Pollutant Removal Calculations

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3/31/2017

Agenda

1. EPA Simple Method
2. Runoff Reduction Method
3. Innovative Practices
4. Q&A

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1 EPA Simple Method

The EPA Simple Method

Estimates annual pollutant load exported in stormwater runoff from small urban catchments

$$L = P \times Pj \times Rv \times C \times A \times {}^{2.72}\!/_{12}$$

The Simple Method

$$L = P \times Pj \times Rv \times C \times A \times {}^{2.72}\!/_{12}$$

L = total post-development pollutant load (pounds/year)

P = average annual rainfall depth (inches) = **43** inches (VA)

P_j = fraction of rainfall events that produce runoff = 0.9

Rv = volumetric runoff coefficient

C = flow-weighted event mean concentration (EMC) of TP (mg/L) = 0.26 mg/L

A = area of the development site (acres)

2.72 = unit conversion factor: L to ft^3, mg to lb, and acres to ft^2

12 = unit conversion factor: rainfall inches to feet

The Simple Method

$$L = P \times Pj \times Rv_{composite} \times C \times A \times {}^{2.72}/_{12}$$

Parameter	Median EMC (mg/L)
Total Nitrogen	
National	1.9
Virginia	1.86
Residential	2.67
Non-Residential	1.12
Virginia Coastal Plain	2.13
Residential	2.96
Non-Residential	1.08
Virginia Piedmont	1.70
Residential	1.87
Non-Residential	1.30
Total Phosphorus	
National	0.27
Virginia	0.26
Residential	0.28
Non-Residential	0.23
Virginia Coastal Plain	0.27
Virginia Piedmont	0.22
Total Suspended Solids	
National	62
Virginia	40

The Modified Simple Method

$$L = P \times Pj \times Rv_{composite} \times C \times A \times {}^{2.72}/_{12}$$

$$Rv_{composite} = (Rv_I \times \%I) + (Rv_T \times \%T) + (Rv_F \times \%F)$$

2 Runoff Reduction Method

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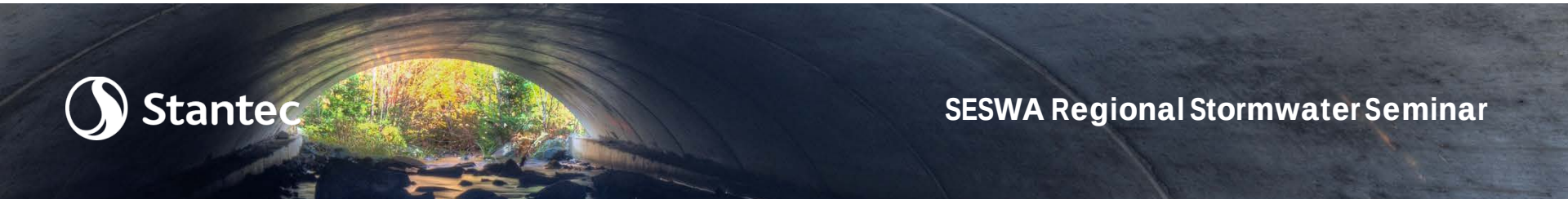
Runoff Reduction Method

- Emphasizes Volume -based treatment and Sizing for BMPs
- Based on NSWQD and literature reviews of BMP Performance
- Allows for Quantification of loads and reductions for compliance



Land Cover and Volumetric Runoff Coefficients in the RRM

- Treatment Volume:

  Site Runoff Coefficients (Rv)

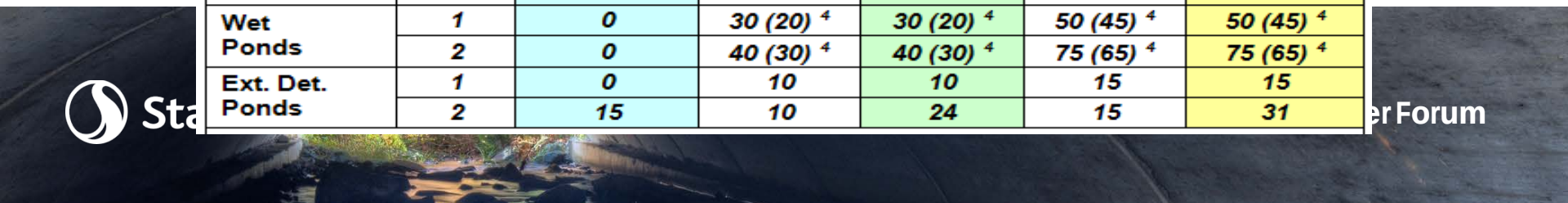
Cover	HSG A	HSG B	HSG C	HSG D
Forest/Open	**0.02**	**0.03**	**0.04**	**0.05**
Managed Turf / Disturbed Soil	**0.15**	**0.20**	**0.22**	**0.25**
Impervious Cover	**0.95**	**0.95**	**0.95**	**0.95**

