NORTH CAROLINA
Department of Transportation

Bridge Stormwater Runoff

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CLEAR Lunch-N-Learn February 9, 2022

Agenda

- Historical Perspective
- Regulations – Stormwater Runoff Perspective
- Guidance Documents, Tools, & Other Resources
- Demonstrating NPDES Compliance
- Bridge Specifics
- Agency Concerns
- Research
- Conclusions
- Panel Discussion

History

- 2008 – General Assembly drafts legislation to have stormwater BMPs installed on all bridges over water in the state.
- NCDOT says we need to look at the science.
- House Bill 2436, Session Law 2008-107

Bridge Stormwater Project:

Requirement:

Session Law 2008-107

- Characterize stormwater runoff pollutants (Quality and Quantity)
- Construct 50 Pilot Waterway Bridge Stormwater Controls
- Cost of implementing effective treatments to **all** Bridges

Objective:

- Determine effect of bridge runoff on receiving waters and aquatic life.
- Identify effective stormwater control measures to treat bridge deck runoff and determine cost of implementing controls.

Approach:

- Conduct water quality, sediment and biological monitoring.
- Use Weight of Evidence to determine effect of bridge runoff.
- Determine effective treatments for all bridges and associated costs.

Partnership and Approach

Project Team

STATE OF NORTH CAROLINA DEPARTMENT OF TRANSPORTATION

USGS science for a changing world

DWQ

Kimley-Horn and Associates, Inc.

URS

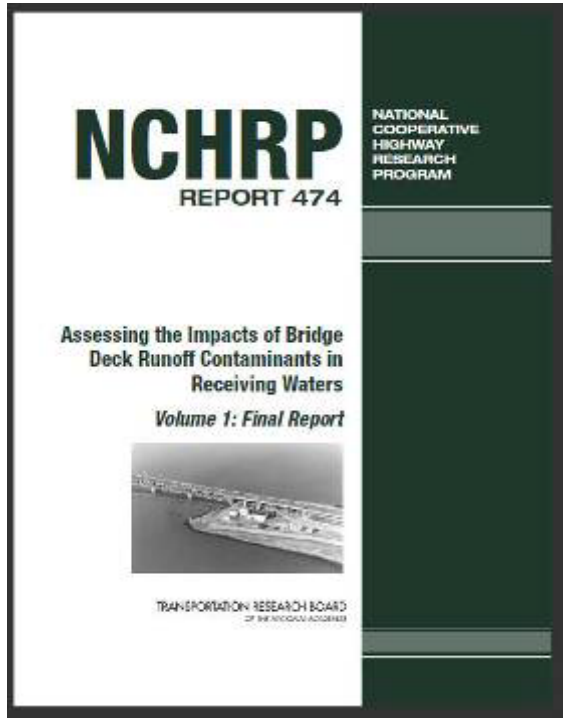
WITHERS & RAVENEL

NC STATE UNIVERSITY

ETS

Lenat Consulting Services

Guidance



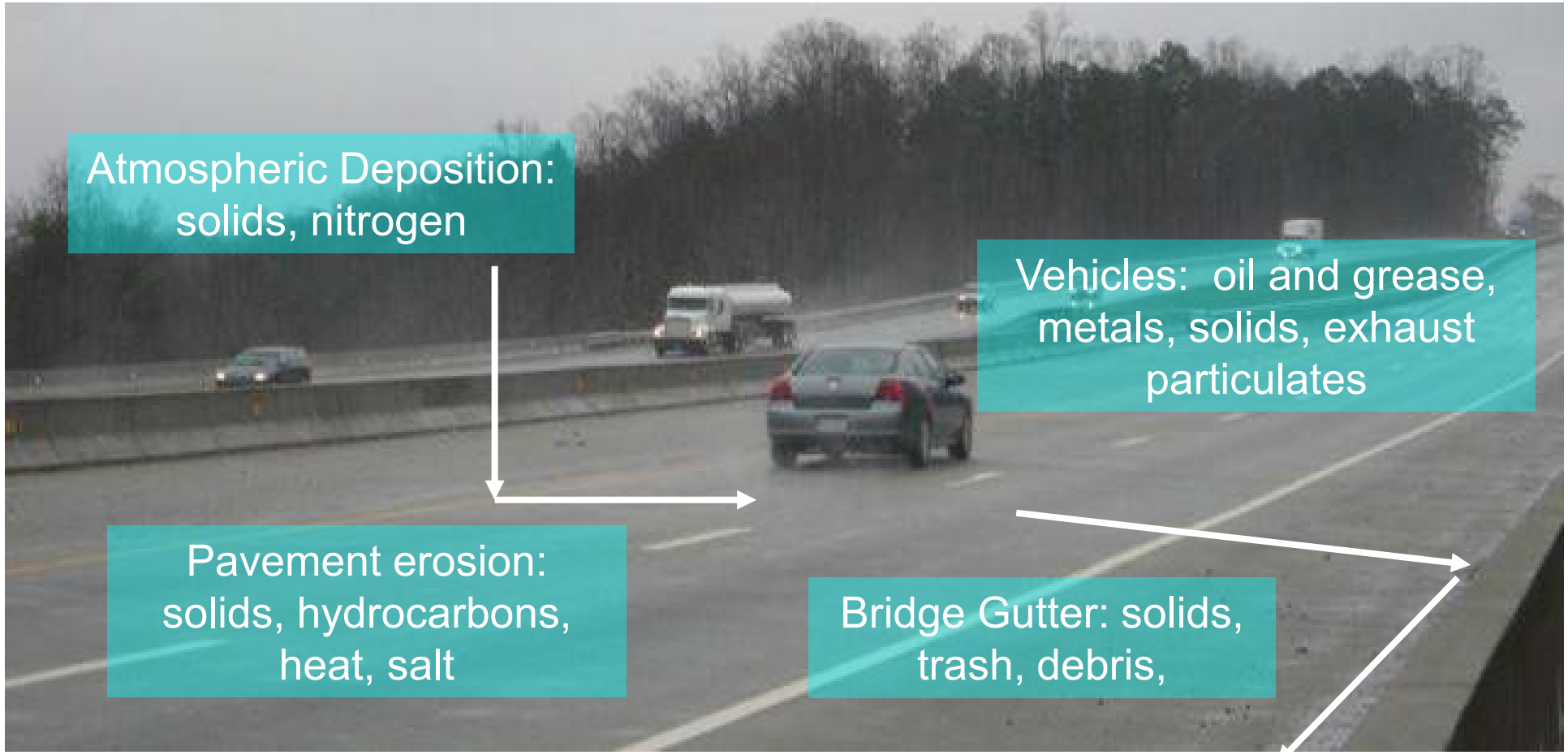
Bridge Runoff Pollutants

Metals (Zn, Pb, Cu, Cd, Fe, Cr)

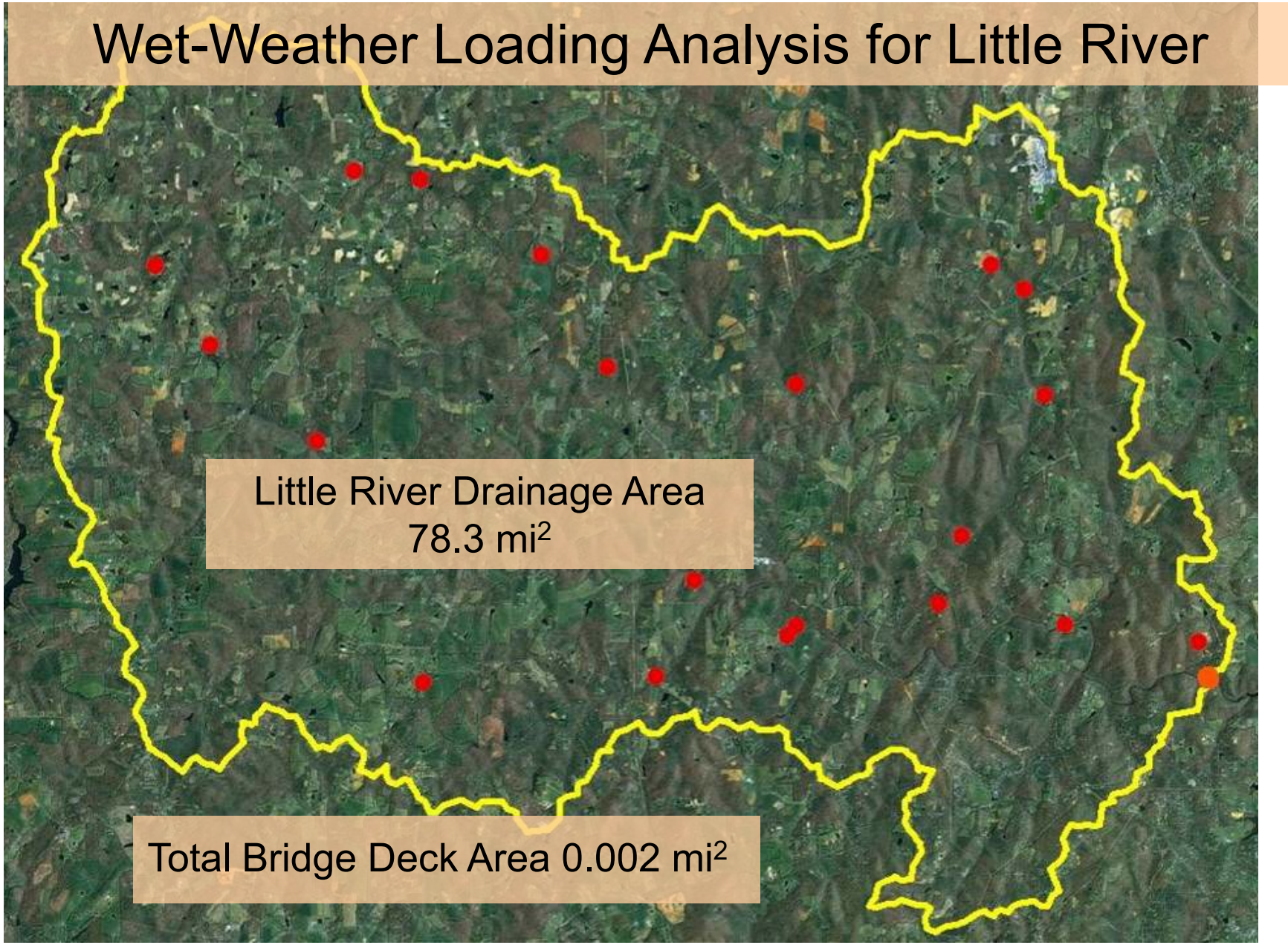
Nutrients (Nitrogen, Phosphorus)

Hydrocarbons (oil, grease, PAHs)

Total Suspended Solids and Sediment



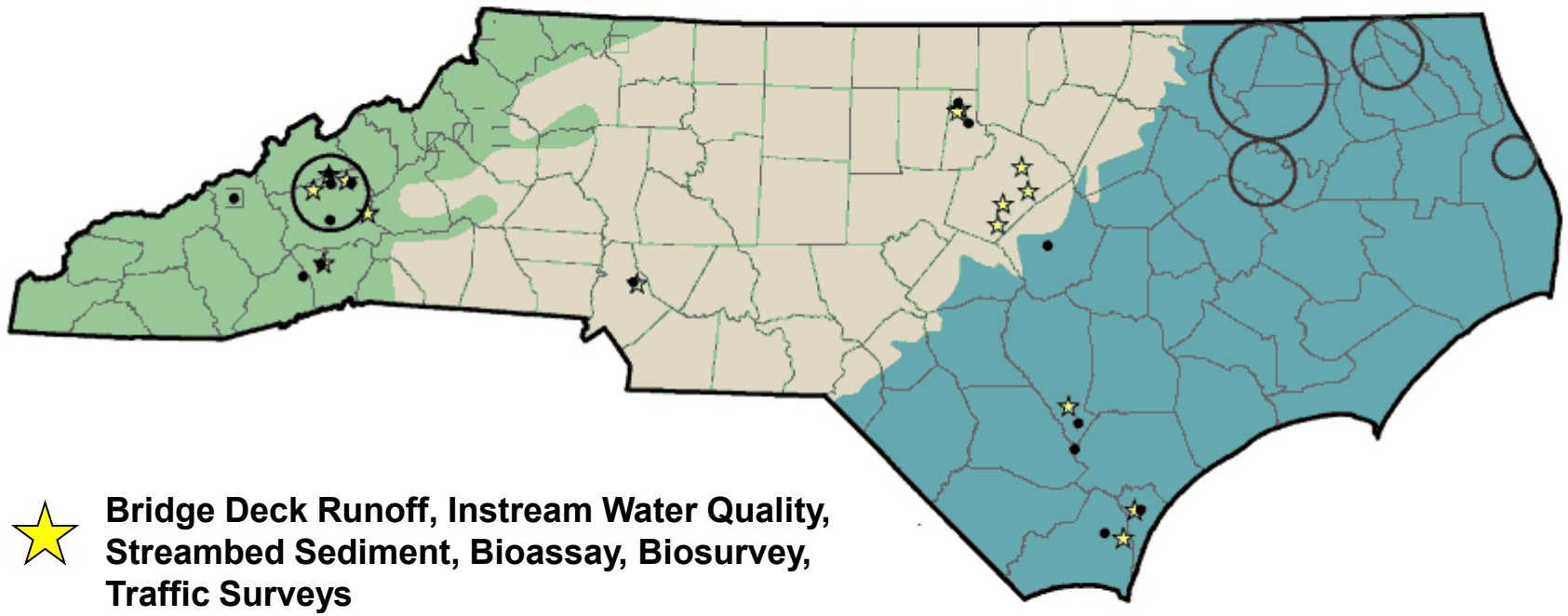
Wet-Weather Loading Analysis for Little River



