Stormwater BMPs for Vegetative Biofilters

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Module 1: Introduction

Learning Objectives

By the end of this section, you will be able to:

- **Identify** the specific roles and applications of vegetative biofilters within the context of the three-volume stormwater BMP guidance series.
- **Categorize** the five distinct types of vegetative biofilter BMPs used for urban stormwater management.
- **Outline** the major design, analytical, and maintenance considerations required for successful biofilter implementation.

Executive Summary: Vegetative biofilters have evolved from simple conveyance tools into sophisticated multi-functional BMPs. They serve as critical components in the "treatment train" approach, addressing groundwater recharge, water quality, and peak discharge control for urban runoff.

Scope of the Manual

This manual serves as Volume 2 of a comprehensive three-volume set dedicated to the design of **Best Management Practices (BMPs)**. While Volume 1 covers general design considerations and Volume 3 focuses on Pond BMPs, this volume provides specialized technical guidelines for **vegetative biofilters**.

Evolution of Vegetative Biofilters

Historically, vegetative biofilters like grass swales were utilized primarily for **stormwater conveyance**. However, modern engineering practices, driven by the **Clean Water Act (CWA)**, now utilize these systems to meet a broad range of design objectives:

- **Impact Reduction:** Mitigating the environmental effects of urban runoff on receiving waters.
- **Groundwater Recharge:** Promoting infiltration to replenish local aquifers.
- **Water Quality Control:** Removing pollutants through filtration and biological uptake.
- **Stream Channel Protection:** Managing flow to prevent downstream erosion.
- **Peak Discharge Control:** Managing both small-frequency (6-month/1-year) and large-frequency (2- to 100-year) storm events.

Primary BMP Classifications

Engineers can select from three primary categories of vegetative biofilters, which expand into five specific BMP types:

1. **Grass Swales:**
    - Traditional Grass Swales
    - Grass Swales with a Media Filter
    - Wet Swales
2. **Vegetated Filter Strips (VFS)**
3. **Bioretention Cells**

💡 **Design Tip:** Biofilters are most effective when applied as the **first stage of a treatment train**, specifically targeting groundwater recharge and water quality for small headwater areas.

Manual Roadmap and Design Framework

The technical content of this manual is organized to facilitate the complete design lifecycle of a biofilter project:

General Design Considerations (Section 3)

- Establishing **design flow volumes** and rates.
- Implementing **flow regulation** and **pretreatment** to protect system integrity.
- Selecting appropriate **filter media** and **vegetation**.
- Planning for long-term **inspection and maintenance**.

Analytical Procedures (Section 4)

- Computing **runoff volumes** and loading calculations for sediment and nutrients.

System-Specific Guidelines (Sections 5, 6, and 7)

- **Section 5 (VFS):** Analysis of factors affecting performance, such as soil infiltration, topography, and depth to water table.
- **Section 6 (Grass Swales):** Engineering parameters including **peak flow rate**, **slope**, **velocity**, and the use of enhancements like **check dams**.

- **Section 7 (Bioretention):** Detailed components including shallow ponding areas, mulch layers, and underdrain systems.

⚠️ **Safety Constraint:** Proper site stabilization and erosion control must be maintained to prevent the premature clogging of biofilter media during and after construction.

Checkpoint Quiz

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1. **Which of the following is considered a variation of the Grass Swale BMP?**
   a) Vegetated Filter Strip
   b) Wet Swale
   c) Bioretention Cell
   d) Detention Pond

Answer: (b). The manual identifies three variations of grass swales: traditional, media filter, and wet swales.

2. **In a "treatment train" approach, vegetative biofilters are typically utilized for which primary purpose?**
   a) Final stage polishing for large regional basins
   b) Primary structural support for embankments
   c) First stage treatment for groundwater recharge and water quality
   d) Exclusive management of 100-year storm events

Answer: (c). Biofilters are most commonly used as the first stage of the treatment train to address small headwater areas.

3. **According to the manual, what has driven the transition of biofilters from simple conveyance to water quality management tools?**
   a) The invention of synthetic filter media
   b) The passage of the Clean Water Act (CWA)
   c) A decrease in urban runoff volumes
   d) The obsolescence of Pond BMPs

Answer: (b). The CWA shifted the focus toward the water quality management of urban runoff.

Module 2: Vegetated Biofilter Types

Learning Objectives

By the end of this section, you will be able to:

- **Differentiate** between the five types of vegetated biofilters based on their physical components and pollutant removal mechanisms.
- **Evaluate** the specific site conditions that warrant the selection of a dry swale, wet swale, or bioretention cell.
- **Identify** the design requirements for creating overland sheet flow in Vegetative Filter Strip (VFS) applications.

Executive Summary: Vegetated biofilters are categorized into three primary types—grass swales, filter strips, and bioretention cells—each offering unique mechanisms for peak discharge reduction, infiltration, and phytoremediation. Selecting the correct type depends on whether the design intent is conveyance (traditional swales), extended filtration (dry swales), or biological processing (bioretention).