Land Cover and Volumetric Runoff Coefficients in the VRRM

- Land Cover Definitions

Managed Turf	
Areas intended to be mowed and maintained as turf within:	
Residential	Industrial
Commercial	Institutional settings

Practice	Design Level	Runoff Reduction	TN EMC Removal[3]	TN Mass Load Removal	TP EMC Removal	TP Mass Load Removal [6]
Rooftop Disconnect	1 [2]	25 to 50 [1]	0	25 to 50 [1]	0	25 to 50 [1]
	No Level 2 Design					
Sheet Flow to Veg. Filter or Conserv. Open Space	1	50	0	50	0	50
	2 [5]	50 to 75 [1]	0	50 to 75 [1]	0	50 to 75 [1]
Grass Channels	1	10 to 20 [1]	20	28 to 44 [1]	15	24 to 41 [1]
	No Level 2 Design					
Soil Compost Amendment	Can be used to Decrease Runoff Coefficient for Turf Cover at Site. See the design specs for Rooftop Disconnection, Sheet Flow to Vegetated Filter or Conserved Open Space, and Grass Channel					
Vegetated Roof	1	45	0	45	0	45
	2	60	0	60	0	60
Rainwater Harvesting	1	Up to 90 [3, 5]	0	Up to 90 [3, 5]	0	Up to 90 [3, 5]
	No Level 2 Design					
Permeable Pavement	1	45	25	59	25	59
	2	75	25	81	25	81
Infiltration Practices	1	50	15	57	25	63
	2	90	15	92	25	93
Bioretention Practices	1	40	40	64	25	55
	2	80	60	90	50	90
Urban Bioretention	1	40	40	64	25	55
	No Level 2 Design					
Dry Swales	1	40	25	55	20	52
	2	60	35	74	40	76
Wet Swales	1	0	25	25	20	20
	2	0	35	35	40	40
Filtering Practices	1	0	30	30	60	60
	2	0	45	45	65	65
Constructed Wetlands	1	0	25	25	50	50
	2	0	55	55	75	75
Wet Ponds	1	0	30 (20) [4]	30 (20) [4]	50 (45) [4]	50 (45) [4]
	2	0	40 (30) [4]	40 (30) [4]	75 (65) [4]	75 (65) [4]
Ext. Det. Ponds	1	0	10	10	15	15
	2	15	10	24	15	31



Site Data Tab

	A	B
1	Virginia Runoff Reduction Method Nev	
2	Site Data	
3		
4	Project Name:	
5	Date:	
6		
7		data input cells
8		calculation cells
9		constant values
10		
11	1. Post-Development Project & Land Cover Information	
12		
13	Constants	
14		
15	Annual Rainfall (inches)	43
16	Target Rainfall Event (inches)	1.00
17	Phosphorus EMC (mg/L)	0.26
18	Target Phosphorus Target Load (lb/acre/yr)	0.41
19	Pj	0.90
20		
21	Land Cover (acres)	

	A soils	B Soils	C Soils	D Soils	Totals
22					
23 Forest/Open Space (acres) -- undisturbed, protected forest/open space or reforested land	0.00		0.00	0.00	0.00
24 Managed Turf (acres) -- disturbed, graded for yards or other turf to be mowed/managed	0.00		12.09	0.00	12.09
25 Impervious Cover (acres)	0.00		7.71	0.00	7.71
26				Total	19.80

27					
28	Rv Coefficients				
29		A soils	B Soils	C Soils	D Soils
30	Forest/Open Space	0.02	0.03	0.04	0.05
31	Managed Turf	0.15	0.20	0.22	0.25
32	Impervious Cover	0.95	0.95	0.95	0.95
33					
34					
35					
36	Land Cover Summary				
37	Forest/Open Space Cover (acres)	0.00			
38	Weighted Rv(forest)	0.00			
39	% Forest	0%			
40	Managed Turf Cover (acres)	12.09			
41	Weighted Rv(turf)	0.22			
42	% Managed Turf	61%			
43	Impervious Cover (acres)	7.71			
44	Rv(impervious)	0.95			
45	% Impervious	39%			
46	**Total Site Area (acres)**	19.80			
47	**Site Rv**	0.50			
48					
49	Post-Development Treatment Volume (acre-ft)	0.83			
50	Post-Development Treatment Volume (cubic feet)	36,243			
51	Post_Development Load (TP) (lb/yr)	22.77	Post_Development Load (TN) (lb/yr)		162.90
52	Total Load (TP) Reduction Required (lb/yr)	14.65			

