

Forsyth County Addendum to the Georgia Stormwater Management Manual

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Section 1: Purpose and Applicability

The Department of Engineering has adopted the Georgia Stormwater Management Manual (GSMM)¹ as the basis for the design and review of stormwater management facilities and practices in Forsyth County. The purpose of this addendum is to augment and clarify the guidelines set out in the GSMM for the specific management of stormwater runoff within unincorporated Forsyth County, Georgia (i.e., excluding the city of Cumming). Chapter 34, Article V Stormwater Management, of the Forsyth County Code of Ordinance² (the Ordinance) provides the Department with the authority to manage stormwater based on the scope of responsibilities it defines. Persons owning property or wishing to develop land in Forsyth County should also reference the following documents for additional guidance:

- **Chapter 34, Article V Stormwater Management, of the Forsyth County Code of Ordinance** provides the legal authority for stormwater management, definitions, and a description of the appeal / penalty processes.
- **Georgia Stormwater Management Manual (GSMM)** Volume I, Chapter 4 for guidance on implementing stormwater management requirements during development. Volume II provides specific guidance for unified stormwater sizing criteria and for methods of estimating stormwater runoff.
- **Forsyth County Addendum** (this document) to the GSMM provides county-specific clarification and is organized into the following sections:
 - *Section 1: Purpose and Applicability* – provides guidance on the application and exemption of these regulations to new development, redevelopment projects, and existing stormwater management facilities.
 - *Section 2: Stormwater Conveyance (Drain Pipe) Design* – provides guidance on the design of stormwater conveyance facilities such as Gutter Flow and Inlets, Storm Drain Pipes, Culverts, and Small Ditches.
 - *Section 3: Stormwater Detention Facilities and Practices* – describes the criteria for requiring stormwater detention, provides guidance on the design of stormwater detention facilities and practices, and other miscellaneous requirements.
 - *Section 4: Stormwater Plan Review Process and Requirements* – delineates the process for the design and review of stormwater management facilities for new and redevelopments, including the pre- and post-construction requirements necessary to obtain development permits, and establishes maintenance responsibilities for existing and new stormwater management facilities.
 - *Section 5: Supplemental Stormwater Documents* – provides instructions to using the Stormwater Quality Site Development Review Tool and the Stormwater Inspection and Maintenance Covenant also described in Section 4.

¹ The Georgia Stormwater Management Manual (GSMM) can be downloaded from www.georgiastormwater.com or ordered from the Atlanta Regional Commission bookstore, <http://www.atlreg.com/regionaldata/bookstore.html> or by calling 404.463.3100.

² The ordinance can be viewed on <http://livepublish.municode.com/LivePublish/newonlinecodes.asp?infobase=13631>.

1.1 Applicability

All land development activities in Forsyth County including planned construction of commercial, industrial, governmental, residential, parks or recreational type developments shall be governed by Chapter 34, Article V Stormwater Management, of the Forsyth County Code of Ordinance (the Ordinance). Land development activities meeting any of the following criteria will be required to comply with the stormwater management standards of the Ordinance, the Georgia Stormwater Management Manual (GSMM), and this addendum:

1. new development that involves the creation of 5,000 square feet or more of impervious cover, or that involves other land development activities disturbing (one) 1 acre or more;
2. redevelopment that includes the creation or addition of 5,000 square feet or more of impervious cover, or that involves other land development activity disturbing one (1) acre or more;
3. those developments that regardless of size are defined to be a hotspot land use by the Ordinance, or
4. those developments that construct improvements in phases and that meet criterion No.1 above when considering the cumulative runoff increase due to all phases.

When one of these conditions is met, the development shall be governed by the stormwater design specifications in the GSMM and Section 3 of this addendum. The Forsyth County Stormwater Quality Development Review Tool described in Sections 4 and 5 should be used to determine compliance with standards for total suspended solids (TSS) reduction for the proposed development.

Existing, new and planned stormwater facilities shall comply with the maintenance requirements of Section 4 of this addendum.

1.2 Exemptions

The following activities are exempt from the requirements of the Ordinance:

- Additions or modifications to existing single-family detached or duplex residential structures if they do not disturb over 5,000 square feet of land area;
- Developments that do not disturb over 5,000 square feet of land area;
- Individual single-family residential lots that are not part of a subdivision or phased development project;
- Agricultural or silvicultural land management activities within areas zoned for these activities; and,
- Repairs to any stormwater management facility or practice deemed necessary by the Department of Engineering.

Notwithstanding the foregoing, the maintenance obligations established in Section 4.2.2 shall not be subject to this exemption.

Section 2: Stormwater Conveyance (Drain Pipe) Design

2.1 Runoff Computation

Unless otherwise noted in this Addendum, computing runoff and generating hydrographs must be done by one of the methods outlined in the GSMM. Table 2-1 summarizes the hydrologic calculation methods that will be accepted by the Director of the Engineering Department and the section reference from the GSMM that explains each. The table also provides guidelines for using the appropriate method based on the size of the drainage area. Additional information relating to the design of conveyance structures can be found in Section 4.1 of the GSMM. The Rational Formula can be used to design conveyance systems. One of the other methods listed must be used for designing the stormwater detention facilities described in Sections 3.

TABLE 2-1

Methods for Runoff Computation

Computation Task	GSMM Chapter	Rational Formula	SCS	USGS Equations	Water Quality Volume
<i>Size Limitations for Each Method</i>		<i>25 acres</i>	<i>25 to 2,000 acres</i>	<i>2,000 acres to 25 square miles</i>	<i>Based on Structural Control</i>
Water Quality Volume (WQ _v)	1.3				X
Channel Protection Volume (Cp _v)	1.3		X		
Overbank Flood Protection (Qp ₂₅)	1.3		X	X	
Extreme Flood Protection (Q _f)	1.3		X	X	
Storage Facilities	2.2		X	X	
Outlet Structures	2.3		X	X	
Gutter Flow and Inlets	4.2	X			
Storm Drain Pipes	4.2	X	X	X	
Culverts	4.3	X	X	X	
Small Ditches	4.4	X	X	X	
Open Channels	4.4		X	X	
Energy Dissipation	4.5		X	X	

Source: Georgia Stormwater Management Manual, Volume II, p. 3.1-2.

2.2 Storm Drain Pipe Design

Piped Drainage Structures shall be designed to meet the following criteria:

- Street catch basins, inlets, cross drains serving basins of 20 acres or less and longitudinal piping shall be designed for the 25-year storm and shall have a minimum size of 18 inches in diameter.
- Inlet and outlet headwalls are required for all pipes.
- The 100-year storm frequency shall be used on live streams, cross drains serving basins of 20 acres or larger and any other drainage system receiving and/or transferring offsite drainage flow.
- Velocities for all pipes should be kept to a minimum of two (2) feet per second and outlet velocities, if practical, shall not exceed four (4) feet per second when flowing full. However, if outlet velocities exceed (5) feet per second then energy dissipation devices and/or channel protection must be provided.
- The downstream end of all storm drain pipe shall be located at a minimum of fifty (50) feet past the building line for pipe sizes up to and including thirty-six (36) inches in diameter, unless the storm drainage is on a live stream.
- For all pipe design, the designer shall check the 100-year hydraulic grade line to determine that no inlet structures are flooded and that the collection capacity of any structure has not been compromised by the 100-year hydraulic grade line.

The type of pipe required shall be bituminous coated corrugated metal pipe (BCCMP); aluminized coated corrugated metal pipe (ACCMP); reinforced concrete pipe (RCP); high density polyethylene pipe (HDPE); and polyvinyl chloride pipe (PVC). The construction standards and design criteria for each type of pipe may be obtained from the Department of Engineering. RCP will be required under the following conditions:

- When the storm drain pipe will be placed in a live stream and a more economical solution is not a viable alternative as determined by the Director of the Engineering Department.
- When the storm drain pipe will have over fifteen (15) feet of cover.

The storm drain pipe designs and related plans and specifications shall be prepared by a Professional Engineer, a registered Land Surveyor, or a Landscape Architect registered in the State of Georgia. The computations must be dated, project identified, signed and sealed by the Designer. The designer's seal and signature shall be on all residential and commercial subdivision plans that involve new public improvements.

