Assessment of Erosion Control and Stormwater Regulatory Programs in the Saluda-Reedy Watershed: Greenville County and City of Greenville

Report prepared by
North Wind, Inc.

Melanie Ruhlman, CPESC
Dave Hargett, Ph.D.

Submitted to
Saluda-Reedy Watershed Consortium

April 2007

This research project was funded by
A Grant from the V. Kann Rasmussen Foundation
To Upstate Forever, on behalf of
The Saluda-Reedy Watershed Consortium
www.saludareedy.org
## Table of Contents

1.0 EXECUTIVE SUMMARY ................................................................................................... 1

2.0 INTRODUCTION ................................................................................................................. 4

3.0 FEDERAL STORMWATER PROGRAM ............................................................................. 6
   3.1 Background .................................................................................................................. 6
   3.2 Phase I NPDES Stormwater Program ......................................................................... 6
   3.3 Phase II NPDES Stormwater Program ......................................................................... 7
   3.4 NPDES Construction General Permit ......................................................................... 8
   3.5 State and Local NPDES Requirements in the Saluda-Reedy Watershed ..................... 9

4.0 SOUTH CAROLINA SEDIMENT, EROSION AND STORMWATER MANAGEMENT PROGRAM ...................................................................................... 10
   4.1 Regulatory Authority ................................................................................................. 10
   4.2 Exemptions ................................................................................................................ 10
   4.3 Erosion Control and Stormwater Management Plan Requirements ........................... 10
   4.4 Stormwater Quantity Control .................................................................................... 12
   4.5 Stormwater Quality Control ....................................................................................... 12
   4.6 Maintenance Requirements ....................................................................................... 13
   4.7 Criteria for Program Delegation ............................................................................... 13
   4.8 Enforcement .............................................................................................................. 14
   4.9 Penalties .................................................................................................................... 14
   4.10 When Only NPDES Applies ................................................................................... 14
   4.11 When NPDES and SC DHEC’s Program Both Apply ............................................... 15

5.0 GREENVILLE COUNTY STORMWATER MANAGEMENT PROGRAM .............. 16
   5.1 Greenville County Stormwater Management Ordinance ........................................... 16
      5.1.1 Purpose ............................................................................................................. 16
      5.1.2 Legal Authority ................................................................................................. 16
      5.1.3 Applicability ..................................................................................................... 17
      5.1.4 Exemptions ....................................................................................................... 17
      5.1.5 Erosion Control and Stormwater Management Plan Requirements ............... 17
      5.1.6 Stormwater Quantity Control ........................................................................... 18
      5.1.7 Stormwater Quality Control .............................................................................. 18
      5.1.8 Waivers and Variances ..................................................................................... 19
      5.1.9 Inspections ....................................................................................................... 20
      5.1.10 Enforcement Procedures .................................................................................. 20
      5.1.11 Penalties for Violations .................................................................................... 21
      5.1.12 Performance Bonds ........................................................................................ 21
      5.1.13 Stormwater Facility Ownership and Maintenance ....................................... 21
   5.2 Greenville County NPDES Stormwater Permit and Program Activities .................. 21
5.2.1 Structural Controls and Storm Water Collection System Operation....... 22
5.2.2 New Development, Redevelopment and Construction Site Runoff....... 23
5.2.3 Existing Roadways.............................................................................. 26
5.2.4 Flood Control Projects.......................................................................... 26
5.2.5 Municipal Waste Treatment, Storage, or Disposal Facilities.......... 27
5.2.6 Pesticides, Herbicides, and Fertilizers (PHFs) Application ....... 27
5.2.7 Illicit Discharge Detection and Elimination:...................................... 28
5.2.8 Regulation of Sites Classified as Associated with Industrial Activity..... 29
5.2.9 Monitoring Program............................................................................ 29
5.2.10 Education and Public Information.................................................... 29

6.0 CITY OF GREENVILLE STORMWATER MANAGEMENT PROGRAM............ 31

6.1 City of Greenville Soil Erosion, Stormwater, and Flood Protection Ordinance ...... 31
6.1.1 Purpose.................................................................................................. 31
6.1.2 Applicability.......................................................................................... 31
6.1.3 Exemptions............................................................................................. 32
6.1.4 Erosion Control and Stormwater Management Plan Requirements....... 32
6.1.5 Water Quantity Control........................................................................... 32
6.1.6 Water Quality Control............................................................................. 33
6.1.7 Waivers and Variances.......................................................................... 33
6.1.8 Inspections............................................................................................. 34
6.1.9 Enforcement Procedures......................................................................... 34
6.1.10 Penalties for Violations......................................................................... 34
6.1.11 Performance Bonds............................................................................... 35
6.1.12 Stormwater Facility Ownership and Maintenance............................. 35

6.2 City of Greenville NPDES Stormwater Program and Permit Activities........ 35
6.2.1 Public Education and Outreach............................................................. 35
6.2.2 Public Involvement and Participation.................................................... 35
6.2.3 Illicit Discharge Detection and Elimination........................................... 36
6.2.4 Construction Site Storm Water Runoff Control.................................... 37
6.2.5 Post-Construction Stormwater Management for New Development and
    Redevelopment Sites.................................................................................... 37
6.2.6 Pollution Prevention/Good Housekeeping for Municipal Operations...... 38

7.0 RECOMMENDATIONS ................................................................................. 39

7.1 Recommendations for Greenville County Stormwater Management Program ...... 39
7.1.1 Stormwater Advisory Committee............................................................ 39
7.1.2 Increased Enforcement for Improved Erosion and Sediment Control ...... 41
7.1.3 Ordinance Changes for Improved Water Quality Protection.................. 42
7.1.4 Changes to Water Quantity Control Waiver.......................................... 49
7.1.5 Stream Channel Protection and Riparian Buffer Ordinance.................... 49
7.1.6 Mass Grading Ordinance....................................................................... 52
7.1.7 Tree Canopy Protection and Restoration................................................. 52
7.1.8 Ordinance Provisions for Redevelopment Sites..................................... 53
7.1.9 Ordinance Variance Criteria Needed .......................................................... 54
7.1.10 Incentives for Better Site Design for Low Impact Development ............ 54
7.1.11 Incentives for Use of Innovative Water Quality BMPs ......................... 54
7.1.12 Better Design of Stormwater Detention Basins ...................................... 55
7.1.13 Maintenance and Retrofit of Stormwater Management Facilities ........... 56
7.1.14 Ordinance Restructuring Recommendations ........................................ 57
7.1.15 Water Quality BMP Guidelines for Businesses ..................................... 58
7.1.16 Environmental/Watershed Coordinator Position .................................... 59
7.1.17 Creating Partnerships for Public Education, Outreach and Involvement.. 59
7.1.18 Improvements to County Stormwater Website ...................................... 61
7.2 Recommendations for City of Greenville Stormwater Management Program .. 62
7.2.1 Ordinance Changes for Improved Water Quality Protection .................... 62
7.2.2 Water Quantity Control for Redevelopment Sites ................................. 62
7.2.3 Other Recommendations ........................................................................ 63
List of Tables

Table 1. Water Quality Performance Criteria
Table 2 Greenville County Riparian Buffer Criteria

List of Figures

Figure 1 Phase I and II NPDES Stormwater Program Areas in the Saluda-Reedy Watershed
Figure 2. Delegated Authorities for South Carolina’s Stormwater Management Program in the Saluda-Reedy Watershed
Figure 3. Cumulative average annual rainfall depth by storm size for Raleigh, NC
Figure 4. Comparison of methods for determining water quality runoff volume

Appendices

Appendix A. Greenville County Storm Water Management Program NPDES MS4 Phase I Permit: Summary of Completed Activities Years 1-5
Appendix B Greenville County Stormwater Management Program (SWMP) Proposed Phase I NPDES Permit (2005)
Appendix C Summary of Stormwater Best Management Practices (BMPs)
1.0 EXECUTIVE SUMMARY

Stormwater impacts from existing and new development are a major issue of concern for the integrity of streams and rivers in the Saluda-Reedy Watershed (SRW). Polluted stormwater runoff is often discharged to waterways without sufficient control or treatment, leading to significant changes in watershed hydrology and degradation of water quality and stream health. Federal and state regulations for stormwater management and erosion and sediment control have prompted local communities to develop a programmatic approach to address the issue. The following report is an overview of stormwater regulations affecting both municipal and unincorporated areas of Greenville County and their existing and proposed stormwater programs. Greenville County was selected as the area of study since it does contain the majority of developed areas in the SRW, and since the County’s stormwater program is more established than others in the watershed. Ordinance and program recommendations are also presented at the end of the report, and are submitted on behalf of the Saluda-Reedy Watershed Consortium (SRWC). A similar report, Assessment of Erosion Control and Stormwater Management Practices for Development Sites in the Saluda-Reedy Watershed: Greenville County, was also conducted as part of the SRWC, and is complimentary to the information and recommendations contained herein.

Greenville County and the City of Greenville are delegated authorities to administer the Sediment, Erosion and Stormwater Management Program under the South Carolina Department of Health and Environmental Control. Both the County and City have had a development site permit review and approval process for a number of years. Greenville County has had a comprehensive stormwater management program in place for six years due to its delegation as a larger municipal area according to federal law. Newer USEPA regulations mandate that comprehensive stormwater management programs also be developed and implemented by smaller local governments. The Cities of Greenville, Travelers Rest, Mauldin, Simpsonville, and Fountain Inn are captured under these newer rules. The City of Greenville is starting its own program and therefore is currently undergoing significant transformation. The other municipalities are listed as co-permitees on Greenville County’s permit renewal. Programs for both large and small municipalities are based on a five-year permit cycle and are aimed to control stormwater pollution discharges and eliminate non-stormwater discharges from entering the stormwater system. Programs must include minimum control measures or Best Management Practices (BMPs) for stormwater management. Theses measures include, for example, treatment of stormwater runoff from construction sites for water quality, detection and elimination of illicit discharges to streams, and public education and outreach on impacts of stormwater runoff and pollution prevention measures. Similarly, new federal rules for large and small construction sites have parallel requirements for stormwater pollution prevention plans, and include new requirements for site inspection, reporting, and water quality, among others.

Greenville County’s Stormwater Management Ordinance and Stormwater Program were reviewed and summarized. Program elements are described according to permit requirements and program activities over the past five years. Proposed activities for the next permit cycle are also given. The following recommendations are given for Greenville County’s program:
An active and representative stormwater advisory committee similar to the 2001 Greenville County Storm Water Stakeholders group is needed that is dedicated exclusively to the County’s stormwater program, to focus on policy direction, needed ordinance changes, and to help coordinate public education and outreach activities (Section 7.1.1).

Better enforcement mechanisms are needed for erosion and sediment control during development activities (Section 7.1.2).

Ordinance changes are needed for improved water quality protection. Post-development water quality performance standards applicable to new development and redevelopment sites are needed that require sufficient treatment of “first flush” stormwater runoff, and that will encourage the use of more innovative and effective BMPs for water quality treatment. A change is needed in the definition of water quality volume to more accurately define first flush, so that BMPs are more correctly sized for water quality purposes, and to provide better incentive for low impact development (Section 7.1.3).

Ordinance and procedural changes are needed to prohibit exemptions from stormwater quantity control for those developments that do not discharge directly to large rivers; detention and water quality treatment should be required on all developments unless it is definitively shown to be a risk to downstream areas (Section 7.1.4).

A riparian buffer ordinance is needed for channel protection on smaller streams as well as larger rivers. Protection of riparian buffers is critical BMP to protection of streams and aquatic health. Better erosion and sediment control during construction and extended detention of runoff from specified storm events are also needed to protect stream channels from erosive flows (Section 7.1.5).

A mass grading ordinance is needed that limits the large-scale grading on subdivision developments, and promoting a phased approach for infrastructure and lot development (Section 7.1.6).

Our analysis and review of the present program indicates that measures such as those recommended by the Greenville County Tree Policy Advisory Committee for tree canopy protection and restoration will provide significant enhancements to erosion and sediment control and stormwater management initiatives (Section 7.1.7).

Specific ordinance provisions are needed to require some level of detention and/or water quality treatment for redevelopment sites (Section 7.1.8).

Specific criteria are needed for granting or denying variances (Section 7.1.9).

Better incentives are needed to encourage innovative site design for low impact development and to encourage the use of more effective BMPs for water quality treatment (Sections 7.1.10 and 7.1.11).

Improved standards are needed for stormwater detention basins to prevent their over-design for improper purposes (Section 7.1.12).
Better long-term maintenance and incentives for retrofit of stormwater management facilities are needed for improved water quality and stream protection. A program should be developed to provide for County-based management of these facilities through the County stormwater program as individual property owners simply do not have the technical capability, will, or incentive to properly maintain these facilities (Section 7.1.13).

Recommendations are given for restructuring of the stormwater ordinance (Section 7.1.14).

Recommendations are given for developing water quality BMP guidelines for businesses (Section 7.1.15).

A recommendation for an environmental/watershed coordinator position is given (Section 7.1.16).

Partnerships are needed between the City and County and various community organizations to assist with public education, outreach and involvement activities (Section 7.1.17).

Improvements are needed to the County’s stormwater website to more effectively communicate the objectives, functions, policies and procedures of the stormwater program; to provide citizens with better access to data and watershed information; to provide tools for pollution prevention; and to provide information on community programs, activities and other opportunities for involvement (Section 7.1.18).

The City of Greenville is just getting started with their comprehensive stormwater management program. A summary of their proposed program and program elements is given. Programmatic and ordinance recommendations are provided and are very similar to those given for the County. Ordinance recommendations include substantive changes for improved water quality protection and provisions for improved stormwater quantity control for redevelopment sites and sites situated along the Reedy River and its floodplains as well as smaller tributaries. Consideration should also be given to the fact that most development in the City is redevelopment (infill development) on smaller sites. Therefore for sites that are severely constrained, consideration could be give to allowing a reduced level of quantity and/or quality control in lieu of off-site mitigation, or control measures elsewhere in the watershed. The City’s new stormwater advisory committee should be responsible for addressing issues related to policy changes and program direction and should consist of community stakeholders from businesses, the development sector, environmental interests, educational institutions, and other citizen representatives.
2.0 INTRODUCTION

One of the many issues facing urban and urbanizing areas is the impact of stormwater runoff. Greenville is a relatively large and rapidly growing metropolitan area situated in the upper portion of the Saluda-Reedy Watershed; therefore minimizing stormwater impacts from both existing and new development is an issue of concern for the Greenville County area. Citizen complaints about flooding caused by increased stormwater runoff upstream are common and are becoming more frequent as urbanization exacerbates the frequency and severity of flooding. Additionally, state and federal governments are mandating local stormwater programs for both the City of Greenville and Greenville County to control stormwater pollution.

The United States Environmental Protection Agency (USEPA) considers stormwater pollution to be one of the most significant sources of contamination in our nation's waters. Polluted stormwater runoff is often transported to municipal separate storm sewer systems (MS4s) and discharged into local rivers and streams without treatment. Water quality in streams draining urbanized areas such as Greenville is typically fair to very poor, due in large part to increased stormwater runoff from impervious surfaces (roads, parking lots, buildings, etc.) and improperly controlled runoff from land disturbing activities. Other SRWC studies have shown that water quality in the Reedy River below Greenville is degraded, particularly in comparison to less developed areas of the watershed.

Impacts of uncontrolled and untreated stormwater runoff from developed areas cause significant changes to watershed hydrology, water quality, and stream health:

- **Larger and more frequent flooding.** Increased runoff from impervious surfaces increases streamflow and can increase the magnitude and frequency of downstream flooding.

- **Lower normal stream flow.** More extensive impervious surfaces results in increased surface runoff and less infiltration of stormwater into the ground; this effect results in less slow-release subsurface flow available to maintain normal stream flow, therefore causing base flow, or normal dry weather stream flow, to decrease.

- **Highly eroded streams.** Higher stormflows and stormflow velocities cause accelerated stream channel erosion; channel sediments are delivered downstream where they can clog channels, culverts, and pipes and can contribute significantly to the filling of ponds, lakes and reservoirs.

- **Highly polluted streams.** Untreated stormwater runoff delivers a variety of pollutants to streams and rivers including sediment, nutrients, bacteria, oxygen demanding substances, oil and grease, trace metals, road salt, herbicides and pesticides, and other toxic and synthetic chemicals.

- **Degraded aquatic habitat.** In-stream habitat for aquatic species is severely impacted by increased flows and higher loads of pollutants, particularly sediment.

Besides environmental effects, human and quality of life impacts of uncontrolled stormwater runoff can also be substantial:
- Increased flood damage to private property
- Loss of property due to stream bank erosion
- Damage to public property and infrastructure (roads, bridges, pipes, etc.)
- Impaired recreational uses (swimming, fishing, boating)
- Threats to public health (contaminated water and fisheries)
- Aesthetics (dirty water, trash and debris, foul odors)
- Increased cost of water and wastewater treatment
- Reduction of the assimilative capacity of waterbodies that receive wastewater to handle existing or additional pollutant loads

Similarly, the impacts of uncontrolled erosion are significant from both a human and environmental standpoint:
- Loss of topsoil and soil fertility
- Damage to downstream property and infrastructure
- Degradation of aquatic habitat
- Filling of lakes and reservoirs
- Impairment of water quality

The philosophy of stormwater management has undergone a significant shift in focus and priorities in recent years. What was initially an approach of draining water offsite as quickly as possible, evolved to controlling stormwater onsite for downstream flood prevention, and more recently to incorporation of treatment and protection measures for water quality control. Similarly, applications for erosion and sediment control have improved from early efforts to control erosion from farmlands to a variety of specific structural and vegetative measures designed to prevent erosion and control sediment runoff from land disturbing activities.

In response to the need for improved stormwater management, federal, state and local regulations have emerged for land disturbing activities. The following sections summarize these requirements for the study area.
3.0 FEDERAL STORMWATER PROGRAM

The Phase I and Phase II regulations for stormwater were published in 1990 and 1999, respectively, and are summarized below.

3.1 Background

Amendments to the 1972 Clean Water Act (CWA) prohibit discharge of pollutants to waters of the U.S. from point sources unless authorized by a National Pollutant Discharge Elimination System (NPDES) permit. The NPDES permitting program is designed to track point sources, monitor discharges of pollutants to surface waters, and require the implementation of controls necessary to minimize pollutant discharge. Initial efforts to improve water quality under the NPDES program focused primarily on reducing pollutants in industrial process wastewater and discharges from municipal sewage treatment plants.

More recent watershed studies have shown that diffuse sources of water pollution, such as stormwater runoff from agricultural and urban areas, are major causes of water quality impairment. The CWA was amended in 1987 to address problematic stormwater discharges from non-agricultural sources, including runoff from urban and industrial sites, and required EPA to address them through the NPDES permitting program using a two-phased approach.

3.2 Phase I NPDES Stormwater Program

The Phase I Rule requires NPDES permits for stormwater discharges from:

- "Medium" and "Large" municipal separate storm sewer systems (MS4s, serving populations of 100,000 - 250,000 and >250,000, respectively), and
- Eleven categories of industrial activity, one of which is construction activity that disturbs five acres or greater of land.

A municipal separate storm sewer system is a system of conveyances (roads with drainage systems, municipal streets, catch basins, curbs, gutters, ditches, man-made channels, storm drains) that are:

- Owned or operated by a state or local government,
- Designed or used for collecting and conveying stormwater,
- Not combined with sewer conveyances, and which are
- Not part of a publicly owned treatment works.

Permit coverage for Phase I is either through an individual NPDES permit used by MS4s and some industrial facilities, or through a general NPDES permit used by most industrial facilities and construction sites (see NPDES Construction General Permit below). Under the individual permit, Phase I MS4s are required to implement a stormwater management program as a means to control polluted discharges from these MS4s.
Designated entities must develop stormwater management plans that address 11 categories of best management practices (BMPs) for managing stormwater pollutants:

1. Structural Control Maintenance
2. Areas of Significant Development or Redevelopment
3. Roadway Runoff Management
4. Flood Control related to Water Quality Issues
5. Municipal Owned Operations (landfills, WWTPs)
6. Hazardous Waste Treatment Storage/Disposal
7. Application of Pesticides, Herbicides, Fertilizers
8. Illicit Discharge Detection/Elimination
9. Regulation of Industrial Activities
10. Construction and Post-Construction Site Runoff Control
11. Public Education and Outreach

3.3 Phase II NPDES Stormwater Program

In late 1999, EPA published the Final Rule for NPDES Regulations for Revision of the Water Pollution Control Program Addressing Storm Water Discharges, commonly known as the “Phase II rule.” Phase II requires NPDES permit coverage, mostly under general permits, for stormwater discharges from:

- “Small” MS4s located in urbanized areas, and
- Construction activities that disturb both large (> 5 ac) and small (>1 and < 5 ac) areas (see NPDES Construction General Permit below).

A small MS4 is any MS4 not covered under Phase I. Urbanized areas are determined by the 2000 Census and are areas with a population of at least 50,000 and a density of at least 1,000 people per square mile. The definition also includes any other public storm sewer system located fully or partially within an urbanized area. Permittees are subject to similar yet distinct stormwater management requirements from those of Phase I. In addition, the rule includes a revised version of the original Phase I industrial "no exposure" exclusion whereby facilities with no exposure of industrial activities or materials to stormwater do not need to seek permit coverage.