Characterize Bridge Deck Stormwater Pollutants and Determine Impacts

Bridge Monitoring Sites and Study Areas

Monitoring Period: March 2009 - February 2010

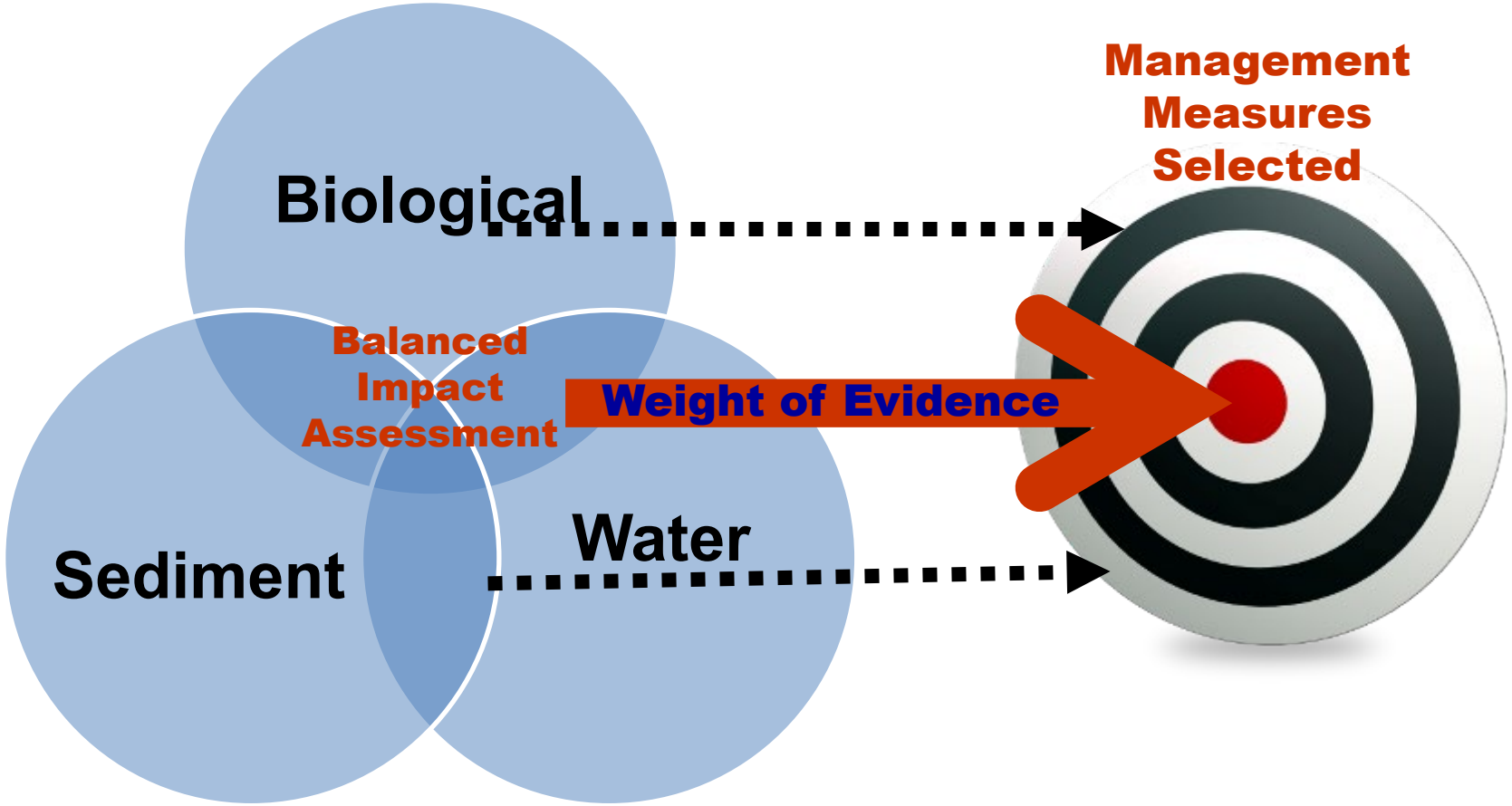


Bridge Deck Runoff, Instream Water Quality, Streambed Sediment, Bioassay, Biosurvey, Traffic Surveys

Streambed Sediment Survey

Bridge Deck Sweeping Regions

Targeting Effective Measures



Allocation of resources to maximize water quality benefit.

Regulations

(From a Stormwater Runoff Perspective)

Regulations

(From a Stormwater Runoff Perspective)

- ~~State Stormwater Regulations~~ (15A NCAC 02H .1001)
- ~~Local Government Ordinances~~ (NC G.S. § 160D-925 and § 153A-454)
- Nutrient Sensitive Watersheds
  - Buffer Rules
  - GREEN program
- Stormwater Outlet Protection (15A NCAC 04B .0109)
- 404/401 Water Quality Certification
- National Pollutant Discharge Elimination System (NPDES)
  - Statewide permit coverage

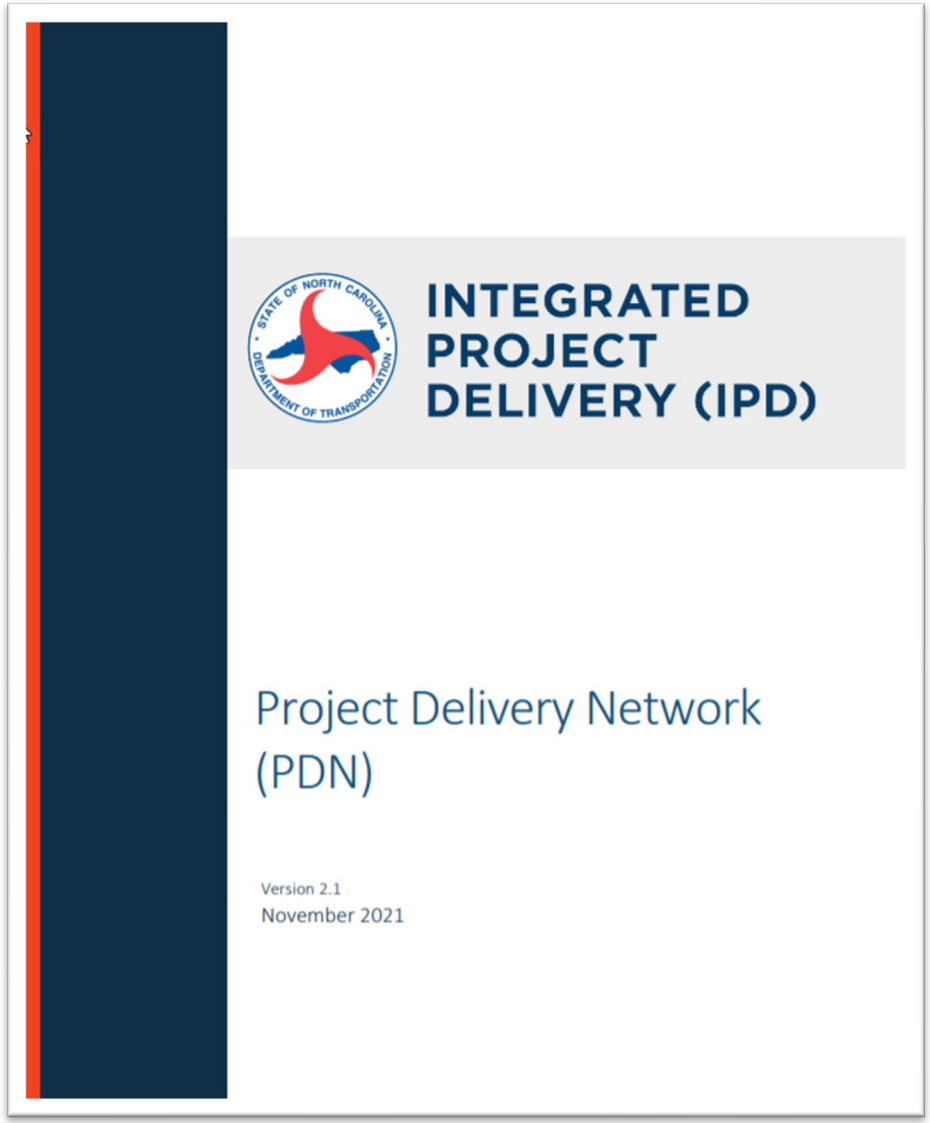
Follow the Post-Construction Stormwater Program (PCSP)!!!

Guidance Documents, Tools, and Other Resources

Guidance & Tools

Moving stormwater treatment goal decisions earlier in the process via the PDN

- Sets expectations for both designers and regulators
- Minimizes risk of change orders and supplemental agreements
- Minimize potential additional project costs
  - Time
  - Budget
    - Utility Conflicts
    - ROW expenses



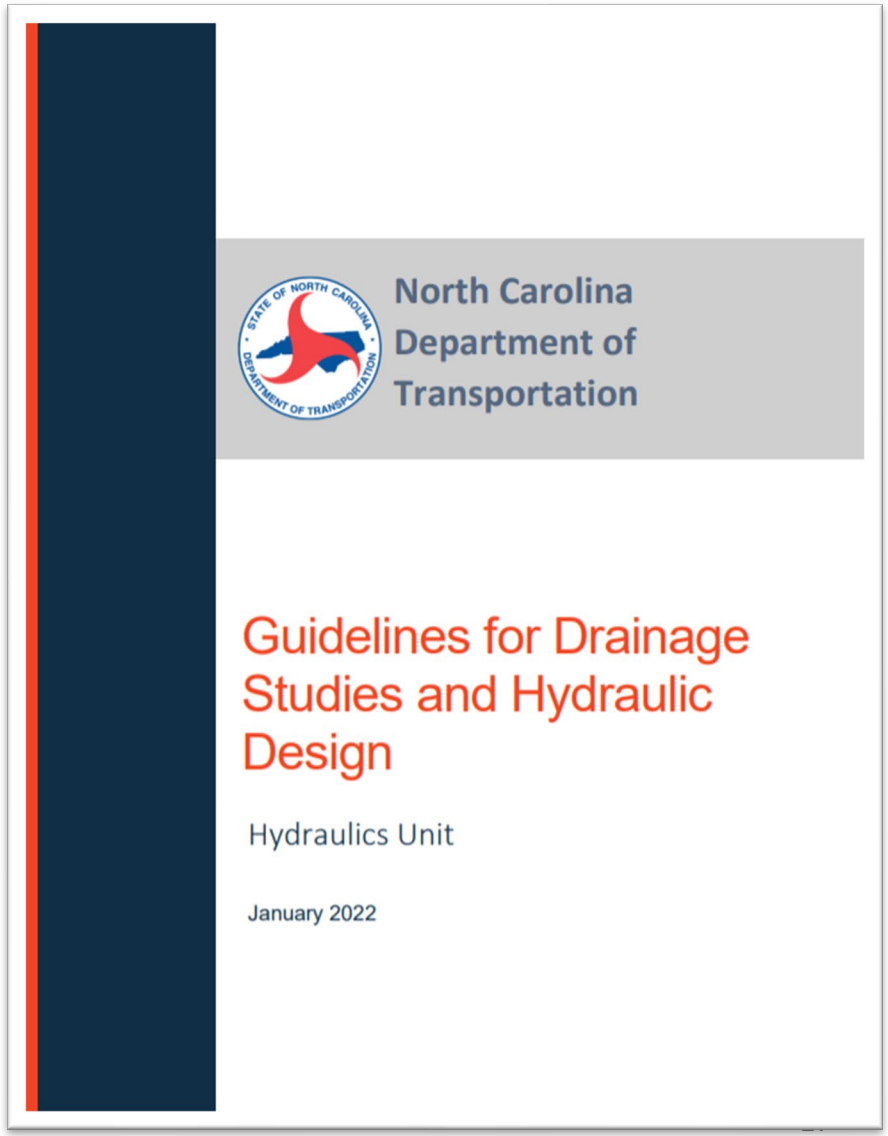
Guidance & Tools

Guidelines for Drainage Studies and Hydraulic Design

- aka: “Drainage Guidelines”
  - Chapter 13 – Stormwater Management
    - NPDES
      - » PCSP

Coming Soon!

