

Table of Contents

Chapter 1: Introduction to the Manual

1.0	Introduction	1.1
1.1	Why Stormwater Matters: Impact of Runoff on Maryland's Watersheds	1.2
1.1.1	Declining Water Quality	1.4
1.1.2	Diminishing Groundwater Recharge and Quality	1.5
1.1.3	Degradation of Stream Channels	1.7
1.1.4	Increased Overbank Flooding	1.9
1.1.5	Floodplain Expansion	1.11
1.2	Managing the Stormwater Impacts of Land Development - What's New	1.13
1.2.1	Precipitation and Design Storms	1.13
1.3	General Performance Standards for Stormwater Management in Maryland	1.19
1.4	Symbols and Acronyms	1.22

Chapter 2: Stormwater Management Criteria and Environmental Site Design

2.0	Stormwater Management Criteria and Environmental Site Design	2.1
2.1	Computing SWM Requirements	2.2
2.1.1	Computing WQ_v , Rev, and Cp_v	2.4
2.1.2	Weighted Direct Runoff Depth for Computing WQ_v and Cp_v	2.5
2.2	Water Quality Volume (WQ_v)	2.7
2.2.1	Determining the Water Quality Treatment and WQ_v	2.8
2.3	Recharge Volume (Rev)	2.12
2.3.1	Determining Recharge Volume	2.13
2.4	Channel Protection Volume (Cp_v)	2.15
2.4.1	Determining Channel Protection Volume	2.16
2.4.2	Designing ESD practices to Manage Cp_v	2.18
2.4.3	Designing Structural BMPs to Manage Cp_v	2.19
2.5	Overbank Flood Protection (q_p)	2.20
2.5.1	Standards for Determining Overbank Flood Protection	2.20
2.6	Extreme Flood Protection (q_f)	2.23
2.6.1	Standards for Determining Extreme Flood Protection Criteria	2.23
2.7	Environmental Site Design	2.25
2.7.1	ESD to the Maximum Extent Practicable Standard	2.26
2.7.2	Elements for ESD Planning Techniques	2.26
2.8	Redevelopment	2.32
2.8.1	Redevelopment Policy	2.32
2.9	Summary	2.34

Chapter 3: Introduction to the Manual

3.0	Stormwater BMP Design	3.1
3.0.1	ESD Practices	3.1

3.0.2	Structural Practices	3.2
3.0.3	Applicability and Limitations of BMPs for Managing Design Criteria	3.2
3.0.4	General Performance Criteria for Stormwater Practices	3.7
3.0.5	Chapter Outline.....	3.8
3.1	Environmental Site Design Practices.....	3.10
3.1.1	Non-structural Practices.....	3.11
3.1.2	Alternative Surfaces.....	3.22
3.1.3	Micro-Scale Practices	3.36
3.1.4	Open Channel Practices	3.78
3.2	Structural Practices	3.98
3.2.1	Stormwater Ponds	3.99
3.2.2	Stormwater Wetlands.....	3.114
3.2.3	Stormwater Infiltration.....	3.121
3.2.4	Stormwater Filtering Practices.....	3.131

Chapter 4: Selecting the Best BMP at a Development Site

4.0	Selecting the Best BMP at a Development Site.....	4.1
4.1	Physical Feasibility Factors	4.1
4.2	Watershed Factors.....	4.4
4.2.1	Cold Water Resource Areas (Use III & IV).....	4.5
4.2.2	Wellhead Protection.....	4.7
4.2.3	Reservoir Protection (Use I-P, III-P and IV-P).....	4.7
4.2.4	Tier II Watersheds.....	4.7
4.2.5	Maryland Critical Area Intensely Developed Areas.	4.8
4.2.6	FEMA Floodplains.....	4.8
4.3	Terrain Factors	4.10
4.4	Permitting Factors.....	4.13
4.5	Hot Spots.....	4.14

Appendix.....

References.....

