Table of Contents

Introduction.....1

Chapter 1

1.1 Fact Sheets and Selection Guidance.....5

Bioretention System Fact Sheet.....6

Wet Pond Fact Sheet.....7

Water Quality Wetland Fact Sheet.....8

Green Roofs Fact Sheet.....9

Vegetated Swale Fact Sheet.....10

Porous Pavement Fact Sheet.....11

Dry Pond Fact Sheet.....12

Infiltration Trench Fact Sheet.....13

Surface Sand Filter Fact Sheet.....14

Filter Strip Fact Sheet.....15

Oil Grit/Separator Fact Sheet.....16

Catch Basin Insert Fact Sheet.....17

1.2 Selecting the Best BMPs for Stormwater Treatment.....18
Step 1 Stormwater Treatment Suitability Matrix.....18
Step 2 Physical Feasibility Factors Matrix.....20
Step 3 Community and Environmental Factors Matrix.....21

Treatment BMP Selection Flow Chart.....23

Chapter 2

Bioretention Fact Sheet.....25

A. General Description.....26

B. Components....26
Pretreatment....26
Flow entrance....26
Ponding zone/area....26
Plant material....26
Mulch layer....27
Planting soil layer....27
Overflow structure....27
Gravel and perforated pipe underdrain system....27

C. Variations and Applications....31

D. Pollution Reduction Capabilities and Mechanisms....32
Volume Reduction Capabilities....32
Pollutant Removal Capabilities....32
Pollutant Removal Mechanisms....32

E. Planning and Design criteria....35
Design and Site Considerations....35
Landscaping Bioretention Areas....37

F. Construction Specifications....38
Temporary Erosion Control....38
Excavation, Backfill and Grading....38
Native Plants, Planting and Transplanting....39
Construction Sequence Scheduling....39
Construction Observation....39

G. Operation and Maintenance Requirements....39
Design Phase Maintenance Considerations....40
Construction Phase Maintenance....40
Post-construction Operation and Maintenance....40
Sample Inspection and Maintenance Provisions....41

H. Construction and Maintenance Costs....45

I. Design Procedure....46
Step 1 Make a preliminary judgment....46
Step 2 Confirm design criteria and applicability....46
Step 3 Perform field verification of site suitability....47
Step 4 Compute runoff control volumes....47
Step 5 Determine Bioretention Type and Size Practice....48
Step 6 Size outlet structure and/or flow diversion structure, if needed....48
Step 7 Perform ground water mounding analysis....48
Step 8 Determine pre-treatment volume and design pre-treatment measures....48
Step 9 Check volume, peak discharge rates and period of inundation....49

Step 10 Determine pre-treatment volume and design pre-treatment measures.....49
Step 11 Check volume, peak discharge rates and period of inundation.....50
Step 12 Prepare Vegetation and Landscaping Plan.....50
Step 13 Prepare Operations and Maintenance (O&M) Plan.....50
Step 14 Prepare Cost Estimate.....50

Appendix 1.....51

Appendix 2.....53

Appendix 3.....55

Chapter 3

Stormwater Ponds Fact Sheet.....57

A. General Description.....58

B. Components.....58
Sediment forebay…….....58
Permanent pool (dead storage)…….....58
Live storage…….....58
Spillway system…….....58

C. Variations and Applications.....63

D. Pollution Reduction Capabilities and Mechanisms…….....64
Volume Reduction Capabilities.....64
Pollutant Removal Capabilities.....65
Pollutant Removal Mechanisms.....65

E. Planning and Design criteria.....65
Design and Site Considerations.....65
Landscaping Bioretention Areas.....68

F. Construction Specifications.....73
Excavation…….....73
Subsoil Preparation…….....73
Planting Soil (Topsoil)…….....73
Vegetation…….....73
Outlet Control Structure.....74

G. Operation and Maintenance Requirements.....74
Commom Maintenance Issues…….....74
Sample Inspection and Maintenance Provisions.....75

H. Construction and Maintenance Costs.....78

I. Design Procedure.....79
Wet Pond……..……..79
Step 1 Compute the Water Quality Volume.....79
Step 2 Determine if the development site and conditions are appropriate for the use of wet pond…….....79
Step 3 Determine pretreatment volume…….....79
Step 4 Determine permanent pool volume.....80
Step 5 Determine pond preliminary geometry and storage available for pool areas…….....80
Step 6 Size the outlet system for other storm events..…….....80
Step 7 Design embankment and spillway.....80
Step 8 Investigate potential dam hazard classification…….…….....80
Step 9 Design Inlets, sediment forebays, outlet structure, maintenance access and safety features…….…….....80
Step 10 Prepare the vegetation and landscaping plan…..…….....80

