# Chapter 10
# Stormwater


NEW HAMPSHIRE DEPARTMENT OF Environmental Services

## Overview

*Improving stormwater management as New Hampshire's landscape continues to be developed is necessary in order to avoid continuing deterioration in water quality, reductions in groundwater recharge, and costly damage to infrastructure. In the past stormwater has been managed with the goals of controlling erosion and flooding, but the conventional approach has not been successful in either protecting water quality or accommodating flood waters. Recent changes in state and federal programs – and to some extent in local programs – recognize the shortcomings of the conventional approach and lay a course for a more up-to-date approach that can preserve both water quality and pre-development hydrologic conditions. The new approach employs tools such as low impact development techniques and stormwater utilities. Using these tools, it is possible to maintain water quality, ecosystem health and groundwater resources.*

## 10.1 Description and Significance

Stormwater runoff begins as rainwater or snowmelt. When rain falls on a forested landscape, about half of it seeps into the ground and 40 percent evaporates or is taken up by vegetation and transpires from plants to the atmosphere. The remaining 10 percent moves slowly through the forest floor towards surface water, undergoing natural processes that filter and purify it. Landscape change significantly alters this part of the hydrologic system. Stormwater that falls on a developed landscape hits roofs, parking lots, roadways, and other impervious surfaces that prevent the infiltration of water. This reduces the amount of water that can seep into the ground and increases the speed and volume of stormwater running off a site (Figure 10-1).

In addition to affecting the hydrology of a site, landscape development also affects the quality of runoff. Aside from air pollutants picked up as it falls, rainwater is clean. As the resulting stormwater washes over developed or disturbed areas, it picks up a wide variety of pollutants such as nutrients, sediment, petroleum products, heavy metals and pathogens (Figure 10-2). In summer months the stormwater may also be warmed by its encounter with roofs and pavement.

**Studies conducted on large numbers of watersheds in other regions of the country have demonstrated water quality deterioration where impervious surfaces cover greater than 10 percent of the watershed area.**

While there are no statewide records regarding impervious surface coverage, a study by the University of New Hampshire found that the coverage of impervious area in New Hampshire's coastal watersheds increased from 4.7 percent in 1990 to 8.0 percent in 2005 (New Hampshire Estuaries Project, 2006). Statewide, an estimated 13,500 acres of open space is converted to developed area each year (Society for the Protection of New Hampshire Forests, 2006).

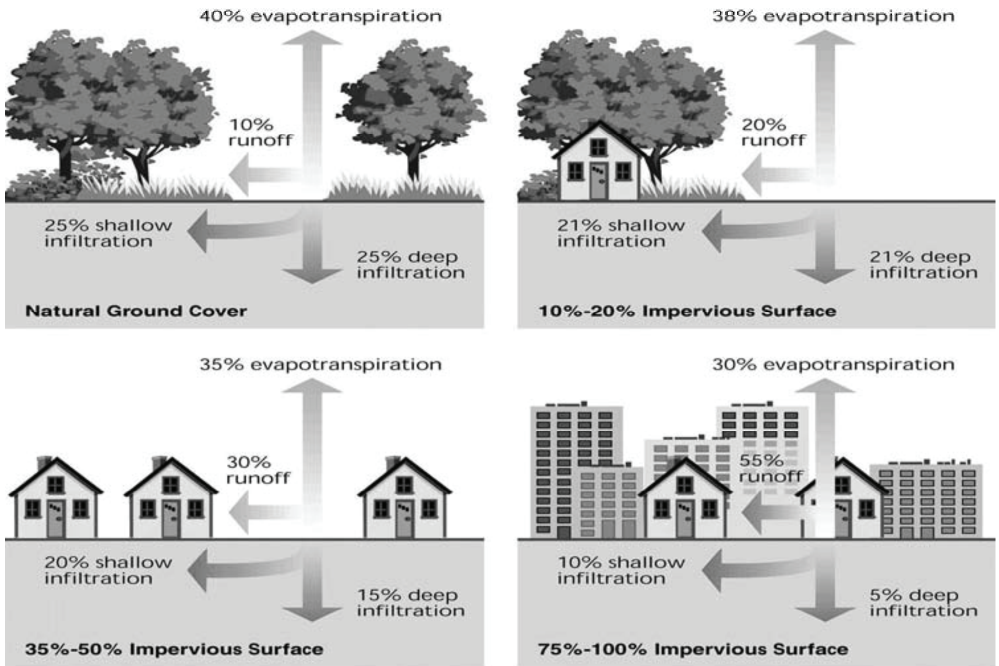


**Figure 10-1. Effects of increasing impervious cover.** ***Source: U.S. Environmental Protection Agency, 2006.***

## 10.2 Issues

### 10.2.1 Conventional Stormwater Management Practices Are Harmful to Water Resources

Historically, in order to prevent localized flooding and reduce erosion resulting from increased runoff at developed sites, storm drain networks were designed to collect and quickly carry stormwater runoff to the nearest surface water, such as a stream, river, lake or pond. Prior to 1960 there was little or no treatment to remove contaminants carried by the runoff (USEPA, 1983).

