

# Stormwater Regulation in Virginia: Status Report to the Regulatory Advisory Panel

Presented by:

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# Quality Control

## *Chesapeake Bay Watershed Requirement*

What should the allowable loading rate be?

- Original 2009 Draft regulation: **0.28 lb/ac/yr TP**
- 2009 Final regulation (suspended): **0.45 lb/ac/yr TP**
- 2010 Virginia Watershed Implementation Plan (WIP): **0.26 lb/ac/yr TP**  
*“Allocations for newly developed land will be set at a level that results in no increase above allowable 2025 average nutrient loads per acre from previous land uses.” (May change from previous land assumption or WIP revisions.)*

Analysis of 2025 Unit TP Loads Across Sectors in Virginia			
	2025 draft WIP TP Allocation (lb/yr) <sup>1</sup>	Area (ac) <sup>2</sup>	Unit TP Load (lb/ac-yr)
Forest	1,090,000	9,776,274	0.111
Agriculture	2,146,000	2,836,970	0.756
Urban	380,000	1,180,696	0.322
Total	3,616,000	13,793,940	0.262
<b>Weighted Average of Forest and Agriculture<sup>3</sup></b>	<b>3,236,000</b>	<b>12,613,244</b>	<b>0.257</b>

<sup>[1]</sup> 2025 WIP allocations are from the September 2010 Public Review Draft WIP.

<sup>[2]</sup> The 2010 sector acreages shown here were received from Russ Perkinson via e-mail on 8/12/2010.

<sup>[3]</sup> This calculation assumes that “2025 average nutrient loads per acre from previous land uses” are the loads resulting from the straight average of forest and agriculture.

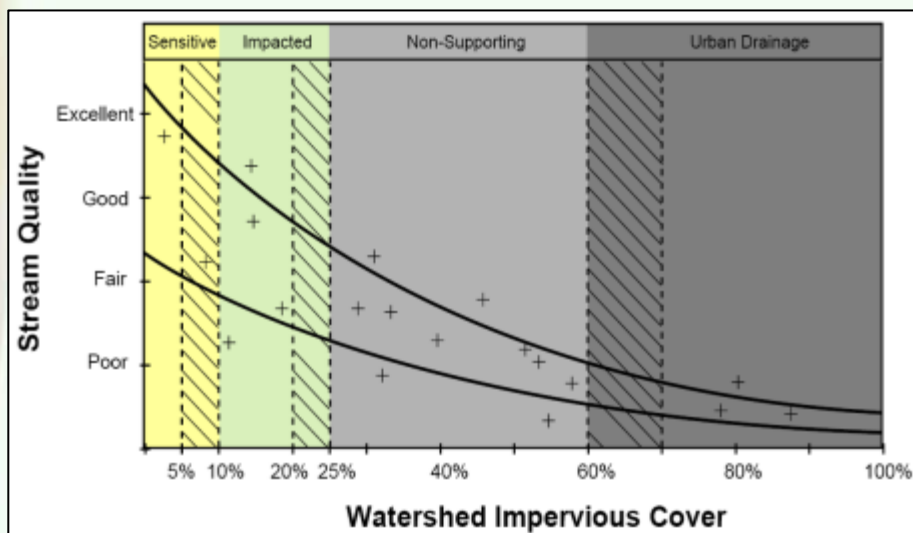


# Quality Control

## State-wide Requirement

How should the allowable loading rate be calculated state-wide?

- The subcommittee originally recommended **0.32 lb/ac/yr** TP based on the VRRM (which does not account for forest):
  - Assumes 10% impervious cover
  - This equates to 10% impervious cover, 20% turf, and 70% forest on Hydrologic Soils Group (HSG) C
- However, the subcommittee now recommends **0.36 lb/ac/yr** TP based on a Modified VRRM calculation (to account for forest):
  - Assumes 7.5% impervious cover<sup>1</sup>, 30% turf, and 62.5% VA-average forest cover
  - Assumes 1.15% HSG A, 61.28% HSG B, 28.60% HSG C, and 8.97% HSG D<sup>2</sup>



<sup>[1]</sup> Schueler, T., Fraley-McNeal, L., and Capiella, K. "Is Impervious Cover Still Important? Review of Recent Research." Journal of Hydrologic Engineering, April, 2009.