Wet Extended Detention (ED) pond……..……..……..80
Step 1 Compute the Water Quality Volume.....81
Step 2 Determine if the development site and conditions are appropriate for the use of wet ED pond….…….....81
Step 3 Determine pretreatment volume…….....81
Step 4 Determine permanent pool volume.....81
Step 5 Determine pond preliminary geometry and storage available for pool areas…….....81
Step 6 Compute extended detention orifice release rate(s)…….....81
Step 7 Size the primary spillway system for other storm events.…..……83
Step 8 Design embankment and spillway.....83
Step 9 Investigate potential dam hazard classification…….…….....83
Step 10 Design Inlets, sediment forebays, outlet structure, maintenance access and safety features…….…….....83
Step 11 Prepare the vegetation and landscaping plan…..…….....83

Micropool ED Pond……...……..……..……..83
Step 1 Compute the Water Quality Volume.....83
Step 2 Determine if the development site and conditions are appropriate for the use of wet pond…….....83
Step 3 Determine pretreatment volume…….....83
Step 4 Determine permanent pool volume.....83
Step 5 Determine pond preliminary geometry and storage available for pool areas…….....83
Step 6 Compute extended detention orifice release rate(s)…….....83
Step 7 Size the outlet system for other storm events..…….....83
Step 8 Design embankment and spillway.....83
Step 9 Investigate potential dam hazard classification…….…….....83

Step 10 Design Inlets, sediment forebays, outlet structure, maintenance access and safety features……..…….....83
Step 11 Prepare the vegetation and landscaping plan…..…….....83

Chapter 4

Stormwater Wetland Fact Sheet.....85

A. General Description.....86

B. Components.....86
Deepwater zone…….....86
Low marsh zone.....86
High marsh zone…....…….....86
Semi-wet zone……..…….....86

C. Variations and Applications.....93

D. Pollution Reduction Capabilities and Mechanisms…….....94
Volume Reduction Capabilities.....94
Pollutant Removal Capabilities.....94
Pollutant Removal Mechanisms.....95

E. Planning and Design criteria.....95
Design and Site Considerations.....95
Landscaping Bioretention Areas.....98

F. Construction Specifications.....99
Excavation…….....99
Subsoil Preparation…….....99
Impermeable Liner…….....99
Planting Soil (Topsoil)…….....99
Vegetation…….....99
Outlet Control Structure.....99

G. Operation and Maintenance Requirements.....100
Commom Maintenace Issues…….....100
Sample Inspection and Maintenance Provisions.....102

H. Construction and Maintenance Costs.....103

I. Design Procedure.....104

Step 1 Compute the Water Quality Volume.....104

Step 2 Determine if the development site and conditions are appropriate for the constructed wetland.....104

Step 3 Confirm design criteria and applicability to site.....105

Step 4 Determine pretreatment volume.....105

Step 5 Allocate the WQv amon marsh, micropool, and ED volumes.....105

Step 6 Determine wetland location and preliminary geometry, including distribution of wetland depth zones…….....105

Step 7 Compute extended detention orifice release rate(s) and size(s), and establish WQv elevation…….....105

Step 8 Calculate 100-year storm release rate and water surface elevation…....106

Step 9 Design embankments(s) and spillway(s)…….....106

Step 10 Design safe design velocity for on-line systems……..….....106

Step 11 Investigate potential pond/wetland hazard classification…….....106

Step 12 Design inlets, sediment forebay(s), outlet structures, maintenance access, and safety features.....106

Step 13 Prepare Vegetation and Landscaping Plan…….....106

Chapter 5

Vegetated Swales Fact Sheet.....107

A. General Description.....108

B. Components.....108
Open trapezoidal or parabolic channel sized to store entire WQV….....108
Filter bed of permeable, engineered soil…….....108
Underdrain system for impermeable soils (dry swale only).....108
Level spreaders every 50 feet, if length exceeds 100 feet..…….....108

C. Variations and Applications.....112

D. Pollution Reduction Capabilities and Mechanisms…….....113
Volume Reduction Capabilities.....113
Pollutant Removal Capabilities.....113
Pollutant Removal Mechanisms.....113

E. Planning and Design criteria.....114
Design and Site Considerations.....114

F. Construction Specifications.....116
Swale soil…….....116
Swale sand…….....116
Check dams…….....116

G. Operation and Maintenance Requirements.....116
Common Maintenance Issues…….....116
Sample Inspection and Maintenance Provisions.....137

