
Section 1: Introduction

1.1 Background

The current North Carolina Division of Water Quality's Stormwater Practices Manual (BMP Manual) was published on July 2, 2007 and revised on September 28, 2007. The City of Greensboro's requirements will follow the State's requirements and guidelines, but will also contain additional requirements to those listed in the State's Stormwater BMP Manual. The City of Greensboro's Stormwater Management Manual will serve as a supplement to the State's Stormwater BMP Manual and will additionally include the following requirements: stormwater quantity control, flood damage prevention, utilizing conveyance systems and minimizing erosive conditions (i.e. streams). In cases where City of Greensboro's requirements are more stringent than those of the State, they are provided in this Manual. In those cases, the City's requirements shall be applicable and replace those given in the State's Stormwater BMP Manual. Also, information or requirements unique or specific to City of Greensboro area is covered in this Manual. The State Stormwater BMP Manual primarily covers the water quality of stormwater runoff.

This manual also includes the requirements of the City of Greensboro's NPDES Phase II permit which was effective on June 1, 2009. The City of Greensboro is currently a NPDES Phase 1 Community but is required to adopt the minimum stormwater requirements for the NPDES Phase 2 regulations as part of the City's Comprehensive Stormwater Management Program.

This Stormwater Management Manual is to be used in conjunction with the State's Stormwater BMP Manual. It is intended to provide engineers, developers, property owners and managers, and interested citizens with information on stormwater management requirements, technical guidance on the methodology that can be used to meet the requirements, and guidelines for designing, implementing, and maintaining the Best Management Practices (BMPs) that may be used in the City of Greensboro to improve the quality of surface waters, and minimize the stormwater runoff volume and discharge rates from developed areas. This manual will describe the minimum design requirements and accepted methodology for meeting City ordinance requirements. The City reserves the right to limit the applicability of the State Stormwater BMP Manual on a site specific basis (water quality devices can not be dedicated to the City of Greensboro).

Each section of this Manual has a date on the header of each page so that users of this Manual can be sure which updated version they are using. This supplemental manual to the State Stormwater BMP Manual along with the City's current Storm Drainage Design Manual represent current drainage policy for the City.

Stormwater Utility Credit Policy

A stormwater utility fee is assessed on all properties within city limits. Stormwater Utility credit is available for Commercial Developments only. Residential Developments are not eligible for this credit. Stormwater Management measures that exceed the minimum requirements may also be eligible for credit under this policy. This manual provides guidelines for BMP's to be considered to receive credit. Refer to the City's *Stormwater Utility Credit Policy* (available on the City's

website) for more information regarding credit opportunities, including the actual credit that can be awarded for implementation of BMP's.

1.2.1 Non-Structural BMPs

Non-structural BMPs generally are techniques incorporated in site planning/design to promote low-impact development. These BMPs may be used to reduce the volume of runoff generated, reduce runoff discharge and provide partial pollutant removal. These practices are relatively inexpensive to implement, with the major cost usually being land area. But, with thoughtful site design, these practices can improve the stormwater management and aesthetic value of the development.

Non-structural stormwater BMPs can be implemented to help meet requirements for "low density" development in water-supply watershed areas and to reduce the amount of impervious area that is required to be treated for "high density" development. These BMPs can be incorporated in the site design to reduce stormwater runoff quantity and prevent adverse effects on the downstream property and receiving streams.

1.2.1.1 Public Education

1.2.1.1.1 Employee Education of commercial and industrial establishments.

Description

Employee education programs are designed to educate employees on the proper operational practices to minimize the potential for on-site pollutants to contact stormwater runoff. Through education, employees become more aware of potential stormwater pollutants, runoff characteristics, spill control measures, and methods to minimize off-site migration of polluted stormwater runoff from commercial and industrial properties. As a result, it is one of the easiest to implement and most beneficial pollution prevention BMPs available. In addition, a proper employee education program outlines methods by which employees can also reduce potential for stormwater pollution at their individual residences.

Applicability

Commercial, industrial or related facility that stores materials outside or is involved with receiving or shipping materials can benefit from employee education programs regarding on-site stormwater management practices.

Employee education programs are required by Federal law under *40 CFR Part 112 - Oil Pollution Prevention Regulations* and *40 CFR Part 122, 123, and 124 - National Pollutant Discharge Elimination System Regulations for Storm Water Dischargers*. As a result, all facilities conforming to these regulations should already be performing employee education.

To be eligible for stormwater utility credit for implementation of this BMP, organizations must meet the minimum criteria outlined in the table below. For more information regarding credit opportunities, refer to the City's *Stormwater Utility Credit Policy* document.

