BRUNSWICK COUNTY, NORTH CAROLINA

Storm Water Management Manual

Approved by
Brunswick County Board of Commissioners
September 16, 2002

1.0 Introduction

1.1 Purpose of the Brunswick County Storm Water Program

Brunswick County (County) is an important regional center that offers a wide range of employment opportunities, business and professional services, and important historical, cultural, and recreational attractions. Brunswick County residents desire to maintain the character of their communities and sustain and improve the excellent quality of life that the area provides. Residents and County officials favor growth and development that is environmentally-responsible, well-designed and located, and respectful of the character of the County. Future development is expected to involve a mix of residential development with varying densities and building styles, as well as new business, industrial, and institutional land uses. It is the purpose of the Brunswick County Storm Water Program (Program) to meet the current and anticipated needs for storm water services and to protect public and private properties, rivers, estuaries, and other water bodies from unnecessary damage due to storm water releases and non-point source pollution. The provision of those services will be based upon compatibility with the County's development plans, the County's taxpayers and developers financial capacities, and upon compliance with applicable Federal and State laws and regulations.

1.2 Summary of Goals and Elements of the Brunswick County Storm Water Program

The goals of the Program are to:

- Minimize the public's risk of injury and death and limit damages to private and public property caused by storm water runoff within the County's jurisdiction.
- Maintain and increase the riparian buffers along the streams and waterways within the County's jurisdiction.
- Provide for the public's health, safety, and welfare by protecting the water quality of the County's rivers, estuaries, and other water bodies and wetlands.
- Ensure County compliance with all applicable Federal and State regulations.

In order to meet these goals, the County will require anyone proposing new non-residential development or residential development that will ultimately result in disturbance of one acre or more of land or anyone proposing new developments within 30 feet of intermittent and perennial streams or other water bodies, to obtain a

Brunswick County Storm Water Permit. Obtaining a Brunswick County Storm Water Permit requires property owners and developers to address five topics:

1.2.1 Protecting and Enhancing Riparian Areas

The Brunswick County Storm Water Quality Management and Discharge Control Ordinance (Brunswick County Storm Water Ordinance) requires that the County protect riparian buffers on new developments. The Program will ensure that a 30-foot riparian buffer will be maintained on all sides of intermittent and perennial streams and other water bodies within the County's jurisdiction during future development. The Program will also seek restoration and enhancement of impaired buffers within the County's jurisdiction. The County seeks to cooperate with other communities and with the North Carolina Wetlands Restoration Program (NCWRP) and others to ensure that available funds are best used to protect water quality and provide attractive green space.

1.2.2 Controlling Peak Storm Water Discharges

Controlling the peak discharge rate of water leaving a developed area is one of the key factors in managing the impact of new development on the property of downstream landowners, on the County's roads, buildings, and storm water facilities, and on local streams and other natural water bodies.

The Program sets a goal of no net increase in runoff occurring from permitted development. It requires that all developments obtaining a Stormwater Permit control water runoff so that there is no more than a 5 percent net increase in the peak discharge from the predevelopment conditions for the 10-year, 24-hour storm as defined in this Brunswick County Storm Water Management Manual (Manual). Where this restriction places an undue hardship upon a property owner, a variance may be granted by the Storm Water Administrator to developments that meet the following requirements:

- The proposed new development appropriately uses the parcel's total remaining pervious area, to the extent practical, to convey and control the storm water runoff, and it is demonstrated to the satisfaction of the Storm Water Administrator that no damage to public or private properties will be caused by granting of the variance, including damage to the County's storm water facilities and to the quality of the public waters.

The Program also requires that all new permitted development control storm water runoff so that there is no net increase in the peak discharge from the predevelopment conditions for the 1-year, 24-hour storm as defined in this Manual. Where this requirement places an undue hardship upon a property owner, variances from the requirement may be granted by the Storm Water Administrator to developments that meet one or both of the following requirements:

- The development will control the impacts of development on the quantity and quality of storm water runoff to the Maximum Extent Practicable. The increase in peak flow for pre- to post-development conditions does not exceed 5 percent and it is demonstrated to the satisfaction of the Storm Water Administrator that no damage to public or private properties will be caused by granting of the variance, including damage to the County's storm water facilities and to the quality of the public waters.
- The proposed new development does not cause the development parcel's total impervious area to exceed 15 percent, the remaining pervious portions of the site are utilized to the Maximum Extent Practical to convey and control the storm water runoff, and it is demonstrated to the satisfaction of the Storm Water Administrator that no damage to public or private properties will be caused by granting of the variance, including damage to the County's storm water facilities and to the quality of the public waters.

1.2.3 Controlling Export of Pollutants

Owners and developers of all new non-residential developments and residential developments that will ultimately disturb an area of one acre or more must obtain a Storm Water Permit before any land disturbing activities occur. Criteria and methodologies are established in this Manual for the documentation of expected export of specific pollutants (nutrients, specifically total nitrogen and total phosphorus; suspended sediments; and fecal coliforms). All applications for a Storm Water Permit must include calculations of the nutrient, suspended solids, and fecal coliform exports from the proposed disturbance or development consistent with the methods specified in this Manual.

1.2.4 Use of Best Management Practices (BMPs)

The Program seeks to encourage the use of modern design principles and management practices that will allow the community to grow and prosper while

reducing the pollution of our land and water. The Program encourages and, in some cases requires, the use of BMPs from the conceptual design of a new development project through the project's construction and operation. Chapter 7 of this Manual describes some of the project design BMPs that can be used to minimize the negative impacts of development. Chapter 8 describes some of the structural BMPs that may be used to reduce the remaining impacts.

1.2.5 Maintaining BMPs

In order to be effective, BMPs for storm water control must be appropriately maintained. The Program includes an annual inspection program under which County staff, or others working in their behalf, will inspect BMPs and their maintenance records. The Program may provide procedures under which the County will accept the responsibility by maintaining BMPs servicing residential properties and establishing the requirement that BMPs servicing non-residential properties be maintained by their owners. The County will have the authority and capability to perform necessary maintenance of all BMPs and will charge delinquent owners for maintenance services that the County performs.

1.3 Stormwater Quality Management and Discharge Control Ordinance

This Brunswick County Board of Commissioners adopted the Stormwater Quality Management and Discharge Control Ordinance on September 16, 2002. A copy of that Ordinance is contained in Appendix D of this Manual. The purpose of this Manual is to present materials that help to explain the Ordinance and to illustrate the technical requirements and practices that may be used to ensure compliance with it. Any disagreements between statements in the Ordinance and in this Manual are to be resolved in favor of the Ordinance.

1.4 Disclaimer

This Manual is established to provide the County's Storm Water Administrator, property owners, developers, engineers, surveyors, and builders a better understanding of acceptable methods to meet the intent of the County's Storm Water Quality Management and Discharge Control Ordinance. Design of storm water management for development requires experienced judgment by the designer. The County accepts no responsibility for any loss, damage or injury as a result of the use of this Manual.

2.0 Definitions

The terms used in this Manual shall have the following meanings:

(a) **Applicant:** An owner or developer of a site who executes the Storm Water Permit Application pursuant to the County's Storm Water Quality Management and Discharge Control Ordinance (hereinafter "Storm Water Ordinance").

(b) **Best Management Practices**: Activities, practices, and procedures to prevent or reduce the discharge of pollutants directly or indirectly to the storm drain system and waters of the United States. BMPs include but are not limited to: treatment facilities to remove pollutants from storm water; operating and maintenance procedures; facility management practices to control runoff, spillage or leaks of non-storm water, waste disposal, and drainage from materials storage; erosion and sediment control practices; and the prohibition of specific activities, practices, and procedures and such other provisions as the County determines appropriate for the control of pollutants. Please refer to Chapters 7 and 8 and Appendix C of this manual for further information and specific requirements.

(c) **Bona Fide Farm**: Any tract of land containing at least one acre, which is used for activities relating to production, and activities incidental to production of crops, fruits, vegetables, ornamental and flowering plants, grasses and grains, forest products, dairy, livestock, fish and shellfish, poultry, and other agricultural products having a domestic or foreign market, and excludes commercial and industrial processing.

(d) **Built-upon Area**: Built-upon areas shall include that portion of a development project that is covered by impervious or partially impervious cover including buildings, pavement, gravel roads, and recreation facilities.

(e) **Channel Bank**: The location of the upper edge of the active channel above which the water spreads into the overbanks on either side of the channel or the elevation of the two-year frequency storm. Where the channel bank is not well-defined, the channel bank shall be considered the edge of the waterline during a two-year frequency storm.

(f) **Clean Water Act**: The Federal Water Pollution Control Act (33 U.S.C. § 1251 et seq.), and any subsequent amendments thereto.

(g) **Cluster Developments**: Grouping of buildings in order to conserve land resources and provide for innovation in the design of the project including minimizing storm water runoff impacts. This term includes non-residential development, Planned Unit Developments (PUDs), and single and multi-family residential developments.

(h) **Construction Activity**: Activities subject to National Pollution Discharge Elimination System (NPDES) Construction Permits. Such activities include, but are not limited to, clearing and grubbing, grading, excavating, and demolition.

(i) **County**: Brunswick County, North Carolina.

(j) **Design Storm**: The specific frequency and, if necessary, duration of the rainfall event to be used in design to meet the criteria established in this Manual.

(k) **Development**: Any land disturbing activity which adds to or changes the amount of impervious or partially impervious cover on a land area or which otherwise decreases the infiltration of precipitation into the soil.

(l) **Drainage Structures**: Shall include swales, channels, storm sewers, curb inlets, yard inlets, culverts, and other structures designed or used to convey storm water.

(m) **Hazardous Materials**: Any material, including any substance, waste or combination thereof which, because of its quantity, concentration, or physical, chemical or infectious characteristics may cause, or significantly contribute to, a substantial present or potential hazard to human health, safety, property, or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

(n) **Illegal Discharge**: Any unlawful disposal, placement, emptying, dumping, spillage, leakage, pumping, pouring or other discharge of any substance other than storm water into a storm water conveyance system, the waters of the State or upon the land such that the substance is likely to reach a storm water

conveyance system or waters of the State constitutes an illegal discharge, except as exempted in Division II, Section 2.1 of the Brunswick County Storm Water Ordinance.

(o) **Illicit Connections**: An illicit connection is defined as either of the following:

1. Any drain or conveyance, whether on the surface or subsurface, which allows an illegal discharge to enter the storm water system including but not limited to, any conveyances which allow any non-storm water discharge including sewage, process wastewater, and wash water to enter the storm water system and any connections to the storm water system from indoor drains and sinks, regardless of whether said drain or connection had been previously allowed, permitted or approved by a government agency; or

2. Any drain or conveyance connected from a commercial or industrial land use to the storm water system, which has not been documented in plans, maps or equivalent records and approved by the County.

(p) **Industrial Activity**: Activities subject to NPDES Industrial Permits as defined in U.S. 40 CFR, Section 122.26 (b)(14).

(q) **Impervious Surface**: Any surface that, in whole or part, restricts or prevents the natural absorption of water into the ground. Such surfaces may include, but are not limited to, compacted earth (such as marl and coquina), gravel, concrete, asphalt or other paving material, and all areas covered by the footprint of buildings or structures. Uncovered wooden slatted decks and the water area of a swimming pool are considered pervious.

(r) **Intermittent Streams**: A natural drainage way, including streams that appear as a blue line on the United States Geological Survey (USGS) 7.5-minute quadrangle maps, that has a contributing drainage area of 300 acres or less, shall be considered an intermittent stream for the purposes of this Manual.

(s) **Land Disturbing Activities**: The use of land by any person that results in a change in the natural cover or topography that may contribute to or alter the quantity and or quality of storm water runoff.

(t) **Major Subdivision**: The division of a tract of land into six (6) or more lots.

(u) **Minor Subdivision**: Any development or subdivision of land that does not meet the description of a major subdivision.

(v) **NPDES Storm Water Discharge Permits**: General, group, and individual storm water discharge permits that regulate facilities defined in federal NPDES regulations pursuant to the Clean Water Act.

(w) **Natural Drainageway**: An incised channel with a defined channel bed and banks that are part of the natural topography. Construction channels, such as drainage ditches, shall not be considered a natural drainageway unless the constructed channel was a natural drainageway that has been relocated, widened or otherwise modified.

(x) **Non-Storm Water Discharge**: Any discharge to the storm water system that is not composed entirely of storm water.

(y) **Perennial Stream**: Perennial streams are streams that have essentially continuous flows and are shown on the USGS 1:24,000 (7.5 min.) scale topographic maps. Streams that have a contributing drainage area of more than 300 acres shall be considered a perennial stream for the purposes of the Brunswick County Stormwater Quality Management and Discharge Control Ordinance.

(z) **Plat**: A map or plan of a parcel of land, which is to be or has been subdivided or developed.

(aa) **Pollutant**: Anything which causes or contributes to pollution. Pollutants may include, but are not limited to: paints, varnishes, and solvents; oil and other automotive fluids; non-hazardous liquid and solid wastes and yard wastes; refuse, rubbish, garbage, litter or other discarded or abandoned objects, articles, and accumulations, so that same may cause or contribute to pollution; floatables; pesticides, herbicides, and fertilizers; hazardous substances and wastes; untreated commercial car wash water and industrial discharges, contaminated fountain drains, and cooling waters; sewage, fecal coliform, and pathogens; dissolved and particulate metals; animal wastes; wastes and residues that result

from constructing a building or structure (including, but not limited to, sediments, slurries, and concrete rinsates); and noxious or offensive matter of any kind.

(bb) **Pollution**: The human-made or human-induced alteration of the quality of waters by waste to a degree which unreasonably affects, or has the potential to unreasonably affect, either the waters for beneficial uses or the facilities which serve these beneficial uses.

(cc) **Premises**: Any building, lot, parcel of land or portion of land, whether improved or unimproved, including adjacent sidewalks and parking strips.

(dd) **Riparian Buffer**: An area of trees, shrubs or other vegetation that is adjacent to a natural drainageway. Riparian buffers reduce the impact of upland sources by trapping, filtering, and converting nutrients, sediments, and other chemicals, and maintain the integrity of the natural drainageway. For the purposes of this Manual, surface water shall be present if the feature is approximately shown on the most recent version of the 1:24,000 (7.5 min.) quadrangle topographic maps prepared by the United States Geological Survey (USGS) or on the latest version of the Brunswick County Soil Map as prepared by the U.S. Department of Agriculture Natural Resource Conservation Service (NRCS).

(ee) **Storm Drain System**: Publicly-owned facilities operated by the County by which storm water is collected and/or conveyed including, but not limited to, any roads with drainage systems, streets, gutters, curbs, inlets, piped storm drains, pumping facilities, retention and detention basins, natural and human-made or altered drainage channels, reservoirs, and other drainage structures which are within the County and are not part of a publicly owned treatment works as defined on U.S. 40 CFR Section 122.2.

(ff) **Storm Water**: Any surface flow, runoff, and drainage consisting entirely of water from rainstorm events.

(gg) **Storm Water Administrator**: The person designated by the County's Manager to have authority to review and approve Storm Water Permits and Storm Water Management Plans. The Storm Water Administrator shall also be responsible for inspecting development and making sure the provisions of this Ordinance are being followed.

(hh) **Storm Water Management Manual**: The manual of design, performance, and review criteria adopted by Commissioners of the County for the administration of the Program.

(ii) **Storm Water Facilities**: Shall include devices designed specifically to detain or retain storm water for water quantity or water quality control. These devices shall not include those drainage structures that provide incidental water quantity or water quality control. These devices include, but are not limited to, wet and dry ponds, bioretention areas, filter strips, and infiltration trenches.

(jj) **Storm Water Management Plans**: A document, submitted as part of an application for a Storm Water Permit, which presents the design, operation, and maintenance specifications for one or more drainage structures, BMP, or other facilities and practices to be implemented for the management of storm water quality and/or discharge control.

(kk) **Variance**: A permission to develop or use property granted by the County relaxing or waiving a management requirement where that permission is granted at the discretion of the County under:

1. authority that it solely owns;
2. authority delegated to it by the State of North Carolina and specifically the Environmental Management Commission; or
3. the County's authority because of a direct action by the State of North Carolina and its Environmental Management Commission.

(ll) **Vegetative Buffer**: An area that has a dense ground cover of herbaceous or woody species, which provides for diffusion and infiltration of runoff and filtering of pollutants.

(mm) **Vested Rights**: Vested right shall be based upon the following criteria:

1. Having an outstanding valid building permit in compliance with GS 153A-344.1 or GS 160A-385.1; or
2. Having an approved site specific or phased development plan in compliance with GS 153A-344.1 or GS 160A-385.1.

3. Projects that require a State permit, such as landfills, NPDES wastewater discharges, land application or residuals and road construction activities, shall be considered to have vested rights if a State permit was issued prior to the effective date of the adoption of the Storm Water Ordinance.

(nn) **Water Dependent Structures**: Those structures which require the access or proximity to, or sitting within surface waters to fulfill its basic purpose, such as boat ramps, boat houses, docks, and bulkheads. Ancillary facilities such as restaurants, outlets for boat supplies, parking lots, and commercial boat storage areas are not considered water-dependent structures.

(oo) **Waters of the United States**: Surface watercourses and water bodies as defined in U.S. 40 CFR § 122.2, including all natural waterways and definite channels and depressions in the earth that may carry water, even though such waterways may only carry water during rains and storms and may not carry storm water at and during all times and seasons.

(pp) **Wetland:** For purposes of this Manual, means those areas regulated under Section 404 of the Clean Water Act as identified under guidelines employed by the United States Army Corps of Engineers in evaluating permit applications under 33 U.S.C. 1344 and applicable Federal regulations.

3.0 Storm Water Permits

3.1 Storm Water Management and Site Plans

Persons proposing to conduct land disturbing activities that require a Storm Water Permit as identified in the Brunswick County Storm Water Ordinance shall submit a Storm Water Management Plan that includes a site plan with the storm water permit application. The site plan shall include:

3.1.1 Site Plan Requirements for Single-Family Residential Developments and Minor Subdivisions

The owner shall provide one or more drawings that show the size, shape, and orientation of property lines; structures, driveways, walkways, and other impervious areas; rivers, streams, swales, wetlands, and other drainage features; utilities and easements; and the names of streets or other local features that identify the location of the property and its existing and proposed features. An example of an acceptable drawing and related documentation is provided in Appendix A of this Manual.

3.1.2 Site Plan Requirements for Multi-Family Residential, Non-Residential, and Major Subdivisions

The owner shall provide one or more drawings at a scale necessary to show the size and shape of all elements of the plan on sheets no smaller than 24 inches by 24 inches with a scale no smaller than 1 inch equal to 50 feet, collectively referred to as the Site Plan. For the purpose of applying for a Storm Water Permit, the Site Plan shall include at minimum the following information:

- Address or vicinity map showing the location of the activity.
- Subdivision name and the date of the approved subdivision plat, if applicable.
- The date of the subdivision's approved Storm Water Permit, if applicable.
- The site boundaries.
- Street right-of-way.
- Street name and state road number.
- Existing roadway width and pavement type.
- Existing and proposed structures and finished floor elevations.

- Existing and proposed driveway locations and types (gravel, asphalt, concrete, etc.).
- Existing and proposed storm water facilities (swales, pipes, inlets, etc.).
- General drainage patterns indicated on a topographic map showing 1-foot (or smaller) contour intervals.
- Show any easements and identify type of easement.
- Show any natural drainageways and direction of flow.
- Show the location and extent and label the name of any waterbody that is shown on the most recent revision of either the 7.5-minute USGS topographic map or the NRCS Soil Survey map.
- Show any flood boundaries and/or elevations.
- Show any phasing of land disturbing activities. If needed, a separate drawing can be provided for each phase.
- Other information that may be necessary to develop an understanding of the project.

A complete list of the drawing requirements is included on a reproducible sheet included in Appendix A. No text presented on the drawings and documents shall be in a font smaller than 10-point type. The Storm Water Administrator may waive any of the format specifications and required items that are deemed not to be necessary for the review, reproduction, and storage of the documents.

All drawings and specifications that include structural BMPs such as storm water detention ponds, sand filters, and other similar constructed elements, must present the seal and signature of a professional engineer or a professional land surveyor.

3.1.3 BMP Design and Operation Specifications

Each structural and non-structural BMP included in an applicant's Storm Water Management Plan must be designed and operated according to appropriate, documented principles and practices. Specific design and operation details, to the satisfaction of the Storm Water Administrator, must be presented in the Storm Water Management Plan. The nature of those details will vary with the type of BMP proposed. For example, for a wet detention pond, details of the containment berm, outlet structures, sediment forebay, maintenance access

area, and safety features and facilities (e.g., side slopes, fencing) must be described in the Plan. Additional necessary items may include plant species to be introduced and maintained. Soil and hydrologic calculations that verify maintenance of the depth of surface water necessary for the proper and operation of the BMP also must be presented.

Each applicable BMP has a specific set of design, operation and maintenance principles and practices that must be followed. Appendix C of this Manual provides many of these details for a range of BMPs. It is the applicant's responsibility to provide the Storm Water Administrator with sufficient documentation on the principles and practices of a proposed BMP to assure the Administrator that the BMP will be constructed and will operate sufficiently to provide the benefits claimed in the applicant's Storm Water Management Plan.

3.1.4 Supporting Calculations

The owner shall provide formulas, tables, and other forms of supporting calculations in hard copy or electronic forms as may be required by the Storm Water Administrator to determine the accuracy of any of the items described in the Storm Water Management Plan, shown on the Site Plan or otherwise represented in the application for a Storm Water Permit. There are specific requirements for the documentation of the control of peak discharges and for the calculation of pollutant exports from developments. Acceptable methods of performing those calculations are outlined in Sections 5 and 6 of this Manual.

