

Chapter 1

INTRODUCTION

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1.1 INTRODUCTION

This manual shall be used to assist in the design of stormwater infrastructure and to aide in regulatory compliance of development projects within the City of Raleigh (City) and its extraterritorial jurisdiction (ETJ). The audience for this manual is technical professionals, including:

- Designers associated with development projects
- Designers hired by the City for project design
- City staff conducting plan review or project management

This manual and its contents are fully incorporated into the City's Unified Development Ordinance (UDO) under UDO Sections [1.1.12](#) and [9.2.1.B](#) and 9.4.2, and all development activity shall be subject to these requirements. Unless otherwise stated, these requirements apply to all projects including development, redevelopment, and public projects.

1.2 LIMITATIONS

The manual provides a compilation of readily available literature ~~relevant regarding to~~ stormwater management ~~activities~~ in the Raleigh area. Although it is intended to establish uniform design practices, it ~~neither does not~~ replaces the need for sound ~~engineering professional~~ judgment, ~~nor precludes the use of information not presented~~. Because materials presented were obtained from numerous publications and have not been duplicated in their entirety, the applicant must obtain original or additional reference materials, as appropriate.

Any web links/URLs provided in this manual were current at the time of Manual completion. If the links have changed, documents and other resources may need to be searched by name.

1.3 CITY STORMWATER REGULATIONS

The City's stormwater plan review team reviews the requirements in the stormwater areas listed below and issues the associated permits.

~~With each regulatory section, the applicable qualified design professional has been added. This varies between requirements based on State and Federal laws in addition to the requirements of the UDO and this Manual.~~

1.3.1 Watercourse Buffers

Watercourse buffers, also known as riparian buffers, help protect water quality. These buffer rules protect vegetated areas adjacent to intermittent and perennial streams, lakes, reservoirs, ponds, estuaries, and modified natural streams. The Neuse buffer rules specifically protect buffers for their nutrient removal abilities. All areas of the City may require buffers associated with the Neuse River Basin. Areas within a watershed protection and other overlay districts may have additional buffer requirements.

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
9.2.3. Watercourse Buffers	NA	Watercourse Buffer (WCB)

Design Professional: NA

Permit Information:

Watercourse Buffer permits are issued for all projects that have a regulated watercourse buffer on site per UDO Section 9.2.3.E. If the project falls in a watershed overlay district with watercourse buffer requirements (Falls, Swift Creek, and Urban Watershed Protection Overlay Protection Districts, Conservation Management Districts, and the Metro-Park Overlay District), buffers apply to all watercourses, not only those that may appear on the USGS 7.5 Minute Quadrangle Map or published Wake or Durham County Soil Survey Map.

Watercourse Buffer permits are also issued for projects sites that have streams or waterbodies subject to the Neuse River Riparian buffer rules. If streams depicted on the USGS 7.5-Minute Quadrangle Map or published Wake or Durham County Soil Survey Map have had a stream/buffer determination from NCDEQ, include the determination and applicable map in an appendix of the Stormwater Compliance Report (SCR), which is described in Chapter 2.

If stream buffer impacts are proposed, the following information must be submitted to the City based on the designation in the Table of Uses in the [Neuse Buffer Rules \(15A NCAC 02B .0714\)](#):

- If Deemed Allowable impacts are proposed, provide a narrative listing the applicable section of the Table of Uses and provide any relevant-associated data such as impact width or area.
- If Allowable Upon Authorization impacts are proposed, provide the application to NCDEQ – including maps – and the approval letter from NCDEQ.

Underlying Regulations:

- North Carolina (NC) [Neuse Buffer Rules \(15A NCAC 02B .0714\)](#)
- NC Water Supply Watershed Regulations 15A NCAC 02B .0624

- [Falls Lake Nutrient Strategy 15A NCAC 02B .0277](#)

Required Reference Material:

- NC Neuse Buffer Rules ([15A NCAC 02B .0714](#)), including the Table of Uses
- [NCDEQ Resources for Stream Identification, Buffer Authorization, Buffer Variance](#)
- USGS Maps, in one of the following formats:
 - [United States Geological Survey \(USGS\) 7.5-Minute Quadrangle Maps](#)
 - [National Map Viewer](#)
- The digital version of the last paper copy of the NRCS Soil Survey maps including the Wake County 1970 maps and Durham County 1976 maps. The paper copies depict streams, which are not depicted on the current digital maps (Web Soil Survey). Streams on these maps are used for surface water and buffer identification purposes.
 - <https://www.nrcs.usda.gov/conservation-basics/natural-resource-concerns/soil/soil-surveys-by-state>
 - <https://archive.org/details/usda-soil-surveys>
- Both the USGS 7.5-Minute Quadrangle maps and the last paper copy of the NRCS Soil Survey maps are currently available on a NCDEQ Map Viewer:
 - [NCDEQ Map Viewer for USGS and Soil Maps](#)

1.3.2 Stormwater Conveyance System

Stormwater Conveyance infrastructure includes pipes, inlets, junctions, swales, roadway gutters, culverts, and bridges. Requirements are related to both hydraulic design and to materials. Information regarding as-built and ~~inspection closed-circuit television (CCTV)~~ submittals ~~is~~ are also in Chapter 4 of this Manual.

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
NA	Chapter 4 Stormwater Conveyance Design Chapter 3 Hydrology Chapter 7 Easements	Stormwater Conveyance (SCON)

Design Professionals:

- Conveyance design in general: Qualified, registered professional engineers in NC and registered landscape architects in NC, as allowed by law

- Inspection certification in Section 4.8: Qualified, registered professional engineers in NC

Permit Information:

A Stormwater Conveyance Permit is required for the construction, reconstruction, replacement, extension, renovation, alteration, demolition or abandonment of, replaced, stormwater conveyance systems that are specified in Section 4.8.1 of this Manual. A Stormwater Conveyance System Permit is required for the construction, reconstruction, replacement, extension, renovation, alteration, demolition or abandonment of, replaced, stormwater conveyance systems that meet at least one of the following:

- ~~Is located in the public right-of-way.~~
- ~~Is located on public or private property and is greater than or equal to 12 inches in diameter.~~
- ~~Is located on public or private property and conveys public runoff.~~

Any project requiring a Stormwater Conveyance System Permit will be required to submit an electronic file of the approved stormwater conveyance system in a format specified in the plan review checklist and prior to permit issuance. Stormwater conveyance systems also require GGTV inspection and as-built certification submittal to and acceptance by the Stormwater Division in the City of Raleigh's Engineering Services Department (Raleigh Stormwater) prior to final inspection approval and Certificate of Occupancy issuance.

Underlying Regulations:

- For NCDOT roads, NCDOT standards must be met.
- For City Roads and other areas in the City and ETJ, this Manual contains the requirements.

Required References:

- [City of Raleigh Standard Detail Drawings](#)
- NCDOT Standard Details – most recent version
- AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specification, Section 12 ASCE 15-17 "Standard Practice for Direct Design of Buried Precast Concrete Pipe using Standard Installations (SIDD)" 2017.
- NCDOT "Guidelines for Drainage Studies and Hydraulic Design" - most recent version
- FHWA "Hydraulic Design of Highway Culverts", "Hydraulic Design of Energy Dissipators for Culverts and Channels" & "Hydraulic Design of Safe Bridges"
- HEC-22 Urban Drainage Design Manual

- ASTM C76, C1479, C1628, C507, F2881, F477, D3212, & D2321
- AASHTO M330 & M294
- NCDEQ “Erosion and Sediment Control Planning and Design Manual”
- NASSCO “Pipeline Assessment and Certification Program”

1.3.3 Stormwater Management

Also referred to as post-construction stormwater management, stormwater management ~~considers~~includes compliance with regulations for water quality (nutrients) and runoff rate (peak discharge). This includes design requirements for traditional stormwater control measures (SCMs) and green stormwater infrastructure (GSI).

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
9.2.2. Active Stormwater Control Measures	Chapter 5 Stormwater Management Calculations Chapter 6 SCM Design Chapter 3 Hydrology Chapter 7 Easements	Stormwater Control (SC) Stormwater Control 2 (SC2)

Design Professionals: Qualified registered North Carolina professional engineer, surveyor, soil scientist or landscape architect, as detailed in UDO Section 9.2.2.A.D.1.a

Permit Information:

Stormwater control permits are issued for properties that are increasing or substituting impervious area per UDO Section 9.2.2.C. Properties fall into two categories of requirements:

- **Exempt Property Requirements:** UDO Section 9.2.2.A provides exemptions for some properties that, dependent on age, size, or use, do not have to comply with the full Active Stormwater Control Measure rules contained in UDO Sections 9.2.2 B through H. Instead, those properties are to comply with~~can meet~~ the impervious surface limitations defined in 9.2.2.A. However, These impervious surface limitations may be exceeded by (a) choosing to comply with the Full Stormwater Requirements or (b) the methods described in UDO Section 9.2.2.A.4.b. with constructed stormwater controls or ~~engineering studies prepared by a qualified licensed professional as described in the~~

~~UDO and in Chapter 5.~~

- **Traditional-Full Stormwater Requirements:** UDO [Sections](#) 9.2.2.B through H requires full stormwater calculations prepared by a qualified licensed professional [as described in UDO Section 9.2.2.D.1.a.](#). These rules address water quality (UDO [Section](#) 9.2.2.B Nitrogen Reduction) and runoff control (UDO [Section](#) 9.2.2.E Stormwater Runoff Controls). Typically, ~~at~~ the development constructs one or more stormwater control measure (SCM) to meet those requirements. Calculations are documented in the SCR.

Underlying Regulations:

- [City of Raleigh](#) NPDES MS4 Permit
- NC Neuse Nutrient Strategy Rules- [15A NCAC 02B .0711](#)
- North Carolina Department of Environmental Quality (NC DEQ) Stormwater Minimum Design Criteria (MDC)
- Local requirements related to localized flooding as stated in the UDO and this Manual.

Required Reference Material:

- [NCDEQ Stormwater Design Manual - Required reference for SCM Design](#)
- [NCDEQ Stormwater Control Measure Credit Document - Needed reference to determine if a SCM is considered a Primary SCM.](#)
- [NCDEQ SNAP Tool - Required tool for Nutrient Calculations.](#)
- [City of Raleigh Standard Detail Drawings - Optional Details for SCMs.](#)

1.3.4 Erosion and Sediment Control (ESC)

ESC requirements protect the environment and property from erosion and sediment runoff during active construction. The temporary control devices are removed once the site is stabilized.

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
9.4 Erosion and Sediment Control	Chapter 8 Erosion and Sediment Control Chapter 3 Hydrology	Land Disturbance – Grading (LDG)

Design Professionals: Qualified registered North Carolina professional engineer, surveyor, soil scientist or landscape architect performing in their area of competence.

Permit Information:

Land Disturbance Grading permits are required for all projects that disturb 12,000 square feet (0.275 acres) or more of land area per UDO Section 9.4.6.-

Underlying Regulations:

- NC Sedimentation Pollution Control Act of 1973
- City of Raleigh NPDES MS4 Permit

Required Reference Material:

- NCDEQ Erosion and Sediment Control Planning and Design Manual

1.3.5 Floodplain Management

The City requires management of floodplains delineated by FEMA mapping and local requirements to delineate floodplains upstream of the FEMA mapping limits.

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
9.3 Special Flood Hazard Area Regulations	Chapter 9 Floodplains Chapter 3 Hydrology Chapter 7 Easements	Floodplain (FL): FL (FEMA) FL (non-FEMA)

Design Professionals: Some requirements in UDO Article 9.3 and Chapter 9 of this Manual must be signed and sealed by the qualified, registered North Carolina professional engineer.

Permit information:

Flood permits are required for all development activities conducted on a property that contains floodplain, as defined in the UDO- Section 9.3.2 and this Manual.

Underlying Regulations:

- Federal Emergency Management Agency (FEMA) Floodplain Regulations
- Local requirements, as stated in the UDO and this Manual, that extend floodplain protections upstream of the limits studied by FEMA.
-

Required Reference Material:

- FEMA Floodplain delineations

- [North Carolina Flood Risk Information System](#)
- Flood Hazard Soils
 - The last paper copy of the NRCS Soil Survey maps including the Wake County 1970 maps and Durham County 1976 maps, which may be found on the [USDA Natural Resources Conservation Service](#) website and [USDA NRCS archive](#).
- [FEMA Technical Bulletins](#)

1.3.6 Water Supply Watersheds and Metro-Park Overlay District

Water Supply Watershed Protection Overlay Districts and the Metro-Park Overlay District are in place to ensure the availability of public water supplies at a safe level of water quality for residents of the City and surrounding areas.

UDO Section(s)	Design Manual Chapter(s)	Permit(s)
9.5. Watershed Protection Areas	Chapter 5 Stormwater Management Calculation Chapter 6 SCM Design Chapter 3 Hydrology Chapter 7 Easements	Water Supply Watershed (WSWP)

Design Professionals: When stormwater management calculations or SCM design is required, a qualified registered North Carolina professional engineer, surveyor, soil scientist or landscape architect, as detailed in UDO Section 9.2.2.A.D.1.a

Permit Information:

Watershed permits are issued for projects within the following regulated overlay districts:

- [Urban Watershed Protection Overlay District](#)
- [Falls Watershed Protection Overlay District](#)
- [Swift Creek Watershed Protection Overlay District](#).

Underlying Regulations:

- NC Water Supply Watershed Regulations [15A NCAC 02B .0624](#)
- [Falls Lake Nutrient Strategy 15A NCAC 02B .0277](#)
- Swift Creek Land Management Plan [Inter-Local Agreement](#)

Required Reference Material:

See the 1.3.1 Watercourse Buffers and 1.3.3 Stormwater Management ~~for the~~ required reference materials.

1.4 State and Federal Regulations

It is the responsibility of the applicant to be fully aware of all applicable ~~f~~Federal and ~~S~~State government laws and regulations. The City has the delegated authority for review of some State and Federal regulations. Those are as follows:

- NC Water Supply Watershed Regulations 15A NCAC 02B .0624
- City of Raleigh NPDES MS4 Permit
- Falls Lake Nutrient Strategy 15A NCAC 02B .0277
- NC Neuse Nutrient Strategy Rules- 15A NCAC 02B .0711
- NC Sedimentation Pollution Control Act of 1973
- Federal Emergency Management Agency (FEMA) Floodplain Regulations

The following regulations are not directly implemented by the City. Applicants must apply for permits directly with the applicable State and/or Federal agency. The City will request confirmation that applicable permits or authorizations have been obtained.

- NC Neuse Buffer Rules (15A NCAC 02B .0714) Neuse Buffer Rules (15A NCAC 02B .0714)
- Federal Clean Water Act Sections 4041 & 4044 for temporary and permanent impacts to streams, wetlands and waterways, which includes:
 - 401 Water Quality Certifications (WQC) by NCDEQ
 - 404 Permits from the US Army Corps of Engineers (USACE)
- NC State Dam Safety Regulations

The information above is not intended to be a comprehensive list of required permitting. It is the applicant's responsibility to obtain necessary permits.

1.5 SUBMITTAL REQUIREMENTS

Project submittal requirements are stated throughout the mManual. Designers are responsible for thorough review and adherence to all applicable Mmanual and UDO requirements. The City has development checklists as an additional resource for ensuring compliance with all applicable requirements; checklists are available on the City's Stormwater website.

1.6 ABBREVIATIONS

The following abbreviations are used frequently in this document:

AASHTO	American Association of Highway and Transportation Officials
ASTM	American Society for Testing and Materials
BFE	Base Flood Elevation
BUA	Built Upon Area
CCTV	Closed-circuit television
EPA	Environmental Protection Agency
ESC	Erosion and Sediment Control
FEMA	Federal Emergency Management Administration
NFIP	National Flood Insurance Program
FHWA	Federal Highway Administration
FRO	Financially Responsibility/Ownership Form
GIS	Geographic Information System
GSI	Green Stormwater Infrastructure
HDPE	High-density polyethylene
HGL	Hydraulic Grade Line
LGP	Lot Grading Plan (City-specific)
LOD	Limits of Disturbance
LOMR	Letter of Map Revision
MDC	Minimum Design Criteria
MS4	Municipal Separate Storm Sewer System
<u>NC</u>	<u>North Carolina</u>
NCAC	North Carolina Administrative Code
NCDEQ	North Carolina Department of Environmental Quality
NCDOT	North Carolina Department of Transportation
NCFMP	North Carolina Floodplain Mapping Program
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PP	Polypropylene
PVC	Polyvinyl Chloride
RFPE	Regulatory Flood Protection Elevation
ROW	<u>Public Street</u> Right-of-Way
RCP	Reinforced Concrete Pipe
SCM	Stormwater Control Measure
SCR	Stormwater Compliance Report (City-specific)
SFHA	Special Flood Hazard Area
<u>SNAP</u>	<u>Stormwater Nitrogen and Phosphorus, a tool from NCDEQ</u>
<u>TN</u>	<u>Total Nitrogen</u>
UDO	Unified Development Ordinance

USACE	United States Army Corps of Engineers
WSEL	Water Surface Elevation
WSWP	Water Supply Watershed Program
WQv	Water Quality Volume

1.8 DEFINITIONS

Applicant

The Owner or Owner's Representative submitting required materials to the City for review and potential approval.

Built Upon Area (BUA)

Defined in [UDO 9.2.1.F](#).

City Standards

Requirements for design, construction, and maintenance of stormwater infrastructure. These standards include the City Stormwater Management Design Manual, [the Raleigh City Code](#), including its [UDO](#) and all [City standard details](#).

Culvert

A structure that conveys any flow collected in an open-ended pipe and can be utilized as a cross-drain.

Freeboard

An additional depth (added to the top of a basin, pond, ditch, dam or roadway embankment, etc.) regarded as a safety factor, above the peak design storm water surface elevation.

Frequency

The average time interval between equal magnitude storm events. For example, a 25-year storm event has the probability of being equaled or exceeded once every 25 years, or a 4% chance of being equaled or exceeded in any given year.

Green Stormwater Infrastructure (GSI)

Defined in [UDO Section 12.2](#).

Gutter

A depression along the edge of the roadway, attached to the inside part of the curb, used to convey stormwater runoff, typically directing it to a curb opening inlet.

Hydraulic Grade Line (HGL)

In open-channel flow, the HGL is equal to the water surface elevation in the channel or partially full pipe. In pressure flow (full-pipe flow), the HGL denotes the level water will rise to if

unconstrained.

Hydrograph

A graph of runoff over time for a given storm and watershed.

Impervious Surface

Defined in [UDO Section 12.2](#).

Infiltration

A complex process of allowing runoff to penetrate the ground and flow through the upper or lower soil surface.

Invert

The lowest point inside of a pipe, channel, or structure.

Limits of Disturbance (LOD)

See Chapter 8, Section 8.2.

Lot Grading Plan (LGP)

See Chapter 2.

Peak Discharge

The maximum rate of flow for water passing a given point during or after a rainfall event. Also referred to as peak flow.

Person

Any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, interstate body or other legal entity.

Post-Development

The condition of a property following any development activity.

Pre-Development

The existing condition of a property before development occurs.

Runoff

The portion of rainfall that is not part of the initial abstraction (evaporation, infiltration, surface depression storage).

Spread

The width of flow measured perpendicularly from the roadway pavement edge or the face of

curb towards the center of the roadway.

Stage

The elevation of the water surface above a given elevation datum.

Stormwater Compliance Report (SCR)

See Chapter 2.

Time of Concentration (Tc)

The time required for water to flow from the most hydraulically remote point of the watershed to the location being analyzed. Thus, the time of concentration is the maximum time for water to travel through the watershed, which is not always the maximum distance from the outlet to any point in the watershed.

Unified Development Ordinance (UDO)

Part of the Raleigh City Code document that contains most local regulations- applicable to the city limits of the City of Raleigh and its extra-territorial jurisdiction concerning the use and development of land and buildings, including zoning, subdivision, stormwater, and natural resource conservation.

Water Quality Volume (WQv)

The design volume for a nutrient treatment SCM as defined by NCDEQ in General MDC 1.

Chapter 2

SITE DEVELOPMENT REQUIREMENTS

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FOR REVIEW ONLY

2.1 LOT GRADING PLAN (LGP)

A Lot Grading Plan (LGP) is required as detailed in Section 2.1.1. below. It addresses possible off-site stormwater impacts for projects that are not subject to the Full Stormwater Requirements (UDO Section 9.2.2.B through H). ~~It serves as a visual summary of drainage information related to a development.~~ The LGP ~~will be~~ required at site or building permit review, whichever comes first.

~~Preparation of the LGP requires familiarity with this Manual, particularly the following chapters:~~

- ~~• Chapter 4 – Stormwater Conveyance Design~~
- ~~• Chapter 7 – Easements~~

2.1.1 LGP Applicability

An LGP is required for development projects that meet the following are adding impervious area or performing grading or changing how flow leaves the property, and meet one of the following criteria:

:

- ~~• Under Less than or equal to 1 acre (one and two unit detached residential) or~~
- ~~• or under Less than or equal to 0.5 acre (all other development types) or~~
- ~~• Over 1 acre (one and two unit detached residential) with impervious area of 5% or less.~~

AND

- ~~• Adding impervious area or performing grading or changing how flow leaves the property.~~

LGP are not required for the following situations:

- Interior-only projects
- Deck-only projects
- Projects that do not increase impervious area, do not conduct grading, and do not change how flow leaves the property.
- Projects subject to the ~~traditional Full~~ Full Stormwater ~~R~~ requirements in UDO 9.2.2.B through H ~~and include grading and drainage plans.~~

Note that there may be ~~other requirements for a~~ other requirements for a plot plan, as defined by Planning and Development, requirements even in situations where an LGP is not required.

2.1.2 LGP Design Requirements

2.1.2.1 Concentrated Flow

For the purposes of the LGP, concentrated flow means flow that has been combined into a channel, pipe, or downspout. Flow being concentrated with the development project must address the potential impacts in one of the following ways:

- A. Quantify the impervious area draining to the concentrated flow point and demonstrate that it is less than 800 square feet of impervious area.
- B. Discharge flow from up to 19,000 square feet of impervious area into the ROW. This meets the 3 cfs limit in Section 4.2.7 of this Manual.
- C. Demonstrate that the flow can be redistributed by meeting the following criteria:
 - a. Discharge to a vegetated receiving area on the parcel that is a minimum of 10 feet in length or 0.04 times the drainage area, whichever is greater.
 - b. The vegetated receiving area shall have a slope of 8% or less and shall be planted with a non-clumping, deep-rooted grass species.
- D. Construct dry wells for piped flow, sizing based on the following chart or formula:

Roof Square Footage	Dry Well Size (length x width x depth in feet)
100	3 x 3 x 3.5
200	4 x 4 x 3.5
400	6 x 6 x 3.5
500	6 x 6 x 4
1000	9 x 9 x 4

Commented [HS1]: Based on the NCDEQ MDC for Disconnected Impervious Surface.

Commented [HS2]: Taken from Montgomery County, Maryland which is also in the Piedmont and has similar rainfall.

Commented [HS3R2]: <https://montgomerycountymd.gov/DEP/Resources/Files/downloads/rainscapes/factsheets/drywells.pdf>

Minimum Volume of Dry Well (cubic feet) = 0.3 x Impervious Area (square feet)

- E. Tie-into a stormwater conveyance system on adjacent property. Obtain a private drainage easement from the downstream property owner, as presented in Section 7.2 of this Manual. Provide calculations that demonstrate the downstream system has capacity per Chapter 4 of this Manual.

2.1.2.2 Impervious Limits

A. Determining Impervious Limits

The impervious limits for the site may be based on UDO Section 9.2.2.A, on limits established on recorded maps, or on watershed overlays. Contact stormwater.impervious@raleighnc.gov for assistance determining the limit for a specific property.

B. Exceeding impervious limits

Whether a site may exceed the impervious limit is based on the underlying regulations.

- For sites with impervious limits based on UDO Section 9.2.2.A, the methods for

exceeding the limits are given in UDO Section 9.2.2.A.4.b.

- o For the method in UDO Section 9.2.2.A.4.b.i, the calculations shall be based on the Volume Reduction method in Chapter 5 of this Manual.
- o For the method in UDO Section 9.2.2.A.4.b.ii., the calculations shall be based on Section 5.2 of this Manual, Rate of Runoff Control Requirements.
- For sites with impervious limits established by a previous subdivision plan, increasing the impervious limit will require modifying the subdivision-wide plan.
- For sites with impervious limits based on a watershed overlay, available methods are listed in UDO Section 9.5.

Commented [HS4]: As identified in the list of changes from September 2023, we intend to change UDO Section 9.2.2.A.4.b.ii. To pre- v. post- discharge calculations for the 2 and 10 year storm.

2.1.2.3 Other Requirements

- A. No flooding or impounding of water against an insurable structure shall be permitted during the 100-year storm event, except for properly floodproofed non-residential structures.
- B. Proposed reverse slope driveways must identify the flow route for the driveway runoff. Flow shall not pond against the building structure in the 10-year storm.

2.1.22.1.3 LGP Submittal Requirements

Lot grading plans shall contain the following information at minimum. These requirements are in addition to the Planning and Development requirements for a site plan.:-

- Existing and Proposed Topography at a minimum of 2-foot intervals
- ~~Flow patterns represented by arrows~~
- ~~Arrows showing where flow leaves the lot~~
- Top and bottom elevations for proposed retaining walls
- First floor elevation for every ~~building primary structure and accessory dwelling unit~~
- Existing and proposed stormwater conveyance system infrastructure
- Proposed downspout flow directions.
- ~~connections to the existing or proposed storm drain system~~
- ~~Proposed downspout flow path when discharging within 10 feet of the property line.~~
- Swale typical cross-sections
- Adjacent street and sidewalk elevation(s)
- Locations of proposed septic tank(s) and drainfield(s)

- Location of porches, decks, swimming pools, AC pads, doorways, sheds, and other accessory structures
- Easements (existing and proposed) ~~and building setbacks (per Stormwater Management Design Manual, Chapter 2, Section 2.9)~~
- Limits of disturbance
- Existing environmental features, including: Special Flood Hazard Areas, Wetlands, Streams, Watercourse Buffers

After ~~a~~ LGP has been submitted and approved, any changes to the proposed development that ~~may impact the lot grading and/or stormwater flow patterns~~ change the method of compliance with Section 2.1.2 above will require ~~a new LGP submittal for review and approval~~ revision to the approved plans.

~~2.1.3 LGP Design Considerations and Requirements~~

~~Below are the considerations and requirements that shall be taken into account during design of the LGP for both single lot and multi lot development:~~

- ~~When placing fill on a single lot development, existing flow patterns and concentrated stormwater discharge locations shall be maintained to the maximum extent practical. When Where that is not possible and new concentrated flow discharge locations are created, the lot shall drain to an available drainage swale or system (with appropriate easement). Calculations shall be submitted to demonstrate adequate conveyance capacity of the swale or system. When existing swales are not available, a swale may be placed entirely on the applicant's property or along the property line of the adjacent property with the impacted property owner(s); approval and easement recordation, as appropriate.~~
- ~~No flooding or impounding of water against an insurable structure shall be permitted during the 100-year storm event, except for properly floodproofed non-residential structures.~~
- ~~When roof drains are proposed as surface drainage, provisions shall be included to discharge roof drain flows away from the building foundation and to control erosion at the discharge point.~~
- ~~Reverse slope driveways without associated engineered drainage design will not be allowed as they would likely fail to drain during major rainfall events.~~
- ~~Any downspouts or other concentrated discharge shall be offset a minimum of 10 feet from at the property line by a minimum of 10 feet (or at the building setback line, whichever is less), a public street City right-of-way (ROW), or public/private drainage easement.~~

Commented [H55]: Moved to 2.1.2.3

- ~~If newly concentrated stormwater discharge locations are created by the proposed development, then stormwater flows from these new discharge locations shall be conveyed through an offsite private drainage easement as detailed in Chapter 7 of this Manual.~~

2.2 STORMWATER COMPLIANCE REPORT (SCR)

Prior to the approval of any preliminary or permitting submittal (whichever comes first), the applicant shall submit a Stormwater Compliance Report (SCR) that complies with the requirements set forth in the UDO and this Manual.

