Engineering Services

Stormwater

Stormwater Design Manual Training for Designers

October 1, 2024

Raleigh

Agenda

1:00-1:30 Arrival

1:30-4:30 Presentation with 1 Break

4:30-5:00 Staff Available for Questions

Bathrooms: Out back doors, M to left, W to right

Water: Out back doors, in middle or to right

Presentation Topics

- Overview of changes
- Conveyance Design
- Conveyance Permit
- Hydrology Calcs
- Stormwater Management Calcs
- Impervious Limits for Infill
- BREAK

Presentation Topics

- SCM Design
- SCM O&M and As-builts
- Other Easement Info
- ESC
- Flood Studies
- Submittal Requirements
- Wrap-up

Raleigh Stormwater Plan Review Team

Supervisor:

- Sally Hoyt, PE

Senior Reviewers:

- Nathan Burdick, CFM*
- Sean Eggleston
- Kendall Kausler, PE, CFM
- Ross Keith
- Alan Reyes, PE

Reviewers:

- Lauren Poole
- Brian McHouell, CFM
- Molly Zahorian, EIT, CFM

Senior Specialist:

- Donnell Perry

**Part-Time*

Why Changes?

- Address frequent concerns
- Design Manual hadn’t been changed since 2002
- Ensure quality infrastructure

Where to Find the Changes

- Google “Raleigh Stormwater Manual”
- https://raleighnc.gov/stormwater/services/stormwater-design-manual

New Design Manual

The City of Raleigh **Stormwater Design Manual** and associated **UDO text changes** will become effective on Saturday, November 2, 2024. Plans submitted after that date will be required to follow the new Manual and the revised UDO.

- Stormwater Design Manual (Dated September 3, 2024)
- TC-1B-2024 Stormwater Design Manual Update UDO Related Changes

Training for the new design manual will be hosted by Raleigh stormwater staff for home builders and designers. Find more details for the training options and registration.

Old Design Manuals

There are two manuals in effect in the City of Raleigh through November 1, 2024:

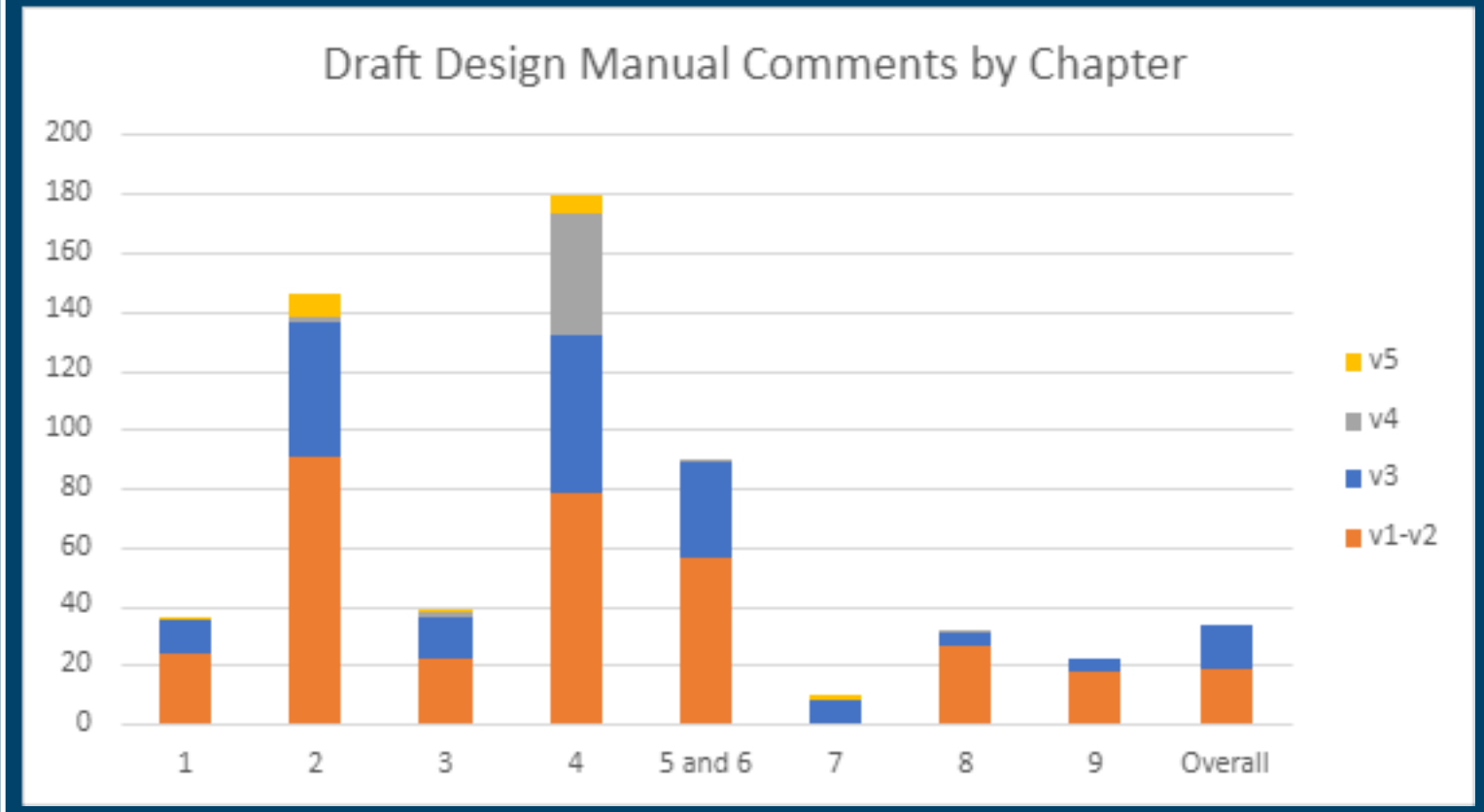
When?

- Saturday, November 2, 2024, so effectively, submittals on Monday, November 4.
- Can choose new Manual/UDO even if submitted before that date.

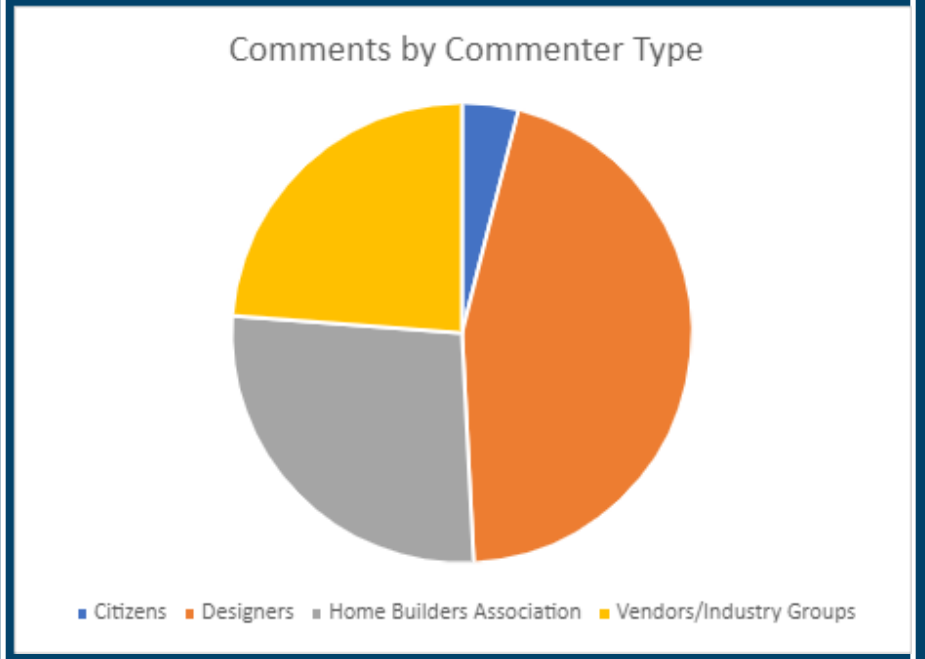
Process

- Stakeholder meetings in 2019-2020
- Four drafts posted for informal comment (2020, 2021, 2023 x 2)
- Meetings upon request, including 4 with HBA in 2023
- Formal Comments in 2024
- Presented 2x to Text Change Committee and 1x Planning Commission
- Approved by Council on September 3, 2024

Comments Summary



For v3-v5



Total Public Comments > 600

Engineering Services

Stormwater

Chapter 4

Stormwater Conveyance Design

Raleigh

Gravity Design is required

- No pumping will be allowed for any system on public or private property
    - Except as allowed in Section 6.3.1

4.2.3 Flow Leaving the Site

Sites greater than 1 acre used for 1- or 2-unit dwellings or greater than 0.5 acre for all other uses

Newly concentrated flow into pipes or swales shall leave the site in one of the following methods:

- Approved discharge to a jurisdictional stream or stream buffer
- Connection to the ROW
- Discharge to an existing or proposed public or private drainage easement

Lot Grading Plan (2.1)

Sites <= 1 acre used for 1- or 2-unit dwellings or <=0.5 acre for all other uses

Newly concentrated flow into pipes or swales shall leave the site in one of the following methods:

- Same as above, PLUS
- Rain garden
- Disconnected impervious surface
- Surface Infiltration Pit

Lot Grading Plan

Sites <= 1 acre used for 1- or 2-unit dwellings or <=0.5 acre for all other uses

- Rain Garden
- Surface Infiltration Pit
- Disconnected Impervious Area
- Approved discharge to a jurisdictional stream or stream buffer
- Connection to the ROW
- Discharge to an existing or proposed public or private drainage easement
- OR

Chapter 7.2 Upstream Discharge (Easements)

Establishment of a drainage easement on the property being developed shall be required, as follows:

If flow enters in a stream, no drainage easement is required

If flow enters in an existing or proposed pipe or swale, then drainage easements shall be provided per Section 7.3

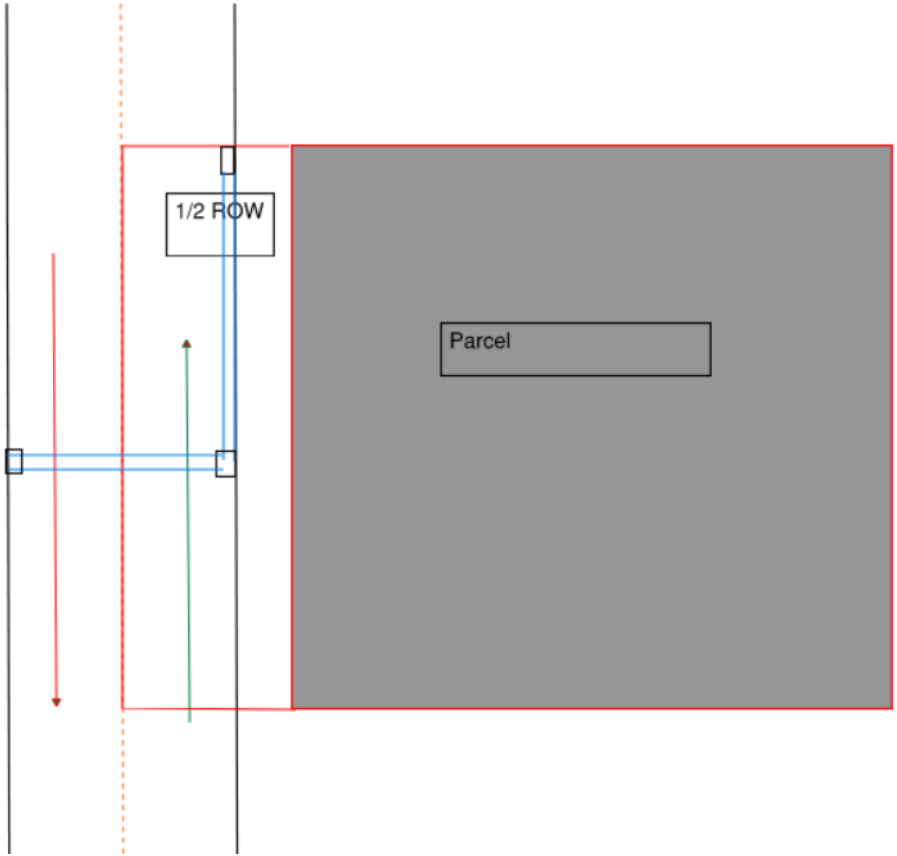
If flow enters via sheet flow, then one 20' wide drainage easement will be required for each entering drainage area of one acre or more

4.2.3 Existing Systems

Existing stormwater conveyance systems on the site or in the half of the City ROW adjacent to the property (and parallel to the lanes) shall be analyzed w/any Tier 3 site plan.