Phase II MS4s are required to establish comprehensive stormwater management programs (SWMP) to control stormwater pollution discharges to waters of the State to the maximum extent practical and to eliminate non-stormwater discharges from entering the stormwater system. Programs must include six minimum control measures, or categories of BMPs for stormwater management:

1. **Public Education** - BMPs for MS4s to inform individuals and households about ways to reduce stormwater pollution.

2. **Public Involvement** - BMPs for MS4s to involve the public in the development, implementation, and review of an MS4's stormwater management program.
3. **Illicit Discharge Detection and Elimination** - BMPs for identifying and eliminating illicit discharges and spills to storm drain systems.

4. **Construction Site Runoff** - BMPs for MS4s and construction site operators to address stormwater runoff from active construction sites.

5. **Post-Construction Runoff** - BMPs for MS4s, developers, and property owners to address stormwater runoff after construction activities have completed.

6. **Pollution Prevention and Good Housekeeping** - BMPs for MS4s to address stormwater runoff from their own facilities and activities.

Stormwater management ordinances, erosion and sediment control ordinances, development regulations and other local regulations provide the necessary legal authority to implement stormwater management programs.

### 3.4 NPDES Construction General Permit

The reissued NPDES Construction General Permit (CGP) now covers both Phase I large construction sites (>= 5 ac) and Phase II small sites (1-5 ac). Permit requirements are geared towards erosion and sediment control and stormwater management during construction and do not specify measures for post-construction water quality.

The permit compels the owner and operator of the construction site to adhere to a number of requirements, including:

- Develop and implement a storm water pollution prevention plan (SWPPP),
- Post a visible public notice at the main entrance of the construction site containing confirmation of permit coverage and details on where the SWPPP may be viewed,
- As part of the SWPPP, develop a site map showing surface waters, disturbed areas, best management practices (BMPs), etc.,
- Have "qualified personnel" (that are certified through an approved construction site inspector certification course) inspect all erosion and sediment control BMPs (once every 7 days or once every 14 days and within 24 hours of the end of a 0.5 inch or greater rainfall event), maintain BMPs after storm events and keep records in the SWPPP of all inspections and maintenance performed,
- Owners of Projects with 10 acres or more of disturbance must submit monthly reports summarizing their inspections and compliance with the general permit,
- Requirements for compliance with Total Maximum Daily Loads (TMDLs),
- Control wastes, such as discarded building materials, concrete truck washout, and sanitary wastes, and
- File a Notice of Termination (NOT) form when the construction site is stabilized/revegetated.

Penalties for civil violations are up to $10,000/day/violation and for criminal violations $25,000/day/violation or 2 years imprisonment or both.
More information on the Phase I and Phase II programs can be found on EPA’s website at: http://cfpub.epa.gov/npdes/stormwater/swphases.cfm. Additional information on the Construction General Permit can be found at: http://cfpub.epa.gov/npdes/stormwater/cgp.cfm

3.5 State and Local NPDES Requirements in the Saluda-Reedy Watershed

Most states are authorized to implement the Federal Stormwater NPDES stormwater program. SC DHEC is the NPDES permitting authority for all regulated discharges in the state of South Carolina.

Phase I and Phase II NPDES Stormwater Program Areas within the Saluda-Reedy Watershed are shown in Figure 1. Greenville County falls under the requirements of Phase I, and is currently in its second 5-year cycle of program implementation. In Greenville County, the following jurisdictions are subject to Phase II stormwater requirements:

- City of Greenville
- City of Mauldin
- City of Simpsonville
- City of Fountain Inn
- City of Travelers Rest

Other jurisdictions in the Saluda-Reedy Watershed covered under Phase II include:

- Belton
- Easley
- Anderson County
- Pickens County

Since Phase II is a newer program, and because it was held up at the state level in South Carolina, the small MS4s listed above have only begun to implement their programs. The cities of Mauldin, Simpsonville, Fountain Inn, and Travelers Rest have submitted as co-permittees with Greenville County for their NPDES permit and are awaiting approval from SC DHEC. The City of Greenville is also awaiting their general MS4 permit and approval of their stormwater management program.

On November 7, 2003, the South Carolina Department of Health and Environmental Control (SC DHEC) issued the General Permit for Storm Water Discharges from Regulated Small Municipal Separate Storm Sewer Systems (MS4s). The South Carolina Association of Stormwater Managers and other adjoining parties appealed the permit. The appeal was settled on December 28, 2005 and the new effective date for the Phase II MS4 permit in South Carolina was March 1, 2006. The NPDES General Permit for Storm Water Discharges from Large and Small Construction Activities in the State of South Carolina became effective September 1, 2006.
4.0 SOUTH CAROLINA SEDIMENT, EROSION AND STORMWATER MANAGEMENT PROGRAM

SC DHEC, as the environmental regulatory agency on behalf of South Carolina, was delegated in 1975 to administer the NPDES permit program by EPA. This delegation includes the NPDES Stormwater Program, which is administered by the Bureau of Water’s Industrial, Agricultural, and Stormwater Permitting Division.

4.1 Regulatory Authority

In 1983, the South Carolina legislature passed the *Erosion and Sediment Reduction Act*, which established authority for promulgation of erosion and sediment reduction and stormwater management only on land either owned or managed by the State. In 1991, South Carolina passed the *Stormwater Management and Sediment Reduction Act*, which largely replaced the 1983 Act as the controlling law for stormwater management and sediment reduction and expanded permit coverage to most land disturbing activities.

4.2 Exemptions

The following land use activities are listed as exemptions:

- Single family residences not part of a subdivision development
- Agricultural activities
- Forestry operations
- Mining activities
- Maintenance/repair activities for gas, electric, or communication utilities
- Maintenance/repair activities for railroad facilities
- Activities regulated on State lands
- Activities regulated under other state or federal permits (e.g. Section 404 of the CWA)
- Local government activities for repair/maintenance of existing facilities

Separate regulations exist for land disturbing activities conducted by the South Carolina Department of Transportation.

The South Carolina Land Resources Conservation Commission is responsible for the implementation and supervision of the stormwater management and sediment control program. Standards for the program were adopted in 2002 and are summarized below.

4.3 Erosion Control and Stormwater Management Plan Requirements

All land disturbing activities not exempted may not proceed without an approved stormwater management and sediment control plan and permit. Plan requirements are as follows:

- < 2 acres land disturbance – simplified plan, does not require a permit
- > 2 and <= 5 acres disturbance – simplified plan and permit approval process
The following summary applies to comprehensive requirements for larger sites (> 5 acres).

Stormwater management and sediment control plans are required to include supporting computations, drawings, and sufficient information describing the manner, location, and type of measures in which stormwater runoff will be managed from the entire land disturbing activity.

The following items are required for all plans:

- Certification that the activity will be accomplished pursuant to the plan
- Certification for agency on-site inspections
- Design certification (stamp) by registered professional engineer, landscape architect, or land surveyor
- Standard application form
- Vicinity map
- A plan containing:
  - Location map on USGS topographic map
  - Existing and proposed topography
  - Proposed grading, including surface area and limits of grading
- FEMA flood maps and Federal and State wetland maps, where appropriate
- Federal and State permits when wetlands used for stormwater management
- **Stormwater drainage** computations containing:
  - Pre- and post-development velocities, peak discharges, and inflow and outflow (volume-based) hydrographs of stormwater runoff
  - Site conditions around discharge points and method of conveyance
  - Design details for structural controls
- **An erosion and sediment control plan** which includes:
  - Provisions to preserve topsoil and limit disturbance
  - Details of site grading
  - Details and descriptions of temporary and permanent control measures
  - Design details for structural controls
  - Provisions for inspections once every 7 days or once every 14 days and after any 0.5” 24- hr storm
  - Sequence of construction operations
o Description of predominant soil types
o Provisions to minimize sediment transport for work in waterways
o Provisions to minimize tracking sediment onto public roads

- When ponds are used for stormwater management, a downstream analysis for the 10- and 100-year events is required to determine the impact of hydrograph timing
- Access to stormwater management structures for maintenance
- A clear statement of maintenance responsibility

4.4 Stormwater Quantity Control

The following outlines specific requirements for stormwater quantity control.

- Post-development peak discharge rates shall not exceed pre-development discharge rates for the 2-and 10-year frequency 24-hour duration storm event. A less frequent storm event (e.g. 25-year, 24-hour) may be utilized to address existing or future stormwater quantity or quality problems.
- Discharge velocities shall be reduced to provide a non-erosive velocity flow from a structure, channel, or other control measure or the velocity of the 10-year, 24-hour storm runoff in the receiving waterway prior to the land disturbing activity, whichever is greater.
- Watersheds, other than Designated Watersheds, that have well documented water quantity problems may have more stringent, or modified, design criteria determined by the local government that is responsive to the specific needs of that watershed.
- A waiver from stormwater quantity control may be granted if it is demonstrated through a complete watershed hydrologic/hydraulic analysis that rate and volume control is detrimental to the hydrologic response of the basin.

*It is important to note the waiver for quantity control, which applies primarily to those developments discharging directly to large river systems.*

4.5 Stormwater Quality Control

The following outlines specific requirements for stormwater quality control.

- When ponds are used for water quality protection, the ponds shall be designed for both quantity and quality control. Sediment storage volume shall be calculated considering the clean out and maintenance schedules specified by the designer during the land disturbing activity.
- Stormwater runoff/drainage to a single outlet from land disturbing activities which disturb ten acres or more shall be controlled during the land disturbing activity by a sediment basin designed/constructed to accommodate anticipated sediment loading and to meet a removal efficiency of 80 percent suspended solids or 0.5 ml/L peak settable solids concentration, whichever is less, taking into account the total drainage area to the basin.
Use of measures other than ponds to achieve water quality improvement is recommended on sites disturbing < 10 acres.

- Other practices may be acceptable if they achieve a removal efficiency of 80 percent for suspended solids or 0.5 ml/L peak settable solids concentration, which ever is less, for disturbed conditions for the 10-year 24-hour storm.
- Permanent water quality ponds having a permanent pool shall be designed to store and release the first 1/2 inch of runoff from the site over a 24-hour period. The storage volume shall be designed to accommodate at least 1/2 inch of runoff from the entire site.
- Permanent water quality ponds, not having a permanent pool, shall be designed to release the first inch of runoff from the site over a 24-hour period.
- Permanent infiltration practices, when used, shall be designed to accept, at a minimum, the first inch of runoff from all impervious areas.

It is important to note that there are no uniform performance criteria for post-construction water quality.

4.6 Maintenance Requirements

- Preventative maintenance is required for all stormwater management practices to ensure proper functioning and is ensured through agency inspections and reports.
- Agencies to provide procedures for deficiency correction, including notification, subsequent inspection, and enforcement procedures.
- Criteria for evaluating and correcting damages include:
  - Determining extent of damage
  - Determine classification of waterbody (impaired or not)
  - Determine impact and severity of damage
  - Evaluate alternatives for correction
  - Develop landowner agreement for corrections, including schedule

Failure to implement corrections constitutes a violation

4.7 Criteria for Program Delegation

The State may delegate the following components of stormwater management and sediment control programs to local governments or conservation districts as follows:

- Stormwater management and sediment control plan review and approval/disapproval
- Inspections during construction and maintenance inspections
- Enforcement
- Education and training
Delegated authorities have the authority to issue permits in their jurisdiction, but are not authorized to issue permits for their own projects, state owned projects or projects that cross jurisdictional boundaries.

Greenville County and the City of Greenville are both delegated authorities of the program and have assumed the above responsibilities. Pickens County is the only other delegated authority in the Saluda-Reedy Watershed (Figure 2). Delegated local governments must have a certified plan reviewer and a certified inspector. The Commission may conduct inspections in delegated areas and make recommendations for enforcement actions.

4.8 Enforcement

The Commission may request the implementing agency to:

- Issue a stop work order
- Refrain from issuing any further permits to the violator and/or
- Levy fines

Stop work orders may be issued if:

- Off-site sedimentation resulting from non-compliance with the approved plan has eliminated or severely degraded use in a lake or natural waterway or that such degradation is imminent
- Off-site sedimentation resulting from non-compliance with the approved plan has caused severe damage to adjacent land or
- The activity is being conducted without an approved plan

4.9 Penalties

Any person violating any provision is subject to a civil penalty of not more than $1,000. Each day of a violation constitutes a separate violation. Civil action may be filed in circuit court if payment is not received or if equitable settlement is not reached within 30 days. Half of the money generated through fines issued by SC DHEC goes to the general fund of the county in which the violation occurred, and half goes to SC DHEC.

4.10 When Only NPDES Applies

When a land disturbing activity is exempt from the requirements of the State Sediment, Erosion, and Stormwater Management Program but is captured under the Federal NPDES Construction General Permit program (for sites >1 and < 2 ac, for example), the Stormwater Pollution Prevention Plan (SWPPP) is submitted with an NOI to SC DHEC for review. General NPDES permit coverage is not automatic in this situation and is granted only after review and approval of the SWPPP.
4.11 When NPDES and SC DHEC’s Program Both Apply

For those land disturbing activities that fall under the requirements of both the State Sediment, Erosion, and Stormwater Management Program and Federal NPDES Construction General Permit program (sites > 2 ac, for example), the SWPPP is submitted under the State Program to SC DHEC or to the delegated entity. The SWPPP must meet the requirements of both programs. Approval of the SWPPP then serves as the NOI for automatic coverage under the Construction Stormwater NPDES permit. Therefore, there is normally only one review of the SWPPP even though there are two separate permits.

As an important side note, the SC DHEC website states:

“In situations where there are water quality concerns which are not adequately addressed by a delegated entity's review and approval, the Department can require submittal of the SWPPP to the Department for review and approval before general permit coverage is granted. However, the Department does not expect this situation to arise very often.”

With the implementation of the Phase II NPDES Stormwater Program, there is considerable overlap with the State’s Sediment and Erosion Control Program, particularly for individual construction sites. However, the NPDES program is more comprehensive as it is also requires programmatic changes to local governments. To help minimize duplication, SC DHEC will be working toward issuing one state permit for construction activities rather than two, as is presently the case.

Stormwater management programs for Greenville County and the City of Greenville are outlined below and recommendations for each are given.
5.0 GREENVILLE COUNTY STORMWATER MANAGEMENT PROGRAM

Greenville County is a delegated authority to administer South Carolina’s Erosion and Sediment Reduction and Stormwater Management Program to unincorporated areas of the County. Greenville County has a single ordinance that addresses both erosion control and stormwater management for development sites, the Greenville County Stormwater Management Ordinance. It also contains provisions for illicit discharges. The Ordinance refers to the County’s Stormwater Management Design Manual, which contains much of the technical design requirements for development plans. The most recent ordinance changes came into effect in 2001 and include new provisions for water quality control. Below is a summary of the Ordinance followed by a broader overview of the County’s program with respect to its Phase I NPDES Stormwater Permit issued in 2000. Ordinance and program recommendations follow.

5.1 Greenville County Stormwater Management Ordinance

The Greenville County Stormwater Ordinance Management Ordinance was developed to control the adverse effects of increased stormwater runoff associated with both future and existing development and to comply with Federal and State NPDES regulations.

5.1.1 Purpose

The following purpose statement is given in the County Stormwater Ordinance:

“It is the purpose of this ordinance to protect, maintain, and enhance the environment of Greenville County and the short-term and long-term public health, safety, and general welfare of the citizens of Greenville County by establishing requirements and procedures to control the potential adverse effects of increased stormwater runoff associated with both future development and existing developed land. Proper management of stormwater runoff will minimize damage to public and private property, insure a functional drainage system, reduce the effects of development on land and stream channel erosion, attain and maintain water quality standards, enhance the local environment associated with the drainage system, reduce local flooding, reduce pollutant loading to the maximum extent practicable the predeveloped runoff characteristics of the area, and facilitate economic development while mitigating associated pollutant, flooding and drainage impacts.”

5.1.2 Legal Authority

The Stormwater Ordinance gives Greenville County the authority to:

- Control the contribution of pollutants to receiving waters by stormwater discharges associated with residential, commercial, industrial, and related facility activity,
- Prohibit illicit discharges to receiving waters,
- Control discharge to receiving waters of spills, dumping or disposal of materials other than stormwater,
- Control through intergovernmental agreements pollutant contributions from one MS4 to another,
Require compliance conditions in ordinances, permits, contracts or orders, and
Carry out all inspections, surveillance and monitoring procedures necessary to determine compliance and noncompliance with permit conditions including the prohibition of illicit discharges to the Greenville County MS4 and receiving waters.

5.1.3 Applicability

The Stormwater Ordinance is applicable to the following:

- All development that involves the disturbance of one acre of land or greater,
- Redevelopment that involves the disturbance of one acre of land or greater;
- Any commercial or industrial development that falls under the NPDES Industrial Storm Water Permit, and
- Development that creates a peak flow increase of greater than one cubic foot per second (cfs).

5.1.4 Exemptions

The following are exemptions to the Ordinance, in addition to those previously listed under the section outlining DHEC’s regulatory authority:

- Development that does not disturb more than one acre of land.
- Development that does not create a peak flow increase of greater than one cfs.
- Customary and routine grounds maintenance, landscaping, and home gardening which does not require a zoning use exception or building permit, and does not affect storm water drainage entering or leaving any public right-of-ways.
- Emergency repairs of a temporary nature made on public or private property that are necessary for the preservation of life, health, or property and are made under circumstances where it would be impracticable to obtain a Storm Water Management Permit.

5.1.5 Erosion Control and Stormwater Management Plan Requirements

All applicable development activities are required to submit the following:

- Completed Storm Water Management Permit application form,
- Final Storm Water Management Drainage Plans,
- Erosion Prevention and Sediment Control (EPSC) plans, and

The Final Storm Water Management Drainage Plan shall consist of maps, narratives, and supporting design calculations for the proposed storm water system and should include the following sections when applicable:

- Pre- and Post- development hydrologic analysis and calculations that determine existing stormwater runoff volumes, peak flow rates and flow velocities,
Storm water management control facility location, design, and supporting calculations, and
donstream analysis calculations showing the effect of post-development design flows on
downstream storm water conveyance systems and channels.

In addition to standard items previously listed, the following items are required by the County to
be included as part of the Erosion Prevention and Sediment Control Plan:

- Location of all erosion and sediment control structures,
- Design details and computation for all erosion and sediment control structures,
- List of the trapping efficiency for each sediment control structure,
- Calculation of required sediment storage volumes,
- Explanation of any computer models or software used with highlights of the output data, and
- Description of required clean-out frequencies and maintenance schedules.

5.1.6 Stormwater Quantity Control

The following design criteria are given for water quantity control (i.e. stormwater volume and
discharge rate control), unless a waiver or variance is granted:

- Stormwater volumes may be controlled with above ground wet or dry detention basins, and/or
  underground detention facilities.
- Post-development discharge rates shall not exceed pre-development discharge rates for the 2-,
  10-, and 25-year frequency 24-hour duration storm events.
- Post-development discharge velocities shall be reduced to provide non-erosive flow velocities
  from structures, channels or other control measures, or be equal to the pre-development 2-year
  24-hour storm event flow velocities, whichever is greater.
- Emergency spillways shall be designed to safely pass the post-development 100-year 24-hour
  storm event without overtopping any dam structures.
- Downstream analysis shall be required for the 2-, 10-, 25-, and 100-year frequency 24-hour
  duration storm events. However, when water quantity controls are implemented, an off-site
  analysis waiver may not be required, provided that all other required design criteria are met.
- Watersheds that have well documented water quantity problems may have more stringent or
  modified design criteria determined from master plan studies by Greenville County.

5.1.7 Stormwater Quality Control

The Design Manual specifies a water quality standard for sediment control structures during
land disturbing activities (i.e. during construction), which is the same standard set by SC DHEC:

“Sediment control structures shall be designed to accommodate the anticipated sediment loading
from all land disturbing activities and meet a design removal efficiency of 80 percent total
suspended solids (TSS) or 0.5 mL/L peak settleable solids concentration, whichever is less, for
disturbed conditions for the ten-year 24-hour storm event.”
The following design criteria are given for water quality control unless a waiver or variance is granted. Note they are the same as those given by SC DHEC.

- Permanent water quality ponds and detention structures having a permanent pool elevation (i.e. wet ponds) shall be designed to store and release the first 1/2-inch of runoff from the site over a minimum period of 24-hours.

- Permanent water quality structures not having a permanent pool elevation (i.e. dry ponds) shall be designed to store and release the first 1-inch of runoff from the site over a minimum period of 24-hours.

- Permanent water quality infiltration practices shall be designed to accommodate at a minimum the first 1-inch of runoff from impervious areas located on the site.

- When existing wetlands are intended to be water quality structures, the Storm Water Management Permit shall not be implemented until all necessary Federal and State permits have been obtained.

It is important to note that there are not uniform performance standards for post-construction water quality treatment. The only water quality performance standard given in the Ordinance, (80% TSS removal), applies only to activities during construction. The criteria given above are for storage and slow release of a given water quality volume, as defined in the Design Manual. Performance for water quality treatment is assumed. Furthermore, the definition of water quality volume is not consistent with that used by more progressive neighboring metropolitan areas. These issues are discussed in more detail in the recommendations section of this report.

5.1.8 Waivers and Variances

A waiver from stormwater management water quantity control requirements may be granted under the following conditions:

- The proposed project will not create any significant adverse effects on the receiving natural waterway or road crossings downstream of the property, including but not limited to:
  - Increased flow velocity that would enhance channel erosion,
  - Increased peak flow rates that are higher than the capacity of downstream bridges and culverts, and/or
  - Increased flow depth that would flood outbuildings, air conditioning units, crawl spaces, or finished floor elevations.