Summary of Employee Education Requirements			
ACTIVITY	DESCRIPTION	FREQUENCY	DOCUMENTATION
Employee Briefings	Education sessions for all employees regarding proper water quality and environmental protection activities.	30 min./ quarter	Submit programs with agenda to SW for approval prior to briefings.
Employee Surveys	Conduct written surveys of each employee per EPA regulations	Once annually	Submit summary of survey responses in Annual Report.
Post/Distribute Information	Post and/or distribute periodic stormwater information provided by Stormwater Management Division	As received	Verify posting of Annual Report.

1.2.1.1.2 City of Greensboro Public Education Outreach

The City of Greensboro is committed to educate citizens on environmental awareness issues. The Stormwater Management Division, as part of its municipal NPDES permit, has developed educational programs to inform citizens on ways they can help protect the quality of Greensboro's streams and lakes. The City has produced several television and radio ads campaigning surface water quality protection. The City has also produced informational videos, brochures, etc., on various environmental topics for a wide range of audiences, including industries, businesses, schools and interested citizens.

The City also has helped form several volunteer groups to assist in educating citizens on water quality issues and to encourage citizens to get involved in cleaning up the City's surface waters. These groups include:

Environmental Business Partners

This program is setup to create a partnership with the City government and local businesses in order to provide the community with environmental/stormwater information.

“Green Heroes” (Includes Adopt-A-Stream, Adopt-A-Street, and Adopt-A-Park)

This program consists of volunteer groups that periodically remove litter along the stream section that they have adopted.

“Drain Markers” Program

This program involves placing the drain markers on storm water inlets that read “Don’t Dump – Drains to Lakes and Creeks”

The City has also set up an “Environmental Helpline” (373-2812) to take calls on pollution problems from spills to excessive erosion problems from construction sites and to answer questions.

If you have an interest in obtaining any informational material, participating in the volunteer groups or have any other questions regarding environmental issues, please contact the Helpline.

1.2.1.1.3 On-Site Refuse Management

On-site refuse management programs include specific operating practices designed to minimize the potential for on-site litter and debris. The goal for these types of programs is to limit the amount of floatables and debris collecting in stormwater runoff and discharging off-site. In addition, on-site refuse management programs entail good housekeeping practices and help maintain a clean facility appearance.

Commercial and industrial facilities can benefit from an active on-site refuse management program. Many facilities already employ such a program either formally or informally as part of good housekeeping efforts to maintain a clean, aesthetically pleasing business environment.

Litter reduction and recycling activities are essential to improving solid waste management. Nearly 60% of North Carolina’s municipal solid waste comes from local commercial and industrial businesses.

To be eligible for stormwater utility credit for implementation of this BMP, organizations must develop and implement an on-site refuse management plan which focuses on litter reduction, recycling, and proper disposal and storage. Organizations wishing to receive credit for on-site refuse management must prepare and submit an on-site refuse management plan. The plan should include the following items at a minimum:

1. A litter reduction program encouraging staff to properly dispose of waste materials. This program should outline the appropriate disposal options for all waste, including hazardous, non-hazardous and general solid waste material.
2. A comprehensive on-site waste material recycling program. This program should include all materials that could be reused or reclaimed either on-site or through the use of contractors or vendors. This may include paper wastes, waste treatment solids, and other materials.
3. Maintain area of refuse container covers designed to eliminate exposure to the environment (i.e. wind, rain, snow, etc.).

For more information regarding credit opportunities, refer to the City's *Stormwater Utility Credit Policy* document.

City of Greensboro Solid Waste Management

The City's Field Operations Department offers weekly waste collection and recycling services to its business customers. Business owners are responsible for providing city-approved trash and recycling dumpsters. Residential recycling services are offered every other week.

Businesses may recycle the following materials in the Team Recycle dumpster program:

Office and computer paper	Newspapers	Steel cans (no lids)
Plastic soda bottles	Magazines	Empty aerosol cans
#1 or #2 Plastic jugs	Aluminum cans	Chipboard
Cardboard (unwaxed & uncoated)		Rigid Plastic

The City does **NOT** allow the following to be disposed at the City landfill:

Aluminum cans	Yard waste	Scrap whole tires
Lead batteries	Large appliances	Oil filters
Anti-freeze	Plastic Bottles	Wood pallets
Beverage containers (from ABC permit holders)		

If you have any questions concerning the City's refuse and recycling program, or would like help setting up a recycling program for you business please contact the City of Greensboro Field Operations Department at 335-5444.

1.2.1.1.4 Stormwater System Maintenance

On-site stormwater system maintenance entails property owners or management companies regularly maintaining the stormwater system on their property. Often, it is very effective for individual facilities to periodically clean out on-site stormwater structures to assist in the City's effort in maintaining the stormwater system. By regularly maintaining on-site storm sewer systems and open channel conveyances, a facility may reduce the amount of sediment and other pollutants that can potentially migrate into the City's storm sewer system and downstream receiving waters. This helps the City meet the pollutant reduction goals associated with its Federal National Pollutant Discharge Elimination System (NPDES) Stormwater Permit. Also, periodic cleanings of the stormwater infrastructure can prevent water back ups in the system and potential damage from flooding due to a clogged system.