Systems that do not meet the requirements of this chapter for capacity or condition as identified by the project's visual pipe inspection (on site) or by the City (in City ROW) shall be replaced or improved to meet criteria.

Half of the City ROW



4.2.5 Public Versus Private Infrastructure

Structures & pipes sized 15 inches or greater + Located within the ROW = Publicly-maintained stormwater infrastructure

EXCLUDES driveway culverts

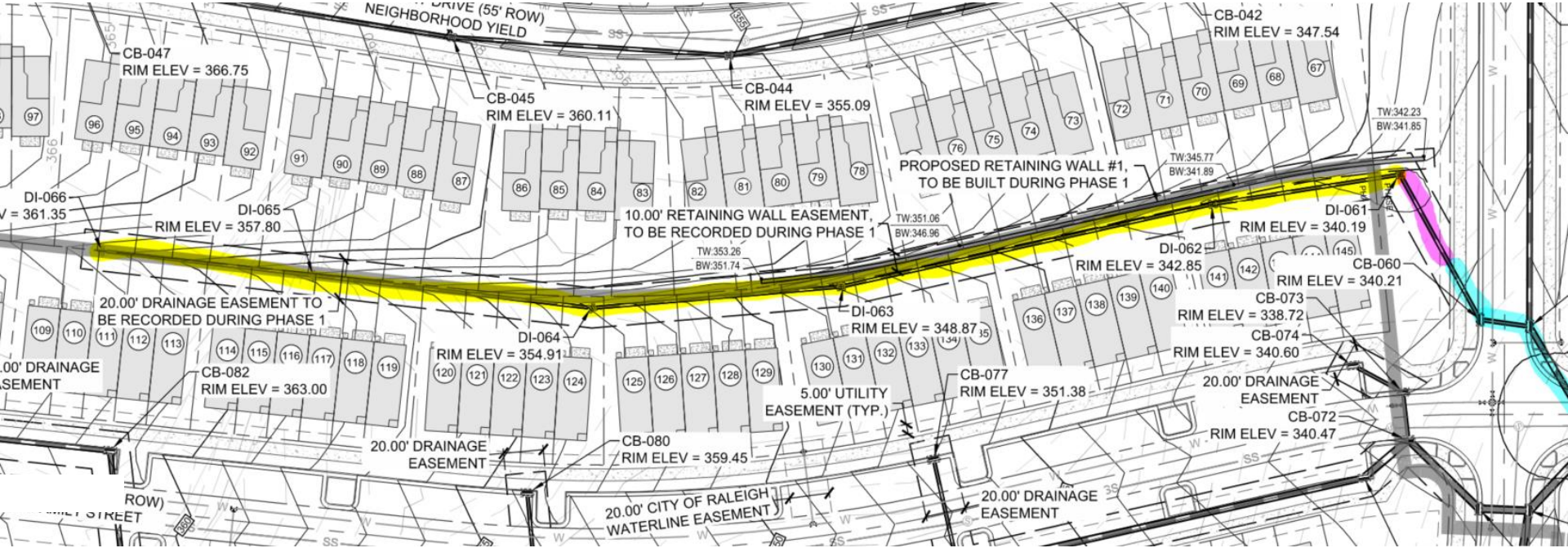
Public Drainage Easements

- Drainage easements identified by NCDOT as drainage easements held by NCDOT
- Drainage easements associated with culverts or bridges serving City ROW will be held by the City
- Drainage easements for the purposes of stormwater conveyance that convey public runoff shall be held by the City
  - Such easements shall exclude areas required to be in private drainage easements for SCMS
- Drainage easements held by public entities other than the City or NCDOT, when identified as such by those entities

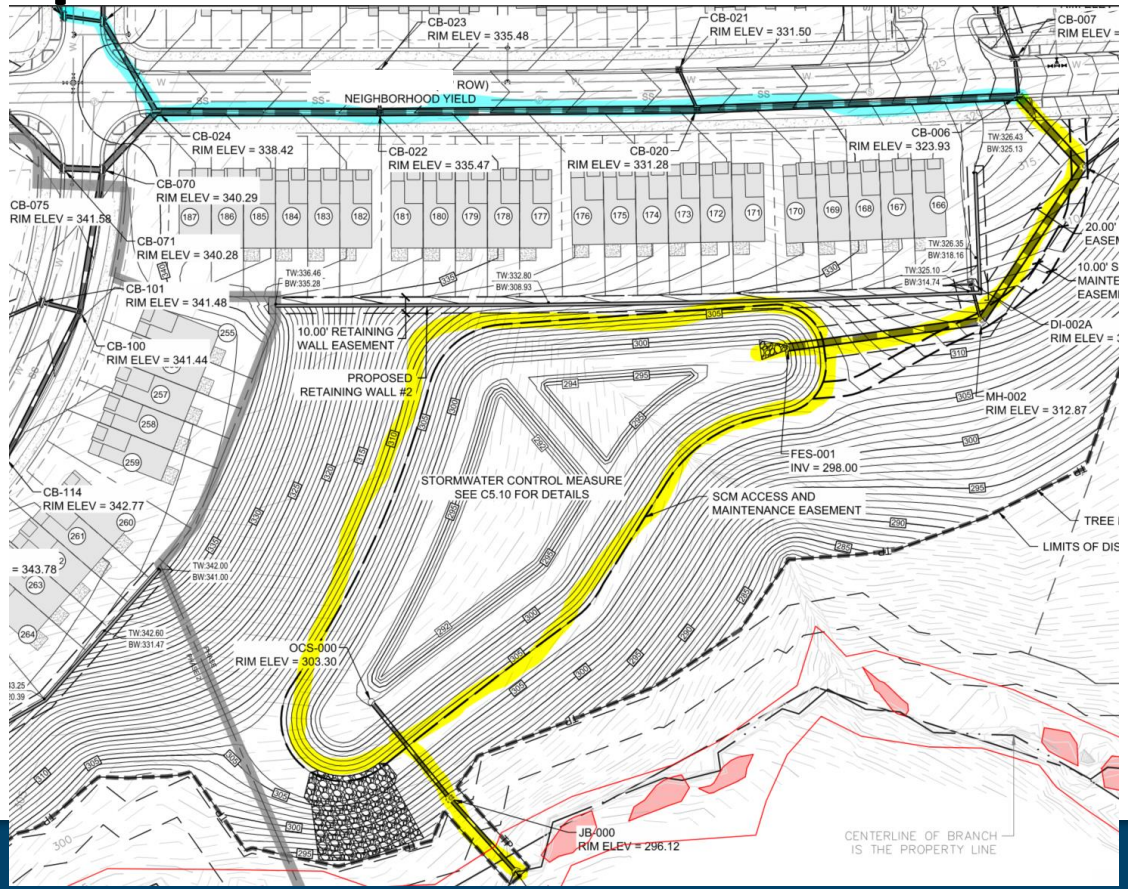
Pipe Easement Widths

- Unchanged from old Manual

Example – Upstream



Example – at SCM



4.2.6 Decreased Capacity Downstream

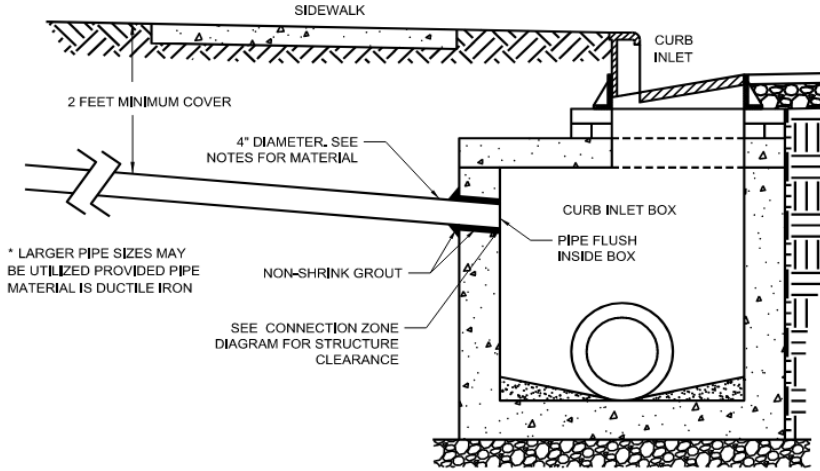
Proposed system has higher capacity than the offsite component immediately downstream, provide:

- Narrative description of why this design is necessary & required special maintenance
- Map identifying locations where new surcharging will occur
- Analysis of the impacts of the surcharging

4.2.8 Connecting to Conveyance System in City ROW

- Requires a Stormwater Conveyance System permit
- Connections shall be performed in accordance with City of Raleigh details

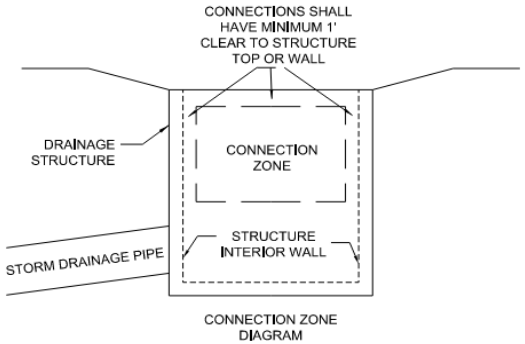
This is not the final approved version



FOR DRAINS INTO DRAINAGE STRUCTURE:
1. STRUCTURE PENETRATION SHALL NOT OCCUR WITHIN 12 INCHES OF STRUCTURE CORNER.
2. ENTRY PENETRATION MUST BE CORED/SAWCUT.
3. ALL CONNECTIONS MUST BE TO THE REAR OF THE BOX (THE SIDE FARTHEST FROM CURB).
4. DRAIN PENETRATION MUST BE WITHIN THE APPROVED CONNECTION ZONE SHOWN IN DETAIL.
5. DRAIN PIPE UNDER SIDEWALK AND WITHIN PUBLIC RIGHT-OF-WAY MUST BE DUCTILE IRON PIPE. SCHEDULE 40 PVC IS ACCEPTABLE IN OTHER PORTIONS OF DRAINAGE STRUCTURE TIE-INS PROVIDING THE TIE-IN PIPE IS 2 FEET OR GREATER FROM THE GROUND SURFACE TO THE TOP OF THE PIPE