- The installation of storm water management facilities would have insignificant effects on reducing downstream peak flow rates and flood peaks.

- Storm water management facilities are not needed to protect downstream developments and the downstream drainage system has sufficient capacity to receive increases in runoff from the development.

- The imposition of peak flow rate control for storm water management would create,
aggravate, or accelerate downstream flooding.

A **waiver from stormwater management water quality control** requirements may be granted under the following conditions:

- The proposed land development activity will return the disturbed areas to the pre-development land use and runoff conditions.
- The proposed land development will create land use conditions that have the potential to discharge less pollutant loads than the pre-development land use conditions.
- The pre-development land use conditions are unchanged at the end of the project.

Waivers do not apply to water quality, erosion prevention, sediment control and water quantity controls required during active construction.

**Variance**s may be granted for any of the requirements of the regulations set forth in the Design Manual. Variance applies when there are exceptional circumstances applicable to sites such that strict adherence to the regulations could result in unnecessary hardship and not fulfill the intent of the regulations. No criteria are given in the Ordinance or Design Manual for variances.

### 5.1.9 Inspections

Inspections are required by contractors every seven calendar days or once every fourteen calendar days and within 24-hours after each rainfall event that produces 1/2-inch or more of precipitation. Contractors are responsible for preparing inspection reports and having those reports available onsite for Greenville County inspectors. Starting in 2007, the County plans to require that contractors doing on-site inspections be 3rd party contractors and not direct employees of the developer or contractor, and that they be certified through an approved program.

County inspectors conduct periodic site inspections about every two weeks on all land disturbing activities and sites that have post-development permanent water quality BMP facilities. Inspections are performed to ensure stormwater management and erosion prevention plans are being followed correctly and to identify and report any problems to the financially responsible person for corrective actions.

### 5.1.10 Enforcement Procedures

If an inspection by County inspectors is deemed unsatisfactory due to improper BMP installation or maintenance, and if there are no off-site or water body/water quality impacts, a **Correction Order** is issued which serves as a notice of violation and includes a list of corrective actions needed. Correction Orders are issued when changes are required for stormwater management controls, and may be issued in such cases as:

- Failure to comply with stormwater design plans.
- Incorrect/improper measurements, materials, installations, or procedures.
- Failure to provide certification for completed storm water structures.
Failure to properly maintain permanent storm water structures.

In most cases, a Correction Order is used for first offenses and serves as a warning. If the deficiencies are corrected, the violation is closed. Subsequent non-compliance with the Ordinance or failure to complete the items on the Correction Order within a specified time period may result in a second notice of violation or Stop Work Order along with a citation, or fine, which is settled with the Magistrate Court. Stop Work Orders are typically used more frequently by the County than fines, as they are generally more effective, depending on the phase of construction of the development site. If there are off-site or water body/water quality impacts, the site may be referred to SC DHEC for further enforcement actions.

5.1.11 Penalties for Violations

Violations are subject to a civil penalty of not more than $1,000 per violation per day. Any person who negligently, willfully or intentionally violates any provision of the Ordinance can be found guilty of a misdemeanor subject to criminal penalties and shall be punished within the jurisdictional limits of magistrate's court. Each day of a violation constitutes a separate offense. Half of the money generated through fines levied through the County goes to the County Magistrate Court and half goes to the County's General Fund.

5.1.12 Performance Bonds

According to Section 8-86 of the 2003 Greenville County Stormwater Management Ordinance, applicants of developments requiring a stormwater management facility are required to obtain a security bond no less than $3,000 per acre of disturbed area prior to the issuance of any building and/or grading permit. The bond is released once “as-built” plans are submitted, a final inspection occurs, and the director issues certification of completion.

5.1.13 Stormwater Facility Ownership and Maintenance

Most storm water management facilities in Greenville County are privately owned and maintained unless the County has accepted the facility for County ownership and maintenance. The County owns only one detention pond. Owners of private facilities grant the County a perpetual, non-exclusive easement for public inspection and emergency repair. A permanent maintenance plan for each permanent storm water management facility is included in the Final Storm Water Management Drainage Plan and a letter of acceptance for permanent maintenance responsibilities is filed with the Director.

5.2 Greenville County NPDES Stormwater Permit and Program Activities

The Phase I NPDES Stormwater Permit was issued for Greenville County on August 1, 2000. The permit had a five-year term that expired July 31, 2005. A Storm Water Management Plan (SWMP) was developed in the first year of the Permit, setting the general direction for the program. The Plan is designed to reduce the discharge of pollutants from the County’s Municipal Separate Storm Sewer System (MS4) to the maximum extent practicable (MEP). The
program is funded through a stormwater utility which was enacted in 2002 and generates approximately 3 million dollars a year. The utility funds 13 positions and several contractors.

The County has developed a proposed plan for the next permit cycle and is still awaiting approval from SC DHEC for its permit renewal. The Cities of Travelers Rest, Mauldin, Simpsonville, and Fountain Inn are listed as co-permittees on the new permit. The following is a summary of program activities to date, followed by a brief summary of the proposed plan for the next five-year permit cycle.

The SWMP is structured to be implemented on a watershed basis within the County and will be implemented in four phases. Each phase corresponds to increments of approximately two hundred square miles of watershed area. The prioritization of the work was determined based on the degree of urbanization within the County. Some tasks apply countywide and others are specific to individual watersheds.

The Permit outlines 11 key program elements corresponding to NPDES regulations previously described. County program requirements and activities are summarized below. Yearly activities are presented in further detail in Appendix A. Appendix B is summary of proposed activities for the second five-year permit cycle.

### 5.2.1 Structural Controls and Storm Water Collection System Operation

**Permit Requirements**

Three tasks are outlined in the Permit for this program element:

1. A description of existing structural and source controls that control pollutants discharged from the MS4,
2. A summary of the inspection and maintenance program for structural controls, and
3. A topographic map (extending one mile beyond the service boundary of the MS4) with the following information:
   - Location of municipal storm sewer system outfalls
   - Description of land uses, runoff coefficients, population densities, and projected growth for a ten year period within the drainage area served by the MS4
   - Location of municipal landfills or other municipal treatment, storage or disposal facilities
   - Location of all known discharges associated with NPDES permits
   - Location of major structural controls for stormwater discharge
   - Location of publicly owned recreational areas and other open lands
   - Location of major stormwater outfalls from industrial facilities

**County Program Activities**
All known stormwater outfalls have been inventoried. The County owns one detention pond; all others are privately owned. An inspection program was developed in Year 2 to locate, inspect, and evaluate private detention basins. All basins have been inspected at least once (775), and some have been re-inspected (163). Their locations and attribute data are stored in a database. Deficiencies in structural controls have been reported to the County for correction. There was no additional information given in County reports on corrective actions, if any had been initiated or completed.

Regular system maintenance activities include:

- Mowing grassed areas
- Vacuuming storm drains and closed systems
- Trash removal as necessary
- Reporting dumping to the Sheriff’s Office

An ArcIMS website has been created for easy access to land use (GIS), facility and stormwater survey data. The system is updated as new data becomes available.

5.2.2 New Development, Redevelopment and Construction Site Runoff

Note: Two program elements, development areas and construction site runoff, are lumped together for summary purposes since there is considerable overlap in program requirements and activities.

Permit Requirements

Five tasks are outlined in the Permit for areas of new development and significant redevelopment:

1. Limit increases in the discharge of pollutants in stormwater from new development
2. Reduce the discharge of pollutants in stormwater from redeveloped areas
3. Establish requirements for post-construction stormwater management
4. Include clear standards for developers, design engineers and permittees consistent with specific water quality design criteria
5. Identify the following seven components in the SWMP:
   - Management objectives for streams, wetlands and other receiving waters
   - Areas where urban development is likely to occur and areas sensitive to urbanization effects
   - Design criteria and performance standards for stormwater controls for new developments
   - Measures to minimize the effects of new development on stormwater quality
   - Site development review process
Measures to protect highly sensitive waters, including proposed and existing Outstanding Resource Waters (ORWs), trout waters, and drinking water intakes

Measures to address discharges of pollutants to impaired (TMDL) water bodies

Three tasks are outlined in the Permit for construction site runoff:
1. Site planning and non-structural & structural BMPs
2. Inspection and enforcement
3. Site operator training

County Program Activities

Greenville County’s Stormwater Management Ordinance establishes requirements to limit increases in the discharge of pollutants in stormwater from new development sites. A summary of the Ordinance is given in subsequent report sections.

The County also has developed a Stormwater Design Manual and a BMP manual for designers and developers. A separate manual was also developed to simplify design of detention ponds. Training is provided for design engineers, plan reviewers, contractors, inspectors, and county employees. A plan review and approval process is established for development plans to obtain a grading permit.

The County has four positions authorized, with 2 positions currently staffed, and 2 positions remaining open. At any given time, the County has approximately 200-250 active development sites. Inspectors try to inspect each site every two weeks. Inspection efforts are directed to larger sites, with smaller sites receiving lower priority. The County utilizes stop work orders more often and fines less often for violations. Fines are limited to $1000/offense. The magistrate usually reduces first offense to $250. Therefore, stop work orders are generally more effective.

The 2004 audit of the County’s program by EPA noted that due to the volume of citizen complaints, the County inspections were focused more on determining off-site impacts and were not adequately reviewing plans or addressing BMPs at the sites. According to Public Works, the County is addressing these concerns through formally increased review and has increased inspection staff since the audit.

The EPA audit also recommended increasing the fines to the allowable $1,000 per offense up to $7,500 per site per day, which according to the audit report is allowable under the County’s Ordinance, rather than $1,000 per site per day, as was/is the common practice. The second time a site receives a violation, it is sent to SC DHEC, who has the authority to issue civil penalties up to $10,000/day and criminal fines up to $25,000/day. According to discussions with staff, and according to the 2004 audit report, water quality problems (off-site discharges of sediment) are referred to SC DHEC for enforcement.
The County Stormwater Ordinance does not have separate provisions for redevelopment sites. Redevelopment that involves the disturbance of less than one acre of land or that does not create a peak flow increase of greater than one cubic foot per second (cfs) is exempt; all other redevelopment projects are subject to the same requirements as new development sites.

The County Stormwater Ordinance was revised in 2003. Revisions included new provisions for water quality, as summarized below and described in further detail in other report sections.

- BMP designs are required to demonstrate an 80% removal of Total Suspended Solids (TSS) during construction.
- Post-development water quality standards require extended detention of the first 1⁄2” and 1” of runoff from the site for retention and detention ponds, respectively, and for infiltration practices to accommodate the first 1 inch of runoff from impervious areas on the site.
- The County has developed a water quality model (IDEAL model) to model BMP pollutant removals.
- Development plans must also disclose whether or not the site discharges to an impaired (TMDL) waterbody. For some waterbodies, SC DHEC and Greenville County will develop a TMDL that includes recommended limits or loads for both point sources and nonpoint sources. For other waterbodies, the identified load may be only for nonpoint sources, or for point sources only.

Recommendations for ordinance changes for improved water quality and stream channel protection are given in subsequent sections of this report.

Management objectives for streams, wetlands and other receiving waters, and measures to protect highly sensitive waters are not clearly outlined in any of the materials reviewed. The County does not have a separate and distinct riparian buffer ordinance. Although the design manual states that “all major streams, drainageways and waterbodies shall have buffer protection,” it is not clear whether the standards outlined are uniformly required or applied. Furthermore, they do not provide standards for protection of smaller streams, which make up the majority of stream length throughout the county. Further discussion of riparian buffers and buffer requirements is given in the recommendations.

Watershed master planning is ongoing and incorporates GIS and land use data and information from watershed studies to identify priority areas for capital improvement projects, regional BMPs, and water quality management. Prioritization of management units for stormwater master planning is based on the following, listed in order of importance:

1. Impaired water bodies for which TMDLs have been established
2. Waters identified on various EPA water quality lists (303(d), 304, 305(b), 314(a), 319(a), etc.)
3. Water bodies showing known signs of impairment, with no TMDLs
4. Waters draining urbanized areas
5. Drinking water supply sources
6. Highly Sensitive Waters
7. Management units containing RCRA sites
8. Management units containing NPDES permitted facilities and municipalities

These parameters along with water quality data are given various weights and a score is assigned to each watershed management unit (approximately 5 square miles in size). Plans are developed and revised as new data becomes available.

5.2.3 Existing Roadways

**Permit Requirements**

Public roads are to be operated and maintained in a manner to reduce the discharge of pollutants to the MEP. This includes limiting the amount of soil disturbance and stabilizing and revegetating stormwater conveyances.

**County Program Activities**

There are approximately 5,000 roads in the County covering 1,500 mi. The County has 51 employees and most maintenance is done on an on-call basis that is complaint driven. The existing maintenance activities for County roads are outlined below.

- **Mowing** – The County mows within the right of way three times per year on collector streets and on main rural roads. No mowing is done on residential streets.
- **Scraping of Dirt Roads** - There are approximately 90 miles of dirt roads remaining within the county. The County scrapes a portion of residential dirt roads quarterly.
- **Resurfacing** - The County has a resurfacing budget of $151 million for the next 10 years. $13 million was designated for fiscal year 2000-2001 that will resurface 33 miles. During fiscal year 2001-2002, 10 miles were resurfaced. All roads within the county will be evaluated once every 4 years by a geotechnical firm to determine their stability. The roads are then resurfaced on a worst first basis.

The County maintains roadside ditches on County owned roads. The Road/Bridge Department is responsible for cutting grass areas and weeds twice a year and collects trash and litter. The Storm Water Utility uses a vacuum truck to clean out storm drains. A street sweeper will be included in future budgeting. These activities do not include “state” jurisdictional roads, which are subject to the SC DOT program.

5.2.4 Flood Control Projects

**Permit Requirements**
Water quality impacts on receiving waters are to be assessed for all flood management projects identified in the watershed planning process.

**County Program Activities**

Two basin studies were performed to update existing FEMA flood studies. The Rocky Creek Watershed Study was done to determine effects from the Pelham Road widening project and included estimates of pollutant loads and development of conceptual alternatives for flooding and water quality problems. The Gilder Creek Watershed study was conducted to address flooding complaints. Both of these studies areas are in the Enoree River Watershed (non-SRW).

5.2.5 **Municipal Waste Treatment, Storage, or Disposal Facilities**

**Permit Requirements**

A program is to be developed and implemented to identify measures to monitor and reduce pollutants in stormwater discharges from facilities that handle municipal waste.

**County Program Activities**

All municipal waste treatment, storage, and disposal facilities within the County are operating under NPDES Permits. Greenville County is not responsible for any sewerage treatment facilities. Enoree Landfill is a County-owned and operated municipal solid waste landfill. It will close in fall 2006 and a new facility near Princeton (in SRW) will open. Greenville County owns three maintenance yards, where vehicle repair is no longer performed. Fueling stations are used by large machinery, the sheriff’s department and other county staff. All County vehicles are fueled at work camps and repaired at the Vehicle Service Center (VSC), which is owned and operated by the County. Some vehicles are sent to dealerships for repairs outside of the expertise of the VSC.

Facilities that handle municipal waste such as the county sanitary landfill and public and private transfer stations have been included in a list of facilities that were sent a questionnaire and then prioritized for inspection based on the likelihood of discharges that impact storm water from the facility.

5.2.6 **Pesticides, Herbicides, and Fertilizers (PHFs) Application**

**Permit Requirements**

Six tasks are outlined in the Permit for this program element:

1. An education program,
2. Controls to reduce the discharge of pollutants related to the storage and application of PHFs by commercial applicators and distributors on private property,
3. Controls to reduce the discharge of pollutants related to the storage and application of PHFs by employees or contractors to public property,
4. Encourage the reduction of the discharge of pollutants through minimizing the use of PHFs,
5. Identify high use areas and prioritize problem areas, and
6. Inclusion of provisions from guidance document provided.

**County Program Activities**

Clemson University has been designated by SC DHEC to implement pesticide enforcement through its Integrated Pest Management (IPM) program. All commercial applicators are licensed through Clemson. County applications of pesticides are through a commercial vendor, and no herbicides are used on county property.

### 5.2.7 Illicit Discharge Detection and Elimination:

**Permit Requirements**

Six tasks are outlined in the Permit for this program element:

1. Inspection, ordinances, and enforcement measures,
2. Dry weather field screening program,
3. Investigation of suspected illicit and/or improper disposal,
4. Spill prevention and response,
5. Oils, toxics, and household hazardous waste control, and

**County Program Activities**

Illicit discharge investigations are conducted on a watershed basis. All of Greenville County has been divided into sub-hydrologic units based on watersheds of similar size. There are 42 watersheds that have been defined and designated as Phase I, II, III, or IV based on their priority level and permit phase. A database has been developed to coordinate dry weather screening information with inventory data to help with the location of illicit discharge. Appendix A gives details of inventory, tracking and detection activities. Any sewage overflows are reported to Western Carolina Regional Sewer Authority (WCRSA), erosion and soil problems are reported to the Storm Water Utility, and dumping of trash is reported to the Sheriff’s Department Environmental Enforcement Unit. The Stormwater Program is not involved in spill response; local fire and State respond to emergencies. However, a Multi-Hazard Task Plan is currently being developed that will incorporate Stormwater Program staff. The 2004 EPA audit recommended continued work towards implementation of the plan and coordination with the fire department for spill response.
5.2.8 Regulation of Sites Classified as Associated with Industrial Activity

Permit Requirements

The NPDES permit requires the County to develop and implement a program to monitor and control pollutants in storm water discharges to municipal systems for municipal landfills, hazardous waste TSDs, and any other industrial facilities which contribute substantial pollutant loading to the MS4. Two tasks are outlined in the Permit for this program element:

1. Identify priorities and procedures for inspections, and
2. Review of Discharge Monitoring Reports (DRMs) for industries.

County Program Activities

Greenville County fulfilled this requirement by developing a list of facilities for review. The list was populated with information relating to the facility and its location within the Greenville County watershed system. A storm water compliance questionnaire was developed and mailed out to facilities identified on the list. Based on the responses to the questionnaire priorities for facility inspections were developed.

5.2.9 Monitoring Program

Permit Requirements

The Permit requires development and implementation of a storm water quality monitoring program.

County Program Activities

Monitoring is performed on a watershed basis. A monitoring plan was developed during the first permit year, the pilot program implemented in subsequent years. Appendix A gives details of monitoring activities. A lab analyzes samples and data is entered into a database. Baseline data is currently being collected and is used to determine pollutant loadings and event mean concentration estimates, and to update and verify the County’s water quality model. Limited BMP performance monitoring has also been conducted.

5.2.10 Education and Public Information

Permit Requirements

The Permit requires development and implementation of a public education program.

County Program Activities

The County has a public education coordinator who is responsible for the recycling program and other outreach activities. Other aspects of the education program are developed and implemented
by Clemson University's Clear Water Program. A storm drain marking program has been developed along with a children's game and brochures. A website has also been developed. Other public education activities are listed in Appendix A.

The Greenville County Soil and Water Conservation Board serves as the Advisory Committee for the County’s stormwater program for major stormwater policy and program decisions. The Board is composed of five appointed or elected commissioners that meet monthly.
6.0 CITY OF GREENVILLE STORMWATER MANAGEMENT PROGRAM

The City of Greenville’s stormwater management program is funded through a stormwater utility which generates approximately 3 million dollars per year of program funds. Staff consists of three engineering positions, 5-6 inspectors, and 15 people that work on stormwater crews for clean-up and maintenance.

Like the County, the City is a delegated authority to administer South Carolina’s Erosion and Sediment Reduction and Stormwater Management Program, and has been reviewing development plans and inspecting construction sites since the late 1980’s. The City has a single ordinance that addresses erosion control and stormwater management for development sites, the Soil Erosion, Stormwater, and Flood Protection Ordinance. Below is a summary of the Ordinance followed by an overview of the City’s proposed Phase II program. Ordinance and program recommendations follow.

6.1 City of Greenville Soil Erosion, Stormwater, and Flood Protection Ordinance

The following is a summary of the City of Greenville’s regulations for erosion and sediment control and stormwater management contained in Article V of its municipal code, entitled Soil Erosion, Stormwater, and Flood Protection.

6.1.1 Purpose

The purpose statement for stormwater control given in the City’s ordinance is nearly identical as that given in the County ordinance. A separate purpose statement is given for erosion and sediment control:

“(a) Soil erosion and sediment deposition onto land and into water within the Greenville area are occurring as a result of failure to apply proper soil erosion and sedimentation control practices in land clearing, soil movement and construction activities. This sediment deposition results in the pollution of waters and damage to domestic, agricultural and recreational uses as well as other natural resources.

(b) The purpose of [the ordinance chapter] is to control and minimize the extent of erosion and sedimentation, to conserve and protect land, water, air and other resources, and to promote the public health, safety and general welfare.”

6.1.2 Applicability

Ordinance provisions for erosion control impose requirements on any person, unless specifically excluded, who engages in land disturbing activities which require planning and implementation of effective temporary and permanent control measures to prevent accelerated erosion and sedimentation. Additionally, no person is permitted to develop any land in the City without having provided for appropriate stormwater management measures that control or manage runoff and that are in compliance with ordinance provisions.
6.1.3 Exemptions

The following development activities are exempt from stormwater management requirements:

- Agricultural and forestry activities
- Additions or modifications to existing detached single-family dwellings
- Residential developments consisting of one single-family or one duplex dwelling
- Developments that do not disturb more than 10,000 square feet of land area
- Residential subdivision developments of less than five acres and 40 percent impervious area

Exemptions for erosion and sediment control are the same as those listed by SC DHEC, with one additional exemption:

“Minor land disturbing activities, as determined by the city engineer, that would not violate the integrity of the [ordinance.]” No specific criteria for this exception basis are provided.

