# Chapter 2

## Building a Local Program to Improve the Quality of Permanent Stormwater Discharges



### What's in this Chapter?

Section 2.1 provides background information on the potential impacts of land development on water resources.

Section 2.2 provides a brief overview of MS4 permit requirements for stormwater treatment within the broader context of stormwater management.

Section 2.3 cites scientific literature that supports the use of infiltration-based SCMs and low impact development as components of an effective stormwater program.

Section 2.4 outlines how the permanent stormwater management requirements intersect with other state and federal permits and programs.

Section 2.5 provides general guidance for the design and review of stormwater management measures by the development community and MS4 operators.

### 2.1 How Permanent Stormwater Discharges Can Impact Tennessee's Water Resources

Permanent stormwater discharges result from the runoff generated from impervious surfaces at development projects after site construction has been completed. Please note that "permanent stormwater discharge" is a term that was introduced by TDEC in the 2010 general permit and is synonymous with "post-construction runoff". This section describes how these stormwater discharges can negatively affect water quality. It is important to understand these effects because water resources are essential to the general welfare and economic viability of Tennessee, where we have over 60,000 miles of rivers and streams and over 570,000 acres of lakes and reservoirs.

#### Water Quality

Runoff from impervious surfaces carries pollutants to surface waters and has the potential to degrade water quality and aquatic habitat. The Tennessee Division of Water Resources publishes a bi-annual report titled "The Status of Water Quality in Tennessee". In a recent report, approximately 50% of the streams and rivers that were assessed and 30% of the assessed reservoirs and lakes were considered polluted (TDEC, 2014). The causes of pollution included common stormwater pollutants: sediment, pathogens, nutrients, and toxicants. This illustrates the need for state and local programs that will improve the water quality of stormwater discharges.

Table 2.1 lists the potential pollutants and other parameters of concern that affect water quality and their relative propensity to originate from different land uses. A national project was conducted to summarize water quality monitoring data associated with MS4s across the country (Pitt et al, 2004). The goal of the project was to characterize the chemical makeup of permanent stormwater discharges. The National Stormwater Quality Database is available here:

http://unix.eng.ua.edu/~rpitt/Research/ms4/Paper/Mainms4paper.html

**Table 2.1: Relative Sources of Parameters of Concern for Different Land Uses in Urban Areas (Summarized from Burton and Pitt, 2002, and Law et al, 2008).**

| Problem Parameter | Residential | Commercial | Industrial | Freeway | Construction |
|---|---|---|---|---|---|
| Sediment | Low | Moderate | Low | Low | Very High |
| Toxicants (heavy metals/organics) | Low | Moderate | High | High | Moderate |
| Microorganisms (Pathogens) | High | Moderate | Moderate | Low | Low |
| Inappropriate discharges (mostly sewage and cleaning wastes) | Moderate | High | Moderate | Low | Low |
| Nutrients | Moderate | Moderate | Low | Low | Moderate |
| Debris (floatables and gross solids) | High | High | Low | Moderate | High |
| High flow rates (energy) | Low | High | Moderate | High | Moderate |
| Large runoff volumes | Low | High | Moderate | High | Moderate |
| Heat (elevated water termperature) | Moderate | High | Moderate | High | Low |

Water quality degradation also affects drinking water supplies and the recreational use of surface waters for swimming and boating. This can lead to increased costs and/or increased risk to public health. A study found that the estimated annual cost of waterborne illness in the U.S. is comparable to the long-term capital investment needed for improved drinking water treatment and stormwater management (Gaffield et al., 2003). Stormwater discharges also have the potential to impact fisheries and reduce the assimilative capacity of surface waters for other pollutant discharges.

## Hydrologic Processes

Interception, infiltration, replenishing soil moisture, evaporation, transpiration, and recharging stream baseflow are hydrologic processes that occur on and in the landscape. Water budget studies indicate that up to 50% of the annual rainfall is intercepted by foliage and evaporated during the growing season in deciduous forests in the southeastern United States (Wilson, 2001). Native soils also play a critical role in storing and conveying rainfall. Further studies have shown soil hydraulic properties to be compensating mechanisms of soil water supply to meet forest transpiration demands (Luxmoore, 1983).

The transformation from natural landscapes to a built environment increases the amount of impervious surfaces, such as roads, parking areas, and rooftops. Native soils are altered during the construction process such that their infiltration properties are generally degraded. These changes reduce, disrupt, or eliminate natural hydrologic functions. As development progresses, the land area that contributes overland flow (or runoff) in short time periods increases (usually occurring on a scale of minutes), while the land area that stores runoff, allows infiltration, and recharges groundwater over long periods of time (days or weeks) decreases (Booth, 2002). The cumulative effect of these changes on the water budget

(Figure 2.1) results in increased pollutant loading, degraded water quality, impacted groundwater resources, destabilized stream channels, and more frequent flooding. As a further implication, these effects can also lead to increased maintenance and capital costs for stormwater infrastructure.

