ACEC Erosion Control Design Training 2013

Barney Blackburn, PE, CPESC, CPSWQ
NCDOT – Roadside Environmental Unit
Soil & Water Engineering Section Supervisor

Erosion Control Plans

- Considered Temporary Construction Plans
- PE Seal not Required or Recommended
- Level III/IIIA Certification Name & No. required on all NCDOT Erosion Control Plans
  - EC Title Sheet Only

Reasons to Not Seal EC Plans

- Temporary, not Permanent
- Revisions would require new sealed plan sheet
- Sediment Law/Land Quality does not require
- Sediment Law is performance-based

Perimeter Devices

- Temporary Silt Fence (TSF)
- Special Sediment Control Fence (SSCF)
- Wattle Barrier (EW, CFW)
- Temporary Silt Ditch
- Earthen Berm - 

for this application

Temporary Silt Fence

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

Placement – Along stream banks and at the toe of fill slopes

Function - Silt Fence temporarily traps sheet flow from disturbed slopes allowing sediment to settle on the flow side

Silt Fence Tips

- Commonly Overused in EC design!
- Placement Locations on EC Plans:
  - Toe of Bridge Approach Fill Slopes
  - Toe of Fill Slopes in Wetlands
  - Toe of Fill Slopes in Urban Areas
  - Above Culvert Inlets and Outlets, esp. on Final Grade Phase
  - Perimeter of Streams and Fill Slopes inside Riparian Buffers

Silt Fence Guidelines

- Drainage Area is not greater than ¼ acre per 100 ft. of silt fence – Rule of Thumb!
- Maximum Slope Length behind Silt Fence

Slope	Slope Length (ft)	Maximum Area (ft^2)
<2%	100	10,000
2 to 5%	75	7,500
5 to 10%	50	5,000
10 to 20%	25	2,500
>20%	15	1,500

Table 6.62a, Erosion and Sediment Control Planning and Design Manual NCDENR

Silt Fence Drainage Breaks

- Special Sediment Control Fence 
- Excelsior Wattle 

- Coir Fiber Wattle 

Special Sediment Control Fence

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

Placement – Short Sections between Silt Fence unless longer sections required

Function - Special Sediment Control Fence provides a drainage break for Silt Fence Sections in Low Areas

SSCF Tips

- Commonly Overused in EC design!
- Can be used in wetlands, but difficult to remove
- Placement Locations on EC Plans:
  - Drainage Breaks in Silt Fence (Max. Spacing of 200 ft.)
  - Adjacent to Stream Relocations
  - Some Permit Conditions require Special Sediment Control Fence at Toe of Bridge Approach Fills parallel to stream

Silt Fence Wattle Breaks

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

Placement – Between Long Segments of Silt Fence

Function – Wattle provides a drainage break for Silt Fence Sections and in Low Areas

Wattle Break Tips

- Design for Wattle of 10 ft. in length
- Can be used in wetlands, easy to remove (or not!)
- Maximum Spacing of 200 ft.
- Use Coir Fiber Wattles (CFW) for projects > 1 year
  - Environmentally Sensitive Areas (Trout, 303(d), etc.)

Wattle Barrier

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

Placement - At the toe of bridge approach fill slopes and along slopes

Function - Wattle Barrier temporarily traps sheet flow from disturbed slopes allowing sediment to settle on the flow side

Wattle Barrier Tips

- Utilize where Silt Fence can't be installed
- Can be used in wetlands, easy to remove (or not!)
- Maximum Spacing of 20 ft. for breaks on slopes
- Use Coir Fiber Wattles (CFW) for projects > 1 year
  - Environmentally Sensitive Areas (Trout, 303(d), etc.)

Wattle Barrier Update

- Utilize where vertical clearance between ground and bottom of bridge is less than 4 ft.
- Increased Minimum Diameter from 12” to 18”
- Deepened Trench from 1” to 2” to 2” to 3”
- Pay Item – Wattle Barrier, Coir Fiber Wattle Barrier

Temporary Silt Ditch

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

Placement - Toe of fill slopes

Function - TSD directs sheet flow from fill slopes into sediment traps and basins

TSD Tips

- Extend TSD to inflow side of sediment basins without leaving any gaps
- Place velocity checks (either a Rock Silt Check or Wattle) with TSD
- Do not place inside slope stake lines in the footprint of the project!