<sup>[2]</sup> Weighted average soil cover was derived from STATSGO state-wide soils database soils breakdown for Virginia outside of the Chesapeake Bay Watershed. STATSGO breakdown: 210 mi<sup>2</sup> HSG A; 0 mi<sup>2</sup> HSG A/D; 11,207 mi<sup>2</sup> HSG B; 0 mi<sup>2</sup> HSG B/D; 5,231 mi<sup>2</sup> HSG C; 373 mi<sup>2</sup> HSG C/D; 1,153 mi<sup>2</sup> HSG D; 115 mi<sup>2</sup> Unrated. C/D and unrated soils were assigned to HSG D.

### Other Options

- 10% imp. cover, 30% turf, 60% forest  
= **0.41 lb/ac/yr**
- 5% imp. cover, 30% turf, 65% forest  
= **0.30 lb/ac/yr**

3 (Revised)

# New Development Land-Use Pattern

Jantz, P., Goetz, S., and Jantz, C. 2005. *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. *Journal of Environmental Management*. 36 (6): 808-825.

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increase in developed land (from 5,177 to 8,363 km<sup>2</sup>). Most of this new development (64%) occurred on agricultural and grasslands, whereas 33% occurred on forested land. Some smaller municipalities lost as much as 17% of their forest lands and 36% of their agricultural

## Chesapeake Bay Watershed:

33% converted from forest  
64% converted from agriculture

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later, we do not present maps of wetland loss. We found that some smaller municipalities, particularly those adjacent to growing urban centers such as Norfolk and Richmond in Virginia, lost as much as 17% of their forest lands and 36% of their agricultural lands to development (Figs 8A and B). High losses are also observed in the counties near Washington, DC, Baltimore, MD, and Philadelphia, PA. Outlying counties further from rapidly urbanizing centers experienced losses from 0% to 1.5% for forests and 0% to 2.5% for agriculture. The spatial pattern of these “hot spots” of

## Virginia-Specific Examples:

17% forest + 36% agriculture = 53% total converted  
17% / 53% total = **32%** converted from Forest  
36% / 53% total = **68%** converted from agriculture

1.5% forest + 2.5% agriculture = 4% total converted  
1.5 / 4 total = **38%** converted from forest  
2.5 / 4 total = **63%** converted from agriculture



See slide 6 for alternate interpretation

# Potential New Development Unit Loads - Based on Landuse Trends

Based on historic development trends per Jantz et. al, **TP = 0.52 to 0.55 lb/ac/yr** to achieve no-net-increase above the allowable average 2025 nutrient loads from previous land uses per the draft September 2010 WIP.

TP Load Based on Varying Percentages of Previous Land Uses Converted to Development					
Source	% Forest	Forest TP Load (lb/ac/yr) <sup>2</sup>	% Agriculture	Agriculture TP Load (lb/ac/yr) <sup>2</sup>	Total TP Load (lb/ac/yr) <sup>3</sup>
Chesapeake Bay Watershed <sup>1,4</sup>	36%	0.11	64%	0.76	<b>0.53</b>
Growing Urban Centers <sup>1,5</sup>	32%		68%		<b>0.55</b>
Outlying Counties <sup>1,5</sup>	38%		63%		<b>0.52</b>

1. Historic development trends were derived from: Jantz, P., Goetz, S., and Jantz, C. 2005. *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. Journal of Environmental Management. 36 (6): 808-825.
2. Calculated as the draft WIP 2025 forest and agricultural allocations divided by 2010 sector acreages (which were transmitted to WSSI via e-mail from Russ Perkinson on 8/12/2010).  
(For forest: 1,090,000 lb/yr / 9,776,274 ac = 0.11 lb/ac/yr. For agriculture: 2,146,000 lb/yr / 2,836,970 ac = 0.76 lb/ac/yr)
3. Total TP Load is calculated as the sum of (% Forest x Forested TP Load + % Agriculture x Agriculture TP Load)
4. Calculated from information on page 808 of *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. See Slide 3.
5. Calculated from information on page 818 of *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. See Slide 3.