Owners of sites that have stormwater conveyance systems (pipe system, open channel, and water bodies) on their property that drain the site runoff are responsible for maintaining the conveyances. Storm sewer conveyances that cross through private property but receive public runoff will be maintained by the City of Greensboro. Inlet structures on public lines that collect runoff from private property are maintained as part of the public system.

To be eligible for stormwater utility credit for implementation of this BMP, organizations must prepare and submit an on-site stormwater system maintenance plan. This plan must meet the following minimum criteria:

1. Catch basins (e.g. curb inlets, grate inlets, etc.) and outfalls must be cleaned a minimum of 2 times per year.
2. Curb and gutter systems must be cleaned a minimum of 4 times per year.
3. Other implemented structural BMPs must be routinely maintained and inspected on an annual basis (minimum).

For more information regarding credit opportunities, refer to the City's Stormwater Utility Credit Policy document.

1.2.1.1.5 Paved Area Sweeping

The City of Greensboro Street Cleaning Division is responsible for periodically cleaning major and secondary public roads and public parking lots. The City uses a street sweeper that is equipped with a vacuum to pick up loose debris once it is swept to the curb. This prevents the debris from entering the storm sewer system.

A paved area sweeping program can significantly reduce sediment and other potential pollutants from migrating into the City's waterways. Paved areas are a source of various pollutants (especially hydrocarbons and heavy metals emitted by vehicles). Small pollutants attach to sediment and when it rains, the sediment, along with the attached pollutants, flow with the stormwater runoff to the nearest waterway. By employing a regular paved area sweeping program, a facility can dramatically reduce the amount of sediment entering the stormwater runoff. This not only helps the City maintain clean waterways but also improves general housekeeping efforts at individual facilities.

Essentially, every commercial and industrial facility that has paved areas can employ a sweeping program. Commercial and industrial facilities with large parking lots often receive the most benefit from paved area sweeping. In addition, it is often more cost effective to sweep large paved areas as compared to small paved areas. Many industries may already be employing routine paved area sweeping to comply with their NPDES Stormwater Permit.

To be eligible for stormwater utility credit for implementation of this BMP, organizations must develop, submit, and document implementation of a detailed paved area sweeping management plan. The plan should include at a minimum: sweeping frequency, name of sweeping contractor, sediment and debris disposal method, and areas regularly swept. For more information regarding credit opportunities, refer to the City's Stormwater Utility Credit Policy document.

1.2.1.1.6 Used Oil Recycling

Petroleum-based products are one of the major pollutants found in many urban surface waters. One of the major contributors is improperly managed used oil. Therefore, a used oil recycling program employed at facilities that utilize oil in their operations can be extremely beneficial with

respect to improving stormwater runoff quality. Many facilities that utilize oil should already have a used oil recycling practice in place as it has become relatively convenient and cost effective.

Commercial and industrial facilities that use oil in its operations can employ a used oil recycling program. There are many commercial vendors that collect used oil and haul it to a commercial recycling facility. This significantly reduces the amount of effort required by facilities to employ used oil recycling. Furthermore, by using a reputable used oil recycling company, a facility can reduce its potential liability regarding used oil contamination.

To be eligible for stormwater utility credit for implementation of this BMP, organizations must meet the following minimum criteria:

1. Offer and maintain on-site, used oil recycling collection area.
2. Utilize a registered commercial oil recycling company to collect, haul, and recycle the used oil, as necessary.
3. Provide upon request, to Stormwater Division, copies of all manifests for used oil collection performed each year.
4. Display City of Greensboro Used Motor Oil Recycling informational material in clearly visible and frequented on-site locations.

For more information regarding credit opportunities, refer to the City's *Stormwater Utility Credit Policy* document.

City of Greensboro Household Hazardous Collection Center

The U.S. EPA estimates that 50% of Americans change their own oil and only 35% of that oil makes its way into the recycling stream. This equates to some 200 million gallons of used oil being disposed of improperly (dumped on the ground, disposed in landfills, and poured down storm sewers and drains) in the U.S. every year. In North Carolina, over 20,000,000 gallons of oil are sold annually for light trucks and automobiles.

The City of Greensboro, Guilford County, and ECOFLO, Inc. provide a service to collect household hazardous waste (including used oil) from all households in Guilford County (no commercial or business waste is accepted). The Household Hazardous Waste Collection Center is located at 2750 Patterson Street, Greensboro.

The HHW program provides residents with a safe, economical, and environmentally sound disposal option for hazardous materials. The program also:

1. Decreases injury to solid waste workers
2. Diminishes the possibility of groundwater contamination
3. Assists in meeting state waste reduction goals.