H. Construction and Maintenance Costs.....119

I. Design Procedure.....119
Step 1 Compute Water Quality Volume.....119
Step 2 Determine if development site and conditions are appropriate for the use of enhanced swale system (dry or wet swale).....119
Step 3 Determine pretreatment volume.....119
Step 4 Determine swale dimensions.....119
Step 5 Compute number of check dams or similar structures required to detain WQ_v.....121
Step 6 Calculate drawdown time in the swale.....121
Step 7 Check 2-year velocity erosion potential and provide 6 inches of freeboard above 10-year storm..... 121
Step 8 Design low flow orifice at downstream headwalls and checkdam…….....121

Chapter 6

Porous Pavement Fact Sheet.....123

A. General Description.....124

B. Components.....124
Open graded pavement mix or pavers with open surfaces.....124
Settling layer.....124
Open-graded base material…….....124
Filter fabric…..…….....124
Bottom filter layer…..…….....124
Underlying soil……..…….....124

C. Variations and Applications.....125

D. Pollution Reduction Capabilities and Mechanisms…….....127
Volume Reduction Capabilities.....127

Pollutant Removal Capabilities.....127
Pollutant Removal Mechanisms.....127

E. Planning and Design criteria.....128
Design and Site Considerations.....128

F. Construction Specifications.....129
Stone…….....129
Non-Woven Geotextile…….....130
Pipe…….....130
Storm Drain Inlets and Structure.....130
Pervious Bituminous Asphalt.....130
Pervious Concrete…….....131

G. Operation and Maintenance Requirements.....132
Common Maintenance Issues…….....132
Sample Inspection and Maintenance Provisions.....133

H. Construction and Maintenance Costs.....134

I. Design Procedure.....134
Step 1 Confirm Concept Design and Treatment Performance.....134
Step 2 Pretreatment Design…….....134
Step 3 Determine Design Flows…….....134
Step 4 Size Porous Paving System…….....135
Step 5 Underdrainage Design and Check…….....137
Step 6 Check Emptying Time…….....138
Step 7 Check Requirement for Impermeable Lining.....138
Step 8 Specify Porous Paving Layers Elements…….....138
Step 9 Size Overflow Pit/Pipe…….....139

Chapter 7

Green Roofs Fact Sheet.....141

A. General Description.....142

B. Components.....142
Structural roof support sufficient to hold greenroof weight.....142
Waterproof membrane appropriate for greenroof…….....142
Root barrier, if not integral to membrane….....142
Drainage layer…….....142
Filter fabric between the drainage layer and the growing medium…….....142
Growing medium…….....142
Vegetation…….....143

C. Variations and Applications.....145

D. Pollution Reduction Capabilities and Mechanisms…….....146
Volume Reduction Capabilities.....146
Pollutant Removal Capabilities.....146
Pollutant Removal Mechanisms.....146

E. Planning and Design criteria.....148
Design and Site Considerations.....148

F. Construction Specifications.....149
Root-barriers…….....150
Granular drainage media…….....150
Growth media…….....150
Separation fabric…….....151

G. Operation and Maintenance Requirements.....151
Commom Maintenance Issues…….....151
Sample Inspection and Maintenance Provisions.....152

H. Construction and Maintenance Costs.....152

I. Design Procedure.....153
Step 1 Investigate the feasibility of the installation of a green roof.....153
Step 2 Determine the portion of roof that will have a green roof.....153
Step 3 Extensive green roofs that have an engineered media at least 3 inches thick are permitted a DCIA reduction equal to the entire area of the green roof…..153
Step 4 The green roof is not considered impervious area when determining whether a redevelopment project has reduced DCIA by 20%.....153
Step 5 The area of the green roof is not included in the calculation of the Water Quality Volume…….....153
Step 6 The area of the green roof is not included in the calculation of the Channel Protection Volume.....153
Step 7 The green roof area can be considered pervious open space in good condition with moderate soils when determining post-development flow rates for the Flood Control Requirement…….....153
Step 8 Although green roofs are not considered as impervious surfaces when determining stormwater management requirements, they are not zero discharge systems…….....153
Step 9 Green roofs with a media thickness less than 3 inches can only be considered pervious if the designer can demonstrate that the initial abstraction of the green roof will be 0.5 inches or greater…….....153
Step 10 Develop planting plan based on the thickness of the planting media.....153
Step 11 Complete construction plans and specifications.....153