Over time it became clear that the conventional curb-and-gutter approach to stormwater management results in more frequent and more severe downstream flooding in urbanized watersheds due to the increased volume of runoff

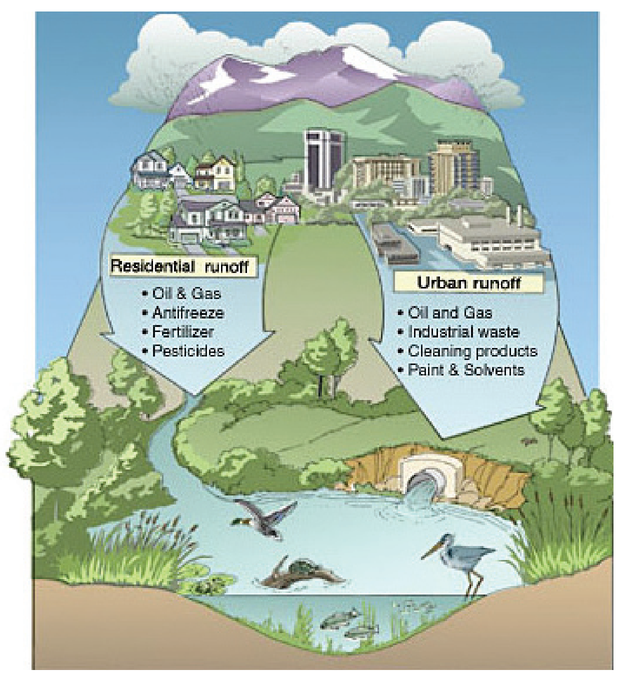


**Figure 10-2. Both residential and urban areas of development contribute pollutants to stormwater runoff, many of which have everyday uses.** ***Source: Clean Water Education Project, 2008.***

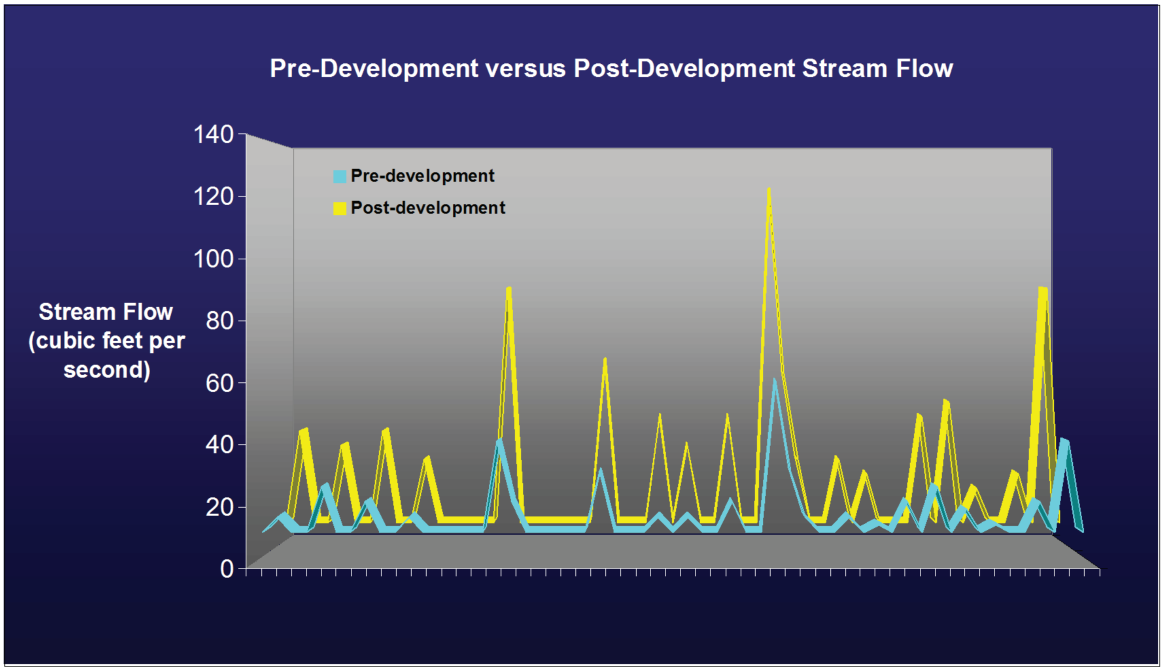


**Figure 10-3. With impervious surfaces, the delivery of rainfall to streams is shortened immensely, as shown in the typical stream-flow effects of developed areas versus undeveloped areas. The sharp, accented peaks in post-development streamflow are a result of the greater volumes of water delivered to the stream in a shorter period of time. These conditions cause stream channel scouring and sediment pollution downstream. *Source: Adapted from Maryland Department of the Environment and Center for Watershed Protection, 2000.***

and the rapidity with which it reaches receiving water bodies (Figure 10-3). It also became quite clear that stormwater from developed areas contains high concentrations of a wide range of water pollutants (USEPA, 1983).

