NORTH CAROLINA
Department of Transportation

Transportation Resiliency - Building a More Resilient Transportation System

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Connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina

Agenda

1. Background
2. Legislation
3. Policy
4. Program
5. Practice and Products
    1. Planning
    2. Design/Construction
    3. Operations
6. Research
7. Questions and Answers

Background

Extreme Events

Hurricanes, prolonged flooding, increased maintenance/asset repairs

- **2018 Florence**
- **2016 Matthew**
- Other isolated, intense storms

Last Decade

2015-Present

Federal Response

- FAST Act
- Infrastructure and Investment Jobs
- FHWA Emergency Relief Funds
- Vulnerability and Adaptation
- Resiliency considerations in long range plans
- Toolkits, training, peer exchanges (e.g., RAMCAPs Colorado procedure document)
- USACE Flood Risk Feasibility Studies on Tar Pamlico, Neuse, and Lumber River Basins
- **IIJA**

State Response

- **EO 80**
- NC Climate Change Interagency Council
- ZEV Plan
- NC Climate Risk and Resiliency Plan
- NC Moves 2050
- Ongoing Research, Studies
- EO 266
- 2022 Budget

2018-Present

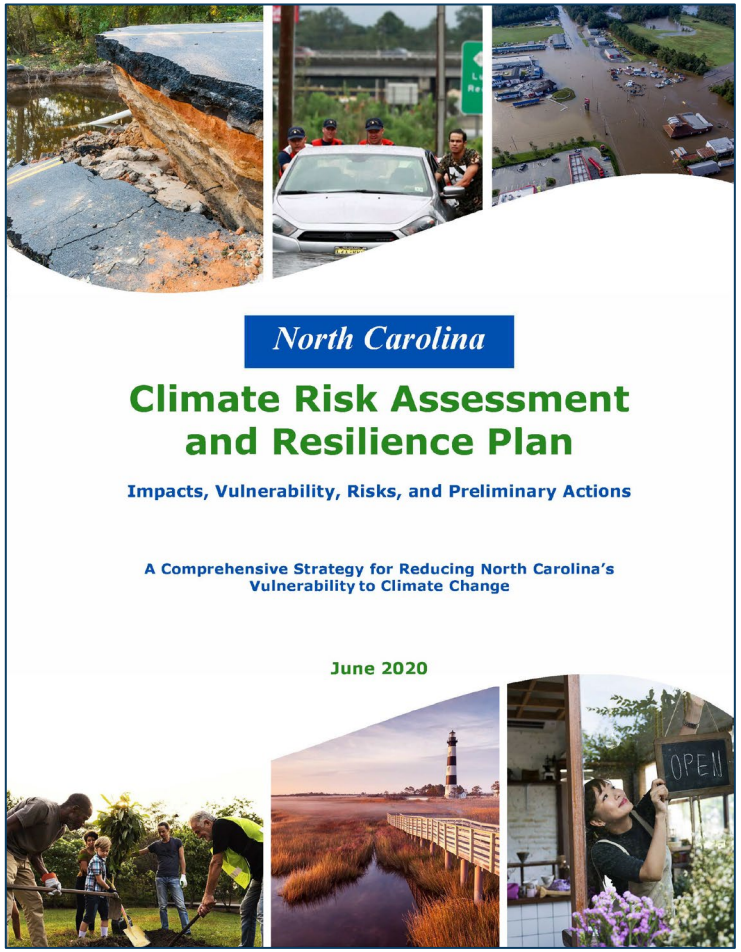
Executive Order 80

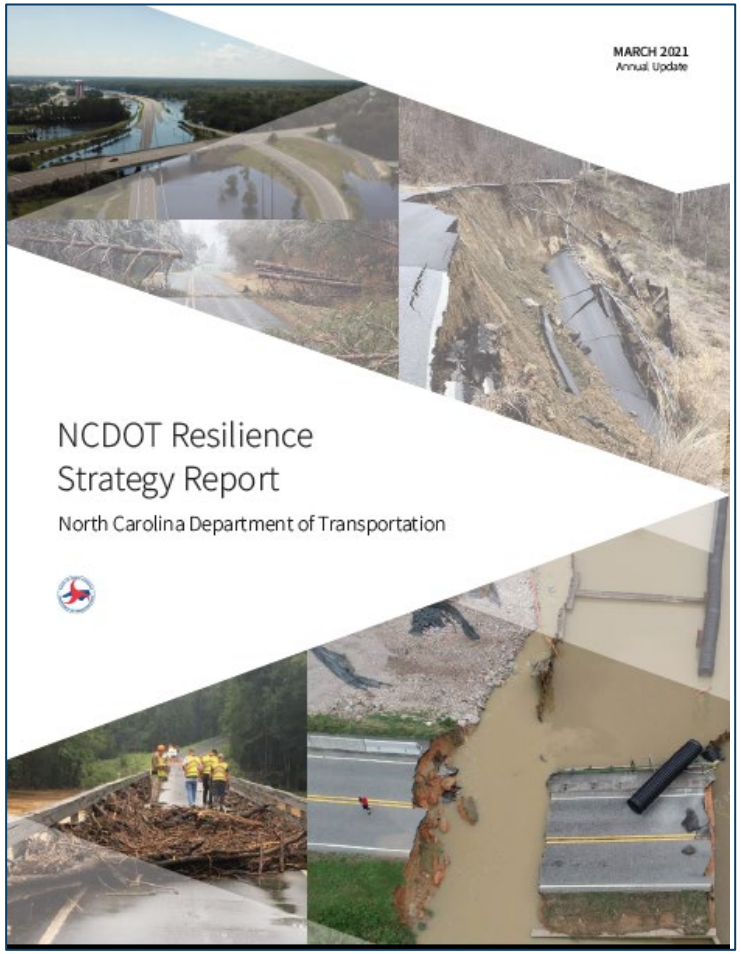
9. Cabinet agencies shall integrate climate adaptation and resiliency planning into their policies, programs, and operations (i) to support communities and sectors of the economy that are vulnerable to the effects of climate change and (ii) to enhance the agencies' ability to protect human life and health, property, natural and built infrastructure, cultural resources, and other public and private assets of value to North Carolinians.

a. DEQ, with the support of cabinet agencies and informed by stakeholder engagement, shall prepare a North Carolina Climate Risk Assessment and Resiliency Plan for the Council to submit to the Governor by March 1, 2020.

b. The Council shall support communities that are interested in assessing risks and vulnerabilities to natural and built infrastructure and in developing community-level adaptation and resiliency plans.

Resilience Strategy Report

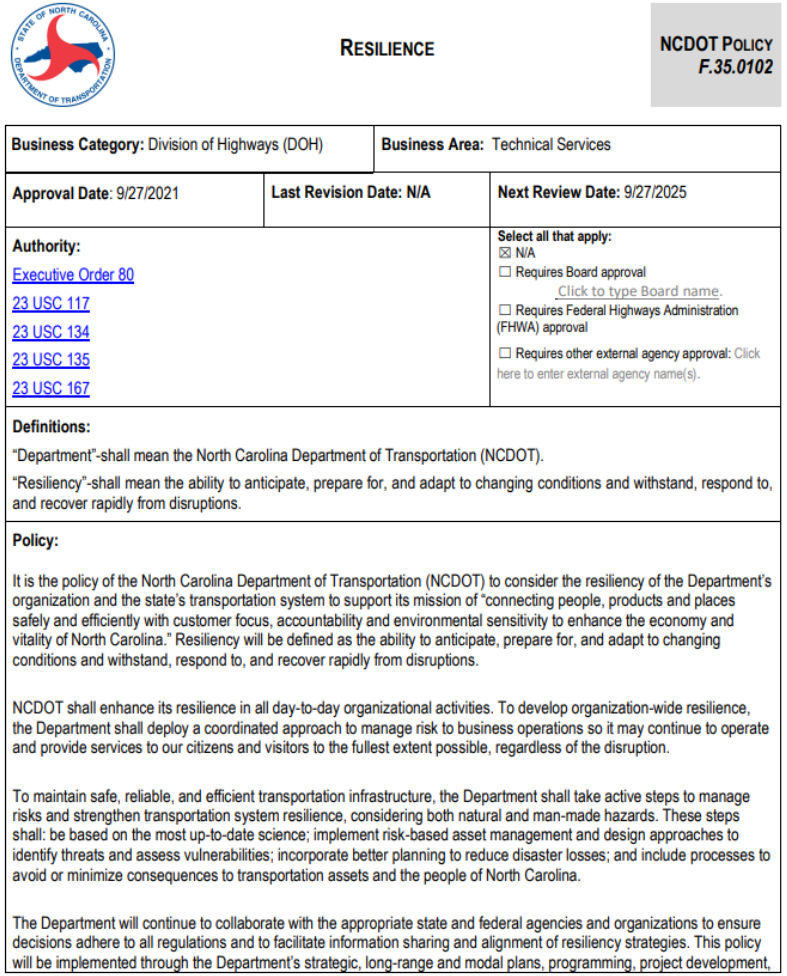




https://www.ncdot.gov/initiatives-policies/Transportation/transportation-resilience/Documents/ncdot-resilience-report.pdf
https://deq.nc.gov/energy-climate/climate-change/nc-climate-change-interagency-council/climate-change-clean-energy-plans-and-progress/nc-climate-risk-assessment-and-resilience-plan

NCDOT Resilience Policy

1. Defines Resiliency
2. Defines Department Resilience Integration
3. Provides Strategic Framework for Department Resilience



RESILIENCE

NCDOT POLICY *F.35.0102*

Business Category: Division of Highways (DOH)	**Business Area:** Technical Services	
Approval Date: 9/27/2021	**Last Revision Date: N/A**	**Next Review Date:** 9/27/2025
Authority: Executive Order 80 23 USC 117 23 USC 134 23 USC 135 23 USC 167		**Select all that apply:** ☒ N/A ☐ Requires Board approval Click to type Board name. ☐ Requires Federal Highways Administration (FHWA) approval ☐ Requires other external agency approval: Click here to enter external agency name(s).

Definitions:

"Department"-shall mean the North Carolina Department of Transportation (NCDOT).

"Resiliency"-shall mean the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

Policy:

It is the policy of the North Carolina Department of Transportation (NCDOT) to consider the resiliency of the Department's organization and the state's transportation system to support its mission of "connecting people, products and places safely and efficiently with customer focus, accountability and environmental sensitivity to enhance the economy and vitality of North Carolina." Resiliency will be defined as the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions.

NCDOT shall enhance its resilience in all day-to-day organizational activities. To develop organization-wide resilience, the Department shall deploy a coordinated approach to manage risk to business operations so it may continue to operate and provide services to our citizens and visitors to the fullest extent possible, regardless of the disruption.

To maintain safe, reliable, and efficient transportation infrastructure, the Department shall take active steps to manage risks and strengthen transportation system resilience, considering both natural and man-made hazards. These steps shall: be based on the most up-to-date science; implement risk-based asset management and design approaches to identify threats and assess vulnerabilities; incorporate better planning to reduce disaster losses; and include processes to avoid or minimize consequences to transportation assets and the people of North Carolina.

The Department will continue to collaborate with the appropriate state and federal agencies and organizations to ensure decisions adhere to all regulations and to facilitate information sharing and alignment of resiliency strategies. This policy will be implemented through the Department's strategic, long-range and modal plans, programming, project development,

https://www.ncdot.gov/initiatives-policies/Transportation/transportation-resilience/Documents/ncdot-resilience-policy.pdf

Threats and Hazard Categories

Natural	Technological	Human-caused
Avalanche	Dam failure	Active shooter incident
Drought	Hazardous materials release	Armed assault
Earthquake	Industrial accident	Biological attack
Epidemic	Levee failure	Chemical attack
Flood	Mine accident	Cyber-attack against data
Hurricane/Typhoon	Pipeline explosion	Cyber-attack against infrastructure
Space weather	Radiological release	Explosives attack
Tornado	Train derailment	Improvised nuclear attack
Tsunami	Transportation accident	Nuclear terrorism attack
Volcanic eruption	Urban conflagration	Radiological attack
Winter Storm	Utility Disruption	

Source: CPG 201, DHS 2018

Resilience - Definition

A resilient North Carolina is a state where our communities, economies, and ecosystems are better able to rebound, positively adapt to, and thrive amid changing conditions and challenges, including disasters and climate change; to maintain and improve quality of life, healthy growth, and durable systems; and to conserve resources for present and future generations.