See slide 6 for alternate interpretation

# Potential New Development Unit Loads - Based on Landuse Trends

Alternate  
interpretation

TP Load Based on Acres of Previous Land Uses Converted to Development							
Source	% Forest	Acres of Forest <sup>6</sup>	Forest TP Load (lb/ac/yr) <sup>2</sup>	% Agriculture	Acres of Ag <sup>7</sup>	Agriculture TP Load (lb/ac/yr) <sup>2</sup>	Total TP Load (lb/ac/yr) <sup>3</sup>
Chesapeake Bay Watershed <sup>1,4</sup>	36%	3,519,458	0.11	64%	1,815,660	0.76	0.33
Growing Urban Centers <sup>1,5</sup>	17%	1,661,966		36%	1,021,309		0.36
Outlying Counties <sup>1,5</sup>	1.5%	146,644		2.5%	70,924		0.32

1. Historic development trends were derived from: Jantz, P., Goetz, S., and Jantz, C. 2005. *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. Journal of Environmental Management. 36 (6): 808-825.

2. Calculated as the draft WIP 2025 forest and agricultural allocations divided by 2010 sector acreages (which were transmitted to WSSI via e-mail from Russ Perkinson on 8/12/2010).

(For forest: 1,090,000 lb/yr / 9,776,274 ac = 0.11 lb/ac/yr. For agriculture: 2,146,000 lb/yr / 2,836,970 ac = 0.76 lb/ac/yr)

3. Total TP Load is calculated as: (Acres of Forest x Forested TP Load + Acres of Ag x Agriculture TP Load)/(Acres of Ag + Acres of Forest)

4. Calculated from information on page 808 of *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. See Slide 3.

5. Calculated from information on page 818 of *Urbanization and the Loss of Resource Lands in the Chesapeake Bay Watershed*. See Slide 3.

6. Calculated based on % Forest x total acres of forest in the Chesapeake Bay portion of VA (9,776,274)

7. Calculated based on % Ag x total acres of ag in the Chesapeake Bay portion of VA (2,826,970)

# Potential New Development Unit Loads -

## Based on the Phase 5.3 Model

Basing trends on the Phase 5.3 Model is problematic because forest acres increased:

Acres of Land for 1985 and 2009 Progress Model Years <sup>1</sup>			
Source	1985 Model Year (Acres)	2009 Progress Model Year (Acres)	Decrease
Agriculture	3,190,411	2,817,228	373,183
Urban Runoff	992,591	1,173,577	-180,986
Forest	9,623,213	9,804,011	-180,798

1. Based on the Phase 5.3 Model, released 7/21/10 for the Chesapeake Bay portion of Virginia.

We cannot base trends on the Phase 5.3 mod Model because we are still waiting on landuse data.

# Potential New Development Unit Loads - Based on the Tributary Strategy Data

<b>Conversion of Land for 1985 and 2007<sup>1</sup></b>				
<b>Forest (ac)</b>	<b>Forest TP Load</b>	<b>Agriculture (ac)</b>	<b>Agriculture TP Load</b>	<b>Total Load</b>
47,075	0.11	579,743	0.76	0.71

1. Based on an analysis of Land Use Acreages and Trends from the Tributary Strategies from 1985 to 2007, prepared by Chris Hornung with Silver Companies. Transmitted electronically from Doug Beisch (WEG) to Mike Rolband (WSSI) on November 24, 2010.

# Quality Control

## Effect of Variation in Allowable Loading Rate

Will the allowable loading rate have a great effect on future water quality in the Chesapeake Bay?

Effect of Stormwater Management Loading Rates					
Land Use	Area (ac) <sup>1</sup>	TP Unit Load (lb/ac/yr)	Total TP Load (lb/yr)	Annual Difference from 0.26 (lb/yr)	Total Difference in 2025 (lbs)
Total Bare Construction	13,965	0.26	3,631	--	--
		0.36	5,027	1,396	20,940
		0.40	5,586	1,955	29,325
		0.45	6,284	2,653	39,795
		0.52	7,262	3,631	54,465
		0.55	7,680	4,049	<b>60,735</b>

<sup>[1]</sup> In Virginia for the 2009 Progress model year; based on the Phase 5.3 Chesapeake Bay Model released 7/21/2010.