1.2.1.1.7 Material Exposure Controls to avoid or limit exposure of materials to precipitation

Covering includes protecting certain areas of a facility from contact with precipitation. Covering dramatically reduces the contact of precipitation on potential stormwater pollutant sources, thereby reducing the pollutant levels in stormwater runoff from a particular property. Covering can include a building, canopy, or other structure that directs rainfall away from areas of concern. Areas at a facility that are commonly covered in some form are stockpile areas, hazardous material storage areas, maintenance areas (i.e. motor vehicle), and loading/unloading areas.

Covering is a common practice employed by many commercial and industrial facilities. The City recognizes that constructing coverings for large outdoor storage areas may not be cost effective for some facilities and therefore other BMPs may be utilized.

To be eligible for stormwater utility credit for implementation of this BMP, covering must be employed at all hazardous and petroleum-based material storage areas and any area that entails maintenance activities. Organizations must meet the following minimum criteria:

1. All hazardous and petroleum-based materials must be covered and protected from stormwater contact.
2. A Spill Prevention, Control, and Countermeasures (SPCC) plan must be developed and submitted to Stormwater Division for all hazardous and petroleum-based materials stored on-site (unless an exempt material or facility).
3. All maintenance activities must be performed under covered areas.
4. A site sketch with the covered areas must be submitted to the Stormwater Division with the credit application before final approval of a covered area can be granted.

1.2.1.1.8 Spill Prevention and Cleanup

Spill containment BMPs are provisions incorporated to prevent spilled materials which are potentially hazardous from migrating outside storage areas. The containment may be a dike or pit (for example, a concrete or steel berm) constructed around individual storage containers or a storage area. The dike or pit may have drain pipes with isolation valves to allow “clean” stormwater to discharge from the containment area; however, the valve is kept shut under normal conditions in cases of a leak or spill. It is preferred, if possible, to cover large volume storage areas to prevent rainfall from entering the containment area.

If the area to be contained is a large area with a storm drainage network, it may be appropriate to construct a basin at the storm sewer outfall. The basin can be designed to trap floating materials through the use of a retaining baffle, as shown in the following figure.

If a facility uses hazardous or petroleum-based materials (i.e. chemicals, wastes, oils, etc.) and stores them outside, they should employ spill containment around their storage areas. In many cases, however, if facilities do store hazardous materials outside, Federal law (40 CFR Part 112 - Oil Pollution Prevention Regulations and 40 CFR Part 264 - Hazardous Waste Regulations) require such facilities to have spill containment for these areas.

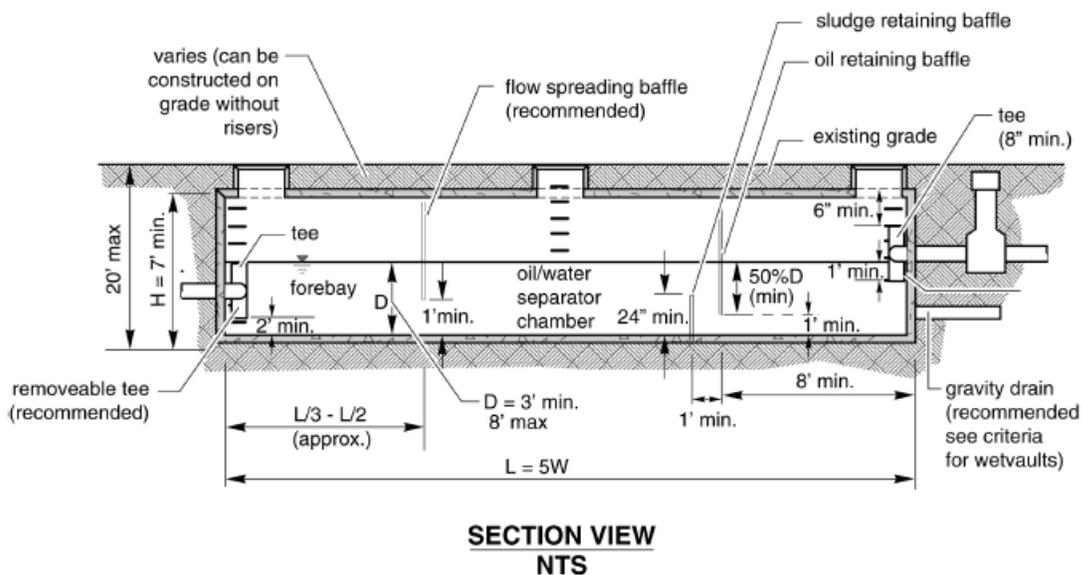
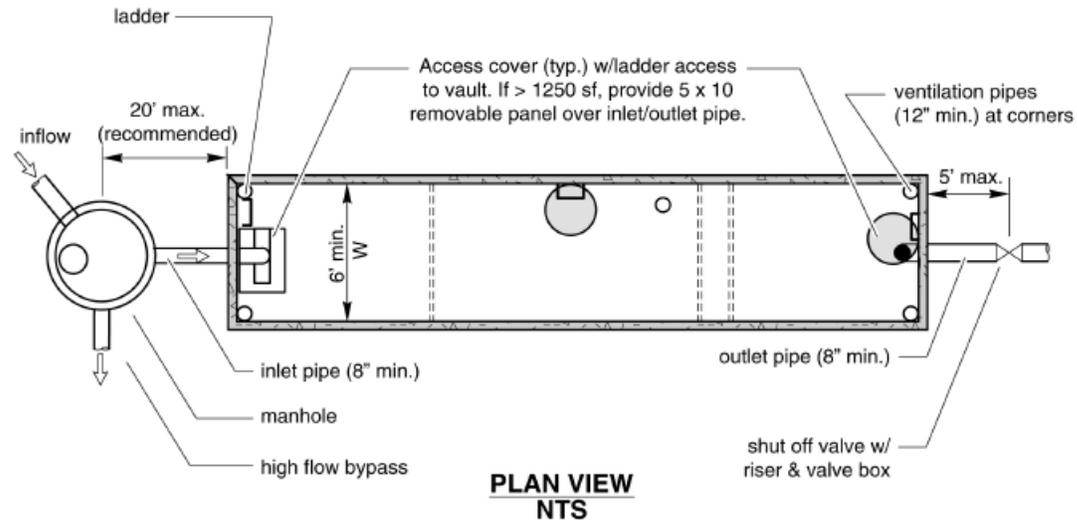
To be eligible for stormwater utility credit for implementation of this BMP, all hazardous and petroleum-based materials that are stored outside must have spill containment. Organizations wishing to receive credit for spill containment must meet the following minimum criteria:

1. All spill containment facilities must be capable of containing the contents of the largest tank in the applicable storage area with sufficient freeboard to contain precipitation.
2. For storage areas that contain hazardous materials, a secondary containment structure must be provided with an isolation valve. The valve must remain closed during normal facility operation. In the event of a rainfall event, the collected stormwater must be visually inspected (sight and smell) for any potential contamination. If no potential contamination is visible, the containment valve may be opened and the collected stormwater discharged. Any contaminated stormwater must be disposed in a proper manner.
3. For storage areas that contain potentially hazardous material that floats on water (e.g. oil), a structure using a retaining baffle as shown on the next page or other trapping provision may be used.
4. A site plan detailing the storage areas and spill containment measures must be submitted to Stormwater Division.
5. Display easily visible signage indicating a hazardous material storage area.
6. Implement a regular inspection program for all spill containment areas.
7. Document all inspection and maintenance activities associated with spill containment facilities (inspection and maintenance records should be available for review upon request).

For more information regarding credit opportunities, refer to the City's *Stormwater Utility Credit Policy* document which is available online.

API-Type (Baffle) Oil/Water Separator

Source: Washington Department of Ecology



1.2.1.1.9 Erosion and Sedimentation Control

Soil erosion has a major impact on the quality of surface waters. Erosion increases the sediment loading to surface waters causing adverse impacts such as increased turbidity, reduced light penetration, clogging of gills/filters of fish and aquatic invertebrates, and reduced spawning. Other impacts of increased sediment loading occur in low flow receiving waters, such as slow moving meandering streams, ponds and lakes, where the sediment has a chance to settle out. Impacts include smothering of aquatic habitat and more rapid filling of impoundments, increasing the need for costly cleanouts and decreasing the aesthetic value (Schueler, 1987).

The greatest amount of soil erosion occurs during development construction and related land disturbance, where grading activities expose the soil. Soil erosion can also occur on developed

sites where pervious areas are not well stabilized (for example, sparse grass cover), and in urban streams where increased flow velocities due to increased runoff has eroded the stream banks, and other places where runoff has been concentrated and the conveyance system is not adequately protected to resist erosion.

For all land disturbance activities erosion and sedimentation controls are to be implemented to prevent excessive sediment transport via stormwater runoff. After construction, it is important that property owners periodically inspect the construction site to check for any erosion problems or areas where earth is exposed due to poor grass cover or landscape cover.

City of Greensboro Soil Erosion and Sedimentation Control

As a result of the City's adoption of a local erosion and sediment control ordinance deemed equal to or more restrictive than the State's model ordinance and commitment of resources to implement the ordinance, the State Division of Land Resources has delegated program implementation and enforcement to the City. The City's program is based on the Soil Erosion and Sedimentation Control Act of 1973 and the City's National Pollution Discharge Elimination System (NPDES) Stormwater Permit.

The City of Greensboro enforces sedimentation and erosion controls on all new commercial and residential projects. The Engineering and Inspections Department's Sediment & Erosion Control Section is responsible for erosion control plan review, grading permits, erosion control inspections, and permanent stabilization of development.