NC Climate Risk and Resilience Plan, Executive Summary

resilience - *the ability to anticipate, prepare for, and adapt to changing conditions and withstand, respond to, and recover rapidly from disruptions*

Federal Highway Administration

Strategy, Vision, Goals, Objectives

Outcomes: Resiliency incorporated within each phase of transportation – *Planning* → *Maintenance*

Resiliency Strategy

Goals, Objectives

O1: Define the core components of a Policy Framework

O2: Assess the vulnerability and risk of North Carolina's multimodal transportation network.

O3: Identify and develop risk/resiliency efforts across the spectrum of NCDOT activities.

O4: Identify current and future opportunities to more closely coordinate with federal and state agencies and local planning partners

https://www.ncdot.gov/initiatives-policies/Transportation/transportation-resilience/Documents/ncdot-resilience-report.pdf

Practice and Products

FHWA Competitive Grants

Opening Date	Grant Program	Funding (FY22-FY26)	Closing date	Purpose	Federal Share
11/30/2022	Rebuilding American Infrastructure with Sustainability and Equity (RAISE)	$8.275billion	2/28/2023	Fund transportation infrastructure projects with significant local or regional impact	Up to 80 percent, with flexibility for higher shares based on various project specifications
Spring 2023	Nationally Significant Multimodal Freight and Highway Projects (INFRA)	$7.25billion		Advance multimodal freight and highway projects of national or regional significance that improve the safety, efficiency, and reliability of the system	Up to 80 percent, with flexibility based on various project specifications
Spring 2023	National Infrastructure Project Assistance Program (MEGA)	$5billion		Support multijurisdictional or regional projects of significance that may also cut across multiple modes of transportation	Up to 80 percent, with flexibility based on various project specifications
Spring 2023	Rural Surface Transportation Grant Program	$2billion		Improve and expand surface transportation infrastructure in rural areas	80 percent, with flexibility for higher shares based on various project specifications

FHWA Competitive Grants

Opening Date	Grant Program	Funding (FY22-FY26)	Closing date	Purpose	Federal Share
Summer 2023	Bridge Investment Program	$1billion	9/8/2022	Fund the planning and improvement of bridge condition, safety, efficiency, and reliability	Flexible and in some instances higher than 80 percent based on project specifications.
Late Spring 2023	Reconnecting Communities Pilot Program	$1billion		Restore community connectivity by removing highways that create barriers	Up to 80 percent
Winter/ Spring 2023	Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Discretionary Grants	$1.4billion		Support resilience improvements	up to 80 percent, with flexibility for higher shares based on various project specifications
10/06/2022	National Culvert Removal, Replacement, and Restoration Grants	$1billion	2/6/2023	Improve or restore passage for anadromous fish	Up to 80 percent

Tribal Competitive Funding

Grant Program	Funding (FY22-FY-26)	Federal Share	Purpose
Tribal High Priority Projects Program	$45million	Up to 100%	Funding for those whose annual allocation of funding received under the TTP is insufficient to complete the highest priority project.
Tribal Transportation Facility Bridge Program	$200million	100%	Replace, rehabilitate, preserve, protect, and construct new bridges.
Nationally Significant Federal Lands and Tribal Projects (NSFLTP) Program	$275million		Address significant challenges across the nation for transportation facilities that serve Federal and tribal lands

https://highways.dot.gov/sites/fhwa.dot.gov/files/docs/federal-lands/programs-tribal/36311/transportation_funding_opportunities_for_tribal_nations.pdf

Things To Be Aware Of

- Executive Order 266
- Statewide Flood Resiliency Blueprint
- Transportation Resiliency Fund Grants
- Water and Sewer Infrastructure Funds
- Statewide Hazard Mitigation Plan adopted 12/2022
- NCORR Regional Resilience Portfolios
- Funding Forum in Greenville on 2/28
- Climate Resilience Clearinghouse
- AASHTO Risk and Resilience Working Group
- TRB -Standing Committee on Extreme Weather and Climate Change Adaptation

Resources for PROTECT PROGRAM

- PROTECT Formula Program Implementation Guidance:
  - https://www.fhwa.dot.gov/environment/sustainability/resilience/policy_and_guidance/protect_formula.pdf
- PROTECT Formula Program Fact Sheet:
  - https://www.fhwa.dot.gov/bipartisan-infrastructure-law/protect_fact_sheet.cfm

NHI Web Training

  - FHWA-NHI-142081 Understanding Past, Current and Future Climate Conditions
  - FHWA-NHI-142082 Introduction to Temperature and Precipitation Projections
  - FHWA-NHI-142083 Systems Level Vulnerability Assessments
  - FHWA-NHI-142084 Adaptation Analysis for Project Decision Making
- ***Prerequisites*** for the in-person course: ***Addressing Resilience in Highway Project Development & Preliminary Design***

FHWA Resilience Pilots with State DOTs & MPOs

- 2010-2011 Vulnerability Assessments (5 pilot projects)
- 2013-2015 Vulnerability Assessments and Adaptation Options (19 pilot projects)
- 2016-2017 Nature-based Resilience for Coastal Highways (5 Pilot projects)
- 2017-2019 Asset Management, Extreme Weather, and Proxy Indicators (6 pilot projects)
- 2018-2020/2024 Resilience & Durability to Extreme Weather (11 pilot projects)

https://www.fhwa.dot.gov/environment/sustainability/resilience/pilots/

Practice and Products Planning

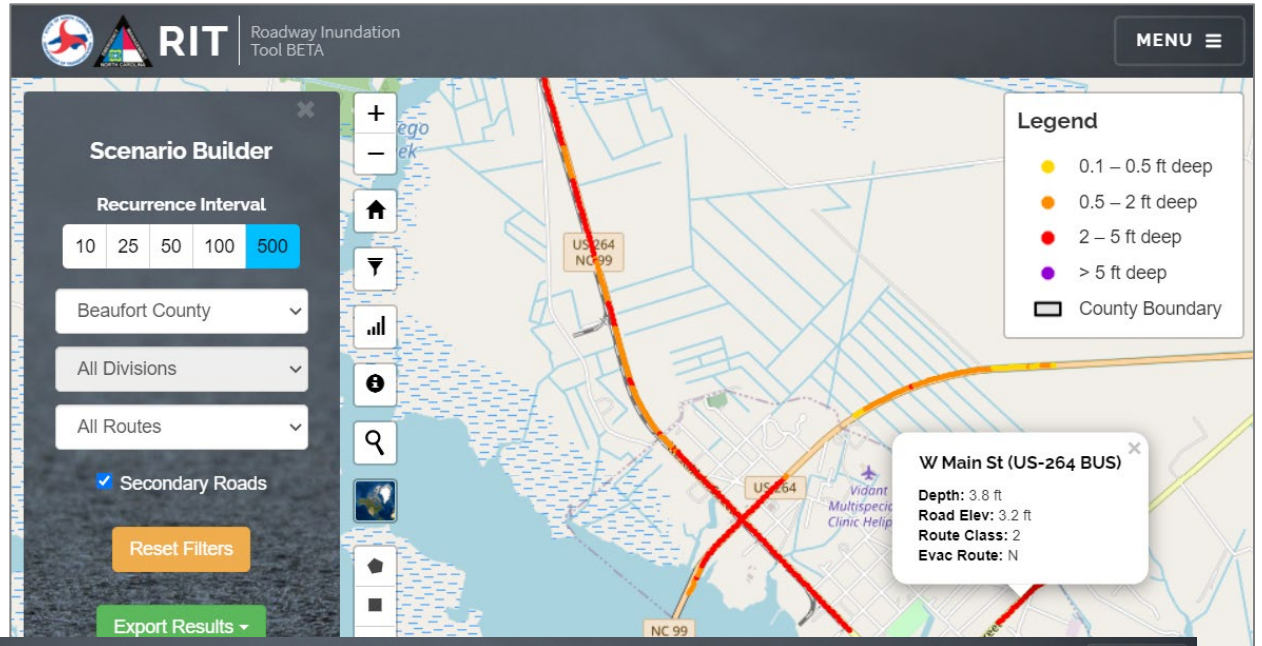
Planning:

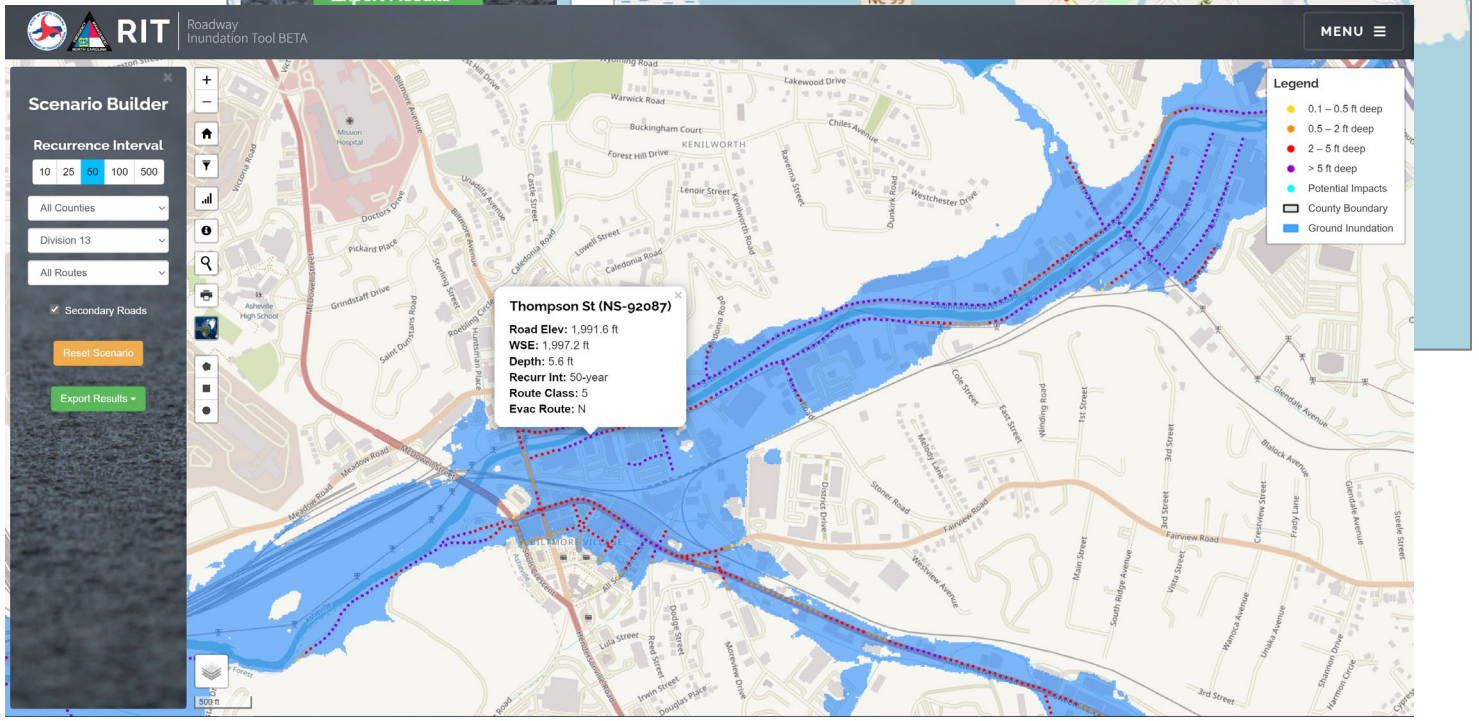
1. Natural Hazard Characterization Tools
    a) Road and Rail Inundation
    b) Coastal Inundation
    c) Geohazards
2. Vulnerability Assessments
3. Incorporate Resilience Assessments in Long Range Plans
4. Gap Analysis in Planning and Standards

Road Inundation Tool (RIT)

- Based on multi-frequency flood studies
  - 10-, 25-, 50-, 100- and 500-year recurrence intervals
- Analyzed primary and secondary roads
- Incorporating NCEM Flood Advisory Data in Future

Register: https://raft.nc.gov/register.php





Coastal Roadway Inundation Simulator (CRIS)

- Comprises 23 coastal counties
- Inundation from 1-17 ft
- 4 inundation categories:
- Analyzed primary and secondary roads
- Route Selection
- Reporting
- Hindcast Events