Versus overall 2025 VA TMDL allocation of **5.41 Million lbs.**



# Quality Control – Other Options?

Discuss other options.



# Quantity Control

## Federal Guidance Requirements

Executive Order 13508, Section 502 Guidance, Chapter 3:  
Maintain the predevelopment hydrology with respect to volume,  
flow rate, and temperature.

Predevelopment hydrology is based on the site's historic (pre-colonial) land cover (forest or meadow). Predevelopment hydrology is **not** the site's existing condition directly before the development or redevelopment activity takes place.

Maintaining predevelopment hydrology will help decrease Urban Stream Syndrome



The Section 502 Guidance gives two design options for meeting the above criteria.



# Quantity Control

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## Federal Guidance Requirements

### Option 1

- Retain the 95<sup>th</sup> percentile storm event (approximately 1.7” in the Washington, D.C. area).

Retention means that the water will be evapotranspired, infiltrated, or used onsite. Retention does **not** mean that the water will be temporarily detained and discharged slowly over some predetermined period.

### Option 2

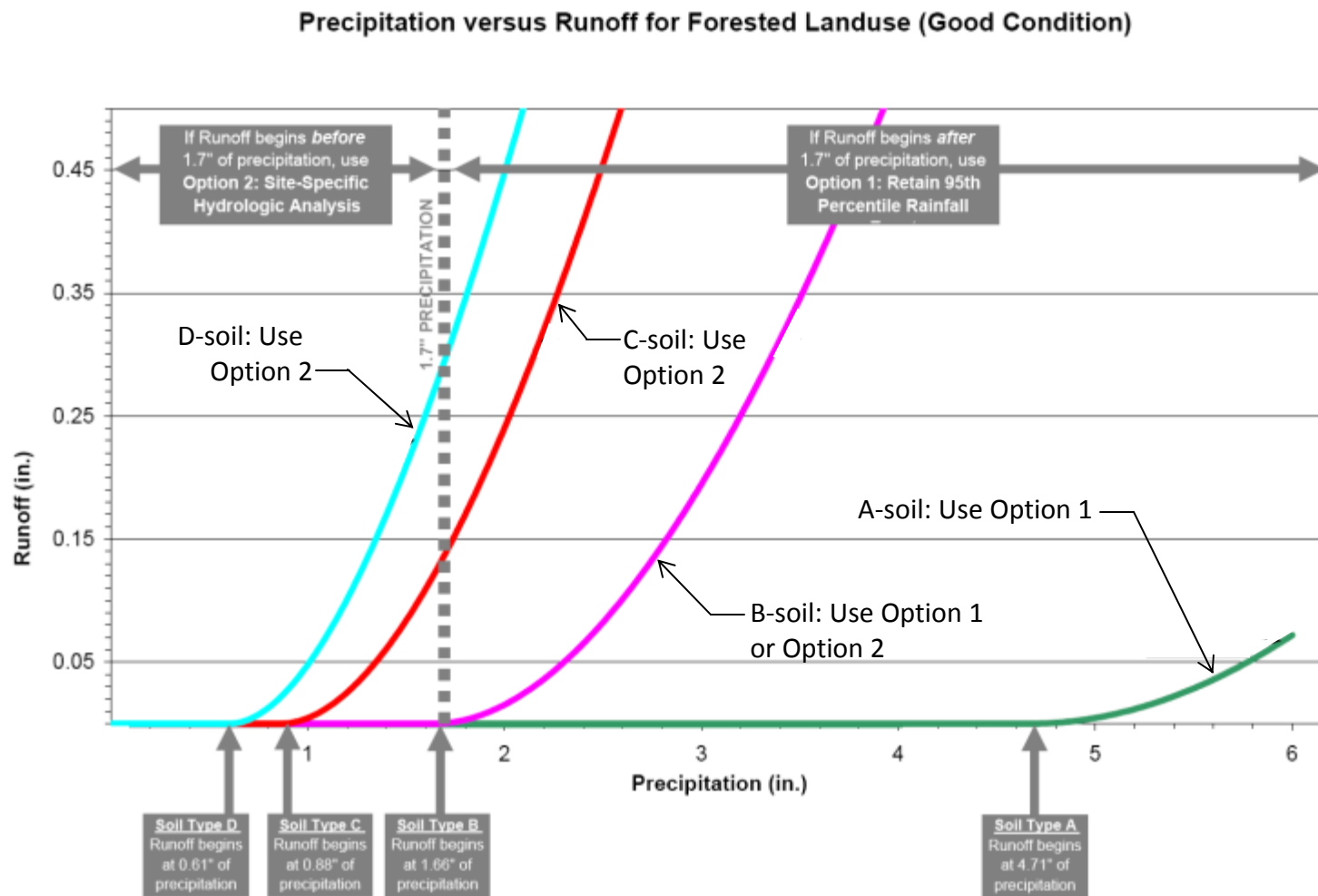
- Site-specific hydrologic analysis to mimic pre-development hydrology.