Turf = 12.09
Imp = 7.71
Area Total = 19.8 acres

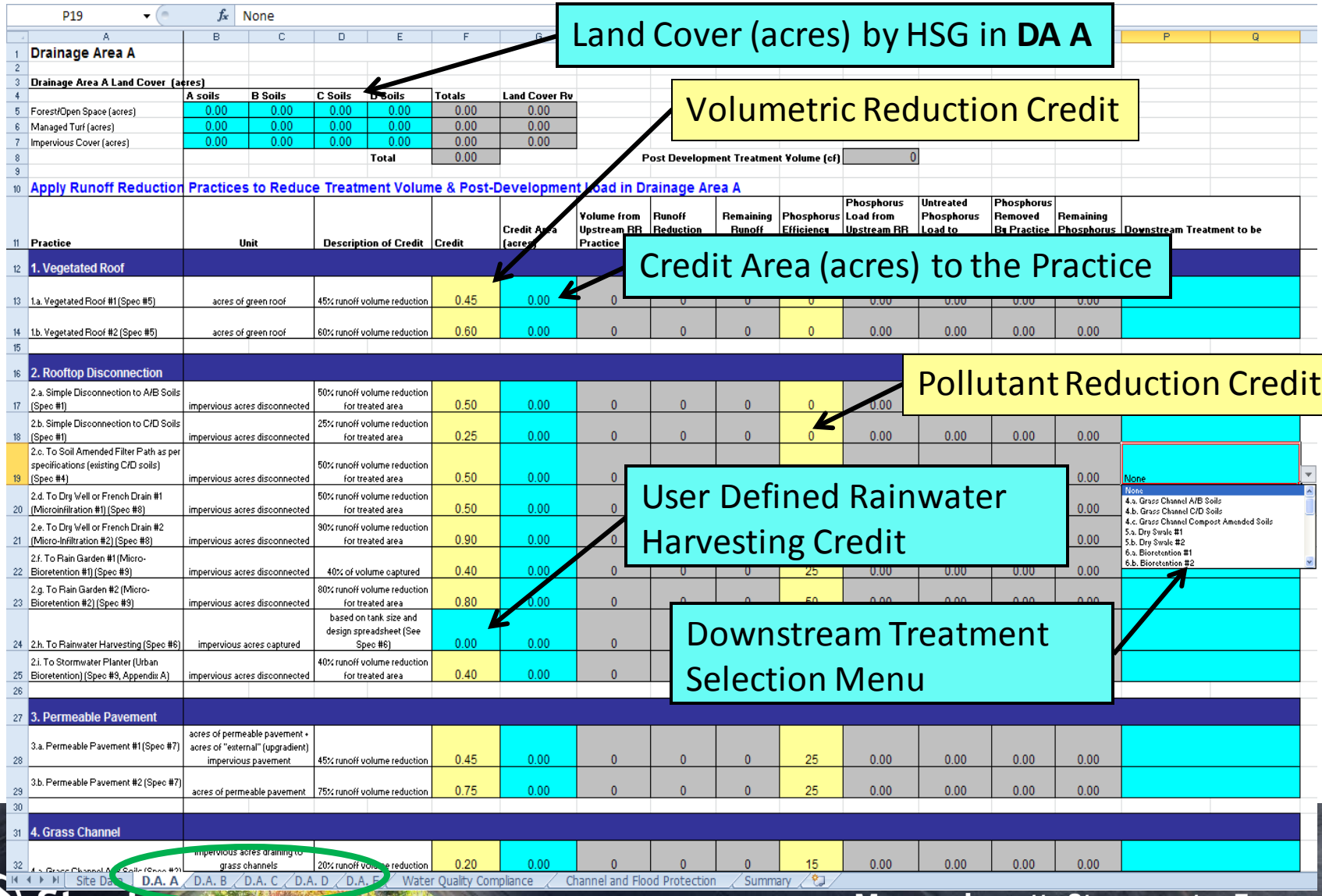
Site Rv = 0.50

Post Dev Tv = 0.83 ac-ft

Post Dev TP Load = 22.77 lb/yr

Load Reduction Required = 14.65 lb/yr

VRRM Spreadsheet DA Tabs



P19 | None

Drainage Area A

Drainage Area A Land Cover (acres)

	A soils	B Soils	C Soils	D Soils	Totals	Land Cover Rv
Forest/Open Space (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Managed Turf (acres)	0.00	0.00	0.00	0.00	0.00	0.00
Impervious Cover (acres)	0.00	0.00	0.00	0.00	0.00	0.00
				Total	0.00	

Post Development Treatment Volume (cf): 0

Apply Runoff Reduction Practices to Reduce Treatment Volume & Post-Development Load in Drainage Area A

