Designers will likely continue to use Rational Method for drainage infrastructure sizing
- Although permitted by regulation, it is unlikely (in the near term) that these methods will be used for SWM compliance purposes, because tools have not yet been developed