6.1.4 Erosion Control and Stormwater Management Plan Requirements

Erosion control plans are designated as either type 1 or type 2 plans. Type 1 plans involve developments with a disturbed area of ½ acre or greater and must be prepared by a certified or registered professional. Type 1 plan requirements are listed below. All other developments must submit type 2 plans which only require a narrative description of the sediment control plan and a sketched site plan, and do not require preparation by a certified or registered professional. In either case, small construction sites (1-5 ac) are still subject to the federal NPDES Construction General Permit and must submit a Notice of Intent (NOI) to SC DHEC for review.

Type 1 erosion control plans requirements include:

- Acreage and site boundary
- Existing and proposed contours
- Proposed improvements
- Temporary and permanent vegetative and structural erosion and sediment control measures
- An approved concept plan for stormwater runoff control
- Grading plan including restoration and revegetation measures
- Soil types
- Maintenance program for sediment control facilities, including inspection procedures at lease once every 7 calendar days and after any 24-hr storm event greater than 0.5 inch
- Minimization of vehicular sediment tracking on public roads

6.1.5 Water Quantity Control

A stormwater concept plan is submitted prior to the preliminary or final development plan.
Water quantity (volume) control measures should be specified in stormwater master plans for those areas selected for master planning, or in stormwater management plans to control the adverse effects of stormwater runoff. Ordinance criteria require stormwater management facilities to be designed to limit the 2- and 10-year developed peak discharge rate to the pre-developed peak discharge rates to control bankfull flow velocities to a level which will not cause erosion problems at the outfall(s) and immediately downstream. For all facilities, a hydrologic-hydraulic study is required to show how the drainage system would function with and without the facilities. *Studies are to extend downstream to a point where the proposed development represents less than ten percent of the total watershed.*

Stormwater facility designs are to be based on procedures contained in the stormwater management design manual. Examples given of control measures in the order of preference to the city are:

- Stormwater detention structures (dry basins)
- Stormwater retention structures (wet ponds)
- Facilities designed to encourage overland flow, slow velocities of flow, and flow through buffer zones
- Infiltration practices

For detention and retention facilities, a limited number of large structures is preferred over a large number of smaller structures.

### 6.1.6 Water Quality Control

Water quality control is required during construction activities and criteria for control is the same as that given by SC DHEC. There are no requirements or performance standards for post-development water quality control or treatment given in the ordinance. The only reference to water quality is given in the provisions for a landscape plan which refers to specification of types of vegetation that will be used for stream bank stabilization, erosion control, sediment control, aesthetics and water quality improvement.

### 6.1.7 Waivers and Variances

Requirements for *stormwater quantity control* may be waived under the following conditions:

- The installation of stormwater management facilities would not have a detrimental effect on reducing downstream flood peaks.
- Stormwater management facilities are not needed to protect downstream developments and the downstream drainage system has sufficient capacity to receive any increase in runoff for design storms up to and including the 100-year event.
- It is not necessary to install stormwater management facilities to control developed peak discharge rates at the exit to a proposed development and installing facilities would increase flood peaks at some downstream locations.
The city engineer determines that stormwater management facilities are not needed to control developed peak discharge rates and installing such facilities would not be in the best interest of the city.

A variance from erosion and sediment control provisions may be granted by the planning commission after a public meeting is held and under the following circumstances:

- There are no special conditions and circumstances which are peculiar to the land, structure or building involved which are not applicable to other land, structures or buildings in the same area.
- A literal interpretation of the provisions of the ordinance would deprive the applicant of rights commonly enjoyed by similar properties.
- Granting the variance requested will not confer on the applicant any special privilege that is denied by this chapter to similar lands, structures or buildings.
- The variance requested will be in harmony with the general purpose and intent of the ordinance and will not be injurious to the neighborhood or otherwise detrimental to the public welfare.
- The variance requested is the minimum variance that will make possible the legal use of the land, building or structure.

A variance from stormwater management provisions may be granted if there are exceptional circumstances applicable to the site such that strict adherence to the provisions would result in unnecessary hardship and not fulfill the intent of the ordinance.

6.1.8 Inspections

The city engineer is required to inspect land disturbing activities and stormwater management facilities periodically and determine if activities are being conducted in accordance with the approved plan, if measures are effective in controlling erosion and sedimentation, and if systems are functioning in accordance with the approved plan. The engineer will conduct such inspections at a frequency he deems necessary.

6.1.9 Enforcement Procedures

A failure to comply with an approved plan will result in a written notice of violation and an immediate stop work order. Failure to obtain a grading permit will also result in a stop work order. Failure to implement corrective measures set forth in a notice constitutes a violation. Failure to correct off-site damage identified during inspections and resulting from the land disturbing activity may also constitute a violation.

6.1.10 Penalties for Violations

Violations are subject to a civil penalty of not more than $1,000 per violation per day.
6.11 Performance Bonds

The City does not use performance bonds.

6.12 Stormwater Facility Ownership and Maintenance

Any stormwater management facility which serves a single lot or commercial and industrial developments is privately owned and maintained. The City is granted easements to all stormwater facilities to allow for inspection and emergency repair. For systems within subdivisions, the owner must include in its covenants provisions for maintenance.

Maintenance of all temporary and permanent soil erosion and sedimentation practices are the responsibility of the owner.

6.2 City of Greenville NPDES Stormwater Program and Permit Activities

The City of Greenville is classified by EPA as a small MS4, and therefore is subject to NPDES Phase II requirements for stormwater management. While they have had a plans review and permitting system in place for a number of years, its broader Phase II stormwater program, required by federal law, is just getting underway. The following is a summary of the City’s Notice of Intent (NOI) for compliance submitted to SC DHEC.

6.2.1 Public Education and Outreach

The City proposes to conduct activities about the impacts of stormwater discharges on water bodies and the steps the public can take to reduce pollutants in stormwater runoff. The following are examples of means by which this will be accomplished:

- Clemson University's Educational Publications
- City Scene Quarterly News Paper
- City T.V. Channel
- City's Web Page
- City's Environmental Recycling Center
- Storm Drain Stenciling

The City will develop educational materials in the first year of the 5-year permit and will implement the program in the remaining years.

6.2.2 Public Involvement and Participation

The City will establish a system that actively involves the public in establishing their stormwater management program. The following are examples of proposed public participation programs and activities:

- Stakeholders Group (to address ordinance and other issues involving the City's stormwater management plan)
Adopt-a-Stream Program
Stream Cleanups
Storm Drain Stenciling
Greenville Cares Phone Line

The City will work to establish these groups and programs with implementation following in the remaining years.

6.2.3 Illicit Discharge Detection and Elimination

The City will develop, implement, and enforce a program to detect and eliminate illicit discharges. The following is a list of existing and proposed program elements:

- **GIS System** – The City currently has an active GIS system that includes stormwater and sanitary sewer systems, rivers and streams, parcel information, buildings, ownerships, detention facilities, and other attributes aiding in illicit discharge detection. Dry weather walks will be done to verify GIS information.

- **Stormwater basins** - The City has established 14 stormwater basins, or watersheds, for use in determining priority areas.

- **Master Plans** - Master plans have been developed for 13 of the basins. Included in each is preliminary pollution level data based on typical pollutant loadings and land use (zoning). Also included is information on stormwater and sanitary sewer pipes for use in rehab and maintenance operations. Updates to FEMA and City floodplains are approximately 90% complete.

- **SSOs Reduction Program** - The city is embarking on a program with EPA to reduce the number of sanitary sewer overflows (SSOs) occurring within the City’s system. The City owns the collection lines for sanitary sewers, while Western Carolina Sewer Authority owns trunk lines. The program includes a $5 million contract to rehabilitate one of the City's sanitary sewer basins, a maintenance cleaning program for regular cleaning, root control, grease control, and point repairs.

- **City Ordinance** – The City has a current ordinance that prohibits illegal dumping enforced by the Fire Department. The City will be establishing an ordinance effectively prohibiting non-stormwater discharges into the stormwater sewer system and to establish an enforcement procedure.

- **Dry Weather Screening** - The City will establish priority areas for detecting and eliminating illicit discharges and will perform dry weather screening for detection.

During the first permit year, (a five-year program cycle), the City will establish the ordinance and procedures for prohibiting illicit discharges and will conduct dry weather screening for the 20 percent of the City in the highest priority areas. Dry weather screening will continue on the remaining 80 percent of the City during the remaining four years along with enforcement and elimination of the illicit discharges to the extent possible.
6.2.4 Construction Site Storm Water Runoff Control

The City has developed a program to reduce pollutants in stormwater runoff from construction activities that result in land disturbance of greater than or equal to one acre:

- **Authority** - The City of Greenville has been a delegated authority from SC DHEC to review and inspect construction sites since the late 1980's. Majority of sites within City limits are redeveloped sites less than five acres.

- **Quantity Control** - The City reviews stormwater quantity control measures for each construction site.

- **Sediment Control** - The City reviews sediment control measures for each construction site.

- **Ordinance** - The City has an ordinance in place that regulates all control measures/activities and provides a mechanism for enforcement.

- **Site Inspections** - All construction sites within the City that disturb 1 acre or more are inspected bi-monthly to ensure that the contractor is taking appropriate measures concerning erosion control and to ensure that the site construction coincide with approved plans.

The City will continue this established program for the length of the permit.

6.2.5 Post-Construction Stormwater Management for New Development and Redevelopment Sites

The City will develop, implement, and enforce a program to address stormwater runoff from new development and redevelopment projects that disturb one acre or more and will ensure that controls are in place to prevent or minimize water quality impacts. The City will use a variety of BMPs, such as:

- Preserving Open Space
- Riparian Buffers
- Protection of Wetlands
- Minimize Impervious Surfaces
- Cluster Development
- Various Structural BMPs
- Stream Bank Restoration

The City is currently working with the Corp of Engineers to restore an existing wetland in downtown Greenville. The City has restored 1000 feet of stream bank and has two additional projects in the planning and design phase to restore banks in the park system.

Other management measures include:

- **Stormwater Facilities Inventory** - The City has inventoried all of its detention/retention facilities (approx. 350) within City limits.
Facility Inspections - Annual inspections are performed for existing detention facilities and a database tracking system has been set up. This tracking system will be applied to other BMP control measures as well.

Ordinance - An ordinance and procedure is in place to assure that detention/retention facilities are in compliance.

An ordinance will be developed during year 1 of the permit establishing post-construction stormwater management. The second year will be used to develop and educate the design community on the City’s new requirements and years 3 through 5 will be used to implement the new requirements.

6.2.6 Pollution Prevention/Good Housekeeping for Municipal Operations

The City will develop and implement an operation and maintenance program that includes a training component and has the ultimate goal of preventing or reducing pollutant runoff from municipal operations. The City will train staff and implement programs in the following areas:

- **Park and Open Space Maintenance** - The City presently maintains approximately 3.5 miles of park system along the Reedy River.
- **Fleet and Building Maintenance**
- **New Construction and Land Disturbances** - The City inspects all of City construction projects for erosion control.
- **Storm Water System Maintenance** - The City presently has a regular cleaning program for all stormwater systems and installs oil/water separators in all new garages maintained by the City.
- **Auto Maintenance**
- **Vehicle Washing**
- **Street Cleaning** - The City sweeps 5,920 miles of street annually.
- **Recycling Program** - The City currently operates a comprehensive recycling program.

The City closed its landfill in 2001 and now uses the County landfill. The city will use the first year of the permit to evaluate all housekeeping measures and determine if additional measures are needed, and to develop personnel training. Years 2-5 will be used to implement any new programs, maintain existing programs and train employees on good housekeeping measures.
7.0 RECOMMENDATIONS

7.1 Recommendations for Greenville County Stormwater Management Program

The following are initial recommendations presented on behalf of the Saluda-Reedy Watershed Consortium for Greenville County’s Stormwater Management Program. Ordinance recommendations are given to provide a framework for improved water quality and stream channel protection for Greenville County. Other recommendations are made to clarify existing ordinance requirements and other stormwater/erosion control requirements presented in the Greenville County Storm Water Management Design Manual.

Suggestions and recommendations are made based on information gathered through limited meetings with County staff, review of annual program reports, and a plans review and field survey of active construction sites. (Review and survey findings are detailed in a separate report, Assessment of Erosion Control and Stormwater Management Practices for Development Sites in the Saluda-Reedy Watershed: Greenville County). Further discussions with County program managers, SC DHEC, and County Council are recommended to explore various issues, establish priorities, and develop a strategy for action.

7.1.1 Stormwater Advisory Committee

Problem: An active stormwater advisory committee is needed to review stormwater management policies and procedures, to address ordinance revisions as needed, to review capital and operational programs, and to offer recommendations and comments to County Council. This group could also help to facilitate public education and outreach components of the program, provide increased citizen access to county staff for stormwater and drainage issues, and assist the County in identifying drainage problems and developing priorities for stormwater drainage projects.

Background: In January 1998, prior to the County receiving an NPDES permit, County Council formed the Flood Mitigation Task Force to identify existing drainage problems, determine appropriate levels for flooding, evaluate regulatory intervention issues, and determine the fiscal impacts and potential funding mechanisms for a stormwater management program. Pertinent recommendations by the Task Force were incorporated in the County’s Storm Water Management Plan developed for NPDES compliance.

In January 2001, the Greenville County Storm Water Stakeholders group was established with representation from the following groups:

- Planning Commission
- SC Department of Transportation
- Municipalities within Greenville County
- Home Builders Association
- Engineers Council
- Flood Mitigation Task Force
- Chamber of Commerce
- Reedy River Task Force
- Friends of the Reedy River
- Upstate Forever
According to the County program representative, the stakeholders group was appointed by the County Council to accomplish the following:

- Become familiar with urban stormwater management as it relates to Greenville County
- Become familiar with the NPDES program and the impacts and implications for Greenville County
- Meet regularly with County staff and the stormwater consultants to aid in crafting a stormwater management program that meets regulatory mandates and provides benefits to the County
- Bring the understanding and expectations of citizens and citizen groups into the process
- Disseminate stormwater program information back to citizens and citizen groups
- Advise County Council as it adopts the NPDES Program.

The culmination of this effort was a comprehensive stormwater ordinance that was approved by County Council in November 2001.

Currently, the Greenville County Soil and Water Conservation Board (serving the Greenville County Soil and Water Conservation District) acts as the County’s Stormwater Advisory Committee. There are five appointed or elected Commissioners that meet monthly and deal with a wide range of topics, stormwater being one of many. Nevertheless, the Board is designated for major stormwater policy and program decisions affecting the County.

The County’s program is comprehensive, complex and affects a wide cross-section of community interests. Since public involvement is a key requirement of the NPDES stormwater program, an active stormwater advisory committee is needed that can focus exclusively on County stormwater issues. Ordinance issues should be a top priority. Ordinance recommendations for better water quality and stream channel protection are provided in subsequent report sections.

**Proposed Solution:** We recommend that the 2001 Stormwater Advisory Committee be resurrected to be solely dedicated to the County Stormwater Management Program. In addition to representatives of the 2001 committee, the new committee should also include a member of County Council and a member of the Planning Commission who are familiar with County policies and program objectives to act as liaisons to the larger Council and Commission to help make informed decisions regarding policy and program direction. The Committee should set a regular meeting schedule and timeline for tasks. Policy review should be a top priority to
include periodic review and continuous improvement of the existing stormwater management ordinance.

7.1.2 Increased Enforcement for Improved Erosion and Sediment Control

Problem: A review of County procedures combined with field observations from the complimentary SRWC project involving plans review and field surveys revealed that there is a strong need for better erosion control during construction activities. Impacts to streams and rivers are significant, widespread, and ongoing. County staff is often unfairly blamed for poor enforcement of erosion control regulations due to lack of responsibility on behalf of developers and contractors and perhaps due to the enforcement process itself. While encouraging developers and contractors to do the right thing provides some incentive, stronger enforcement mechanisms for violations provide much greater incentive. One of the barriers to effective enforcement in the County is the enforcement process, which requires essentially a warning and period of time for corrections. Often corrective actions are not quite sufficient to fix the problem, and in the case of off-site and water body/water quality impacts, not only is damage already done, but it is ongoing until the next round of repairs is made.

It is not until a second or third notice of violation that a stop work order or citation is typically issued. In the case of citations, they must go to the Magistrate Court to be settled. The Magistrate Court process for settling citations and issuing fines is a real barrier to effective enforcement of erosion control regulations. A significant period of time often occurs between the time of the violation and correction of the problem. However, the Court often finds that the developer has done his due diligence by (eventually) correcting the problem and fines are often drastically reduced to what effectively becomes a cost of doing business for the developer/contractor, even though there may have been significant off-site and/or downstream damage.

Currently, the County’s enforcement capability appears to be limited by State law that does not provide for penalties to exceed the jurisdiction of magistrates’ court. At this time, the maximum penalty that can be assessed by the magistrates’ court is not more than five hundred dollars per violation or 30 days in jail. Each day of a violation constitutes a separate violation.

Another barrier to effective enforcement is simply staffing needs. Management staff estimated some years ago that over 30 inspectors were needed at the time in Greenville County alone to be able to inspect all active construction sites on a weekly basis. Currently there are 4 County inspectors, with the anticipation of adding 2 more. The other staffing problem is retention of inspectors. Salaries are low and there is little to no opportunity for movement beyond that position, therefore it is difficult to get and retain good inspectors.

Another significant barrier to effective enforcement is the role of politics in enforcement issues. While it is easy to blame inspectors for not preventing site failures, it has been suggested that political influence sometimes interferes in the process by pressuring staff to be lenient with enforcement of erosion control regulations for certain sites.
Proposed Solution: State and local laws should allow for local enforcement for erosion control to be swift and direct. An outside attorney familiar with South Carolina laws may be needed to determine if the County can bypass the magistrate system. Warnings or notifications should only be used for minor problems associated with BMP installation and maintenance. County staff should have the authority to be able issue stop work orders directly, bypassing the notification or warning stage, particularly when there is gross negligence on behalf of the developer/contractor to follow the plan and/or when there are off-site and/or water body/water quality impacts. Furthermore, issuance of citations and levying of fines would be much more effective if it could all be done administratively through the County, rather than having to go through the Magistrate Court system. Therefore, we recommend further investigations into these issues and identification of feasible alternatives for improved enforcement procedures. We also recommend more resources be directed to developing more positions for erosion control inspection. Finally, we advocate full support by all levels of leaders, political and otherwise, for properly enforcing erosion control measures required through the County’s ordinance.

7.1.3 Ordinance Changes for Improved Water Quality Protection

Problem: Greenville County’s Stormwater Management Ordinance does not have performance standards for post-construction water quality treatment and has an oversimplified method for defining water quality volume that is inconsistent with good design principles for low impact development.

Lack of Performance Standards for Post-Construction Water Quality Treatment

The County’s Design Manual gives a performance standard for development sites during construction (80% TSS removal), but no similar standard exists after construction activities are complete. The Ordinance states that the drainage plan shall include BMPs to control the water quality of runoff during land disturbing activities and during the life of the development. However, it does not specify uniform performance standards for post-construction water quality treatment necessary for the life of the development.

While the Ordinance does include the following water quality regulations, these regulations do not go far enough for adequate treatment of the first flush of stormwater runoff, nor do they include a standard level of treatment for this highly concentrated runoff.

Existing State and Local Water Quality Requirements:

- Permanent water quality ponds having a permanent pool shall be designed to store and release the first 1/2 inch of runoff from the site over a 24-hour period. The storage volume shall be designed to accommodate at least 1/2 inch of runoff from the entire site.
- Permanent water quality ponds, not having a permanent pool, shall be designed to release the first inch of runoff from the site over a 24-hour period.
Permanent infiltration practices, when used, shall be designed to accept, at a minimum, the first inch of runoff from all impervious areas.

Of these, dry detention ponds (stormwater ponds not having a permanent pool) are by far the most common BMP used for water quality. Performance for water quality treatment is only assumed for these practices. No specific performance standards are given in state or local regulations that would apply uniformly across developed sites. These and other existing County ordinance and design manual provisions have resulted in the routine construction of dry detention ponds that are not only inappropriately used for water quality treatment but are much larger than needed for water quality purposes. Dry detention ponds, while effective and commonly used for temporary stormwater detention to control erosive velocities and prevent downstream flooding, are not the best choice for water quality treatment. However, when combined with appropriate and effective water quality BMPs such as bioretention areas, stormwater wetlands, or infiltration practices, for example, dry detention ponds can be more effective as final settling basins to “polish” stormwater. Dry detention basins alone may only typically achieve on average a 60% TSS removal, whereas recent studies from North Carolina indicate that bioretention facilities in the southeast Piedmont can achieve 90% or more TSS removal, along with the added benefit of reducing stormwater quantity due to increased infiltration. (Notice also in Appendix C that dry detention ponds are not listed as a BMP for water quality treatment purposes. Yet they are routinely used as such in Greenville County and elsewhere throughout the SRW.)

