# New Hampshire Stormwater Manual

## Volume 1

## Stormwater and Antidegradation

December 2008

United States Environmental Protection Agency

New Hampshire Department of Environmental Services

Comprehensive Environmental Inc

**NEW HAMPSHIRE STORMWATER MANUAL**

VOLUME 1 Stormwater and Antidegradation

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Rain garden and pervious walkway installation at Peterborough Town Hall in Peterborough, NH.

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# NEW HAMPSHIRE STORMWATER MANUAL

## VOLUME 1
## Stormwater and Antidegradation

December 2008
Revision 1.0

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# Chapter 1
# Introduction

New Hampshire's surface waters are a valuable natural resource. Through their function and beauty, they power industry, provide vital habitat, supply drinking water, and offer recreational opportunities to residents and visitors throughout the state. However, as the population grows and development pressures increase to provide needed housing and services, it is becoming increasingly difficult to protect and maintain the quality of our surface waters for the fishing, swimming, and recreational activities that we are so used to enjoying in New Hampshire.

Pemigewasset River, New Hampshire

The responsibility falls on us all - federal, state, and local governments, developers, and private citizens - to plan and act responsibly and in a manner that protects and works with the landscape to meet both water quality and land use goals. Development and natural resource protection do not need to be at odds. Existing scientific knowledge and technology in the field of stormwater management provide us with tools that can minimize the impacts of development and balance the needs of a healthy environment with those of social and economic growth.

The New Hampshire Department of Environmental Services (NHDES) has developed this New Hampshire Stormwater Manual to provide communities, developers, designers, and regulatory personnel with a reference guide for the selection, design, and application of measures to manage stormwater from newly developed and redeveloped properties, while meeting environmental objectives in the New Hampshire regulatory setting. These measures include source controls, design techniques (including low impact development (LID) design approaches), structural practices, and construction practices designed to minimize adverse hydrologic and water quality impacts, protecting and enhancing the functions of our natural wetlands and waterways.

The remainder of this Chapter presents an overview of the three-volume New Hampshire Stormwater Manual, and summarizes the contents and organization of information presented in Volume 1.

## 1-1. About the New Hampshire Stormwater Manual

Odiorne State Park, Rye, New Hampshire

The New Hampshire Stormwater Manual is intended as a planning tool for the communities, developers, designers, and members of regulatory boards, commissions, and agencies involved in stormwater programs in New Hampshire. The Manual addresses measures to manage stormwater runoff through site design, pollutant source controls, structural Best Management Practices (including associated operation and maintenance measures), and construction-phase practices. These practices are expected to be applied to meet specific objectives under current state and federal regulatory programs. However, if any discrepancies are found between this manual and the New Hampshire Code of Administrative Rules for the programs discussed here, the Rules should be followed.

The Manual is issued in three volumes:

*Volume 1: Stormwater and Antidegradation* presents an overview of New Hampshire's stormwater program together with related federal program requirements, describes New Hampshire's "Antidegradation Provisions" with respect to controlling water quality impacts due to stormwater discharges, and provides an introduction to the non-structural and structural measures for managing stormwater.

*Volume 2: Post-Construction Best Management Practices Selection and Design* presents a detailed description of the structural Best Management Practices (BMPs) applicable for use in New Hampshire for the prevention, control, and treatment of stormwater. Volume 2 describes information applicable to the screening, selection, design, and application of particular post-construction BMPs.

*Volume 3: Erosion and Sediment Controls During Construction* provides a selection of practices applicable during the construction of projects, to prevent adverse impacts to water resources as a result of the land-disturbance activities typically associated with development and redevelopment projects.

NHDES intends the New Hampshire Stormwater Manual to serve as:

- A living document with the ability to be updated as needed to accommodate the changes in stormwater management as the wealth of information in this area grows, and as technology and research broaden its scope and our perspective.

- A resource for developers and engineers in site planning, source control, and pollution prevention measures, as well as the selection and application of stormwater Best Management Practices (BMPs) to protect the surface waters of the state from potential adverse impacts of construction and post-construction stormwater runoff.

- A resource to local and state government officials, such as planning and zoning boards, town engineers, planners, conservation commissions, and New Hampshire state agencies involved in project review or approval to ensure that state and federal stormwater requirements are met, and that projects are reviewed in a consistent manner.

- A source of information on state and federal stormwater programs and their requirements that apply to development projects in New Hampshire, and a resource for selecting management measures to meet those requirements, including:

    - Stormwater management techniques commonly used, including BMPs and better site design techniques. Using better site design techniques in combination with traditional BMPs will result in more effective stormwater management systems to more easily meet the runoff volume and pollutant removal requirements of federal and state stormwater programs.

    - Selection criteria to assist in the selection of appropriate management techniques for a site and in the preparation of Stormwater Pollution Prevention Plans (SWPPPs) and other stormwater management planning documents.

    - Summaries of stormwater management techniques including the target pollutants, general site requirements, removal mechanisms, and pollutant removal efficiencies.

    - An explanation of various modeling tools that can be used as a surrogate to water quality monitoring to verify that pollutant loading requirements will be met in the post-development condition.

## 1-2. About Volume 1

Within this context, Volume 1 provides the foundation for understanding stormwater management requirements in New Hampshire, and planning for the implementation of measures to protect the environment from the adverse impacts caused by stormwater runoff from land development and redevelopment. Volume 1 provides information for municipalities involved in the regulation of stormwater, discusses underlying principles key to understanding stormwater management, describes the regulatory setting, and provides an introduction to the practices available for managing stormwater to meet regulatory objectives.

A key component of Volume 1 is the explanation of the Antidegradation Provisions of the New Hampshire Surface Water Quality Regulations (Env-Wq 1700). This Volume provides guidance in determining the applicability of these Regulations to a project. Where the regulations apply, this Volume describes the calculations required to show that stormwater discharges meet the requirements of the Antidegradation Provisions. Guidance is also offered about the non-structural site design techniques and structural management practices that can be implemented to meet the Alteration of Terrain (AoT) Program and Antidegradation Provisions. The chapters are organized as follows:

*Chapter 2: Message for Municipalities* provides a summary of the information contained in the manual that is applicable to municipal governments, as well as additional resources specifically geared toward municipalities. It is anticipated that municipalities will refer developers and project engineers to individual chapters for more detailed information on each topic.

*Chapter 3: Understanding Stormwater Management* discusses the fundamental concepts of stormwater management, including the relationship between land use and water quantity and quality, sources of stormwater pollutants, watershed planning, and traditional stormwater management concerns.

*Chapter 4: State and Federal Permitting Programs* discusses the state and federal permitting programs that apply to stormwater management in New Hampshire. These programs aim to balance the need for development with water quality protection. This chapter outlines water quality requirements that must be met in order to permit development activities.

*Chapter 5: Antidegradation* discusses the requirements of the Antidegradation Provisions of the New Hampshire Surface Water Quality Regulations (Env-Wq 1708). These methods include targets for effective impervious cover (EIC), undisturbed cover (UDC), and pollutant loading. The chapter includes a description of the Impervious Cover Method, developed by the Center for Watershed Protection, to calculate the total impervious cover of a site as well as the EIC and UDC.

*Chapter 6: Non-Structural Site Design Techniques* discusses the non-structural, better site design techniques, often referred to as low impact development (LID) techniques. These techniques minimize the amount of stormwater runoff generated on a site and reduce the treatment volume by maintaining and mimicking the natural hydrology of a site. This chapter also discusses how these techniques can be used to "disconnect" impervious surfaces on a site to lower the EIC and better meet the target for that parameter.

*Chapter 7: Introduction to Best Management Practices* provides a brief description of structural stormwater best management practices. It also provides an overview of the factors that should be considered when selecting or narrowing down stormwater management practices for a site including land use, watershed resources, BMP capability, maintenance, and community and environmental factors.

*Chapter 8: Pollutant Loading Calculations* describes the calculations that should be used to determine if a project is in compliance with the Antidegradation Provisions. This chapter describes the Simple Method for calculating pollutant loads and includes a link to a Simple Method spreadsheet template. It also provides pollutant removal efficiencies for various BMPs.

# Chapter 2
# Message for Municipalities

New Hampshire's Queen City, Manchester, New Hampshire

The majority of land use decisions are made at the local level. New Hampshire Revised Statutes Annotated (RSA) 672 – 677, describe the authority given to municipal governments to develop, implement, and enforce planning, zoning, and related regulations. Although there are state and federal regulatory requirements for development activities, they typically apply to larger projects with over 1 acre of disturbance. Smaller, one- or two-lot residential developments scattered throughout the state are often not subject to these requirements because of their limited size of disturbance[1]. The cumulative impact of these small disturbances is large, however; and can have a substantial impact on water quality. For these small-scale developments, the local municipality is the regulatory authority.

The New Hampshire Alteration of Terrain (AoT) Regulations (Env-Wq 1500), the Antidegradation Provisions of the New Hampshire Surface Water Quality Regulations (Env-Wq 1708), and the federal regulatory requirements under EPA's NPDES Stormwater Program (40 CFR (Code of Federal Regulations) 122) require the management of the quantity and quality of stormwater runoff to protect our water resources. These regulatory programs affect local governments as they undertake municipal projects that need to comply with the regulations. The requirements of these state and federal programs can be adopted by municipalities to regulate the smaller-scale projects under their authority.

To help direct municipal officials to information that may be of particular relevance to local government, this chapter provides a summary of the issues of concern, where these issues are discussed in this volume of the New Hampshire Stormwater Manual, and information that the municipality should expect to receive when developers present projects subject to the AoT Regulations and the Antidegradation Provisions. This chapter also discusses some additional management techniques particularly appropriate for municipalities to employ to address stormwater controls, including watershed management planning, municipal ordinances, and easements and deed restrictions.

1 Small scale development projects in New Hampshire are subject to the Alteration of Terrain (AoT) Program Permit by Rule. The Alteration of Terrain permit is discussed in greater detail in Section 4-2.

To include the pertinent information in one document, Volume 1 has been written with a diverse audience in mind. Because of this, some of the information contained in the chapters may be more technical in nature than necessary for the purposes of municipal planning boards, town planners, conservation commissions, and other groups involved in development review at the local level. It is anticipated that municipalities will refer developers and project engineers to each chapter for more detailed information on the methods that should be used to meet the state Antidegradation Provisions.

## 2-1. Municipal Issues of Concern

The following is a brief introduction to municipal stormwater issues, together with a reference to the Chapter of this Volume where the concern is discussed in greater detail:

### Alternatives to Conventional Stormwater Management Methods

Municipalities have historically been, and will continue to be, concerned with stormwater management, including flooding and the reasons for more frequent flooding, as well as the impacts of stormwater pollutants. To address evolving requirements for stormwater control, conventional measures such as "end-of-pipe" control facilities for handling stormwater may no longer suffice, and alternative strategies may be required to minimize the generation of increased runoff, prevent pollution, and manage the runoff that does occur from land development activities. Chapter 3 discusses concerns with conventional stormwater management methods and recommends that municipalities consider changes in zoning and other municipal regulations to allow for alternatives to conventional stormwater management.

The alternative stormwater measures include not only structural practices, but a number of non-structural practices. Chapter 6 provides an overview of these practices. Municipalities are encouraged to consider and require these practices in the overall process of review and approval of projects at the local level, including:

- Methods that either preserve or mimic the natural condition of a site (e.g., stream buffers, etc.) to potentially reduce the number and size of structural management practices (i.e., stormwater ponds, infiltration basins, sand filters) that are needed to treat stormwater. Although these non-structural site design techniques promote infiltration, reduce the amount of stormwater generated, and can reduce costs by reducing the need for structural practices, many municipal ordinances and codes do not allow for them to be used. Section 6-1 can be used as a starting point for municipalities to determine if they would be able to implement these site design techniques and determine the zoning modifications or exceptions that need to be considered to allow for them.

- Methods whereby rooftop and non-rooftop (i.e., driveways, walkways, patios) impervious surface runoff can be "disconnected" from the drainage network of a site (see Section 6-2) and how this factors into the calculation for Effective Impervious Cover (Section 5-2). Municipalities can adopt these disconnection measures or can refer engineers or consultants to this section for projects that require state or federal stormwater permits.

### State & Federal Permitting Programs

Several federal and state programs relate to stormwater management in New Hampshire. Chapter 4 serves as primer on stormwater permitting and can be used to help determine if the regulations at the municipal level are consistent with those at the state and federal levels.

### Antidegradation Provisions

At the core of this Volume of the New Hampshire Stormwater Manual is the introduction and explanation of the Antidegradation Provisions. The Antidegradation Provisions are part of the New Hampshire Surface Water Quality Regulations (Env-Wq 1700). The purpose of the Antidegradation Provisions is to prevent degradation of surface waters. In order to determine whether a proposed project would degrade water quality NHDES must conduct an antidegradation review. Municipalities should be familiar with important basic concepts about these requirements and be able to direct project applicants to the more technical aspects that project designers and regulators must consider. Chapter 5 covers this material in detail, including the following concepts:

> *Antidegradation Notice*
>
> In 2009, NHDES staff will be convening a workgroup of interested stakeholders to review the proposed antidegradation requirements described in Section 5-2. The workgroup will finalize the requirements for meeting the antidegradation provisions and the procedure for NHDES review of proposed activities. This manual will be updated to incorporate the requirements at the completion of the workgroup.

- *Proposed project thresholds* that trigger review under the Antidegradation Provisions, summarized in a decision flowchart that should be useful for municipalities and project applicants, as well as for regulatory review personnel. See Section 5-1.

- *Water Quality Categories* that are applicable under the Antidegradation Provisions, how these water quality determinations are made, and how to find information about individual waterbodies to determine their category. Understanding water quality categories is important for later discussions on Antidegradation Provisions to know when and to what waterbodies they apply. See Section 5-1.

- *The concepts of Effective Impervious Cover (EIC) and Undisturbed Cover (UDC)* as they relate to the total impervious cover of a site. The Impervious Cover Model, used to establish impervious cover targets, is also discussed. Understanding the concepts of impervious cover is important in understanding the proposed EIC and UDC targets set under the Antidegradation Provisions and can also be used in reviewing development plans at the local level if similar municipal targets are set. See Section 5-2.

- *NHDES targets* to protect water quality by proposing pollutant loading requirements for each Water Quality Category and proposed targets for EIC and UDC under the Antidegradation Provisions (Section 5-2). This information is important in reviewing development plans if similar municipal targets are set, or to provide guidance to engineers and consultants on projects that will require state or federal stormwater permits.

- *The difference between insignificant and significant pollutant loading*, how it is determined, and what it means in terms of additional information that may need to be submitted with permit applications (Section 5-2). Municipalities can apply this information to their own permitting programs, or provide it as guidance to engineers and consultants on projects that will require state or federal stormwater permits.

- *Proposed information with permit applications* to satisfy the Antidegradation Provisions (Section 5-2). Municipalities may want to adopt these proposed submittal requirements, or refer engineers and consultants to this section for projects that will require state or federal stormwater permits.

- *Guidance to performing calculations* proposed to document compliance with Antidegradation Provisions. This includes calculations of EIC and UDC (Section 5-2), as well as a detailed discussion of pollutant loading calculations (Chapter 8). The latter chapter describes the estimation of pollutant loading using the Simple Method, including a spreadsheet developed by NHDES. In addition, this chapter includes the event mean concentrations for stormwater pollutants and the pollutant removal efficiencies of BMPs to determine if a project will meet the pollutant loading requirements described in Section 5-2. Municipalities may refer engineers and consultants to this chapter for guidance on conducting calculations. Municipalities may also want to consider adopting similar requirements for applicants to show how their projects will impact water quality.

### Selection and Design of Best Management Practices (BMPs)

There are numerous structural best management practices that can be used to treat stormwater runoff. These include both temporary and permanent BMPs, as well as BMPs that should be used for pre-treatment. Chapter 7 provides an introduction to the various BMP options available.

Chapter 7 also introduces various criteria that can be used to select a structural stormwater best management practice, such as land use factors, physical feasibility, watershed resources, the capability of the BMP, maintenance considerations, and community and environmental factors.

Volume 2 of the New Hampshire Stormwater Manual discusses the selection and design of these BMPs in further detail, and will provide guidance to engineers, consultants, reviewers, and others on the detailed criteria for siting and sizing of these measures. Volume 3 of the Manual discusses construction phase measures in greater detail, and will provide guidance to engineers, contractors, and reviewers in the application of these practices during site development.

## 2-2. Municipal Stormwater Management Tools

Municipalities have several management tools available to assist in implementing stormwater quantity and quality control objectives. These tools include (but are not necessarily limited to) the ability to plan for stormwater management on a watershed basis, to adopt and apply municipal ordinances that govern stormwater management, and to require and enforce easements and deed restrictions pertaining to stormwater management. These tools are further discussed below.

### Watershed Management Planning

A watershed is a geographic area in which all water drains to a given stream, lake, wetland, estuary, or ocean. Our landscape is made up of many interconnected watersheds. The boundary between each is defined by the line that connects the highest elevations around the waterbodies. Watersheds in New Hampshire often cross political boundaries, spanning multiple towns and crossing county and even state lines. This often requires municipalities to work together to address water quantity and quality concerns[2].

Within each watershed, water runs to the lowest point on the landscape, either a stream, river, lake, estuary, or the ocean. Along its path, water travels over and through fields, farms, forests, backyards, parking lots, and roads and highways. Any pollutant in its path is picked up and carried to the receiving water. It is important, then, to look at land use activities and potential sources of pollution across the entire watershed when trying to determine the cause of pollutants in downstream receiving waters. It is also important, when planning new development, to recognize that impacts could be far reaching. Even if there isn't a stream or river running through the site, stormwater runoff and the pollutants it can carry, eventually end up in downstream

2 To help facilitate municipalities working together, nine Regional Planning Commissions were established to, among other things, increase communication between municipalities, promote intergovernmental cooperation and coordinate development of the various regions. More information on the Regional Planning Commissions is available from the New Hampshire Association of Regional Planning Commissions website at: http://www.nharpc.org.

surface waters. Because of this, stormwater management is most effective when addressed at a watershed scale, through a watershed management plan.

Unfortunately, at the state level the opportunity for watershed management planning is limited. Permit applications for development projects are submitted for individual projects statewide. Because the state only sees the larger development projects, the small projects that fall below the state permitting threshold are not easily factored into state planning. Municipal governments, however, have the benefit of reviewing even the small projects in their town. This makes watershed management planning much more feasible at the local and regional level.

A watershed management plan is a management tool intended to identify and implement activities in the watershed with the intention of protecting and restoring water quality. A watershed management plan should include the following nine elements, as determined by the United States Environmental Protection Agency (EPA) (EPA, 2003):

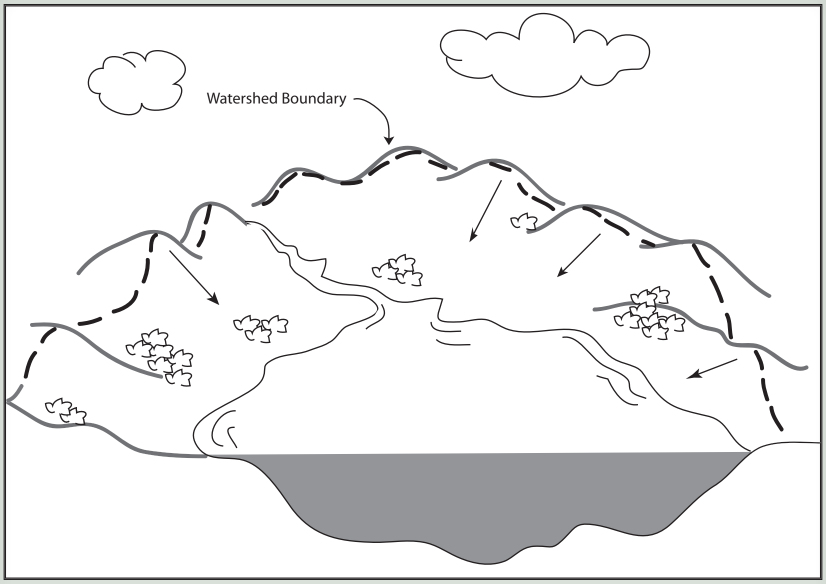

Figure 1-1. Illustration of the boundary of a watershed.

- The causes and sources of pollutants in the watershed.
- An estimate of the load reductions expected for the Nonpoint Source Pollution (NPS) management measures to be implemented under the plan.
- A description of the type and location of the NPS management measures that will be implemented to achieve the expected load reductions.
- An estimate of the technical and financial assistance necessary to implement the plan, including costs and sources of assistance.
- An informational/educational outreach component to improve public understanding and involvement with stormwater management projects and plan implementation.
- A schedule for implementing the watershed management plan.

- A description of interim, measurable milestones to determine if the management measures described in the plan are being implemented.
- A set of criteria to determine if loading reductions are being achieved and if progress is being made toward meeting water quality standards and, if not, the criteria for determining if the watershed management plan should be revised.
- A monitoring component to evaluate the effectiveness of implementation efforts over time.

NHDES offers grants to develop and implement Watershed Management Plans. These grants are made available through the 319 Watershed Assistance Grants Program, which is administered by the NHDES Watershed Assistance Section with funding provided by EPA under Section 319 of the Clean Water Act.

### Municipal Ordinances

The Regional Environmental Planning Program (REPP) has recently developed guidance for model ordinances and regulations on a number of innovative land use techniques, for municipalities to use to develop their own local ordinances. The Innovative Land Use Planning Techniques: A Handbook for Sustainable Development contains chapters on:

- Multi-density zoning
- Environmental characteristics zoning
- Site level design

It specifically includes a model ordinance for stormwater management that is consistent with state stormwater and water quality regulations described in this manual.

The Innovative Land Use Planning Techniques: A Handbook for Sustainable Development is available on the NHDES website at: http://des.nh.gov/organization/divisions/water/wmb/repp/innovative_land_use.htm

### Easements and Deed Restrictions

Easements and deed restrictions are legal tools that municipalities can employ to assure the attainment of stormwater management objectives. These tools can be used to impose permanent restrictions on the use of property or facilities, or to facilitate the performance of necessary activities such as operation and maintenance.

An easement is an agreement between a land owner and an easement holder (e.g., a local government agency or a utility company), which gives the holder a right to use a defined part of the property for a specific purpose (Byers and Marchetti Ponte, 2005). Common examples of easements are ones established for a utility company to install and maintain power lines on a property, or established for a driveway extending over a neighboring property to access a landlocked property. Easements are typically documented in the deed to the property. They are described in terms of the resource they are designed to protect and explain the restriction on the uses of the property.

Easements may be used to help control stormwater quantity and protect water quality by providing for such elements as:

- Access for construction and grading activities, where a project depends on off-site improvements;
- Access for the construction and maintenance of conveyance and stormwater management facilities when there are or will be multiple property owners served by these facilities;
- Permanent access by parties responsible for stormwater system operation and maintenance to the facilities that must be maintained to ensure the long-term performance of the stormwater system.
- Such easements may include provisions for municipal access where appropriate, either because the municipality will be the responsible operator or the municipality will need to have access on an emergency or contingency basis.

A deed restriction is a clause in a deed that limits the use of a property. Deed restrictions are usually initiated by the developer, possibly as a permit condition, and transfer with the property. They typically cannot be changed or removed by subsequent owners. Deed restrictions are filed with the New Hampshire Registry of Deeds for each county and the deed restriction language is included in all future real estate transactions.