The list below provides an overview of the SCR format. Additional detailed requirements are contained in the ~~applicable relevant~~ chapters of this ~~Manual~~ document.

2.2.1 SCR Applicability

A SCR, with applicable sections, is required for ~~development~~ projects that meet any one of the following:

- ~~Greater than~~ Larger 1 acre (one and two unit detached residential) or more than 0.5 acre (all other development types).
- ~~Under~~ Less than or equal to 1 acre (one and two unit detached residential) or under 0.5 acre or less (all other development types) AND ~~changing how flow leaves the property~~ OR seeking to exceed established impervious surface limits.
- Located in a Watershed Protection Overlay or Metro Park Overlay.
- Requiring a flood study per Chapter 9 of this Manual.
- If a stormwater conveyance system, as defined in Chapter 4 of this Manual is installed, replaced, or hydraulically altered as part of the development project.

2.2.2 SCR Components

A completed package, sealed by a North Carolina licensed design professional, shall be provided with each plan or permit submittal. The report shall contain a main body (narrative) and appendices.

- Cover** – The cover of the report shall contain the project name, the package revision date, and the case number (~~one known once provided by Planning and Development~~). It shall be signed and sealed by a North Carolina licensed design professional.
- Project Data** – The following project data shall be provided at the beginning of the SCR:
 - A map fitting on 8.5" x 11" paper showing project area, aligning with parcel boundaries, so that it is clear ~~what~~ the area is covered by the SCR

b. The following information, in a table format as shown on the City's website (~~Table will be added to website before final Manual version~~):

- i. Floodplain – Presence, Type, Impacts
- ii. Neuse Buffers – Presence, Impacts
- iii. Streams – Presence, Impacts
- iv. Wetlands – Presence, Impacts
- v. Watershed Protection Overlay – Presence, Compliance Method
- vi. Active Stormwater Controls -
 1. Subject to Exempt Property Requirements (UDO 9.2.2.A) OR ~~Traditional Full~~ Stormwater Requirements (UDO 9.2.2.B to H) OR Exempt per (specify Code section within 9.2.2.A.3)
 2. Meeting Existing Impervious Allocation
 3. Will stormwater compliance be on a lot-by-lot basis (only allowed when all lots > 1ac) or shared between multiple lots
 4. ~~Traditional Full~~ Stormwater Requirements (UDO 9.2.2.B to H) Nitrogen Rules Calculation Method – SNAP or Runoff Volume Match
- vii. Documented Downstream Structural Flooding
- viii. Rezoning Conditions
- ix. Site Use – Previous and Proposed
- x. Zoning

3. Streams, Wetlands and Buffers –

a. Any streams subject to the Neuse River riparian buffer rules on the property must be shown on the plans. If there are streams depicted on the USGS 7.5-Minute Quadrangle Map or published NRCS Wake or Durham County Soil Survey Map, that have had a stream/buffer determination from NCDEQ, include the determination and applicable map in an appendix of the SCR.

b. If stream buffer impacts are proposed, include the applicable information in the SCR based on the [Neuse Buffer Rules \(15A NCAC 02B .0714\)](#):

- i. If Deemed Allowable impacts are proposed, provide a narrative listing the applicable section(s) of the ~~the~~ Table of Uses and provide ing any relevant associated data such as impact width or area.
- ii. If Allowable Upon Authorization impacts are proposed, provide a copy of

the application to NCDEQ – including maps – and a copy of the approval letter from NCDEQ with impact map in an appendix.

- iii. If Mitigation is required, provide documentation that the mitigation requirements have been completed in an appendix.
- c. If jurisdictional wetlands and streams are present, provide ~~the~~ the jurisdictional determination from the ~~US Army Corps of Engineers (USACE)~~ in an appendix ~~to~~of the SCR.
- d. If impacts to jurisdictional wetlands and streams are proposed, provide the ~~relevant~~the following documents in the SCR, including:
 - i. ~~Approval of~~ 401 Water Quality Certification from NCDEQ with impact map.
 - ii. Approval by the USACE or documentation that a Nationwide Permit applies.
 - iii. If a Nationwide Permit applies, list the permit number and name and provide an active web link to the document.
 - iv. Include copies of the submitted pre-construction notification application (PCN) and associated maps providing the wetland and stream reference labels. Also include copies of any revised submittals to NCDEQ or USACE.
- e. If the project falls within a watershed overlay district with watercourse buffer requirements (Falls, Swift Creek, and Urban Watershed Protection Overlay Protection Districts, Conservation Management Districts, and the Metro-Park Overlay District), indicate the buffer width(s) that apply to the project. Note that these buffers apply to all watercourses, not only those that may appear on the USGS 7.5-Minute Quadrangle Map or published Wake or Durham County Soil Survey Map. For disturbance of any city-regulated riparian buffer, documentation of how the buffer disturbance complies with UDO Section 9.2.3 must be provided.
- f. The narrative shall explain how **diffuse flow**, if applicable, is being maintained for stormwater discharge from the proposed project into a riparian or watercourse buffer.

4. Drainage Design

- i. Methodology - A thorough description of all methodologies, procedures and data sources used in the calculations shall be included in the narrative, as well as a detailed record of all assumptions.
- ii. See Chapter 4 of this Manual for additional requirements.
- iii. —

5. Active Stormwater Controls

- a. **Exemptions based on UDO Section 9.2.2.A**
- i. State any Applicable impervious limitations with reference to UDO Section 9.2.2.A, as detailed in-
 - ii. State any other exemption being claimed with reference to UDO Section 9.2.2.A.
- b. **Meeting Existing Impervious Allocation** - The following shall be provided in the main body of the report.
- i. State the source of the allocation, including the case number (assigned by Planning and Development) that established the limit and the applicable Register of Deeds reference (book and page) for the associated recorded map.
 - ii. List the limit-maximum allowable impervious area and the proposed site-impervious area.
- c. **Nitrogen Compliance –**
- i. Provide a table showing the following items in the main body/narrative of the SCR:
 - 1. %BUA
 - 2. WQv needed and WQv provided
 - 3. For SNAP, show the target export in pounds/year, the export after SCMs are applied, and the buy-down needed.
 - 4. For runoff volume match, summarize the pre- and post-development volumes of runoff leaving the site for the 90th percentile storm event
 - ii. Methodology – in narrative
 - 1. Summarize which methodology used (SNAP versus runoff volume match).
 - 2. State any deviations from the City's guidance on SNAP input and explain these inputs.
 - 3. Describe the method used for runoff volume match.
 - iii. PDF of City's SNAP input summary tables in an appendix.
 - iv. PDF of SNAP worksheets or Runoff Volume Match calculations as an appendix.
 - v. WQv needed calculations
- d. **Runoff Rate Compliance**
- i. In the narrative:
 - 1. Provide a table showing the pre- and post-development peak

discharge for the regulated storms for each point of analysis. ~~POI~~. Indicate the % change.

2. Methodology - A thorough description of all methodologies, procedures and data sources used in the calculations shall be included in the narrative, as well as a detailed record of all assumptions.

ii. In appendix:

1. Development of input data (e.g. CN, C, Tc, etc)
2. PDF sheets from the software used showing the following
 - a. Model configuration/Routing Schematic/Node Diagram - e.g. how do drainage areas combine, what drainage area is routed through a channel or a SCM.
 - b. Input data such as drainage area, coefficients, time of concentration, time step.
 - c. Input data for SCMs such as stage-storage tables, outlet elevations and shapes, ~~etc~~
 - d. Output hydrograph from each step.

e. Establishing Impervious Allocation

1. Provide a table showing the maximum impervious area per lot.

6. Stormwater Control Measure Summary

a. In narrative

- i. List each SCM with a unique identifier ~~f~~used in the project with the SCM type and the regulation(s) the SCM is meeting- (e.g. Nitrogen only, Nitrogen and Runoff Rate, Watershed Overlay, Diffuse Flow).

b. See Chapter 6 of this Manual for additional requirements.

7. Erosion and Sediment Control Design

~~i.a.~~ Methodology - A thorough description of all methodologies, procedures and data sources used in the calculations shall be included in the narrative, along with a detailed record of all assumptions.

~~b.~~ See Chapter 8 of this Manual for additional requirements.

~~a-c.~~ This section is not required at preliminary review. It is required at permitting review.

8. Floodplain Compliance

- a. If fill in the floodplain fringe is allowed and pursued for this site, ~~indicate why.~~ Provide a figure showing the floodplain boundaries, the fill areas, and the percent of the floodplain being filled.

- b. If floodproofing is allowed and pursued, indicate the floodproofing strategy.
- c. If floodplain is present on the site, state that -and an elevation certificate is needed.
- d. If a flood study is needed, state the type of flood study needed (based on Chapter 9 of this Manual) and indicate the case number for the study, as assigned by Planning and Development, and the Flood Study (FS) number, once assigned by the stormwater reviewer.

9. Overlay Districts

If the project falls in an overlay district with watercourse buffer requirements (Falls, Swift Creek, and Urban Watershed Protection Overlay Protection Districts, Conservation Management Districts, and the Metro-Park Overlay District), indicate in the narrative how those requirements apply to the project and how they will be met.

- a. Impervious limitations specific to the overlay district. State the Limit, maximum allowable impervious area allowed in the specific district and the proposed site impervious in the SCR.
- b. Documentation of all additional requirements (e.g. impervious area, built area, nutrient loading, buffer, retention, detention, etc.), as applicable, to the respective Watershed Protection Area Overlay Districts, as detailed in UDO Article 9.5

10. Rezoning Conditions

List the applicable rezoning case number issued by the City and any the stormwater-related conditions included with that rezoning request. For each stormwater-related zoning condition, state in the narrative how compliance is achieved in the narrative of the SCR. This description may reference other sections of the SCR or plans for details.

11. Figures/Maps

- a. Pre- and Post- Development Land Cover, per Chapter 5 of this Manual.
- b. Drainage Areas for Runoff Rate Analysis, per Chapter 5 of this Manual.
- c. Drainage Areas for SCMs.
- d. Drainage Areas for Drainage Design, per Chapter 4 of this Manual.

12. SCM Construction Cost Estimate(s)

A construction cost estimate shall be provided for each SCM. This section is not required at preliminary review. It is required at permitting review.

The cost estimate will contain the following information:

- Quantities for cost items
- Unit costs adjusted to the current year's dollars

- Total cost

The following cost items shall be included:

- Structures and their appurtenances
- Pipe within the SCM or embankment
- Excavation and grading
- Fill material, including specialized material for embankments
- Rip rap
- Geotextiles
- Plantings
- Soil media
- Soil preparation
- Retaining walls, as required in Chapter 6

2.3 ADDITIONAL SITE CRITERIA

2.3.1 Restoration of pervious areas

Pervious areas compacted during construction shall be restored to continue being considered pervious area. ~~Similarly, any a~~ Areas that were impervious in the existing condition that are proposed to be pervious in the final condition must be restored per this section.

The following requirements apply to all pervious areas compacted during construction or that are proposed in place of previously existing impervious areas:

- Till the area to a depth of 12 inches below the top of the compacted subgrade.
- Provide soil amendments, as needed, in accordance with soil tests. If lime and/or fertilizer are to be used, it shall be applied uniformly during seedbed preparation and mixed well in the top four to six inches of soil or applied as recommended in the planting specifications for proposed landscaping.

These requirements should be reflected in the project's plans and in the project's construction sequence.

2.3.2 Substitution of Impervious Area

To obtain credit for existing impervious area under the substitution of impervious surface credit, one of the following must be true:

- The impervious area must not be removed more than one year prior to the plan submittal claiming substitution.
- The demolition permit must be open at the time of plan submittal.

If a plan has been approved with substitution of impervious, the work must take place prior to

the expiration of a valid ~~b~~Building ~~p~~Permit or the sunsetting of an approved subdivision or site plan.

2.3.3 Maximum Slopes

The maximum slope of a newly graded vegetated area shall be 3:1 unless an alternate stabilization method is approved.~~—~~

2.3.4 Vehicle and Equipment Cleaning Requirements

2.3.4.1 All Facilities

- All wash water must be discharged to sanitary sewer.
- ~~Appropriate g~~Grading and drainage shall be provided so that wash water does not bypass the sanitary sewer collection system and enter the storm drain system.
- These requirements do not negate the need to meet Raleigh Water's requirements about discharges to the sanitary sewer.

2.3.4.2 City Properties

These requirements shall apply to new or renovated City of Raleigh facilities.

The City of Raleigh has specific ~~BMP~~ requirements in its~~within the~~ NPDES permit pertaining to vehicle and equipment cleaning measures. These projects must **clearly demonstrate and describe measures that prevent/minimize contamination of stormwater from all areas used for vehicle and equipment cleaning.**

- New or renovated City facilities ~~shall~~will have a designated wash station if vehicle and/or equipment maintenance or cleaning occurs at the site~~—~~.
- ~~Acceptable~~ Approved measures include performing cleaning operations indoors, cover cleaning operations, ensure wash water drains to the sanitary sewer, collect stormwater run-on from the cleaning area and provide treatment or recycling.
- If sanitary sewer is not available and cleaning operations must take place outdoors, the cleaning operations must take place on, or drain directly to, a grassed or graveled area.
- If none of the above measures can be achieved, direction needs to be provided that then storm drain~~(s)~~ must be covered with portable drain covers during cleaning activities, and any standing water present after the cleaning activities are completed are to be removed and properly handled before the drain~~(s)~~ are~~is~~ uncovered.

Chapter 3

HYDROLOGY

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FOR REVIEW ONLY

3.1 Introduction

This chapter addresses hydrologic methods that are acceptable for use in the required calculations detailed in subsequent chapters [of this Manual](#).

3.2 Drainage **Area** Delineation and Analysis

The drainage area for a watershed must be determined from topographic maps and field surveys within the project area. The vertical datum associated with the topographic information must be stated [in the plan set](#).

3.2.1 ~~Points of Analysis~~ **Analysis Points**

For runoff rate control, the selection of points of analysis is described in Chapter 5 [of this Manual](#), “Stormwater Management Calculations”.

For storm drainage design, ~~points of analysis~~ [analysis is are](#) needed for:

- ~~every new inlet, for~~
- ~~any existing inlet with whose a~~ drainage area that has been modified, ~~and for~~
- ~~upstream flows that have will~~ entered the pipe system(s) being analyzed.

For floodplain analysis, the designer will determine the number of drainage areas needed for the analysis. Analysis points for flow change locations can be established at the upstream end of the site, ~~the~~ downstream end of the site, and the entrances of tributaries. If only one drainage area is used [for the analysis](#), it must be the ~~flow discharge at the~~ downstream end of the site, ~~and applied throughout the site~~.

3.2.2 Drainage Area Maps

Pre-development (existing) and post-development (proposed) drainage area maps shall be provided [in the SCR, and sealed by a North Carolina licensed design professional](#). Pre-development maps must depict existing conditions including topography, natural channels, stormwater conveyance infrastructure, impoundments, stormwater control measures (SCMs), and impervious area. Post-development maps shall depict existing features to remain, changes in topography, proposed [stormwater](#) conveyance infrastructure, proposed SCMs, and proposed impervious area.

Delineated drainage areas shall be clearly ~~depicted~~ [displayed on the pre-development and post-development drainage area maps](#). All drainage areas ~~must should~~ be labeled consistently between pre- and post- development with the total area (acres) provided for each. Each drainage area ~~provided~~ shall accurately represent the areas contributing to the selected points of analysis, which may include off-site areas ~~contributing that contribute~~ [stormwater](#) runoff ~~to the selected point of analysis~~.

When using the [SCSNRCS](#) method for Time of Concentration, segmented flow paths are to be clearly ~~depicted~~ [displayed](#) on both pre-~~development~~ and post-development drainage area maps. The differing flow path segments and their transitions from one to another shall be depicted and labeled (e.g., sheet flow to shallow concentrated flow). Additional information on Time of Concentration is provided in Section 3.6, below.

3.3 Hydrologic Design Methods

Hydrology involves the estimation of flow peaks, volumes, and time distributions of stormwater runoff. The analysis of these parameters is fundamental to the design of stormwater management infrastructure, such as stormwater conveyance systems and SCMs.

It is the designer's responsibility to be knowledgeable about hydrologic methodologies and apply them on a site-specific basis within the limitations of specific methods.

3.3.1 Watershed Characteristics

~~Acceptable~~ The approved methods ~~listed in Table 3.1 will~~ consider some or all of the following characteristics:

- Rainfall amount and storm distribution
- Drainage area size and/or shape
- Groundcover and soil type
- Slopes of terrain and stream channel(s)
- Antecedent moisture condition
- Rainfall abstraction rates (initial and constant)
- Storage potential (e.g., floodplains, ponds, wetlands, reservoirs, channels, ~~etc.~~)
- Watershed development potential
- Characteristics of the local drainage system

3.3.2 Channel Routing

Some aspects of stormwater design require routing hydrographs through channels. Methods for performing routing calculations include:

- Muskingum
- Muskingum–Cunge
- Lag and K
- Kinematic Wave
- Modified Puls

3.3.3 Impoundment Routing

Some calculations require consideration of routing through SCMs or other impoundments.

~~Acceptable~~ Approved methods for this type of routing ~~include~~ are:

- Storage-Indication Method

3.3.4 Approved Methods

~~Acceptable~~ Hydrologic design methods vary by application and have method-specific constraints. This is addressed in table 3.1, where the methods with check marks are approved for use for those pertinent design applications and those methods without a check mark cannot be used for that pertinent design application. ~~Overall, acceptable~~ Approved methods ~~include~~ are:

- Rational Method – Applicable for drainage areas under 100 acres.
- NRCS Method as detailed in *TR-55 Urban Hydrology for Small Watersheds* and the *National Engineering Handbook*, Part 630, Hydrology, NEH-630.10 and 630.16.
- HEC-HMS – Applicability varies based on selected method within the model. This is the Hydrologic Modeling System (HMS) from the USACE's United States Army Corps of Engineers-Hydrologic Engineering Center's (HEC).
- Stormwater Management Model (SWMM) - This method was developed by the United States Environmental Protection Agency (EPA).

TABLE 3.1 ACCEPTABLE-APPROVED APPLICATIONS USES OF PEAK-FLOW HYDROLOGIC METHODS					
Design Application	Manual Chapter	Rational	NRCS	SWMM	HEC-HMS
Stormwater Conveyance Systems: • Closed Systems • Open Systems • Culverts <= 72" dia.	4	✓	✓	✓	
Stormwater Conveyance Systems: • Inlets and Gutters	4	✓	✓	✓	
Stormwater Conveyance Systems: • Bridges • Culverts > 72" dia.	4		✓	✓	✓
SCM Design	5		✓	✓	
Erosion Controls	8	✓	✓		
Flood Studies	9		✓	✓	✓

Many software programs use the methods listed above. Software that uses those methods without alteration are approved ~~deemed acceptable~~ for hydrology calculations. Some examples of acceptable software approved for hydrologic analysis are listed below in alphabetical order:

- CivilStorm
- EPA SWMM
- HEC-HMS
- Hydraflow
- HydroCAD
- Hydrology Studio
- InfoDrainage

- Infoworks ICM
- PC SWMM
- PondPack
- Stormwater Studio
- WinTR-20
- WinTR-55
- XP SWMM

Approved/acceptable methods for flood studies can be found in Chapter 9 of this Manual, “Floodplain Management”.

3.3.5 Methods Not Allowed

The following hydrologic design methods are not allowed for hydrologic analysis unless specifically noted elsewhere in this Manual:

- Chainsaw Routing Method
- Modified Rational Method
- Simple Method for Runoff Volume
- ~~Chainsaw Routing Method~~

3.4. Rainfall Data

While traditionally NOAA Atlas 14 has been used for Rainfall-Intensity-Duration data, several projects were underway to update or replace ~~that reference~~ NOAA Atlas 14 at the time of this manual’s writing adoption. To keep pace with advances in the science and engineering around current and future rainfall data, the City will post ~~the effective~~ rainfall data on the City’s Stormwater website. The website will list the effective Release date for each rainfall data update. Projects must use the Rainfall-Intensity-Duration data effective at the time of the project’s first submittal. s will be provided for use in determining the effective data at the time of a project’s submittal. Use of the Rainfall-Intensity-Duration data specified by the City is required.

[LINK LOCATION TO BE ADDED IN FINAL VERSION]

3.5 Land Cover and Infiltration Characteristics

Sections 3.5.3 and 3.5.4. below give additional detail on the Rational and NRCS methods. This does not preclude the use of other methods shown as approved in Section 3.3. above.

3.5.1 Antecedent Moisture Conditions

Average antecedent soil moisture conditions shall be used for all hydrologic analysis.

3.5.2 Land Use/Land Cover

All stormwater modeling ~~must should~~ be designed based on fully developed (future) land use conditions or existing land use, whichever generates the higher stormwater runoff rate.

Approved/acceptable sources for future land use are:

- The current City of Raleigh Zoning Map

- The current Future Land Use Maps or Zoning Maps for adjacent jurisdictions when those areas are part of the drainage area to the analysis point.

Values for Rational C and NRCS CN that align with Raleigh's ~~z~~Zoning ~~d~~Districts are included in the tables below.

Regardless of method chosen, the development of inputs related to land cover and infiltration characteristics shall be shown in the ~~Stormwater Compliance Report (SCR)~~. For example, if the NRCS Method is used, the calculation of the composite CN value will be shown for each drainage area, including the hydrologic soil groups, land cover category, and condition.

3.5.3 Rational Method Runoff Coefficient (C)

If the Rational Method is selected, the Runoff Coefficient will be calculated based on the C values found in ~~the~~ Table 3.2 below. These are adapted from the 2013 update to the ~~Federal Highway Administration (FHWA)~~ Hydraulic Engineering Circular No. 22, otherwise known as *HEC-22 Urban Drainage Design Manual*.

TABLE 3.2 RATIONAL METHOD COEFFICIENTS	
Description Of Area	Runoff Coefficient (C)
<u>Impervious Areas (BUA):</u>	
Compacted Gravel Areas	0.95
Drives, Walks, and Roofs	0.95
Asphalt and Concrete	0.95 to 1.00
<u>Woodlands</u>	
Woodlands	0.25
Playgrounds	0.35
<u>Lawns:</u>	
Sandy Soil, Flat, 2%	0.10
Sandy Soil, Average, 2 – 7%	0.15
Sandy Soil, Steep, >7%	0.20
Clay Soil, Flat, 2%	0.17
Clay Soil, Average, 2 – 7%	0.22
Clay Soil, Steep, >7%	0.35
<u>Graded or No Plant Cover (Including during construction):</u>	
Sandy Soil, Flat, 0 – 5%	0.30
Sandy Soil, Average, 5 – 10%	0.40
Clay Soil, Flat, 0 – 5%	0.50
Clay Soil, Average, 5 – 10%	0.60
<u>Zoning:</u>	

Single-Family (R – 1) and (R – 2)	0.40
Single-Family (R – 4)	0.55
Single-Family (R – 6)	0.5575
Multi-family (R – 10)	0.75
Residential Mixed Use (RX-)	0.85
Office Park (OP-)	0.90
<u>Office Mixed Use (OX-)</u>	<u>0.90</u>
Neighborhood Mixed Use (NX-)	0.95
Commercial Mixed Use (CX-)	0.95
Downtown Mixed Use (DX-)	0.95
Industrial Mixed Use (IX-)	0.80
Conservation Management (CM)	0.15
Agriculture Productive (AP)	0.30
Heavy Industrial (IH)	0.90
Manufactured <u>HousingHomes</u> (MH)	0.75
Campus (CMP)	0.60
<u>Planned Development (PD)</u>	<u>Custom number based on actual impervious area</u>

3.5.4. NRCS Curve Number (CN)

The NRCS method uses a combination of soil conditions and land use (groundcover) to assign a stormwater runoff factor to an area. These runoff factors, CN, indicate the stormwater runoff potential of an area.

CN values shall be based on NRCS Technical Release 55 (TR-55), Urban Hydrology for Small Watersheds publication, Table 2-2.

Typically, the most recent version of the Web Soil Survey Map is used to determine the hydrologic soil group (HSG). Soils assigned to a dual hydrologic group (A/D, B/D or C/D) shall be considered to be in the least infiltrative soil group. Alternatively, a site-specific geotechnical or soil survey may be used to determine the hydrologic soil group classification, using the least-permeable soil layer within six inches of the surface to determine determination the HSG. A legible map, clearly delineating and labeling the site boundary and soil types, shall be provided to substantiate the chosen classification.

If the site is making use of disconnected impervious area as a stormwater runoff reduction strategy, the “Urban impervious area modifications” described in TR-55, pages 2-9 and 2-10, may be used. Designers must demonstrate that the impervious area would remain disconnected, either through use of the Disconnected Impervious Surface SCM or by demonstrating there is no potential for connecting the impervious area in the future.

TABLE 3.3 NRCS CURVE NUMBERS FOR FUTURE CONDITIONS	
Raleigh Zoning District	Equivalent TR-55 Land Cover Description

R-1	Residential districts by average lot size – 1 acre
R-2	Residential districts by average lot size – 1/2 acre
R-4	Residential districts by average lot size – ¼ acre
R-6	Residential districts by average lot size – 1/8 acre
R-10	Residential districts by average lot size – 1/8 acre
Residential Mixed Use (RX-)	Residential districts by average lot size – 1/8 acre
Office Park (OP-) <u>and</u> <u>Office Mixed Use (OX-)</u>	Commercial and business
Neighborhood Mixed Use (NX-)	Commercial and business
Commercial Mixed Use (CX-)	Commercial and business
Downtown Mixed Use (DX-)	Commercial and business
Industrial Mixed Use (IX-)	Industrial
Conservation Management (CM)	Open space
Agricultural Productive (AP)	Other agricultural lands
Heavy Industrial (IH)	Industrial
Manufactured <u>Housing Homes</u> (MH)	Residential districts by average lot size – 1/8 acre
Campus (CMP)	Residential districts by average lot size – 1/8 acre
<u>Planned Development</u>	<u>Custom number based on actual impervious area</u>

3.6 Time of Concentration

The time of concentration (t_c) is a concept used in hydrology to measure the response of a watershed to a storm event based on the 2-year, 24-hour precipitation value. It is defined as the time needed for water to flow from the most hydraulically distant point in a watershed to the watershed outlet. Time of concentration is a function of topography, soil properties and land use within the watershed and varies depending on these factors. Time of concentration is only applied to surface runoff and shall be no less than 5 minutes for hydrologic analysis.

This Manual follows the standard set by NCDOT and requires the NRCS method.

3.6.1 NRCS Method

The NRCS Method of time of concentration is an approved valid method to use for either the Rational Method or the NRCS Unit Hydrograph Method. For sheet flow, maximum lengths are limited to 100 feet in forested or meadow conditions and 50 feet in developed areas, after which sheet flow becomes concentrated flow. These maximum lengths may need to be shortened if steep slopes or other land cover conditions that would result in a flow depth of greater than 0.1 ft are present. Shallow concentrated flow follows the sheet flow condition, and will may not be considered shallow concentrated flow if in a well-defined channel. The travel time for shallow concentrated flow is in based on a velocity to slope relationship based on land cover type. Open channel flow is assumed to begin where flow enters a roadway gutter pan, an open channel, or an USGS blue lined stream. Additionally, flow within pipes and culverts not under pressure is considered to be closed channel flow. Manning's n values for use in this method are found in TR-55.

3.7 Hydrograph Peak Flow Development

Information is provided below on the two most common methods used for peak flow development. This does not preclude use of the other approved methods in Section 3.3 of this Manual.

3.7.1 Rational Method

The Rational Method estimates the peak rate of runoff at any location in a watershed as a function of the drainage area, runoff coefficient, frequency factor and mean rainfall intensity for a duration equal to the time of concentration.