Earth Berm

Design - Utilized on Clearing & Grubbing and Final Grade Phases of Erosion Control Plans

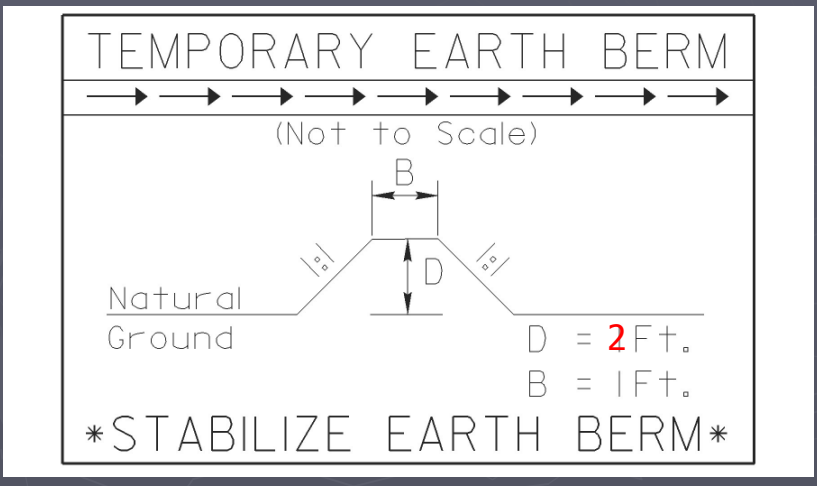
Placement - Toe of fill slopes

Function – Provides sediment storage for large fill slopes where sediment basins are not feasible

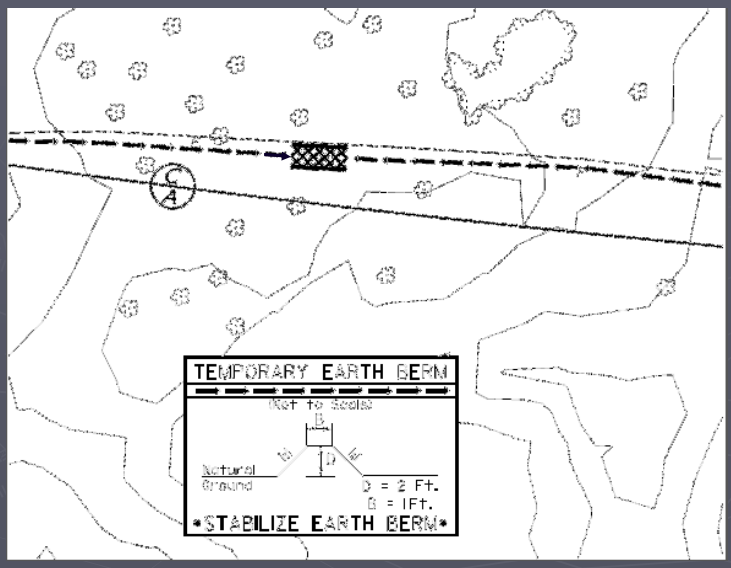
Earth Berm Tips

- Consider for:
  - Fill Slopes > 20 ft. in height measured along slope
  - Fill Slopes > 2 acres in area
- Place Stone Drainage Breaks, DA < 1 acre
  - Temporary Rock Silt Check Type A
  - Temporary Sediment Dam Type A
- Place Geotextile Spillways, DA > 1 acre

Temporary Earth Berm Detail



Earth Berm at Toe of Fill Slope



Runoff Diversion Devices

- Temporary Diversion (TD) → TD →
- Temporary Earth Berm →→→→
- Clean Water Diversion (CWD) → CWD →
- Temporary Berms and Slope Drains

Temporary Diversion

Design - Utilized on Clearing & Grubbing Phase of Erosion Control Plans

Placement - Outside proposed cuts and across graded areas to reduce slope length

Function - TD diverts sheet flow from exposed slopes into rock dams, sediment traps and basins; used to reduce the size of drainage areas

Temporary Diversion Tips

- Place in small proposed ditches on Clearing & Grubbing phase so that ditch can be built early
- Place velocity checks (either a Rock Silt Check or Wattle) with TD
- Utilize TD to divert runoff inside footprint of project to perimeter sediment basins (Cuts)
- Can be used in Buffer Zones in proposed permitted ditches

Temporary Earth Berm

Design - Utilized on Clearing & Grubbing and Final Grade Phases of EC Plans

Placement - Outside cuts and fills and parallel to the ROW; across graded areas to reduce slope length (Fills)

Function - Earth Berms divert offsite runoff to minimize the runoff flowing to erosion control devices; used to reduce the size of drainage areas

Earth Berm Tips

- Include Earth Berm Detail on plan sheets where utilized
- Place velocity checks (either a Rock Silt Check or Wattle) with Earth Berms
- Place Earth Berms inside footprint of fill slopes to divert runoff to sediment basins