SC State law currently sets minimum requirements for water quality detention. The County’s program is not allowed to be less stringent than the State’s requirements. These State and County standards have resulted in the routine construction of dry detention ponds that are not only inappropriately used for water quality treatment purposes but are much larger than needed for this purpose, and are a disincentive for good site design. However, state law does not prohibit local governments from passing regulations that are more restrictive, as long as they meet requirements imposed by the state and federal governments. Greenville County and other local governments in the SRW could feasibly require post-construction water quality standards without violating South Carolina law. This is explained further in the proposed solution section below.

**Defining Water Quality Volume**

The second part of the stormwater quality issue deals with the definition of water quality volume. The definition of water quality volume presented in the County’s Design Manual should be changed to more correctly define first flush stormwater runoff. The concept of first flush is discussed below. A description of the County’s definition of water quality volume follows and examples of water quality volume definitions used by other communities that more accurately approach first flush are given in Table 1.
In summary, a small proportion of stormwater runoff that first runs off following a rain event carries most of the pollutants to streams and is commonly known as “first flush.” An excerpt from an article entitled Evaluating First Flush in Stormwater Magazine by Mary Catherine Hagar, (see http://www.onsitewater.com/sw_0109_evaluating.html for full article):

"First flush" is the runoff that occurs at the beginning of a rainstorm. Generally thought to be more pronounced on impervious surfaces, the first flush carries with it concentrations of pollutants that have accumulated during the period of dry weather between storms, which could be one day or several months. Communities often struggle to adequately define first flush, such as what volume of rain it constitutes and whether or not it is affected by rainfall frequency or intensity, and to provide adequate treatment measures to counter it. First-flush concerns often figure prominently as smaller cities and counties work toward gaining compliance with Phase II of the National Pollutant Discharge Elimination System (NPDES), and with meeting EPA’s total maximum daily load (TMDL) requirements as specified by each state. Communities vary considerably in how they define first flush and how they treat it."

It is the runoff from the smaller more frequent storms (of 1” or less) that deliver the most pollutants to streams. Figure 3 shows the cumulative average annual rainfall depths for storms of various depths using 30 years of rainfall data from North Carolina. The graph shows that the majority of rainfall generated in a given year is from storms of about 1 inch or less. With this rainfall, the bulk of pollutants are also delivered. Therefore, to achieve water quality performance standards (both during and after construction), BMPs should be designed to capture and treat the runoff from this first flush of stormwater before releasing it to surface waters.

The definition of water quality volume given in the Design Manual is not consistent with that used by comparable neighboring metropolitan areas in the region that have more progressive and ambitious standards (see below What Other Communities Are Doing). With regards to dry ponds, the County’s Design Manual does not encourage low impact site design, and may unnecessarily require over-design of certain BMPs such as ponds for the wrong purposes. The Manual specifies water quality volume as a depth of runoff (1” for non-pool structures such as dry ponds or ½” for pool structures such as wet ponds) for any storm event over the drainage area (regardless of impervious or pervious area), rather than runoff resulting from a particular design storm event which varies according to site design. Runoff resulting from 1” of rain is very different from first 1” runoff over a drainage area. Using the County’s definition of first flush volume, ponds are therefore inappropriately designed for extended detention of larger volumes than necessary for water quality purposes (note that the Atlanta metro counties use extended detention of runoff resulting from the 1-year event for channel protection purposes, not water quality, which they define as an even smaller volume; see below). This approach results in negative unintended consequences to include larger BMPs/measures than needed, disturbance of excessive areas, loss of more trees and vegetation than necessary, and significant additional costs.
As an example, using what we have termed the County’s “area-based” method, for a given drainage area, a low density development with high forest cover would have to treat the same volume of water for water quality purposes as would a highly impervious development area with low forest cover, even though the latter generates more stormwater and more stormwater pollutants. In “precipitation-based methods,” which are more commonly used across the region, for a given design storm, the low density development would treat a smaller volume of runoff compared to the high density development while still achieving the same level of water quality. Figure 4 illustrates this concept.

What Other Communities Are Doing For Post-Construction Stormwater Quality

Table 1 gives post-development stormwater quality performance criteria for neighboring metropolitan areas. Each of the programs is briefly summarized below. The Metropolitan North Georgia Water Planning District (http://www.northgeorgiawater.com) was created in 2001 to develop regional and watershed specific plans for watershed management, wastewater management and water supply and conservation in a 16-county area. As part of this effort, the Atlanta Regional Commission developed a statewide stormwater design manual to introduce new and more protective stormwater requirements for the Atlanta Metro Region (http://www.georgiastormwater.com). The unified manual was the first of its kind in Georgia, and was needed to protect streams and lakes from the fast pace of land development across the jurisdictions of numerous counties and municipalities. It includes separate provisions for water quality, stream channel, overbank flooding, and extreme flooding protection (see http://www.georgiastormwater.com/vol2/1-3.pdf). Most local governments within the Atlanta Metro Region have incorporated provisions of the manual into their local ordinances.

The state of North Carolina has water quality criteria for stormwater runoff. The previous State standard required 85% reduction in annual loadings of TSS from runoff from first 1” of rainfall from a given storm event. Because no duration was specified for rainfall (e.g. 24 hrs), many developers were extending the 1” event over days resulting in inadequately sized (smaller) BMPs. Newer standards specify rainfall duration for at least part of the state. The town of Huntersville, North Carolina is a suburb of the Charlotte-Mecklenburg area and has received regional and national attention due to its progressive and innovative growth management policies. They are one of the first to implement Low Impact Development (LID) standards. LID development integrates site ecology and environmental goals and requirements into all phases of urban planning and design from the individual residential lot level to the entire watershed. One of the more progressive provisions of their water quality ordinance is that no one BMP shall
<table>
<thead>
<tr>
<th>Location</th>
<th>Water Quality Performance Criteria</th>
</tr>
</thead>
</table>
| Atlanta Metropolitan Region, Georgia | - Stormwater systems must be designed to remove at least 80% of the average annual post-development TSS load and satisfy any other watershed- or site-specific water quality requirements.  
- Compliance is assumed if controls are sized to capture and treat the prescribed water quality treatment volume = runoff volume resulting from the first 1.2 inches of rainfall from a site. This includes runoff from all storm events of 1.2 inches or less, as well as the first 1.2 inches of runoff for all larger storm events. (Atlanta metro counties have also adopted standards for stream channel protection, which includes extended detention over 24 hours of runoff resulting from the 1-year, 24-hour storm event, a volume slightly larger than the water quality volume) |
| North Carolina | - In non-coastal areas, stormwater controls should be designed to treat the runoff from the first inch of rain; for coastal areas not in proximity to shellfishing waters, treatment is required for the runoff from the first 1.5 inches of rain; and for coastal areas in proximity to shellfishing waters, the treatment for the difference in the runoff pre-development and post-development for the 1-year, 24-hour storm is required. Under all scenarios, water quality treatment is required to achieve an annual loading reduction of 85% for TSS. |
| Charlotte-Mecklenburg, North Carolina | - Treatment of the runoff generated from the 1-yr 24 hr storm (2.58” for Charlotte) for post-development conditions is required to achieve an 85% TSS annual loading removal. |
| Huntersville, North Carolina | - All stormwater treatment systems shall be designed to achieve annual 85% TSS removal for developed areas. All sites must employ LID practices to control and treat runoff from the first inch of rainfall. LID practices or a combination of LID and conventional storm water management practices shall be used to control and treat the increase in storm water runoff volume associated with post-construction conditions as compared with pre-construction (existing) conditions for the 2-year frequency, 24-hour duration storm event in Rural and Transitional Zoning Districts. For all other Zoning Districts, LID practices or a combination of LID and conventional storm water management practices shall be used to control and treat the increase in storm water runoff volume associated with post-construction conditions as compared with pre-construction (existing) conditions for the 1-year frequency, 24-hour duration storm event. |

* It is important to note that each of the standards given in the table above are a function of the runoff resulting from a particular design storm, rather than an absolute runoff amount as designated in the Greenville County Stormwater Design Manual.
receive runoff from an area greater than five acres. However, the total drainage area for BMPs used in series (i.e. integrated) can exceed this five acre maximum.

**Proposed solution:** Several things are needed to “fix” the County’s ordinance for improved performance for achieving a higher quality of stormwater runoff. First, performance standards for post-development water quality treatment that apply uniformly across development sites and not just to specific BMPs are needed. Therefore, we recommend that the County begin requiring *treatment* of the (redefined) first flush volume of stormflow runoff to a given performance standard for water quality protection. This same standard should apply uniformly to all development sites for post-developed conditions. Meeting this standard then becomes the goal of all development designs and the designer can then have the flexibility to choose the BMPs most appropriate to meet the standard.

Secondly, we recommend changing the definition of water quality volume given in the Design Manual to more correctly define first flush volume as the *runoff resulting from* a given precipitation amount (e.g. 1”) or design storm event (e.g. 1-yr 24 hr storm), rather than a fixed amount of runoff that only varies with drainage area and not land cover. Improved standards should then require *treatment* for this runoff that is known to generate the most stormwater pollutants over time, rather than just extended detention of a fixed amount of runoff across an area. This not only provides an incentive for designs that generate less runoff, but also results in facilities more correctly sized to effectively treat water quality. Compliance with the aforementioned post-construction water quality standards may then be assumed if controls are sized to capture and treat the prescribed water quality treatment volume.

Finally, dry detention ponds should not be accepted as water quality treatment facilities, unless used in conjunction with other BMPs that meet water quality performance standards. The use of more bioretention facilities and other BMPs that mimic the natural system (i.e. that treat and infiltrate runoff) are recommended. Dry detention ponds should not be accepted as water quality treatment structures, unless used in conjunction with other BMPs suited for an appropriate level of water quality treatment. **These and other ordinance issues should be addressed by the Stormwater Advisory Committee, with appropriate technical input.**

A common goal for treating a defined water quality volume from a development site is to reduce post-development total suspended solids (TSS) annual loadings by 80%. This performance goal has been adopted nationwide by many local and statewide agencies and is based upon USEPA guidance. TSS (a measure of suspended sediments) is an effective surrogate pollutant for measuring water quality treatment effectiveness for several reasons:

- The use of TSS as an indicator pollutant is well established,
- Sediment and turbidity, and other pollutants that adhere to sediment, are a major source of water quality impairment due to urban development,
- A large fraction of other pollutants are removed along with TSS, and
- 80% TSS removal is reasonably attainable using well-designed stormwater controls.
However, it is important to recognize that while the 80% TSS retention objective meets most agencies’ standards for practicability, it also allows potentially 20% of TSS to escape the site into local streams. The result is a predictable diminution of water quality and stream health. Other programs have demonstrated that with a modest additional level of effort TSS retention can be pushed above 85 percent or better (see Table 1).

The defined water quality volume should be an expression of runoff resulting from a given amount of precipitation or design storm event (not a fixed runoff amount) to encourage better site design (less imperviousness) that generates less runoff. Hydrologic studies show that small, frequent storms account for the majority of rainfall in a given year and that runoff from these smaller storms, not the larger ones, delivers the majority of pollutant loadings to streams, rivers and other waterbodies. Therefore, by treating the frequently occurring smaller rainfall events and a portion of the stormwater runoff from larger events, it is possible to effectively mitigate the water quality impacts from a developed area.

To summarize, 1) effective performance criteria are needed for post-construction water quality treatment, 2) the definition of water quality volume should be changed to more correctly define first flush stormwater runoff, and 3) dry detention ponds should not be accepted for water quality treatment purposes. Combined, these changes will provide better treatment of stormwater quality, provide better incentive for low impact development design, and result in better protection of downstream water quality.

**Compliance with State Laws and Proposed Changes to State Requirements**

Local governments such as Greenville County may adopt more stringent standards for stormwater quality runoff and still comply with the South Carolina Stormwater Management and Sediment Reduction Act. By redefining water quality volume and requiring a treatment standard for this quality of water, runoff volumes for extended detention of the first ½ or 1 inch of runoff may be reduced, thus reducing the sizing requirements for ponds. The extended detention requirements that currently exist in state and local stormwater regulations, while not as effective as well-defined post-construction water quality performance standards, may still be warranted for the purposes of downstream channel protection. However, more investigation is needed as to the effectiveness of the standard as written for this purpose. One suggestion is to explore the effectiveness of the similar extended detention standard for downstream channel protection given by the Atlanta Metro Area (extended detention over 24 hours of runoff resulting from the 1-year, 24-hour storm event, see Table 1).

Therefore, concurrent with recommendations outlined for the County, it is recommended that SC DHEC be made aware of the inconsistencies surrounding the issue of post-construction water quality treatment that currently exists in SC Code and to explore the possibility of altering these provisions to be consistent with more effective stormwater management.
7.1.4 Changes to Water Quantity Control Waiver

**Problem:** The County routinely grants waivers for stormwater quantity control for developments situated near large rivers such as the Saluda or Reedy. The justification is that stormwater facilities for such a small proportion of the stream’s watershed would have an insignificant effect on reducing downstream peak flows for the stream’s entire (larger) watershed. This argument can be sound from a hydrologic standpoint if the stormwater outfall from the development is discharged directly into the river (i.e. from the bank). However, it was commonly observed that waivers for stormwater detention were granted for developments that discharge to smaller streams that then flow into the larger rivers. This is cause for concern for the integrity of the receiving stream, as uncontrolled or poorly controlled stormwater causes significant stream channel erosion leading not only to stream and property damage, but also to accelerated sedimentation downstream. In addition, water quality is degraded for all situations where stormwater is discharge directly to a stream without any detention or treatment, regardless of stream size.

**Proposed Solution:** The ordinance language and procedures for granting waivers should be changed to only allow such waivers for stormwater quantity control if the discharge (outfall) is located directly on the large waterbody. In such circumstances, the permittee is still not exempt from water quality control requirements. However, even when quantity control is exempted and quality controls are in place, it is often difficult to provide adequate water quality treatment for stormwater. Unless it is definitively demonstrated through hydrologic modeling or other means that stormwater detention would cause adverse downstream effects, it is recommended that development sites near large waterbodies incorporate BMPs for both stormwater quantity and quality control for maximum stream protection.

7.1.5 Stream Channel Protection and Riparian Buffer Ordinance

**Problem:** Greenville County does not have a clear and uniformly implemented riparian buffer ordinance. Riparian buffers are needed to protect streams, particularly smaller streams, from becoming unstable and eroded and contributing to downstream sedimentation and water quality problems. Better erosion and sediment control during construction and extended detention of runoff from specified storm events are also needed to protect stream channels from erosive flows.

The County’s Design Manual lists stream buffers as a BMP for water quality control, but it is not clear if these standards apply to all development sites (Table 2). Furthermore, these standards apply only to streams draining greater than 100 acres and therefore do not apply to small streams. Thus there is no protection for many of the most vulnerable headwater streams that flow through Greenville County. Enforcement and implementation of the stream buffer guidance in the Design Manual has been very irregular thus far.
Table 2. Greenville County Riparian Buffer Criteria (source: Greenville County Stormwater Management Design Manual).

<table>
<thead>
<tr>
<th>Stream Class</th>
<th>Stream Side Zone (ft)</th>
<th>Managed Use Zone (ft)</th>
<th>Upland Zone (ft)</th>
<th>Total Buffer Width on Each Side of the Stream (ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>30</td>
<td>None</td>
<td>15</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>20</td>
<td>15</td>
<td>65</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>45</td>
<td>25</td>
<td>100</td>
</tr>
</tbody>
</table>

Class 1: Streams that have a drainage area greater than or equal to 100 acres.
Class 2: Streams that have a drainage area greater than or equal to 300 acres.
Class 3: Streams that have a drainage area greater than or equal to 640 acres.

*Note:* All buffer widths shall be measured from the top of the streambank.

**Stream Side Zone:** closest to stream; remains undisturbed; clearing and cutting of vegetation is prohibited; permitted uses include flood control structures, restoration activities, footpaths, utility or road crossings.

**Managed Use Zone:** limited tree removal allowed; no fill materials allowed; grading and other land disturbance prohibited; stormwater BMPs, greenway trails and bike paths allowed.

**Upland Zone:** Grading permitted w/out damage to tree roots in Managed Zone; grass permitted; generally no fill material allowed; gardens, gazebos, decks, and storage buildings < 150 ft² permitted.

Poor erosion control and control of erosive stormwater flows and loss of riparian vegetation can cause stream channels to become severely eroded. Many stream reaches in the Saluda-Reedy Watershed are already considerably eroded and incised. Accelerated stream erosion can cause loss of or damage to property and can lead to considerable water quality and sedimentation problems downstream including clogging of channels and infrastructure and filling in of ponds, lakes and reservoirs.

The County’s Manual requires extended detention of the first 1” and ½” of runoff for dry and wet ponds, respectively, for water quality purposes. As explained in the previous section, this is not sufficient for water quality treatment, and results in significant overdesign of these facilities for such purpose. So while a better definition of water quality runoff for water quality control is needed, so is a requirement for extended detention for stream channel protection purposes. The metro Atlanta area and other communities in Georgia require extended detention of runoff from the 1-year, 24-hour storm event for stream channel protection, which like the recommended water quality volume given in Section 7.1.3, is a lesser volume than is currently required by the County for water quality purposes.

The majority of stream length in any watershed is made up of the smaller perennial and intermittent streams. Perennial streams are those that flow year-round in normal water years and in the Saluda-Reedy Watershed can have drainage areas as small as 25 acres or less. Intermittent streams flow for part of the year when water tables are generally higher and can have drainage areas as small as 15 acres or less. A third class of streams, ephemeral streams, flow only for a short period after rain events. Perennial and intermittent streams have well-defined channels with distinct characteristics and are defined as waters of the U.S protected by the Clean Water Act. Ephemeral channels are less distinctive, and their protection under federal law is more
ambiguous. Unfortunately, small perennial, intermittent and ephemeral streams are often overlooked and impacts to them are generally considered insignificant. Often they are not identified at all on development plans, or are improperly identified as drainage ditches.

Small streams provide a multitude of human and environmental services and benefits, and therefore their protection is critical for the protection of channel integrity, stream health and water quality in larger downstream waters. Furthermore, wetlands in watersheds such as the Saluda-Reedy often occur in association with stream and riparian systems. Therefore, the protection of stream buffers can serve a dual purpose of also protecting wetlands.


- Provide natural flood control
- Maintain water supplies
- Trap excess sediment
- Natural cleansing ability protects water quality
- Natural recycling sustains downstream ecosystems and
- Maintain biological diversity

For these reasons, a riparian buffer ordinance is needed to help provide adequate protection of both small and large streams during development activities and as part of the prescription for post-development stormwater management.

**Proposed Solution:** We recommend Greenville County develop a riparian buffer ordinance that includes provisions for protection of smaller perennial and intermittent streams, as well as protection of riparian areas along larger stream and river corridors. We also recommend better erosion and sediment control during construction activities, and extended detention of runoff from the 1-year, 24-hour storm event for stream channel protection.

A good model for stream channel protection criteria is given in Georgia’s Stormwater Management Manual which specifies a three-prong approach:

1. Preservation, restoration and/or reforestation with native vegetation of an applicable stream buffer.
2. 24-hour extended detention storage of runoff from the 1-year, 24-hour return frequency storm event (which varies according to the amount of impervious surface).
3. Erosion prevention measures such as energy dissipation and velocity control.

Greenville County’s Stormwater Ordinance does address each of these elements to a degree, but not to the full extent needed for adequate channel protection, particularly with regards to riparian buffer protection for smaller streams.
The development of a riparian buffer ordinance should focus on the critical elements listed below and should be a process open to input from stakeholders in the watershed.

- Clear standards as to the types and sizes of streams to which the riparian buffer ordinance applies,
- Identification of data sources and methodologies for identifying and mapping streams, rivers and other waterbodies subject to riparian buffer requirements,
- Activities prohibited in riparian buffer areas, and the associated transition protective zones,
- Riparian buffer widths and methodologies for determining width, and
- Criteria for variances and waivers for stream buffer requirements, among others.

The Greenville County Tree Policy Advisory Committee has recommended a 50-foot buffer for all perennial, intermittent and USGS blue line streams in the County as part of the recommendations for a County tree ordinance (see below). We support this initial recommendation and suggest that the Tree Advisory Committee work in concert with the Stormwater Advisory Committee on specific ordinance provisions, including those outlined above for riparian buffers.

### 7.1.6 Mass Grading Ordinance

**Problem:** One of the fundamental causes of poor erosion and sediment control on residential development sites is mass grading of wide expanses of land and the extended time that individual lots are left unstabilized. This problem is most consequential where entire sites are totally cleared and graded, infrastructure (roads, sewer, and water) are installed, and then the majority of the site is left unstabilized or poorly stabilized often for a long period of time until individual lots are developed and final stabilization is accomplished. The extent of land initially cleared at one time should be minimized and should only be that necessary for installation of roads, sewer, water, and stormwater management facilities.

**Solution:** We recommend an ordinance prohibiting the mass grading of land for residential subdivision developments in the County. Land disturbing activity should be limited by permit only to those grading and clearing activities within the areas identified on the preliminary plat as street rights-of-way, water and sanitary sewer easements, and stormwater management facilities. No land disturbing activities should be permitted outside of such areas. Final plat approval should be granted only after all required improvements have been installed or constructed and accepted by the County, including stabilization of disturbed areas. No permit for land disturbing activity or building construction for an individual lot should be issued until the final plat has been approved.

