

# Chesapeake Bay TMDL Urban Stormwater Estimated Costs

January 7, 2011



**GREELEY AND HANSEN**

# EPA's Watershed Model Land Use Data for Fairfax County

Sector	General Land Use	P533 Landuse / Source Designation	P53 Landuse /Source Name	2010 No Action	2009 Progress Run	Everything, Everywhere, by Everyone
Agricultural	Row	hwm	high-till with manure	348	87	0
		nhi	high-till with manure nutrient management	0	2	0
		hom	high-till without manure	147	96	0
		nho	high-till without manure nutrient management	0	33	134
		lwm	low-till with manure	0	182	0
		nlo	low-till with manure nutrient management	0	3	317
	Hay	hyw	hay with nutrients	863	503	0
		nhy	hay with nutrients nutrient management	0	282	835
		alf	alfalfa	32	34	0
		nal	alfalfa nutrient management	0	0	31
		hyo	hay without nutrients	107	547	140
	Pasture	pas	pasture	1,977	1,611	0
		npa	pasture nutrient management	0	258	1,912
		trp	pasture corridor	104	94	0
		afo	animal feeding operations	4	4	0
urs		nursery	7	7	0	
Urban Runoff	Pervious	puh	high-intensity pervious urban	16,234	16,111	25,116
		pul	low-intensity pervious urban	79,039	79,021	75,201
	Impervious	imh	high-intensity impervious urban	21,062	20,861	10,520
		iml	low-intensity impervious urban	12,898	12,892	10,830
	Bare Const	bar	bare-construction	1,544	1,544	0
	Extractive	ext	extractive	757	755	0
	CSO	css	combined sewer system	0	0	0
Forest	for	forest	115,946	116,147	127,205	
	hvf	harvested forest	1,171	1,173	0	
Wastewater	ps	wastewater	0	0	0	
Septic	septic	septic	0	0	0	
Air Dep	atdep	atmospheric deposition to non-tidal water	0	1,681	0	
<b>Total - Acres</b>				<b>252,240</b>	<b>253,928</b>	<b>252,240</b>
<b>Total - Square Miles</b>				<b>394.1</b>	<b>396.8</b>	<b>394.1</b>

Urban Stormwater

US Census Land Area  
395.04 Sq Mi

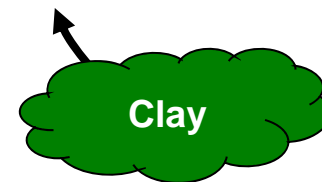
# EPA's Urban Stormwater Data is basis for Cost Estimates

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<b>P533 Landuse / Source Designation</b>	<b>P53 Landuse / Source Name</b>	<b>EPA Watershed Model Data for Fairfax County</b>
<b>pul</b>	<b>low-intensity pervious urban</b>	<b>16,234</b>
<b>iml</b>	<b>low-intensity impervious urban</b>	<b>79,039</b>
<b>puh</b>	<b>high-intensity pervious urban</b>	<b>21,062</b>
<b>imh</b>	<b>high-intensity impervious urban</b>	<b>12,898</b>
<b>bar</b>	<b>bare-construction</b>	<b>1,544</b>
<b>ext</b>	<b>extractive</b>	<b>757</b>
<b>css</b>	<b>combined sewer system</b>	<b>0</b>

# How much Rainfall Runs off the Watershed?

Type of Cover	Soil Type			
	Soil A	Soil B	Soil C	Soil D
	Infiltration Rate (in/hr)			
	1.00-8.30	0.50-1.00	0.17-0.27	0.02-0.10
Forest	2%	3%	4%	5%
Pervious	15%	20%	22%	25%
Impervious	95%	95%	95%	95%



# How much of each soil type is in Fairfax County?

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Community	Soil Type (based on NRCS Soil Data Mart)			
	Soil A	Soil B	Soil C	Soil D
	Infiltration Rate (in/hr)			
	1.00-8.30	0.50-1.00	0.17-0.27	0.02-0.10
Fairfax	0.2%	25.4%	12.3%	62.0%

# Estimate Runoff

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Community	Soil Type			
	Soil A	Soil B	Soil C	Soil D
	Infiltration Rate (in/hr)			
	1.00-8.30	0.50-1.00	0.17-0.27	0.02-0.10
Percent of Soil Type	0.2%	25.4%	12.3%	62.0%
Pervious Area	174	23,811	11,534	58,068
Pervious Runoff Coeff	15%	20%	22%	25%
Effective Runoff Area	26	4,762	2,537	14,517

