WAKE COUNTY STORMWATER MANUAL

Submittal and Design Guidance

October 2013

WAKE COUNTY
NORTH CAROLINA

Contents

APPENDICES

1.0 INTRODUCTION

The purpose of this document is to provide guidance for the management of stormwater runoff from development in Wake County's jurisdiction. This manual provides support to Article 9 of the Wake County Unified Development Ordinance (UDO) and applicable State regulations which establish minimum requirements to address impacts of stormwater runoff associated with new development and expansions.

Wake County uses a "volume-control" stormwater ordinance with target curve number (TCN) runoff volume limits for residential development. Wake County applies the Neuse Rules countywide in both the Neuse and Cape Fear River basins. The Jordan Lake Rules supersede the Neuse Rules in the Jordan Lake Nutrient Management Strategy area. Both residential and commercial developments must adhere to the Neuse Rules requirements for peak flow, nutrient management, and riparian buffer rules. The Neuse Rules were adopted by the North Carolina Environmental Management Commission **(EMC)** to support implementation of the Neuse River Nutrient Sensitive Waters Management Strategy. Proposed projects located within the Falls Lake watershed must adhere to the Falls Lake Nutrient Management Strategy (Falls Lake Rules) and projects in the Jordan Lake watershed must adhere to the Jordan Lake Nutrient Management Strategy (Jordan Lake Rules). Both were adopted by Wake County in January of 2011 as part of the State's staged nutrient management strategies.

Wake County requires the use of the Wake county Stormwater Hybrid Design Tool for all stormwater management submittals. Accurate use of this tool ensures compliance with the Neuse Rules, Wake County UDO and the Falls Lake and Jordan Lake Rules. Tool calculations are based on a combination of the Falls/Jordan Nutrient Accounting Tool developed by the State for nutrient loading and a Wake County Design Tool previously prepared for Wake County by Withers and Ravenel (2006) for volume control and peak flow compliance. The prior *Draft Stormwater Design Manual* developed by Withers and Ravenel was edited and incorporated into this manual. The purpose of the tool is to streamline the many different stormwater requirements and facilitate more timely review and approval of stormwater management plans. For each regulatory requirement, Wake County adheres to design standards readily accepted by the State of North Carolina.

2.0 STORMWATER PROCESS AND REQUIREMENTS IN WAKE COUNTY

Site plans within Wake County's planning jurisdiction must be submitted to Watershed Management Program for review and approval to ensure compliance with Article 9 of the Unified Development Ordinance and applicable State and Federal regulations.

Wake County also administers erosion and sediment control and floodplain regulations including related plan review, permit issuance and inspections. For erosion control and floodplain information, visit our website. In addition, Wake County administers an urban stormwater ordinance adopted by the

Town of Rolesville, the Town of Wendell, and the Town of Zebulon that focuses on water quality and flood prevention. The stormwater ordinance is a result of recommendations made by a countywide Stormwater Task Force and approved by the Wake County Board of Commissioners in 2007. Note: This stormwater manual is only for development in Wake County (non-municipal planning jurisdictions). For stormwater process information specific to Rolesville, Wendell, or Zebulon, visit our website for details.

The Stormwater process in Wake County is composed of the following:

- pre-submittal Meeting
- preliminary Plan Review
- technical review committee (TRC)
- construction plan review
- construction plan approval
- preconstruction meeting
- permit issuance
- permit completion
- post-construction maintenance

Prior to initiating a stormwater application, the applicant should be familiar with The *Wake County Unified Development Ordinance, Article 9 Stormwater Management*.

2.1 Pre-submittal Meeting

All development proposals are required to schedule a pre-submittal meeting with the Wake County Land Development staff before any plan submittal process is initiated. County Watershed Management staff will provide guidance on floodplain management, erosion control and stormwater submittals and site plan design guidance, in coordination with the planning / zoning staff. Applicants should contact the Planning Department at 919-856-6621 to schedule a meeting with the County. Applicants shall complete a pre-submittal meeting request form (See Appendix A) and provide staff with the following:

- project name
- contact information
- PIN number
- approximate disturbed acreage (if available)
- summary
- sketch Plan

2.2 Preliminary Plan Review

After the pre-submittal meeting, the applicant will receive comments and/or request for additional information. Once comments are resolved, the applicant shall provide a preliminary subdivision plan or a Commercial Permit Application. Plans requiring Planning Board approval (regular

subdivisions, special use permits, planned compliance permits) will be reviewed by the **Technical Review Committee (TRC)**. See Wake County Planning website for fees and submittal requirements.

Note: Non-residential projects NOT requiring Planning Board approval may proceed to the Construction Plan Process after obtaining **zoning approval** (land use permit application).

The Preliminary Plan submittal for stormwater should include the following:

- Cover letter stating the purpose of the submission
- Two (2) copies of the Hybrid Stormwater Tool; digital submittal and hardcopy
- Wake County Stormwater Submittal Checklist (Preliminary Plan portion)
- Stormwater standards Checklist (Wake County and if applicable Falls Lake or Jordan Lake)
- Site Plan - a concept plan drawn to scale showing the proposed location of structures, roads, parking and other impervious surfaces, environmental features and proposed BMP location(s); shall include PIN number
- Drainage Area Map (pre and post development areas for peak flow analysis – should match completed tool)
- Copy of USGS Quad Map and Wake County Soil Survey map with delineated project limits
- Flood Hazard Area impacts
- Any additional calculations available

2.3 Construction Plan Review

Following the TRC review process and Planning Board approval, regular subdivisions and non-residential development and redevelopment projects are required to obtain a Stormwater Permit through Wake County if the disturbance threshold is met. Disturbance thresholds are set by the location of the project (See Standards Checklists in Appendix A).

The applicant shall submit the following to Wake County for stormwater construction plan review:

- Cover letter stating the purpose of the submission
- Erosion Control and Stormwater Joint Application and Fees. Applicant shall adhere to the fee schedule for all resubmittals.
- Wake County Stormwater Submittal Checklist (Preliminary Plan and Construction Plan portion)
- Wake County Standards Checklist (Falls Lake, Jordan Lake, or Wake County)
- Two (2) copies of the Stormwater Design Tool (All sheets) ; digital submittal and hard copy
- Two (2) copies of a complete set of construction drawings

- Drainage Area Map (pre and post development outfalls – should include offsite areas and match completed tool)
- Copy of USGS Quad map and Wake County Soil Survey with delineated project limits
- All supporting calculation documentation
- Flood Studies / Flood Hazard Soil Redelineations
- Buffer Impacts / stream delineations
- Nitrogen Payment Offset receipt (required prior to permit issuance)
- Fees (visit website)

2.4 Pre-construction Meeting

Following approval of construction drawings by Wake County Environmental Services and Planning/Zoning, a pre-construction meeting must be scheduled prior to any land disturbance. At this time, applicants will obtain the Stormwater Permit as well as a Land Disturbance Permit (if applicable). Additionally, applicant shall receive two copies of the approved stormwater and/or erosion control plan. Applicant should bring the following to the preconstruction meeting:

- All associated permit fees
- Site contractor(s)
- Financially responsible representative
- Design Engineer (if requested)

2.6 Permit Issuance

Outstanding permit fees for erosion control and/or stormwater are due following the preconstruction meeting and prior to permit issuance. Permits are issued by the Plans Facilitator on the 1st floor, WCOB, 336 Fayetteville Street, Raleigh, NC 27602. Installation of required erosion control measures may proceed following permit issuance. Grading may begin after Wake County field inspection and approval of initial measures.

2.7 Stormwater Improvements

Stormwater Improvements typically refer to engineered stormwater devices required to meet Wake County or state requirements for plan approval. Improvements include but are not limited to wet ponds, dry detention, level spreaders, bioretention areas, swales, constructed wetlands and cisterns. See BMP Design Principles for additional information.

2.8 Permit Completion

All conditions of approval (COAs) outlined in the Wake County approval letter must be completed prior to permit completion. Additionally, regular subdivisions require record plats prior to selling lots. Plats are not approved until all COAs are met. Likewise, nonresidential development will not receive a Certificate of Occupancy until COAs are met.

2.8.1 Conditions of Approval

Conditions of Approval can include but are not limited to:

- Recorded Stormwater Agreement (provides assurance that improvements will be maintained)
- Recorded Operation and Maintenance Plan
- Engineer's Certification
- Covenants
- As-built Survey
    - Include As-built Checklist with all as-built submittals
    - As-built survey shall show required stormwater improvements (easements, impervious surface coverage, engineered stormwater devices, stream crossings, etc)
- Record Plat
    - Include and ensure completeness with Final Plat Checklist with all plat submittals
    - Plat shall show impervious limits for each lot and indicate the basis for the impervious limits
    - Stormwater agreement and Operation and Maintenance Plan shall be recorded concurrently (book and page numbers).
    - If the stormwater improvements were not completed prior to plat recordation or certificate of occupancy for a non-residential project, a performance guarantee shall be posted (see below).

2.8.2 Procedures for Posting a Financial Guarantee for Completion of Stormwater Improvements

The Wake County's Water Quality Division allows for the posting of a financial guarantee pending the completion of required stormwater devices. *[Wake County UDO, Article 9-31-1 Performance Guarantee] and [8-22-3 Form and Amount of Performance Guarantee]*

The performance guarantee (PG) process is as follows:

Step 1: Owner / Developer contacts the Wake County Watershed Manager to determine remaining work to be completed per the approved stormwater permit.

Step 2: Based on field inspection, engineer provides Wake County with an Engineer's sealed detailed estimate of the cost to complete the remaining stormwater work. Revisions may be required prior to its acceptance.

- The financial guarantee shall be 125% of the cost of the stormwater improvements.
- Hard and soft costs should be included (installation, stabilization, engineering, project management, surveying, project management etc.)

Step 3: Watershed Manager approves the amount of the financial guarantee.

Step 4: Owner / Developer furnishes the County with a draft financial guarantee and the Stormwater Improvements Performance Guarantee for the approved amount.

- PG shall be in the form of a performance bond, letter of credit, cash or cashiers/certified check

  Irrevocable Letter of Credit Option
  The letter of credit must be obtained from a bank doing business and having a location in Wake County. The expiration date on the letter of credit is to be at least one year from the date of execution. The letter of credit must be renewable for additional one-year terms, for so long as the stormwater improvements have not been completed.

- A Stormwater Improvements Performance Guarantee Agreement form should be submitted with the PG. **Item #24 in the agreement should have a person's name, not the LLC alone.**

  Note: As with any legal binding agreement, the Stormwater Improvements Performance Guarantee Agreement should be read over carefully before it is signed and notarized by the owner / developer. Changes to the typewritten text of the agreement are not permitted.

- A Disclosure Statement will be required on the Final Plat
- Copies of the Maintenance and Stormwater Agreement forms shall be submitted for review. The forms shall be recorded at the Register of Deeds concurrently with the Final Plat and the Stormwater Agreement shall be cross referenced on the Final Plat.

Step 5: Release of Performance Guarantee

- Once all of the required improvements have been certified by the applicant's licensed professional engineer or licensed professional surveyor or other professional as authorized by the North Carolina General Statutes that the improvements have been installed in accordance with all applicable standards, the financial guarantee may be released. Certification includes an as built survey, field inspection by Wake County staff, review and approval of maintenance documents and easement plat.
- Once all of the required improvements have been at least 50 percent certified, the financial guarantee may be reduced by the ratio that the completed improvements bear to the total improvements required, provided that no more than one such reduction may be permitted prior to releasing the performance guarantee.