Clean Water Diversion

Design - Utilized on Clearing & Grubbing and Final Grade Phases of EC Plans

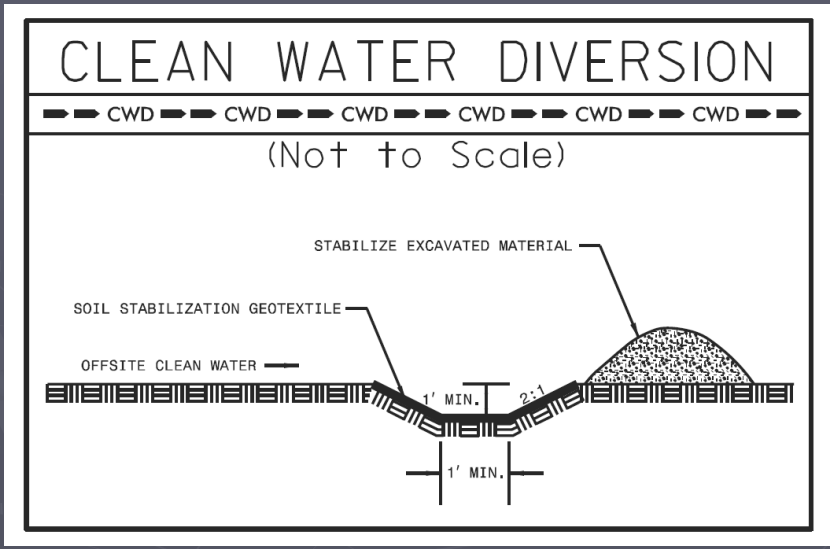
Placement - Outside cuts and fills and parallel to the ROW

Function – Clean Water Diversions divert offsite runoff to minimize the runoff flowing to erosion control devices; used to reduce the size of drainage areas

Clean Water Diversion Tips

- Include Clean Water Diversion Detail on plan sheets where utilized
- Place Type B Silt Checks for velocity control with CWD's every 2 ft. of elevation change
- Place Type A Silt Checks at outlets
- Do not show wattles in Diversions

Clean Water Diversion Detail



Temporary Slope Drains

Design - Utilized on Clearing & Grubbing and Final Grade Phases of EC Plans

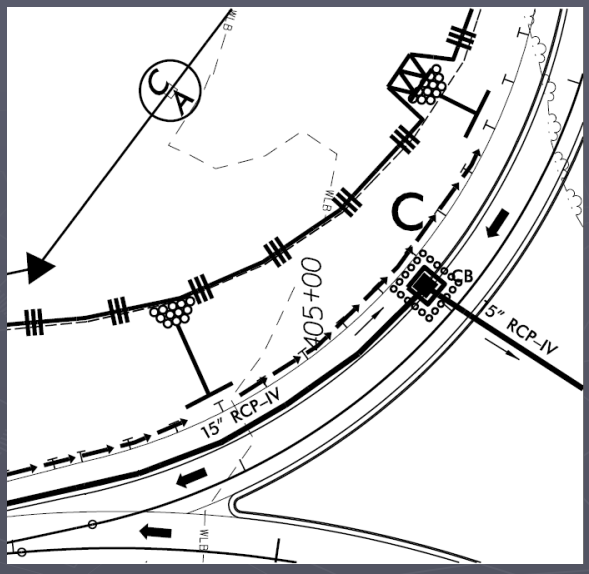
Placement – On large cuts and fills

Function – Convey concentrated runoff to bottom of slopes in a non-erosive manner

Slope Drains

- Utilize on fill slopes with 3:1 grade or steeper and fill slope height of:
  - 8 ft. and higher in Piedmont & Mountains
  - 5 ft. and higher in Sand Hills & Coastal Plain
- Don't need on fills with 4:1 or flatter slope
- Make sure slope drain outlets to a basin, trap, check dam or stone energy dissipater
- Use maximum spacing of 200 ft.

Slope Drains on EC Plans



NCG-01 Construction Permit

- Effective August 3, 2011
- Outlet devices must withdraw from basin surface unless drainage area is < 1 acre
- Ground Stabilization Time Frames of 7 or 14 days

Surface Dewatering Devices

- Skimmer Devices
- Infiltration Basins
- Silt Basin B (excavated below ground)
- Riser Basins
- Earth Berm at Toe of Fill Slopes