3.1.5 Maintenance Plans

The effectiveness of each of the BMPs described in the previous section depends upon appropriate maintenance. Also, many of the health and safety concerns that arise when the BMPs are installed can be significantly reduced by a program of planned, regular maintenance. For those reasons, the applicant's Storm Water Management Plan must contain a maintenance plan, including schedule, for each of the BMPs incorporated into the storm water system. The maintenance plan must address the normal and emergency procedures that will be followed to avoid:

- Any condition, which blocks, hinders or obstructs in any way the natural or intended flow of surface waters;

- The improper operation of any storm water retention or impoundment device or any structure or device used for the improvement of the quality of surface runoff;
- Any condition that would damage the County's storm water collection system or that would harm the quality of the County's waters;
- Any other conditions specifically declared to be a danger to the public health, safety, and general welfare of inhabitants of the County.

Failure to properly operate and maintain storm water facilities and BMPs in accordance with the Storm Water Management Plan is a violation of the County's Storm Water Ordinance.

3.2 Maintenance Records and Inspections

Once the Storm Water Administrator has accepted the applicant's Storm Water Management Plan and the facilities have been constructed, the Storm Water Administrator will conduct an as-built inspection and will inspect, from time-to-time (a minimum of annually), the BMP facilities. The Storm Water Permittee shall pay an annual inspection fee and a fee for each necessary re-inspection in an amount approved by the County and available from the office of the Storm Water Administrator. Whenever inspections are conducted, the Storm Water Permittee shall make available records of the maintenance of all Storm Water facilities and BMPs. At a minimum, those records shall contain:

- Descriptions, including design drawings, of any structural changes to a BMP and the dates on which construction of those changes commenced and were completed.
- Descriptions, including landscape drawings, of any changes in the drainage pathways included in the site's Storm Water Management Plan and in any drainage pathways leading to or from a BMP.
- Descriptions, to include volumes and material descriptions, of any excavation or fill operations to or impacting a BMP or the drainage of storm water to or from a BMP and including the dates when those operations commenced and were completed.
- Confirmation of completion over the previous year of all the routine maintenance items required by each BMP and documented in the Storm Water Management Plan.

Failure to perform required or emergency maintenance and repairs, or to maintain and provide the required records of that maintenance is a violation of the County's Storm Water Ordinance.

4.0 Riparian Buffers

4.1 Riparian Buffer Requirements

The Program requires that 30-foot wide riparian buffers be maintained on all sides of intermittent and perennial streams, ponds, lakes, and other water bodies in the County.

In order to obtain a Storm Water Permit, an owner or developer must meet one or more of the following requirements:

1. Provide certification, acceptable to the Storm Water Administrator, that no development or other land disturbing activities will occur within 30-feet of the banks of a river, stream, lake, or other natural waterway.
2. Provide certification, acceptable to the Storm Water Administrator, that the only development or other land disturbing activities that will occur within 30-feet of the banks of a covered stream or other natural waterway are “exempt” or “allowed” activities as shown within the Table of Uses contained in this Manual.
3. Apply to the Storm Water Administrator and obtain a variance that allows the development or other activity and demonstrate that all the conditions of that variance, including all mitigation requirements, will be met.

4.2 Riparian Buffer Map

The Storm Water Administrator will prepare and, from time-to-time, correct and update a map portraying the riparian buffer areas covered by the Brunswick County Storm Water Ordinance. The map will be available in the office of the Storm Water Administrator, provided for the convenience of the public. It is the owner’s responsibility to verify the accuracy of that map as it relates to development or other land disturbing activities on a specific parcel. The County accepts no responsibility for any loss, damage, or injury as a result of the use of the map.

4.3 Riparian Buffer

The Program provides for protection of riparian buffers while allowing necessary and reasonable activities within the buffer. The tables that follow define the two zones of a riparian buffer and set forth the types of exempt, allowed, allowable with mitigation, and prohibited activities that may occur in each zone.

THE RIPARIAN BUFFER. The protected riparian buffer shall consist of a vegetated area that is undisturbed except for uses provided for in the Table of Uses presented later in this section.

(1) For intermittent and perennial streams, the riparian buffer shall begin at the most landward limit of the top of bank or the rooted herbaceous vegetation and extend landward a distance of 30 feet on all sides of the surface water, measured horizontally on a line perpendicular to the surface water.

(2) For ponds, lakes, and reservoirs located within a natural drainage way, the riparian buffer shall begin at the most landward limit of the normal water level or the rooted herbaceous vegetation and extend landward a distance of 30 feet, measured horizontally on a line perpendicular to the surface water.

(3) For coastal surface waters, the riparian buffer shall begin at the most landward limit of the normal high water level and extend landward a distance of 30 feet, measured horizontally on a line perpendicular to the surface water.

DIFFUSE FLOW REQUIREMENT. Diffuse flow of runoff shall be maintained in the riparian buffer by dispersing concentrated flow and reestablishing vegetation.

(1) Concentrated runoff from new ditches or manmade conveyances shall be converted to diffuse flow before the runoff enters the riparian buffer.

(2) Periodic corrective action to restore diffuse flow shall be taken if necessary to impede the formation of erosion gullies.

TABLE OF USES. The following table sets out the uses and their designation under the Brunswick County Stormwater Quality Management and Discharge Control Ordinance as exempt, allowed, allowable with mitigation, or prohibited.

	Exempt	Allowed	Allowable with Mitigation	Prohibited
Airport facilities: ➢ Airport facilities that impact equal to or less than 150 linear feet (LF) or one-third of an acre of riparian buffer. ➢ Airport facilities that impact greater than 150 LF or one-third of an acre of riparian buffer.		X	X	
Archaeological activities	X			
Bridges		X		
Dam maintenance activities	X			
Drainage ditches, roadside ditches, and storm water outfalls through riparian buffers: ➢ Existing drainage ditches, roadside ditches, and storm water outfalls provided that they are managed to minimize the sediment, nutrients and other pollution that convey to water bodies. ➢ New drainage and roadside ditches and storm water outfalls provided that a storm water management facility is installed to control pollutant discharge and attenuate flow before the conveyance discharges through the riparian buffer. ➢ New drainage and roadside ditches and storm water outfalls that do not provide control for pollutant discharge before discharging through the riparian buffer. ➢ Excavation of the streambed in order to bring it to the same elevation as the invert of a ditch.	X	X		X X
Drainage of a pond in a natural drainageway provided that a new riparian buffer meeting the requirements of the County Ordinance is established adjacent to the new channel.	X			
Driveway crossings of streams and other surface waters subject to this Rule: ➢ Driveway crossings on single-family residential lots that disturb equal to or less than 25 LF or 2,500 square feet (SF) of riparian buffer. ➢ Driveway crossings on single-family residential lots that disturb greater than 25 LF or 2,500 SF of riparian buffer. ➢ In a subdivision that cumulatively disturb equal to or less than 150 LF or one-third of an acre of riparian buffer. ➢ In a subdivision that cumulatively disturb greater than 150 LF or one-third of an acre of riparian buffer.	X	X X	X	

	Exempt	Allowed	Allowable with Mitigation	Prohibited
Fences, provided that disturbance is minimized and installation does not result in removal of forest vegetation.	X			
Forest harvesting			X	
Fertilizer application: ➢ One-time fertilizer application to establish replanted vegetation. ➢ Ongoing fertilizer application.	X			X
Greenway/hiking trails		X		
Historic preservation	X			
Landfills as defined by G.S. 130A-290				X
Mining activities: ➢ Mining activities that are covered by the Mining Act provided new riparian buffers are established adjacent to the relocated channels. ➢ Mining activities that are not covered by the Mining Act or where new riparian buffers are not established adjacent to the relocated channels. ➢ Wastewater or mining dewatering wells with	X	X	X	
Non-electric utility lines: ➢ Impacts other than perpendicular crossings			X	
Non-electric utility line perpendicular crossing of streams and other surface waters subject to this buffer requirement: ➢ Perpendicular crossings that disturb equal to or less than 40 LF of riparian buffer with a maintenance corridor equal to or less than 10 feet in width. ➢ Perpendicular crossings that disturb greater than 40 LF of riparian buffer with a maintenance corridor greater than 10 feet in width. ➢ Perpendicular crossings that disturb greater than 40 LF but equal to or less than 150 LF of riparian buffer with a maintenance corridor equal to or less than 10 feet in width. ➢ Perpendicular crossings that disturb greater than 40 LF but equal to or less than 150 LF of riparian buffer with a maintenance corridor greater than 10 feet in width. ➢ Perpendicular crossings that disturb greater than 150 LF of riparian buffer.	X	X X	X X	
On-site sanitary sewage systems - new ones that utilize ground absorption.				X
Overhead electric utility lines: Impacts other than perpendicular crossings.			X	

	Exempt	Allowed	Allowable with Mitigation	Prohibited
Overhead electric utility line perpendicular crossings of streams and other surface waters subject to this rule. ➢ Perpendicular crossings that disturb equal to or less than 150 LF of riparian buffer. ➢ Perpendicular crossings that disturb greater than 150 LF of riparian buffer.	X	X		
Periodic maintenance of modified natural streams such as canals and a grassed travelway on one side of the surface water when alternative forms of maintenance access are not practical.		X		
Playground equipment: ➢ Playground equipment on single-family lots provided that installation and use does not result in vegetation removal. ➢ Playground equipment installed on lands other than single-family lots or that requires vegetation removal.	X	X		
Ponds in natural drainageways, excluding dry ponds: ➢ New ponds provided that a riparian buffer is established adjacent to the pond. ➢ New ponds where a riparian buffer is NOT established adjacent to the pond.		X	X	
Protection of existing structures, facilities, and streambanks when this requires additional disturbance of the riparian buffer or the stream channel.		X		
Railroad impacts other than crossings of streams and other surface waters subject to this Rule.			X	
Railroad crossings of streams and other surface waters subject to this Rule: ➢ Railroad crossings that impact equal to or less than 40 LF of riparian buffer. ➢ Railroad crossings that impact greater than 40 LF but equal to or less than 150 LF or one-third of an acre of riparian buffer. ➢ Railroad crossings that impact greater than 150 LF or one-third of an acre of riparian buffer.	X	X	X	
Removal of previous fill or debris provided that diffuse flow is maintained and any vegetation removed is restored.	X			
Road crossings of streams and other surface waters: ➢ Road crossings that impact equal to or less than 40 LF of riparian buffer. ➢ Road crossings that impact greater than 40 LF but equal to or less than 150 LF or one-third of an acre of riparian buffer. ➢ Road crossings that impact greater than 150 LF or one-third of an acre of riparian buffer.	X	X	X	

	Exempt	Allowed	Allowable with Mitigation	Prohibited
Road impacts other than crossings of streams and other surface waters subject to this Rule.			X	
Scientific studies and stream gauging.	X			
Storm Water management ponds excluding dry ponds: ➢ New Storm Water management ponds provided that a riparian buffer is established adjacent to the pond. ➢ New Storm Water management ponds where a riparian buffer is NOT established adjacent to the pond.		X	X	
Stream restoration	X			
Temporary roads: ➢ Temporary roads that disturb less than or equal to 2,500 square feet provided that vegetation is restored within six months of initial disturbance. ➢ Temporary roads that disturb greater than 2,500 SF provided that vegetation is restored within six months of initial disturbance. ➢ Temporary roads used for bridge construction or replacement provided that restoration activities, such as soil stabilization and revegetation, are conducted immediately after construction.	X	X X		
Temporary sediment and erosion control devices: ➢ To control impacts associated with uses approved by the DWQ or that have received a variance provided that sediment and erosion control for upland areas is addressed to the maximum extent practical outside the buffer. ➢ In-stream temporary erosion and sediment control measures for work within a stream channel.	X	X		
Underground electric utility lines: ➢ Impacts other than perpendicular crossings.			X	
Underground electric utility line perpendicular crossings of streams and other surface waters: ➢ Perpendicular crossings that disturb less than or equal to 40 LF of riparian buffer. ➢ Perpendicular crossings that disturb greater than 40 linear feet of riparian buffer.	X	X		
Vegetation management: ➢ Emergency fire control measures provided that topography is restored. ➢ Planting vegetation to enhance the buffer. ➢ Pruning forest vegetation, including understory vegetation, provided that the health and function of the vegetation is not compromised. ➢ Removal of individual trees which are in danger of causing damage to dwellings, other structures	X X X X			

	Exempt	Allowed	Allowable with Mitigation	Prohibited
Vegetation Management: ➢ Removal of understory nuisance vegetation as defined in: Smith, Cherri L. 1998. Exotic Plant Guidelines. Department of Environment and Natural Resources. Division of Parks and Recreation. Raleigh, NC. Guideline 30	X			
Water dependent structures as defined in 15A NCAC 2B .0202.		X		
Water supply reservoirs: ➢ New reservoirs provided that a riparian buffer is established adjacent to the reservoir. ➢ New reservoirs where a riparian buffer is NOT established adjacent to the reservoir.		X	X	
Water wells	X			
Wetland restoration	X			

5.0 Controlling Peak Discharge

5.1 Peak Discharge Requirements

The County requires that there be no net increase in peak discharge leaving a development site from the predevelopment conditions for the 1-year, 24-hour storm. Variance from the requirement may be provided to developments that meet one or all of the following requirements:

1. The increase in peak flow between pre- and post-development conditions does not exceed five percent.
2. The proposed new development meets both of the following criteria:
   - Overall impervious surface is less than fifteen percent, and
   - The remaining pervious portions of the site are utilized to the maximum extent practical to convey and control the storm water runoff.

The County also requires that all new development within the jurisdictional limits of the County control water runoff so that there is no net increase in the peak discharge from the predevelopment conditions for the 10-year, 24-hour storm as defined in this Manual. Where this requirement places an undue hardship upon a property owner, variances from the requirement may be granted by the Storm Water Administrator to developments that meet the following requirement:

- The increase in peak flow between pre- and post-development conditions does not exceed five percent.
- The proposed new development appropriately uses the parcel's total remaining total pervious area to the maximum extent practical to convey and control the storm water runoff, and it is demonstrated, to the satisfaction of the Storm Water Administrator, that no damage to public or private properties, including to the County's storm water facilities and to the quality of the public waters, will be caused by granting of the variance.

5.2 The 1-year, 24-hour Design Storm

The 1-year, 24-hour storm is defined to deliver a total volume of precipitation equal to 3.7 inches in 24 hours and having a temporal distribution of precipitation given by an SCS Type III distribution (SCS, 1985). Figure 5.1 on page 5-2 presents the cumulative precipitation distribution for the SCS Type III distribution. Table 5.1 includes the ratio for

accumulated to total precipitation in 24 hours for 0.2-hour (12-minute) time intervals. For purposes of peak discharge calculations, average antecedent moisture conditions are to be assumed.

5.3 The 10-year, 24-hour Design Storm

The 10-year, 24-hour storm is defined to deliver a total volume of precipitation equal to 7.0 inches in 24 hours and having a temporal distribution of precipitation given by an SCS Type III distribution (SCS, 1985). Figure 5.1 on page 5-2 presents the cumulative precipitation distribution for the SCS Type III distribution. Table 5.1 on page 5-3 includes the ratio for accumulated to total precipitation in 24-hours for 0.2-hour (12-minute) time intervals. For purposes of peak discharge calculations, average antecedent moisture conditions are to be assumed.

Figure 5.1 SCS Rainfall Distribution Curve for Brunswick County

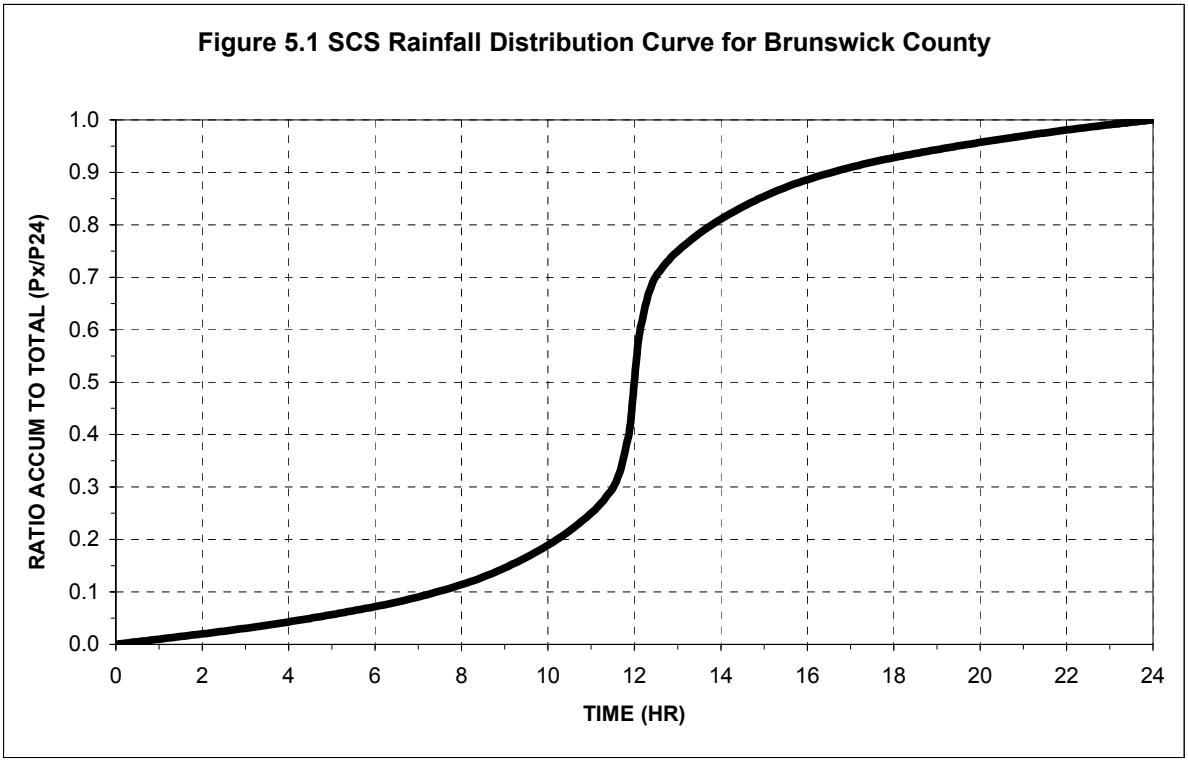


Table 5.1
SCS Type III Rainfall Distribution Curve Data

Time (hour)	Ratio Accumulated/ Total Precipitation	Time (hour)	Ratio Accumulated/ Total Precipitation	Time (hour)	Ratio Accumulated/ Total Precipitation	Time (hour)	Ratio Accumulated/ Total Precipitation
0.0	0.00000	6.0	0.07200	12.0	0.50000	18.0	0.92800
0.2	0.00200	6.2	0.07530	12.2	0.62670	18.2	0.93117
0.4	0.00400	6.4	0.07880	12.4	0.68570	18.4	0.93428
0.6	0.00600	6.6	0.08250	12.6	0.71344	18.6	0.93733
0.8	0.00800	6.8	0.08640	12.8	0.73356	18.8	0.94032
1.0	0.01000	7.0	0.09050	13.0	0.75000	19.0	0.94330
1.2	0.01200	7.2	0.09480	13.2	0.76412	19.2	0.94612
1.4	0.01400	7.4	0.09930	13.4	0.77728	19.4	0.94893
1.6	0.01600	7.6	0.10400	13.6	0.78948	19.6	0.95168
1.8	0.01800	7.8	0.10890	13.8	0.80072	19.8	0.95437
2.0	0.02000	8.0	0.11400	14.0	0.81100	20.0	0.95700
2.2	0.02203	8.2	0.11943	14.2	0.82057	20.2	0.95958
2.4	0.02412	8.4	0.12532	14.4	0.82968	20.4	0.96211
2.6	0.02627	8.6	0.13167	14.6	0.83833	20.6	0.96460
2.8	0.02848	8.8	0.13848	14.8	0.84652	20.8	0.96704
3.0	0.03080	9.0	0.14580	15.0	0.85430	21.0	0.96940
3.2	0.03308	9.2	0.15348	15.2	0.86152	21.2	0.97179
3.4	0.03547	9.4	0.16167	15.4	0.86833	21.4	0.97410
3.6	0.03792	9.6	0.17032	15.6	0.87468	21.6	0.97636
3.8	0.04043	9.8	0.17943	15.8	0.88057	21.8	0.97858
4.0	0.04300	10.0	0.18900	16.0	0.88600	22.0	0.98080
4.2	0.04563	10.2	0.19928	16.2	0.89110	22.2	0.98288
4.4	0.04832	10.4	0.21052	16.4	0.89600	22.4	0.98496
4.6	0.05107	10.6	0.22272	16.6	0.90070	22.6	0.98700
4.8	0.05388	10.8	0.23588	16.8	0.90520	22.8	0.98899
5.0	0.05670	11.0	0.25000	17.0	0.90950	23.0	0.99090
5.2	0.05968	11.2	0.26644	17.2	0.91360	23.2	0.99284
5.4	0.06267	11.4	0.28656	17.4	0.91750	23.4	0.99470
5.6	0.06572	11.6	0.31430	17.6	0.92120	23.6	0.99651
5.8	0.06883	11.8	0.37330	17.8	0.92470	23.8	0.99828
						24.0	1.00000

5.4 Calculating the Peak Discharge

The County requires, for the purpose of computing the peak discharge from the above-described design storms, that one of the following methods be used for all development purposes.

1. The Peak Discharge Method [United States Department of Agriculture, Soil Conservation Service (USDA-SCS)-Technical Release 55] and/or the methods given in the Hydrology section of the National Engineering Handbook and included in the TR-20 model, and described in USDA Technical Release 20, and its revisions and derivatives.
2. The use of Green-Ampt or Horton infiltration functions and Kinematic or Dynamic Wave Routing as used in the U.S. Environmental Protection Agency's Storm Water Management Model (SWMM) and its revisions and derivatives.

3. The methods incorporated into the Interconnected Channel and Pond Routing (ICPR) model including, where appropriate, the Santa Barbara Urban Hydrograph methodology, and its revisions and derivatives.

For development where the final built-out development will impact less than 10 acres, the Rational Method may be used. The Rational Method is based on the simple formulation of:

q = CiA where:

q is the estimated peak runoff in cfs,

C is a dimensionless runoff coefficient,

i is the average peak rainfall intensity applicable over the appropriate period of time (e.g., the "time of concentration" of the design basin) in units of inches per hour, and

A is the drainage area given in acres.

