

Chapter I. Introduction to the Manual

What's in This Chapter

Section 1.1 provides an overview of the general stormwater management approach for Municipal Separate Storm Sewer Systems (MS4s).

Section 1.2 addresses the purpose of the Manual and its intended audiences, with reference to the MS4 General Permit.

Section 1.3 outlines the stormwater management criteria in the MS4 General Permit and the sections of the Manual that provide more detailed guidance on meeting these criteria.

Section 1.4 explains how the MS4 General Permit intersects with other regulatory drivers for site design and stormwater management.

Section 1.5 directs the user to parts of the Manual that outline the design methodology for the various Best Management Practices (BMPs) that can be used to comply with the standards in the MS4 General Permit.

Section 1.6 points to the detailed design guidance for BMPs contained in the Manual, and includes a pictorial explanation for the BMPs.

Section 1.7 includes a table with a brief overview of each chapter and appendix of the Manual.

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1.1. Stormwater Management Approach in West Virginia

The urbanization of the landscape creates an increase in the volumes, rates and duration of runoff-related discharges, along with a corresponding increase in pollutant loadings. The traditional design approach to managing these impacts has been based on the peak rate of discharge to control downstream flooding. Unfortunately, this approach ignores the increased frequency, volume, and duration of discharges among other changes in the hydrologic response of the contributing watershed, and fails to protect the physical, chemical and biological characteristics of receiving waters.

There is now a large body of research demonstrating that BMPs that are designed to infiltrate, evapotranspire, and capture and use stormwater (referred to as runoff reduction techniques) serve to mimic the way natural vegetated landscapes respond to precipitation events. This approach is simultaneously advantageous for protecting the physical, chemical and biological characteristics of receiving waters.

As a result, the West Virginia stormwater management approach establishes runoff volume control as the treatment objective for new development and redevelopment projects. This Manual provides detailed information on how to design sites and stormwater practices to meet this treatment objective.

For more information on West Virginia's stormwater approach, readers are referred to the MS4 General Permit referenced below and associated fact sheet.

<http://www.dep.wv.gov/WWE/Programs/stormwater/MS4/Pages/default.aspx>

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1.2. Purpose and Audiences for the Manual

The primary purpose of this Manual is as a design resource to accompany the MS4 General Permit for stormwater discharges (Permit No. WV0116025). The MS4 General Permit specifies elements of a stormwater management program that must be developed by the local jurisdictions that have been determined by population and/or population density to be owners or operators of an MS4. Following federal discharge permit regulations, the MS4 General Permit contains six “Minimum Measures” that must be included in a local stormwater management program. These Minimum Measures include:

1. Public Education and Outreach
2. Public Involvement and Participation
3. Illicit Discharge Detection and Elimination
4. Controlling Runoff from Construction Sites
5. Controlling Runoff from New Development and Redevelopment (once construction is complete)
6. Pollution Prevention and Good Housekeeping for Municipal Operations

This Manual primarily provides guidance and technical support for Minimum Measure #5: Controlling Runoff from New Development and Redevelopment. The target audiences for the Manual include:

1. Local officials and administrators in designated MS4 communities that must comply with this Minimum Measure.
2. Other localities or entities in West Virginia that choose to develop a stormwater management program or implement stormwater BMPs to protect aquatic resources.
3. Designers, consultants or other individuals or companies that engage in regulated new and/or redevelopment activities.
4. Others interested in stormwater management technical criteria (e.g., businesses, state agency staff, watershed groups, citizens).

Table 1.1 includes suggestions on the Manual sections that may be of particular interest to different types of users. This is not meant to be definitive, as many users will find the Manual content useful for particular purposes.

Table I.1. Suggestions for How Various Parties Can Use the Manual¹

MS4 Program Manager	Utilize Chapters 2 and 3 to understand the MS4 General Permit requirements and range of available stormwater BMPs. It is important for program managers to understand all 6 of the Minimum Measures in the MS4 General Permit; therefore, other resources should be used to supplement this Manual. Appendix H is relevant for MS4s that discharge to impaired waters.
MS4 Plan Reviewer (may be same as program manager)	Utilize Chapter 3 to understand the BMP selection process and the specifications in Chapter 4 and checklists in Appendix A to help review plans.
Design Professional/ Consultant	Similar to plan reviewers; the specifications in Chapter 4 are particularly geared to help designers with the proper design of BMPs. Designers may find the design examples in Chapter 6 to be particularly useful. Designers and developers should also become familiar with the site design information in Chapter 2 and Chapter 4 (Specification 4.1), as these are an important means to achieve site compliance.
West Virginia Department of Environmental Protection (WVDEP) Staff	The Manual allows WVDEP to gauge how certain BMP features translate to performance toward achieving the one-inch volume reduction standard. The Manual is a major outreach and technical assistance tool to MS4s and can also be helpful for program reviews.
Currently Non-Regulated Local Government or other Entity (e.g., university, prison, wastewater treatment plant)	Chapter 2 provides a framework for setting up a local program. The individual specifications in Chapter 4 provide an a-la-carte menu for the design of BMPs at any site in West Virginia.
Interested Businesses, Watershed Groups, Citizens, and other Stakeholders	The Manual allows WVDEP to gauge how certain BMP features translate to performance toward achieving the one-inch volume reduction standard. The Manual is a major outreach and technical assistance tool to MS4s and can also be helpful for program reviews.