NOT Surface Dewatering Devices

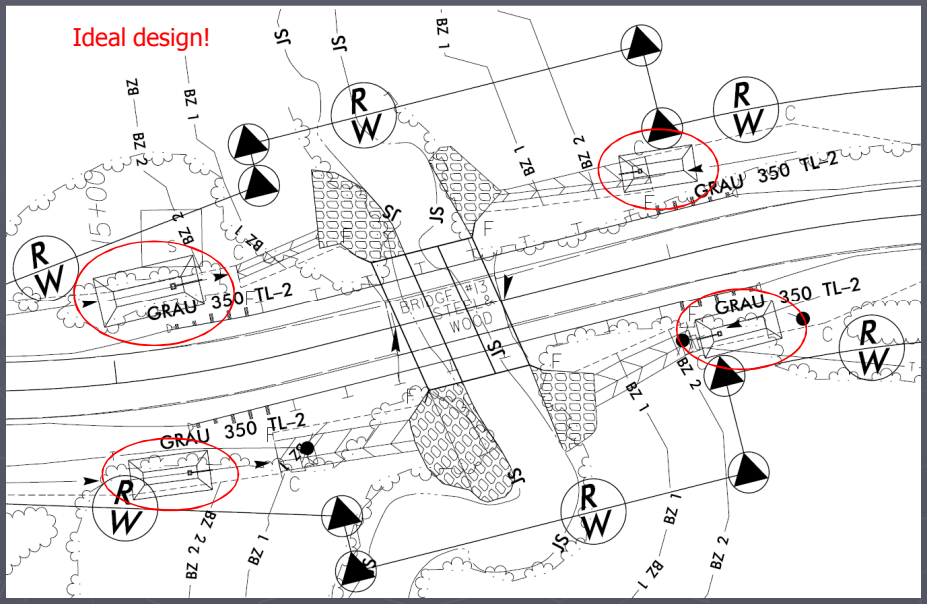
- Temporary Rock Silt Checks
- Temporary Rock Sediment Dams
- Silt Fence
- Stone Inlet Protection Devices
- Wattles

Standard Sediment Basins

- Silt Basin Type B
- Temporary Rock Sediment Dam Type B
- Infiltration Basin

Sediment Basin FYI

- Optimal Length:Width Ratio is 3:1, with 2:1 minimum and 6:1 maximum - exceptions
- NCDOT Sediment Basins have 1.5:1 side slopes
  - Not Required but Flatter Side Slopes = Less Volume
- Don't place basins in following locations:
  - Riparian Buffer Zones (unless permitted)
  - Wetlands (unless permitted)
  - Close to Homes or Businesses
  - In live streams



Silt Basin Type B

- Surface Area Requirement
  - 435 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
  - 325 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow at drainage inlet structures (i.e. DI's, CB's, etc.)
- Sediment Storage Requirement
  - 3600 ft^3 per disturbed acre
  - 1800 ft^3 per disturbed acre at drainage inlet structures (i.e. DI's, CB's, etc.)

Silt Basin Type B Tips

- Can be utilized in medians at drainage inlets
- Utilize adjacent to Rock Pipe Inlet Sediment Traps (PIST-A, PIST-B)
  - Surface Area = 435 ft^2 per cfs of $Q_{10 \text{ or } 25}$
  - Sediment Storage = 3600 ft^3 per disturbed acre
- Use Silt Basin B's for additional sediment storage upgrade of drainage outlet

Sediment Dam Type B

- Surface Area Requirement
  - 435 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
- Sediment Storage Requirement
  - 3600 ft^3 per disturbed acre
- Minimum Weir Length is 4 ft.
- Maximum Drainage Area is 1 Acre (NCG-01)

Sediment Dam Type B Tips

- Place Temporary Rock Sediment Dams Type B (TRSD-B) at drainage outlets that do not drain directly to a jurisdictional water body
- Place TRSD-B's inside footprint of project on Clearing & Grubbing EC Plans
- TRSD-B's are relatively inexpensive, but have largest basin footprint

Infiltration Basin

- Surface Area Requirement
  - 325 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
- Sediment Storage Requirement
  - 1800 ft^3 per disturbed acre
- Minimum Weir Length is 4 ft.
- Maximum Dewatering Time is 3 days

Infiltration Basin Tips

- Infiltration Basins can be placed at drainage outlets that drain directly to jurisdictional water bodies and Riparian Buffer Zones
- Utilize Infiltration Basins at toe of fill slopes; **do not use in proposed ditches**
- Recommend knowing ground water elevation for berm height construction
- Do not place in "Soils Prone to Flooding"