The Rational Method is expressed as follows:

$$\text{[EQ 3.1]} \quad Q = C \times I \times A$$

Where,

Q = maximum rate of runoff (cfs)

C = runoff coefficient representing a ratio of runoff to rainfall

i = average rainfall intensity for a duration equal to the time of concentration or calculated travel time (in/hr)

A = drainage area contributing to the design point location (ac)

3.7.23 NRCS Unit Hydrograph Method

The NRCS hydrologic method requires data, such as drainage area, runoff factor, time of concentration and rainfall. The NRCS approach also considers the time distribution of the rainfall, the initial rainfall losses to interception and depression storage and an infiltration rate that decreases during a storm event. Details of the methodology can be found in TR-55 and the NRCS National Engineering Handbook, Section 4.

CHAPTER 4

STORMWATER CONVEYANCE DESIGN

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4.1 INTRODUCTION

The stormwater conveyance system encompasses pipes, culverts, bridges, structures, gutters, and constructed channels conveying runoff from public and private lands. Note that roof drainage and building foundation drainage systems are considered building systems until they are connected to a structure (i.e. manhole, junction, inlet) or channel (gutter, swale, ditch) that is part of the stormwater conveyance system. Building systems are subject to building codes, not this Manual.

For guidance related to specific hydraulic design and calculations, please refer to the most recent version of ~~the North Carolina Department of Transportation (NCDOT)~~ manual "*Guidelines for Drainage Studies and Hydraulic Design*" and the ~~Federal Highway Administration's (FHWA)~~ manuals "*Hydraulic Design of Highway Culverts-HDS 05*" and "*HEC-22 Urban Drainage Design Manual*". Where discrepancies exist ~~among the manuals~~, this ~~M~~manual shall govern.

4.2 REQUIREMENTS FOR ALL STORMWATER CONVEYANCE

4.2.1 Overland Flow Path Required

While stormwater conveyance systems do not need to convey the 100-year storm, an overland flow path shall be provided for the 100-year storm. This means that all sites shall be designed so that no building floods or has water impounded against it during the 100-year storm event.

If the water surface is altered on parcels that are not part of the development project, the 100-year storm ponding elevations and areas shall be shown and labeled on the preliminary or permitting submittal, whichever occurs first.

~~See Chapter 7 of this Manual, "Easements", for the requirements for downstream, private drainage conveyance easements and flood storage easements.~~

Commented [HS1]: moved to 4.2.9 below

4.2.2 Gravity Design Required

All stormwater conveyances must flow by gravity. No pumping will be allowed for any stormwater system on public or private property.

4.2.3 Existing Systems

~~If the e~~Existing stormwater conveyance systems on the site or parallel to the street in the half of a City right-of-way (ROW) adjacent to the property shall be analyzed with any Tier 3 site plan. ~~Systems that do not meet the requirements of this chapter for capacity do not comply with the current design criteria or condition as identified by the project's visual pipe inspection (on parcel) or the City (in City ROW); the existing systems~~ shall be replaced or improved to meet the criteria.

4.2.4 Location Relative ~~to~~ Buildings and Other Structures

Stormwater conveyance systems shall not be placed under or within 10' of any permanent structure or the associated foundation, including retaining walls. Additionally, buildings are not allowed within ~~the stormwater conveyance drainage~~ easements, as defined in Chapter 7 ~~of this Manual~~. The only stormwater conveyance system that may be placed under or within a building is the discharge from a stormwater control measure and it must follow the requirements for stormwater control measures, which can be found in ~~Section Chapter 6.2 of this Manual~~.

4.2.5 Public Versus Private Infrastructure

~~Structures and pipes located fully within the ROW are considered publicly-maintained infrastructure, unless an encroachment agreement was executed. Structures and pipes located fully within a parcel are maintained by the parcel owner unless a drainage easement indicates otherwise. Pipes with flow leaving a parcel and entering a ROW are considered private until they connect with or outfall to the publicly-maintained system at a structure, ditch, or gutter.~~

~~The first structure within the ROW delineates the publicly-maintained system and the privately-maintained infrastructure. Any infrastructure that crosses into the ROW that is connected to a ROW structure is privately-maintained owned starting at the structure.~~

[GRAPHIC TO BE ADDED IN FINAL VERSION]

4.2.6 Decreased Capacity Downstream

If a proposed ~~stormwater conveyance~~ system has a higher capacity than the ~~offsite stormwater conveyance~~ system component immediately downstream, the ~~applicable Stormwater Compliance Report (SCR)~~ must contain the following information:

- Narrative description of why this design is necessary and what special maintenance will be required.
- Map identifying locations where new surcharging will occur.
- Analysis of the impacts of the surcharging, including delineation of flow paths and identification of any buildings to be impacted between the site and the next floodplain studied by FEMA or the City.

4.2.7 Flow into the ROW

~~Flow from pipes, swales, or gutters in excess of 3 cfs shall not flow from a parcel onto a sidewalk, multi-use path, greenway, or street. Concentrated runoff from stormwater pipes or swales in excess of 3 cfs shall not flow across or onto sidewalks.~~

4.2.8 Connecting to Conveyance System in City ROW

Connecting a private stormwater conveyance system to a stormwater conveyance system in the City ROW requires a Stormwater Conveyance Permit ~~permitting~~. This can be obtained under a building permit or site permit case type, whichever applies. A modified version of the as-built process will be required ~~—See as described in~~ Section 4.8 of this Manual.

Connections to storm structures (e.g. inlets, manholes) and to the gutter through the curb shall be performed in accordance with City of Raleigh details.

7.1.1 Easements

See Chapter 7 of this Manual, “Easements”.

4.3 SIZING CRITERIA

4.3.1 Closed Conveyance Systems Sizing Criteria

Closed stormwater conveyance systems, designed for by either public or private projects sectors, shall be sized based upon the criteria listed in Table 4.1, below.

DRAINAGE AREA	DESIGN STORM	DESIGN CRITERIA
≤ 25 acres	10-year	Hydraulic Grade Line (HGL) for the entire system is to be at or below the crown of all pipes.
	25-year	HGL shall not exceed the top of inlet structures or gutter elevations.
> 25 acres	25-year	HGL for the entire system is to be at or below the crown of all pipes.
	100-year	<u>Outside the ROW</u> , inundation does not exceed the limits of the <u>drainage easement or ROW</u> .

HGL calculations shall consider all head losses, friction factors, and bypass flows. The downstream HGL at the outlet end of the stormwater conveyance system shall begin at a known water surface elevation or at the downstream crown of pipe, whichever is greater.

HGL calculations shall be provided in the SCR at the building or site permitting submittal, whichever comes first. Include the following data in the report:

- Drainage area maps
- Profiles showing HGL's

- Calculation tables listing the input and output values.

4.3.2 Open Channel Conveyance Systems Sizing Criteria

For purposes of this Manual, open channel conveyance systems refer to ditches, swales and other constructed channels used as part of the overall stormwater conveyance system. These requirements do not apply to jurisdictional streams.

Open channel conveyance systems shall be sized based upon the criteria listed in Table 4.2, below.

TABLE 4.2 SIZING CRITERIA OPEN CHANNEL CONVEYANCE SYSTEMS		
DRAINAGE AREA	DESIGN STORM	DESIGN CRITERIA
< 25 acres	10-year	Water surface elevation for the entire system is at or below top of banks.
	25-year	<u>Outside the ROW, inundation does not exceed the limits of drainage easement/ROW.</u>
≥ 25 acres	25-year	Water surface elevation for the entire system is at or below top of banks.
	100-year	<u>Outside the ROW, inundation does not exceed the limits of drainage easement/ROW.</u>

The channel design calculations shall be included in the SCR at the building or site permitting submittal, whichever comes first. Include the following data in the report:

- Drainage area map
- Calculations showing inputs and outputs

See Section 4.5.2 of this Manual regarding channel lining.

4.3.3 Bridge And Culvert Sizing Criteria

Bridges and culverts shall be sized based upon the criteria listed in Table 4.3, below, and the following two criteria.

- All bridges and culverts shall be designed so that no building (unless the structure(s) is a properly floodproofed, non-residential structure(s)), either proposed or existing, floods or has water impounded against it during the 100-year storm event, unless the building

structure is a properly permitted, floodproofed, non-residential structure as defined in UDO Section 9.3.5.B.2.-

- For road crossings serving 10 acres or more, the maximum depth of the water impounded during the 100-year storm event must not exceed 15 feet, as measured from the upstream invert of the culvert to the water surface elevation. Should the maximum depth be exceeded, a Design Exception shall be submitted along with engineering calculations that verify the stability of the embankment against slope failure and seepage effects.
- For bridges and culverts in an existing or proposed City ROW, any spans with a cumulative opening width exceeding 13 feet shall be designed as Federally-qualifying bridge.

Commented [HS2]: Add link to definition

TABLE 4.3

FREEBOARD CRITERIA FOR CULVERTS AND BRIDGES

SYSTEM	DESIGN STORM	DESIGN CRITERIA
Road crossings with drainage area ≤ 25 ac	25-yr	12 in to top of road ¹ with HW/D ≤ 1.2 or 12 in from the low chord. ²
	100-yr	Outside the ROW, No increased in inundation shall exceed occur outside the limits of drainage easement/ ROW .
Road crossings with drainage area > 25 ac	50-yr	24 in to top of road ¹ with HW/D ≤ 1.2 or 12 in from the low chord. ²
	100-yr	Outside the ROW, No increase in inundation shall exceed occur outside the limits of drainage easement/ ROW .
Road crossings over regulated floodways	100-yr	24 in to top of road ¹ with HW/D ≤ 1.2 or 24 in from the low chord. ²
	100-yr	No increased inundation project proposing expansion of the floodplain shall be approved without approved floodplain map revisions.

Commented [ZM3]: Combine Table with UDO 9.3.8 & 9.3.9

¹Culvert Freeboard is measured from the top of the road and is defined as the lowest adjacent point where roadway overtopping would occur.

²Bridge freeboard is measured from the low chord, which is the bottom of the bridge structure that defines the waterway opening.

For road crossings serving 10 acres or more, the maximum depth of the water impounded during the 100-year storm event must should not exceed 15 feet, as measured from the upstream invert of the culvert to the water surface elevation. Should the maximum depth be exceeded, appropriate engineering calculations shall be submitted to verify the stability of the embankment against slope failure and seepage effects.

Commented [HS4]: moved above

For guidance related to Bridges and Culverts, please design per the most recent version of NCDOT manual *Guidelines for Drainage Studies and Hydraulic Design* and the FHWA Hydraulic Design Series Number 7, *Hydraulic Design of Safe Bridges*. Where discrepancies exist among the manuals, this Mmanual shall govern.

4.3.4 Inlet And Gutter Sizing Criteria

Inlets and gutters shall be designed based on Table 4.4. below.

TABLE 4.4 INLET AND GUTTER SIZING CRITERIA	
TOPIC	DESIGN CRITERIA
Design storm	<ul style="list-style-type: none"> 10-year storm
Maximum spread	<ul style="list-style-type: none"> Half the width of one travel lane on two- or three-lane streets and one-lane width on wider streets When the typical section includes a full shoulder (four feet or greater), parking lane, or bike lane, no encroachment into the travel lane will be allowed.
Additional Inlet locations	<ul style="list-style-type: none"> Sags* Upgrade of intersections, including intersection of a non-residential driveway or private road with a public road. Upgrade of superelevation crossovers Any location where more than 3 cfs would reach a <u>public</u> ROW from a private site during the 10-year storm.
Yard inlets	<ul style="list-style-type: none"> Ponding at yard inlets outside the <u>public</u> roadway shall be limited to a maximum of one foot above an inlet elevation for the 10-year storm if no structures are flooded as a result. Ponding may not extend into the ROW.
Inlet blockage	<ul style="list-style-type: none"> Inlets shall be designed assuming 50% blockage for locations where grate inlets are required. <u>In combination inlets, only the grate portion must be shown as 50% blockage.</u>

*In sag areas where relief by curb overflow is not provided, the stormwater conveyance system standard design level (25- or 50-year storm events) is to be used for analysis to ensure traffic flow is not interrupted. Guidance for sag area calculations can be found in the NCDOT "Guidelines for drainage studies and Hydraulic Design". In a sag condition where relief by overflow for a typical roadway cross section is not provided, inlet capacity and the stormwater conveyance system must be designed for:

- One dry eight-foot travel lane in the 25-year event on two- or three-lane streets
- Two dry eight-foot travel lanes (one in each direction) in the 50-year event on four-lane or more streets

Gutter spread calculations shall be provided for all proposed public and private streets with such calculations to be included in with the SCR for the building or site permitting submittal, whichever is submitted first. Gutter spread calculations shall include the following:

- All flow rates in cfs to the nearest hundredth
- Calculation table(s) listing the input and output values.
- Tables shall include structure number, bypass structure, spread, allowable spread, and a column indicating whether spread requirements were met.

4.4 ALL MATERIALS

~~All pipe and fittings shall be delivered to the site and unloaded with handling that conforms to the manufacturer's instructions for reasonable care. The Contractor shall take necessary precautions to ensure the method used in lifting or placing the pipe does not induce undue stress fatigue in the pipe or other item by following manufacturer or industry wide standards.~~

~~As newer materials are approved/accepted by the City, the City's website will post these materials and associated design criteria.~~

4.5 STORMWATER PIPES

This section applies to stormwater conveyance pipes located:

- Fully and partially within the City ROW
- -Downstream of City or NCDOT ROW, when the pipes convey public roadway runoff, which City ROW or outside ROW that connect to the City stormwater infrastructure or otherwise convey public runoff.

~~The requirements in this Section apply~~ is applies to pipes that are part of closed conveyance systems and to culverts.

For pipes located within NCDOT ROW, NCDOT details and specifications apply.

~~All proposed stormwater conveyance pipes located within the City of Raleigh shall follow the manufacturer's minimum cover specifications unless otherwise noted below in Table 4.5.~~

4.5.1 Overall Criteria

**TABLE 4.5
OVERALL STORMWATER PIPE CRITERIA**

TOPIC	DESIGN CRITERIA
Diameter	<ul style="list-style-type: none"> Minimum of 15 in See site specific materials for maximum diameter
Cover	<ul style="list-style-type: none"> Minimum cover is 1.5 ft from the outside wall of the pipe to grade unless manufacturer's specifications require additional cover See site specific materials for maximum cover
Velocity	<ul style="list-style-type: none"> Minimum flow velocity is 3 fps
Slope	<ul style="list-style-type: none"> Minimum slope is 0.5% Maximum slope is 10%
Installation Trench Width	<ul style="list-style-type: none"> See City details. Follow manufacturer's specifications or NCDOT details
Tie-Ins	<ul style="list-style-type: none"> All tie-ins of pipe must occur at a structure. No "break-ins" or taps to pipes allowed.
Bedding details	<ul style="list-style-type: none"> See material-specific sections
Joint type	<ul style="list-style-type: none"> See material-specific sections
Approved/ Accepted pipe materials:	<ul style="list-style-type: none"> Reinforced concrete pipe (RCP) Double wall Polypropylene (PP) Double wall high-density polyethylene (HDPE)

Commented [HS5]: Note that City details are being revised. They will be updated by Spring 2024.

4.5.2 Reinforced Concrete Pipe

- ~~The City does not have restrictions on where RCP may be used.~~
- ~~Reinforced Concrete Pipe (RCP) shall be Class III or greater. Greater pipe strength class and maximum cover requirements shall be based on the Indirect Design Method as found in Section 12 of the AASHTO Load and Resistance Factor Design (LRFD) Bridge Design Specification.~~

Commented [HS6]: Follow up with ACPA/CCPPA about alternate reference material.

- Pipe shall be installed per a ~~City COR or NCDOT~~ detail.
- Pipe shall be manufactured to meet ASTM C76 and shall be installed per ASTM C1479.
- Joints shall meet one of the following requirements:

Use single offset joints - Bell and spigot pipe using a single offset joint shall consist of a -profile gasket and shall conform to the requirements of ASTM C1628.

Commented [HS7]: CCPPA comment: Should also list Tongue and groove with single offset spigot as larger diameter pipe may be straight wall (no bell)

Commented [HS8R7]: Dan following up for clarification.

Use Conseal (ASTM C990) sealant with the addition of filter fabric wrap on exterior and Wrap Joint Externally with geotextile.

• ~~Pipe cover shall meet the requirements in ASCE 15-17 "Standard Practice for Direct Design of Buried Precast Concrete Pipe using Standard Installations (SIDD)" 2017.~~

Commented [HS9]: Replaced with AASHTO LRFD above

• ~~Materials changes require a structure except for repairs of existing systems. For repairs, any transition of RCP to PP or HDPE shall have a dissimilar materials adapter incorporating a geotextile coupler with mastic coating and stainless-steel straps.~~

•

• ~~Pipe must be specified to meet the following requirements:~~

~~Adhere to AASHTO R-73 for acceptance of pipe at time of delivery and until backfill is placed.~~

• ~~In addition to any deficiencies not covered by ASTM C76 for non-pressurized pipe, concrete pipe, which has any one of the following visual defects, will not be approved/accepted.~~

- ~~— Pipe, which has been patched to repair porous spots, cracks, or other defects, when such patching was not approved by ENGINEER.~~
- ~~— Exposure of the reinforcement when such exposure would indicate that the reinforcement is misplaced.~~
- ~~— Pipe that has been damaged during shipment or handling even when previously approved before shipment.~~

Concrete pipe, ~~at when~~ delivered to the job site, shall have cured and reached the design strength as required by ASTM C76 for non-pressurized pipe or ASTM C507 for Elliptical Pipe and ~~be at least three (3) days (seventy-two (72) hours)~~ shall have elapsed since time of manufacture.

Acceptance of the pipe at point of delivery shall not relieve ~~CONTRACTOR~~ the contractor of full responsibility for any defects in materials due to workmanship.

• Lifting holes: one lifting holes per pipe length will be allowed for stormwater pipes. Lifting holes must be filled in one of the following ways:

- ~~Fully grouted using a non-shrink grout after installation and before backfilling the pipe.~~
- ~~Filled with a lifting-hole-specific cap.~~

4.5.3 Polypropylene

Polypropylene (PP) may be used ~~for stormwater conveyance pipes to be installed within~~ private property and ~~in City ROW for~~ "Local" streets, "Sensitive Area Residential Street" and "Alley, Residential" streets as ~~each is~~ defined in the City of Raleigh "Street Design Manual", provided ~~the stormwater conveyance pipes# are~~ installed according to all of the following requirements:

- ~~Pipe shall be D~~double ~~W~~wall with a smooth interior pipe (Type S) ~~and~~ shall conform to the American Association State Highway and Transportation Officials (AASHTO) M330 or ASTM F2881 ~~and is the only allowed type within the ROW.~~
- ~~Maximum~~ pipe diameter is 60" ~~.~~
- ~~and m~~Maximum cover is 15'.
- Certification shall be provided by [Plastic Pipe Institute](https://www.plasticpipe.org/PPI-Home/PPI-Home/Default.aspx), <https://www.plasticpipe.org/PPI-Home/PPI-Home/Default.aspx>
- Double Gasketed Bell and spigot joints with O-ring gasket (on spigot end) shall be installed on all pipes. Bells shall cover two full corrugations on each section of pipe. Gaskets shall conform to ASTM F477. Joint performance shall meet the watertight joint performance requirements of ASTM D3212.
- Installation trench minimum width shall be per ~~manufacturer's specifications.~~ City standard details.
- PP shall be backfilled per manufacturer's specification with a minimum of ASTM D2321 Class II or AASHTO A1 or A3 granular fill with minimum 6" bedding and fill to top of pipe. Remaining backfill shall be installed in accordance with ~~City, NCDOT, or manufacturer~~ details.
- ~~Materials changes require a structure except for repairs of existing systems. For repairs, any~~ Transition of PP to RCP shall have a dissimilar materials adapter incorporating a geotextile coupler with mastic coating and stainless-steel straps.
- Connections to structures shall be ~~blocked and grouted with non-shrink grout.~~ Made with a resilient water tight connector. Resilient connectors shall meet ASTM C923, ASRM C1478, and ASTM F2510.
- Mandrel testing results shall be submitted with the As-built Certification. See Section 4.98, below.

Commented [ZM10]: Is this what we are noting to be removed?

Commented [HS11R10]: Needs follow-up with ADS commenters.

4.5.4 High Density Polyethylene

Double Wall High-Density Polyethylene (HDPE) may be used for stormwater conveyance pipes to be installed within private property and other areas outside the ROW on parcels provided

~~the stormwater conveyance pipes are #18~~ installed according to all of the following requirements:

- Corrugated exterior/smooth interior pipe (type S) shall conform to AASHTO M294.
- ~~Maximum pipe diameter is 48" and~~
- ~~The~~ maximum cover is 12'.
- Certification shall be provided by Plastic Pipe Institute (PPI).
- Bell and spigot joints with O-ring gasket (on spigot end) shall be installed. Bells shall cover two full corrugations on each section of pipe. Gaskets shall conform to ASTM F477. Joint performance shall meet the watertight joint performance requirements of ASTM D3212.
- Installation trench minimum width shall be per manufacturer's specifications.
- HDPE shall be backfilled with six inches of #57 stone bedding under the pipe and to the top of pipe. Nonwoven Geotextile fabric six (6) ounces or greater shall be used to separate the #57 stone from the remaining backfill. Remaining backfill shall be installed in accordance with ~~current~~ City standard details.
- ~~Transition of HDPE to RCP shall have a dissimilar materials adapter incorporating a geotextile coupler with mastic coating and stainless-steel straps.~~
- ~~Materials changes require a structure except for repairs of existing systems. For repairs, any transition of HDPE to RCP shall have a dissimilar materials adapter incorporating a geotextile coupler with mastic coating and stainless-steel straps.~~
- Mandrel testing results shall be submitted with the As-built Certification. See Section 4.98, below.

Commented [ZM12]: Is this what we are removing?

Commented [ZM13R12]: Sally noted on previous comment she will be following up the flexible pipe people

4.6 OPEN CHANNELS AND ENERGY DISSIPATION

Open channel conveyance systems shall be designed per ~~the City's Unified Development Ordinance (UDO)~~ Section 9.4.4.G, unless otherwise specified below.

4.6.1 Channel Configuration

The maximum allowable side slopes for vegetated conveyance shall be 3H:1V with a minimum longitudinal slope of 1%.

4.6.2 Channel Lining

Channel lining shall be determined per UDO Section 9.4.4.G.2.

Vegetated conveyances shall be sodded, not seeded (fully stabilized before operational with permanent stabilization).

A table with channel segment, slope, drainage area, proposed velocity, proposed discharge, channel lining, and maximum channel lining velocity shall be provided either on the plans or in the SCR.

4.6.3 Energy Dissipation At Pipe Outlets

Energy dissipation calculations shall be provided with the preliminary or permitting submittal, whichever occurs first. The following outlet protection and energy dissipators are approved/allowable:

- Plunge pools
- Riprap apron
- Baffled outlets

Calculations shall be in accordance with ~~the the North Carolina Department of Environmental Quality (NCDEQ)~~ "Erosion and Sediment Control Planning and Design Manual" ~~and/or~~ the FHWA manual, "Hydraulic Engineering Circular No. 14 Hec-14: Hydraulic Design of Energy Dissipators for Culverts and Channels".

4.7 DRAINAGE STRUCTURES

NCDOT or CityOR standard structures shall be used for all City of Raleigh streets. Other details will be allowed if they meet the minimum design criteria for all structures, as listed below, and have been sealed by a North Carolina licensed structural engineer.

4.7.1 Minimum Criteria For Structures

The following criteria apply to enclosed drainage structures, including manholes, junctions, inlets, and catch basins.

**TABLE 4.6
DRAINAGE STRUCTURE DESIGN CRITERIA**

TOPIC	DESIGN CRITERIA
Access	<ul style="list-style-type: none"> • All <u>drainage</u> structures shall allow for access to the stormwater conveyance system with a grate, manhole cover or a lid capable of being removed. • The lid must be capable of being removed for immediate maintenance concerns (capable of being removed manually). • Access opening must be a minimum of 2' in diameter.

Interior dimensions	<p>For the area below the access opening, extending to the structure invert:</p> <ul style="list-style-type: none"> • Minimum dimension is 2.5 feet in any direction. • Minimum area is 9 square feet. • For <u>drainage</u> structures greater than x depth, the minimum area is xxx.
Invert drop	<ul style="list-style-type: none"> • Minimum invert drop at <u>drainage</u> structures is 0.5% slope or 0.1 feet whichever is greater. • Minimum invert drop at <u>drainage</u> structures for pipe size increases is based on matching crown elevations.
Labelling	<ul style="list-style-type: none"> • All <u>drainage</u> structures shall be labelled with the following language or its approved equivalent: "Dump No Waste. Drains to River."
Loading	<ul style="list-style-type: none"> • <u>Drainage</u> structures and access lids must withstand HL-93 loading.
Location	<ul style="list-style-type: none"> • For pipe systems with a 48-inch pipe (or equivalent cross-sectional area) or larger, there <u>must</u> be a maximum spacing of 300 feet. • For pipe systems with an equivalent size of less than a 48-inch pipe, there <u>must</u> be a maximum spacing of 250 feet. • A <u>drainage</u> structure shall be provided wherever there is a change in pipe size, <u>pipe material</u>, <u>pipe slope</u>, or <u>flow</u> direction within a stormwater conveyance network. <u>This requirement does not apply to pipe sections used as underground storage SCMs. For SCM access locations, see Chapter 6.</u>
Pipe angles	<ul style="list-style-type: none"> • Any change in pipe direction which results in an angle less than 90° between the inflow and outflow pipe will require a detailed study and a drop equal to or greater than the diameter of the pipe out.
Steps	<ul style="list-style-type: none"> • Required for all structures deeper than 3'-6" . • Steps must be positioned such that they can be used by personnel to access the structure.

4.7.2 End Treatments

End treatment is required for all stormwater conveyance pipes.

- Flared End Sections shall be placed on pipes smaller than 36 inches. These must be reinforced concrete. No polypropene end treatments are allowed.
- Cast-in-place or pre-cast concrete headwalls and endwalls are required for all pipe system outfalls 36 inches or larger.

End treatments shall be designed in accordance with [NCDOT standards and design details](#) except when those standards conflict with the above criteria in this Section 4.7.2 of the Manual.

4.8 **STORMWATER CONVEYANCE SYSTEM PERMITTING AND**

CERTIFICATIONS4.8.1 Permit Applicability

The City ~~shall~~ requires certifications of ~~stormwater conveyance pipe closed-circuit television (CCTV)~~ inspection data and as-built documentation ~~of stormwater conveyance systems that for projects that~~ require a Stormwater Conveyance System Permit ~~(Ssee Chapter 1 of this Manual for when such a permit is required).~~

INSERT TABLE OF WHEN PERMIT, INSPECTION, AND AS-BUILT ARE REQUIRED4.8.2 As-built Submittal

As-built documentation, and certification for both public and private stormwater conveyance systems, must be submitted to the City's Stormwater Division. The as-built submittal must be certified by a North Carolina licensed professional engineer (PE) or registered landscape architect (RLA) that the stormwater conveyance infrastructure has been installed per the approved plan. At a minimum the following items shall be included/documentated with the as-built submittal:

- Stormwater Conveyance As-Built Submittal Checklist – A completed copy of this checklist including the signed and sealed statement provided by a qualified North Carolina licensed design professional which certifies that the as-built stormwater infrastructure (both public and private) complies with the approved plans and meets all UDO requirements.
- As-Built Drawings – A certified set of as-built drawings, signed and sealed by a North Carolina licensed PE or RLA, for stormwater infrastructure only.
- As-Built Survey Submittals
 - As-Built Survey – A certified post construction as-built survey, signed and sealed by a North Carolina Professional Land Surveyor (NCPLS), for stormwater infrastructure only.
 - Survey File – An electronic file of the NCPLS-certified post-construction as-built survey in format specified in the Stormwater Conveyance As-Built Submittal Checklist for stormwater infrastructure only.
 - Survey Point File – A file of the NCPLS-certified post construction as-built survey in the format specified on the Stormwater Conveyance As-Built Submittal Checklist for stormwater infrastructure only.
 - All recorded public and private drainage easements properly labeled and provided as polygons in the format specified on the Stormwater Conveyance As-Built Submittal Checklist.
- Recorded plat(s) files

4.8.32 Inspection4.8.32.1 Required Inspections

- A. Pipes must be clear of sediment and debris as verified by City staff.
- B. CCTV Inspection

The CCTV inspection

- Applies to pipes 12" up to 72" in diameter.
- CCTV inspection shall be performed in accordance with the latest testing requirements set forth by the National Association of Sewer Service Companies (NASSCO) Pipeline Assessment & Certification Program (PACP).