For determination of the area-averaged value of C, Table 5.2 that follows can be applied.

Table 5.2
Value of Runoff Coefficient (C) for Rational Formula

Land-use	C Value	Land-use	C Value
Business:		Roofs	0.75-0.95
- Downtown areas	0.70-0.95		
- Neighborhood areas	0.05-0.70	*Lawns:*	
		- Sandy soil, flat, 2%	0.05-0.10
Residential:		- Sandy soil, average, 2-7%	0.10-0.15
- Single-family areas	0.30-0.50	- Sandy soil, steep, 7%	0.15-0.20
- Multi units, detached	0.40-0.60	- Heavy soil, flat, 2%	0.13-0.17
- Multi units, attached	0.60-0.75	- Heavy soil, average, 2-7%	0.18-0.22
- Suburban	0.25-0.40	- Heavy soil, steep, 7%	0.25-0.35
Industrial:		*Agricultural Land:*	
- Light areas	0.50-0.80	Bare packed soil	
- Heavy areas	0.60-0.90	- Smooth	0.30-0.60
- Parks, cemeteries	0.10-0.25	- Rough	0.20-0.50
- Playgrounds	0.20-0.35	Cultivated Rows	
- Railroad yard areas	0.20-0.40	- Heavy soil no crop	0.30-0.60
- Unimproved areas	0.10-0.30	- Heavy soil with crop	0.20-0.50
		- Sandy soil no crop	0.20-0.40
Streets:		- Sandy soil with crop	0.10-0.25
- Asphalt	0.70-0.95	Pasture	
- Concrete	0.80-0.95	- Heavy soil	0.15-0.45
- Brick	0.70-0.85	- Sandy soil	0.05-0.25
- Drives and walks	0.75-0.85	- Woodlands	0.05-0.25

NOTE: The designer must use judgment to select the appropriate C value within the range for the appropriate land-use. Generally, larger areas with permeable soils, flat slopes, and dense vegetation should have lowest C values. Smaller areas with slowly permeable soils, steep slopes, and sparse vegetation should be assigned highest C Values.

Source: American Society of Civil Engineers.

For consistent comparison, the same method must be applied for estimation of the pre- and post-development discharges.

Tables 5.3 and 5.4 can be used to determine the time of concentration (Tc) and peak rainfall intensity for the 1- and 10-year, 24-hour design storms in the County.

Table 5.3
Mean Flow Velocity

Land Cover	Slope (ft/100ft)	Velocity[1] (ft per min.)
Pavement/Concrete	0.25	19.0
Graded/Bare Ground	0.25	15.5
Lawn	0.25	13.1
Pasture/Meadow	0.25	11.4
Woodland	0.25	8.5
Pavement/Concrete	0.5	26.8
Graded/Bare Ground	0.5	21.9
Lawn	0.5	18.6
Pasture/Meadow	0.5	16.1
Woodland	0.5	12.1
Pavement/Concrete	1	37.9
Graded/Bare Ground	1	31.0
Lawn	1	26.2
Pasture/Meadow	1	22.7
Woodland	1	17.1
Pavement/Concrete	2	53.6
Graded/Bare Ground	2	43.9
Lawn	2	37.1
Pasture/Meadow	2	32.2
Woodland	2	24.1
Pavement/Concrete	5	84.8
Graded/Bare Ground	5	69.3
Lawn	5	58.7
Pasture/Meadow	5	50.9
Woodland	5	38.1
Pavement/Concrete	10	119.9
Graded/Bare Ground	10	98.1
Lawn	10	83.0
Pasture/Meadow	10	71.9
Woodland	10	53.9
Pavement/Concrete	20	169.5
Graded/Bare Ground	20	138.7
Lawn	20	117.3
Pasture/Meadow	20	101.7
Woodland	20	76.3

[1]Assumes overland flow depth of 1-inch.

Table 5.4
Peak Rainfall Intensity vs. Time of Concentration

Time of Conc. (minutes)	1-year (in/hr)	10-year (in/hr)
10	2.46	4.66
20	2.34	4.43
30	1.93	3.64
45	1.57	2.98
60	1.33	2.52
90	1.04	1.96
120	0.58	1.09
240	0.36	0.68
360	0.26	0.50
480	0.21	0.40

Rational Method Sample Calculation

The Rational Method may only be used for development where the final built-out development will impact less than 10 acres. A blank form (Form SW-006) for use while using the Rational Method is included in Appendix A. A description of the Rational Method is included in the North Carolina Storm Water Guidance Manual. An example of the application of this method follows.

Given: Location: Brunswick County, North Carolina
Drainage Area: 2.5 acres
Average Slope: 0.5 percent
Maximum Slope Length: 320 feet

Find: For the watershed draining through the development, compute the design peak runoff rate for a 1-year, 24-hour storm and a 10-year, 24-hour storm both before and after the area is developed.

Step 1: Determine the drainage area, A, in acres.
2.5 acres

Step 2: Determine the runoff coefficient, C, for the type of soil/cover in the pre-development drainage area (see Table 5.2).

Pre-Development Conditions

Type of Land Use	C	Area (acre)	C x A
Woodland	0.20	2.0	0.40
Pasture – Heavy Soil	0.40	0.5	0.20
Total		**2.5**	**0.60**

Area-weighted C = 0.60/2.5 = 0.24

Step 3: Determine the time of concentration, Tc, for the drainage area (i.e., the time of flow from the most remote point in the basin to the design point, in minutes) (see Table 5.3).

For an average slope of 0.5 percent and 80 percent woodland, 20 percent pasture land cover the weighted mean velocity is: 0.8(12.1) + 0.2(16.1) = 12.9 feet/minute.

Time of concentration = Length of overland flow/weighted mean velocity
Tc = 320 feet/(12.9 feet/minute) = 24.8 minutes

Step 4: Determine the peak rainfall intensity (i), (Table 5.4).

Interpolate maximum intensity for 1-year, 24-hour storm,
I_1 = 2.14 inches/hour

Maximum Intensity for 10-year, 24-hour storm,
I_{10} = 4.05 inches/hour

Step 5: Determine the peak discharge, q (ft^3/sec), by multiplying the previously determined factors using the Rational formula: q=CiA

Peak flow for 1-year, 24-hour storm, q_1 = CiA = 0.24 x 2.1 x 2.5 =1.26 cfs
Peak flow for 10-year, 24-hour storm, q_{10} = CiA = 0.24 x 4.1 x 2.5 = 2.46 cfs

Repeat Steps 2 through 5 for post-development conditions.

Step 2: Determine the runoff coefficient, C, for the type of soil/cover in the post-development drainage area (see Table 5.2).

Post-Development Conditions

Type of Land Use	C	Area (acre)	C x A
Woodland	0.20	1.5	0.300
Pasture – Heavy Soil	0.40	0.5	0.200
Lawn – heavy soil, flat	0.15	0.4	0.060
Roof	0.85	0.05	0.043
Driveway	0.75	0.05	0.038
Total		**2.5**	**0.641**

Area-weighted C = 0.641/2.5 = 0.256

Step 3: Determine the time of concentration, Tc, for the drainage area (i.e. the time of flow from the most remote point in the basin to the design point, in minutes) (see Table 5.3).

For an average slope of 0.5 percent and 60 percent woodland 20 percent pasture 16 percent lawn 2 percent roof 2 percent driveway.

The weighted mean velocity is:
0.8(12.1) + 0.2(16.1) + 0.16(18.6) + 0.02(26.8) + 0.02(26.8) = 14.53 feet/minute

Time of concentration = Length of overland flow / weighted mean velocity
Tc = 320 feet / (14.5 feet/minute) = 22.1 minutes

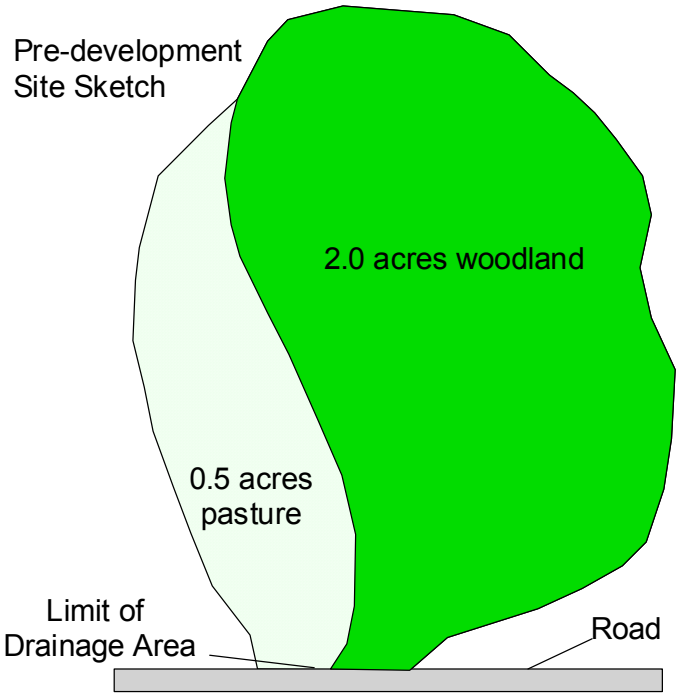
Step 4: Determine the peak rainfall intensity (i), (Table 5.4).

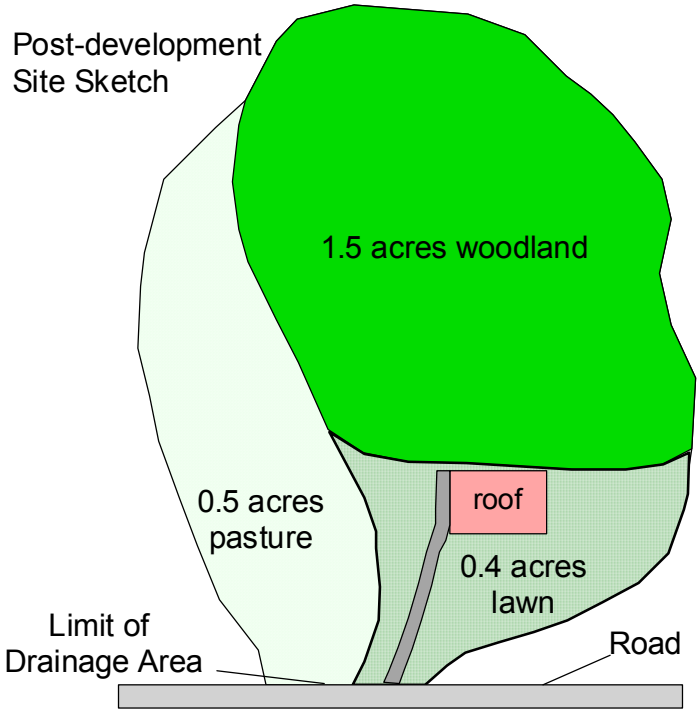
Interpolate maximum intensity for 1-year, 24-hour storm,
I_1 = 2.26 inches/hour

Maximum Intensity for 10-year, 24-hour storm,
I_{10} = 4.27 inches/hour

Step 5: Determine the peak discharge, q (ft^3/sec), by multiplying the previously determined factors using the Rational formula: q=CiA

Peak flow for 1-year, 24-hour storm, q_1 = CiA = 0.256 x 2.26 x 2.5 =1.45 cfs
Peak flow for 10-year, 24-hour storm, q_{10} = CiA = 0.256 x 4.27 x 2.5 = 2.73 cfs


Pre-development
Site Sketch
2.0 acres woodland
0.5 acres
pasture
Limit of
Drainage Area
Road


Post-development
Site Sketch
1.5 acres woodland
0.5 acres
pasture
roof
0.4 acres
lawn
Limit of
Drainage Area
Road

The SCS Peak Discharge Method Sample Calculation

The SCS Peak Discharge Method may be used to calculate peak discharge for any development. The following is a simplified example of the SCS Method. Details of this method are presented in USDA-SCS Technical Release 55. A simplified process, taken from North Carolina Stormwater Management Guidance Manual, 1993, is presented in this section. Equally acceptable methods are given in the Hydrology section of the National Engineering Handbook and in the TR-20 model, which is described in USDA Technical Release 20 (including its revisions and derivatives). Table 5.5 may be used to determine the area-averaged value of the runoff curve number (CN). A blank form (Form SW-007) for calculating peak runoff using the SCS Method is included in Appendix A.

Given: Location: Brunswick County, North Carolina
Drainage area: 21 acres
Average slope: 1.0 percent
Maximum Hydraulic Slope Length: 3,000 feet
Hydrologic Soil Group: C

Find: For the watershed draining through the development, compute the design peak runoff rate for a 1-year, 24-hour storm and a 10-year, 24-hour storm both before and after the area is developed.

Step 1: Determine the drainage area, A.
A = 21 acres

Determine the hydraulic length (distance from most remote point to design point).
L = 3,000 feet

Determine the average slope (percent) of the watershed.
S = 1.0 %

Step 2: Calculate the curve number, CN, for the drainage area (see Table 5.5).

Pre-Development Conditions

Type of Land-use	CN	% Imp.	Area (acre)	CN x A	Imp x A
Industrial	91	72	5	455	360
Single-Family residential, 1/2acre lots	80	25	8	640	200
Woodland – good stand	70	0	8	560	0
Total			**21**	**1,655**	**560**

Area-weighted CN = 1,655/21 =78.8

Overall percent Impervious = 560/21 = 26.7 %

Step 3: Select design storm and determine the runoff depth and volume.

1-year, 24-hour design rainfall amount: P_1 = 3.7 inches

10-year, 24-hour design rainfall amount: P_{10} = 7.0 inches

Determine runoff depth: $V = (P - 0.2S)^2/(P + 0.8S)$ for $S = (1000/CN) - 10$

$S = (1000/78.8) - 10 = 2.69$ inches

$V_1 = (3.7 - 0.2(2.69))^2/(3.7 + 0.8(2.69)) = 1.71$ inches

$V_{10} = (7.0 - 0.2(2.69))^2/(7.0 + 0.8(2.69)) = 4.56$ inches

Step 4: Determine the peak rate of runoff for the design storm with an adjustment for watershed shape. This procedure adjusts for the influence of the shape of the watershed on the peak discharge rate. All other factors equal, a watershed that has a lot of its area contributing to flow at the discharge point at nearly equal times will have a higher peak storm discharge than one whose majority of area contributes to flow at the discharge point at widely varied times. Figure 5.3, taken from the North Carolina Stormwater Management Guidance Manual, can be used to determine the watershed shape adjustment factor in terms of an "equivalent watershed area." The nomographs presented in Figures 5.4 through 5.6 can then be used to determine the peak discharge rate per inch of runoff for the "equivalent drainage area." The final estimated runoff is the peak discharge for the equivalent area multiplied by the actual inches of runoff and by the ratio of the actual watershed area to the "equivalent watershed area."

Equivalent drainage area, Ac for hydraulic length of 3,000 feet: Ac = 90 acres

Total peak runoff rate for equivalent drainage are, Q_{Ac} = 37 cfs/inch runoff:

Q_1 = 37 cfs/inch x 1.71 inch (21/90) = 14.8 cfs

Q_{10} = 37 cfs/inch x 4.56 inch (21/90) = 39.4 cfs

Step 5: Adjust peak discharge to account for impervious area. Adding impervious area to a watershed generally decreases the flow times and increases the peak watershed discharges. Figure 5.7 can be used to estimate the magnitude of this impact.

Q_1 = 14.8 cfs x 1.12 = 16.5 cfs
Q_{10} = 39.4 cfs x 1.12 = 44.1 cfs

Step 6: Adjust peak discharge to account for modifications of the natural drainage pattern. This adjustment factor accounts for channel straightening that has been, or will be, performed in the watershed. Figure 5.8 provides a method of estimating this factor based on the estimated percentage of modification of the watersheds average hydraulic length.

For this example, no improved channel adjustment necessary for pre-development conditions.

Q_1 = 16.5 cfs x 1.0 = 16.5 cfs
Q_{10} = 44.1 cfs x 1.0 = 44.1 cfs

Step 6: Adjust the peak discharge based on the average watershed slope. Table 5.6 provides a slope adjustment factor for the peak discharge. In that table a 1% slope is the normative value. Slopes less than 1% have an adjustment factor less than 1.0, slopes greater than 1% have an adjustment factor greater than 1.0.

For this example, the watershed slope is assumed to be 1% and no watershed slope adjustment is necessary. .

Q_1 = 16.5 cfs x 1.0 = 16.5 cfs
Q_{10} = 44.1 cfs x 1.0 = 44.1 cfs

Step 7: Adjust the peak discharge for ponding and swampy areas in the watershed. Areas with large amounts of depression storage attenuate the peak discharge rate. The attenuation effect is more important for more frequent, lower volume storms than it is for larger storms. Table 5.7 may be used to estimate this factor for the coastal areas of North Carolina.

No ponding and swampy area adjustment necessary for pre-development conditions.

Repeat Steps 2 though 7 for post-development conditions.

Step 2: Calculate the curve number, CN, for the drainage area (see Table 5.5).

Post-Development Conditions

Type of Land-use	CN	% Imp.	Area (acre)	CN x A	Imp x A
Industrial	91	72	6	546	432
Single Family residential, 1/2 acre lots	80	25	8	640	200
Woodland – good stand	70	0	0	0	0
Commercial	94	85	7	658	595
Total			**21**	**1,844**	**1,227**

Area-weighted CN = 1,844/21 = 87.8
Overall percent Impervious = 1,227/21 = 58.4 %

Step 3: Select design storm and determine the runoff depth and volume.
1-year, 24-hour design rainfall amount: P_1 = 3.7 inches
10-year, 24-hour design rainfall amount: P_{10} = 7.0 inches

Determine runoff depth: $V = (P - 0.2S)^2/(P + 0.8S)$ for $S = (1000/CN) - 10$
S = (1000/87.8) – 10 = 1.39 inches
$V_1 = (3.7 - 0.2(1.39))^2/(3.7 + 0.8(1.39)) = 2.43$ inches
$V_{10} = (7.0 - 0.2(1.39))^2/(7.0 + 0.8(1.39)) = 5.57$ inches

Step 4: Determine the peak rate of runoff for the design storm by adjusting for watershed shape.
Equivalent drainage area, Ac for hydraulic length of 3,000 feet: Ac = 90 acres
Total peak runoff rate for equivalent drainage are, Q_{Ac} = 49 cfs/inch runoff:
Q_1 = 49 cfs/inch x 2.43 inch (21/90) = 27.8 cfs
Q_{10} = 49 cfs/inch x 5.59 inch (21/90) = 63.9 cfs

Step 5: Adjust peak discharge to account for impervious area and channel improvements.
Q_1 = 27.8 cfs x 1.20 = 33.4 cfs
Q_{10} = 63.9 cfs x 1.20 = 76.7 cfs
No improved channel adjustment necessary for post-development conditions.

Step 6: Adjust the peak discharge based on the average watershed slope.
No watershed slope adjustment necessary for post-development conditions.

Step 7: Adjust the peak discharge for ponding and swampy areas in the watershed.
No ponding and swampy area adjustment necessary for post-development conditions.