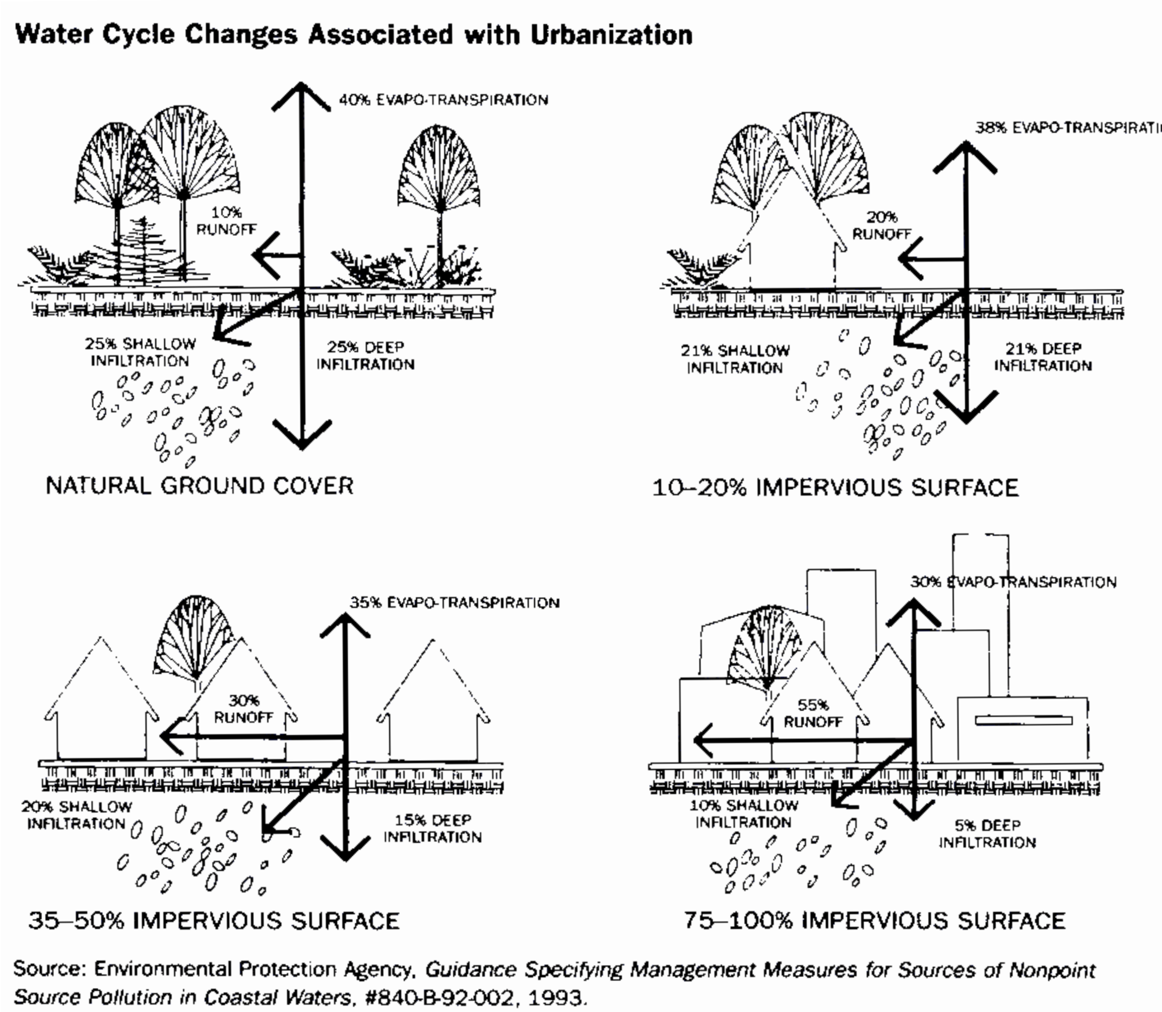


**Figure 2.1: Water cycle changes in response to development.**

Changes to the land cover in watersheds also affects the way water flows in streams and rivers. After development, a larger portion of precipitation leaves the landscape as direct runoff, without interception by tree canopies, infiltration into soils, or filtering through ground vegetation. As explained in Figure 2.2 (by using hydrographs, diagrams of runoff discharge over time), there are two major changes in runoff discharge patterns as a response to development of the landscape: an increase in the peak rate of discharge, a faster time to peak, and a shortened lag time.

Runoff is then concentrated in stream channels, where similar compounding effects are seen (Figure 2.3). These physical changes in water flow affect stream channel shape and transport mechanisms for sediment and generally translate to large-scale watershed degradation or persistent undesirable conditions as described in Table 2.2. Often times, urban streams possess these degraded conditions, which is documented as the “urban stream syndrome”. Symptoms of urban stream syndrome include elevated concentrations of pollutants, altered channel shape and stability, rapidly fluctuating hydrographs, and negative impacts to fish and aquatic life (Walsh et al., 2005).

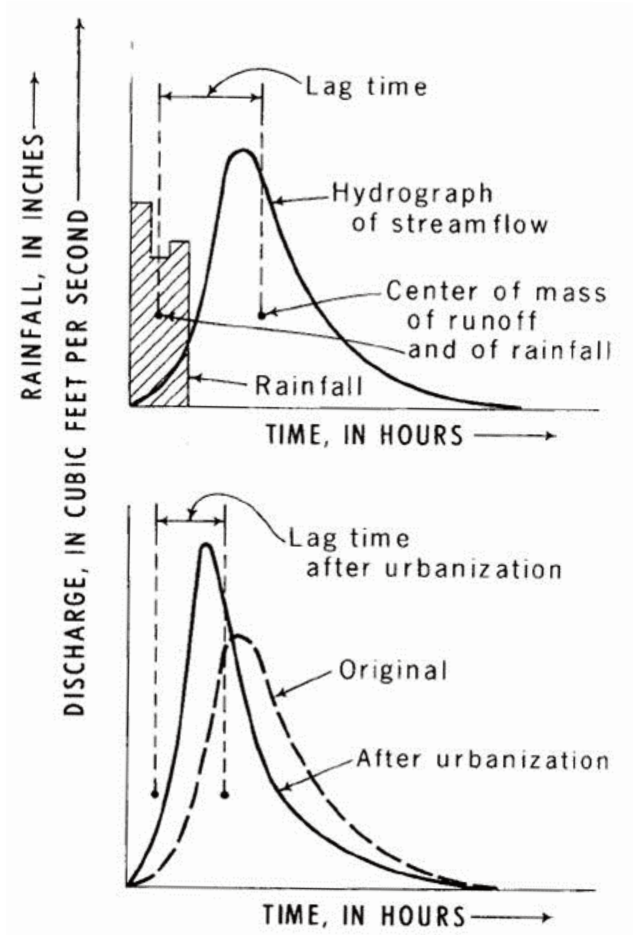


**Figure 2.2: Comparison of hydrographs in a natural system *(top)* versus an urban system *(bottom)* to show changes in hydrologic response to rainfall (Leopold, 1968).**

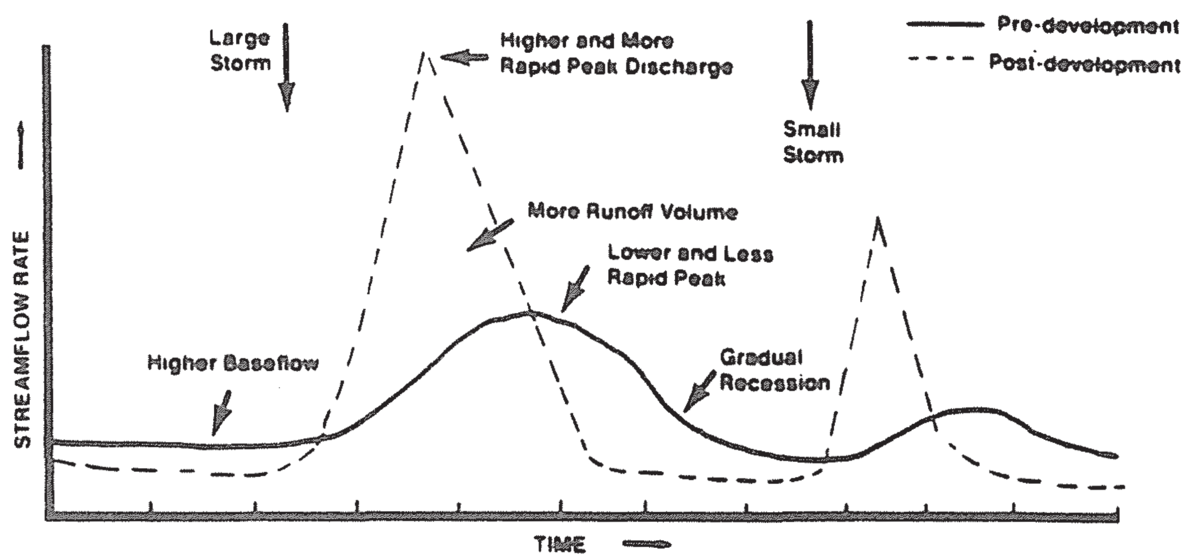


**Figure 2.3: Changes in stream hydrology in response to development (From US EPA, 2000 after Schuler, 1992).**

**Table 2.2: Watershed conditions due to development and their respective impacts on water resources (Modified from Hinman and Wulkan, 2012).**

