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Stormwater BMP Design Guide

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Module 1: Introduction

Learning Objectives

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

- **Identify** the primary environmental impacts of urban runoff on receiving waters.
- **Select** the appropriate regulatory framework (Phase I vs. Phase II NPDES) applicable to specific project scales.
- **Evaluate** different BMP design goals ranging from peak discharge control to multi-parameter ecological sustainability.

Executive Summary: Stormwater management has evolved from simple flood mitigation to complex systems addressing water quality, stream channel protection, and groundwater recharge. Effective BMP design requires balancing engineering hydraulics with ecological sustainability and strict adherence to evolving NPDES regulations.

Evolution of Stormwater Management

The goals and objectives of implementing **Best Management Practices (BMPs)** vary significantly by municipality, State, or watershed. Since their introduction in the 1960s, stormwater controls have undergone a major paradigm shift:

- **Initial Focus (1960s-1970s):** Primarily flood control. Engineers focused on capturing peak flows, providing local drainage, and managing the quantity of runoff during **Wet Weather Flow (WWF)**.
- **Water Quality Era:** In response to the **Clean Water Act (CWA)** and the National Urban Runoff Program (NURP), BMPs were adapted for **pollutant removal**.
- **Modern Integrated Approach:** Current designs prioritize stream channel protection, groundwater infiltration, and the protection of riparian habitats. Modern BMPs also explore non-potable reuse of collected runoff for irrigation and urban aesthetics.

Regulatory Framework

Laws and regulations governing WWF parallel our increasing awareness of environmental impacts. These regulations are the primary drivers of stormwater technology development.

NPDES Stormwater Permitting

The implementation of the **National Pollution Elimination Discharge Program (NPDES)** has dramatically increased the number of sources requiring BMPs.

Program Phase	Applicability	Land Disturbance Threshold
Phase I	Large municipal sources (>100,000 population) and industrial sources	> 5 acres
Phase II	Regulated small MS4s (urbanized areas)	1 to 5 acres

⚠️ **Safety Constraint:** Engineers must ensure that all designs for regulated MS4s and construction activities disturbing more than one acre comply with the **Phase II Final Rule** published in the Federal Register.

BMP Design Concepts and Guidance

BMPs can be designed for a spectrum of goals. The management goal dictates the specific mix of ecological and engineering principles required, including **hydrology**, **inflow hydraulics**, and **soil infiltration rates**.

Levels of Control

- Flood and peak discharge control.
- Combined flood control and specified pollutant guidelines.
- Integrated flood, peak discharge, and **water quality control**.
- Multi-parameter (**Unified Sizing Criteria**) and ecologically sustainable control.

💡 **Design Tip:** While this course focuses primarily on pollutant removal and water quality, you should consider multi-parameter control for projects in recently developed watersheds to ensure long-term ecological sustainability.

Hydrologic Concepts for BMP Design

- **Rainfall Frequency Spectrum:** Analyzing the full range of storm events.
- **Large Storm Hydrology:** Focused on flood prevention and conveyance.
- **Small Storm Hydrology:** Focused on water quality and frequent runoff events.
- **Groundwater Recharge Hydrology:** Focused on maintaining baseflow and infiltration.

BMP Classification and Selection

BMPs are classified by their functional role in the treatment train. Selection depends on the specific goals of the project and site-specific constraints.

Common Classifications

- **Pollution Prevention** and Source Control.
- **Runoff Control** and End-of-pipe Treatment.
- **Structural vs. Non-structural** Controls.
- **Regional vs. Micro-management** Controls.

Critical Design Factors for Selection

- **Watershed Factors:** Drainage area and land use.
- **Terrain Factors:** Slope and topography.
- **Physical Site Factors:** High water table, soil permeability, and space availability.
- **Community and Environmental Factors:** Aesthetics and safety.
- **Location and Permitting Factors:** Setbacks and local zoning.

🧮 **Calculation Note:** When determining the suitability of a BMP, refer to Appendix A for Large Storm modeling and Appendix B for the three distinct approaches to Small Storm hydrology to ensure the water quality volume (WQV) is accurately captured.

Checkpoint Quiz

1. **A construction project disturbs 3.5 acres of land in a suburban area. Under which regulation must the engineer obtain an NPDES permit?**
   a) Phase I NPDES
   b) Phase II NPDES
   c) NURP Standard
   d) CWA Section 404

Answer: (b). Phase II applies to construction activities disturbing between one and five acres.

2. **Which hydrologic concept is primarily used to design for water quality control and pollutant removal?**
   a) Large Storm Hydrology
   b) 100-year Flood Analysis
   c) Small Storm Hydrology
   d) Peak Discharge Attenuation

Answer: (c). Small storms represent the majority of annual runoff events and carry the bulk of the pollutant load, making them the primary focus for water quality design.

Module 2: Wet Weather Flow Impacts on Receiving Waters

Learning Objectives

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

- **Analyze** the physical, chemical, and biological impacts of urbanization on receiving water systems.
- **Calculate** volumetric runoff coefficients based on watershed imperviousness.
- **Evaluate** regional differences in stormwater pollutant concentrations and snowmelt dynamics.

Executive Summary: Stormwater runoff represents the final major threat to water quality in the U.S. Urbanization fundamentally alters the hydrologic cycle by increasing runoff volume and velocity while decreasing groundwater recharge. These physical shifts, combined with chemical pollutants, lead to severe biological degradation, typically beginning at just 10% watershed imperviousness.

Design Fundamentals and Background

Historically, Best Management Practices (BMPs) served strictly as flood and drainage controls. Modern engineering now requires BMPs to perform multiple tasks, including stormwater treatment and protection of receiving waters. This shift involves moving from traditional design concepts to "small storm hydrology" and the **treatment train** approach.

Managing water pollution on a **watershed basis** allows for optimal balances between point source treatment and pollution prevention. This approach facilitates simultaneous control of pollution, flooding, and erosion by strategically siting BMPs to maximize pollutant removal and reduce environmental stressors.

Regulatory Context and Ecological Integrity

The Clean Water Act (CWA) provides the legal and technical foundation for water quality standards. Its primary objective is to restore and maintain the **ecological integrity** of water bodies.

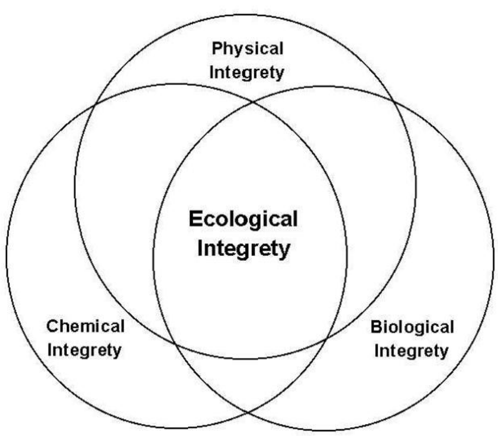

Figure 2-1: Goal of Ecological Integrity Under the Clean Water Act

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