### 7.1.7 Tree Canopy Protection and Restoration

**Problem:** Loss of tree canopy in Greenville County continues to increase at a fairly significant rate. Among the many benefits of trees is their ability to hold soils in place, intercept rainfall and
to help minimize runoff. A study in Atlanta reported that heavy decline in tree cover has resulted in a 33 percent increase in stormwater runoff and that managing this increase requires stormwater facilities at a cost of approximately $1.18 billion (see http://www.upstateforever.org/program_tree.html). Therefore, local regulations are needed to help preserve, protect, and replace trees on development sites.

Solution: The Greenville County Tree Policy Advisory Committee is currently addressing the loss of tree canopy throughout the County. We support the recommendations of the Greenville County Tree Policy Advisory Committee, as written on the date of this report. These include recommendations for a riparian buffer for all (perennial and intermittent) streams and wetlands, requirements for tree buffers around all new residential, industrial and commercial developments, provisions for tree protection during development activities, and requirements for planting, among others.

7.1.8 Ordinance Provisions for Redevelopment Sites

Problem: The County ordinance does not have separate and specific provisions for redevelopment projects. The Stormwater Ordinance applies to all redevelopment sites that involve disturbance of one acre of land or more. However, redevelopment sites can be exempt from provisions of the ordinance if the proposed development does not create a peak flow increase of greater than 1 cfs from existing conditions. This means that if a proposed redevelopment site does not increase or if it decreases impervious area from the existing condition, it can be exempt from stormwater quantity and quality controls. Therefore, the exemption does not facilitate reduction of either stormwater discharge volumes or pollutants discharged in stormwater from redeveloped areas, which are major contributors to water quality degradation in urban areas.

Currently most redevelopment occurs within Greenville City limits, and therefore does not fall under the permitting authority of the County. City of Greenville issues are addressed in subsequent sections of this report. However, as growth continues and areas of the County become built out, more redevelopment will occur in the future and therefore clear standards are needed for this type of development. These may include stormwater quality control for all redevelopment and at least some quantity control where it is feasible.

Proposed Solution: Ordinance provisions are needed for redevelopment. Redevelopment standards may differ from those for new development sites. For example, more flexibility may be given for granting variances or allowing partial controls for those sites that are too constrained, rather than wholesale exemptions for redevelopment. Such allowances could be offset by requiring mitigation practices elsewhere in the watershed where they may be beneficial for stormwater quantity and quality control, such as older developed sites with little to no stormwater control. These and other ordinance issues should be addressed by the Stormwater Advisory Committee.
7.1.9 Ordinance Variance Criteria Needed

Problem: There are no criteria given in the County’s Stormwater Management Ordinance for granting or denying variances.

Proposed Solution: The Stormwater Advisory Committee should be directed to address this issue along with other ordinance issues. Variance criteria given in other city/county ordinances should be evaluated for comparison.

7.1.10 Incentives for Better Site Design for Low Impact Development

Problem: There is a need for better site design standards and incentives for low impact development to reduce the quantity and improve the quality of stormwater runoff from development sites.

Proposed solution: One of the best ways to reduce the impacts of stormwater runoff is by reducing the amount of runoff generated from development sites. This can be significantly affected at the planning level by incorporating guidelines and incentives for better site design for low impact development into local ordinances. Examples include guidelines for reducing street and cul-de-sac sizes, eliminating requirements for curb and gutter when vegetated open channels are suitable, changing parking lot standards to reduce their size and allow for use of porous materials in low use areas, and providing incentives for open space, conservation subdivisions, and tree preservation and other land conservation measures, to name a few. Incorporating post-development water quality standards into local ordinances will provide incentive for low impact designs. Other Saluda-Reedy Watershed Consortium projects focus specifically on this issue.

7.1.11 Incentives for Use of Innovative Water Quality BMPs

Problem: There is little to no use of more innovative and effective BMPs for water quality treatment across development sites in the County. While the County’s design manual does provide information about the use and design of such practices, there are no requirements or incentives for their use built into the ordinance.

The most common water quality BMP observed at development sites during the field survey was dry detention ponds. While dry ponds do achieve some level of stormwater treatment, their primary purpose is for detention or quantity control, while their suitability for water quality control is less useful. In the literature, dry ponds are generally not referred to as a water quality BMP (Appendix C). They often become large collectors of sediment during the construction phase causing accumulated materials to become resuspended during storm events resulting in subsequent delivery to streams. Other stormwater BMPs are being used that can be much more effective for water quality treatment, such as bioretention areas, constructed wetlands, infiltration practices, among others. Many designers and developers may hesitate to consider these BMPs because they are not as familiar as more traditional BMPs. While some have been used more than others, there is sufficient data available to support their effectiveness if designed, installed and maintained correctly. Furthermore, they can often be incorporated into the landscaping
design to provide an amenity to the overall aesthetics of a site, rather than an eyesore like some ponds. Research out of North Carolina is finding that bioretention areas are particularly effective not only at treating stormwater quality, but also at reducing the volume (quantity) of stormwater that must be controlled. Examples of common water quality stormwater BMPs are given in Appendix C.

**Proposed Solution:** Water quality performance standards are needed in Greenville County’s Stormwater Management Ordinance. By requiring a standard of performance, designers will be given more of an incentive to develop innovative designs that incorporate more progressive and effective stormwater BMPs for water quality management. Additionally, the County should provide other incentives for site designers to utilize more innovative (e.g. low impact development) techniques.

### 7.1.12 Better Design of Stormwater Detention Basins

**Problem:** Stormwater detention basin designs are inappropriately used for water quality treatment and appear to be unnecessarily oversized for several reasons: 1) the newer water quality requirements of the County’s Stormwater Ordinance direct developers to choose detention ponds and unfairly require control of the first inch (or half inch, depending on the BMP) of runoff, rather than control of the runoff from the first flush of stormwater; 2) to compensate for the lack of adequate erosion and sediment control during the construction; and 3) the simplified detention method given by the County promotes larger than necessary basins. Furthermore, there is little use of more innovative and effective BMPs for water quality treatment used in combination with standard detention practices.

Oversized detention basins are not only visually unappealing in a typical development, they require land area that could otherwise be used for additional development units, more effective stormwater treatment practices, or retained in some settings for riparian buffers and greenspace. Uncontrolled erosion during the development phase causes the ponds to fill in and become concentrated areas of sediment that can easily remobilize during future storm events. While some may consider the ponds the “last line of defense” under such circumstances, their long-term water quality value can easily decrease over time. Large and multiple detention ponds are becoming the norm for subdivision developments in Greenville County. Besides taking up unnecessary land area and being less than ideal for water quality purposes, their size and lack of long-term maintenance cause them to be an eyesore for many communities, thus having a significant impact on property values.

**Proposed Solution:** The definition of water quality volume should be changed (as previously explained) to more accurately reflect first flush stormwater and to allow for more correct sizing of basins, when used for water quality purposes. Incentives are needed for better BMPs for water quality treatment. When dry detention basins are used for water quality, other water quality BMPs should be used in conjunction to provide optimal treatment.

The County’s policies and procedures should not encourage over-design of detention basins for sediment control. Better erosion control is needed during construction. Temporary soil
stabilization is lacking across most observed development sites, and BMPs above ponds are often not maintained. The ponds should not be thought of as a catch-all during development activities.

### 7.1.13 Maintenance and Retrofit of Stormwater Management Facilities

**Problem:** Long-term maintenance of stormwater facilities is an ongoing and prevalent problem throughout the county. Often they become filled with sediment and trash, short-circuiting (channelization) occurs between inlets and the outlet, pond slopes become eroded, there is little to no outlet protection, and maintenance is needed for structural controls, among other issues. Furthermore, older detention basins were designed to control only large flood events and do little to control the smaller more frequent storms that deliver the bulk of pollutants to streams, rivers and other waterbodies.

Procedures are outlined in the County Stormwater Management Ordinance and Design Manual for regular County inspections, reporting, and correction of problems. Although a maintenance plan and signed agreement are required as part of the site’s drainage plan, no uniform criteria exist for maintenance activities. In many instances, maintenance plans were never developed, or if they ever were, are lost to the owner.

**Proposed Solution:** The County should develop and require maintenance standards for detention ponds, to include at a minimum, provision for the following:

- Sediment removal
- Erosion control and slope stabilization
- Outlet protection inside pond
- Outlet protection at discharge point
- Maintenance of pipes and control structures
- Elimination of channelization inside the pond
- Elimination of short-circuiting of flow around the pond
- Re-grading pond bottom for proper drainage
- Tree and brush removal from dam
- Vegetation maintenance
- Trash removal
- Dam repair
- Maintenance of access points

Detention pond maintenance standards should also include suggestions or even requirements for retrofitting ponds for improved water quality treatment. Existing detention basins can be modified, or retrofit, to achieve improved pollutant removal, as well as to reduce existing maintenance, aesthetics, and operational problems. Some examples include:

- Retrofitting outlet structures to extend detention times for smaller storms
Creating sediment forebays to enhance removal of settleable pollutants
Creating bioretention or wetland treatment systems
Eliminating paved low-flow channels and bypass pipes
Reducing short-circuiting by installing berms to increase the flow path from the inlet(s) to the outlet

For future basins, the County might want to consider taking over ownership and maintenance responsibilities for certain types of ponds, like those in subdivision developments. Funding for doing this could be developed by creating special tax districts and requiring homeowners associations to include as part of their regular homeowners association regime fees, a dedicated fee for maintenance that would go directly to the County.

7.1.14 Ordinance Restructuring Recommendations

The following recommendations are given to help streamline requirements and minimize confusion during planning and permitting.

Suggest changing ordinance title to include reference to erosion and sediment control and illicit discharge detection and removal. Many local governments have ordinances for erosion and sediment control and for illicit discharge detection and elimination that are separate from those for stormwater management. Greenville’s Stormwater Management Ordinance addresses all three program areas in a single ordinance. It may be practical to think about creating separate ordinances for each:

- Erosion and Sediment Control Ordinance,
- Post-Development Stormwater Management Ordinance, and
- Illicit Discharge Detection and Elimination Ordinance.

Alternatively, it may be preferred to build a unified and integrated ordinance that deals with these issues comprehensively. If provisions for each are to remain in a single ordinance, the title of the ordinance should be reflective of these primary program elements, since each are separate and distinct. A date should also be given on the title page to indicate when the ordinance became effective.

**General permit requirements and standards should be included in ordinance language, rather than scattered throughout various chapters of the design manual. Better consistency is also needed between the ordinance and the manual.** There are important ordinance requirements absent from the ordinance language, but included in the design manual, while others are included in both and are sometimes inconsistent. The ordinance should include a clear outline of permit requirements, standards and procedures, while the BMP manual should be more of a technical guidance document for design purposes that outlines details and specific procedures and methodologies for site design of stormwater management and erosion control systems, hydrologic analysis, BMP selection, etc.
The ordinance should contain a section up front on applicability to identify what types of development are subject to ordinance requirements. This is currently contained in Chapter 2 of the Design Manual. Other provisions such as the list of permit requirements are inconsistent between the ordinance and the manual. The manual contains a more complete list of permit requirements than does the ordinance and therefore it may be confusing to a new permittee. For example, an erosion prevention and sediment control plan is not included with other permit requirements in the ordinance language. While it is specified as such in the design manual, it should at a minimum be listed in the ordinance along with other permit requirements, with the particulars of plan requirements outlined in the manual. As another example, the ordinance language specifies that stormwater management facilities should be designed to limit the 2 and 10-year peak discharge rates for post-development conditions to pre-development rates, whereas the design manual states that post-development discharge rates shall not exceed pre-development discharge rates for the 2-, 10-, and 25-year frequency, 24-hour duration storm events. Furthermore, provisions for exemptions and waivers from ordinance requirements should be specified in the ordinance language rather than the design manual. Exemptions are listed in both but are not consistent. For example, exemptions for developments with < 1 acre disturbance and those with < 1 cfs peak flow increase are missing from the ordinance language. Similarly, waivers from water quality and quantity control requirements are included in the manual but not in the ordinance.

Update the tables of contents for both the ordinance and the design manual to match corresponding sections of the ordinance. For example, Sec 8-84 to 8-86 of the ordinance are not correctly referenced in the table of contents. The table of contents for the design manual does not have the correct page numbering for most sections. Several of the figures are also missing from the manual.

The BMP field manual should be made available online. Furthermore, the BMP Field Manual does not include standards and specifications for dry detention ponds, although they are perhaps the most commonly used structural BMP for both quantity and quality control (although not ideal for water quality, as previously explained).

7.1.15 Water Quality BMP Guidelines for Businesses

Problem: Greenville County is required to complete inspections of certain identified priority industrial activities as part of the County’s NPDES Stormwater Permit. In addition to inspections, there is a need to provide water quality BMP guidelines for industries and businesses to help them comply with those sections of the County’s Stormwater Management Ordinance that deal with illicit discharges.

Proposed Solution: We recommend the County work to develop a series of water quality BMP guidelines tailored to specific business types for use in their industrial inspection program and as part of their public outreach and education program. Gwinnett County, Georgia has developed such guidelines with the following goals in mind: (1) provide details of water quality best management practices that may be implemented to assist in controlling pollutants associated with potentially polluting activities and prevent water
pollution; (2) serve as a reference for regulators, inspectors and others who assess the water quality impacts of potentially polluting activities; and (3) provide guidance that, if implemented, will assist in securing compliance with Gwinnett County's Illicit Discharge and Illegal Connection (IDIC) Ordinance.

Businesses or activities for which such guidelines have or will be developed include:

- Motor vehicle repair shops,
- Vehicle cleaning and detailing activities,
- Fuel dispensing facilities
- Metal forming workshops.
- Commercial Lawn and Garden Services’ Secondary Containment practices
- Surface Cleaners
- Portable toilet management
- Secondary containment – fuel storage at construction sites
- Commercial landscaping and lawn care services
- Commercial Car Washing Operations
- Wash Bay Design Standards
- Residential Car Washing
- Charitable Car Washing
- Mobile Car Washing
- Swimming Pool Management
- Carpet Cleaning

7.1.16 Environmental/Watershed Coordinator Position

**Problem:** County inspectors spend a significant amount of time responding to citizen complaints on erosion and stormwater issues, which takes valuable time from their regular inspection duties. As the illicit discharge detection program continues to develop, there is and will continue to be even more of a need for County personnel to respond to illicit discharge problems. Therefore, the need exists for a position in the County government that would work with inspectors to respond to citizen complaints, to interface with businesses and industries on illicit discharge issues, and to work across departments as needed to help coordinate and respond to water quality issues.

**Proposed solution:** We recommend the County consider developing an Environmental Coordinator or Watershed Coordinator position to help respond and deal with water quality issues across the County.

7.1.17 Creating Partnerships for Public Education, Outreach and Involvement

**Problem:** Currently there is little coordination between the County’s public education and outreach component of their Stormwater Management Program with other similar ongoing efforts in the County and in the City. The creation of partnerships with organizations that share
similar goals of educating citizens on stormwater and providing opportunities for public involvement activities could be cost-effective and highly beneficial to the community.

**Proposed solution:** A series of round-table discussions with representatives from City and County stormwater programs and local organizations could be set up to explore opportunities for partnerships for collaboration of community education and outreach efforts.

Upstate Forever (http://www.upstateforever.org/) has an active education campaign that focuses on growth issues in the Upstate. It uses a variety of media, including publications, annual conferences, and numerous seminars, field trips and workshops to promote sensible growth. One of its primary goals is to promote the use of innovative strategies for stormwater control.

Friends of the Reedy River (http://www.friendsofthereedyriver.org/index.php) is another local organization dedicated to protection and improvement of the river and its tributaries. It sponsors a number of educational activities for audiences ranging from kindergarten to retirees including environmental poster contests, stormwater drain tagging projects involving scout organizations, middle-school science fairs, civic organizations, and post-graduate research. It has also coordinated numerous volunteer river clean-ups.

The Conestee Foundation owns the former Lake Conestee millpond located on the Reedy River six miles downstream from Greenville in central Greenville County. This site is a very significant asset to the City and the County in that it very effectively attenuates stormwater flows and sediment transport down the Reedy River from the 65 square mile urban watershed upstream. The Conestee Foundation is also planning a watershed education center on its Lake Conestee Nature Park property. Given its central location and venue for watershed education, development of a partnership with the Conestee Foundation to provide stormwater education and outreach for the public at its facilities on behalf of both the City and the County is a great partnership opportunity.

Coordination with such groups could potentially reach more of the community and provide a higher level of visibility to and awareness of City and County stormwater management programs. One example of a potentially successful collaboration is the formation of an Adopt-A-Stream program, whereby citizens are trained to monitor an adopted section of stream and report results to the county. There are many resources available for developing and implementing such a program, and community organizations could be called upon to assist with training and recruiting of citizen volunteers, with the County providing necessary supplies and other technical assistance.

The City and County should seek opportunities to partner on education and outreach initiatives, which are common elements of each of their respective NPDES stormwater programs. This may be accomplished through a third party to help coordinate programs and activities.
7.1.18 Improvements to County Stormwater Website

Problem: The Greenville County website for stormwater can be a valuable tool for public education, outreach and involvement which are key requirements of all NPDES stormwater programs. However, while it is commendable that the County has a webpage, the extent of information is skeletal and therefore the site should be significantly augmented and updated.

Solution: The following is a list of recommended items for inclusion on the County’s stormwater page(s). A list of exemplary websites follows.

- More information on stormwater impacts and management
- Links to community resources and organizations
- Contact information for reporting spills, dumping, etc.
- Frequently asked questions
- Stormwater utility information
- Information on what is a watershed and the County’s watershed priority areas
- More information on specific elements of the County’s program
- Program updates, including past and current projects
- Water quality condition map and links to data summaries by stream and/or watershed
- Calendar of upcoming events for community involvement projects
- A single page containing links to public information documents, forms, ordinances, etc.
- Development requirements
- Online forms for reporting violations and for public feedback
- Links to educational articles on stormwater
- Links to local news events related to stormwater
- Local, regional, state, and federal links to stormwater program and other info
- Flooding information
- Information on stormwater and water quality BMPs
- Septic tank maintenance information
- Information on recycling and other disposal center locations
- Links to other educational sources of information

The following is a brief list of websites given for reference:

- Athens-Clarke County, Georgia: [http://www.accstormwater.com](http://www.accstormwater.com)
- Griffin, Georgia: [http://www.griffinstorm.com/SW/Home.htm](http://www.griffinstorm.com/SW/Home.htm)
- NC DENR’s Stormwater and Runoff Pollution page: [http://www.ncstormwater.org](http://www.ncstormwater.org)
7.2  Recommendations for City of Greenville Stormwater Management Program

Many of the following recommendations for the City’s program and related ordinances for erosion control and stormwater management are the same as those given for the County.

7.2.1  Ordinance Changes for Improved Water Quality Protection

**Problem:** City of Greenville’s Stormwater Management Ordinance does not have adequate performance standards for post-construction water quality treatment.

**Proposed Solution:** Through the new stormwater advisory committee, performance standards for post-construction water quality should be developed for adoption into the City’s stormwater management ordinance and first flush water quality volume for treatment defined. All sites, whether new development or redevelopment, should be required to have some level of water quality treatment. For sites that are constrained and for which the full degree of treatment is not possible, consideration could be given to establishing a mitigation system whereby compensatory measures could be taken elsewhere (off-site) to improve water quality in lieu of on-site treatment. See County recommendations for more discussion and details of water quality performance standards.

7.2.2  Water Quantity Control for Redevelopment Sites

**Problem:** Currently redevelopment sites are exempt from controlling stormwater flows (i.e. via on-site detention/retention) if there is less than 1 cfs change in peak flow of the 10-year 24 hour storm event. This means that existing sites that currently lack adequate stormwater control can be redeveloped with no additional quantity controls as long as the impervious area of the development remains the same or is reduced. Moreover, development sites that discharge to floodplains of larger rivers are exempt from quantity controls. While these exemptions may not be perceived to cause any additional downstream flooding issues on an individual project basis, on a collective basis they can combine to have significant deleterious effects. These may include exacerbation of flooding and destabilization of streambanks and channels. Furthermore, they can and do contribute to significant downstream water quality impacts, particularly increased delivery of sediment from developing sites and from stream bed and bank erosion caused by the uncontrolled flows.

**Proposed Solution:** Similar to suggestions given for the County’s stormwater advisory committee, the City’s advisory committee should address this issue and discuss alternatives for wholesale exemption of stormwater quantity control for redevelopment sites and sites adjacent to large floodplains.
### 7.2.3 Other Recommendations

Other recommendations for changes to the City’s erosion control and stormwater management regulations and programs mirror many of those of the County (see County recommendations for details):

- Increased enforcement of erosion and sediment control regulations
- A riparian buffer ordinance (with clear variance criteria for constrained properties or those properties with existing buffer impacts)
- Incentives for use of innovative and effective water quality BMPs
- Use of performance bonds
- Maintenance and retrofit of existing stormwater management facilities for water quality control and downstream channel protection
- Development of BMP water quality guidelines for businesses
- Creating partnerships for public education, outreach and involvement
- Creating an environmental or watershed coordinator position
- Creating a city stormwater information website
Figure 1. Phase I and II NPDES Stormwater Program Areas in the Saluda-Reedy Watershed
Figure 2. Delegated Authorities for South Carolina's Stormwater Management Program in the Saluda-Reedy Watershed
Figure 3. Cumulative average annual rainfall depth by storm size for Raleigh, NC.

Note: Graph showing that most rainfall occurs during storm events of 1 to 1.5 inches or less.

Source: Jonathan Smith and Bill Hunt
Figure 4. Comparison of methods for determining water quality runoff volume.