- Owner / Developer and Watershed Management must sign the Release of Performance Guarantee form which will be supplied to the finance department.

Step 6: Project is ready for permit completion

2.9 Post-Construction Maintenance

Stormwater improvements shall be maintained by the entities identified on the record plat, owner's association document, and/or maintenance plan and agreement for the life of the project. The maintenance agreement outlines requirements for maintenance. Per the stormwater agreement, the parties responsible for maintenance of stormwater improvements agree to inspect and maintain these devices. In addition to regular maintenance, an annual inspection of each device is required. The responsible party shall submit an inspection report to the County each year.

3.0 WAKE COUNTY STORMWATER HYBRID DESIGN TOOL OVERVIEW

Engineers complete the Wake County Stormwater Hybrid Design Tool by inputting site information, site land uses and time of concentration data by drainage area for pre and post-development conditions.

Target Curve Number (TCN)

Developers must manage residential runoff for post- development to ensure the site will not exceed the designated curve numbers, in accordance with procedures specified in the *United States Department of Agriculture, Natural Resource Conservation Service, Technical Release 55, Urban Hydrology for Small Watersheds* (TR-55) [*Wake County UDO, Article 9*]. While land uses and hydrologic soil groups (HSGs) are input by engineers by drainage area, the tool calculates the target curve number and post development curve number for the site as a whole. The difference between the two numbers translates to a volume that must be detained for the site. The hybrid tool calculates and flags the volume that is the developer's responsibility to detain. For more information on TCN see Section 4, Stormwater Design Principles.

Peak Flow

Engineers are responsible for inputting land use and time of concentration information and the Tool will calculate the associated peak flows for pre and post development. If runoff leaves the site at several locations, the engineer must conduct a separate analysis for each outfall and enter site information by individual drainage areas.

The hybrid tool calculates and flags peak flow increases requiring potential attenuation using the TR-55 Graphical Peak Discharge Method for Type II Distribution. The tool does not calculate and perform

routing for BMP design and engineers are required to provide their own drainage area maps, stormwater model and supporting calculations to show peak flow compliance with state rules. For more information on peak flow see Section 4, Stormwater Design Principles.

Nutrient Loading

Nutrient loading calculations are directly from the Jordan/Fall Nutrient Accounting Tool and were reviewed and approved by the NC Department of Water Quality as part of Wake County's submittal for compliance with the Falls Lake and Jordan Lake Nutrient Strategies. For more information on nutrient loading see Section 4, Stormwater Design Principles.

The following sections provide detailed design methodology, supporting data and further guidance on Wake County stormwater requirements.

4.0 STORMWATER DESIGN PRINCIPLES

4.1 TARGET CURVE NUMBER (TCN)

4.1.1 Concept

The Wake County Stormwater Ordinance (UDO Article 9) requires that the calculated composite curve number of the proposed development conditions meet a specific "target" curve number. The target curve numbers (TCN) are provided in Table 4.1.2 below. If the proposed development does not meet the "target" curve number then the difference in runoff volume for 3 inches of precipitation between the target curve number and the proposed development curve number must be retained and infiltrated or stored and drawn down over a period of 2 to 5 days.

Table 4.1.2 Wake County Target Curve Numbers

Zoning District	Maximum Composite Curve Number by Soil Group			
	A	B	C	D
R-80W and R-80	37	60	73	79
R-40W and R-40	41	62	75	80
R-30, R-20, R-15, R-10, R-5, Residential Highway, General Business and Office and Institutional	43	63	76	81

The curve number concept was developed by the Soil Conservation Service to estimate runoff volume for specific rainfall events. Curve number values are whole numbers ranging from 30 to 98 – lower values correspond to smaller runoff volumes and higher values correspond to larger runoff

volumes. The curve number (CN) is determined using two factors: hydrologic soil group (HSG) and land use.

Soil classifications are divided into four hydrologic soil groups (A, B, C, and D) according to their minimum infiltration rate. Soils that are HSG "A" soils are those which have high infiltration capacity and subsequently low runoff rates. HSG "D" soils are those with very low infiltration capacity and very high runoff rates. The hydrologic soil groups for the soil classifications found in Wake County are listed in Table B-1 In Appendix B.

Land use is the second contributor to determining a curve number. The curve number for wooded area is lower and therefore corresponds to a smaller runoff volume than impervious surface which has a higher curve number. Curve number values for proposed development conditions in Wake County in all four hydrologic soil groups are provided in Table B-2 in Appendix B.

4.1.2 Design Methodology

A composite curve number (CN) is calculated to represent the hydrologic characteristics of the site as a whole. To calculate a composite curve number – the soil types, proposed land uses, and the proposed acreage of each should be known. The land use types listed in Table B-2 are representative of most developments in Wake County. The land uses types were chosen for simplicity and consistency with the Division of Water Resources' land use categories used in the Jordan/Falls Stormwater Load Accounting Tool. The Wake County Hybrid Tool calculates the CN, TCN and required volume storage for the site. For Tool information, see Wake County Hybrid Stormwater Design Tool section. The below examples demonstrate the calculations used in the Tool.

Example 4.1.2a Composite Curve Number

The proposed R-40 development is a 10-acre site with the below land uses. Using Table B-2, the curve number can be determined for each area of land use.

Proposed land uses:
Woods, HSG B (CN = 55) = 4 acres
Managed Pervious (Open Space), HSG B (CN = 61) = 1.5 acres
Managed Pervious (Open Space), HSG C (CN = 74) = 2 acres
Roof, HSG B (CN = 98) = 1.5 acres
Roadway, HSG C (CN=98) = 0.5 acres
Grassed ROWs, HSG C (CN=80) = 0.5 acres

Solution:
Multiply the acreage by the curve number and sum the products.
55 * 4 acres = 220
61 * 1.5 acres = 91.5
74 * 2 acres = 148
98 * 1.5 acres = 147
98 * 0.5 acres = 49
80 * 0.5 acres = 40

220 + 91.5 + 148 + 147 + 49 + 40 = 695.5
Divide the sum by the total site acreage to determine the composite curve number.
695.5 / (10 acres) = 69.55
A curve number must be a whole number – therefore the composite curve number is 70.

Based on Table 4.1.2, this site would have also have a TCN of **66** (See below solution):
Solution:
*Multiply the HSG acreages by the **Maximum Composite Curve Number by Soil Group**, sum the products, and divide by the total site acreage.*
B Soils = 7 acres => 7*62 = 434
C soils = 3 acres => 3*75 = 225
(434+225) = **65.9**
10
The proposed development CN of 70 is greater than the TCN of 66.

TCN Volume Requirement - SCS Runoff Method

In cases where the proposed development composite CN is higher than the TCN for the site, the additional volume of runoff must be stored. Runoff volumes shall be calculated using the SCS runoff equation as follows:

Q* = Runoff depth (in)
P = Rainfall depth (in)
S = Potential maximum retention after rainfall begins (in)

$$\mathbf{Q= (P-.2S)^2/(P+.8S)}$$
$$\mathbf{S= (1000/CN)-10}$$

Example 4.1.2b Determination of Runoff Volume

In **Example 4.1.2a**, the proposed CN for the site was determined to be 70 and the TCN was determined to be 66. Using the proposed and target curve numbers –determine the volume to be stored on this site. This will be done by calculating the runoff in inches for each curve number and then multiplying the difference between the two runoff values by the acreage of the site.

Runoff for Proposed CN:

Determine the value of S first. Divide 1000 by the curve number and subtract 10.
S = (1000 / CN) – 10
S = (1000 / 70) – 10 = 4.29 inches

Now calculate the runoff by using the SCS runoff equation. Per the Wake County rules, P = 3 inches.

$Q^* = (P - 0.2S)^2 / (P + 0.8S)$
$Q^* = (3 - (0.2*4.29))^2 / (3 + (0.8*4.29)) = (2.14)\ 2 / (6.43) = 4.45 / 6.43$
$Q^*_{Proposed}$ = 0.71 inches

Runoff for TCN:
S = (1000 / CN) – 10
S = (1000 / 66) – 10 = 5.15 inches

$Q^* = (P - 0.2S)^2 / (P + 0.8S)$
$Q^* = (3 - (0.2*5.15))^2 / (3 + (0.8*5.15)) = (3 - (0.99))\ 2 / (3 + (3.94)) = (2.01)\ 2 / (6.94) = 4.04 / 6.94$
Q^*_{Target} = 0.55 inches

Runoff Volume to be Stored:

Subtract the runoff produced by TCN by the runoff produced by the proposed CN to determine the runoff in inches that exceeds the allowed amount.

$Q^*_{Proposed} - Q^*_{Target} = 0.71 - 0.55 = 0.16$ inches

Convert the runoff to a volume
0.16 inches * (1/12) feet/inches = 0.01 feet
Multiply the site acreage by the runoff to determine the volume required to be stored.
10 acres * 0.01 feet = 0.10 acre-feet
Convert volume to cubic feet.
0.10 acre-feet * 43,560 square feet = 4,356 cubic feet

Therefore the volume required to be stored by the Wake County Stormwater Ordinance is 4,356 cubic feet.

Note: The total volume required is for the site and can be spread across multiple drainage areas.

4.2 PEAK FLOW

4.2.1 Concept

The Neuse Rules [15A NCAC 02B.0235 (4)(a)], the Falls Rules[15ANCAC 02B.0277, Section 4(f)] and The Jordan Rules[15ANCAC 02B.0265, Section 3(a)(iv)] all state "…new development shall not result in a net increase in peak flow leaving the site from the pre development conditions for the 1 yr-24hr storm event". The purpose of peak flow control for stormwater runoff from new development is to ensure that the integrity and nutrient processing function of receiving waters and associated riparian buffers are not compromised by erosive flows.

Engineers must calculate the pre- and post-development discharges for each point of discharge from the site (ie: by drainage area). If runoff leaves the site at several locations, the engineer must conduct a separate analysis for each point.

The hybrid tool calculates and flags peak flow increases requiring potential attenuation using TR-55 Graphical Peak Discharge Method for Type II Distribution. The tool does not calculate and perform routing for BMP design and engineers are required to provide drainage area maps, stormwater model and supporting calculations to show peak flow compliance.