| Change in Watershed Condition | Response |
|---|---|
| Increased pollutant concentrations and loads | - Total Suspended Solids (TSS): disrupt aquatic food chains, interfere with fish gills, increase the cost of drinking water treatment.<br>- Metals: increase toxicity to sensitive aquatic species.<br>- Nutrients: excessive aquatic plant growth and drastic diurnal oxygen fluctuations.<br>- Pesticides and herbicides: toxic to sensitive aquatic plants and animals.<br>- Synthetic organic compounds and trace elements: tumors in fish, altered migration and spawning activities, possible synergistic influence of multiple types of pollutants. |
| Increased impervious area | - Increased fine sediment and urban stormwater pollutants.<br>- Increased runoff volume, peak flow rate and frequency, and channel erosion.<br>- Potential reduction in local groundwater recharge and stream base flow conditions. |
| Increased road networks, road crossings, and stormwater drainage pipes | - Increased fine sediment and urban stormwater pollutants.<br>- Increased flow volume from runoff, peak flow rate and frequency, and channel erosion.<br>- Increased fish passage barriers. |
| Increased fine sediment deposition | - Reduced interstitial space (between gravels/cobbles).<br>- Loss of fish spawning and macroinvertebrate habitat. |
| Loss or fragmentation of riparian area | - Decreased pollutant removal from urban runoff.<br>- Reduced bank stability and loss of bank habitat structure.<br>- Reduced shading and temperature buffer.<br>- Increased potential for harmful algal blooms.<br>- Decreased wildlife habitat. |

## 2.2 Overview of Permanent Stormwater Management Requirements in Tennessee

This section provides a brief overview of permanent stormwater management requirements in Tennessee MS4 permits. For full details and more information, please see the permit, rationale, and Notice of Determination that applies to the stormwater system of interest.

### Permanent Stormwater Management Requirements in Tennessee

Under authority of the Tennessee Water Quality Control Act of 1977 and approval from the US EPA, operators of an MS4 are authorized to discharge stormwater runoff into waters of the State of Tennessee in accordance with the various eligibility criteria, administrative procedures, program requirements, and reporting requirements set forth in Tennessee MS4 permits. These permits require operators to implement a Stormwater Management Program designed to reduce the discharge of pollutants from the MS4 to protect water quality.

Tennessee's larger cities (Memphis, Nashville, Knoxville, and Chattanooga) and the state Department of Transportation are issued permits individually for the stormwater discharges from their MS4 areas. Other regulated MS4 jurisdictions may be permitted under the NPDES General Permit For Discharges from Small Municipal Separate Storm Sewer Systems that was issued September 30, 2016. The permits include requirements that comply with the Clean Water Act directive to reduce the discharge of pollutants to the Maximum Extent Practicable (MEP) while giving permittees discretion in selecting measures appropriate to their jurisdictions.

To comply with the permit requirements for permanent stormwater management, MS4 operators must:

- Use an ordinance or other mechanism to address permanent runoff from new development and redevelopment projects;
- Develop, implement, and enforce a program to address permanent stormwater runoff management from new development and redevelopment projects that disturb greater than or equal to one acre, including projects less than one acre that are part of a larger common plan of development;
- Develop and implement a set of requirements to establish, protect, and maintain a permanent water quality buffer along all streams (including wetlands, reservoirs, etc) at new development and redevelopment projects; and
- Ensure the long-term maintenance of SCMs through a local ordinance or other enforceable policy.

The developer of a site has the responsibility to propose plans for the treatment of permanent stormwater discharges, to be reviewed by the local MS4 operator. In the general permit, the water quality treatment volume (WQTV) is defined as the runoff generated from impervious surfaces during the first inch of a rainfall event. A representative storm event, a volumetric runoff coefficient, or other method must be used to design and review site-specific plans for managing the WQTV.

SCMs that rely on infiltration, evapotranspiration, or capture and reuse of the water quality treatment volume are practices that approach 100% pollutant removal and constitute MEP where site-specific conditions allow. If site-specific limitations do not allow infiltration, evapotranspiration, or capture and reuse of the entire WQTV, then a combination of SCMs must be proposed in the site design in order to maximize pollutant removal consistent with site-specific limitations and, at a minimum, be designed to achieve an overall treatment efficiency of 80% TSS removal.

Compliance with permanent stormwater discharge standards is determined by meeting design criteria. For design purposes, total suspended solids may be used as the indicator for the removal of pollutants (such as sediment, nutrients, and pathogens). SCMs must be designed to provide full treatment capacity within 72 hours following the end of the preceding rain event.

The Division also considers compliance with the permanent stormwater design performance standards detailed in the previous NPDES general permit (issued August 31, 2010) to satisfy the permanent stormwater standards in this permit. Although the phrase "WQTV" was not included in the 2010 general permit, that permit required permittees to enact programmatic controls so that new development sites would manage the "first inch" of every rainfall event with no discharge where possible (i.e., to manage the runoff with infiltration, evaporation, or capture and reuse) or to treat runoff to 80% TSS removal where limitations exist. Examples of such site conditions include the following:

- insufficient infiltration capacity of soils;
- a potential for introducing excessive pollutants into groundwater;
- pre-existing soil contamination in areas subject to contact with infiltrated runoff;
- presence of sinkholes or other karst features on the site or in close proximity;
- an extensive presence of shallow ground water table, shallow bedrock, or other restrictive layers;
- presence of contractive or expansive soils in close proximity to structures; and
- other conditions as identified by the MS4 operator.