C. Mandrel Testing for flexible pipe (PP and HDPE)

- The deflection test will must be completed no sooner than 30 days after installation and backfill of flexible pipes.
- A 9-vane mandrel sized for 7.5% deflection will must be used to complete the test.
- The mandrel shall be pulled by hand through the pipe sections.
- Full length laser profiling may be substituted for mandrel testing.

D. Bridge Inspection

- Applies to any infrastructure with openings 72" or greater in any direction.
- The Bridge Inspector shall be prequalified by NCDOT to perform municipal bridge inspections.
- Inspection shall be completed in compliance with the National Bridge Inspection Standards (NBIS)

4.8.23.2. Acceptance StandardsA. CCTV

- Pipes that have NASSCO PACP structural and O&M (operational and maintenance) scores of 1 will be accepted.
- Pipes that have NASSCO PACP structural or O&M defects with a score of 2 or greater must submit a Repair Plan.

B. Mandrel Testing

- Pipes with deflection less than or equal to 7.5% will be accepted.
- Pipes with deflection of greater than 7.5% must be included in the repair plan for replacement.

C. Bridge Inspections

- Inspection shall be compliant with NBIS

4.8.23.3. Inspection Submittal Requirements

This inspection results must be certified by a North Carolina licensed professional engineer (PE) and must be submitted to and accepted by the City's Raleigh Stormwater Division to verify there are no defects in the stormwater conveyance system in the ROW or on parcels, both on public and private property. At a minimum the following items shall be included/documentated with the CCTV pipe inspection submittal:

- Completed, signed and sealed by a North Carolina licensed PE Stormwater Conveyance CCTV/P Inspection Checklist
- Repair plan when defects are present including associated CCTV pipe inspection videos
- ~~Storm drainage video of final inspection showing all pipes are free of obstruction, defects, surface damage, structural deterioration, infiltration and inflow sources, and/or~~

- deposits, etc.
- All CCTV Report(s)
- All CCTV Videos
- All CCTV Inspection Database Files
- Mandrel Test Report or Full Length Laser Profiling for all Flexible Pipe
- North Carolina licensed PE Engineer Certified WIGINS sealed NBIS-Compliant Bridge Inspection Report for pipes or box culverts of 72" or greater with open channel on both sides

4.8.3 As-built Submittal

Once the CCTV inspection has been accepted by the City's Raleigh Stormwater Division and, when applicable, the last inch of asphalt has been applied to the project, as-built documentation, and certification for both public and private stormwater conveyance systems, must be submitted to the City's Raleigh Stormwater Division. The as-built submittal must be certified by a North Carolina licensed professional engineer (PE) or registered landscape architect (RLA) that the stormwater conveyance infrastructure has been installed per the approved plan. The as-built submittal must be accepted by the City's Raleigh Stormwater Division. At a minimum the following items shall be included/documented with the as-built submittal:

- Stormwater Conveyance As-Built Submittal Checklist — A completed copy of this checklist including the signed and sealed statement provided by a qualified North Carolina (NC) licensed design professional which certifies that the as-built stormwater infrastructure (both public and private) complies with the approved plans and meets all Unified Development Ordinance (UDO) requirements. — A completed copy of this checklist, including the signed and sealed statement provided by a qualified North Carolina (NC) licensed design professional which certifies that the as-built stormwater infrastructure (both public and private) complies with the approved plans and meets all Unified Development Ordinance (UDO) requirements.
- As-Built Drawings — A certified set of as-built drawings, signed and sealed by a North Carolina licensed professional engineer PE or RLA, for stormwater infrastructure only.
- As-Built Survey Submittals
 - As-Built Survey — A certified post construction as-built survey, signed and sealed by an North Carolina Professional Land Surveyor (NCPLS), for stormwater infrastructure only.
 - Survey File — An electronic file of the NCPLS certified post construction as-built survey in format specified in the Stormwater Conveyance As-Built Submittal Checklist for stormwater infrastructure only.
 - Survey Point File — A file of the NCPLS certified post construction as-built survey in the format specified on the Stormwater Conveyance As-Built Submittal Checklist for stormwater infrastructure only.
 - All recorded public and private drainage easements properly labeled and provided as polygons in the format specified on the Stormwater Conveyance As-Built Submittal Checklist.
- Recorded plat(s) files

The CCTV pipe inspection submittal and as-built documentation must be reviewed and accepted by the City's Raleigh Stormwater Division prior to:

- Issuance of a Certificate of Occupancy/Certificate of Compliance
- Final approval of the Stormwater Conveyance System Permit inspection
- Project Closeout and Certificate of Completion

The City's Raleigh Stormwater Division's acceptance of the stormwater conveyance system ~~CCTV pipe~~ inspection and as-built certifications does not constitute acceptance of the system for maintenance by the City, unless the stormwater conveyance system is one the City has had constructed and is located within City-maintained ROW (see below) or City-held public drainage easements.

- When the stormwater conveyance system is located on private property it is the responsibility of the property owner and/or property owner's association to maintain.
- Acceptance of stormwater conveyance systems within City-maintained the public ROW for maintenance purposes shall be made by the City's Transportation Department.

Chapter 5

STORMWATER MANAGEMENT CALCULATIONS

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5.1 INTRODUCTION

This chapter provides additional information and requirements for compliance with the ~~Traditional Full~~ Stormwater Requirements contained in [UDO Sections 9.2.2.B through 9.2.2.H](#). Additional information about compliance with the Exempt Property Requirements in [UDO Section 9.2.2.A](#), can be found in Chapters 1 and 2 [of this Manual](#).

The term Built Upon Area (BUA) as described in Article 9.2 of the UDO is synonymous with impervious area and will be used throughout this chapter.

5.2 RATE OF RUNOFF CONTROL REQUIREMENTS

Sites subject to active stormwater control measures as specified in ~~the City's Unified Development Ordinance (UDO)~~ [Section 9.2.2.E](#) are required to meet runoff limitations and shall not have any increase in peak stormwater runoff leaving the site at each point of discharge between pre- and post-development conditions for the 2- and 10-year storm events ~~unless meeting an exemption in UDO Section 9.2.2.E.2.~~

Note that additional runoff control measures may be required if:

- Runoff from a site could cause adverse impacts on other properties as ~~provided stated in UDO Section 9.2.2.E.3.~~
- Rezoning has resulted in a specific ~~zoning~~ condition related to rate of runoff control.

Requirements for ~~rate of runoff control~~ the calculations are found in Chapter 3 [of this Manual](#), —“Hydrology”, and in this chapter [of the Manual](#). The same method of calculating peak stormwater runoff leaving the site must be used for pre-development (existing) and post-development (proposed) conditions.

Stormwater Control Measures (SCMs), as detailed in Chapter 6 [of this Manual](#), —“Stormwater Control Measure (SCM) Design”, shall be implemented as needed to comply with the rate of runoff control requirements.

5.2.1 Defining the Regulated Area

The regulated site area includes:

- Entire parcel(s) area
- Newly dedicated ~~ROW right of way (ROW)~~
- Existing ROW where BUA is added, or fee-in-lieu is paid (e.g. for sidewalks)
- Greenways - if a new greenway easement is being dedicated [to the City](#), applicants shall account for greenway built upon area in their compliance calculations for the project.

The drainage areas to the points of analysis must incorporate the entire regulated area.

5.2.2 Points of analysis (POA)

For runoff rate control, selected points of analysis shall be located at each point where flow leaves the parcel being developed. For added BUA in the ROW, flow will be analyzed either at the edge of the limits of disturbance or where flow leaves the existing ROW. For project sites

with an on-site stream, a point of analysis shall be provided where concentrated runoff enters the stream. ~~In this context, concentrated runoff shall be as defined in the Neuse Buffer Rules.~~ For existing sheet flow conditions, the property line may be treated as the POA, but a separate drainage area must be delineated for flow to each adjacent property.

The physical locations and labels for points of analysis shall remain consistent between pre-development and post-development exhibits and associated calculations to show compliance with pre-~~development~~developed (existing) and post-development (proposed) runoff conditions. If the POA needs to be relocated due to a change in site conditions, the reason for that change shall be explained in the ~~Stormwater Compliance Report (SCR)~~ narrative.

5.2.3 Additional Runoff Control Requirements

To determine if a ~~project~~ site is subject to additional runoff controls per [UDO Section 9.2.2.E.3.](#), contact a stormwater plan reviewer, ~~as the mapping associated with downstream flooding is not available in a public mapping application.~~

To demonstrate compliance with [UDO Section 9.2.2.E.3.d](#), delineate the drainage area to the location of downstream flooding. Calculate the total drainage area to that downstream point. Next, calculate the acreage of the project site within the drainage area. Divide the acreage of the project site within the drainage area by the total drainage area to find the percentage of the drainage area composed of the ~~subject project~~ site. ~~Provide the calculations and the drainage area map with your submittal.~~

For rezoning cases, applicants ~~will~~may be asked to provide a map showing the point at which the ~~project~~ site becomes less than 5% of the drainage area. The steps to develop this map are as follows:

- i. Determine whether the ~~project~~ site drains ~~all~~ to ~~just~~ one stream or if it drains to multiple streams.
- ii. If the ~~project~~ site drains to more than one stream, delineate the drainage divide between the streams on the ~~project~~subject site.
- iii. Calculate the acreage of ~~those portions of the project~~ site that drains to each stream.
- iv. For Stream A, take the acreage of the ~~project~~ site that drains to Stream A and multiply it by 20.
- v. Now, find the first point downstream of the ~~project~~ site where the drainage area is greater than or equal to 20 times the acreage from the site draining to Stream A. If the site is adjacent to a large watercourse, this point could be immediately downstream of the site.
- vi. Repeat steps iv and v for each stream.
- vii. Submit a map that shows the ~~project~~subject site and the drainage areas delineated.

Examples of the above procedure can be found on the City's website.

~~[LINK TO STORMWATER WEBSITE TO BE ADDED IN FINAL VERSION]~~

5.3 NITROGEN REDUCTION REQUIREMENTS

Sites subject to active stormwater control measures as specified in ~~the City's~~ UDO Article 9.2, must meet nitrogen export targets that are tied to the Neuse Nutrient Strategy. The current version of these rules was adopted by the City effective May 1, 2023 and can be found in UDO Section 9.2.2.B. These rules are based on 15A NCAC 02B .0711, were drafted based on the Model Ordinance and Local Program Development Guide from NCDEQ, and were approved by the State of North Carolina prior to adoption by the City.

There are two methods of demonstrating compliance:

- Match Runoff Volume for the 90th percentile storm (1.34") as demonstrated through Storm-EZ or equivalent method.
- Meet the 3.6 lb/ac/yr target as demonstrated through the NCDEQ Stormwater Nitrogen and Phosphorus (SNAP) Tool.

Commented [HS1]: This may be updated before the final version based on feedback from NCDEQ.

For both methods, Sections 5.3.1 through 5.3.6 and 5.3.10, all of this Manual, of this document apply. For the Runoff Volume method requirements, Section 5.3.7 of this Manual also applies. To meet the 3.6 lb/ac/yr target through the SNAP tool, see also see Sections 5.3.8 through 5.3.10 of this Manual document.

5.3.1 Common Plan of Development

'Common Plan of Development' means a site where multiple separate and distinct development activities may be taking place at different times on different schedules but governed by a single development plan regardless of ownership of the parcels. Information that may be used to determine a 'common plan of development' include plats, blueprints, marketing plans, contracts, building permits, public notices or hearings, zoning requests, and infrastructure development plans.

This definition is taken from Common Plan of Development Definition in 15A NCAC 02H .1002(8) and is included in ~~the~~ UDO Section 9.2.1.F.2.

The following example situations fall under a Common Plan of Development:

- Projects submitted as one case under one application to the City of Raleigh.
- Adjacent parcels (including those separated by ROW) that are managed as one project entity. E.g. Multiple apartment buildings managed by one entity.

The following example situations do not fall under a Common Plan of Development for the purpose of ~~the~~ Nitrogen Reduction Rules compliance:

- Two residential lots sharing a driveway, when those lots are used for any detached house or tiny house used for single-unit living or any attached house, tiny house or two-unit townhouse development used for two- unit living, including accessory uses.

Please contact Stormwater ~~s~~Staff at raleighstormwater@raleighnc.gov if you are unclear about whether a project meets the definition of Common Plan of Development.

5.3.2 Existing BUA

The treatment of existing BUA in the Nitrogen Reduction ~~R~~rules varies based on the date the BUA was permitted and/or constructed. The timeframes of significance are addressed below.

5.3.2.1 BUA placed or permitted before May 1, 2001

Existing BUA that was in place before May 1, 2001 or was permitted before May 1, 2001:

- Will not be counted towards the % BUA for the site.
- Will not be included as part of the project's regulated site area.
- Will not be required to be treated by an SCM.
- Will not require additional nutrient offset credit purchases.

Designers may use historic aerial photographs, which are available in iMaps, or sealed surveys to demonstrate that BUA was in place prior to May 1, 2001.

5.3.2.2 Unpermitted BUA placed after May 1, 2001

If BUA was placed on or after May 1, 2001 but did not receive a stormwater control permit, it will be considered new BUA for the purposes of the Nitrogen Reduction Rules compliance.

5.3.2.3 BUA permitted under previous Nitrogen Reduction Rules (2001-2023)

The previous Nitrogen Reduction Rules were in effect in the City of Raleigh from May 1, 2001 to April 30, 2023. The associated calculation requirements for the previous version of the rules can be found in the archived version of the City of Raleigh Stormwater Design Manual, dated 2002. BUA that was permitted under the previous rules was either permitted or submitted for permitting between May 1, 2001 and April 30, 2023.

Existing BUA permitted under the previous Nitrogen Reduction Rules (2001-2023):

- Will count towards the total proposed BUA.
- Will be included in the project's regulated site area.
- Will not be required to provide additional SCM treatment beyond what was required at the time of permitting for this BUA.
- May be required to complete additional nutrient offset credits based on the results of the nutrient analysis.

Designers have two options for showing the calculations for BUA permitted under the previous Nitrogen Reduction Rules. In either method, credit will be given for the previous nutrient offset credits associated with the parcel area and for the previously constructed SCMs.

- **Method A:** Put ~~all~~ information in SNAP, recalculating all areas with the new method.
- **Method B:** Use first generation calculation method for the existing BUA permitted 2001 and later, which requires recalculation because the pervious area decreases. If the drainage area to the existing SCMs is altered, the credit associated with the existing SCMs will need to be recalculated. Use SNAP for the new BUA. Show the overall compliance in a spreadsheet. See the City's website for an example spreadsheet documenting Method B.

[\[INSERT LINK TO CITY WEBSITE WITH EXAMPLE IN FINAL VERSION\]](#)

5.3.2.4 BUA previously permitted under Nitrogen Reduction Rules effective May 1, 2023

Previously placed BUA that was permitted under the rules effective May 1, 2023:

- Will be counted towards the %BUA,
- Will be included as part of the project’s regulated site area.
- Will not be required to provide additional SCM treatment beyond what was required at the time of permitting,
- May require additional nutrient offset credits.

Any BUA permitted under the rules effective May 1, 2023 must use the SNAP Tool or Runoff Volume Match to demonstrate compliance.

5.3.3 Defining the Regulated Site Area

The site used for the nitrogen calculations may be different than the site as defined for runoff rate control. It is not necessary to separate the calculations by drainage area for nitrogen calculations. In the case of multi-phase subdivisions, the nitrogen calculations must be separated for each phase or group of phases that will individually comply with the requirements.

The regulated site area includes:

- Entire parcel(s) area minus the BUA that was placed or permitted prior to May 1, 2001 as defined above. The removal of this BUA from the calculation in the 2023 Nitrogen Reduction Rules methodology replaces the previous apportioning method.
- Newly dedicated ROW
- Existing ROW where BUA is added or fee-in-lieu is paid (e.g. for sidewalks)
- Greenways - If a new greenway easement is being dedicated to the City, applicants shall account for greenway built upon area in their compliance calculations for the project.

These areas will be detailed in the City Nutrient Summary Sheets ([The City Nutrient Summary Sheets](#) are available in PDF form along with a contact for obtaining the Excel version.)

5.3.4 Determine Compliance Method

Each project must determine if the Nitrogen requirements will be met through Runoff Volume Match or by meeting the Nitrogen Target. [See Table 5.1, below.](#)

TABLE 5.1 COMPARISON OF NITROGEN COMPLIANCE METHODS		
	<i>Runoff Volume Match</i>	<i>Nitrogen Target</i>
Design Storm	1.34"	1"
Pre-Development Condition	Impervious = Impervious Pervious = Forest	Impervious = Impervious Pervious = Managed Pervious
Target Nitrogen Loading	NA	3.6 lb/ac/yr

Nutrient Offset Credit Threshold	NA – No credits allowed	If %BUA <= 24%, credits-only allowed. If %BUA >24, primary SCM required before use of credits.
SCM Required	No, but will likely be needed for compliance <u>SCMs not automatically required, but are typically needed to meet the standards of the Runoff Volume Match method.</u>	If %BUA <= 24%, SCM is not required <u>but may be used</u> . If %BUA >24%, primary SCM required.
WQv to be Treated	No minimum threshold.	If %BUA >24%, primary SCM required to treat 100% of WQv associated with the new BUA.
Calculation Method	Storm-EZ or custom spreadsheet	SNAP

Some considerations for determining the method:

- Sites with high existing infiltration rates (e.g. HSG A or B) may find it easier to meet infiltration requirements than sites with clayey soils (e.g. HSG C and D).
- Sites with greater amounts of pervious areas and greater disconnected impervious areas will find it easier to meet runoff match requirements than high density sites.
- Sites that cannot meet the full runoff volume match requirements will still see benefits from using volume reduction practices, as the infiltration rate is considered in the SNAP tool, effectively allowing for a partial infiltration method.

5.3.5 Using Volume Reduction to Meet Nutrient Loading Requirements

Volume Reduction practices are a subset of SCMs that closely align with GSI practices. However, not all GSI practices achieve Volume Reduction. Volume Reduction practices are intended to minimize stormwater impacts of development by matching the volume of water leaving each site before and after construction, thereby, preserving the existing hydrology of the area. These practices address the difference in volume of runoff, not just peak discharge, by infiltration, evapotranspiration, or rainwater harvesting the increase in runoff from pre-development to post-development.

Practices approved suitable for Volume Reduction are identified in Chapter 6 of this Manual, – “Stormwater Control Measure (SCM) Design”. To meet nutrient loading requirements for either the Nitrogen Reduction Rules or any overlay district, applicants are required to adhere to NCDEQ guidance provided in the May 13, 2014 memorandum “Procedure for Meeting the Requirements for Nutrient Sensitive Waters Stormwater Management Programs by Implementing Low Impact Development” and “Calculating Runoff Volume Using the SCS Method as a Voluntary Alternative to the Simple Method” from March 2014 or any future updates to that procedure as issued by NCDEQ.

For new development, the pre-development land cover must be assumed to be forested for the entire development site. For redevelopment of sites with existing BUA built upon area, a modified calculation may be performed. For the purposes of this modified calculation, any BUA built upon area added as part of the redevelopment must be assumed to be forested in the predevelopment condition.

For the runoff volume match requirements, the State of North Carolina requires use of the 1.34" storm, as opposed to the 1" storm used in the water quality volume requirements.

Calculations for showing Volume Reduction must be based on either the Storm-EZ tool, or the same methodology, which includes:

- NRCS (SCS) Discrete Curve Number Method, which is used to generate inflow hydrographs. This involves running the CN calculation in TR-55 twice: first for connected impervious area and secondly for the remaining site area.
- The runoff rates described in the Stormwater Control Measure Credit Document, which are applied to the inflow hydrograph.

5.3.6 Required On-site Treatment

For sites with a BUA% over 24%, a primary SCM shall be required on-site before off-site credits can be purchased.

The percentage BUA for the project is calculated based on the proposed total impervious area on the project area.

- For a Greenfield Site, the formula is:

$$(\text{Proposed BUA}/\text{Regulated Project Area}) * 100 = \% \text{BUA}$$
- For sites with Existing BUA, the formula is:

$$[(\text{Proposed Total BUA} - \text{Existing BUA placed or permitted prior to May 1, 2001}) / (\text{Regulated Project Area} - \text{Existing BUA placed or permitted prior to May 1, 2001})] * 100 = \% \text{BUA}$$

If the %BUA is greater than 24%, then a Primary SCM is required for nutrient treatment. If the %BUA is less than or equal to 24%, a SCM may be used but it is not required for water quality purposes. A SCM might be needed to meet peak discharge requirements. Primary SCMs are defined by NCDEQ; the Primary versus Secondary designations can be found in the *Stormwater Control Measure Credit Document* in table A-2.

5.3.7 Determining Water Quality Volume

The UDO Section Article 9.2.2.B.1.g states, "Stormwater control measures shall be designed to control and treat the volume of runoff generated from all built-upon area by one inch of rainfall or equivalent runoff volume, in one or more primary stormwater control measure." Per NCDEQ clarifications via e-mail, this means that all new BUA (or an equivalent amount of previously untreated BUA) must drain to the SCMs on the site and that the SCMs must provide at least 100% treatment for that BUA. After the City's webinar on 4/20/2023, NCDEQ clarified that 100% of the BUA must drain to the SCMs — it is not acceptable to provide treatment >100% in lieu of sending BUA to SCMs.

Calculate the required WQv based on all the newly proposed BUA on site.

Treat that volume of WQv in one or more SCMs on site.

The amount of actually treated WQv will be based on:

- Determining the WQv associated with the actual land cover draining to each SCM.
- Existing BUA on the site may be treated in lieu of the newly proposed BUA if that existing BUA is not currently treated by another SCM.
- ROW that drains to the SCM may be given credit for treatment if that ROW BUA is not currently treated by another SCM.
- Credit will be given for the WQv associated with pervious areas draining to the SCM.

5.3.8 Calculations in the SNAP Tool

As of the ~~adoption date of this Manual~~~~writing of this manual~~, the SNAP Tool is the required calculation method for compliance with the Nitrogen Reduction Rules. The most recent version of the SNAP tool shall be used. If NCDEQ changes the required calculation method, that NCDEQ directive will supersede this subsection of ~~the this M~~manual.

5.3.8.1 SNAP Project Info Worksheet

On the Project Info worksheet, the following fields must be filled in:

- Project Name
- Nutrient Management Watershed, Sub-watershed, Delivery Zone
- Nitrogen Export Rate Target = 3.6 lb/ac/yr

For additional guidance, see the City's stormwater website.

5.3.8.2 SNAP Land Cover Characteristics Worksheet

On the Land Cover Characteristics worksheet, ~~the following criteria apply:~~

- Precipitation Station will be Raleigh.
- The category "Roof" ~~will may~~ be used for any impervious surface elevated above the surrounding ground and not used for vehicular traffic. Slatted decks ~~will may~~ be included in this category at 50% or 30% according to the UDO definition of "impervious surface."
- The category "Roadway" will be used for road surface impervious area in the ~~public~~ ROW.
- The category "Parking/Driveway/Sidewalk" will be used for all impervious area outside the ROW that is located at ground level. So, it encompasses miscellaneous impervious areas such as HVAC pads, retaining walls, plazas, patios, compacted gravel, synthetic turf/sports courts, and other similar surfaces that do not meet the permeable pavement SCM criteria. It also includes private roads and non-roadway BUA in the ROW.
- "Protected Forest" refers to Permanently Protected Undisturbed Open Space (PPUOS) ~~as defined in the UDO~~. This area must be ~~recorded on the~~~~depicted on a recorded~~ plat, permanently fenced, and treated like an SCM, – requiring an Operations and Maintenance (O&M) Manual and annual inspections. Note that Tree Conservation Area (TCA), ~~as defined by UDO Article 9.1~~, is not automatically Protected Forest.
- "Managed Pervious/Landscaping" will be used for all pervious area that is not PPUOS. This also applies to existing conditions.
- "Offsite or Existing" categories will not be used ~~when submitting to~~ the City of Raleigh. This is because SNAP does not give nutrient credit for these areas.

- Pools and Open water will be entered as “Custom Land Cover” with values of Impervious Value =0, TN EMC = 1.18, TP EMC = 0.11.
- Zone 1 of riparian buffers, when forested, will may be treated as “Protected Forest” for both existing and proposed conditions.
- For Existing BUA, reference the section on Existing BUA above.

5.3.8.3 SCM Characteristics Worksheet

- The Hydrologic soil group at SCM location, means the HSG specifically where the SCM is sited, not the HSG for the project site. If the SCM location falls on the line between two HSG's then the less infiltrating HSG must be chosen.
- The SCM Description will align with the Stormwater Compliance Report (SCR) and the plan sets. E.g. if SCMs are labeled A, B, and C, those labels will would be used herein SNAP.
- The Design Storm size for all SCMs in Raleigh is 1 inch.
- All SCMs shall be designed to a minimum of 100% sizing if they are used for regulatory purposes.

Note that comparison between existing TN load and proposed TN load is not used for compliance.

5.3.9 Nutrient Offset Credit Eligibility and Calculations

Sites that have a BUA Percentage less than or equal to 24% may meet the nutrient target through nutrient offset credits only. The thresholds of 6 lb/ac/yr and 10 lb/ac/yr from the previous Nitrogen Reduction Rules are no longer in use. Sites that have more than 24% BUA, purchase nutrient offset credits after the requirement to treat BUA in Section 5.3.6 of this Manual has been satisfied for the parcel.

Credits bought will now be in lb/yr rather than lb. The annual load of lb/yr will no longer be multiplied by 30 years. Thirty years was assumed to be the lifespan in the past; it is we now understood know that we should assume the credits will be in effect in perpetuity. Therefore, the perpetual credits will be sold in lb/yr. Per NCDEQ, mitigation banks will offer credits in both formats for some period of time.

5.3.10 Nitrogen Compliance Submittal Requirements

The signed and sealed ~~and signed~~ Stormwater Compliance Report (SCR) shall contain the following items related to the nutrient calculations and runoff volume match:

- Existing Conditions and Post-Development mMaps showing the project site land cover with SNAP categories.
- PDF versions s of the following SNAP Tool worksheets:
 - Project Info
 - Land Cover Characteristics
 - SCM Characteristics
 - Nutrient Export Summary
 - Nutrient Offset

- PDF versions of “City Nutrient Summary Sheets” (The “City Nutrient Summary Sheets” are available on the City’s [stormwater](#) website in PDF form along with a contact for obtaining the Excel version.)

Additionally, the Excel file of the SNAP tool shall be submitted [as part of the permitting case](#) with the City’s [assigned cCase file](#) number in the file name [prior to issuance of the stormwater control permit.](#)

5.4 WATERSHED SUPPLY WATERSHED PROGRAM REQUIREMENTS

~~Under this program,~~ The [State of North Carolina](#) requires cities and counties statewide to implement watershed protection programs for areas where drinking water is supplied by surface impoundments or by direct withdrawal from streams. These requirements include limitations for [BUA built upon area](#), required use of SCMs on lots exceeding certain specified [BUA built upon area](#) limitations, and the incorporation of ~~green stormwater infrastructure (GSI)~~ for volume control. The [water supply watershed program](#) requirements are specific to the watershed protection areas which can be found in the UDO as follows:

- Urban Watershed [Protection Overlay District](#) – [UDO Section 9.5.1](#)
- Falls Watershed [Protection Overlay District](#) – [UDO Section 9.5.2](#)
- Swift Creek Watershed [Protection Overlay District](#) – [UDO Section 9.5.3](#)

5.4.1 SNAP Calculations for WSWP

To comply with the Watershed Protection Area nutrient requirements, the NCDEQ SNAP Tool must be used for calculating the Nitrogen and Phosphorus loading rates. Projects with a watershed overlay need to meet both the Nitrogen Reduction Rules and the Watershed Rules. The more stringent requirements ~~must~~ be shown in the SNAP Tool. The SNAP input on the Land Cover Characteristics and SCM Characteristics ~~must~~ follow the guidance above.