[redacted]

GENERAL NOTES:
1. A RIGHT-OF-WAY PERMIT IS REQUIRED FOR ANY CONNECTION OF RESIDENTIAL DRAINAGE INTO THE RIGHT-OF-WAY.
2. ALL STORMWATER PIPE DISCHARGES SHALL BE TIED INTO A STORMWATER SYSTEM STRUCTURE (JUNCTION, MANHOLE, INLET, ETC.) IF A DIRECT TIE IN IS NOT POSSIBLE DUE TO ELEVATION CONSTRAINTS, LOCATION CONSTRAINTS, UTILITY/PHYSICAL OBSTRUCTIONS OR OTHER REASON ACCEPTABLE TO THE CITY, A CURB-O-LET (OR EQUAL) MAY BE USED TO TIE INTO THE CURB LINE. IF CURB-O-LET CANNOT BE USED, CURB BORE DETAIL (SW-10.XX) MAY BE USED WITH APPROVAL BY THE CITY.
3. WHEN SIDEWALK IS PRESENT, THE FULL SIDEWALK PANEL (FROM JOINT TO JOINT) MUST BE REPLACED WHEN INSTALLING DRAIN. BORING UNDER THE SIDEWALK IS NOT ALLOWED.
4. ALL CONCRETE USED SHALL BE 3000 PSI OR GREATER.
5. FUTURE MAINTENANCE IS THE RESPONSIBILITY OF THE OWNER OF THE PROPERTY FROM WHICH THE DRAIN ORIGINATES.



4.3.1 Closed Conveyance Systems Sizing Criteria

TABLE 4.1 SIZING CRITERIA FOR CLOSED STORMWATER CONVEYANCE SYSTEMS		
DRAINAGE AREA	**DESIGN STORM**	**DESIGN CRITERIA**
≤ 25 acres	10-year	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	Outside the ROW, inundation does not exceed the limits of the drainage easement.

4.3.2 Open Channel Conveyance Systems Sizing Criteria

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

Open Channel Easements

TABLE 7.2 MINIMUM EASEMENT WIDTHS FOR OPEN CHANNELS OR SWALES*	
Drainage Area	**Easement Width**
< 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
*Applies to channels and swales that are not jurisdictional waters or regulated streams with riparian buffers.	

4.3.3 Bridge and Culvert Sizing Criteria

- For culverts in an existing or proposed City ROW, culverts that span 18 feet shall be upsized to exceed 20 feet.
- Bridges 25 feet or less in span along the centerline of the structure will require approval by the City's Transportation Director.
- The spacing between barrels must not exceed half the diameter of the barrel of the culverts.

4.3.3 Bridge and Culvert Sizing Criteria

- Also see this topic in UDO 9.3.8
- See Table 4.3 within the Design Manual

Bridge and culvert easements

- 10' offset from structure including headwalls and wingwalls
- If larger than 36" opening, access path to invert required:
  - 25' width – can be off a side street
  - No slopes greater than 3:1

Inlet Details have changed NCDOT

Inlet Type – *to improve maintainability*

NCDOT table of applicable details

4.3.4 Inlet and Gutter Sizing Criteria

Requirements apply to roads and driveways located as follows:

- ROW
- Public drainage easement
- On a City-owned parcel

Submittal Requirements:

Tables shall include structure number, bypass structure, spread, allowable spread, and a column indicating whether spread requirements were met.

4.3.4 Inlet & Gutter Sizing Criteria

Table 4.4

- Design Storm = 10 yr
- Inlets shall be designed assuming 50% blockage for locations where grate inlets are required. In combination inlets, only the grate portion must be shown as 50%
- More Stringent requirements apply when there is no curb overflow available

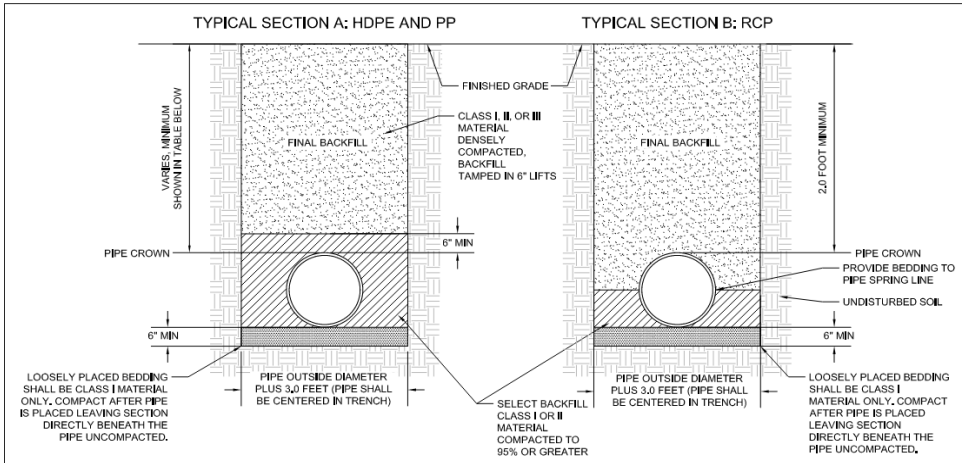
4.3.5 Maximum Ponding Depth

- Yard Inlets
  - Outside ROW = 1 ft above inlet for the 10yr storm
- Fire Lanes
  - Shall not exceed 7 inches depth at the 10yr storm
  - Assumed to be met in areas with a 6-inch curb

4.4 Stormwater Pipes

- Min 15-inch diameter
- Min 2ft of cover
- Min slope 0.5%
- Max slope 10%
- All tie-ins at a structure
- Approved pipes: RCP, PP, HDPE

Example of Details for all pipes



DIAMETER (In)	HIGH DENSITY POLYETHYLENE (HDPE) AND POLYPROPLYENE (PP) MIN COVER CROWN TO FINISHED GRADE (ft)
15	2.0
18	2.0
24	2.0
30	2.0
36	2.1
42	2.4
48	2.8

GENERAL NOTES:

1. BACKFILL MATERIAL SHALL BE #57 STONE, #67 STONE, ASTM D2321 CLASS II MATERIAL, OR AASHTO A1 OR A3 MATERIAL.
2. MAXIMUM COVER REQUIREMENTS SHALL BE ESTABLISHED BY THE ENGINEER OF RECORD THROUGH ENGINEERING CALCULATIONS BASED UPON AASHTO LRFD BRIDGE DESIGN SPECIFICATIONS FOR THE PIPE MATERIALS SPECIFIED ON THE PLANS.
3. MAXIMUM ALLOWABLE DIAMETER FOR HDPE AND PP IS 48".
4. IF WATER TABLE IS HIGHER THAN SUBGRADE OF TRENCH, STONE BACKFILL MATERIAL SHALL BE WRAPPED IN NCDOT TYPE 4A GEOTEXTILE.
5. IT IS THE RESPONSIBILITY OF THE ENGINEER TO CONFIRM THE STRUCTURAL DESIGN ASSUMPTIONS REGARDING THE FOUNDATION SUPPORT AND THAT THE ASSUMED GROUNDWATER CONDITIONS OF THE STRUCTURAL TRENCH SUPPORT WILL BE MET.

[redacted]

This is not the final approved version

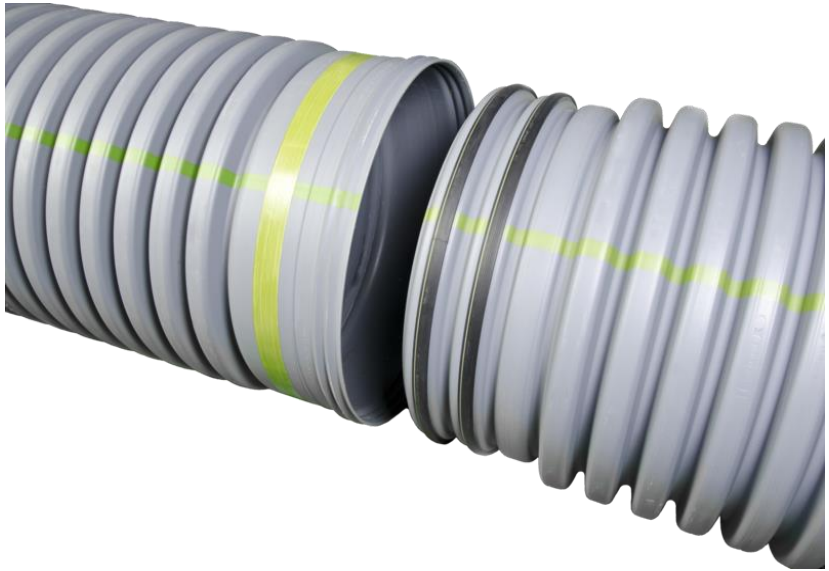
4.4.2 Reinforced Concrete Pipe (RCP)

- Specified acceptable joint types
  - Needs to be shown on plans
- Requirements for transition of RCP to PP or HDPE not at structures
- Pipe quality prior to installation
  - Will also require note on plans
- Lifting holes

4.4.3 Polypropylene (PP)

Only allowed:

- Private property
- Specific City Streets:
  - “Local” Streets
  - “Sensitive Area Residential Street”
  - “Alley, Residential”



4.4.3 Polypropylene (PP)

- Type S (smooth interior)
- Max diameter = 48 inches
- Max Cover = 20 ft
- Joint specification
  - On plans
- Requires watertight connectors to structures
  - On plans
- Mandrel or laser testing required (to be discussed more in 4.7.4)

4.4.4 HDPE (High Density Polyethylene)

- Type S (smooth interior)
- Max diameter = 48 inches
- Max Cover = 17 ft
- Joint specification
  - On plans
- Backfill Specification
  - On plans
- Mandrel or laser testing required (to be discussed more in 4.7.4)

Only allowed on a parcel

4.5.1 Channel Configuration & 4.5.2 Channel Lining

- Max side slope for vegetated = 3H:1V with a minimum longitudinal slope of 1%
- Vegetated conveyance shall be sodded
- 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.

4.6.1 Minimum Criteria for Drainage Structures

Table 4.6

- Lid must be capable of being removed for immediate concerns
- Interior Dimensions
  - Manholes get bigger the deeper they go
- All structures must be labeled
  - "Dump no waste. Drains to River."
- Steps are required when structure is 3'-6" or deeper

4.6.2 End Treatments

End Treatment is required for all stormwater conveyance pipes

Flared End Section or Headwall/Endwall for all pipes smaller than 36”

Headwalls and Endwalls for all pipe outfalls 36” or greater

Questions?