If site conditions do not allow for pollutant removal to be fully accomplished on-site, then the MS4 operator may create alternatives for off-site stormwater mitigation. The MS4 operator may also develop incentives for development sites that meet any of these criteria:

- redevelopment projects (including, but not limited to, brownfield redevelopment)
- vertical density (floor to area ratio of at least 2, or at least 18 units per acre)
- incentives defined by the MS4 operator

Elements of Smart Site Design may be useful in minimizing the WQTV and are described in detail in Chapter 3. Pre-development infiltrative capacity of soils at the project site must be taken into account in the selection of SCMs. Treatment design targets for structural SCMs are discussed in Chapter 4.

## 2.3 Infiltration-Based Stormwater Control Measures as a Treatment Technology

In the mid-1990s, Prince George's County, Maryland, began to adopt an approach for stormwater management that used technology-based practices to ensure that a site's post-development hydrology mimicked the pre-development conditions, and they termed this approach Low Impact Development, or "LID" (Coffman, 2000). The goals of LID were to retain the land's hydrologic functions of groundwater recharge and infiltration, and to moderate the frequency and volume of stormwater discharges. Figure 2.4 shows how incorporating LID into development re-establishes some of the lost hydrologic functions of a traditionally-developed urban environment and mimics the balance of a natural water cycle. The practices that can create a shift towards a natural cycle are:

- Preserve open space and minimize land disturbance
- Protect sensitive natural features and natural processes
- Identify and link on- and off-site conservation lands
- Incorporate natural features into site designs, such as wetlands, riparian corridors, mature trees, and forests
- Customize site design according to the site analysis
- Decentralize and micromanage stormwater at its source

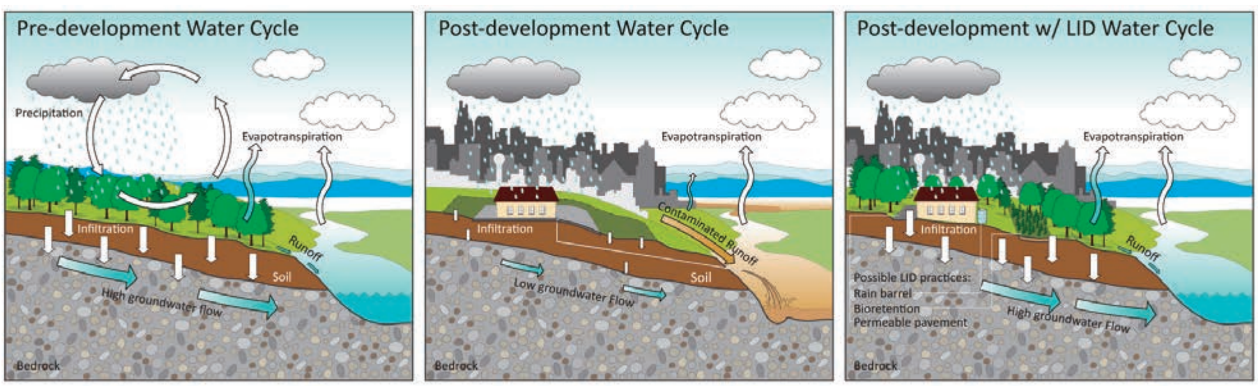


**Figure 2.4: Comparison of the natural and urban water cycles and a depiction of how low impact development creates opportunities in the urban environment to mimic the natural cycle (modified from The Auckland City Council, 2010).**

Scientific and technical literature supports the use of LID and other policy and planning avenues as a means to minimize the impact of development on surface and ground water resources. Studies have found that preserving forested areas and limiting the extent of impervious surfaces that drain into receiving waters without treatment will lessen the risk of degradation to stream channels (Booth et al, 2002, Konrad and Burges, 2001). Case studies further support that LID is practical in varied applications and community scenarios (US EPA, 2013).

Infiltration-based stormwater control measures (SCMs) are an integral part of the LID approach. An SCM is defined by the USEPA (1999) as "a technique, measure, or structural control that is used for a given set of conditions to manage the quantity and improve the quality of stormwater runoff in the most cost-effective manner." SCMs can be engineered or constructed facilities, such as bioinfiltration basins and constructed wetlands, or preventative measures, such as education and better site design policies. Case studies have shown that structural SCMs, such as bioretention, green roofs, permeable pavements, and vegetated swales, can be implemented to achieve LID goals (US EPA, 2000). Through the remainder of this manual, discussion of SCMs will be limited strictly to the engineered structural facilities used for water quality treatment or stormwater detention. Chapter 5 describes in depth some of the practices that are available and their effective application and design.

Although the State of Tennessee does not require comprehensive Low Impact Design, local governments are encouraged to consider the long-term implications of their decisions regarding stormwater management. Local factors and site-specific conditions will vary and so will the resultant overall cost and benefit of stormwater control measures. While it can be difficult to compare the costs and benefits associated with stormwater management, an independent review found that infiltration-based stormwater control measures can be both cost-effective compared to conventional stormwater measures and provide greater benefits to individual property owners and their communities (MacMullan and Reich, 2007). Similarly, a review by North Carolina State University (WECO, 2009) gives an overview of economic comparisons and supports the conclusion that infiltration-based stormwater control measures can decrease costs and increase value for land developers and local governments.

This manual is focused on pollutant removal from stormwater discharges, and there is theoretically no discharge of pollutants to surface waters during the majority of storms where infiltration-based SCMs are designed to treat pollutants in the stormwater generated by up to one inch of rainfall. This common-sense conclusion is further supported by the National Research Council:

> "These SCMs are designed to remove perhaps the first inch of runoff. Therefore, for storms of less than an inch, there is no surface water release, **so the treatment is 100 percent effective for surface discharges**. During larger events, a bioretention SCM or green roof may export pollutants. When viewed over the entire spectrum of storms, these devices are an outstanding success." (NRC, 2009)

While the removal of 100% of all pollutants for all storms and all sites would be impracticable as a performance standard (e.g., with analytical monitoring required to demonstrate compliance), it is appropriate to use 100% TSS removal as a design standard for small storms of up to an inch of rainfall, since the SCMs are designed to function without any surface discharge during small storms.

Tennessee's MS4 permit requirements for permanent stormwater discharges are also focused on pollutant removal from stormwater prior to discharge. Infiltration-based SCMs have the highest rated effectiveness and should therefore have an important role in local stormwater programs.

## 2.4 Other State and Federal Programs that Influence Site Design or Local Stormwater Programs

MS4 permit requirements are not the only regulatory influence on site development or local stormwater programs. There are several other state and/or federal regulatory drivers that will influence site design or how stormwater is managed by an MS4 operator (Table 2.3). While MS4 operators are not responsible for administering or enforcing state or federal permits, they might be placed in the role of integrating or coordinating state and federal permits with the local stormwater program for certain new development and redevelopment projects. For instance, the site designer and MS4 operator should be aware of other approvals for activities in or near streams and wetlands, underground injection, or dam safety. Local policy and ordinances specific for MS4 jurisdictions also affect permanent stormwater management planning and design. Examples of these include land use codes, right-of-way easements, and roadway setbacks. The site designer or developer should also check with local municipal offices for more information on development codes and policy.