On the Project Info worksheet, the following fields must be filled in:

- Project Name
- Nutrient Management Watershed, Sub-watershed, Delivery Zone
- Nitrogen and Phosphorus Export Rate Targets

For additional guidance, see the City’s stormwater website.

5.4.2 WSWP Nutrient Calculation Submittal Requirements

The submittal requirements [for nutrient calculations](#) are the same as the Nitrogen submittal requirements in Section 5.3.10, above.

5.5 NCDOT WORK UNDERTAKEN BY ~~THE CITY~~ OTHER ENTITIES

Projects in the NCDOT ROW undertaken by ~~an entity~~ the City ~~other than North Carolina Department of Transportation (NCDOT)~~ may fulfill the Nitrogen Reduction requirement for linear transportation projects per the requirements found in 15A NCAC 02H .1001(1)(c). Find more information in the [NCDOT Stormwater BMP Toolbox](#).

FOR REVIEW ONLY

Chapter 6

STORMWATER CONTROL MEASURE (SCM) DESIGN

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FOR REVIEW ONLY

6.1 INTRODUCTION

Stormwater control measures (SCMs) improve water quality and detain peak runoff to meet the City's ~~a~~Active ~~s~~Stormwater ~~c~~Control requirements set forth in the UDO [Section 9.2.2](#), and described in the previous chapter [of this Manual](#).

All SCMs used for regulatory compliance must follow the design requirements in this Manual. SCMs used to comply with the Nitrogen Reduction requirements must also comply with the State's Minimum Design Criteria (MDCs) that were established in Rule 15A NCAC 2H and can be found in the NCDEQ Stormwater Design Manual. For each SCM, this includes compliance with:

- MDCs ~~applicable tofor a~~All SCMs
- Section 6.3 ~~(of this Manual) d~~Design ~~r~~Requirements ~~applicable tofor a~~All SCMs
- The device-specific MDC
- The device-specific [design requirements in Section 6.4 of this Manual](#).

If the MDCs are updated after the effective date of ~~the most recent revision of~~ this Manual, ~~then~~ the [updated](#) MDC requirements shall govern [in projects submitted to Planning and Development after the new MDC effective date](#). If a new device-type is added to the MDCs, then it may be used for Nitrogen Reduction per the criteria established by NCDEQ.

6.2 SELECTING A SCM

The City encourages the use of ~~green stormwater infrastructure (GSI)~~ as a best practice for stormwater management. GSI practices contribute to managing, treating, and reducing stormwater runoff as close as possible to the runoff's source, by preserving natural landscape features and/or by mimicking natural processes through installation and maintenance of structurally engineered devices. The majority of stormwater treated through GSI practices is designed to infiltrate or evapo-transpire rather than leave the property as stormwater runoff. Thus, in comparison to conventional stormwater management practices, GSI practices can provide additional water quality benefits. Additionally, GSI practices can enhance site aesthetics, improve air quality, reduce urban heat island impacts, create wildlife habitat, reduce energy consumption, reduce infrastructure costs, and increase property values. More information and resources for implementing GSI in the City of Raleigh, including special programs and incentives, can be found on the [City of Raleigh's Stormwater website](#). Additionally, standard details for GSI can be found on the City's Standard Details website.

6.3 DESIGN REQUIREMENTS FOR ALL SCMS

6.3.0 Pumping Restrictions

No pumping of stormwater shall be allowed as a necessary component of any SCM except for rainwater harvesting. This does not preclude the use of a temporary pump for maintenance drawdown.

6.3.1 Clarifications on General MDCs

The following requirements apply to the design of all regulatory SCMs:

A) The requirements specified in Chapter A-5—“Common Structures and Materials” of the NCDEQ Stormwater Design Manual must be adhered to.

~~B) No pumping of stormwater shall be allowed as a necessary component of any SCM except for rainwater harvesting.~~

~~C) B) _____~~ General MDC 2 regarding contaminated soils shall apply to all brownfield or contaminated sites, including those sites that have not entered into a Brownfields Agreement with NCDEQ. This includes sites identified by NCDEQ as having Underground Storage Tanks (UST), Hazardous Waste (active or inactive), or Pre-Regulatory Landfills.

~~D) C) _____~~ General MDC 3 regarding ~~sSide s~~Slopes indicates that “Side slopes of SCMs stabilized with vegetated cover shall be no steeper than 3:1 (horizontal to vertical). Retaining walls, gabion walls, and other engineered surfaces may be steeper than 3:1. Steeper vegetated slopes may be considered on a case-by-case basis if the applicant demonstrates that the soils and vegetation shall remain stable.” ~~However, no vegetated slopes steeper than 3:1 will be allowed. Notwithstanding the last sentence of General MDC 3, vegetated slopes steeper than 3:1 will not be considered on a case-by-case basis.~~

~~E) General MDC 5, “All measures shall include an overflow or bypass device for inflow volumes in excess of the treatment, or, if applicable, the peak attention volume.” This shall be applied based on the design intent of the SCM. e.g. For example, if an SCM is designed for solely Nitrogen Reduction, then the treatment is the 1” storm. If the SCM is designed for Runoff Control of the 10-year storm, then treatment is the 10-year storm. If the 25-year or higher storm is the design basis, then the 25-year or higher storm is the treatment.~~

Commented [HS1]: Re-read the State Guidance and determined this bullet isn't needed

6.3.2 Embankments and Freboard

The following freeboard requirements apply to constructed embankments for SCMs of all types where the design depth of water to be impounded is 3 feet or greater.

Constructed embankments are those that are created by placing compacted fill above the original grade. For the definitions of constructed embankments versus excavated ponds and for further definition of depth of water impounded, refer to NRCS Conservation Practice Standards Pond Code 378 for NC.

- A) There must be 1-foot of freeboard between the largest storm with peak discharge requirements and the crest of an emergency spillway.
- B) Flow from the 100-year storm event may not flow through the emergency spillway and must be safely conveyed through the primary outlet control structure.
- C) The freeboard to the top of an embankment must be a minimum of 1 foot above the elevation of the highest stage calculated for the 100-year storm.
- D) Embankments shall be designed per the standards in NRCS Conservation Practice Standards Pond Code 378 for NC for all design components, except when the NCDEQ Stormwater Design Manual or this Manual document have more stringent requirements.
- E) Embankments shall comply with North Carolina Dam Safety Regulations.
- E)F) The only penetration through the embankment shall be the outflow barrel. Seepage associated with the barrel shall be minimized through the use of anti-seep collar or filter and drainage diaphragms.

6.3.3 Proximity to Buildings

All SCM measures shall be located a minimum of 10 feet from any building unless all of the following criteria are met:

- A) The SCM is watertight.
- B) Plastic tanks molded as one piece are assumed to be watertight. Other materials must include leak testing specifications.
- C) The specified leak rate in the testing must be acceptable to the design professionals responsible for geotechnical recommendations and structural design.
- D) A signed and sealed letter from the North Carolina-licensed structural engineer is required with the SCR at the time of permitting review. This letter must specify that the structural engineer is aware of the location of the SCM per dated plans and has approved a specific acceptable leak rate.
- E) If a SCM is located in or under a building, SCM approval also will also require a signed letter from the applicable property owner or party responsible for maintaining and repairing the SCM acknowledging awareness of the increased long-term maintenance costs associated with the SCM location. This shall be submitted with the SCR at the

time of permitting review.

- F) Adequate access is provided for maintenance. If access by maintenance vehicles such as pump trucks is not directly available, a "will-serve" letter from a maintenance company shall be required. This also may require a hose pull diagram. These shall be submitted with the SCR at the time of permitting review.

6.3.4 Use of Retaining Walls

Retaining walls may be used to contain ponded water associated with the SCM treatment volume if all of the following requirements are met:

- A) A leak rate associated with the wall must be established. The leak rate must be used in conjunction with the outlet structure hydraulic design to demonstrate compliance.
- B) For walls over 5' height, a signed and sealed letter by the North Carolina-licensed structural engineer responsible for the retaining wall must be submitted with the SCR, indicating that the engineer is aware of the saturated soil conditions as shown on the dated plans.
- C) Wall design details must be submitted with the permitting drawings prior to permit approval that demonstrate no short circuiting of the SCM will occur through drainage systems associated with the retaining wall.
- D) Retaining walls within an SCM are considered an element of the SCM and must be included in the drainage easement for SCM easement,access, the SCM O&M Manual, and the SCM construction cost estimate.
- E) If retaining walls are within a wet pond or stormwater wetland, the lowest grade adjacent to a retaining wall must be above the water quality volume elevation.

Permitting for disciplines other than stormwater may be required. For example, building permits may be required. Retaining wall designs must meet the requirements for other disciplines, such as providing railings at the top of walls.

6.3.5 Plantings

The following requirements apply to all SCMs:

- A. Proposed plantings in the SCM or on its side slopes shall not include be any species listed as an "Invasive Plant Species" in the North Carolina Extension Gardener Plant Toolbox.

B. No woody vegetation shall be planted on embankments.

C. Vegetation shall not impede sight distance on any public road. Per the Raleigh Street Design Manual (2018), this means that no foliage shall be present between 24" and 8

feet above the curb line elevation.

D. Woody vegetation shall not be planted within three feet of the inflow.

B.E. Woody, deep-rooted vegetation (e.g., trees) must not be planted directly over buried underdrains.

6.3.6 Infiltration Testing

When infiltration testing is required, the following are approved tests ~~will be accepted~~:

- a. Double-ring Infiltrometer (ASTM D3385-18)
- b. Modified Philip-Dunne Infiltrometer (ASTM D8152-18)
- c. Constant head permeameter (also known as the Amoozometer) (ASTM D2434-22)

6.3.7 Maintenance Access

See Section Chapter 7.4 of this Manual, "SCM-Easements" for the requirements for the access path to the ~~easement~~SCM.

6.3.8 Location relative to ROW

SCMs owned and maintained by the City are allowed in the City ROW. As of the adoption date of writing of this Manual, privately owned and maintained SCMs are not allowed in the ROW.

6.3.9 Outlet Design

When designing the outlet of a SCM all of the following apply:

A. Inlets and outlets of SCMs shall be designed/located to avoid short circuiting of the measure.

B. The outlet structure must be designed with maintenance in mind by ensuring access for cleaning, inspection, and repair. Specifically, the following shall be shown on the plans:

~~A. The outlet shall be placed such that it will be visible and accessible for maintenance purposes at all times.~~

2. Risers-Outputs shall be accessible by foot in the treatment storm which the SCM is designed for.
3. Riser-Outlet structures deeper than 4 feet must be designed with internal ladders for maintenance access.

C. Outlet size and shape shall prevent blockages or clogging of the outlet. Also, the outlet must be designed to ensure the safety of people and wildlife in the surrounding area.

1. This may include the use of a trash rack on a riser structure to prevent debris or wildlife from entering the outlet. If a track rack is used, the maximum opening

size shall be 4", and there shall be a method of latching the rack closed.

2. All drawdown orifices shall include a method for preventing clogging. Approved methods include:

- Trash rack
- Uprturned elbow in the outlet structure
- Downturned elbow in a permanent pool

~~B. Outlet size and shape shall prevent blockages or clogging of the outlet.~~

D. For outlet structure calculations:

1. Pipes smaller than or equal to 12 inches in diameter shall be analyzed as a submerged orifice if H/D is greater than 1.5. When incorporating an orifice into an outlet structure design, the orifice discharge coefficient must be based on the type of orifice proposed and must be documented in the SCR.
2. Pipes greater than 12 inches in diameter must be analyzed as a discharge pipe with headwater and tailwater effects considered. The outlet hydraulics for pipe flow can be found in the NCDOT manual, "Guidelines for Drainage Studies and Hydraulic Design".
3. When using weirs, weir discharge coefficient must be based on the edge treatment of the proposed weir and must be documented in the SCR.

E.

~~C.F.~~ The outlet must be designed to control the velocity of water flowing out of the SCM to prevent erosion and other issues caused by high-velocity stormwater using the 10-year storm.

~~D. Inlets and outlets of SCMs shall be designed/located to avoid short-circuiting of the measure.~~

~~E. Pipes smaller than 12 inches in diameter may be analyzed as a submerged orifice if H/D is greater than 1.5. When incorporating an orifice into an outlet structure design, an appropriate orifice discharge coefficient must be used and documented for the type of orifice proposed.~~

~~F. Pipes greater than 12 inches in diameter must be analyzed as a discharge pipe with headwater and tailwater effects considered. The outlet hydraulics for pipe flow can be found in the NCDOT manual, "Guidelines for Drainage Studies and Hydraulic Design".~~

~~G. When using weirs, an appropriate weir discharge coefficient must be used and documented for the edge treatment of the proposed weir.~~

G. Wet ponds and wetlands shall include an emergency draw down feature that is operable above the 100-year water surface. The draw down shall not exceed the flow rate of the 10-year storm.

H. Principal outlet barrels passing through an embankment as described in Section 6.3.2 above shall be composed of concrete pipe.

~~H.I.~~

The following Recommendations shall be required for City-maintained SCMs:

- A. Non-corrosive material and mounting hardware should be implemented to extend device longevity, ease operation, and reduce the cost of maintenance.

- B. Locking of trash racks and other elements is discouraged due to potential maintenance issues.

6.3.10 Requirements for All Underground SCMs

- A. Underground SCMs shall provide access in accordance with OSHA standards and requirements such as those for confined space entry.
- B. Underground SCMs must meet structural requirements for HL-93 loading.
- C. A minimum of two access points shall be required.
1. Access points shall be reachable by a pump truck.
 2. Access points should not be impeded by vehicular or pedestrian traffic. If traffic control will be required for maintenance access, a traffic control plan shall be provided in the O&M Manual.
 3. Access manways shall meet the access, interior dimensions, labelling, loading, and steps criteria from Table 4.6 of this Manual.
- D. Each chamber of the underground SCM shall be reachable by a pump truck suction hose.
- E. Access provided shall also meet manufacturer's requirements.

6.3.11 Maintenance Requirements for all SCMs

- A. Temporary pumps may be used for drawdown of the water for SCM maintenance. However, the discharge rate for the temporary pump shall not exceed the 10-year peak discharge rate for the SCM.

6.3.12 Emergency Spillway

For SCMs with embankments as defined in Section 6.3.2 above, an emergency spillway is required to prevent failure of the embankment structure during large storm events.

- B. The barrel of the principal spillway or outlet shall not be under the emergency spillway.
- C. Ensure the emergency spillway is modeled in the outlet definition of the routing analysis.

6.3.13 City-Maintained SCMs

All City-Maintained SCMs shall use the Standard Specifications for SCM components, available from Raleigh Stormwater.

6.4 SUBMITTAL REQUIREMENTS

The following sub-sections describe the submittal components-SCM-related SCR components required to demonstrate compliance and appropriate design of SCM's. Include all

~~applicable items for the analysis and SCM design being conducted.~~

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6.4.1 Stormwater Compliance Report (SCR)

All calculations associated with SCM design must be included in the signed and sealed SCR. This includes all of the following which apply to the SCM type under design:

- A) SCM Drainage Area map(s).
- B) Water quality volume provided, based on the drainage area to each specific SCM.
- C) Infiltration Testing report, if applicable required.
- D) Infiltration Calculations.
- E) Soil testing report for Seasonal High Water Table (SHWT) and depth to confining layer, if applicable required.
- F) Draw-down rate calculations for the water quality orifice.
- G) Underdrain calculations, if applicable required.
- H) Information related to building proximity, if applicable required.
- I) Information related to retaining walls, if applicable required.
- ~~J) Ensure the emergency spillway is modeled in the outlet definition of the routing analysis.~~
- J) Routine calculations that include the primary outlet structure and emergency spillway.
- K) Calculations are provided for anti-flotation measures, if applicable.
- L) Outlet protection calculations.
- M) Hydraulic calculations for flow splitters.
- N) For **Sand Filters**, hydraulic calculations for the connection between the sediment chamber and filter chamber.
- O) For **Sand Filters**, calculations for the minimum sizes of the sediment and filter chambers.
- P) For **Wetlands**, calculations of the zone areas.

6.4.2 SCM Plan View

The plans must clearly show the following items in plan view. Depending on the scale of the project, these items may either be shown on the Grading/Drainage Plan or on a Separate SCM Plan View.

- A) Outlet location.
- B) Outlet control structure location shown and labelled.
- C) Existing and proposed Private Drainage Maintenance easements. See Chapter 7, – “Easements”, for private drainage easement maintenance access requirements for SCM.

access.

- D) Dimensions for the distance between the SCM and adjacent structures (buildings) if they are closer than 20'.
- E) Emergency spillway showing proposed contours and dimensions and calling out the spillway liner, if applicable.
- F) Underdrains with clean-out location, if applicable.
- ~~G)~~ Outlet protection, ~~must be~~ shown to scale in plan view and with the dimensions and including depth and class of stone, ~~must be called out.~~
- ~~G)~~H) For plans with retaining walls, the top of wall and bottom of wall elevations along the length of the retaining wall must be labeled at least every 20-feet.
- ~~H)~~I) Swales must be called out and display proposed contours. The width, side slopes, longitudinal slope and any proposed liners must be specified. If check dams are present along the swale alignment, they must be shown to scale and be labeled with all applicable dimensions.
- ~~H)~~J) Wetlands require zone hatching and area labels including the percentage of each zone proposed. This may be provided as an exhibit in the SCR in lieu of providing in the plan set.
- ~~J)~~K) For Level Spreaders, LS-VFS and DIS, show the associated vegetated area with dimensions and slope.

6.4.3 SCM Plan Sheet Notes

- The SCM plans must reference the Landscaping plan sheets by number if plantings are not shown on the SCM plan.
- Give the specifications as notes or reference the location of specifications for liners and geotextiles. If the designer is relying on specifications rather than notes, the relevant specification sections for liners or geotextiles must be provided in the SCR for the reviewer to see.
- All media and stone types associated with a SCM must be stated on the plans.
- Bioretention media must reference the composition, P-Index, and infiltration rate per the applicable Bioretention MDCs.

6.4.4 SCM and SCM Component-Related Details

6.4.4.1 Cross-Section Through SCM

- Show calculated water surface elevations for the water quality, 2-year, 10-year and 100-year storms. If treatment was required for other design storms, those shall also be shown. These shall shown correctly in reference to the elevation of the SCM components.
- Label the freeboard provided per the freeboard requirements in Section 6.3.2. above, if applicable.
- Label the elevation of the top of embankment and embankment width, if applicable.

- Specify the SHWT elevation, if applicable required for the SCM type
- If a liner is proposed, show the liner and refer to the location for specifications or details.
- Geotextiles must be shown and called out as appropriate.
- Dimension or call out SCM media depth.
- All underdrain systems and clean-outs or observation wells with callouts indicating pipe material, size, perforations (if applicable), and slope.
- The outlet protection must be shown to scale and indicate the surface slope.

6.4.4.2 Outlet Structure Detail

- Provide a detail for the outlet control structure that includes all relevant needed components including weirs, orifices, emergency draw-down valves, pipes in and out, and anti-flotation measures, and anti-clogging measures.
- Label the invert elevations, structure dimensions, pipe/weir/orifice sizes and elevations, and any other components.
- Show calculated water surface elevations for the water quality, 2-year, 10-year and 100-year storms. If treatment was required for other design storms, those shall also be shown.

6.4.4.3 Flow Splitters

- Flow splitters must be called out in plan view and a cross section detail must be provided labeling all relevant elevations as described in the cross-section through SCM section above. This detail may be a part of the SCM cross-section or a stand-alone detail.
- Show calculated water surface elevations in each chamber for the water quality, 2-year, 10-year and 100-year storms. If treatment was required for other design storms, those shall also be shown.

6.4.4.4 Outlet Protection

- An installation detail must be provided on the plans.

6.5 SCM TYPE-SPECIFIC DESIGN REQUIREMENTS

6.5.1 Infiltration System

DESCRIPTION AND APPLICATIONS:
Infiltration practices may also be classified as runoff-reducing, green stormwater infrastructure practices. They consist of an area that intercepts and temporarily stores runoff until it infiltrates into the underlying and surrounding soils.
Varieties: Infiltration Trenches, Infiltration Basins
ADDITIONAL REQUIREMENTS BEYOND MDC <u>APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS-</u>

- A. Medium or coarse sand, or crushed stone (with a uniformity coefficient of two or smaller) is required for the drainage media. The media shall be hard, durable, inert particles, free from slate, shale, clay, silt and organic matter. Media shall be ~~double-washed~~washed until it is free of fines.
- B. ~~Trench-Permeable, non-woven~~ geotextiles shall enclose drainage media on all sides of the infiltration system and shall be in contact with the in-situ soil.
- C. Infiltration trench media shall be a minimum depth of 1.5 feet.
- D. A minimum 12-inch cover is required from the top of all piping to the finished grade.
- E. A minimum of 12 inches of head is required to promote infiltration.
- F. Infiltration practices shall not be used over occupied structures (buildings).
- F.G. One infiltration test shall be provided for every 7,000 square feet of infiltration surface area.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-1 Infiltration System](#)

6.5.2 Bioretention

DESCRIPTION AND APPLICATIONS:

Bioretention consists of a vegetated depression over special filtration media. After passing through the media, water infiltrates or is collected in underdrains.

Varieties: Planter Boxes, Curb-side Bioretention, Bump-out Bioretention, Median Bioretention, Transit Stop Bioretention, Pedestrian Refuge Bioretention

ADDITIONAL REQUIREMENTS BEYOND MDC APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:

- A. Pretreatment is required. The most commonly used pretreatment devices are:
 - a. *A grass and gravel combination*: eight inches of gravel followed by three to five feet of sod perpendicular to slope.
 - b. *A forebay*: 18 to 30 inches deep where the water enters and shallower where water exits in order to dissipate hydraulic energy. The forebay must be lined to ensure that water will not flow into the underdrain without first flowing through the treatment area of the bioretention cell. Lining material shall allow for removal of sediment and debris with a shovel or vac-truck.
 - c. *Vegetated Swale*: maximum longitudinal slope of 5%, 2% preferred. Non-porous check dams with a minimum height of 6" shall be placed as appropriate to provide ponding behind them. Minimum swale bottom width of 2'.
- B. Flow shall enter a bioretention cell via dispersed flow with a velocity less than one foot per second (fps) for mulched cells or three fps for sodded cells to prevent erosion. If

inflow ~~is concentrated in~~ enters via a pipe or swale, then a rip-rap lined entrance, a forebay, or another energy-dissipation device shall be used.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

~~B-C.~~ Clean-out pipes shall extend upwards from the underdrain pipe to an elevation 3" above the water quality ponding. They shall be located at the end of the bioretention surface, near the toe of slope. Underdrain pipes shall have a minimum slope of 0.5%.

~~C-D.~~ The minimum width of a bioretention cell shall be 18 inches.

~~E.~~ The surface of the bioretention shall not slope more than 0.5 percent in any direction. Installation in multiple cells is allowed and ~~should~~ shall be considered at sloped ~~s~~ sites.

~~D-F.~~

~~E-G.~~ Bioretention adjacent to public or private roads or sidewalks have the following additional criteria:

- a. All features including vegetation must ensure clear sightlines for pedestrians and drivers per the City of Raleigh Street Design Manual.
- b. Pedestrian access shall not be impacted by the bioretention design.
- c. For drop offs greater than 12", pedestrian and vehicle safety measures shall be installed.
- d. There must be a location adjacent to the bioretention area for a maintenance truck to safely park. This may be a parking spot or a grassed area.
- e. Gutter spread requirements must be met.
- f. Bioretention shall not prevent the placement of residential trash, recycling, and yard waste bins for pick-up.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

- A. The minimum width of embankment is 5 feet. This allows for mowing access.
- B. A flow splitter shall be used to route flows above WQv away from the bioretention area.
- C. The minimum maintenance vehicle parking area for median bioretention is 12 feet by 22-18 feet.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-2 Bioretention Areas](#)

City of Raleigh Standard Details

City of Raleigh Street Design Manual

Bioretention is ~~approved applicable~~ in many configurations, including:

- Planter Boxes – Planter boxes may be installed as part of streetscapes, site landscaping, or adjacent to structures.
- Curb-side Bioretention or Bump-out Bioretention – This may function as traffic calming or street-scaping.

- Median Bioretention
- Transit Stop Bioretention - A transit bump-out is designed to accommodate bus stops. It extends the curb into the street to create a wider boarding area for passengers, and may also include shelter, seating, and other amenities.
- Pedestrian Refuge Bioretention - A pedestrian refuge bump-out is designed to provide a safer crossing for pedestrians by extending the curb into the street and creating a shorter crossing distance. It typically includes a painted crosswalk, a raised curb or planter and may also include seating or other amenities.

Figure 6.1 below gives multiple examples of installation locations in the ROW.

Figure 6.X Bioretention Example Configuration

[Insert GSI Example Configuration AKA Detail GSI-06.1]

6.5.3 Wet Pond

DESCRIPTION AND APPLICATIONS:
<p>A stormwater wet pond is an excavated basin that captures and detains stormwater runoff, releasing it slowly over a period of two to five days. Pollutants are removed through sedimentation in the permanent wet pool.</p> <p>Older Names: Detention Basin</p>
ADDITIONAL REQUIREMENTS BEYOND MDC <u>APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:</u>
<p>A. The riser shall be near the embankment to facilitate maintenance and reduce flotation forces. All flotation force for any outlet design subject to flotation forces shall be calculated by the designer.</p> <p>B. The orifice at the permanent pool must have a turned-down elbow in order to prevent trash or other material floating on the surface from clogging the pipe.</p> <p>C. Measures such as anti-seep collars or similar shall be provided along the barrel of the principal spillway to prevent piping.</p> <p>D. Durable materials, such as reinforced concrete, are required for the barrel of the principal spillway.</p> <p>E. An emergency spillway is required to prevent failure of the embankment structure during large storm events. The barrel of the principal spillway shall not be under the emergency spillway.</p> <p>F.A. An impermeable liner must be specified if the permanent pool elevation is not within 6" of the SHWT.</p> <p>G.B. Wet ponds shall have the ability to sustain a wet pool by one of the following mechanisms:</p> <ol style="list-style-type: none"> Permanent pool elevation within 6 inches of the SHWT. Impermeable liner and with a minimum drainage area of 25 acres. Site specific measurements and water balance calculations showing there is sufficient inflow to the pond to sustain the permanent pool with or without a liner.

Commented [HS2]: Removed from Wet Ponds because addressed in All SCMs Section 6.3 Above.

~~H.C. _____ The rate of drawdown for maintenance shall be non-erosive and no more than the design flow out of the pond for the 10-year storm.~~

Commented [HS3]: Removed from Wet Ponds because addressed in All SCMs Section 6.3 Above.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

As part of design, a geese management strategy shall be designed for the period of plant establishment.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-3 Wet Pond](#)

FOR REVIEW

6.5.4 Stormwater Wetland**DESCRIPTION AND APPLICATIONS:**

Stormwater wetlands combine the detention and setting of a wet pond with the vegetated benefits of a wetland.

Other Names: Constructed Wetland

ADDITIONAL REQUIREMENTS BEYOND MDC APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:

- A. Stormwater wetlands shall have the ability to sustain the permanent pool by one of the following mechanisms:
- a. Permanent pool elevation within 6 inches of the SHWT.
 - b. Lined and with a minimum drainage area of 10 acres.
 - c. Site specific measurements and water balance calculations showing there is sufficient inflow to the pond to sustain the permanent pool with or without a liner.
- B. A minimum flow length to width ratio (L:W) shall be 3:1.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

As part of design, a geese management strategy shall be designed for the period of plant establishment.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-4 Stormwater Wetland](#)

6.5.5 Permeable Pavement System

DESCRIPTION AND APPLICATIONS:

Permeable pavement systems have a surface layer than allows rainfall to pass through to the underlying gravel layer. Water stored in the gravel layer is either infiltrated (Infiltration Design) or slowly released (Detention Design).