# Land Use & BMP Assumptions

Land Use	Percent of Area	Bioretent #2	Urban Bioretent (Curbside Planters)	Dry Swale #2	Permeable Pavement #2	Infiltration Trench / Basin (For A&B Soil)	Filtera®	Filter Strip	Rain Garden, Rain Barrel, Planter
Right of Way	21.8%	5%	10%	5%		5%	5%	5%	
Municipal Owned Parking	1.1%	80%							
Municipal Owned Driveway	0.4%	10%			5%				
Municipal Owned Building	0.6%	60%							10%
Municipal Owned Pervious	1.6%	70%							
Townhouse, Apartment & Condominium Parking	3.7%	80%							
Residential Driveway	6.3%								
Residential Building	10.3%								10%
Residential Pervious	23.9%								10%
Commercial/Industrial Parking	14.5%	80%							
Commercial/Industrial Driveway	1.2%	10%			5%				
Commercial/Industrial Building	7.2%	60%							
Commercial/Industrial Pervious	7.4%	70%							

# Percent of Urban Land Treated by BMPs

Community	Bioretent #2	Urban Bioretent (Curbside Planters)	Dry Swale #2	Permeable Pavement #2	Infiltration Trench / Basin (For A&B Soil)	Filtera®	Filter Strip	Rain Garden, Rain Barrel, Planter	Total
Fairfax	27.6%	1.1%	1.1%	0.1%	1.1%	2.2%	1.1%	6.9%	41.1%

Coastal Areas or Class D Soils may limit land treated to about 20%

# CWP BMP Clearinghouse Efficiencies

BMP		RR	TP	TN	TSS
1. Vegetated Roof	1.a. Vegetated Roof #1 (Spec #5)	45%	45%	45%	73%
	1.b. Vegetated Roof #2 (Spec #5)	60%	60%	60%	80%
2. Rooftop Disconnection	2.a. Simple Disconnection to A/B Soils (Spec #1)	50%	50%	50%	75%
	2.b. Simple Disconnection to C/D Soils (Spec #1)	25%	25%	25%	63%
	2.c. To Soil Amended Filter Path as per specifications (existing C/D soils) (Spec #4)	50%	50%	50%	75%
	2.d. To Dry Well or French Drain #1 (Microinfiltration #1) (Spec #8)	50%	63%	58%	75%
	2.e. To Dry Well or French Drain #2 (Micro-Infiltration #2) (Spec #8)	90%	93%	92%	95%
	2.f. To Rain Garden #1 (Micro-Bioretenion #1) (Spec #9)	40%	55%	64%	70%
	2.g. To Rain Garden #2 (Micro-Bioretenion #2) (Spec #9)	80%	90%	92%	90%
	2.h. To Rainwater Harvesting (Spec #6)	75%	75%	75%	88%
	2.i. To Stormwater Planter (Urban Bioretention) (Spec #9, Appendix A)	40%	55%	64%	73%
	Composite for 2.g through 2.i.	65%	73%	77%	83%
3. Permeable Pavement	3.a. Permeable Pavement #1 (Spec #7)	45%	59%	59%	81%
	3.b. Permeable Pavement #2 (Spec #7)	75%	81%	81%	91%
4. Grass Channel	4.a. Grass Channel A/B Soils (Spec #3)	20%	32%	36%	44%
	4.b. Grass Channel C/D Soils (Spec #3)	10%	24%	28%	37%
	4.c. Grass Channel Compost Amended Soils as per specs (see Spec #4)	30%	41%	44%	51%
5. Dry Swale	5.a. Dry Swale #1 (Spec #10)	40%	52%	55%	64%
	5.b. Dry Swale #2 (Spec #10)	60%	76%	74%	76%
6. Bioretention	6.a. Bioretention #1 or Urban Bioretention (Spec #9)	40%	55%	64%	70%
	6.b. Bioretention #2 (Spec #9)	80%	90%	92%	90%
7. Infiltration	7.a. Infiltration #1 (Spec #8)	50%	63%	58%	75%
	7.b. Infiltration #2 (Spec #8)	90%	93%	92%	95%
8. Extended Detention Pond	8.a. ED #1 (Spec #15)	0%	15%	10%	50%
	8.b. ED #2 (Spec #15)	15%	28%	24%	58%
9. Sheetflow to Filter/Open Space	9.a. Sheetflow to Conservation Area with A/B Soils (Spec #2)	75%	75%	75%	75%
	9.b. Sheetflow to Conservation Area with C/D Soils (Spec #2)	50%	50%	50%	50%
	9.c. Sheetflow to Vegetated Filter Strip in A Soils or Compost Amended B/C/D Soils (Spec #2 & #4)	50%	50%	50%	75%
10. Wet Swale (Coastal Plain)	10.a. Wet Swale #1 (Spec #11)	0%	20%	20%	40%
	10.b. Wet Swale #2 (Spec #11)	0%	40%	20%	40%
11. Filtering Practices	11.a. Filtering Practice #1 (Spec #12)	0%	60%	20%	60%
	11.b. Filtering Practice #2 (Spec #12)	0%	65%	20%	60%
12. Constructed Wetland	12.a. Constructed Wetland #1 (Spec #13)	0%	50%	20%	50%
	12.b. Constructed Wetland #2 (Spec #13)	0%	75%	20%	50%
13. Wet Ponds	13.a. Wet Pond #1 (Spec #14)	0%	50%	20%	50%
	13.b. Wet Pond #1 (Coastal Plain) (Spec #14)	0%	45%	20%	50%
	13.c. Wet Pond #2 (Spec #14)	0%	75%	20%	50%
	13.d. Wet Pond #2 (Coastal Plain) (Spec #14)	0%	65%	20%	50%
14. Manufactured BMP	14.a. Bacteria/Filtrerra	0%	65%	45%	85%

