

## **Appendix G**

### Concept-Level Stormwater Calculations



**BWI****ESD Computations for****BWI Service Station**

**Total LOD =** 121,968 s.f. = 2.80 ac. \*Existing Impervious area of parcel

**Existing impervious area in LOD=** 121,968 s.f. 2.80 ac.  
**%Existing impervious area in LOD=** 100% **4,828**

Pavement Removal = 0 s.f = 0.00 ac.  
 New Pavement = 0 s.f = 0.00 ac.  
 Net= 0 s.f = 0.00 ac.

Redevelopment Area Requiring ESD = 60,984 s.f = **1.40 ac.**  
 (50% of existing impervious area in LOD)

New Development for ESD = 0 s.f = 0.00 ac.  
 (Net increase/decrease in impervious area)  
 0.00%

**A. Compute ESDv1 for Redevelopment**

**Target Pe = 1.00** inch for Redevelopment

$$Qe1 = Pe \times Rv$$

$$Rv = 0.05 + .009 \times \%I$$

$$Rv = 0.05 + .009 \times \mathbf{100\%} \quad \mathbf{FOR REDEVELOPMENT}$$

$$Rv = 0.95000$$

$$Qe1 = 1 \times 0.95$$

$$Qe1 = 0.95$$

$$ESDv1 = \frac{(Pe)(Rv)(A)}{12} = \frac{0 \quad (1)(0.95)(60984)}{12}$$

**ESDv1** 0.00% 4,828 c.f.  
**ESDv1** = **0.11 ac-ft**

**B. Compute ESDv2 for New Development**

New Development = 0 s.f. = 0.00 ac.

**C. Compute ESDv Total**

$$ESDv \text{ Total} = ESDv1 + ESDv2$$

$$ESDV \text{ Total} = 4827.9 \text{ c.f.} + 0 \text{ c.f.} =$$

$$ESDV \text{ Total} = \mathbf{4,828} \text{ c.f.} \quad \mathbf{0.11} \text{ ac-ft}$$

BWI

ESD Computations for

BWI Service Station

Table 5.3 Rainfall Targets/Runoff Curve Number Reductions used for ESD

Hydrologic Soil Group A										
%I	RCN*	P <sub>s</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	40									
5%	43									
10%	46									
15%	48	38								
20%	51	40	38	38						
25%	54	41	40	39						
30%	57	42	41	39	38					
35%	60	44	42	40	39					
40%	61	44	42	40	39					
45%	66	48	46	41	40					
50%	69	51	48	42	41	38				
55%	72	54	50	42	41	39				
60%	74	57	52	44	42	40	38			
65%	77	61	55	47	44	42	40			
70%	80	66	61	55	50	45	40			
75%	84	71	67	62	56	48	40			
80%	86	73	70	65	60	52	44	40		
85%	89	77	74	70	65	58	49	42	39	
90%	92	81	78	74	70	65	58	48	42	38
95%	95	85	82	78	75	70	65	57	50	39
100%	98	89	86	83	80	76	72	66	59	40

Hydrologic Soil Group B										
%I	RCN*	P <sub>s</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	61									
5%	63									
10%	65									
15%	67	55								
20%	68	60	55	55						
25%	70	64	61	58						
30%	72	65	62	59	55					
35%	74	66	63	60	56					
40%	75	66	63	60	56					
45%	78	68	66	62	58					
50%	80	70	67	64	60					
55%	81	71	68	65	61	55				
60%	83	73	70	67	63	58				
65%	85	75	72	69	65	60	55			
70%	87	77	74	71	67	62	57			
75%	89	79	76	73	69	65	59			
80%	91	81	78	75	71	66	61			
85%	92	82	79	76	72	67	62	55		
90%	94	84	81	78	74	70	65	59	55	
95%	96	87	84	81	77	73	68	63	57	
100%	98	89	86	83	80	76	72	66	59	55

C<sub>p</sub> Addressed (RCN = Woods in Good Condition)  
 RCN Applied to C<sub>p</sub> Calculations

Table 5.3 Runoff Curve Number Reductions used for Environmental Site Design (continued)

Hydrologic Soil Group C										
%I	RCN*	P <sub>s</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	74									
5%	75									
10%	76									
15%	78									
20%	79	70								
25%	80	72	70	70						
30%	81	73	72	71						
35%	82	74	73	72	70					
40%	84	77	75	73	71					
45%	85	78	76	74	71					
50%	86	78	76	74	71					
55%	86	78	76	74	71	70				
60%	88	80	78	76	73	71				
65%	90	82	80	77	75	72				
70%	91	82	80	78	75	72				
75%	92	83	81	79	75	72				
80%	93	84	82	79	76	72				
85%	94	85	82	79	76	72				
90%	95	86	83	80	77	73	70			
95%	97	88	85	82	79	75	71			
100%	98	89	86	83	80	76	72	70		