Plans, specifications and computations must be complete in detail sufficient to enable an engineer to fully check and verify the results and computations. The plans used for construction must contain basic design data, a project narrative, schedule of construction, name and address of person responsible for construction, and the designer's seal, signature and address. After construction and before acceptance for occupancy or final plat approval, the engineer, land surveyor or landscape architect must certify with their seal and signature that the "as-built" conditions of the storm drains will meet the requirements of this ordinance.

Section 3. Stormwater Management Facilities and Practices

Stormwater management typically relies on a system of natural and constructed facilities (practices) for the storage, treatment, and conveyance of runoff. In Forsyth County, the necessary maintenance and inspection of this system is primarily the responsibility of individual property owners or associations, though the County recognizes its role in facilitating these activities and addressing regional stormwater planning needs.

Forsyth County encourages the use of better site design practices that preserve the natural drainage system and on-site, non-structural stormwater management practices whenever practical. These practices decrease the quantity and increase the quality of stormwater discharged to lakes and streams during rain events. Forsyth County also encourages the protection and enhancement of existing wetlands and floodplains, which are protected from dredging and filling by 33 CFR Part 330 of the Federal Register and Section 404 of the Clean Water Act.

3.1 Stormwater Design Requirements / Unified Sizing Criteria

The GSMM has developed a set of Unified Stormwater Sizing Criteria that serves as the basis of designing stormwater facilities in Forsyth County. These criteria provide an integrated approach for meeting the stormwater runoff quality and quantity management requirements for those applicable developments identified in Section 1.1. The purpose of the Unified Stormwater Sizing Criteria is to design a stormwater management system to:

- Remove stormwater runoff pollutants and improve water quality;
- Prevent downstream streambank and channel erosion;
- Reduce downstream overbank flooding; and
- Reduce the runoff from and safely pass extreme storm events.

Stormwater detention facilities in Forsyth County must be designed to meet the criteria in Table 3-1 using the appropriate runoff calculation methods described in Table 2-1 of Section 2. Additional discussion of these criteria can be found in the GSMM, Volume II, Section 3.1.

TABLE 3-1

Summary of the Statewide Stormwater Sizing Criteria for Stormwater Control and Mitigation

Sizing Criteria	Description
Water Quality	Treat 85% of the runoff from the storms that occur in an average year and reduce average annual post-development total suspended solids loadings by 80%. For Georgia, these conditions equate to providing water quality treatment for the runoff resulting from the initial 1.2 inches of rainfall for every storm.
Channel Protection	Provide extended detention so that the 1-year, 24-hour storm event is released over a period of 24 hours to reduce bankfull flows and protect downstream channels from erosive velocities and unstable conditions.
Overbank Flood Protection	Provide peak discharge control of the 25-year storm event such that the post-development peak rate does not exceed the predevelopment rate to reduce overbank flooding.
Extreme Flood Protection	Control and safely convey the flood produced by the 100-year, 24-hour storm event. Conduct a downstream hydrologic analysis to determine whether there are any additional impacts in terms of peak flow increase or downstream flooding. This analysis shall be conducted at the outlets of the site, and at each downstream tributary junction until the area of the portion of the site draining into the system is less than or equal to 10% of the total drainage area above that point. The comparison shall be conducted for the 100-year flood resulting from full build-out conditions in the watershed.

Notes: Source: Georgia Stormwater Management Manual, Volume II, p. 1.3-1.

3.2 Water Quality Performance Criteria

Total suspended solids (TSS) is a key pollutant associated with sediment runoff. It also serves as a “carrier” of other pollutants such as organics, nutrients, and metals. Thus, TSS, a measure of suspended matter-including soils and sediments-will serve as the watershed improvement guideline for managing pollutants.

Stormwater management systems (which can include both structural stormwater controls and better site design practices) must be designed to remove 80% of the average annual post-development TSS load and be able to meet any other additional watershed- or site-specific water quality requirements. All stormwater detention facilities shall be designed to control the peak flow rates associated with storms having 1-, 25- and 100-year storm frequencies as specified in Table 3-1.

Forsyth County will require that all sites utilizing dry detention structures discharge at 90% of the pre-developed rate of release. Sites using wet or regional detention structures will be allowed to release runoff at 100% of the pre-developed rate of release. It is presumed that a stormwater management system complies with this performance standard if:

- It is sized to capture and treat the prescribed water quality treatment volume, which is defined as the runoff volume resulting from the first 1.2 inches of rainfall of every storm,

- Appropriate structural stormwater controls are selected, designed, constructed, and maintained according to the specific criteria in the GSMM, and
- Runoff from hotspot land uses and activities is adequately treated and addressed through the use of appropriate structural stormwater controls and pollution prevention practices.

Use of the Stormwater Quality Site Development Review Tool, described in Section 5.1, provides the developer and reviewer with a summary of the TSS reduction from each of the drainage areas and also presents the overall TSS reduction efficiency of the planned site. Please note that if this overall efficiency is less than 80%, then the site will fail to meet the recommendations of the Georgia Stormwater Management Manual and will not be approved.

3.3 Criteria for Requiring Stormwater Management

Whenever a Stormwater Management Report (Section 4.1.2) indicates that adverse stormwater runoff impact is expected from the development of a property, that project shall be required to provide a stormwater management facility or facilities so that the Unified Sizing Criteria are met. The following criteria shall be evaluated by the Engineer preparing the Stormwater Management Report and used in determining whether stormwater management facilities should be required for any portion of any site:

- Existing land uses downstream,
- Anticipated future land uses downstream,
- Magnitude of increase in peak flows due to development,
- Presence of existing drainage problems,
- Capacity of existing and anticipated drainage systems,
- Creation of concentrated flows where none had occurred previously,
- Existing flows generated off-site that pass through the project site, and
- The nature of the receiving watercourse.

3.3.1 Stormwater Management Not Required

Stormwater management facilities shall be required for all development activities not meeting the Unified Sizing Criteria described in Section 3.1, unless the Engineer provides certified documentation supporting the conclusion that one of the following is true and correct as applicable:

- The uncontrolled, post-development runoff will leave the project site as sheet flow and will not have an adverse impact upon downstream properties due to dispersal of stormwater.

- The effect of stormwater management will be to concentrate flows where sheet flow had occurred under pre-developed conditions, and any impact of increased sheet flows upon downstream properties would be less adverse than that which would result from the concentrated flow from a stormwater management facility, even if energy dissipation devices were employed.
- The runoff will flow directly into a flood plain without crossing off-site properties, and the post-development runoff will constitute less than five (5%) percent of the total peak flow in the watercourse, at the point where the watercourse crosses the project site's downstream property line. This condition will be referred to hereafter as the "5% rule."
- The runoff will flow directly into the 1085.00 flood elevation of Lake Sidney Lanier, provided however that a stormwater quality facility is installed prior to discharging into the lake.
- The uncontrolled flow will pass through downstream properties in drainage easements obtained by the developer to existing stormwater management facilities that have been designed to manage the upstream property's runoff, and the flow is shown not to produce adverse impacts to the downstream properties.

Should the Professional Engineer conclude that stormwater management facilities may not be necessary because of anticipated compliance with the foregoing items, then rigid compliance with all of the following criteria is mandatory:

- A Stormwater Management Report (Section 4.1.2) shall always be required whether or not stormwater management facilities are required.
- If the applicant proposes to show that the detention requirements may be eliminated for all or a portion of a project, then a pre-submittal conference with the Department of Engineering is recommended prior to preparation and submittal of construction plans for the project.
- A studied FEMA floodplain or the 100-year floodplain as determined by the consulting Engineer for ultimate build-out conditions must be present on the property of the proposed development in order for elimination of the detention requirement to be considered.