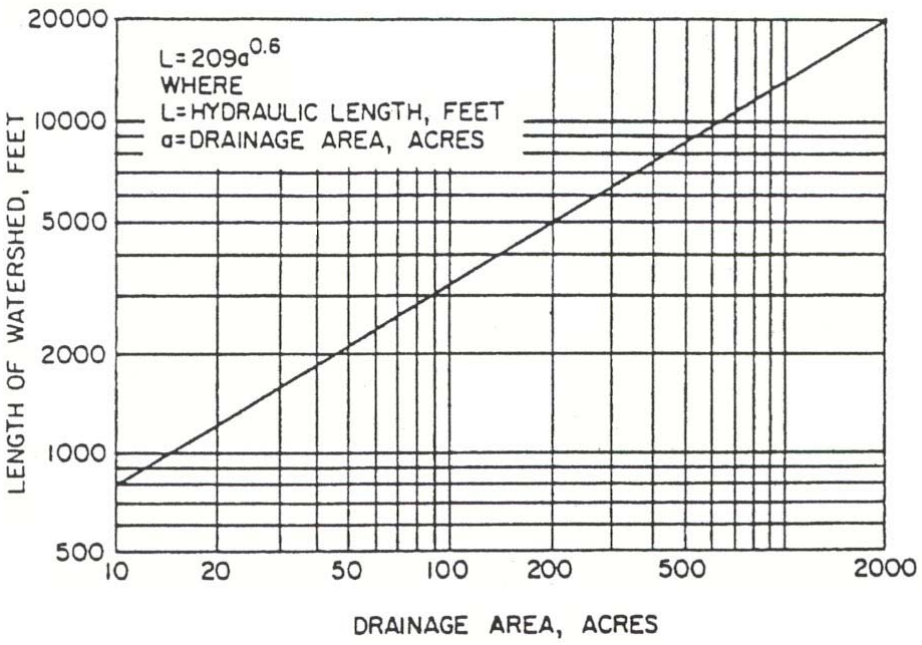


Figure 5.3 Hydraulic length and equivalent drainage area relationship

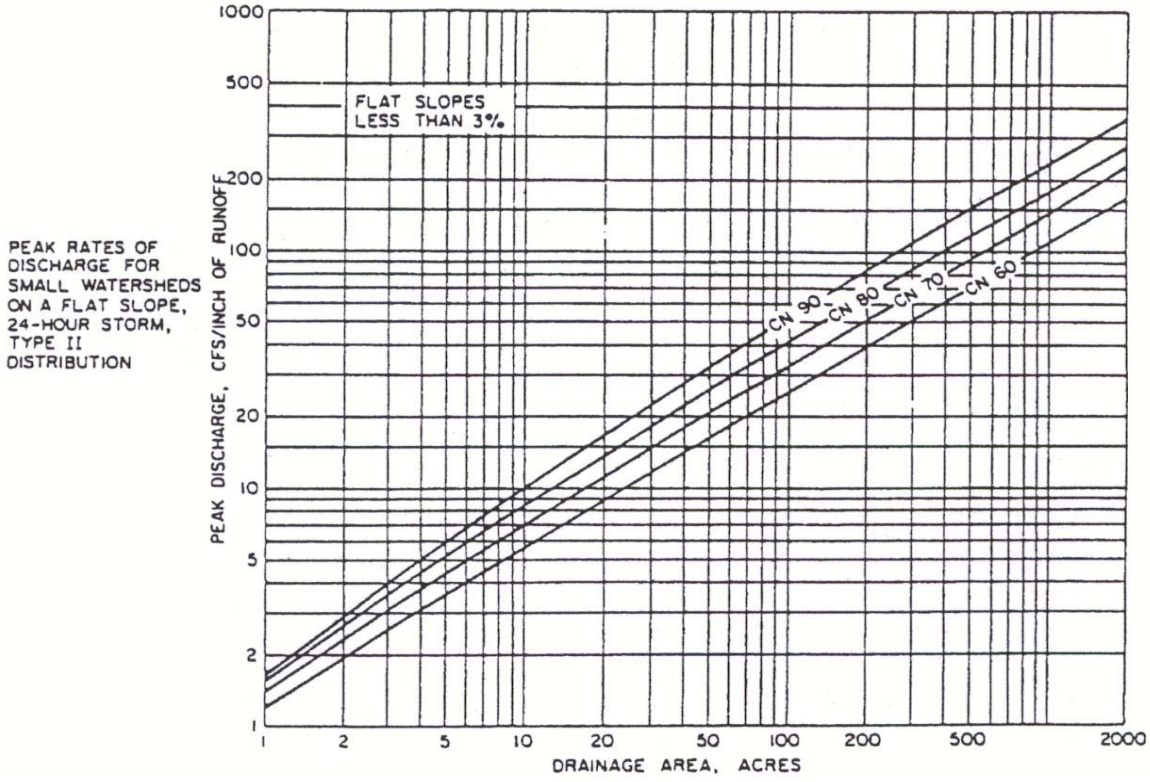


Figure 5.4 Discharge versus equivalent drainage areas for average watershed 0-3% slope

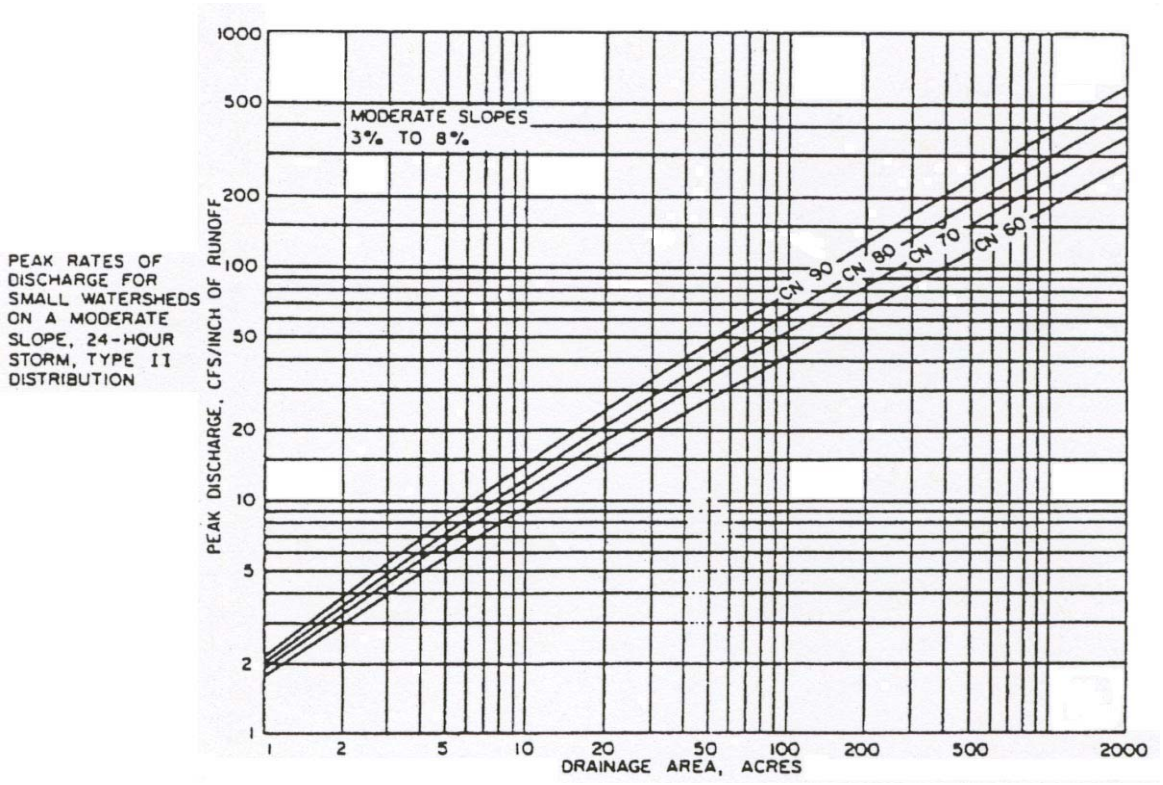


Figure 5.5 Discharge versus equivalent drainage area for average watershed 3-8% slope

PEAK RATES OF DISCHARGE FOR SMALL WATERSHEDS ON A STEEP SLOPE, 24-HOUR STORM, TYPE II DISTRIBUTION

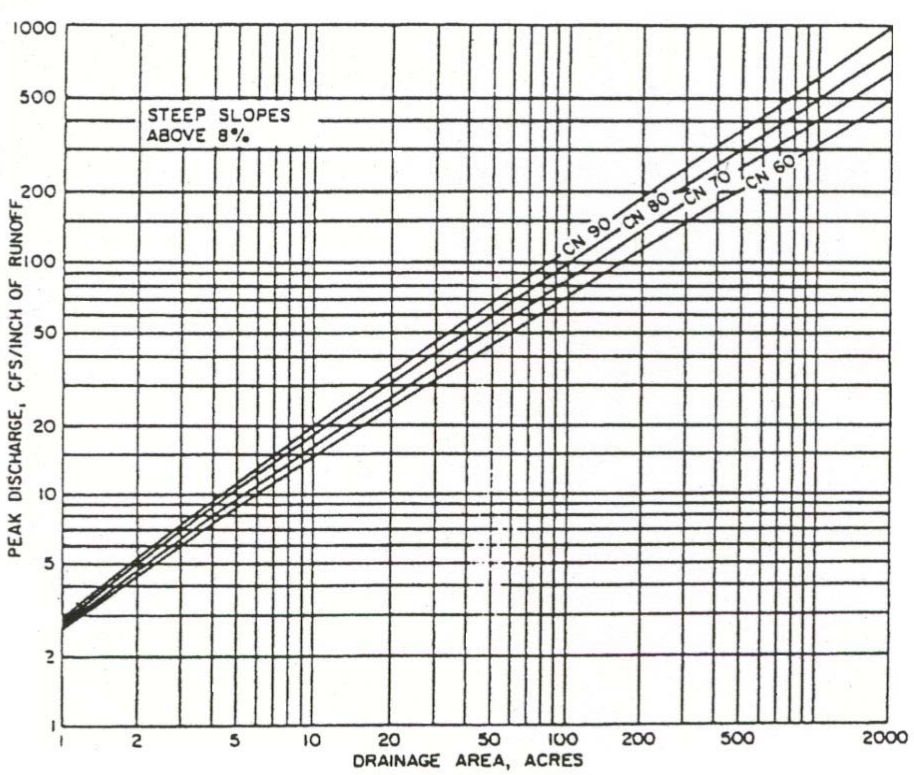


Figure 5.6 Discharge versus equivalent drainage area for average watershed 8-50% slope

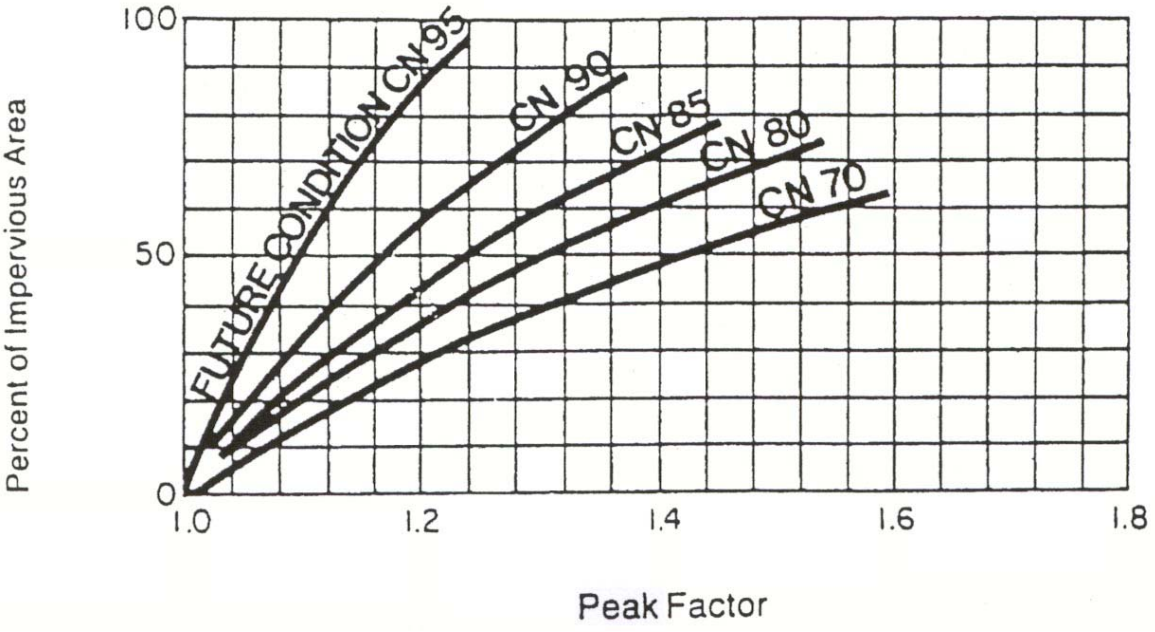


Figure 5.7 Peak Discharge Adjustment Factor for Impervious Area

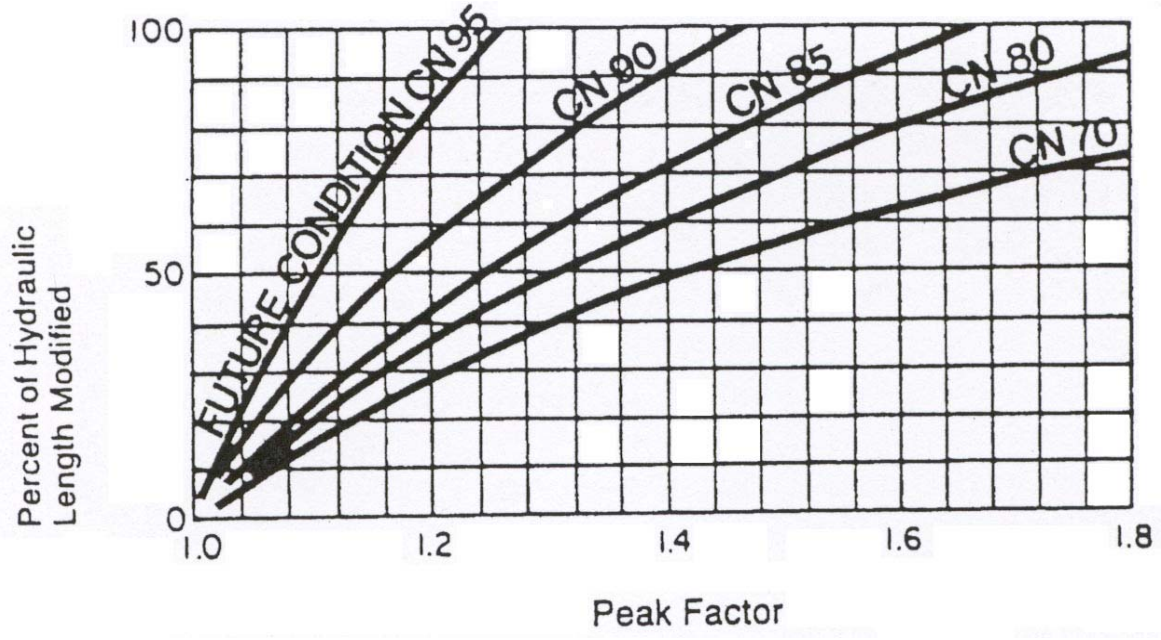


Figure 5.8 Peak Discharge Adjustment Factor for Hydraulic Length Modification

Table 5.5
SCS Runoff Curve Numbers (CN)

Land-use/Cover		Hydrologic Soil Group A	B	C	D
			CN		
Cultivated land					
- without conservation		72	81	88	91
- with conservation		62	71	78	81
Pasture land					
- poor condition		68	79	86	89
- good condition		39	61	74	80
Meadow					
- good condition		30	58	71	78
Wood or forest land					
- Thin stand – poor cover, no mulch		45	66	77	83
- Good stand – good cover		25	55	70	77
Open spaces, lawns, parks, golf courses, cemeteries, etc.					
- Good condition: grass cover on 75% or more of the area		39	61	74	80
- Fair condition: grass cover on 50 to 75% of the area		49	69	79	84
Commercial and business areas (85% impervious)		89	92	94	95
Industrial districts (72% impervious)		81	88	91	93
Residential[1]: Development completed and vegetation established					
Average lot size	Average % Impervious				
1/8 acre or less	65	77	85	90	92
1/4 acre	38	61	75	83	87
1/3 acre	30	57	72	81	86
1/2 acre	25	54	70	80	85
1 acre	20	51	68	79	84
2 acres	15	47	66	77	81
Paved parking lots, roofs, driveways, etc.		98	98	98	98
Streets and roads paved with curbs and storm sewers		98	98	98	98
- gravel		76	85	89	91
- dirt		72	82	87	89
Newly graded area		81	89	93	95
Residential: Development underway and no vegetation					
- Lot sizes of 1/4 acre		88	93	95	97
- Lot sizes of 1/2 acre		85	91	94	96
- Lot sizes of 1 acre		82	90	93	95
- Lot sizes of 2 acres		81	89	92	94

[1] Curve numbers are computed assuming the runoff from the house and driveway is directed toward the street.

Source: USDA-SCS

Table 5.6 Slope Adjustment Factors

	Slope (percent)	10 (acres)	20 (acres)	30 (acres)	40 (acres)	50 (acres)
Flat	0.1	0.49	0.47	0.44	0.43	0.42
	0.2	0.61	0.59	0.56	0.55	0.54
	0.3	0.69	0.67	0.65	0.64	0.63
	0.4	0.76	0.74	0.72	0.71	0.70
	0.5	0.82	0.80	0.78	0.77	0.77
	0.7	0.90	0.89	0.88	0.87	0.87
	1	1.00	1.00	1.00	1.00	1.00
	1.5	1.13	1.14	1.14	1.15	1.16
Moderate	3	0.93	0.92	0.91	0.90	0.90
	4	1.00	1.00	1.00	1.00	1.00
	5	1.04	1.05	1.07	1.08	1.08
	6	1.07	1.10	1.12	1.14	1.15
	7	1.09	1.13	1.18	1.21	1.22
Steep	8	0.92	0.88	0.84	0.81	8.00
	9	0.94	0.90	0.86	0.84	0.83
	10	0.96	0.92	0.88	0.87	0.86
	11	0.96	0.94	0.91	0.90	0.89
	12	0.97	0.95	0.93	0.92	0.91
	13	0.97	0.97	0.95	0.94	0.94
	14	0.98	0.98	0.97	0.96	0.96
	15	0.99	0.99	0.99	0.98	0.98
	16	1.00	1.00	1.00	1.00	1.00
	20	1.03	1.04	1.05	1.06	1.07
	25	1.06	1.08	1.12	1.14	1.15
	30	1.09	1.11	1.14	1.17	1.20
	40	1.12	1.16	1.20	1.24	1.29
	50	1.17	1.21	1.25	1.29	1.34

Source: USDA-SCS

Table 5.7 Adjustment Factors for Ponds and Swampy Areas

Adjustment factors where ponding and swampy areas occur at the design point.

Ratio of drainage area to ponding and swampy areas	Percentage of ponding and swampy area	Storm frequency (years)					
		2	5	10	25	50	100
500	0.2	0.92	0.94	0.95	0.96	0.97	0.98
200	0.5	0.86	0.87	0.88	0.90	0.92	0.93
100	1	0.80	0.81	0.83	0.85	0.87	0.89
50	2	0.74	0.75	0.76	0.79	0.82	0.86
40	2.5	0.69	0.70	0.72	0.75	0.78	0.82
30	3.3	0.64	0.65	0.67	0.71	0.75	0.78
20	5	0.59	0.61	0.63	0.67	0.71	0.75
15	6.7	0.57	0.58	0.60	0.64	0.67	0.71
10	10	0.53	0.54	0.56	0.60	0.63	0.68
5	20	0.48	0.49	0.51	0.55	0.59	0.64

Adjustment factors where ponding and swampy areas are spread throughout the watershed or occur in central parts of the watershed.

Ratio of drainage area to ponding and swampy areas	Percentage of ponding and swampy area	Storm frequency (years)					
		2	5	10	25	50	100
500	0.2	0.94	0.95	0.96	0.97	0.98	0.99
200	0.5	0.88	0.89	0.90	0.91	0.92	0.94
100	1	0.83	0.84	0.86	0.87	0.88	0.90
50	2	0.78	0.79	0.81	0.83	0.85	0.87
40	2.5	0.73	0.74	0.76	0.78	0.81	0.84
30	3.3	0.69	0.70	0.71	0.74	0.77	0.81
20	5	0.65	0.66	0.68	0.72	0.75	0.78
15	6.7	0.62	0.63	0.65	0.69	0.72	0.75
10	10	0.58	0.59	0.61	0.65	0.68	0.71
5	20	0.53	0.54	0.56	0.60	0.63	0.68
4	25	0.50	0.51	0.53	0.57	0.61	0.66

Adjustment factors where ponding and swampy areas are located only in upper reaches of the watershed.

Ratio of drainage area to ponding and swampy areas	Percentage of ponding and swampy area	Storm frequency (years)					
		2	5	10	25	50	100
500	0.2	0.96	0.97	0.98	0.98	0.99	0.99
200	0.5	0.93	0.94	0.94	0.95	0.96	0.97
100	1	0.90	0.91	0.92	0.93	0.94	0.95
50	2	0.87	0.88	0.88	0.90	0.91	0.93
40	2.5	0.85	0.85	0.86	0.88	0.89	0.91
30	3.3	0.82	0.83	0.84	0.86	0.88	0.89
20	5	0.80	0.81	0.82	0.84	0.86	0.88
15	6.7	0.78	0.79	0.80	0.82	0.84	0.86
10	10	0.77	0.77	0.78	0.80	0.82	0.84
5	20	0.74	0.75	0.76	0.78	0.80	0.82

Note:

No summary forms or examples are provided in this Manual for developers who want to use Green-Ampt or Horton infiltration functions and Kinematic or Dynamic Wave Routing methods or the methods of the ICPR model for the calculation of runoff volumes and peak discharge rates. When submitting calculations based on those methods an engineering summary of the calculations should be prepared and computer input and simulation results should be submitted to the Storm Water Administrator in both printed and electronic forms.

6.0 Calculating and Controlling Pollutant Exports

6.1 The Pollution Control Program

The County, in order to quantify the impact of its storm water pollution control program and to document its compliance with its NPDES discharge permit, requires a computation of the average potential pollutant exports from each new development. For purposes of pollutant export control the County requires that pollutant exports be controlled to the Maximum Extent Practicable on all new commercial, industrial, and other non-residential development and on residential developments where the new development will ultimately disturb one or more acres. New development does not include agriculture, mining, or forestry activities. Land disturbance is defined to include grubbing, stump removal, and/or grading.

6.2 Calculating Total Pollutant Exports

The County program requires computation of the pollutant export of four indicator constituents, total nitrogen (TN), total phosphorus (TP), total suspended solids (TSS), and fecal coliforms (FC). Table 6.1 presents average export rates of each of those constituents for key combinations of land cover and management practices. The export rates presented in Table 6.1 are to be used to compute the pre- and post-development pollutant exports for each new development or redevelopment subject to the County's Storm Water Quality Control and Discharge Ordinance.