¹These are suggested uses for various parties, but not exhaustive, as many types of users will find various sections of the Manual to be helpful for particular purposes.

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1.3. Stormwater Criteria in the MS4 General Permit, Minimum Measure #5

Controlling runoff from new and redevelopment sites is required at sites that disturb one acre or greater of land in a designated MS4 community. Minimum Measure #5 is a comprehensive standard that protects water quality, as mandated by the federal Clean Water Act, by addressing stormwater runoff with two distinct criteria:

1. Watershed Protection Elements
2. Site and Neighborhood Design Elements

1. Watershed Protection Elements represent a series of criteria that serve to influence site design decisions so as to minimize the impact of the land development process on the natural landscape and receiving waters. The intent of the Watershed Protection Elements is to change and adapt local development codes (e.g., zoning and subdivision ordinances) to reduce stormwater impacts “by design.”

- **Chapter 2, Section 2.1** provides a brief overview of the Watershed Protection Elements.
- **Chapter 4, Specification 4.1** outlines several “better site design” practices that can be used at the site scale and also authorized in local development codes.

2. Site and Neighborhood Design Elements address specific stormwater management criteria that apply to new development and redevelopment sites. For any given site, these criteria will result in one or more permanent stormwater BMPs located and designed within the developed landscape that serve to reduce stormwater runoff volume and pollutant loads through infiltration, evapotranspiration, reuse, extended filtration, and other means.

- **Chapter 2, Section 2.1** provides a very brief introduction to the general design objectives of these practices.
- **Chapter 4, Specifications 4.2.1 through 4.2.11** provide detailed guidance on the performance and design criteria for each practice.

Figure 1.1 below provides an introductory pictorial for these practices.

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1.4. Other Regulatory Drivers That Influence Site Design and Stormwater Management

It is important to acknowledge that, for many sites, there are overlapping regulations at the local, state, and federal levels. In addition to controlling runoff, new and redevelopment projects may have to comply with other requirements related to stormwater, such as floodplains, wetlands, natural streams, and dam safety, among others. Any new or redevelopment project that disturbs one acre or more of land will also be required to obtain coverage under the Construction Stormwater General Permit that provides the details for controlling soil erosion and sedimentation (among other construction related control measures) during the construction process.

While the Manual makes reference to the flood control aspects of stormwater management for larger storms, this is not its intended purpose. In West Virginia, flood control (sometimes referred to as “stormwater detention”) remains the purview of local government codes, ordinances, and policies. As such, it should be understood that the practices in this manual will not be a panacea for existing flooding and drainage problems in West Virginia communities. The practices can certainly help with these issues, when they are used in conjunction with other stormwater control and floodplain management measures.

For MS4s, the manual is not intended to supersede existing procedures and policies for the review of site, drainage, or infrastructure plans. The manual can complement existing procedures by specifying the types of practices that can be used to comply with Minimum Measure #5.

- **Chapter 2, Section 2.2** contains an overview of how the MS4 General Permit intersects with other regulatory programs and drivers. MS4 managers, plan reviewers, and design professionals should all be cognizant of the array of programs that may affect a particular site.

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1.5. Understanding BMP Selection and Design Methodology

Once all the requirements for the new or redevelopment project have been determined, the designer must establish the layout and select the appropriate BMPs that fit the physical characteristics of the site and meet the permit requirements.

The standards and practices described in the Manual (and introduced in Figure 1.1) apply to relatively small storm events (generally one-inch of rainfall or less), because these are the high frequency storms that have the most profound implications for water quality. Therefore, the practices tend to fit into the development infrastructure and may require careful consideration of the limiting design elements such as depth, volume, and long term maintenance.

- **Chapter 3** explains the design methodology and selection criteria for the practices as well as the basis for the sizing (design storms) that will influence the selection of one practice over another. The chapter also references to Design Compliance Spreadsheet, which is a tool for selecting and sizing practices as well as gauging compliance with the performance standards in the MS4 General Permit.

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1.6. Detailed Design Guidance for the BMPs

The selection and design of the Watershed Protection Elements and the Site and Neighborhood Design Elements require the designer to be familiar with the minimum design elements and features that influence performance.