Deed restrictions may be used to protect water quality by imposing limitations in order to require or maintain:

- Buffers to wetlands, streams or other sensitive natural areas;
- Limitations on fertilizer application
- Limitations on clearing or removing vegetation

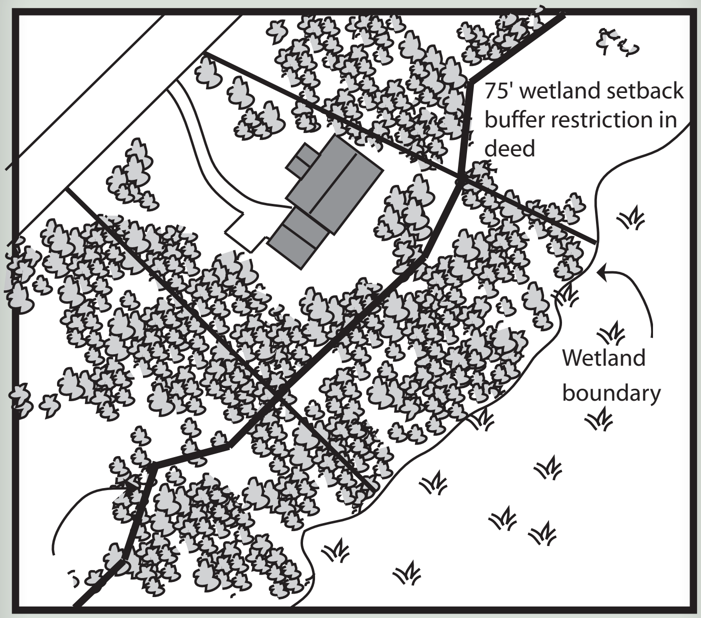


Figure 1-2. Deed restricted wetland buffer area within 75 feet of the wetland boundary must remain undisturbed in perpetuity.

- Maintenance of privately owned best management practices

A template for deed restrictions can be found in Appendix A and example language for easements are included in Appendix B.

### Stormwater Utilities

Many communities across the state and throughout the country are exploring options for funding stormwater management activities. As the challenges and costs of improving stormwater management programs and meeting increasing regulatory requirements grow, municipalities are looking at stormwater utilities as a way to fund stormwater improvements. The funding from stormwater utilities can be used for catch basin cleaning, street sweeping, and stormwater infrastructure upgrades required by the Clean Water Act National Pollutant Discharge Elimination System (NPDES), Phase II. It can be used by non-Phase II communities to reduce local problems such as flooding, erosion, and beach closures, and to protect the quality of the land and water resources for residents through capital improvements and proper operation and maintenance of stormwater facilities.

In the 2008 New Hampshire legislative session, House Bill (HB) 1581 passed, enabling municipalities to construct and maintain stormwater systems, and to establish special assessment districts (i.e., stormwater utility districts) to generate funding specifically for stormwater management. Users within the district pay a stormwater fee, often based on the percentage of impervious surfaces on their property, which directly supports maintenance and upgrades of existing storm drain systems, development of drainage plans, flood control measures, and water quality programs that service the users. This is similar to the dedicated municipal funds that manage water and sewer utilities.

For additional information on House Bill 1581 and stormwater utilities, go to the New Hampshire General Court website at http://www.gencourt.state.nh.us/legislation/2008/HB1581.html or contact Eric Williams of the NHDES Watershed Assistance Section at (603) 271-2358.

## Chapter 2 References

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# Chapter 3
# Fundamentals of Stormwater Management

Chapter 3 describes several fundamental concepts of stormwater management. Among these are the relationships between land use and water quantity and quality, sources of stormwater pollutants, watershed planning, and traditional stormwater management concerns. This chapter may be useful to better understand the basic concerns and causes of stormwater pollution and to help understand the interconnectedness of activities in a watershed to plan for protection and restoration of water quality.

## 3-1. Hydrologic Impacts

Development activities can alter the natural hydrologic cycle and the movement of water off of the land. Development removes natural vegetation and introduces impervious surfaces, such as roads, rooftops, driveways, and parking areas. Precipitation falling on these impervious areas can no longer soak into the ground, resulting in an increase in stormwater runoff. Vegetation no longer slows down the rate of flow. Because of this, developed areas generate a greater amount of stormwater, and this runoff reaches rivers and lakes in a shorter amount of time. This runoff picks up sediment and other pollutants in its flow path, and carries these pollutants to the receiving waterbodies. The increased runoff can also result in erosion of the land surface, conveying the resultant sediment load to the receiving waters as well.

Stormwater flows into a catch basin from a commercial parking lot during a rainstorm in Concord, New Hampshire.

Potential hydrologic impacts from development activities include the following[3]:

- Changes to Stream Flow
- Increased runoff volumes
- Increased peak runoff discharges
- Increased runoff velocities
- Increased frequency of bank-full & near bank-full events
- Increased flooding

3 Adapted from Minnesota Stormwater Manual, 2006.

- Lower baseflows (dry weather flows)

Changes to Stream Geomorphology

- Stream widening & bank erosion
- Changes in flow velocities
- Stream degradation (downcutting) or aggradation (rise in channel elevation due to sediment deposition), resulting from changes in flows or sediment load
- Other changes in stream bed due to sedimentation
- Loss of riparian vegetation & canopy
- Increased flood elevation
- Isolation of the primary channel from its natural flood plain, resulting in further changes in channel geometry

Changes to Aquatic Habitat

- Degrading of habitat structure - channel scour, streambank erosion, riparian vegetation loss, sediment deposition
- Loss of pool-riffle structure
- Reduced baseflows
- Increased stream temperatures
- Decline in abundance and biodiversity of fish and benthic organisms

## 3-2. Water Quality Impacts

In addition to the water quantity impacts from development activities, stormwater runoff also affects water quality. The pollutants affecting water quality come from changes in land use and associated activities as well as social behavior. As the population grows, many changes occur in the landscape. Forests and other undisturbed lands are converted to make room for homes and businesses. Transportation infrastructure is expanded including roads, highways, and parking lots, which are salted and sanded for safety. This decreases the amount of vegetated areas that are available to naturally treat stormwater and increases the impervious surfaces. Fertilizers and other household products, including pet waste, septic system leachate, trash, and a variety of other pollutants are introduced into the environment, all of which would not be present in the undeveloped landscape (CT DEP, 2004).

These pollutants are picked up and carried by stormwater runoff and discharged to receiving waters. Fortunately, there are ways to lessen the water quality impacts of these changes in the landscape through environmentally sensitive site planning. Implementing better site design techniques and best management practices can not only reduce the volume and velocity of runoff leaving a site, but can also reduce pollutant runoff that can threaten water quality.

- Potential water quality impacts from development activities may result in:

- Shellfish bed closures due to bacterial contamination.

- Swimming beach closures due to bacterial contamination.

- Pathogenic bacteria/viruses from fecal material in combined sewer overflows (CSOs), pet and wildlife waste.

- Nuisance algal growth from excess nutrients in runoff.

- Toxicity from ammonia, metals, organic compounds, pesticides, and other contaminants.

- Depleted dissolved oxygen (DO) levels due to increased biochemical oxygen demand (BOD) of the water from biodegradable organic material – leading to oxygen deprivation of aquatic organisms.

- Increased temperatures due to warm impervious surfaces and loss of shade from decreased riparian canopy, leading to reduced DO levels as warm water can hold less oxygen than cold water.

- Contamination of groundwater with soluble organic chemicals, metals, nitrates, and salt.

Turbidity in Hodgson Brook, Portsmouth, New Hampshire.

## 3-3. Concerns with Conventional Stormwater Management

Conventional stormwater management has focused on removing stormwater from a site as quickly as possible to reduce on-site flooding. This has meant implementing management techniques, such as curb and gutter and piping systems, that discharge runoff to the nearest receiving water, or implementing detention type BMPs to reduce peak runoff discharge rates (CEI, 2003).

Although this is an efficient way to remove water quickly and prevent on-site flooding, it has proven to be devastating to downstream waters by increasing the frequency and magnitude of floods, altering stream channel morphology (alignment, cross-section geometry, streambed composition) and reducing groundwater recharge, all of which make less water available for drinking water withdrawal and stream base flows.


Flooding of New Hampshire's Exeter and Squamscott Rivers, April, 2007.

These shortcomings of traditional stormwater management are largely because the methods used rely on conveyance efficiency and end-of-pipe treatment. Although end-of-pipe practices still have their place in stormwater control and treatment, *the key to effective management of stormwater runoff is to reduce the amount of stormwater generated in the first place by maintaining and working with the hydrology of a site and managing stormwater at the source.*

Subsequent chapters of Volume 1 present alternative measures to this conventional approach to stormwater management. As will be seen in the discussion of the Antidegradation Provisions in Chapter 5, New Hampshire's approach to managing stormwater to meet water quality standards includes objectives to limit increased impervious surface and to retain natural undisturbed areas. Chapter 6 offers guidance to address site design, including low impact development techniques, to minimize the generation of stormwater, and to control quantity and quality impacts close to its source.

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# Chapter 4
# State and Federal Permitting Programs

This chapter describes state and federal permitting programs related to stormwater that aim to balance development with water quality protection. These permitting programs specify water quality requirements that must be met in order for development activities to occur. Although these are federal and state requirements, the majority of land-use planning decisions are made at the local level.

Municipalities may find this chapter useful to better understand federal and state programs and to determine if decisions being made at the local level agree with federal and state regulations. Permit applicants under state and federal stormwater programs may find this chapter useful to better understand the conditions and requirements of permits related to water quality. Figure 4-2 (at the end of Section 4-1) summarizes the applicability of various permit programs in New Hampshire.

State House, Concord, New Hampshire

## 4-1. Regulatory Authority

The Federal Clean Water Act, RSA 485-A, Water Pollution and Waste Disposal, and the New Hampshire Surface Water Quality Regulations (Env-Wq 1700) that implement RSA 485-A, are the primary regulatory authorities for the protection of water quality. They are the basis for the various New Hampshire permitting and certification programs related to stormwater.

### Federal Clean Water Act

The Federal Water Pollution Control Act of 1948 was the first major federal legislation regarding the control of pollutants in surface waters in the United States. It was significantly amended in 1972, when it became commonly known as the Clean Water Act (CWA), and again under the Water Quality Act of 1987 (NEIWPCC, 2004). There are four sections of the CWA that involve stormwater:

*Section 303 – Water Quality Standards and Implementation Plans*

Section 303 of the CWA requires states to adopt surface water quality standards (e.g., the New Hampshire Surface Water Quality Regulations) and identify waters that do not meet these standards. Waters that do not meet the water quality standards are considered "impaired" and are listed on the 303(d) list of impaired waters. All impaired waters must undergo a Total Maximum Daily Load (TMDL) study for the pollutants that do not meet the water quality standards. The TMDL specifies the maximum amount of the pollutants that the waterbody can receive and allocates the amount (or load) that various point and nonpoint sources can discharge to that waterbody.

*Section 319 – Nonpoint Source Management Program*

Section 319 of the CWA, established in 1987, provides federal guidance and funding to support activities that address nonpoint source pollution. These activities include technical assistance, education and training, technology transfer, demonstration projects, and monitoring projects. Section 319 provides funding to the NHDES Watershed Assistance Program, which provides direct financial assistance, through a competitive grant program, to municipalities and other local groups to address nonpoint source pollution.

*Section 401 – Water Quality Certification*

Section 401 of the CWA requires applicants for a federal license or permit, including wetlands permits from the U.S. Army Corps of Engineers, to obtain a certificate from the state for any activity that may result in a discharge to navigable waters. This includes wetlands, rivers, and natural and man-made ponds. More information on the New Hampshire 401 Surface Water Quality Certification is provided in Section 4-2.

*Section 402 – National Pollutant Discharge Elimination System*

Section 402 of the CWA established the National Pollutant Discharge Elimination System (NPDES) Program. The NPDES Program regulates only point sources (i.e., direct discharges from pipes, ditches, etc.) to surface water by municipalities, industries, and other facilities and includes stormwater from certain urbanized areas, industrial activities, and construction sites More information on the NPDES program in New Hampshire is provided in Section 4-2.

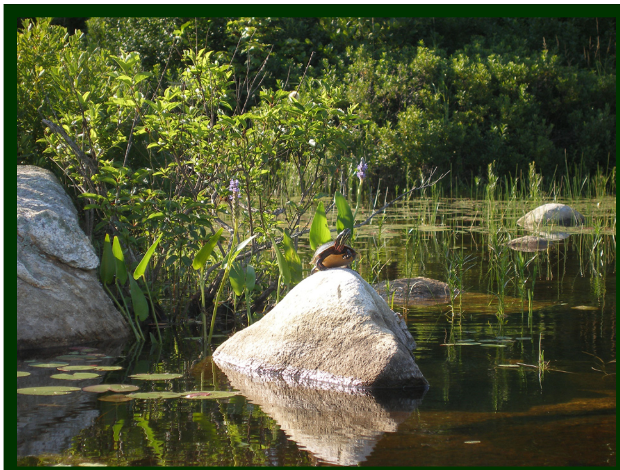
### New Hampshire Surface Water Quality Regulations

New Hampshire Surface Water Quality Regulations (Env-Wq 1700) implement RSA 485-A and federal Clean Water Act (CWA) requirements and are intended to protect the state's surface waters. The New Hampshire Surface Water Quality Regulations are implemented through various state permitting and certification programs detailed in this chapter, including the 401 Water Quality Certificate and the Alteration of Terrain Permit.

The Water Quality Regulations 1) establish **designated uses**, 2) specify appropriate **water quality criteria** to protect those designated uses, and 3) establish an **antidegradation policy** to protect surface water from pollutants.

*Designated Uses*

Designated uses define the goals of a waterbody and can be thought of as a waterbody's role. The designated uses for an individual waterbody are determined by how the waterbody is actually used. For example, if a waterbody is used as a public water supply, its designated use includes drinking water after adequate treatment. If a waterbody is used for recreational swimming and boating, its designated uses include primary and secondary contact recreation, and so on. A single waterbody can have multiple designated uses (USEPA, Module 3, 2005).



Turtle at Swains Lake, Barrington, New Hampshire

Federal statute (40 CFR 131.10) requires that all states take into consideration the designated uses described in Sections 101(a) and 303(c) of the federal CWA. These include the protection and propagation of fish, shellfish, and wildlife, as well as public water supplies, recreational, agricultural, industrial, and other purposes. Designated uses in New Hampshire include:

- Primary Contact Recreation
- Secondary Contact Recreation
- Aquatic Life
- Fish Consumption
- Shellfish Consumption
- Wildlife
- Drinking Water After Adequate Treatment

*Water Quality Criteria*

Water quality criteria are designed to protect a specific designated use. The criteria are assigned water quality standards for each water quality parameter (e.g., dissolved oxygen, pH, and bacteria) that must be met. Section 101(a) of the CWA requires, where possible, that water quality of all surface waters provide for the protection and propagation of fish, shellfish and wildlife, and recreation in and on the water. This means it is presumed that every surface water of the state, under federal law [40 CFR 131.3, 131.10] and state law [RSA 485-A:8], attains the designated uses of "fishable" and "swimmable" unless there is documentation that proves a waterbody does not meet one or more of the water quality criteria designed to support that use (USEPA, Module 7, 2005).

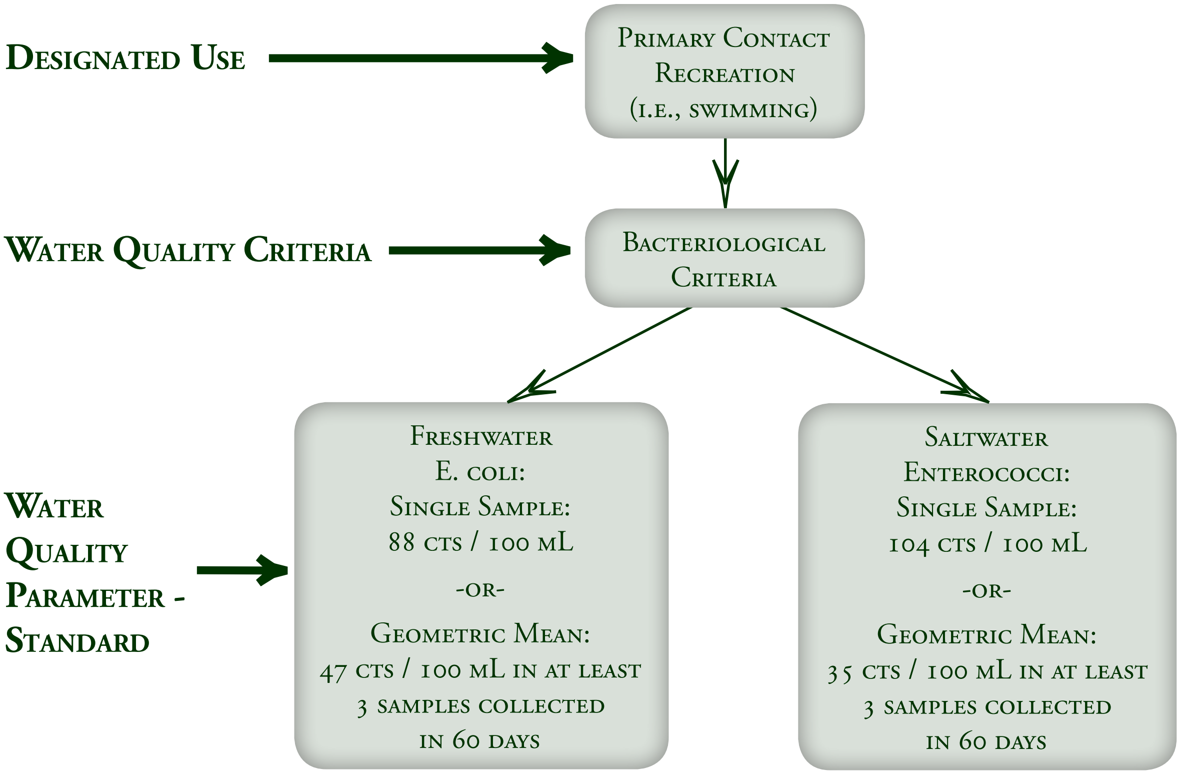



Figure 4-1. Illustration of the relationship between designated uses, water quality criteria, and water quality parameters in the New Hampshire Surface Water Quality Regulations (Env-Wq1700).

If a waterbody meets or is better than the water quality criteria, the designated use is supported; however, if a waterbody does not meet the water quality criteria, the waterbody is considered impaired for that designated use. Types of water quality criteria include: human health, bacteriological, aquatic life, biological, and nutrient criteria. An example flow chart of how designated uses, water quality criteria, and water quality parameters are related is shown in Figure 4-1.

*Antidegradation*

The purpose of antidegradation is to maintain or improve the quality of surface waters in the state (USEPA, Module14, 2005). The New Hampshire Antidegradation Provision (Env-Wq 1708) describes how water quality is to be protected from pollutants. It outlines limitations (or reductions) for future pollutant loading based on how a water body meets the water quality criteria for its designated uses. These limitations are on a parameter by parameter basis. The requirements of the Antidegradation Provision are explained further in Chapter 5.

### New Hampshire Wetland Rules

The New Hampshire Wetland Rules (Env-Wt 100-800) implement RSA 482-A:1 and are intended to protect and preserve the submerged lands under tidal and fresh waters and their wetlands, (both salt water and fresh-water), from unregulated alteration. Alteration of these areas, including vital habitats and reproduction areas, if not properly managed, could adversely affect the shellfish and wildlife that depend on them. In addition, the recreational, economic, and esthetic values they provide to the public could be put at risk. Proper management of these waters and wetlands are important to maintaining adequate groundwater levels and stream channel flows, and handling runoff by maintaining the natural ability of wetlands to absorb flood waters and silt. This results in less flood damage and silting of open water channels that would otherwise adversely affect the interests of the general public.

Under the Wetland Rules, NHDES implements a Fill and Dredge Permit to protect the natural environment while allowing individual landowners the freedom to use and enjoy their own land. The NHDES Fill and Dredge Permit is described in greater detail in Section 4-2.

### New Hampshire Comprehensive Shoreland Protection Act

The New Hampshire Shoreland Rules (Env-Wq 1400) implement the Comprehensive Shoreland Protection Act (RSA 483-B) and are intended to protect the shorelands of the state to maintain the integrity of the public waters they surround. The shoreland provides a natural woodland buffer, consisting of trees and other vegetation located in areas adjoining public waters. These buffers are important to intercept surface runoff, wastewater, subsurface flow, and deeper groundwater flows from upland sources of pollution and to reduce the effects of nutrients, sediment, pesticides, and other pollutants as well as to moderate temperature and protect nearby surface waters from thermal impacts of development.

There is a great concern throughout the state relating to the use, protection, restoration, and preservation of shorelands because of their effect on state waters. The Comprehensive Shoreland Protection Act and the Shoreland Rules were substantially updated and became effective July 1, 2008. One of the major changes was the creation of a Shoreland Permit, described in greater detail in Section 4-2.

## 4-2. Water Quality Certification and Permitting Programs

The Section 401 Water Quality Certification, New Hampshire Alteration of Terrain Permit, New Hampshire Wetland Permit, New Hampshire Shoreland Permit, and the National Pollutant Discharge Elimination System (NPDES) Program Permits are the primary programs that permit land disturbance activities for the protection of water quality and stormwater management.

### 401 Water Quality Certification

There are several federal permits that may be required in order to conduct an activity that could result in a discharge to navigable waters. Common examples include dredge or fill of wetlands under the New Hampshire

Programmatic General Permit (PGP) issued by the Army Corps of Engineers, and construction activity under the EPA National Pollutant Discharge Elimination System (NPDES). Section 401 of the federal Clean Water Act requires that an applicant for such federal permits must provide the permitting agency with a 401 Certificate from the state before the federal permit is issued. The 401 Certificate verifies that the discharge from the permitted activity will meet the New Hampshire Surface Water Quality Regulations (USEPA, Module 19a, 2005). It may include specific conditions for construction, operation, water quality monitoring, and reporting. In New Hampshire, the 401 Certificate is issued by the NHDES Watershed Management Bureau with the exception of NPDES permits, where the 401 Certificate is issued by the NHDES Wastewater Engineering Bureau.

Brody, age 1, enjoys the New Hampshire seacoast.

The 401 Certification review process considers all discharges associated with the construction and operation of an activity. It considers the potential impacts of the discharge to the designated uses of the surface water. Potential impacts can include discharges during construction, such as erosion and sedimentation, as well as long-term impacts from the operation of the activity, such as post-construction runoff. The review process often involves consultation with other state and federal programs and agencies, including the NHDES Rivers Management and Protection Program, the New Hampshire Fish and Game Department, and the U.S. Fish and Wildlife Service.

The U.S. Army Corps of Engineers (ACOE), the Federal Energy Regulatory Commission (FERC), and the U.S. Environmental Protection Agency (EPA) are federal agencies with permitting authority over wetland and water development projects, including permits for wetland alteration and the NPDES program. These agencies will not issue a permit until NHDES issues a 401 Certificate. Projects that are likely to require a 401 Certificate include, but are not limited to: road construction or subsurface pipeline installation over or near surface waters, such as rivers and lakes; construction projects that require dredge or fill of a wetland; and hydroelectric power developments that require licensing. All projects requiring a federal NPDES Construction General Permit (CGP) need a 401 Certificate.