**Table 2.3: Regulatory Programs and Drivers That Influence or Intersect With Site Design and Stormwater Management.**

| Responsible Agency | Program Name | How it interacts with permanent stormwater management |
|---|---|---|
| TN Department of Environment and Conservation, Division of Water Resources (TDEC-DWR) | Construction Stormwater General Permit | Applies to all sites with disturbance of one acre or greater to regulate stormwater discharges into waters of the state. Projects disturbing at least one acre are required to submit a Notice of Intent and Stormwater Pollution Prevention Plan (SWPPP) for the specific project. The overarching permit is reissued on a periodic basis (e.g. every five years). The permit is accompanied by the Tennessee Erosion and Sediment Control Handbook.<br>*Link With Stormwater Program:* This permit provides an opportunity for local programs to coordinate construction and post-construction stormwater in plan review, inspection and maintenance.<br>Contact: Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources:<br>https://tn.gov/environment/article/permit-water-npdes-stormwater-construction-permit |
| TDEC-DWR | Multi-Sector Stormwater General Permits (for Industrial Activities) | In order to minimize the impact of stormwater discharges from industrial facilities, the National Pollutant Discharge Elimination System (NPDES) program includes an industrial stormwater permitting component. Operators of industrial facilities that discharge or have the potential to discharge stormwater to an MS4 or directly to waters of the state are required to obtain coverage under the general permit by submitting an application to TDEC.<br>*Link With Stormwater Program:* This permit provides an opportunity for local programs to coordinate stormwater review and inspections for industrial operators. In addition, industrial activities often discharge into an MS4; therefore the MS4 operator should be aware of this discharge and have the ability to address adverse impacts to their system.<br>Contact: Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources:<br>https://tn.gov/environment/article/permit-water-npdes-industrial-stormwater-general-permit |

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**Table 2.3 – continued**

| Responsible Agency | Program Name | How it interacts with permanent stormwater management |
|---|---|---|
| TDEC-DWR; U.S. Army Corps of Engineers | Aquatic Resources Alteration Permit (ARAP); Clean Water Act Section 404 Permits and Section 401 Certifications | Persons who wish to make an alteration to a stream, river, lake or wetland must first obtain a water quality permit. Physical alterations to waters of the state require an Aquatic Resource Alteration Permit (ARAP) or a §401 Water Quality Certification (§401 certification). Examples of stream alterations that require a permit from the Tennessee Division of Water Resources include:<br>• Dredging, excavation, channel widening, or straightening<br>• Bank sloping; stabilization<br>• Channel relocation<br>• Water diversions or withdrawals<br>• Dams, weirs, dikes, levees or other similar structures<br>• Flooding, excavating, draining and/or filling a wetland<br>• Road and utility crossings<br>• Structural fill<br>A federal permit may also be required from the U. S. Army Corps of Engineers (Corps) for projects that include the discharge of dredged or fill material into waters of the U.S. including wetlands. This permit is called a §404 permit. When a §404 is required from the Corps, a §401 certification must first be obtained from the division. A §401 certification affirms that the discharge would not violate Tennessee's water quality standards. The application process for a §401 certification is the same as the ARAP process.<br>*Link With Stormwater Program:* Often construction stormwater and permanent stormwater control measures and related activities involve some physical alteration of a water body and would require coverage under the ARAP program.<br>Contact: Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources<br>http://www.tn.gov/environment/article/permit-water-aquatic-resource-alteration-permit |

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**Table 2.3 – continued**

| Responsible Agency | Program Name | How it interacts with permanent stormwater management |
|---|---|---|
| TDEC-DWR | Underground Injection Control Permits (UIC) | TDEC-DWR regulates Class V injection wells (shallow non-hazardous) under the Underground Injection Control (UIC) program. There are cases where stormwater infiltration practices are regulated as Class V wells. The division encourages the use of infiltration practices and notes that when designed to manage only the treatment volume specified in MS4 permits, these practices do not meet the Class V definition and can be installed without requiring UIC permits. Any additional volumes must daylight or bypass the infiltration practice.<br>There are two general exceptions, with the following practices requiring UIC permits:<br>1) Commercially manufactured stormwater devices include a variety of pre-cast or pre-built proprietary subsurface detention vaults, chambers or other devices designed to capture and infiltrate stormwater runoff. These devices are Class V wells since their designs often meet the Class V definition of subsurface fluid distribution.<br>2) Improved sinkholes include any bored, drilled, driven, or dug shaft or naturally occurring karst feature where stormwater is infiltrated. A naturally occurring karst feature receiving runoff that has been modified in volume or quantity is also considered an improved sinkhole. These practices are Class V wells since their designs often meet the Class V definition of subsurface fluid distribution.<br>*Link with Stormwater program:* At the local level, a UIC program integrated with careful planning and the utilization of SCMs and other ground water protection initiatives can significantly reduce the threat to drinking water supplies.<br>Contact: Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources<br>http://www.tn.gov/environment/article/permit-water-underground-injection-control-permit |

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**Table 2.3 – continued**

| Responsible Agency | Program Name | How it interacts with permanent stormwater management |
|---|---|---|
| U.S. Environmental Protection Agency | Section 438 of the Energy Independence and Security Act (EISA) | Section 438 of EISA states that "the sponsor of any development or redevelopment project involving Federal facility with a footprint that exceeds 5,000 square feet shall use site planning design, construction, and maintenance strategies for the property to maintain or restore, to the maximum extent technically feasible the predevelopment hydrology of the property with regard to the temperature, rate, volume, and duration of flow." In 2009, the U.S. Environmental Protection Agency (EPA) issued technical guidance for implementing this provision of EISA.<br>*Link With Stormwater Program:* The local program should be aware of the EISA requirements and guidance for federal facilities that may be constructed or redeveloped within the community. The local program may not have the authority to review federal projects, but these federal facilities often seek to coordinate with any local requirements. In addition, federal facilities often discharge into an MS4; therefore the MS4 should be aware of this discharge and have the ability to address adverse impacts to their system.<br>Contact: U.S. Environmental Protection Agency |
| Tennessee Department of Environment and Conservation | Floodplain Insurance | The National Flood Insurance Program (NFIP) in Tennessee works closely with private insurance companies to offer flood insurance to property owners and renters. In order to qualify for flood insurance, a community must join the NFIP and agree to enforce sound floodplain management standards.<br>The National Flood Insurance Program (NFIP) is a federal program created in 1968 that allows citizens in participating communities to purchase insurance coverage for potential property damage as a result of flooding. This is a voluntary program for local communities. The three components of the NFIP are:<br>• Flood Insurance<br>• Floodplain Management<br>• Flood Hazard Mapping<br>In return for a local community adopting and enforcing local floodplain management regulations, flood insurance is available in the community. Currently, nearly 400 Tennessee communities participate in the NFIP. Of all natural disasters, flooding is historically responsible for the most loss of life and the greatest damage to property in the state. There are currently more than 21,000 stream miles that have identified flood hazard risks in Tennessee.<br>*Link With Stormwater Program:* The local program will have to coordinate reviews for any controls that are authorized to be located in the floodplain. Also preservation, protection, and/or restoration of floodplains and riparian corridors can be very beneficial for stormwater management.<br>Contact: Tennessee Department of Environment and Conservation<br>http://www.tn.gov/environment/section/nfip-national-flood-insurance-program |