- **Chapter 4, Specification 4.1** provides a detailed and practical guide to implementing “better site design” practices. These practices can be used at the site scale and also support implementation of the Watershed Protection Elements
- **Chapter 4, Specifications 4.2.1 through 4.2.11** provide detailed guidance on the performance and design criteria for the BMPs for compliance with the Site and Neighborhood Design Elements. **Figure 1.1** provides an overview of the practices.

Figure I.1. Overview of Stormwater Best Management Practices (BMPs) With Reference to Design Specifications in Chapter 4

Vegetated Filter Strips (Specification 4.2.1)



Vegetated Filter Strips are areas that manage runoff from adjacent developed areas by slowing the runoff and allowing sediment and attached pollutants to settle out, filtering runoff through the vegetation, and infiltrating into the existing or amended soils.

- Applies to small commercial and residential impervious areas.
- Critical design elements include maximum allowable contributing impervious area, slope, and minimum dimensions.

Sheet Flow to Conservation Area (Specification 4.2.1)



Conservation Areas are the “natural” alternative to Vegetated Filter Strips, and consist of areas of natural vegetation (e.g., forest, meadow) that receive runoff as sheetflow from adjacent developed areas. Conservation Areas are often adjacent to streams or natural features, and should be protected with easements or other legal instruments to ensure that they function as a natural buffer system. As opposed to Vegetated Filter Strips, Conservation Areas are outside the limits of disturbance and are not graded.

- Applies to residential and commercial drainage areas.
- Critical design elements include maximum allowable contributing drainage area, slope, minimum dimensions, and long-term management of vegetation.

Simple Impervious Surface Disconnection (Specification 4.2.2)



Simple Impervious Disconnection is a landscape practice that directs runoff from rooftops and other small areas of impervious surface to adjacent pervious areas as sheet flow.

- Small-scale (as compared to filter strips) and intended for residential or small commercial areas;
- Critical design elements include maximum allowable drainage area, slope, and minimum dimensions

Impervious Disconnection with Alternative Practices (Specification 4.2.2)



Alternative Practices are utilized when there is insufficient room to establish sheet flow or meet other Simple Impervious Disconnection criteria (see above).

- Alternative Practices include Soil Amendments, Residential Rain Gardens, Rainwater Harvesting, Stormwater Planters, and Infiltration.
- Effectiveness is based on the same performance mechanisms as the individual practices (covered separately in more detail below).
- Critical design elements include the volume and depth of incorporation of soil amendments, and design elements of the alternative practice

Bioretention (Specification 4.2.3)



Credit: Beckley Sanitary Board

Bioretention is a landscaped practice that uses plants, mulch, and soil to treat runoff. Commonly used in parking lot islands and edges and as part of commercial site plans.

- Can be designed as an infiltration practice or an extended filtration practice (with an underdrain).
- Critical design elements include surface ponding volume, soil media depth, and underdrain. Includes several design variations.

Permeable Pavement (Specification 4.2.4)

Permeable Paving materials include concrete, asphalt, and interlocking pavers that allow runoff to filter through voids into a gravel storage reservoir.

- Can be designed as an infiltration practice, extended filtration practice (with an underdrain and stone sump), or a filtering practice (underdrain without sump).
- Critical design elements include structural load capacity for traffic, surface slope, and limiting the size of the “external” drainage area (adjacent impervious that “runs onto” the permeable pavement).

Grass Swale (Specification 4.2.5)

Grass Swales are designed as conveyance systems with enhanced design features to also provide a level of stormwater treatment and retention.

- Designs can be cost effective when used in place of curb & gutter, pipes, and other conveyance systems.
- Design features include maximum allowable longitudinal slope (or the use of check dams), maximum velocity and depth of flow, large storm conveyance, and trapezoidal cross-section geometry.

Infiltration (Specification 4.2.6)

Infiltration practices utilize temporary surface or underground storage to allow incoming stormwater runoff to infiltrate into underlying soils. Runoff first passes through multiple pretreatment mechanisms to trap sediment and organic matter before it reaches the practice.

- Can be designed as basin, trench, or small-scale practice
- Key design features include runoff pre-treatment, soil permeability testing, and subsoil conditions – such as groundwater. Strict limitations on use at hotspots or Brownfields.

Regenerative Stormwater Conveyance (RSC) System (Specification 4.2.7)



Source: Biohabitats, Inc.

The RSC System is an open-channel conveyance structure that encourages surface flow to transition to shallow groundwater flow through a series of step-pools and riffles and an underlying sand/mulch bed. Can be adapted for moderately steep slopes.

- Can be used to retrofit existing degraded outfalls or for new development in some cases.
- Critical design features include storage volume and peak flow design of riffles and pools, adequate energy dissipation and anchoring system, hydraulic design for large storms, and tying into existing stream channels.