At the pre-submittal conference with the staff, the consultant shall be prepared to discuss the downstream analysis findings as follows:

- a) The affected stream must be analyzed for a distance downstream to a point where the proposed development represents less than (10%) percent of the total watershed. This analysis shall be referred to hereafter as the "10 % rule." The analysis must include all culverts, obstructions, existing and potential erosion problems, existing structures, proposed structures, proposed improvements and any other pre-developed or post-developed modifications to natural conditions;
- b) If the existing downstream conditions are overburdened within the "10 % downstream point" by the pre-development flows in the stream, then stormwater management shall be required unless the developer elects to

eliminate the downstream overburdened conditions at his or her expense when the development occurs.

c) If the 5% percent rule described above is to be used to show that the stormwater management requirements may not apply, then the following must be included in the Stormwater Management Report:

- The 5% study point has to be at the downstream property line and,
- The 5% study will compare peak developed flows originating on the site against peak flows for the 1-, 25-, and 100-year storm events of the major stream at the downstream property line. Comparison of the peak flows shall include the timing of the peak flows.

3.3.2. Special Provisions for Redevelopment

Urban redevelopment has numerous advantages. It reduces the loss of natural areas and open space, revitalizes older neighborhoods, and avoids the need to build infrastructure to support new development. However, space limitations sometimes preclude the application of the stormwater management criteria specified above. In these cases, alternate stormwater management requirements can be applied for redevelopment projects.

Redevelopment projects that are shown to be unable to meet the stormwater criteria above, are required to implement one of the following options:

- 1) reduce existing site imperviousness by 20%,
- 2) provide water quality treatment for 20% of the site's imperviousness, or
- 3) a combination of 1) and 2).

Some techniques that may be used to achieve the 20% imperviousness reduction goal in 1) are green roofs, smaller parking areas, or landscaping. Option 2) can be implemented through the application of bioretention facilities, stormwater planters, rainwater capture devices, and sand filters. If these alternatives are still not feasible, the Department of Engineering may allow for other alternatives that may contribute to the improvement of water quality; for example payment of fees to undertake other projects, mitigation of other nearby imperviousness off-site but in the same watershed, off-site mitigation for a drainage area comparable in size, or retrofitting of existing on-site stormwater controls. The solutions proposed must be fully documented in the Stormwater Management Report (Section 4.1.2).

3.4 Structural BMP Specifications

Table 3-2 provides an overview of the structural BMPs that can be used for stormwater detention in Forsyth County. For specific design criteria and examples refer to Volume II, Section 3 of the GSMM. These BMPs are for general application and can be designed for use in a variety of situations.

Other structural controls, including proprietary hydrodynamic separation systems and others listed in the GSMM as "limited application structural controls," are recommended for limited use with particular land uses and densities or as one part of a

larger stormwater management design and will only be accepted by the Director of the Engineering Department where appropriate.

TABLE 3-2

General Application Structural Best Management Practices

Structural Control	Examples	Description
Stormwater Ponds	Wet Pond Wet Extended Detention Pond Micropool Extended Detention Pond Multiple Pond Systems	Stormwater ponds are constructed stormwater detention basins that have a permanent pool of water. Runoff from rain events is detained and treated in the pool.
Stormwater Wetlands	Shallow Wetland Extended Detention Shallow Wetland Pond / Wetland Systems Pocket Wetland	Stormwater wetlands are constructed wetland systems used for stormwater management. Stormwater wetlands consist of a combination of shallow marsh areas, open water and semi-wet areas above the permanent water surface.
Bioretention Areas	Bioretention facilities (rain gardens) Stormwater planters	Bioretention areas are shallow stormwater basins or landscaped areas that utilize engineered soils and vegetation to capture and treat stormwater runoff. Runoff may be returned to the conveyance system, or allowed to partially exfiltrate into the soil.
Sand Filters	Surface Sand Filter Perimeter Sand Filter	Sand filters are multi-chamber structures designed to treat stormwater runoff through filtration, using a sand bed as its primary filter media. Filtered runoff may be returned to the conveyance system, or allowed to partially exfiltrate into the soil.
Infiltration Trenches		An infiltration trench is an excavated trench filled with stone aggregate used to capture and allow infiltration of stormwater runoff into the surrounding soils from the bottom and sides of the trench.
Enhanced Swales	Dry Swale Wet Swale / Wetland Channel	Enhanced swales are vegetated open channels that are explicitly designed and constructed to capture and treat stormwater runoff within dry or wet cells formed by check dams or other means.

Source: Georgia Stormwater Management Manual, Volume II, p. 3.1-2.

3.5 Miscellaneous Requirements for Stormwater Facilities and Practices

3.5.1 Oil/Grit Separator Requirement for Hot Spot Land Uses

While these devices are for the most part ineffective as a stand-alone treatment of stormwater runoff quality for large areas, the use of oil/ grit separators is effective for addressing pollutants of concern such as hydrocarbons from hotspot land uses. A full definition of these land uses can be found in the Ordinance but they generally refer to service stations, convenience stores, and other developments with commercial fueling facilities. Hydrocarbons in urban runoff can reach water bodies and negatively impact aquatic ecosystems. As a result, Forsyth County requires that all proposed service stations, convenience stores, and other developments with commercial fueling facilities

shall provide an oil/ grit separator for water quality. Additional information on design considerations related to oil/ grit separators can be found in Volume II, Section 3.1 of the GSMM.

3.5.2 Stormwater Management Drainage Easements

Drainage easements suitable for the construction and maintenance of the drainage system shall be provided. A minimum of twenty (20) feet in width will be required for any drainage easement along a drainage pipe, ditch, stream or other area that is designated for stormwater to flow. No obstruction shall be built, constructed or planted that would inhibit proper function of the drainage system. All stormwater management facilities shall be accessible from a public street by a minimum twenty (20)-foot access easement, and there shall be an easement for the detention facility including twenty (20) feet extending horizontally beyond the 100-year high water elevation of the facility. No fences or planting of shrubbery shall be allowed on access easements. Fences and/or shrubbery may be placed within a piped drainage easement, if an indemnification agreement is provided to Forsyth County.

3.5.1 Stormwater Management Pond Fencing

When a stormwater management pond is over four (4) feet deep and in a location that constitutes a danger to humans, access shall be restricted by a permanent fence or barrier and warning signs. Fences shall be five (5) feet high chain link or other approved material with a ten (10) foot wide gate. Fences shall be located on the outside edge of the twenty (20) foot perimeter easement when possible (section 3.5.2).

3.5.3 Silt Gauge

A silt gauge will be installed on all detention ponds consisting of a durable weather-resistant post. The post will be embedded a minimum of 2 feet and extend a minimum of 5 feet above ground. Numbers and adjacent tick marks must be on the post beginning with the number "1" at 1 foot above the ground elevation and thereafter a number tick mark for each corresponding foot. Numbers and tick marks must be clear, readable, weather resistant, and durable. A comparable alternative may be used upon approval by the Department of Engineering.

Section 4. Stormwater Management Review Requirements

This section provides guidance on the process for the design and review of proposed stormwater management facilities for new and redevelopments in Forsyth County, including the pre- and post-construction requirements necessary to obtain development permits. This section also establishes obligations for maintenance of existing and new stormwater maintenance facilities.

4.1 Pre-Construction Requirements

4.1.1 Stormwater Quality Site Development Review Tool

An automated spreadsheet tool was developed to facilitate the consistent review of development projects across the 16 county Metropolitan North Georgia Water Planning District (the District)³ of which Forsyth County is part of. The tool was specifically designed to meet the unified sizing and water quality performance criteria outlined in Section 3 of this Addendum and the Georgia Stormwater Management Manual. The overall goal is to provide an effective tool for both Forsyth County review staff and the development community to quickly evaluate the water quality performance of stormwater management plans for development sites. It allows the developer to use a variety of BMPs and provides incentives for leaving key areas, particularly riparian buffers, undisturbed.

Forsyth County currently requires every project, unless otherwise exempt, to use a County-specific version of the District tool that is available for download from: <http://www.forsythco.com/engineering/stormwater>. Additional information and instructions for using the Stormwater Quality Site Development Review Tool are provided in Section 5.1 of this Addendum.