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**Table 2.3 – continued**

| Responsible Agency | Program Name | How it interacts with permanent stormwater management |
|---|---|---|
| TDEC-DWR | Total Maximum Daily Load (TMDL) | Section 303(d) of the Clean Water Act establishes the Total Maximum Daily Load (TMDL) program. TMDLs provide a system to develop studies and plans for stream segments that do not meet water quality standards.<br>A TMDL is a study that: 1) quantifies the amount of a pollutant in a stream, 2) identifies the sources of the pollutant, and 3) recommends regulatory or other actions that may need to be taken in order for the stream to cease being polluted.<br>Some of the actions that might be taken involve re-allocation of limits on the sources of pollutants documented as impacting streams. It might be necessary to lower the amount of pollutants being discharged under NPDES permits or to require the installation of other control measures, if necessary, to ensure that water quality standards will be met.<br>*Link With Stormwater Program:* If an MS4 discharges into a water body with an approved or established TMDL, then the Stormwater Management Program must include BMPs specifically targeted to achieve the wasteload allocations and requirements prescribed by the TMDL.<br>Contact: Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources<br>http://www.tennessee.gov/environment/article/wr-ws-tennessees-total-maximum-daily-load-tmdl-program |

## 2.5 General Procedure for New Development and Redevelopment Projects in Tennessee

The MS4 Permit establishes a requirement for plans review, approval, and enforcement, so that local stormwater management programs control runoff from new development and redevelopment. Successful implementation requires coordinated efforts by both the MS4 operator and the owner or applicant for new development or redevelopment projects. The program elements include preparation, submittal, review, and approval of stormwater management plans as well as construction, inspection, and maintenance of permanent stormwater SCMs.

Figure 2.5 illustrates the general order of recommended actions for both the MS4 program and the project applicant in order to be compliant with the MS4 permit provisions. The left side lists the responsibilities of the MS4 program, and the right side those of the project applicant. This is a generalized order of actions; individual local programs will have specific plan review and inspection procedures.

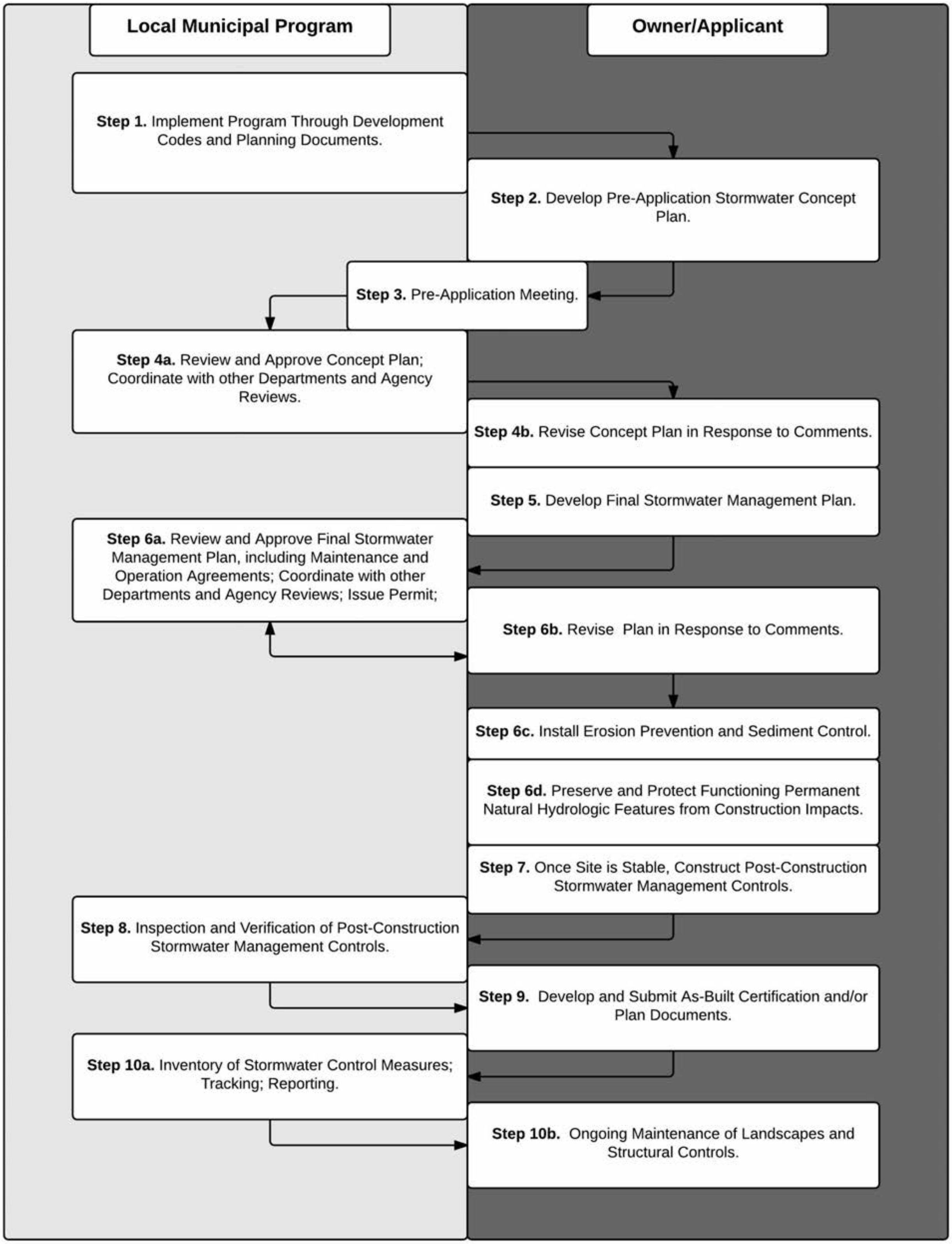


**Figure 2.5: Typical Compliance Pathway for Permanent Stormwater Runoff Management for New Development and Redevelopment Projects.**

**The following are recommended steps in Permanent Stormwater Management Implementation and Project-Level Compliance:**

### Step 1 Implement Program Through Ordinance or Other Regulatory Mechanisms

**Who Does This Step?**

- The MS4 operator or local stormwater program

**When Does This Step Occur?**

- At initial program development prior to plans being submitted

**Description**: The MS4 Permit contains provisions for the development, implementation and enforcement of a local program to address permanent stormwater runoff management from new development and redevelopment projects. This program should include strategies which use a combination of structural and/or non-structural stormwater control measures (SCMs) appropriate for your community, requirements to establish, protect and maintain a permanent water quality buffer along all streams, wetlands, and reservoirs and the use of ordinances or other regulatory mechanisms to address permanent runoff from new development and redevelopment projects.