In order to streamline the permitting process for wetland permits, the ACOE issued a general permit, the *New Hampshire State Programmatic General Permit* (NH PGP), for projects that are expected to have a minimal impact on the aquatic environment. The NH PGP includes criteria for eligible projects. Because it is still a federal permit, it requires 401 Certification. NHDES issues “general 401 Certificates” for the NH PGP that includes general provisions for protecting water quality. Most projects under NH PGP do not require an individual 401 Certification review since water quality is addressed through the general 401 Certification. However, NHDES can modify the general 401 Certification, or revoke and issue a new 401 Certificate for any project included under the general permit. In New Hampshire, the NHDES Wetlands Bureau contacts the ACOE to determine if a project falls under the NH PGP and the general 401 Certification, or if a separate 401 Certification is required.

Further information about the 401 Water Quality Certification Program may be found at NHDES's website at: http://des.nh.gov/organization/divisions/water/wmb/section401/index.htm

### New Hampshire Alteration of Terrain Permit

The New Hampshire Alteration of Terrain permit is issued by the Alteration of Terrain (AoT) Program within NHDES. This permit protects New Hampshire surface waters, drinking water supplies, and groundwater by controlling soil erosion and managing stormwater runoff from developed areas. An AoT permit is required whenever a project proposes to disturb more than 100,000 square feet of contiguous terrain (50,000 square feet, if a portion of the project is within the protected shoreland). In addition to these larger disturbances, the AoT Permit by Rule applies to smaller sites.

This permitting program applies to earth moving operations, such as industrial, commercial, and residential developments as well as sand pits, gravel pits, and rock quarries. Permits are issued by NHDES after a technical review of the application, which includes the project plans and supporting documents. Information on this program, including current rules, AoT forms, and worksheets may be found at the following website: http://des.nh.gov/organization/divisions/water/aot/index.htm

Traditionally, the Alteration of Terrain permitting program addressed water quantity and quality, with a primary focus on prevention of downstream flooding and increased peak flows to receiving waters and treatment of stormwater. In 2005, the NHDES began substantial revisions of the Alteration of Terrain Program Rules (Env-Wq 1500, formerly Env-Ws 415).

### New Hampshire Wetland Permit

The New Hampshire Wetland permit is issued by the Wetlands Bureau within NHDES under RSA 482-A, which authorizes NHDES to protect the State's wetlands and surface waters by requiring a permit for dredge or fill or construction of structure in wetlands or other waters of the state.

A Wetland Permit is required for any alteration of tidal or non-tidal wetlands. Permits are issued by NHDES after a technical review of the application, which includes a statement of the impact from the proposed activity. The statement of impact must include evidence to demonstrate that potential impacts have been avoided to the maximum extent practicable and that any unavoidable impacts have been minimized. Any proposed permanent impacts to wetlands must be mitigated. The permit application should include a plan for mitigation to compensate for the wetland areas lost due to the proposed activity. There are certain exemptions from the required mitigation such as if the impact is considered minor. Information on this program, including current rules, permit forms, and worksheets may be found at the following website: http://des.nh.gov/organization/divisions/water/wetlands/index.htm.

### New Hampshire Shoreland Permit

The New Hampshire Shoreland Permit is issued by the NHDES Wetland Bureau. This permit protects the shorelands surrounding state surface waters by managing disturbance within the protected shoreland area. The protected shoreland is defined as the land within 250 feet of a surface water. A Shoreland Permit is required whenever a project proposes construction, excavation, or filling within the protected shoreland.

Permits are issued by NHDES after a technical review of the application, which includes a narrative description of the project, the project plans, a detailed worksheet, and supporting documents. Information on this program, including current rules, application, and worksheets may be found at the following website: http://des.nh.gov/organization/divisions/water/wetlands/cspa/index.htm.

### National Pollutant Discharge Elimination System Program

The Clean Water Act authorized the U.S. EPA to regulate point sources that discharge pollutants into waters of the United States through the National Pollutant Discharge Elimination System (NPDES) permit program. In some states, this regulatory authority is delegated to state government for administration. In New Hampshire, the NPDES program is administered by the U.S. EPA. The program regulates "point sources" generated from a variety of municipal and industrial operations, including treated wastewater, process water, cooling water, and includes stormwater from certain urbanized areas, industrial activities, and construction sites.

In 1990, EPA implemented the NPDES Phase I Storm Water Program, which regulates cities and counties with populations of 100,000 that operate a municipal separate storm sewer system (MS4), specific industrial operations (as defined at 40 CFR 122.26(b)(14) ), and construction activities that disturb 5 or more acres of land. Industrial activities are covered under a Multi-Sector General Permit (MSGP) issued by the EPA.

Since March of 2003, municipalities and developers have been subject to stormwater management requirements under Phase II of EPA's Storm Water Program. Phase II regulates municipally owned industrial activities (e.g., runoff from municipal wastewater treatment facilities and transfer stations), small municipal separate storm systems (MS4s) located within "urbanized areas" as defined by the latest census from the U.S. Census Bureau, and construction activities that disturb between 1 and 5 acres. The Phase II regulations related to land disturbance are implemented through the following general permits:

- General Permit for Storm Water Discharges from Small Municipal Separate Storm Sewer Systems (MS4s). The MS4 General Permit involves the implementation of a stormwater management program encompassing six minimum control measures for addressing stormwater impacts. Two of the minimum control measures relate to construction and development (including redevelopment).

Condominium development under construction in New Hampshire

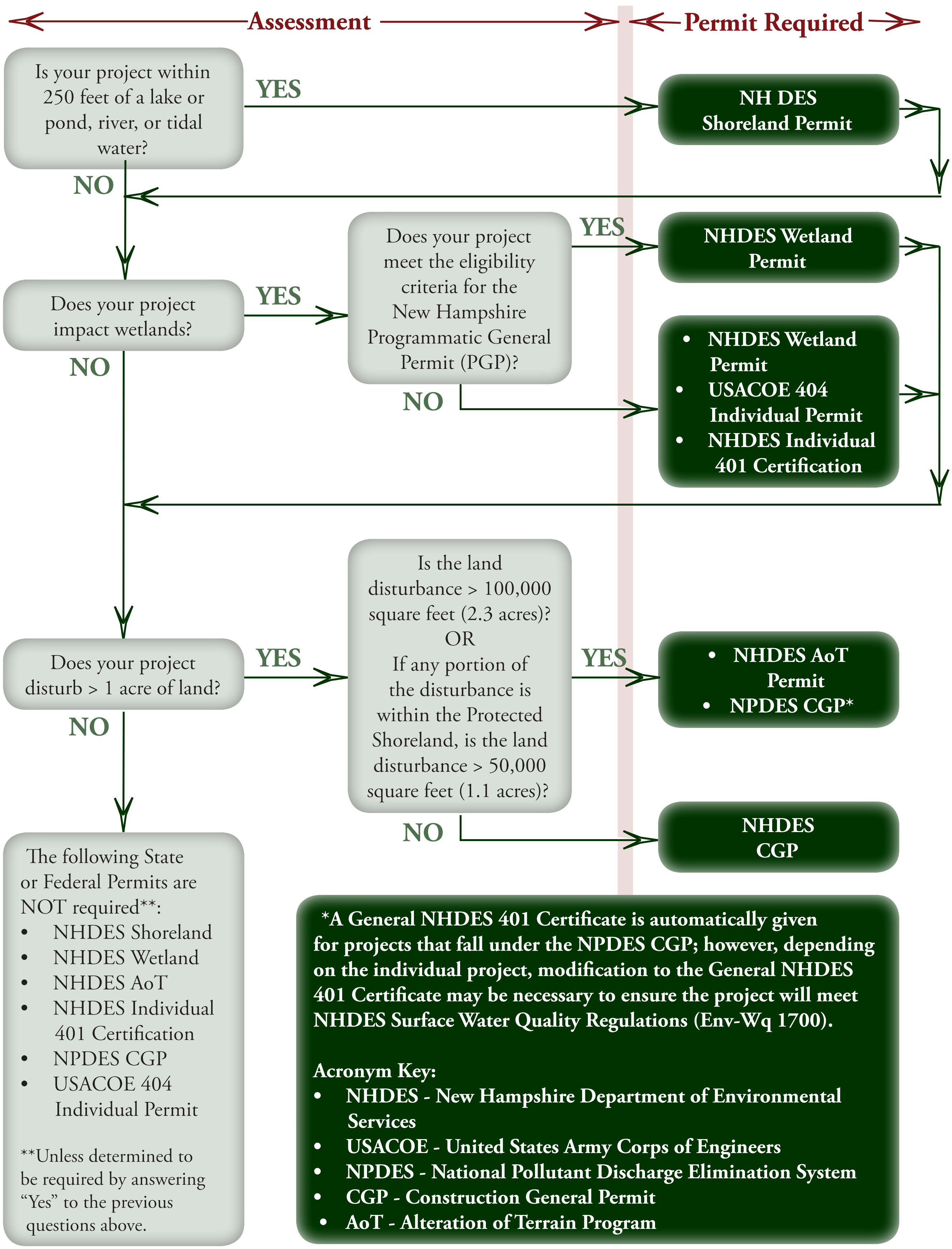
- The NPDES Construction General Permit (CGP), which is the primary federal permit involved in land disturbance activities, is required for construction activity that disturbs one or more acres of land. If the construction activity creates less than one acre of disturbance, but is part of a larger common plan or sale of development totaling over one acre of disturbance (e.g., a single lot within a planned subdivision), a permit is needed. It is important to note that the one acre threshold is for the total disturbance and does not need to be a contiguous (or connected) disturbed area to be included in the total disturbance.

EPA and NHDES define "construction activity" to include clearing, grading, and excavating that results in land disturbance including activities related to construction such as landscaping, demolition, and building homes, office buildings, factories, roads and other development activities. Because the NPDES CGP is a federal permit, projects are required to obtain a 401 Certificate from NHDES, as discussed earlier in this section.

Further information about the NPDES Storm Water Phase I and Phase II Programs may be found at EPA's website at the following webpage: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm#phase1

Information regarding the applicability of the program to certain municipally owned or operated "industrial activities" may be found at the following webpage: http://epa.gov/boston/npdes/stormwater/industrial_act.html

## Figure 4-2. Applicability of Permit Programs



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# Chapter 5
# Antidegradation

Development projects requiring any of the permits or certificates described in Chapter 4 are subject to a NHDES Antidegradation Review to ensure compliance with the New Hampshire Surface Water Quality Regulations (Env-Wq 1700).

### *Antidegradation Notice*

In 2009, NHDES staff will be convening a workgroup of interested stakeholders to review the proposed antidegradation requirements described in Section 5-2. The workgroup will finalize the requirements for meeting the antidegradation provisions and the procedure for NHDES review of proposed activities. This manual will be updated to incorporate the requirements at the completion of the workgroup.

## 5-1. Antidegradation Provisions

This section defines the components of the antidegradation provisions including water quality categories used to classify waterbodies for each parameter, assimilative capacity of receiving waters, significant versus insignificant pollutant loading, and demonstration of economic or social development.

### Water Quality Categories

Existing water quality places a waterbody into one of four categories for each water quality parameter, including: Impaired Waters, Tier One Waters, Tier Two Waters (High Quality Waters), and Outstanding Resource Waters. A single waterbody can fall into one or more categories depending on the parameter being evaluated.

For example, a river with a low phosphorus concentration and a high chloride concentration could be Tier Two (High Quality) for phosphorus and Tier One for chloride. Further, if the chloride concentration is so high that it violates the chloride water quality standard, the waterbody would be impaired for chlorides, but still Tier Two (High Quality) for phosphorus. These categories are described in detail below and a schematic is shown in Figure 5-1.

### Impaired Waters

An impaired waterbody is one that does not meet one or more water quality criteria due to an individual pollutant, multiple pollutants, a cause other than pollution (e.g., hydrologic modification, such as dam construction and water withdrawals), or for reasons that have not yet been determined. By failing to meet the criteria, the waterbody fails to support one or more of its designated uses. Many of the waterbodies in New Hampshire are impaired by pollutants that are not associated with development activities (e.g., mercury). Although these pollutants are still a concern, they are not typically factored into the antidegradation review for development activities.

The list of impaired waters in New Hampshire, including the 303(d) list of impaired waters and waters that are impaired by sources other than pollutants, is available on the NHDES website at: http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm. This assessment is updated by NHDES and approved by EPA every two years.

### Tier One Waters

A Tier One waterbody is one that supports the existing uses of that waterbody by meeting one or more water quality criteria within the reserve assimilative capacity of that waterbody. The reserve assimilative capacity is typically 10% of the total assimilative capacity of the waterbody for each parameter. Assimilative capacity is described further below. In general terms, the water quality criteria are met, but just barely (within sampling and analytical variation (10%)), so that any increase in pollutant loads could cause the quality to decrease below the criteria and make the waterbody impaired for those criteria. The Tier One classification should be determined on a project specific basis depending on the availability of data.

Spring flooding along the Merrimack River, Concord, New Hampshire

### Tier Two Waters (High Quality)

A Tier Two waterbody is one that supports the existing uses of the waterbody by meeting one or more water quality criteria to support the existing uses by greater than the reserve assimilative capacity of that waterbody. In general terms, the water quality is better than the water quality criteria and an increase in pollutant loads would not cause the waterbody to become impaired. ***Insignificant*** increases in pollutant loading are allowed, however, significant increases in pollutant loading require a demonstration of social or economic development. Insignificant versus significant pollutant loading and the requirements of demonstration of social or economic development are described in greater details below. The Tier Two classification should be determined on a project specific basis depending on the availability of data.

### Outstanding Resource Waters

In addition to the three water quality categories that are based solely on meeting water quality criteria, Outstanding Resource Waters (ORW) are administratively designated in New Hampshire for their outstanding natural or cultural resources. ORWs include waters of the national forests and natural segments of New Hampshire's designated rivers under the Rivers Management Protection Act (RSA 483:7-a). An ORW can be either Tier One, Tier Two or impaired depending on its existing water quality for each parameter.

Refer to the following resources to determine if the waterbody in question is an Outstanding Resource Water:

- New Hampshire Designated Rivers, Natural Segments: this list is updated as additional New Hampshire rivers are designated as natural and is available on the NHDES website at: http://des.nh.gov/organization/divisions/water/wmb/rivers/index.htm. Details of river segment delineation are described in RSA 483.
- If the waterbody is within the designated National Forest boundaries. A map of the White Mountain National Forest is available at: http://www.fs.fed.us/r9/forests/white_mountain/maps/location_map.php

### Assimilative Capacity

A waterbody may be able to accept additions of some pollutants without violating water quality standards. However, the addition of other pollutants to the same waterbody may cause an impairment. The amount of each

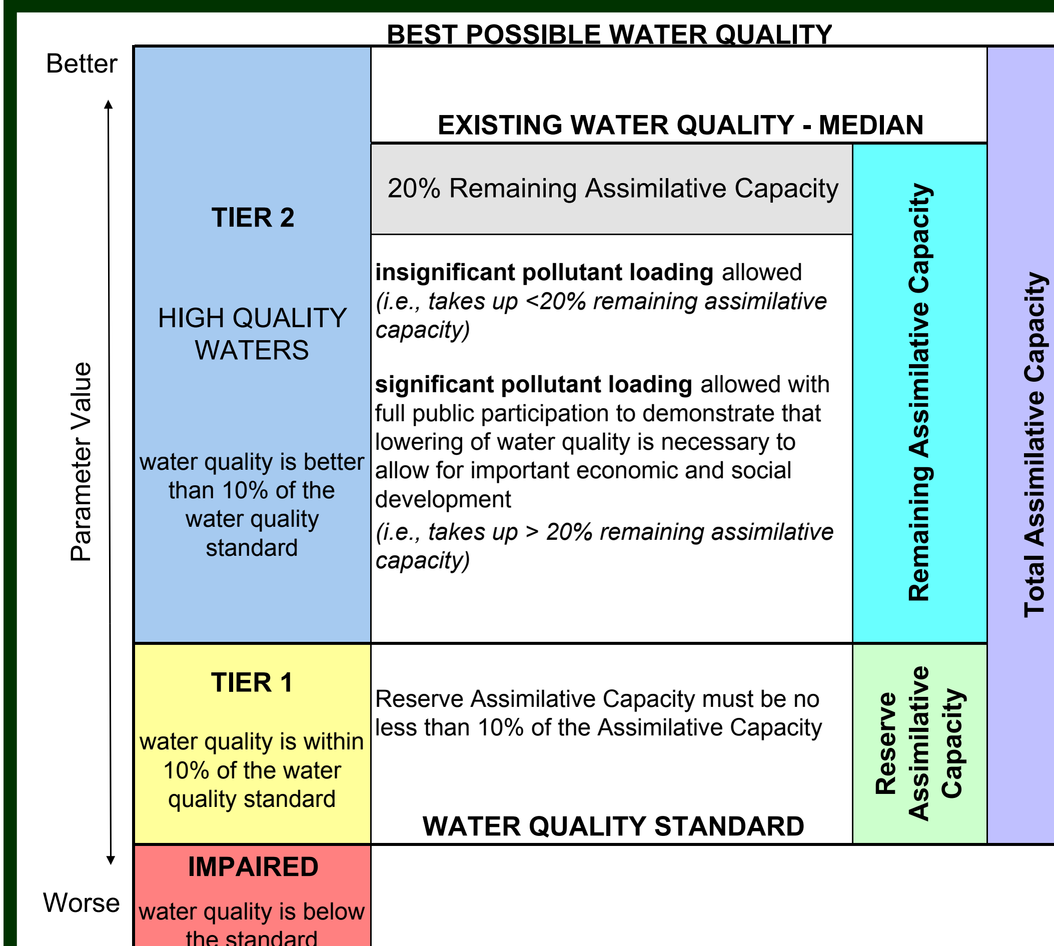



Figure 5-1. Summary of water quality categories related to Antidegradation.

pollutant that can be released to a waterbody without causing violations of applicable water quality criteria is called the assimilative capacity.

Determining the assimilative capacity of a waterbody for the purposes of antidegradation only applies to Tier 2 - High Quality Waters that have useable remaining assimilative capacity. Tier one waters have assimilative capacity, but it is held in reserve. Each waterbody has a unique remaining assimilative capacity for each water quality parameter that is based on the current concentration of that parameter in the waterbody.

The total assimilative capacity of a waterbody is the difference between the best possible water quality and the water quality standard, below which we observe impairments. The remaining assimilative capacity is the difference between the existing water quality, typically the median value, and the reserve assimilative capacity. The reserve assimilative capacity must be at least 10% of the total assimilative capacity. This is to provide additional water quality protection and prevent the quality of a waterbody from being degraded all the way down to the water quality standard. Figure 5-1 describes this further.

### Insignificant Versus Significant Pollutant Loading

An increase in loading to a waterbody is allowed for parameters that classify that waterbody as Tier 2. The Antidegradation Provisions of the New Hampshire Surface Water Quality Regulations (Env-Wq 1708) describe insignificant and significant pollutant loading and the requirements for each classification.

Insignificant pollutant loading is defined as a discharge or activity that is projected to utilize less than 20% of the remaining assimilative capacity for a given parameter, in terms of either concentration or mass of pollutants, or volume or flow rate for water quantity. In most situations insignificant discharges are acceptable. However, if NHDES determines that the effect of the discharge will have a greater impact than a normal insignificant discharge, either because of the cumulative lowering of water quality over time, possible additive or synergistic effects, or for other reasons defined in Env-Wq 1708.09(d), the discharge would be considered significant and would be subject to the requirements for significant pollutant loading.

Significant pollutant loading is defined as a discharge or activity that is projected to utilize 20% or more of the remaining assimilative capacity for a water quality parameter. Significant discharges must demonstrate that the proposed lowering of water quality is necessary to achieve important economic or social development.

### Demonstration of Economic or Social Development

Development activity in a Tier Two (High Quality) watershed that is determined to result in a significant discharge, requires the submittal of documentation to demonstrate that the lowering of water quality is necessary to achieve important economic or social development in the area where the waterbody is located.

At this time, the New Hampshire Water Quality Standards Advisory Committee is defining the guidelines for development and the process for reviewing a Demonstration of Economic and Social Development. Until this process has been completed, the following information is required for NHDES to determine if sufficient justification exists, as described in Env-Wq 1708.10:

- Alternative methods of production or operation;
- Improved process controls;
- Water conservation practices;
- Wastewater minimization technologies;
- Non-discharging alternatives;
- Improved wastewater treatment facility operations;
- Alternative methods of treatment, including advanced treatment beyond applicable technology requirements of the Clean Water Act; and
- Alternative sites, and associated water quality impacts at those sites.

More information on the Demonstration of Economic or Social Development can be found in Interim Economic Guidelines for Water Quality Standards, EPA-823-B-95-002, published by the EPA in March 1995. Additional information is also available on the New Hampshire Water Quality Standards Advisory Committee website at: http://des.nh.gov/organization/divisions/water/wmb/wqs/index.htm.

*Antidegradation Notice*

In 2009, NHDES staff will be convening a workgroup of interested stakeholders to review the proposed antidegradation requirements described in Section 5-2. The workgroup will finalize the requirements for meeting the antidegradation provisions and the procedure for NHDES review of proposed activities. This manual will be updated to incorporate the requirements at the completion of the workgroup.

## 5-2. Proposed Antidegradation Requirements

The antidegradation requirements are based on the existing water quality of a waterbody. Recognizing that water quality data may not always be available or may be costly to obtain, NHDES has proposed specific targets for meeting the Antidegradation Provisions based on the availability of water quality data. This section describes the proposed water quality requirements that must be met and the items that should be submitted by the applicant to satisfy the NHDES Antidegradation Review.

Refer to the flow chart presented as Figure 5-4 for a summary of the proposed requirements of the Antidegradation Provisions.

### Proposed Surrogate Measures for Pollutant Loading Analysis – The 1065 Rule

NHDES has proposed a target 10% effective impervious cover (%EIC) maximum and 65% undisturbed cover (% UDC) minimum for development sites, referred to as "the 1065 Rule." This is based on the Center for Watershed Protection's Impervious Cover Model, discussed in greater detail below. It means that, in general and regardless of land use type, there should be no greater than 10% EIC and no less than 65% UDC within the property boundary of a site; otherwise, pollutant loading calculations need to be performed to quantify the effects of the development.

### Effective Impervious Cover (EIC)

Effective impervious cover (EIC) is best described in relation to total impervious cover. The total impervious cover of a site includes all impervious areas on the land surface, such as pavement, roofs, roadways, or other human structures with a low capacity for soil infiltration and having a curve number (CN) of 98 or greater. Refer to the call out box on Curve Numbers on page 41. Total impervious cover is typically expressed as a percentage of the total project area or subwatershed area.