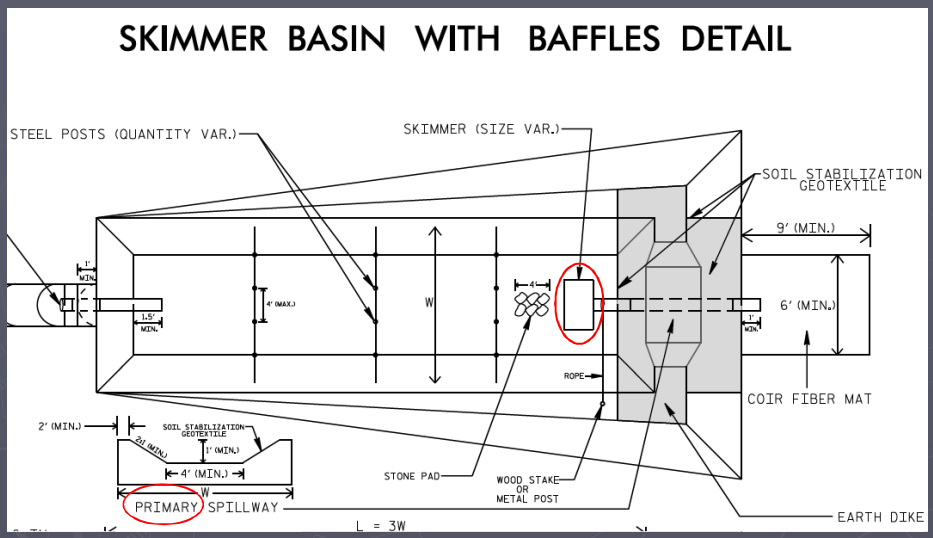
Break!

Skimmer Devices

- Skimmer Basin
- Tiered Skimmer Basin
- Earthen Dam with Skimmer
- Stormwater Basin with Skimmer

Skimmer Device Update

- Removed references to "Faircloth Skimmer"
- Revised Appearance of Skimmer in Detail
- Changed "Emergency" to "Primary" Spillway
- Revised Spillway Weir Formula to Q/0.4



Skimmer Device Spillway Update

- Impermeable Geomembrane for Spillways
  - Polypropylene
  - Polyethylene

- Divisions 1, 2, 3, 4, 6
- Cost More than Soil Stabilization Geotextile
- Skimmer, Tiered Skimmer, Infiltration, Dam

Skimmer Basin Design Criteria

- Surface Area Requirement
  - 325 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
- Sediment Storage Requirement
  - 1800 ft^3 per disturbed acre
- Minimum Primary Spillway Weir Length is 4 ft.
- Minimum Dewatering Time is ~~24~~ 48 hours

Skimmer Basin Tips

- Place Skimmer Basins at drainage outlets that drain directly to jurisdictional water bodies and Riparian Buffer Zones
- Skimmer Orifice is sized to dewater basin in 2 to 3 days in DOT Basin Design spreadsheet
- Skimmer Basins are more expensive than TRSD-B's, but have smaller footprint

Tiered Skimmer Basin Tips

- Place Tiered Skimmer Basins at drainage outlets that drain directly to jurisdictional water bodies and Riparian Buffer Zones
- Utilize Tiered Skimmer Basin when elevation difference is greater than 6 ft. from inflow to outflow ends of basin
- Label length, width and weir dimensions of upper basin (Modified Silt Basin Type B) and lower basin

Earthen Dam with Skimmer Design Criteria

- Surface Area Requirement
  - 325 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
- Sediment Storage Requirement
  - 1800 ft^3 per disturbed acre
- Minimum Weir Length is 4 ft.
- Minimum Dewatering Time is ~~24~~ 48 hours

Skimmer Dam Tips

- Place Earthen Dam with Skimmer in ditches with Large Cross Section (i.e. Base Ditch)
- Utilize when ditch grade is less than 2%
- Label weir length and height of designed dam
- Economic and Construction Benefits if feasible

Stormwater Basin with Skimmer Design Criteria

- Surface Area Requirement
  - 435 ft^2 per cfs of $Q_{10 \text{ or } 25}$ peak inflow
- Sediment Storage Requirement
  - 1800 ft^3 per disturbed acre
- Primary Spillway (Riser) to Convey 2-yr Storm
- Minimum Dewatering Time is ~~24~~ 48 hours

Stormwater Basin Tips

- Size Skimmer and Orifice Diameter for provided Stormwater Basin volume
- Size orifice to dewater volume 1 ft. from basin bottom
- Show Skimmer attached to Riser with label
- Include Note to use Stormwater Basin during construction

Stormwater Basin Construction Concerns

- Rock Layer or Water Table Too Close to Surface
- Unsuitable Material for Berms
- Inadequate Compaction in Berms
- Stormwater Basin may be too large to maintain