Table 6.1 Pollutant Export Coefficients

A1	Forest	0.6	0.04	62	5.5
A2	Unmown Meadow	0.6	0.04	62	5.5
A3	Wetland and Open Water	0.0	0.00	0	4.0
B	Managed Open Space	15.7	0.98	93	7.9
B1	Mown Meadow	2.4	0.15	77	6.9
B1.1	Unfertilized	1.2	0.08	77	6.0
B1.2	Fertilized	2.4	0.15	77	6.9
B2	Lawn Grass	3.6	0.15	93	7.5
B2.1	Unfertilized	1.2	0.08	93	6.9
B2.2	Fertilized	3.6	0.23	93	7.5
B3	Landscaped areas	3.6	0.23	93	7.5
B3.1	Unfertilized	1.2	0.08	93	6.9
B3.2	Fertilized	3.6	0.23	93	7.5
B4	Residential Lawn	13.3	0.83	93	7.9
B4.1	Unfertilized - Sewered	1.2	0.08	93	6.9
B4.2	Unfertilized - Unsewered - See Note 1	13.3	0.83	93	7.3
B4.3	Fertilized - Sewered	3.6	0.23	93	7.5
B4.4	Fertilized - Unsewered - See Note 2	15.7	0.98	93	7.9
C	Pasture	10.0	0.63	114	10.5
C1	With Nutrient Plan	5.0	0.31	114	9.1
C2	Without Nutrient Plan	10.0	0.63	114	10.5
D	Animal Lot	50.0	3.13	1033	150.0
D1	With Management Plan	25.0	1.56	516	50.0
D2	Without Management Plan	50.0	3.13	1033	150.0
E	Impervious Surfaces	21.2	0.44	83	9.1
E1	Roads and Driveways	21.2	0.44	83	9.1
E1.1	with curb and gutter	21.2	0.44	83	9.1
E1.2	roadside grass-lined ditch	17.0	0.35	52	6.4
E1.3	drains via pervious sheet flow > 100 feet	13.6	0.28	31	5.6
E2	Parking Lots and Paved Storage Areas	21.2	0.44	83	9.1
E2.1	with curb and gutter	21.2	0.44	83	9.1
E2.2	roadside grass-lined ditch	17.0	0.35	52	6.4
E2.3	drains via pervious sheet flow > 100 feet	13.6	0.28	31	5.6
E3	Roof Areas	21.2	0.44	83	6.0
E3.1	connected to impervious drainage	21.2	0.44	83	6.0
E3.2	connected to pervious surfaces	14.8	0.31	41	4.0
E4	Gravel Roads and Driveways	18.0	0.38	83	6.8
E4.1	connected to impervious drainage	18.0	0.38	83	6.8
E4.2	connected to pervious surfaces	12.6	0.26	41	4.8
F	Heavy Residential / Institutional areas	21.2	1.33	83	9.1
G	Light Residential areas	12.0	0.75	72	6.9
H	Heavy Industrial areas	21.2	0.66	83	2.7
I	Heavy Commercial	21.2	0.66	72	2.7
J	Light Commercial / Industrial areas	12.0	0.75	72	3.2

Notes:

1: TN = 1.2+12.1 / lot size (in acres); FC = 6.9 + 0.4 / lot size (in acres)

2: TN = 3.6+12.1 / lot size (in acres); FC = 7.5 + 0.4 / lot size (in acres)

6.3 Method of Calculation

Each new development or regulated redevelopment must submit computation forms SW-004 and SW-005 with the required storm water permit application. These forms document the expected annual export of each of the four indicator constituents for the predevelopment (SW-004) and post development (SW-005) conditions. In order to prepare form SW-004 it is necessary to determine the area within the development parcel that is currently in each of the land cover and management classifications shown in Table 6.1. The classifications in the table are general and the table may not present an exact description of the current land cover and management present on a given site. In those cases, the best match in the table for the current land use and management should be used. For each land cover classification the area is multiplied by the appropriate constituent export coefficient to produce the expected annual export of each of the four indicator constituents.

Form SW-005 must be completed in a similar manner with the land cover and management selections appropriately representing the ultimate built-out conditions of the parcel. If the development is to occur in multiple stages and a new storm water permit will be obtained for each stage, then form SW-005 should reflect ultimate built-out conditions for the current development phase. Updated forms will then need to be submitted for each phase of development.

Examples of the use of forms SW-004 and SW-005 follow:

Example 1: Single Residential Lot

Given:

- Single Residential Lot that is currently 75% forested and 25% meadow or fallow.
- 1.5 acres total, 2,000 sf footprint of the new house plus a 600 sf outbuilding and a 15'x 40' concrete driveway.
- Roof drains onto pervious lawn.
- 25% of the lot will remain forested, the remainder will be graded and replaced with residential lawn.
- Developed as single family residence with an on-site septic system.

Forms SW-004 and SW-005 completed for the above described development are shown on the following page. Comparing the two forms it can be noted that total nitrogen exports are expected to increase from 0.9 to 13.6 lbs/year; total phosphorus exports will increase from 0.06 to 1.07 lbs/year; total suspended solids are expected to increase from 93 to 124 lbs/year; and fecal coliforms exports are expected to increase from 8.2 to 10.5 (10^9 colony units / year).

Brunswick County, North Carolina
Pollutant Export Calculations

Pre-Development Conditions Form (SW-004)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If currently a residential development enter average lot	1.5

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
A1	1.125	0.6	0.7	0.04	0.04	62	70	5.5	6.2
A2	0.375	0.6	0.2	0.04	0.01	62	23	5.5	2.1
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**1.5**		**0.9**		**0.06**		**93**		**8.2**

Brunswick County, North Carolina
Pollutant Export Calculations

Post-Development Conditions Form (SW-005)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If residential development enter average lot size:	1.5

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
A1	0.375	0.6	0.2	0.04	0.01	62	23	5.5	2.1
E3.2	0.060	14.8	0.9	0.31	0.02	41	2	4.0	0.2
E1.2	0.014	17.0	0.2	0.35	0.00	52	1	6.4	0.1
B4.4	1.052	11.7	12.3	0.98	1.03	93	98	7.8	8.2
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**1.5**		**13.6**		**1.07**		**124**		**10.5**

Example 2: Residential Multi-Lot Subdivision

Given:

- 80 acre parcel: Currently having 56 acres forested, 16 acres unmanaged pasture, 4 acres of wetland, and two single family homes (4000 sf of roof with 1000 sf of gravel driveway) with on-site septic systems each on 2 acre lots.
- Parcel has a stream running through it and 8 acres will be set-aside for a riparian buffer around the stream.
- An additional 5 acres will remain as undisturbed forest.
- 9 acres will be developed into roadways 50% of which will be curb and gutter construction and 50% will have grass lined roadside ditches.
- 40 lots will be developed with an average lot size of 0.75 acres.
- All lots are connected to an approved sanitary sewer system.
- Homes will average a footprint of 2400 sf and impervious driveways of 600sf.
- All remaining space will be maintained as unfertilized, mown meadow.

Brunswick County, North Carolina
Pollutant Export Calculations

Pre-Development Conditions Form (SW-004)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If currently a residential development enter average lot	2

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
A1	56	0.6	33.6	0.04	2.10	62	3470	5.5	306.9
C2	16	10.0	160.0	0.63	10.00	114	1818	10.5	168.0
A3	4	0.0	0.0	0.00	0.00	0	0	4.0	16.0
E3.2	0.092	14.8	1.4	0.31	0.03	41	4	4.0	0.4
E4.2	0.023	12.6	0.3	0.26	0.01	41	1	4.8	0.1
B4.2	3.885	7.3	28.2	0.83	3.23	93	361	7.1	27.6
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**80**		**223.4**		**15.36**		**5654**		**518.9**

Note on form SW-004 above, that the TN and Coliform export coefficients for land use classification B4.2 (unfertilized residential lawns) have been adjusted to reflect the lot size of 2 acres per household. The formula for this adjustment is shown at the bottom of Table 6.1.

Brunswick County, North Carolina
Pollutant Export Calculations
Post-Development Conditions Form (SW-005)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If residential development enter average lot size:	0.75

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
A1	8.0	0.6	4.8	0.04	0.30	62	496	5.5	43.8
A1	5.0	0.6	3.0	0.04	0.19	62	310	5.5	27.4
E1.1	4.5	21.2	95.4	0.44	1.99	83	372	9.1	41.0
E1.2	4.5	17.0	76.3	0.35	1.59	52	232	6.4	28.8
E3.1	0.551	21.2	11.7	0.44	0.24	83	46	6.0	3.3
E3.2	1.653	14.8	24.5	0.31	0.51	41	68	4.0	6.6
E1.1	0.551	21.2	11.7	0.44	0.24	83	46	9.1	5.0
B4.3	27.245	3.6	98.1	0.23	6.13	93	2532	7.5	204.3
B1.1	28.0	1.2	33.6	0.08	2.10	77	2169	6.0	168.6
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**80**		**359.1**		**13.29**		**6270**		**528.8**

Comparing the two forms, this development results in an expected average annual increase in exports of 135.7 lbs of TN, 616 lbs of TSS, and 10.9 (10^9 colony forming units) of Coliforms. There is an expected decrease of 2.07 lbs of TP export annually.

This example can illustrate some of the design practices that will help limit pollutant exports resulting from development. For example, exports of all four constituents would be reduced if more of the development was constructed with roadside grass-lined ditches instead of curb and gutter construction (i.e switch from land cover code E1.1 to E1.2). Further reductions could be obtained reducing the manicured lawn area (code B4.3) and replacing it with native grasses and other covers that do not require annual fertilization. Several so called “low-impact design” practices are discussed in the next section of this manual.

Example 3: Commercial Development

Given:

- 1.75 acre site that currently has a service station and parking lot. Site has a total of 1.5 acres of impervious area of which .15 acres is rooftop directly connected to impervious drainage. Current .25 acres is fertilized lawn. Site is served by sanitary sewer.

- The current building is to be renovated and continue its use as a service stations. The impervious parking area will be reduced to 0.75 acres. The parking area and rooftop will be drained, as sheet flow, across a 0.35 acre strip of lawn that separates the impervious areas from the nearby roadway drainage. The remaining 0.5 acres will be replanted into native meadow grasses and mown as required.

Brunswick County, North Carolina
Pollutant Export Calculations
Pre-Development Conditions Form (SW-004)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If currently a residential development enter average lot size:

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
E2.1	1.35	21.2	28.6	0.44	0.60	83	112	9.1	12.3
E3.1	0.15	21.2	3.2	0.44	0.07	83	12	6.0	0.9
B2.2	0.25	3.6	0.9	0.23	0.06	93	23	7.5	1.9
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**1.75**		**32.7**		**0.72**		**147**		**15.1**

Brunswick County, North Carolina
Pollutant Export Calculations
Post-Development Conditions Form (SW-005)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If residential development enter average lot size:

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
E3.2	0.15	14.8	2.2	0.31	0.05	41	6	4.0	0.6
E2.3	0.750	13.6	10.2	0.28	0.21	31	23	5.6	4.2
B2.2	0.350	3.6	1.3	0.23	0.08	93	33	7.5	2.6
B1.1	0.500	1.2	0.6	0.08	0.04	77	39	6.0	3.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
		0.0	0.0	0.00	0.00	0	0	0.0	0.0
Totals	**1.75**		**14.3**		**0.37**		**101**		**10.4**

6.4 Restrictive Covenant

The proper design, installation, and maintenance of a storm water facility plan are conditions under which the Storm Water Administrator can issue a County Storm Water Permit. This section of the manual set forth the requirements for the computation of pollutant exports that must be completed prior to the issuance of a County Storm Water Permit. The applicant's storm water facility plan must specify the areas of impervious surface, undisturbed open space, and managed open space in the development. In order to ensure that the facilities maintained in a development result in compliance with the plan presented in the application the applicant must execute the Covenant Agreement contained in Appendix C of this manual, or other legal instrument acceptable to the Storm Water Administrator, before a County Storm Water Permit may be issued.

7.0 Site Design Best Management Practices

7.1 Low-impact Development (LID)

The County encourages developers and property owners to adopt the principles and practices of Low-Impact Development (LID) to achieve storm water control and improve the quality of the runoff from developed areas. LID can be described as the effort to create a hydrologically functional landscape in a developed area that mimics the natural hydrologic regime. This objective is accomplished by:

- Minimizing storm water impacts to the extent practicable. Techniques to accomplish this include reducing imperviousness, conserving natural resource and ecosystems, maintaining natural drainage courses, reducing use of pipes, and minimizing clearing and grading.
- Providing runoff storage measures dispersed uniformly throughout a site's landscape with the use of a variety of detention, retention, and runoff practices.
- Maintaining predevelopment time of concentration by strategically routing flows to maintain travel time and control the discharge.
- Implementing effective public education programs to encourage property owners to use pollution prevention measures and properly maintain the on-lot hydrological function landscape management practices.

7.1.1 LID Strategies

The County is reviewing its ordinances, operations and practices in order to better manage storm water from its properties and the County expects developers and property owners applying for Storm Water Permits to use LID strategies in their site designs and storm water management plans. Some of the strategies that can provide for improved storm water management and for the reduction of the total pollutant exports include:

- **Reducing Road and Driveway Widths**

  Reducing road and driveways widths reduces the amount of impervious area of a site. Roads are often designed at widths that are excessive, and sometimes even counterproductive, for vehicular safety. Overly wide roads inadvertently increase impervious area that, in turn, increases storm runoff and the transport of nutrients and other pollutants. Applicants for Storm Water Permits should show that they have considered road and driveway

widths and have appropriately reduced them while maintaining a minimum consistent with health, safety requirements, and the requirements of the County's Land Use Ordinance.

- **Reducing Parking Areas**

  Similar to road and driveway widths, parking areas (both the number and size of spaces) often are designed with no consideration of the storm water and water quality impacts of those facilities. Some methods that may be used to reduce the impervious area created by parking facilities are use of angled parking and smaller parking spaces and the use of pervious parking materials.

  Parking facilities do not have to be visually unappealing and, fortunately, many of the methods used to reduce the unpleasant visual impacts of parking facilities can be incorporated into its water quality mitigation plans. Depressed, rather than raised, parking lot islands and median strips not only enhance the aesthetic value of the area, but can also serve a functional purpose for water quality enhancement. These interruptions in the impervious parking lots can have vegetative filter strips to receive pavement runoff or contain bioretention areas or other engineered BMPs.

  Porous pavements can be used in parking lots to reduce the amount of runoff and decrease the required size of associated BMP structures.

- **Minimizing Use of Curb and Gutter**

  Curb and gutter are often used in areas where they are not required for storm water control and where alternative designs such as grass swales are feasible. In the application for a Storm Water Permit, the applicant should present information about the development's street design procedures and should show that alternatives to curb and gutter have been considered. Useful alternative approaches include designs that allow sidewalk, driveway, and parking lot flows to drain into grass swales or bioretention areas, away from street gutter and pipe systems. These systems should use flush surface curbstones that allow sheet flow off of the impervious surface while providing lateral support for the pavement. Where both curb and gutter are necessary, the use of frequent curb cuts, which divert a designed portion of the runoff onto vegetated areas, should be considered.

- **Cluster and Open-Space Developments and "Traditional" Neighborhood Developments.**

  Among the strategies for improved storm water management are the use of innovative community and subdivision designs that can significantly reduce the impact of new development on water quality and on required municipal services. The County will encourage these innovations by review of its current Land Use Ordinance and require storm water management BMP design review as part of the site review process. The North Carolina State Model Program for the Neuse River system defines "traditional" neighborhoods as rectangular block development with mixed residential and commercial land use. Such neighborhoods can have the advantage of reducing automobile travel and promoting increased usage of alternative transportation modes, including mass transit and pedestrian. The use of these LID design concepts is encouraged in Brunswick County.

- **Maintaining Green Space**

  How a development and its residents manage green space has an important impact on water quality. In dense urban settings, rain gardens can be used to reduce runoff from buildings and create a pleasant environment. Rain garden systems consist of piping roof storm water into a cistern that bleeds the water into a nearby, vegetated area. Filtration through the vegetation and the soil removes pollutants from the water and reduces the impacts of the impervious roof area. Developing County procedures to properly manage the application of fertilizers on County property and publishing guidelines on the use of fertilizers (and other chemicals) for residential and commercial properties are low-cost, highly effective methods of reducing TN exports to local waters.

- **Disconnecting Impervious Surfaces**

  One of the methods that can be used to reduce the amount of runoff from a development site is the disconnection of impervious surfaces. This BMP can be implemented in many ways, including:
  - Leaving a 2 or 3 feet wide pervious strip between the edge of a street and the beginning of driveways.
  - Using pervious pavement stones along strips of a parking lot and in sections of sidewalks.
  - Ensuring that rooftop drain water passes over a pervious strip before running onto a paved lot or into a Storm Water collection system.

These simple techniques are valuable methods for reducing both the quantity of storm water leaving a project and improving the quality of that storm water.

- **Other**

  Other areas in which County land use ordinances can have significant impacts on water quality are property setback requirements and lot size zoning. Excessive setback and lot size requirements have the impact of decreasing the compactness of development, which can increase the overall impervious area, decrease the applicability of some BMPs, and increase the use of automobile transportation. While large-lot zoning may be desirable for water quality impacts in some sensitive areas and for other reasons, it can negatively impact water quality when applied as a uniform standard.

References:

Low-Impact Development Design Strategies, An Integrated Design Approach, Prince George's County, Maryland Department of Environmental Resources, January 2000.

Better Site Design, An Assessment of the Better Site Design Principles for Communities Implementing Virginia's Chesapeake Bay Preservation Act, Center for Watershed Protection, Inc, Ellicot County, Maryland 21043.

Principles of Low-Impact Design

Conservation of Natural Areas

1. **Native Plant and Tree Conservation**: Conserve trees and other vegetation at each site by planting additional vegetation, clustering tree areas, and promoting the use of native plants. Wherever practical, manage community open space, street right-of-ways, parking lot islands, and other landscaped areas to promote natural vegetation.

2. **Minimized Clearing and Grading**: Clearing and grading of forests and native vegetation at a site should be limited to the minimum amount needed to build lots, allow access, and provide fire protection. A fixed portion of any community open space should be managed as protected green space in a consolidated manner.

Lot Development

3. **Open Space Design:** Promote open space development that incorporates smaller lot sizes to minimize total impervious area, reduce total construction costs, conserve natural areas, provide community recreational space, and promote watershed protection.

4. **Shorter Setbacks and Frontages:** Relax side yard setbacks and allow narrower frontages to reduce total road length in the community and overall site imperviousness. Relax front setback requirements to minimize driveway lengths and reduce overall lot imperviousness.

5. **Common Walkways:** Promote more flexible design standards for residential subdivision sidewalks. Where practical, consider locating sidewalks on only one side of the street and providing common walkways linking pedestrian areas.

6. **Shared Driveways**: Reduce overall lot imperviousness by promoting alternative driveway surfaces and shared driveways that connect two or more homes together.

Residential Streets and Parking Lots

7. **Narrower Streets**: Design residential streets for the minimum required pavement width needed to support travel lanes; on-street parking; and emergency, maintenance, and service vehicle access. These widths should be based on traffic volume.

8. **Shorter Streets**: Reduce the total length of residential streets by examining alternative street layouts to determine the best option for increasing the number of homes per unit length.

9. **Narrower Right-of-Way Widths**: Residential street right-of-way widths should reflect the minimum required to accommodate the travel-way, the sidewalk, and vegetated open channels. Utilities and storm drains should be located within the pavement section of the right-of-way wherever feasible.

10. **Smaller and Landscaped Cul-de-Sacs**: Minimize the number of residential street cul-de-sacs and incorporate landscaped areas to reduce their impervious cover. The radius of cul-de-sacs should be the minimum required to accommodate emergency and maintenance vehicles. Alternative turnarounds should be considered.

11. **Vegetated Open Channels:** Where density, topography, soils, and slope permit, vegetated open channels should be used in the street right-of-way to convey and treat Storm Water runoff.


PHOTO: LARRY COFFMAN, PGC DEPT OF ENV. RESOURCES

12. **Reduced Parking Ratios:** The required parking ratio governing a particular land use or activity should be enforced as both a maximum and a

minimum in order to curb excess parking space construction. Existing parking ratios should be reviewed for conformance taking into account local and national experience to determine if lower ratios are warranted and feasible.

13. **Mass Transit and Shared Parking**: Parking codes should be revised to lower parking requirements where mass transit is available and enforceable shared parking arrangements are made.

14. **Less Parking Lot Imperviousness:** Reduce the overall imperviousness associated with parking lots by providing compact car spaces, minimizing stall dimensions, incorporating efficient parking lanes, and using pervious materials (see lattice paving stones in photo to right) in the spillover parking areas where possible.


PHOTO: BRUCE K. FERGUSON

15. **Structured Parking:** Provide meaningful incentives to encourage structured and shared parking to make it more economically viable.

16. **Treated Parking Lot Runoff**: Provide Storm Water treatment for parking lot runoff
using bioretention areas (see photos to right and below), filter strips, and/or other practices that can be integrated into required landscaping areas and traffic islands.


PHOTO: LARRY COFFMAN, PGC DEPT OF ENV. RESOURCES


PHOTO: TOM LIPTAN, PORTLAND, OR

Site Design Resources

Conservation Design for Storm Water Management (1997), Delaware Department of Natural Resources and Environmental Control, Sediment and Storm Water Program, 89 Kings Highway, Dover, DE 19901, Phone: (302) 739-4411.

Conservation Design for Subdivisions: A Practical Guide to Creating Open Space Networks (1996) by Randal Arendt, American Planning Association, Planners Book Service, 122 S. Michigan Avenue, Suite 1600, Chicago, IL 60603, (312) 786-6344.

Low Impact Development Design Manual (1997), Low Impact Development Center, 3230 Bethany Lane, Suite 9, Ellicott County, MD 21042, (410) 418-8476.

Building Greener Neighborhoods: Trees as Part of the Plan (1995) by Jack Petit, Debra Bassert, and Cheryl Kollin, American Forests, PO Box 2000, Washington, DC 20013, (202) 667-3300.

The Wild Lawn Handbook: Alternatives to the Traditional Front Lawn (1995) by Steven Daniels.

Clearing and Grading: Strategies for Urban Watersheds (1995) by Kathleen Corish, Metropolitan Washington Council of Governments, Information Center, 777 North Capitol Street, NE, Suite 300, Washington DC, 20002, (202) 962-3256.

Site Planning for Urban Stream Protection (1995) by Thomas R. Schueler, Center for Watershed Protection, 8391 Main Street, Ellicott County, MD 21043, (410) 461-8323.

Design by Design (1992) by James W. Wentling and Lloyd Bookout, Urban Land Institute, 1025 Thomas Jefferson Street, NW, Suite 500 West, Washington, DC 20007, (800) 321-5011.

Best Development Practices: Doing the Right Thing and Making Money at the Same Time (1996) by Reid Ewing, American Planning Association, Planners Book Service, 122 S. Michigan Avenue, Suite 1600, Chicago, IL 60603, (312) 786-6344.

Flexible Parking Requirements (1984) b Thomas P. Smith, American Planning Association, Planners Book Service, 122 S. Michigan Avenue, Suite 1600, Chicago, IL 60603, (312) 786-6344.

The University of Washington Permeable Pavement Demonstration Project (1997) by Derek B. Booth, Jennifer Leavitt, and Kim Peterson, Center for Urban Water Resources Management, University of Washington, Civil and Environmental Engineering, Box 352700, Seattle, WA 98195. http://depts.washington.edu/cuwrm.

Design of Storm Water Filtering Systems (1996) by Richard A. Claytor and Thomas R. Schueler, Center for Watershed Protection, 8391 Main Street, Ellicott County, MD 21043, (410) 461-8323.