4.1.2 Stormwater Management Report

For every project, a Stormwater Management Report shall be prepared and sealed by a Professional Engineer or Registered Landscape Architect currently registered in the State of Georgia. The purpose of this report shall be to formulate a plan to manage stormwater, so that stormwater runoff hazards are not created, existing runoff-related problems are not exacerbated, and stormwater quality is not adversely affected, either upstream or downstream from or within the boundaries of the property being developed. Nevertheless, a Stormwater Management Report shall be prepared regardless of whether the project requires stormwater management.

The Stormwater Management Report shall address the following issues and analyze compliance with the water quantity and water quality performance indicators noted in Section 1:

- A) A brief narrative description of the project;
- B) Geotechnical investigations including soil maps, borings, site specific recommendations, and any additional information necessary for the proposed stormwater management design;

³ For more information on the Metropolitan North Georgia Water Planning District please visit www.northgeorgiawater.com.

- C) Site plan that depicts all streams, lakes, wetlands and other bodies of water. Additionally, the plan shall depict relevant boundaries of the 100-year floodplain for ultimate build-out conditions (the administrative floodplain). The administrative floodplain boundary must be calculated using Federal Emergency Management Agency (FEMA) methodologies for delineating floodplains using future hydrology conditions.
- D) Hydrologic computations, including drainage area maps depicting pre development and post development runoff flow paths and land use, including the locations and quantities of stormwater runoff entering and exiting the site for both pre-developed and post-developed conditions. Analysis of the off-site properties shall anticipate future development in addition to addressing existing conditions.
- E) Drainage area delineation maps and other exhibits at a satisfactory scale and sufficient in quantity and scope to define the boundaries of the site relative to any applicable water courses, drainage divides, drainage structures and other pertinent features.
- F) Estimates of the stormwater quality in terms of total suspended solids for both pre-developed and post-developed conditions using the Stormwater Quality Site Development Tool described in Section 4.1.1 and Section 5.1.
- G) Hydraulic computations;
- H) Structural computations;
- I) Unified sizing criteria volume computations according to the Forsyth County Addendum to the Georgia Design Manual;
- J) Analysis of downstream conditions at each and every point or area along the project site's boundaries at which runoff will exit the property.
- K) Analysis of the portion of the drainage way "immediately" downstream from the project. In determining downstream effects from stormwater discharge control structures and the development, hydrologic-hydraulic engineering studies, using the 100-year flood for ultimate build-out conditions, shall extend to a point where the proposed development represents less than (10%) percent of the total watershed (the 10% rule). If the discharge calculations indicate that adjacent properties, between the exit of the proposed development and the "10% downstream point" might be adversely impacted by the proposed development, then the Engineer will provide a summary of recommendations.

Whenever adverse stormwater runoff related impacts are expected to result from the development of a property, the Stormwater Management Report shall describe in detail the proposed stormwater management plan. Plans, specifications and computations must be complete in detail sufficient to enable another Engineer to fully check and verify the results and computations. The plans used for construction must contain design data, a project narrative, schedule of construction, name and address or person responsible for construction and the Engineer's seal, signature and address on the engineering drawings required for the project construction.

This section of the report shall include the following items:

- Description of the overall stormwater management strategy
- Topographic maps showing all on-site and off-site contributing drainage areas,
- Basis for determining runoff coefficients and times of concentration,
- Inflow and outflow hydrographs with peak flows for the 1-, 25- and 100-year storm frequencies,
- Hydraulic performance properties for all stormwater management facilities (e.g., stage/storage/discharge curves, infiltration capacities, overflow relationships),
- Details and calculations for all outlet control structures, including buoyancy calculations and emergency spillways,
- Configuration of the stormwater management system, including outflow and overflow control devices, shall be clearly described in Report with cross-sections depicted on all construction drawings,
- Graded access easements, (maximum 3:1 slope) around all stormwater management ponds in areas inaccessible to vehicular traffic,
- Temporary sediment basins are required for all detention sites and major drainage exits. The detention facility shall be designed to provide temporary sediment control unless a live stream exists.
- Underground detention facilities with details that provide:
 - The location and type of access protection for the detention facility.
 - Safety requirements as specified by Forsyth County for the site.
- Outline of the maintenance procedure to be filed with Forsyth County for all components of the stormwater management report, and
- Summary of the proposed stormwater management approach and the expected performance.

Construction drawings submitted for stormwater management plan approval shall include the following:

- A vicinity map;
- Topography survey showing existing and proposed terrain, including the area to be included in the downstream analyses;
- Any proposed improvements including location of buildings or other structures, impervious surfaces, storm drainage facilities, and all grading;
- The location of existing and proposed structures and utilities;
- Any easements and rights-of-way;

- The delineation, if applicable, of the 100-year administrative floodplain and any on site wetlands;
- Structural and construction details for all components of the proposed drainage system or systems, and stormwater management facilities.
- All necessary construction specifications;
- A sequence of construction;
- Data for total site area, disturbed area, new impervious area, and total impervious area;
- A table showing the unified sizing criteria volumes required in the County Addendum to the Design Manual;
- A table of materials to be used for stormwater management facility planting;
- All soil boring logs and locations;
- A maintenance schedule;
- Certification by the owner/developer that all stormwater management construction will be done according to this plan; and
- An as-built certification signature block to be executed after project completion.

4.2 Post-Construction Requirements

4.2.1 As-Built Certification of Stormwater Management Facilities

After construction and before acceptance for occupation or otherwise, the designer shall submit a certified field run topographic map of all areas including the stormwater management facilities, a revised Stormwater Management Report (if needed), and a long-term inspection and maintenance covenant signed by the property owner or organization. The designer shall certify that the as-built conditions regarding storage and outflow meet Forsyth County requirements.

4.2.2 Inspection and Maintenance Covenant

Prior to the issuance of any new permit of occupancy, the developer must execute an inspection and maintenance agreement, and/or a conservation easement, if applicable, that shall be binding on all subsequent owners of the site. A copy of this covenant is provided in Section 5.3. The inspection and maintenance agreement shall identify by name or official title the person(s) responsible for carrying out the inspection and maintenance. Responsibility for the operation and maintenance of the stormwater management facility or practice shall remain with the property owner and shall pass to any successor owner. If portions of the land are sold or otherwise transferred, legally binding arrangements shall be made to pass the inspection and maintenance responsibility to the appropriate successors in title. These arrangements shall designate for each portion of the site, the person to be permanently responsible for its inspection and maintenance.

As part of the inspection and maintenance agreement, a schedule shall be developed for routine inspection and maintenance to ensure proper function of the stormwater management facility or practice. The agreement shall also include plans for annual inspections to ensure proper performance of the facility between scheduled maintenance events and shall also include remedies for the default thereof.

Maintenance by Private Parties

On all commercial sites and on residential property where stormwater management facilities exist, the maintenance of new and existing stormwater management facilities is the responsibility of the owner or operator of the property. Forsyth County Department of Engineering, Stormwater Division personnel will perform periodic inspections of existing and new private stormwater management facilities to determine whether they are maintained properly. Deficiencies will be noted to the owner or operator in writing. It shall be the responsibility of the owner or operator to repair deficiencies in a timely manner. Failure on the part of the owner or operator to repair deficient stormwater management facilities will be a violation of the Forsyth County Stormwater Ordinance and will be punishable according to Section 15, Penalties.

Maintenance by Property or Homeowners Associations

When any subdivision or industrial/ commercial park, whether new or existing, has a legally created property or homeowners association, the association will be responsible for maintenance of all drainage easements and all stormwater facilities within the entire development. The association may be required to apply larvicides, stock mosquito fish or take other measures, as required by the Department of Engineering, to protect the health, safety and welfare of the public. Any emergency maintenance required by Forsyth County will be done or subcontracted and the charge will be assessed to the association. Forsyth County Department of Engineering, Stormwater Division personnel may perform periodic inspections of existing and new private stormwater management facilities to determine whether they are maintained properly. Deficiencies will be noted to the association in writing. It shall be the responsibility of the association to repair deficiencies in a timely manner. Failure on the part of the association to repair deficient stormwater management facilities will be a violation of the Forsyth County Stormwater Ordinance and will be punishable according to Section 15, Penalties.