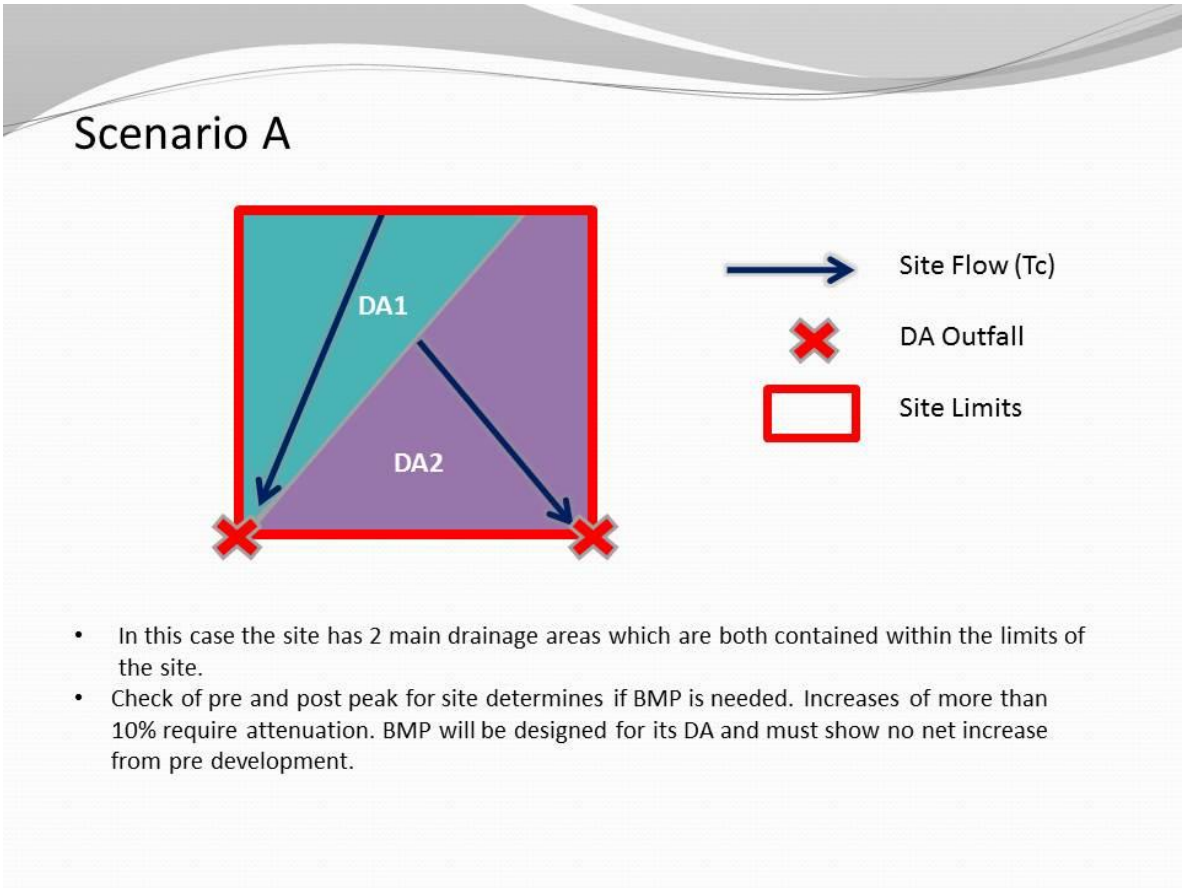
- Development with a net change in peak flow in excess of 10% the pre-development peak will be required to provide mitigation in the drainage area showing an increase. Note: An increase in runoff rates less than 10% does not automatically mean that a project will not be required to provide detention or make drainage improvements.

- If a BMP is required, BMP must be designed for the actual drainage area coming to the device (existing conditions for offsite).

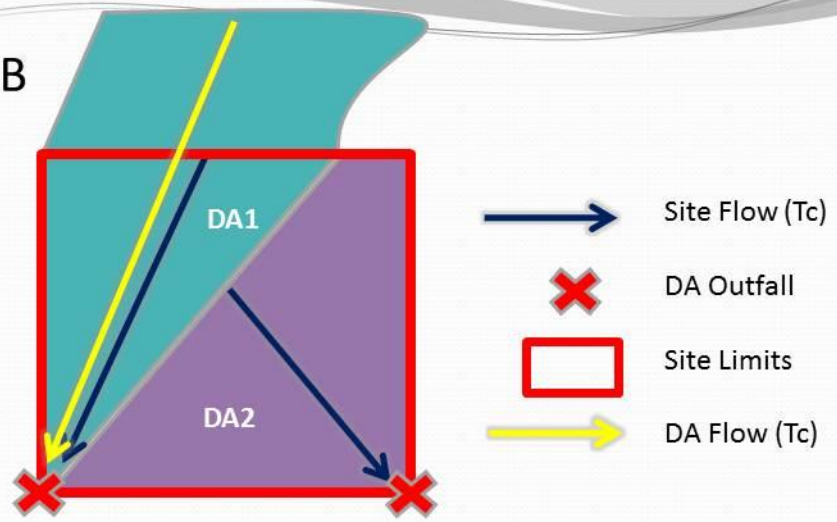
    - If BMP is designed to treat offsite as well, the engineer must provide calculations for Pre, Post, and Post BMP peak for the entire drainage area (including offsite).

    - Post BMP peak flow must be equal or less than Pre peak flow

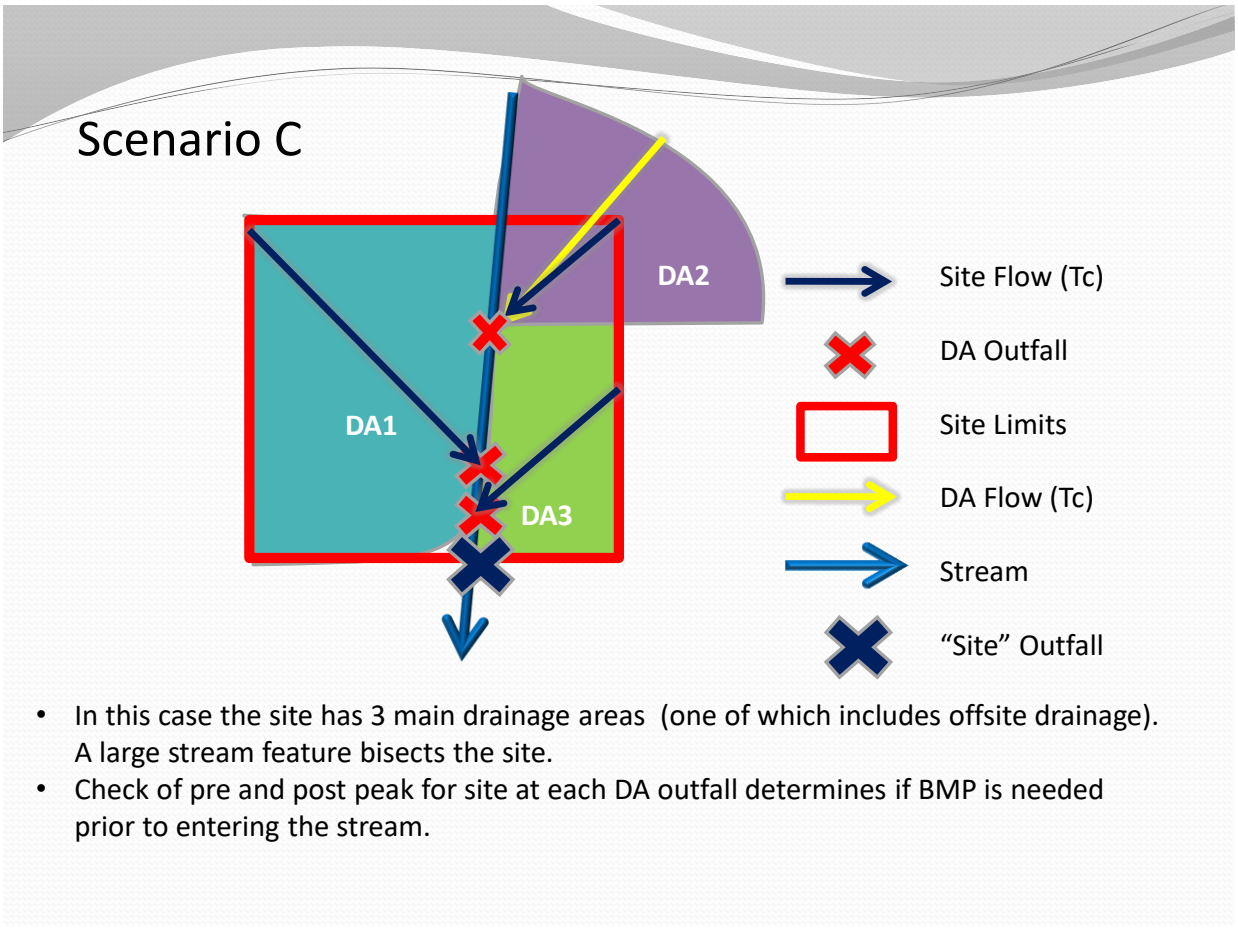
The following scenarios are provided to clarify compliance with the intent of the Neuse/Falls/Jordan regulations:



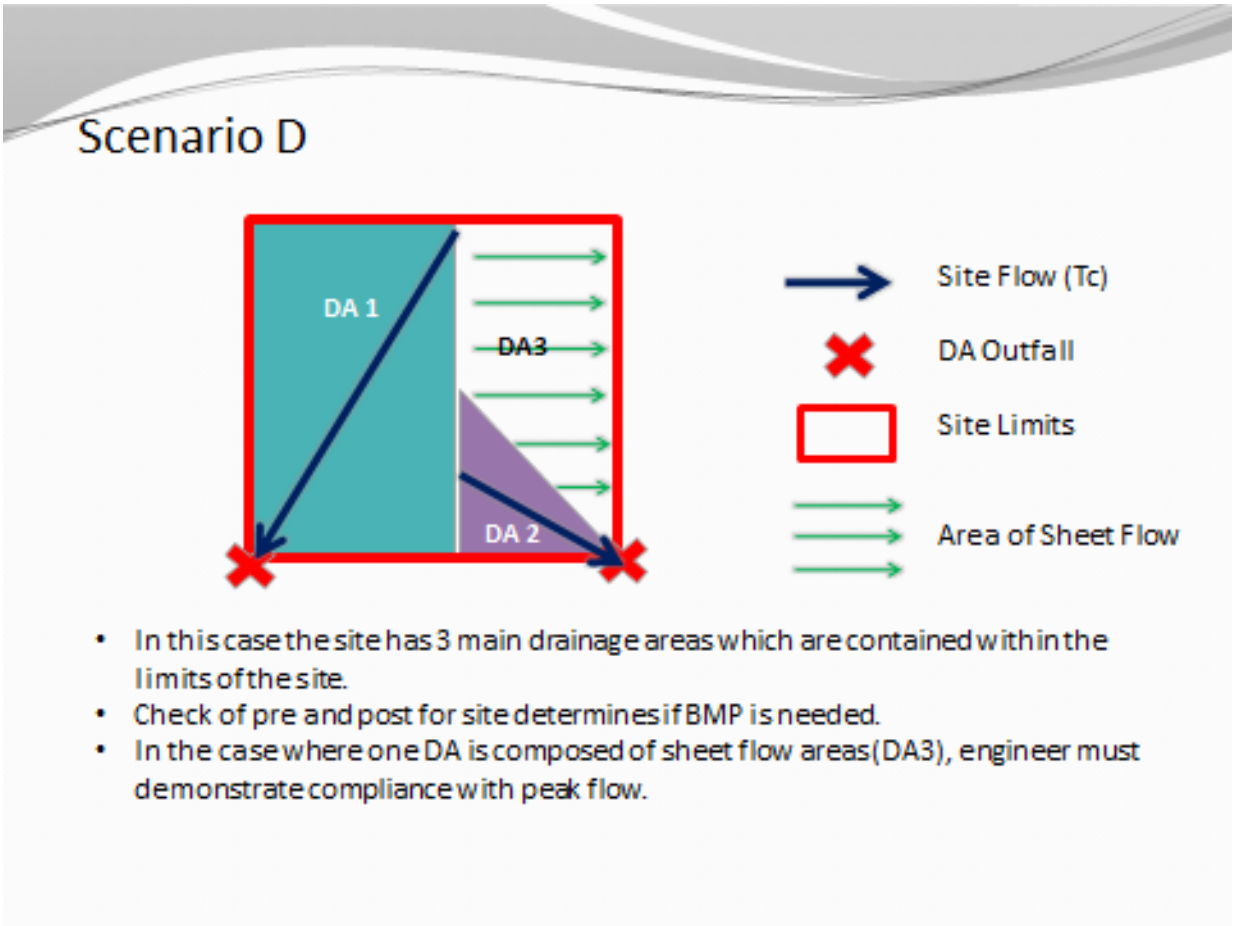
Scenario B



- In this case the site has 2 main drainage areas. DA1 takes in some offsite areas.
- Check of pre and post site peak determines if a BMP is needed. IF DA 1 needs a BMP then the engineer will need to size the BMP for its actual drainage area (using DA Flow).
- Development must show no net change in peak flow for the total drainage area to the BMP (pre to post BMP)



Note: There may be cases where Scenario C has other options. Site peak flow may be examined at the *"Site" Outfall*. This discharge point may significantly underestimate peak flow for the site when there is a large offsite drainage used in peak flow calculations. As a general rule, perform Scenario C as above. On a case by case basis, engineers may choose to provide further documentation to show compliance with the peak flow by performing a downstream impact analysis and/or providing additional information. Engineers must also ensure that internal streams are protected from erosive flows. In these cases, the burden of proof will rest on the submitting engineer to demonstrate compliance.