### Step 2 Develop Pre-Application Stormwater Concept Plan

**Who Does This Step?**

- The owner/applicant/design engineer for a new development or redevelopment project that disturbs one-acre or greater, including projects of less than one acre that are part of a common plan of development.

**When Does This Step Occur?**

- Very early in the site planning process before infrastructure and lot configurations are locked down.

**Description**: Identify water resources with additional regulatory requirements (such as streams and wetlands) and site assets that can be incorporated into the design (such as good soils or mature trees). The Concept Plan provides the opportunity for the applicant to put basic stormwater design ideas and measures on paper before expending time and resources preparing complex engineering plans. This step can help both the local stormwater program and the site developer avoid problems that could occur if the plan is submitted later in the process.

### Step 3 Pre-Application Meeting

**Who Does This Step?**

- Both the MS4 operator/local stormwater program AND the owner/applicant along with the project design engineer

**When Does This Step Occur?**

- Soon after the owner/applicant prepares the Concept Plan outlined in Step 2. However, it may be advantageous for the parties to meet in the office or in the field prior to the completion of the Concept Plan if preliminary discussions would aid the applicant in preparing the Concept Plan.

**Description**: The intent of this meeting is to discuss compliance issues and allow for constructive interaction between the parties. It is hoped that this meeting will result in a higher quality submittal and a faster review schedule. The meeting is particularly relevant to discuss site design issues that could reduce the volume of rainfall to be managed on the site, application of site design incentives, and the most applicable SCMs for the site.

### Step 4a Review & Approve Concept Plan; Coordinate with Other Departments & Agency Reviews

**Who Does This Step?**

- MS4 operator/local stormwater program

**When Does This Step Occur?**

- Within the specified time for review of the Concept Plan after accepting the submittal as complete

**Description**: The approval of the Concept Plan should mean that there is enough information to confirm that the Final Stormwater Management Plan (Step 5) is very likely to achieve compliance. This is the time to coordinate with other internal reviews such as roads and drainage plans, plats, water and sewer, floodplains, erosion and grading. This is the chance to vet and resolve possible internal conflicts that may limit the use of certain measures. The applicant should also coordinate the review with external agencies, especially for plans subject to state or federal reviews, such as wetlands and stream permits, and other discharge permits required for the site.

### Step 4b Revise Concept Plan in Response to Comments

**Who Does This Step?**
- Owner/applicant and design engineer

**When Does This Step Occur?**
- After receiving comments, if any, from the plan reviewer

**Description**: The design engineer revises the Concept Plan components in response to the reviewer comments. The objective at this point is to ensure that there is enough information to develop a complete Final Stormwater Management Plan. Engineering details and final computations are not expected at the Concept Plan stage.

### Step 5 Develop Final Stormwater Management Plan

**Who Does This Step?**
- Owner/applicant and design engineer

**When Does This Step Occur?**
- After approval of Concept Plan

**Description**: Using the approved Concept Plan as a framework, the Final Stormwater Management Plan is developed. A typical plan submittal package would include the items listed in Table 2.4. It should be noted that the Final Stormwater Management Plan is often coordinated with other final plans such as grading and drainage, erosion control, utilities and road plans. The actual content for the final plans is dictated by the local program requirements; the items in Table 2.4 are guidelines.

### Step 6a Review and Approve Final Stormwater Management Plan; Coordinate with Other Departments & Agency Review; Issue Permit; Collect Bond;

**Who Does This Step?**
- MS4 operator/local stormwater program

**When Does This Step Occur?**
- Within the specified time for the review of the Final Stormwater Management Plan after accepting the submittal as complete.

**Description**: This is a detailed review to verify compliance with the standards in the MS4 permit and the local ordinance. The reviewer should verify that the information submitted matches the information shown on the plan sheets, the engineering design specifics, and the narrative and computational elements of the plan. The plan reviewer can at this point develop specific comments that need to be addressed in order for the plan to receive approval. Final plan approval requires coordination with other internal and external reviews for the project. Some programs specify that a performance bond be posted as a condition of final approval.

### Step 6b Revise Final Plan in Response to Comments

**Who Does This Step?**
- Owner/applicant and design engineer

**When Does This Step Occur?**
- After receiving comments from the plan reviewer

**Description**: The design engineer responds to comments from the reviewer. This is an iterative step with Step 6a.

**Table 2.4: Recommended Components of a Comprehensive Stormwater Management Plan (Adapted from Claytor, 2006).**

| Component | Component Items |
|---|---|
| Graphical | • Vicinity map<br>• Plan view showing SCM locations, sizing, post-development drainage areas, and layout with storm sewer and other utilities<br>• For each SCM necessary, cross-sections and profile details with elevations of critical components<br>• Graphical portrayal of coordination with erosion prevention and sediment control measures (EPSCs) and SCMs (i.e. how will they transition from EPSC to SCM)<br>• Typical details and notes<br>• Soil survey, geology, slope, land cover, and other relevant maps for design |
| Narrative and Computations | • Cover: Project title, client, nature of computations<br>• Summary comparison of design outputs to design criteria<br>• Table of proposed SCMs with target treatment volume per drainage area, storage volume, and sizing<br>• Contributing area delineation for pre- and post-development conditions with times of concentrations, land use, and soils<br>• Narrative of stormwater management systems<br>• Summary of hydrology and hydraulics<br>• Table of drainage areas, curve numbers, time of concentration, and peak discharge (pre-and post-development) that summarizes the performance of proposed stormwater SCMs<br>• Detailed hydraulic calculations<br>• Hydrologic analyses<br>• Supporting calculations (i.e. channel sizing, outfall channel, downstream analyses, structural calculations)<br>• Site photographs<br>• List of permit requirements and how project is in compliance (including other pertinent permits)<br>• Soil test pits or borings; results of infiltration tests<br>• Pollutant monitoring data<br>• Groundwater table elevation<br>• Habitat evaluations<br>• Tree surveys<br>• Threatened and endangered species<br>• Receiving waters classification<br>• Topographic maps |
| Supporting Documents | • Maintenance agreements<br>• Maintenance plan for each SCM<br>• Submittal fees<br>• Engineer's certification statement<br>• Documentation of other permits<br>• Performance bond<br>• Land use restrictions or deed restrictions |