- Register: https://raft.nc.gov/register.php
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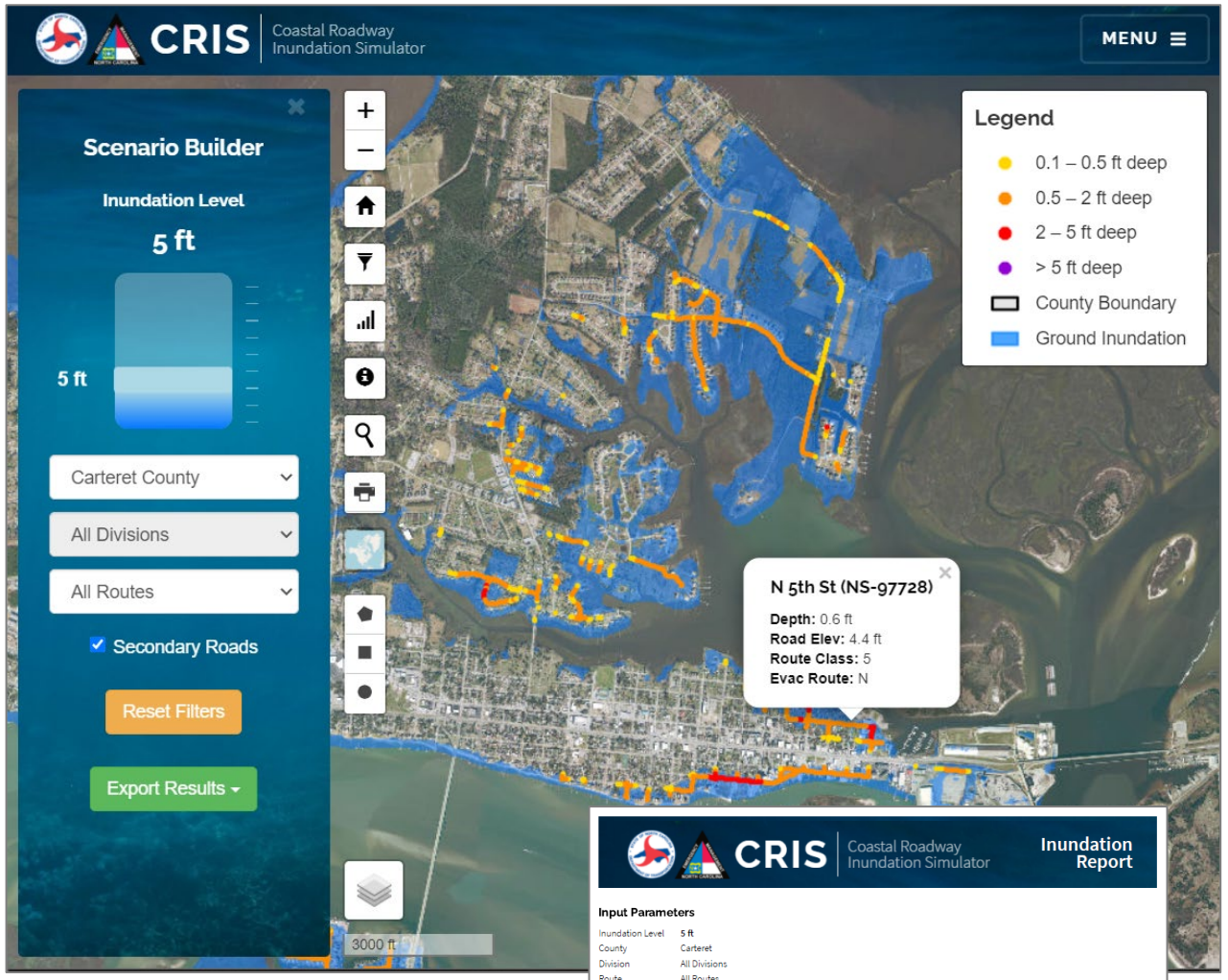
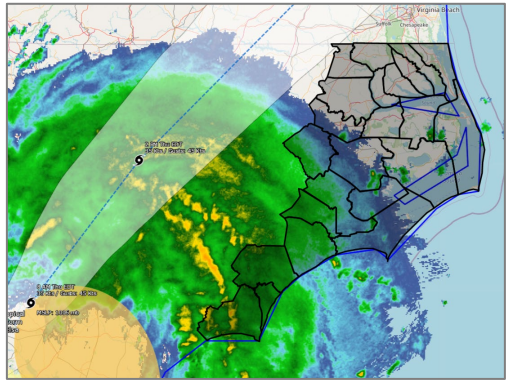
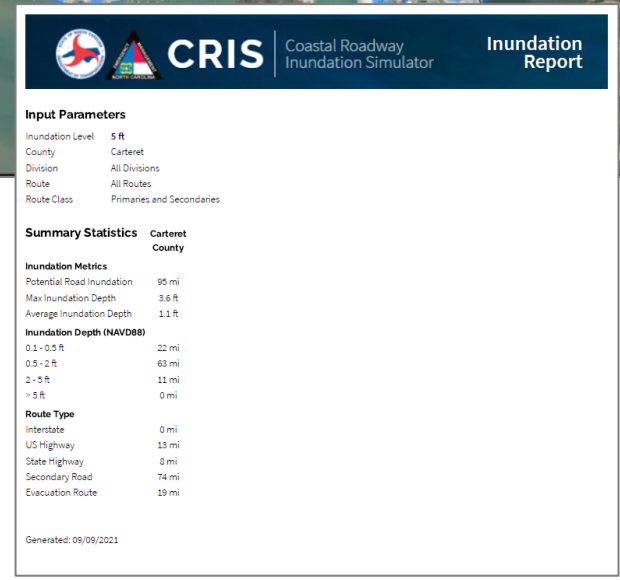
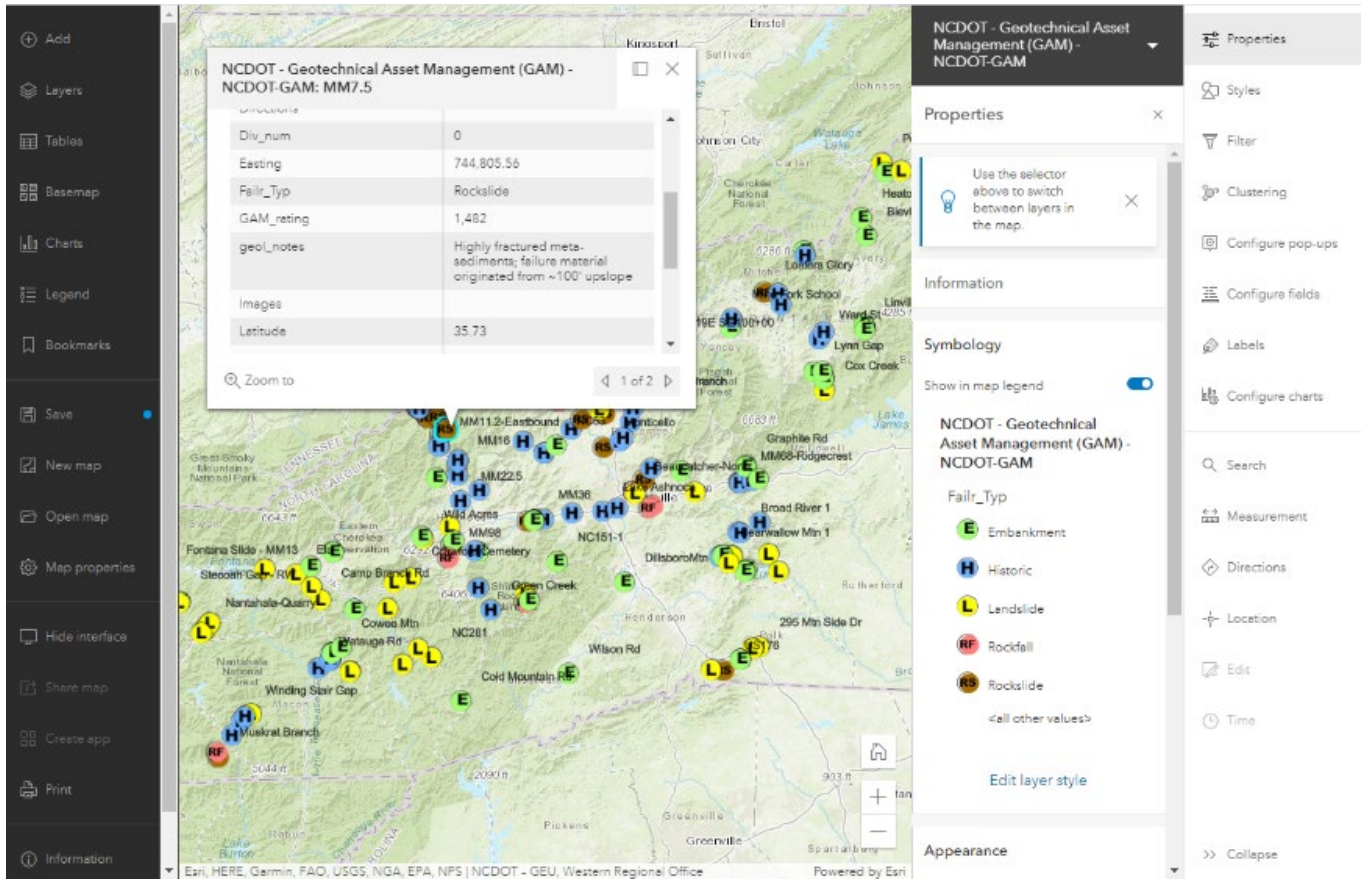






Geotech Asset Management Database



https://ncdot.maps.arcgis.com/apps/mapviewer/index.html?layers=6908e4d9497d462c90c0101b50308bd1

Coastal Bridge Vulnerability Assessment

- 193 bridges
- 61 bridges with detailed hydraulic data for individual bridge spans
  - Low chord elevation
  - 100-year wave height
  - Vulnerability index
  - Criticality index
- Updates including Sea Level Rise coming with research project 2024-015 beginning August 2023.

NCDOT BRIDGE NO. 260035

SUPERSTRUCTURE WAVE ENERGY EXPOSURE

BRIDGE VULNERABILITY SUMMARY

SPAN NUMBER	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
CRITICALITY INDEX (defined below)	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
VULNERABILITY INDEX (defined below)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SURGE/WAVE LOAD COMPUTATION INPUT VALUES

HYDRAULIC VALUES																
100-yr Water Surface Elevation (ft - MSL)	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3
Bed Elevation (ft - MSL)	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-5	-4	-5	-5
Low Chord Elevation (ft - MSL)	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7	13.7
100-yr Max Wave Crest Elevation (ft - MSL)	9.9	10.0	10.1	10.2	10.1	10.1	10.1	10.0	10.0	9.9	9.9	9.8	9.8	9.7	9.8	9.8
100-yr Wave Height (ft)	6.6	6.7	6.9	7.0	6.9	6.9	6.8	6.7	6.7	6.6	6.5	6.5	6.4	6.3	6.4	6.5
100-yr Wave Period (seconds)	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5

SPAN PROPERITES																
Span Length (ft)	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1	60.1
Span Width (ft)	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4	38.4
Deck Thickness (ft)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Overhang (ft)	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2
Number of Beams	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5	5
Beam Dead Weight (lb/lf) - Each	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581	581
Beam Dead Weight (kip/ft) - Total	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Slab Dead Weight (kip/ft)	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5	5.5
Total Dead Weight (kip/ft)	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4
Resisting Moment (kft/ft)	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6	160.6
Resisting Vertical Force (kip/ft)	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4	8.4

100-YEAR FORCE-MOMENT VALUES																
Maximum Vertical Force (kips/span)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Vertical Force (kips/ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Horizontal Force (kips/span)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Horizontal Force (kips/ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Moment (k-ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Maximum Moment (k-ft/ft)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