Watershed Determinants of Ecosystem Functioning (1996) by Richard R. Horner, Derek B. Booth, Amanda Azous, and Christopher W. May, (originally published in the conference proceedings of the Engineering Foundation conference, "Effects of Watershed Development and Management on Aquatic Ecosystems," August 4-9, 1996). Subscriber price = $5.00 (publication no. K12), Center for Urban Water Resources Management, University of Washington, Civil and Environmental Engineering, Box 352700, Seattle, WA 98195. http://depts.washington.edu/cuwrm.

PHOTO: BRUCE K. FERGUSON

8.0 Structural Best Management Practices

8.1 Use of Structural Best Management Practices

While much can be done by planning and land use control, when development occurs it will generally be necessary to design and construct one or more facilities for storm water and pollutant export control. The above-described site planning BMPs are useful in controlling the generation of storm runoff and reducing the concentrations of pollutants in the runoff. Constructed BMPs may then be used to collect, direct, filter, and biologically treat the runoff. Appendix C of this manual contains Storm Water Technology Fact Sheets on many of the structural BMPs that may be used to control storm water runoff and quality. Storm Water Permit applicants should use the design criteria given in those fact sheets, in the latest version of the North Carolina Storm Water Management Guidance Manual (North Carolina Cooperative Extension Service and NC DENR), in the Maryland Storm Water Design Manual (Maryland Department of the Environment), and the information given below in their design of structural BMPs.

8.2 Allowable BMPs and Pollutant Reduction Factors

The following items are among the constructed BMPs that may be used to further reduce and control runoff and pollutant export and that may be incorporated into a applicant's Storm Water Management Plan.

8.2.1 Wet Detention Ponds (WDP)

These are ponds designed to have a permanent water pool with a 3-foot minimum average depth and a temporary pool that retains the volume of runoff produced by at least the first 1" of rainfall for a period of 2 to 5 days. When WDPs are incorporated into a project's Storm Water Management Plan there are several health, safety, and aesthetic issues that must be addressed by the plan, including:

- Since a WDP maintains a minimum depth of 3 feet or more, there is the safety concern associated with drowning. In some cases, fencing may be required to exclude children from the pond. Because of the requirements for a low-sloped shelf at the edges of a WDP, the safety concerns can often be limited to the pond forebay and outlet.
- Insect breeding within the WDP may create health and nuisance concerns. The Brunswick County Health Department recommends stocking certain fish

species to reduce the number of nuisance insects. Other useful techniques include installation of spray aerators and other means of regularly disturbing the pond's surface.

- WDPs often attract wildlife. In many situations that is a positive impact, but it also may become a nuisance. This is particularly a problem with respect to waterfowl and the accumulation of large amounts of fecal matter. In some areas there may be concerns about the attraction of dangerous wildlife.
- Water and wind move debris and trash into the WDP and cause unsightly conditions. Routine maintenance should include a regular cleaning schedule and cleaning after significant storm events.
- For a WDP to continue operating, it is necessary to remove accumulated sediments every two to five years. This operation usually requires large equipment and the safety and noise concerns associated with that equipment should be recognized.

For purposes of computing the total pollutant export reductions due to the installation of a WDP designed to retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, for a period of not less than 48 hours, the following pollutant export reduction factors may be assumed.

Pollutant	BMP export reduction factor
Total Nitrogen	25%
Total Phosphorus	40%
Total Suspended Solids	80%
Fecal Coliforms	70%

8.2.2 Storm Water Wetlands

A Storm Water Wetland is simply a WDP that has been designed to have longer water detention times and a shallower average depth. All of the health, safety, and aesthetic concerns for WDPs are relevant to Storm Water Wetlands. Despite their similarities, Storm Water Wetlands are generally more costly to design and construct than are Wet Detention Ponds. Much of the additional cost is related to the fact that much care is taken in developing a diverse, healthy, and ecologically stable wetland.

The health and safety issues listed in the above discussion of WDPs must also be addressed for Storm Water wetlands.

For purposes of computing the total pollutant export reductions due to the installation of a Storm Water Wetland designed to retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, for a period of not less than 72 hours, the following pollutant export reduction factors may be assumed:

Pollutant	BMP export reduction factor
Total Nitrogen	40%
Total Phosphorus	60%
Total Suspended Solids	80%
Fecal Coliforms	50%

8.2.3 Extended Dry Detention Ponds

Dry Detention Ponds (DDPs) are a common storm water management facility. When they are to be used for water quality purposes, the design criteria are modified to provide for longer detention times and for sediment trapping and removal. Extended DDPs are generally less expensive to construct and maintain than are Wet Detention Ponds and Storm Water Wetlands.

When a DDP or Extended DDP is incorporated into a storm water management facility then the relevant health and safety issues must be addressed by the Storm Water Management Plan.

For purposes of computing the total pollutant export reductions due to the installation of an Extended DDP designed to retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, for a period of not less than 48 hours, the following pollutant export reduction factors may be assumed:

Pollutant	BMP export reduction factor
Total Nitrogen	10%
Total Phosphorus	20%
Total Suspended Solids	50%
Fecal Coliforms	40%

8.2.4 Bioretention Areas (BAs)

Bioretention Areas use soils and vegetation to detain and reduce runoff volumes, and remove pollutants from storm water runoff. Runoff is conveyed as sheet flow to the BA, where it passes through a sand bed and into a vegetated shallow ponding area that exfiltrates the flow. Excess runoff is diverted away from the BA. BAs can take many forms and can be designed to fit a variety of site layouts. BAs are particularly suitable BMPs for median strips, parking lot islands, and swales where grading or excavation will already be occurring and there will be no additional environmental damage.

The aesthetic value of the BA is substantial, because several varieties of groundcover, bush, and tree species are suitable for different sections of the BA. The BA can provide shade and wind breaks, absorb noise, and improve the area's landscape. Strategic placement of BAs can significantly reduce costs by eliminating the need for extensive storm drainage pipe systems.

Limitations for site selection include avoiding areas with high water tables (< 6 ft below ground surface), unsuitable soils, or large slopes (> 20 percent). Some maintenance is recommended including periodic inspection of the overall condition and the health of vegetation, pruning, application of an alkaline product to counteract soil pH reduction by acidic storm water, and aesthetic maintenance such as weeding and replacing mulch.

Rain gardens are one particularly appropriate BA design for smaller scale areas such as commercial buildings or residential homes. Rain gardens consist of piping roof storm water drainage into a cistern that bleeds the water into a nearby vegetated area. Filtration through the vegetation and the soil removes pollutants from the water and reduces the impacts of the impervious roof area.

For purposes of computing the total pollutant export reductions due to the installation of a BA designed to fully retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, the following pollutant export reduction factors may be assumed.

Pollutant	BMP export reduction factor
Total Nitrogen	30%
Total Phosphorus	40%
Total Suspended Solids	60%
Fecal Coliforms	30%

8.2.5 Riparian Buffers

A Riparian Buffer established and managed consistent with the Neuse Riparian Buffer Rules (15A NCAC 2B. 0233) can be used as a pollutant export reducing BMP. For purposes of computing the total pollutant export reductions due to the establishment of a riparian buffer the following pollutant export reduction of factors may be assumed for a project area not to exceed the area of the established riparian buffer:

Pollutant	BMP export reduction factor
Total Nitrogen	30%
Total Phosphorus	40%
Total Suspended Solids	60%
Fecal Coliforms	30%

In order to qualify for the credit the Storm Water Management Plan must demonstrate that runoff from the serviced project area will be supplied in a diffused manner to the edge of the riparian buffer.

8.2.6 Grassed Swales

Grassed Swales are shallow earthen channels covered with dense growths of a hardy grass. The major impacts of a grassed swale are to slow runoff, increase infiltration, and reduce the transport of solid particles to receiving waters.

For purposes of computing the total pollutant export reductions due to the installation of a grassed swale designed to have a mean residence time of not less than 60 minutes for the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, the following pollutant export reduction factors may be assumed.

Pollutant	BMP export reduction factor
Total Nitrogen	20%
Total Phosphorus	30%
Total Suspended Solids	50%
Fecal Coliforms	30%

8.2.7 Filter Strips

Filter Strips share many of the characteristics and concerns of the Bioretention Areas outlined above. They are gently sloping areas of natural vegetation that are designed to provide sheet flow throughout an area. They are used to separate runoff-producing areas from receiving waters and storm water collection facilities. Runoff is evenly spread throughout the filter strip area allowing for infiltration, sediment and pollutant removal, and flow retardation.

For purposes of computing the total pollutant export reductions due to the installation of a filter strip designed to have a mean residence time of not less than 60 minutes for the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, the following pollutant export reduction factors may be assumed.

Pollutant	BMP export reduction factor
Total Nitrogen	10%
Total Phosphorus	20%
Total Suspended Solids	50%
Fecal Coliforms	30%

8.2.8 Sand Filters and other Infiltration Devices

Sand Filters and other Infiltration Devices capture storm water runoff and allow it to infiltrate into the ground. They may be above or below ground structures with their design parameters being determined primarily from design runoff volumes, available space, and soil and groundwater conditions. Use is limited in areas with soils of low permeability and where the groundwater table is close to the ground surface. It is important to plan for maintenance, which often includes cleaning of sediment trapping forebays, stripping and replacement of sand materials, and vegetation management. Since this BMP depends on the rapid transfer of surface runoff into the ground, it cannot be used where there is a concern for contamination of groundwater drinking supplies.

For purposes of computing the total pollutant export reductions due to the installation of a sand filters and other infiltration devices designed to fully retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, and to allow subsurface drainage of that volume in not less than a 24-hour period, the following pollutant export reduction factors may be assumed:

Pollutant	BMP export reduction factor
Total Nitrogen	20%
Total Phosphorus	50%
Total Suspended Solids	80%
Fecal Coliforms	40%

8.2.9 Rain Barrels and Cisterns

Rain barrels and cisterns are low-cost, effective, and easily maintainable retention devices applicable to all types of development sites. They operate by retaining a predetermined volume of runoff from rooftops or other impervious areas. In order to receive credit as a pollutant export reducing BMP the Storm Water Management Plan must demonstrate effective long-term maintenance of the storage unit and an operational plan that empties the storage unit in not less than 2 days following a rainfall event and not more than 10 days.

For purposes of computing the pollutant export reductions due to the installation of a rain barrel or cistern, the discharge method and location must be considered. For example, if the stored water is applied to a lawn, garden or other Bioretention Area then a nitrogen export reduction percentage equal to 30% may be assumed. If the stored water is discharged to a grassy swale then a nitrogen export reduction equal to 20% may be assumed. If the stored water is discharged directly to a storm sewer, gutter, or other impervious device, then no nitrogen export reduction may be assumed. Since solids in the runoff will settle in the cistern, and since fecal coliforms have a natural die-off rate when held in storage, additional export reduction factors are provided for those pollutants.

Pollutant	BMP pollutant export reduction factor
Total Nitrogen	0%
Total Phosphorus	0%
Total Suspended Solids	20%
Fecal Coliforms	20%

8.2.10 Porous Pavement

Porous pavement is a special type of pavement that allows rain to pass through it, thereby reducing the runoff from a site and surrounding areas that drain to the pavement. In addition, porous pavement filters some pollutants from the runoff if it is properly maintained. Where appropriate, Storm Water Permit applicants should consider the use of porous pavement to reduce runoff and pollutant export. Credit for pollutant export reductions may be obtained for the use of porous pavement. In order for credit to be obtained the design and maintenance

specifications of the BMP must be provided to the Storm Water Administrator along with scientific evidence of the degree of pollutant removal to be expected by the porous pavement system.

Pollutant	BMP export reduction factor
Total Nitrogen	10%
Total Phosphorus	20%
Total Suspended Solids	30%
Fecal Coliforms	40%

8.2.11 Storm Water Runoff Reuse

Storm water runoff reuse entails capturing storm water in an on-site retention pond and utilizing the collected runoff as a source for industrial process water or site irrigation water. For process water use, the primary concern associated with the runoff is total solids, dissolved and suspended, as they may adversely impact process equipment. In addition, petroleum products in the runoff have the potential to contaminant an industrial process. In these cases, primary or intermediate water treatment may be required to remove potential contaminants from the runoff.

Some of the advantages of storm water reuse are:

- Reduces treated water demand (i.e. operating cost savings)
- Retention facility can be aesthetically pleasing
- “Environmentally friendly” operation
- Reduces or eliminates off-site runoff and any associated responsibility

Some of the disadvantages of storm water runoff reuse are:

- May require pretreatment before use as process water
- May require periodic monitoring for quality control purposes
- Maintenance requirements
- Depending on sediment loading, periodic dredging or vacuuming of retention facility will be required.

For purposes of computing the total pollutant export reductions due to the installation of storm water reuse systems designed to fully retain the runoff from at least the first 1" of rainfall, under normal antecedent moisture conditions, and to provide for full reuse of that water in not more than a 120-hour period, the following pollutant export reduction factors may be assumed:

Pollutant	BMP export reduction factor for industrial process reuse and discharge to a sanitary sewer or under another NPDES permit.
Total Nitrogen	100%
Total Phosphorus	100%
Total Suspended Solids	100%
Fecal Coliforms	100%

Pollutant	BMP export reduction factor for irrigation reuse
Total Nitrogen	50 - 100% *
Total Phosphorus	50 - 100% *
Total Suspended Solids	80 - 100% *
Fecal Coliforms	70 - 100% *

* Calculations and explanation must be provided to justify the assumed reduction factor.

8.2.12 Proprietary BMPs

Proprietary BMPs take various forms and are typically designed to accommodate specific pollutant types or site limitations. One example is underground concrete structures for oil or solid separation for high impact land uses, such as County vehicle maintenance yards or industrial locations. Most propriety BMPs are designed for high pollutant removal efficiency, safety, and ease of access for maintenance purposes. Credit for pollutant export reductions may be obtained for the use of custom designed and other proprietary BMPs. In order for credit to be obtained the design and maintenance specifications of the BMP must be

provided to the Storm Water Administrator along with scientific evidence of the degree of pollutant removal to be expected from that BMP.

8.3 Including BMPS in pollutant export computations

If more than one BMP is installed in series on a development, then the removal rate shall be determined through serial rather than additive calculations. For example, if a wet detention area discharges through a riparian buffer, then the removal rate shall be estimated to be 47.5 percent. The pond removes 25 percent of the nitrogen and discharges 75 percent to the buffer. The buffer then removes 30 percent of the remaining nitrogen. The total nitrogen removal is calculated as: 25% + (0.75 * 30%) = 47.5%. This same procedure shall be used for all of the required pollutant export computations.

8.4 Restrictive Covenant

The proper design, installation, and maintenance of storm water facilities plan are conditions under which the Storm Water Administrator can issue a County Storm Water Permit. This section of the manual set forth the requirements for the computation of total pollutant export reductions expected to result from structural BMPs and the criteria under which the Storm Water Administrator may issue a County Storm Water Permit. The applicant's Storm Water facility plan must specify the details of design, installation and maintenance of all structural BMPs in sufficient detail to ensure the Storm Water Administrator of their proper performance. In order to ensure that the facilities maintained in a development result in compliance with the plan presented in the application the applicant must execute the Covenant Agreement contained in Appendix C of this manual, or other legal instrument acceptable to the Storm Water Administrator, before a County Storm Water Permit may be issued.

8.5 References

Storm Water Management Guidance Manual, North Carolina Cooperative Extension Service and North Carolina Department of Environment, Health and Natural Resources, 1993.

Maryland Storm Water Design Manual, Maryland Department of the Environment, 1998.

Low-Impact Development Design Strategies, An Integrated Design Approach, Prince George's County, Maryland Department of Environmental Resources, January 2000.

9.0 Fees

9.1 Purpose of Fees

The cost of performing storm water plan reviews and of administering applications for County Storm Water Permits vary based on the size and complexity of the development. The fee schedule given below is established to assist in financing the County storm water management program, the storm water plan review process, and inspection of storm water management structures.

9.2 Storm Water Permit and Inspection Fee Schedule

Type of Development or Activity	Ultimate Disturbance	Standard Fee	Additional Fee
Residential-individual single family	<1 acre	Exempt – no fee	
Residential – single family or subdivision	≥1 acre	$200/acre disturbed or part thereof	
Residential – multi-family	≥ 1 acre	$400/acre disturbed or part thereof	
Non-Residential	Any	$400/acre disturbed or part thereof	
Review of application for variance	Any	$200	$250 per fact-finding meeting
Technical Review of Structural BMPs in Storm Water Plan and As-Built Inspection	Each	$200	
Annual Inspection of Structural BMP	Each	$400	
Re-inspection Fee	Each	$400	

10.0 Duties of the Storm Water Administrator

10.1 Appointment of Storm Water Administrator

The Brunswick County Manager shall appoint the Storm Water Administrator. It shall be the duty of the Storm Water Administrator to administer and enforce the provisions of the Brunswick County Storm Water Ordinance and the Storm Water Management Program. That responsibility includes all the duties presented in this section.

10.2 Riparian Buffer Program

It is the duty of the Storm Water Administrator to administer the County's Riparian Buffer Program as that program is described in Section 4 of this Manual. Those duties include, but are not limited to, the following:

- Preparing a riparian buffer map and from time to time correcting and updating that map.
- Ensuring that all required riparian buffer areas are clearly identified on the site plans and specifications of the storm water management facilities submitted in application for a County Storm Water Permit and that access to and maintenance of those areas is provided for under a maintenance covenant (see Appendix B).
- Preparing public information about the County's Riparian Buffer Program including the preparation of information that will assist in the operation of the County's Environmental Concerns Hotline.
- Seeking opportunities to protect and improve the County's riparian buffers. Examples of activities that the Storm Water Administrator may undertake in this area include:
    - Recommending that the County accept landowner donations of riparian lands and landowner grants of permanent environmental easements for riparian areas.
    - Recommending that the County purchase parcels that are deemed to be of particular value for storm water control and water quality improvement.
    - Cooperating with agencies and foundations that may provide methods and funds for riparian protection and enhancement.
    - Using County personnel and equipment to perform improvements on the riparian areas of private properties where such improvements serve the public

interests in storm water control and water quality improvement and where the landowner has provided maintenance and environmental easements, guarantees of maintenance, and other assurances acceptable to the Storm Water Administrator.

10.3 Peak Discharge Calculations

The Storm Water Administrator has the responsibility to ensure that requirements presented in Section 5 of this Manual are met before issuing a County Storm Water Permit for any new development within the County's jurisdictional limits. To meet that responsibility the Storm Water Administrator shall:

- Review the information presented in each application for a County Storm Water Permit (see Appendix A: Forms SW-001, SW-006, and SW-007) to verify the accuracy of that information.
- Review all site plans and Storm Water Management Plans submitted in support of a County Storm Water Permit and verify the technical adequacy of those plans.
- Ensure that all site plans, calculations, and other information requiring the seal and signature of a registered professional engineer or land surveyor have been properly executed.
- Consider, and grant or deny, petitions for variance from the requirements of controlling the peak discharge from the 1-year, 24-hour and the 10-year, 24-hour storms consistent with the criteria for variance presented in Section 5.
- Perform, as necessary, construction phase inspections of each development.
- Inspect constructed storm water facilities to ensure that the as-built conditions are equivalent to the design included in the development's Storm Water Management Plan.
- Ensure that the long-term maintenance requirements of all storm water facilities covered under a County Storm Water Permit are incorporated into the development's Storm Water Management Plan and that the plan is covered by and adhered to by the signing and recording of a restrictive maintenance covenant (Appendix B).
- Inspect, from time to time, developments operating under a County Storm Water Permit to ensure that the storm water management facilities are properly

maintained and are performing their functions as specified in the development's Storm Water Management Plan.

10.4 Pollutant Export Calculations

Pollutants include, but are not limited to, total nitrogen, total phosphorus, total suspended solids, and fecal coliform. The Storm Water Administrator has the responsibility to ensure that requirements are met as presented in Section 6 of this Manual regarding the computation and documentation of the expected reductions in pollutant exports that occur due to improved site planning and the use of best management practices. To meet that responsibility the Storm Water Administrator shall review the site plans and the pollutant export calculations prepared by the applicant for a Storm Water Permit. No permit may be issued until the Storm Water Administrator is satisfied as to the technical accuracy of the submitted items and is satisfied that all the requirements of Section 6 have been met. To meet that responsibility the Storm Water Administration shall:

- Review and verify the accuracy of the information provided on forms SW-001, SW-002, and SW-003 (Appendix A) and supplemental submittals.
- Conduct an as-built inspection to ensure that the facilities and the areas that they service are equivalent to those described in the application and the Storm Water Management Plan.

10.5 BMP Design Review

The Storm Water Administrator has the responsibility to ensure that requirements are met as presented in Sections 7 and 8 of this Manual regarding the design details of any Best Management Practices proposed as part of a development's Storm Water Management Plan. Those details must be sufficient to determine the accuracy of the design parameters as they relate to storm water detention and pollutant removal and must be submitted in the Storm Water Permit application. The site plan and BMP details must allow the Storm Water Administrator to determine and verify:

- Areas to be drained to the BMP;
- Volume and geometry of the BMP;
- Inflow volume, peak outlet discharge, and mean hydraulic detention time under the 1 year, 24-hour and the 10-year, 24-hour design storms;

- Volumes and characteristics of filter materials, plant types and densities included in the design;
- Adequacy of outlet works and their operation, emergency spillways and other features effecting the BMPs operability and safety; and
- Where required, the signature and seal of a registered professional engineer on the BMP design plans and specifications.

A Storm Water Permit shall not be issued until the above information has been provided to the satisfaction of the Storm Water Administrator.

10.6 BMP Pollutant Reduction Calculations

Whenever structural BMPs for pollutant reduction are included in a proposed development's Storm Water Management Plan, the Storm Water Administrator shall verify the accuracy of the applicant's calculation of the estimated pollutant export reduction consistent with the methods and requirements of Sections 6 and 8 of this Manual.