# BMP Unit Costs

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- Typical Unit Cost for BMP:
  - \$/cf of volume treated
  - \$/sf of BMP surface area
- Normalize the Unit Cost to \$/acre

# Virginia Watershed Implementation Plan

## Table 2.2 - 2025 Phosphorus Allocations

**Table 2.2: VIRGINIA CHESAPEAKE BAY TMDL ALLOCATIONS - PHOSPHORUS - 2025 [Million Pounds/Year]**

Source Sector	Potomac	Rapp	York	James	E Shore	VA TOTAL
Agriculture	0.674	0.533	0.157	0.622	0.111	2.097
Urban Runoff <sup>1</sup>	0.273	0.094	0.090	0.528	0.009	0.994
Wastewater <sup>1</sup>	0.278	0.079	0.155	0.967	0.008	1.487
On-Site <sup>1</sup>	0	0	0	0	0	0
Forest	0.205	0.183	0.126	0.543	0.015	1.072
Non-Tidal Dep	0.008	0.007	0.009	0.030	0.002	0.056
Total	1.438	0.896	0.538	2.690	0.145	5.707
<b>Draft Allocations</b>	<del>1.472</del> <sup>2</sup> <b>1.439</b>	<b>0.900</b>	<b>0.540</b>	<b>2.340</b> <sup>4</sup>	<del>0.463</del> <sup>3</sup> <b>0.145</b>	<b>5.357</b> <sup>4</sup>

1 Allocations for these source sectors can be attained through expansion of the VA Nutrient Credit Exchange Program

2 For Potomac Basin, a portion of the TP allocation is transferred to the TN allocation using 1:5 ratio [removed 34,000 lbs/yr from TP]

3 For E Shore, a portion of the TP allocation is transferred to the TN allocations using 1:5 ratio [removed 18,139 lbs/yr from TP]

4 Refer to James River Strategy section of the WIP for Virginia's approach to conform with EPA's draft July 1 TMDL allocations by 2025; 0.35 MPY will be included in the TMDL as an aggregated allocation for reduction in the wastewater sector; adjustments will be made, as warranted, in 2017 following completion of scientific review of chlorophyll standards

# Loads and Percent Reductions for E3, Tributary Strategy, & Virginia WIP

Constituent	Urban Runoff for Potomac Watershed - Delivered							
	2010 No Action	Everything, Everywhere, by Everyone		Tributary Strategy		Virginia November 29, 2010 Watershed Implementation Plan		
	Load (lbs/yr)	Load (lbs/yr)	% Reduction	Load (lbs/yr)	% Reduction	Load (lbs/yr)	% Reduction	% of E3
Total Nitrogen	3,010,322	988,279	67.2%	2,285,583	24.1%	2,635,000	12.5%	18.6%
Total Phosphorus	323,503	70,984	78.1%	261,601	19.1%	273,000	15.6%	20.0%
Sediment	240,644,068	22,659,626	90.6%	177,162,941	26.4%			