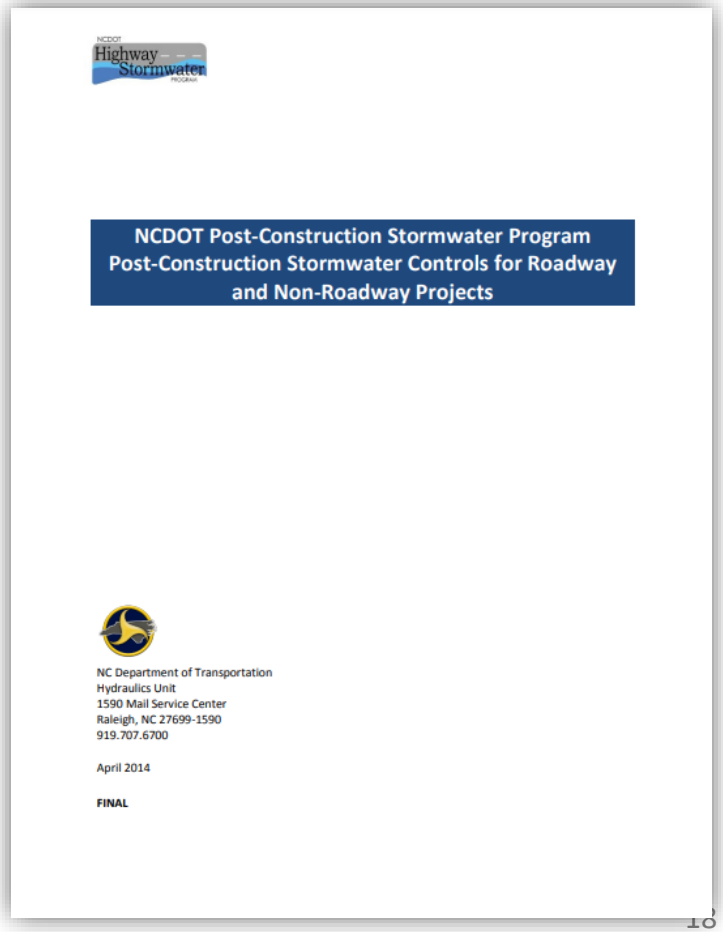
HOT OFF THE PRESS



Guidance & Tools

Post-Construction Stormwater Program (PCSP) Manual

- Provides workflows for roadway and non-roadway projects
- Current version – April 2014
- Update coming – June 2022
  - Complete 540 Settlement Agreement
    - By June 2022
  - IPD/PDN
    - Earlier stormwater decisions
  - Changes in Regulations

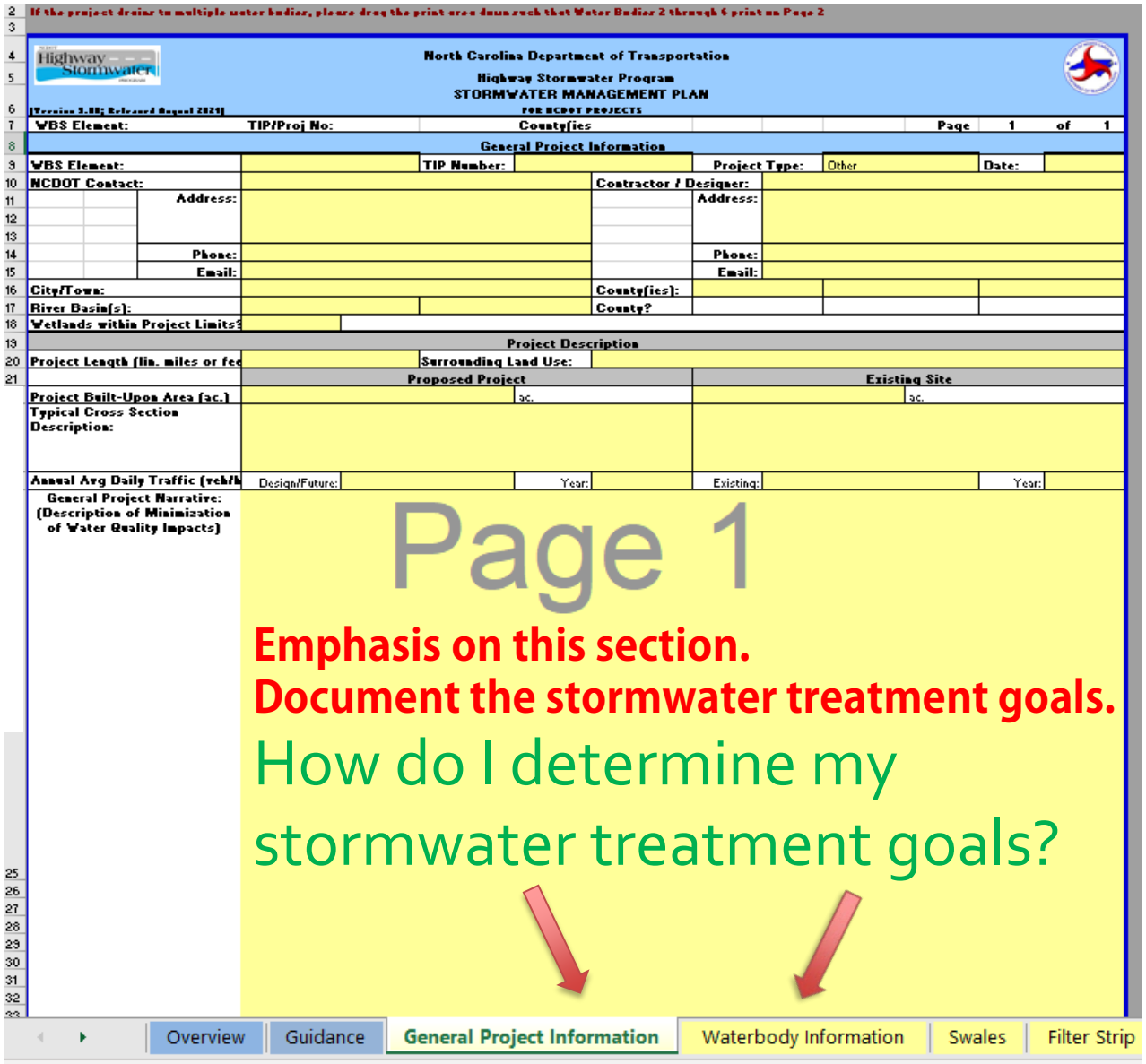


Preliminary Stormwater Management Plan (pSMP)

- Document Stormwater Treatment Goals in the pSMP
  - Excel form (SMPv3.01) – Dec. 2021
    - General Project Information
    - Waterbody Information

https://connect.ncdot.gov/resources/hydro/Pages/HSPProductPages.aspx?PROD=SMP

  - Save a pdf to the Preconstruction site.
    - For projects not on the Preconstruction Site submit via email to NCDOT_Hydraulics_SMP@ncdot.gov

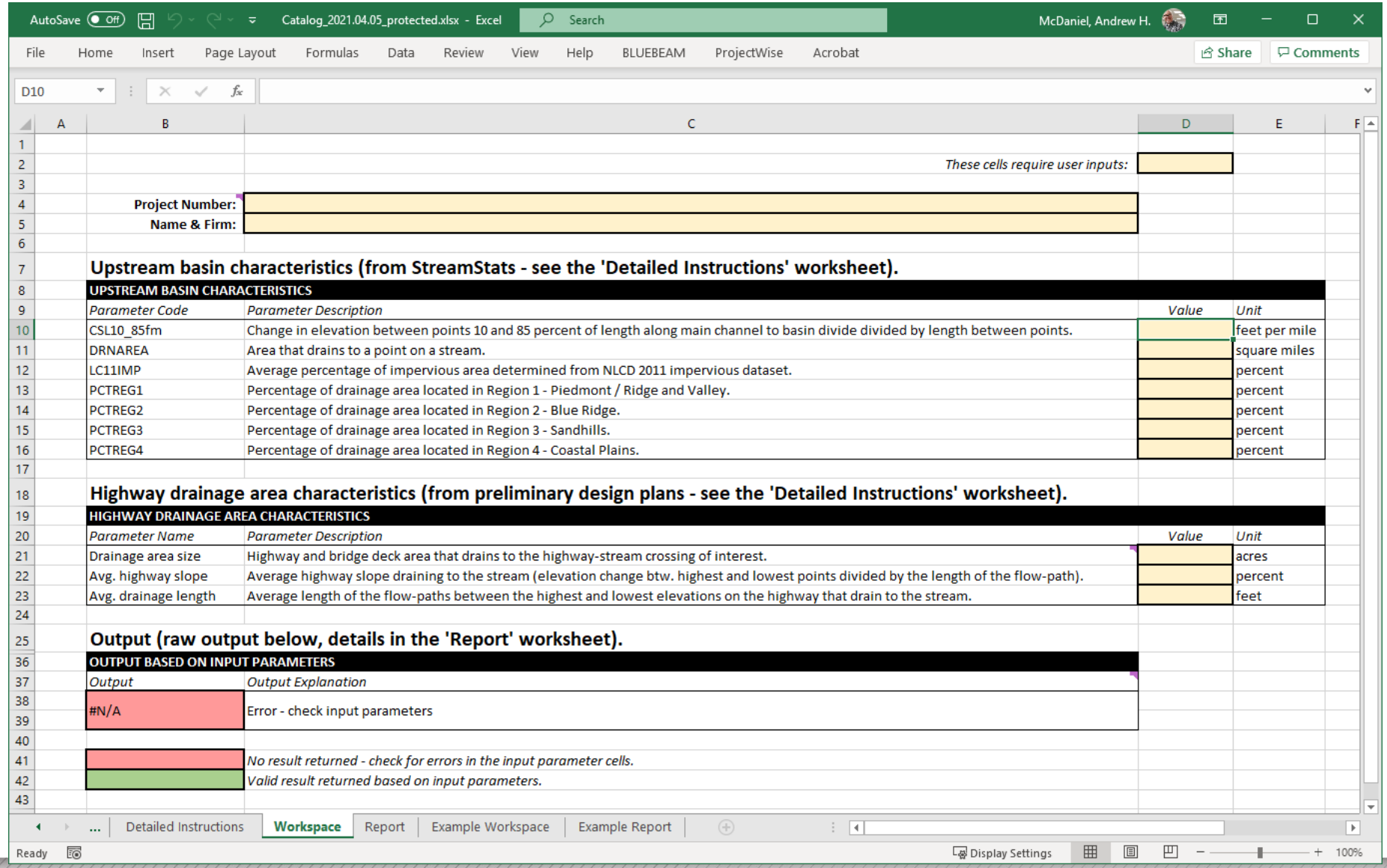


New Tool for Establishing Stormwater Treatment Goals

- NC-SELDM Catalog
- Provides environmentally conservative estimates of the level of treatment needed to avoid water quality degradation
- No knowledge of the SELDM model required – we've pre-run the model for you

USGS science for a changing world

NC-SELDM Catalog Tool



Catalog_2021.04.05_protected.xlsx - Excel

			These cells require user inputs:	
	Project Number:			
	Name & Firm:			

Upstream basin characteristics (from StreamStats - see the 'Detailed Instructions' worksheet).