Practice	Unit	Description of Credit	Credit	Credit Area (acres)	Volume from Upstream RR Practice	Runoff Reduction	Remaining Runoff	Phosphorus Efficiency	Phosphorus Load from Upstream RR	Untreated Phosphorus Load to	Phosphorus Removed By Practice	Remaining Phosphorus	Downstream Treatment to be
1. Vegetated Roof													
1.a. Vegetated Roof #1 (Spec #5)	acres of green roof	45% runoff volume reduction	0.45	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
1.b. Vegetated Roof #2 (Spec #5)	acres of green roof	60% runoff volume reduction	0.60	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2. Rooftop Disconnection													
2.a. Simple Disconnection to A/B Soils (Spec #1)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0	0	0	0	0.00				
2.b. Simple Disconnection to C/D Soils (Spec #1)	impervious acres disconnected	25% runoff volume reduction for treated area	0.25	0.00	0	0	0	0	0.00	0.00	0.00	0.00	
2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0							0.00	None
2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	impervious acres disconnected	50% runoff volume reduction for treated area	0.50	0.00	0							0.00	
2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	impervious acres disconnected	90% runoff volume reduction for treated area	0.90	0.00	0							0.00	
2.f. To Rain Garden #1 (Micro-Bioretention #1) (Spec #9)	impervious acres disconnected	40% of volume captured	0.40	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
2.g. To Rain Garden #2 (Micro-Bioretention #2) (Spec #9)	impervious acres disconnected	80% runoff volume reduction for treated area	0.80	0.00	0	0	0	50	0.00	0.00	0.00	0.00	
2.h. To Rainwater Harvesting (Spec #6)	impervious acres captured	based on tank size and design spreadsheet (See Spec #6)	0.00	0.00	0								
2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	impervious acres disconnected	40% runoff volume reduction for treated area	0.40	0.00	0								
3. Permeable Pavement													
3.a. Permeable Pavement #1 (Spec #7)	acres of permeable pavement + acres of "external" (upgradient) impervious pavement	45% runoff volume reduction	0.45	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
3.b. Permeable Pavement #2 (Spec #7)	acres of permeable pavement	75% runoff volume reduction	0.75	0.00	0	0	0	25	0.00	0.00	0.00	0.00	
4. Grass Channel													
4.a. Grass Channel A/B Soils (Spec #2)	impervious acres draining to grass channels	20% runoff volume reduction	0.20	0.00	0	0	0	15	0.00	0.00	0.00	0.00	

None
4.a. Grass Channel A/B Soils
4.b. Grass Channel C/D Soils
4.c. Grass Channel Compost Amended Soils
5.a. Dry Swale #1
5.b. Dry Swale #2
6.a. Bioretention #1
6.b. Bioretention #2

Site Da | D.A. A | D.A. B | D.A. C | D.A. D | D.A. E | Water Quality Compliance | Channel and Flood Protection | Summary

Water Quality Compliance Tab

	A	B	C	D	E	F	G
1	**Site Results**						
2							
3		**D.A. A**	**D.A. B**	**D.A. C**	**D.A. D**	**D.A. E**	**AREA CHECK**
4	IMPERVIOUS COVER	7.71	0.00	0.00	0.00	0.00	OK.
5	IMPERVIOUS COVER TREATED	7.71	0.00	0.00	0.00	0.00	OK.
6	TURF AREA	12.09	0.00	0.00	0.00	0.00	OK.
7	TURF AREA TREATED	12.09	0.00	0.00	0.00	0.00	OK.
8	AREA CHECK	OK.	OK.	OK.	OK.	OK.	
9							
10	**Phosphorus**						
11	TOTAL TREATMENT VOLUME (cf)	36,243					
12	TOTAL PHOSPHORUS LOAD REDUCTION REQUIRED (LB/YEAR)	14.65					
13							
14	RUNOFF REDUCTION (cf)	0					
15	PHOSPHORUS LOAD REDUCTION ACHIEVED (LB/YR)	17.06					
16							
17	ADJUSTED POST-DEVELOPMENT PHOSPHORUS LOAD (TP) (lb/yr)	5.71					
18							
19	REMAINING PHOSPHORUS LOAD REDUCTION (LB/YR) NEEDED	CONGRATULATIONS!! YOU EXCEEDED THE TARGET REDUCTION BY 2.4 LB/YEAR!!					
20							
21							
22							
23	**Nitrogen (for information purposes)**						
24	TOTAL TREATMENT VOLUME (cf)	36,243					
25							
26							
27	RUNOFF REDUCTION (cf)	0					
28	NITROGEN LOAD REDUCTION ACHIEVED (LB/YR)	32.54					
29							
30	ADJUSTED POST-DEVELOPMENT NITROGEN LOAD (TN) (lb/yr)	130.36					
31							