Consequently, conventional stormwater management evolved to include stormwater detention structures to slow the release of runoff from large developed sites and to provide an opportunity for settling of suspended sediment in runoff. However, as stated in a recent report from the National Research Council, "Stormwater cannot be adequately managed on a piecemeal basis due to the complexity of both the hydrologic and pollutant processes and their effect on habitat and stream quality. Past practices of designing detention basins on a site-by-site basis have been ineffective at protecting water quality in receiving waters and only partially effective in meeting flood control requirements." (National Research Council [NRC], 2008, p. 8)

### *Water Quality Effects*

Studies conducted on large numbers of watersheds in other regions of the country have demonstrated water quality deterioration where impervious surfaces cover more than 10 percent of the watershed area (Center for Watershed Protection [CWP], 2003). A recent study in New Hampshire demonstrated that the percent of urban land use in stream buffer zones and the percent of impervious surface in a watershed can be used as indicators of stream quality (Figure 10-4) (Deacon et al., 2005).

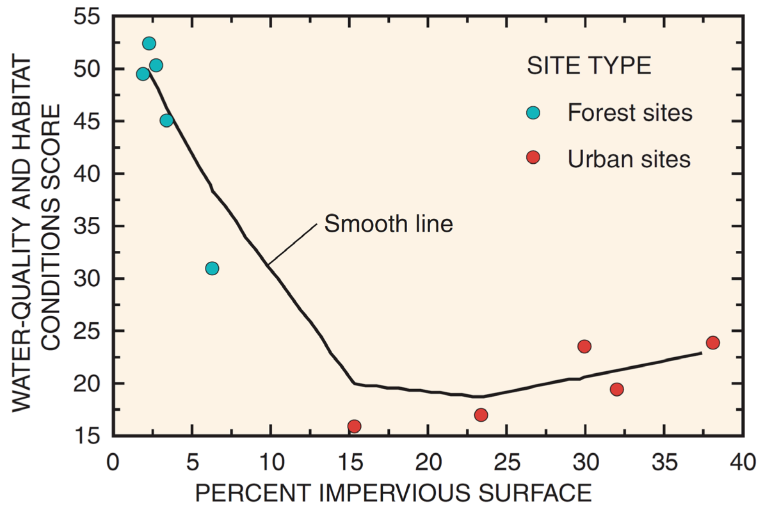


**Figure 10-4. Water quality and aquatic habitat condition as a function of impervious coverage (percent) in small coastal watersheds in N.H. A lower score indicates poorer water quality and habitat conditions.** ***Source: Deacon et al., 2005.***

Eighty-three percent (23,778 acres of lakes and 1,524 miles of rivers) of the water quality impairments (Figure 10-5) listed in DES's 2008 water quality assessment report were attributed wholly or in part to stormwater (New Hampshire Department of Environmental Services, 2008). The most common nonpoint source pollutants are nutrients and sediment. These wash into rivers, lakes and ponds from agricultural land, construction sites, and other developed or disturbed areas. Other common nonpoint source pollutants include pesticides, pathogens (bacteria and viruses), salts, oil, grease, toxic chemicals and heavy metals. Beach closures, degraded habitat, increased drinking water treatment costs, fish kills, and many other environmental and human health problems result from stormwater-related nonpoint source pollutants.

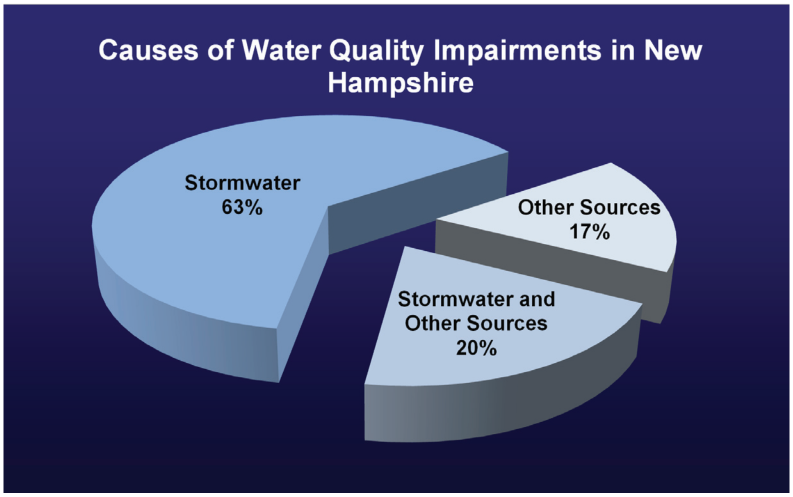


**Figure 10-5. Causes of water quality impairments in New Hampshire.** ***Source: NHDES, 2008.***

Data from national studies and from the UNH Stormwater Center have shown that conventional approaches to stormwater management (detention basins, treatment swales) do not meet DES's current performance standard of 80 percent removal of total suspended solids (the most commonly used benchmark for such structures) and that they do not provide a viable means of meeting future water quality objectives (J. Houle, University of New Hampshire Stormwater Center, personal communication, October 10, 2008).