Engineering Services

Stormwater Division

Stormwater Conveyance Permit

October 1, 2024

Raleigh

Stormwater Conveyance Permit

- As-built drawings – *to address asset inventory requirements*
- Inspection – *to improve infrastructure quality*
  - CCTV
  - Mandrel Testing
  - Inspection for >72” diameter

SCON Permit Required

A SCON permit is required if you meet at least one of the following:

- Located in the ROW
- Located on public or private property & greater than or equal to 12” in diameter
- Located on public or private property & conveys public runoff

SCON Permit Not Required

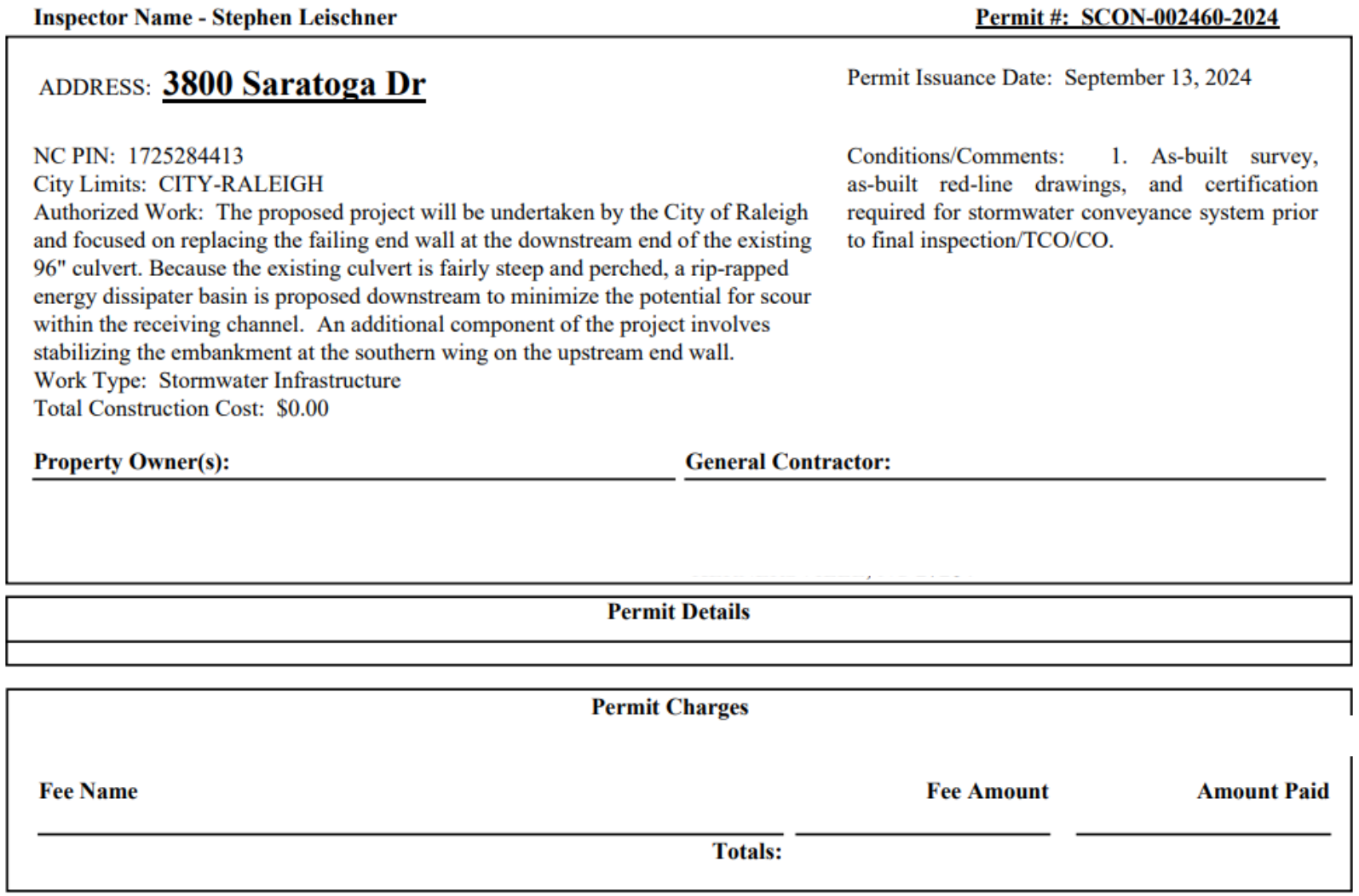
Private Pipe less than 12” in diameter outside ROW and does not connect to ROW

Repairing or Replacing pipes that do not convey public runoff

How to Obtain a SCON Permit

- Site Permit Review (SPR)
- Building Permit
- Zoning Permit

Whichever is Applicable



Inspector Name - Stephen Leischner

Permit #: SCON-002460-2024

ADDRESS: **3800 Saratoga Dr**

Permit Issuance Date: September 13, 2024

NC PIN: 1725284413
City Limits: CITY-RALEIGH
Authorized Work: The proposed project will be undertaken by the City of Raleigh and focused on replacing the failing end wall at the downstream end of the existing 96" culvert. Because the existing culvert is fairly steep and perched, a rip-rapped energy dissipater basin is proposed downstream to minimize the potential for scour within the receiving channel. An additional component of the project involves stabilizing the embankment at the southern wing on the upstream end wall.
Work Type: Stormwater Infrastructure
Total Construction Cost: $0.00

Conditions/Comments: 1. As-built survey, as-built red-line drawings, and certification required for stormwater conveyance system prior to final inspection/TCO/CO.

Property Owner(s):

General Contractor:

Permit Details

Permit Charges

Fee Name	Fee Amount	Amount Paid
Totals:		

Calculations/CAD File

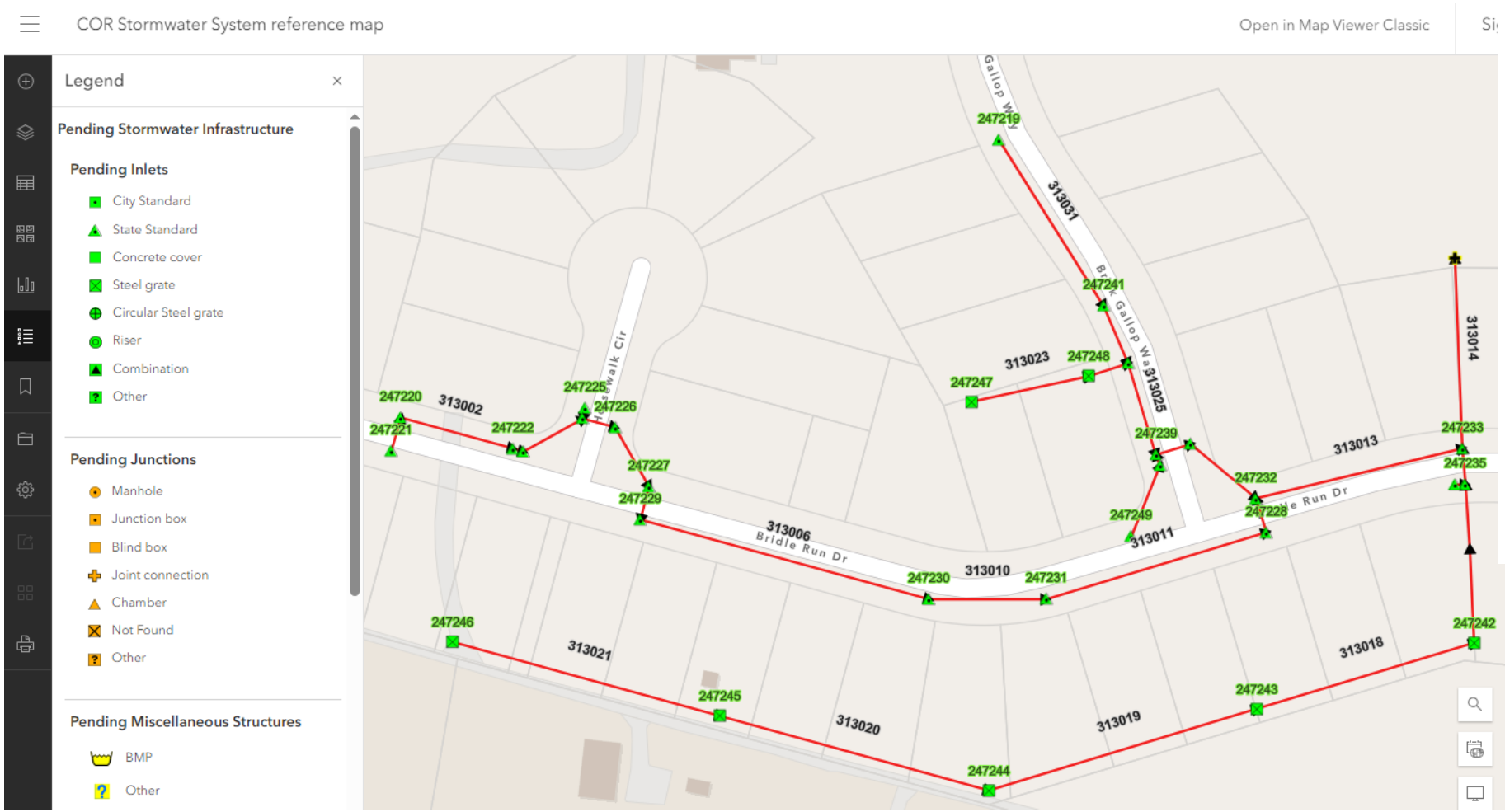
Calculations (Provided During Plan Review)

- Required for new stormwater conveyance pipes (including replacements) and repairs and
- When installation will require hydraulic performance

Electronic File (Provided During Plan Review)

- CAD file is required prior to permit issuance and submitted to StormwaterPermit.Submittals@raleighnc.gov (copy plan reviewer)

Facility IDs Assigned After Permit Issued



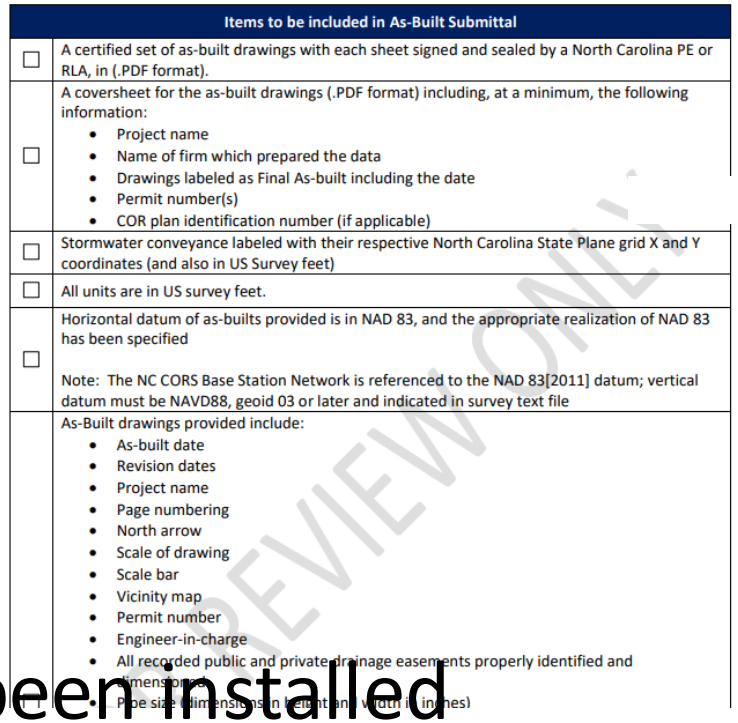
As-builts

As-builts Required

- Required for New, Repaired, Abandoned, Replaced Pipes ≥12” diameter

How/When to Submit

- After Stormwater Conveyance System has been installed
- As-built Checklist/Surveyed by PLS/Certified by PE
- Surveyed and Red-line of plans
- Submit as-built package to asbuiltsubmittal@raleighnc.gov
- You can track status of review through Permit Portal
- This will hold up CO