List of Tables

Title	Page
Table 1.1 Typical Pollutant Concentrations Found in Stormwater Runoff	1.5
Table 1.2 Estimates of Annual Recharge Rates Based on NRCS Soil Type.....	1.6
Table 1.3 Summary of New Stormwater Management Criteria	1.18
Table 1.4 Key Symbols and Acronyms Cited in Manual	1.22
Table 2.1 Statewide Stormwater Management Criteria.....	2.1
Table 2.2 Rainfall Depths (P) for Design Storms in Maryland	2.3
Table 2.3 Direct Runoff Depth (Q) for Selected CNs and Rainfall Depth (P)	2.6
Table 2.4 Effective Impervious Area Treated.....	2.11
Table 2.5 Stormwater Management Requirements for New Development and Redevelopment	2.35
Table 2.6 BMP Type, BMP Sizing, and Provided Management Calculations	2.36
Table 3.1 Applicability and Limitations of BMPs for Managing Design Criteria	3.3
Table 3.2 ESD Practices and Their Function.....	3.5
Table 3.3 Structural Practices and Their Function.....	3.6
Table 3.4 Summary of Design Elements for Rooftop and Non-rooftop Disconnection and Sheetflow to Conservation Area Credits.....	3.21
Table 3.5 Portion of Permeable Pavement Area Disconnection.....	3.25
Table 3.6 Post Development CNs.....	3.26
Table 3.7 Portion of Reinforced Turf Area Disconnection.....	3.29
Table 3.8 Post Development CN for Reinforced Turf.....	3.30
Table 3.9 Summary of Design Elements for Reinforced Turf.....	3.31
Table 3.10 Summary of Design Elements for Rain Gardens.....	3.40
Table 3.11 Summary of Design Elements for Infiltration Berms.....	3.44
Table 3.12 Summary of Design Elements for Micro-Bioretenion Facilities	3.54
Table 3.13 Summary of Design Elements for Landscape Infiltration Practices.....	3.61
Table 3.14 Summary of Design Elements for Dry Wells	3.67
Table 3.15 Summary of Design Elements for Pocket Submerged Gravel Wetland	3.75
Table 3.16 Summary of Design Elements for Grass Swales	3.83
Table 3.17 Summary of Design Elements for Bioswales	3.89
Table 3.18 Summary of Design Elements for Wet Swales.....	3.96
Table 3.19 Summary of Design Elements for Wet Ponds	3.106
Table 3.20 Summary of Design Elements for Dry Ponds.....	3.108
Table 3.21 Summary of Design Elements for Stormwater Wetland Ponds.....	3.117
Table 3.22 Summary of Design Elements for Infiltration Trench	3.125
Table 3.23 Summary of Design Elements for Infiltration Basin	3.127
Table 3.24 Summary of Design Elements for Sand Filters	3.138
Table 3.25 Summary of Design Elements for Bioretention Facilities	3.145
Table 3.26 Summary of Design Elements for Submerged Gravel Wetland	3.150
Table 4.1 BMP Selection - Physical Feasibility Factors.....	4.3
Table 4.2 Solar Reflectance Indices (SRI) for Typical Paving & Roofing Materials	4.7

Table 4.3 BMP Selection - Watershed Factors	4.9
Table 4.4 BMP Selection - Terrain Factors	4.12
Table 4.5 Permits to Consider.....	4.13
Table 4.6 Classification of Stormwater Hotspots	4.14

List of Figures

Title	Page
Figure 1.1 Water Balance at a Developed and Undeveloped Site	1.3
Figure 1.2 Decline in Stream Flow Due to Diminished Groundwater Recharge	1.7
Figure 1.3 Increased Frequency of Erosive Flows in a Stream Channel After Development	1.8
Figure 1.4 Change in Hydrograph following Development	1.10
Figure 1.5 Change in Floodplain Elevations.....	1.12
Figure 2.1 Location of the Western and Central/Eastern Rainfall Zones in Maryland for Determining the Water Quality Storm.....	2.2
Figure 2.2 NOAA Atlas 14 Rainfall Distribution Map for Maryland	2.22
Figure 3.1 Disconnection of Rooftop Runoff	3.14
Figure 3.2 Non-Rooftop Disconnection.....	3.17
Figure 3.3 Sheetflow to Conservation Areas	3.20
Figure 3.4 Examples of Permeable Pavements.....	3.27
Figure 3.5 Typical Green Roof.....	3.35
Figure 3.6 Rain Garden.....	3.41
Figure 3.7 Infiltration Berm.....	3.45
Figure 3.8 Rain Barrels	3.48
Figure 3.9 Micro-Bioretenction	3.56
Figure 3.10 Landscape Infiltration.....	3.63
Figure 3.11 Dry Well	3.68
Figure 3.12 Pocket Submerged Gravel Wetland.....	3.77
Figure 3.13 Bioswale	3.91
Figure 3.14 Wet Swale.....	3.97
Figure 3.15 Wet Extended Detention Pond	3.110
Figure 3.16 Wet Pond	3.111
Figure 3.17 Micro Topography for Multiple Cells	3.112
Figure 3.18 Dry Detention Pond.....	3.113
Figure 3.19 Shallow Wetland	3.119
Figure 3.20 Extended Detention Shallow Wetland.....	3.120
Figure 3.21 Infiltration Trench.....	3.129
Figure 3.22 Infiltration Basin.....	3.130
Figure 3.23 Surface Sand Filter	3.140
Figure 3.24 Perimeter Sand Filter	3.141
Figure 3.25 Underground Sand Filter	3.142
Figure 3.26 Bioretention	3.147
Figure 3.27 Submerged Gravel Wetland	3.151
Figure 3.28 Cistern.....	3.155
Figure 4.1 Map of Maryland Showing Key Terrain Factors	4.11