UPSTREAM BASIN CHARACTERISTICS			
Parameter Code	*Parameter Description*	*Value*	*Unit*
CSL10_85fm	Change in elevation between points 10 and 85 percent of length along main channel to basin divide divided by length between points.		feet per mile
DRNAREA	Area that drains to a point on a stream.		square miles
LC11IMP	Average percentage of impervious area determined from NLCD 2011 impervious dataset.		percent
PCTREG1	Percentage of drainage area located in Region 1 - Piedmont / Ridge and Valley.		percent
PCTREG2	Percentage of drainage area located in Region 2 - Blue Ridge.		percent
PCTREG3	Percentage of drainage area located in Region 3 - Sandhills.		percent
PCTREG4	Percentage of drainage area located in Region 4 - Coastal Plains.		percent

Highway drainage area characteristics (from preliminary design plans - see the 'Detailed Instructions' worksheet).

HIGHWAY DRAINAGE AREA CHARACTERISTICS			
Parameter Name	*Parameter Description*	*Value*	*Unit*
Drainage area size	Highway and bridge deck area that drains to the highway-stream crossing of interest.		acres
Avg. highway slope	Average highway slope draining to the stream (elevation change btw. highest and lowest points divided by the length of the flow-path).		percent
Avg. drainage length	Average length of the flow-paths between the highest and lowest elevations on the highway that drain to the stream.		feet

Output (raw output below, details in the 'Report' worksheet).

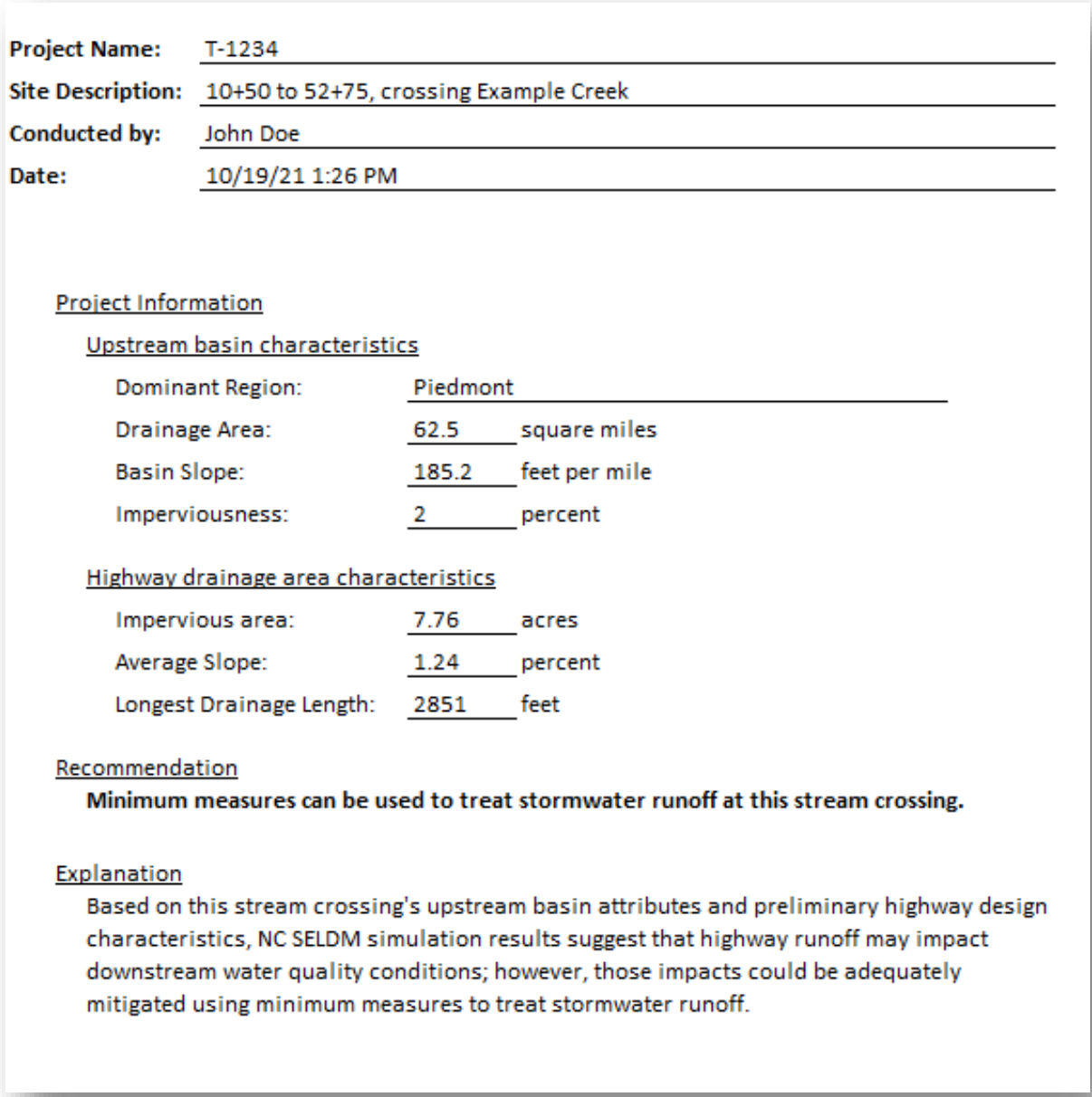
OUTPUT BASED ON INPUT PARAMETERS	
Output	*Output Explanation*
#N/A	Error - check input parameters
	No result returned - check for errors in the input parameter cells.
	Valid result returned based on input parameters.

Detailed Instructions | Workspace | Report | Example Workspace | Example Report

NC-SELDM Catalog Tool

Results

- Direct Discharge
- Minimum Measures
- Toolbox BMP



Project Name: T-1234
Site Description: 10+50 to 52+75, crossing Example Creek
Conducted by: John Doe
Date: 10/19/21 1:26 PM

Project Information

Upstream basin characteristics

Dominant Region:	Piedmont	
Drainage Area:	62.5	square miles
Basin Slope:	185.2	feet per mile
Imperviousness:	2	percent

Highway drainage area characteristics

Impervious area:	7.76	acres
Average Slope:	1.24	percent
Longest Drainage Length:	2851	feet

Recommendation

Minimum measures can be used to treat stormwater runoff at this stream crossing.

Explanation

Based on this stream crossing's upstream basin attributes and preliminary highway design characteristics, NC SELDM simulation results suggest that highway runoff may impact downstream water quality conditions; however, those impacts could be adequately mitigated using minimum measures to treat stormwater runoff.

Training: NC-SELDM Catalog

NC-SELDM Catalog

- Currently available on the USGS Science Base website
- https://www.sciencebase.gov/catalog/item/5ec5517882ce476925eacf9a

- Linked from the Hydraulics Connect Site

BMP Decision Support Matrix

BMP Selection Criteria	Bio-embankment[1a]	Biofiltration Conveyance[1a]		Bioretention[1a,2]		Bioswale[1a]		Dry Detention Basin[1a]	Filter Strip w/ Level Spreader[1a]	Filtration Basin[1a,2]		Green Roof[1a]	Infiltration Basin[1b]	Open Graded Friction Course[1a]	Permeable Pavement		Preformed Scour Hole[1a]	Rainwater Harvesting[1a,3]	Sand Filter[1a,4]	Soil Improvement[1a]	Storm-water Wetland[1a]	Swale[1a]		Tree Box[1a]	Wet Detention Basin[1a]
		w/o IWS	w/IWS	w/o IWS	w/IWS	w/o IWS	w/IWS			w/o IWS	w/IWS				Detention[1a]	Infiltrating[1b]						Dry	Wet		
Removal Efficiency for Parameters of Concern (POCs)[1]																									
Bacteria	Med	Med		High		Med		Low	Low	High		Low[12]	High	Low	Med	High	Low	Varies	Med	Low	High	Low		Med	High
Metals																									
Dissolved Metals	Low	Low		Med		Med		Low	Low	Med		Low	High	Low	Low	High	Low	Varies	Low	Low	Med	Low		Med	Low
Total Recoverable Metals	Low	Low		High		Med		Med	Med	High		Low	High	Low	Med	High	Med	Varies	Low	Low	High	Low		Med	Med
Nutrients																									
Dissolved Nitrogen[5]	Low	Low	Med	Med	High	Low	Med	Low	Low	Med	High	Low	High	Low	Low	High	Low	Varies	Low	Low	Med	Low	Low	Low	Low
Total Nitrogen[5]	Low	Low	Med	Med	High	Low	Med	Low	Low	Med	High	Med	High	Low	Low	High	Low	Varies	Low	Low	High	Low	Med	Med	Low
Dissolved Phosphorus	Med[11]	Med[11]		Med[11]		Med[11]		Low	Low	Med[11]		Low	High	Low	Low	High	Low	Varies	Med[11]	Low	Med	Low	Low	Med[11]	Low
Total Phosphorus	Med	Med		High		Med		Med	Low	High		Med	High	Low	Med	High	Low	Varies	Med	Low	High	Low	Med	Med	Med
Oil and Grease	High	High		High		High		Med	Med	High		N/A	High	Med	Med	High	Med	Varies	Med	Med	High	Med		High	Low
Organics	High	High		High		High		Med	Med	High		Med	High	Low	Low	High	Med	Varies	Med	Med	High	Med		High	Low
Temperature	Med	Med		High		Med		Low	Med	High		High	High	Low	High		Med	Low	Med	High	Low	Low		High	Low
Total Suspended Solids	High	High		High		High		Med	Med	High		High	High	Med	High		Med	High	High	Med	High	High		High	High
Trash	Med	High		High		High		High	High	High		N/A	High	Med	High		High	High	High	Med	High	Med		High	High
Water Quantity																									
Runoff Volume Reduction	Med	Low	Med	Med	High	Med	High	Med	Low	Med	High	Med	High	Low	Low	High	Low	Varies	Low	Med	Low	Low		Med	Low
Peak Flow Control	Low	Low		Med		Med		High	Med	Med		Med	High	Low	Med	High	Low	Varies	Med	Low	High	Low		Low	High
Siting Constraints and Other Implementation Considerations																									
Space Requirement	Low	Low		Med		Med		Med	Low	Med		Low	Med	Low	Low		Low	Low	Med	Low	High	Low		Low	High
Environmental Issues[6]																									
Contaminated Soils[7]	Use liner	Use liner		Use liner		Use liner		Use liner	Use liner	Use liner		Yes	No	Yes	Use liner	No	No	Yes	Use liner	No	Use liner	Use liner		Use liner	Use liner
Physical Site Limitations[6]																									
Karst Topography	Use liner	Use liner		Use liner		Use liner		Use liner	Yes	Use liner		Yes	No	Yes	Use liner	No	Yes	Yes	Use liner	Yes	Use liner	Yes		Use liner	Use liner
Shallow Bedrock[8]	Yes	Yes		Yes		Yes		Yes	Yes	Yes		Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes
Shallow Water Table[9]	No	Yes		No		No		No	Yes	No		Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes	No	Yes	No	Yes
Steep Slopes (>5%)[10]	No	Yes		No		No		No	Yes	No		Yes	No	Yes	No		No	Yes	No	Yes	No	No		No	No
Cost Considerations																									
Construction Cost	$-$$	$$-$$$		$-$$		$-$$		$-$$	$-$$	$-$$		$$-$$$	$-$$	$$-$$$	$$-$$$		$	Varies	$-$$$	$-$$	$-$$	$		$-$$	$-$$
O&M Cost	$-$$	$$		$-$$		$-$$		$-$$	$	$		$-$$	$-$$	$$	$$-$$$		$	Varies	$-$$$	$	$-$$	$		$$-$$$	$-$$

[1] "High", "Med", "Low", or "N/A". [1a] EMC-based pollutant reduction. [1b] Load-based pollutant reduction.

[2] All NCDOT Bioretention and Filtration Basin facilities include underdrain; if no underdrain, see Infiltration Basin.

[3] Water quality and quantity performance varies based on size of system and use of captured water.

[4] For Sand Filter, an enclosed chamber type system (e.g., Austin/Delaware) is assumed.