For sites where land disturbances are greater than one (1) acre, a grading permit is required by City Ordinance. For sites where land disturbances are less than one (1) acre, no grading permit is required; however, the City still requires, manages and enforces erosion control on the site.

Refer to the City's Soil and Sedimentation Control Section Standards of Practice for more information on the City's regulations, policies, and procedures. Also, you may contact the Operations management Section of the Storm Water Management Division at 373-2055.

1.2.1.2 Land Use Planning and Management

Description

Cluster Development (Clustering) is a land development practice which can be implemented to concentrate development away from environmentally sensitive areas such as streams, wetlands, mature forests, etc. Because the idea of clustering is to compact development in one location, it will also reduce the amount of roadways, sidewalks and drives required compared to development that sprawls over the entire land area.

Applicability

Clustering and conservation of natural areas should be practiced at least to some extent for all developments, not only to reduce the impacts to our natural resources by minimizing disturbance and percentage impervious, but also to maintain some of the natural beauty of the site.

Clustering and conservation may be used for the following:

- ⇒ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points for clustering (Factor #1) can be received based on the criteria listed in the water-supply watershed ordinance (Chapter 30). Points can also be earned for conservation of stream buffers (Factor #7) and for conservation or re-creation of wooded areas (Factor #11). Also, by reducing built-upon surfaces, points may be gained for built-upon area (Factor #2).
- ⇒ *Protection of fragile areas in the watershed critical area.* The City ordinance requires development to conserve fragile areas in the undisturbed state. Fragile areas are steep slopes (>15%) lying adjacent and parallel to streams and drainageways, and wetlands.
- ⇒ *Reduction of stormwater utility fee.* Clustering and conservation practices are designed to reduce the impervious areas required for the site. Because the stormwater utility is directly based on impervious surfaces, the fee will be reduced for the site.
- ⇒ *Other considerations.* Reducing the amount of impervious area reduces the volume of runoff required to be treated by structural BMPs thus reducing the cost and size of the BMPs. Concentrating development away from environmentally sensitive areas will also likely reduce the amount of time and expense to get federal and state permits for impacts to jurisdictional waters.

Planning and Design Considerations

Concentrate development on the flattest part of the land away from environmentally sensitive areas such as steep slopes, streams, and wetlands. This will not only reduce the impacts to these areas but may reduce the amount of earth moving necessary.

Minimize the width of streets (in accordance with City standards).

Minimize the number of parking spaces and reduce the size of parking stalls and parking aisle widths (in accordance with City standards).

Reduce the amount of overflow parking to the minimum needed.

Take inventory and preserve mature trees and forests.

1.2.2 Structural BMPs

Structural BMPs are “engineered and constructed stormwater management structures” that can be designed to improve the quality of stormwater runoff and reduce stormwater runoff rates and/or volumes. These BMPs are designed to capture surface runoff from developed areas and improve the quality of the runoff from the site by removing pollutants through processes such as sedimentation, plant uptake, filtration, microbial activity, etc.

Structural BMPs are generally the costliest of the various BMPs to implement and to maintain. Most potential BMP owners are generally aware of the initial construction costs and land allocation that is required for structural BMPs, but some do not fully understand or appreciate the responsibility and costs associated with the maintenance of stormwater BMPs. This section supplements the State BMP Manual by providing design, installation, and maintenance guidelines for each of the structural BMPs.

1.2.2.1 Open Vegetated Conveyance / Grass Swale

Description

Open vegetated conveyances may be used instead of curb and gutter (where permitted) and hard piping to convey stormwater runoff where feasible. Open vegetative conveyances may be channels, swales, and, where runoff is in the form of sheet flow, any vegetated area that accepts runoff. Vegetated conveyances help to improve water quality by providing partial pollutant removal as the water is filtered by the vegetation and an opportunity for a portion of the water to infiltrate into the soil. They can also improve stormwater runoff quantity management by reducing the velocity of the flow through the conveyance and providing some infiltration into the soil.

Applicability

Vegetated conveyance systems can best be incorporated into moderate to low density development where land area is available and where the land surface is gently sloping (5% maximum). The site soils must be able to withstand erosion and a dense cover of strong rooted vegetation, such as tall fescue grass, must be established within the conveyance. Vegetated conveyances usually work best when the conveyance is “cut” into existing soils.

A benefit of using open vegetated conveyances is that they can save on construction costs by eliminating the need for stormwater sewer systems.

Open vegetated conveyances may be used for the following:

- ⇒ *Stormwater conveyance in the watershed critical area.* Section 30-7-3.2 (2) of the City’s Ordinance (a) states that drainage shall be provided by means of open channels. Subsection (b) states that the drainage shall have protected channels.
- ⇒ *Scoring points on the “scoresheet” for low density development in the General water-supply watershed area.* (see Section 2 for an explanation and details on the Scoresheet) Use of open

vegetated conveyances will provide more points than piped conveyances (Factor #10). Also, vegetated conveyances that are used and are designed to resist soil erosion (10-year event), will classify as “protected drainageways” on the scoresheet (Factor #5).