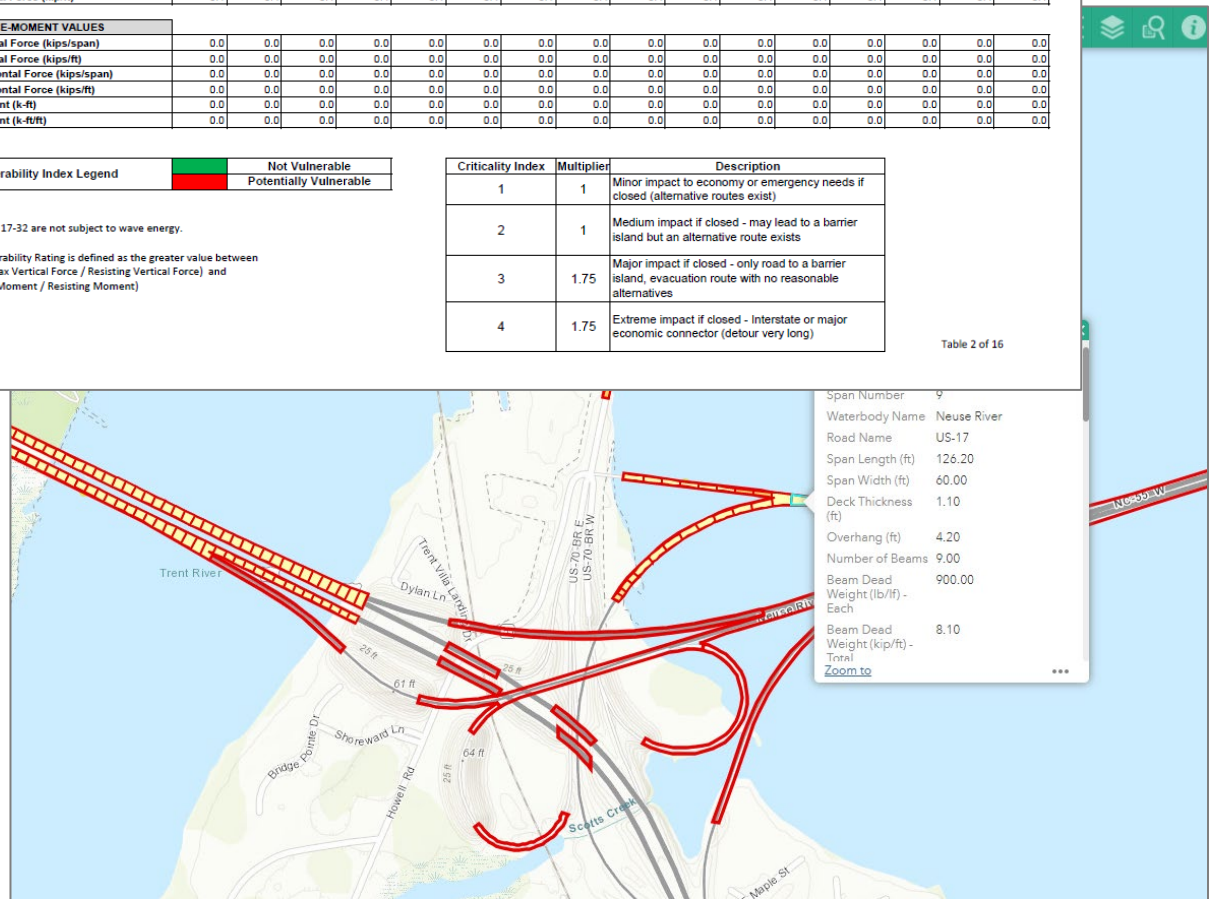
Vulnerability Index Legend	
	Not Vulnerable
	Potentially Vulnerable

Notes:
1 - Bridge spans 17-32 are not subject to wave energy.

2 - Bridge Vulnerability Rating is defined as the greater value between the Ratio (Max Vertical Force / Resisting Vertical Force) and Ratio (Max Moment / Resisting Moment)

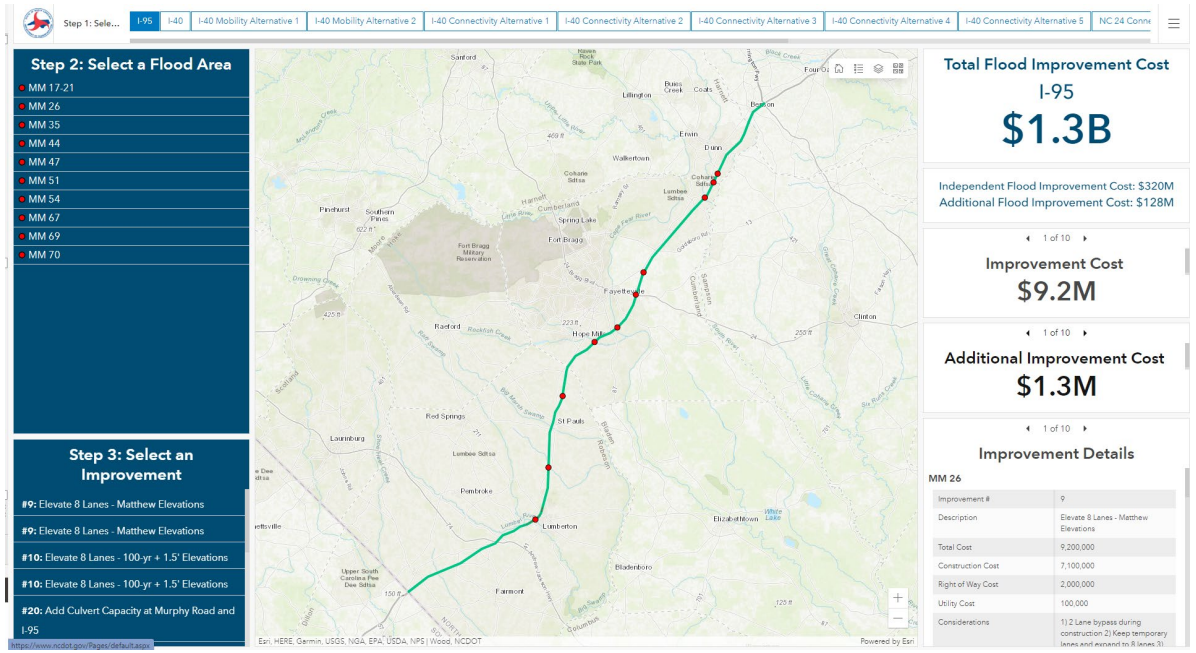
Criticality Index	Multiplier	Description
1	1	Minor impact to economy or emergency needs if closed (alternative routes exist)
2	1	Medium impact if closed - may lead to a barrier island but an alternative route exists
3	1.75	Major impact if closed - only road to a barrier island, evacuation route with no reasonable alternatives
4	1.75	Extreme impact if closed - Interstate or major economic connector (detour very long)

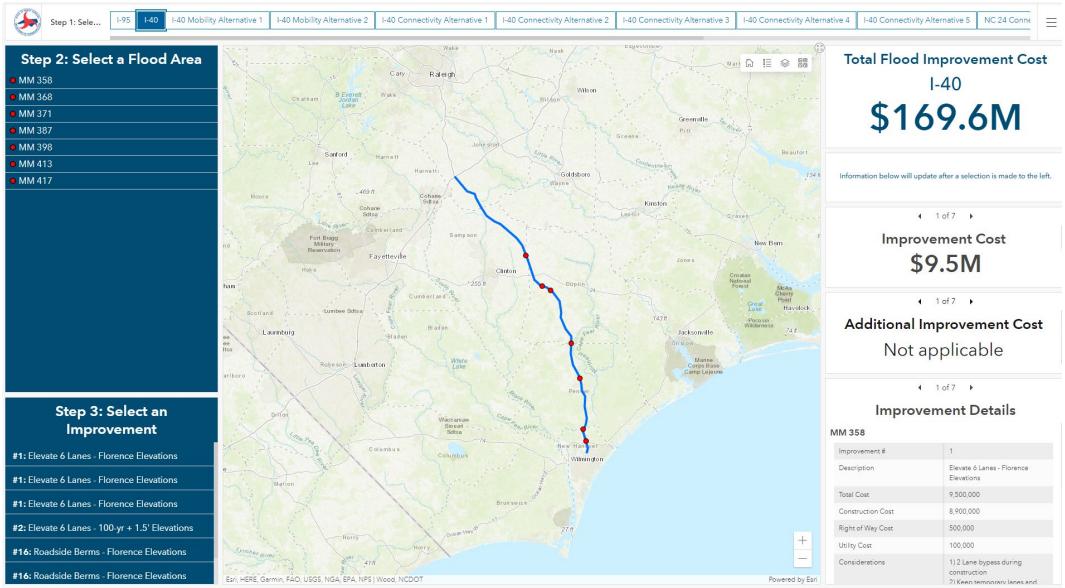
Table 2 of 16



I-95/I-40 and US-17/US 258 Flood Resilience Feasibility Studies

- Documented flood impacts from historical storms.
- Assessed the flood vulnerability.
- Defined a Resilience Criteria
- Identified Improvement Options
    - Connectivity
    - Mobility

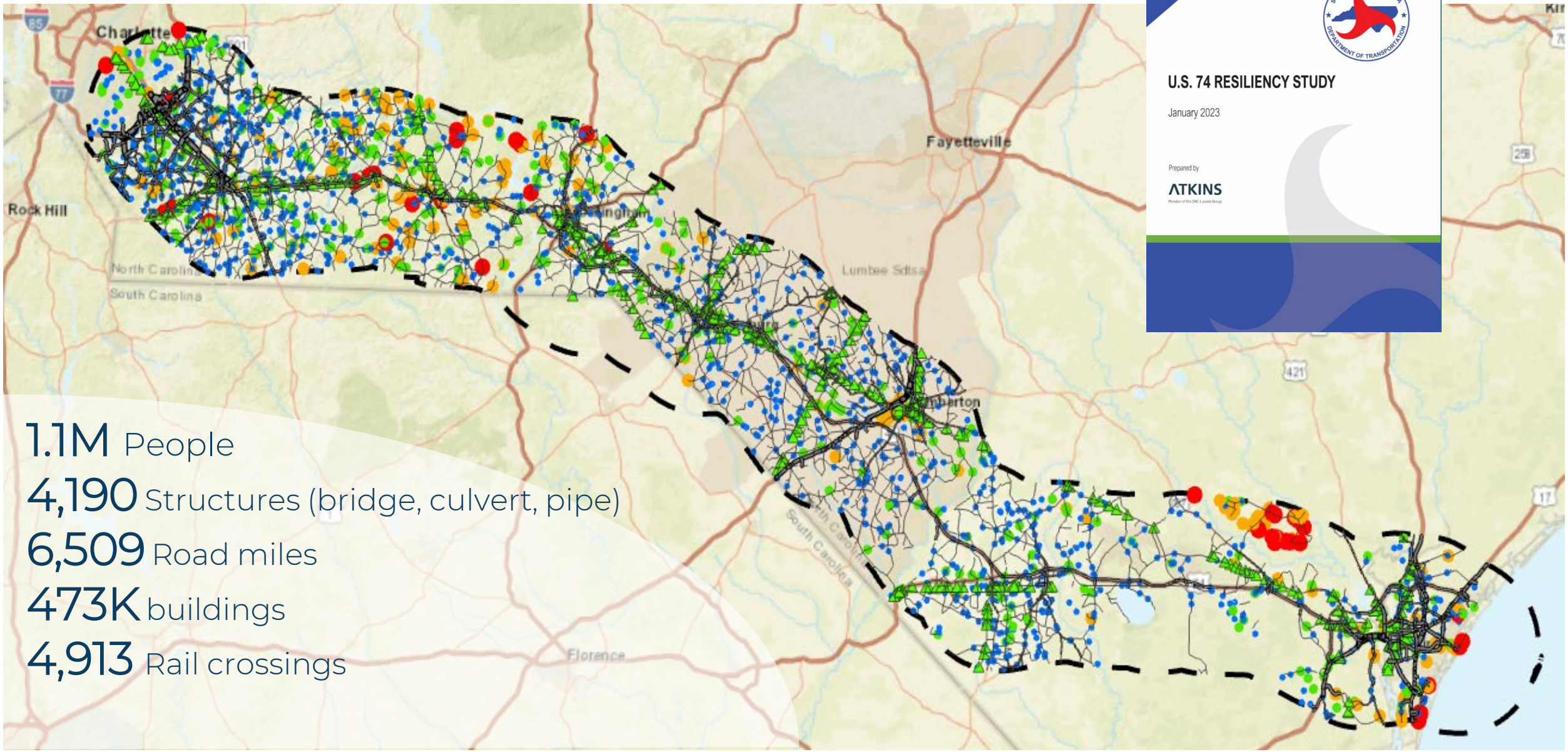


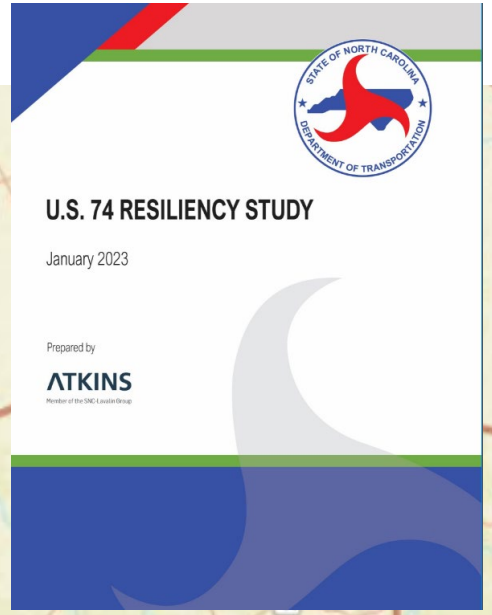


US-70 Vulnerability and Risk Assessment Study

- Coordination
- Stakeholder Engagement
- Existing Conditions
- ★ Asset Criticality
- ★ Vulnerability Assessment
- Final Report