Stormwater Basin Construction Specs

- Minimum of 3 Baffles with Equal Spacing
- Anti-Seep Collars

  ftp://ftp-fc.sc.egov.usda.gov//IL/engineer/supplements/6-36.1.pdf
- Berm Material

  -Compact Embankment to at least 90% of AASHTO T 99 Test
- Specify Matting and Permanent Seed Mix for Slopes

When surface area and/or sediment storage requirement for a basin cannot be achieved:

- Design sediment basin or sediment trap to the maximum practical length and width dimensions
- Utilize Polyacrylamide (PAM) devices (Wattle, Silt Check A with Matting) upgrade of the sediment basin/trap

PAM Devices

- Excelsior Wattle
- Coir Fiber Wattle
- Silt Check Type A with Matting

Excelsior Wattle

- Can be used with or without PAM
- When utilized, place wattles every 50 ft. in temporary and/or permanent ditches
- Use Excelsior Wattles on short term projects (one year project duration or less)

Coir Fiber Wattle

- Can be used with or without PAM
- When utilized, place coir wattles every 50 ft. in temporary and/or permanent ditches
- Use Coir Fiber Wattles on long term projects (project duration of more than a year)
  - Environmentally Sensitive Areas (Trout, 303(d), etc.)

Silt Check Type A with Matting

- When utilized, place Silt Check Type A (TRSC-A) with Matting and PAM in temporary and/or permanent ditches
- When utilized, place TRSC-A's with Matting and PAM every 50 ft. in temporary and permanent ditches
- Use TRSC-A's with Matting and PAM on short and long term projects where ditch grade > 2.5%

Environmentally Sensitive Areas

- 50 ft. zone from top of streambank (TOB)
  - 50 ft. from water's edge if TOB is not delineated on plans
- Shown inside and to ROW/Easement; **do not hatch the water surface**!
- Match ESA hatch spacing to ESA plan sheet note

ESA Locations

- DWQ High Quality Waters & Critical Area (CA) Waters
  - WS-I, WS-II, HQW, ORW, SA, CA
- DWQ and WRC Trout Streams
- Streams with Riparian Buffers
- Relocated Streams
- 303(d) Streams for Turbidity Impairment
  - 2010 Construction-related Impairments
  - 2012 Final 303(d) List
- Design Standards in Sensitive Watersheds Commitment

EC in Riparian Buffers

- No excavated erosion control devices inside Riparian Buffer, unless permitted by DWQ!
- Runoff treated separately inside and outside Buffer
- Protect Buffer and Stream with Perimeter EC Devices

Allowed EC Devices in Buffers

- Temporary Silt Fence
- Special Sediment Control Fence
- Rock Silt Checks
- Wattles
- Stone Inlet Protection
- Special Stilling Basins

Temporary Rock Silt Check Type A

- Utilize at the outlet of diversion ditches and berms for offsite runoff
- Place at the outlet of permitted ditches in Buffer Zones
- Utilize at outlet of proposed tail ditches

Temporary Rock Silt Check Type B

- Utilize in diversion ditches and berms for offsite runoff
- Place in any temporary and permanent ditch
- Use spacing of 250 / % ditch grade
- Use at inlets of sediment basins and driveway pipes

Type A Inlet Protection

- Use Type A Rock Inlet Sediment Traps (RIST-A, PIST-A) in high flow situations
- Utilize Type A Inlet Protection devices in medians and ditches on new alignments
- Must be at least 30 ft. from travel lane

Type B Inlet Protection

- Use Type B Rock Inlet Sediment Traps (RIST-B, PIST-B) in moderate flow situations
- Utilize Type B Inlet Protection devices in urban areas; widening projects
- No minimum offset distance from travel lane