# Virginia Watershed Implementation Plan

## Table 6-4.1 – Net Reductions

**Table 6-4.1 Urban / Suburban Stormwater Scoping Scenario Level 2 Effective Net Reductions Using Phase 5.3 Land Loads**

Existing Non-federal Urban Lands

Land Use Category	Practice Description	Level 2 Practice % Coverage	Effective Net Reduction Prorated Over Entire Land Use Category Acreage		
			Total Nitrogen	Total Phosphorus	Sediment
Impervious Urban High and Low Intensity	Impervious Cover Reduction	7.5%	0%	5%	6%
	Filtration Practices	7.5%	3%	4%	6%
	Infiltration Practices	8.0%	6%	7%	8%
	<b>Total</b>		<b>9%</b>	<b>16%</b>	<b>20%</b>
Pervious Urban High and Low Intensity	Impervious Cover Reduction	-			
	Filtration Practices	5%	2%	3%	4%
	Infiltration Practices	5%	4%	4.25%	4.75%
	<b>Total</b>		<b>6%</b>	<b>7.25%</b>	<b>8.75%</b>

Nutrient Reduction Efficiencies:

Impervious Cover Reduction: 2% N, 65% P, 85% Sediment (based on differences in Phase 5.3 Watershed Model no BMP loads for pervious/impervious average Virginia loads)

Filtration Practices: 40% N, 60% P, 85% Sediment

Infiltration Practices: 80% N, 85% P, 95% Sediment

# Total Phosphorus Percent Reductions

Segment	Total Phosphorus Percent Reductions					
	EPA Backstop <sup>(1)</sup>		Tributary Strategy		November 29, 2010 Virginia WIP	
	Average Phosphorus BMP Performance	Phosphorus Reduction to meet TMDL WLA in Appendix Q-1	<u>With</u> Non-Structural BMPs	<u>Without</u> Non-Structural BMPs	WIP Table 6-4.1 <u>With</u> Non-Structural BMPs	WIP Table 2.2 <u>Without</u> Non-Structural BMPs
Eastern Shore	28.4%	44.2%	15.8%	35.7%	12.0%	26.5%
James River	36.1%	54.5%	18.4%	31.2%	12.0%	20.6%
<b>Potomac River</b>	<b>36.3%</b>	<b>55.6%</b>	<b>19.3%</b>	<b>28.6%</b>	<b>12.1%</b>	<b>15.6%</b>
Rapp River	32.9%	58.4%	25.5%	29.6%	11.5%	19.0%
York River	34.0%	59.0%	25.0%	27.6%	11.5%	24.0%
<b>Virginia</b>	<b>35.7%</b>	<b>55.4%</b>	<b>19.7%</b>	<b>29.9%</b>	<b>12.0%</b>	<b>19.5%</b>

Notes: (1) EPA's TMDL Report indicated a 50% retrofit of regulated urban areas and 25% retrofit of unregulated urban areas.

# Fairfax County Urban Stormwater Costs associated with Chesapeake Bay TMDL

Category	Row	Item	Virginia WIP Assumptions in Table 6-4.1 <sup>(1)</sup>	Reductions to Meet WLA in WIP Table 2.2 (Without Non-Structural BMPs)
Estimated Costs	A	Estimated Capital Cost (Millions)	\$651	\$845
	B	Estimated Annual Cost (Millions per year)	\$70	\$91
Estimated Average Annual Stormwater Bills	C	Residential House (\$/yr)	\$160	\$200
	D	Convenience Store/ Gas Station (\$/yr)	\$1,400	\$1,800
	E	Neighborhood Shopping Center (\$/yr)	\$9,600	\$12,000
	F	Church (\$/yr)	\$3,200	\$4,000
	G	Regional Mall (\$/yr)	\$145,000	\$181,000
Census Households & Population	H	2009 Household Estimate	384,242	384,242
	I	2009 Population Estimate	1,037,605	1,037,605
	J	Total Annual Fee Per Household <sup>(2)</sup> (\$/yr) (Row "B" / Row "H")	\$180	\$240
	K	Total Annual Fee Per Person <sup>(2)</sup> (\$/yr) (Row "B" / Row "I")	\$70	\$90
Financial Burden	L	2009 Medium Household Income Estimate	\$104,158	\$104,158
	M	Residential House Stormwater Fee as Percentage of MHI (Row "C" / Row "L")	0.2%	0.2%
	N	Total Household Stormwater Fee <sup>(2)</sup> as Percentage of MHI (Row "J" / Row "L")	0.2%	0.2%

Note: (1) Include performance of urban nutrient management  
(2) Simulates stormwater costs passed on to consumer by retail stores, gas stations, etc.