### *Effects on Groundwater Quantity*

In an undeveloped landscape approximately half of the precipitation from a rain storm seeps into the ground. This water replenishes groundwater and provides water for vegetation. Chapter 4 – Groundwater provides information about the importance of groundwater for water supply and its role in supporting surface water flows and ecosystems. As Figure 10-1 demonstrates, as more impervious surfaces cover the landscape, less water is getting back into the ground. The current practice of routing stormwater to surface waters was developed in part because of concern for groundwater quality and because infiltration in the winter was thought to be infeasible. Federally funded studies in New Hampshire now indicate that stormwater can be properly treated and infiltrated on-site and year-round in areas where large quantities of regulated substances are not stored (University of New Hampshire Stormwater Center, 2008).

### 10.2.2 Existing Stormwater Infrastructure Is Inadequate

As Chapter 1 – Introduction and Overview and Appendix A explain, climate change is bringing higher temperatures and more frequent, intense storm events to the Northeast. Studies in New Hampshire have shown that the state's existing drainage infrastructure (culverts, etc.) is seriously under-sized to accommodate the increases in storm intensity and frequency expected in the coming decades. Specifically, a study of culverts in Keene found that 44 percent of culverts are likely undersized as a result of climate change and build-out of the watershed (Stack et al., 2006). Recent research examining impacts of climate change in the Northeast demonstrated that existing urban infrastructure, such as culverts, will be under-capacity by 35 percent (Ballestero et al., 2008). Nationwide research indicates that the frequency of heavy rainfall events is already increasing and that existing guidelines for the sizing of stormwater infrastructure are inadequate (Guo, 2006). Continuing to convert forests to impervious surfaces without implementing stormwater management designs that replicate pre-development hydrology will only exacerbate this situation, increasing the likelihood of costly damage to infrastructure during high runoff events.

### 10.2.3 Municipalities Have Inadequate Funding and Regulatory Mechanisms to Improve Stormwater Management

The National Pollutant Discharge Elimination System (NPDES) Phase II permit requirements, explained below in Section 10.3.1, increased municipalities' awareness of and responsibility for stormwater management. With these additional responsibilities come added costs. Maintaining catch basins and other stormwater infrastructure and cleaning streets is critical to protecting water quality downstream. Most municipalities are expected to manage stormwater with no increase in staff or budget. New funding mechanisms are needed for municipal management of stormwater if it is to be effective.

Another factor driving the need for expanded municipal stormwater programs is the evolution taking place in stormwater management. As noted above, conventional stormwater management, i.e., collect, detain, treat and release, does not fully address the negative impacts of increased impervious cover. Recognizing this problem, both state and local stormwater management programs – including DES's Alteration of Terrain program – are moving towards requiring management practices that infiltrate a prescribed volume of stormwater. However, these infiltration management practices require proper monitoring and maintenance in order to function as intended. Either individual property owners or municipalities must be responsible for ongoing monitoring and maintenance. DES's recent amendments to its Alteration of Terrain rules enable property owners to transfer their maintenance responsibilities to a willing municipality.

Since municipal budgets are supported by property taxes, property owners pay for municipal stormwater services based on the value of their property rather than the amount of stormwater generated on that property. In a typical community with a mix of residential and non-residential development, commercial and industrial entities generate most of the stormwater, but owners of residential property collectively pay more in taxes.

An alternative to general funding is the use of a stormwater utility, a special assessment district created to generate funding for stormwater management based on those who use or benefit from the system. Similar to rate-based Enterprise Funds used by water and sewer departments, stormwater utilities charge residents and businesses a fee specifically for storm drain system maintenance and upgrades, drainage plan development, flood control measures, water quality programs, administrative costs, and some capital improvements (Figure 10-6). Separate fees are typically established for residential properties and commercial/industrial properties, with commercial/industrial fees based on the amount of impervious area on the property. Monthly fees are typically quite small for single family residences, ranging from three to five dollars.

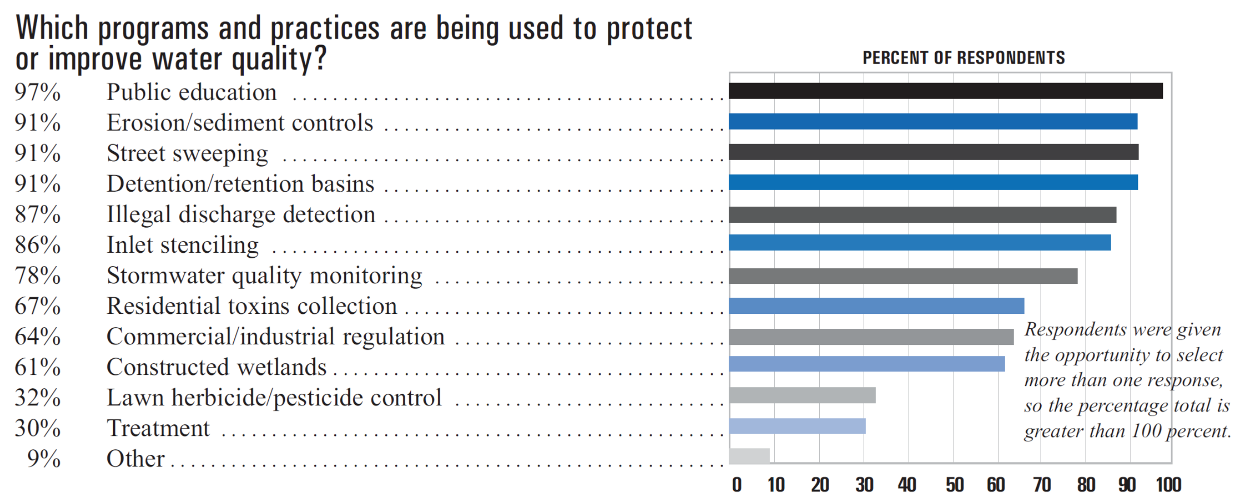


**Figure 10-6. Stormwater utilities, responding to a national survey, conduct a variety of activities to protect water quality.** ***Source: Black & Veatch, 2007.***