[5] Note that nitrogen concentrations in roadway runoff are generally low; this reduces the removal efficiency of many BMPs.

[6] "Yes" indicates BMP is suitable for locations with a particular siting constraint. "No" indicates that the BMP is not suitable.

[7] When contaminated soils are present, consultation with the Geotech Unit and Hydraulics Unit is highly recommended.

[8] For suitable BMPs, it may be necessary to increase practice footprint and/or install an impermeable liner to achieve desired performance.

[9] For suitable BMPs, an impermeable liner may be required. Additional investigation and consultation with Geotech and Hydraulics Units recommended.

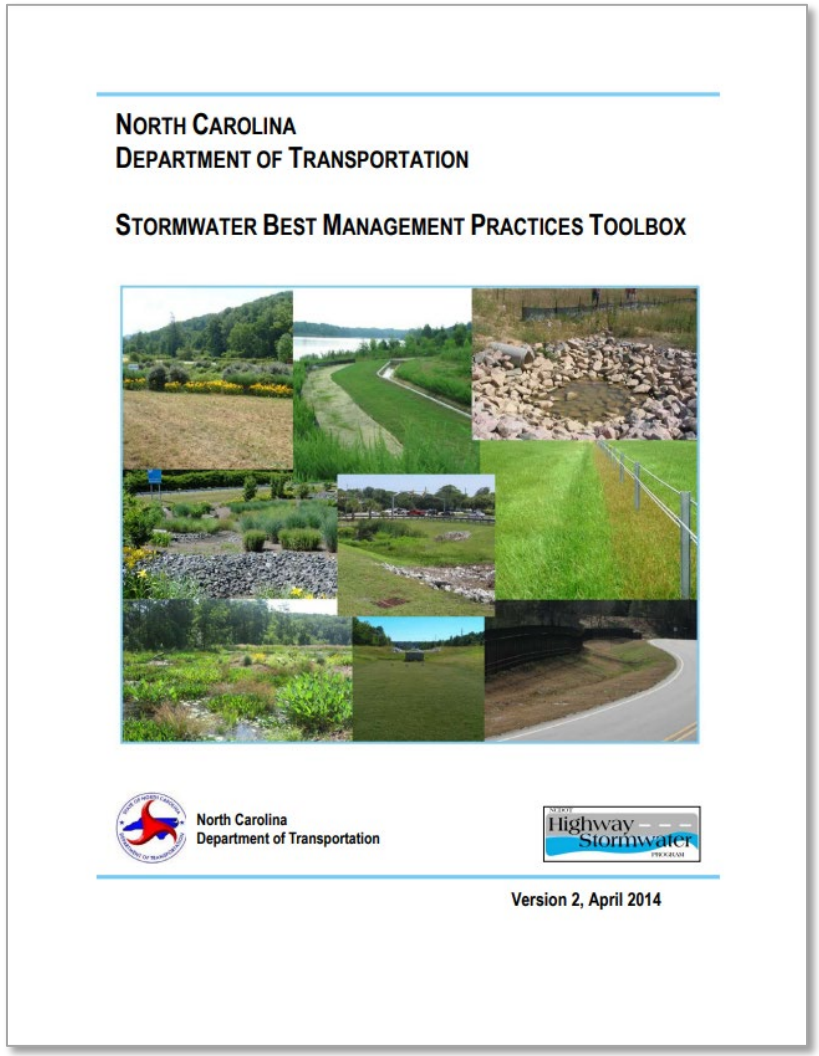
[10] For green roof, slope refers to roof pitch. Note that design modifications are required for roof pitch >8% (per NCDEQ).

[11] With media amended or enhanced to increase dissolved P removal.

[12] Green roofs are not typically a significant source of bacteria.

BMP Toolbox Update

- Revised Chapters
- New Chapters
- Focus on less "specialized" maintenance needs
- 2022 (target schedule to coincide with PCSP)



https://connect.ncdot.gov/resources/hydro/Pages/HSPProgramPages.aspx?PGM=BMPT

Stormwater Management Plan (SMP) v3.00

North Carolina Department of Transportation
Highway Stormwater Program
STORMWATER MANAGEMENT PLAN
FOR NCDOT PROJECTS
(Version 3.00; Released August 2021)

WBS Element: | TIP/Proj No.: | County(ies): | Page | of 1

Other Non-Toolbox Best Management Practices

Sheet No.	Line	Station	Location (LT,RT,CL)	Latitude	Longitude	Surface Water Body	BMP Type	Drainage Area (ac)	New Built-Upon Area (ac)	BMP Associated w/ Buffer Rules?

BMP Type
Provide the BMP type located at the listed station. Drop down items can be overwritten for dual purpose BMPs (e.g., "HSB/DDB" can be entered for a HSB/dry detention basin).

Page 1

... | Swales | Filter Strip | PSHs & Energy Diss. | Level Spreader & HSB | Other Toolbox BMPs | Other Non-Toolbox BMPs | Bridge to Culvert | SCM Summary | CAMA Map

https://connect.ncdot.gov/resources/hydro/Pages/HSPProductPages.aspx?PROD=SMP

New tab with more stormwater control measures.

Stormwater Management Plan (SMP)

North Carolina Department of Transportation
Highway Stormwater Program
STORMWATER MANAGEMENT PLAN
FOR NCDOT PROJECTS
(Version 3.00; Released August 2021)

WBS Element: | TIP/Proj No.: | County(ies): | Page | of 1

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Page 1

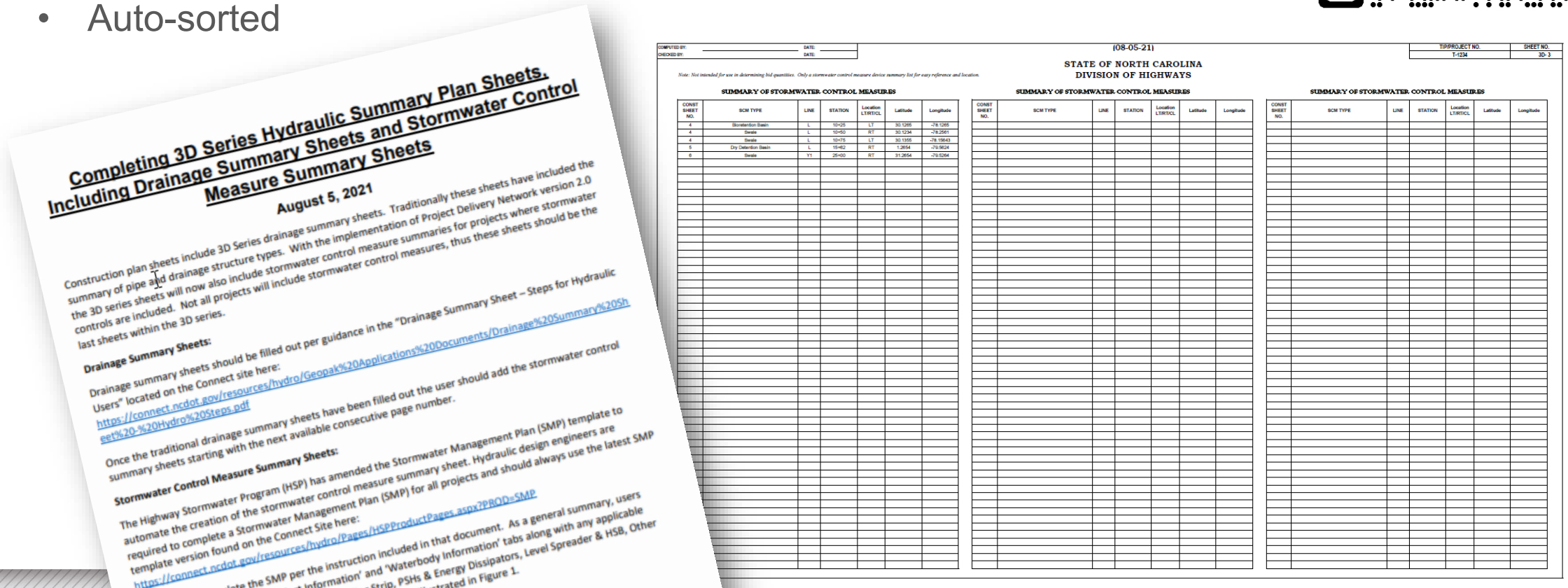
Swales | Filter Strip | PSHs & Energy Diss. | Level Spreader & HSB | Other Toolbox BMPs | **Other Non-Toolbox BMPs** | Bridge to Culvert | SCM Summary | CAMA Map

https://connect.ncdot.gov/resources/hydro/Pages/HSPProductPages.aspx?PROD=SMP

New tab = SCM Summary

SCM Summary

- To be a part of the 3D series (Drainage Summary) sheets in plan sets
- Guidance Document linked from both:
  - Hydro Connect > HSP > SMP
  - Hydro Connect > Guidelines > Additional Resources
- Auto-filled from entries on the SMP tabs
- Auto-sorted



Completing 3D Series Hydraulic Summary Plan Sheets, Including Drainage Summary Sheets and Stormwater Control Measure Summary Sheets

August 5, 2021

Construction plan sheets include 3D Series drainage summary sheets. Traditionally these sheets have included the summary of pipe and drainage structure types. With the implementation of Project Delivery Network version 2.0 the 3D series sheets will now also include stormwater control measure summaries for projects where stormwater controls are included. Not all projects will include stormwater control measures, thus these sheets should be the last sheets within the 3D series.

Drainage Summary Sheets:

Drainage summary sheets should be filled out per guidance in the "Drainage Summary Sheet – Steps for Hydraulic Users" located on the Connect site here:
https://connect.ncdot.gov/resources/hydro/Geopak%20Applications%20Documents/Drainage%20Summary%20Sheet%20-%20Hydro%20Steps.pdf

Once the traditional drainage summary sheets have been filled out the user should add the stormwater control summary sheets starting with the next available consecutive page number.

Stormwater Control Measure Summary Sheets:

The Highway Stormwater Program (HSP) has amended the Stormwater Management Plan (SMP) template to automate the creation of the stormwater control measure summary sheet. Hydraulic design engineers are required to complete a Stormwater Management Plan (SMP) for all projects and should always use the latest SMP template version found on the Connect Site here:
https://connect.ncdot.gov/resources/hydro/Pages/HSPProductPages.aspx?PROD=SMP

...te the SMP per the instruction included in that document. As a general summary, users ...information' and 'Waterbody Information' tabs along with any applicable ...Strip, PSHs & Energy Dissipators, Level Spreader & HSB, Other ...strated in Figure 1.

COMPUTED BY: DATE:
CHECKED BY: DATE:

(08-05-21)

TIP/PROJECT NO. T-1234 | SHEET NO. 3D-3

STATE OF NORTH CAROLINA
DIVISION OF HIGHWAYS

Note: Not intended for use in determining bid quantities. Only a stormwater control measure device summary list for easy reference and location.

SUMMARY OF STORMWATER CONTROL MEASURES

CONST SHEET NO.	SCM TYPE	LINE	STATION	Location LT/RT/CL	Latitude	Longitude
4	Bioretention Basin	L	10+25	LT	30.1265	-78.1265
4	Swale	L	10+50	RT	30.1234	-78.2561
4	Swale	L	10+75	LT	30.1355	-78.19643
5	Dry Detention Basin	L	15+62	RT	1.2654	-79.9624
6	Swale	Y1	25+00	RT	31.2654	-79.5264

SUMMARY OF STORMWATER CONTROL MEASURES

CONST SHEET NO.	SCM TYPE	LINE	STATION	Location LT/RT/CL	Latitude	Longitude

SUMMARY OF STORMWATER CONTROL MEASURES

CONST SHEET NO.	SCM TYPE	LINE	STATION	Location LT/RT/CL	Latitude	Longitude

Demonstrating/Documenting Compliance with the NPDES Permit

Defined in the Drainage Guidelines and the PCSP

Projects Requiring Regulatory Review

- Follow PCSP workflows
- Complete SMP (accompanies permit applications)
- Issuance of a permit, authorization, certification, or approval
  - Example: 404 permit/401 water quality certification

Projects Not Requiring Regulatory Review

- Follow PCSP workflows
- Complete SMP

Specific Options and Measures for Bridge Stormwater Runoff

Specific Options and Measures for Bridge Stormwater Runoff

Planning and Design Minimum Measures

- Measures to be considered on all projects

A lot of these may seem to be common sense and common practice.