The above scenarios by no means represent all possible situations and are intended to provide general guidance for peak flow calculations. For calculations in conflict with these scenarios, engineers may choose to provide supplementary documentation to show compliance with the peak flow. In these cases, the burden of proof will rest on the submitting engineer to demonstrate compliance.

4.2.2 Design Methodology

Time of Concentration

Time of concentration (Tc), as described by TR-55, is the time required for runoff to travel from the hydraulically most distant point of the watershed to a point of interest within the watershed. A higher Tc corresponds to a lower peak flow since the longer flow time stretches out the hydrograph and a lower Tc corresponds to a higher peak flow. Tc is computed by calculating the travel time for each type of flow (sheet, shallow, or channel) separately and then summing the calculations. As stated in TR-55, any flow over a lake or reservoir can be neglected since the travel time is very close to zero. The minimum value for a time of concentration is 5 minutes. The Wake County tool calculates Tc based on engineer inputs. Engineers may also compute and provide their own calculations for Tc but are required to input their calculated values into the tool.

Tc = Tt Sheet + Tt Shallow + Tt Channel

Sheet Flow

Sheet flow occurs as flow over plane surfaces. Calculation of the travel time for sheet flow requires that the flow length, slope, and Manning's roughness coefficient for sheet flow be determined. The maximum flow length for sheet flow is 300 feet, as determined by the NRCS. The Manning's roughness coefficients (n values) are in Table 4.2.2. When selecting an n-value from the table, consider the cover to a height of about 0.1-foot since this is the only part of the plant that will obstruct sheet flow.

Table 4.2.1 Manning's Roughness Coefficients

SURFACE DESCRIPTION	Manning's roughness coefficient n
Paved, Gravel, or Bare Soil	0.011
Grass	0.24
Woods	0.40

Shallow Flow

After a maximum of 300 feet of sheet flow, the runoff usually becomes shallow concentrated flow. The average velocity of this flow should be determined using the equations below.

Unpaved: $V = 16.1345(s)^{0.5}$

Paved: $V = 20.3282(s)^{0.6}$

V=Average Velocity (ft/s)

s = slope of hydraulic grade line (watercourse slope, ft/ft)

$$T_t = \frac{L}{3600V}$$

T_t =travel time (hr)

L = flow length (ft)

V = average velocity (ft/s)

3600 = conversion factor from seconds to hours

Channel Flow

Open channels include, but are not limited to channels that are assumed to begin where surveyed cross section data has been obtained, where channels are visible on aerial photographs, or where blue lines appear on the United States Geological Survey (USGS) quadrangle sheets. Manning's

equation should be used to estimate average flow velocity. Average flow velocity is usually determined for the bank-full elevation.

Manning's equation is:

$$V = \frac{1.49 r^{2/3} s^{1/2}}{n}$$

V=Average Velocity (ft/s)

r = hydraulic radius (ft)

s = slope of hydraulic grade line (channel slope, ft/ft)

n = Manning's roughness coefficient for open channel flow

$$r = \frac{a}{p_w}$$

a = cross sectional flow area (ft2)

p_w=wetted perimeter (ft)

$$T_t = \frac{L}{3600V}$$

T_t =travel time (hr)

L = flow length (ft)

V = average velocity (ft/s)

3600 = conversion factor (sec-hrs)

Table 4.2.2 Representative Manning's Roughness Coefficients for Open Channel Flow

CHANNEL LINING	n
Asphalt	0.016
Concrete, finished	0.012
Concrete, unfinished	0.014
Grass	0.035
Gravel Bottom/riprap sides	0.033
Weeds	0.040

Peak Flow Calculations

The Wake County tool uses the Discrete SCS Curve Number Method for runoff volume (the Simple Method is used for the loading calculations) and TR-55 Graphical Peak Discharge Method for Type II Distribution for peak flow. Offsite and site land uses are used to determine pre and post development runoff and peak flow. The SCS Curve Number Method for runoff was detailed previously in this manual. The Discrete runoff method is used in the tool for runoff calculations used in peak flow calculations (See below equation).

$$Q=Q^*_{(imp)} \text{ x } DA_{(imp)} + Q^*_{(pervious)} \text{ X } DA_{(pervious)}$$

$Q^*_{(imp)}$ = Runoff from Impervious Area (in)
$DA_{(imp)}$ = Drainage from impervious area (acre)
$Q^*_{(pervious)}$ = Runoff from pervious area (in)
$DA_{(pervious)}$ = Drainage from pervious area (acre)

Once the runoff and Tc have been determined, the peak flow can be calculated.

TR-55 Graphical Peak Discharge Method for Type II Distribution

$$\mathbf{Q_p = q_u A_m Q^* F_p}$$

Where:

Q_p = Peak Discharge (cfs)

q_u = Unit peak discharge (csm/in)
TR-55 Appendix F

A_m = Drainage Area (mi^2)

Q^* = runoff (inches)

F_p = pond adjustment factor

$$\mathbf{\log(q_u) = C_o + C_1 \log(Tc) + C_2 [\log(Tc)]^2}$$

Where:

C_o, C_1, C_2 = coefficient from Table F-1

T_c = time of concentration (hr)

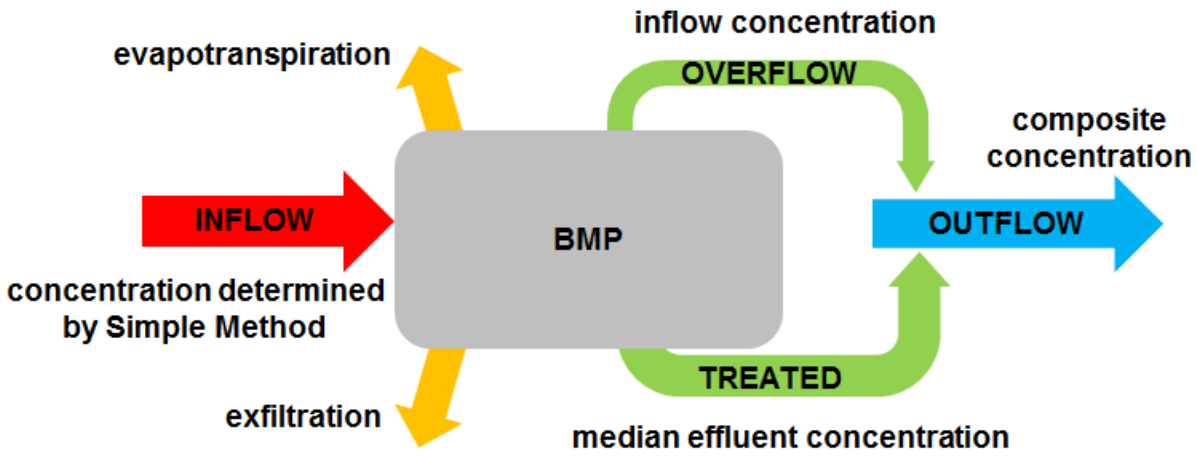
4.3 NUTRIENT LOADING

4.3.1 Concept

Depending on the location of a project, development must not show a nitrogen export in excess of State limits (Ex: A development in the Neuse may not export more than 3.6 lbs/ac/yr of nitrogen for post development and must provide mitigation/offset for any overage). In Falls and Jordan Lake Watersheds, phosphorus export is also regulated. While land uses are input into the Wake County Tool by engineers by drainage area, the tool calculates the pre and post development and post BMP nitrogen for the site as a whole. Nutrient calculations in the Wake County Hybrid Tool were reviewed and approved by NCDENR, DWR as part of local government compliance with the Falls and Jordan Rules.

Nutrient calculations performed within the hybrid stormwater tool are governed by two basic principles: Simple Method (for runoff volume and pollutant loading calculations) and the median effluent concentration BMP efficiency metric (for BMP reduction calculations). Each of these principles is described below and is based on the methodology found in the Jordan and Falls Lake New Development Accounting Tool. *The Jordan Lake Stormwater Load Accounting Tool User's Manual* (Version 1.1 - revised 11-29-11), *Model Documentation* section provides in-depth discussion on the basis for all calculations in the Wake County Hybrid Tool. Figure 5.3 visually shows the governing principle behind nutrient loading calculations.

Figure 4.3 BMP Treatment Schematic



Note: A newer version of the The Jordan Lake Stormwater Load Accounting Tool User's Manual and accounting tool was released this year. This manual and the Wake County tool will be modified early 2014 to conform to the State's updates. Updates will include modifications such BMP hydrologic soils, additional BMPs, and increased visibility of calculations.

4.3.2 Design Methodology

Simple Method

The Simple Method is used in the Wake County Tool to calculate pollutant load. The impervious cover of a catchment is represented by the runoff coefficient Rv:

Rv = 0.05 + (0.009 * I) (1)

Where Rv = Simple Method runoff coefficient; and
I = percent impervious cover of the catchment (%).

The Wake County Tool breaks the catchment into discrete land use types. Each land use type is either impervious (I=1) or pervious (I = 0). This results in Rv for impervious areas of 0.95 and 0.05 for pervious areas.

Volume is a function of the runoff coefficient, Rv, the area of the catchment and the annual rainfall amount. To estimate the mass of pollutant that leaves the catchment on an annual basis,

L = [(P * Pj * Rv)÷12] * (C * A *2.72)

Which can be reduced to:

L = (P * Pj * Rv) * (C * A *0.226)

Where L = average annual pollutant load (lbs),
P = annual runoff in inches, 45.41 inches used in Wake County
Pj = fraction of rainfall events that produce runoff (use a value of 1)
C = event mean concentration of the pollutant (mg/L)

The event mean concentrations used in the Wake County tool for land uses are discussed in detail in the "Watershed Characteristics" section of the *JLSLAT User's Manual*, version 1.1. All residential land uses use the custom lot option instead of the general lot sizing method because detailed breakdown of residential land use is required by Wake County UDO for Target Curve Number (TCN) requirements.

- Additional land uses were added to comply with Wake County TCN requirements: Transportation-High Density Grassed ROWs, Transportation-Low Density Grassed ROWs and Residential Grassed ROWs.