Neither option allows water to be released from the site until the threshold (1.7” or pre-development runoff) is reached. EPA did not discuss the effect of back-to-back storms, which could drastically increase facility size.



# Quantity Control

## Option 1 vs. Option 2



This figure was developed using Equations 2-3 and 2-4 from *TR-55: Urban Hydrology for Small Watersheds* (Soil Conservation Service, 1986). The CN's used for soil types A, B, C, and D were respectively 30, 55, 70, and 77 (*TR-55: Urban Hydrology for Small Watersheds*; Table 2-2c. Runoff curve numbers for other agricultural lands).

# Quantity Control

## 4VAC50-60-66 (Suspended Regulation)

### Five Outfall Conditions

1. *Manmade* conveyance systems:  
Convey the peak flow from the 2-yr, 24-hr storm without erosion
2. *Restored* conveyance systems:  
Convey the peak flow to a functional restored system or a channel that will be restored
3. *Stable* natural conveyance systems:  
 $Q_{\text{developed}} \times RV_{\text{developed}} \leq Q_{\text{pre-developed}} \times RV_{\text{pre-developed}}$
4. *Unstable* natural conveyance systems:  
 $Q_{\text{developed}} \times RV_{\text{developed}} \leq Q_{\text{good pasture}} \times RV_{\text{good pasture}}$  (changed from “forest”)
5. *Unstable* natural conveyance systems (from redevelopment sites < 5 acres or new development sites < 1 acres):  
 $Q_{\text{developed}} \times RV_{\text{developed}} \leq Q_{\text{pre-developed}} \times RV_{\text{pre-developed}}$



# Quantity Control

## 4VAC50-60-66 (RAP Proposal)

### Three outfall conditions

1. Manmade conveyance systems
2. Restored conveyance systems
3. Natural conveyance systems

### Allowable 1-yr, 24-hr peak flow rate for all conditions:

- $Q_{\text{developed}} \leq \text{IF} \times Q_{\text{pre-developed}} \times \text{RV}_{\text{pre-developed}} / \text{RV}_{\text{developed}}$   
 $Q_{\text{developed}}$  shall not be required to be less than  $[Q_{\text{forested}} \times \text{RV}_{\text{forested}}] / \text{RV}_{\text{developed}}$   
And  $Q_{\text{developed}}$  must be  $\leq Q_{\text{pre-developed}}$
- Improvement Factor (IF) = 0.8 for sites > 1 ac  
0.9 for sites  $\leq$  1 ac
- Pre-developed = conditions prior to development, not pre-colonial conditions

### Additional options for manmade and restored conveyance systems:

- Manmade: convey the 2-year, 24-hr storm without erosion, or satisfy the "One Percent Rule" (4VAC50-60-66.D).
- Restored: the discharge was considered in the design of the restored system.



# Quantity Control

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See Redline Regulation Handout.



