FHWA Highway Resilience Pilots

USACE Interagency Flood Risk Management Seminar
Special Hazards in Flood Risk Management – Hurricanes/Coastal Flooding
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How many miles of coastal roads are there in the US?

(Coastal roads defined as roads at least occasionally exposed to coastal waves and surge. Includes estuaries, not just open coast.)

a. 1,000  
b. 20,000  
c. 60,000  
d. 100,000
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Source: FHWA, HEC-25: Highways in the Coastal Environment
Question

How many vehicle hours of delay does nuisance flooding cause annually on the U.S. East Coast? ("Nuisance" or "sunny day" flooding refers to flooding from tides)

a. 10,000  
b. 200,000  
c. 3,000,000  
d. 100,000,000

King tide flooding on Dock Street in Annapolis, Maryland, on December 21, 2012. Photo credit: Amy McGovern (CC BY 2.0) via NCA (2018)
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a. 10,000  
b. 200,000  
c. 600,000  
d. 100,000,000  
e. 160,000,000

King tide flooding on Dock Street in Annapolis, Maryland, on December 21, 2012. Photo credit: Amy McGovern (CC BY 2.0) via NCA (2018)
Coastal Impacts

Three breaches in NC12 after Hurricane Irene. Credit: Tom MacKenzie, FWS
About the Federal Highway Administration (FHWA)

- Part of US Department of Transportation
- Provides $44 billion in funding for highways annually
- Mostly distributed via formula to states
- Almost all roads in US owned by state and local government (even Interstate)
- State and local role: plan, design, construct, maintain, operate highways
- FHWA role: funding, leadership, oversight, research, technical assistance
Extreme Weather Resilience Related Regulations

- Risk-based **asset management** plans must address risks associated with current and future environmental conditions (23 CFR 515)
- Assets requiring repeated repair require **evaluation of alternatives** (23 CFR 667)
- State and metropolitan **transportation planning** should now include resilience as a planning factor (23 USC 134, 23 CFR 450)
- **Metropolitan transportation plans** shall include an assessment of capital investment and other strategies to… reduce the vulnerability of the existing transportation infrastructure to natural disasters (23 CFR 450.324(f)(7))
Integrating Resilience

Planning
- Asset Management Plans
- Long Range Transportation Plans

Project Level
- Project development
- Environmental Processes
- Engineering
- Design

Operations & Maintenance
- Cleaning drainage
- Road weather management
- Emergency Response

Credit: WSDOT
Photo credit: CO DOT
Photo credit: DEL DOT
MassDOT 2012-2014 Pilot

- Assess vulnerability of Central Artery/Tunnel System to sea level rise and extreme storm events.
- Investigate options to reduce identified vulnerabilities.
Boston Harbor Flood Risk Model

- Simulated thousands of storms to get probabilities of flooding around the Central Artery/Tunnel System today and in the future
- Included medium and high sea level scenarios for 2013, 2030, and 2070/2100
- Simulated hurricanes, tropical storms, nor’easters (ADCIRC model)
- Modeled wave impacts (SWAN model)
- Included effects of tides, storm surge, wind, river discharge
- Included effects of wetlands and barrier islands

Credit: MassDOT and Google Earth
- Flooding pathways and depths. Maps of inundation extent for 0.1%, 0.2%, 1%, 2%, 5%, 10%, 20%, 50%, and 100% annual exceedance probability storms for 2013, 2030, 2070, 2100 intermediate and high scenarios.
Non-Roadway Flood Protection

Credit: MassDOT
From Programmatic Categorical Exclusion for the replacement of Bridge No. S-0019 Bryan Hall Road over Marumsco Creek, Somerset County, MD. Sept 27, 2016
Climate Change Impact Areas

Is this Project within an area potentially affected by Sea Level Change? Yes
- Mean Sea Level 2050
- Mean Sea Level 2100
- Mean High High Water 2050
- Mean High High Water 2100

Project must consider sea level change.
See attached Sea Level Change Map, if applicable

Is this a non-state Project located on State lands? No

Is this project involving construction of a new road or bridge, or reconstructing an existing road or bridge due to a storm event? No

Is this project involving construction of a new building/facility or reconstructing an existing building/facility due to a storm event? No

Notes: The hydraulics analysis determined that up to 100-year storm flooding events would not overtop the bridge. The roadway approaches to the bridge are being raised between 1 to 2.5 feet. Additional roadway improvements may be needed to address future flooding.
- Excel-based tool
- Walks a user through completing an **indicator-based** vulnerability assessment
- User makes decisions, enters information at each step
- Tool provides step-by-step guidance through the process
Maryland SHA - Early Planning Use of Vulnerability Data
Southeast Florida (Broward MPO)

Identify Assets of Interest

- Regional road network
- Tri Rail network

Calculate the Vulnerability Scores for Each Asset

1. Sensitivity
   - Bridge condition index
   - Scour rating (roads)
   - Substructure condition rating (roads)

2. Exposure
   - % of segment permanently inundated by SLR (1, 2, & 3 Ft.)
   - Current flood exposure index (storm surge and precipitation)
   - Future potential flood exposure index (storm surge and precipitation)

3. Adaptive Capacity
   - Average annual daily traffic (roads)
   - Tri-Rail ridership on segment (rail)
   - Detour length (roads)

Rank Flood Vulnerabilities by County
Southeast Florida (Broward MPO)

Final results for Miami Dade County

Credit: Broward MPO
• Provides an in-depth and structured **process** for conducting a vulnerability assessment.

• Features **examples** from assessments conducted nationwide.

• Includes links and references to related resources and tools.
Incorporate Extreme Weather Risk into Design: FHWA Resources

- **Synthesis of Approaches for Addressing Resilience in Project Development**
  - Coastal Hydraulics
  - Riverine Flooding
  - Pavements and Soils
  - Mechanical and Electrical Systems
- **HEC 25**: Highways in the Coastal Environment, V2
  - How to incorporate extreme events and sea level change into coastal highway design
  - Sea level rise, storm surge, wave action
  - 3 approaches (low, medium, high level of effort)
- **HEC 17**: Highways in the River Environment
  - Strategies ranging from sensitivity analysis with higher discharges to integrating climate model rainfall projections into local hydrologic models
- **Advanced 2D Hydraulic Modeling (CHANGE)**
Research Gap: Nature-based Solutions and Integrated Approach

- Natural features
- Nature-based features
- Hybrid approaches
Program Overview

Nature-Based Solutions for Coastal Highway Resilience

- 5 pilot projects
  - OR DOT
  - ME & NH DOTs jointly
  - MS DOT
  - DE DOT
  - US Army Corps of Engineers in NJ
- White paper
- Regional peer exchanges
- Implementation Guide
- Incorporated into HEC-25

Participants at Alabama Peer Exchange. Credit: Susan Asam
Implementation Guide

- Implement nature-based solutions to enhance the resilience of coastal highways

- Overview
  - Technical factsheets
  - Benefits and typical costs
  - Implementation considerations

Now available for download at bit.ly/FHWA_Nature
THANK YOU!

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