- Under other state stormwater programs the grassed right of way is not treated as impervious area. However, the Jordan/Falls Tool does not allow for the differentiation of ROWs from the associated impervious roadways. As a temporary fix to the Jordan/Falls tool, engineers that submit plans include the surface area of a proposed road under one of the transportation land uses and the grassed portion of the ROW as a "managed pervious" land use. This approach will be changed at a later date according to NCDENR as EMC values are determined for these areas. The Wake County

tool does differentiate the grassed ROWs but assigns the "managed pervious" values for nutrient loading. Once EMC values are developed for grassed ROWs, the Wake County tool will be updated to reflect more appropriate values.

Volume Reduction Can Play a Significant Role in Pollution Reduction

Percent removals do not adequately reflect the effect of volume reductions. Volume reductions are an integral part of calculating effluent loads from a given BMP. The volume reduction values assigned to each BMP type vary based upon the physiographic region. These assignments are displayed in the JLSLAT manual and are expressed as percent of the inflow volume. The JLSLAT accounts for volume reductions by the BMP in determining how much nutrient reduction is achieved by the BMP (See **Table 5.3.2** below). Each BMP type has a Treated Outflow (%), a Bypass (Overflow) (%), and a Volume Reduction (%).

Table 4.3.2 BMP Details

BMP DETAILS

(Figure 7, Jordan/Falls Lake Stormwater Load Accounting Tool User's Manual)

BMPs	TN Mass Removal %	TN EMC (mg/L)	TP Mass Removal %	TP EMC (mg/L)
Bioretention with IWS	0.55	0.95	0.6	0.12
Bioretention without IWS	0.55	1	0.6	0.12
Dry Detention Pond	0.15	1.2	0.1	0.2
Grassed Swale	0	1.21	0.5	0.258
Green Roof	0.2	1.08	0.2	0.15
Level Spreader, Filter Strip	0.6	1.2	0.45	0.154
Permeable Pavement	0.4	1.44	0.7	0.39
Sand Filter	0.4	0.92	0.45	0.14
Water Harvesting	0	1.08	0	0.15
Wet Detention Pond	0.28	1.01	0.45	0.113
Wetland	0.5	1.08	0.65	0.117

For more information regarding nutrient loading calculations, please refer to most current version of the JFSLAT.

4.3.3 Mitigation/Banking

In nutrient strategy areas, a developer not meeting the loading rate targets on their site has the option to 'buy down' a portion of their nutrient load from a DWR approved nutrient offset provider to meet loading rate targets. While rules vary by watershed, they allow developers not meeting the nutrient requirements on their site to have the option of offsetting nutrient loading. Onsite reductions required before buy down are also specified by watershed.

Using the Wake County Hybrid Tool, the developer calculates their new development nutrient loading. For the development to proceed, the loading rate targets or, at a minimum, the offsite threshold requirements must be met for their watershed (see Table 4.3). Once that obligation is met, they may buy down the remainder of their nutrient loads to meet the loading rate targets. Developers are encouraged to visit NCDENR's website for the most up to date buy down information.

Based on the developers approved proposal, Wake County will issue a letter to the developer authorizing that they are allowed to purchase offsite offsets. Once payment is made to the approved nutrient offset provider, a receipt is issued documenting the amount of offset credit purchased. In turn, that receipt must be provided to Wake County to demonstrate the developer's compliance with meeting the loading rate targets for the development site prior to permit issuance.

In the Cape Fear River Basin (outside of Jordan Lake Watershed, a buy-down system only exists for Jordan Lake Watershed. Therefore, demonstration should be made that BMPs have been incorporated to a reasonable extent with a goal of 3.6 lbs/ac/yr.

Table 4.3 Current Nutrient Targets (2013)

Nutrient Strategy Area	Nutrient Reduction Goal	Offsite Thresholds
Neuse	3.6 N lb/ac/yr & No P goal	6 N lbs/ac - Single-family, detached, duplex dev't (1 acre minimum); 10 N lbs/ac – Commercial, multi-family residential, industrial (1/2 acre minimum)
Jordan Lake Watershed		
Upper New Hope	2.2 N lb/ac/yr & 0.82 P lb/ac/yr	
Lower New Hope	4.4 N lb/ac/yr & 0.78 P lb/ac/yr	
Haw River	3.8 N lb/ac/yr & 1.43 P lb/ac/yr	

Falls Lake Watershed	2.2 N lb/ac/yr & 0.33 P lb/ac/yr	30% of N & P reduction need onsite for projects less than one acre or expansions; 50% of N & P reduction need onsite for projects over one acre

Example: Calculation of Buy-down Amount for Nitrogen

Project :
A 20-acre residential development in the Neuse River Basin has a stormwater management plan yielding a final nitrogen loading of 5.8 lbs/ac/yr.

The developer needs an additional 2.2 N lbs/ac/yr to meet the loading rate targets for the Neuse (6 N lbs lbs/ac/yr – 3.6 N lbs/ac/yr).

The developers final nutrient obligation:
20 acres * (2.2 lbs/ac/yr) * 30 years = 1,320 lbs of N

References:

Rule 15A NCAC 0.2B .0240 and Session Laws 2009-337 and 2011-343.

Jordan Lake Stormwater Load Accounting Tool User's Manual, (most current version)

4.3.4 Project Expansions

Nutrient management for existing developments varies by watershed. In the Neuse Basin, expansion projects with increases in built upon area may address nutrient loading using the Apportioning Method which re-defines the project area as the new impervious area and a portion of the open space allocated in the ratio of new impervious to total impervious. Offset fees are based on this new "site expansion area". This technique is best described through example.

Given:

- 10 acre site with existing, approved 5 acres of impervious surface
- Expansion to add an additional 3 acres of impervious surface for a total of 8 acres of impervious and 2 acres pervious.
- Using the apportioning system, the existing development gets credit for 5/8 of the 2 acres of the remaining open space for 1.25 acres pervious.
- The new development gets 3/8 credit of the 2 acres for 0.75 acres.

Assuming the open space is managed, the nitrogen load calculations would look like this:

(5 acre x 21.2 lb/acre) + (1.25 acre x 1.2 lb/acre) = 106 lb + 1.5 lb = 107.5 lb (existing)

(3 acre x 21.2 lb/acre) + (0.75 acre x 1.2 lb/acre) = 63.6 + 0.9 lb = 64.5 lb (new)

Total TN export = 107.5 + 64.5 = 172 lb

-Or -

172lb / 10 acres = 17.2 lbs/ac/yr

The expansion site is defined as 3 acres impervious plus 1.25 acres pervious = 4.25 acres. Basically, expansions meet the target but using a smaller site area to determine load (lbs/yr).

5.0 STORMWATER CREDITS

Land use practices involve stormwater management strategies to reduce the volume of runoff without the use of structural controls. Practices such as wooded area preservation and disconnected impervious area increases opportunities for infiltration and stormwater runoff absorption. Land use practices help to decrease the proposed curve number of a site therefore reducing hydrological impacts, as well as achieving additional environmental benefits.

5.1 Preservation of Wooded Areas and Reforestation

The preservation of wooded areas or creation of woods by reforestation is an important management tool to lower the proposed curve number of a site. Wooded areas are assigned a lower curve number than any other land use (See Table B-2). Therefore, when determining a composite curve number for a proposed site, increasing the area of woods decreases the proposed curve number. Preserving existing wooded areas is recommended over creation of woods by reforestation. Effort should be made to maintain existing woods in a proposed subdivision.

5.1.1 General Design Criteria

In order for a wooded area to contribute as woods in the calculation of the proposed site curve number, it must be designated as preserved woods or reforested area, or as a Neuse River Buffer or Wake County Watercourse Buffer. Preserved or reforested wooded areas should be designated in common open space areas. At the construction plan phase the house, driveway, and septic field location is largely unknown. Due to this – the recordation of a boundary of preserved or reforested wooded areas may not be practical. Therefore - preserved or reforested wooded areas on lots do not need to be designated as preserved unless the percentage of woods which is being claimed as woods in the proposed curve number calculation on the lots exceeds the values listed in Table 5.1.

Table 5.1 Maximum Assumption of Wooded Areas on Lots for Determination of Proposed CN

Zoning District	Maximum Assuption of Woods on Lots without Designation
R-80W and R-80	30%
R-40W and R-40	20%
R-30	15%
R-20, R-15, R-10, R-5, Residential Highway, General Business and Office and Institutional	0%

If the area claimed as woods for proposed curve number calculation on the lots exceeds the maximum assumption allowed by the table above, then the entire area claimed as woods on the lots must be designated by a boundary on the construction plan and recorded plat. This is required so that the developer, builder, and homeowner are all aware of the area that cannot be disturbed or must remain reforested. This boundary may be moved by the builder or homeowner provided that an equivalent area of existing woods or reforested area is provided and the plat is modified and recorded to reflect the new boundary. Areas that are within the Neuse River Buffer or Wake County Watercourse Buffer and areas that are designated in common open space areas are counted separately and are not included in the maximum allowed assumption of wooded area on lots.

5.1.2 Reforestation Design Criteria

In areas that are not naturally wooded, the creation of wooded areas by reforestation is allowed. The reforested area counts as woods in the proposed curve number calculation. Areas that are reforested must be planted with trees and/or shrubs and mulched properly as specified in the following standards.

- **Tree/shrub Density and Spacing**
  Planted trees or shrubs must meet the minimum density and spacing standards of the Natural Resources Conservation Service. Existing trees or shrubs may be used towards meeting the planting standard. Standards regarding seedling quality and planting instructions and considerations are included in the Field Office Technical Guide, Code 612 (December 2011) published by the Natural Resources Conservation Service which is attached in Appendix C of this manual.

- **Mulching**
  An initial application of mulch is required for the area designated for reforestation. Existing groundcover may be used towards meeting the mulching standard. The site should be prepared and mulch spread and anchored per the standards included in the Field Office Technical Guide, Code 484 (January 2013) published by the Natural Resources Conservation Service and attached in Appendix C of this manual.

5.2 Disconnected Impervious

Disconnected impervious is a term used to describe runoff from an impervious area that has been directed over a pervious surface, such as lawn or woods, as sheet flow to allow infiltration. Connected impervious describes an impervious area in which the runoff is directed on to another impervious surface, a pipe, or a channel without an opportunity for infiltration or absorption. TR-55 recognizes that disconnected impervious areas produce less runoff than connected impervious area when the total impervious area is less than 30 percent. Once over 30 percent impervious, the absorptive capacity of the remaining pervious areas will not significantly affect runoff. TR-55 gives credit for this practice by reducing the composite curve number and provides an equation to determine the composite curve number when using disconnected impervious. This equation is incorporated into the Wake County Tool and is as follows:

$$CN_{adjusted} = CN_p + [(P_{imp}/100)*(98-CN_p)*(1-(0.5*R))]$$

Where:

$CN_{adjusted}$ = Composite Curve Number
CN_p = Pervious runoff curve number
P_{imp} = Percent Imperviousness % (expressed as whole number)
R = ratio of unconnected impervious area to total impervious area (decimal)

This equation reduces the curve number by counting half of the disconnected impervious area as pervious. Therefore if considering the effects on a single lot in which the entire roof was disconnected impervious, half of the roof would be assigned a curve number of 98 and half of the roof would be assigned the curve number for the pervious portion of the lot.

Each subdivision has a maximum allowable assumption of disconnected impervious for the whole site based on zoning as shown in Table 5 2. The maximum assumption is the percent of the total impervious surface of the site that is considered disconnected.