US 74 Corridor Resiliency Study



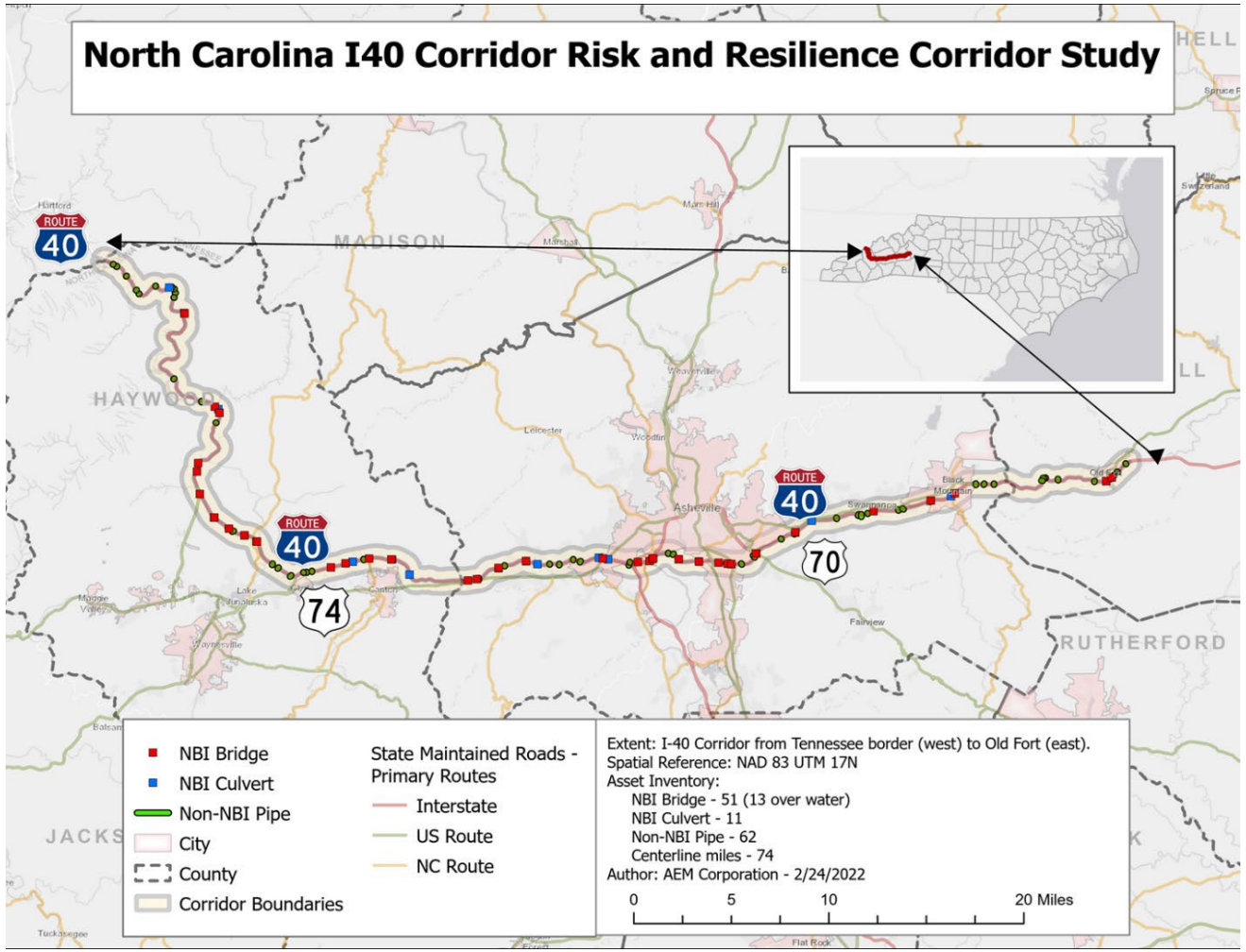


US-74 Adaptation and Mitigation

Policy and Planning	Implement TSO solutions to provide efficient guidance and detour options	Adjust maintenance schedules to maximize preparedness	Increase real-time sensoring
General Infrastructure Improvement	Prioritize improvement to maximize resilience	Improve alternate routes	Avoid Response-driven capital improvement
Physical Climate Change Countermeasures	Elevate Roads	Harden roads	Harden rail crossings

Western Vulnerability Assessments

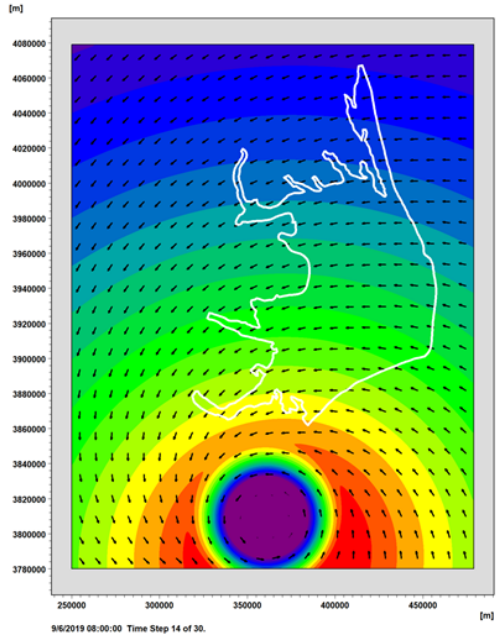
- I-26 from Hendersonville to South Carolina line
- I-40 from Tennessee line to Old Fort, McDowell County

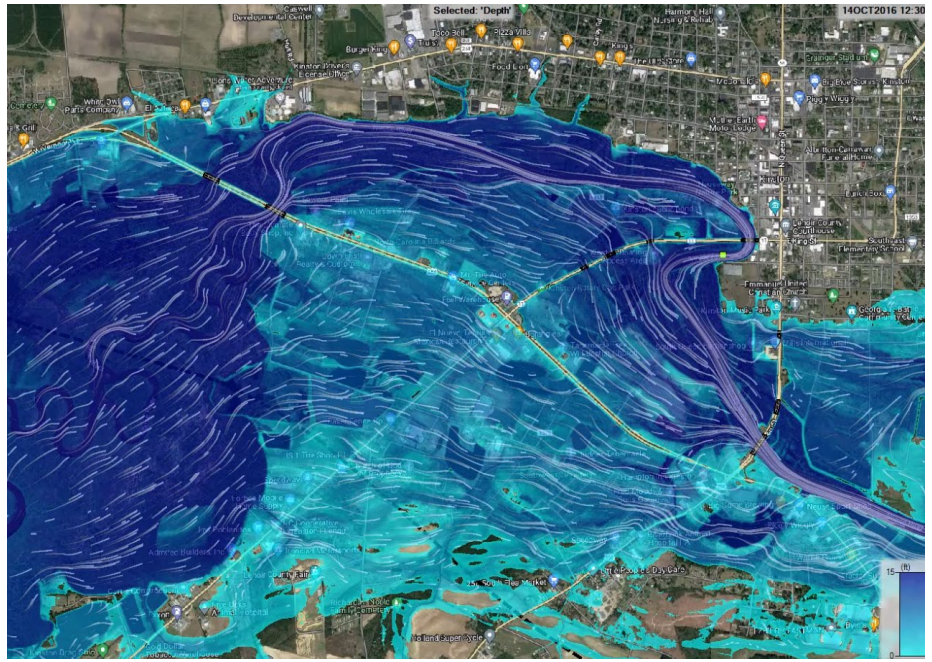


Practice and Products Design and Construction

Design

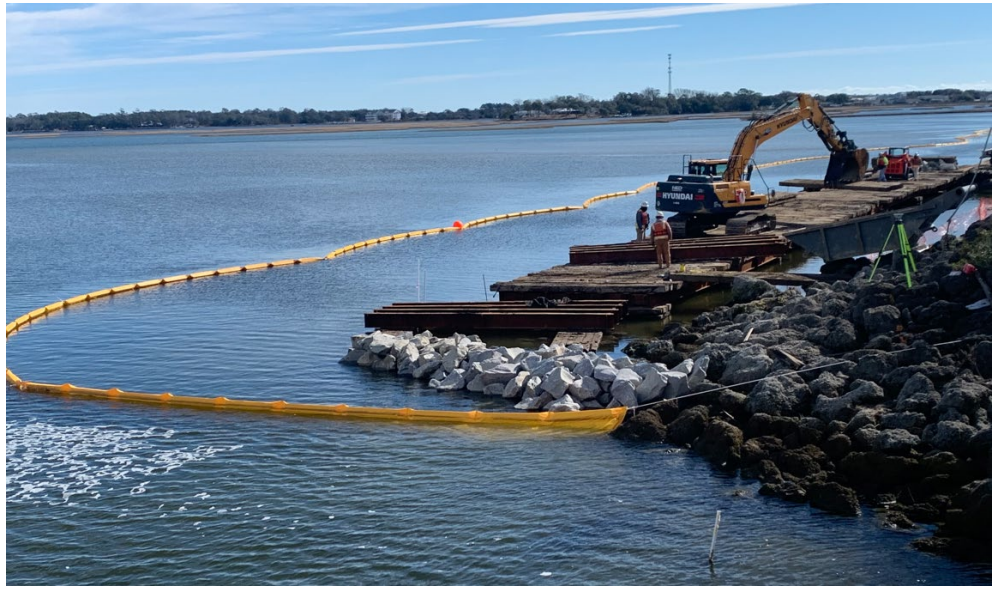
1. Risk Assessments
2. Resilient Context Design
3. Integration into Project Delivery
4. Systems Approach
5. Adapted Delivery
6. Next Generation Design Tools
7. Resilient Projects
   - I-95/I-26
   - Alligator River Bridge
   - R-2553 - Kinston Bypass
   - US-70 – James City

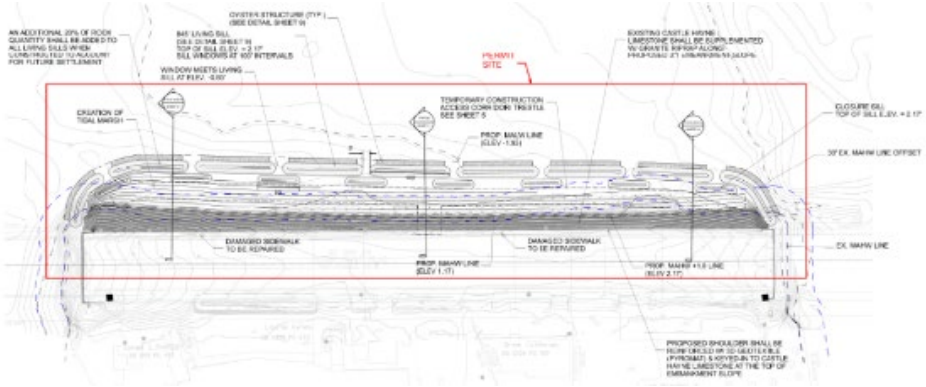




NC 24 Causeway Hardening – Nature Based Design

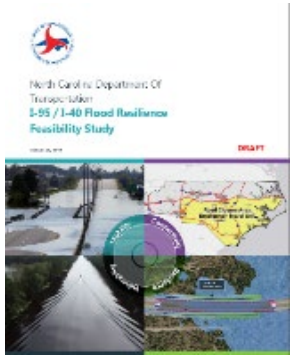
- NFWF Grant in partnership w/ NCCF
- Protect NC 24 from Overtopping and Wave Forces
- Living Shoreline
- Military Corridor
- Complex Hydrodynamic Modeling
- Modeling for wave height and surge