Grass Swales

Traditionally used as low-cost conveyance practices (grated waterways) in low-to-medium density residential areas, grass swales have evolved into critical water quality elements. Public works standards often allow these within the public right of way.

Key Engineering Attributes

- **Velocity Reduction:** Slower flow velocities compared to piped systems increase the **time of concentration**, reducing peak discharges.
- **Hydrologic Disconnection:** They "disconnect" impervious surfaces like driveways and roads, effectively reducing the **Runoff Curve Number (CN)**.
- **Pollutant Mitigation:** Achieved through mechanical filtering by grass media and **phytoremediation** (pollutant uptake by roots).
- **Infiltration:** Reduces runoff volume by promoting percolation into the soil profile.

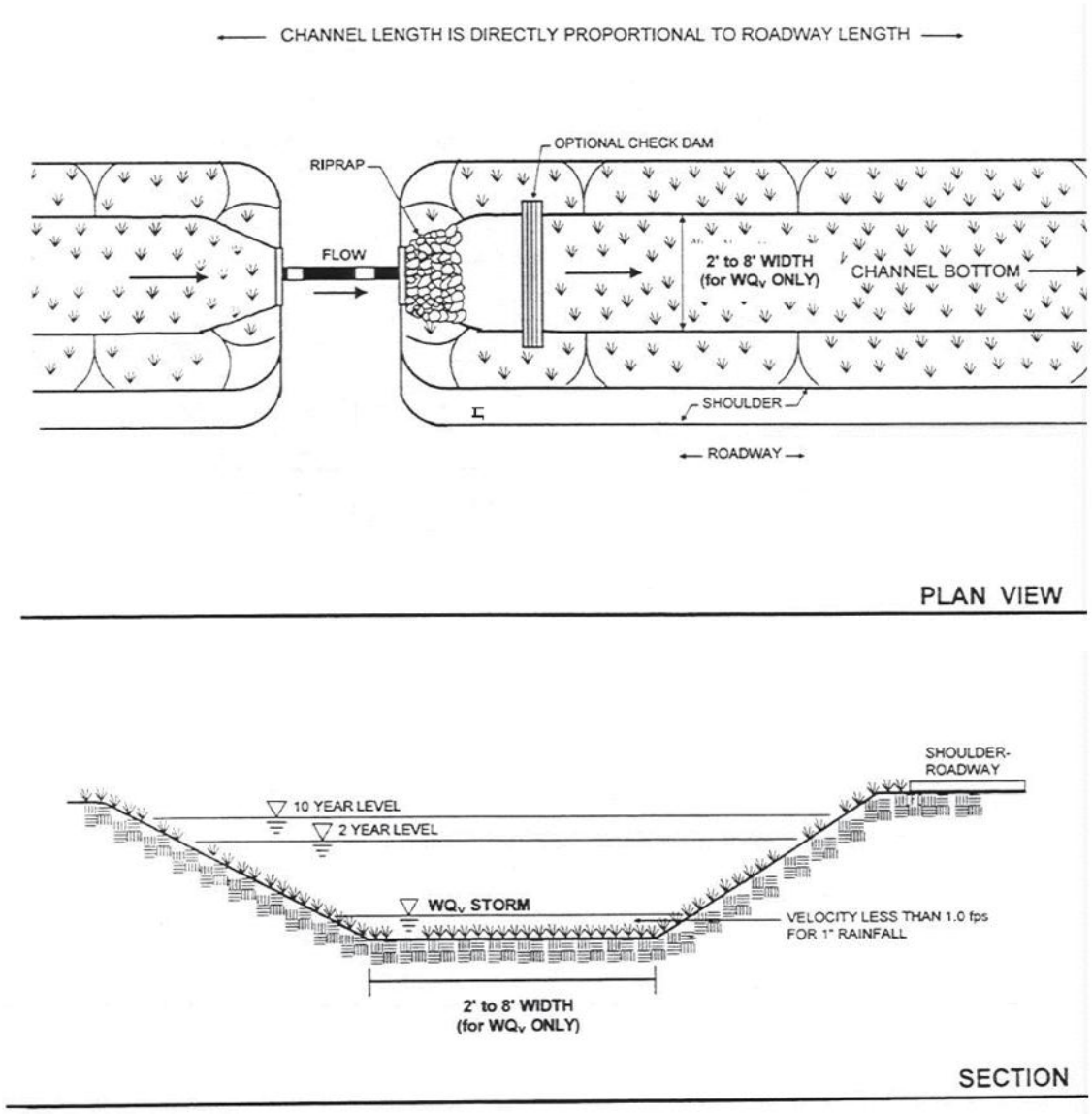

Figure 2-1: Grass Swale (MDE, 2000)

Dry Swale with Filter Media

A dry swale is an open channel modified with a soil bed and an underdrain system to enhance water quality treatment.

- **Function:** It temporarily stores the **Water Quality Volume (VwQ)** and allows it to percolate through the treatment medium.
- **Drainage:** Designed to drain completely within approximately **one day** between storm events.
- **Mechanism:** Similar to bioretention, though nutrient uptake is more limited as it relies solely on a grass cover crop.

Purchase this course to see the remainder of the technical materials.