4.2.3 Spill Prevention and Containment Requirements (Commercial / Industrial)

Commercial / Industrial Spill Prevention

All proposed commercial and industrial facilities that store designated hazardous waste materials as defined in Sec. 34-184. Definitions. (c) of the Forsyth County Code of Ordinances for any purpose are required to submit a spill prevention and containment plan for the proposed facility. This plan must be submitted to the Director of the Engineering Department prior to the approval of the Final Plat. All chemical/raw material storage and handling must occur under a covered portion of the facility. Proposed storage areas must contain signs with phone numbers at Forsyth County and the State EPD for reporting spills.

Spill prevention and containment plans must address the following issues as a minimum:

- a) Description of the types and quantities of designated hazardous waste materials to be stored at the proposed facility.
- b) Measures that will be taken to prevent spills.
 - i) Chemical/raw material storage methods.
 - ii) Loading/unloading instructions.
- c) Spill containment measures.
 - i) Methods for spill capture and location of materials and equipment to implement these methods
 - ii) Provide graded berm around large storage areas for containment of spills. The storage inside the berm shall be at least 110% of the volume of the largest tank in the containment area. The containment area should be lined to prevent infiltration of the spillage in the ground.
- d) Document plan for collection of spilled materials and procedures to prevent the spill from entering the storm sewer system.

Commercial / Industrial Spill Notification and Containment

Notwithstanding other requirements of law, as soon as any person responsible for a facility, activity or operation, or responsible for emergency response for a facility, activity or operation has information of any known or suspected release of pollutants or non-stormwater discharges from that facility or operation which are resulting or may result in illicit discharges or pollutants discharging into stormwater, the Forsyth County separate storm sewer system, State Waters, or Waters of the U.S., said person shall take all necessary steps to ensure the discovery, containment, and cleanup of such release so as to minimize the effects of the discharge.

The person responsible for a facility, activity or operation, or responsible for emergency response for a facility shall:

- notify the Department of Engineering in person or by phone, facsimile or in person no later than 24 hours of the nature, quantity and time of occurrence of the discharge. Notifications in person or by phone shall be confirmed by written notice addressed and mailed to the Department of Engineering within three business days of the phone or in person notice.
- If the discharge of prohibited materials emanates from a commercial or industrial establishment, the owner or operator of such establishment shall also retain an on-site written record of the discharge and the actions taken to prevent its recurrence. Such records shall be retained for at least three years. Said person shall also take immediate steps to ensure no recurrence of the discharge or spill.
- In the event of such a release of hazardous materials, emergency response agencies and/or other appropriate agencies shall be immediately notified.

Failure to provide notification of a release as provided above is a violation of this ordinance.

Section 5. Supplemental Stormwater Documents

5.1 Stormwater Quality Site Development Review Tool Instructions

Source: *Instruction Guide, Stormwater Quality Site Development Review Tool, Version 1.1, Georgia Stormwater Management Manual, March 2004.* www.northgeorgiawater.com.

The Site Development Review Tool is used to evaluate the expected stormwater runoff quality from a proposed site design. It can be used for both residential and commercial developments, and allows site designers to easily perform “what if” analyses using different design scenarios. The Tool gives the site designer the option of utilizing a number of stormwater management approaches including nonstructural “site design” methods as well as the structural stormwater controls included in the Georgia Stormwater Management Manual.

The goal of using the Site Development Review Tool is to prepare a stormwater management system design that achieves the goal of an 80% reduction in the average annual total suspended solids (TSS) loading leaving the site. This can be achieved through any combination of nonstructural or structural approaches.

The Site Development Review Tool assumes that all of the runoff leaving the site is going to a common downstream drainage area, stream or other water body. For a development that lies in two or more distinct watersheds, the site should be divided up and a separate copy of the Tool be run and submitted for each watershed.

Overview of the Site Development Review Tool

The Site Development Review Tool spreadsheet has four main components:

1. Main Form
2. Drainage Area Worksheets
(each drainage area has its own individual sheet)
3. Structural Stormwater Control TSS Removal Efficiencies
4. Supplemental Information on Other Pollutants of Concern

When working with the Tool, the following fields will require input:

- All cells highlighted in yellow require user input
- All dropdown menus require user input
- All cells highlighted in blue require input from the local review staff

All other cells within the Tool are password-protected and cannot be changed.

Main Form (Summary Sheet)

Georgia Stormwater Management Manual
Stormwater Quality Site Development Review Tool

General Information

Name of Developer:	Shake Properties	Date Submitted:	1/26/2004
Development Name:	Clear Creek Apartments	Permit Number:	12345
Site Location / Address:	3111 Cloverhurst Circle East Park, GA	Contact:	Jack Jones
Development Type:	Medium Density Residential	Phone Number:	678-123-4567
Area of Development (acres):	50.00	Name of Engineer(s):	David Hansen, PE
		Maintenance Responsibility:	Home Owners Association

Summary of Site and Structural Control Information

Number of Drainage Areas: 3

Sum of Drainage Areas (ac): 50.00

Total (IA) Impervious Area (ac): 10.50

Total (DP) Disturbed Pervious Area (ac): 26.00

Total (NC) Natural Conservation Area (ac): 13.50

Percent Imperviousness (%): 21%

Land Use Distribution Pie

Section 2

Total # of Structural Controls Used: 3

General Application Structural Stormwater Controls		Limited Application Structural Stormwater Controls	
Stormwater Pond	1	Fiber Strip	1
Stormwater Wetland	0	Grass Channel	0
Detention Area	0	Sand Filter	0
Sand Filter	0	Stormwater Control Wetland	0
Infiltration Trench	0	Gravity (Oil-Grit) Separator	0
Enhanced Swale	0	Porous Concrete™	0
Detention Structural Stormwater Controls	0	Modular Porous Paver System™	0
Dry Detention / Dry ED Basin	0	Alum Treatment System	0
Multi-Purpose Detention Area	0	Proprietary Structural Control™	0
Underground Detention	0		

TSS Reduction

Total TSS Reduction (%): 81%

Section 4

Official Use Only

Tracking #:

Reviewed By:

Date Approved:

Conditions of Approval:

Section 5

FIGURE 5-1. SUMMARY SHEET

The Main Form has five sections (see Figure 5-1):

Section 1: General Information

The first section requires the user to fill out general site information. This includes the Name of Developer, Name of Development, Site Location and Address, Type of Development or Land Use Category (to be selected from a pull-down list), Area of Development (in acres), Date Submitted, Permit Number (if applicable), Contact Name and Phone Number, Name of Engineer, and Party for long-term Stormwater Maintenance Responsibility.

Section 2: Land Use Distribution

The second section shows the land use distribution for the entire site, which is based upon the data provided for each drainage area. This includes the amount of Impervious Area (IA), Disturbed Pervious Area (DP) and Natural Conservation Area (NC). If the *Sum of Drainage Areas* does not equal the *Area of Development* entered in Section 1, then the message "Land Use Distribution Error" will appear. Simply ensure that the proper information has been entered for each drainage area.

Section 3: Structural Control Information

The third section is a summary of all the structural controls chosen for the site, which is based upon the selections provided for each drainage area. The “Generate Tracking Forms” button located within this section allows the user to generate tracking forms for each structural control proposed on the site (see Figure 5-2). This information can be used for long-term maintenance tracking.

Section 4: TSS Reduction Summary

The fourth section is a summary of the total suspended solids (TSS) reduction from each of the drainage areas as well as the overall TSS reduction efficiency of the entire proposed site. The overall TSS reduction for the entire site must be at least 80% to meet the recommendations of the Georgia Stormwater Management Manual.

Section 5: Comments

The fifth section is used for comments and tracking purposes by local review staff. Leave this blank unless given instructions by the local review authority.

Drainage Area Worksheets

The Drainage Area Worksheets are used to provide the land use and stormwater management information for the proposed site. On many sites, there is more than one drainage outlet from the site or it may not be physically possible to treat the runoff from the entire site at a single location. In these cases, the proposed site needs to be evaluated as two or more separate drainage areas, with the information for each area provided on a separate Drainage Area Worksheet. This tool allows a proposed development to be split into 10 drainage areas.