- ⇒ *To provide stormwater quantity control.* Vegetated conveyance systems can provide temporary retention to reduce stormwater discharge rates. A hydrologic-hydraulic analysis will have to be performed to determine the design that will provide the desired reduction (for more information on design guidelines, see Section 14, Grass Swales, and Section 13, Filter Strips).
- ⇒ *Credit towards the stormwater utility fee.* Using vegetated conveyances instead of “hard” conveyances and are designed according to the guidelines given below, may be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

Planning and Design Guidelines

To improve its effectiveness as a stormwater BMP, open vegetated conveyance systems should be used in gently sloping areas to promote shallow, low velocity flow. This will maximize the channel filtering surface, and facilitate sedimentation and infiltration while increasing the travel time to the discharge point.

Channels and swales should be designed to promote shallow flow (i.e. trapezoidal). Conveyances designed with narrow cross sections will have higher velocities and deeper flow depths which allows for less pollutant removal, increased erosion potential, and higher quantity of flow at the discharge point.

The bottom width should be wide enough to maintain a shallow flow but narrow enough to prevent small rills from forming in the bottom during low flows.

Generally the side slopes should not be steeper than 3H:1V. The slopes should be flat enough to maximize the contact surface area (the water with vegetation) and prevent bank erosion while steep enough to reasonably contain the flow.

The permissible velocity for vegetated conveyances should be limited to prevent erosion within the channel. The permissible velocity varies depending on the soil type, the vegetation type, how well the conveyance is maintained, etc. Generally, the velocity should not exceed 4 ft/sec within the channel (10 year storm), for velocities greater than this, check dams may need to be constructed within the channel to slow the velocity.

It is recommended that the lining of open conveyances be a dense cover of erosion resistant grass, such as tall fescue. For channels and swales where relatively steep slopes exist (greater than 3:1), it may be beneficial to plant trees along the top of the slope. Tree roots will provide additional stabilization to the channel banks. It may be necessary to use temporary matting to get the grass established or to use sod.

1.2.2.2 Riparian Buffers

Description

Stream buffers are required to be implemented along streams, drainageways, and impoundments. The function of the buffers are to:

- ⇒ protect the overall stream quality by providing shading for the stream and provide wildlife habitat;
- ⇒ remove pollutants from stormwater runoff through infiltration and filtering of stormwater runoff from adjacent land areas;
- ⇒ help attenuate flow rates from developed areas;
- ⇒ provide a setback from the stream to prevent damage to structures or improved property due to flooding or changes in the stream channel.

The most effective stream buffers for protecting the overall quality of the stream are those that are left undisturbed including a tree line maintained along the stream bank.

Applicability

All major streams, drainageways, and water bodies are required to have buffer protection.

Stream buffers must be provided for the following:

Meet water-supply watershed and stormwater management requirements. Refer to Section 2.9.3 of this Manual for more information.

Stream buffers may be provided for the following:

- ⇒ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points on the scoresheet can be granted for buffers placed on drainageways and jurisdictional streams (Factor #7).
- ⇒ *Reduce the stormwater runoff that a site generates.* Stream buffers can serve to reduce the runoff rates that flow into the buffer. The actual reduction depends of the quantity of flow entering the buffer, the flow source (e.g. pipe discharge, sheet flow), the width of the buffer, buffer ground cover, etc.

1.2.2.3 Rooftop Runoff Management

Description

Disconnecting rooftop drainage can reduce the runoff flow rates from developed areas. Disconnecting means that runoff from rooftops will not be directed to storm drainage systems but

rather be directed toward pervious surfaces where it can filter through the grass or other landscape material, or infiltrate into the soil.

Applicability

This practice is applicable mostly for low density residential or commercial developments (less than 50% impervious). Disconnection is not applicable where the volume of runoff from rooftops will cause erosion or problems to adjacent downstream properties.

Disconnection practices may be used for the following:

- ⇒ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points on the scoresheet can be granted for dispersing flow instead of concentrating it (Factor #5). To receive points, the rooftop should be disconnected as specified below (along with other impervious areas).
- ⇒ *Provide stormwater quantity control.* Disconnection of impervious areas can increase the time it takes for runoff to travel to the site outfall (increase time of concentration) and may allow a portion of the runoff to infiltrate into the soil. The effect that disconnection has on stormwater quantity depends on many factors, such as the storm event, the amount of impervious area that is being disconnected, whether the flow is concentrated or not, the soil type, the type of cover on the pervious surface, and the distance from where the runoff is “disconnected” to the nearest downstream area of imperviousness, stormwater conveyance system, or site outfall.
- ⇒ *Credit towards the stormwater utility fee.* Properties that disconnect rooftop drainage according to the guidelines below, may be eligible for credit as specified in the *Stormwater Utility Credit Policy* document.