Types of permeable pavement systems: Permeable Interlocking Concrete Pavers (PICP), Permeable Concrete, Permeable Asphalt, Concrete Grid Pavers, Plastic Turf Reinforcing Grid.

The following may also be designed as permeable pavement systems: Permeable Sports Courts, Synthetic Turf

ADDITIONAL REQUIREMENTS BEYOND MDC APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:

- In an infiltration design, geotextiles (permeable and non-woven) shall line the sides of the aggregate base to prevent migration of adjacent soils into it and subsequent permeability and storage capacity reduction.
- Geotextiles are not allowed under the aggregate base in an infiltration design because they can accumulate fines and inhibit infiltration.
- In a detention design, geomembranes shall be used to provide a barrier on the sides and bottom of the aggregate base to prevent infiltration into the subgrade. Geomembranes ~~should~~ shall also be used to line the sides of the aggregate base when structures or conventional pavement is within 20 feet or less.
- The slope of permeable surface shall be less than 5-6 percent.
- The designer shall ensure that the pavement meets its structural design requirements by involving a North Carolina-licensed design professional with ~~appropriate~~ expertise in pavement design.
- The system shall be accessible for the surface maintenance technique(s) specified by the manufacturer or trade association. Permeable asphalt, permeable concrete, and PICP shall be accessible by a regenerative air street sweeper.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

- Signage shall be posted that indicates permeable pavement is present and that materials storage and sanding/salting the area is prohibited.
- Permeable surface materials other than those listed in the NCDEQ Stormwater Design Manual shall provide maintenance procedure information during permitting review. The unlisted permeable surface material must be approved by the Raleigh Stormwater SCM and Dams Asset Manager prior to permitting approval.
- The minimum width of a section of permeable pavement confined between curbs on 3 sides shall be 50 feet. Therefore, there must be at least 6 parking spots contiguous. This is for maintenance access by a street sweeper.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-5 Permeable Pavement](#)
City of Raleigh Standard Details

FOR REVIEW ONLY

6.5.6 Sand Filter

DESCRIPTION AND APPLICATIONS:

A sand filter consists of a settling area (sediment chamber) and a sand filter (sand chamber) area. Flow through the sand either infiltrates or is collected in underdrains. Sand filters may be located above ground or underground.

ADDITIONAL REQUIREMENTS BEYOND MDC ~~APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE~~ REQUIREMENTS:

- ~~The flow distribution system between the sediment chamber and the sand chamber shall be sized for the water quality storm. While storage above the sand may be counted for peak flow attenuation per MDC 4, the higher incoming flows should be otherwise routed to avoid erosion of the sand layer.~~
- ~~The sediment chamber shall be separate from any chambers used for detention. This allows for easier sediment removal.~~
- ~~Maximum drainage area of five acres unless the width of the sand chamber is limited to 20 feet and the interface between the sediment chamber and sand chamber is proportionally increased.~~

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

~~All of t~~The following apply to underground sand filters:

- A minimum of 4' of vertical space ~~shall~~ould be provided between the surface of the sand and the "ceiling" of the chamber.
- Access ~~should~~shall be provided to every sand chamber. _
- ~~Sediment chambers should not be oversized for detention purposes. This increases the effort for maintenance. —~~

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-6 Sand Filter](#)

6.5.7 Rainwater Harvesting (RWH)

DESCRIPTION AND APPLICATIONS:

Rainwater harvesting systems capture water runoff and store the water in a cistern. The system must include a passive drawdown or a dedicated non-potable use such as irrigation or toilet flushing.

ADDITIONAL REQUIREMENTS BEYOND MDC ~~APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE~~ REQUIREMENTS:

- ~~A. A passive drawdown, designed to prevent clogging, is required for residential-scale, above ground systems. The passive drawdown should discharge over two to five days to another SCM, which may include DIS. Passive drawdowns shall discharge by gravity.~~
- ~~B. Cisterns over 500 gallons that utilize passive drawdown and are intended for nutrient treatment shall direct the drawdown to another SCM that has been sized to receive that rate of runoff.~~
- ~~C-A.~~ Pumping is allowed as part of a rainwater harvesting system only when it serves as part of a distribution system to a non-potable use.
- ~~D-B.~~ Systems other than those on a one- or two-unit residential property must be designed to prevent accidental consumption of non-potable water. Therefore, spigots and hose bibs shall be lockable or opened only by use of a special tool.
- C. The soil or foundation upon which the cistern will be placed must be sufficient to support the weight of the cistern when full.
- ~~E-D.~~

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

- A passive drawdown is required for residential-scale, above ground systems. The passive drawdown shall discharge over two to five days to another SCM, which may include DIS. Passive drawdowns shall discharge by gravity.
- Cisterns over 500 gallons that utilize passive drawdown and are intended for nutrient treatment shall direct the drawdown to another SCM that has been sized to receive that rate of runoff.
- Any passive drawdown shall be installed in such a way to prevent easy breakoff of pipes or fittings by people or by-passing equipment.
- Signage for passive drawdown shall be installed and the passive drawdown shall be locked or require the use of a special tool.
- Because the orifice for passive drawdown is often very small, the passive release mechanism shall be equipped with a filter or other device, located on the inside of the tank, to prevent clogging.
- Above ground systems shall include a draw down method.
- Above ground systems shall include a first flush diverter than is accessible by a person standing on the ground or on a ladder.
- On residential-scale above ground systems, screens shall be installed to prevent

access to the water by mosquitoes.

- ~~Screens to prevent mosquitoes for cisterns should be used on residential property.~~

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-7 Rainwater Harvesting](#)

FOR REVIEW ONLY

6.5.8 Green Roof

DESCRIPTION AND APPLICATIONS:

Green roofs layer drainage material, soil media, and plants over waterproofing and insulation layers.

ADDITIONAL REQUIREMENTS BEYOND MDC APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:

NA

- ~~A. The stormwater designer shall ensure that the roof meets its structural goals by involving a North Carolina-licensed design professional with appropriate expertise in roof design. The roof must be designed to support the loads associated with the green roof layers, the designed rainwater storage, and maintenance activities in addition to standard roof loading design.~~
- ~~B. Permanent fall protection measures shall be provided for maintenance activities.~~
- ~~C. A geotextile layer and a drainage layer shall be placed beneath the growing media for roofs with slopes of less than 2%. Granular or aggregate materials may also be used for a drainage layer. The drainage layer should drain to the roof gutters and downspouts.~~
- ~~D.A. The roof shall be equipped with a waterproof membrane to protect against leaks. Structural evaluation of the roof shall be signed and sealed by a North Carolina-licensed structural engineer. Sealed structural calculations shall be included in the calculation submittal package.~~

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):

- The stormwater designer shall ensure that the roof meets its structural goals by involving a North Carolina-licensed design professional with expertise in roof design. The roof must be designed to support the loads associated with the green roof layers, the designed rainwater storage, and maintenance activities in addition to standard roof loading design.
- Permanent fall protection measures shall be provided for maintenance activities.
- A nonwoven, permeable geotextile layer and a drainage layer shall be placed beneath the growing media for roofs with slopes of less than 2%. Granular or aggregate materials may also be used for a drainage layer. The drainage layer shall drain to the roof gutters and downspouts.
- The roof shall be equipped with a waterproof membrane to protect against leaks. Structural evaluation of the roof shall be signed and sealed by a North Carolina-licensed structural engineer. Sealed structural calculations shall be included in the calculation submittal package.
- Fall protection shall be in the form of permanent installed barrier systems. Personal fall protection systems such as cable-based lifelines are not approved will not be accepted as these increase the cost and difficulty of maintenance.
- The green roof shall be accessible to maintenance staff from the building floor serviced by an elevator. Ladder access is not approved will not be accepted.

- Irrigation source shall be provided for plant establishment. If irrigation is desired after establishment, this must be considered in the green roof design as it will impact the stormwater function.
- The use of a leak detection system shall be discussed with the ~~owning department~~ owner or the owning department (for City projects).
- The desired vegetation shall be considered when planning the soil depth.

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-8 Green Roof](#)

FOR REVIEW ONLY

6.5.9 Level Spreader – Filter Strip

DESCRIPTION AND APPLICATIONS:
Level Spreader – Filter Strips (LS-FS) are designed to slow down and distribute the flow of stormwater over a vegetated strip, allowing for natural filtration and pollutant removal. These practices consist of a collection area, a hardened level spreader, and a vegetated filter strip.
ADDITIONAL REQUIREMENTS BEYOND MDC:
<p><u>NA</u></p> <p>RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS):</p> <ul style="list-style-type: none"> A. Pretreatment via a forebay is required when using this device is not downstream of another SCM. The forebay shall be designed to “Recommendation 1: Pretreatment” in the NCDEQ Stormwater <u>Design Manual</u>, Chapter C-9. B. Soil amendment is required to promote plant growth per “Recommendation 2: Soil Amendment” in the NCDEQ Stormwater <u>Design Manual</u>, Chapter C-9. The FS and side slopes shall be covered with at least six inches of stockpiled topsoil, imported topsoil, or a combination of the two. A one-time fertilizer application to the topsoil shouldshall be specified. C. Non-clumping, native, deep-rooted grasses shall be specified. See “Recommendation 3: Grass Specification for FS” in the NCDEQ Stormwater <u>Design Manual</u>, Chapter C-9. D. The depth to the SHWT shall be a minimum of 12 inches measured from the lowest ground surface elevation. E. The angle of entry from the point of discharge to the level spreader shouldshall be parallel and must not be not less than 45 degrees. F. The maximum slope of the Filter Strip shall be 8% in the direction of flow.
IMPORTANT LINKS:
<p>NCDEQ Stormwater Design Manual Chapter C-9 Level Spreader-Filter Strip</p>

Commented [HS4]: removed because this is in LS-FS MDC 10

6.5.10 Level Spreader – Diffuse Flow (No Filter Strip)

Commented [HS5]: This practice is no longer allowed

DESCRIPTION:
A level spreader without a filter strip may be used to meet the Neuse Buffer rules diffuse flow requirement. It will not receive nutrient credit or infiltration credits.
DESIGN REQUIREMENTS:
<ul style="list-style-type: none"> A. The Level Spreader-Filter Strip MDC criteria and guidance shall be utilized for this measure. The MDCs related solely to the Filter Strip will not apply. B. Level Spreader shall be located at least 10 feet upstream from any property line or building and at least 50 feet upstream from streams. C. The angle of entry from the point of discharge to the level spreader shall be parallel and must not be not less than 45 degrees. D. If the land within the first 50 feet downstream of the Level Spreader has a slope greater than 5%, this type of SCM practice may not be used as it will not result in diffuse flow.
IMPORTANT LINKS:
NCDEQ Stormwater Design Manual Chapter C-9 Level Spreader-Filter Strip

6.5.11 Disconnected Impervious Surface (DIS)

DESCRIPTION AND APPLICATIONS:
DIS can mitigate the impacts of stormwater runoff from impervious surfaces in urban and developed areas by directing water that would traditionally be conveyed to stormwater conveyance concentrated drainage systems to vegetated areas where water can be slowed down and encouraged to infiltrate. DIS can also reduce the size and/or number of other site-required SCMs through their reduction of peak flow rate and volume.
<u>ADDITIONAL REQUIREMENTS BEYOND MDC, APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS: None</u>
<u>RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS): None</u>
IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-10 Disconnected Roofs \(DR\) and Disconnected Pavement \(DP\)](#)

6.5.12 Treatment Swales

DESCRIPTION AND APPLICATIONS:

Treatment swales are vegetated, open channels that are explicitly designed and constructed to capture and treat stormwater runoff within dry or wet cells formed by check dams or other means.

ADDITIONAL REQUIREMENTS BEYOND MDC, APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS: None

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS): None

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-11 Treatment Swale](#)

6.5.13 Dry Pond

DESCRIPTION AND APPLICATIONS:

Dry ponds hold water immediately after a storm event and drain to be dry between storm events.

Other Names: Dry Detention Basin

ADDITIONAL REQUIREMENTS BEYOND MDC, APPLICABLE WHEN SCM IS USED FOR RUNOFF RATE REQUIREMENTS:

- If designing for nutrient removal credit, the flow length to pond width ratio (L: W) shall be 3:1.
- If not designing for nutrient removal credit, maximum drawdown is two days.

RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS): None

IMPORTANT LINKS:

[NCDEQ Stormwater Design Manual Chapter C-12 Dry Pond](#)

FOR REVIEW ONLY

6.5.14 Proprietary SCMs

DESCRIPTION AND APPLICATIONS:
<p>Proprietary SCMs are manufactured treatment systems available from commercial vendors. These systems are designed to treat stormwater runoff and/or provide peak runoff control. Only NCDEQ approved <u>Proprietary</u> SCMs will be <u>approved</u> accepted by the City for compliance with nutrient treatment requirements.</p>
ADDITIONAL REQUIREMENTS BEYOND MDCs:
<ul style="list-style-type: none"> • SCMs must have a NCDEQ approved EMC_{effluent} for Total Nitrogen to be used for meeting Nitrogen requirements. This can be found in the NCDEQ <i>Stormwater Control Measure Credit Document</i>. • SCMs Devices that can meet the MDC for Silva Cell Suspended Pavement With Bioretention may be used in lieu of the Silva Cell. <p><u>RECOMMENDATIONS (REQUIRED FOR CITY FUNDED PROJECTS): None</u></p>
IMPORTANT LINKS:
<p>NCDEQ Stormwater Control Measure Credit Document</p> <p>NCDEQ Stormwater Design Manual Part D</p>

6.5.15 Underground Detention

DESCRIPTION AND APPLICATIONS:
Underground detention storage is in subsurface tanks, pipes, or vaults designed to provide peak runoff control.
DESIGN REQUIREMENTS:
<p>A. Joint sealing specifications shall be provided <u>included in the plans or specifications. If in specifications, the joint sealing specification sections shall be included in the SCR.</u> -</p> <p>B. Leak testing procedures and the “acceptable leak rate”, <u>as defined in Section 6.3.3 above</u> shall be <u>included in the plans or specifications. If in the specifications, the leak testing specification sections shall be included in the SCR.</u> specified.</p> <p>C. Adequate maintenance access must be provided for all underground detention systems, and at a minimum, be provided over the inlet pipe and outflow structure. Access openings must meet the drainage structure requirements in Chapter 4 of this Manual.</p> <p>D.C. <u>_____</u> If the underground detention does not have other SCMs upstream, a separate sediment sump or chamber shall be provided for pretreatment. This shall be sized to 0.1 inches of depth per acre of contributing drainage area. The minimum depth shall be X3 inches. The sediment sump or chamber does not count towards the storage volume for <u>underground detention</u>the practice.</p> <p>E. The minimum orifice diameter is three inches. Outlets shall be adequately protected from clogging by trash rack. Adjustable gate valves can also be used to achieve smaller equivalent diameters.</p> <p>F.D. <u>_____</u> A high-flow bypass shall be included to safely pass the 100-year storm.</p>

Commented [HS6]: This requirement is encompassed by Section 6.3.10 above.

Commented [HS7]: See section 6.3.9 above

Minimum Maintenance Requirements:

TYPICAL MAINTENANCE ACTIVITIES FOR UNDERGROUND DETENTION SYSTEMS	
Activity	Schedule
Remove any trash/debris and sediment buildup in the underground vaults or pipe/tank systems	Annually
Perform structural repairs to inlet and outlets	As needed, based on inspection

Maintain groundcover and stability of overall site to reduce incoming sediment loads	As needed, based on inspection
--	--------------------------------

FOR REVIEW ONLY

6.5.16 Permanently Protected Undisturbed Open Space (PPUOS)**DESCRIPTION AND APPLICATIONS:**

PPUOS ensures that vegetated areas will remain in a forested state. This reduces the required nutrient treatment and runoff control at a site.

DESIGN REQUIREMENTS:

- Permanent fencing of the PPUOS is required. This requirement is waived within stream buffers and floodways.
- PPUOS must be recorded on a map.

TYPICAL MAINTENANCE ACTIVITIES FOR UNDERGROUND DETENTION SYSTEMS

<i>Activity</i>	<i>Schedule</i>
<u>Inspect the perimeter of the PPUOS for encroachments of unallowed activities.</u>	<u>Annually</u>
<u>Inspect the fencing.</u>	<u>Annually</u>

6.6 SCM OPERATIONS & MAINTENANCE REQUIREMENTS

Operations and maintenance (O&M) refer to the performance and ongoing upkeep of an SCM after construction has finished. An O&M Manual, a recorded drainage Easement for the purposes of SCM access, and an Inspection and Maintenance Agreement shall be completed ~~at~~ as part of the permitting process to ensure proper long-term maintenance of each SCM.

6.6.1 Operations and Maintenance Manual

To provide stormwater treatment as designed, SCMs must be properly operated and maintained. Therefore, a site-specific Operations and Maintenance Manual (O&M Manual) that specifies all upkeep necessary for the function of all SCM components is required. The O&M Manual shall be submitted with the permitting submittal and an updated version of the O&M Manual shall will be submitted with the SCM as-built submittal. If the O&M procedures associated with a SCM must be changed, an updated O&M Manual shall be submitted with the Annual Inspection documentation.

One O&M Manual shall be provided for each project or phase of development and shall address each SCM to be constructed for that particular project or phase of development device, and The O&M Manual shall be signed and sealed by a qualified ~~registered~~ North Carolina-licensed professional engineer, land surveyor, or landscape architect.

The O&M Manual shall cover requirements for the stormwater conveyance system, perimeter of the applicable SCM device, inlet(s), pretreatment measures, main treatment area, outlet, vegetation, and discharge point.

All SCMs O&M Manuals must incorporate the elements and O&M tasks found in reflect the following sources at a minimum:

- UDO Section 9.2.2.D.2.
- NCDEQ Stormwater Design Manual, Part A-7, SCM Operation and Maintenance.
- NCDEQ Stormwater Design Manual, SCM-specific chapters dealing with maintenance items.

The ~~above~~ NCDEQ items are summarized in the Storm EZ O&M Supplement.

Components of an O&M Manual shall include all of the following:

- A cover page with the project name, City case file number, name and seal of the North Carolina-licensed design professional.

- A table listing each SCM name(s)/identification, device-type, brief description, and purpose (e.g. Nitrogen only, Nitrogen and Runoff Rate, Watershed Overlay, Diffuse Flow).
- An exhibit, sized to 8.5" x 11", showing the SCM(s) locations, identifiers ~~and easement locations~~, and identifying the parcels that achieve compliance under this stormwater control plan.
- Exhibit(s) showing the drainage areas to each SCM, such exhibit(s) sized to no more than 11"x17," and showing parcel boundaries.
- Plan sheets or exhibits that show the plan view and details (cross-section, profile, flow-splitter, outlet control structures) of each SCM sized to no more than 11"x17".
- A description of the maintenance access procedures. If confined entry will be required, this shall be included.
- Planting plan and schedule of plantings.
- SCM or SCM component manufacturer information, if applicable.
- SCMs that serve to meet stormwater runoff compliance requirements for multiple lots are shared in their entirety among all lots within the subdivision, regardless of which lots drain to each SCM in the subdivision device. ~~Each~~ In each O&M Manual for a shared SCM, ~~the design professional~~ shall provide include a description of which lots are served by the SCM device (UDO Section 9.2.2.D.2.d).
- An inspection checklist including frequency of inspection and SCM items/components to be inspected.
- Maintenance ~~instructions~~ including:
 - ~~Minimum of the sSteps~~ Maintenance tasks listed in the NCDEQ Stormwater Design Manual and this Manual document.
 - SCM Manufacturer sSpecified sSteps maintenance procedures.
 - Quantitative triggers for when ~~actions-maintenance or repair actions~~ must be taken.
 - Expectations for documenting maintenance.
 - Inspection of maintenance access route.
 - Special equipment needed for maintenance.
 - The maximum pumped draw down rate of the SCM for maintenance, given in gallons per minute (gpm).
 -
- An indication of which O&M actions are needed for the SCM(s), who will be responsible for those actions, and the specific, quantitative criteria that shall be used to determine when these actions will be taken (UDO Section 9.2.2.D.2.e)

- An indication of the steps that shall be taken to restore a SCM device to the design specifications in the event of a failure (UDO Section 9.2.2.D.2.f)
- A statement about the expected repair life of the SCM device (UDO Section 9.2.2.D.2.g)
- A replacement cost schedule, derived by dividing the initial construction cost of the SCM by the expected life of the SCM device and its components. (UDO Section 9.2.2.D.2.g)
- A budget to include annual costs, such as routine maintenance, repair, periodic sediment removal, replenishment of riprap, insurance premiums associated with the SCM device/SCM facilities, taxes levied against the SCM device/SCM facilities, mowing and reseeding, replacing vegetation as necessary, and required inspections (UDO Section 9.2.2.D.2.j h)

6.6.2 Recorded Easement Requirements

See Chapter 7 of this Manual, Section 7.4, for SCM drainage eEasement requirements for SCM access.

6.6.3 Inspection and Maintenance Agreements

To ensure proper long-term maintenance, an Inspection and Maintenance Agreement shall be required for any site containing one or more SCMs. These agreements shall be signed and notarized and recorded. The Agreement will reference the O&M Manual.

6.7 AS-BUILT CERTIFICATIONS AND SURVEYS

Upon project completion of the permitted work, the City shall requires submittal of certifications and as-built information to verify compliance with all applicable stormwater regulations. City acceptance of the as-built certifications and/or impervious or built area surveys are required on a project or a building prior to final approval of one or more of the following for a project or building: the Stormwater Control Permit, the Certificate of Compliance, the Certificate of Occupancy or the Partial Certificate of Occupancy (commercial only).

6.7.1 Stormwater Control Measures

All SCMs require certification by an appropriate design-licensed professional qualified in SCM design as detailed in UDO Section 9.2.2.D.1.a., verifying that the actual construction of the SCM measure conforms to the approved plans and provides the required level of stormwater treatment and/or peak flow control. The as-built plans and certification must be signed and sealed by an appropriate design professional, and all applicable checklist items must be included. Refer to the As-Built Checklist on the City's Stormwater website.

As-built Submittals shall will include all of the following:

- Form 503, signed by the City sStormwater inspector
- Completed checklist and certification by a licensed professional qualified in SCM

~~design as detailed in UDO Section 9.2.2.D.1.a. professional qualified in stormwater design.~~

- Reference to the recorded map showing private drainage easements for SCM access (reference Register of Deeds book and page).
- Narrative summary ~~of SCMs and~~ any deviations from approved development plans.
- Surveyed elevations of ~~key~~ SCM components.
- Redlines of approved SCM plans, details, and planting plans.
- Shop Drawings (when applicable).
- Updated SCR calculations reflecting any hydrologic and hydraulic changes from the ~~permitted approved development~~ plans to the as-built conditions.
- Updated O&M Manual, including any changes to the O&M Manual to reflect as-built conditions.
- Photos of ~~the following SCM components~~ key components of the SCM:
 - Above Ground SCMs: ~~Including but not limited to A~~ all orifices (where flow enters and exits), inside of the riser structure, all inlets and outlets (including flared end section, pipe interior, and dissipater pads), outlet discharge area, earthen berms/weirs, emergency spillways, dam embankments, and all slopes (interior and exterior), ~~etc.~~ Photos shall be dated and must be taken within 7 days of the initial as-built submittal to the City.
 - Underground SCMs: ~~including but not limited to A~~ all orifices (where flow enters and/or exits), inlet structures (interior/exterior), weir walls, interior of SCM (for example, ex: detention pipes, sand filter chambers, sediment chambers, flow splitters), interior of outlet piping, outlet dissipator, and discharge area. ~~Confined space training or specialized equipment may be required.~~ Photos ~~As-~~ shall be dated and must be taken within 7 days of the initial as-built submittal to the City.
 - Some SCMs will require photographs taken during construction to verify that they were constructed in accordance with the approved development plans (~~ex-~~ permeable pavers, underground SCMs, and/or any SCM that ~~requires~~ includes underdrains, ~~or~~ anti-seep collars, or filter diaphragms). SCMs that require underdrains must be photographed during construction to show that ~~shall provide photographs of underdrains showing appropriate capping~~ has been provided to prevent bypass. Any during-construction photographs submitted, ~~must should~~ be dated. These photos shall be included with the as-built submittal to the City.
 - Planting photos of plantings in the SCM. Photos shall be dated and must be taken within 7 days of the initial as-built submittal to the City.
- Receipt/invoice/bill of sale with list of plants purchased.
- Documentation of any required testing or materials certification with respect to the

applicable SCM.

Once ~~the~~ as-built plans and certification are ~~is~~ accepted by the City, the SCM will enter the maintenance phase and will be maintained and inspected by the responsible party in perpetuity.

6.7.2 Impervious Area or Built Area Surveys

Submittal of as-built impervious surveys is required if impervious restrictions are a ~~permit~~ condition ~~of the Stormwater Control permit for the project of approval for a project, and~~ the submitted impervious area or built area survey shall be sealed by a North Carolina licensed professional land surveyor. An as-built impervious survey ~~must~~ should include depict all areas considered impervious per the UDO. The requirement applies to:

- New single-family dwellings and additions/improvements to single-family dwellings when the total impervious area is within 10% or 400 SF of the maximum impervious area limit, whichever is greater.
- Re-development proposing no change in impervious area and substitution of impervious area over 400 SF.
- Any non-residential site with an impervious area limit as part of its conditions of development or Stormwater Control permit approval.

Chapter 7

EASEMENTS

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7.1 INTRODUCTION

Several types of drainage easements are required with development in the City of Raleigh. ~~This~~ These shall include drainage easements for the purposes of:

- Downstream ~~d~~Discharge where concentrated flow enters a private property at a location other than a stream. See Section 7.2 of this Manual.
- Conveyance ~~s~~Systems, including easements for new and existing open and closed conveyance systems such as, including pipes, channels, structures, culverts, and bridges. These easements shall include access from the ROW for maintenance and repair purposes. See Section 7.3 of this Manual.
- SCMs ~~e~~Easements that encompass, including both the SCM and the access path from the ROW for maintenance and repair purposes. See as detailed in Section 7.4 of this Manual.
- Dams not considered SCMs. See Section 7.5 of this Manual.
- Flood storage ~~easements~~, where development results in an increase in flood levels. See Section 7.6 of this Manual.

A specific drainage easement may serve several of the purposes described above. However, public and private drainage easements shall not overlap. The described easements purposes may share the same easement space if all other requirements are met.

Drainage Easements shall be ~~determined~~ deemed to be either pPublic Drainage Easements or Pprivate Drainage Easements as described in Section 7.27 of this Manual.

Proposed drainage easement locations shall be shown on the preliminary and/or permitting submittals, ~~whichever comes first. See Section 7.8 of this Manual regarding recording easements. All required drainage easements, unless otherwise specified in the UDO, shall be recorded on a plat to be recorded in the Wake County Register of Deeds Office or the Durham County Register of Deeds office, whichever shall apply.~~

7.2 DOWNSTREAM DISCHARGE EASEMENTS

Downstream Pprivate drainage easements shall be provided ~~for the following on any new development or redevelopment~~ when newly concentrated stormwater discharge locations are created by ~~the~~ proposed development or redevelopment that discharges to other parcels. ~~For this section, "Newly concentrated flow" shall include any flow that is more concentrated than existing conditions even if it passes through a level spreader, plunge pool, dissipation pad or other engineered device.~~

~~then the 10-year stormwater flows from these new discharge locations shall be conveyed through an offsite drainage easement that has been secured and recorded in the Wake County Register of Deeds Office or the Durham County Register of Deeds Office, whichever shall apply, between the developer and all downstream, impacted property owner(s). Such private drainage~~

easements are required on or off the project site until the point where the newly concentrated stormwater flow reaches:

- ~~Aa~~ jurisdictional water body,
- ~~Aa~~ City or NCDOT ROW ~~right-of-way (ROW), or~~
- Another public or ~~/~~private drainage easement.