Area Check: OK

Runoff Reduction = 0

TP Reduction = 17.06 lb/yr

Channel & Flood Protection Tab

	1-year storm	2-year storm	10-year storm
Target Rainfall Event (in)	2.79	3.38	5.14

Drainage Area A	
Drainage Area (acres)	19.80
Runoff Reduction Volume (cf)	0
Drainage Area B	
Drainage Area (acres)	0.00
Runoff Reduction Volume (cf)	0
Drainage Area C	
Drainage Area (acres)	0.00
Runoff Reduction Volume (cf)	0
Drainage Area D	
Drainage Area (acres)	0.00
Runoff Reduction Volume (cf)	0
Drainage Area E	
Drainage Area (acres)	0.00
Runoff Reduction Volume (cf)	0

1, 2, and 10-year storm rainfall depths

No volume reduction

Based 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
Managed Turf -- disturbed, graded for yards or other turf to be mowed/managed	Area (acres)	0.00	0.00	12.09	0.00
	CN	39	61	74	80
Impervious Cover	Area (acres)	0.00	0.00	7.71	0.00
	CN	98	98	98	98

Weighted CN	S
83	2.05

	1-year storm	2-year storm	10-year storm
$RV_{Developed}$ (in) with no Runoff Reduction	1.28	1.76	3.30
$RV_{Developed}$ (in) with Runoff Reduction	1.28	1.76	3.30
Adjusted CN	83	83	83