# Virginia Runoff Reduction Method (VRRM) Issues

1. The VRRM removes forest nutrient loads from overall nutrient load calculations
  - This results in lower modeled loads than actual loads.
2. The VRRM loading rates do not match loading rates from the Bay Act Simple Method; therefore, the two are not comparable.
  - 0.45 lb/ac/yr (based on VRRM) is not the same as 0.45 lb/ac/yr (based on the Simple Method)!
  - The Simple Method calculation relies solely on impervious area
  - The VRRM accounts for impervious and turf areas (but not forest)
3. The VRRM loading rates do not match loading rates from the TMDL; therefore, these two are also not comparable.
4. VA regulations only address TP; TMDL addresses TN and TP (VRRM calculates TN)

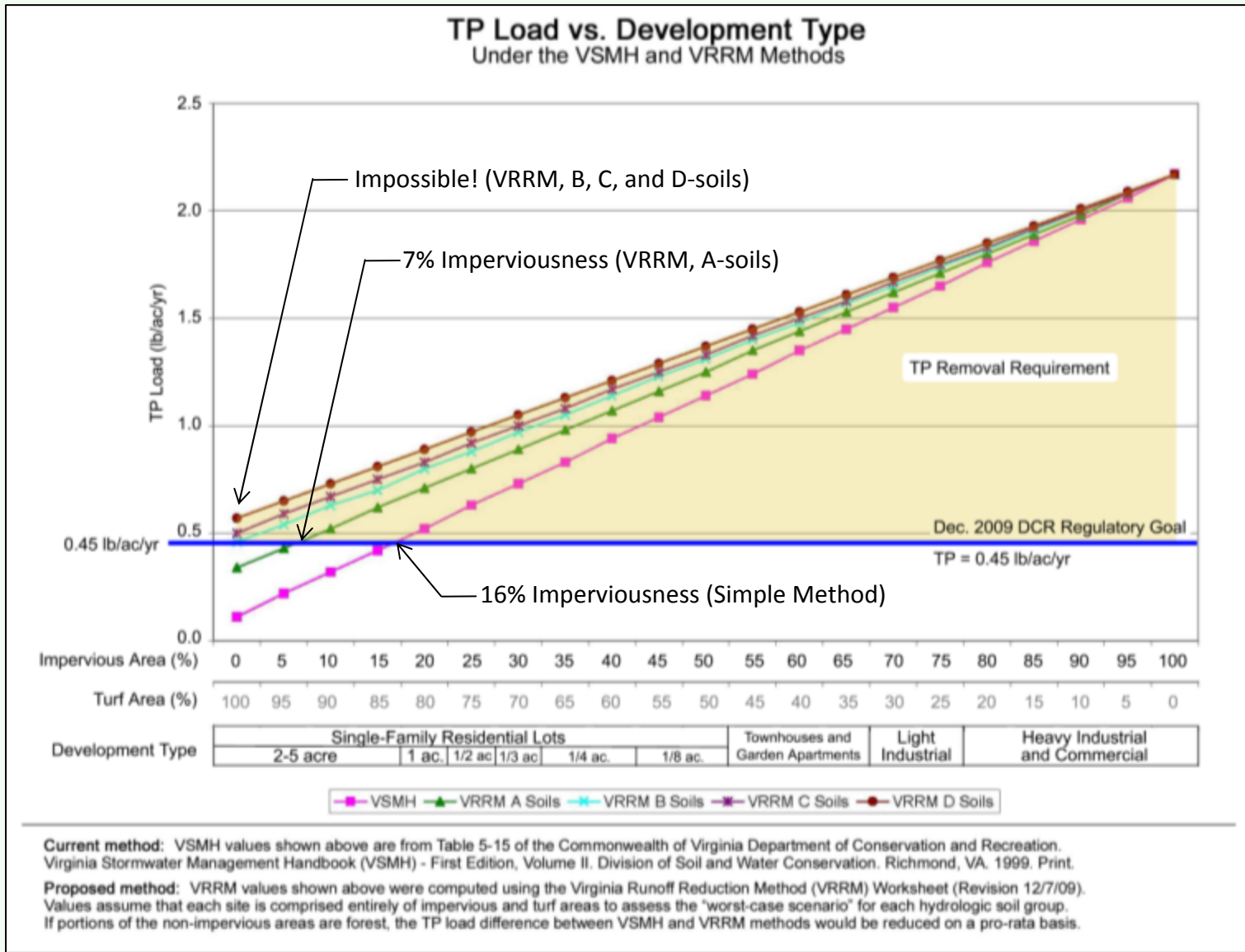


# VRRM TP Load with and without Forest

	Cover Type %		Resulting TP Load (lb/ac/yr)		% Load Increase w/Forest
	Pervious	Forest	VRRM w/o Forest	VRRM w/Forest	
10% Impervious	0	90	0.22	0.29	32%
	10	80	0.27	0.33	22%
	20	70	0.31	0.37	19%
	30	60	0.36	0.41	14%
	40	50	0.41	0.45	10%
	50	40	0.46	0.49	7%
	60	30	0.51	0.53	4%
	70	20	0.56	0.57	2%
	80	10	0.60	0.61	2%
	90	0	0.65	0.65	0%
30% Impervious	0	70	0.65	0.71	9%
	10	60	0.70	0.75	7%
	20	50	0.75	0.79	5%
	30	40	0.80	0.83	4%
	40	30	0.84	0.87	4%
	50	20	0.89	0.91	2%
	60	10	0.94	0.95	1%
	70	0	0.99	0.99	0%
50% Impervious	0	50	1.08	1.12	4%
	10	40	1.13	1.17	4%
	20	30	1.18	1.21	3%
	30	20	1.23	1.25	2%
	40	10	1.28	1.29	1%
	50	0	1.33	1.33	0%