GA Stormwater Management Manual - Site Development Review Tool	
Structural Control Tracking Form	
Project Information	
Development Name:	B-Line Office Park
Developer:	King Properties
Address:	3111 Cloverhurst Circle East Park, Ga 30099
Contact:	Jack Jones
Phone Number:	123-234-3456
Organization Responsible for Maintenance:	Property Manager
Structural Control Information	
Structural Control Identifier:	USF-01-1
District LL Parcel:	NA
Watershed Basin:	NA
Comm. District:	NA
Type of Structural Control	Underground Sand Filter
Land Use	Office/Professional
Treated Area (in acres)	5.00
Maintenance Responsibility	Property Manager
Official Use Only	
Node Number:	
Maintenance Agreement:	Y / N / R
Maintenance Bond Length (months):	
Bond Exp. Date:	
Review Date:	
Reviewer:	
Permit Number:	GA12345
Notes:	
CH2M HILL	

FIGURE 5-2. STRUCTURAL CONTROL TRACKING FORM

The Drainage Area Worksheet includes sections for land use information, areas treated by non-structural controls (site design credits), structural control selection and downstream treatment. It graphically calculates and displays the Water Quality Volume (WQ_v) and TSS Reduction for the structural control(s) and the entire drainage area (which includes both structural controls and the non-structural controls).

The Drainage Area Worksheet has six sections (see Figure 5-3):

Section 1: Land Use Distribution

The first section requires the user to provide the size of the drainage area as well as the proposed land use (in acres). The three choices include:

- Impervious Area (IA) – The planned impervious (paved or covered) area. This includes streets and roadways, sidewalks, buildings, parking areas and structures, homes, driveways, walkways, patios, and all other surfaces that do not allow the infiltration of rainwater.
- Disturbed Pervious Area (DP) -- All other areas that will be cleared/graded and revegetated.
- Natural Conservation Area (NC) – The area that will be left in an undisturbed natural vegetated state in perpetuity.

After entering the land use areas, the imperviousness of the drainage area will be calculated and a graphical distribution of the land use will be displayed. [NOTE: *The "Total Area for check" field will turn red if the sum of land use areas does not equal the value input at the top*]

Drainage Area 01			
Land Use Distribution (acres)			
Enter Total Area :	12.60		
Enter Impervious Area (IA) :	5.91		
Enter Disturbed Pervious Area (DP) :	4.54		
Enter Natural Conservation Area (NC) :	2.15		
Total Area for check :	12.60		
Percent Imperviousness (%) :		47%	
Non-Structural Controls (Site Design Credits)		Water Quality Volume (WQ _V)	
Natural Conservation Area (acres):	2.15	WQ _V (ac-ft) w/o Credits = 0.595	
Enter Area (acres) Treated by (if applicable):		WQ _V w/ Non-Struc. Credits = 0.400	
Undisturbed Stream Buffers :	1.74		
Vegetated Channels :			
Overland Flow Filtration / Recharge :	0.23		
Total Area receiving Credits (acres):	4.12		
Structural Controls		TSS Reduction Chart	
Select Structural Control(s)	Control ID	TSS Reduction from Structural Controls: 80%	
Control 1 Stormwater Pond	STP-01-1		
Control 2 NONE	NONE		
Control 3 NONE	NONE		
Control 4 NONE	NONE		
Control 5 NONE	NONE		
Additional Downstream Treatment			
If the runoff leaving this area is treated by one or more additional structural controls downstream, please specify the appropriate drainage area(s) below:			
<input type="checkbox"/> DA 2 <input type="checkbox"/> DA 3 <input type="checkbox"/> DA 4 <input type="checkbox"/> DA 5 <input type="checkbox"/> DA 6 <input type="checkbox"/> DA 7 <input type="checkbox"/> DA 8 <input type="checkbox"/> DA 9 <input type="checkbox"/> DA 10			
Total TSS Reduction Using Non-Structural Controls (Site Design Credits), Structural Controls, and Additional Downstream Treatment (if applicable):		83%	
Local Government Specific Information (fill in only if required by your Review Department)			
Watershed Basin:		District/LL/Parcel:	Comm. District:

FIGURE 5-3. DRAINAGE AREA WORKSHEET

Section 2: Non-Structural Controls (Site Design Credits) and Water Quality Volume

The second section allows the site designer to take credit for the use of nonstructural controls, also known as “Stormwater Better Site Design Credits” in the Georgia Stormwater Management Manual. These credits include:

- Natural Conservation Area – Undisturbed natural areas in the drainage area that are conserved and protected in their existing vegetated state. In order to count as

a credit, these areas *must* have a minimum contiguous area of 10,000 square feet (0.23 acres) and cannot be disturbed during project construction. Natural conservation areas are subtracted from the total drainage area when computing the water quality volume and provide 100% TSS removal in the area-based TSS reduction calculation. The natural conservation area from Section 1 is carried down and displayed as long as it meets the minimum 10,000 square foot requirement.

- Undisturbed Stream Buffers – Portion(s) of the drainage area *treated* by a naturally vegetated or forested riparian buffer. [NOTE: *The buffer itself should be counted as a natural conservation area*] The *minimum* buffer width required for this credit is 50 feet, and the *maximum* contributing drainage length allowed to the buffer is 150 feet for pervious areas and 75 feet for impervious areas. In addition, the average slope of the contributing drainage area *must* be 3% or less (unless a flow spreader is used) and the runoff *must* enter the buffer as overland sheet flow. Areas treated by undisturbed stream buffers are subtracted from the total drainage area when computing the water quality volume and provide 80% TSS removal in the area-based TSS reduction calculation.
- Vegetated Channels – Portions of the drainage area treated by vegetated (grass) channels. This credit can *only* be applied to moderate- to low-density residential land uses (3 dwelling units per acre maximum) with channel slopes of 3% or less. The maximum flow velocity for the water quality design storm *must* be less than or equal to 1.0 feet per second. Areas treated by vegetated channels (as a site design credit) are subtracted from the total drainage area when computing the water quality volume and provide 80% TSS removal in the area-based TSS reduction calculation. [NOTE: *This credit cannot be taken if grass channels are being used as a structural control in Section 3 for the same portion of the drainage area*]
- Overland Flow Filtration / Recharge – Portions of the drainage area (impervious areas) such as rooftops, driveways or small parking lots that drain to pervious vegetated areas. The *maximum* impervious surface area for any given overland flow discharge is 5,000 square feet (0.115 acres). The receiving area *must* have relatively pervious soils (hydrologic soil groups A or B) and have a slope of 3% or less. In addition, the *maximum* contributing impervious drainage length is 75 feet, and the length of the flow path across the pervious area must be equal to or greater than the contributing length. Areas treated by overland flow filtration are subtracted from the total drainage area when computing the water quality volume and provide 80% TSS removal in the area-based TSS reduction calculation.

After entering the site design credits, the tool calculates and graphically displays the Water Quality Volume (WQ_v) for the drainage area before and after site design credits are applied. The latter volume is the *adjusted* WQ_v that must be adequately treated to achieve an overall site TSS reduction of 80%. Structural controls must be sized and designed to treat this volume. [NOTE: *Structural control designs must also take into account the additional runoff from site design credit areas if these drain to the structural control*]

The tool does not have an explicit entry for the Environmentally Sensitive Large Lot Subdivision site design credit in the Georgia Stormwater Management Manual. However, if the site design follows the criteria for this credit (2 acre minimum lot size, total impervious cover less than 15%, use of grass channels instead of curb and gutter, and disconnected rooftop runoff as overland flow filtration), then adjust one or more of the non-structural credits (stream buffers, vegetated channels, and overland flow filtration) until the adjusted WQ_v is reduced to zero.

Section 3: Structural Controls and TSS Reduction Chart

The third section allows the site designer to specify the structural controls that will be used to treat the adjusted WQ_v calculated in Section 2. The dropdown menus include General and Limited Application and Detention structural controls from the Georgia Stormwater Management Manual. The tool automatically assigns a Control Identification Number (ID) for each structural control. This ID should be used to identify the facilities on the proposed development site and stormwater management reports.