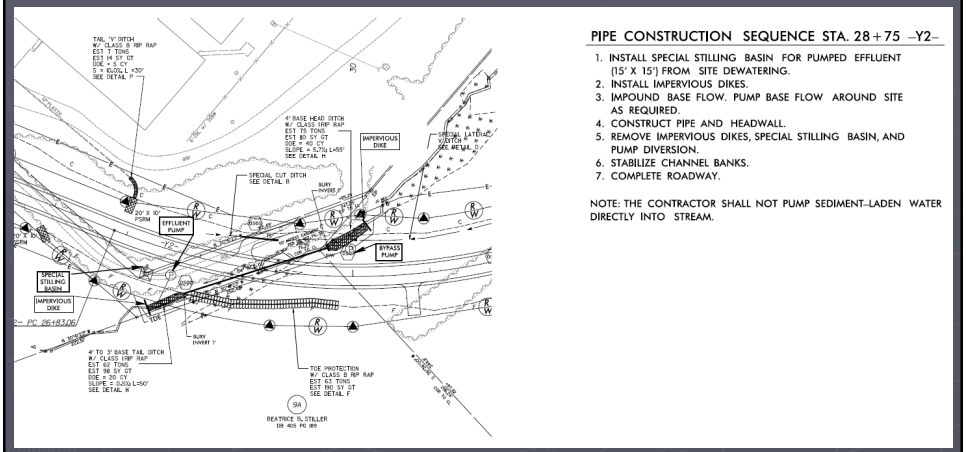
Type C Inlet Protection

- Use Type C Rock Inlet Sediment Traps (RIST-C) in low to moderate flow situations
- Utilize Type C Inlet Protection devices in urban areas with C&G; widening projects
- Use RIST-C's for fill slope drainage inlets at shoulder break points

Culvert/Pipe Phasing

- Provide Phasing for Pipes 48” and up
- Do not show EC design on phasing
- Make sure all phasing measures are labeled
- Be consistent with label and text language

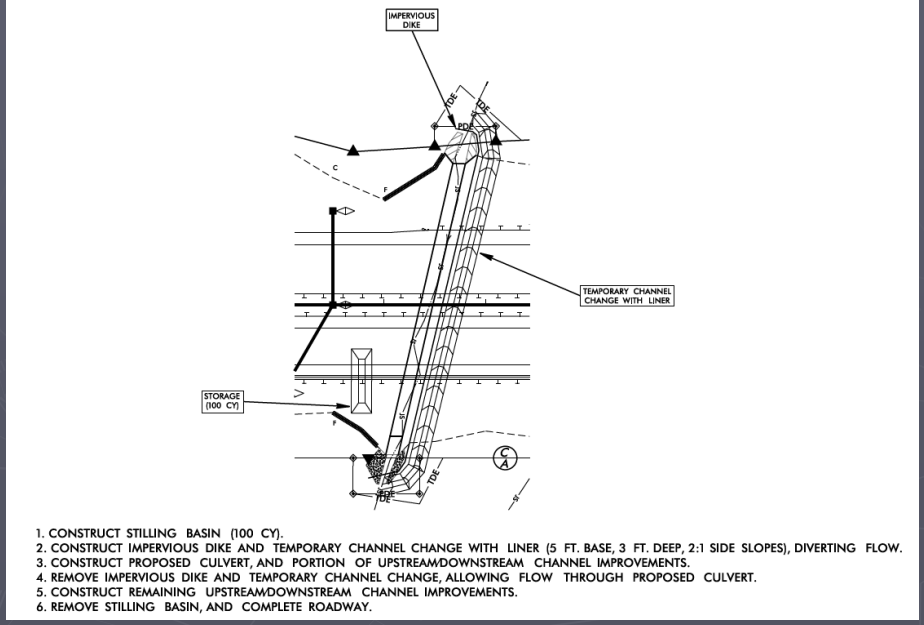
Pipe Phasing



PIPE CONSTRUCTION SEQUENCE STA. 28+75 –Y2–

1. INSTALL SPECIAL STILLING BASIN FOR PUMPED EFFLUENT (15' X 15') FROM SITE DEWATERING.
2. INSTALL IMPERVIOUS DIKES.
3. IMPOUND BASE FLOW. PUMP BASE FLOW AROUND SITE AS REQUIRED.
4. CONSTRUCT PIPE AND HEADWALL.
5. REMOVE IMPERVIOUS DIKES, SPECIAL STILLING BASIN, AND PUMP DIVERSION.
6. STABILIZE CHANNEL BANKS.
7. COMPLETE ROADWAY.

NOTE: THE CONTRACTOR SHALL NOT PUMP SEDIMENT–LADEN WATER DIRECTLY INTO STREAM.



Design-Build Updates

- Vegetation Management Plan
- Field Verification of EC devices
- Monthly Field Reviews for Intermediate EC
- Approval for Modification of EC Devices