CN = 83

1, 2, and 10-year volume (RV) measured in watershed inches =

RV_1 = 1.28 inches

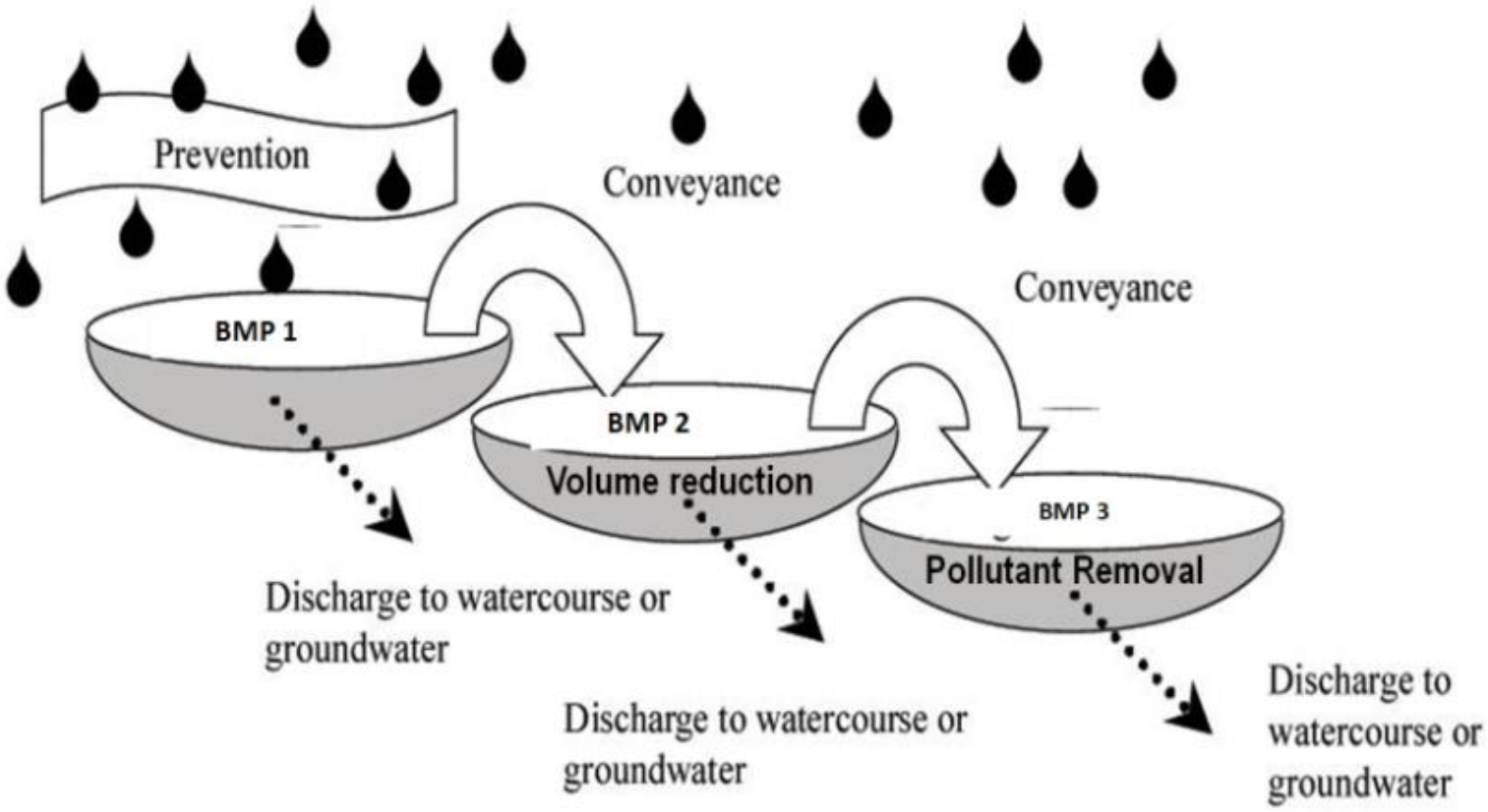
RV_2 = 1.76 inches

RV_{10} = 3.30 inches

No RR

No CN Adjustment!

BMP Treatment Train



3 Innovative Practices

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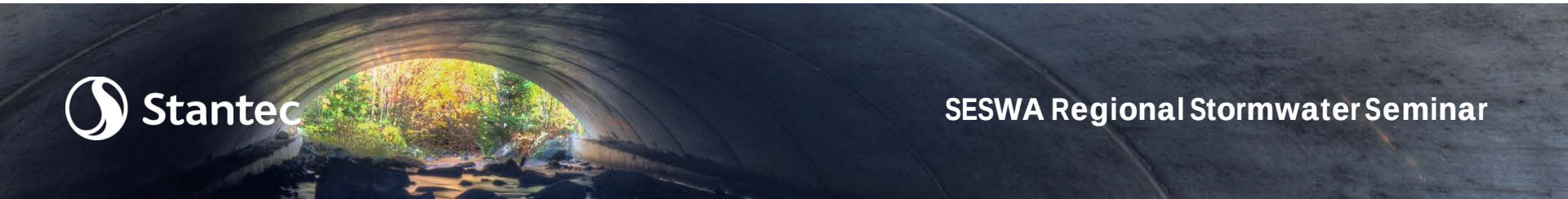
Stream Restoration

Urban Streams – EPA Protocols

- Prevented Sediment
- Hyphoreic Box
- Regenerative Conveyance
- Floodplain Reconnection