STORMWATER CONVEYANCE AS-BUILT SUBMITTAL CHECKLIST

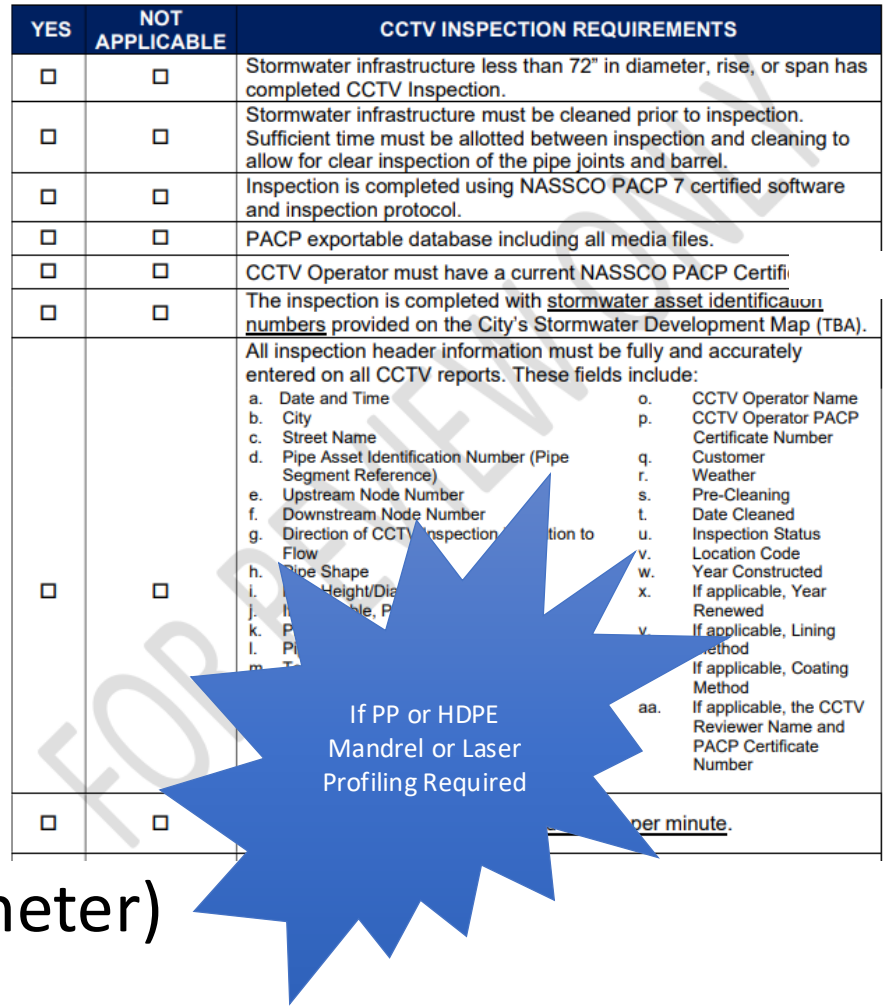
	Items to be included in As-Built Submittal
☐	A certified set of as-built drawings with each sheet signed and sealed by a North Carolina PE or RLA, in (.PDF format).
☐	A coversheet for the as-built drawings (.PDF format) including, at a minimum, the following information: • Project name • Name of firm which prepared the data • Drawings labeled as Final As-built including the date • Permit number(s) • COR plan identification number (if applicable)
☐	Stormwater conveyance labeled with their respective North Carolina State Plane grid X and Y coordinates (and also in US Survey feet)
☐	All units are in US survey feet.
☐	Horizontal datum of as-builts provided is in NAD 83, and the appropriate realization of NAD 83 has been specified Note: The NC CORS Base Station Network is referenced to the NAD 83[2011] datum; vertical datum must be NAVD88, geoid 03 or later and indicated in survey text file
☐	As-Built drawings provided include: • As-built date • Revision dates • Project name • Page numbering • North arrow • Scale of drawing • Scale bar • Vicinity map • Permit number • Engineer-in-charge • All recorded public and private drainage easements properly identified and dimensioned • Pipe size (dimensions in height and width in inches)

PREVIEW ONLY

3rd Party Pipe Inspections

CCTV Inspections Required

- New pipes in City ROW or pipe conveying public runoff is ≥12” diameter (NBIS if ≥72” diameter)
- Repair of pipe ≥12” diameter in City ROW or conveying public runoff (NBIS if ≥72” diameter)



YES	NOT APPLICABLE	CCTV INSPECTION REQUIREMENTS
☐	☐	Stormwater infrastructure less than 72” in diameter, rise, or span has completed CCTV Inspection.
☐	☐	Stormwater infrastructure must be cleaned prior to inspection. Sufficient time must be allotted between inspection and cleaning to allow for clear inspection of the pipe joints and barrel.
☐	☐	Inspection is completed using NASSCO PACP 7 certified software and inspection protocol.
☐	☐	PACP exportable database including all media files.
☐	☐	CCTV Operator must have a current NASSCO PACP Certifi
☐	☐	The inspection is completed with stormwater asset identification numbers provided on the City’s Stormwater Development Map (TBA).
☐	☐	All inspection header information must be fully and accurately entered on all CCTV reports. These fields include: a. Date and Time b. City c. Street Name d. Pipe Asset Identification Number (Pipe Segment Reference) e. Upstream Node Number f. Downstream Node Number g. Direction of CCTV Inspection tion to Flow h. Pipe Shape i. Height/Dia j. ble, P k. P l. Pi o. CCTV Operator Name p. CCTV Operator PACP Certificate Number q. Customer r. Weather s. Pre-Cleaning t. Date Cleaned u. Inspection Status v. Location Code w. Year Constructed x. If applicable, Year Renewed y. If applicable, Lining ethod If applicable, Coating Method aa. If applicable, the CCTV Reviewer Name and PACP Certificate Number
☐	☐	per minute.

If PP or HDPE Mandrel or Laser Profiling Required

FOR REVIEW ONLY

Still Photo Required but no CCTV

- Pipes <12” diameter connecting to City stormwater conveyance system in the ROW

3rd Party Pipe Inspections

How/When to Submit Pipe Inspections

- Required prior to final lift of asphalt (if applicable)
- Flush pipes (inspection in Permit Portal associated with this)
- CCTV operator must be NASSCO PACP certified
- Repair Plan for pipes that have NASSCO PACP structural or O&M defects with a score of 2 or greater
- Still photo if applicable (<12” connecting to SW conveyance system in City ROW)
- Mandrel Test for flexible pipes
- Bridge Inspection Report (If applicable) NBIS pipes>72” diameter
- Pipe Inspection Checklist/Certified by PE
- Submit as-built to asbuiltsubmittal@raleighnc.gov
- You can track status of review in Permit Portal
- This will hold CO

Questions?

Engineering Services

Stormwater Design Manual Chapter 3 Changes

Designer Training

October 1, 2024

Raleigh

What's Changed?

- Heavily streamlined chapter contents
- Anything that could be found in reference materials was excluded
  - Removed several equation references
  - Removed all figures and example problems

Drainage Area Delineation

- Provide guidance on:
  - Selection of analysis points
  - Determining drainage areas
  - Exhibits (pre and post)

Hydraulic Methods

- Table of approved methods based on design application type

TABLE 3.1
APPROVED USES OF 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		✓	✓	✓

Hydrologic Analysis

- Added list of approved software for analysis :
  - CivilStorm
  - EPA SWMM
  - HEC-HMS
  - Hydraflow
  - HydroCAD
  - Hydrology Studio
  - InfoDrainage
  - Infoworks ICM
  - PC SWMM
  - PondPack
  - Stormwater Studio
  - WinTR-20

Methods Not Allowed

- Specifically noted methods not allowed unless noted otherwise elsewhere
- Include:
  - Chainsaw Routing Method
  - Modified Rational Method
  - Simple Method (for Runoff Volume)

NRCS Curve Numbers

- Created a table to provide comparisons between COR zoning districts to TR-55 land cover descriptions

TABLE 3.3
NRCS CURVE NUMBERS (CN) 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-) and Office Mixed Use (OX-)	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
Agriculture Productive (AP)	Other agricultural lands
Heavy Industrial (IH)	Industrial
Manufactured Housing (MH)	Residential districts by average lot size – 1/8 acre
Campus (CMP)	Residential districts by average lot size – 1/8 acre
Planned Development	Custom number based on actual impervious area

Rational Method Coefficients

- Updated to reflect 2013 update to HEC-22 Drainage Design Manual
- Added runoff coefficients for Raleigh zoning classifications

Zoning:	
Single-Family (R – 1) and (R – 2)	0.40
Single-Family (R – 4)	0.55
Single-Family (R – 6)	0.75
Multi-family (R – 10)	0.75
Residential Mixed Use (RX-)	0.85
Office Park (OP-)	0.90
Office Mixed Use (OX-)	0.90
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 Housing (MH)	0.75
Campus (CMP)	0.60
Planned Development (PD)	Custom number based on actual impervious area

Rainfall Data

- To align with future updates or replacement of NOAA Atlas 14, effective rainfall data will be posted on the City's stormwater website

Raleigh Stormwater

Questions?

Engineering Services

Stormwater Design Manual Chapter 5

Plan Review Team Training

September 24, 2024

Raleigh

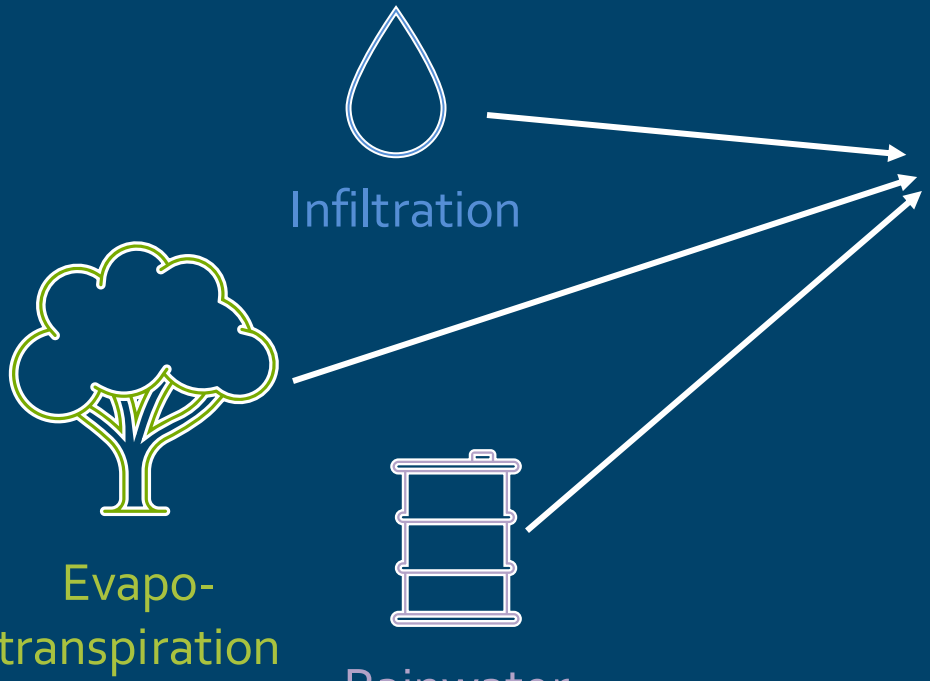
Presentation Outline

- Chapter 5 – Stormwater Management Calculations (Sally)
- UDO 9.2.2.A.4 Increasing IA (Sean)