~~“Newly concentrated flow” shall include any flow that is more concentrated than existing conditions even if it passes through a level spreader, plunge pool, dissipation pad or other engineered device.~~

~~Also note the requirements for a Flood Storage Easements (Section 7.6) and for an overland flow path for the 100-year storm.~~

7.3 CONVEYANCE SYSTEMS EASEMENTS

Drainage Easements for open or closed stormwater conveyance systems are required for conveyance systems carrying runoff from:

- More than one parcel
- An upstream conveyance system in a drainagen easement.
- ~~An~~ SCMs
- ~~The~~ Public ROW

Minimum Easements widths are have been determined based on maintenance needs. ~~Adequate sized d~~Drainage e easements shall ~~be provided to~~ allow for access of construction equipment, taking into consideration the limitations that may be imposed by embankment slopes or other obstacles. Drainage Easements for conveyance systems shall be centered over the pipe or channel/swale. Proposed Off-center easement locations shall ~~be allowed when it can~~ be demonstrate in the SCR to City Stormwater staff that the infrastructure could be accessed, maintained, and replaced using the proposed easement configuration. The access portion of a drainagen easement does not need to be centered over the structure.

TABLE 7.1 <u>MINIMUM</u> EASEMENT WIDTHS FOR PIPES	
<i>Pipe Scenario</i>	<i>Easement Width</i>
Single Pipe	20 ft or 10 ft + pipe diameter + (2x the larger invert depth), whichever is greater
Multiple Pipes	20 ft or 10 ft + outside pipe widths + (2x the larger invert depth), whichever is greater

TABLE 7.2 MINIMUM EASEMENT WIDTHS FOR OPEN CHANNELS OR SWALES*	
Drainage Area	Easement Width ¹
< 5 ac	5 ft on each side from centerline
5 ac to <25 ac	10 ft on each side, from top of bank
25 ac and larger	50 ft on each side, from top of bank
*This applied applies to channels and swales that are not jurisdictional waters or regulated Neuse riparian buffers.	

TABLE 7.3 MINIMUM EASEMENT WIDTHS FOR BRIDGES AND CULVERTS	
Equivalent Size	Easement Configuration
Up to 36" dia.	The <u>Drainage</u> Easement must contain the upstream and downstream inverts of the conveyance structure + minimum 10' offset from the structure(s) including headwalls and wingwalls
36" and greater diameter	The <u>Drainage</u> Easement must contain the upstream and downstream inverts of the conveyance structure + minimum 10' offset from the structure(s) including headwalls and wingwalls And Provide a 25' <u>width-wide drainage easement for access path</u> to the structure invert from a public ROW where <u>the path drainage easement</u> does not involve traversing lateral or across <u>incline</u> slopes that exceed 3:1. <u>The configuration of this portion of the easement will vary based on site conditions. ∴ the easement shall not increase the impacts to buffers and waterways.</u>

Where other utilities are involved, such as water and sewer, additional easement width for the combined easements shall be provided according to guidelines in the [Public Utilities Handbook](#), but in no case shall the easement widths be less than those listed above.

7.4 SCMs EASEMENTS

Stormwater control measures, conveyance systems transporting stormwater runoff from a SCM, space for maintaining the SCM, and access to the SCM from the ROW all shall be placed in a Private Drainage Easement. This includes:

- The entire footprint of the SCM system shall be included in the drainage easement, plus an additional 10 feet or more around the SCM to provide adequate room for ~~the~~ construction equipment and activities necessary to complete maintenance, repair, or replacement tasks.
- Direct maintenance access shall be provided to each component of the SCM requiring maintenance activities. This includes components such as the forebay, riser structure, plantings, embankment, outlet, and emergency spillway.
~~If heavy equipment For constructed ponds and wetlands, will be necessary to perform maintenance tasks, such as for devices with a forebay that will require sediment clean-out, the required easement is shall be 25 feet off the edge of the SCM at points where forebay and main pool sediment removal will be performed. Drainage eEasements do not need to be centered on the SCM if it can be shown that adequate space for maintenance, repair, and replacement is provided.~~
- A private drainage Stormwater Conveyance easement for ~~at~~ stormwater conveyance systems will shall be applied to each outflow from the SCM, beginning at ~~from~~ the SCM ~~to~~ and extending to a point where the flow reaches a ROW, a jurisdictional water body, or another public or private drainage easement.
- Drainage easements for maintenance of and access to SCMs shall extend to a public ROW and shall not include longitudinal or cross slopes that exceed 3:1 (horizontal to vertical).

~~Direct maintenance access shall be provided to each component of the SCM requiring maintenance activities. This includes components such as the forebay, riser structure, plantings, embankment, outlet, and emergency spillway.~~

~~Drainage eEasements for maintenance of and access to of SCMs shall extend to a public right of way ROW and shall not include lateral or incline slopes that exceed 3:1 (horizontal to vertical).~~

Drainage Easements for SCM facilities, including for conveyance systems transporting stormwater runoff from the SCM facilities, shall be held by the entity responsible for the operation and maintenance of the SCM facility, whether an individual, a corporation or a government unless determined otherwise. See the requirement in UDO Sec. 9.2.2.G.2 that private drainage easements are required for off-site SCMs that are shared devices among multiple lots. Easements for SCMs that are not publicly maintained require provisions that allow the permitting entity-City to access the device for inspections and to perform maintenance and repair activities in the event the responsible party is failing to do so. ~~potential assessments.~~ In no case shall the recorded easement confer an obligation on the City to assume responsibility for the SCM.

7.5 EASEMENTS FOR DAMS

For existing or proposed dams that are not considered SCMs, the primary and emergency dam spillways shall be placed in a private drainage easement. The drainage easement ~~will~~ shall include access to the dam from a public right-of-way ROW and the accompanying ~~at~~ access path shall not include ~~lateral~~ longitudinal or ~~incline~~ cross slopes that exceed 3:1 (horizontal to vertical). The easement shall grant rights to the parties considered owners of the impoundment. It shall also allow the City to access the device for inspections and to perform maintenance and repair activities in the event the responsible party is failing to do so.

7.6 FLOOD STORAGE EASEMENTS

No increased ponding or conveyance depth shall be permitted on adjacent properties for the 100-year event, unless the increase is located within a flood storage-private drainage easement granted by the impacted property owner(s) to the owner ~~owner responsible for creating the the~~ increased ponding.

A backwater analysis will be required to be submitted to the the City for new culverts to show possible impacts to flood levels both on site and on neighboring properties. If the backwater analysis shows there is an impact on neighboring properties for the 100-yr storm event, a flood storage-private drainage easement will be required.

For regulated floodplain areas, Chapter 9 of this Manual and UDO Article 9.3 may have more stringent requirements.

7.7 PUBLIC VERSUS PRIVATE DRAINAGE EASEMENTS

Unless otherwise specified in this Manual, all required easements ~~should be assumed to~~ shall be Private ~~d~~ Drainage ~~e~~ Easements.

The following items ~~should be~~ Public ~~d~~ Drainage ~~e~~ Easements:

- Easements identified by NCDOT as easements to be held by NCDOT.
- Easements associated with ~~the~~ culverts or bridges serving a City Road will be held by the City and shall be labeled as City of Raleigh Permanent Drainage Easement.
- Easements for the purposes of stormwater conveyance that convey runoff from public ROWs, starting at the first structure after the tie-in of a new SCM shall be held by the City and shall be labeled as City of Raleigh Permanent Drainage Easement.
- Easements held by public entities other than the City of Raleigh or NCDOT, when identified by those entities.

7.8 RECORDING EASEMENTS

Easement recordation on maps will take place via the City's Recorded Map process at the timeline specified in the project's conditions of development approval or in the UDO. Proposed maps depicting drainage easements are required to show metes and bounds for the drainage easement(s). Maps must label all drainage easements as "Private Drainage Easement", "City of Raleigh Permanent Public Drainage Easement", or "Private Flood Storage Easement NCDOT Permanent Drainage Easement" or as public easement held by a public entity other than the City or NCDOT as discussed above determined by Section 7.7 of this Manual. The applicant may choose to include a parenthetical sub-label, but that is not required by the City.

An instrument document establishing the rights and obligations associated with the drainage easement also shall ~~also~~ be recorded in the Wake County Register of Deeds Office or the Durham County Register of Deeds Office, whichever shall apply. This can be accomplished through completion and recording of one of the City's locked templates for drainage ~~E~~easements, either the "Declaration of Maintenance Covenant and Grant of Protection Easements for Stormwater Control Facilities" which applies to off-site SCMs that are shared devices among multiple lots, with the recording of the Maintenance Covenant required by UDO Section 9.2.2.G.2, or the "Private Drainage Easement" [new document to be named].

7.9 ABANDONMENT OF EASEMENTS

There are specific cases where easements may be relocated or removed.

- If a site ~~redevelops, including~~ relocates stormwater infrastructure, the associated existing drainage easement ~~shall be~~ abandoned and new drainage easement location(s) ~~may~~ shall be proposed during the development review process.
- If the existing drainage easement does not meet one of the purposes listed in this chapter and does not ~~provide additional flood protection and water quality benefits by~~ preserving a wider stream or channel buffer, then abandonment may occur through the City's Recorded Map process. Potential applicants are advised to discuss the property with a stormwater reviewer prior to application.

7.10 WORK IN EASEMENTS

This section defines what is allowed and disallowed in ~~p~~Private ~~D~~rainage ~~E~~easements and, City of Raleigh Permanent Public Drainage Easements, ~~and Private Flood Storage Easements.~~

When evaluating proposed work in an easement, the goals of the purpose of the easement are evaluated. The following principles are applied:

- A. The work must not permanently limit access for maintenance, repair, and replacement ~~of~~ the drainage infrastructure contained in the easement.
- B. The work must not increase the cost to the easement holder for conducting maintenance, repair, or replacement ~~of the drainage~~ stormwater conveyance infrastructure or SCM contained in the easement.
- C. The work must not impede the flow of water through the easement.
- D. The work must not directly damage the drainage infrastructure contained in the easement.
- E. The work must not increase the loading on the drainage infrastructure beyond the load originally ~~considered~~ contemplated in the stormwater design.

The table below applies these principles to common situations. This table does not negate the need for other required permitting. Please contact a stormwater reviewer if there are questions about what is allowed in an easement.

Proposed Item	Allowed?	Conditions or Exceptions:
Accessory Structures (e.g. Sheds, Garages, Carports, Coops, etc.)	Not Allowed	<u>N/A</u>
Buildings	Not Allowed for Residential Not Allowed, with 1 exception <u>Conditional</u> for Non-Residential.	F <u>Exception</u> for Non-Residential structures: Underground SCMs may be placed under buildings when the specific requirements in <u>Chapter Section 6.3.4 of this Manual</u> have reviewed and approved <u>been met.</u>
Decks/porches	Not Allowed, including the overhang of these structures.	<u>N/A</u>
Driveways	Conditional	Allowed if <u>stormwater</u> conveyance pipes and structure <u>SCMs</u> meet current City requirements for cover and loading <u>per Chapter 4 and 6 this Manual.</u> Not allowed infor open conveyance <u>unless perpendicular.</u>
Fences	Conditional	Fences are allowed if they meet the following criteria, as demonstrated on the plot plan: <ul style="list-style-type: none"> - Crossing a conveyance easement perpendicular to the easement. - When <u>If</u> running perpendicular <u>parallel</u> at to the conveyance easement, footings need to be a minimum of

		<p>5' from the infrastructure pipe centerline/<u>SCM edge</u> or at a 1:1 slope away from the pipe <u>or SCM</u> invert, whichever is larger.</p> <p>AND</p> <ul style="list-style-type: none"> -Not impeding flow <p>AND</p> <ul style="list-style-type: none"> -Not over a drainage structure <p>AND</p> <ul style="list-style-type: none"> -Posts in the easement will be hand dug. <p><u>AND</u></p> <ul style="list-style-type: none"> <u>-A gate is provided for access.</u>
Headwalls, Endwalls and Wingwalls	Allowed	These structures are directly related to stormwater infrastructure.
HVAC or Other Equipment	Conditional	Must demonstrate that the principles listed above this table are met. <u>Allowed on residential lots if the conditions for fences are met.</u>
Patios and Private Pathways	Conditional	Allowed if conveyance pipes and structures meet current City requirements for cover and loading. Not allowed for open conveyance <u>Allowed if the conditions for Driveways are met.</u>
Play Equipment	Conditional	Must demonstrate that the principles listed above this table are met. <u>Allowed on residential lots if the conditions for fences are met.</u>
Pools	Not Allowed	<u>N/A</u>
Retaining walls	Dependent on where the retaining wall and the fill are placed. <u>Conditional</u>	<p><u>In drainage easements around SCMs, retaining walls are allowed if Section 6.3.4 of this Manual is met.</u></p> <p><u>Retaining walls with perpendicular intersections with storm drainage pipe are allowed if designed and permitted at the same time.</u></p> <p><u>Applications for new retaining walls in existing drainage easements containing stormwater conveyance infrastructure or SCMs must contain analysis that addresses principles A through E at the start of this Section. It is important to</u></p>

		analyze the increased pressure any wall will add to the pipe, if additional fill is placed on the pipe or if the wall is located in close proximity to the pipe more analysis may be required
Signs	Conditional	<p>Dependent on the type of sign, e.g.:</p> <ul style="list-style-type: none"> - Large sign with footers placed on top of pipe, would will not be allowed - <u>Signs on posts less than 6" in width or depth</u> Street sign would will be allowed if followed the <u>must follow the criteria guidance</u> for fence posts in this table. - <u>Signs with larger footers are not allowed.</u>
Vegetation - Planting (Trees, Shrubs, Landscape Beds)	Conditional	<p>In general plants complement stormwater functions. Plants are allowed in <u>drainage</u> easements when the following <u>is are met as</u> demonstrated on the plans:</p> <ul style="list-style-type: none"> • <u>Plants-Vegetation</u> other than grass <u>are is</u> not allowed in <u>the easement for access path</u> portion(s) of an <u>easement serving a</u> SCM <u>easement</u>. • Plants cannot change the topography in a way that redirects flow outside the <u>drainage</u> easement. • Trees may not be planted directly over stormwater infrastructure that has less than <u>X5</u> feet of cover.
Vegetation - Planting (Grass)	Allowed	
Vegetation - Removal	Conditional	<ul style="list-style-type: none"> • Removal cannot change the topography in a way that redirects flow outside the easement. • Removal with <u>in</u> SCMs must be <u>in performed according to</u> line with the SCM design and O&M documents.

Chapter 8

EROSION AND SEDIMENT CONTROL

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8.1 INTRODUCTION

Erosion and sedimentation control devices and best practices are imperative in the protection of waterways, downstream properties, and infrastructure. This chapter describes the erosion and sedimentation control (ESC) requirements for the City. Adherence to this chapter, the City's ~~Unified Development Ordinance (UDO)~~, City ESC Standard Detail Drawings, as well as to ~~the North Carolina Department of Environmental Quality (NCDEQ's)~~ ["Erosion and Sediment Control Planning and Design Manual"](#) is required.

Land Disturbance grading (LDG) permits are required for all projects that disturb 12,000 square feet (0.275 acres) or more of land area. Prior to the issuance of a LDG permit, an erosion and sedimentation control (ESC) plan must be designed/submitted to and approved by the City. ~~Appropriate measures~~The approved plan must include ESC measures must be designed, approved, permitted, and that shall be installed on the site prior to any land-disturbing activities. See UDO Article 9.4 for ~~cases that require when~~ permitting is required for less than 12,000 square feet of land disturbance.

All land-disturbing activities undertaken within the City shall provide ~~adequate~~ ESC measures to protect public and private property from erosion and sediment damage as a result of the land-disturbing activity, regardless of the amount of land disturbed. Whether a LDG permit is required or not, ESC measures are required to be installed to protect from erosion and sediment as necessary for water quality and natural resource protection in our communities.

8.2 SELECTED DESIGN CRITERIA

All ESC measures shall be designed to the standards in ~~the~~ NCDEQ's ["Erosion and Sediment Control Planning and Design Manual"](#), the City's ESC Standard Detail Drawings, the City's UDO, or this Manual, whichever is more stringent.

8.2.1 Limits of Disturbance

The Limits of Disturbance (LOD) shall include all land disturbing activity, as defined in UDO Section 12.2, and encompass all construction activities including, but not limited to, the following:

- Construction Access (minimum of 10' around structures or extended to the property line if the property line less than 10 feet away from the structure)
- Equipment and Vehicle Parking
- Equipment and Vehicle Maneuverability
- Demolition
- Clearing and Grubbing
- Erosion Control Measures
- Material Staging and Storage
- Earthen Stockpiling

- Excavating and Filling
- Fine Grading
- Change of Cover (i.e. draining a pond, ~~etc.~~)
- Dredging

8.2.2 Clean Water Diversions

Offsite runoff that naturally enters the disturbed area can be directed around the disturbed area as “clean water” via stabilized ditch or pipe/culvert. A stable diversion ditch shall be designed to the same standards as a temporary diversion ditch. However, when utilizing a ditch as a “clean water” diversion, seed and straw alone ~~shall may~~ not be used for stabilization. A stable outfall shall be designed in combination with a ditch or piped conveyance. Treatment or detention of “clean water” runoff is not required and silt fence shall not be placed upslope of the “clean water” diversion.

8.2.3 Dewatering

When de-watering of an erosion control measure by pumping is required, the outflow of the pump shall be connected to a silt bag. The silt bag shall be installed per the City's ESC Standard Detail Drawing, as the same may be amended from time to time, shall be placed on a flat area, and silt fence/silt fence outlet shall be placed at the downslope side of the bag. The City inspector shall be notified prior to dewatering.

8.2.4 Stockpile Requirements

Earthen stockpiles shall be shown on the ESC plan and setback from adjacent property lines to allow for construction access and installation and maintenance of surrounding ESC measures. Stockpile slopes shall be 2:1 or flatter. At no time shall a stockpile exceed a height of 35-feet. Stockpiles shall be removed prior to the end of the project and closeout of LDG permit.

8.2.5 Work in or Over Watercourses

Temporary bridges or culverts shall be employed when construction equipment is required to cross natural or constructed channels. These structures must be identified on the approved ESC plan and include the applicable City ESC Standard Detail Drawing. Prior to installing bridges or culverts, authorization may be required by state and/or federal agencies.

When permitted work is required within an active watercourse, work must be conducted in the dry or a means of diverting the watercourse must be provided. All components of the diversion plan must be shown on the ESC plan with ~~relevant~~associated details provided. This includes grading for diversion channels, silt bag placement, impermeable berm locations, pump intakes, pump outlet and energy dissipation, and any other physical elements as applicable.

8.2.6 Sites One Acre or Larger

The National Pollutant Discharge Elimination System (NPDES) General Construction Permit, NCG010000 (NCG01), requires that ~~land-disturbing activities disturbing one acre or more, or that are part of a larger common plan of development (as defined in the NCG01 permit) disturbing one acre or more, are required to~~ obtain NCG01 coverage ~~under National Pollutant~~

~~Discharge Elimination System (NPDES) General Construction Permit, NCG010000 (NCG01).~~ Coverage under the NCG01 ~~p~~Permit requires, at a minimum, an approved ESC plan and subsequent submission of electronic Notice of Intent (e-NOI) to NCDEQ in order for the NCG01 to be issued to by NCDEQ.

8.2.7 Sites 20 Acres or Larger

If 20 acres or more are included in the LOD, the following ~~requirements shall be required in the ESC plan submittal~~ apply:

- Demonstrate how Method of limiting the time of exposure and amount of exposed area is limited.
- Cut/fill analysis with an exhibit that shows where soil will ultimately be moved from one area of the tract to another between the pre-development and post-development conditions, which must include pre- and post-construction contours. When earthen material is proposed to be hauled off-site, the ESC plan must include address of location material is to be hauled including applicable project name and permit number (when required).
- The construction sequence on the ESC plan shall detail phasing to justify the time and amount of exposure.

8.3 SINGLE-FAMILY RESIDENTIAL CONSTRUCTION

8.3.1 Common Plan of Development and Permit Requirements

A LDG permit is required when 12,000 square feet or more of land disturbance will occur within a new proposed residential development ~~plan~~ (including demolition), on a single residential lot, or on multiple residential lots by the same person within the same residential subdivision. A person conducting land-disturbing activity is any individual, partnership, firm, association, joint venture, public or private corporation, trust, estate, commission, board, public or private institution, utility, cooperative, interstate body or other legal entity. Subdivision will be defined by one of the following: an active subdivision case or, a ~~recorded~~ subdivision as demonstrated by a ~~recorded~~ map or other land records recorded in the Register of Deeds information. Staff will also review the applicable cCounty GIS parcel data and the ~~City's~~ subdivisions layer in iMaps.

When determining the area of land disturbance, the square footage of disturbance shall be aggregated, regardless of:

- Whether the lots are under single or diverse ownership
- Whether the lots are adjoining or not
- The date of the subdivision-

The NCG01 ~~p~~Permit requires a Certificate of Coverage from NCDEQ if a single-family lot(s) is

within a common plan of development that disturbs one acre or more.

~~Unless otherwise required in Article 9.4 of the UDO, if a person disturbs less than 12,000 square feet within a common plan of development disturbing one acre or more, the City will not require a LDG Permit. However, a NCG01 Permit must be obtained from NCDEQ which would also require ESC plan approval through NCDEQ. Therefore, an ESC plan approval may be required by NCDEQ.~~

If a person disturbs 12,000 square feet or more within a common plan of development disturbing one or more acre, the City will require a LDG Permit. The LDG Permit submittal to the City must include the items noted below in Section 8.4.5.

8.3.2 Requirements if LOD under 12,000 sf

For single-family lots with a LOD under 12,000 square feet that do not require a LDG Permit, ESC measures are required to be installed per City ESC Standard Detail Drawing specifications. These measures must be appropriate for site and topographic conditions and include, but are not limited to, the following:

- Construction entrance for each point of access measuring, at a minimum, 12 feet in width by 20 feet in length and composed of two- to three-inch railroad ballast or at least six inches of surge stone per the City ESC Standard Detail Drawing. When existing paved driveways remain, the construction entrance shall extend from the point of entrance onto the site from the existing driveway.
- Silt fence/silt fence outlets on the low sides of the lot.
- ESC measures on high sides of lot to prevent off-site sedimentation and to restrict access to the construction entrance.
- Inlet protection if a catch basin or yard inlet is located within the limits of disturbance.

8.3.3 Groundcover/Stabilization Requirements for Single-Family Lots

Projects on single-family lots vary in size and the amount of land disturbance associated with each project also varies.

- For projects that results in a LOD of less than 400 square feet, permanent groundcover must be applied over 100% of the disturbed area prior to approval of final inspection of the Stormwater Control Permit and issuance of Certificate of Occupancy. See Section 8.7.1, below, for groundcover specifications.
- For projects that results in a LOD of 400 square feet or more, permanent stabilization must be achieved prior to approval of final inspection of the Stormwater Control Permit and issuance of Certificate of Occupancy. See Section 8.7.2, below, for stabilization specifications.

8.4 SUBMITTAL REQUIREMENTS

The following items are required for LDG permit approval.

8.4.1 Financial Responsibility/Ownership (FRO) Form

The original FRO form must be submitted to the City prior to LDG ~~p~~Permit issuance. See the UDO for the FRO requirements and the City's website for specific submittal procedures.

8.4.2 Surety

A surety ~~as required in Section 9.4.4.A.1.c. of the UDO~~ must be supplied to the City for the area of land disturbance prior to LDG ~~p~~Permit issuance. See the UDO for the surety requirements and the City's website for specific submittal procedures.

8.4.3 ESC Calculations

Design calculations associated with the ESC measures ~~either~~ shall be ~~either~~ shown on the ~~design-ESC~~ plans or included in the SCR. Calculations must be sealed by a North Carolina licensed professional engineer, landscape architect, or land surveyor. The following shall be included as applicable:

- Sizing for sediment basins.
- Sizing for skimmers or other surface draw down devices.
- Sizing temporary diversion ditches or clean water diversions.
- Calculations for outlet protection.
- Calculations and a summary table for during construction detention compliance per UDO Section 9.2.2.E.1.b. See Chapter 3 of this ~~M~~manual for ~~approved acceptable~~ methods of analysis.
- Drainage area maps associated with the ESC measures.
- Narrative statements about assumptions and methodology.
- Cut/fill analysis as described in this ~~C~~chapter ~~8~~ for sites over 20 acres.
- Any other calculations required by ~~the~~ NCDEQ's ["Erosion and Sediment Control Planning and Design Manual"](#).

8.4.4 Plan Requirements

All ESC plans required for land-disturbing activities, as identified in this ~~C~~chapter ~~8~~, shall meet ~~all of~~ the following requirements:

- ESC plans shall clearly show existing and proposed site features, drainage features, jurisdictional streams, wetlands, and buffers, as well as any SFHA's.
- ~~ESC p~~Plans shall clearly ~~demonstrate~~ ~~depict~~ the proposed ESC measures including applicable City ~~ESC~~ Standard Detail Drawings and areas of required vegetative stabilization.
- ~~ESC~~ Plans shall include notes, details, and a construction sequence (See Section 8.5, below) ~~relevant to~~ ~~for~~ the ESC measures proposed and sequence of installation.
- A copy of the approved ~~ESC~~ plan shall be maintained on the job site.
- The signature and seal of the North Carolina licensed professional engineer, landscape

architect, or land surveyor who prepared the plan must be on each sheet of the ESC plan.

- Primary point of contact for the project, including name, address, email and phone number shall be included in the ESC plan.
- Total acreage for the property/site shall be provided in the ESC plan.
- Total proposed LOD on each ESC plan view sheet. Round to hundredths of an acre. Place the LOD in the ESC plan view sheet in a clearly visible box outlined in black.
- A note included in each ESC plan indicating that prior to commencing land-disturbing activities, the approved limits of land disturbance shall clearly and accurately be demarcated on the ground with stakes, ribbons or other approved appropriate means, and shall be demarcated on the ground for the duration of the construction activity and no land disturbance shall occur outside the limits indicated on the approved ESC plans.

8.4.5 NPDES Plan Requirements

Although NCDEQ provides NCG01 coverage, to meet the requirements of the NCG01 permit, all of the following must be included in the E&SC plan that is submitted to the City:

- The most recently approved detail sheets provided by NCDEQ (NCG01 Ground Stabilization and Materials Handling Plan Sheet and the NCG01 Inspection, Recordkeeping and Reporting Plan Sheet).
- A separate plan sheet titled "NPDES Stabilization Plan" to include required ground stabilization timeframes based on site areas as outlined in the NCG01 permit. The critical areas which require more stringent stabilization requirements must be hatched and an associated legend must be included.
- Drainage areas of one acre or more shall include the use of outlet structures that withdraw from the surface. These structures shall be included on the ESC plan.
- A statement block with the following standard language must be included on each NPDES Stabilization Plan sheet:
 - This page is submitted to comply with NPDES General Stormwater Permit NCG010000.
 - This page can be approved by the City pursuant to NPDES General Stormwater Permit NCG010000 only.
 - This page of the approved plans is enforceable exclusively pursuant to NPDES General Stormwater Permit NCG010000.
 - The City is not authorized to enforce this page of the plans and it is not a part of the approved plans for purposes of enforcement action under the City Code.

8.4.6 Plan Revisions

Changes to the construction sequence on the approved ESC plan must be discussed with the stormwater inspector and noted on approved ESC plans. Major changes to the

sequence that would result lack of installation of, delay of installation or change in ESC measures will require a ESC plan revision. In addition, if the measures installed are not functioning and/or do not meet applicable City requirements, City sStormwater inspections staff will shall require a ESC plan revision.

8.5 CONSTRUCTION PHASING AND SEQUENCING

All land-disturbing activities must be planned and conducted to prevent erosion on-site, which could result in off-site sedimentation. To meet these objectives, ESC plans require multiple phases as construction progresses. The number of phases necessary for a project will be site-specific and based on the complexity and/or sequencing of the site development.