The EIC of a site is the portion of the total impervious cover that is directly connected to the storm drain network. EIC usually includes roadways,

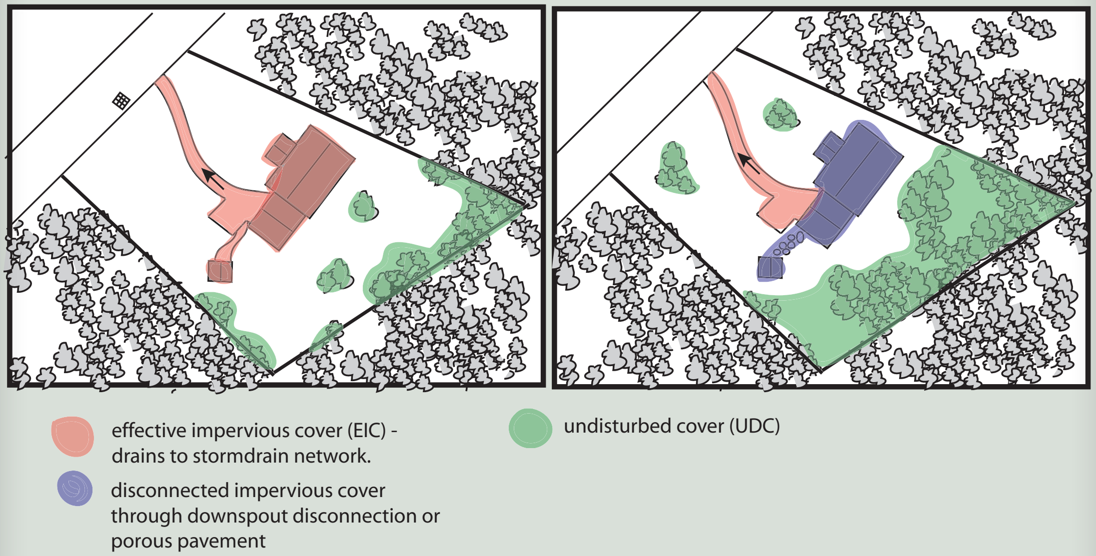



Figure 5-2. The volume of stormwater entering the storm drainage network can be reduced by decreasing the amount of effective impervious cover and increasing the amount of undisturbed cover on a site.

**Common Misconception about Effective Impervious Cover**

The EIC limit is often misinterpreted as a limit on total impervious cover and therefore a limit on development in general. It is also often thought to promote sprawl by limiting development in a watershed, which would expand the amount of disturbed land as development is pushed outward. This is incorrect. In actuality, sprawl is often caused by regulations on minimum lot size, e.g., 2-acre single family lots. Municipalities in New Hampshire often enforce minimum lot sizes in an attempt to maintain the towns' rural character and limit development. In reality, they may be contributing to sprawl.

The misunderstanding of the Impervious Cover Model is most often due to not recognizing the distinction between effective impervious cover and total impervious cover. In theory, a development can create the same amount of impervious cover (i.e. the same size houses and driveways or the same size commercial development) as in traditional development as long as site design techniques are implemented to disconnect the impervious surfaces from each other and route runoff to pervious areas where it can be infiltrated. Therefore, the density of development can remain the same and continues to be a function of local zoning. Site design techniques used to minimize the effective impervious cover are explained further in Chapter 6.

driveways and other impervious surfaces, such as rooftops, that are hydraulically connected to the drainage network. However, if a roof drain transporting rooftop runoff is directed to a pervious, vegetated area to infiltrate into the ground, it may be considered disconnected and is not included as EIC (see Figure 5-2). EIC is also typically expressed as a percentage of the total project area.

### Undisturbed Cover (UDC)

Undisturbed cover is land surface that has not been altered by human activity. In the northeastern United States there are very few truly undisturbed, natural areas. At one point the majority of land in New Hampshire had been cleared of its forests to make way for agriculture. When agriculture was abandoned for industry, the forests were able to re-establish. NHDES considers the reclaimed forests and other land left to return to its natural state over time as undisturbed cover. Therefore, a forest, meadow, field, or other vegetated land area that has been allowed to return to its natural state and is not maintained is considered undisturbed cover. Undisturbed Cover (UDC) is typically expressed as a percentage of the total project area.

### Impervious Cover Model Background

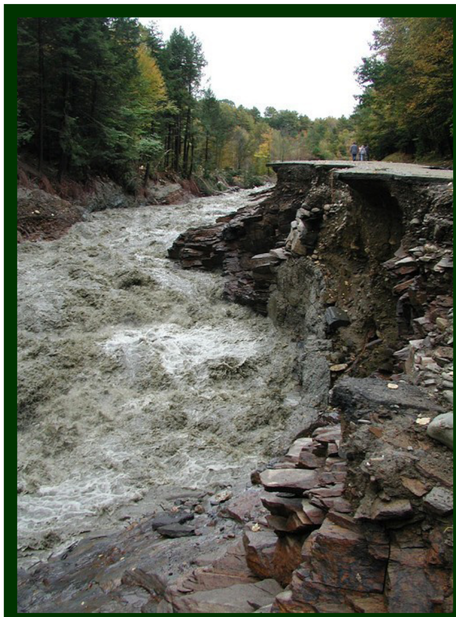
The Impervious Cover Model (ICM) was developed by the Center for Watershed Protection to relate surface water quality (state of impairment) to the amount of impervious cover in the watershed. It is based on several studies that relate EIC to the extent of impairment to receiving waters. The studies indicate that when EIC is in the range of 0 to 10%, receiving waters are slightly impacted by watershed development, while EIC values exceeding 25% are associated with significant impairment (CWP, 2003), as shown in Figure 5-3. Although these percentages are typically measured on a watershed scale, for purposes of permitting and reviewing the impact of individual development activities, this concept has been modified to the site level. This allows permit applicants and reviewers the ability to quickly assess the potential impact of a proposed project on the receiving waters.

There are several assumptions and limitations to the ICM including:

- It does not account for wastewater pollutant loadings
- It does not account for in-stream water quality processes
- It is best suited for 1st through 3rd order streams
- Additional site specific information is required for identification and specification of BMPs to achieve water quality goals

The majority of information required to calculate the effective impervious cover and the undisturbed cover of a site is already completed when the project drainage analysis is prepared. The following should be used when calculating the EIC and UDC to improve the accuracy of the calculations:

- Project-specific impervious cover data-layer
- Project-specific estimates of directly-connected (effective) impervious cover
- Incorporation of storm sewer networks to refine watershed delineation and directly-connected impervious cover
- Accounting for existing BMPs in impervious cover and load determinations.


New Hampshire's Route 123 after flooding of the Cold River in October, 2005.

### Proposed Water Quality Requirements

Under the proposed requirements, the majority of projects, with the exception of those listed below, would need to show that the proposed activity would not significantly degrade water quality. This is accomplished through one of the following proposed options, summarized in Figure 5-4:

1. Submit calculations showing that the project meets the 1065 Rule, i.e., creates ≤ 10% EIC and maintains ≥ 65% UDC within the property boundary (or no increase in EIC or decrease in UDC for redevelopment projects), or
2. Submit calculations showing that the project will not increase pollutant loading, will not increase the stormwater peak flow, and will maintain the ground water recharge volume , or
3. Conduct a water quality analysis to determine the remaining assimilative capacity of the water body. If it is determined that the waterbody is:
   Tier 1: Submit calculations showing that the project will not increase pollutant loading, will not increase the stormwater peak flow, and will maintain the groundwater recharge volume.
   Tier 2: a. Submit calculations showing that any pollutant from the

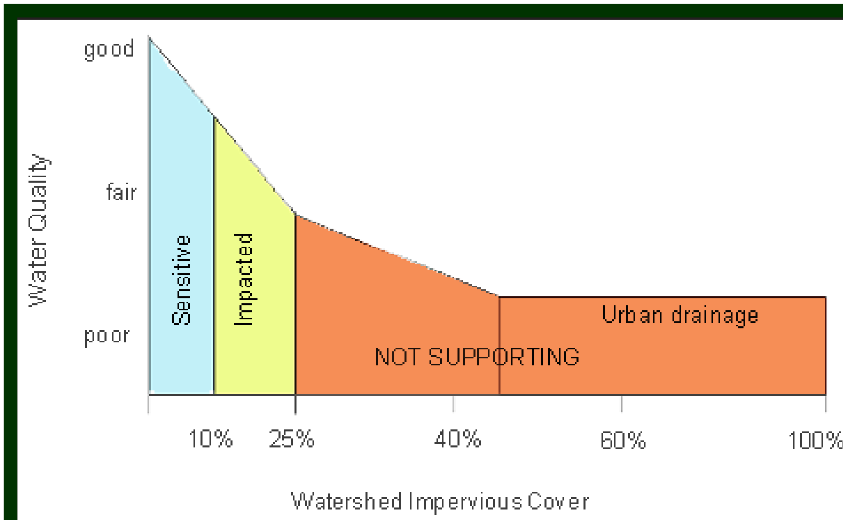



Figure 5-3. Impervious Cover Model relating percent watershed impervious cover to stream quality. Adapted from Center for Watershed Protection's *Impacts of Impervious Cover on Aquatic Systems*.

project will not take up more than 20% of the remaining assimilative capacity of the surface water, or

b. Submit calculations showing that any pollutant from the project will not take up more than 90% of the total assimilative capacity of the surface water, and demonstrate, in accordance with Env-Wq 1708.10, that significantly lowering the water quality is necessary for important social or economic development. Note that this is considered a significant impact (see Section 5-1).

*Exceptions to the Proposed Water Quality Requirements*

*Impaired Waters*

If the project is within one-mile upstream of an impaired water the following is required:

a. Submit pollutant loading calculations showing that the proposed activity complies with the TMDL (if a TMDL has been completed) or does not increase the loading of any pollutant that could affect the impairment; and,

b. Submit pollutant loading calculations (or approved surrogate measure) for all other pollutants not affecting the impairment (see options 1 through 3 above).

*Outstanding Resource Waters*

If the project is within one-mile upstream of an ORW the following is required:

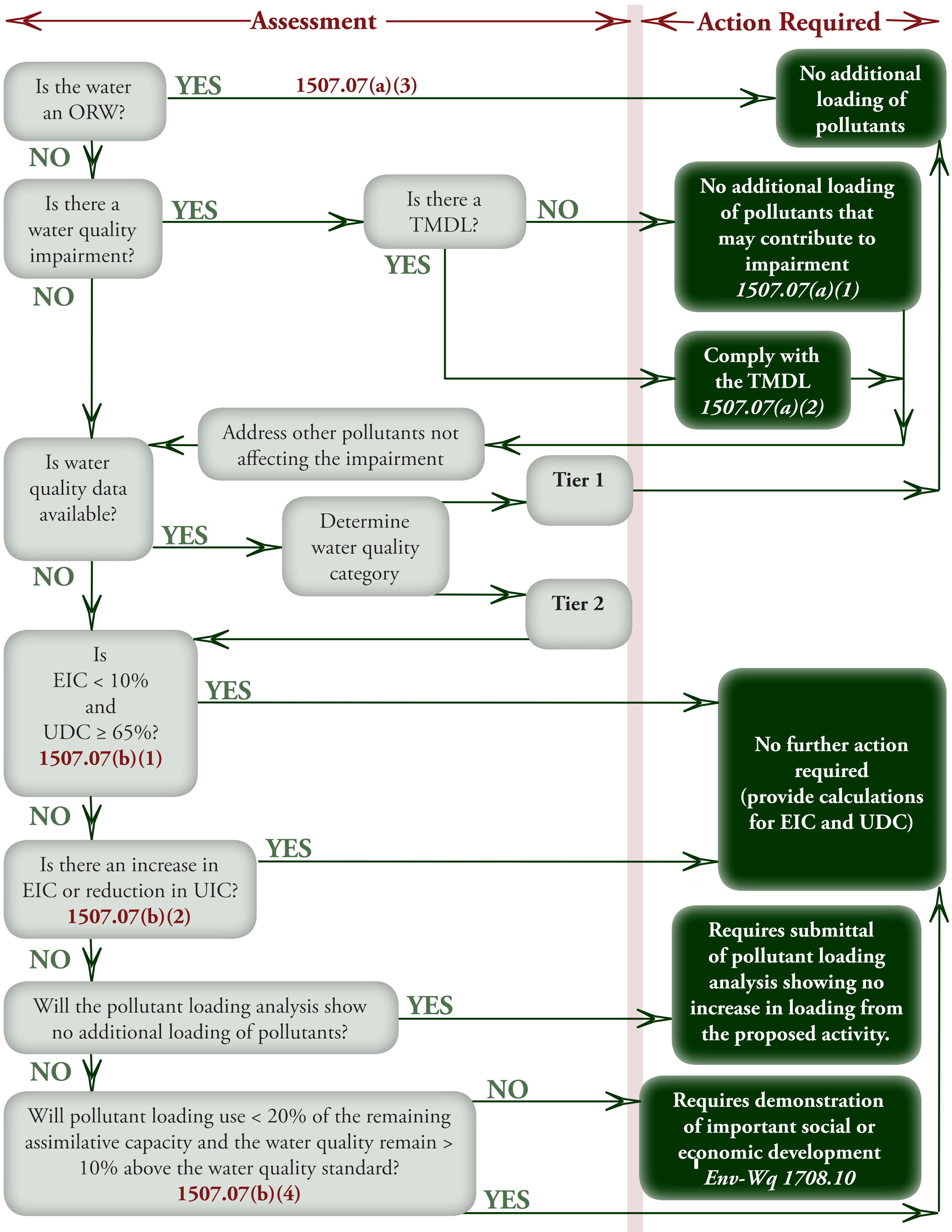
a. Submit pollutant loading calculations showing that the project will not increase pollutant loading, will not increase the stormwater peak flow, and will maintain the ground water recharge volume.

### Proposed Submittal Items and Formats

For the purposes of Antidegradation Review, it is proposed that documentation of meeting the above Water Quality Requirements should be submitted electronically to NHDES in accordance with the submittal matrix below, with hard copies to be submitted upon request by NHDES. Electronic submittals should include the following:

- Reference to the Alteration of Terrain, NPDES-Construction General Permit, or other permit or certificate application,
- Site plans showing the project boundaries, lot lines, surface waters, drainage system and drainage divides, areas of undisturbed cover, and the location of all existing and proposed impervious areas, including but not limited to roadways, sidewalks, rooftops, buildings, and driveways,
- Calculations of percent EIC,
- Calculations of percent UDC,
- If the EIC and UDC targets are not met, pollutant loading calculations including:
  - Event mean concentrations
  - BMP descriptions and removal efficiencies for each land use
  - Schematic showing how the project was modeled (i.e., locations of subwatersheds and BMPs)
  - A summary of pre- and post-development annual loads for all pollutants of concern (see Chapter 8 for guidance on completing the necessary calculations).
  - A certification stating that the project, if built as designed, will meet the pollutant loading criteria set forth by the Department, signed and stamped by a New Hampshire licensed Professional Engineer (please provide an original certification, P.E. stamp and signature).
- For an area to be disconnected, copies of the recorded deed restrictions when the plans show that the drainage for individual lots or portions of individual lots will be maintained within the lot boundary and not connected to the site drainage network stating that the current and future connection of the lot drainage to the site drainage network is prohibited and that all stormwater must be treated and drainage maintained, as approved, on the individual lot.
- A Stormwater System Operation and Maintenance Plan (the Plan). The purpose of the Plan is to show how the stormwater system will be maintained so that it will continue to achieve the estimated post-development pollutant loads. At a minimum, the Plan should address inspection and maintenance of all aspects of the stormwater drainage system and associated BMPs as described in Section 7-5 and give the authority of a second entity (e.g., town, neighborhood association, etc.) to maintain systems if a site owner fails to do so.

Figure 5-4. Applicability of the Proposed Antidegradation Provisions



### Curve Numbers

Curve number (CN) values are commonly used parameters to determine how much rainfall will become runoff. They are based on land use cover and soil type, with higher CN values corresponding to poorly drained soils and more impervious area, resulting in increased runoff. Thus, a natural wooded area that infiltrates runoff will have a lower CN value than a paved area where no runoff can infiltrate. Impervious areas have a CN value of 98 or greater. The following table contains a condensed version of the Natural Resource Conservation Service (formerly the Soil Conservation Service) Runoff Curve Number values from TR-55.

| Runoff Curve Numbers[1] | | | | |
|---|---|---|---|---|
| **Cover Description** | **Curve Number for Hydrologic Soil Group** | | | |
| **Cover Type and Hydrological Condition** | **A** | **B** | **C** | **D** |
| **Open Space (lawns, parks, golf courses, cemeteries, etc)[2]:** | | | | |
| Poor condition (grass cover <50%) | 68 | 79 | 86 | 89 |
| Fair condition (grass cover 50% to 75%) | 49 | 69 | 79 | 84 |
| Good condition (grass cover >75%) | 39 | 61 | 74 | 80 |
| **Impervious areas:** | | | | |
| Paved parking lots, roofs, driveways, etc. (excluding right-of-way) | 98 | 98 | 98 | 98 |
| **Streets and roads:** | | | | |
| Paved; curbs and storm sewers (excluding right-of- way) | 98 | 98 | 98 | 98 |
| Paved; open ditches (including right-of-way) | 83 | 89 | 92 | 93 |
| Gravel (including right-of-way) | 76 | 85 | 89 | 91 |
| Dirt (including right-of-way) | 72 | 82 | 87 | 89 |
| **Woods:** | | | | |
| Poor condition (forest litter, small trees, and brush are destroyed by heavy grazing or regular burning) | 45 | 66 | 77 | 83 |
| Fair condition (Woods are grazed but not burned, and some forest litter covers the soil) | 36 | 60 | 73 | 79 |
| Good condition (Woods are protected from grazing, and litter & brush adequately cover the soil) | 30[3] | 55 | 70 | 77 |

[1] Condensed from Tables 2-2 (a-d) of NRCS (formerly SCS) TR-55(1986).

[2] CN's shown are equivalent to those of pasture. Composite CN's may be computed for other combinations of open space cover type.

[3] Actual curve number is < 30; use CN = 30 for runoff computations.

## Chapter 5 References


Center for Watershed Protection. 2003. *Impacts of Impervious Cover on Aquatic Systems.* Watershed Protection Research Monograph No. 1. March 2003.

Center for Watershed Protection. Better Site Design: A Handbook for Changing Development Rules in Your Community. August 1998.

ENSR Corporation. Pilot TMDL Applications Using the Impervious Cover Method. October 2005.

Partnership for Environmental Technology Education and Maine Department of Environmental Protection, Bureau of Land and Water Quality. *Barberry Creek Total Maximum Daily Load (TMDL) Draft Report.* July 2005.

Prince George's County Maryland Department of Environmental Resources, Programs and Planning Division. *Low Impact Development Design Strategies: An Integrated Design Approach*. January 2000.

State of New Hampshire Code of Administrative Rules. *PART Env-Ws 415 Alteration of Terrain Activities Revised Draft.* February 16, 2006.

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United States Environmental Protection Agency Office of Science and Technology Region 1 and New England Interstate Water Pollution Control Commission. Water Quality Standards Academy – Basic Course. June 21-24, 2005. *Water Quality Standards Academy Participant Manual Module 14 – Antidegradation.* 2005.

# Chapter 6 Non-Structural Site Design Techniques

There are many non-structural site design techniques that can be used to reduce the volume of stormwater runoff generated at a site. Reduced volume means less stormwater requiring treatment before entering a receiving water. These techniques focus on maintaining and mimicking the natural hydrology to the maximum extent practical, minimizing land disturbance, and minimizing the amount of impervious cover.

Some of the techniques mentioned in this chapter may differ from some of the traditional site planning practices upon which local zoning requirements and subdivision standards have been based. As such, application of these techniques will need to be considered in the context of these local requirements. Where allowed by local requirements, the application of the techniques may be feasible with appropriate waivers or exceptions. In some cases, use of the techniques may require changes to zoning provisions or other local requirements.

## 6-1. Site Design Techniques

Traditionally, runoff management has focused on end-of-pipe methods to detain and treat stormwater. Although end-of-pipe methods have their place in stormwater management, when used alone they are often more costly and maintenance intensive than techniques that minimize stormwater runoff or treat it close to the source. Fortunately, there are many simple, non-structural methods that can be incorporated into the planning process that maintain the natural landscape and preserve the hydrologic functions of a site (U.S. Department of Housing and Urban Development, 2003). Applying such methods minimizes the amount of runoff generated and lessens the treatment volume by controlling stormwater at the source. This approach can also lower overall development costs by reducing the need for, and the sizing requirements of, structural, engineered devices. More information on the cost benefit of these site design

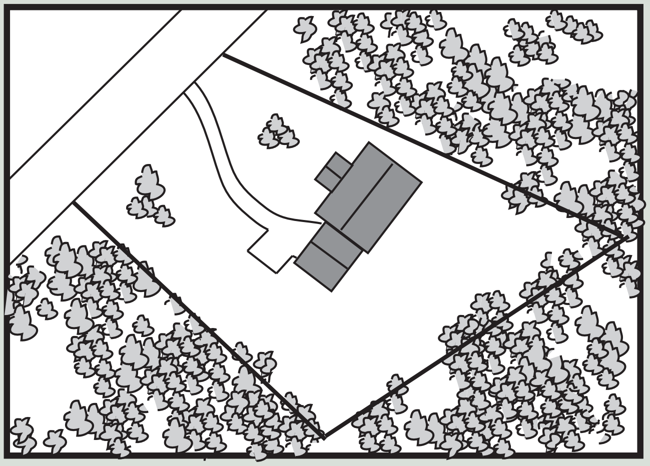

Figure 6-1. Property with maximum disturbance and nearly all of the vegetation removed.

techniques is available from the Low Impact Development Center at: http://www.lid-stormwater.net/background.htm

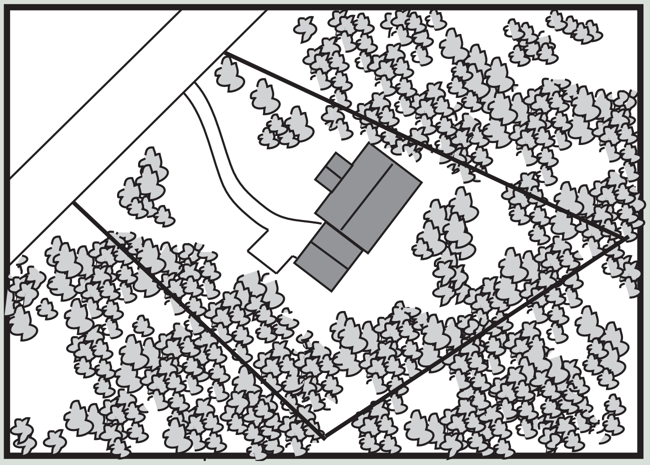

Figure 6-2. Property with vegetation selectively cleared to minimize disturbance.

In order to effectively incorporate these methods, the runoff from a site needs to be managed on a smaller scale. Accomplishing this often requires a shift in thinking. Instead of managing all of a site's runoff through one practice, e.g., collecting the runoff from a subdivision or a commercial development in one large stormwater pond, the runoff is addressed at the individual lot level through many different practices. For example, a site design might incorporate the use of rain barrels or dry wells to collect roof runoff, rain gardens to collect runoff from driveways or parking lots, and smaller stormwater ponds to collect runoff from common, open space areas. This design approach also requires a shift away from altering and grading a site to pipe runoff to a single discharge point, to instead, working with the existing topography and hydrology to maintain flow paths and maximize opportunities for natural flow attenuation and infiltration. This reduces the dependence of the development on downstream carrying and treatment capacity. The following site design concepts assist in reducing the amount of stormwater generated by managing stormwater at the source.