Changes

- Nutrient Calculation Method must be updated to reflect change in Neuse State Rules that were adopted into UDO with TC-1-23
- Encouraging use of Volume Reduction to further GSI goals

SCM Mechanisms & Benefits



Volume Reduction

Benefits

- Reduced Flooding
- Maintained Water Quality
- Protected Streambanks
- Recharged Groundwater

SCM Mechanisms & Benefits

Settling

Filtration

Detention

Benefits

- Maintained Water Quality
- Reduced Flooding

Nutrient Requirements

Two Paths

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

Nutrient Requirements

Runoff Match

5.3.5 Use Volume Reduction

Meeting 3.6 lb/ac/yr

5.3.6 Required Onsite Tx

5.3.7 Determine WQv

5.3.8 SNAP Calcs

5.3.9 Nutrient Offset Calcs

Both

5.3.1 Common Plan of Dev't

5.3.2 Existing BUA

5.3.3 Define Regulated Area

5.3.4 Determine Method

5.3.10 Submittals

Regulated Area

Rate Control & Nitrogen

- Entire parcel(s) area
- Newly dedicated ROW
- Existing ROW where BUA is added or fee-in-lieu is paid (e.g. sidewalks)
- Future greenways in greenway easements being dedicated

Regulated Area

Rate Control v. Nitrogen

- Rate Control must consider off-site drainage area to parcel in sizing conveyance, SCMs, flood studies. Full drainage areas must be shown in exhibits.
- Nitrogen shall NOT consider those off-site areas

Regulated Site Area

Subdivisions

For multi-phase:

- Each phase must show compliance separately.
- If a phase depends on an earlier phase, must state that.

Commercial subs:

- For purposes of Nitrogen rules, identify whether % impervious will be over or under 24% at build-out. We will assume over 24% unless demonstrated otherwise.

Rate of Runoff Control Requirements

Points of Analysis

- Each point where flow leaves the parcel
- Separate POA for each pipe system, even if they combine further downstream
- In existing ROW – edge of LOD or where flow leaves ROW
- Flow to each adjacent parcel calculated separately

5.3.1 Common Plan of Development

Yes

- Projects with one application.
- Adjacent parcels managed as one project.

No

- Two one or two unit dwellings with a shared driveway.

- Contact us if common plan could put a site over the threshold for full stormwater rules.

Photo Credit

5.3.7 Water Quality Volume

- Required WQv is based on new BUA.
- Provided WQv is based on what is actually treated for the 1" storm.

- We will give credit for treating existing ROW that isn't already treated.
- Existing BUA can be treated instead of new BUA.
- No credit towards the Primary SCM requirement for existing SCMs.
- We will allow new BUA in existing ROW to remain untreated if treatment isn't feasible. It still has to be included in calcs to meet 3.6 threshold.

5.3.9 Nutrient Offset Credit Eligibility and Calcs

- Less than 24% BUA
- Greater than 24% and all BUA treated with Primary SCM

5.3.10 Nutrient Compliance Submittal Req's

- Existing and Post-Dev Maps with land cover in SNAP categories
- PDF of SNAP worksheets
- PDF of City Nutrient Summary Sheets
- Excel file of SNAP before permit marked ready for issuance

Impervious Limits

Determining Impervious Surface Limits

- Check the plat
- If "Grandfathered," check the zoning
- Email Stormwater.Impervious@raleighnc.gov

Exceeding UDO 9.2.2.A.4 impervious limits

Three methods:

- Full nitrogen and runoff requirements
- Volume control
- ~~Downstream flood analysis~~ Peak discharge

Exceeding UDO 9.2.2.A.4 impervious limits

Full nitrogen and runoff requirements (UDO 9.2.2.A.4.a)

- Nitrogen reduction (UDO 9.2.2.B)
- Runoff limitation (UDO 9.2.2.E)

Exceeding UDO 9.2.2.A.4 impervious limits

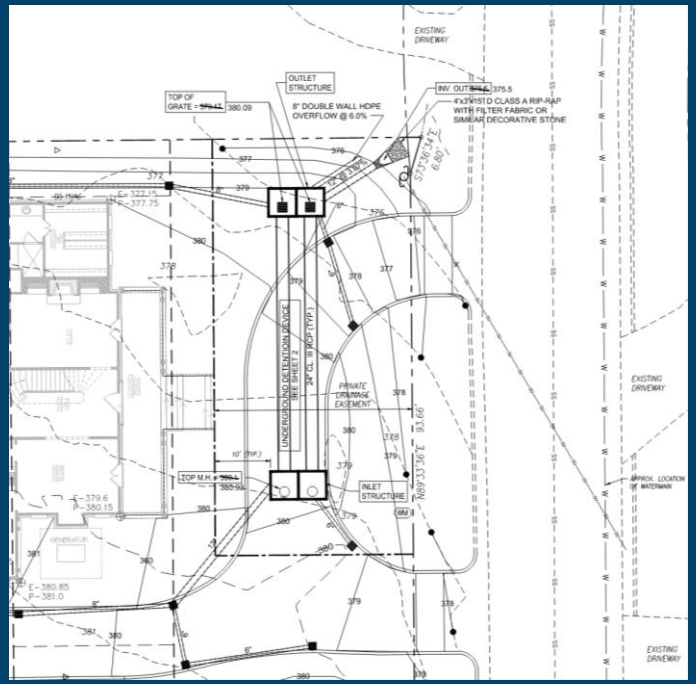
Volume control (UDO 9.2.2.A.4.b.i)

- Compares proposed conditions to maximum
- SCM to infiltrate the runoff generated by the excess impervious surface

Exceeding UDO 9.2.2.A.4 impervious limits

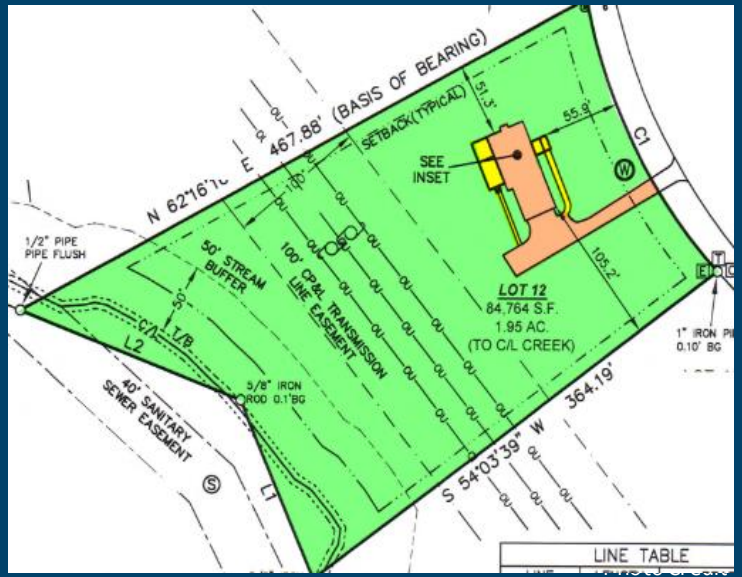
Peak discharge (UDO 9.2.2.A.4.b.ii)

- Replaces the "downstream flood analysis"
- Limit peak runoff to that expected of the maximum for the 2- and 10-year storms



Residential Lots Greater than 1 Acre

- Changed 5/1/23 due to Neuse Nutrient Management Strategy
- Subject to nitrogen and runoff requirements when BUA added since 5/1/2001 exceeds 5%



ENGINEERING SERVICES

Chapter 6
SCM Design

Designer Training
October 1, 2024

Raleigh

6.1 Introduction

All SCM's used to comply with Nitrogen Reduction must comply with:

- MDC's applicable to all SCM's
- Section 6.3 of this manual
- The device specific MDC
- The device specific requirements in Section 6.4

*If the MDC is updated or if a new device is added after the effective date of the manual, then is may be used for Nitrogen Reduction.

6.3.1 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.)

6.3.3 Embankments and Freeboard

Freeboard requirements apply to embankments where the depth of water to be impounded is >= 3'

A. 1' freeboard between the largest storm with peak discharge requirements and the E-spillway.
B. Flow from the 100-yr storm must be safely conveyed through the primary outlet control structure.
C. Freeboard to top of embankment must be a min. 1' above the 100-yr storm elevation.

6.3.3 Embankments and Freeboard Cont.

D. Embankments designed per NRCS Conservation Practice Standards Pond Code 378 except where NCDEQ SDM is more stringent.

E. Comply with NC Dam Safety Regulations

F. The only penetration through the embankment shall be the outflow barrel. Seepage shall be minimized using anti-seep collar or filter and drainage diaphragms.

6.3.4 Proximity to Buildings

All SCMs shall be located a min. of 10 feet from any building unless all the following criteria are met:

A. The SCM is watertight.

B. Plastic tanks molded as one piece are assumed to be watertight.

C. The leak rate specified in testing must be acceptable to the professional responsible for geotechnical and structural design.

D. A sealed letter from a NC licensed structural engineer with the SCR at the time of permitting review.

6.3.4 Proximity to Buildings Cont.

E. If in or under a building, a signed letter from the property owner shall be submitted acknowledging the increased long-term maintenance costs associated with the location.

F. Adequate access is provided for maintenance. If access by maintenance vehicles is not directly available, a letter from a maintenance company indicating that are willing to maintain the SCM shall be required.

6.3.5 Use of Retaining Walls

Retaining walls may be used to contain ponded water associated with the SCM treatment volume if:

A. A leak rate must be established and must be used in conjunction with the outlet structure hydraulic design.

B. For walls over 5 feet in height, a sealed letter by the NC-licensed structural engineer must be submitted with the SCR, indicating that the engineer is aware of the saturated soil conditions as shown on the plans.

6.3.5 Use of Retaining Walls Cont.

C. Wall design details must be submitted that demonstrate no short circuiting of the SCM will occur.

D. Retaining walls within a SCM must be included in the drainage easement for SCM 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.

6.3.6 Plantings

A. Proposed plantings shall not include any species listed as an "Invasive Plant Species"
B. No woody vegetation shall be planted on embankments.
C. Vegetation shall not impede sight distance on any public road.
D. Woody vegetation shall not be planted within 3 feet of the inflow.
E. Woody, deep-rooted vegetation must not be planted directly over underdrains.

6.3.7 Infiltration Testing

When infiltration testing is required, the following are approved tests:

A. Double-ring Infiltrometer (ASTM D3385-18)

B. Modified Philip-Dunne Infiltrometer (ASTM D8152-18)

C. Constant head permeameter (also known as the Amoozemeter) (ASTM D2434- 22)

6.3.8 Maintenance Access (Refers to 7.4)

- Footprint + 10 feet
  - +25 feet off edge of wet pond and wetland forebay and deep pools for sediment removal
- Maintenance access to components
  - Forebay, riser, plants, embankment, outlet, spillway
- From ROW to SCM
  - Min 10' width
  - Max 3:1 slopes
- Outflow to ROW, stream, easement

6.3.10 Outlet Design

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.