Multiple controls can be specified if more than one structural control is used in a “treatment train” process. The first control in the treatment train would be Control 1, the second would be Control 2, etc. [NOTE: *Structural controls in downstream drainage areas should be specified in Section 4*]

The tool then automatically calculates the combined pollutant removal efficiency for multiple structural stormwater controls in a treatment train, and graphically displays the cumulative TSS reduction efficiency for the multiple controls in the treatment train. The cumulative efficiency can be easily compared against the 80% TSS reduction target.

An overview of pollutant removal calculations for structural controls in series is found in the Appendix.

Section 4: Additional Downstream Treatment

The fourth section allows the user to specify whether the runoff from the current drainage area is treated by additional structural controls in drainage areas downstream. The site designer should use the check boxes to denote all downstream drainage areas that will treat 100% of the runoff leaving the current drainage area. [NOTE: *If only a portion of this runoff will be treated downstream then leave the box unchecked*] The adjusted pollutant removal efficiency will be applied to the runoff of the current drainage area after the information for the downstream drainage areas are entered.

Section 5: Total TSS Reduction

The fifth section calculates the overall TSS reduction efficiency for the given drainage area after applying the site design credits, structural control removal efficiencies, and treatment by downstream drainage areas (if applicable).

Section 6: Local Government Specific Information

If required, the user will use this section to provide watershed- and parcel-specific information regarding the drainage area for tracking purposes. Leave this blank unless given instructions by the local review authority.

Structural Control TSS Removal Efficiencies

This sheet contains the pollutant reduction efficiencies for total suspended solids (TSS) for each structural control based on the Georgia Stormwater Management Manual. Please refer to the Manual for more information.

Supplemental Information on Other Pollutants of Concern (Total Phosphorus, BOD, and Lead)

The Georgia Stormwater Management Manual does not include target reduction goals for other pollutants, though it does provide design removal efficiencies for several other pollutants of concern. This component provides estimates of the reduction in total phosphorus (TP), biochemical oxygen demand (BOD) and lead to assist local governments in assessing the performance of stormwater control. This sheet presents summaries for TP, BOD and lead by drainage area. The algorithms described for TSS in the sections above are used to compute the pollutant reduction efficiencies.

Default reduction efficiency information for TP, BOD, and lead is provided in this component based on the Georgia Stormwater Management Manual and other sources. If literature data were not available, "NA" is listed.

Calculating Pollutant Removal for Structural Controls in Series

Pollutant removal calculations for structural stormwater controls in series (also known as a "treatment train") take into account that the majority of the heavy (easily removed) suspended pollutants and particulate matter will be removed by the first structural control in a treatment train. Therefore, the runoff leaving the first structural control contains much smaller pollutant particles. As these smaller particles are much harder to remove, the *effective* removal efficiency of the subsequent downstream structural controls is significantly reduced.

To estimate the pollutant removal rate of structural controls in series, the effective removal efficiency of a downstream structural control is reduced to account for the pollutant removal of the upstream control(s). The following two cases are used:

Case 1. Two structural controls in series, with the more efficient control downstream -or- both controls having the same removal efficiency

In these cases, the following equation applies:

$$TRR = R_d + 0.5 R_u^2(1-R_d)/R_d$$

Where: TRR = total removal rate (fraction)

R_u = upstream removal rate (fraction)

R_d = downstream removal rate (fraction)

Example 1 - Two structural controls in series, both have a TSS removal efficiency of 80%. The total removal rate would be:

$$TRR = 0.80 + [0.5 * 0.80^2 * (1-.80)]/0.80 = 0.88 \quad \text{or} \quad 88\%$$

Example 2 – An upstream structural control has a removal rate of 40%, the downstream control has a removal rate of 70%. The total removal rate would be:

$$TRR = 0.70 + [0.5 * 0.40^2 * (1-0.70)]/0.70 = 0.734 \quad \text{or } 73.4\%$$

Case 2. Two structural controls in series, with the more efficient control upstream

In this case, the following equation applies:

$$TRR = R_u + (0.57 R_d/R_u - 0.07) (1-R_u) R_d$$

Where: TRR = total removal rate (fraction)

R_u = upstream removal rate (fraction)

R_d = downstream removal rate (fraction)

Example – An upstream control has a 70% removal rate, the downstream control has a 40% removal rate. The total removal rate would be:

$$TRR = 0.70 + [0.57 * (0.40/0.70) - 0.07] * (1 - 0.70) * 0.40 = 0.731 \quad \text{or } 73.1\%$$

It is assumed that the removal capability of the downstream control is proportional to the ratio of the downstream to upstream control removal efficiencies. That is, if the removal rates are nearly equal then the downstream control should achieve a greater contribution than if its removal efficiency is small relative to the upstream control. In the limiting case where the two are equal, the equation will be identical to Case 1.

It is assumed that if the downstream control is 1/8 of the upstream control's efficiency its removal rate is zero (e.g. a 10% efficiency control downstream from a general application control would have zero removal credit). If it is equal to the upstream control its removal rate is half. Removals are assumed to vary linearly between these two extremes.

The following assumptions serve as the basis for this approach:

- This methodology is limited to TSS and related particulate removal.
- The maximum TSS removal efficiency for a stand-alone structural control is assumed to be 80% (all general application structural controls have an 80% TSS removal efficiency).
- The combined removal rate can never be less than the removal rate of the most effective of the controls, and never more than the equivalent of the more effective control plus half the effectiveness of the less effective control operating on the remaining pollutant.
- For a control of lesser efficiency downstream from one of greater efficiency the removal ability of the downstream control is assumed to be zero if its independent removal rate is ten percent. It varies in a linear fashion up to the case where it equals the upstream control.

The graph in Figure 5-4 shows the graphic results of the equations presented above and can be used to quickly determine the total TSS removal rate for two structural controls in series.

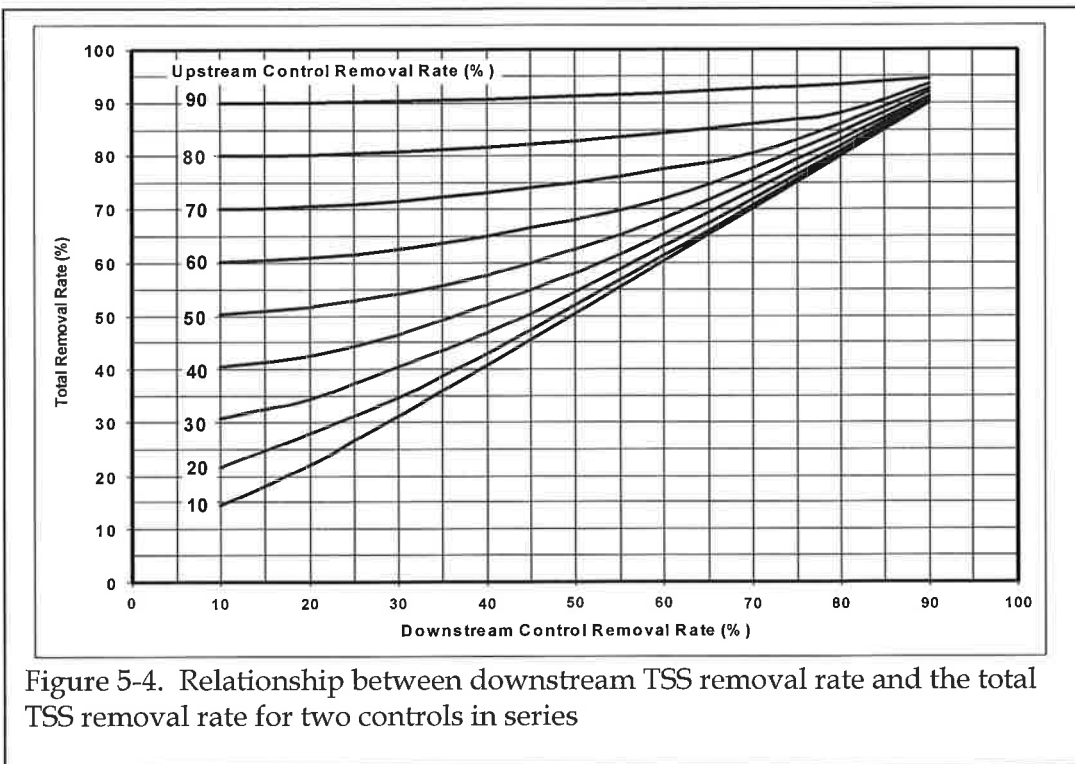


Figure 5-4. Relationship between downstream TSS removal rate and the total TSS removal rate for two controls in series

STORMWATER MANAGEMENT/BMP

FACILITIES COVENANT

Forsyth County, Georgia

Department of Engineering

(770) 781-2165

THIS Covenant made and entered into this _____ day of _____, 20__, by and between (Insert Full Name of Owner) _____ hereinafter called the "Landowner", and Forsyth County, Georgia hereinafter called the "County."