Weighted average soil cover was derived from SSURGO state-wide soils database soils breakdown for Virginia. SSURGO breakdown: 2,798 mi<sup>2</sup> HSG A; 135 mi<sup>2</sup> HSG A/D; 21,464 mi<sup>2</sup> HSG B; 1,400 mi<sup>2</sup> HSG B/D; 28,771 mi<sup>2</sup> HSG C; 1,755 mi<sup>2</sup> HSG C/D; 5,206 mi<sup>2</sup> HSG D; 2,958 mi<sup>2</sup> Unrated. A/D, B/D, and C/D soils were broken equally and added to each respective soil group (i.e., B/D soils were split equally, and 10,732 mi<sup>2</sup> each were added to HSG B and HSG D). Unrated soils were broken equally and 739.5 mi<sup>2</sup> were added to each soil group. The resulting soil breakdown is as follows: 3,605 mi<sup>2</sup> (5.6%) HSG A, 22,904 mi<sup>2</sup> (35.5%) HSG B, 30,388 mi<sup>2</sup> (47.1%) HSG C, and 7,591 mi<sup>2</sup> (11.8%) HSG D.

# VRRM vs. VSMH



# VRRM vs. TMDL Loading Rates

The VRRM loading rates do not match loading rates from the TMDL; therefore, the two are not comparable

- Policy issue – WIP uses load from TMDL

Comparison of VRRM and TMDL Loading Rates						
Land Use Type	TP Load (lb/ac/yr)			TN Load (lb/ac/yr)		
	VRRM*	VRRM* (Weighted Average for all HSGs)	TMDL	VRRM*	VRRM* (Weighted Average for all HSGs)	TMDL
Impervious	2.17	-	2.1	15.50	-	11.8
Pervious – HSG A	0.34	0.49	1.1	2.45	3.50	8.7
Pervious – HSG B	0.46			3.26		
Pervious – HSG C	0.50			3.59		
Pervious – HSG D	0.57			4.08		
Forest – HSG A	0.05	0.08	0.1	0.33	0.59	2.0
Forest – HSG B	0.07			0.49		
Forest – HSG C	0.09			0.65		
Forest – HSG D	0.11			0.82		

\*Analysis assumes 43" of annual precipitation.