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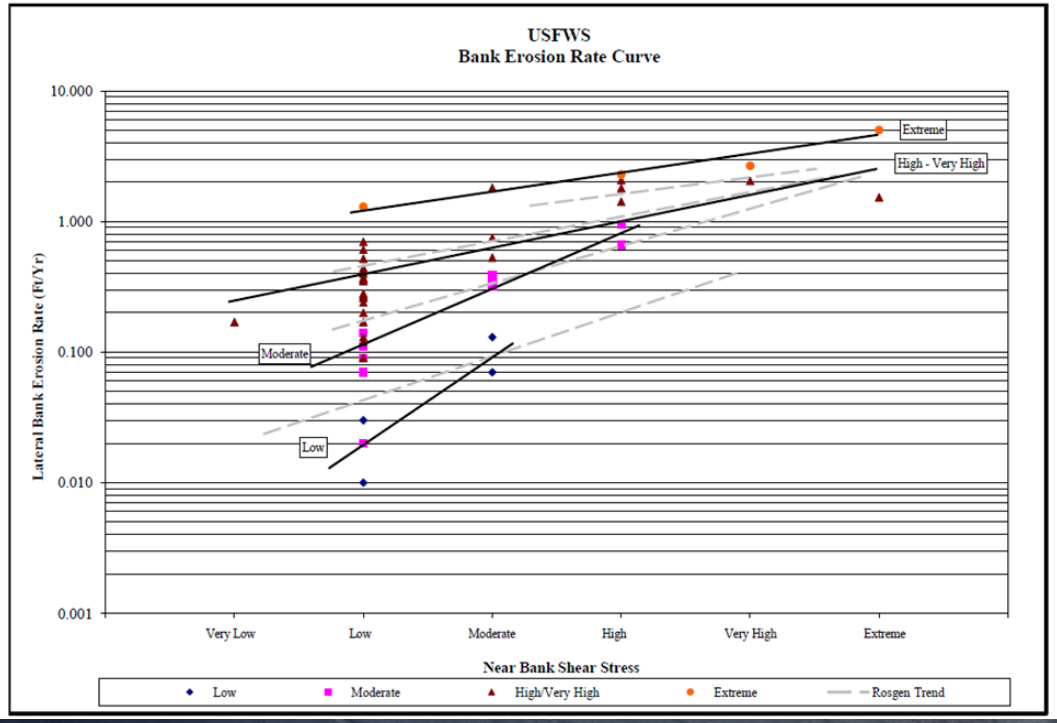
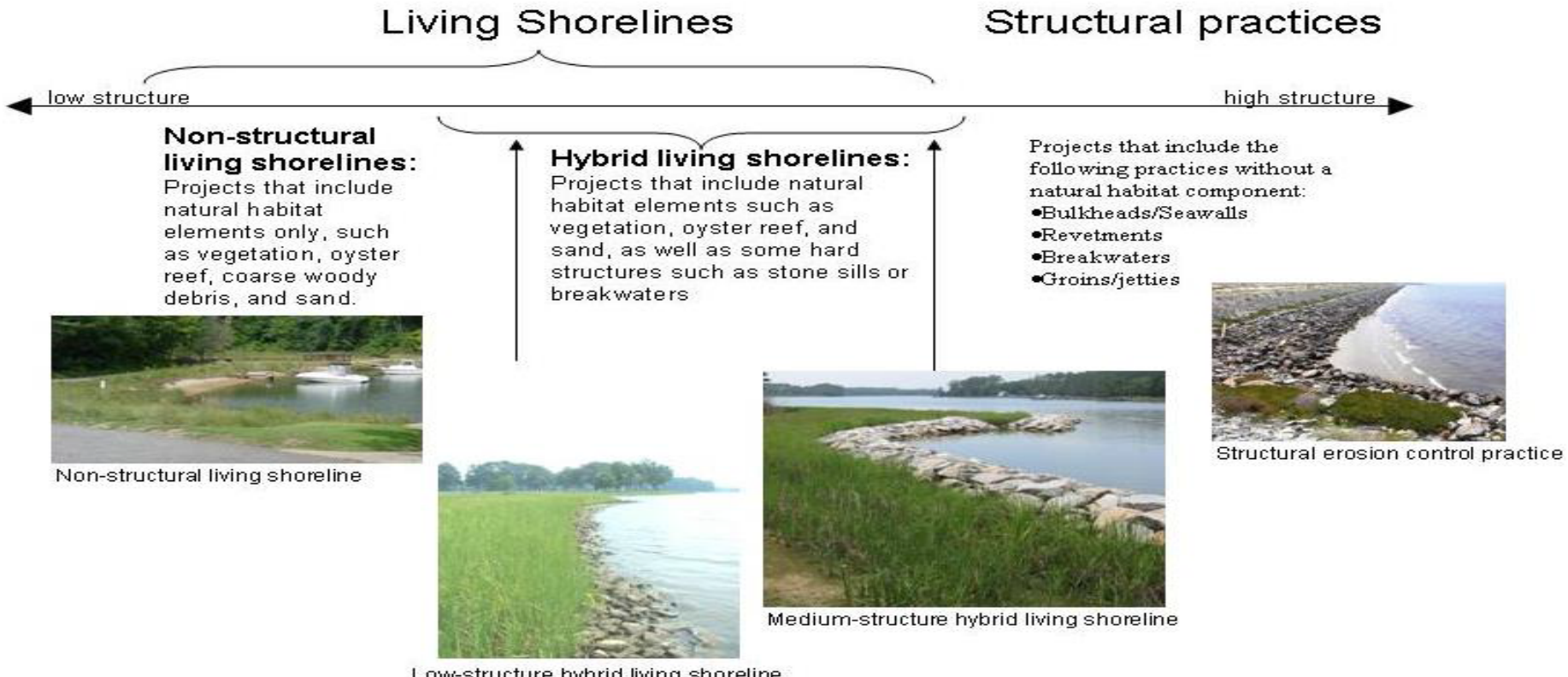
Prevented Sediment

- Assess Existing Stream Erosion using field assessment methods and Bank Erosion Curves
- Near Bank Shear Stress
- Bank Erodibility Hazard Index