Area-Based

Note: Area-based determination of runoff quality/quantity does not take into account the change in site hydrology in response to the proportion of site developed. More precipitation is needed to generate the same amount of runoff for a low impact development (e.g. low density residential) vs a high impact development (e.g. high density commercial).

Precipitation-Based

Note: Precipitation-based determination of runoff quality/quantity does take into account the change in site hydrology in response to the proportion of site developed. Given the same precipitation, less runoff is generated from a low impact development (e.g. low density residential) vs a high impact development (e.g. high density commercial).
Appendix A

Greenville County Storm Water Management Program NPDES MS4 Phase I Permit: Summary of Completed Activities Years 1-5
<table>
<thead>
<tr>
<th>Program Element</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Structural Control Maintenance and Storm Water Collection System Operation</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Database and Mapping</td>
<td>Created a database of information to be utilized with a GIS topographic map, locating known outfalls, land uses, landfills and TSDs, NPDES permit sites, structural controls, and public lands</td>
<td>ArcIMS website created to provide the County with access to integrated land use and storm water data</td>
<td>Data and system updates to ArcIMS website</td>
<td>Data and system updates to ArcIMS website</td>
<td>Data and system updates to ArcIMS website</td>
</tr>
<tr>
<td>Inventory of Detention Facilities</td>
<td>Completed field inventory of publicly and privately owned detention facilities in Phase I watersheds</td>
<td>All accessible constructed detention basins in Greenville County (approximately 775) were located and attributed</td>
<td>Re-inspection of large detention basins and detention basins in highly urbanized or highly sensitive areas only. (163 total). Deficiencies in structural controls reported to County for correction.</td>
<td>Re-inspection of Phase I watershed areas.</td>
<td>Re-evaluated large detention basins (&gt;1 ac), and those in highly urbanized areas and in sensitive (flood prone or highly visible) areas (163 total). Deficiencies in structural controls reported to County for correction.</td>
</tr>
<tr>
<td>Regular Maintenance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RoadBridge Dept. responsible for grass/weed areas</td>
<td>Re-inspected large detention basins and detention basins in highly urbanized or highly sensitive areas only. (163 total). Deficiencies in structural controls reported to County for correction.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2. Areas of New Development and Significant Redevelopment and Construction Site Runoff</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ordinance Revisions</td>
<td>Developed draft ordinances for stormwater management and erosion and sediment control</td>
<td>New stormwater/erosion control ordinance enacted by Greenville County Council (effective November 2001)</td>
<td>New fee ordinance enacted for continuous program funding</td>
<td></td>
<td>The Greenville County Water Quality Protection BMP Field Manual was created for use by contractors in the field. The field manual covers proper BMP installation and maintenance.</td>
</tr>
<tr>
<td>Design Manual Revisions</td>
<td>Revised BMP design manual</td>
<td>New stormwater/erosion control ordinance enacted by Greenville County Council (effective November 2001)</td>
<td>New fee ordinance enacted for continuous program funding</td>
<td></td>
<td>The Greenville County Water Quality Protection BMP Field Manual was created for use by contractors in the field. The field manual covers proper BMP installation and maintenance.</td>
</tr>
<tr>
<td><strong>Storm Water Audit</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training for Designers, Plan Reviewers, Contractors, Construction Inspectors, and County Employees</td>
<td>Developed a plan reviewer training and certification course</td>
<td>Periodic training for plan reviewers via office visits, phone and e-mail correspondence</td>
<td>Draft SCDHEC certifications course for plan reviewers and design engineers was created through a cooperative effort</td>
<td>Comments on SCDHEC certifications course materials have not been received at end of Year 5</td>
<td>County plan reviewers attended contractor inspector course</td>
</tr>
<tr>
<td>Construction Site Inspections</td>
<td>Developed a plan reviewer training and certification course</td>
<td>Periodic training for plan reviewers via office visits, phone and e-mail correspondence</td>
<td>Draft SCDHEC certifications course for plan reviewers and design engineers was created through a cooperative effort</td>
<td>Comments on SCDHEC certifications course materials have not been received at end of Year 5</td>
<td>County plan reviewers attended contractor inspector course</td>
</tr>
<tr>
<td>Internet Permit Application</td>
<td>Developed a plan reviewer training and certification course</td>
<td>Periodic training for plan reviewers via office visits, phone and e-mail correspondence</td>
<td>Draft SCDHEC certifications course for plan reviewers and design engineers was created through a cooperative effort</td>
<td>Comments on SCDHEC certifications course materials have not been received at end of Year 5</td>
<td>County plan reviewers attended contractor inspector course</td>
</tr>
<tr>
<td>Permit and Complaint Tracking System</td>
<td>Developed a plan reviewer training and certification course</td>
<td>Periodic training for plan reviewers via office visits, phone and e-mail correspondence</td>
<td>Draft SCDHEC certifications course for plan reviewers and design engineers was created through a cooperative effort</td>
<td>Comments on SCDHEC certifications course materials have not been received at end of Year 5</td>
<td>County plan reviewers attended contractor inspector course</td>
</tr>
<tr>
<td>Watershed Prioritization</td>
<td>Developed a plan reviewer training and certification course</td>
<td>Periodic training for plan reviewers via office visits, phone and e-mail correspondence</td>
<td>Draft SCDHEC certifications course for plan reviewers and design engineers was created through a cooperative effort</td>
<td>Comments on SCDHEC certifications course materials have not been received at end of Year 5</td>
<td>County plan reviewers attended contractor inspector course</td>
</tr>
<tr>
<td>Review existing storm water master plans for water quality impacts</td>
<td>Delineated county watersheds (42) and developed priority areas (Phases I – IV)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Greenville County Storm Water Management Program NPDES MS4 Phase I Permit: Summary of Completed Activities Years 1-5**
3. Roadway Runoff Management

<table>
<thead>
<tr>
<th>Program Element</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduce Roadway Pollutants</td>
<td>• Ongoing maintenance activities</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ongoing roadway management practices reviewed including mowing, ditch and storm drain cleaning, removal of trash, and scraping of dirt roads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Coordinated with SCCDOT</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

4. Flood Control Projects Related to Water Quality Issues

| Program Development to Address PHF Runoff | • Review of existing PHF program by Clemson University | • Implementation pending on water quality monitoring data |

5. Municipal Waste Treatment, Storage, or Disposal Facilities

| Outfall Inventory               | • Program developed to inspect and eliminate illicit discharges | • Developed standard operating procedures for eliminating illicit discharges |
|                                | • Revised field data collection software and outfall database design |        |
|                                | • Field inventoried outfalls to USGS streams in Phase I watershed |        |
|                                | • Performed QA/QC analysis in Phase I watershed areas |        |
|                                | • Collected storm sewer infrastructure information for Phase III watershed areas during illicit tracking activities |        |

6. Pesticide, Herbicide, and Fertilizers (PHF’s) Application

| Outfall screening              | • Divided County into areas for outfall screening |        |
|                                | • Field inventoried outfalls to USGS streams in Phase I watershed |        |
|                                | • Performed QA/QC analysis in Phase I watershed areas |        |
|                                | • Collected storm sewer infrastructure information for Phase III watershed areas during illicit tracking activities |        |
|                                | • All outfalls in Phase I areas with flow during dry conditions were sampled. Three new illicit discharges were found |        |
|                                | • Performed field screening and dry weather sampling for outfalls in Phase II watersheds; identified 80 illicit discharges |        |
|                                | • Begun coordination with Georgia Tech to streamline dry weather sampling procedures and methods |        |

7. Illicit Discharge Detection and Elimination

| Outfall Discharge Tracking Plan | • Illicit tracking software program in process | • Enhanced tracking methodologies, procedures and code of the illicit tracking software |
|                                | • Identified and tracked illicit discharges in Phase I watershed |        |
|                                | • Completed identification of potential continuous illicit discharges in Phase III watershed |        |
|                                | • Completed identification of potential continuous illicit discharges in Phase II watershed |        |
|                                | • Ten illicit discharges were confirmed |        |

8. Industrial Runoff

| Inspection Priorities and Procedures | • List developed for all industrial facilities | • A priority list for the inspections of industrial facilities within Phase I watershed was developed. |
|                                    | • Questionnaire developed to prioritize facilities for inspection | • A priority list for the inspections of industrial facilities within Phase II watershed was developed |
|                                    | • Responses evaluated for Phase III and IV area facilities and priority lists for inspections were developed | • Priority lists for the inspection of industrial facilities within Phases III and IV watersheds were developed |
|                                    | • Inspections were conducted |        |

<p>| Program Development               | • Implemented the program developed to monitor and control pollutants in storm water discharges associated with industrial activities in Phase II watersheds. |
|                                    | • Completed inspections of facilities in Phase II watershed area |        |
|                                    | • Inspections in all phased watershed are now complete. |        |</p>
<table>
<thead>
<tr>
<th>Program Element</th>
<th>Year 1</th>
<th>Year 2</th>
<th>Year 3</th>
<th>Year 4</th>
<th>Year 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Training</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• An industrial operators course was developed and conducted for operators of industrial facilities required to have an industrial storm water permit</td>
<td>Conducted the second annual industrial operator's course</td>
<td>Conducted the third annual industrial operator's course. Material cover during the 2004 course included: - Greenville County NPDES Program Overview. - NPDES storm water permit basics. - Storm water utility structure and how implementing water quality BMPs could be used to reduce storm water fees</td>
<td>Created CD containing previous years’ presentations and a summary of the County’s future plan for this program to move to a web-based training.</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Facility Discharge Monitoring Reports (DMR) Review</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• DMR reviews indicate potential concerns including TSS, metals, and pH among others. This info will be incorporated into the GIS database and will help cross-reference known water quality concerns. Procedures for addressing pollutant levels outside acceptable ranges will be developed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

9. **Monitoring Program**

<table>
<thead>
<tr>
<th>Watershed Monitoring</th>
<th>Developed monitoring plan approach</th>
<th>Monitoring plan developed for all watersheds</th>
<th>Set up one sampling point and identified other locations</th>
<th>Collected samples for five qualified storm events from one sampling station; did not send to testing laboratory</th>
<th>Purchased and setup other samplers for Year 3</th>
<th>Continued negotiations with Rogers and Calcutt Engineers, Inc. for lab analysis of samples collected</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pollutant Loading and Event Mean Concentrations (EMC) Estimates</td>
<td>Calculated land use-based EMC values and annual pollutant loads at each of the regulated outfalls within Phase I watersheds for the 14 parameters listed in the permit</td>
<td>EMC estimates calculated for 12 parameters for land uses in Phase III watersheds</td>
<td>Average EMCs calculated for six land uses using Phase I and III monitoring data</td>
<td>Annual pollutant loads calculated for 12 parameters for each outfall in Phase III watersheds using average EMCs</td>
<td>Average EMCs calculated for six land uses based on monitoring data collected from Phase I areas in Year 3, Phase III areas in year 4 and any Year 5 data EMC estimates calculated for 12 water quality parameters for land uses corresponding to the 5 Year 5 monitoring stations (3 from Phase III and 2 from Phase II)</td>
<td></td>
</tr>
<tr>
<td>Water Quality Modeling: Develop/Update/Verify IDEAL and SUDS Models</td>
<td>Performed wet weather monitoring at five locations</td>
<td>Performed wet weather monitoring at 5 locations within Phase III watershed areas</td>
<td>Developed wet weather monitoring program for Phase I watershed areas and installed 3 monitoring stations</td>
<td>Continued wet monitoring in Phase III watersheds</td>
<td>Established 3 wet monitoring stations in Phase II watersheds</td>
<td></td>
</tr>
</tbody>
</table>

10. **Public Education and Outreach**

| Program Development | Reviewed current programs | Developed comprehensive plan for public education program | Enhanced current public education components | County Storm Water Advisory Board designated for major storm water policy and program decisions | Developed a pond maintenance brochure, an overall stormwater information brochure, and several interactive games for school children. |
| Storm Drain Marking Program | Developed and implemented a storm drain marking program | Storm drain marking program expanded, and a unique Greenville County storm drain marker was developed | Added printable brochure of storm drain marking program to County’s website | Created pond maintenance brochure and several interactive games for school children. | Created brochures on storm water property rights, pond maintenance, and car washing, to be uploaded to website. |
| County Web Site | Developed web site material dealing with the storm water program and public education issues. | Created the County storm water web page | Public education reporting form being added to County website to make reporting easier for co-permitees | Public Education reporting form added to County website | Public Education reporting form added to County website |
| Reporting Form | Developing a public education form to track various participating municipalities and their activities | | | | |
| Materials | Developed a pond maintenance brochure, an overall stormwater information brochure, and several interactive games for school children. | Created brochures on storm water property rights, pond maintenance, and car washing, to be uploaded to website. | | | |
| Presentations | Created a mascot: Sammy the Salamander | Created the County’s stormwater program and water quality | | | |
| Training | Employee training course provided with emphasis on public education and community involvement | | | | |
| Public Survey | A survey was developed to gauge public understanding of the County’s stormwater program and water quality | Mailed survey to a randomly selected group of County residents and generated a detailed report. | | | |
Appendix B

Greenville County Stormwater Management Program (SWMP)
Proposed Phase I NPDES Permit (2005)
GREENVILLE COUNTY STORMWATER MANAGEMENT PROGRAM (SWMP)
Proposed Phase I NPDES Permit (2005)

Greenville County submitted its NPDES Phase I Permit Renewal to SCDHEC in August 2005, constituting the County's second 5-year permit term. The renewed SWMP program activities are intended to complete and/or build upon the first permit term activities. Activities related to NPDES Phase II requirements are included in this second permit term because the City of Fountain Inn, City of Mauldin, City of Simpsonville, and City of Travelers Rest are all co-permitted under Greenville County's Phase I Permit.

1. **Structural Controls and Storm Water Collection System Operation:**
   - Review newly permitted site plans and update Inventory Database.
   - Review, summarize, and modify the existing inspection and maintenance program for detention ponds and storm water collection system.
   - Annual evaluations shall be made to assess the accomplishments of the inspection and maintenance program in maintaining the proper operation of the structural controls.
   - Describe all existing source controls that control pollutants discharged to the MS4. Determine potential sources of pollutants of concern that were identified through the watershed prioritization process and from wet weather monitoring data.

2. **Areas of New Development and Significant Redevelopment and Construction Site Runoff:**
   - Continue to identify water quality problems and areas of concern.
   - Continue to operate and maintain the Permit Tracking System.
   - Continue Designer Training courses for plan reviewers, construction inspectors and county design community emphasizing post-construction water quality BMP design.
   - Complete wet weather monitoring of water quality BMPs and analysis of the collected data for validation and verification of post-construction water quality model predictions.
   - Continue to monitor site development and plan reviews for adherence to design criteria and requirements.
   - Conduct Erosion Control Audits (every 5 years).
   - Continue to provide South Carolina Clear Water Contractor Training to emphasize the importance of the installation and maintenance of sediment controls.

3. **Existing Roadways**
   - Standard road repair practices include: limiting the amount of soil disturbance to the immediate area under repair and scheduling potential pollutant-causing routine repair work during dry seasons, when possible.
   - Seed and mulch storm water conveyances for rapid revegetation, and have effective erosion control until stabilized.
   - Continue general coordination with SCDOT and coordination with SCDOT's storm water program for transportation projects within the County as developed and implemented by SCDOT.
Perform a preliminary review of County's transportation plans to review opportunities to reduce traffic impacts related to water quality.


4. Flood Control Projects

- Perform a preliminary review of Greenville County’s two existing structural flood control devices (major lakes or ponds) for retrofit potential/feasibility to provide additional pollutant removal from storm water.
- Coordinate flood control and channel improvement projects with water quality improvement activities. Continue to use bioengineering techniques for channel stabilization projects. Employ the use of vegetation as much as possible as an alternative to harder less environmentally beneficial solutions for all open channels and perennial streams that are in need of stabilization or modification. Protect and enhance stream corridor drainage ways and adjacent open space areas, subject to county stream buffer requirements.

5. Municipal waste treatment, storage, or disposal facilities: not covered by an NPDES storm water permit - See specific activities for Industrial Runoff below.

6. Pesticide, Herbicide, and Fertilizers (PHFs) Application: The Clemson University Regulatory Program for licensed commercial PHF applicators and distributors sufficiently addresses and requires activities that meet the requirements of this section. Therefore, there are no additional activities proposed for Greenville County.

7. Illicit Discharges and Improper Disposal

- Dry weather screening was conducted throughout the entire County in all 4 phased watershed areas during the first permit term. Since the purpose of dry weather screening is to find illicit discharges, and the effort to continuously re-walk all county streams would be cost prohibitive, a different approach must be taken to continue to identify illicit discharges within Greenville County. First, the areas that are most likely to contain illicit discharges will be identified and prioritized. These will most likely be in urbanized areas. Ambient flow monitoring stations will then be set up near these areas to sample. If the samples show potential of illicit discharges then the streams upstream will be walked to look for dry weather flows. Flows will then be tested, and tracked as necessary. Watershed samples with no indication of illicit discharges will be placed at the bottom of the priority list.
- Review and summarize existing spill prevention and response programs.
- The program shall address reporting procedures, spills containment, storage and disposal activities, and documentation and follow-up procedures. Implement the spill-prevention/spill-response plan and procedures.
- Focus shall be placed on good housekeeping and materials management practices with detailed procedures that address spill prevention, material management practices, and good housekeeping measures established at all municipal equipment yards & maintenance shops. Special training requirements for municipal employees...
to respond to spills of hazardous chemicals from any facility into the storm sewer system shall be identified.

- Use GIS to map spill locations and identify chronic problem areas.
- Develop a database to record and track spills.
- Limitation of Sanitary Sewage and Septage Seepage: Since the Greenville County does not have authority over the sewer collection system, the County will continue to coordinate with Western Carolina Sewer District and sub-districts, as necessary.

8. Industrial Runoff

- Develop and complete necessary follow-up activities for the facility inspection program.
- Continue to provide annual Industrial Operators Training Course.
- Continue implementation of DMR request in Phase III and Phase IV watershed areas.
- Review DMRs received for compliance with stated exceedance limitations. Conduct inspections when monitoring data or complaints indicate a concern about a facility. Identify chronic permit violators in GIS.

9. Monitoring

- Use monitoring data to track effectiveness of storm water program.

10. Public Education

- Develop an index or indices using ambient monitoring data and biological data to indicate water quality conditions within each major watershed or basin. These indices can be used to identify water quality problem areas for additional monitoring and follow-up or to produce a “water quality condition” map of the County that can be updated quarterly and posted on the County's website to ensure that water quality data and information are readily available to the general public in an understandable format.
- Implement public education portions of the enhanced used oil recycling and household hazardous waste programs as described in Illicit Discharges.
Appendix C

Summary of Stormwater Best Management Practices (BMPs)
### Summary of Stormwater Best Management Practices (BMPs)