# VRRM vs. TMDL Loads - TN

% Impervious	% Pervious (turf; no forest)	Development Type	TMDL		VRRM*				
			All Soils	Calculated TN Load lb/ac/yr	A Soils	B Soils	C Soils	D Soils	Weighted Average lb/ac/yr
			Calculated TN Load lb/ac/yr		Calculated TN Load lb/ac/yr	Calculated TN Load lb/ac/yr	Calculated TN Load lb/ac/yr		
0	100	2-5 Acre Residential	8.70	8.70	2.45	3.26	3.59	4.08	3.47
5	95		8.86	8.86	3.10	3.88	4.19	4.65	4.07
10	90		9.01	9.01	3.75	4.49	4.78	5.22	4.67
15	85		9.17	9.17	4.41	5.10	5.38	5.79	5.27
20	80	1/3 to 1 Acre Residential	9.32	9.32	5.06	5.71	5.97	6.36	5.87
25	75		9.48	9.48	5.71	6.32	6.57	6.93	6.48
30	70		9.63	9.63	6.36	6.93	7.16	7.51	7.07
35	65	1/4 Acre Residential	9.79	9.79	7.02	7.55	7.76	8.08	7.68
40	60		9.94	9.94	7.67	8.16	8.35	8.65	8.28
45	55	1/8 Acre Residential	10.10	10.10	8.32	8.77	8.95	9.22	8.88
50	50		10.25	10.25	8.97	9.38	9.54	9.79	9.48
55	45	Townhouses and Garden Apartments	10.41	10.41	9.63	9.99	10.14	10.36	10.08
60	40		10.56	10.56	10.28	10.61	10.74	10.93	10.69
65	35		10.72	10.72	10.93	11.22	11.33	11.50	11.29
70	30	Light Industrial	10.87	10.87	11.58	11.83	11.93	12.07	11.89
75	25		11.03	11.03	12.24	12.44	12.52	12.64	12.49
80	20	Heavy Industrial and Commercial	11.18	11.18	12.89	13.05	13.12	13.22	13.09
85	15		11.34	11.34	13.54	13.66	13.71	13.79	13.69
90	10		11.49	11.49	14.19	14.28	14.31	14.36	14.30
95	5		11.65	11.65	14.85	14.89	14.90	14.93	14.90
100	0	Pavement	11.80	11.80	15.50	15.50	15.50	15.50	15.50

- VRRM calculates a lower load than TMDL
- VRRM and TMDL calculate the same load
- VRRM calculates a higher load than TMDL



# VRRM vs. TMDL Loads - TP

% Impervious	% Pervious (turf; no forest)	Development Type	TMDL	VRRM*				
			All Soils	A Soils	B Soils	C Soils	D Soils	Weighted Average
			Calculated TP Load	Calculated TP Load	Calculated TP Load	Calculated TP Load	Calculated TP Load	
			lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/ac/yr	lb/ac/yr	
0	100	2-5 Acre Residential	1.10	0.34	0.46	0.50	0.57	0.49
5	95		1.15	0.43	0.54	0.59	0.65	0.57
10	90		1.20	0.52	0.63	0.67	0.73	0.65
15	85		1.25	0.62	0.70	0.75	0.81	0.73
20	80	1/3 to 1 Acre Residential	1.30	0.71	0.80	0.83	0.89	0.82
25	75		1.35	0.80	0.88	0.92	0.97	0.90
30	70		1.40	0.89	0.97	1.00	1.05	0.99
35	65	1/4 Acre Residential	1.45	0.98	1.05	1.08	1.13	1.07
40	60		1.50	1.07	1.14	1.17	1.21	1.16
45	55	1/8 Acre Residential	1.55	1.16	1.23	1.25	1.29	1.24
50	50		1.60	1.25	1.31	1.33	1.37	1.32
55	45	Townhouses and Garden Apartments	1.65	1.35	1.40	1.42	1.45	1.41
60	40		1.70	1.44	1.48	1.50	1.53	1.49
65	35		1.75	1.53	1.57	1.58	1.61	1.58
70	30	Light Industrial	1.80	1.62	1.65	1.67	1.69	1.66
75	25		1.85	1.71	1.74	1.75	1.77	1.75
80	20	Heavy Industrial and Commercial	1.90	1.80	1.82	1.83	1.85	1.83
85	15		1.95	1.89	1.91	1.92	1.93	1.92
90	10		2.00	1.98	2.00	2.00	2.01	2.00
95	5		2.05	2.08	2.08	2.08	2.09	2.08
100	0	Pavement	2.10	2.17	2.17	2.17	2.17	2.17

- VRRM calculates a lower load than TMDL
- VRRM and TMDL calculate the same load
- VRRM calculates a higher load than TMDL



# Offsets / Credits

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# Grandfathering

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# Local Program Criteria



# Questions?