Once LDG permits are issued, the construction sequence is part of the approved ESC plans and must be followed.

8.5.1 Initial Phase of Construction

An erosion control construction sequence shall be included with all ES&C plans, broken out by phase as necessary. The construction sequence provided in the ESC plan for the initial phase of construction shall include, at a minimum, all of the following items:

1. *After obtaining a land disturbance grading permit but prior to beginning construction, schedule an on-site pre-construction meeting with the City Stormwater Inspections Regional Coordinator (Inspector Name) at (Inspector's Phone Number). (See map of Regional Coordinators) The project limits of disturbance ~~of the project~~ shall be demarcated on-site.*
 2. *Install all perimeter erosion and sedimentation control measures including silt fence, silt fence outlets, and construction entrances as well as sediment basins. Limit clearing and land disturbing activity to only the area necessary to install the permitted measures. After construction of Groundcover shall be installed on temporary diversions, berms, and basins, groundcover shall be installed immediately after construction.*
 3. *Schedule an initial Land Disturbance Grading Permit inspection through the City Permit and Development Portal.*
 4. *Upon approval of the Land Disturbance Grading Permit iinitial inspection, commence permitted land disturbing activity.*
 5. *For sites greater than one acre, erosion control measures shall be inspected and maintained at least once per week and after every rainfall event.*
- ★ *Modify and add sequencing for site specific details (for example, stream crossing sequencing, installation of clean water diversions, ~~etc.~~) as necessary.*

8.5.2 Intermediate Phasing of Construction

One common error in ESC plan design is a failure to provide adequate intermediate phasing to address evolving construction activities. Phasing mustshould follow changes to the site during

construction, both in topography and development/construction activities. Some of these intermediate phasing activities may include, but are not limited to:

- Bypass of off-site and on-site water
- Stream crossings
- Rough grading of the site
- Installation of infrastructure including stormwater conveyance system
- Fine grading
- Installation of pavement
- Building construction

Intermediate phasing and associated construction sequencing may also need to address the relocation or resizing of specific erosion control measures. This intermediate phasing ~~must~~ ~~should~~ be clearly addressed in the construction sequence and shown on the ESC plans with notes/callouts notating the sequential nature.

Later phase(s) of the ESC erosion control plan ~~must~~ ~~should~~ reflect a plan to keep sediment from the building site from being washed onto the pavement and tracked off-site. ~~This may~~ The ESC must include ESC measures ~~include silt fence~~ around the building's limit of disturbance with controlled openings/access points for construction access. These ~~silt fence measures~~ will help prevent tracking of sediment from un-sodded/non-stabilized areas around active building construction onto the newly paved surfaces and then off the site.

The construction sequence provided in the ESC plan for the intermediate phase of construction shall include, at a minimum, all of the following items:

1. *All erosion and sedimentation control measures shall be inspected and maintained throughout construction.*
 2. *Stabilization is required within 14 calendar days of completion of any phase of grading or inactivity on the project site.*
 3. *Install additional erosion and sedimentation control measures when instructed by a the City ~~s~~ Stormwater inspector.*
- ★ *Modify and add sequencing for site specific details (for example, bBasin removal/relocation/sizing, silt fence installation around buildings, ~~etc.~~) as necessary.*

If the site requires a Stormwater Conveyance System permit, the following also ~~will also~~ be added to the intermediate construction sequence:

- *As stormwater infrastructure is installed, install inlet protection or other approved ESC measures s as shown on the ESC plan.*
- *After all stormwater infrastructure is installed, submit a red-lined approved ESC plan to the City with as-built conditions of the stormwater conveyance system.*

8.5.3 Final Phase(s) and Project Close-Out

All ESC plans shall have a final phase that includes permanent stabilization of the site and removal of ESC devices. This is required even if the owner/developer has submitted separate plans for further development on the site.

The construction sequence provided in the ESC plan for the final phase of construction shall include, at a minimum, all of the following items:

1. *Site stabilization is required prior to final approval of Land Disturbance Grading Permit and issuance of Certificate of Occupancy. [Insert site specific stabilization requirements, see Section 8.7, below]*
2. *No temporary erosion and sedimentation control measures shall be removed without prior approval by athe City sStormwater inspector.*
3. *Once approved, remove remaining temporary erosion and sedimentation control measures. All permanent erosion control measures [for example, permanent ditch stabilization, riprap outlet protection, ~~etc.~~] must should be installed and functioning at this time.*
4. *Schedule a fFinal Land Disturbance Grading Permit inspection through the City Permit and Development Portal.*
- ★ *Modify and add sequencing for site specific details (for example, bBasin conversion, pipe flushing, ~~etc.~~) as necessary.*

If the site requires a Stormwater Conveyance System permit, the following also will ~~also~~ be added to the final construction sequence:

Stormwater Conveyance System As-built Certification

- Once the stormwater conveyance system has been installed, prepare a surveyed as-built of the stormwater conveyance system.
- Submit the Stormwater Conveyance As-built Submittal Checklist and required checklist items to the City.

CCTV-Stormwater Conveyance System Pipe Inspection Certification

- After the stormwater conveyance system as-built certification has been accepted by the City and ~~W~~when the area draining to the stormwater conveyance system is at least 70% stabilized, consult with a City sStormwater inspector and, upon approval, flush sediment from conveyance system.
- Flushing the conveyance system shall not result in sediment laden water in the downstream system, stream, and/or wetland.
- The contractor shall coordinate and provide closed-circuit television (CCTV) inspection of all stormwater infrastructure- 12" or greater and less than 72" (both public and private)- and larger.

- For stormwater conveyance infrastructure 72" or greater, a Bridge Inspection Report, in compliance with National Bridge Inspection Standards (NBIS), must be sealed by a North Carolina licensed professional engineer.
- If defects are identified during CCTV/pipe inspection, submit a repair plan to the City, correct defects and conduct additional CCTV/pipe inspection(s) to confirm defect correction.
- When the stormwater conveyance system (both public and private) is free of defects, submit the Stormwater Conveyance CCTV/Pipe Inspection Checklist and required checklist items to the City. This must be submitted a minimum of 7 days prior to scheduling the Final Stormwater Conveyance System Permit Final Acceptance inspection.

As-built Certification

- ~~Once the CCTV inspection has been accepted by the City and the final inch of asphalt has been installed, prepare a surveyed as-built of the Stormwater Conveyance System.~~
- ~~At a minimum of 7 days prior to scheduling the Final Stormwater Conveyance System Permit Final Acceptance inspection, submit the Stormwater Conveyance As-built Submittal Checklist and required checklist items to the City.~~

If the site includes conversion of ESC measures to a permanent, post-construction SCMs (See Section 8.6, below), all of the following shall be addressed in the final construction sequence:

- When the area draining to the SCM is at least 70% stabilized, consult with a City stormwater inspector and, upon approval, install and/or convert the erosion control measures to the permanent SCM. No conversion of erosion control measures to SCMs shall occur without the prior approval of the City stormwater inspector.
- [ESC plans shall address conversion of ESC devices within the construction sequence. Reference Section 8.6, below, for guidance regarding conversion to post-construction SCMs.]
- As-built certifications of all post-construction SCMs on-site shall be provided/~~approved/accepted~~ by the City a minimum of seven calendar days prior to scheduling the final inspection. Refer to the Stormwater Control Measure (SCM) As-Built Submittal Checklist for required items and submittal process. As-built device certifications must be approved/accepted in writing prior to a Certificate of Occupancy or Certificate of Compliance being issued.

The construction sequence in the ESC plan for the final phase of construction shall also include any information or certifications required prior to final approval of permits and/or Certificate of Occupancy, as detailed below:

- *As-built impervious surveys are required if impervious restrictions are a permit condition of approval for a project and shall be sealed by a North Carolina-licensed surveyor.*

For any projects subject to the NPDES NCG01 pPermit, include the following:

- *Projects subject to the NPDES NCG010000 pPermit may also apply for termination of coverage of this permit from NCDEQ after approval of the final land disturbance grading permit inspection and issuance of Certificate of Completion by the City.*

8.6 POST-CONSTRUCTION SCM

For post-construction stormwater designs that include stormwater ponds, wetlands or similar SCM control measures, it is common practice for the control measure to be installed initially as a temporary sediment/skimmer basin. The timing of conversion from temporary to permanent control measure depends on the exposed areas and continued land disturbance. **Table 8.1**, below, provides general guidance (not device- specific) for the planning and conversion of ESC measures to post-construction SCMs. The ESC plan must ~~should~~ account for these items and provide a site- and device-specific phasing plan for the conversion of any ESC measures to post-construction SCMs in the construction sequence.

TABLE 8.1
CONVERTING ESC MEASURES TO POST-CONSTRUCTION SCMs

<i>Topic</i>	<i>Conversion Guidance</i>
Drainage Areas	Drainage areas shall be limited by the <u>applicable</u> appropriate post-construction SCM design specifications, even if construction phase drainage areas could be larger. This means that sites may have to be divided into smaller drainage areas with the use of multiple ESC basins and other ESC measures.
Grading to Blend into Topography	Some temporary ESC measures are graded into slopes, have steep embankments or side slopes and otherwise do not blend well into the surrounding topography. These types of measures are not good candidates to convert to post-construction SCMs, unless regrading is part of the conversion plan. A sounder approach is to design the temporary ESC <u>measure practice</u> so that this type of regrading is not necessary, which may include changing the footprint, grading, slopes and other features of the ESC <u>measure practice</u> .
Stabilizing the Drainage Area	Ensure that the contributing drainage area is stabilized prior to conversion. This is a positive aspect to using ESC basins, because they cannot be removed until their erosion control function is complete. Therefore, the tendency to prematurely install post-construction SCMs is lessened. The conversion can proceed when City s Stormwater i nspectors indicate that the drainage area is properly stabilized, and conversion may begin. In addition to drainage area stabilization, other supplemental ESC measures may be warranted, such as diverting flow around the <u>ESC measure practice</u> during the conversion process and using silt fence or matting/sod on the side slopes of the <u>ESC measure practice</u> .
Removing Construction Sediment	All construction sediment shall be removed as the first step in the conversion process. This requires flushing all stormwater infrastructure of sediment and dewatering the ESC <u>measure practice</u> using an approved dewatering and sediment capture method (e.g. silt bags, etc.). All notification requirements by <u>applicable</u> permitting agencies shall be met prior to and during dewatering the basin for conversion.
Excavating Below the ESC Measure Bottom Elevation	The bottom of the post-construction SCM shall be at least one foot lower than the temporary ESC measure bottom elevation. It is important that the bottom of the post-construction SCM will be in undisturbed soils that are not impacted by construction activities. During excavation to the post-construction design elevation, scarify or rip the underlying soil to promote infiltration.
Installing Underdrains	It is recommended that a permanent riser be installed while the <u>ESC</u> device is temporary if it will have underdrains as a permanent SCM. During the conversion to a permanent measure, the underdrains may then <u>will</u> be installed.
Post-Construction SCM Installation	Install the SCM per the approved construction plans. Sequencing items specific to the proposed <u>SCM</u> design must be detailed. Some minor grading or adjustments to the footprint may be needed to meet the post-construction

Easement/SCM Location Awareness	Because the post-construction SCM must be located within a <u>permanent drainage</u> easement, it is very important to make sure the final SCM is within the specified area to avoid costly relocation of the SCM or re-recording of the required <u>permanent drainage</u> easement.
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8.7 GROUNDCOVER VS. STABILIZATION

NCDEQ surface stabilization standards and specifications found in ~~its~~ the “Erosion and Sediment Control Planning and Design Manual” and the groundcover/stabilization requirements of this Manual shall be adhered to throughout construction. Whenever in conflict the more stringent shall apply.

8.7.1 Groundcover

When a land-disturbing activity occurs, the person undertaking the activity shall install groundcover, devices, or structures sufficient to restrain erosion and always retain sediment within the approved LOD limits of disturbance.

The City approves supports the use of many types of groundcover, including but not limited to, seed/~~straw~~, seed/straw/tackifier, hydroseed, rolled erosion control products (e.g. matting, ~~etc.~~), pine or hardwood mulch, and tarps and landscaped areas (e.g. shrubs, trees, pine straw, ~~etc.~~). It is important to identify what type of groundcover(s) is suitable for a site. Aspects to consider include landscape position, slope, sun/shade exposure, soil type, duration of groundcover application and/or stabilization requirements at project completion.

Groundcover is required on any portion of a site upon which further land-disturbing activity has ceased (temporarily or permanently). When demolition is complete and prior to building commencement, groundcover must be applied. It is important to comply with timeframes for groundcover application. These timeframes must ~~should~~ be clearly presented in the construction sequence on the approved ESC plans. Refer to UDO Article 9.4. for the City’s most current ground-cover requirements. If more stringent, state and/or federal timeframe requirements for groundcover application shall be followed.

When land-disturbing activities have ceased but final grade has not yet been established, temporary groundcover may be used. However, when final grade has been met, permanent groundcover must be installed, and permanent stabilization must be achieved.

8.7.2 Stabilization

The application of groundcover is intended to counteract the erosive influences of rain and wind on bare soil and is effective at preventing erosion until permanent stabilization has been achieved.

Stabilization of soil can be achieved using one or a combination of the following methods:

- Grass – permanent groundcover must be applied over 100% of the disturbed area. Permanent stabilization is achieved when there is 100% growth and 80% density of permanent groundcover with no evidence of erosion.

- Sod – when seed is applied to a site and is unable to germinate, sod may be utilized to achieve permanent stabilization. Sod must be installed so that it does not move and/or create voids that could cause areas of accelerated erosion. If environmental or mechanical conditions prevent the installation of sod this will result in delay of Certificate of Occupancy and/or Certificate of Compliance.
- Mulch – triple-shredded hardwood mulch at a depth of six inches must be applied to prevent movement of mulch.
- Artificial/Synthetic Turf – when artificial/synthetic turf is utilized for stabilization, it must be ~~permitted-approved/permitted by the City prior to installation~~ and will be considered 100% impervious unless permitted as a stormwater control device.
- Gravel, Concrete, or other Impervious ~~S~~surface (See definition in UDO Article 12.2)/ Built Upon Area (See definition in UDO ~~Section 9.2.1.F.1~~Article 9.2) – When using impervious surface/built upon area for stabilization, it must be ~~permitted-approved/permitted by the City prior to installation~~ and may include parking lots, buildings, gravel, ~~and~~ rip rap, ~~etc.~~
- Landscaping – shrubs, trees, pine straw and/or mulch must be used in combination with any of the above methods and cannot be the sole method to stabilize a site.
- Native plants – the use of native plants is encouraged to stabilize sites. When temporary wetland, riparian buffer, and/or stream bank impacts have been approved by the appropriate agency, stabilization shall include installation of permanent native grasses/trees/shrubs/plugs. This permanent vegetation must be applied to 100% of the disturbed area and is not considered permanently stabilized until 100% growth and 80% density is achieved with no evidence of erosion.

8.7.2.1 STABILIZATION FOR PERMIT CLOSE-OUT/CERTIFICATE OF OCCUPANCY

Permanent stabilization is required prior to closing ~~out~~ LDG ~~p~~Permits, closing out Stormwater Control ~~p~~Permits with 400 square feet or more ~~of~~ land disturbance, and/or prior to issuance of Certificates of Occupancy(s) or Certificates of Compliance.

Chapter 9

FLOODPLAIN MANAGEMENT

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9.1 INTRODUCTION

The City of Raleigh (City) is a participating community in ~~Federal Emergency Management Agency's (FEMA's)~~ National Flood Insurance Program (NFIP). The City, ~~the~~ North Carolina Floodplain Management Program (NCFMP), and FEMA have identified more than 23 square miles of floodplain, otherwise known as flood-prone areas or ~~the~~ Special Flood Hazard Areas (SFHA), within Raleigh's jurisdictional area. The implementation and enforcement of the City's Floodplain Management Program has far-reaching effects, including but not limited to the ability for our residents to obtain flood insurance under the NFIP.

~~Any landowners and/or professionals planning any development activity within the SFHA shall have the knowledge and skills to plan, design, and construct their project in compliance with SFHA regulations. For purposes of floodplain management, "development" is defined in Article 12.2. of the UDO.~~

9.2 TYPES OF SPECIAL FLOOD HAZARD AREAS

The City currently recognizes three types of floodplains as SFHAs: those identified as FEMA-designated, those identified by a drainage basin study, and those identified by flood hazard soils. Any development within any of these three areas is subject to the City's SFHA regulations. (UDO 9.3).

9.2.1 FEMA-Designated SFHA

Note that FEMA mapping includes only areas with a contributing drainage area of at least one square mile (640 acres).

9.2.2 SFHA Based on Drainage Basin Study Maps

The City completes drainage basin studies that produce mapped flood hazard areas to supplement the DFIRMs. The City Drainage Basin Study Maps use the same criteria as FEMA's Digital Flood Insurance Rate Maps (DFIRMs) to illustrate SFHAs with a contributing drainage area of at least 100 acres but less than one square mile (640 acres). A list of all completed drainage basin studies may be found on the [TO BE DETERMINED]. The City performs drainage basin study updates periodically.

9.2.3 SFHA Based on Flood Hazard Soils

~~Guidance on flood hazard soils may be found in~~—Flood hazard soils are soil types defined in UDO ArticleSection 12.2. and are illustrated on the last paper copy of the Wake County or Durham County Soil Survey Map.

There are several options for how to establish the SFHA and the ~~Regulatory Flood Protection Elevation (RFPE)~~ for Flood Hazard Soils:

- Use the delineation from the published Wake County or Durham County Soil Survey Map as the SFHA. Determine the RFPE as described in ~~the UDO Section (UDO 9.3.4)~~.
- A North Carolina-licensed soil scientist may establish the presence, highest elevation, and extent to which the flood hazard soils exist on the project site.
- A Flood Study may be used, as is detailed in Section 9.5.1, below.

9.2.4 SFHA Based on Flood Study

In addition to the above requirements, the City requires that a flood study be completed to determine base flood elevations for any stream on or ~~adjacent intersecting to~~ a development site that has a drainage area of 25 acres or more. Sites containing or adjacent to streams that drain greater than or equal to 25 acres and less than 100 acres must complete a Simple Flood Study. Sites that drains 100 acres or more must complete a Comprehensive Flood Study. See Section 9.5.1, below, for the detail about these study types and their requirements.

~~You can find a~~Additional information about flood studies can be found in the [NCDOT Guidance for Drainage Studies and Hydraulic Design](#).

9.3 FLOODPLAIN DEVELOPMENT REQUIREMENTS

To reduce vulnerability during future flood events, the SFHA regulations set forth by the City exceed FEMA minimum floodplain management standards. Adoption of these higher standards reduces the risk of loss of life and decreases the amount of damage in future floods.

Specific ~~guidancerequirements for~~ SFHA regulations can be found in [UDO Article 9.3](#).

9.4 PERMIT APPLICATION

The submittals for a site in the floodplain shall adhere to the requirements in UDO Sections 9.3.2 & 9.3.11 and the requirements below.

- ~~Certification with supporting technical data by a registered professional engineer licensed in the State of North Carolina is provided to the Floodplain Administrator and/or his or her designee. A sealed engineering report shall be required for projects within the floodway of any SFHA which add any new obstructions.~~ Exclusions are determined based on FEMA-480 Floodplain Management Requirements. Floodway realignments must be approved by the City. If a floodway realignment is being requested, the applicant shall submit all necessary data for review, as per the [Flood Study Submittal Checklist](#).
- See Section 9.5, below, for the requirements for Flood Studies, including Conditional

Letter of Map Revision (CLOMR) and No-Rise/No Impact studies.

- On sites that create or reconfigure parking, the parking lots must be elevated to ensure the elevation of the lowest parking space is no more than six inches below the RFPE. This provision does not apply to single-family lots.
- For sites that require elevation certificates and/or floodproofing certificates:
 - The applicant submits required information certifications upon the completion of the project.
 - The applicant schedules the final floodplain inspection through the City Permitting and Development Portal, once the required information elevation certifications (FEMA Elevation Certificate, Floodproofing Certificate, Lowest Floor Certificate, etc.) is are approved by the City.
 - The City closes out the Floodplain Development Permit Flood Permit (UDO 9.3.2). If the Floodplain Development Permit is not closed out then the a Certificate of Occupancy will not be issued.
- For sites that require a LOMR, the applicant must submit a LOMR to the City within six months of the Certificate of Occupancy being issued or completion of construction, whichever occurs first per FEMA's LOMR requirements.

9.5 FLOOD STUDY REQUIREMENTS

Flood Study requirements are found may be found on in the *Flood Study Submittal Checklist* on the City's Stormwater Plan Review website. Flood studies shall be submitted as indicated on the website and in this Manual document.

9.5.1 Local Flood Study Requirements

Flood Study requirements are broken into two categories. Note that when a Simple Flood Study is required, a Comprehensive Flood Study may be performed.

<i>Location of Development</i>	<i>Study Requirement</i>
Flood hazard soil areas that drain 5 acres or less	No study required
Flood hazard soil areas that drain more than 5 acres and less than 100 acres	Simple Flood Study required

Non-flood hazard soils that drain between 0-25 acres	No study required
Sites containing <u>a stream</u> or <u>adjacent to has a stream intersecting its</u> that drain greater than 25 and less than 100 acres	Simple Flood Study required
Flood hazard soil areas or <u>sites containing or areas adjacent to any stream that drains</u> 100 acres or more	Comprehensive Flood Study required

- Simple Flood Study
 - Establishes the 100-year future conditions water surface elevation for the cross-section locations
 - Can-~~Shall~~ be used to establish the RFPE
 - Floodway determination not required
 - Approved~~Acceptable~~ methods include: HEC-RAS, Manning's equation, or NCDOT standard headwater analysis
 - If there is a structure on the property or downstream that influences the Water Surface Elevation (WSEL) on this property, then ~~a method~~ (see Table 3.1 of this manual) that accounts for backwater from that structure is required
- Comprehensive Flood Study
 - Establishes the 100-year future conditions water surface elevation for the cross-section locations
 - Can-~~Shall~~ be used to establish the RFPE
 - Delineates the Floodway versus Floodway Fringe
 - Approved~~Acceptable~~ methods include: One-Dimensional or Two-Dimensional Steady Flow Models capable of modeling ineffective flow areas and developing a floodway that is~~are~~ listed by FEMA as "Hydraulic Numerical Models Meeting the Minimum Requirement of National Flood Insurance Program"

For both types of studies, analysis must be performed at a minimum along of the following locations (i.e. cross-sections)

- Upstream and downstream property lines
- Upstream and downstream of every structure with hydraulic impacts (e.g. dams, bridges, culverts, weirs)
- Representations of each change in channel and floodplain shape, slope, or roughness
- Flow change locations (e.g. tributary or pipe inflow locations)

Flood study submittal process:

- Flood studies shall be submitted to the City as a separate development review case.
- See the City Stormwater Plan Review website for the checklist, submittal process, and review turnaround times.

9.5.2 FEMA Flood Map Changes

To make changes to the adopted maps within FEMA flood-prone areas, an applicant must complete an application to FEMA for a Conditional Letter of Map Revision (CLOMR), Letter of Map Revision (LOMR), Letter of Map Revision based on Fill (LOMR-F) or Letter of Map Amendment (LOMA), where appropriate. All of these map change documents are issued by FEMA and individual submittal requirements can be found at www.fema.gov.

A CLOMR is required when a proposed project will, upon construction, affect the hydrologic or hydraulic characteristics of a flooding source, thus, resulting in the modification of the existing regulatory floodway, the effective ~~Base Flood Elevation (BFE)~~, or extents of the SFHA. The CLOMR does not revise an effective DFIRM; however, it indicates that the project, if built as proposed, will revise the effective DFIRM. City staff approval of the change is required prior to an applicant submitting a CLOMR application to FEMA (UDO Ssection 9.3.4.B). A public hearing must be held for the City Council to approve the flood map change associated with a CLOMR. This public hearing cannot be scheduled until after obtaining approval from City sStormwater rReview sStaff. City Council and FEMA approval can run concurrently, and the project can be approved once all three approvals have been obtained. Each CLOMR must be followed by a LOMR (issued by FEMA) confirming that the project was built as designed, with the LOMR to be submitted to the City no later than within six months of the completion of the project per FEMA requirements. In cases where the City is not requiring the modification of the existing regulatory floodway (i.e., required road or utility crossing), all three approvals must come before the first City approval of the project.

A LOMR is FEMA's official modification to an effective DFIRM and shall be submitted by the applicant within six months of the project's completion of construction or issuance of a Certificate Certification of Occupancy, whichever occurs first.

A LOMR-F is FEMA's official modification to the effective DFIRM outside of the regulated Floodway. This shall be submitted to FEMA within six months of the modification.

A LOMA is a letter that reflects an official revision and/or an amendment to an effective DFIRM. If a property owner thinks itstheir property has been mapped in an SFHA in error, itthey may submit a request to the City and FEMA for a LOMA. Note that a LOMA may not necessarily need a Flood Study and may be based on surveyed data.

9.5.3 No-Rise/No Impact

A No Impact study may be submitted to show the project will have no effect on the characteristics of the floodplain. This may be required by the UDO 9.3 or can be submitted to show encroachment into the FEMA Floodway without going through the CLOMR process. If there is no impact to the published flood elevations, then City stormwater review staff can administratively approve the project with a detailed engineering analysis. The No Impact Study must be conducted-submitted and approved by City stormwater review staff before a flood permit can be issued (submittal guidelines can be found on the City's Stormwater Plan Review webpage). The City's flood permit file must have a record of the results of this analysis, which

shall be in the form of a No-Impact Certification. This No-Impact Certification must be supported by technical data and signed and sealed by a North Carolina-licensed professional engineer. The supporting technical data shall be based on the standard step-backwater computer model used to develop the 100-year annual floodplain shown on the DFIRM or Flood Boundary and Floodway Map (FBFM).

9.6 ELEVATION CERTIFICATE PROCESS

The following certifications, if required by Udo Article 9.3, must be received, reviewed, and approved by City Stormwater Staff prior to the final inspection. All required documentation shall be submitted to the City prior to scheduling final floodplain inspection and issuance of a Certificate of Occupancy.

9.6.1 FEMA Elevation Certificate

For structures located within FEMA-designated floodplain areas, the current effective FEMA Elevation Certificate form must be ~~completed and submitted prior to the final inspection and issuance of a Certificate of Occupancy~~used. Find more information on the [Elevation Certificate Form](#).

9.6.2 City of Raleigh Lowest Floor Certificate

For structures located within non-FEMA-delineated floodplains, a [Lowest Floor Certificate](#) ~~providing elevation and flood vent information shall be completed and submitted prior to the final inspection and issuance of a Certificate of Occupancy. A mid-point construction inspection is required to confirm that the elevation of the structure and associated equipment is at or above the RFPE elevation. FEMA Elevation Certificate form must be used, this form can be found on the City's Stormwater Plan Review webpage.~~

9.7 FLOODPROOFING CERTIFICATE

New construction or substantial improvement of nonresidential or residential accessory structures located in SFHA areas may ~~incorporate~~utilize floodproofing measures. Residential buildings are not allowed to floodproof.

Applicants must ~~utilize~~used the current [FEMA Floodproofing Certificate](#).

9.8 SUBSTANTIAL IMPROVEMENT OR SUBSTANTIAL DAMAGE

If the cumulative cost of improvements and repairs to a existing structure in a SFHA is greater than or equal to 50% of the market value of the structure over any five-year period, that

structure is considered substantially impacted and must be brought fully into compliance with current City SFHA regulations (UDO 9.3.5.B.6). Market value will be determined by the tax value of the structure, per the Wake County Real Estate records, if the applicant does not provide the City with an appraisal of the structure's value signed and sealed by a North Carolina-licensed general appraiser. ~~North Carolina-licensed real estate appraisal of the structure~~ (building only, no land value). See Equation below for calculating substantial improvement or substantial damage.

[EQ]
$$\frac{\text{5-year Cumulative Cost of Improvements and Repairs}}{\text{Pre-Improvement or Pre-Damage Market Value Condition of Building}} \geq 50\%$$

FOR REVIEW ONLY