### Minimize Disturbed Areas

Any change in the landscape from the existing condition is considered a disturbance. Disturbed areas include all impervious areas such as roads, sidewalks, and rooftops as well as pervious areas such as graded lawns and open drainage systems. The most effective way to minimize the amount of disturbed area and to reduce the stormwater impacts of a site is to use hydrology-based site design.

The primary function of hydrology-based site design is to work within the boundaries of the existing landscape. The first step is to identify existing natural features on the site to restrict and define site disturbance (Prince George's County, Maryland, 1999). For example, are there any steep slopes? Are there wetlands or streams? What are the soil conditions? Asking these questions and determining the most appropriate locations for disturbance and for preservation on the site is often referred to as "site fingerprinting".

Designers are encouraged to avoid disturbing sensitive areas, such as wetlands and streams and their buffer areas, flood plains, and steep slopes. It is also important to try to target disturbance to areas that already have a low capacity for infiltration, such as soils classified as hydrologic soil group C and D or other existing impervious areas. Once these areas have been identified it should be clearer where to locate the areas of disturbance on the site. Regulated resource areas such as wetlands should be clearly marked in the field for survey. All of these areas should be clearly identified on the base plans that the designer will use to develop the site plans for the project.

The following methods are examples of measures that can minimize the disturbed area on a site:

- Define the development envelope and clearly mark it on the plans and in the field.
- Use existing drainage divides by maintaining existing site topography.
- Avoid the removal of trees.
- Limit clearing and grading to the smallest amount required; disturbance should be limited to the building footprint, construction access and safety setbacks.
- Cluster vegetated areas and connect them with vegetated corridors.
- Cluster developed impervious areas and **disconnect** them (see explanation of "Disconnect Impervious Areas" below).
- Establish buffers to wetlands and streams.
- Conserve as much of the site in natural or existing vegetated condition as possible, or in re-development activities, reduce the amount of effective impervious cover by removing or replacing existing impervious cover and disconnecting it.

### Maintain Natural Buffers

Maintaining natural buffers goes hand in hand with minimizing disturbed areas. Natural buffers around streams, wetlands, and other sensitive areas intercept runoff from pervious and impervious areas and treat it through natural filtration, infiltration, and vegetative uptake. The following criteria, adapted from the Center for Watershed Protection's "Site Design Credits", should be followed for a natural buffer to effectively treat stormwater.

- The minimum stream buffer width (i.e., perpendicular to the stream flow path) should be 50 feet as measured from the top of bank elevation of a stream or the boundary of a wetland;
- The stream buffer should meet the maintenance and design requirements of a local buffer ordinance, if applicable;

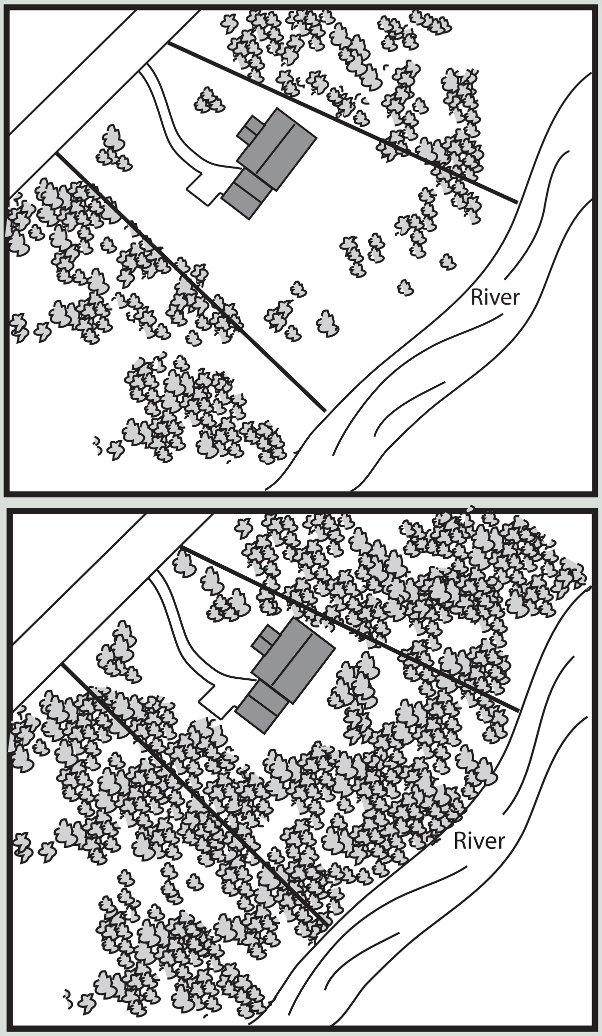


Figure 6-3. Comparison of a lot with very little natural buffer to one with a significant natural buffer intact.

- The maximum contributing flow path should be 150 feet for pervious surfaces and 75 feet for impervious surfaces;
- The average contributing overland slope to and across the stream buffer should be less than or equal to 5.0%;
- Runoff should enter the stream buffer as sheet flow. A stone level spreading device should be used where local site conditions prevent sheet flow from being maintained;
- The stream buffers should remain preserved by a conservation easement or similar protective mechanism. The ground surface must remain ungraded and uncompacted, and the over-story and under-story vegetation maintained in a natural condition.

### Minimize Impervious Cover

Impervious cover includes areas such as sidewalks, driveways, roadways, parking areas and rooftops. In some cases, even lawn areas can be essentially impervious depending on construction practices and the extent to which the soils are compacted (USEPA, 2005).

Frequently, the highest percentage of impervious cover from a development site consists of the roadway. This is particularly the case in many residential subdivisions, and some commercial and industrial park areas.

Methods to minimize the impervious area associated with roadways include:

- Consider alternative roadway layouts.
- Employ narrower road widths.
- Use rural road design (“country drainage”) instead of curb, gutter, and piped roadway drainage (“closed drainage”).

- Limit sidewalks to only one side of the road, or consider pervious trails instead of sidewalks.
- Reduce the amount and type of on-street parking – only on one side, or parallel instead of diagonal.
- Incorporate porous or permeable pavement.

In commercial and industrial developments, as well as residential sites, rooftops, driveways, and parking areas also contribute to the total impervious cover. The following is a sample of methods that can be used to reduce impervious cover from these areas:

- Use a green roof .
- Build two story structures instead of single story structures, to maintain the square footage but reduce the building footprint.
- Use narrow driveway widths.
- Shorten driveway lengths, where grade allows.
- Use shared driveways.
- Use porous pavers or other pervious type of pavement for driveways, parking lots, and overflow parking areas.
- Reduce pavement within parking areas through careful design of efficient aisles and parking bays (e.g., parking on both sides versus one side of an aisle), coupled with the use of vegetated parking lot islands (instead of paved or gravel islands) with depressed planting beds to infiltrate runoff.

### Disconnect Impervious Cover

Although the amount of impervious cover on a site can be minimized, it is unrealistic to think it can be eliminated completely. Despite this, impervious areas do not necessarily have to contribute to the runoff leaving the site. For example, by disconnecting the impervious areas and directing the flow to infiltration basins or designated buffer areas, a portion of additional runoff that would contribute to stormwater runoff is instead infiltrated close to the source. The runoff that would potentially carry pollutants from the site to a surface water instead gets treated and helps recharge groundwater. Disconnection methods and criteria are explained in Section 6-2 below.

### Minimize Soil Compaction

As noted above, even lawns and gravel-surfaced areas can be essentially impervious. We typically think that the infiltration capacity of a lawn should be similar to that of a naturally vegetated area. This is not the case and is most often due to soil compaction during construction.

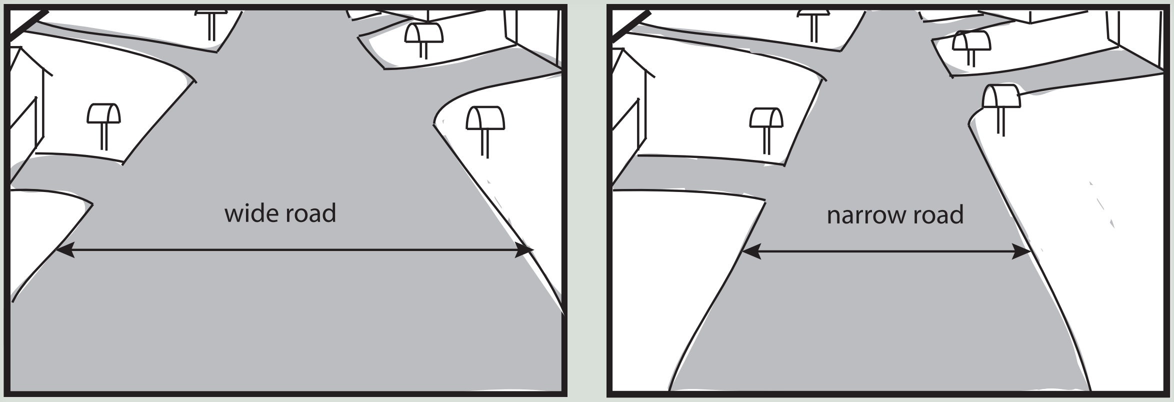


Figure 6-4. Reducing roadway widths can decrease impervious cover.

To reduce the potential for compacted soils, similar to minimizing impervious cover, the following methods can be used:

- Use site "fingerprinting" (discussed above) to determine the areas most appropriate for locating impervious cover.
- Limit development to soils with existing low infiltration capacity such as hydrologic soils group C and D soils (note, however, that some areas classified as D soils may be wetland resource areas or may have water tables at or near the surface and may not be suitable for development).
- Store machinery and equipment within the construction envelope to avoid unnecessarily disturbing areas that could remain vegetated.
- Store construction material and soil stockpiles within the construction envelope.
- Clearly mark on the plans and in the field the boundaries of disturbed areas.
- To the extent feasible, avoid repeated trafficking with construction equipment over areas that will be landscaped, and where construction traffic cannot be diverted, prior to final landscaping deeply scarify impacted soils to restore their infiltration capacity.
- If areas are proposed for use for infiltration of stormwater, then particular efforts will be required to avoid compaction of these areas by construction equipment or traffic, discharge of sediment laden waters to these areas during construction, and premature use of these areas for stormwater management prior to stabilization of these facilities and the contributing drainage areas.

### Use Alternative Pavement

The largest portion of impervious cover in most developed areas is created by parking lots and roadways. It may not be feasible, at this stage in the development of alternative pavements, to use them on highways and heavily traveled secondary roadways. However, parking areas, including commercial parking lots and residential driveways, present an ideal opportunity for alternative pavements to reduce impervious cover. Alternative pavements can also be used on sidewalks, low-traffic alleys or side streets, and walking paths. They may also be used in overflow parking areas, rest areas, and park-and-ride lots. The most common alternative pavement materials are separated into two types: modular pavers and porous pavement.

Modular pavers consist of a solid, structural component such as brick, block, concrete, stone, or interlocking grid pavers separated by a pervious material such as sand, gravel, or sod. They are typically set on a sand or gravel base and are load bearing sufficiently to support vehicles. Porous pavements are either porous asphalt or porous concrete. Porous asphalt is similar to traditional asphalt with the exception that there are no fine aggregate materials. Instead only coarse aggregate is used, which creates voids in the material for water and air to easily pass. Similarly, porous concrete is a discontinuous mixture of Portland cement, coarse aggregate, admixtures, and water that result in voids where water and air can pass. Both porous asphalt and concrete are typically underlain by a reservoir comprised of coarse aggregate (such as uniformly graded stone). Further information on the design of these systems can be found in the New Hampshire Stormwater Manual Volume 2: Post-Construction Best Management Practices Selection and Design.

Using these alternatives to traditional asphalt pavement reduces the overall impervious cover of a site and can also act as a mechanism to disconnect other impervious areas. It can reduce the need for conventional stormwater management facilities as more water is infiltrated and the volume of water to be treated through detention or retention is reduced. Research conducted by the University of New Hampshire's Stormwater Center has also found that porous pavement can reduce the amount of salt needed for deicing road and parking area surfaces, and reduces the formation of black ice due to less pooling of water on the pavement surface.

There may be a number of barriers to using alternative pavement. The most common barrier seems to be the misconceptions in regard to maintenance, long term effectiveness, and use in cold climates. These misconceptions are summarized in Table 6-1. An additional barrier may be that a municipality's zoning ordinance or subdivision regulations do not allow for alternative pavement. Overcoming these barriers can be accomplished through education, observation of example projects in other locations, and local demonstration projects, as well as revisions to local land use regulations. More information on porous pavement can be found at the University of New Hampshire's Stormwater Center website at: http://www.unh.edu/erg/cstev/

**Table 6-1. Misconceptions & Truths about Porous Pavement Compared to Traditional Pavement**

| Misconception | Truth |
|---|---|
| Freezes faster | Has demonstrated increased speed in thawing due to flow through by meltwater |
| Higher maintenance and cost | Overall costs are comparable |
| Slippery | Developed to have higher friction than traditional asphalt |
| Cannot plow, salt, or de-ice | Can be plowed and de-iced, however salt brine solutions are recommended over road salt application |
| Heaving and shifting | Reduced compared to traditional asphalt due to vadose zone disconnect |
| Lower life span | Actually increased life span due to reduced freeze thaw |

Source: University of New Hampshire Stormwater Center.

## 6-2. Impervious Surface Disconnection Methods

The amount of runoff and associated pollutants from a project can be reduced by disconnecting impervious surfaces. These disconnection methods are non-structural stormwater management practices focused on infiltrating stormwater. They are based on the "Site Design Credits" developed by the Center for Watershed Protection. By implementing the disconnection methods according to the criteria described here, a project can more easily meet the effective impervious cover targets described in Section 5-2. In addition, well-conceived use of disconnection methods can reduce overall project costs by reducing or eliminating the need for more expensive structural practices.

Disconnection methods should be incorporated at the planning and design level. However, the designer and reviewer should note that these methods must be used in concert with the design of other stormwater conveyance and treatment practices. The use of these disconnection methods does not relieve the designer or reviewer from following the standard engineering practices associated with safe conveyance of stormwater runoff and good drainage design. The nonstructural disconnection methods are presented in this manual under two categories:

- Disconnection of Rooftop Runoff
- Disconnection of Non-Rooftop Runoff

The minimum criteria that must be met in order to be considered sufficiently disconnected and eligible to omit the disconnected impervious areas from the Effective Impervious Cover (EIC) of the site (see discussion in Chapter 5) are described below.

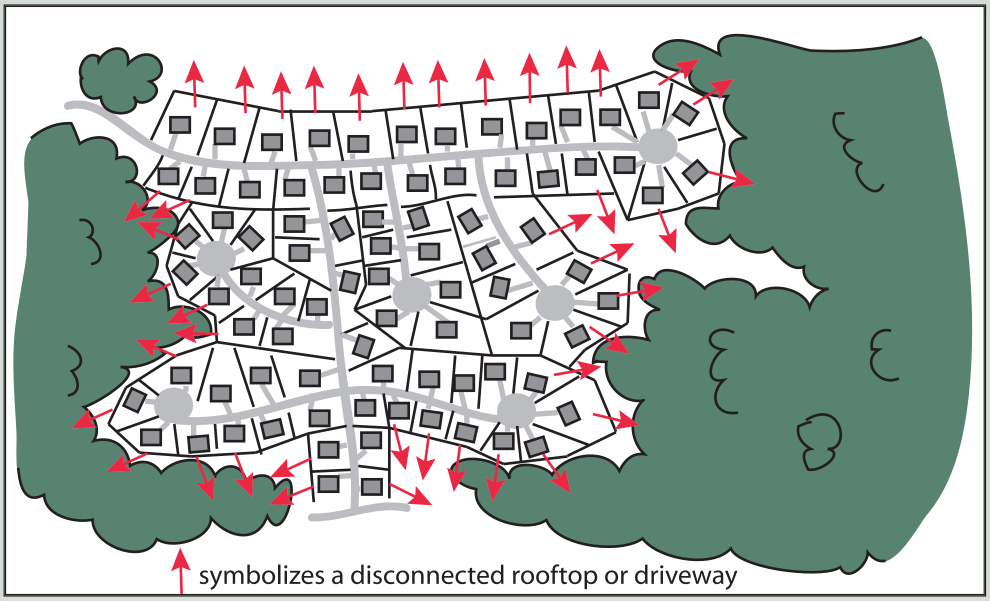


Figure 6-5. The amount of runoff and associated pollutants from a project can be reduced by disconnecting impervious surfaces through the disconnection methods described in Section 6-2.

### Disconnection of Rooftop Runoff

The impervious area associated with a rooftop can be omitted from the impervious cover of a site when the rooftop runoff is "disconnected" and then directed to an area where it can infiltrate the soil or flow over a pervious area such as a lawn or a swale with sufficient time and velocity to allow for filtering. This is typically accomplished by grading an area of the site, if natural slopes are not suitable, to promote overland flow through a vegetated buffer, or by directing the flow to an infiltration practice.

If a rooftop is adequately disconnected, the disconnected impervious area can be deducted from the total site impervious cover. Disconnections of rooftop runoff must meet the following criteria:

*Criteria:*
The disconnection must be designed to ensure no basement seepage or connection to foundation drains;

- The contributing rooftop length should be 75 feet or less;
- The rooftop contributing area to any one discharge location cannot exceed 1,000 square feet;
- The length of the "disconnection" flow path over the pervious area should be equal to or greater than the contributing rooftop length;

- Credit for disconnections will only be given for lot sizes greater than 6,000 square feet unless management practices include dry wells, infiltration trenches or basins, or equivalent infiltration practices;

*Example Disconnection of Rooftop Runoff Calculation*

Scenario

Site Data: 54 Single Family Residential Lots (~ ½ acre lots)
Site Area: 27 acres
Total Impervious Cover (TIC): 6 acres
Number of disconnected rooftops: 20
Average house area: 2,500 $ft^2$
Conversion factor (ft2 to acres): 43,560 $ft^2$/acre

Calculation

Disconnected Area (AD)
= (# Disconnected rooftops) * (Average house area)
= (20) * (2,500 $ft^2$)
= 50,000 $ft^2$
= 1.15 acres

Effective Impervious Cover (EIC)
= TIC - AD
= (6 acres) – (1.15 acres) = **4.85 acres**

- The disconnection flow path length should be only that which drains continuously through a vegetated channel, swale, or through a filter strip to the property line or a stormwater treatment practice;
- The entire vegetative "disconnection" should be on a slope less than or equal to 5.0%;
- Downspouts must be at least 10 feet away from the nearest impervious surface to discourage re-connection to the drainage network;
- Disconnections are encouraged on relatively permeable soils (USDA Hydrologic Soil Groups A and B);
- For rooftop disconnection in a designated high load land use, the rooftop must not commingle with runoff from any paved surfaces.

### Disconnection of Non-Rooftop Runoff

Non-rooftop impervious surfaces associated with site development, such as driveways or parking areas, can be omitted from the impervious cover of a site, when the impervious surfaces are directed to an area where runoff can infiltrate into the soil or is allowed to flow over a pervious area such as a lawn or swale that provides sufficient time and slows the flow of water enough to allow for filtering or infiltration.

If impervious areas are adequately disconnected, the disconnected areas can be deducted from the total site impervious cover. Disconnections of non-rooftop runoff must meet the following criteria:

*Criteria:*

- The maximum contributing impervious flow path length should be 75 feet;
- Runoff cannot come from a designated hotspot land use;

- The disconnection must drain continuously through a vegetated channel, swale, or filter strip to the property line or a stormwater treatment practice;
- The length of the "disconnection" flow path over pervious surface must be equal to or greater than the contributing length;
- The entire vegetative "disconnection" should be on a slope less than or equal to 5.0%;
- The area of impervious surface contributing to any one discharge location cannot exceed 1,000 ft2;
- Disconnections are encouraged on relatively permeable soils (HSGs A and B).

*Example Disconnection of Non-Rooftop Runoff Calculation*

Scenario

Site Data: 54 Single Family Residential Lots
(~½ acre lots)
Site Area: 27 acres
Total Impervious Cover (TIC): 6 acres
Number of disconnected driveways: 32
(avg. length 100 ft)
Driveway width: ~10 ft
Total disconnected driveway length: 3,200 ft
Conversion factor ft2 to acres: 43,560 $ft^2$/acre

Calculation

Disconnected Area (AD)
= (driveway width) (total disconnected driveway length)
= (10ft) (3,200 ft)
= 32,000 $ft^2$
= 0.73 acres

Effective Impervious Cover (EIC) = TIC - AD
= (6 acres) – (0.73 acres) = 5.27 acres

## Chapter 6 References


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# Chapter 7 Introduction to Best Management Practices

This chapter provides an overview of structural Best Management Practices for managing and treating stormwater runoff. It includes a brief description of post-construction pretreatment and treatment practices for long-term management of stormwater, as well as an introduction to temporary (construction phase) practices. This chapter also discusses the screening and selection of structural best management practices and their operation and maintenance needs.

Structural BMPs should be considered only after non-structural site design techniques, discussed in Chapter 6, have been implemented to reduce the volume of stormwater runoff. While the goal is to minimize the generation of runoff requiring treatment, it is anticipated that many projects will still require structural BMPs to treat the stormwater from the remaining connected impervious surfaces. Structural BMPs are designed to remove pollutants from stormwater runoff as well as provide for groundwater recharge, peak runoff attenuation, and stream channel protection.

Note that Volume 2 of the New Hampshire Stormwater Manual addresses the selection and design of BMPs in greater detail, along with additional information on operation and maintenance. Volume 3 of the Manual provides additional detailed discussion of construction phase practices.

## 7-1. Pre-Treatment Practices

Pre-treatment practices are used to treat runoff prior to a permanent best management practice to settle out coarse sediments, slow runoff velocities, and in some cases, provide additional treatment (such as removal of floating debris and oil). This increases overall pollutant removal and reduces the maintenance requirements on permanent treatment practices.

Pretreatment Practices include the following measures:

### Sediment Forebays

A sediment forebay is an impoundment, basin, or other storage structure designed to dissipate the energy of incoming runoff and allow for initial settling of coarse sediments. Forebays are used for pretreatment of runoff prior to discharge into the primary water quality treatment BMP. In some cases, forebays may be constructed as separate structures but often, they are integrated into the design of larger stormwater management structures.

### Vegetated Filter Strips

Filter strips (grassed filter strips, vegetated filter strips, grass filters) are vegetated surfaces designed to treat stormwater sheet flow. Filter strips are designed to slow stormwater velocity, filter out sediment and associated pollutants, and provide minimal infiltration of runoff. Filter strips are most appropriate for receiving sheet flow runoff before it enters another treatment practice or leaves a site. They function best at removing sediment. They also provide wildlife habitat and travel corridors.

A level spreader may be necessary to convert runoff to sheet flow as it enters the filter strip. Vegetation may consist of meadow, forest, or a combination. Vegetated Filter Strips may have substantially shorter lengths of flow path than "Vegetated Buffers," and would not be anticipated to provide the level of treatment afforded by buffers sized in accordance with the Alteration of Terrain regulations (Env-Wq 1500). Therefore, Filter Strips are not considered "Treatment Practices" but may be used as pretreatment practices.