# Potomac Watershed Urban Stormwater Costs associated with Chesapeake Bay TMDL

Category	Row	Item	Virginia WIP Assumptions in Table 6-4.1 <sup>(1)</sup>	Reductions to Meet WLA in WIP Table 2.2 (Without Non-Structural BMPs)
Estimated Costs	A	Estimated Capital Cost (Millions)	\$2,101	\$2,712
	B	Estimated Annual Cost (Millions per year)	\$225	\$291
Estimated Average Annual Stormwater Bills	C	Residential House (\$/yr)	\$150	\$200
	D	Convenience Store/ Gas Station (\$/yr)	\$1,400	\$1,800
	E	Neighborhood Shopping Center (\$/yr)	\$9,200	\$11,900
	F	Church (\$/yr)	\$3,100	\$4,000
	G	Regional Mall (\$/yr)	\$139,500	\$180,300
Census Households & Population	H	2009 Household Estimate	1,087,812	1,087,812
	I	2009 Population Estimate	2,875,480	2,875,480
	J	Total Annual Fee Per Household <sup>(2)</sup> (\$/yr) (Row "B" / Row "H")	\$210	\$270
	K	Total Annual Fee Per Person <sup>(2)</sup> (\$/yr) (Row "B" / Row "I")	\$80	\$100
Financial Burden	L	2009 Medium Household Income Estimate	\$65,245	\$65,245
	M	Residential House Stormwater Fee as Percentage of MHI (Row "C" / Row "L")	0.2%	0.3%
	N	Total Household Stormwater Fee <sup>(2)</sup> as Percentage of MHI (Row "J" / Row "L")	0.3%	0.4%

Note: (1) Include performance of urban nutrient management  
(2) Simulates stormwater costs passed on to consumer by retail stores, gas stations, etc.

# Virginia Urban Stormwater Costs associated with Chesapeake Bay TMDL

Category	Row	Item	Virginia WIP Assumptions in Table 6-4.1 <sup>(1)</sup>	Reductions to Meet WLA in WIP Table 2.2 (Without Non-Structural BMPs)
Estimated Costs	A	Estimated Capital Cost (Millions)	\$5,151	\$8,710
	B	Estimated Annual Cost (Millions per year)	\$552	\$934
Estimated Average Annual Stormwater Bills	C	Residential House (\$/yr)	\$160	\$300
	D	Convenience Store/ Gas Station (\$/yr)	\$1,400	\$2,600
	E	Neighborhood Shopping Center (\$/yr)	\$9,600	\$17,100
	F	Church (\$/yr)	\$3,200	\$5,700
	G	Regional Mall (\$/yr)	\$145,100	\$259,100
Census Households & Population	H	2009 Household Estimate	2,663,652	2,663,652
	I	2009 Population Estimate	6,881,351	6,881,351
	J	Total Annual Fee Per Household <sup>(2)</sup> (\$/yr) (Row "B" / Row "H")	\$210	\$350
	K	Total Annual Fee Per Person <sup>(2)</sup> (\$/yr) (Row "B" / Row "I")	\$80	\$140
Financial Burden	L	2009 Medium Household Income Estimate	\$59,985	\$59,985
	M	Residential House Stormwater Fee as Percentage of MHI (Row "C" / Row "L")	0.3%	0.5%
	N	Total Household Stormwater Fee <sup>(2)</sup> as Percentage of MHI (Row "J" / Row "L")	0.4%	0.6%

Note: (1) Include performance of urban nutrient management  
(2) Simulates stormwater costs passed on to consumer by retail stores, gas stations, etc.

# Closing Thoughts

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- Estimated costs are based on EPA's Watershed Model, which contains incorrect Land Use Data (i.e. costs may be low)
- Estimated costs do not include land acquisition costs
- Retrofit costs are about 2 to 3 times more expensive than new construction (redevelopment cheaper)
- Implementation schedule too short