Recent years have seen increased interest in stormwater utilities in New Hampshire and other New England states, which so far have lagged behind other parts of the country in the formation of stormwater utilities. Although there are only a handful of these utilities in New England, there are over 600 nationwide (Hoskins, 2006). However, a combination of aging infrastructure, NPDES regulatory requirements, municipal budget constraints, and the positive experiences of communities in neighboring states that operate stormwater utilities are driving several New Hampshire municipalities toward the formation of their own utilities (M. Schramm, personal communication, October 14, 2008).

In 2008 the New Hampshire Legislature amended RSA 149-I to enable municipalities to form stormwater utilities.

# 10.3 Current Management and Protection

There are a number of federal, state, and local programs that address stormwater management. The key programs are explained below.

## 10.3.1 National Pollutant Discharge Elimination System

The Construction General Permit under the National Pollutant Discharge Elimination System (NPDES) stormwater program is the farthest-reaching regulatory program dealing with erosion and stormwater management in New Hampshire because it applies statewide to any construction activity that disturbs as little as one acre of land. The NPDES program includes several other important elements that address stormwater in New Hampshire.

In New Hampshire the NPDES under the federal Clean Water Act is administered by the U.S. Environmental Protection Agency. Since 1991, Phase I of the NPDES stormwater program has regulated stormwater discharges from large municipal separate storm sewer systems (large MS4s), stormwater associated with industrial activity, and construction sites disturbing five acres or more. Since March of 2003, Phase II of the NPDES stormwater program has regulated stormwater discharges from small MS4s, municipally owned industrial activities, and construction sites disturbing one acre or more. The EPA implemented the Phase I and II regulations by issuing three general permits:

- Municipal Separate Storm Sewer System (MS4) General Permit.
- Multi-Sector General Permit (MSGP).
- Construction General Permit (CGP).

The EPA's MS4 General Permit for New Hampshire covers certain small MS4s based on population or location near an "urbanized area." Forty-five towns (Table 10-1) are affected, although Brentwood, Chester, East Kingston, Hampton Falls, Lee, Madbury and Newington received waivers from the requirement to obtain a permit. An owner of an MS4, which may or may not be a municipality, in one of the affected towns must develop and

**Table 10-1. New Hampshire towns that are fully or partially within an urbanized watershed.**

| | | | | |
|---|---|---|---|---|
| Amherst | Durham | Hooksett | Milford | Portsmouth |
| Atkinson | East Kingston | Hudson | Milton | Rochester |
| Auburn | Exeter | Kingston | Nashua | Rollinsford |
| Bedford | Goffstown | Lee | New Castle | Rye |
| Brentwood | Greenland | Litchfield | Newington | Salem |
| Chester | Hampstead | Londonderry | Newton | Sandown |
| Danville | Hampton | Madbury | North Hampton | Seabrook |
| Derry | Hampton Falls | Manchester | Pelham | Somersworth |
| Dover | Hollis | Merrimack | Plaistow | Windham |

implement a stormwater management program that addresses six minimum control measures (Table 10-2).

**Table 10-2. Control measures required under MS4 general permit.**

| |
|---|
| 1. Public Education and Outreach |
| 2. Public Participation/Involvement |
| 3. Detection and Elimination of Illicit Discharges |
| 4. Control of Runoff from Construction Sites |
| 5. Control of Runoff from Sites After Construction |
| 6. Pollution Prevention/Good Housekeeping |

Consequently, 38 New Hampshire municipalities and four "Non-Traditional MS4s," e.g. University of New Hampshire and New Hampshire Department of Transportation, are now responsible for requiring erosion controls and post-construction stormwater best management practices for sites as small as one acre. Those municipalities and non-traditional MS4s must monitor these activities through reviewing applications, inspecting controls in the field, and ensuring long-term maintenance. Additionally, municipalities and non-traditional MS4s are required to educate and involve the public in stormwater management, investigate and remove illicit discharges, and maintain stormwater infrastructure to avoid contamination of surface waters (Table 10-2).

There are three regional coalitions in New Hampshire representing the 38 small municipal MS4 municipalities and four non-traditional MS4s. The coalitions include the Nashua, Manchester, and Seacoast areas. Members include department of public works stormwater representatives, town administrators, and consultants contracted to work on municipal stormwater programs. DES provides assistance to the coalition members through attending the monthly or quarterly meetings and any associated events or training, and providing technical and grant resources, grant project management, networking opportunities, meeting agendas and facilitation, presentations, permit updates, DES updates and communication, outreach planning and implementation, and coordination between the three coalitions.