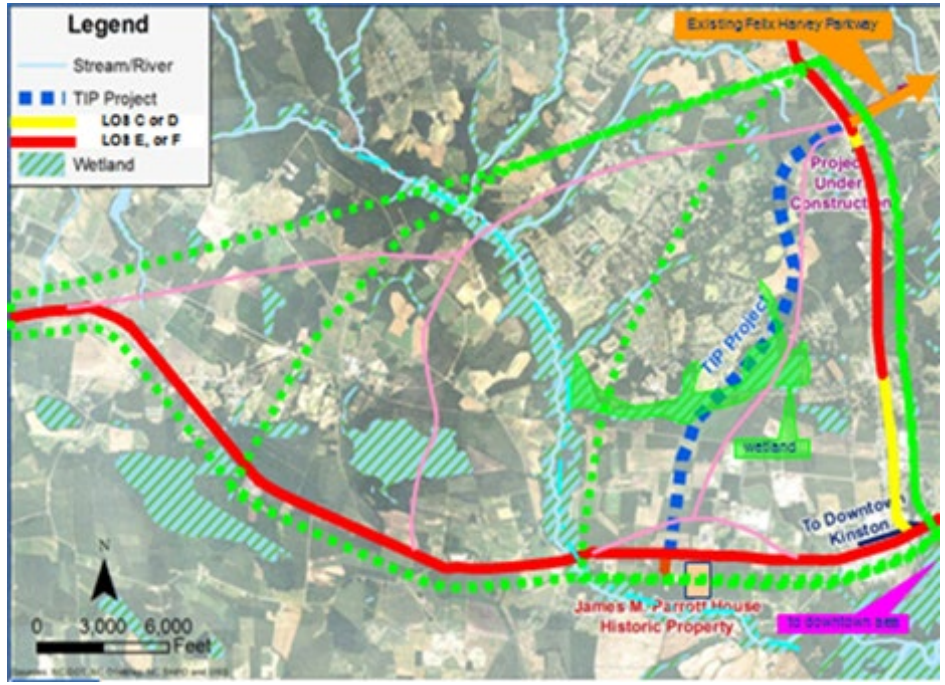
The problem with things that become common is that we often loose sight of the benefits they offer.

Those benefits need to be highlighted!!!

It starts at planning!

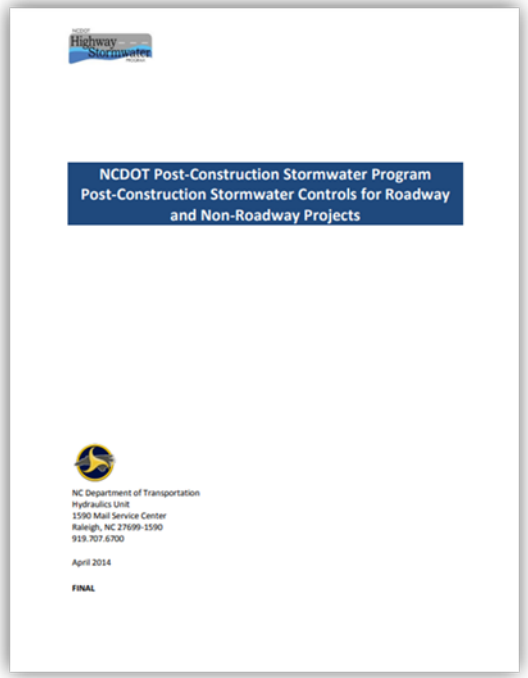
Planning Minimum Measures

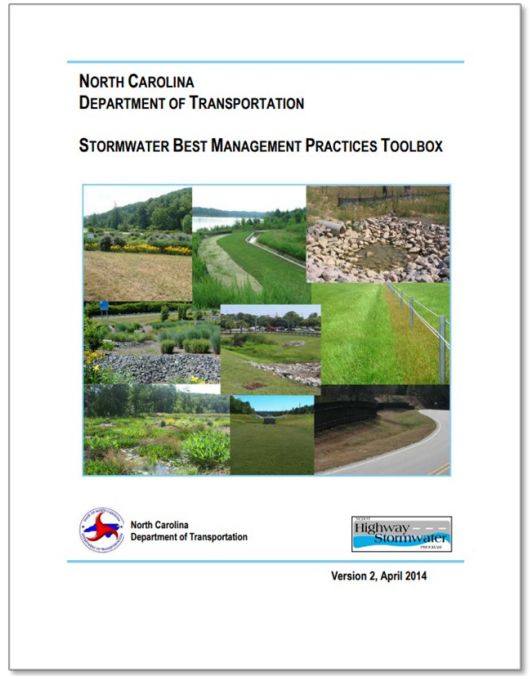
- Assessing and Minimizing the Impacts of Stormwater Runoff to Environmentally Sensitive Areas
- Promoting Sensitive Crossing of Streams



Design Measures

- Minimum Measures from the PCSP
- Specific Design Considerations from the BMP Toolbox
  - Chapter 9 – Bridge BMPs





Design Measures

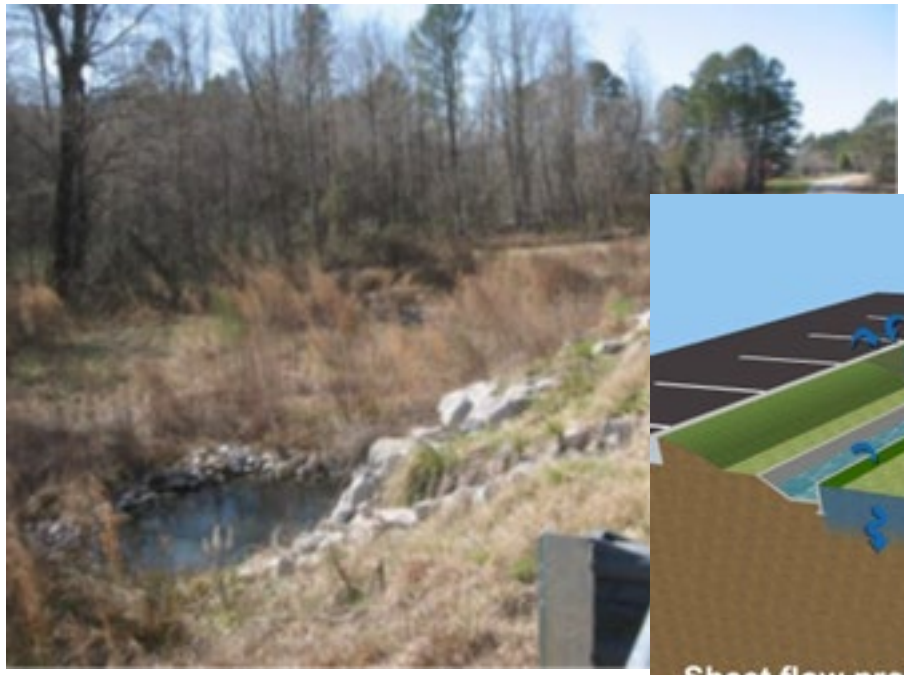
- Providing Adequate Ground Cover
- Stabilizing Embankments and Drainage Ditches

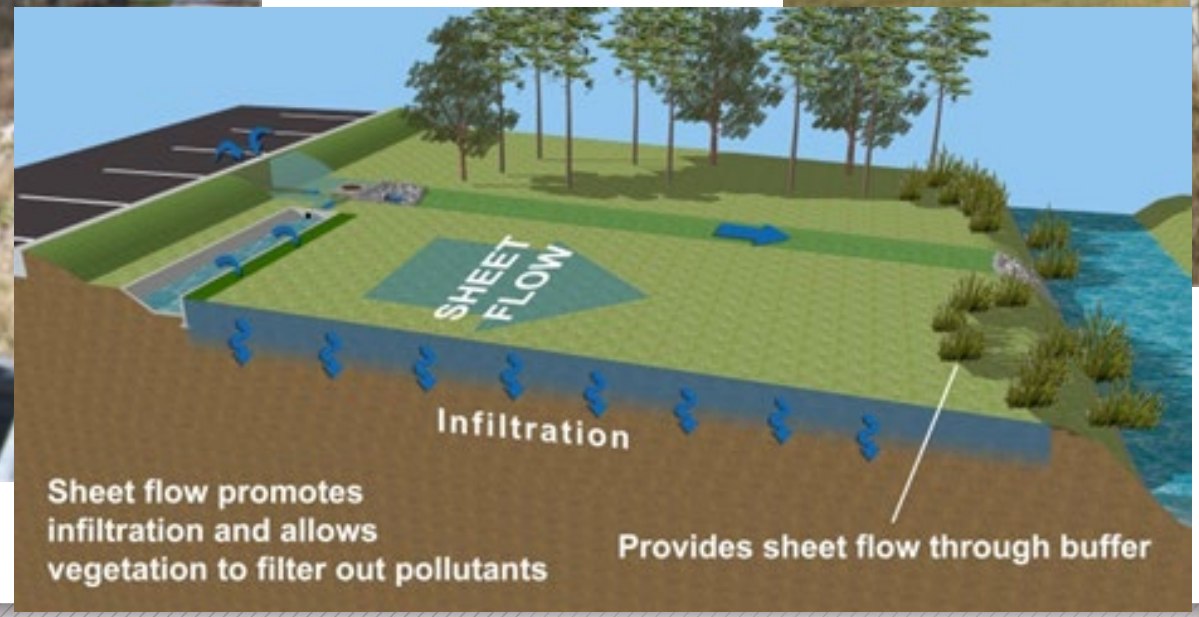
Design Measures

- Providing Adequate Energy Dissipation

Design Measures

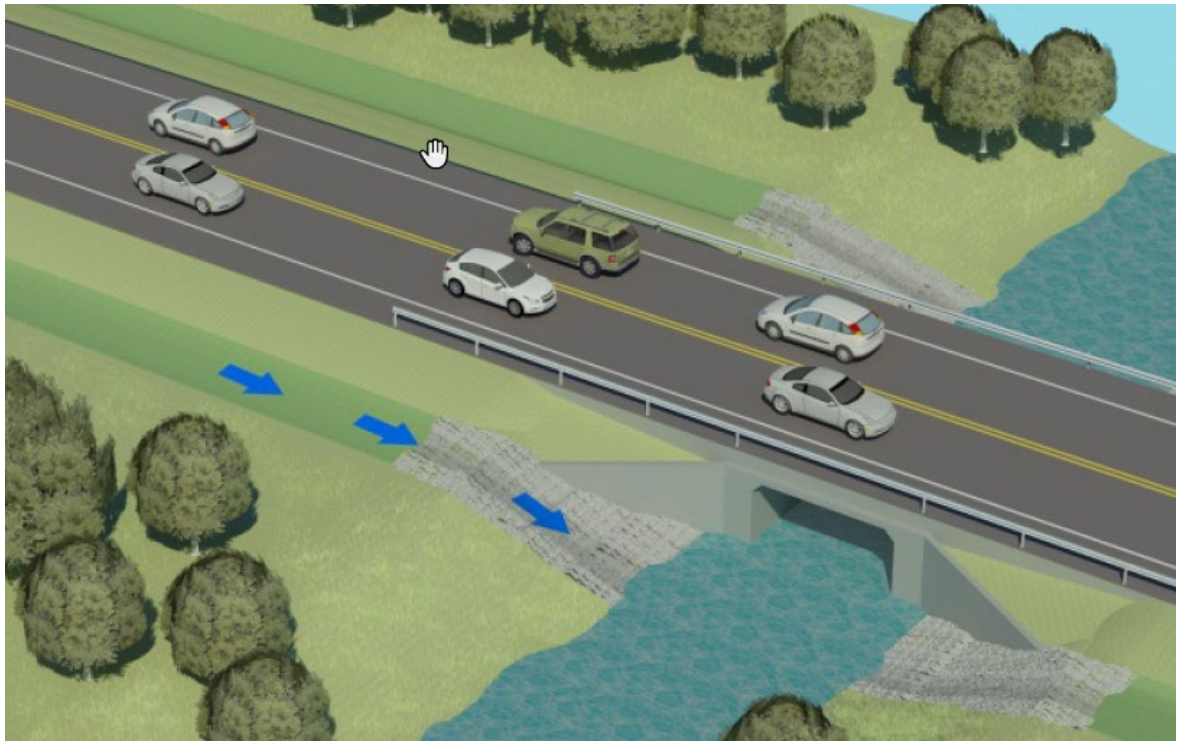
- Utilizing Natural Features and Drainage Pathways
- Maximizing Vegetative Conveyance
- Encouraging Diffuse Flow