### Pre-treatment Swales

Pre-treatment swales are shallow, linear, vegetated, earthen channels designed to convey flows, while capturing a limited amount of sediment and associated pollutants. A pre-treatment swale differs from a Treatment Swale in that the pre-treatment swale is not designed for a specified hydraulic residence time, but only for a minimum length. Therefore, pre-treatment swales do not necessarily provide sufficient time for the removal of pollutants other than those associated with larger sediment particles, and may only be used for pretreatment.

### Flow Through Devices

Flow-through devices can provide pre-treatment of stormwater runoff before entering a treatment practice. These devices include:

*Water Quality Inlet*

A water quality inlet is an underground storage structure with multiple chambers, designed to capture coarse sediments, floating debris, and some hydrocarbons from stormwater runoff. Such inlet devices are typically used for pretreatment of runoff prior to discharge to another treatment practice.

The devices use baffles with weirs or orifices to control flow and help capture sediment, and inverted baffles or hooded outlets to help capture floating materials. Depending on the design of the unit and the magnitude of peak flow events, the captured sediments may be subject to re-suspension and flushing from the device. Floating hydrocarbons captured in the unit can be removed for disposal during maintenance operations by skimming or by use of sorbent materials. To limit potential for re-suspension of captured materials, the device is usually designed as an "off-line" unit sized for the Water Quality Flow. Larger storm events would then bypass the unit.

*Proprietary Flow Through Devices*

Proprietary flow through devices may be used for pretreatment of stormwater. Several manufacturers offer a number of proprietary flow-through stormwater treatment devices. These devices are variously referred to as "oil/particle separators," "oil/grit separators," or "hydrodynamic separators." Some of these devices use multiple chambers arranged horizontally or vertically to help trap and retain sediments and floating substances. Some use internal components to promote a swirling flow path to help enhance removal and retention of sediment.

These flow-through devices are normally sited close to the source of runoff, often receiving stormwater from relatively small areas that are mostly, if not entirely, impervious surface. They may only be used as pretreatment of stormwater prior to discharge to other treatment BMPs added.

*Deep Sump Catch Basins*

A deep sump catch basin consists of a manhole-type structure with an inlet grate, an outlet pipe connected to the piped drainage system, and a sump with a depth several times the diameter of the outlet pipe. The inlet grate is located at the surface, and is sometimes combined with a vertical inlet integrated with a street or parking area curb. The sump's purpose is to capture coarse sediments and debris from the runoff intercepted by the structure. The outlet pipe can be fitted with a "hood" consisting of a cast metal or formed plastic fitting, designed to prevent floating materials from exiting the structure.

Deep sump catch basins used as pretreatment are most effective when they only receive flow from the inlet grate (i.e. no piped inflow from adjacent catch basins) since flow-through basins are more susceptible to sediment re-suspension. The outlet hood provides benefits for trapping floating trash, as well as for short-term spill containment.

## 7-2. Treatment Best Management Practices

NHDES recognizes the following categories of primary BMPs to treat stormwater runoff. These BMPs provide water quality treatment and are permanent practices for post-construction stormwater management.

### Stormwater Ponds

Stormwater ponds are impoundments designed to collect, detain and release stormwater runoff at a controlled rate. They provide treatment through the use of a permanent pool, which helps settle solids and associated pollutants. Extended detention features can be incorporated into stormwater ponds by combining permanent micropools or other permanent pool storage with an extended drawdown time of the water quality volume.

In addition to water quality benefits, by providing additional storage capacity and a multi-stage outlet structure, stormwater ponds can also be designed to provide flood control.

The following are examples of Stormwater Ponds:

*Micropool Extended Detention Pond*

An extended detention pond with a micropool temporarily stores and releases the Water Quality Volume over an extended drawdown time. The micropool is typically provided near the outlet, to enhance pollutant removal and to help prevent resuspension of captured sediments. Except for the micropool, the basin is designed to be dry between storms, once the WQV has been discharged. The basin provides pollutant removal by settling of sediments and associated pollutants.

*Wet Pond*

Wet ponds are designed to maintain a permanent pool of water throughout the year. The pool, located below the outlet invert, allows for pollutant removal through settling and biological uptake or decomposition.

Wet ponds, if properly sized and maintained, can achieve high rates of removal for a number of urban pollutants, including sediment and its associated pollutants: trace metals, hydrocarbons, BOD, nutrients and pesticides. They also provide some treatment of dissolved nutrients through biological processes within the pond.

*Wet Extended Detention Pond*

Wet extended detention ponds combine the features of wet ponds and extended detention ponds. The combined permanent pool and extended detention volume can be used to treat the Water Quality Volume and meet Channel Protection requirements .

*Multiple Pond System*

The multiple pond system is similar to the wet pond, except that the total treatment volume is distributed over two or more pond "cells," rather than a single pond. This type of design can be useful for adapting the component ponds to fit a particular site layout, provide for a more aesthetic design, or address changes in elevation on a sloping site.

*Pocket Pond*

The pocket pond is a wet pond or wet extended detention pond designed to serve a small contributing area. While similar to other wet ponds and wet extended detention ponds in design, the water budget for this pond will likely depend on the presence of groundwater, because the smaller contributing watershed would not sustain a permanent pool. Note that NHDES considers a "wet swale" type of water quality swale to be a "pocket pond."

*Stormwater Wetlands*

Stormwater wetlands are similar to stormwater ponds in that the design includes a permanent pool of water. However, the retained pool is designed with varying depths to support a wetland plant community. In addition to the settling processes that occur in the permanent pool, stormwater wetlands provide pollutant removal/uptake by vegetation and by other biological activity supported within the wetland environment. In some stormwater wetlands, such as "gravel wetlands," the systems provide filtration, as well.

Stormwater wetlands are constructed depressions or impoundments designed to function similar to natural wetlands. However, unlike natural wetlands, stormwater wetlands are designed specifically to treat stormwater. It is important to stress the distinction between using constructed wetlands to treat stormwater versus directing untreated runoff to a natural wetland. The direct discharge of stormwater runoff to natural wetlands is typically not allowed in NH. It alters the critical wetland hydrology and increases the potential to degrade wetland habitat. It can also cause stress to plants and animals and contribute to die-off of these species. Natural wetlands should be protected and should not be used to treat stormwater runoff.

The following are examples of Stormwater Wetlands:

*Shallow Wetlands*

Shallow wetlands for stormwater treatment consist of pools ranging from 6 to 18 inches in depth under normal conditions, with some areas of deepwater pools. They may be configured with a variety of low marsh and high marsh "cells" with sinuous channels to distribute flows to maximize retention time and contact area. Shallow wetland systems are designed with wetland vegetation suitable for these varying depths. The entire Water Quality Volume is provided within the deepwater, low marsh, and high marsh zones.

*Extended Detention Wetlands*

Extended detention stormwater wetlands typically require less space than shallow wetlands systems, because part of the Water Quality Volume is stored above the level of the permanent pool. Deepwater areas tend to be less extensive and semi-wet areas more extensive than those provided for shallow wetlands. Wetland plants that tolerate both intermittent flooding and dry periods must be selected for the area above the permanent marsh.

*Pond/Wetland System*

The wetlands/pond system for stormwater treatment consists of a series of cells using at least one wet pond in combination with shallow marsh wetlands. The first cell typically comprises the wet pond, which provides initial treatment primarily by settling of particulates. The wet pond can also reduce the velocity of runoff entering the system. The shallow marsh provides subsequent additional treatment of the runoff, particularly for soluble pollutants through vegetative uptake and the biological activity associated with the wetland vegetation community. With the deeper pool of the wet pond, these systems can typically require less space than the shallow marsh system.

*Gravel Wetlands*

The gravel wetland system consists of one or more flow-through constructed wetland cells, preceded by a forebay. The cells are filled with a gravel media, supporting an organic substrate that is planted with wetland vegetation. During low-flow storm events, the system is designed to promote subsurface horizontal flow through the gravel media, allowing contact with the root zone of the wetland vegetation. The gravel and planting media support a community of soil microorganisms. Water quality treatment occurs through microbial, chemical, and physical processes within this media. Treatment may also be enhanced by vegetative uptake.

The system can be designed to integrate some stormwater storage, and also to provide infiltration. With these features, the practice would not only remove pollutants, but also contribute to the attenuation of peak rates through temporary storage and reduction in runoff volume through infiltration and evapotranspiration.

### Infiltration Practices

Infiltration practices are designed to capture and temporarily store the water quality volume of stormwater while it infiltrates into the soil. Infiltration practices help to recharge groundwater, but must be designed and maintained to avoid clogging and system failure. Pollutants are removed through adsorption of pollutants onto soil particles, and biological and chemical conversion in the soil.

Infiltration practices differ from filtering practices in that stormwater is infiltrated through native soil and allowed to recharge groundwater, while filtration practices typically employ non-native soil materials or other media, and may use underdrains to convey the filtered water to discharge.

Examples of Infiltration Practice are provided below. Note that “permeable pavements,” discussed under “Filtering Practices,” may also be designed to provide for infiltration.

*Infiltration Trench (Including Drip Edge)*

An infiltration trench is a stone-filled excavation used to temporarily store runoff and allow it to infiltrate into surrounding, natural soil. Typically, runoff enters the trench as overland flow after pretreatment through a filter strip or vegetated buffer. An infiltration trench is suitable for treating runoff from small drainage areas (less than 10 acres). Installations around the perimeter of parking lots, between residential lots, and along roads are most common. Infiltration trenches can also be incorporated along the center of a vegetated swale to increase its infiltration ability.

An infiltration drip edge is constructed similar to an infiltration trench, except that a drip edge intercepts only roof runoff, and does not require pretreatment.

*In-Ground (Surface) Infiltration Basin*

In-ground infiltration basins are impoundments designed to temporarily store runoff, allowing all or a portion of the water to infiltrate into the ground. An infiltration basin is designed to completely drain between storm events. An infiltration basin is specifically designed to retain and infiltrate the entire Water Quality Volume. Some infiltration basins may infiltrate additional volumes during larger storm events, but many will be designed to release stormwater exceeding the water quality volume from the larger storms. In a properly sited and designed infiltration basin, water quality treatment is provided by runoff pollutants binding to soil particles beneath the basin as water percolates into the subsurface. Biological and chemical processes occurring in the soil also contribute to the breakdown of pollutants. Infiltrated water is used by plants to support growth or it is recharged to the underlying groundwater.

*Underground (Subsurface) Infiltration Basin*

Infiltration basins are structures designed to temporarily store runoff, allowing all or a portion of the water to infiltrate into the ground. The structure is designed to completely drain between storm events. An underground infiltration basin is specifically designed to retain and infiltrate the entire Water Quality Volume. Some infiltration basins may infiltrate additional volumes during larger storm events, but many will be designed to release stormwater exceeding the water quality volume from the larger storms. In a properly sited and designed infiltration basin, water quality treatment is provided by runoff pollutants binding to soil particles beneath the basin as water percolates into the subsurface. Biological and chemical processes occurring in the soil also contribute to the breakdown of pollutants. Infiltrated water is recharged to the underlying groundwater.

Subsurface infiltration basins may comprise a subsurface manifold system with associated crushed stone storage bed, or specially-designed chambers (with or without perforations) bedded in or above crushed stone.

*Dry Well & Leaching Basin*

**Dry wells** are essentially small subsurface leaching basins. The dry well consists of a small pit filled with stone, or a small structure surrounded by stone, used to temporarily store and infiltrate runoff from a very limited contributing area. Runoff enters the structure through an inflow pipe, inlet grate, or through surface infiltration. The runoff is stored in the structure and/or void spaces in the stone fill. Properly sited and designed dry wells provide treatment of runoff as pollutants become bound to the soils under and adjacent to the well, as the water percolates into the ground. The infiltrated stormwater contributes to recharge of the groundwater table.

Dry wells are well-suited to receive roof runoff via building gutter and downspout systems. With the small size and manageable cost of these BMPs, they are particularly suited for use in subdivisions and for single-family homes. When used for roof drainage, pretreatment of runoff is not typically required.

**Leaching basins** are dry wells used in well drained soils for the discharge of roadway or parking area runoff. In this case, pretreatment is required prior to discharge to the leaching basin. A typical arrangement is to use a deep sump, hooded catch basin in combination with a leaching basin.

### Filtering Practices

Filtering practices treat stormwater runoff by capturing and passing the water quality volume through a bed of sand, other soil material, or other acceptable treatment media to remove pollutants from the water. Sediments and other pollutants are removed by physical straining and adsorption. Filters can be constructed using common materials, or proprietary systems using various filter media can be employed. Filtration BMPs have shown to be very effective at removing a wide range of pollutants from stormwater runoff, particularly when organic soil filter media have been used.

Filtering practices differ from infiltration practices in that the stormwater filters through an engineered filter media, rather than native soil. However, filtering practices can be constructed in combination with infiltration practices, where the filtered water is discharged into the ground beneath the BMP.

Alternatively, filters can be designed with an underdrain to collect the treated water and convey it to discharge. Underdrained filters can be lined to isolate the filters from the adjacent soil material or underlying groundwater.

The following are examples of filtering practices:

*Surface Sand Filter*
The surface sand filter is typically designed as an off-line device, so that storms exceeding the water quality volume are diverted from the BMP. Thus, the system usually includes a flow splitter, used to divert the first flush of runoff into a pretreatment device, such as a sedimentation chamber (wet or dry) where coarse sediments settle out of the water. Pretreated runoff then enters the sand filter, saturating the filter bed and filling temporary storage volume provided above the bed. As the water filters down through the sand bed, pollutants are strained from the water or adsorbed to the filter media. The top surface of the sand filter is exposed to the elements, but is kept free of vegetation.

If the filter is designed for infiltration, the treated water is allowed to percolate into the underlying native soil. Alternatively, the filter can be designed with a perforated underdrain system to collect treated water at the bottom of the sand filter and direct it to a suitable outlet. If necessary, the underdrained sand filter can be designed with a liner to isolate it from adjacent soil material and prevent discharge of treated water to the groundwater table.

*Underground Sand Filter*

The underground sand filter operates in a similar fashion to the surface sand filter, except that the system is enclosed in a below-grade structure. The structure may consist of a multi-chambered vault that accommodates pretreatment, as well as the filtration component of the system. The structure is made accessible through manholes or grate openings. Typical subsurface filter systems are fully enclosed in structures. However, some systems may be designed with an open bottom in contact with native soils, allowing for infiltration to occur.

*Bioretention System*

A bioretention system (sometimes referred to as a “rain garden”) is a type of filtration BMP designed to collect and filter moderate amounts of stormwater runoff using conditioned planting soil beds, gravel beds and vegetation within shallow depressions. The bioretention system may be designed with an underdrain, to collect treated water and convey it to discharge, or it may be designed to infiltrate the treated water directly to the subsoil. Bioretention cells are capable of reducing sediment, nutrients, oil and grease, and trace metals. Bioretention systems should be sited in close proximity to the origin of the stormwater runoff to be treated.

The major difference between bioretention systems and other filtration systems is the use of vegetation. A typical surface sand filter is designed to be maintained with no vegetation, whereas a bioretention cell is planted with a variety of shrubs and perennials whose roots assist with pollutant uptake. The use of vegetation allows these systems to blend in with other landscaping features.

*Tree Box Filter*

The Tree Box Filter consists of an open bottom or closed bottom concrete box or barrel filled with a porous soil media. An underdrain system, consisting of a perforated pipe bedded in crushed gravel, is provided beneath the soil media. A tree is planted in the soil media. Stormwater is directed from surrounding impervious surfaces through the top of the soil media.

If the device has an open bottom, the stormwater percolates through the media into the underlying ground. If the filtered stormwater exceeds the infiltration capacity of the underlying natural soil, the excess will be intercepted by the underdrain, where it may be directed to a storm drain, other device, or surface water discharge.

Where a closed bottom box filter is used, such as where necessary to protect groundwater resources, the filter is isolated from the underlying soil. In this case, all of the stormwater that passes through the soil media filter will be intercepted by the underdrain and conveyed to a suitable outlet.

*Permeable Pavement*

Permeable pavement consists of a porous surface, base, and sub-base materials which allow penetration of runoff through the surface into underlying soils. The surface materials for permeable pavement can consist of paving blocks or grids, pervious asphalt, or pervious concrete. These materials are installed on a base which serves as a filter course between the pavement surface and the underlying sub-base material. The sub-base material typically comprises a layer of crushed stone that not only supports the overlying pavement structure, but also serves as a reservoir to store runoff that penetrates the pavement surface until it can percolate into the ground.

Although traffic loading capacities vary, permeable pavement alternatives are generally appropriate for low traffic areas (e.g. sidewalks, parking lots, overflow parking, residential roads). Careful maintenance is essential for long term use and effectiveness.

Frequently, permeable pavements filter only the runoff generated on the pavement surface itself. However, runoff from other areas can be directed to permeable pavement if properly designed. Runoff generated from adjacent areas of the site may require pretreatment prior to discharge to the pavement surface, to prevent clogging of the pavement structure and (where the pavement is used to infiltrate as well as filter the runoff) the underlying soils.

### Treatment Swales

Treatment swales are designed to promote sedimentation by providing a minimum hydraulic residence time within the channel under design flow conditions (Water Quality Flow). This BMP may also provide some infiltration, vegetative filtration, and vegetative uptake. Conventional grass channels and ditches are primarily designed for conveyance. Treatment swales, in contrast, are designed for hydraulic residence time and shallow depths under water quality flow conditions. As a result, treatment swales provide higher pollutant removal efficiencies. Pollutants are removed through sedimentation, adsorption, biological uptake, and microbial breakdown.

Treatment swales also differ from practices such as underdrained swales (for example, “dry swales” and “bioretention swales”), which are essentially filtration practices, and “wet swales,” which are similar in function to pocket ponds.

### Vegetated Buffers

Vegetated buffers are areas of natural or established vegetation allowed to grow with minimal to no maintenance. Buffers reduce the velocity of runoff as it flows through the vegetation. Buffers also provide a permeable area where runoff can infiltrate the soil. They promote groundwater recharge, filter out sediments, and create shade to maintain water temperatures. They can also provide wildlife habitat and connect habitat corridors.

Buffers are often provided along the shoreline of waterbodies and wetlands, and may be controlled at the municipal level through buffer requirements and development setbacks. Although municipal buffer requirements are recommended, it may not be appropriate to arbitrarily set a standard buffer width. Instead, a municipality can establish buffer guidelines to determine buffer widths that are dependent on site conditions and goals for individual sites.

Vegetated buffers include, but are not limited to:

*Residential or Small Pervious Area Buffer*
This type of vegetated buffer is for individual residential lots or for developments with limited areas of impervious surface, where runoff enters the buffer as sheet flow without the aid of a level spreader. This type of buffer can be sited adjacent to single family or duplex residential structures, or impervious surfaces where flow length over the surfaces is limited. This design is not appropriate for treating large impervious areas where there is the likelihood for runoff flows to concentrate and create channels through the buffer instead of discharging as dispersed sheet flow.

*Developed Area Buffer*
Developed Area Buffers serve areas that exceed the thresholds for "residential or small pervious area buffers." They may also be used for small areas where the runoff is discharged as concentrated flow, rather than sheet flow. Developed area buffers require the use of stone-berm level spreaders to discharge runoff into the buffers as sheet flow. Runoff is directed to the channel upstream of the stone berm, which is located along the contour of the slope at the upper margin of the buffer area. This stone berm spreads the runoff so that it uniformly seeps through the berm and evenly distributes across the top of the buffer as sheet flow.

*Roadway Buffers*
A buffer adjacent to the down-hill side of a road should be sited directly adjacent to the roadway. In addition, the road must be parallel to the contour of the slope. Runoff must sheet immediately into the buffer, and must not include runoff from areas other than the adjacent road surface and shoulder. The buffer may consist of man-made buffer, natural buffer, or a combination.

*Ditch Turn-out Buffer*
A ditch turn-out buffer diverts runoff collected in a roadside ditch into a buffer. A combination of check dams and bermed level lip spreaders convert the concentrated ditch flows into sheet flow. The sheet flow distributes across the top of the buffer.

## 7-3. Construction-Phase Management Practices

Temporary management practices are intended to protect disturbed soils and stabilize areas during construction until vegetation or other permanent management measures are installed. Temporary measures are expected on all construction sites and are not factored into pollutant load reduction calculations. Temporary measures typically include both erosion control practices and sediment control practices.

### Erosion Control Practices

Erosion controls are employed to prevent the displacement of soils by wind, rainfall, and runoff. These measures depend on limiting areas of disturbance of soils, limiting times of duration of soil disturbance, careful land grading practices, and the implementation of measures to maintain undisturbed surfaces and stabilize disturbed surfaces. Typical erosion control and stabilization practices include:

*Construction Phasing*

Land alteration is an essential component of site development and building construction, and is often required for redevelopment as well. Land grading consists of shaping the existing land surface in accordance with a plan determined by engineering survey and layout. This activity must be performed in a manner to minimize exposure of slopes to runoff and potential erosion, provide for stable permanent slopes, and facilitate the establishment of vegetation.

During construction, land grading practices intended to minimize impacts of surface runoff and erosion include:

- Planning earth disturbance and grading activities so as to minimize the area of soil exposed at one time, as well as the length of time between initial soil exposure and final grading. On large projects this is accomplished by phasing the operation.
- Protecting existing vegetation and natural forest cover.
- Preserving and maintaining buffer strips of undisturbed vegetation.
- Diverting clean water away from the immediate construction area.
- Dispersing clean stormwater to undisturbed, vegetated, flat or moderate-sloped, surfaces wherever possible, rather than concentrating it into channels.
- Upgrading and refining the implementation of fall and winter erosion control measures to protect the site from spring runoff and snowmelt.

*Dust Control*

Dust control consists of applying various measures to prevent blowing and movement of dust from exposed soil surfaces. This practice is applicable to areas subject to dust blowing and soil movement where on-site and off-site damage is likely to occur if preventive measures are not taken. Typical dust control measures include traffic control, construction phasing, and maintenance of existing vegetation to limit exposure of soils and prevent conditions that result in dry soils and dust; application of water, calcium chloride, and temporary stabilization practices to control mobilization of dust by equipment operation or wind; and pavement sweeping to prevent accumulation of dust-producing sediment.

*Surface Roughening*

Surface roughening is a technique for creating furrows in a bare soil surface, by tracking the slope with construction equipment. The purpose of surface roughening is to aid the establishment of vegetative cover from seed, to reduce runoff velocity and increase infiltration, and to reduce erosion and provide for sediment trapping. This practice applies to all construction slopes to facilitate long-term stabilization with vegetation, and particularly slopes steeper than 3:1.

*Soil Stockpile Practices*

Soil stockpile practices include measures to locate, manage, and protect stockpiled earth materials to reduce or eliminate wind and water erosion, and prevent resulting air and water pollution from displaced sediment. Stockpile practices apply to topsoil, excavated materials, borrow materials imported to the site, and construction aggregates and paving materials that are stockpiled on the site prior to use in the construction work.

*Temporary & Permanent Mulching*

Temporary mulching consists of the application of plant residues or other suitable materials to the soil surface. Mulching prevents erosion by protecting the exposed soil surface from direct impact by rainfall. It also aids in the growth of vegetation by conserving available moisture, controlling weeds, and providing protection against extreme heat and cold. Mulches can also protect the infiltration rate of the soil, prevent soil compaction, and provide a suitable microclimate for seed germination. This is the quickest and most cost effective method of preventing erosion on disturbed soils and its value should not be underestimated.