The Multi-Sector General Permit (MSGP) covers industrial activities, including those conducted by municipalities, statewide.

The Construction General Permit (CGP), as noted above, applies to construction activity that disturbs one or more acres of land. Similar to the MSGP, the CGP applies statewide.

To be covered by the MSGP or the CGP, operators of industrial activities and construction sites must file a Notice of Intent with the EPA, and develop and implement a stormwater pollution prevention plan and (for the CGP) appropriate construction site runoff controls to meet the goal of reduced pollutant discharge to receiving waters.

## 10.3.2 Section 401 Water Quality Certification Program and Antidegradation

Under Section 401 of the federal Clean Water Act, if an activity that may result in a discharge requires a federal permit, that activity also requires state certification that it will not violate state water quality standards. Most stormwater related projects, including projects needing wetlands permits, alteration of terrain permits, and federal NPDES construction general permit notices of intent, already have a 401 certification because a general federal permit has been certified. Projects involving large landscape changes may require a separate certification. In New Hampshire, Section 401 Water Quality Certifications are issued by DES's Watershed Management Bureau under RSA 485-A:12.

The U.S. Army Corps of Engineers, EPA, and the Federal Energy Regulatory Commission are the primary federal agencies that issue permits requiring 401 certification. An applicant must contact these agencies to determine whether a federal permit or license is necessary for the project. If a federal permit is necessary, then the applicant must obtain a 401 certification from DES.

The antidegradation provisions of the Clean Water Act (see Chapter 2 – Rivers) are also implemented through the 401 certification process. Antidegradation places limits on water quality degradation for high quality waters.

### 10.3.3 Alteration of Terrain Program

DES's Alteration of Terrain permit program protects New Hampshire surface waters by requiring the prevention of soil erosion and management of stormwater runoff from large development projects. It requires a permit for any disturbance of 100,000 square feet or more, except in areas covered by the Shoreland Protection Act (within 250 feet from lakes, large ponds and large rivers), where the permitting threshold is 50,000 square feet. Until recently, the rules for major alteration of terrain reflected the conventional approach to stormwater treatment (collect, detain, treat, and release to surface water). However the rules have been extensively revised to improve treatment requirements, limit effective impervious cover, and require on-site infiltration where it is appropriate. The new rules will take effect on January 1, 2009.

### 10.3.4 Shoreland Protection Program

Created by the Comprehensive Shoreland Protection Act (RSA 483-B) in 1991, DES's Shoreland Protection Program enforces minimum standards for the subdivision, use, and development of land adjacent to the state's larger water bodies. Protection under the act extends to land within 250 feet of those water bodies, with various levels of restrictions for land within 50 feet, 150 feet, and 250 feet of the water body.

In 2005, Senate Bill 83 established a commission to study the effectiveness of the Comprehensive Shoreland Protection Act. Among other things, the commission was charged with assessing land-use impacts around the state's public waters; size, type, and location standards pertaining to structures as outlined in the CSPA; shoreland buffer and setback standards; and nonconforming use, lot, and structure standards. The final report of the commission (Commission, 2006) contained 17 recommendations for changes to the act. Sixteen of those recommendations for change were enacted into law and became effective April 1, 2008. The changes are broad in scope and include impervious surface limits, a provision for a waterfront buffer in which vegetation removal is restricted, shoreland protection along rivers designated under the Rivers Management and Protection Program (see section 2.3.3 in Chapter 2 – Rivers and Streams), and the establishment of a permit requirement for many construction, excavation or filling activities within the protected shoreland.

Although the 2008 legislation expanded the list of rivers and streams that are covered under the program, the program applies only to 14 percent of all rivers and streams in New Hampshire; lakes and ponds of at least 10 acres; and tidal waters.

## 10.3.5 Local Stormwater Programs

For most development projects that fall below the size threshold of DES's Alteration of Terrain Program and outside the jurisdiction of DES's Comprehensive Shoreland Protection Program, as well as outside the NPDES MS4 communities, the only project-specific review that these projects receive is on the local level. Although construction projects that disturb more than one acre need to file with the EPA under the NPDES Construction General Permit, the majority of these projects do not receive any formal review by the state or EPA. Consequently, municipalities play a crucial role in regulating the majority of development projects and averting the potentially significant cumulative impacts of these projects.

## 10.3.6 Technical Assistance Programs

Stormwater management is a component of much of the technical assistance provided by DES and others, such as the University of New Hampshire Stormwater Center.

Working with the regional planning commissions, the New Hampshire Office of Energy and Planning, and the New Hampshire Local Government Center, DES developed a model stormwater ordinance for municipalities. It addresses water quality concerns beyond traditional peak flow considerations and meets the requirements of the federal MS4 program (Regional Environmental Planning Program [REPP], 2008).

Currently, DES is finalizing a three-volume stormwater manual, which includes guidance on pollutant load reduction (volume 1), design specifications for stormwater BMPs (volume 2), and sediment and erosion control BMPs (volume 3). Volumes 2 and 3 were published in December 2008, soon to be followed by Volume 1.