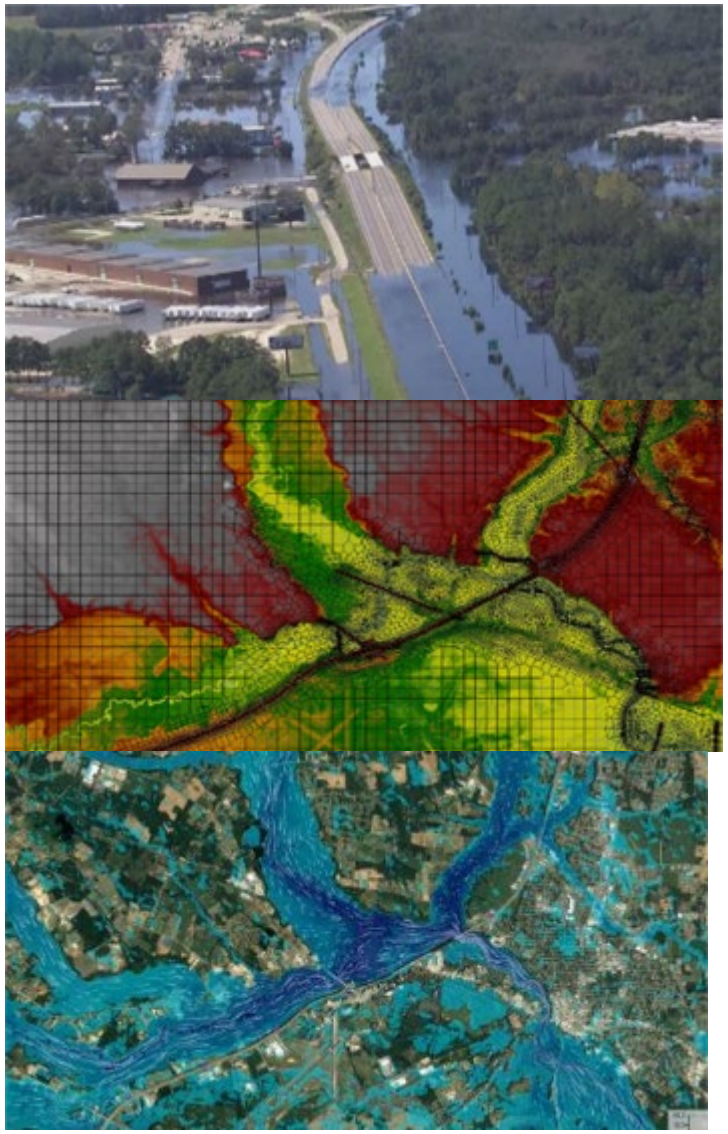




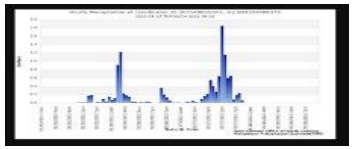
Adaptive Resilient Design – I-95

- I-95/I-40 Flood Resilience Feasibility Study - Directed by the Secretary
- Pre-Design Modeling Provided Performance Criteria for Design-Build Teams
- Climate Adaptation Tested – NCHRP 15-61
- Flood Resilient I-95
- Adopting approach on Kinston By-Pass

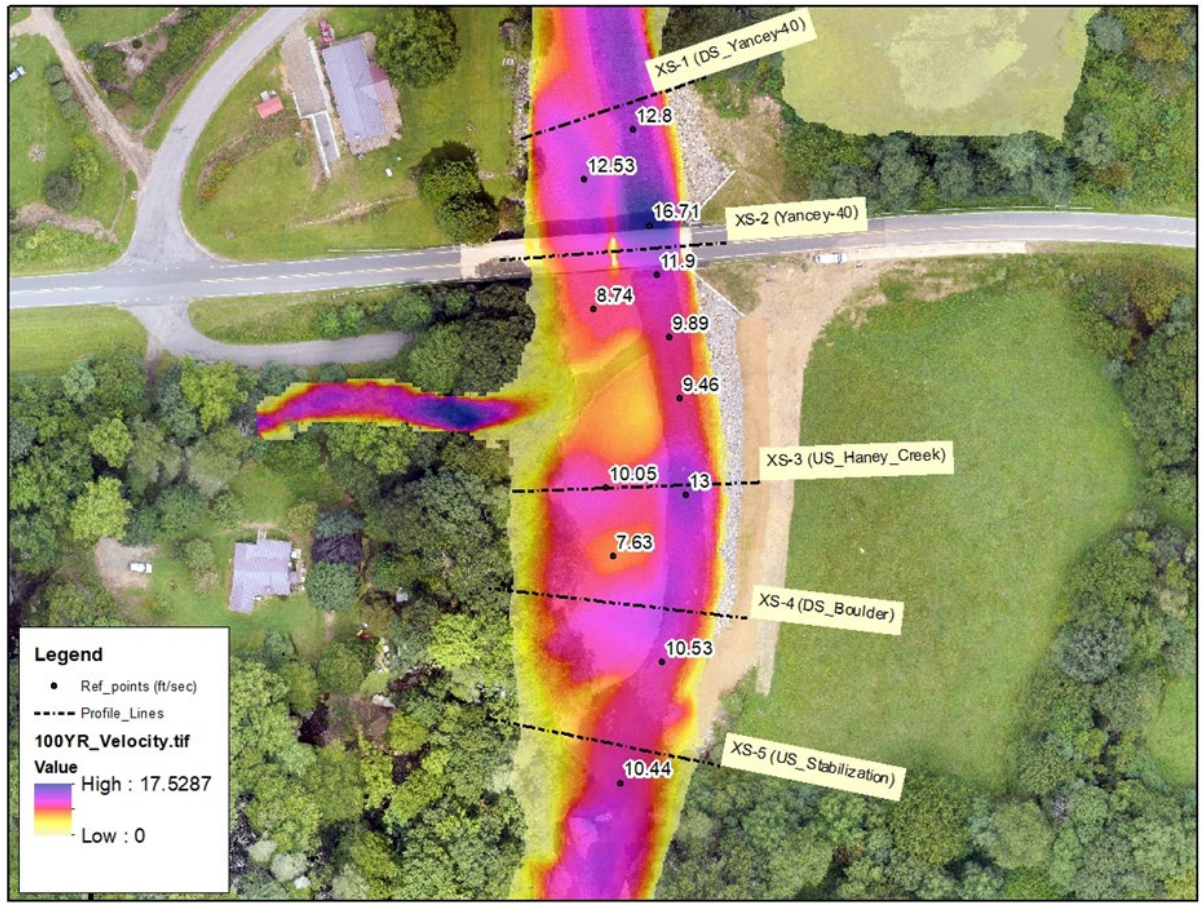


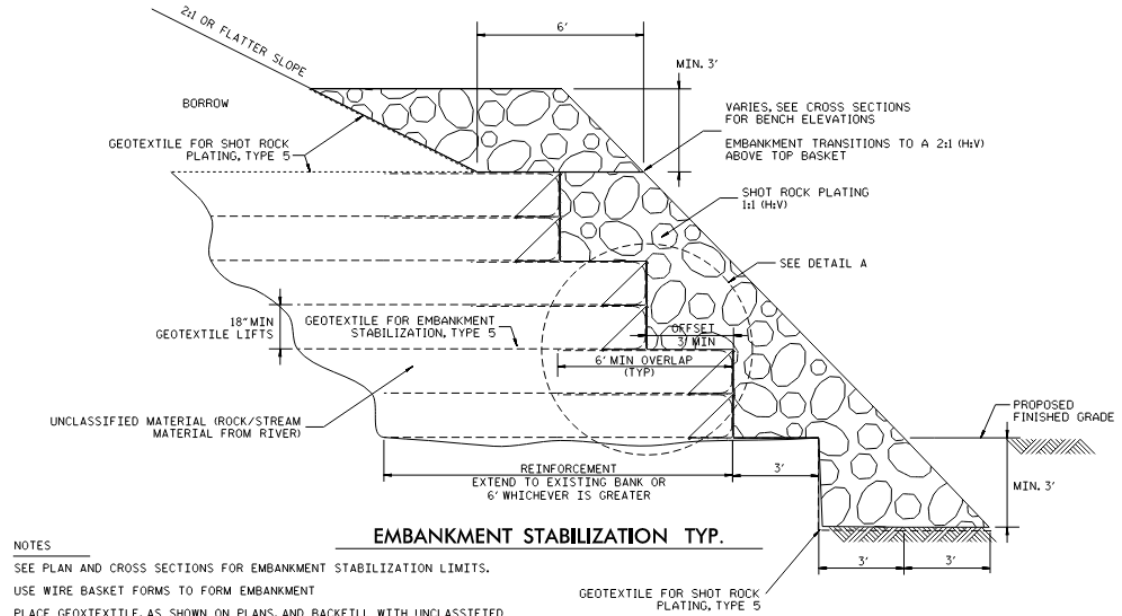


Improving Risk Management and Resilience
NC 197 -Yancey 40 – Tropical Depression Fred



Improving Risk Management and Resilience
NC 197 -Yancey 40





EMBANKMENT STABILIZATION TYP.

NOTES

SEE PLAN AND CROSS SECTIONS FOR EMBANKMENT STABILIZATION LIMITS.

USE WIRE BASKET FORMS TO FORM EMBANKMENT

PLACE GEOXTEXTILE, AS SHOWN ON PLANS, AND BACKFILL WITH UNCLASSIFIED MATERIAL CONSISTING OF ROCK/SAND FROM STREAM BED WITH MAXIMUM AGGREGATE SIZE OF 12 INCHES.

AT THE TOP OF EACH LIFT, WRAP GEOTEXTILE BACK 6 FEET

ONCE THE EMBANKMENT HAS BEEN CONSTRUCTED, PLACE SHOT ROCK PLATING WITH THE LARGER ROCKS CLOSER TO STREAM SIDE.

SHOT ROCK PLATING TO CONSIST OF THE FOLLOWING APPROXIMATE SIZES:

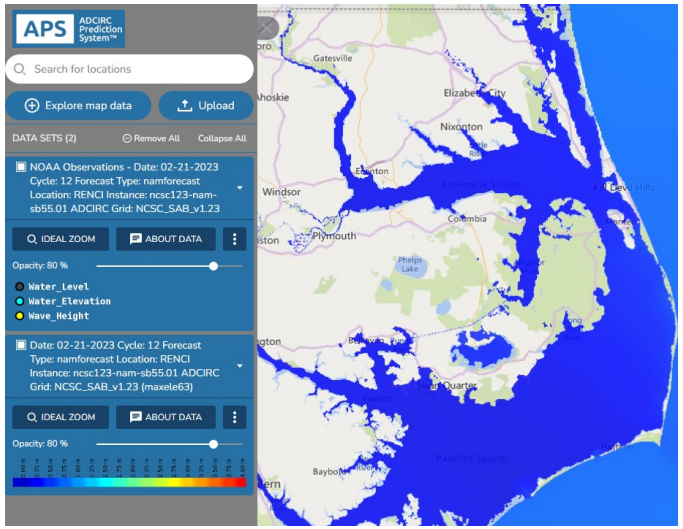
60% SHOT ROCK 3-4 FT ALONG ONE AXIS
30% 6"-18" ALONG ONE AXIS
10% 2"-6" ALONG ONE AXIS