WHEREAS, the Landowner is the owner of certain real property described as (Forsyth County Tax Map/Parcel Identification Number) _____ as recorded by deed in the land records of Forsyth County, Georgia at Deed Book _____ Page _____, hereinafter called the "Property;" and

WHEREAS, the Landowner is proceeding to, or has, made improvements on the Property; and

WHEREAS, the Site Plan/Subdivision Plan known as _____ (Name of Plan/Development) hereinafter called the "Plan," which is expressly incorporated herein by reference, as approved, or to be approved, by the County, provides for detention of stormwater within the confines of the Property; and

WHEREAS, the County requires that onsite stormwater management/BMP facilities as shown on the Plan be constructed and adequately maintained by the Landowner, its successors and assigns, including any homeowners association;

WHEREAS, Chapter Seven of the Georgia Stormwater Management Manual (First Edition, August 2001) addresses issues relating to the operation and/or maintenance of stormwater systems; and

WHEREAS, the Landowner, its successors and assigns, understands that the execution and adherence to the provisions of this Covenant is a condition precedent to the County's permitting, and/or approving the final plat for the Property and subdivision located thereon;

NOW THEREFORE, in consideration of the foregoing premises and mutual covenants the parties hereby agree as follows:

1. The on-site stormwater management/BMP facilities shall be constructed, operated, and maintained by the Landowner, its successors and assigns, in accordance with the plans and specifications identified in the Plan, as well as in accordance with State and federal law, the Georgia Stormwater Management Manual, and any and all applicable County ordinances.
2. The Landowner, its successors and assigns, including any homeowners association, shall adequately maintain the stormwater facilities and improvements on the Property. Adequate Maintenance required by this Covenant shall include, but is not limited to, scheduled and corrective maintenance of all facilities and improvements intended to manage and/or control stormwater on the Property, with such facilities and improvements to expressly include, but not be limited to pipes, channels structures, vegetation, berms, outlet structures, pond areas, access roads, or any other improvement relating to stormwater on the Property, but excluding any such improvements located on, under, or within any publicly owned rights of way (the "Stormwater Facilities and Improvements"). . Adequate maintenance is herein defined as keeping such Stormwater Facilities and Improvements in good working condition such that they satisfactorily perform their intended design functions.
3. The Landowner, its successors and assigns, shall inspect the Stormwater Facilities and Improvements and submit an inspection report to the County on an annual basis. The purpose of the inspection is to assure safe and proper functioning of the Stormwater Facilities and Improvements located on the Property. Each annual inspection shall include a full and complete inspection of all Stormwater Facilities and Improvements located on the Property. Any and all deficiencies identified during such inspections shall be noted in the inspection report submitted to the County. The inspection report shall also include a detailed plan for any and all repairs to the Stormwater Facilities and Improvements necessary to correct any deficiencies identified during the inspection, with the repair plan to be prepared by a professional engineer, or some other duly qualified professional, licensed in the State of Georgia.
4. The Landowner, its successors and assigns, hereby grants permission to the County, its authorized agents and employees, to enter upon the Property and to inspect the Stormwater Facilities and Improvements as deemed necessary by the County for purposes of protecting the public health, safety or welfare, for purposes of investigating or inspecting any

reported or suspected deficiencies in the Stormwater Facilities and Improvements on the Property, for purposes of responding to or investigating citizens' complaints relating to the management or control of stormwater on the Property, or for any other purpose deemed necessary by the County. The County shall provide the Landowner, its successors and assigns, with a copy of the any inspection findings, as well as a directive to commence with any required repairs. To the extent that the County does not agree with or to the contemplated repairs proposed by the Landowner, the County may submit an alternate repair plan to the Landowner.

5. In the event the Landowner, its successors and assigns, fails to maintain the Stormwater Facilities and Improvements on the Property in good working condition acceptable to the County, or fails to make repairs as specified in the inspection report within a reasonable time frame as established by the County, with such timeframe not to be shorter than thirty (30) days, the County may enter upon the Property and take any and all action necessary to correct deficiencies identified in the inspection report. The Landowner, its successors and assigns, shall be responsible for any and all fees and expenses incurred by the County in taking such corrective action. This provision shall not be construed to allow the County to erect any structure of a permanent nature on the land of the Landowner outside the easement for the stormwater management/BMP facilities. It is expressly understood and agreed that this Covenant imposes no obligation or responsibility on the County to routinely maintain or repair any Stormwater Facilities and Improvements located on the property
6. The Landowner, its successors and assigns, will perform all work necessary to keep the Stormwater Facilities and Improvements in good working condition as required by the approved Plan, as well as by State and federal law, the Georgia Stormwater Management Manual, and any and all applicable County ordinances.
7. In the event that the County performs or undertakes work of any kind pursuant to this Covenant or expends any funds or resources in performance of said work for labor, use of equipment, supplies, material, and the like, the Landowner, its successors and assigns, shall reimburse the County upon demand, within thirty (30) days of receipt of same.
8. This Covenant shall impose no liability on the County with respect to the maintenance or repair of any Stormwater Facilities and Improvements on the Property, nor does the County assume any obligation or duty to undertake or perform any action allowed for, or permitted by, this

Covenant. The Landowner, its successors and assigns, further agrees to indemnify and hold the County harmless from any liability arising out of the management, operation, maintenance, or failure of any Stormwater Facilities and Improvements subject to this Covenant.

9. Notwithstanding any right extended to the County pursuant to this Covenant, it is expressly recognized and acknowledged that the County retains all prosecutorial rights and remedies available to it, including the enforcement of any and all applicable County ordinances, against the Landowner, its successors and assigns, relating to the operation, maintenance, and/or repair of Stormwater Facilities and Improvements located on the Property.
10. This Covenant shall be recorded among the land records of Forsyth County, Georgia, and shall constitute a covenant running with the land, and shall be binding on the Landowner, its administrators, executors, assigns, heirs and any other successors in interests, including any homeowners association.

WITNESS the following signatures and seals

Company/Corporation/Partnership Name (Seal)

By: _____
(Signature)

(Type/Print Name)

(Type/Print Title)

STATE OF _____

COUNTY OF _____

The foregoing Instrument was acknowledged before me this ____ day of _____, 2_____, by

_____.

NOTARY PUBLIC

(SEAL)

My Commission Expires: _____

Attachment A
Responsible Person

The Landowner hereby identifies the responsible person or position responsible for ensuring that the inspection and maintenance of the Stormwater Facilities and Improvements is accomplished according to the inspection and maintenance schedule prepared by the engineer of record for this
Property_____

(Address or Name of the Property) as _____
(name and title of person so identified).

Results of the inspections shall be submitted annually to Forsyth County.
Inspection reports shall be submitted to:

Forsyth County
Department of Engineering
110 East Main Street
Suite 120
Cumming, GA 30040

If the responsible entity or contact person changes Forsyth County shall be notified in writing of the change not later than thirty (30) days from the effective date of such change.

Responsible Entity

Contact Person's Name

Signature

Address

City, State, Zip Code

Phone Number

Attachment B
Required Inspection and Maintenance Schedule

Attach a maintenance and inspection schedule. Refer to Chapter 3 of the Georgia Stormwater Management Manual for minimum recommended inspection and maintenance requirements.