The UNH Stormwater Center studies stormwater-related water quality and quantity issues. One unique feature is the field facility used to evaluate and verify the performance of stormwater management devices and technologies. Fifteen different management systems are currently undergoing side-by-side comparison testing under strictly controlled conditions. This on-campus evaluation facility enables the center to offer technology demonstrations and workshops, and also specialized training opportunities. In addition to the primary field facility, the center has other sites available to study stormwater management approaches that need more space or present unique conditions.

# 10.4 Stakeholder Recommendations

This section contains key recommendations that have been developed in concert with a group of volunteer stakeholders that have reviewed and contributed to this chapter.

## 10.4.1 Encourage and Facilitate the Local Adoption of State Stormwater Management Standards

Although DES has taken large strides to improve stormwater runoff management through revisions to the Alteration of Terrain and Shoreland Protection rules, these programs do not affect activities that fall outside the protected shoreland and below the square footage thresholds of the Alteration of Terrain program. Consequently, local land use regulations play an important role in ensuring the effective management of stormwater. Unfortunately, in many towns local regulations focus on the management of peak runoff from only the largest storms, missing the opportunity to minimize the generation of stormwater, to infiltrate it into the ground, and to adequately treat what is discharged to surface waters.

With the adoption of the revised Alteration of Terrain rules and the publication of the Stormwater Guidance Manuals, communities should be encouraged to adopt them for smaller-sized developments and redevelopments. This will require outreach and assistance at the state, regional and local levels.

**Low Impact Development Techniques**

**Design with the Landscape**
- Cluster development
- Open space preservation
- Site fingerprinting

**Reduce and Disconnect Impervious Areas**
- Reduced pavement widths
- Shared driveways
- Reduced setbacks
- Green roofs
- Porous pavement
- Disconnected downspouts
- Eliminating curbs and gutters
- Creating grassed swales and grass-lined channels

**Intercept Runoff**
- Parking lot, street, and sidewalk storage
- Rain barrels and cisterns (rainwater harvesting)
- Depressional storage in landscaped areas

**Infiltration Practices**
- Infiltration basins and trenches
- Infiltration swales
- Rain gardens and other vegetated treatment

**Runoff Conveyance Practices**
- Roughened surfaces
- Long flow paths over landscaped areas
- Smaller enclosed drainage systems
- Terraces and check dams

**Filtration Practices**
- Bioretention/rain gardens
- Vegetated buffers/conservation

**Low Impact Landscaping**
- Native, drought-tolerant plants
- Converting turf areas to shrubs and trees
- Reforestation
- Encouraging longer grass length
- Wildflower meadows rather than turf along medians and in open space
- Amending soil to improve infiltration
- Using locally captured runoff for irrigation

## 10.4.2 Encourage Low Impact Development and Compact Development

### *Preserve Natural Hydrology with Low Impact Development*

Going hand-in-hand with an effort to coordinate local stormwater management regulations with state standards, low impact development (LID) site design techniques, which replicate natural hydrologic conditions, should also be encouraged to lessen the negative effects of development on hydrology and water quality. The National Research Council's stormwater report emphasizes the importance of this approach: "Nonstructural SCMs [stormwater control measures] such as product substitution, better site design, downspout disconnection, conservation of natural areas, and watershed and land-use planning can dramatically reduce the volume of runoff and pollutant load from a new development. Such SCMs should be considered first before structural practices." (National Research Council, 2008, p. 8)

LID techniques go beyond the selection of stormwater infiltration practices, as required in DES's new Alteration of Terrain rules, to encompass the entire site design process. LID site design aims to reduce and separate impervious surfaces, rely on natural treatment processes, decentralize the treatment of stormwater, and infiltrate stormwater where appropriate. Although LID techniques manage stormwater more effectively than traditional management practices and typically do not cost any more (Table 10-3), many municipalities and developers are hesitant to adopt, require and use these techniques. A concerted effort is needed to accelerate the adoption of LID site design techniques.

**Table 10-3. Summary of cost comparisons between conventional and low impact development approaches.** ***Source: USEPA, 2007.***

| Project | Conventional Development Cost | LID Cost | Cost Difference[b] | Percent Difference[b] |
|---|---|---|---|---|
| 2nd Avenue SEA Street | $868,803 | $651,548 | $217,255 | 25% |
| Auburn Hills | $2,360,385 | $1,598,989 | $761,396 | 32% |
| Bellingham City Hall | $27,600 | $5,600 | $22,000 | 80% |
| Bellingham Bloedel Donovan Park | $52,800 | $12,800 | $40,000 | 76% |
| Gap Creek | $4,620,600 | $3,942,100 | $678,500 | 15% |
| Garden Valley | $324,400 | $260,700 | $63,700 | 20% |
| Kensington Estates | $765,700 | $1,502,900 | –$737,200 | -96% |
| Laurel Springs | $1,654,021 | $1,149,552 | $504,469 | 30% |
| Mill Creek[c] | $12,510 | $9,099 | $3,411 | 27% |
| Prairie Glen | $1,004,848 | $599,536 | $405,312 | 40% |
| Somerset | $2,456,843 | $1,671,461 | $785,382 | 32% |
| Tellabs Corporate Campus | $3,162,160 | $2,700,650 | $461,510 | 15% |

[a] The Central Park Commercial Redesigns, Crown Street, Poplar Street Apartments, Prairie Crossing, Portland Downspout Disconnection, and Toronto Green Roofs study results do not lend themselves to display in the format of this table.