10.7 BMP Operation and Maintenance Plan Review

The Storm Water Administrator shall review the BMP operation and maintenance plan submitted by the applicant and shall determine the adequacy of that plan in providing and maintaining the design functions of the BMP.

10.8 BMP Inspections

It is the duty of the Storm Water Administrator to perform on-site inspections from time to time, but not less than annually, in order to verify the function of BMPs incorporated into a permitted development's Storm Water Management Plan. Inspections shall include:

- Review of storm water facility maintenance records since the last inspection;
- Observation of the drainage facilities to ensure that they are functionally equivalent to the facilities described on the permitting site plan and Storm Water Management Plan; and

- Verification that all installed BMPs are in a condition to function in both the control of storm water discharges and the reduction of pollutant exports substantially as defined in the permitting Storm Water Management Plan.

10.9 BMP Inventory

The Storm Water Administrator shall develop and maintain an inventory of BMPs that exist within the County's jurisdiction, that are installed under the County's Storm Water Permit Program, or are otherwise developed in the County, including those installed and owned by the County. That inventory shall contain all the peak discharge and pollutant export reduction information specified in Sections 5, 6, and 8 of this Manual and will record summary information on the maintenance and inspection of each BMP.

10.10 Collection of Fees

The Storm Water Administrator shall collect all applicable fees as described in Section 9 of this Manual.

10.11 Restrictive Covenants

Prior to issuing a County Storm Water Permit, the Storm Water Administrator shall verify that all required restrictive covenants have been signed and recorded.

10.12 Illegal Connections and Discharges Elimination Program

The County's Storm Water Collection System is vulnerable to receiving illegal discharges (even though the person responsible for the discharge may be unaware that it is illegal). Depending on their source, illegal discharges may convey pollutants such as nutrients, phenols, and metals to receiving waters. Table 10a identifies some potential flows to the Storm Water Collection System that may be allowable. Table 10b identifies some discharges that are not allowed.

Table 10a		
Discharges that may be made to the Storm Water Collection System		
Waterline Flushing	Landscape Irrigation	Diverted Stream Flows
Uncontaminated Rising Ground Water	Uncontaminated Ground Water Infiltration to Storm Water collection system	Uncontaminated Pumped Ground Water
Discharges from potable water sources	Uncontaminated Foundation Drains	Uncontaminated Air Conditioning Condensation
Irrigation Water	Springs	Uncontaminated Water from Crawl Space Pumps
Uncontaminated Footing Drains	Lawn Watering	Non-commercial Car Washing
Flows from Riparian Habitats and Wetlands	NPDES permitted discharges	Street wash water
Fire Fighting Emergency Activities	Wash Water from the Cleaning of Buildings	Dechlorinated backwash and draining associated with swimming pools

Table 10b		
Types of Discharges that are not allowed to the Storm Water Collection System		
Dumping of oil, anti-freeze, paint, cleaning fluids	Commercial Car Wash	Industrial Discharges
Contaminated Foundation Drains	Cooling water unless no chemicals added and has NPDES permit	Washwaters from commercial / industrial activities
Sanitary Sewer Discharges	Septic Tank Discharges	Washing Machine Discharges
Chlorinated backwash and draining associated with swimming pools	Contaminated Footing Drains	Contaminated Ground Water

The Storm Water Administration is responsible for the administration of a program to detect and eliminate illegal connections to, and illegal discharges into, the County's Storm Water System. To accomplish this directive the Administrator shall:

- Collect County jurisdiction-wide information on the storm water facilities and the potential for illegal discharges and illicit connections;
- Identify on maps, areas of the County's hydrography and Storm Water System that are the most likely locations for illegal discharges;
- Prioritize areas of the County, not less than 10 percent of the County in each year beginning in 2003, in which to conduct dry weather field screening for illegal discharges;
- Complete field screening reports, and keep them on file for a minimum of 5 years, on all outfalls to the Storm Water System in which dry weather flow is observed, documenting all of the elements specified in Table 10c;

Table 10c

Field Screening Report Information		
General Information	Sheet Number Outfall ID Number Date Time Date, Time and Quantity of Last Rainfall Event	
Field Site Description	Location Type of Outfall Dominant Watershed Land Use(s)	
Visual Observations	Photograph Odor Color Clarity Floatables	Deposits/Stains Vegetation Condition Structural Condition Biological Flow Estimation
Sampling Analysis *	Temperature pH Nitrogen-Ammonia	Nitrogen-Nitrate/Nitrite Fluoride or Chlorine Fecal Coliform

* Analytical monitoring is required only if an obvious source of the dry weather flow cannot be determined through an investigation of the upstream Storm Water collection system.

- Ensure that all detected illicit connections and illegal discharges are removed on a timely basis by following the notification and enforcement procedures specified in the County's Storm Water Ordinance;
- Maintain records of all compliance actions for a minimum of 5 years after complete removal of the illicit connection or illegal discharge;
- Maintain a map and related documentation that includes:

- Points of identified illegal discharges,
- Watershed boundaries of the outfalls where illegal discharges have been identified,
- Summaries of the illegal discharges that have been identified that includes location, a description of pollutants(s) identified, and enforcement status.

The Storm Water Administration shall report to the Board of Commissioners at least annually, and to the NC DENR/DWQ as required by the County's NPDES permit, on the illegal discharge elimination program. Those reports shall contain geographic information at three increasing levels of detail:

- The first, most cursory level is information that shall be collected for the entire jurisdiction. The associated requirements are discussed in Section 10.13.
- The second level is a more detailed screening for high priority areas within the jurisdiction. The associated requirements are discussed in Section 10.14.
- The third level is a very detailed investigation that shall be done upon the discovery of an illegal discharge. The associated requirements are discussed in Section 10.15.

10.13 Jurisdiction-wide Screening for Illicit Discharges and Connections

The Storm Water Administrator shall compile jurisdiction-wide information about the County's storm water facilities and shall present that information in a report and on maps on or before June 30, 2003. The information to be mapped and reported shall include:

- Location of sanitary sewers in areas of the major Storm Water Collection Systems and the location of areas that are not served by sanitary sewers;
- Waters that appear on the USDA – Natural Resources Conservation Service Soil Survey Maps and the U.S. Geological Survey 1:24,000 scale topographic maps;
- Land uses. Categories, at a minimum, should include undeveloped, residential, commercial, agriculture, industrial, institutional, publicly owned open space and others;
- Currently operating and known closed municipal landfills and other treatment, storage, and disposal facilities, including for hazardous materials;
- Major storm water structural controls; and

- Known NPDES permitted discharges to the Storm Water Collection System.

Written descriptions should be provided for the map components as follows:

- A summary table of municipal waste facilities that includes the names of the facilities, the status (open/closed), the types, and addresses;
- A summary table of the NPDES permitted dischargers that includes the name of the permit holder, the address of the facility and permit number;
- A summary table of the major structural storm water control structures that shows the type of structure, area served, party responsible for maintaining, and age of structure; and
- A summary table of publicly owned open space that identifies size, location, and primary function of each open area.

10.14 Mapping and Screening in High Priority Areas

As high priority areas are identified the Storm Water Administrator shall prepare maps of those areas. At a minimum the map that is produced shall include the following:

- Locations of the outfalls of any pipes from non-industrial areas that are greater than or equal to 36 inches diameter;
- Locations of the outfalls of any pipes from industrial areas that are greater than or equal to 12 inches diameter;
- Locations of drainage ditches that drain more than 100 acres of non-industrial lands; and
- Locations of drainage ditches that drain more than 5 acres of industrial lands.

The map must have an accompanying summary table listing the outfalls that meet the above criteria that includes Outfall ID numbers, geographic location, primary and supplemental classification of the receiving water, and use-support classification of the receiving water.

Each high priority area shall be dry weather field surveyed. The survey shall report on each outfall in the high priority area and where dry weather flows are identified a screening report shall be completed (See Appendix A, Form SW-020). Screening reports shall be kept on file for a minimum of five years. Where practicable, further field

investigation should be used to identify the source of the dry weather flow. A summary of dry weather field surveys shall be incorporated into each annual report to the Board of Commissioners and to the NC DWQ as required by the County's NPDES permit.

10.15 Identifying and Removing Illicit Discharges

When a dry weather discharge is identified, potential sources of that discharge should be investigated by systematic field investigation. That investigation may include:

- On-site investigation;
- Additional Chemical Analysis of the discharge;
- Flow Monitoring;
- Dye and/or Smoke Testing; and
- Television Inspection.

Whenever an illicit discharge or connection is identified, the Storm Water Administrator shall proceed under the provisions and procedures of the County Ordinance to have the illicit discharge stopped and illicit connections removed. Such actions by the Storm Water Administrator may include:

- Written notice of violation to the owner of the property and/or the responsible person for the illicit discharge or connection, which may require without limitation:
  - The immediate elimination of illicit discharge or connection;
  - The establishment of a deadline for such remediation and restoration to take place;
  - That abatement or remediation of the pollution or contamination hazard be conducted promptly and that any affected property be restored;
  - Payment of a fine to cover administrative and remediation costs; and
  - The implementation of source control or treatment BMPs.
- Written notice of requirement to the owner of the property and/or the responsible person for the illicit discharge or connection, that monitoring and analyses of the remediation be undertaken by the responsible person(s) and that reports documenting the results of the remediation be furnished to the Storm Water Administrator.

If the violator fails to remediate the pollution or restore the property within the deadline established, the Storm Water Administrator shall have the County or authorize a contractor to perform all work associated with the required remediation and/or restoration at the expense of the violator. Records of all enforcement actions shall be kept for five years with the associated screening reports and field investigation materials.

The Storm Water Administrator shall prepare and maintain a map that includes the following:

- Points of identified illicit discharges; and
- Watershed boundaries of the outfalls where illicit discharges have been identified.

The map must have an accompanying table that summarizes the illicit discharges and/or connections that have been identified, a description of pollutant(s) identified, and a summary of enforcement and corrective actions. A summary of illicit discharge and connection investigations and enforcement/corrective actions shall be incorporated into each annual report to the Board of Commissioners and, as required, to the NC DWQ.

10.16 BMP Retrofit Locations

The Storm Water Administrator shall establish a program to identify locations within existing developed areas that are suitable for retrofitting of storm water BMPs for the reduction of pollutant exports. Those retrofit opportunities shall demonstrate:

- The retrofit, if implemented, clearly has the potential to reduce pollutant loading to the receiving water;
- The watershed is clearly contributing pollutant loading above background levels;
- The landowner where the retrofit is proposed is willing to have the retrofit installed on his property. Securing the landowner's cooperation is one of the most important tasks for the local government, as this is often the most difficult aspect of implementing a retrofit;
- There is adequate space and access for the retrofit; and
- It is technically practical to install a retrofit at that location.

The Storm Water Administrator shall report annually to the Board of Commissioners on the identified retrofit opportunities. That report shall contain, at a minimum, the following information about each retrofit opportunity:

- Location description, including directions from a major highway
- Type and description of retrofit opportunity
- Current property owner
- Is the property owner willing to cooperate?
- Land area available for retrofit (sq. ft)
- Accessibility to retrofit site
- Drainage area size (acres)
- Land use in drainage area (percent of each type of land use)
- Average slope in drainage area (%)
- Environmentally sensitive areas in drainage area (steep slopes, wetlands, riparian buffers, endangered/ threatened species habitat)
- Approximate annual pollutant loadings from drainage area *
- Potential pollutant reductions
- Estimated cost of retrofit
- Receiving water
- DWQ classification of receiving water
- Use support rating for receiving water
- Other important information relevant to the opportunity

The Storm Water Administrator shall update each year the County's storm water facility maps to show the locations of each reported retrofit opportunity. That mapping shall be adequate to determine, at a minimum, the following information:

- Drainage area to retrofit opportunity site.
- Land uses within the drainage area.
- Location of retrofit opportunity.
- Property boundaries in the vicinity of the retrofit opportunity.
- Significant hydrography (as depicted on U.S.G.S. topographic maps and USDA-RCS Soil Survey maps).

- Roads.
- Environmentally sensitive areas (steep slopes, wetlands, riparian buffers, endangered/ threatened species habitat – where available).
- Publicly owned parks, recreational areas, and other open lands.

10.17 Public Education Program

The Storm Water Administrator shall establish and administer a public education program for the purposes of:

- Improving the ways that County citizens manage storm water on their property;
- Informing citizens of the need to maintain and improve riparian buffers; and
- Soliciting assistance in the identification and removal of illicit connections and illegal discharges to the Storm Water System.

The Storm Water Administrator shall annually update the County's public education program and report the revised program plans to the Board of Commissioners.

10.18 Reports to the NC DENR/DWQ and the County Board of Commissioners

The Storm Water Administrator shall prepare an annual report and submit that report to the Board of Commissioners. That report shall document, at a minimum:

- Acres of new development and impervious surface based on plan approvals.
- Acres of new development and impervious surface based on certificates of occupancy.
- Summary of BMPs implemented and the County's use of funds.
- Computed baseline and net change in pollutant exports from new development that year.
- Summary of maintenance activities conducted on BMPs.
- Summary of any BMP failures and how they were handled.
- Summary of results from jurisdictional review of planning issues.
- Summary of requested variances approved and denied.
- Elements of the County's Storm Water Public Education Program completed during the year.

- Summary of land and easements or other legal assurances acquired for riparian buffer protection.

BRUNSWICK COUNTY STORM WATER PERMIT
CERTIFICATION FORM
(Form SW-001)

Name of Owner (Applicant) _____
Name of Contact Person _____
Phone Number _____
Email Address _____
Name of Development _____
Parcel ID _____
Location of Development _____

Who will legally be responsible for or own the development after construction?

Name _____
Address _____
Phone Number _____
Email Address _____

1. Total area disturbed by development does not exceed _____ acres.
2. Is the development Commercial?
   - ☐ Yes - File this form along with General Storm Water Permit Application Form (SW-003).
   - ☐ No - Continue to Question 3
3. Is the disturbed area of development equal to or greater than 1 acre (43560 square feet)?
   - ☐ Yes - File this form along with a Storm Water Permit Application (SW-002 or SW-003).
   - ☐ No - Continue to Question 4.
4. Will the site be graded, filled, or excavated and thereby change the elevation of any location by an amount exceeding four (4) inches?
   - ☐ Yes - File this form along with a Storm Water Permit Appliccation (SW-002 or SW-003).
   - ☐ No - Continue to Question 5.
5. Is the development or any related disturbance within the limits of a Riparian Buffer (within 30 feet of the banks of a natural stream or waterbody)?
   - ☐ Yes - File this form along with General Storm Water Permit Application Form (SW-003).
   - ☐ No - If you answered "NO" to question 2 through 5 then this development does not require a Brunswick County Storm Water Permit

Certification

I, _____ (print name) hereby certify the information included on this and attached pages is true and correct to the best of my knowledge.

Signature _____ Date _____

Official Use Only: Storm Water Permit No. _____ Date Approved _____

BRUNSWICK COUNTY RESIDENTIAL STORM WATER PERMIT APPLICATION FORM

(Form SW-002, must be accompanied by completed Form SW-001)

Name of Developer _____

Name of Contact Person _____

Phone Number _____

Name of Development _____

1. Is the development solely residential?
   _____ Yes – This is the correct form, go on to next question.
   _____ No – You cannot use this form, go to the Non-residential Storm Water Permit Application Form (Form SW-003)

2. What kind of residential development is this?
   _____ Single lot with one single-family residential structure
   _____ Single-family residential subdivision with multiple lots
   _____ Multi-family residential
   _____ Mobile home development
   _____ Assisted living/congregate care facility
   _____ Other _____

3. Calculate pre- and post-development Storm Water runoff from the development for the **1-year, 24-hour storm** with one of the approved methods specified in the Brunswick County Storm Water Management Manual.

   Pre-development peak runoff _____ cfs (1-year, 24-hour storm)

   Post-development peak runoff _____ cfs (1_year, 24-hour storm)

4. Does the post-development peak flow exceed the pre-development peak flow? (1-year, 24-hour storm)
   _____ Yes – Implementation of an approved flow control Best Management Practice (BMP) is requ
   reduce peak flow to pre-development peak before continuing to next question.
   _____ No – A flow control BMP is not required for this development. Continue to next question.

5. Does the development meet one or both of the following criteria: 1) the post-development peak runoff is less than 5 percent greater than the pre-development peak runoff (for the 1 year, 24-hour storm) or 2) the overall impervious surface is less than fifteen percent and the remaining pervious portions of the site are utilized to the maximum extent practical to convey and control the Storm Water runoff?
   _____ Yes – A flow control BMP is not required for this development but the Brunswick County Storm Water Administrator must approve a variance. Continue to next question.
   _____ No - Implementation of an approved flow control Best Management Practice (BMP) is required to reduce peak flow to no more than 105% of the pre-development peak before continuing to next question.

6. Calculate pre- and post-development Storm Water runoff from the development for the **10-year, 24-hour** storm with one of the approved methods specified in the Brunswick County Storm Water Management Manual.

   Pre-development peak runoff _____ cfs (10-year, 24-hour storm)

   Post-development peak runoff _____ cfs (10-year, 24-hour storm)

7. Does the post-development peak flow exceed 105% of the pre-development peak flow? (10-year, 24-hour storm)
   _____ Yes – Implementation of an approved flow control Best Management Practice (BMP) is required to reduce peak flow to no more than 105% of the pre-development peak before continuing to next question.
   _____ No – A flow control BMP is not required for this development. Continue to next question.

8. Where the requirement that the 10-year, 24-hour storm post-development peak flow not exceed the pre-development peak flow places an undue hardship upon a property owner, variances from the requirement may be granted by the Storm Water Administrator if the development meets the following requirement: *The proposed new development appropriately uses the parcel's total remaining total impervious area to the extent practical to convey and control the Storm Water runoff, and it is demonstrated, to the satisfaction of the Storm Water Administrator, that no damage to public or private properties, including to the County's Storm Water facilities and to the quality of the public waters, will be caused by granting of the variance.* Is this requirement met for the proposed development?
   _____ Yes – A flow control BMP is not required for this development but the Brunswick County Storm Water Administrator must approve a variance. Continue to next question.
   _____ No - Implementation of an approved flow control Best Management Practice (BMP) is required to reduce peak flow to pre-development peak before continuing to next question.

9. Are the number of building footprints and sizes for the entire development, to the ultimate built out condition of the development, known?
   _____ Yes – Use Method 2, Form SW-005 for total pollutant export calculations.
   _____ No – Use Method 1, Form SW-004 for total pollutant export calculations.

Submit the completed Total Pollutant Export Calculations Forms with this application.

FEES

The Developer must pay the Standard Storm Water fee plus any additional fees for Technical Review of Structural BMP designs and any offset fees to the County. A fee schedule is available from the Office of the Brunswick County's Storm Water Program Administrator.

1. Standard fee: $ _____
2. Structural BMP Technical Review fee: _____ structural BMPs x $_____per BMP = $ _____
3. County Mitigation fee:

(_____ lb/ac/yr total pollutant export - ??? lb/ac/yr) x _____acres x $???/lb/yr = $ _____

Total Fee $ _____

Is an application being submitted to the State of North Carolina Division of Land Quality for an Erosion and Sediment Control Permit for this development?
   _____ Yes – Approval of a Brunswick County Storm Water permit is contingent upon approval of the State of North Carolina's Erosion and Sediment Control Permit.
   _____ No – What is the reason?

Is development <1 acre?
   _____ Yes – A Brunswick County Storm Water Permit is still required if the disturbed area of the development is greater than ½ acre.
   _____ No – Both and Brunswick County Storm Water Permit and a State Erosion and Sediment Control Permit are required.

Other Reason: _____

BRUNSWICK COUNTY GENERAL STORM WATER PERMIT APPLICATION FORM

(Form SW-003, must be accompanied by completed Form SW-001)

Name of Developer _____

Name of Contact Person _____

Phone Number _____

Name of Development _____

1. Is the development solely residential?
   _____ Yes – You may use the Residential Application Form (Form SW-002).
   _____ No – this is the correct form. Go to the next question.

2. What kind of development is this?
   _____ Commercial
   _____ Industrial
   _____ Single lot with one single family residential structure
   _____ Single family residential subdivision with multiple lots
   _____ Multi-family residential
   _____ Mobile home development
   _____ Assisted living/congregate care facility
   _____ Multi Use (Residential and Commercial)
   _____ Other _____

3. Calculate pre- and post-development Storm Water runoff from the development for the **1-year, 24-hour** with one of the approved methods specified in the Brunswick County Storm Water Management Manual.

   Pre-development peak runoff _____ cfs (1-year, 24-hour storm)

   Post-development peak runoff _____ cfs (1_year, 24-hour storm)

4. Does the post-development peak flow exceed the pre-development peak flow? (1-year, 24-hour storm)
   _____ Yes – Implementation of an approved flow control Best Management Practice (BMP) may be required to reduce peak flow to pre-development peak before continuing to next question.
   _____ No – A flow control BMP is not required for this development. Continue to next question.

5. Does the development meet one or both of the following criteria: 1) the post-development peak runoff is less than 5 percent greater then the pre-development peak runoff (for the 1 year, 24-hour storm) or 2) the overall impervious surface is less than fifteen percent and the remaining pervious portions of the site are utilized to the maximum extent practical to convey and control the Storm Water runoff?
   _____ Yes – A flow control BMP is not required for this development but the Brunswick County Storm Water Administrator must approve a variance. Continue to next question.
   _____ No - Implementation of an approved flow control Best Management Practice (BMP) is required to reduce peak flow to no more than 105% of the pre-development peak before continuing to next question.

6. Calculate pre- and post-development Storm Water runoff from the development for the **10-year, 24-hour** storm with one of the approved methods specified in the Brunswick County Storm Water Management Manual.

   Pre-development peak runoff _____ cfs (10-year, 24-hour storm)

   Post-development peak runoff _____ cfs (10-year, 24-hour storm)

7. Does the post-development peak flow exceed 105% of the pre-development peak flow? (10-year, 24-hour storm)
   _____ Yes – Implementation of an approved flow control Best Management Practice (BMP) may be required to reduce the peak flow. Continue to the next question.
   _____ No – A flow control BMP is not required for this development. Continue to question 9.