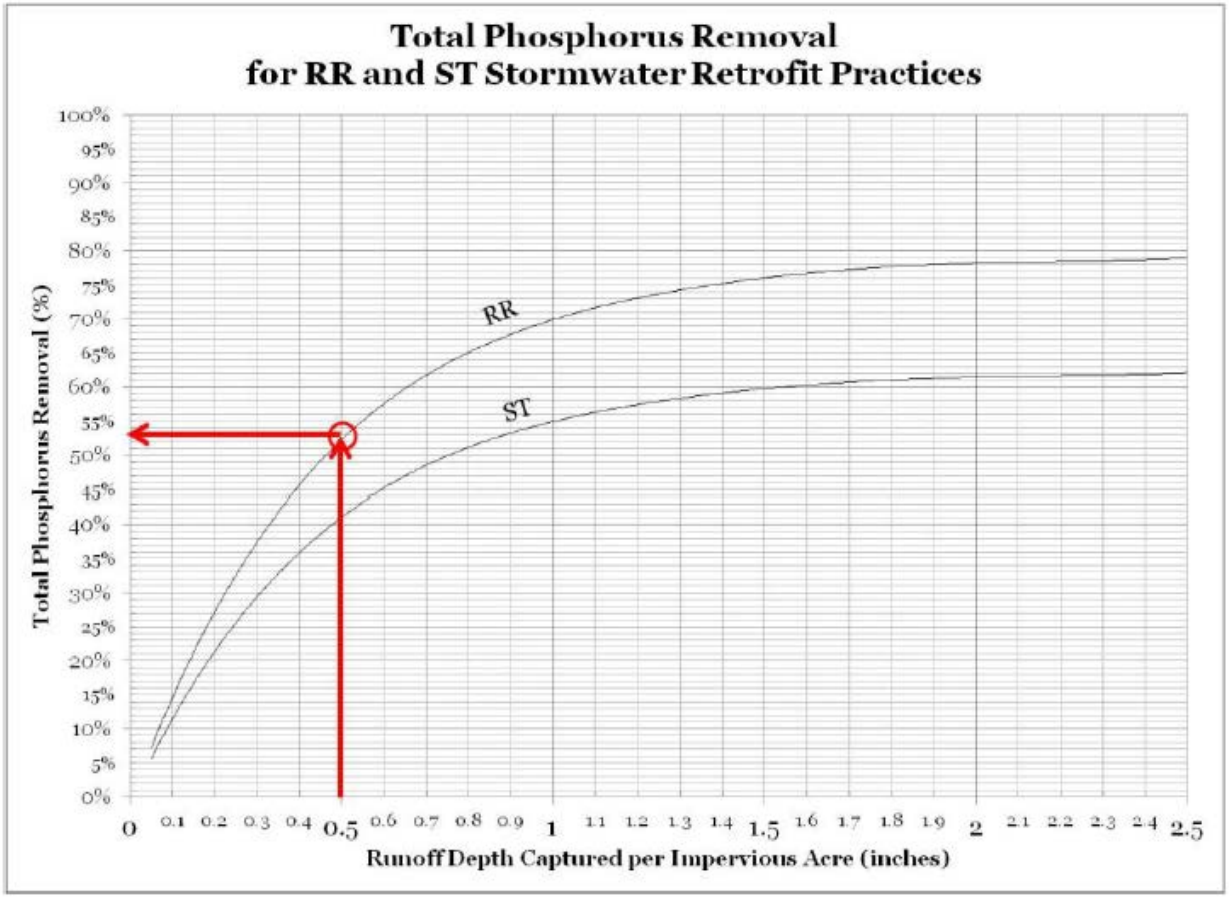


Shoreline Erosion Control

- Preference for Living Shorelines
- Lingering questions about Sediment Loads and Delivery



Retrofitting – Adjustor Curves



Street Sweeping

Mass Loading Approach

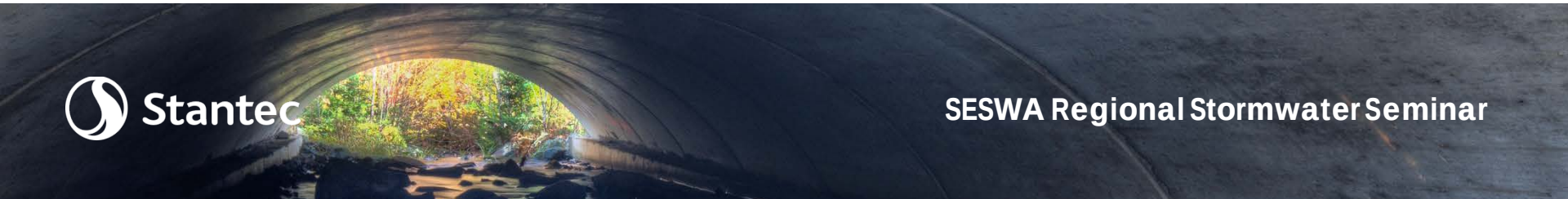
1. Determine pounds of material collected
2. Convert to pounds of material to dry weight using a factor of .7 lbs dry weight/lbs material
3. Multiply by the following factors for each POC to determine the reductions from street sweeping:

TN lbs/yr	TP lbs/yr	TSS lbs/yr
.0025	.001	.3

Qualifying Street Lanes Method

1. Determine the lane miles swept
2. Convert to total impervious acres by multiplying the miles swept by the lane width swept (10 ft) and dividing that figure by 43,560. If both side of the street are swept, then use a lane width of 20 feet.
3. Multiply the impervious acres by the pre-sweeping annual nutrient load for TP (2 lbs/impervious acre/yr) and TN (15.4 lbs/impervious acre/yr):
4. Multiply the pre-sweep baseline load by the pickup factors depending on the technology used to determine the reductions from street sweeping:

Technology	TN lbs/yr	TP lbs/yr	TSS lbs/yr
Mechanical	.04	.04	.10
Regenerative/Vacuum	.05	.06	.25



4 Questions and Answers

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