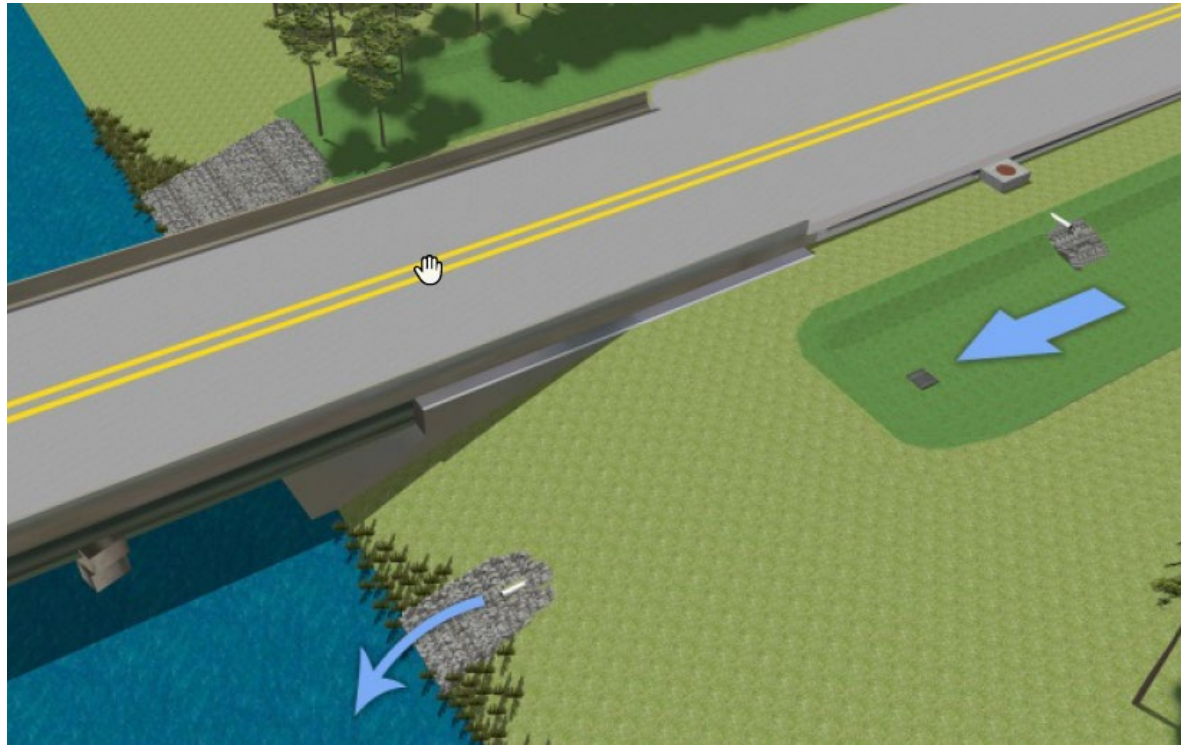


Design Measures

- Stable conveyance to the receiving water
  - Streambank Drop Structures



Rip Rap Bank Drop Structure



Concrete Box Drop Structure

Design Measures

- Dispersed Discharge

Design Measures

- Minimizing Direct Discharge from Bridges

Is this always the appropriate practice?

Let's dig in!

Direct Discharge from Bridges

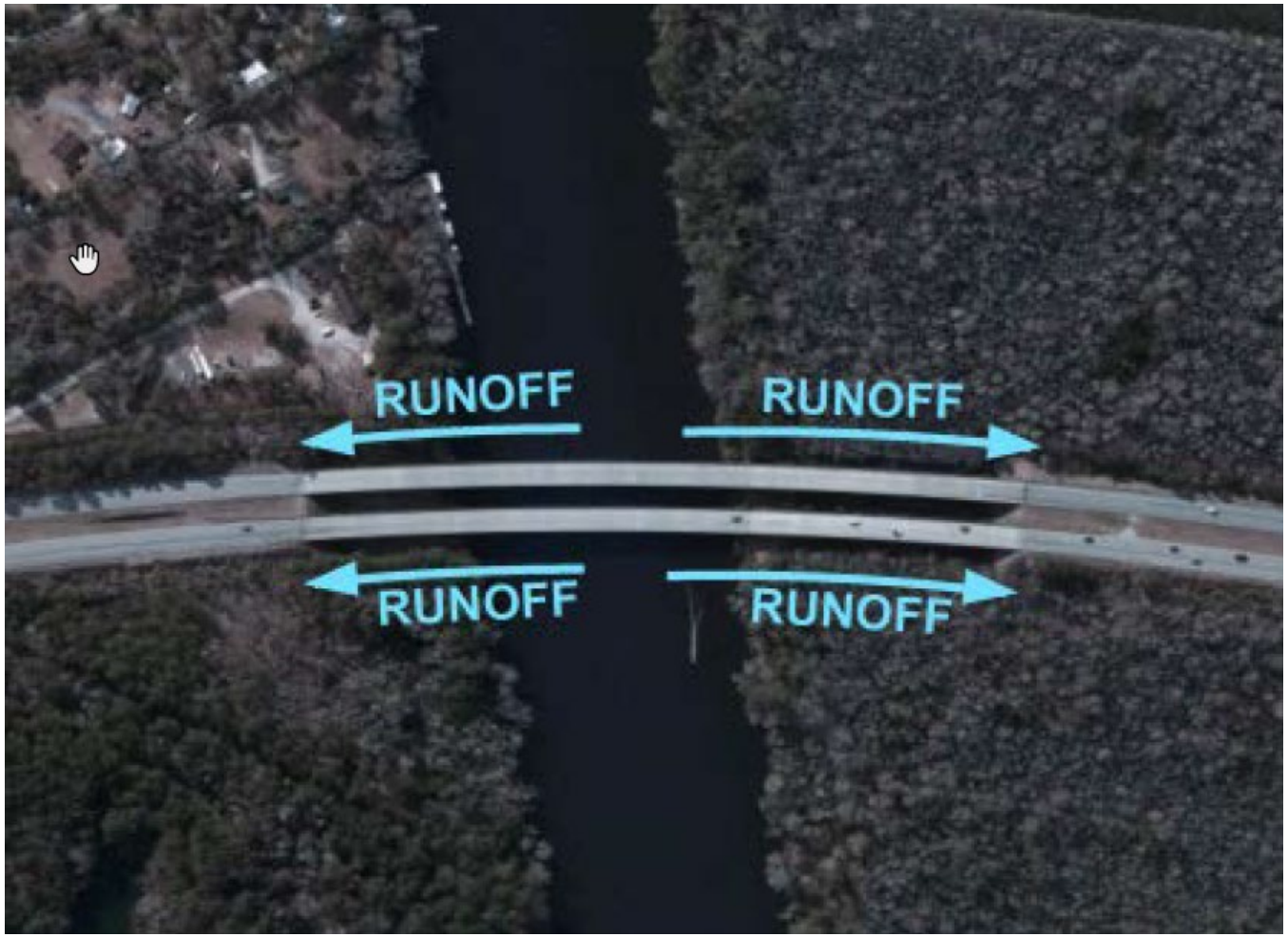
Generally, if runoff can be conveyed via the bridge deck it is recommended.

- Bringing runoff off the bridge allows for the possibility of conveyance through vegetation or other treatment measures if needed.

- Designs which allow conveyance via the bridge deck are encouraged.

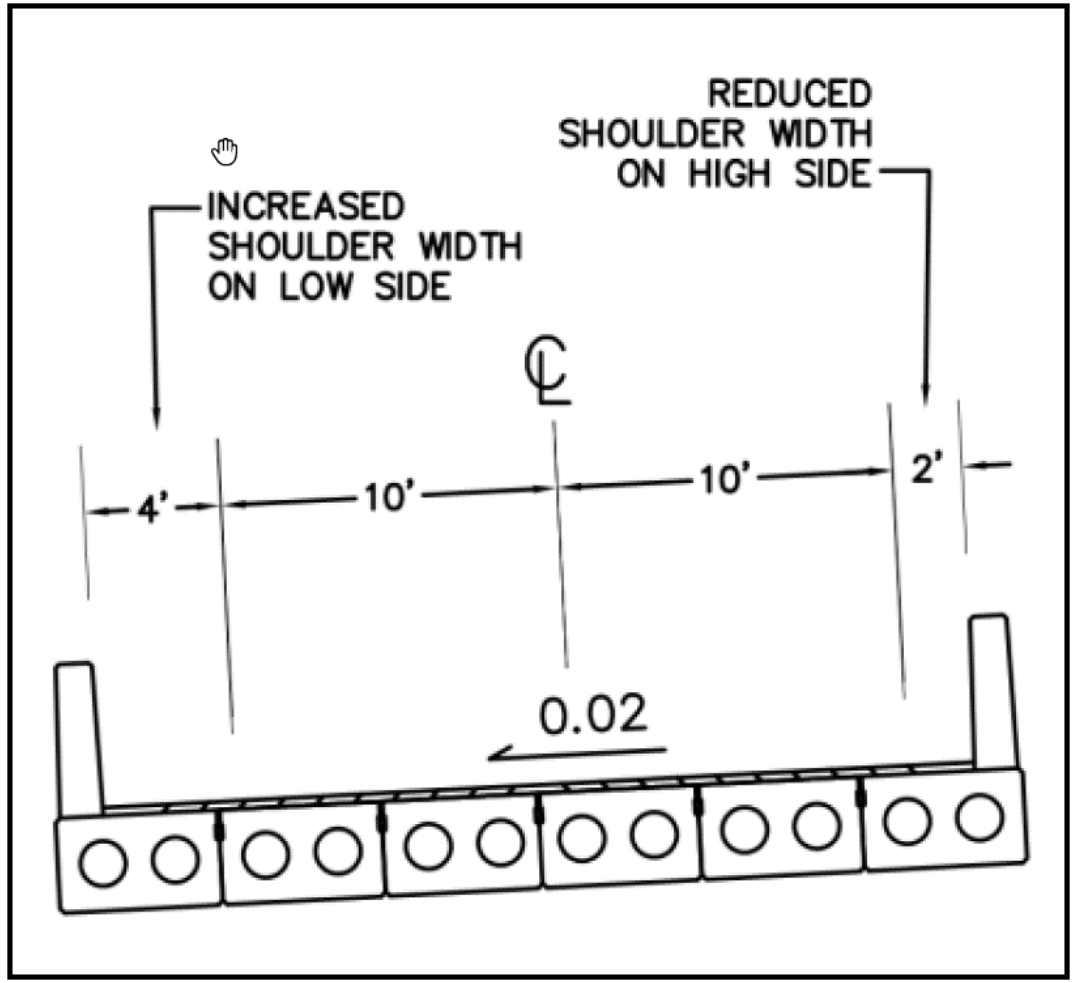
Bridge Design Measures That Help Facilitate Bridge Deck Conveyance