<table>
<thead>
<tr>
<th>Stormwater BMP</th>
<th>Design Criteria</th>
<th>Advantages/Benefits</th>
<th>Disadvantages/ Limitations</th>
<th>Maintenance Requirements</th>
<th>Stormwater Management Suitability</th>
<th>Implementation/ Application</th>
<th>Typical Pollutant Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Application Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Retention (wet) Ponds</strong></td>
<td>Minimum contributing drainage area of 25 acres; 10 acres for micropool ED pond</td>
<td></td>
<td>Moderate to high removal rate of urban pollutants</td>
<td>Potential for thermal impacts/downstream warming</td>
<td>Remove debris from inlet and outlet structures</td>
<td>Water Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>A sediment forebay or equivalent upstream pretreatment must be provided</td>
<td></td>
<td>High community acceptance</td>
<td>Dam height restrictions for high relief areas</td>
<td>Maintain side slopes / remove invasive vegetation</td>
<td>Channel Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimum length to width ratio for the pond is 1.5:1</td>
<td></td>
<td>Opportunity for wildlife habitat</td>
<td>Pond drainage can be problematic for low relief terrain</td>
<td>Monitor sediment accumulation and remove periodically</td>
<td>Overbank Flood Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Maximum depth of the permanent pool should not exceed 8 feet</td>
<td></td>
<td>Traditional. Can double as recreational facility</td>
<td>Relatively land-intensive. Safety issues</td>
<td></td>
<td>Extreme Flood Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Side slopes to the pond should not exceed 3:1 (h:v)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Accepts Hotspot Runoff: Yes (2 feet of separation distance required to water table)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stormwater Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implementation/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Bioretention Areas</strong></td>
<td>Maximum contributing drainage area of 5 acres</td>
<td>Applicable to small drainage areas</td>
<td>Not recommended for areas with steep slopes</td>
<td>Requires extensive landscaping</td>
<td>Inspect and repair/replace treatment area components</td>
<td>Water Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Often located in “landscaping islands”</td>
<td>Good for highly impervious areas, particularly parking lots</td>
<td>Very new practice with little data to prove effectiveness. Plants must be removed if soil clogs or becomes polluted</td>
<td></td>
<td></td>
<td>Channel Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Treatment area consists of grass filter, sand bed, ponding area, organic/mulch layer, planting soil, and vegetation</td>
<td>Good retrofit capability</td>
<td>Very new practice with little data to prove effectiveness. Plants must be removed if soil clogs or becomes polluted</td>
<td></td>
<td></td>
<td>Accepts Hotspot Runoff: Yes (requires impermeable liner)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Typically requires 5 feet of head</td>
<td>Relatively low maintenance costs</td>
<td>Can be planned as an aesthetic feature</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Highest pollutant removal option. Good educational site</td>
<td>Aesthetically pleasing. Can double to meet landscape and water quality objectives</td>
<td></td>
<td></td>
<td>In certain situations</td>
<td></td>
</tr>
<tr>
<td><strong>Stormwater Wetlands</strong></td>
<td>Minimum contributing drainage area of 25 acres; 5 acres for pocket wetland</td>
<td></td>
<td>Good nutrient removal</td>
<td>Requires large land area</td>
<td>Replace wetland vegetation to maintain at least 50% surface area coverage</td>
<td>Water Quality</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimum dry weather flow path of 2:1 (length: width) should be provided from inflow to outflow</td>
<td></td>
<td>Provides natural wildlife habitat</td>
<td>Needs continuous basflow for viable wetland</td>
<td>Remove invasive vegetation</td>
<td>Channel Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Minimum of 35% of total surface area should have a depth of 6 inches or less, 10 to 20% of surface area should be deep pool (1.5- to 6-foot depth)</td>
<td></td>
<td>Relatively low maintenance costs</td>
<td>Sediment regulation is critical to sustain wetlands</td>
<td>Monitor sediment accumulation and remove periodically</td>
<td>Overbank Flood Protection</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stormwater Management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Implementation/</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Suitability</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Residential Subdivision Use: Yes High Density/Ultra-Urban: No Drainage Area: 10-25 acres min. Soils: Hydrologic group “A” and “B” soils may require pond liner</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden: 70%</td>
<td>Total Suspended Solids</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>80%/1</td>
<td>70%/1</td>
<td>Total Suspended Solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>80%2</td>
<td>70%2</td>
<td>80±27%/2</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>50%/1</td>
<td>51±21%/1</td>
<td>Total Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>30%/1</td>
<td>33%/1</td>
<td>Total Nitrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>20%/2</td>
<td>20%/2</td>
<td></td>
<td>Nitrate - Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>50%/1</td>
<td>28-75%/1</td>
<td>Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>70%/1</td>
<td>70±32%/1</td>
<td>Bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>80%/1</td>
<td>80%/1</td>
<td>Total Suspended Solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>71±3%/3</td>
<td>71±3%/3</td>
<td></td>
<td>Total Phytoplankton</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>46%±3%/3</td>
<td>46%±3%/3</td>
<td></td>
<td>Total Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>30%/1</td>
<td>30%/1</td>
<td>Total Nitrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>40±5%/3</td>
<td>40±5%/3</td>
<td></td>
<td>Nitrate - Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>50%2</td>
<td>0-57%3</td>
<td>Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>70%/1</td>
<td>70%/1</td>
<td>Bacteria</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>80%/1</td>
<td>80%/1</td>
<td>Total Suspended Solids</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>81%2</td>
<td>81%2</td>
<td></td>
<td>Total Phytoplankton</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>60%/1</td>
<td>29%/1</td>
<td>Total Phosphorus</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Land Requirement</td>
<td>50%/1</td>
<td>49%/1</td>
<td>Total Nitrogen</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Capital Cost</td>
<td>38%/2</td>
<td>38%/2</td>
<td></td>
<td>Nitrate – Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Maintenance Burden</td>
<td>51-71%3</td>
<td>51-71%3</td>
<td>Metals</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Considerations: Use of native plants is recommended</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>M</td>
<td>L</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* L = Low  M = Moderate  H = High  NA = Not Applicable  ND = No Data (or Insufficient Data)

* Sources:
3. Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwatercenter.net)
<table>
<thead>
<tr>
<th>Stormwater BMP</th>
<th>Design Criteria</th>
<th>Advantages/Benefits</th>
<th>Disadvantages/ Limitations</th>
<th>Maintenance Requirements</th>
<th>Stormwater Management Suitability</th>
<th>Implementation/ Application</th>
<th>Pollutant Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>General Application Controls (cont.)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Sand Filters</strong></td>
<td>• Typically requires 2 to 6 feet of head</td>
<td>• Applicable to small drainage areas</td>
<td>• High maintenance burden</td>
<td>• Inspect for clogging – rake first inch of sand</td>
<td>• Water Quality</td>
<td>L</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td>• Maximum contributing drainage area of 10 acres for surface sand filter, 2 acres for perimeter sand filter</td>
<td>• Good for highly impervious areas</td>
<td>• Not recommended for areas with high sediment content in stormwater or clay/silt runoff areas</td>
<td>• Channel Protection*</td>
<td>H</td>
<td>Total Phosphorus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Sand filter media with underdrain system1</td>
<td>• Good retrofit capability1</td>
<td>• Can fit in high land-cost situations</td>
<td>• High sediment content in</td>
<td>H</td>
<td>Total Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Removes pollutants found in parking areas1</td>
<td>• Relatively costly</td>
<td>stormwater or clay/silt runoff areas</td>
<td></td>
<td>-144%4</td>
<td>Nitrates - Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Replace sand filter media as needed2</td>
<td>• Possible odor problems1</td>
<td></td>
<td></td>
<td>-40%1</td>
<td>Metals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Most expensive per square foot of device</td>
<td></td>
<td></td>
<td>-40%1</td>
<td>Bacteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Maintenance can be cumbersome2</td>
<td></td>
<td></td>
<td>40%1</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td><strong>Infiltration Trench</strong></td>
<td>• Soil infiltration rate of 0.5 in/hr or greater required</td>
<td>• Provides for groundwater recharge</td>
<td>• Potential for groundwater contamination</td>
<td>• Inspect for clogging</td>
<td>M</td>
<td>Total Suspended Solids</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Excavated trench (3 to 8 foot depth) filled with stone media (1.5- to 2.5-inch diameter); pea gravel and sand filter layers</td>
<td>• Good for small sites with porous soils3</td>
<td>• High clogging potential; should not be used on sites with fine-particulate soils (clays or silts) in drainage area</td>
<td>• Remove sediment from forebay</td>
<td>H</td>
<td>Total Phosphorus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• A sediment forebay and grass channel, or equivalent upstream pretreatment must be provided</td>
<td>• Relatively low design and construction cost</td>
<td>• Significant setback requirements</td>
<td>• Replace pea gravel layer as needed3</td>
<td>H</td>
<td>Total Nitrogen</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Observation well to monitor percolation1</td>
<td>• Introduces surface water to ground water3</td>
<td>• Restrictions in karst areas</td>
<td></td>
<td></td>
<td>-1%1</td>
<td>Nitrates - Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Geotechnical testing required, two borings per facility2</td>
<td></td>
<td></td>
<td>-9%1</td>
<td>Metals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Limited application (sandy soils). High potential for clogging2</td>
<td></td>
<td></td>
<td>-9%1</td>
<td>Bacteria</td>
</tr>
<tr>
<td><strong>Enhanced Swales</strong></td>
<td>• Longitudinal slopes must be less than 8%</td>
<td>• Combines stormwater treatment with runoff conveyance system</td>
<td>• Higher maintenance than curb and gutter systems</td>
<td>• Maintain grass heights of approximately 4 to 6 inches (dry swale)</td>
<td>• Water Quality</td>
<td>H</td>
<td>Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td>• Bottom width of 2 to 8 feet</td>
<td>• Less expensive than curb and gutter</td>
<td>• Cannot be used on steep slopes</td>
<td>• Channel Protection*</td>
<td>M</td>
<td>Total Phosphorus</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Side slopes 2:1 or flatter; 4:1 recommended</td>
<td>• Reduces runoff velocity1</td>
<td>• Possible re-suspension of sediment</td>
<td></td>
<td></td>
<td>-50%1</td>
<td>Total Nitrogen</td>
</tr>
<tr>
<td></td>
<td>• Convey the 25-year storm event with a minimum of 6 inches of freeboard2</td>
<td>• Can carry higher flow than traditional grassy swales</td>
<td>• Potential for odor / mosquitoes (wet swale)1</td>
<td></td>
<td></td>
<td>-40%1</td>
<td>Nitrates - Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• More aesthetic and cheaper to construct than rip rap alternative2</td>
<td>• Construction and maintenance costs higher than for traditional grassy swales</td>
<td></td>
<td></td>
<td>ND</td>
<td>Bacteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Relatively new device with limited long-term testing2</td>
<td></td>
<td></td>
<td>ND</td>
<td>Total Suspended Solids</td>
</tr>
</tbody>
</table>

**Notes:**
- L = Low  M = Moderate  H = High  NA = Not Applicable  ND = No Data (or Insufficient Data)
- Sources:
  3. Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwatercenter.net)

3. Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwatercenter.net)
<table>
<thead>
<tr>
<th>Stormwater BMP</th>
<th>Design Criteria</th>
<th>Advantages/Benefits</th>
<th>Disadvantages/ Limitations</th>
<th>Maintenance Requirements</th>
<th>Stormwater Management Suitability</th>
<th>Implementation/ Application</th>
<th>Pollutant Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Limited Application Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Filter Strip</strong></td>
<td>• Runoff from an adjacent impervious area must be evenly distributed across the filter strip as sheet flow&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Can be used as part of the runoff conveyance system to provide pre-treatment</td>
<td>• Cannot achieve the 80% TSS removal target&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Requires periodic repair, regrading, and sediment removal to prevent channelization&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Water Quality&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment</td>
<td>~50%&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can provide groundwater recharge</td>
<td>• Large land requirement&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td>Total Phosphorus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Reasonably low construction cost&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Total Nitrogen</td>
</tr>
<tr>
<td><strong>Grass Channel</strong></td>
<td>• Grass channels can act to partially infiltrate runoff from small storm events if underlying soils are pervious</td>
<td>• Should not be used on slopes greater than 4%, slopes between 1% and 2% recommended&lt;sup&gt;2&lt;/sup&gt;</td>
<td>• Ineffective unless carefully designed to achieve low flow rates in the channel (e&lt;sup&gt;-1&lt;/sup&gt;.8 ft/s)&lt;sup&gt;3&lt;/sup&gt;</td>
<td></td>
<td><strong>Accepts Hotspot Runoff:</strong> Yes, in certain situations&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment</td>
<td>~50%&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Can be used as part of the runoff conveyance system to provide pre-treatment</td>
<td>• Cannot achieve the 80% TSS removal target&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td>Total Phosphorus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Less expensive than curb and gutter systems</td>
<td>• Potential for bottom erosion and resuspension</td>
<td></td>
<td></td>
<td></td>
<td>Total Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Standing water may not be acceptable in some areas&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Remove trash and debris</td>
<td></td>
<td></td>
<td></td>
<td>Nitrate – Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Inspect and correct erosion problems</td>
<td></td>
<td></td>
<td></td>
<td>Metals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Plant alternative grass species if original grass cover not successfully established</td>
<td></td>
<td></td>
<td></td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Rototill or cultivate surface of the sand/soil bed of dry swales if swale does not draw down w/in 48 hours</td>
<td></td>
<td></td>
<td></td>
<td>Bacteria</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Remove sediment build-up within bottom of swale once it has accumulated to 25% of the original design volume&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Organic Filter</strong></td>
<td>• Intended for hotspot or space-limited applications, or for areas requiring enhanced pollutant removal capability&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Removal of dissolved pollutants is greater than sand filters due to cation exchange capacity&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• High maintenance requirements up to 8 feet</td>
<td>• Ensure contributing area, filtering practice, inlets and outlets are clear of debris and not clogging</td>
<td>• Water Quality&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment</td>
<td>~50%&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Minimum head requirement of 5 to 8 feet</td>
<td>• Ensure contributing area is stabilized and mowed, with clippings removed</td>
<td></td>
<td><strong>Accepts Hotspot Runoff:</strong> No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Other: Curb and gutter replacement</td>
<td>~25%&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Severe clogging potential if exposed soil surfaces exist upstream&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Check that filter bed is clean of sediments, and sediment chamber is not more than 1/2 full of sediment; clean as necessary</td>
<td></td>
<td></td>
<td>• Residential Subdivision Use: Yes&lt;sup&gt;1&lt;/sup&gt;</td>
<td>~20%&lt;sup&gt;1&lt;/sup&gt; Total Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Repair/replace any damaged structural parts</td>
<td></td>
<td></td>
<td></td>
<td>Nitrate – Nitrogen</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Stabilize any eroded areas</td>
<td></td>
<td></td>
<td></td>
<td>Metals</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensure flow isn’t bypassing facility</td>
<td></td>
<td></td>
<td></td>
<td>ND</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Ensure that no noticeable odors are detected outside the facility&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td>Bacteria</td>
</tr>
<tr>
<td><strong>Underground Sand Filter</strong></td>
<td>• Intended for space-limited applications&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• High pollutant removal capability</td>
<td>• High maintenance requirements</td>
<td>• Monitor water level in sand filter chamber and clean out when sediment depth reaches 12 inches</td>
<td>• Water Quality&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment</td>
<td>~80%&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• High removal rates for sediment, BOD, and fecal coliform bacteria</td>
<td>• High maintenance requirements&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Remove accumulated oil and floatables in sediment chamber</td>
<td><strong>Accepts Hotspot Runoff:</strong> Yes, in certain situations&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Other: Hotspot areas</td>
<td>~50%&lt;sup&gt;1&lt;/sup&gt; Total Phosphorus</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Precast concrete shells available, which decrease construction costs&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Additional inspection and maintenance requirements for organic filters are similar to those for surface sand filter facilities&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td>• Residential Subdivision Use: No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>~25%&lt;sup&gt;1&lt;/sup&gt; Total Nitrogen</td>
</tr>
</tbody>
</table>

L = Low  M = Moderate  H = High  NA = Not Applicable  ND = No Data (or Insufficient Data)

* Sources:
  1 Georgia Stormwater Management Manual (http://www.georgiastormwater.com)
  3 Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwatercenter.net)
<table>
<thead>
<tr>
<th>Stormwater BMP</th>
<th>Design Criteria</th>
<th>Advantages/Benefits</th>
<th>Disadvantages/Limitations</th>
<th>Maintenance Requirements</th>
<th>Stormwater Management Suitability</th>
<th>Implementation/Application</th>
<th>Pollutant Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Submerged Gravel Wetlands</strong></td>
<td>✷ Intended for space-limited applications&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Generally requires low land consumption, and can fit within an area that is typically devoted to landscaping&lt;br&gt;• High pollutant removal capabilities are expected; however, limited performance data exist&lt;br&gt;• Can be located in low-permeability soils with a high water table&lt;sup&gt;2&lt;/sup&gt;</td>
<td>• High maintenance requirements&lt;sup&gt;2&lt;/sup&gt;• Periodic sediment removal required to prevent sludging of gravel base&lt;br&gt;• Periodic inspection required to ensure survival of plantings&lt;br&gt;• Replacement of dead plant material</td>
<td>• Water Quality&lt;br&gt;Accepts Hotspot Runoff: Yes, in certain situations&lt;sup&gt;2&lt;/sup&gt;</td>
<td>• High Density/Ultra-Urban&lt;br&gt;Other: Hotspot areas&lt;br&gt;Residential Subdivision Use: No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• High Density/Ultra-Urban&lt;br&gt;Other: Hotspot areas&lt;br&gt;Residential Subdivision Use: No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>83%&lt;sup&gt;3&lt;/sup&gt; Total Suspended Solids&lt;br&gt;64%&lt;sup&gt;3&lt;/sup&gt; Total Phosphorus&lt;br&gt;19%&lt;sup&gt;3&lt;/sup&gt; Total Nitrogen&lt;br&gt;81%&lt;sup&gt;3&lt;/sup&gt; Nitrate – Nitrogen&lt;br&gt;21-83%&lt;sup&gt;3&lt;/sup&gt; Metals&lt;br&gt;78%&lt;sup&gt;3&lt;/sup&gt; Bacteria</td>
</tr>
<tr>
<td><strong>Gravity (Oil-Grit) Separator</strong></td>
<td>✷ Intended for hotspot, space-limited or pretreatment applications&lt;br&gt;✷ Intended for the removal of settleable solids (grit and sediment) and floatable matter, including oil and grease&lt;sup&gt;2&lt;/sup&gt;</td>
<td>• Cannot alone achieve the 80% TSS removal target&lt;br&gt;• Limited performance data&lt;br&gt;• Dissolved pollutants are not effectively removed&lt;br&gt;• Frequent maintenance required&lt;br&gt;• Performance dependent on design and frequency of inspection and cleanout of unit&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Inspect the gravity separator unit&lt;br&gt;• Clean out sediment, oil and grease, and floatables, using catch basin cleaning equipment (vacuum pumps); manual removal of pollutants may be necessary&lt;br&gt;• Additional maintenance requirements for a proprietary system should be obtained from the manufacturer&lt;br&gt;• Failure to provide adequate inspection and maintenance can result in the resuspension of accumulated solids&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Water Quality&lt;br&gt;Accepts Hotspot Runoff: Yes, in certain situations&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment&lt;br&gt;High Density/Ultra-Urban&lt;br&gt;Other: Hotspot areas&lt;br&gt;Residential Subdivision Use: No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Pretreatment&lt;br&gt;High Density/Ultra-Urban&lt;br&gt;Other: Hotspot areas&lt;br&gt;Residential Subdivision Use: No&lt;sup&gt;1&lt;/sup&gt;</td>
<td>-40%&lt;sup&gt;4&lt;/sup&gt; Total Suspended Solids&lt;br&gt;-5%&lt;sup&gt;4&lt;/sup&gt; Total Phosphorus&lt;br&gt;-5%&lt;sup&gt;4&lt;/sup&gt; Total Nitrogen&lt;br&gt;ND Nitrate – Nitrogen&lt;br&gt;ND Metals&lt;br&gt;ND Bacteria</td>
</tr>
<tr>
<td><strong>Modular Porous Paver Systems</strong></td>
<td>✷ Intended for low traffic areas, or for residential or overflow parking applications&lt;br&gt;✷ Soil infiltration rate of 0.5 in/hr or greater required&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• High level of pollutant removal&lt;br&gt;• Provides reduction in runoff volume&lt;br&gt;• Available from commercial vendors&lt;sup&gt;3&lt;/sup&gt;</td>
<td>• High maintenance requirements&lt;br&gt;• High cost compared to conventional pavements&lt;br&gt;• Potential for high failure rate if not adequately maintained or used in unstabilized areas&lt;br&gt;• Potential for groundwater contamination&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Monthly inspections to check for sediment accumulation and that the system dewater between storms&lt;br&gt;• Ensure contributing area and paver surface are clear of debris and that adjacent areas are stabilized and mowed with clippings removed&lt;br&gt;• Vacuum sweep porous paver surface 3-4 times per year&lt;br&gt;• Rehabilitate porous paver system including the top and base course as needed and upon failure</td>
<td>• Water Quality&lt;br&gt;Channel/Flood Protection&lt;br&gt;Accepts Hotspot Runoff: Yes, in certain situations&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• High Density/Ultra-Urban&lt;br&gt;Other: Overflow Parking, Driveways &amp; related uses&lt;br&gt;Residential Subdivision Use: Yes&lt;sup&gt;1&lt;/sup&gt;</td>
<td>NA&lt;sup&gt;1&lt;/sup&gt; Total Suspended Solids&lt;br&gt;-80%&lt;sup&gt;4&lt;/sup&gt; Total Phosphorus&lt;br&gt;-80%&lt;sup&gt;4&lt;/sup&gt; Total Nitrogen&lt;br&gt;ND Nitrate – Nitrogen&lt;br&gt;-98%&lt;sup&gt;4&lt;/sup&gt; Metals&lt;br&gt;ND Bacteria</td>
</tr>
</tbody>
</table>

---

<sup>1</sup> Georgia Stormwater Management Manual (http://www.georgiastormwater.com)
<sup>2</sup> Urban Watersways: Urban Stormwater Structural Best Management Practices (BMPs), NC State University and A&T State University Cooperative Extension (http://www.ces.ncsu.edu/Publications/community.php)
<sup>3</sup> Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwaterrcenter.net)

**L = Low  M = Moderate  H = High  NA = Not Applicable  ND = No Data (or Insufficient Data) **

**Sources:**
3. Center for Watershed Protection’s Stormwater Manager’s Resource Center (http://www.stormwaterrcenter.net)
<table>
<thead>
<tr>
<th>Stormwater BMP</th>
<th>Design Criteria</th>
<th>Advantages/Benefits</th>
<th>Disadvantages/ Limitations</th>
<th>Maintenance Requirements</th>
<th>Stormwater Management Suitability</th>
<th>Implementation/ Application</th>
<th>Pollutant Removals</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Detention Controls</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dry Detention / Dry ED Basins</td>
<td>• Applicable for drainage areas up to 75 acres &lt;br&gt;• Used in conjunction with water quality structural control.</td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Remove debris from basin surface to minimize outlet clogging and improve aesthetics &lt;br&gt;• Remove sediment buildup &lt;br&gt;• Repair and revegetate eroded areas &lt;br&gt;• Perform structural repairs to inlet and outlets &lt;br&gt;• Mow to limit unwanted vegetation&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td>• Residential Subdivision Use: Yes&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Underground Detention</td>
<td>• Used in conjunction with water quality structural control &lt;br&gt;• Concrete vaults or pipe/tank systems can be used&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment &lt;br&gt;Intended for space-limited applications&lt;sup&gt;1&lt;/sup&gt;</td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment &lt;br&gt;Intended for space-limited applications&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Controls for stormwater quantity only – not intended to provide water quality treatment</td>
<td>• Channel/Flood Protection&lt;sup&gt;1&lt;/sup&gt; Accepts Hotspot Runoff: Used in conjunction with water quality treatment&lt;sup&gt;1&lt;/sup&gt;</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>