### Step 6c Install Erosion Prevention and Sediment Controls (EPSCs)

**Who Does This Step?**

- Owner/applicant and site contractor

**When Does This Step Occur?**

- After receiving approval and required permits

**Description**: EPSCs are installed before the site is disturbed.

### Step 6d Preserve and Protect Functioning Permanent Natural Hydrologic Features from Construction Impacts

**Who Does This Step?**

- Owner/applicant and site contractor

**When Does This Step Occur?**

- After receiving approval and permits

**Description**: Mark and protect natural hydrologic features from construction impacts using proper fencing materials and signage.

### Step 7 Once Site is Stable, Construct Post-Construction Stormwater Management Controls

**Who Does This Step?**

- Owner/applicant and site contractor

**When Does This Step Occur?**

- After receiving final approval of the Stormwater Management Plan, posting performance bond (if required by the local program), and receiving all necessary permits and approvals

**Description**: The contractor follows the proper construction/SCM installation sequence as specified in the plan. In particular, SCMs that have a filter media, rely on infiltration into the underlying soil, and/or that are vulnerable to construction sediments should only be installed once the contributing drainage areas reach a specific level of stabilization. The Final Stormwater Management Plans should be coordinated with the grading, drainage, and erosion and sediment plans to ensure that the installation of SCMs follows the proper sequence. It is often helpful for the design engineer to have a role in ensuring that post-construction SCMs are built according to the plan.

### Step 8 Inspection & Verification of Post-Construction Stormwater Management Controls

**Who Does This Step?**

- MS4 operator/local stormwater program

**When Does This Step Occur?**

- SCMs should be inspected at critical stages during installation, and a final inspection should be conducted to verify that the SCMs are installed in accordance with the plan and/or any approved field changes.

**Description**: Many SCMs do not perform as intended due to improper installation and construction issues. Figure 2.6 illustrates several common construction and installation pitfalls, using bioretention as an example. Inspection frequency depends on the type of measure. Measures with multiple materials and layers, subgrade construction, and multiple-step construction sequences usually require interim inspections. One of the most important roles of inspectors during SCM installation is to ensure that the drainage areas are adequately stabilized in order to install SCMs. For instance, premature installation of bioretention soil media is one of the major causes of failure of these measures.

Appendix F of this manual contains checklists for various SCMs that can be used as a tool for the inspection process, and a training class has been developed by the University of Tennessee Water Resources Research Center on behalf of TDEC. Information is available at

http://tnpermanentstormwater.org/index.asp?vp=1


*Bioretention swale, installed too early during active construction, has become clogged with sediment.*

*Bioretention area does not drain because of improper soil media, soils compacted during installation, and/or filter fabric under media.*

*Curb inlets to bioretention swale have eroded because of improper sizing of stone.*

*High plant mortality has occurred because improper species were substituted during construction.*

*Site runoff bypasses bioretention swale because of small elevation changes during construction.*

*Some site runoff bypasses bioretention because of inadequate slope of filter strip.*

**Figure 2.6: Common issues with installation of permanent SCMs, using bioretention as an example (Adapted from West Virginia, 2012).**

### Step 9 Develop & Submit As-Built Certification and/or Plan Documents

**Who Does This Step?**

- Owner/applicant, site contractor and/or design engineer

**When Does This Step Occur?**

- Once the final sign-off occurs from the MS4 operator's inspector. A verification process is needed to ensure that permanent SCMs have been installed per design specifications, that includes enforceable procedures for bringing projects into compliance. It is recommended that MS4 communities require the submittal of "as-built certifications" be submitted upon completion of the installation.

**Description**: Once the SCM installation is complete, as verified by the inspector, the applicant's design consultant prepares an as-built plan for each SCM based on actual site conditions. This plan can take the form of "red-lining" the approved design plan to note any discrepancies. The design professional also certifies that the constructed SCM meets or exceeds plan specification. It is important for the as-built plan to confirm:

- Location of SCMs for the site
- Proper sizing, dimensions, and materials
- Elevations of inlets, outlets, risers, embankments, etc.
- Vegetation per the planting plan and any approved substitutions
- Location of permanent access easements for maintenance

### Step 10a Inventory of SCMs, tracking, and reporting

**Who Does This Step?**

- MS4 operator/local stormwater program

**When Does This Step Occur?**

- Ongoing, as part of an SCM maintenance, tracking, and reporting program

**Description**: The proper installation of a permanent SCM is only the beginning of its life-cycle. Long-term maintenance and operation are needed to ensure continued performance and functioning. In this regard, the MS4 operator develops requirements for maintenance agreements and a program for the inventory, inspection and tracking of SCMs. Table 2.5 outlines the MS4 General Permit sections for each of these topics. The appropriate MS4 permit should be consulted for full details concerning these programs requirements.

### Step 10b Ongoing Maintenance of Landscapes and Structural Controls

**Who Does This Step?**

- Owner/applicant or as determined by MS4/local stormwater program

**When Does This Step Occur?**

- Ongoing, as part of an SCM maintenance, tracking, and reporting program

**Description**: Long-term maintenance and operation are needed to ensure continued performance and functioning. In this regard, the MS4 operator develops requirements for maintenance agreements and a program for the inventory, inspection and tracking of SCMs. Table 2.5 outlines the MS4 General Permit sections for each of these topics. The appropriate MS4 permit should be consulted for full details concerning these programs requirements.

**Table 2.5: Outline of MS4 General Permit Sections Pertaining to Long-Term SCM Maintenance, Inventory and Tracking Management Practices and Owner/Operator Inspections.**

| Topic | MS4 General Permit Section | Brief Description |
|---|---|---|
| SCM Maintenance | Section 4.2.5.5 | All SCMs must be maintained. The MS4 must oversee the long-term maintenance of SCMs through a local inspection program. SCM owners/operators must develop and implement a maintenance agreement addressing maintenance requirements for the approved SCMs and authorize the MS4 program to inspect SCMs. |
| Inventory and Tracking Management Practices | Section 4.2.5.6 | Requires the MS4 operator to establish an inventory and tracking system for SCMs installed at new development and redevelopment projects. It is recommended to begin during the plan review and approval process and continue through long-term maintenance. It specifies the minimum content for the tracking system. |

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