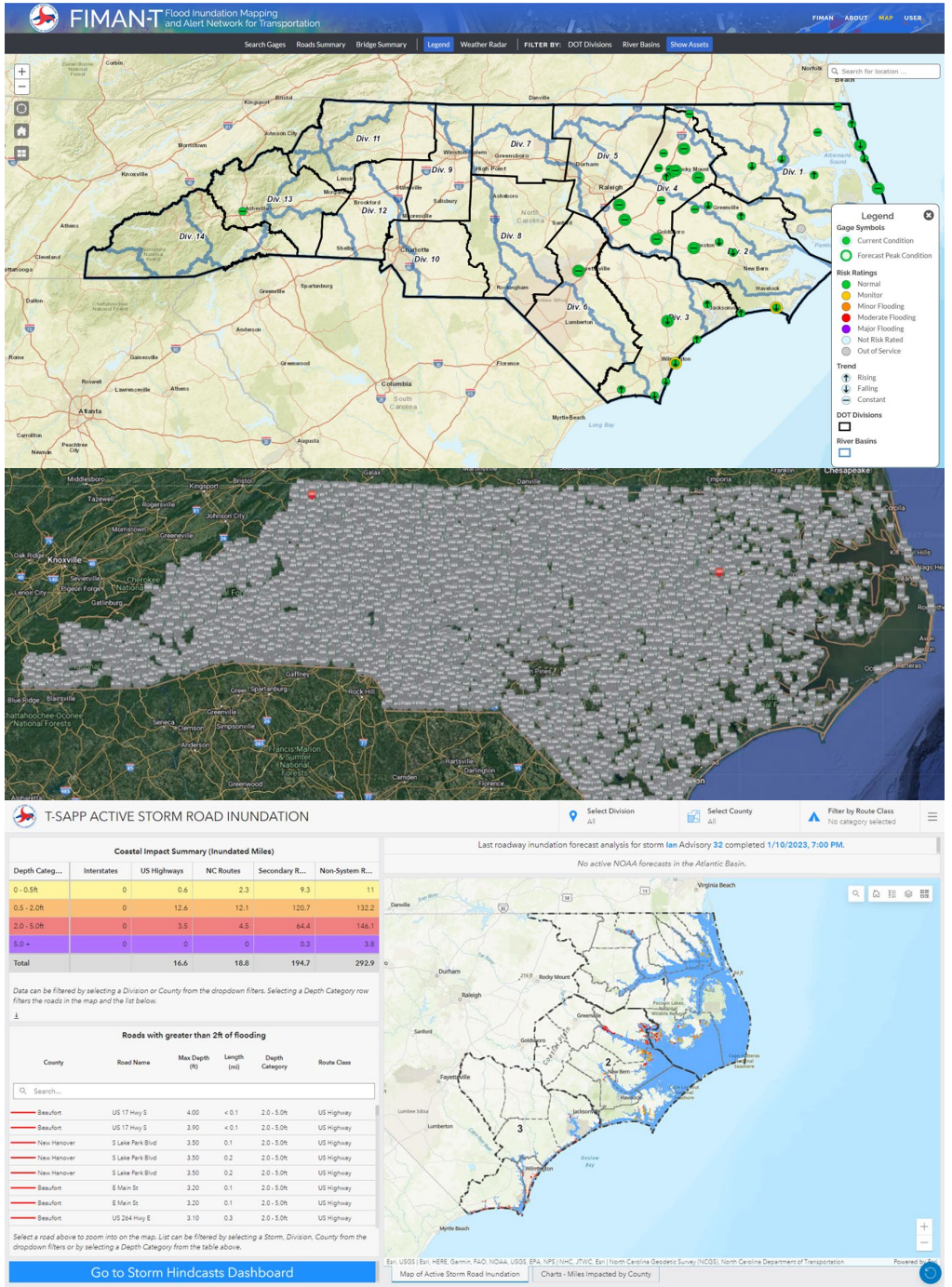
Improving Risk Management and Resilience
NC 197 -Yancey 40

Practice and Products Operations

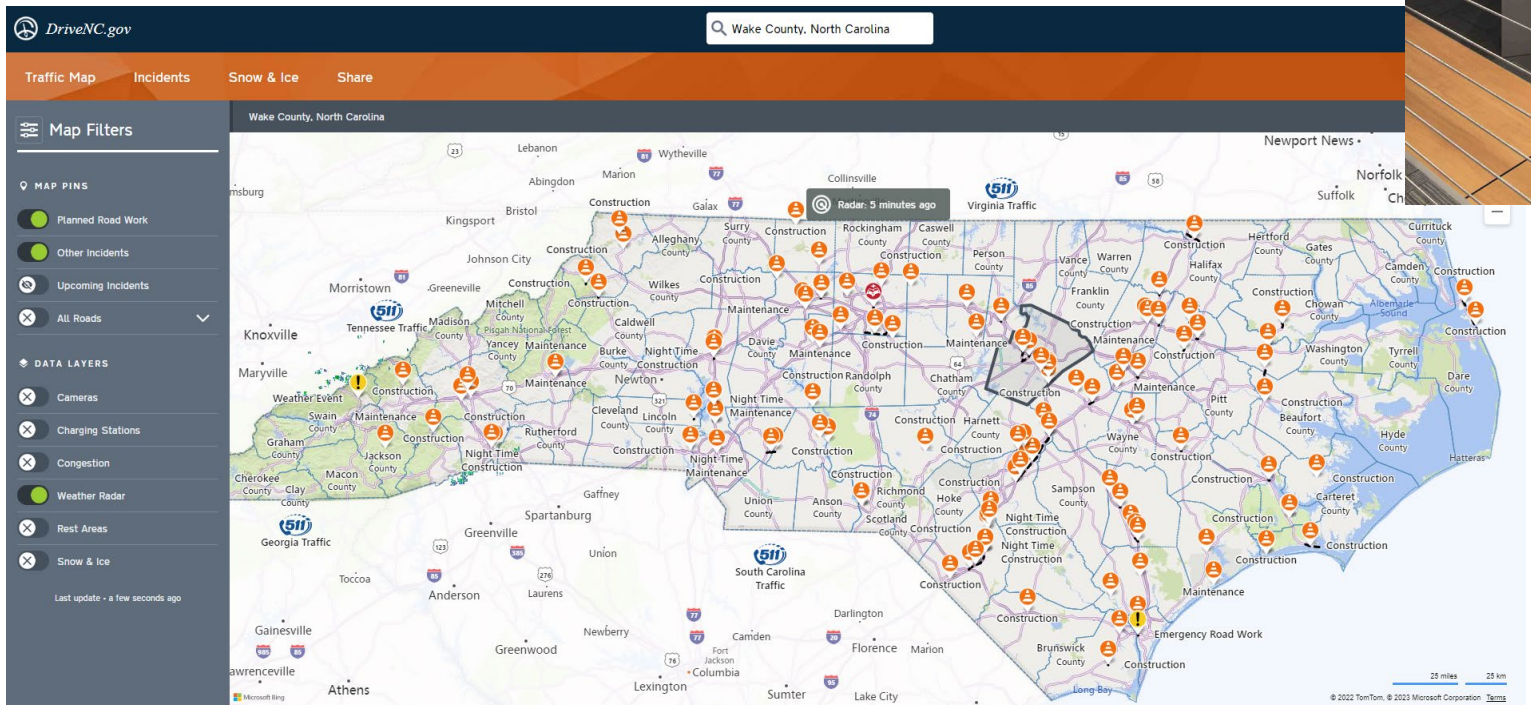
Flood Warning Tools

- FIMAN-T
- BridgeWatch
- T-SAPP (Transportation Surge Analysis Predictive Program





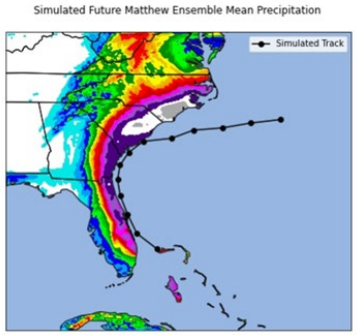
Traffic Systems Operations Support

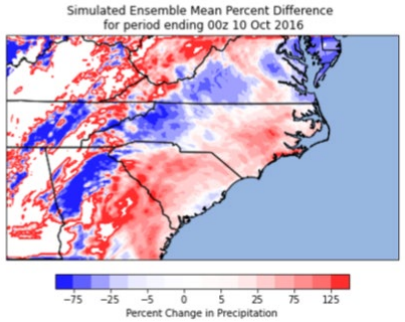


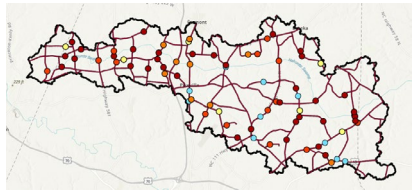
Practice and Products Research

RESEARCH

- NC Future Precipitation for Resilient Design 2020-57
- IDF Rainfall Update – Atlas-14, Volume 13
- NCSU Flood Abatement Studies and predicting roadway washouts– Resilient Routes 2018-32, 2021-03
- NCHRP 51-10 – Practices for Integrated Flood Prediction and Response Systems
- NCHRP – Climate Change for Hydrologic and Coastal Design (NCHRP 15-61/20-44(23))
- Sea Level Rise Assessments

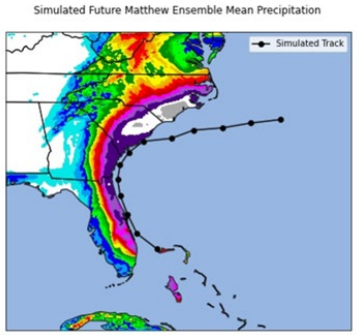


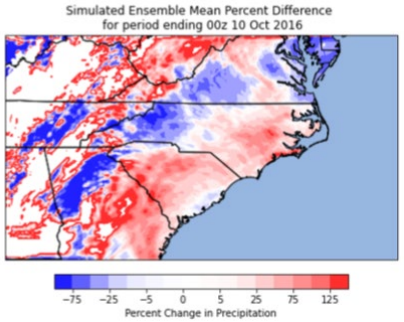


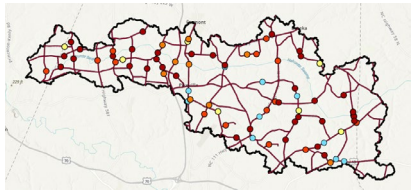


RESEARCH

- Improving Resilience of Transportation Infrastructure to Hurricanes 2021-08
- Predicting Resilience and Reducing Failure of SCMs to Extreme Storm Events 2023-15
- Geo-FRIT: A Web-based Geospatial Analytics Tool for Quantifying Freight Risk and Resilience in Transportation 2022-18
- Evaluation of Road Network Resilience to Natural Hazards using Network Analysis 2023-16
- Natural Hazards Vulnerability Assessment of the NCDOT Ferry Division Assets 2023-14



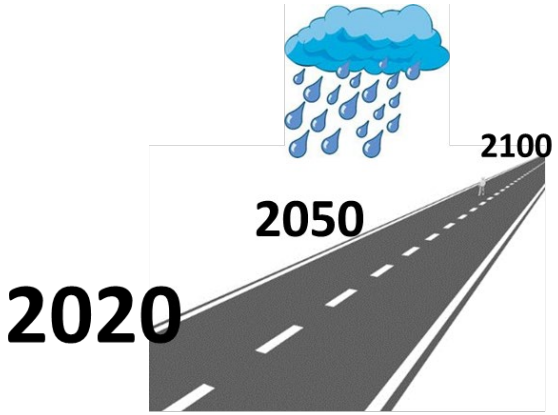




FUTURE RAINFALL DETERMINATION

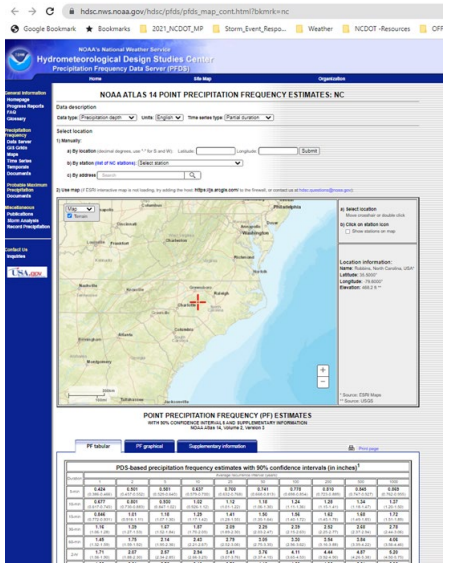
1. Develop IDF and DDF Curves that address Non-Stationarity.

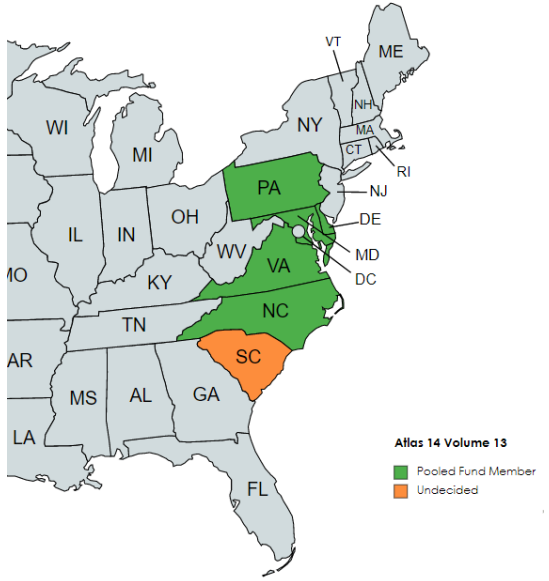
2. Develop an understanding of the magnitude of future extreme events.