Permanent mulch consists of the application of long-term surface cover such as bark, wood chips, or erosion control mix. Permanent mulch can be used as a permanent ground cover, as an overwinter stabilization mulch, or left to naturalize. It is not designed to support grass vegetation, but legumes or woody vegetation may be established for additional stability.

Temporary and permanent mulches may consist of hay or straw, wood chips or bark, or erosion control mix (a mixture of fibrous organic materials such as from shredded bark, stump grindings, composted bark, or equivalent manufactured products). Please note that hay mulch can contain a variety of seeds some of which may be invasive plants such as reed canary grass and purple loosestrife. It is suggested that hay mulches not be used near important resources such as wetland streams and lakes to prevent the spread of invasive plants .

*Temporary Vegetation*

Temporary vegetation consists of the establishment of a grass and legume cover on exposed soils for periods of up to 12 months. The purpose is to reduce erosion and sedimentation by stabilizing disturbed areas that will not be brought to final grade for a year or less and to reduce problems associated with mud and dust production from exposed soil surfaces during construction. Temporary seeding is also essential to preserve the integrity of earthen structures used to control sediment, such as diversions and the embankments of sediment basins.

Runoff and sheet erosion caused by splash erosion (rain drop impact on bare soil) is the source of most fine particles in sediment. To reduce the sediment load in runoff, the soil surface itself should be protected. The most effective and economical means of controlling sheet and rill erosion is to establish a vegetative cover. Annual plants that sprout rapidly and survive for only one growing season are suitable temporary vegetative cover.

*Permanent Vegetation*

Permanent vegetative cover should be established on disturbed areas where permanent, long lived vegetative cover is needed to stabilize the soil, to reduce damages from sediment and runoff, and to enhance the environment. The most effective and economical means of controlling sheet and rill erosion is to establish a permanent vegetative cover.

*Temporary Erosion Control Blanket*

Erosion control blankets or mats consist of protective manufactured mulch blankets, installed on prepared soil surfaces to provide erosion protection and surface stability on steep slopes, vegetated channels, or shorelines during vegetation establishment. Erosion control blankets temporarily stabilize and protect disturbed soil from raindrop impact and surface erosion. Like other types of mulch, the blankets help increase infiltration, decrease compaction and soil crusting, and conserve soil moisture. Erosion control blankets increase the germination rates for grasses and legumes and promote vegetation establishment. Erosion control blankets also protect seeds from predators and reduce desiccation and evaporation by insulating the soil and seed environment.

Erosion control blankets generally consist of machine-made mats made of organic, biodegradable mulch such as straw, curled wood fiber (excelsior), coconut fiber or a combination thereof, evenly distributed on or between manufactured netting. Netting is typically composed of photodegradable polypropylene or biodegradable natural fiber.

Erosion control blankets can be applied to steep slopes, vegetated waterways, and other areas sensitive to erosion, to supplement vegetation during initial establishment and help provide for safe conveyance of runoff over the protected surface.

*Diversion*

A diversion is a temporary channel constructed across the slope to intercept runoff and direct it to a stable outlet or to sediment trapping facilities. The channel may be formed by excavation, placement of a berm (or dike), are a combination of these measures. This temporary measure is used immediately above a new cut or soil fill slope or around the perimeter of a disturbed area. Diversion practices themselves should be stabilized.

Diversions can be used to direct storm runoff from upslope drainage areas away from unprotected disturbed areas and slopes to a stabilized outlet. In this case the diversion is placed upslope of the construction area. They can also be used to divert sediment-laden runoff from a disturbed area to a sediment-trapping facility such as a sediment trap or sediment basin. In this case, the diversion is placed below the disturbed area, to assure that sediment-laden runoff will not leave the site without treatment.

Diversions are intended to facilitate management of the site during construction, and should not be substituted for terracing, vegetated waterways, permanent land grading practices, or other permanent measures for providing long-term erosion control.

*Slope Drain*

A slope drain comprises a pipe, flexible tubing, or other conduit extending from the top to the bottom of a cut or fill slope. During construction, cut and fill slopes are exposed to erosion between the time they are graded and permanently stabilized. During this period, the slopes are very vulnerable to erosion, and temporary slope drains together with temporary diversions can provide valuable protection. The temporary conduit safely conveys runoff down the disturbed face of an embankment without causing erosion. The practice is maintained until the slope has been sufficiently stabilized to enable it to convey runoff by sheet flow, or until another practice has been installed to convey concentrated runoff from the top of slope to a safe outlet. The outlet from the slope drain should be stabilized.

### Sediment Control Practices

Sediment controls interrupt the sediment conveyance process. Once erosion occurs, soil particles are conveyed by runoff away from the source of sediment, and deposited in downslope land areas or in downstream receiving waters. To capture sediment generated during construction, practices are implemented to intercept sediment before it leaves the site; some examples of sediment controls include:

*Silt Fence*

Silt fence is a temporary sediment barrier consisting of filter fabric attached to supporting posts and entrenched into the soil. This barrier is installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Silt fences have a useful life of one season. They function primarily to slow and pond the water and allow soil particles to settle. Silt fences are not designed to withstand high heads of water, and therefore should be located where only shallow pools can form. Their use is limited to areas where overland sheet flows are expected.

Silt fence is a sediment control practice, not an erosion control practice. It is intended to be used in conjunction with other practices that do prevent or control erosion. Improperly applied or installed silt fence will increase erosion.

Silt fences should not be used across streams, channels, ditches or other drainage ways. Silt fences are not capable of effectively filtering the high rates and volumes of water associated with channelized flow.

*Straw or Hay Bale Barrier*

Straw and hay bale barriers are a type of temporary sediment barrier installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Straw or hay bale barriers have a useful life of less than six months. They function primarily to slow and pond the water and allow soil particles to settle. They are not designed to withstand high heads of water, and therefore should be located where only shallow pools can form. Their use is limited to areas that only contribute sheet flow to the device.

Straw or hay bale barriers constitute a sediment control practice, not an erosion control practice. The must be used in conjunction with other practices that do prevent or control erosion. Improperly applied or installed sediment barriers will increase erosion.

Straw or hay bale barriers should not generally be used across streams, channels, ditches or other drainage ways or areas with concentrated flows. Such barriers are not capable of effectively filtering the high rates and volumes of water associated with channelized flow. However, they may be used for check dams in applications where installation access or other conditions prevent the use of preferred materials such as stone; in such cases, installation must provide proper embedment of the straw or hay bale barrier, limit contributing drainage area to less than an acre, and provide for frequent monitoring of the barrier. Straw or hay bale barriers installed across a concentrated flow path are subject to undercutting, end cutting, and overtopping. Please note that hay bales can contain a variety of seeds some of which may be invasive plants such as reed canary grass and purple loosestrife. It is suggested that hay bales not be used near important resources such as wetland streams and lakes to prevent the spread of invasive plants .

*Erosion Control Mix Berms*

An erosion control mix berm is a trapezoidal berm that intercepts sheet flow and ponds runoff, allowing sediment to settle, and filtering sediment as well. They are an environmentally-sensitive and cost-effective alternative to silt fence. An alternative to a simple erosion control mix berm is a "continuous contained berm", consisting of erosion control mix compost encapsulated in a mesh fabric (or "filter sock"). This barrier is installed across or at the toe of a slope, to intercept and retain small amounts of sediment from disturbed or unprotected areas.

Erosion control mix berms and socks sometimes offer a better solution than silt fence and other sediment control methods, because the organic material does not require any special trenching, construction, or removal, unlike straw bales, silt fence or coir rolls. This makes the technique very cost-effective.

The erosion control mix is organic, biodegradable, renewable, and can be left onsite. This is particularly important below embankments near streams, as re-entry to remove or maintain a synthetic barrier can cause additional disturbance. Silt fence has to be disposed of as a solid waste, and is often left abandoned on jobsites. Erosion control mix berms can be easily and quickly fixed, if they are disturbed in the course of construction activity.

*Temporary Check Dams*

Temporary check dams are small temporary dams constructed across a swale or drainage ditch. Check dams are used to reduce the velocity of concentrated stormwater flows, thereby reducing erosion of the swale or ditch. Check dams may also trap small amounts of sediment generated in the ditch itself. However, the check dam is not a sediment trapping practice and should not be used as such. The practice is limited to use in small open channels that drain one acre or less. It should not be used in either perennially flowing streams or intermittent stream channels.

Check dams can be constructed of stone. In locations where stone is not available, timber check dams may be considered. Typical applications include:

- Temporary ditches or swales which, because of their short length of service, cannot receive a non-erodible lining, but still need some protection to reduce erosion.

- Permanent ditches or swales which for some reason cannot receive a permanent non-erodible lining for an extended period of time.

- Either temporary or permanent ditches or swales, which need protection during the establishment of grass linings.

Hay or straw bales should not generally be used as check dams, or in any location where there is concentrated flow.

*Temporary Storm Drain Inlet Protection*

A storm drain inlet protection is a sediment barrier installed around a storm drain drop inlet or curb inlet to reduce sediment discharge. The sediment barrier may be constructed of straw or hay bales, gravel and wire mesh, or concrete blocks and gravel. Sediment removal is accomplished by shallow ponding adjacent to the barrier and resulting settling of the sediment particles.

The purpose of storm drain inlet protection is to prevent sediment from entering a storm drainage system prior to permanent stabilization of the contributing disturbed area. Storm drains made operational before their drainage areas are stabilized can convey large amounts of sediment to storm sewer systems or natural drainage ways. In some cases, the storm drain itself may accumulate sufficient sediment to significantly reduce or eliminate its conveyance capacity. To avoid these problems, it is necessary to prevent sediment from entering the system at the inlets.

*Temporary Construction Exit*

A stabilized construction exit consists of a pad of stone aggregate placed on a geotextile filter fabric, located at any point where traffic will be leaving a construction site to an existing access road way or other paved surface. Its purpose is to reduce or eliminate the tracking of sediment onto public roads by construction vehicles. This helps protect receiving waters from sediment carried by stormwater runoff from public roads.

*Temporary Sediment Trap*

A sediment trap is a small, temporary ponding area to intercept sediment-laden runoff from small disturbed areas. Intercepted runoff is retained long enough to allow for settling of the coarser sediment particles. A sediment trap is usually installed in a drainage swale or channel, at a storm drain or culvert inlet, or other points of discharge from a disturbed area.

*Temporary Sediment Basin*

A sediment basin is a water impoundment constructed to capture and store sediment and/or debris. Sediment is removed by temporarily storing sediment-laden runoff, allowing time for the sediment particles to settle. In some instances, settling may be enhanced by the introduction of flocculants. Sediment basins may be made by constructing a dam or embankment or by excavating a depression.

Sediment basins differ from sediment traps, in that basins are engineered impoundment structures, and may serve larger areas than sediment traps.

The sediment basin is designed to:

- Detain stormwater volume and slowly release it to the downstream waterways;
- Trap sediment originating from construction site and prevent subsequent deposition in downstream drainage waterways;
- Provide storage of the trapped sediment and debris.

*Construction Dewatering*

Construction dewatering must be conducted in a way to prevent sedimentation associated with the management of water removed during construction from excavations, cofferdams, and other work areas that trap stormwater and groundwater. Construction dewatering discharges to surface waters must obtain coverage under either the NPDES Construction General Permit (CGP) (the State Permit Conditions Section details requirements for construction dewatering) or for sites disturbing less than one acre, the NPDES Construction Dewatering General Permit . These permits contain, among other requirements, numeric limits for total suspended solids (TSS).

Construction sites in New Hampshire typically require construction dewatering operations. Excavations that do not “daylight” to existing grade trap either rainwater or groundwater, and cofferdams collect rain, ground or seepage water within the work area. This water needs to be removed before certain operations can be performed or to keep work conditions safe. Contractors typically use ditch pumps to dewater these enclosed areas. If care is not taken to select the point of discharge and provide adequate treatment, the pumped water may discharge to down-gradient natural resources such as lakes, wetlands, or streams, with subsequent sedimentation of those waterbodies.

Construction dewatering activities must be conducted to prevent the discharged water from eroding soil on the site, remove sediment from the collected water, and preserve downgradient natural resources and property.

*Flocculants*

Flocculants (or coagulants) are natural materials or chemicals that cause colloidal particles (clay) to coagulate. The coagulated particles group together to form flocs, which settle out of detained stormwater.

Flocculants can be used in conjunction with sediment basins and sediment traps to remove suspended clay and fine silt particles from stormwater runoff prior to discharge. Use of flocculants improves the ability of these settling facilities to remove finer particles than would be removed otherwise and can increase the percentage of fines removed during the detention period.

Flocculants should only be used upon prior approval by NH DES.

### Winter Weather Stabilization and Construction Practices

A project involving construction activity extending beyond one construction season will require measures to stabilize the site for the over-winter period. If a construction site is not stabilized with pavement, a road gravel base, 85 % mature vegetation cover, or riprap by October 15, then the site must be protected with over-winter stabilization. The winter construction period is from October 15 through May 15.

Winter excavation and earthwork activities need to be limited in extent and duration, to minimize potential erosion and sedimentation impacts. Various erosion and sediment control practices need to be applied, as discussed in Volume 3 of the New Hampshire Stormwater Manual, to stabilize a project site during the winter period.

## 7-4. Selection Criteria for Best Management Practices

There is no single stormwater best management practice that is appropriate for every development site. Soils, topography, slope, and many other factors make each site unique and require individual assessments to determine the most suitable stormwater BMPs. Depending on the needs of a site, BMPs can be implemented to meet one or more of the following management objectives:

- Recharge groundwater and reduce total runoff volumes
- Protect stream channels
- Control peak rates for flood control
- Reduce pollutant loads

Often, a site has a combination of management objectives and requires BMPs that achieve multiple objectives. The selection of BMPs requires careful consideration of these objectives, as well as a variety of constraints that may influence the effective application of particular types of BMPS. In some situations, two or more BMPs in a series may be necessary to achieve sufficient treatment to reduce pollutant loads.

This section provides an overview of the screening criteria that should be considered when selecting BMPs. These criteria are intended to provide only general guidance in the selection of BMPs and should not be used in the place of best professional judgment. Volume 2 of the New Hampshire Stormwater Manual provides a detailed discussion of the criteria in order to select measures that are appropriate for meeting management objectives while taking into consideration unique site constraints.

### Land Use Criteria

Selecting a stormwater BMP requires consideration of, among other factors, space availability, fitting with the neighborhood character, housing density, and future growth and development. Some practices require very little space and some are land intensive. Some practices blend in with the landscape and others are less compatible. As discussed in Volume 2 of the New Hampshire Stormwater Manual, selection of BMPs may be dependent on which of the following land-use settings apply:

- Rural
- Residential
- Roads and Highways
- Commercial Development
- High Load Areas

Of particular note are high-load areas, which include areas where activities involve storage of regulated substances that may be exposed to rainfall or runoff. These areas typically generate higher concentrations of hydrocarbons, metals, or suspended solids than found in typical stormwater runoff and may include industrial facilities, petroleum storage or dispensing facilities, vehicle fueling or maintenance stations, fleet storage areas, public works storage areas, road salt facilities, commercial nurseries, non-residential facilities with uncoated metal roofs, or facilities with outdoor storage, loading, or unloading of hazardous substances. These areas have particular requirements for the management of stormwater, including the prohibition of infiltration of stormwater runoff, in order to protect groundwater supplies.

### Site Physical Feasibility Factors

Physical site constraints such as the infiltration capacity of the soil, depth to bedrock or water table, size of the drainage area, and slope can limit the selection of stormwater BMPs. Depending on the physical site constraints, certain BMPs may be too costly to install or may be ineffective. NHDES has established requirements for physical feasibility factors. These requirements are described in the Alteration of Terrain Program Administrative Rules (Env-Wq 1500) and are summarized in Volume 2 of the New Hampshire Stormwater Manual. Physical feasibility criteria include:

- Soil infiltration capacity
- Water table
- Drainage area
- Slopes

### Watershed Resource Factors

Chapter 3 discussed how the impacts of development activities can be far reaching. Because of this, it is important to look not only at the impacts the development will have at a site, but also how downstream resources may be impacted by development activities. The following downstream resources should be considered when selecting stormwater BMPs:

- Sensitive receiving waters such as impaired waters, outstanding resources waters, and prime wetlands , located downstream of a development site;
- Water supplies: aquifers and surface waters
- Lakes and ponds
- Estuary and Coastal Areas

### BMP Capability Factors

Pollutant removal efficiencies are dependent on many variables including proper selection and installation of the BMP, proper placement of the BMP on a site, and proper maintenance. Various field and laboratory tests have determined average expected pollutant removal efficiencies for various management practices. These values, expressed as a percentage of the total load, can be seen in Chapter 8. As more studies are conducted and the amount of pollutant removal efficiency data grows, these estimates may change to more accurately reflect the level of stormwater treatment provided through these practices.

### Maintenance Factors

Regular inspection and maintenance is essential for long-term effectiveness of stormwater BMPs. Sediment, trash, and other debris can accumulate in BMPs and needs to be removed periodically. Pre-treatment devices, such as sediment forebays, can reduce the amount of sediment accumulation in the primary treatment device; however, pre-treatment practices also require maintenance. If not properly maintained, the BMP will not operate as designed and will not provide effective treatment of stormwater runoff. This jeopardizes water quality and may violate permit conditions. All stormwater BMPs require maintenance; however, the frequency and difficulty of maintenance activities and the equipment needed to carry them out varies. Maintenance criteria need to be considered when selecting a stormwater BMP.

### Community and Environmental Factors

It is important to think about how a stormwater BMP will fit into the community. Some BMPs may be aesthetically attractive and will blend into the local landscape and may actually become a landscape feature. Others may pose a safety risk, such as deep standing water, that may be unsuitable for a residential area with small children or increase mosquito habitat and the potential for human exposure to mosquito-borne illnesses. Some BMPs are more expensive to construct and maintain than others. It is important that the municipality, home association, or homeowner will be able to afford and maintain the practice. In addition, some practices may have other environmental benefits; for example, some BMPS can provide wildlife and wetland habitat.

## 7-5. Stormwater System Operation and Maintenance Plan

It is essential for all stormwater management systems to be carefully planned and to undergo routine inspection and maintenance in order to operate at the designed efficiency. To more easily track the operation and maintenance activities, including the activity schedule, the person(s) responsible, and the maintenance activity records, it is recommended (and sometimes required) that a stormwater management plan is developed and implemented. If a plan is being developed under a specific permit, check with the permit program to see if additional plan elements are required. At a minimum, the Stormwater System Operation and Maintenance Plan should include the following elements:

- The names of the responsible parties who will implement the Plan,
- The frequency of inspections,
- And inspection checklist to be used during each inspection,
- And inspection and maintenance log to document each activity,
- A plan showing the locations of all the stormwater practices described in the plan.

## 7-6. Road Salt and Deicing Minimization Plan

New Hampshire's cold winter climate and snowfall require plowing and de-icing of roadways and other impervious surfaces to allow for safer travel. The most commonly used de-icing salt is sodium chloride ($NaCl$). In general, road salt is used to reduce the adherence of snow to the pavement, keep the snow in a "mealy" condition to allow for easier plowing, and to prevent the formation of ice or snow ice (hard pack).

Although road salt makes for safer travel, it is hard on the environment and can pose a risk to drinking water supplies. Roadside vegetation is visibly impacted from road salt including burned grass and shrubs. High chloride concentrations can be toxic to some aquatic life, including certain types of macroinvertebrates and freshwater fish. New Hampshire has several surface waters that are listed as impaired in the Section 305(b) and 303(d) Surface Water Quality Report. The majority of these waterbodies are in heavily urbanized areas. Chloride impairments in surface waters along the Interstate 93 corridor in southern New Hampshire have lead to the development of several chloride TMDLs for these waters. In addition to the habitat and water quality impacts, private wells can become contaminated by chloride.

Unfortunately, the systems and treatment practices commonly used to treat stormwater runoff do not remove chloride. Practices that do remove chloride, such as reverse osmosis, are very costly. Because of this, source control (i.e., using less salt in the first place), is the best way to prevent further chloride contamination.

To address the concerns associated with the application of chlorides and other deicing materials, NHDES requests the development of a Road Salt and Deicing Minimization Plan when a development will create one acre or more of pavement, including parking lots and roadways. The plan should address the policies that the development will keep in place to minimize salt and other deicer use after the project has been completed. A component of the plan should include tracking the use of salt and other deicers for each storm event and compiling salt use data annually.

New Hampshire does not yet have salt reduction guidance, but recommends following the guidelines available in the *Minnesota Winter Parking Lot and Sidewalk Maintenance Manual* (www.pca.state.mn.us/publications/parkinglotmanual.pdf) and the *Minnesota Snow and Ice Control* handbook, (www.mnltap.umn.edu/pdf/snowicecontrolhandbook.pdf). Deicing application rate guidelines and a form for tracking salt and other deicer usage are included in Appendix C.

## Chapter 7 References


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# Chapter 8
# Pollutant Loading Calculations

This chapter describes the Simple Method for determining pre- and post-development pollutant loadings from a project. It provides the event mean concentrations (EMCs) of pollutants for each land use type, and the pollutant removal efficiencies of various BMPs. This chapter also provides a link to the NHDES Simple Method Spreadsheet. Detailed calculations and guidance on running the Simple Method are described in the NHDES Interim Guidance for Estimating Pre- and Post-Development Stormwater Pollutant Loads, available from NHDES.

At this time, NHDES requires pollutant loading analysis to include only total suspended solids (TSS), total phosphorus (TP), and total nitrogen (TN). Although projects may have other pollutants of concern, TSS, TP, and TN will be used as surrogates for other parameters until such time that additional data becomes available to sufficiently and confidently model other parameters.

## 8-1. The Simple Method

Many models are available to estimate pre- and post-development pollutant loads, such as the STEPL, AVGWLF, WINNSLAMM, and the P8 Urban Catchment Model. Each model varies in strengths and weaknesses. NHDES is reviewing various models and will consider the use of other models if proposed. At this time, however, NHDES recommends using the "Simple Method", a spreadsheet based calculation, for comparing pre-development to post-development pollutant loads. This section has been adapted from the Stormwater Center's The Simple Method to Calculate Urban Stormwater Loads and describes the Simple Method loading analysis.

### Simple Method Calculations

The Simple Method estimates pollutant loading of stormwater runoff for urban and developing areas. The technique is recommended by NHDES because of the modest amount of information it requires, which includes subwatershed drainage area and impervious cover, annual precipitation, and stormwater runoff pollutant concentrations.