Table 5-2. Maximum Allowable Assumption of Disconnected Impervious Surface

Zoning District	Maximum Assumption of Disconnection without Designation
R-80W, R-80, R-40W, R40, R-30	50%
R-20, R-15, R-10, R-5, Residential Highway, General Business and Office and Institutional	25%

If this maximum allowable assumption is exceeded, then details must be provided showing that each impervious surface that is considered disconnected meets the design criteria as described below.

<u>Rooftop Disconnection Design Criteria:</u>

- No more than 500 square feet of roof area should contribute to one downspout.
- Downspout must be installed with a splashblock or equivalent length and width of gravel to establish sheet flow.

- From downspout, a minimum of 50 feet should be provided in the direction of flow across a vegetated surface before intercepted by a grassed channel, pipe, or another impervious surface.

Non-Rooftop Disconnection Design Criteria:

- Maximum length of flow across the impervious surface is 75 feet.
- A flow length across a vegetated surface should be provided that is equal to or greater than the flow path across the contributing impervious surface.
- The maximum slope for the vegetated surface is 5%.
- Pervious pavers are automatically disconnected and do not need to meet the additional criteria above. See Section 6.0 of this manual and the most current version of the *NCDENR DWR Stormwater Best Management Practices Manual* for pervious pavement requirements.

6.0 BMP DESIGN PRINCIPLES

Wake County reviews and permits Best Management Practices (BMPs) designed for Target Curve Number volume control, peak flow management, diffuse flow and nutrient load mitigation. All BMPs are required to be designed according to design specifications noted in the most current version of the *NCDENR DWR Stormwater Best Management Practices Manual*.

In addition, Wake County requires the following:

- All items listed on the Stormwater Submittal Checklist in Appendix A
- BMPs should be designed to treat rainfall events for all associated governing rules (i.e. if a BMP is designed for TCN matching and nutrient mitigation, it must be designed to detain both the water quality *1"* storm and the 1-year, 24-hour *3"* storm).
- DWR Supplemental Worksheets may be required
- All stormwater BMP's should be installed at least 25 feet from septic lines.

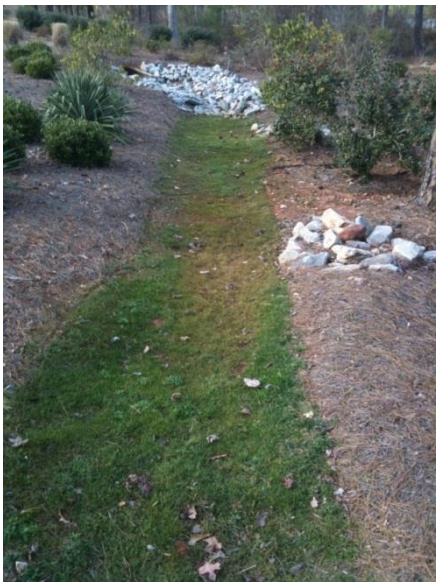
The current version of the *NC Division of Water Quality Stormwater Best Management Practices Manual* provides design standards and regulatory credit for a variety of permeable pavement practices. Wake County now allows permeable pavers that comply with the standards and specifications for design, construction and maintenance of permeable pavers in compliance with the most recent and current version of the State BMP Manual. In addition, the following requirements must be met:

- If there is no foundation drain on a structure then a 5 foot setback is required.
- If there is a foundation drain then the setback is determined by slope.
- If the BMP is down slope from structure then a 10 foot setback is required.
- If the BMP is on an even slope then a 15 foot setback is required.

- If the BMP is above slope then a 25 foot setback is required.

- Certification by an engineer will include a statement that pervious pavement does not affect structural foundations.

6.1 Example BMP Photos



Grass Swale

Infiltration Trench

Dry Well

Level Spreader

Wet Detention Pond

Constructed Wetland

Dry Detention Pond

7.0 WAKE COUNTY HYBRID STORMWATER DESIGN TOOL

Wake County is unique in that it has its own volume control SW ordinance, local and state water supply watershed regulations and is subject to three state nutrient management strategies in addition to the Swift Creek Land Management Plan. The complexity of applying multiple and overlapping regulations necessitates a streamlining of development submittal and review processes through the use of a single hybrid stormwater tool.

For stormwater submittals, engineers are required to complete the Wake County Stormwater Hybrid Design Tool, which incorporates the Neuse, Falls Lake and Jordan Lake Nutrient Strategy requirements. The tool calculates pre and post development runoff, peak flow, nitrogen loading, and target curve number volume requirements. All nutrient load calculations for this tool use the same methods used in the Jordan/Falls Nutrient Accounting Tool.

7.1 Wake County Hybrid Tool Contents

The hybrid tool is comprised of the following calculation sheets:

- Site Data worksheet
- DA worksheets
- Site Summary worksheet
- DA BMP worksheets
- BMP Summary worksheet
- Calculations sheet

Note: Required engineer inputs are denoted by cells highlighted in blue.

Site Data Worksheet

The Site Data Worksheet contains project information including but not limited to:

1. Engineer contact information
2. Site Location (regulatory watershed, geologic region)
    a. Used to determine target N and P Loads and BMP removal rates
3. Development Type (Residential/Nonresidential) and Zoning
    a. Development type is used to determine Target Curve Number (TCN) applicability and zoning assumptions
4. Precipitation Amounts
5. Residential SW Details for subdivisions
6. Stormwater Narrative
    a. Stormwater narrative should describe the site conditions pre and post development including a description of site improvements and proposed stormwater BMPs (number, type and purpose – volume, nutrient removal, peak flow, etc.)

DA1-6 Worksheets

DA worksheets are designed to account for project requirements per Wake County UDO standards as well as the Neuse, Falls Lake and Jordan Nutrient Strategies. All project information is entered by drainage area. The tool allows for up to six drainage areas for the project. See FAQs for projects with more than six drainage areas. **DA** worksheets calculate runoff, time of concentration, peak flow, and volume to be managed per drainage area (if applicable). Inputs are also used to calculate the site composite curve numbers for pre and post development and total nitrogen (TN) and phosphorus (TP) loading calculations by drainage area.

Notes and Assumptions for DA1-6 worksheets:

- Land uses are assigned curve numbers (CNs) adapted from TR-55 as well as Event Median Concentrations (EMCs) as defined by the *Jordan/Falls Lake Stormwater Nutrient Load Accounting Tool User Manual.*

- The following additional land uses have been added to comply with Wake County TCN requirements: Transportation-High Density (right-of-ways, grassed), Transportation-Low Density (right-of-ways, grassed) and Residential-Roadway (right-of-ways, grassed). Per NCDWR, these grassed areas have the same EMCs as "managed pervious" and are treated as pervious. The impervious portions of the roadways have differing CNs and EMCs.

- Offsite and site land uses are used to determine pre and post development runoff and peak flow. Site peak flow is calculated per drainage area to determine the need for a BMP. Post development peak flow exceeding more than 10% of the pre development is flagged for a BMP.

- Time of concentration (Tc) is calculated on this sheet but is also highlighted in blue signifying that the user may override the value. Supporting calculations must be provided if overridden.

- The Wake County tool uses the Discrete SCS Curve Number Method for runoff volume (the Simple Method is used for the loading calculations) and TR-55 Graphical Peak Discharge Method for Type II Distribution for peak flow.

- Peak flow and adjusted CNs are shown for both the site and for the DA. Site peak flow is used for BMP determination. DA peak flow is used to ensure compliance from pre development (i.e. post-BMP peak includes any offsite drainage to the BMP and must be less than the pre development peak flow.)

Site Summary Worksheet

SITE SUMMARY worksheet summarizes the pre and post runoff and peak flow per drainage area based on inputs from **DA1-6** worksheets. TCN and peak flow for pre and post development are also calculated and summarized. If the TCN is exceeded, this worksheet calculates total volume to be managed for the entire site based on TCN requirements.

Nutrient loading rates for the site are compiled and calculated from **DA1-6** worksheets. Target rates for nutrients are also summarized based on regulatory watershed.

Notes and Assumptions for SITE SUMMARY worksheet:

- There is only one engineer input on this sheet. Disconnected Impervious - this area will be used to provide an adjusted post development composite curve number ($CN_{adjusted}$) to allow a credit for the use of disconnected impervious per Wake County stormwater ordinance. See the Stormwater Credits section of this manual for addition details.

DA BMP Worksheets

DA BMP1-6 worksheets require engineers to input proposed BMP information. BMPs are characterized by sub-basins within the drainage area. Engineers input BMP sub-basin land uses, BMP device name, type, volume managed by device, and post-BMP peak flow.

Notes and Assumptions for DA BMP worksheets:

- Engineers shall input site land uses by sub-basin. Off-site drainage to the sub-basin is also required (if said drainage is routed through the BMP). Loading calculations are only based on site land uses/volume. Offsite values are used in addition to onsite values to calculate the required water quality volume (1" runoff). Consequently, while site loading is based on onsite land uses only, required BMP storage volume includes offsite drainage to obtain BMP removal credits.

- BMPs within a sub-basin are assumed to be in a series with the same drainage area. Engineers may specify if sub-basins contribute to other sub-basins within the drainage area.

- This tool does not calculate Post BMP peak flow. Post BMP discharge is marked as an engineer input on these sheets. Engineer shall provide corresponding calculations/documentation for the entered discharge.

BMP SUMMARY Worksheet

BMP SUMMARY worksheet summarizes the post development and post BMP runoff and peak flow per drainage area based on inputs from **DA BMP** worksheets. Nitrogen and Phosphorus loading for the site is calculated based on the results from **DA1-6 BMP** worksheets. Project compliance with the Wake County UDO, Falls Lake Nutrient Strategy, and/or the Jordan Lake Nutrient Strategy is presented on this sheet.

- There are no engineer inputs on this sheet.

CALCULATIONS Worksheet

All calculations and table references are included on this worksheet.

- There are no engineer inputs on this sheet.

8.0 FREQUENTLY ASKED QUESTIONS (FAQs)

Q. How are grassed ROWs treated differently in the Wake County tool?

A. Wake County's policy regarding the right-of-way areas includes an assumption of compaction of these areas. Therefore, the grassed portion of the right-of-way is assigned the curve number for open space in D soils (75) to account for this assumption of compaction.

However, the Jordan/Falls Tool does not allow for the differentiation of ROWs from the associated roadways. As a temporary fix to the Jordan/Falls tool, engineers that submit plans include the surface area of a proposed road under one of the transportation land uses and the grassed portion of the ROW as a "managed pervious" land use. This approach will be changed at a later date according to NCDENR as EMC values are determined for these areas. The Wake County tool does differentiate the grassed ROWs but assigns the "managed pervious" values for nutrient loading. Once EMC values are developed for grassed ROWs, the Wake County tool will be updated to reflect more accurate values.

Q. When placing BMPs in a series, how does the tool calculate total volume storage?

A. The goal of the curve number method is to release the runoff volume at a sufficiently slow rate so that it does not contribute to the peak discharge rate of the site or downstream erosion of stream banks. The storage of this volume is similar to the storage of the first flush volume for water quality purposes that is currently required by the Division of Water Quality for nutrient removal credits.

The assumption is that one device in a series is credited with the volume. The tool requires the user to input one figure as the storage volume for a sub drainage area, whether it is a single BMP or a series. If the applicant desires to justify crediting more than one device in a series, supporting information is required.