Bridge Crest in the Center



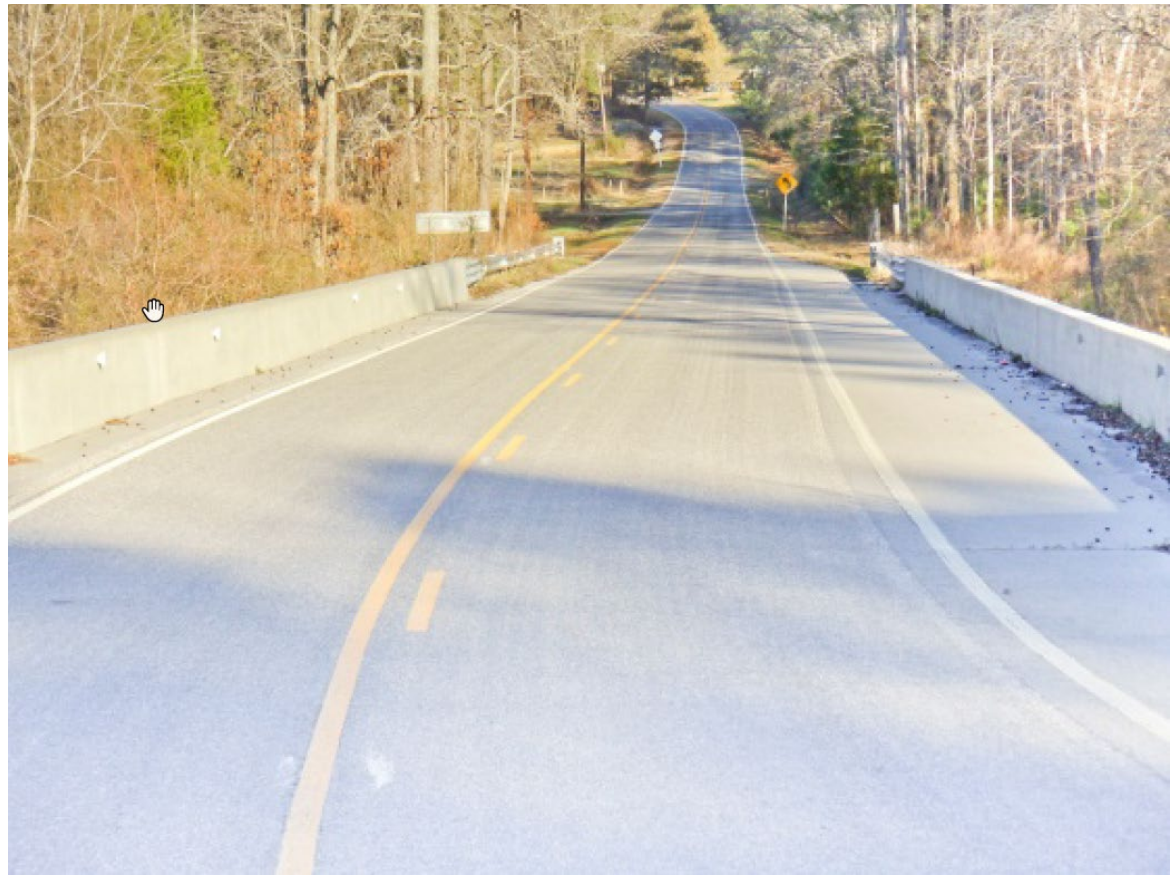
Bridge Design Measures That Help Facilitate Bridge Deck Conveyance

Adjusted Shoulder Widths on Superelevated Bridges



Bridge Design Measures That Help Facilitate Bridge Deck Conveyance

Widen the bridge to convey water via the shoulder



Closed Drainage Systems are NOT Recommended

- Expensive
- Notorious for failure
- Difficult to maintain
- Could have a detrimental effect on the environment

Dispersed Discharge From Bridges - Common Concerns from Agencies

- Water Quality – toxicity to SAVs or other aquatic organisms
- 303(d) Impairment – fecal coliform bacteria loadings
- General anti-degradation of SA, HQW, ORW waters – protection of existing supporting uses
- Mechanical damage to habitat from falling water
  - Submerged Aquatic Vegetation (SAV)
  - Land erosion

Research

- 2008-2010 Bridge Study
  - One of the nation's largest, most comprehensive water quality evaluations of bridge deck runoff
  - NCDENR, NCDOT, USGS and other project partners
- 2010 NCCF study
  - Bacteria study on the Virginia Dare Bridge
- 2010 NCDOT Deck Drain study
  - Erosion from deck drains
- 2015 DWR - Draft 2015 North Carolina Addendum to the Low pH TMDL for the Great Smoky Mountains National Park, TN.
- FHWA, 1993. Design of Bridge Deck Drainage. Hydraulic Engineering Circular 21.

Research

Is bridge deck runoff toxic?

- 2008-2010 Bridge Study
  - Findings:
    - Toxicity Testing
      - *Ceriodaphnia dubia – a fragile organism that is less tolerant to toxins than other organisms and vegetation*
      - 23 bridge deck runoff samples tested
        - Only 3 were identified as toxic due to reduction in the “reproduction” rates
          - Swannanoa River (100% and 50% concentrations) – Deicing operations
          - Black River (100% concentration) - low hardness and low pH
          - Little River (100% concentration) - low hardness and low pH

- DWR - Draft 2015 NC Addendum to the Low pH TMDL for the Great Smoky Mountains National Park, TN.
  - Low pH problem caused by atmospheric acidity
  - No downstream samples were toxic

Research

- 2008-2010 Bridge Study
  - Findings:
    - Toxicity Testing
      - Also included benthic macroinvertebrate monitoring
      - Confirmed the findings of the *Ceriodaphnia* tests
      - Bridge deck runoff has minimal toxic effects.
      - 12 bridge sites
        - No change in benthic bioclassification between the upstream and downstream

Research

- 2008-2010 Bridge Study
  - Findings:
    - The Research suggests that:

      Bridge deck runoff is NON-Toxic

Research

Is there any evidence to suggest that bridge deck runoff will cause other water quality problems, such as nutrient enrichment or depressed dissolved oxygen concentrations?

- 2008-2010 Bridge Study
  - Bridges:
    - Normally don't receive any off-site runoff
    - Do not include any vegetative plantings on the deck
  - Primary source of nutrients in the bridge deck runoff would be from atmospheric deposition.
    - Bridge deck runoff: **0.98 mg/L TN, 0.17 mg/L TP**
      - Very similar to those found in rooftop runoff
    - Forested land runoff: **1.47 mg/L TN, 0.25 mg/L TP**

Bridge deck runoff has less nutrients than forest runoff!

Research

What are the sources of fecal coliform bacteria in bridge deck runoff? What is the likelihood that a bridge would result in increased fecal coliform bacteria concentrations in shellfish waters?

- Bacteria sources:
  - Sanitary sewer utilities aren't common on bridges
  - Animal feces, from birds and other wildlife
    - Already within the area = not likely any significant increase in fecal coliform would occur.

Research

What are the sources of fecal coliform bacteria in bridge deck runoff? What is the likelihood that a bridge would result in increased fecal coliform bacteria concentrations in shellfish waters?

2010 NCCF Study – Bacteria on the Virginia Dare Bridge

- Sampled from: Bridge Deck, Closed Drainage System, Inlet & Outlet of stormwater BMP
- No significant reduction in indicator bacteria was observed along the closed bridge deck system or into the stormwater BMP.
  - Somewhat of an increase in bacteria levels
    - moist, shaded environment within the closed drainage system
    - provided a protective environment shielding the bacteria from desiccating winds and UV radiation from the sun which are known to increase die-off rates in bacteria populations.
    - The opportunity for additional bacteria deposition was further enhanced within the stormwater wetland which offered an attractive habitat and potential food sources to wildlife in the area.

Closed bridge deck systems may make bacteria loadings worse!

Research

Is there any evidence to suggest that water falling from deck drains will cause mechanical damage to SAVs or their potential habitat?

- May be able to locate deck drains to avoid certain areas
- FHWA - HEC-21 'Design of Bridge Deck Drainage (FHWA, 1993)
  - free fall exceeding about 25' will sufficiently disperse the falling water to prevent any erosion
- NCDOT's HSP Deck Drain Study
  - Evaluate the effects of falling water from open deck drains to the ground surface.
  - 70 random bridge sites
    - 23 sites had deck drains over standing water
      - No scour was observed.
    - 47 had deck drains over land
      - Scour was typically observed only where:
        - the fall height was less than 12' (runoff couldn't re-disperse into droplets),
        - the ground surface was sloped and water re-concentrated on the surface and caused rills to form, or vegetation was sparse.

Research

Can we reduce concerns about pollutants being spilled and directly discharged into waterways?

- Bridge geometries are generally:
  - Straight, or gradually curved
  - Don’t have regular stop conditions

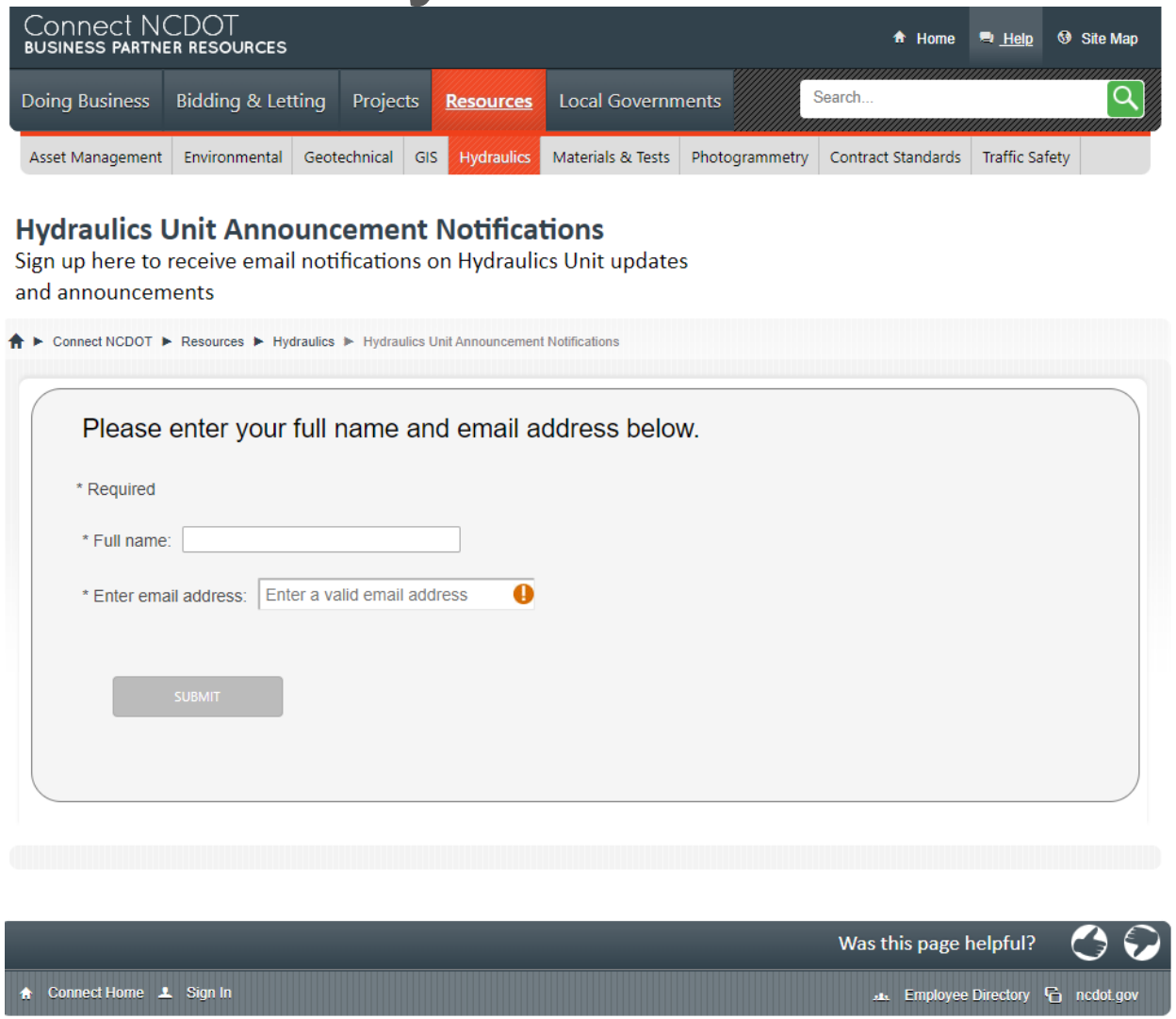
- NCDOT “**Evaluation of Guidelines for the Location and Design of Hazardous Spill Basins**” – July 2021
  - Looked at 10 years worth of crash data
  - Concluded:
    - Low risk of hazardous spill
    - NCDEQ agreed that the existing HSB policy should be rescinded
    - Policy is being removed from Drainage Guidelines

Conclusion

- Bridge stormwater runoff is a small portion of overall stormwater management picture.
- Extensive research data is available to support stormwater management decisions.
- Dispersed discharge of runoff from bridges may be ok, or even the best option.
- Follow the Post-Construction Stormwater Program (PCSP)!
- Use available resource tools.
- If questions, contact the Highway Stormwater Program

NCDOT Highway Stormwater PROGRAM

Stay Informed!



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