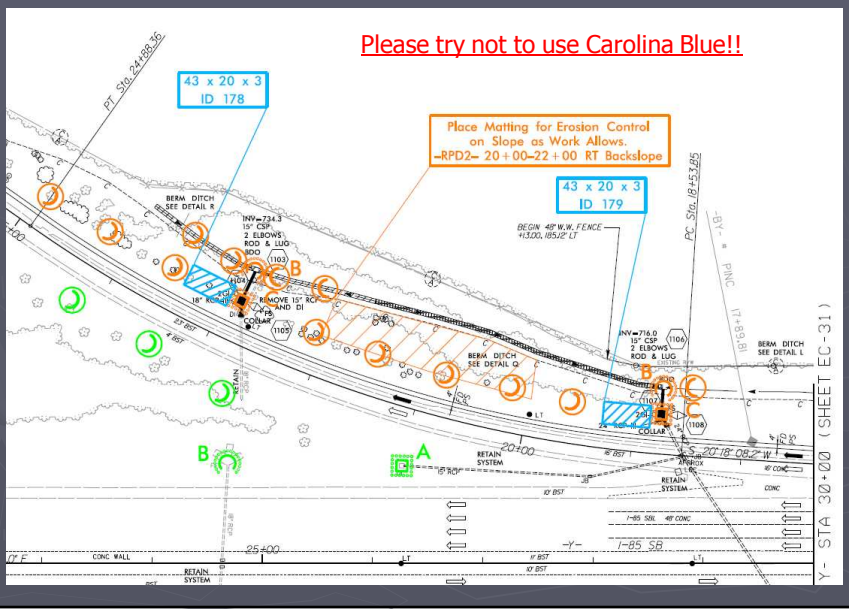
Vegetation Management Plan

- Narrative (Tables, Charts, etc.)
- Address Short, Mid & Long Term Stabilization
- Incorporate 7/14 Day Stabilization Timeframes
- Address ESAs – Timely and Stage Seeding
- Stage Seeding Slopes over 25 ft. in length

Field Verification of EC Devices

- After Clearing & Grubbing Measures Installed
- Monthly (Every 30 Days)
- Verify Device Drainage and Disturbed Area
- Provide Documentation of Field Verifications

Intermediate EC Design



Devices Requiring Calculations and Approval to Modify

- Sediment Basins (Silt Basin B, Infiltration, etc.)
- Skimmer Basin and all devices with skimmers
- Riser Basin
- Temporary Rock Sediment Dam Type A & B
- Temporary Rock Silt Check Type A
- Culvert Construction Sequence
- Temporary and Permanent Stream Channel Relocations

Low Impact Bridge (LIB) EC Plans

- Include Erosion Control Title Sheet
- Stabilization Timeframe Sheet required
- Utilize PAM devices
- Include all Details and Reforestation if needed

LIB Additional Info

- Checklist and Water Quality Sheet
- Cross Sections
- Permit Drawings – Draft & Final
- General Structure Drawing

General EC Plan Review

- Clip/Move All Labels and Notes
- Make Sure EC Measures Print on Top
- Don't Modify EC Title Sheet
- Use Soil & Water Color Scheme for EC devices

Final EC Thoughts

- Consider Final Grade erosion control while designing Clearing & Grubbing phase
- Submit Water Quality AND Checklist sheets
- Don't place EC devices in streams!
- Soil & Water Engineering Section is open to new ideas!

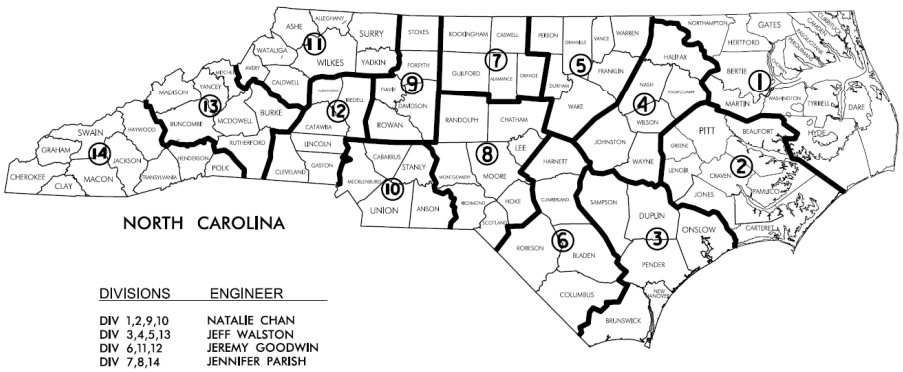
Erosion Control Resources

- REU Soil & Water Engineering Web Page
  http://www.ncdot.org/doh/operations/dp_chief_eng/roadside/soil_water/
- NCDOT Construction BMP Manual
  http://www.ncdot.gov/doh/forms/files/BMPMANUAL.pdf
- NCDOT Highway Stormwater Program
  https://connect.ncdot.gov/resources/hydro/Pages/Stormwater-Program.aspx

Questions?

ROADSIDE ENVIRONMENTAL UNIT

SOIL & WATER ENGINEERING



DIVISIONS	ENGINEER
DIV 1,2,9,10	NATALIE CHAN
DIV 3,4,5,13	JEFF WALSTON
DIV 6,11,12	JEREMY GOODWIN
DIV 7,8,14	JENNIFER PARISH