    A. Outlets shall be accessible by foot in the storm for which the SCM has been designed.

C. 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.

6.3.11 Requirements for All Underground SCM's

A. Underground SCMs shall provide access in accordance with OSHA standards.

B. Underground SCMs must meet structural requirements for HL-93 loading.

C. A minimum of two access points shall be required.

    A. Access points shall be reachable by a pump truck.

    B. Access points shall 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.

    C. Access manways shall meet the access, interior dimensions, labelling, loading, and steps criteria from Table 4.6 of this Manual.

6.3.11 Requirements for All Underground SCM's

D. Each chamber of the underground SCM shall be reachable by a pump truck suction hose.

E. Access provided also shall meet manufacturer’s requirements.

Image source: https://www.conteches.com/media/254fmvun/duromaxx-stormwater-dentention-system.jpgwidth=1920&height=580&v=1db084395a45ed0

6.3.14 City-Maintained SCMs

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

Submittal Requirements

Section 6.4

6.4.1 Stormwater Compliance Report (SCR)

6.4.2 SCM Plan View

6.4.3 SCM Plan Sheet Notes

6.4.4.1 Cross-Section Through SCM

6.4.4.2 Outlet Structure Detail

6.4.4.3 Flow Splitters

6.4.4.4 Outlet Protection

6.5.4 Stormwater Wetland

DESCRIPTION AND APPLICATIONS:

Stormwater wetlands combine the detention and settling 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:
    1. Permanent pool elevation within 6 inches of the SHWT.
    2. Impermeable liner and with a minimum drainage area of 10 acres.
    3. 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.

REQUIREMENTS FOR CITY FUNDED PROJECTS

(RECOMMENDED FOR OTHER PROJECTS)

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

UDO SCM Requirements

Consolidating SCM requirements

- UDO 9.2.2.D
  - O&M Manual, Easement, As-Built, Surety
- UDO 9.2.2.G
  - Maintenance Covenant/Instrument
- UDO 9.2.2.H
  - Annual Inspections

SCM O&M Manual Requirements

SWDM Sec. 6.6, UDO 9.2.2.D.2

- Will now be incorporated by reference into maintenance covenant/instrument, rather than recorded as exhibit
- See Design Manual and UDO for full requirements
- Including exhibits showing:
    - Site
    - SCM locations and drainage areas
    - SCM design details

SCM O&M Manual Requirements

Narrative and checklist including

- Description of maintenance access procedures, including confined space
- Inspection checklist including frequency for each action, including "quantitative triggers"
- Maximum pumped drawdown rate in gpm
- List of steps to restore in event of failure
- Construction cost estimate
- See Design Manual and UDO for full requirements

SCM Construction Cost Estimate

See SWDM Sec. 2.12 for full requirements

Includes:

- **Quantities and unit costs**
- Structures
- Pipe
- Excavation/grading
- Fill material
- Rip rap
- geotextiles
- Plantings
- Soil media
- Soil preparation
- Retaining walls

As-built certifications and surveys

SWDM Sec. 6.7, UDO 9.2.2.D.4

To include:

- Narrative summary of any deviations from approved plans
- Surveyed elevations
- Updated plan/calcs reflecting any changes
- Updated maintenance manual to reflect as-built conditions
- Photos taken within 7 days of submittal
- Receipt/invoice for plants
- Documentation of any required testing

As-built certifications and surveys

Required photos (SWDM Sec. 6.7.1.I.)

- See Design Manual for all required photos
- Photos taken during construction:
  - Underdrains (including caps)
  - Drainage layers
  - Anti-seep collars, filter diaphragms

Maintenance Instrument for Non-Shared SCMs

UDO 9.2.2.G.3

- Similar to maintenance covenant, for single-lot SCMs
- To be recorded prior to building permit issuance

SCM Replacement Fund

- Removing requirement per HB488
  Required by State law

SCM Maintenance Funds

UDO 9.2.2.G.2.t. or UDO 9.2.2.G.3.d

- HOA or lot owner required to retain funds in 5 years equal to 10% of SCM construction cost to be used for maintenance/repairs
- 5th and all subsequent annual inspections will include statement certifying that funds are available.

New Easement Requirements

- Public Easements when carrying public runoff – *for City maintenance*
- Upstream Discharge – *to avoid future impacts with upstream development*
- Dams (not part of SCM) - *to protect public safety*

Work in Easements

Principles

- Do not limit access for maintenance, repair, replacement
- Do not increase cost of maintenance, repair, replacement
- Do not impede flow of water
- Do not damage the infrastructure
- Do not increase loading on infrastructure beyond its design

Not Allowed

- Accessory Structures
- Buildings*
- Decks/porches
- Pools
- Headwalls/Wingwalls for pipes

Allowed with Conditions per Manual

- Driveways, Patios, Sidewalks
- Fences
- HVAC
- Play Equipment
- Retaining Walls
- Signs
- Vegetation

ENGINEERING SERVICES

City of Raleigh

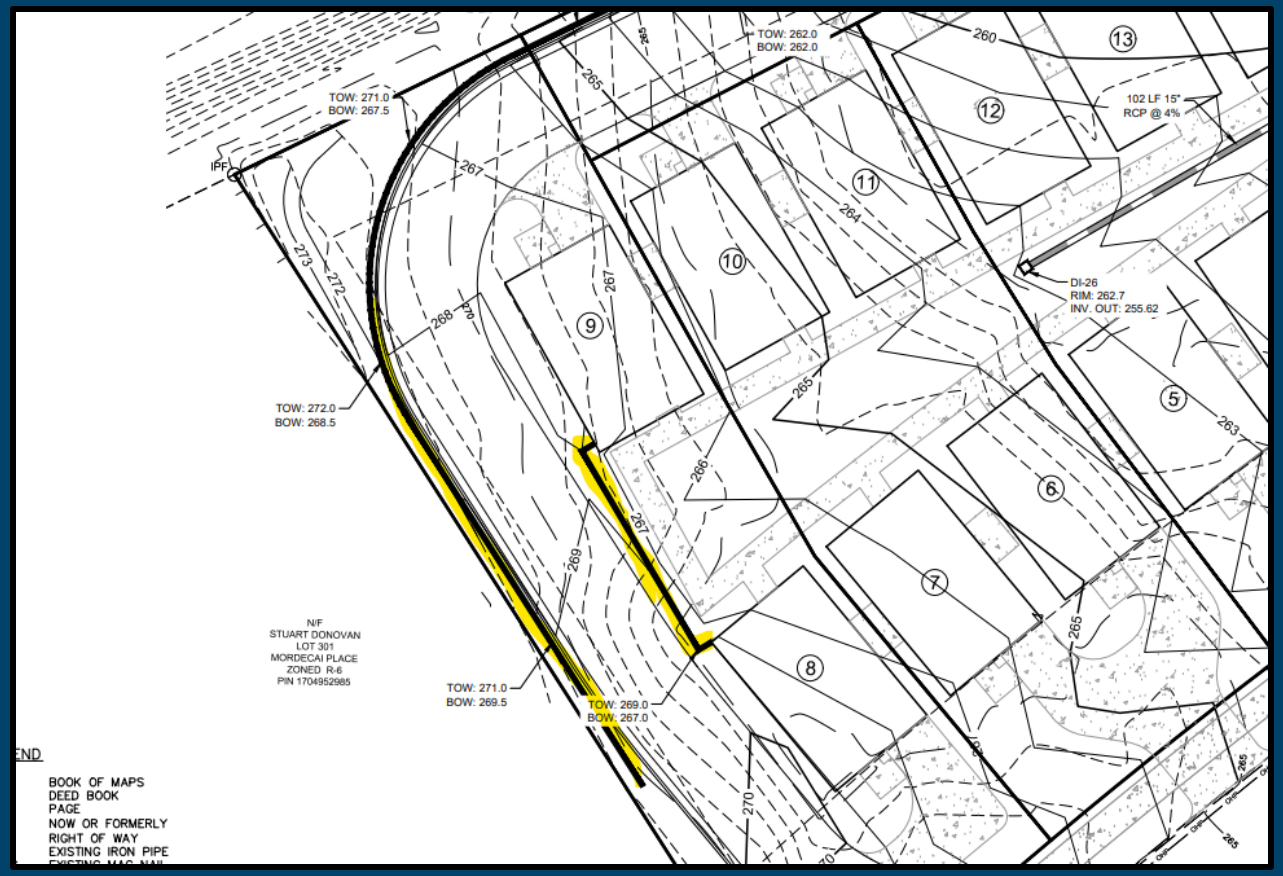
Sediment and Erosion Control

October 1, 2024

Raleigh

Guidelines for Land Disturbing Activities

- Document Eliminated
- Cut/Fill Setbacks Eliminated
  - From building
  - From property



Land Disturbance Surety

- Was $1,000/acre
- Now $2,000/acre

Peak Rate of Runoff – During Construction

- Runoff from 10- and 25-year storm
- No Change
- Was in GLDA
- Now in UDO

Land Disturbance Grading Permit Expiration

- LDG permit shall expire three years following the date of approval if no land disturbing activity has been undertaken.

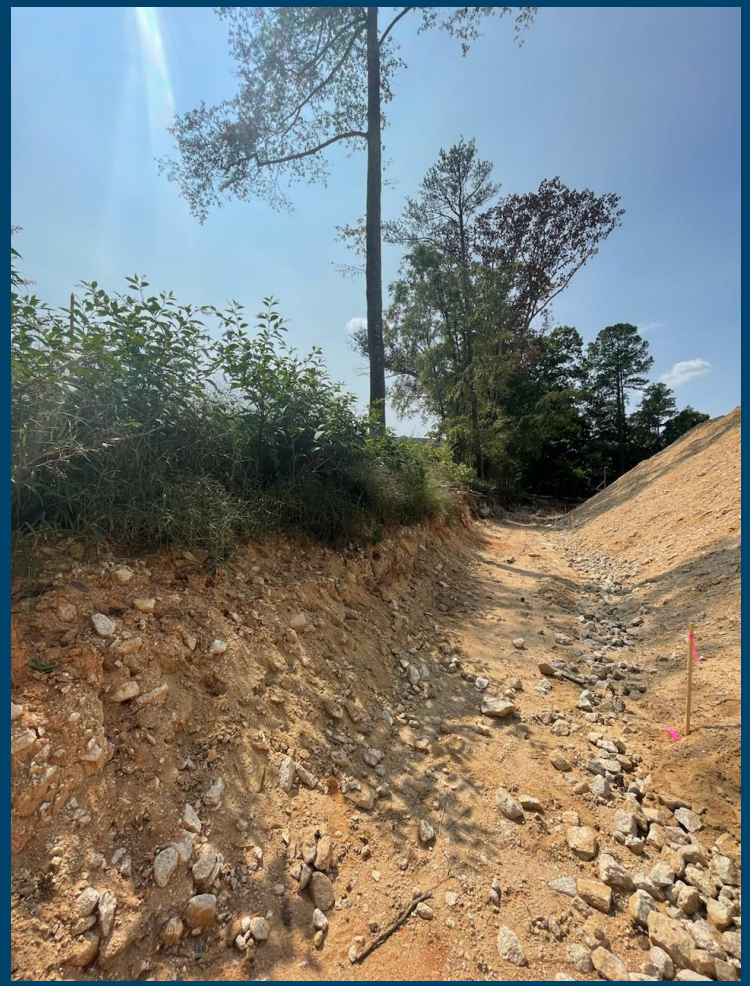
Limits of Disturbance

- Further defines what areas may be included within LOD
- Construction Access - Minimum 10 ft around structures or extended to property line if property line is less than 10 ft from structure