Historic Rainfall Update

- Atlas 14 Volume 13 (six states)
- Atlas 15 – Entire US
  - Non-stationarity/Climate Adaptation





Collaboration between engineers and climate scientists will be a critical step towards determining the best options for adaptation and resilience.

NC DOT is partnering with a team of climate scientists at NCSU to consider how **rainfall extremes** may change in a **warmer climate**.

1. NCSU is focused on **unique comparison** of best available climate model data **to update Intensity, Duration, and Frequency (IDF) Curves**.

2. NCSU is using atmospheric models to develop **future design storms (Hurricanes)** for **stress testing** NC roads and highways

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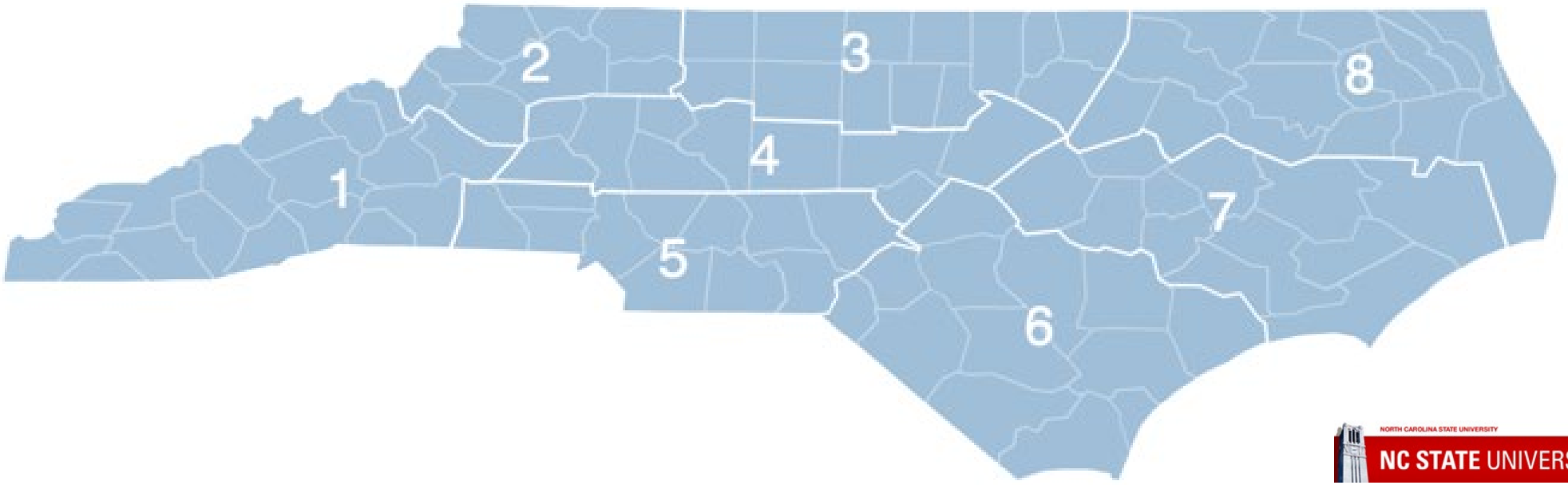
Develop IDF curves for all points and aggregate to climate divisions to better estimate the regional signal for each downscaled GCM and method

Mid-century & End-century
(2041-2069; 2070-2099)

Return Periods
(2yr, 10yr, 25yr, 50yr, 100yr)



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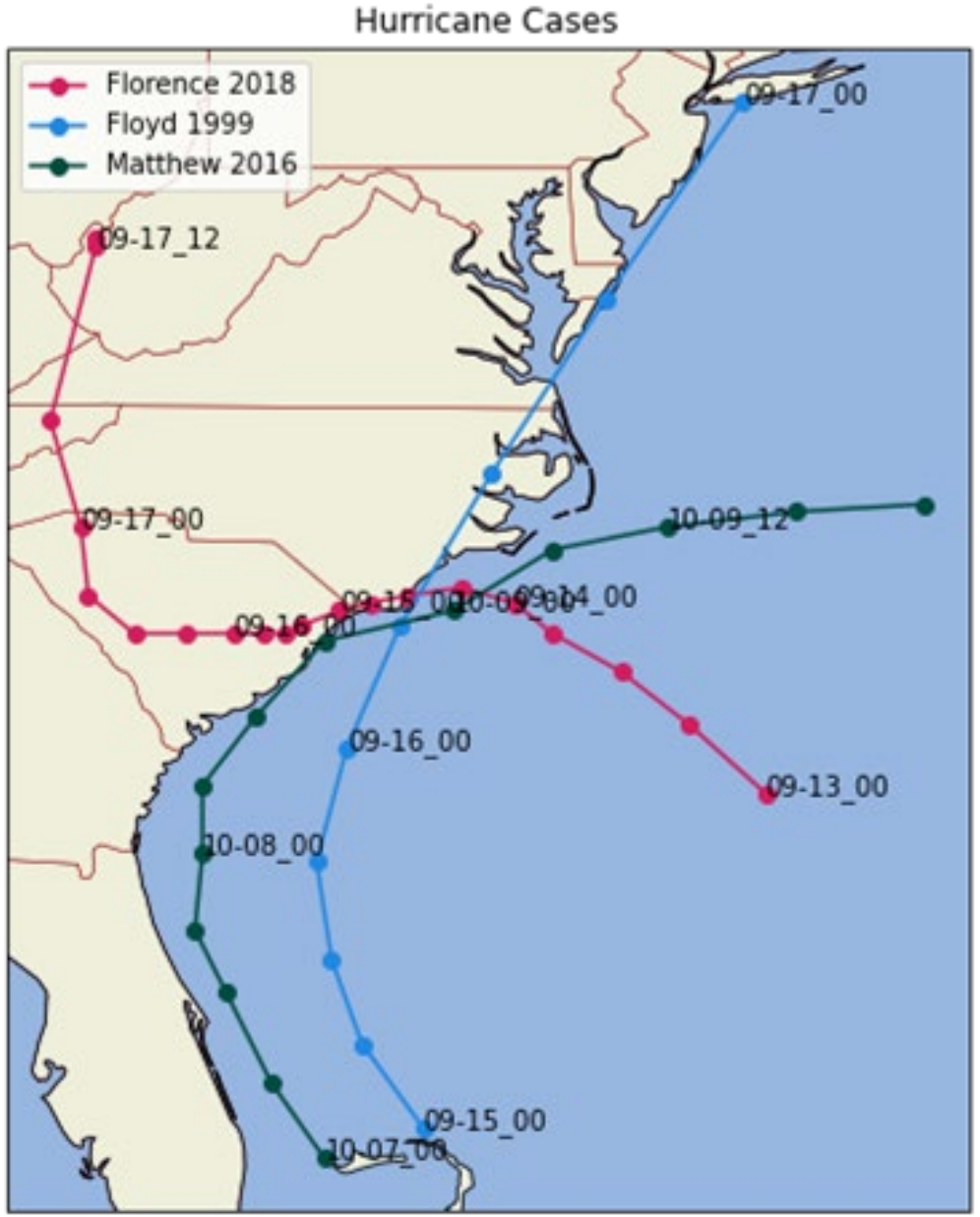
Pseudo Global Warming Models- WRF

- Goal: Examine a variety of events
  - 3 very impactful hurricanes for eastern NC
    - high rainfall totals, flooded/washed out roads
- Diverse tracks and precipitation forcing
  - Tracks:
    - one stalled (Florence)
    - one moved very quickly (Floyd)
    - one only grazed NC (Matthew)
  - Storm characteristics
    - purely tropical (Florence)
    - Midlatitude interactions (Floyd, Matthew)

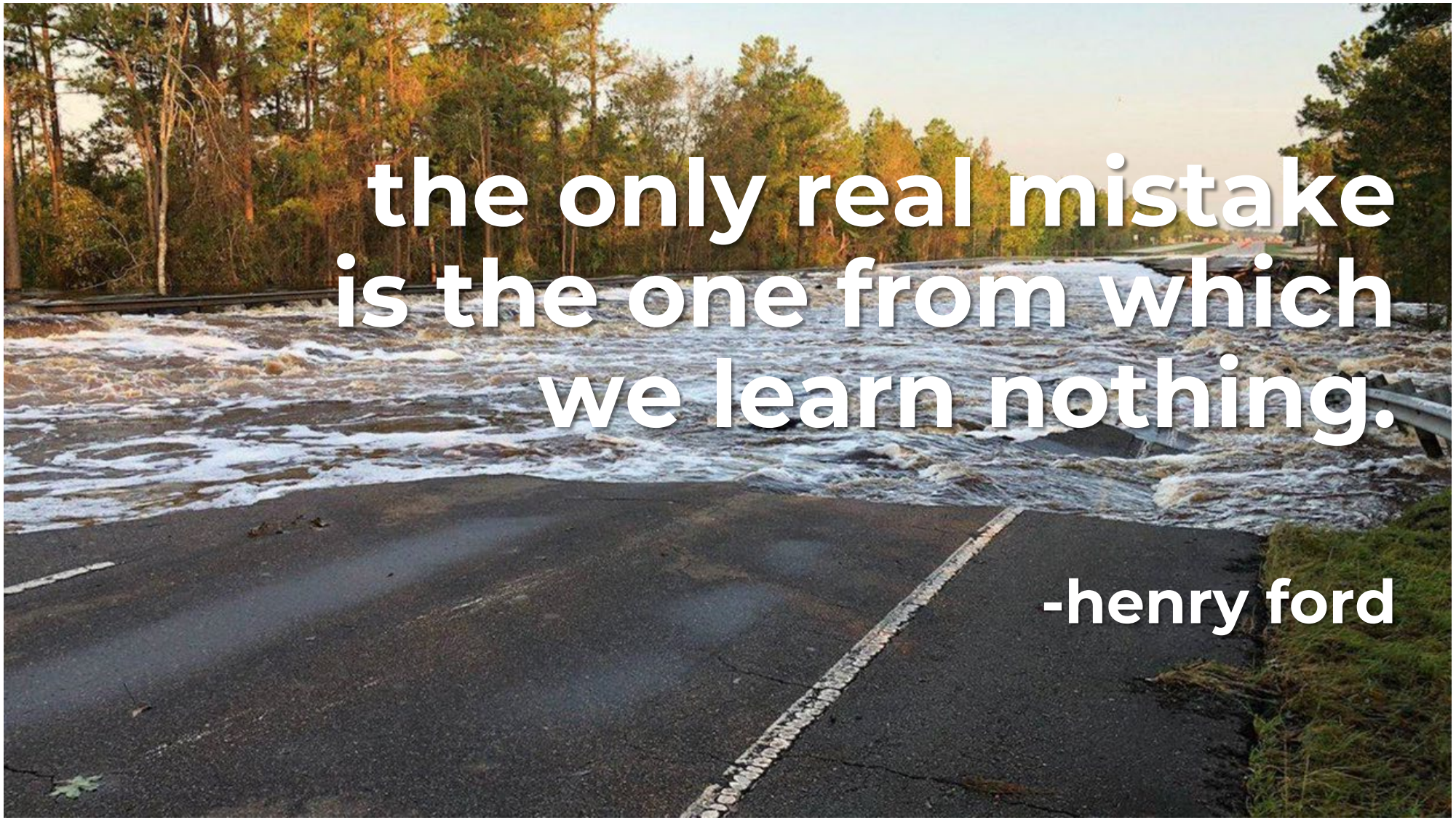


Next Steps

Next Steps

1. Secure Sustainable Funding for the Resilience Program
2. Pursue IIJA grant funding opportunities
3. Continue to incorporate resilience into Department activities
4. Continue to coordinate with other cabinet agencies, federal agencies and communities on federal and state resilience activities
5. Knowledge Share

Discussion:


the only real mistake
is the one from which
we learn nothing.
-henry ford

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