[b] Negative values denote increased cost for the LID design over conventional development costs.

[c] Mill Creek costs are reported on a per-lot basis.

### *Preserve More Natural Areas with Compact Development Strategies*

A key provision of low impact development is to retain as much natural and undisturbed land as possible. This can be done through land purchases, conservation easements, or compact development methods that reduce the area disturbed for new construction.

The current, conventional method to zoning involves a minimum lot size to guide development, which often translates to dispersed development on large, equal-sized lots. Although some natural ground cover is preserved on each lot, the former natural area becomes fragmented, and large areas are converted to lawns, which are less pervious and often a source of nonpoint source pollution, e.g., nutrients and pesticides. The use of innovative zoning techniques to guide development, instead of relying on a minimum lot size, can reduce the amount of disturbed area per dwelling unit and conserve large, contiguous natural areas, which can be especially valuable for groundwater recharge and in areas near sensitive resources, such as near streams (USEPA, 2006) (Figure 10-7). Less fragmentation also allows the working landscape to stay intact which improves New Hampshire's ability to achieve sustainable agriculture and forestry goals.

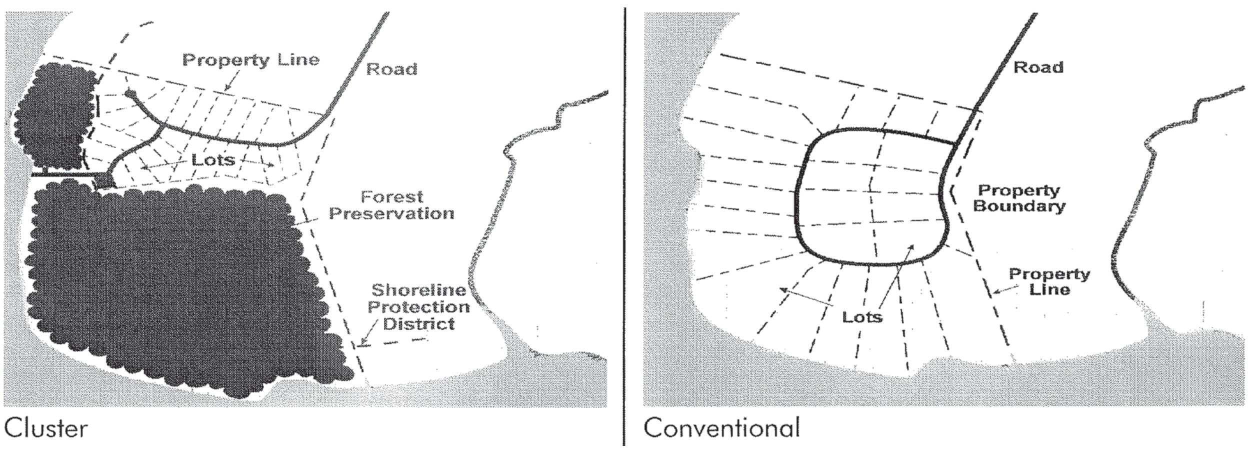


**Figure 10-7. Cluster or conservation subdivision versus conventional subdivision.** ***Source: CWP, 1998.***

Municipalities can use a number of techniques, including conservation subdivision, lot size averaging, transfer of density credits, and feature-based zoning, to provide for a diversity of development densities that can preserve working landscapes and reduce stormwater impacts. Model ordinances for these and several other innovative land use controls are included in the Innovative Land Use Planning Techniques Guide (REPP, 2008). These approaches, coupled with LID techniques, can be highly effective at minimizing the hydrologic and water quality impacts of development (USEPA, 2006).

Local zoning ordinances may also use density bonuses as an incentive for land preservation. In exchange for the permanent protection of natural area, developers may exceed the conventional density to a defined extent.

One of the barriers to overcome in advocating for a diversity of development densities is the perception that concentrating development in some areas negatively impacts rural character. Attention to site design can address this concern by ensuring that new development and redevelopment fit in with the character of the surrounding community (REPP, 2008). In general, municipalities need more tools and assistance to make LID and innovative zoning a reality.

### 10.4.3 Upgrade Stormwater Infrastructure

As indicated in section 10.2.2, existing stormwater infrastructure, culverts in particular, is undersized for both the current climate and expected climate change. In order to avoid costly road washouts and damaging localized floods such as the Cold River flood of October 2005, existing infrastructure needs to be upgraded to accommodate the anticipated flows.

### 10.4.4 Implement Stormwater Utilities

As noted above, stormwater utilities are a viable way for municipalities to raise the funds needed to maintain and upgrade their stormwater infrastructure. Until recently, stormwater utilities have been relatively rare in New England, but this is changing. This lack of familiarity on the part of municipal and regional planners and public works administrators has slowed their acceptance in New Hampshire. Technical assistance is needed to assist municipalities in establishing and operating stormwater utilities in order to accelerate their implementation.

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