Stockpile Requirements

- Shall be shown on plans
- Slopes shall be 2:1 or flatter
- Cannot exceed 35 feet in height
- Shall be removed prior to the end of the project closeout

Sites 20 Acres or Larger Plans to Include



- Demonstrate how time of exposure and amount of exposed area is limited
- Cut/fill analysis with exhibit to show where soils will be moved (internal to site or where off-site)
- Construction Sequence (shall detail phasing to justify the time and amount of exposure)

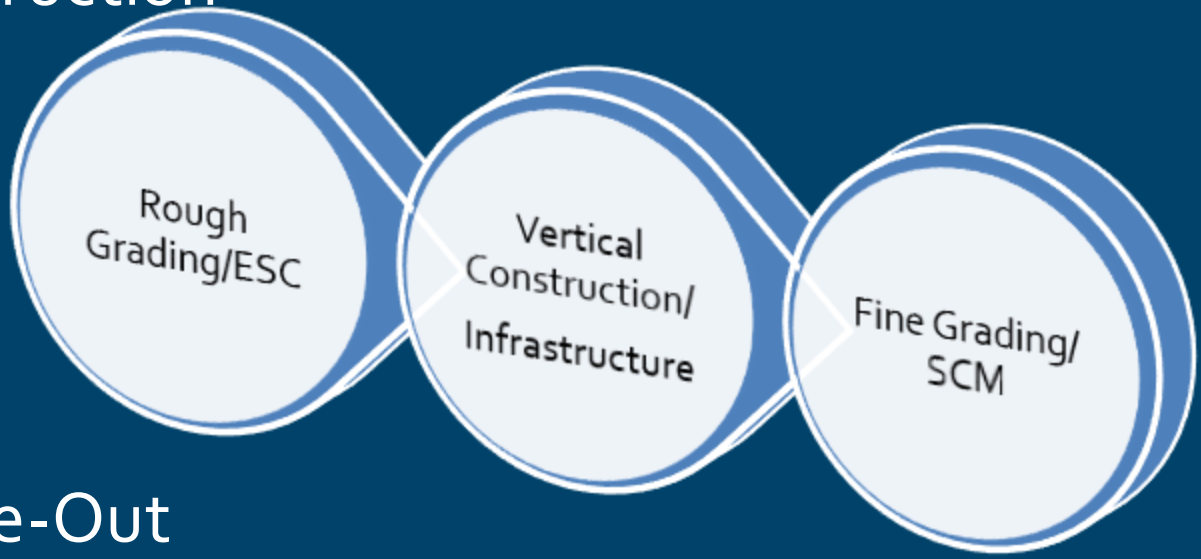
ESC Calculations & ESC Plans

- No Changes
- Detailed Info in 8.4 Design Manual

"I'm starting to think our math might be off."

Construction Phasing and Sequencing

- Initial Phase of Construction
  - Installing Perimeter Measures
- Intermediate Phase of Construction
  - Rough Grading
  - Bypassing off-site water
  - Installing infrastructure
  - Installation of Pavement
  - Vertical Construction
- Final Phase and Project Close-Out
  - Installing SCMs, stabilizing site, as-builts



Raleigh

Questions?

ENGINEERING SERVICES

Stormwater Design Manual Revision

Chapter 9 – Floodplain Management

October 1, 2024

Raleigh

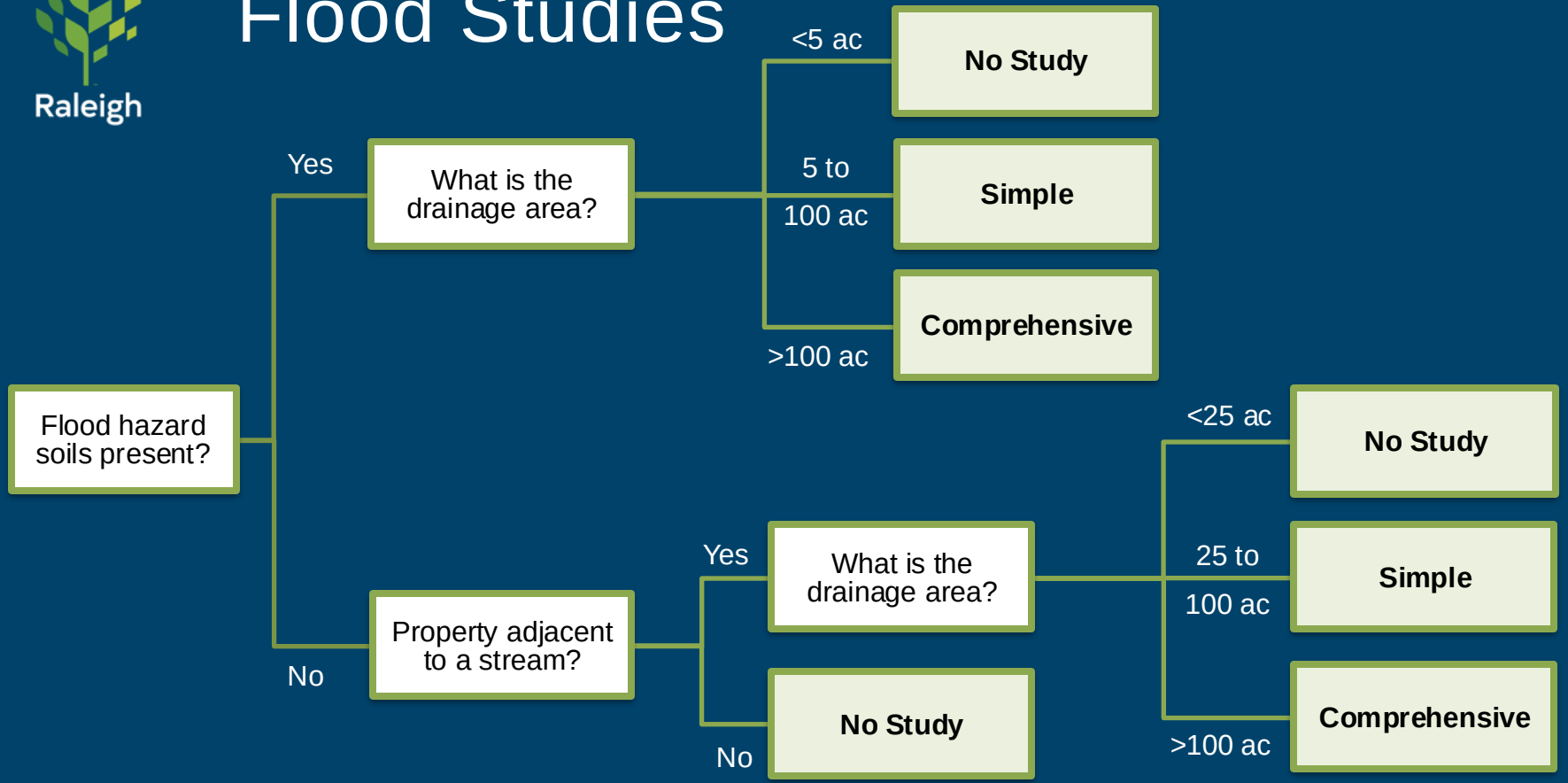
Agenda

- Types of SFHA
- Flood Studies
- Flood Study Checklist

Types of SFHA (UDO Changes)

- FEMA-Designated SFHA
- SFHA Based on Drainage Basin Study Maps
- SFHA Based on Flood Study
- SFHA Based on Flood Hazard Soils

Flood Studies



Flood Studies

Location of Development	Study Requirement
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
Non-flood hazard soils that drain between 0 and 25 acres	No study required
Sites containing or adjacent to any stream that drains greater than or equal to 25 acres and less than 100 acres	Simple flood study
Flood hazard soil areas or sites containing or adjacent to any stream that drain 100 acres or more	Comprehensive flood study

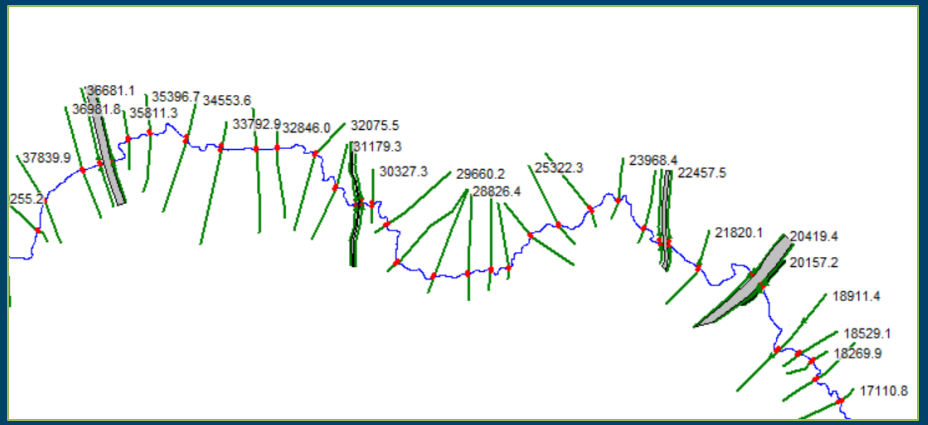
Flood Studies

Simple	Comprehensive
Establishes 100-year existing and future conditions water surface elevations	
Used to establish the RFPE	
Floodway delineation not required – entire 100-year boundary considered floodway	Floodway versus floodway fringe delineation required
Approved methods: HEC-RAS, Manning's equation, or NCDOT standard headwater analysis	Approved methods: 1D or 2D steady flow models approved by FEMA (HEC-RAS, etc.)

* If there is a structure on the property or downstream that influences the WSEL on the property, then a method that accounts for backwater from that structure is required

Flood Study Submittal and Checklist

- Submitted as a separate review
- Checklist available



Submittal Requirements

Contained in SWDM Chapter 2

- Sec. 2.1.4 (Lot Grading Plan)
- Sec. 2.2.2 (Stormwater Compliance Report)
- Additional requirements in other chapters:
  - SWDM Chapter 4 (Conveyance)
  - SWDM Chapter 6 (SCM-specific)
  - SWDM Chapter 8 (Erosion control)
  - SWDM Chapter 9 (Flood studies)

Wrap Up

What is Coming

- Standard Design Details
- Checklists
- Web Updates

Recap

- Google "Raleigh Stormwater Manual"
- Effective for submittals starting Monday, November 4
- Contact us with questions

Contact us:

Plan Review Questions:

stormwater.impervious@raleighnc.gov

sally.hoyt@raleighnc.gov

sean.eggleston@raleighnc.gov

Inspections Questions:

Lauren.Witherspoon@raleighnc.gov