Hydrologic Soil Group D										
%I	RCN*	P <sub>s</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	80									
5%	81									
10%	82									
15%	83									
20%	84	77								
25%	85	78								
30%	85	78	77	77						
35%	86	79	78	78						
40%	87	82	81	79	77					
45%	88	82	81	79	78					
50%	89	83	82	80	78					
55%	90	84	82	80	78					
60%	91	85	83	81	78					
65%	92	85	83	81	78					
70%	93	86	84	81	78					
75%	94	86	84	81	78					
80%	94	86	84	82	79					
85%	95	86	84	82	79					
90%	96	87	84	82	79	77				
95%	97	88	85	82	80	78				
100%	98	89	86	83	80	76	72	70		

C<sub>p</sub> Addressed (RCN = Woods in Good Condition)  
 RCN Applied to C<sub>p</sub> Calculations

**BWI**

**ESD Computations for BWI Service Station  
PRELIMINARY DRAINAGE AREA INFO**

TOTAL DRAINAGE AREA	121,968	SF	
TARGET PE	1.00	IN. FOR REDEVELOPMENT	
	N/A	IN. FOR NEW DEVELOPMENT	
			121,968
ESDv	4,828	CF	

DRAINAGE AREA (DA)	IMPERVIOUS AREA (SF)	LANDSCAPED AREA (SF)	APPROX % SITE	TARGET ESDv (CF)
1	121,968	0	100%	4828
<b>TOTAL</b>	<b>121,968</b>	<b>0</b>	<b>100%</b>	<b>4828</b>

<b>% IMPERVIOUS</b>	<b>100%</b>
<b>RV</b>	<b>0.950</b>

BWI

ESD Computations for  
Site Development Summary

BWI Service Station

DA-1

Drainage Area	121968	Dimensions	Area Treated (SF)	2.8
DA-1				
			121968	0
			ESDv Req'd (CF)	4,828

121968 < ESDv Req'd (CF)  
ESD GOAL HAS NOT BEEN MET - DETERMINE  
STRUCTURAL BMP VOLUME REQUIRED

$$P_e = \frac{12 \times \text{ESDv}}{R_v \times A} = \frac{12 \times 0}{0.95 \times 121968} = 0.00$$

RCN (TABLE 5.3)	=	89		
S	=	(1000/RCN) - 10	1.24	1.4
P1	=	2.7	IN	1-YR STORM
Qe =		$\frac{(P1 - 0.2 S)^2}{(P1 + 0.8 S)}$	$\frac{(2.7 - 0.2 \times 1.24)^2}{(2.7 + 0.8 \times 1.24)}$	$\frac{6.02}{3.69} = 1.631$ IN
V =		$\frac{Q_e \times A}{12}$	$\frac{1.631 \times 121968}{12}$	16577 CF

REDUCED RCN (TABLE 5.3)	=	77		
S	=	(1000/RCN) - 10	2.99	
P1	=	2.7	IN	1-YR STORM
Qe =		$\frac{(P1 - 0.2 S)^2}{(P1 + 0.8 S)}$	$\frac{(2.7 - 0.2 \times 2.99)^2}{(2.7 + 0.8 \times 2.99)}$	$\frac{4.42}{5.09} = 0.869$ IN
V =		$\frac{Q_e \times A}{12}$	$\frac{0.869 \times 121968}{12}$	8829 CF

STRUCTURAL PRACTICE VOLUME REQUIRED = 7749 cf

BWI

ESD Computations for

BWI Service Station

Table 5.3 Rainfall Targets/Runoff Curve Number Reductions used for ESD

Hydrologic Soil Group A										
%I	RCN <sup>a</sup>	P <sub>a</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	40									
5%	43									
10%	46									
15%	48	38								
20%	51	40	38	38						
25%	54	41	40	39						
30%	57	42	41	39	38					
35%	60	44	42	40	39					
40%	61	44	42	40	39					
45%	66	48	46	41	40					
50%	69	51	48	42	41	38				
55%	72	54	50	42	41	39	38			
60%	74	57	52	44	42	40	38			
65%	77	61	55	47	44	42	40			
70%	80	66	61	55	50	45	40			
75%	84	71	67	62	56	48	40	38		
80%	86	73	70	65	60	52	44	40		
85%	89	77	74	70	65	59	49	42	38	
90%	92	81	78	74	70	65	58	48	42	38
95%	95	85	82	78	75	70	65	57	50	39
100%	98	89	86	83	80	76	72	66	59	40

Table 5.3 Runoff Curve Number Reductions used for Environmental Site Design (continued)