8. Where the requirement that the 10-year, 24-hour storm post-development peak flow not exceed the pre-development peak flow places an undue hardship upon a property owner, variances from the requirement may be granted by the Storm Water Administrator if the development meets the following requirement: *The proposed new development appropriately uses the parcel's total remaining total impervious area to the extent practical to convey and control the Storm Water runoff, and it is demonstrated, to the satisfaction of the Storm Water Administrator, that no damage to public or private properties, including to the County's Storm Water facilities and to the quality of the public waters, will be caused by granting of the variance.* Is this requirement met for the proposed development?

   _____ Yes – A flow control BMP is not required for this development but the Brunswick County Storm Water Administrator must approve a variance. Continue to next question.

   _____ No - Implementation of an approved flow control Best Management Practice (BMP) is required to reduce peak flow to no more than 105% of the pre-development peak before continuing to next question.

9. Use Method 2, Form SW-005 for Total Pollutant Export Calculations. Submit the completed pollutant export calculation form with this application.

FEES

The Developer must pay the Standard Storm Water fee plus any additional fees for Technical Review of Structural BMP designs and any offset fees to the Brunswick County. A fee schedule is available from the Office of the Brunswick County's Storm Water Program Administrator.

1. Standard fee: $ _____

2. Structural BMP Technical Review fee: _____ structural BMPs x $_____per BMP = $ _____

4. County Mitigation fee:

(_____ lb/ac/yr Total Pollutant Export - ??? lb/ac/yr) x _____acres x $???/lb/yr = $ _____

Total Fee $ _____

Is an application being submitted to the State of North Carolina Division of Land Quality for an Erosion and Sediment Control Permit for this development?

_____ Yes – Approval of a Brunswick County Storm Water permit is contingent upon approval of the State of North Carolina's Erosion and Sediment Control Permit.

_____ No – What is the reason?

Is development <1 acre?

_____ Yes – A Brunswick County Storm Water Permit is still required if the disturbed area of the development is greater than ½ acre.

_____ No – Both and Brunswick County Storm Water Permit and a State Erosion and Sediment Control Permit are required.

Other Reason: _____

Brunswick County, North Carolina
Pollutant Export Calculations
Pre-Development Conditions Form (SW-004)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If currently a residential development enter average lot size:

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Coliform Coeff.	(10) Coliform Export
Totals									

Brunswick County, North Carolina
Pollutant Export Calculations
Post-Development Conditions Form (SW-005)

Step 1: Determine appropriate codes for each type of land use and management from Table 6.1 and enter in Column 1.
Step 2: Determine the area for each type of land use and management and enter in Column 2.
Step 3: Enter the pollutant export coefficients from Table 6.1 for each land use type in columns 3, 5, 7, and 9.
Step 4. Multiply each area in Column 2 by the export coefficients and enter in columns 4, 6, 8, and 10.
Step 5. Sum columns 4, 6, 8, and 10.

If residential development enter average lot size:	

(1) Type of Land Cover	(2) Area (acres)	(3) TN Export Coeff.	(4) TN Export (# /yr)	(5) TP Export Coeff.	(6) TP Export (# /yr)	(7) TSS Export Coeff.	(8) TSS Export (# /yr)	(9) Collform Coeff.	(10) Coliform Export
Totals	0								

Rational Method Peak Flow Calculation Form (SW-006)

The Rational Method may only be used for single-family residential developments where the final built-out development will impact less than 10 acres.

Location: _____

Drainage area (A): _____ acres

Average slope: _____ percent

Maximum Slope Length: _____ feet

Pre-Development Conditions

Type of Land Use	C	Area (acre)	C x A
Total			

Area-weighted C: _____

Height of most remote outlet: _____ feet

Maximum Length of travel: _____ feet

Tc: _____ min.

Intensity (i) for 1-yr, 24-hr storm: _____ in/hr

Intensity (i) for 10-yr, 24-hr storm: _____ in/hr

Pre-dev. peak flow for 1-year, 24-hour storm:

q = CiA = _____ cfs

Pre-dev. peak flow for 10-year, 24-hour storm:

q = CiA = _____ cfs

Post-Development Conditions

Type of Land Use	C	Area (acre)	C x A
Total			

Area-weighted C: _____

Height of most remote outlet: _____ feet

Maximum Length of travel: _____ feet

Tc: _____ min.

Intensity (i) for 1-yr, 24-hr storm: _____ in/hr

Intensity (i) for 10-yr, 24-hr storm: _____ in/hr

Post-dev. peak flow for 1-year, 24-hour storm:

q = CiA = _____ cfs

Post-dev. peak flow for 10-year, 24-hour storm:

q = CiA = _____ cfs

Certification

I, _____ (print name) hereby certify the information included on this and attached pages is true and correct to the best of my knowledge.

Signature _____ Date _____

BRUNSWICK COUNTY STORM WATER PERMIT
(Form SW-010)

Development _____

Owner or Contact Person _____

Address _____

_____

Date Issued: _____

This permit is provided under the Brunswick County Storm Water Ordinance and covers construction activities as submitted on the Storm Water Management Plan and accompanying drawings, calculations and other documentation for the period ending _____ (1 year from date issued).

Inspection Requirement

Each structural component (Best Management Practice or BMP) constructed under this permit requires a final, as-built inspection prior to the use of the property as described in the Storm Water Management Plan. You must call the Brunswick County Storm Water Administrator's office to schedule that inspection. Failure to arrange for the required inspection prior to beginning the intended use of the property shall void this permit.

No Modifications

There shall be no modifications to the drainage patterns, structures, operation and maintenance, or other features approved in the Storm Water Management Plan without the prior approval of the Storm Water Administrator.

Additional Requirements

Additional requirements, conditions, variances, and approvals are included as part of this permit as attached and here referenced: _____.

Please keep a copy of this Storm Water Permit at your site. This permit does not supersede any other permit requirements or approvals required for you development. Your cooperation is appreciated.

Sincerely,

Brunswick County Storm Water Administrator or Representative

Official Use Only: Storm Water Permit No. _____ Date Approved _____

SCS Method Peak Flow Calculation Form (SW-007)

The SCS Method may be used for any development.

Location: _____

Drainage area (A): _____ acres

Maximum Slope Length: _____ feet

Average slope: _____ percent

Pre-Development Conditions

Type of Land Use	CN	% Imp.	Area (acre)	CN x A	Imp x A
Total					

Area-weighted CN: _____

Overall % Impervious: _____

Design rainfall for 1-year storm, P_1: _____ inches

Design rainfall for 10-year storm, P_{10}: _____ inches

Runoff depth Q_1: _____ inches

Runoff depth Q_{10}: _____ inches

Equivalent Drainage area: _____ acres

Peak runoff rate: _____ cfs/inch

Peak flow for 1-year, 24-hour storm, _____ cfs

Peak flow for 10-year, 24-hour storm, _____ cfs

Adjustments for percent impervious surfaces, improved channels, average watershed slope, ponding, and swampy areas may be necessary. Refer to the North Carolina Cooperative Extension Service, North Carolina State University, and North Carolina Department of Environment, and Natural Resources *Storm Water Guidance* manual or the United States Department of Agriculture, Soil Conservation Service (USDA - SCS) - *Technical Release 55* for details.

Adjusted Peak Flow for percent impervious surfaces and improved channels.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Adjusted Peak Flow for average watershed slope.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Adjusted Peak Flow for ponding and swampy areas.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Repeat the calculations for Post-Development Conditions.

Post-Development Conditions

Type of Land Use	CN	% Imp.	Area (acre)	CN x A	Imp x A
Total					

Area-weighted CN: _____

Overall % Impervious: _____

Design rainfall for 1-year storm, P_1: _____ inches

Design rainfall for 10-year storm, P_{10}: _____ inches

Runoff depth Q_1: _____ inches

Runoff depth Q_{10}: _____ inches

Equivalent Drainage area: _____ acres

Peak runoff rate: _____ cfs/inch

Peak flow for 1-year, 24-hour storm, _____ cfs

Peak flow for 10-year, 24-hour storm, _____ cfs

Adjustments for percent impervious surfaces, improved channels, average watershed slope, ponding and swampy areas may be necessary. Refer to the North Carolina Cooperative Extension Service, North Carolina University, and North Carolina Department of Environment, and Natural Resources *Storm Water* ... design manual or the United States Department of Agriculture, Soil Conservation Service (USDA - SCS) ... *Release 55* for details.

Adjusted Peak Flow for percent impervious surfaces and improved channels.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Adjusted Peak Flow for average watershed slope.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Adjusted Peak Flow for ponding and swampy areas.
Peak flow: 1-yr, 24-hr storm: _____ cfs 10-yr, 24-hr storm: _____ cfs

Certification

I, _____ (print name) hereby certify the information included on this and attached pages is true and correct to the best of my knowledge.

Signature _____ Date _____

County of Brunswick, North Carolina
Storm Water fees

Type of Development or Activity	Ultimate Disturbance	Standard Fee	Additional Fee
Residential-individual single family	<1 acre	Exempt – no fee	
Residential – single family or subdivision	≥ 1 acre	$250/acre disturbed or part thereof	
Residential – multi-family	≥ 1 acre	$500/acre disturbed or part thereof	
Non-Residential	Any	$500/acre disturbed or part thereof	
Review of application for variance	Any	$200	$250 per fact-finding meeting
Technical Review of Structural BMPs in Storm Water Plan and As-Built Inspection	Each	$200	
Annual Inspection of Structural BMP	Each	$400	
Re-inspection Fee	Each	$400	

Effective July 1, 2004

BRUNSWICK COUNTY STORM WATER PROGRAM DRAWING REQUIREMENTS

Submit one mylar and 12 reduced 8.5" x 11" copies of final site plan to the Brunswick County Storm Water Administrator prior to the regularly scheduled meeting of The Board of Commissioners in accordance with the subdivision review schedule. Following recording of the plan by the Brunswick County Registrar of Deeds, the Planning and Inspections Department receives one mylar and three full size copies for County distribution.

The final drawings must contain the following information:

a. General Information
   i. Title
   ii. Date
   iii. Name of developer and contact information
   iv. Name of owner, surveyor, and land planner
   v. Title block on each sheet

b. Location Information, Vicinity Plan
   i. Project location
   ii. North arrow, true north point
   iii. Scale (Drawing scale: 1" = 100' or larger. Drawing sheet size: 18" x 24" or larger)
   iv. All Paved Roads
   v. Adjoining lakes, streams, or other drainage ways shown on either United States Geographical Society (USGS) quad maps or United States Department of Agriculture Soil Conservation Service (SCS) Soils maps

c. Site Features
   i. North arrow
   ii. Scale
   iii. Legend
   iv. All dimensions should be to the nearest 0.1 foot and angles to the nearest minute.
   v. Accurate location of all monuments and markers.
   vi. Names and locations of all adjoining subdivisions and streets, and the location and ownership of adjoining unsubdivided property.
   vii. Zoning classification of subdivision and adjacent properties.
   viii. Reservations, easements, alleys, and any other areas to be dedicated to public use, conservation purposes.
   ix. Restricted access easement on limited access streets
   x. Boundaries of total tract
   xi. Property lines
   xii. Lot numbers and postal addresses, building numbers
   xiii. Lot owners' names
   xiv. Building envelopes in the case of Planned Unit Developments (PUD).
   xv. Sufficient data to determine readily and reproduce on the ground, the location, bearing and length of every street, block line, building line, whether curved or straight, and including true north point. Include the radius, central angle, and tangent distance for the center line of curved streets and curved property lines that are not the boundary of curved streets.
   xvi. Existing and proposed water mains, sanitary sewers, storm sewers, transmission lines, and other relevant utilities.
   xvii. Site plan of existing conditions including wooded areas, marshes, wetlands, Neuse Riparian Buffer limits
   xviii. Existing topographic contours, one foot intervals based on sea level data
   xix. Proposed topographic contours, one foot intervals based on sea level data
   xx. Limit and acreage of disturbed area
   xxi. Planned and existing buildings location and elevations
   xxii. Planned and existing roads location and elevations
   xxiii. Land use of surrounding areas
   xxiv. Rock outcrops
   xxv. Wetland limits - Written approval by Corps of Engineers with reference to wetlands, if applicable.
   xxvi. Streams, lakes, ponds, drainage ways, dams, seeps and springs
   xxvii. Borrow and/or waste areas
   xxviii. Stockpiled topsoil or subsoil location

xxix. Location of structural Best Management Practices (BMPs) and their associated maintenance easements.

d. Site Drainage Features
   i. Existing and planned drainage patterns (include off-site areas that drain through project)
   ii. Size of areas (acreage)
   iii. Size of location of culverts and sewers
   iv. Soils information (type, special characteristics), including below culvert and storm sewer outlets
   v. Name of receiving watercourse or name of municipal operator (only where Storm Water discharges are to occur)

e. Erosion Control Measures
   i. Legend
   ii. Location of temporary and permanent measures
   iii. Construction drawings and details for temporary and permanent measures
   iv. Maintenance requirements during and after construction

f. Vegetative Stabilization
   i. Areas and acreage to be vegetatively stabilized
   ii. Layout of planned vegetation with details of plants, seed, mulch and fertilizer

g. Appropriate certificates and signatures

Declaration of Covenants
For Storm and Surface Water Facility Maintenance

THIS DECLARATION OF COVENANTS, made this _____ day of _____, 20__, by _____ hereinafter referred to as the "Covenantor(s)" to and for the benefit of the Brunswick County, North Carolina and its successors and assigns hereinafter referred to as the "County."

WITNESSETH:

WHEREAS, the County is authorized and required to regulate and control the disposition of storm and surface waters within the County's jurisdiction as set forth in The Brunswick County's Storm Water Ordinance: and

WHEREAS, Covenantor(s) is (are) the owner(s) of a certain tract or parcel of land more particularly described as:

Being all or part of the land which it acquired by deed dated _____ from _____ grantors, and recorded among the Land Records of the Brunswick County, in Lib _____ at Folio _____ such property being hereinafter referred to as "the proper and

WHEREAS, the Covenantors(s) desires to construct certain improvements on its property that will alter the extent of storm and surface water flow conditions on both the property and adjacent lands: and

WHEREAS, in order to accommodate and regulate these anticipated changes in existing storm and surface water flow conditions, the Covenantor(s) desires to build and maintain at its expense, a storm and surface water management facility and system more particularly described and shown on plans titled _____ and further identified under approval number _____; and

WHEREAS, the County has reviewed and approved these plans subject to the execution of this agreement.

NOW THEREFORE, in consideration of the benefits received by the Covenantor(s), as a result of the County's approval of his plans. Covenantor(s), with full authority to execute deeds, mortgages, other covenants, and all rights. title and interest in the property described above do hereby covenant with the County as follows:

1. Covenantor(s) shall construct and perpetually maintain, at its sole expense, the above-referenced storm and surface water management facility and system in strict accordance with the plan approval granted by the County.
2. Covenantor(s) shall, at its sole expense, make such changes or modifications to the storm and surface water management facility and system as may, at the County's discretion, be determined necessary to insure that the facility and system is properly maintained and continues to operate as designed and approved.
3. The County, its agents, employees and contractors shall have the perpetual right of ingress and egress over the property of the Covenantor(s) and the right to inspect at reasonable times and in reasonable manner, the storm and surface water facility and system in order to insure that the system is being properly maintained and is continuing to perform in an adequate manner.
4. The Covenantor(s) agrees that should it fail to correct any defects in the above-described facility and system within ten (10) days from the issuance of written notice, or shall fail to maintain the facility in accordance with the approved design standards and with the law and applicable executive regulation or, in the event of an emergency as determined by the County in its sole discretion, the County is authorized to enter the property to make all repairs, and to perform all maintenance, construction and reconstruction as the County deems necessary. The County shall then assess the Covenantor(s) and/or all landowners served by the facility for the cost of the work, both direct and indirect, and applicable penalties. Said assessment shall be a lien against all properties served by the facility and may be placed on the property tax bills of said properties and collected as ordinary taxes by the County.
5. Covenantor(s) shall indemnify, save harmless and defend the County from and against any and all claims, demands, suits, liabilities, losses, damanges and payments including attorney fees claimed or made by persons not parties to this Declaration against the County that are alleged or proven to result or arise from the

Covenantor(s) construction, operation, or maintenance of the storm and surface water facility and system that is the subject of this Covenant.

6. The covenants contained herein shall run with the land and the Covenantor(s) further agrees that whenever the property shall be held, sold and conveyed, it shall be subject to the covenants, stipulations, agreements and provisions of this Declaration, which shall apply to, bind and be obligatory upon the Covenantor(s) hereto, its heirs, successors and assigns and shall bind all present and subsequent owners of the property served by the facility.
7. The Covenantor(s) shall promptly notify the County when the Covenantor(s) legally transfers any of the Covenantor(s) responsibilities for the facility. The Covenantor(s) shall supply the County with a copy of any document or transfer, executed by both parties.
8. The provisions of this Declaration shall be severable and if any phrase, clause, sentence or provision is declared unconstitutional, or the applicability thereof to the Covenantor is held invalid, the remainder of this Covenant shall not be affected thereby.
9. The Declaration shall be recorded among the Land Records of the County at the Covenantor(s) expense.
10. In the event that the County shall determine at its sole discretion at future time that the facility is no longer required, then the County shall at the request of the Covenantor(s) execute a release of this Declaration of Covenants which the Covenantor(s) shall record at its expense.

WET [WETLAND] DETENTION BASIN OPERATION AND MAINTENANCE AGREEMENT
[Wetland maintenance wording is bracketed. Please modify the document as appropriate.]

The wet [wetland] detention basin system is defined as the wet [wetland] detention basin, pretreatment including forebays and the vegetated filter if one is provided.

Maintenance activities shall be performed as follows:

1. After every significant runoff producing rainfall event and at least monthly:

   a. Inspect the wet [wetland] detention basin system for sediment accumulation, erosion, trash accumulation, vegetated cover, and general condition.

   b. Check and clear the orifice of any obstructions such that drawdown of the temporary pool occurs within 2 to 5 days as designed.

2. Repair eroded areas immediately, re-seed as necessary to maintain good vegetative cover, mow vegetative cover to maintain a maximum height of six inches, and remove trash as needed.

3. Inspect and repair the collection system (i.e. catch basins, piping, swales, riprap, etc.) quarterly to maintain proper functioning.

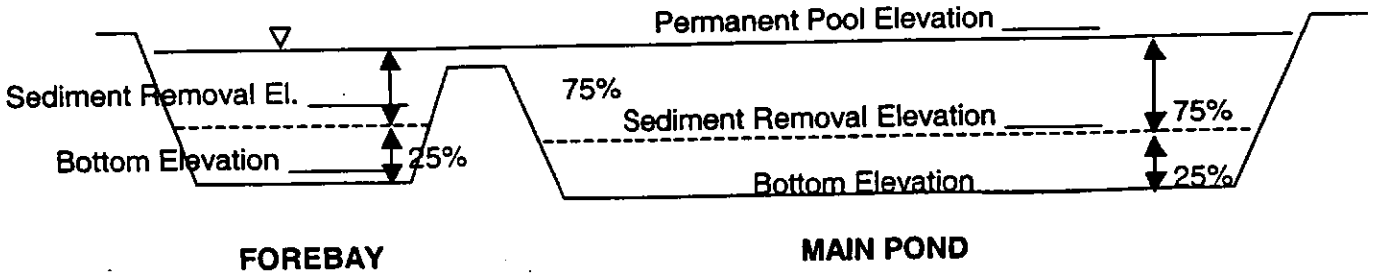
4. Remove accumulated sediment from the wet [wetland] detention basin system semi-annually or when depth is reduced to 75% of the original design depth (see diagram below). Removed sediment shall be disposed of in an appropriate manner and shall be handled in a manner that will not adversely impact water quality (i.e. stockpiling near a wet [wetland] detention basin or stream, etc.).

   The measuring device used to determine the sediment elevation shall be such that it will give an accurate depth reading and not readily penetrate into accumulated sediments.

   When the permanent pool depth reads _____ feet in the main pond, the sediment shall be removed. [For stormwater wetlands: If the elevation of the marsh areas exceed the permanent pool elevation, the sediment should be removed to design levels. This shall be performed by removing the upper [illegible] soil and stockpiling it. Then the marsh area shall be excavated six inches below design el. Afterwards the stockpiled soil should be spread over the marsh surface. The soil should not for more than two weeks.]

   When the permanent pool depth reads _____ feet in the forebay [and micro-pool], the sediment shall be removed.

BASIN DIAGRAM
(fill in the blanks)



5. Remove cattails and other indigenous wetland plants when they cover 50% of the basin surface. These plants shall be encouraged to grow along the vegetated shelf and forebay berm.

   [For wetlands: Wetland planting densities in the marsh areas should be maintained by replanting bare areas as needed. Wetland plants should be encouraged to grow in the marsh areas.]

6. If the basin must be drained for an emergency or to perform maintenance, the flushing of sediment through the emergency drain shall be minimized to the maximum extent practical.

7. All components of the wet [wetland] detention basin system shall be maintained in good working order.

8. Level spreaders or other structures that provide diffuse flow shall be maintained every six months. All accumulated sediment and debris shall be removed from the structure, and a level elevation shall be maintained across the entire flow spreading structure. Any down gradient erosion must be repaired and/or replanted as necessary.

I acknowledge and agree by my signature below that I am responsible for the performance of the seven maintenance procedures listed above. I agree to notify DWQ of any problems with the system or prior to any changes to the system or responsible party.

Print name:_____

Title:_____

Address:_____

Phone:_____

Signature:_____

Date:_____

Note: The legally responsible party should not be a homeowners association unless more than 50% of the lots have been sold and a resident of the subdivision has been named the president.

I, _____, a Notary Public for the State of _____,

County of _____, do hereby certify that _____

personally appeared before me this _____ day of _____, _____, and acknowled

execution of the forgoing wet [wetland] detention basin maintenance requirements. Witness my

official seal,

SEAL

My commission expires_____