Q. My site has more than 6 drainage areas. How should that be handled?

A. For the purposes of demonstrating compliance with the peak flow requirement, an applicant should submit 2 tools in order to capture and characterize all the drainage areas. For volume and nutrient requirements, since they are determined by site, you may combine drainage areas that *are not* going to be treated by a BMP. Any drainage area that goes to a BMP should stand alone in the tool.

Q. Do I have to use the Wake County Hybrid Accounting Tool?

A. Wake County requires all applicants to use its tool since it has been approved by the Division of Water Quality and accounts for various county ordinance nuances. However, any applicant that has differing results or exceptions may submit supporting documents with the completed tool.

Q. What if my version of Excel is not 2010 or greater?

A. While Microsoft provides compatibility packs

(http://www.microsoft.com/en-us/download/details.aspx?id=3) to help bridge the different versions, it may not completely fix bugs that may occur with older versions. We encourage applicants to upgrade they software. If that is not an option, we can provide a kiosk at the Wake County Office Building on an appointment only basis.

Q. Do I need to use the Wake County Hybrid Accounting Tool for any single lot deviation?

A. No. Please refer to the Single Lot Deviation section of this manual for design and process guidance.

Q. Do projects in Wendell, Rolesville, & Zebulon jurisdictions have to now use the Wake County Hybrid Accounting Tool?

A. No. Applicants will continue to use the *Wake County Municipal Stormwater Design Tool* located on Wake County's website.

9.0 SINGLE LOT DEVELOPMENT (DEVIATION PROCESS)

9.1 Concept

The purpose of this manual is to provide guidance for the management of stormwater runoff from development in Wake County's jurisdiction. The Stormwater deviation process was developed to allow individual lot owners a means to increase impervious surface area on lots where allowable.

Impervious allotments can be a result of a recorded limit to comply with a number of State and local stormwater and or Watershed Water Supply Watershed rules. Each zoning district will have a maximum allowable impervious surface limit which ranges from 6% to 30%. (The limit may not always be recorded on the lot but implied from zoning districts.)

To qualify for the deviation process, the lot or subdivision must not have been recorded with a "perpetuity statement" (i.e. *Maximum Impervious area square footage on each Individual Lot will be stringently enforced with no exceptions into perpetuity*). Generally, subdivision lots recorded post 2006 have a perpetuity statement. Lots with a perpetuity statement are not allowed to deviate from the approved impervious limits on an individual lot basis. A quick check of the subject plat on the Wake County Register of Deeds will determine if the perpetuity statement applies.

If there is no perpetuity statement, individual lot stormwater management may be permitted by the installation of approved stormwater treatment device(s). All applications to deviate are reviewed by the stormwater staff (Watershed Managers). Applicants will supply (with the building permit) a to-scale plot plan showing the lot and existing and proposed impervious features (driveway, sidewalk, house, patios, porches, outbuildings, etc.). Watershed managers will contact the applicant to allow for plan revision or to initiate the deviation process.

A treatment volume will be calculated by the permit reviewer. Volume will be based upon capturing the 1- yr, 24-hr storm event (approximately 3") for projects in Wake County's jurisdiction and subject to the Neuse River Stormwater Rules and or any combination of other applicable stormwater requirements. Projects located in the Swift Creek Watershed must meet state stormwater rules and the *Swift Creek Land Management Plan*. See Appendix D for a copy of the *Swift Creek Land Management Plan* and a chart summarizing Swift Creek requirements.

Note: This guidance is meant for individual subdivision lot land owners with small drainage areas only. The Wake County Stormwater Tool and Municipal Stormwater tool are not to be utilized for Single lot stormwater submittals.

9.2 Single Lot Deviation Process

1. Submit building permit application and site plan. IDPP flags project for exceeding maximum impervious surface area (MISA), collects $50 fee for Stormwater Certification reviewand routes permit to the Watershed Manager responsible for the project
2. Watershed Mananger confirms MISA and proposed plan and sends a memo to owner with the requirements to deviate from the recorded MISA
3. The building permit is placed on H-hold pending receipt of deviation application
4. Submit deviation application, $400 stormwater permit fee and proposed stormwater management plan. See Submittal Requirements for details.
5. Watershed Manager reviews plan and provides comments or conditional approval letter with requirements for CO
6. Building permit CO is placed Z-hold pending receipt of final as built plan and maintenance documents.

No Certificate of Occupancy shall be issued until
Stormwater Management Plan is approved and implemented*

9.3 Submittal Requirements

A stormwater management plan is required before any building permits are issued. A final (as-built) site plan will be required prior to the issuance of a Certificate of Occupancy (CO). A good resource for a site plan is a survey issued for a recent mortgage or refinance closing. *An applicant may print plot plan from IMAPs to scale or go to Wake GIS Department.*

The Deviation process in Wake County is composed of the following:

- Site plan submittal
- Plan approval and building permit release
- Applicant notification of BMP construction

- As-built and other conditions of approval submittals
- As-built inspection by Watershed Manager
- Watershed Manager releases Z-hold (CO) on building permit

The stormwater management plan must include:

- Volume calculations of stormwater to be managed.

- Stormwater device plan and profile views detailing proposed elevations, slopes, vegetation, orifice sizing, weirs, and other elements that meet minimum device standards (see***).

- A site plan which includes the entire lot, drawn to scale, with the following:

    - Location, type and relevant dimensions and capacities of stormwater management structures and other devices

    - All existing and proposed impervious surfaces shall be clearly delineated and listed in sq. ft. and as a percentage of the total net lot size listed.

    - Delineate area of impervious surface to be directed to the stormwater device.

    - Show how the stormwater will reach device; pipe network or swale. Show discharge point from device to swale, rear of property, etc.

    - Lot lines with dimensions and road frontage delineated; existing or proposed driveways, parking spaces and walkways, with width and surface material described.

    - All existing and proposed buildings or other structures, with overall dimensions given and their setback(s) from nearest property lines clearly delineated.

    - Existing or proposed well, septic tank and drain field location(s) or sewer and water easements and proposed connection location(s).

    - All surface waters; FEMA 100-year flood fringe and floodway lines (or approximate 100-year flood line in unnumbered A Zones); flood hazard soils areas (adjust flood hazard soils to Wake County topography or field surveyed low points as appropriate); wetlands; reserved open spaces; the location, dimensions and arrangements of all drainageway, watershed, riparian, and other buffers and their associated required setbacks; the location of any existing or proposed easements (widths listed).

    - A title block indicating parcel identification number (PIN), north arrow and scale of the site plan, bar scale (for preliminary plans, indicate that it is a preliminary plan), name of Professional Land Surveyor, Landscape Architect, Professional Engineer, the landowner or his authorized agent's, signature, and for licensed professionals, seal of the person who prepared the plan, date map prepared (and any revision dates).

- For as-built final plans, indicate that it is an as-built plan and provide name of the Professional Land Surveyor who prepared the plan, his signature and seal and date map prepared (and any revision dates).

- If parcel is less than 5 acres, scales of 1" = 30', 40', 50', 60' or 100' are acceptable.

9.4 Example Single Lot Photos

Rain Barrels with Roof Drains

Raingarden (Bioretention)

APPENDIX A
Stormwater Forms

Presubmittal Meeting Request Form

Construction Plan Application

Stormwater Agreement Form

Wake County Stormwater Submittal Checklist

Wake County Standards Checklist

Falls Lake Standards Checklist

Jordan Lake Standards Checklist

As-Built Checklist

Final Plat Checklist

Stormwater Improvements Performance Guarantee Agreement

Release of Performance Guarantee

Deviation Application

Maintenance Agreement Examples

Bioretention

Cistern

Dry Detention

Dry Well

Grass Swale

Infiltration Device

Underground Detention

Wet Detention Pond

APPENDIX B

Table B-1 Wake County Hydrologic Soil Groups

MAP SYMBOL	SOIL SERIES & DESCRIPTION	HYDROLOGIC SOIL GROUPS (HSG)
AfB	Altavista fine sandy loam, 0 to 6 percent slopes, rarely flooded	C
AgB	Appling gravelly sandy loam, 2 to 6 percent slopes	B
AgB2	Appling gravelly sandy loam, 2 to 6 percent slopes, moderately eroded	B
AgC	Appling gravelly sandy loam, 6 to 10 percent slopes	B
AgC2	Appling gravelly sandy loam, 6 to 10 percent slopes, moderately eroded	B
ApB	Appling sandy loam, 2 to 6 percent slopes	B
ApB2	Appling sandy loam, 2 to 6 percent slopes, moderately eroded	B
ApC	Appling sandy loam, 6 to 10 percent slopes	B
ApC2	Appling sandy loam, 6 to 10 percent slopes, moderately eroded	B
ApD	Appling sandy loam, 10 to 15 percent slopes	B
AsB	Appling fine sandy loam, 2 to 6 percent slopes	B
AsB2	Appling fine sandy loam, 2 to 6 percent slopes, moderately eroded	B
AsC	Appling fine sandy loam, 6 to 10 percent slopes	B
AsC2	Appling fine sandy loam, 6 to 10 percent slopes, moderately eroded	B
AuA	Augusta fine sandy loam, 0 to 2 percent slopes, occasionally flooded	B/D
BuB	Buncombe loamy sand, 0 to 5 percent slopes, frequently flooded	A
CaB	Carbonton-Brickhaven complex, 2 to 6 percent slopes	D
CaC	Carbonton-Brickhaven complex, 6 to 10 percent slopes	D
CaD	Carbonton-Brickhaven complex, 10 to 15 percent slopes	D
CeB	Cecil sandy loam, 2 to 6 percent slopes	A
CeB2	Cecil sandy loam, 2 to 6 percent slopes, moderately eroded	B
CeC	Cecil sandy loam, 6 to 10 percent slopes	A
CeC2	Cecil sandy loam, 6 to 10 percent slopes, moderately eroded	B
CeD	Cecil sandy loam, 10 to 15 percent slopes	A
CgB	Cecil gravelly sandy loam, 2 to 6 percent slopes	B
CgB2	Cecil gravelly sandy loam, 2 to 6 percent slopes, moderately eroded	B
CgC	Cecil gravelly sandy loam, 6 to 10 percent slopes	B
CgC2	Cecil gravelly sandy loam, 6 to 10 percent slopes, moderately eroded	B
ClB3	Cecil clay loam, 2 to 6 percent slopes, severely eroded	B
ClC3	Cecil clay loam, 6 to 10 percent slopes, severely eroded	B
CmA	Chewacla sandy loam, 0 to 2 percent slopes, frequently flooded	B/D