Hydrologic Soil Group C										
%I	RCN <sup>a</sup>	P <sub>a</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	74									
5%	75									
10%	76									
15%	78									
20%	79	70								
25%	80	72	70	70						
30%	81	73	72	71						
35%	82	74	73	72	70					
40%	84	77	75	73	71					
45%	85	78	76	74	71					
50%	85	78	76	74	71					
55%	85	78	76	74	71	70				
60%	88	80	78	76	73	71				
65%	90	82	80	77	75	72				
70%	91	82	80	78	75	72				
75%	92	83	81	79	75	72				
80%	93	84	82	79	76	72				
85%	94	85	82	79	76	72				
90%	95	86	83	80	77	73	70			
95%	97	88	85	82	79	75	71			
100%	98	89	86	83	80	76	72	70		

Hydrologic Soil Group B										
%I	RCN <sup>a</sup>	P <sub>a</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	81									
5%	83									
10%	85									
15%	87	55								
20%	88	55	55							
25%	90	56	55	55						
30%	92	57	56	55	55					
35%	94	58	57	56	55					
40%	96	60	59	58	56					
45%	98	62	60	59	57					
50%	99	63	61	60	58					
55%	99	63	61	60	58					
60%	99	63	61	60	58					
65%	99	63	61	60	58					
70%	99	63	61	60	58					
75%	99	63	61	60	58					
80%	99	63	61	60	58					
85%	99	63	61	60	58					
90%	99	63	61	60	58					
95%	99	63	61	60	58					
100%	99	63	61	60	58					

Hydrologic Soil Group D										
%I	RCN <sup>a</sup>	P <sub>a</sub> = 1"	1.2"	1.4"	1.6"	1.8"	2.0"	2.2"	2.4"	2.6"
0%	80									
5%	81									
10%	82									
15%	83									
20%	84									
25%	85	77								
30%	85	77	77	77						
35%	86	78	78	78						
40%	87	81	79	77						
45%	88	82	81	79	78					
50%	89	83	82	80	78					
55%	90	84	82	80	78					
60%	91	85	83	81	78					
65%	92	85	83	81	78					
70%	93	86	84	81	78					
75%	94	86	84	81	78					
80%	94	86	84	82	79					
85%	95	86	84	82	79					
90%	95	87	84	82	79	77				
95%	97	88	85	82	80	78				
100%	98	89	86	83	80	78	77			

C<sub>p</sub> Addressed (RCN = Woods in Good Condition)  
 RCN Applied to C<sub>p</sub> Calculations

C<sub>p</sub> Addressed (RCN = Woods in Good Condition)  
 RCN Applied to C<sub>p</sub> Calculations

A SOIL	REDUCED	CN=		DA=	0.00	AC	
B SOIL	REDUCED	CN=	0	DA=	0.00	AC	CN CUMULATIVE
C SOIL	REDUCED	CN=	0	DA=	0.00	AC	89.0
D SOIL	REDUCED	CN=	89	DA=	2.80	AC	
					2.80	AC	

**BWI  
ESD Computations for  
STRUCTURAL PRACTICES**

**BWI Service Station**

**Underground Sand Filter**

*MDE Design Manual, Chapter 3 - Filtering Treatment Criteria (p.3.39)*

*Sand filter bed minimum depth of 12"*

\*Must treat a minimum of 1st 1" of runoff for 50% of redeveloped area (121,968 sf) or 7,749 cf \*Structural Volume requirement

*Design UG Sand Filter to collect runoff from Service Station Parcel*

<b>Impervious A TOTAL to UG Sand Filter</b>	=	121,968	<b>sf</b>
WQv = A * Pe * Rv /12	=	9,656	<b>cf</b>

**Required filter bed area,  $A_f = (WQ_v) * (d_f) / [(k) * (h_f + d_f) * (t_f)]$**

WQ <sub>v</sub> = water quality volume	=	9,656	<b>ft<sup>3</sup></b>	> <b>7,749 cf WQv requirement</b>
d <sub>f</sub> = filter bed depth	=	1.5	<b>0</b>	* assume 18" depth
k = coeff. Of permeability of filter media	=	3.5	<b>ft/day</b>	*k for sand = 3.5
h <sub>f</sub> = avg. height of water above filter bed	=	1	<b>ft</b>	
t <sub>f</sub> = design filter bed drain time	=	1.5	<b>days</b>	*1.67 days recommended max. for sand filters
A <sub>f</sub> = surface area of filter bed	=	<b>1,104</b>	<b>ft<sup>2</sup></b>	*Estimate ~2,500 ft <sup>2</sup> for surface area of entire underground system, including potential sedimentation and overflow chambers.
Rv	=	<b>0.95</b>		
Total Sand Filter Pe	=	WQ Volume x 12 / Rv / A	=	9655.8 x 12 / 0.95 / 121968
<b>Total Sand Filter Pe Provided</b>	=	<b>1.00</b>	<b>in.</b>	