Rainwater Harvesting (Specification 4.2.8)



Rainwater Harvesting systems provide for the capture, storage, and release of rainwater for future beneficial use, either inside or outside the building. Systems usually capture rooftop runoff. Storage tanks can be a variety of materials and either above ground or underground.

- Ideal for sites with a beneficial use of the water, such as irrigation, toilet flushing, cooling towers, vehicle washing, etc.
- Benefits include reducing use of potable water for irrigation and other outdoor uses, flushing, etc.
- Design elements include establishing a reliable water budget and pretreatment.

Vegetated Roofs (Specification 4.2.9)



Credit: WVDEP

Vegetated Roofs are an alternative roof surface that typically consists of waterproofing and drainage materials and an engineered growing media that is designed to support plant growth.

- Captures and temporarily stores stormwater within the growing media.
- Provides significant life-cycle cost benefits to the building and the environment beyond the stormwater reduction.

Filtration Practices (Specification 4.2.10)

Filtration Practices can be designed as either surface or subsurface systems, and utilize a variety of filter media types (e.g., sand, organic filters). Filters are not considered a runoff reduction practice, but can be used to target stormwater hotspot runoff or areas where specific pollutants must be removed.

- Includes a pretreatment separation chamber to remove particulates and oils, and can effectively target hotspot pollutants.
- Design features include sizing of the pretreatment and filter bed components to prolong the operational life, and adequate maintenance access.

Constructed Stormwater Wetland (Specification 4.2.11)

Constructed Stormwater Wetlands are shallow vegetated depressions with multiple cells of varying depths. Stormwater wetlands are not considered a runoff reduction practice, but can be used for water quality treatment and, in some cases, to meet stormwater detention requirements.

- Design typically includes multiple cells: a pretreatment forebay, an outlet micro-pool, and at least one or two additional cells separated by a submerged weir or overflow.
- Design features include the number of cells and corresponding pool volume, depth zones, maximum allowable storm ponding depth, and vegetation plan.

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I.7. Overview of Manual Content

Table I.2 provides a quick overview of the content of each chapter and appendix of this Manual.

Table I.2. Content of the West Virginia Stormwater Management and Design Guidance Manual

Chapter	Description
Chapter 1: Introduction	Basic introduction to the purpose, scope, and content of the Manual
Chapter 2: West Virginia Stormwater Management Regulations	An overview of Minimum Measure #5, other state and federal permits and programs that intersect with stormwater, and a generalized compliance procedure for MS4s and design consultants to follow
Chapter 3: Best Management Practice Selection and Design Methodology	Review of the treatment objectives, performance goals, and capabilities for stormwater BMPs. Includes screening factors to select appropriate BMPs for a site. Outlines the Runoff Reduction Method and use of the Design Compliance Spreadsheet.
Chapter 4: Stormwater BMP Specifications	Detailed specifications for 11 BMPs. These include BMP descriptions, feasibility, sizing, design, materials, construction and maintenance.
Chapter 5: Stormwater Hotspots (land uses or operations that have a higher risk for discharging stormwater pollutants)	Overview of potential stormwater hotspots land uses, BMP design considerations, and checklist to be used by plan reviewers and designers when potential hotspots are involved.
Chapter 6: Design Examples	Illustrates several design examples of applying the method and using various BMPs to achieve the one-inch capture requirement.
Appendix A: Plan Review, Construction, and Maintenance Checklists	Templates for checklists to be used by plan reviewers and designers during all phases of the BMP life-cycle.
Appendix B: Infiltration Testing Guidance	Guidance for conducting field infiltration testing for BMPs designed to infiltrate water. Also includes U.S. Environmental Protection Agency guidance on when BMPs would be considered as Class V Injection Wells requiring an Underground Injection Control permit from WVDEP.

Chapter	Description
Appendix C: Geotechnical Testing Guidelines for Karst Areas	Recommended approach for field testing to ascertain the suitability of certain BMPs in karst.
Appendix D: Soil Amendments	Specifications for soil amendments that can boost the performance of various BMPs.
Appendix E: Determining Peak Flow Rate for One Inch of Rainfall	Guidance on determining the peak flow for one inch of rainfall for the purposes of designing and sizing flow diversions, BMP inlets, and other flow control elements of certain BMPs.
Appendix F: BMP Landscaping & Plant Lists	General guidance on landscaping BMPs and specific plant lists for bioretention, stormwater wetlands, and BMPs in general.
Appendix G: Resources for Design of Wet and Dry Ponds	Wet and dry pond specifications are not included in the Manual because of their limited runoff reduction capabilities. This appendix provides some design resources for those wishing to design ponds to meet local stormwater detention requirements or as part of an overall BMP strategy.
Appendix H: Considerations for Impaired Waters	Guidance for when an MS4 and/or designer should consider impaired waters and/or a TMDL for new development and redevelopment projects.