MAP SYMBOL	SOIL SERIES & DESCRIPTION	HYDROLOGIC SOIL GROUPS (HSG)
CnA	Colfax sandy loam, 0 to 3 percent slopes	C/D
CoA	Congaree fine sandy loam, 0 to 2 percent slopes, frequently flooded	C
CpA	Congaree silt loam, 0 to 2 percent slopes, frequently flooded	C
CrB	Creedmoor sandy loam, 2 to 6 percent slopes	D
CrB2	Creedmoor sandy loam, 2 to 6 percent slopes, moderately eroded	D
CrC	Creedmoor sandy loam, 6 to 10 percent slopes	D
CrC2	Creedmoor sandy loam, 6 to 10 percent slopes, moderately eroded	D
CrE	Creedmoor sandy loam, 10 to 20 percent slopes	D
CtB	Creedmoor silt loam, 2 to 6 percent slopes	D
CtC	Creedmoor silt loam, 6 to 10 percent slopes	D
DuB	Durham loamy sand, 2 to 6 percent slopes	C
DuB2	Durham loamy sand, 2 to 6 percent slopes, moderately eroded	C
DuC	Durham loamy sand, 6 to 10 percent slopes	C
DuC2	Durham loamy sand, 6 to 10 percent slopes, moderately eroded	C
EnB	Enon fine sandy loam, 2 to 6 percent slopes	C
EnB2	Enon fine sandy loam, 2 to 6 percent slopes, moderately eroded	C
EnC	Enon fine sandy loam, 6 to 10 percent slopes	C
EnC2	Enon fine sandy loam, 6 to 10 percent slopes, moderately eroded	C
EnD2	Enon fine sandy loam, 10 to 15 percent slopes, moderately eroded	C
FaB	Faceville sandy loam, 2 to 6 percent slopes	B
FaB2	Faceville sandy loam, 2 to 6 percent slopes, moderately eroded	B
FaC2	Faceville sandy loam, 6 to 10 percent slopes, moderately eroded	B
GeB	Georgeville silt loam, 2 to 6 percent slopes	B
GeB2	Georgeville silt loam, 2 to 6 percent slopes, moderately eroded	B
GeC	Georgeville silt loam, 6 to 10 percent slopes	B
GeC2	Georgeville silt loam, 6 to 10 percent slopes, moderately eroded	B
GeD2	Georgeville silt loam, 10 to 15 percent slopes, moderately eroded	B
GoA	Goldsboro sandy loam, 0 to 2 percent slopes	B
GrB	Granville sandy loam, 2 to 6 percent slopes	B
GrB2	Granville sandy loam, 2 to 6 percent slopes, moderately eroded	B
GrC	Granville sandy loam, 6 to 10 percent slopes	B
GrC2	Granville sandy loam, 6 to 10 percent slopes, moderately	B

MAP SYMBOL	SOIL SERIES & DESCRIPTION	HYDROLOGIC SOIL GROUPS (HSG)
	eroded	
GrD	Granville sandy loam, 10 to 15 percent slopes	B
HeB	Helena sandy loam, 2 to 6 percent slopes	D
HeB2	Helena sandy loam, 2 to 6 percent slopes, moderately eroded	D
HeC	Helena sandy loam, 6 to 10 percent slopes	D
HeC2	Helena sandy loam, 6 to 10 percent slopes, moderately eroded	D
HeD	Helena sandy loam, 10 to 15 percent slopes	D
HrB	Herndon silt loam, 2 to 6 percent slopes	B
HrB2	Herndon silt loam, 2 to 6 percent slopes, moderately eroded	B
HrC	Herndon silt loam, 6 to 10 percent slopes	B
HrC2	Herndon silt loam, 6 to 10 percent slopes, moderately eroded	B
HrD2	Herndon silt loam, 10 to 15 percent slopes, moderately eroded	B
LdB2	Lloyd loam, 2 to 6 percent slopes, moderately eroded	B
LdC2	Lloyd loam, 6 to 10 percent slopes, moderately eroded	B
LdD2	Lloyd loam, 10 to 15 percent slopes, moderately eroded	B
LoB	Louisburg loamy sand, 2 to 6 percent slopes	B
LoC	Louisburg loamy sand, 6 to 10 percent slopes	B
LoD	Louisburg loamy sand, 10 to 15 percent slopes	A
LwB	Louisburg-Wedowee complex, 2 to 6 percent slopes	B
LwB2	Louisburg-Wedowee complex, 2 to 6 percent slopes, moderately eroded	B
LwC	Louisburg-Wedowee complex, 6 to 10 percent slopes	B
LwC2	Louisburg-Wedowee complex, 6 to 10 percent slopes, moderately eroded	B
LyA	Lynchburg sandy loam, 0 to 2 percent slopes	A/D
MdB2	Madison sandy loam, 2 to 6 percent slopes, moderately eroded	B
MdC2	Madison sandy loam, 6 to 10 percent slopes, moderately eroded	B
MdD2	Madison sandy loam, 10 to 15 percent slopes, moderately eroded	B
MdE2	Madison sandy loam, 15 to 25 percent slopes, moderately eroded	B
MeA	Mantachie sandy loam, 0 to 2 percent slopes, rarely flooded	B/D
MfB	Mayodan sandy loam, 2 to 6 percent slopes	B
MfB2	Mayodan sandy loam, 2 to 6 percent slopes, moderately eroded	B
MfC	Mayodan sandy loam, 6 to 10 percent slopes	B
MfC2	Mayodan sandy loam, 6 to 10 percent slopes, moderately eroded	B
MfD2	Mayodan sandy loam, 10 to 15 percent slopes, moderately	B

MAP SYMBOL	SOIL SERIES & DESCRIPTION	HYDROLOGIC SOIL GROUPS (HSG)
	eroded	
MfE	Mayodan sandy loam, 15 to 25 percent slopes	B
MgB	Mayodan gravelly sandy loam, 2 to 6 percent slopes	B
MgB2	Mayodan gravelly sandy loam, 2 to 6 percent slopes, moderately eroded	B
MgC	Mayodan gravelly sandy loam, 6 to 10 percent slopes	B
MgC2	Mayodan gravelly sandy loam, 6 to 10 percent slopes, moderately eroded	B
NaE	Nanford silt loam, 15 to 25 percent slopes	B
NoA	Norfolk loamy sand, 0 to 2 percent slopes	A
NoB	Norfolk loamy sand, 2 to 6 percent slopes	A
NoB2	Norfolk loamy sand, 2 to 6 percent slopes, moderately eroded	B
NoC	Norfolk loamy sand, 6 to 10 percent slopes	A
NoC2	Norfolk loamy sand, 6 to 10 percent slopes, moderately eroded	B
OrB	Orangeburg loamy sand, 2 to 6 percent slopes	A
OrB2	Orangeburg loamy sand, 2 to 6 percent slopes, moderately eroded	B
OrC2	Orangeburg loamy sand, 6 to 10 percent slopes, moderately eroded	B
PaF	Pacolet sandy loam, 15 to 45 percent slopes	B
PcE3	Pacolet clay loam, 10 to 20 percent slopes, severely eroded	B
PgF	Pacolet-Gullied land complex, 4 to 25 percent slopes	B
PkC	Pinkston sandy loam, 0 to 10 percent slopes	B
PkF	Pinkston sandy loam, 10 to 45 percent slopes	B
PsA	Plummer and Osier soils, 0 to 2 percent slopes	A/D
PtD3	Polkton-White Store complex, 2 to 15 percent slopes, severely eroded	D
RaA	Rains fine sandy loam, 0 to 2 percent slopes	B/D
RoA	Roanoke loam, 0 to 2 percent slopes, occasionally flooded	C/D
UdD	Udorthents loamy, 0 to 15 percent slopes	C
VaB	Vance sandy loam, 2 to 6 percent slopes	C
VaB2	Vance sandy loam, 2 to 6 percent slopes, moderately eroded	C
VaC2	Vance sandy loam, 6 to 10 percent slopes, moderately eroded	C
WaA	Wagram loamy sand, 0 to 2 percent slopes	B
WaB	Wagram loamy sand, 2 to 6 percent slopes	A
WaC	Wagram loamy sand, 6 to 10 percent slopes	A
WgA	Wagram-Troup sands, 0 to 4 percent slopes	B
WhA	Warne fine sandy loam, 0 to 2 percent slopes, occasionally flooded	C/D

MAP SYMBOL	SOIL SERIES & DESCRIPTION	HYDROLOGIC SOIL GROUPS (HSG)
WkC	Wake-Saw-Wedowee complex, 2 to 10 percent slopes, rocky	D
WkE	Wake-Wateree complex, 10 to 25 percent slopes, very rocky	D
WmB	Wedowee sandy loam, 2 to 6 percent slopes	B
WmB2	Wedowee sandy loam, 2 to 6 percent slopes, moderately eroded	B
WmC	Wedowee sandy loam, 6 to 10 percent slopes	B
WmC2	Wedowee sandy loam, 6 to 10 percent slopes, moderately eroded	B
WmD2	Wedowee sandy loam, 10 to 15 percent slopes, moderately eroded	B
WmE	Wedowee sandy loam, 15 to 25 percent slopes	B
WnA	Wehadkee silt loam, 0 to 2 percent slopes, frequently flooded	B/D
WoA	Wehadkee and Bibb soils, 0 to 2 percent slopes, frequently flooded	A/D
WpA	Wehadkee loam, 0 to 2 percent slopes, ponded	B/D
WsB	White Store sandy loam, 2 to 6 percent slopes	D
WsB2	White Store sandy loam, 2 to 6 percent slopes, moderately eroded	D
WsC	White Store sandy loam, 6 to 10 percent slopes	D
WsC2	White Store sandy loam, 6 to 10 percent slopes, moderately eroded	D
WsE	White Store sandy loam, 10 to 20 percent slopes	D
WtB	White Store silt loam, 2 to 6 percent slopes	D
WwC	Wilkes loam, 2 to 10 percent slopes	D
WwE	Wilkes loam, 10 to 20 percent slopes	D
WwF	Wilkes loam, 20 to 45 percent slopes	D
WxE	Wilkes cobbly loam, 15 to 25 percent slopes, very stony	D
WyA	Worsham sandy loam, 0 to 3 percent slopes	D

Note: Web Soil Survey(series info) http://websoilsurvey.nrcs.usda.gov/app/HomePage.htm

Table B-2 Wake County Proposed Development Curve Numbers

LAND USE	Curve Numbers by Hydrolic Soil Group			
	A	B	C	D
COMMERCIAL				
Parking lot	98	98	98	98
Roof	98	98	98	98
Open/Landscaped	39	61	74	80
INDUSTRIAL				
Parking lot	98	98	98	98
Roof	98	98	98	98
Open/Landscaped	39	61	74	80
TRANSPORTATION				
High Density (interstate, main)	98	98	98	98
High Density Grassed Right-of-ways	80	80	80	80
Low Density (secondary, feeder)	98	98	98	98
Low Density Grassed Right-of-ways	80	80	80	80
Rural	98	98	98	98
Rural Grassed Right-of-ways	80	80	80	80
Sidewalk	98	98	98	98
MISC. PERVIOUS				
Managed pervious (Open Space)	39	61	74	80
Unmanaged (pasture)	39	61	74	80
Woods	30	55	70	77
RESIDENTIAL				
Roadway	98	98	98	98
Grassed Right-of-ways	80	80	80	80
Driveway	98	98	98	98
Parking lot	98	98	98	98
Roof	98	98	98	98
Sidewalk	98	98	98	98
Lawn	39	61	74	80
Managed pervious (Open Space)	39	61	74	80
Woods	30	55	70	77
LAND TAKEN UP BY BMP	39	61	74	80
JURISDICTIONAL LANDS				
Natural wetland	30	55	70	77
Riparian buffer	39	61	74	80
Open water	0	0	0	0

Note: Wake County's policy regarding the right-of-way areas includes an assumption of compaction of these areas. Therefore, the grassed portion of the right-of-way is assigned the curve number for open space in D soils to account for this assumption of compaction.

APPENDIX C

NRCS Conservation Practice Standard, Tree/Shrub Establishment Code 612

NRCS Conservation Practice Standard, Mulching Code 484

APPENDIX D

Swift Creek Watershed Land Management Plan

Swift Creek Requirements