### Calculation for Chemical Constituents

The Simple Method estimates pollutant loads for chemical constituents as a product of annual runoff volume and pollutant concentration using the following equation:

$$L = 0.226 * R * C * A$$

Where:

L = Annual loads (lbs)
R = Annual runoff (inches)
C = Pollutant concentration (mg/l)
A = Area (acres)
0.226 = Unit conversion factor

### Calculation for Bacteria

For bacteria, the equation is different, to account for the difference in units. The equation for bacteria is:

**L = 1.03 * 10-3 * R * C * A**

Where:

L = Annual loads (Billion Colonies)
R = Annual runoff (inches)
C = Bacteria concentration (col/100ml)
A = Area (acres)
1.03 * 10-3 = Unit conversion factor

### Calculation for Annual Runoff

The Simple Method calculates annual runoff as a product of annual runoff volume, and a runoff coefficient (Rv). Runoff volume is calculated as:

$$R = P * P_j * Rv$$

Where:

R = Annual runoff (inches)
P = Annual rainfall (inches)
$P_j$ = Fraction of annual rainfall events that produce runoff (usually 0.9)
Rv = Runoff coefficient

### Calculation for Runoff Coefficient

In the Simple Method, the runoff coefficient is calculated based on impervious cover in the subwatershed. This relationship is shown in Figure 8-1. Although there is some scatter in the data, watershed imperviousness does appear to be a reasonable predictor of Rv. The following equation represents the best fit line in the dataset (N = 47, R2 = 0.71).

$$Rv = 0.05 + 0.9I_a$$

Where:

Rv = Runoff coefficient
$I_a$ = Percent impervious area draining to the structure in decimal form

The Simple Method uses different impervious cover values for separate land uses within a subwatershed. Although representative impervious

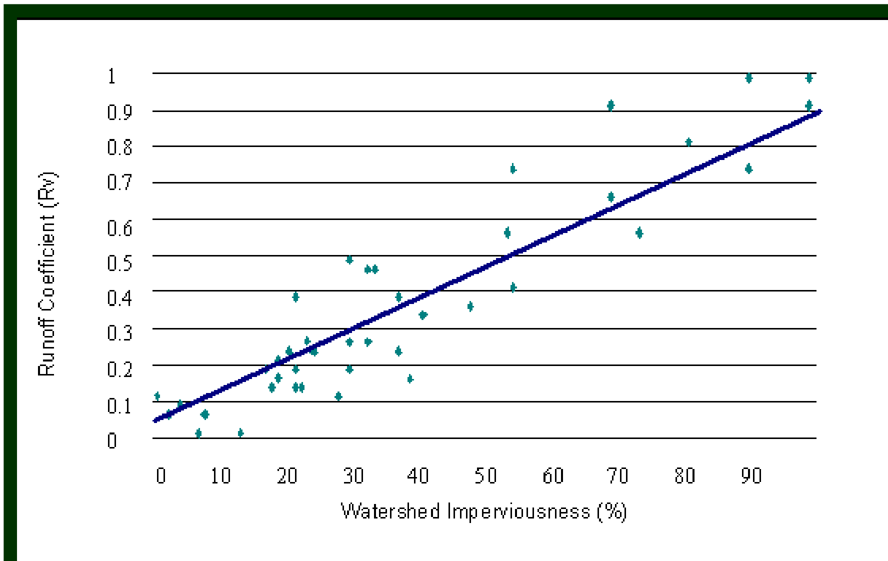


Figure 8-1. Relationship between watershed imperviousness (I) and the storm runoff coefficient (Rv) (Source: Adapted from Schueler, 1987).

cover data is available, DES recommends using impervious cover data specific to an individual project site. Towns may have detailed impervious cover information if they maintain a detailed land use/land cover GIS database, or impervious cover can be measured directly from the site or site plans. Subdivision plans typically do not include the exact size and location of the impervious cover associated with rooftops, driveways, and other impervious areas on individual lots. These areas should be included in the Simple Method analysis by assigning an average house size and driveway length and width for each lot. In addition, the sub-drainage areas to which each lot drains should be estimated.

### Limitations to the Simple Method

The Simple Method should provide reasonable estimates of changes in pollutant export resulting from development activities. However, the following should be kept in mind when applying this method:

- The Simple Method is most appropriate for assessing and comparing the relative stormflow pollutant load changes of different land use and stormwater management scenarios. The Simple Method provides estimates of pollutant export that are probably close to the “true” but unknown values for a development site, watershed, or subwatershed. However, it is very important not to over emphasize the precision of the results obtained. For example, it would be inappropriate to use the Simple Method to evaluate relatively similar development scenarios (e.g., 34.4% versus 36.9% impervious cover).

- The Simple Method provides a general planning estimate of likely pollutant export from areas at the scale of a development site, watershed, or subwatershed. More sophisticated modeling may be needed to analyze larger and more complex watersheds.

- The Simple Method only estimates pollutant loads generated during storm events and does not take into consideration background pollutants associated with baseflow volumes. Baseflow is typically negligible at the scale of a single development site and can usually be safely neglected. However, watersheds and subwatersheds do generate baseflow pollutant loads. Baseflow pollutant loads usually make up only a small fraction of the total pollutant load delivered from a developed area. Still, it is important to remember that the load estimates refer only to storm event derived loads and should not be confused with the total pollutant load from an area.

## 8-2. Simple Method Input Data

This section discusses and provides or references the input data required to run the Simple Method analysis including a link to the Simple Method Spreadsheet, event mean concentrations for stormwater pollutants, stormwater BMP pollutant removal efficiencies, and precipitation data. Additional guidance on conducting pollutant loading analysis using the Simple Method is provided by NHDES.

### Simple Method Spreadsheet

The Simple Method spreadsheet was developed by NHDES to calculate pre- and post-development pollutant loads using the Simple Method. The spreadsheet is in Microsoft Excel format and includes an instruction worksheet ("Instructions"), two data input worksheets ("Input_LU_A_Ia_C" and "Input BMPs"), a summary worksheet ("SUMMARY"), and worksheets for each pollutant showing pre- and post-pollutant loading ("ie, "Pre_TSS", "Post_TSS", "Pre_BOD", etc.).

The "Input_LU_A_Ia_C" worksheet requires the input of general project information (e.g., date, project name, town, etc.) as well as the pre- and post-development conditions for each subwatershed, including the name of the subwatershed, the area (in acres), and the impervious fraction for each applicable land use in the subwatershed. The worksheet is set up for up to ten different subwatersheds; however, more can be added if necessary. After the pre- and post- construction information is entered, the pollutant concentrations for each applicable pollutant and land use should be entered for each subwatershed. This is the "C" value in the Simple Method equations, but it also known as the event mean concentration (EMC). A table of EMC values is included in the worksheet.

The "Input BMPs" worksheet is where descriptions and removal efficiencies of existing and proposed BMPs is entered. This information should be entered for the pre- and post-development condition for each subwatershed.

Once this information has been entered, the "SUMMARY" worksheet shows the total pre- and post-development loading results. The individual pre- and post- pollutant worksheets show the loads and removals for the individual subwatersheds. Additional information, instructions, and the Simple Method spreadsheet are available from NHDES.

### Event Mean Concentrations of Stormwater Constituents

Appendix D shows the list of pollutants with their event mean concentration (EMC) values that should be included in pre- and post-development pollutant loading estimates. The project area can either be grouped into general land use types, such as residential, commercial, industrial, and roadway, or broken down into specific components such as residential roofs, commercial streets, or lawns, to calculate annual pollutant loads. It is important that the approach used to model the pre-condition is also used to model the post-condition. NHDES will consider other EMCs if requested by the applicant and if sufficient documentation is provided.

### Best Management Practices (BMP) Pollutant Removal Efficiencies

If you are using the Simple Method, the pollutant removal efficiencies in Appendix E should be used. NHDES will consider other BMP removal efficiencies if requested and if sufficient documentation is provided.

### Precipitation Data

In addition to the Simple Method, many other models for calculating pollutant loads require input of the average annual precipitation. Average annual precipitation for various towns and cities in New Hampshire for the period of 1971 – 2000 may be obtained from http://www.erh.noaa.gov/gyx/climo/NH_STATS_NEW.htm. The average annual precipitation value in inches for the community closest to your project should be used.

## Chapter 8 References

Camp, Dresser, and McKee. Merrimack River Watershed Assessment Study, Draft Screening Level Model. Jan. 2004.

Center for Watershed Protection. "A Stormwater Design Manual Toolbox". 2006. 24 Feb 2006. http://www.stormwatercenter.net/intro_manual.htm#about.

Horsely Witten Group. Model Stormwater Regulations; Duxbury, Marshfield, and Plymouth, MA. December 31, 2004.

NH Department of Environmental Services, Interim Guidance for Estimating Pre- and Post-Development Pollutant Loads. 17 Oct. 2005.

Stocker, Joel. Nonpoint Education for Municipal Officials. Technical Paper Number 3. *Methods for Measuring and Estimating Impervious Surface Coverage.* 1998.

United States Environmental Protection Agency. National Management Measures to Control Nonpoint Source Pollution from Urban Areas. 2006.

# Appendix A.
# Example Deed Restriction Template

# Example Deed Restriction Template

THIS DEED RESTRICTION is made this ______day of ___________, ____,
date month year

by ______________________________________________________,
name

____________________________________, ___________________,
street address city/town

_________________________ County, New Hampshire, _____________,
county zip code

(hereinafter referred to as the "Grantor", which includes the plural of the word where the context requires, and shall, unless the context clearly indicates otherwise, include the Grantor's heirs, administrators, legal representatives, devisees, successors, and assigns) and hereby imposes the following deed restrictions on those lots specified herein and as described on a plan entitled,

_________________________________________________________
name of plan

dated __________________, consisting of __________ sheets, by
date #

_________________________________________________________,
survey/engineering firm

recorded at Book # _______, Page # _______ at the __________________
county

County Registry of Deeds (hereinafter referred to as the "Plan"), as follows:

Select one or more as appropriate:

- Natural buffer conservation area
- Wetland buffer conservation area
- Critical habitat protection area
- Open space area
- Limited fertilizer application area
- Limited insecticide and/or herbicide application area
- Limited road salt application area
- Other

To all lots which contain ______________________________
enter designated area from above

as referred to on the Plan, and marked with permanent survey monuments on each lot:

That within the ___________________________________,
enter designated area from above

which consists of a designated area on said plan, the following restrictions apply:

Select one or more as appropriate:

Removal of vegetation is prohibited, except for removal of dead, diseased, or invasive species.

Fertilizer application is prohibited except for fertilizer that contains no more than ___ % of phosphorus and % of nitrogen by weight. Fertilizer shall be applied no more than once in the spring and once in the fall at an application rate not to exceed ____ lbs/acre.

Fertilizer application is prohibited.

Insecticide and/or Herbicide application is prohibited or limited as follows:

Use of road salt shall be minimized as follows:

Other (specify)

Include if appropriate:

To all lots which contain on lot best management practices (BMPs) as referred to on the Plan, including, but not limited to rain gardens, bioretention areas, vegetated swales, or other management practices intended to retain and treat stormwater runoff:

The Grantor acknowledges and agrees to:

Assume responsibility for proper maintenance of stormwater quality best management practices.

Perform maintenance and inspection of best management practices, not less than once annually in accordance with NHDES approved _______________ plan of (date).

Retain written proof that the inspection and maintenance were performed, with said proof being retained for a period of not less than five (5) calendar years and provided to NHDES upon request.

This deed restriction shall run with the land and shall be binding upon the Grantor, tenants and any subsequent owners and tenants, their successors, heirs or assigns. Any lease of said specific parcels shall be subject to this restriction.

The above represent enforceable conditions established by the New Hampshire Department of Environmental Services that are necessary to meet NH Surface Water Quality Standards. These conditions are intended to be complied with in perpetuity.

IN WITNESS WHEREOF, I hereby set my hand this ______ day of
date

____________, ________.
month year

GRANTOR:

____________________________

___________________

Witness to Grantor

By: __________________________
representative name, title
Duly Authorized

STATE OF NEW HAMPSHIRE
County of ________________________

On this _______ day of ________________, ______, before me
date month year

____________________________________, the undersigned officer,
name of notary public
personally appeared _____________________________________, who
representative name
acknowledged himself/herself to be the ___________________________ of
representative title
____________________________________, and that he, as such
grantor name
_________________________________, being so authorized to do so,
representative title
executed the foregoing instrument for the purposes contained therein.

In witness whereof, I have set my hand and official seal.

______________________________________________

Notary signature

Commission Expiration Date: enter notary name and date
(Seal)

# Appendix B.
# Example Drainage Easement Language

# Example Drainage Easement Language[1]

There are hereby conveyed the following easements as appurtenant to the parcel of land on which ***[name of highway]*** is located: namely, the right to drain and flow surface water from the culverts and other stormwater management structures shown on the plan on lots ***[insert numbers or other descriptions]*** with the right to enter upon such lots on which the drainage easements are located for the purpose of maintaining and repairing such easements and assuring proper flow, and also including, if applicable, maintaining, repairing and replacing the culverts and other stormwater management structures located in the highway.

---

[1] Source adapted from: The NH Local Government Center, *A Hard Road to Travel: New Hampshire Law of Local Highways, Streets and Trails*, 2004.

# Appendix C.
# Deicing Application Rates and Documentation Form

# Deicing Application Rate Guidelines

**24' of pavement (typcial two-lane road)**

These rates are not fixed values, but rather the middle of a range to be selected and adjusted by an agency according to its local conditions and experience.

| | | | Pounds per two-lane mile | | | |
|---|---|---|---|---|---|---|
| Pavement Temp. (°F) and Trend ( ↑↓ ) | Weather Condition | Maintenance Actions | Salt Prewetted / Pretreated with Salt Brine | Salt Prewetted / Pretreated with Other Blends | Dry Salt* | Winter Sand (abrasives) |
| > 30° ↑ | Snow | Plow, treat intersections only | 80 | 70 | 100* | Not recommended |
| | Freezing Rain | Apply Chemical | 80 - 160 | 70 - 140 | 100 - 200* | Not recommended |
| 30° ↓ | Snow | Plow and apply chemical | 80 - 160 | 70 - 140 | 100 - 200* | Not recommended |
| | Freezing Rain | Apply Chemical | 150 - 200 | 130 - 180 | 180 - 240* | Not recommended |
| 25° - 30° ↑ | Snow | Plow and apply chemical | 120 - 160 | 100 - 140 | 150 - 200* | Not recommended |
| | Freezing Rain | Apply Chemical | 150 - 200 | 130 - 180 | 180 - 240* | Not recommended |
| 25° - 30° ↓ | Snow | Plow and apply chemical | 120 - 160 | 100 - 140 | 150 - 200* | Not recommended |
| | Freezing Rain | Apply Chemical | 160 - 240 | 140 - 210 | 200 - 300* | 400 |
| 20° - 25° ↑ | Snow or Freezing Rain | Plow and apply chemical | 160 - 240 | 140 - 210 | 200 - 300* | 400 |
| 20° - 25° ↓ | Snow | Plow and apply chemical | 200 - 280 | 175 - 250 | 250 - 350* | Not recommended |
| | Freezing Rain | Apply Chemical | 240 - 320 | 210 - 280 | 300 - 400* | 400 |
| 15° - 20° ↑ | Snow | Plow and apply chemical | 200 - 280 | 175 - 250 | 250 - 350* | Not recommended |
| | Freezing Rain | Apply Chemical | 240 - 320 | 210 - 280 | 300 - 400* | 400 |
| 15° - 20° ↓ | Snow or Freezing Rain | Plow and apply chemical | 240 - 320 | 210 - 280 | 300 - 400* | 500 for freezing rain |
| 0° - 15° ↑↓ | Snow | Plow, treat with blends, sand hazardous areas | Not recommended | 300 - 400 | Not recommended | 500 - 750 spot treatment as needed |
| < 0° | Snow | Plow, treat with blends, sand hazardous areas | Not recommended | 400 - 600** | Not recommended | 500 - 750 spot treatment as needed |

* Dry salt is not recommended. It is likely to blow off the road before it melts ice.

** A blend of 6 - 8 gal/ton $MgCl_2$ or $CaCl_2$ added to NaCl can melt ice as low as -10°.

# Anti-icing Route Data Form

| Truck Station: | | | | |
|---|---|---|---|---|
| Date: | | | | |
| Air Temperature | Pavement Temperature | Relative Humidity | Dew Point | Sky |
| Reason for applying: | | | | |
| Route: | | | | |
| Chemical: | | | | |
| Application Time: | | | | |
| Application Amount: | | | | |
| Observation (first day): | | | | |
| Observation (after event): | | | | |
| Observation (before next application): | | | | |
| Name: | | | | |

# Appendix D.
# Typical Stormwater Pollutant EMCs

| Typical Pollutant EMCs Found in Stormwater Runoff by Source Area* | | | |
|---|---|---|---|
| **Source Area Unit** | **TSS mg/L** | **TP mg/L** | **TN mg/L[3]** |
| RESIDENTIAL (general) [4] | 100 | 0.40 | 2.2 |
| Med. Density Residential [5] | 85 | 0.52 | 5.15 |
| Residential roof | 19 [1] | 0.11 [2] | 1.5 |
| Residential street | 172 [1] | 0.55 [2] | 1.4 |
| Driveway | 173 [1] | 0.56 [2] | 2.1 |
| COMMERCIAL (general) [5] | 77 | 0.33 | 2.97 |
| Commercial roof | 9 [1] | 0.14 [2] | 2.1 |
| Commercial street | 468 [1] | | |
| Commercial/ Residential parking | 27 [1] | 0.15 [2] | 1.9 |
| INDUSTRIAL (general) [5] | 149 | 0.32 | 3.97 |
| Industrial roof | 17 [1] | | |
| Industrial parking | 228 [1] | | |
| Heavy industrial | 124 [1] | | |
| HIGHWAY (general) [5] | 141 | 0.43 | 2.65 |
| Urban highway | 142 [1] | 0.32 [2] | 3 |
| Rural highway | 51 [1] | | 22 |
| Lawns | 80 [1] | 2.1 [2] | 9.1 |
| Landscaping | 37 [1] | | |
| Urban open [5] | 51 | 0.11 | 1.74 |
| Rural open/forest [5] | 51 | 0.11 | 1.78 |
| Ag/pasture [5] | 145 | 0.37 | 5.98 |
| Water/wetland [5] | 6 | 0.08 | 1.38 |

Sources: 1: Claytor and Schueler (1996)
2: Average of Steuer et al. (1997), Bannerman (1993) and Waschbusch (2000)
3: Steuer et al. (1997)
4: Caraco (2001), default values averaged from several individual assessments
5: Camp, Dresser, and McKee, *Merrimack River Watershed Assessment Study, Draft Screening Level Model*, January 2004.

*To address the concerns associated with the application of chlorides and other deicing materials, NHDES requests the development of a Road Salt and Deicing Minimization Plan when a development will create one acre or more of pavement, including parking lots and roadways. The plan should address the policies that the development will keep in place to minimize salt and other deicer use after the project has been completed. The plan should include tracking the use of salt and other deicers for each storm event and compiling salt use data annually.

New Hampshire does not yet have salt reduction guidance, but recommends following the guidelines available in the Minnesota Snow and Ice Control handbook, available at: http://www.mnltap.umn.edu/pdf/snowicecontrolhandbook.pdf. Deicing application rate guidelines and a form for tracking salt and other deicer usage are included in Appendix C.

# Appendix E.
# BMP Pollutant Removal Efficiency

## Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis

Best Management Practice (BMP) removal efficiencies for pollutant loading analysis for total suspended solids (TSS), total nitrogen (TN), and total phosphorus (TP) are presented in the table below. These removal efficiencies were developed by reviewing various literature sources and using best professional judgment based on literature values and general expectation of how values for different BMPS should relate to one another. The intent is to update this information and add BMPs and removal efficiencies for other parameters as more information/data becomes available in the future.

NHDES will consider other BMP removal efficiencies if sufficient documentation is provided.

Please note that all BMPs must be designed in accordance with the specifications in the Alteration of Terrain (AoT) Program Administrative Rules (Env-Wq 1500). If BMPs are not designed in accordance with the AoT Rules, NHDES may require lower removal efficiencies to be used in the analysis.

<u>BMP in Series</u>: When BMPs are placed in series, the BMP with the highest removal efficiency shall be the efficiency used in the model for computing annual loadings. Adding efficiencies together is generally not allowed because removals typically decrease rapidly with decreasing influent concentration and, in the case of primary BMPs (i.e., stormwater ponds, infiltration and filtering practices), pre-treatment is usually part of the design and is therefore, most likely already accounted for in the efficiencies cited for these BMPs.

| Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis | | | | Values Accepted for Loading Analyses | | |
|---|---|---|---|---|---|---|
| **BMP Type** | **BMP** | **Notes** | **Lit. Ref.** | **TSS** | **TN** | **TP** |
| Stormwater Ponds | Wet Pond | | B, F | 70% | 35% | 45% |
| | Wet Extended Detention Pond | | A, B | 80% | 55% | 68% |
| | Micropool Extended Detention Pond | TBA | | | | |
| | Multiple Pond System | TBA | | | | |
| | Pocket Pond | TBA | | | | |
| Stormwater Wetlands | Shallow Wetland | | A, B, F, I | 80% | 55% | 45% |
| | Extended Detention Wetland | | A, B, F, I | 80% | 55% | 45% |
| | Pond/Wetland System | TBA | | | | |
| | Gravel Wetland | | H | 95% | 85% | 64% |
| Infiltration Practices | Infiltration Trench (≥75 ft from surface water) | | B, D, I | 90% | 55% | 60% |
| | Infiltration Trench (<75 ft from surface water) | | B, D, I | 90% | 10% | 60% |
| | Infiltration Basin (≥75 ft from surface water) | | A, F, B, D, I | 90% | 60% | 65% |
| | Infiltration Basin (<75 ft from surface water) | | A, F, B, D, I | 90% | 10% | 65% |
| | Dry Wells | | | 90% | 55% | 60% |
| | Drip Edges | | | 90% | 55% | 60% |
| Filtering Practices | Aboveground or Underground Sand Filter that infiltrates WQV (≥75 ft from surface water) | | A, F, B, D, I | 90% | 60% | 65% |
| | Aboveground or Underground Sand Filter that infiltrates WQV (<75 ft from surface water) | | A, F, B, D, I | 90% | 10% | 65% |
| | Aboveground or Underground Sand Filter with underdrain | | A, I, F, G, H | 85% | 10% | 45% |
| | Tree Box Filter | TBA | | | | |
| | Bioretention System | | I, G, H | 90% | 65% | 65% |
| | Permeable Pavement that infiltrates WQV (≥75 ft from surface water) | | A, F, B, D, I | 90% | 60% | 65% |
| | Permeable Pavement that infiltrates WQV (<75 ft from surface water) | | A, F, B, D, I | 90% | 10% | 65% |
| | Permeable Pavement with underdrain | | Use TN and TP values for sand filter w/ underdrain and outlet pipe | 90% | 10% | 45% |

| Pollutant Removal Efficiencies for Best Management Practices for Use in Pollutant Loading Analysis | | | | Values Accepted for Loading Analyses | | |
|---|---|---|---|---|---|---|
| **BMP Type** | **BMP** | **Notes** | **Lit. Ref.** | **TSS** | **TN** | **TP** |
| Treatment Swales | Flow Through Treatment Swale | TBA | | | | |
| Vegetated Buffers | Vegetated Buffers | | A, B, I | 73% | 40% | 45% |
| Pre-Treatment Practices | Sediment Forebay | TBA | | | | |
| | Vegetated Filter Strip | | A, B, I | 73% | 40% | 45% |
| | Vegetated Swale | | A, B, C, F, H, I | 65% | 20% | 25% |
| | Flow-Through Device - Hydrodynamic Separator | | A, B, G, H | 35% | 10% | 5% |
| | Flow-Through Device - ADS Underground Multichamber Water Quality Unit (WQU) | | G, H | 72% | 10% | 9% |
| | Other Flow-Through Devices | TBA | | | | |
| | Off-line Deep Sump Catch Basin | | J, K, L, M | 15% | 5% | 5% |