Planning and Design Guidelines

Downspouts from rooftops should discharge to gently sloping, well vegetated or landscaped areas (mulched areas do a good job in storing and dispersing water as long as the inflow velocity is not great). Erosion control devices, such as splash blocks may be needed at the roof downspout discharge.

Rooftops should provide a downspout for every 5000 square feet of rooftop to reduce the erosion potential at the discharge location. The minimum distance between downspout discharge and the next impervious surface shall be 10 feet.

1.2.2.4 Grass Paving

Description

Grass paving technology allows for the reduction of paved areas by implementing grass paving in areas that are infrequently used such as fire lanes, overflow parking, golf cart paths, etc. A variety of grass paving units are available on the market. Grass paving units are designed to carry

vehicular loading and may be composed of different type materials. The pavers are usually covered with sod to make these areas practically indistinguishable from other grassed areas. Grass paving provides water quality benefits by allowing stormwater to infiltrate into the underlying soils and by filtering of the stormwater as it flows through the grass.

Applicability

Grass pavers can provide a more aesthetically pleasing site and reduce the “sea of asphalt” look. Grass paving should not be used for frequently traveled or parked in areas, since damage could be done to the grass and the grass needs sunlight to survive.

Grass paving may be used for the following:

- ⇒ *Scoring points on the scoresheet for low density development in the General water-supply watershed area.* Points can be received for “Other Measures” (Factor #12) for use of grass paving. Sites that incorporate 5% of their total impervious surface as grass paving will receive 10 points for this category.
- ⇒ *Reduce the runoff generated by a site.* Grass pavers can reduce the runoff volume generated and extend the time of concentration. Some units may provide enough infiltration to be considered a pervious cover; check with the manufacturer for more information on the runoff characteristics of the grass paving.
- ⇒ *Reduction of stormwater utility fee.* Grass paving is not considered an impervious surface (see note below) as it pertains to the fee, therefore the fee will be less.

*Note: Grass paving units are considered by the State and the City to be built-upon area, as it pertains to water-supply watershed regulations.

Design Considerations

Grass paving should not be used in high traffic areas or where vehicles will be permanently parked for long periods of time which may affect the growth of grass.

Refer to the manufacturer’s guidelines for proper design considerations, installation, and maintenance of grass paving.

1.2.2.5 Natural Infiltration

Description

Natural infiltration is a method in which an undisturbed land area covered with natural vegetation accepts runoff from new development and infiltrates the runoff into the soil. Natural infiltration areas should only be used where the soils have a moderate to high infiltration rate (that is, soils in hydrologic group A or B). The area should be in the forested condition with the land surface

covered by leaves, needles, and organic matter and should only be used for passive recreation, such as hiking.

Applicability

A natural infiltration area that meets the State BMP Manual's design criteria may be used as stormwater quality control in the Watershed Critical Area (WCA) where the built-upon area is 6% or less in the Lower Randleman WCA or is 12% or less in any other WCA.

SECTION 2: NORTH CAROLINA'S STORMWATER REQUIREMENTS

Chapter 2.1 Overview of the City of Greensboro's Requirements

To address the adverse effects of urbanization on water quality, Federal, State and local regulations have been adopted to protect the quality of surface waters.

2.1.1 Stormwater Management Ordinance

Chapter 27 of the City Code of Ordinances is the Stormwater Management Ordinance. The main objective of this ordinance is to provide enforcement authority to meet the City's municipal NPDES Permit and associated Stormwater Management Plan. This plan is supplemented by additional portions of the Ordinance, particularly Chapter 30. Another key objective of this ordinance is to protect properties from potential stormwater quantity and quality problems. Potential problems include increased flooding and drainage problems due to inadequate or lack of conveyance systems and excessive stream bank erosion/channel widening due to increased runoff from developed areas. To control the adverse effects of increased stormwater runoff associated with newly developed or redeveloped sites, the City ordinance Chapter 27 requires all new development within the city limits to submit a *Stormwater Management (SWM) Plan*.

The SWM Plan must show stream buffers along (1) perennial streams, (2) intermittent streams and (3) channels. The SWM Plan must also include adequately sized detention or an *offsite stormwater conveyance system analysis* that shows the effects the development will have on the downstream properties including a determination if the development will cause or increase quantity or quality problems. If the analysis shows that negative impacts will result, stormwater management improvements including structural and/or non-structural BMPs are to be implemented to minimize the impact.

2.2.1 NPDES Discharge Permits

With the Clean Water Act, the EPA mandated that it is illegal to discharge any pollutant to "waters of the United States" without a National Pollutant Discharge Elimination System (NPDES) Permit. Refer to the NC State BMP Manual Section 2.2 for a description and explanation of this permit.