

# Low-Lying Roads Project

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Fall 2021- June 2023

Project funded by:  
Municipal Vulnerability Preparedness Program  
Economic Development Administration

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# Purpose and Objectives of Workshop

- **Review flood projections and impacts on roadways for the town under future scenarios**
- **Discuss vulnerable low-lying roads or other transportation infrastructure**
- **Prepare the town to address priority road segments for design and permitting**

# Agenda

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- Project Overview
- Vulnerability and Risk Assessment
- Results of Low-Lying Roads Screening
- Discussion/Breakout Groups
- Next Steps



# Low-Lying Roads



**10**  
TOWNS

|            |           |
|------------|-----------|
| Barnstable | Orleans   |
| Bourne     | Sandwich  |
| Brewster   | Truro     |
| Dennis     | Wellfleet |
| Eastham    | Yarmouth  |

Flooding vulnerability assessment of low-lying roads and transportation infrastructure

Support municipal road segment prioritization

Identify range of potential design solutions, costs

Work performed by Cape Cod Commission and Woods Hole Group

HAZARD  
Storms, SLR  
& Flooding

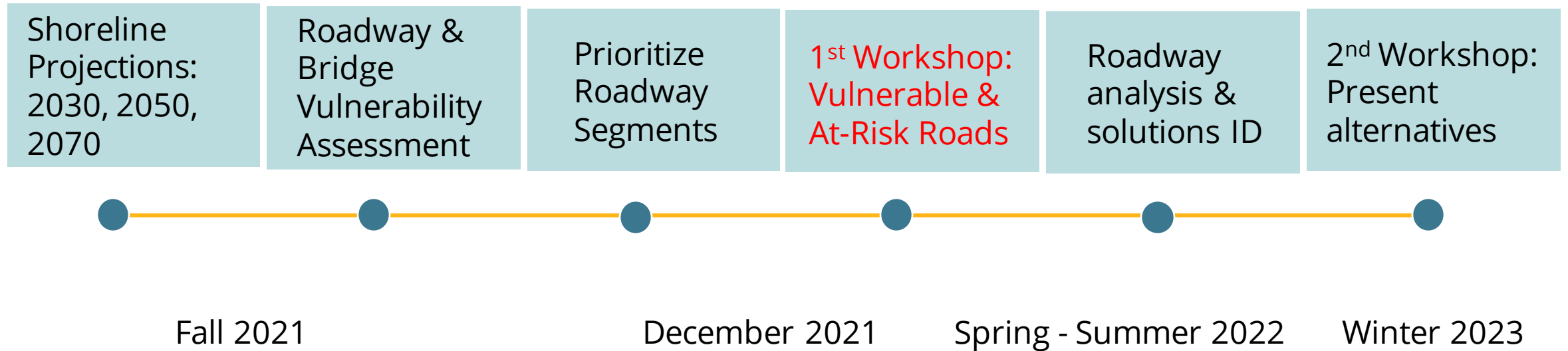


# Adaptation Strategies



- | Green Infrastructure, or Nature-based Solutions
- | Gray Infrastructure, or Traditional Engineering Structures
- | Other approaches – Managed Retreat, Abandonment

# PROJECT TIMELINE & ELEMENTS



# Questions?

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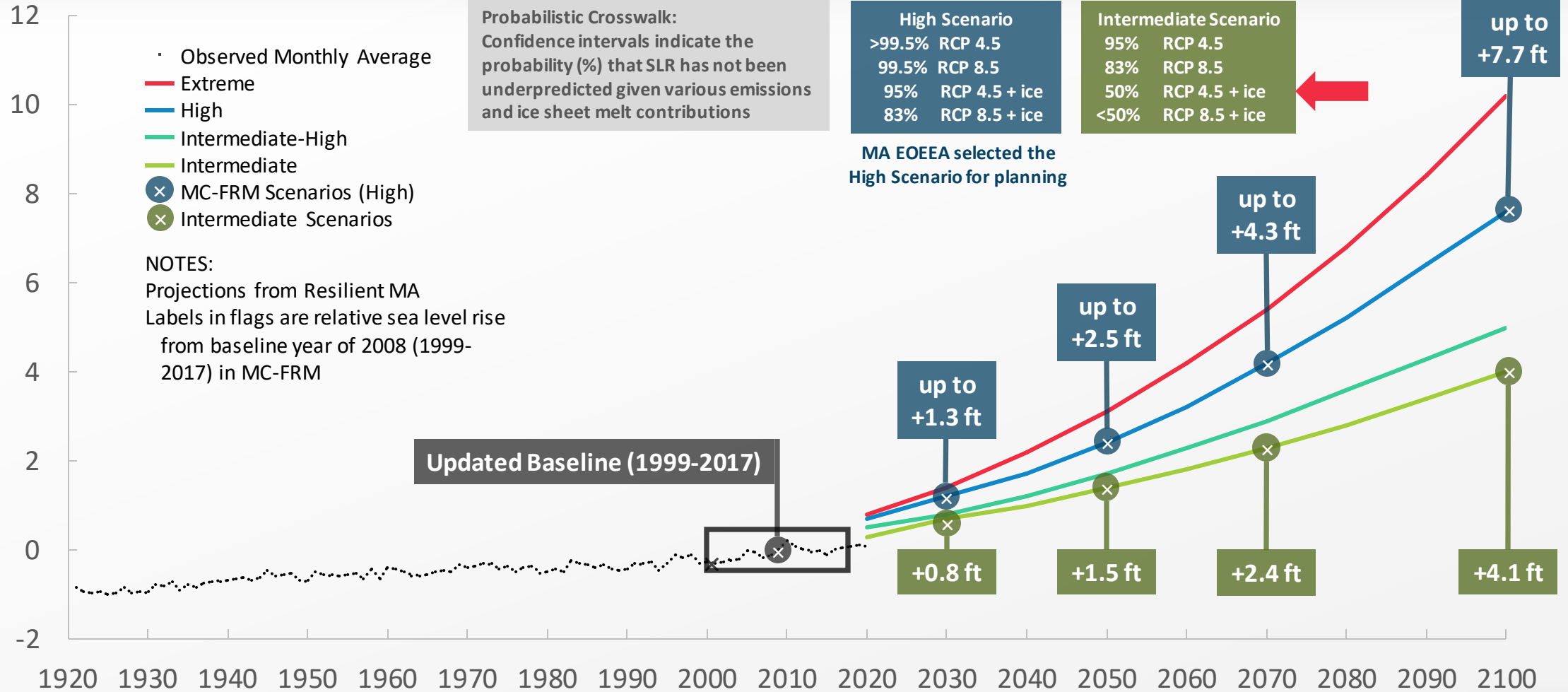
- Workshop Purpose or Objectives
- Low Lying Roads project
  - Key components
    - Vulnerability Assessment - Identify Potential Sites
    - Public Outreach and Engagement
    - Roadway Feasibility and Alternative Solutions
    - Solutions Identification
  - Timeline



# MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM NORTH (DeConto & Kopp, 2017)

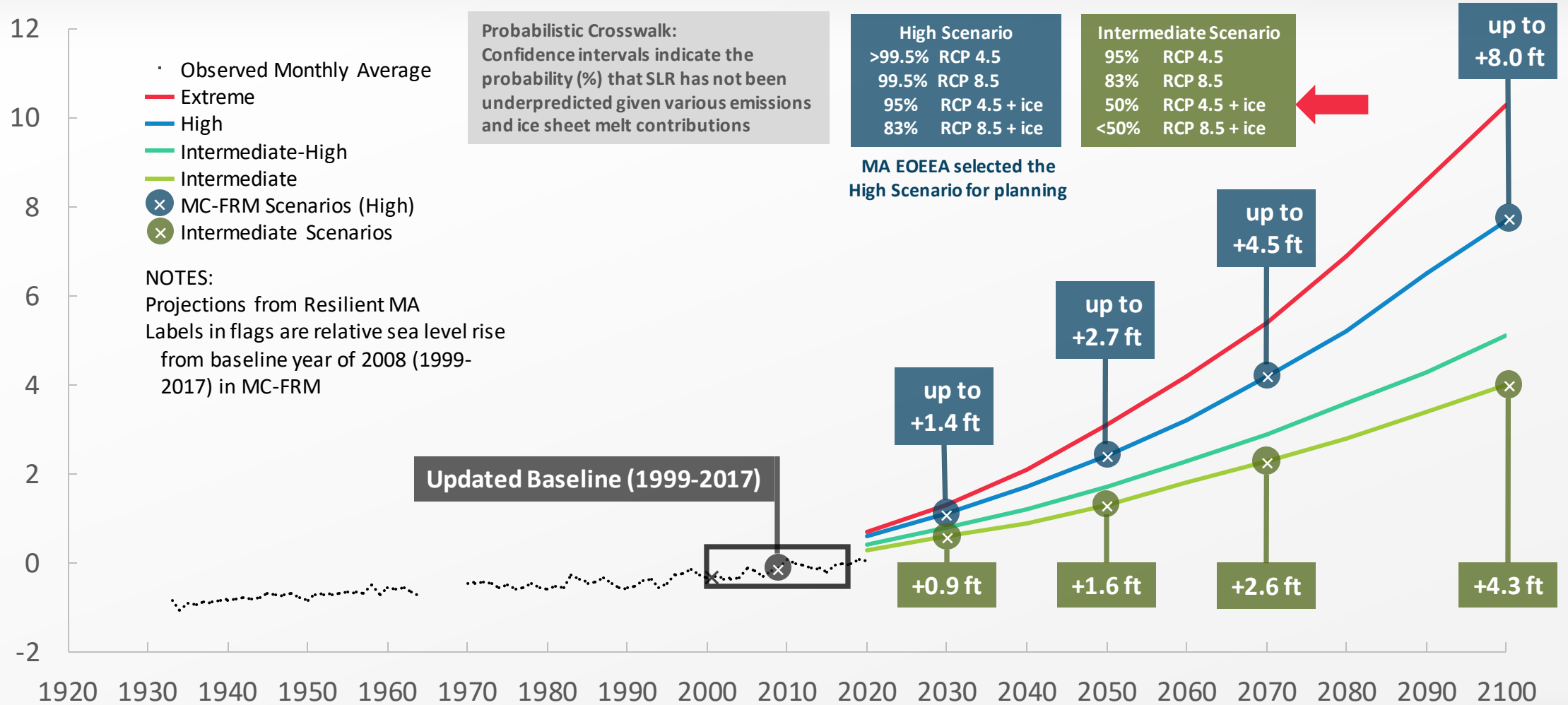
Relative Mean Sea Level (feet NAVD88)



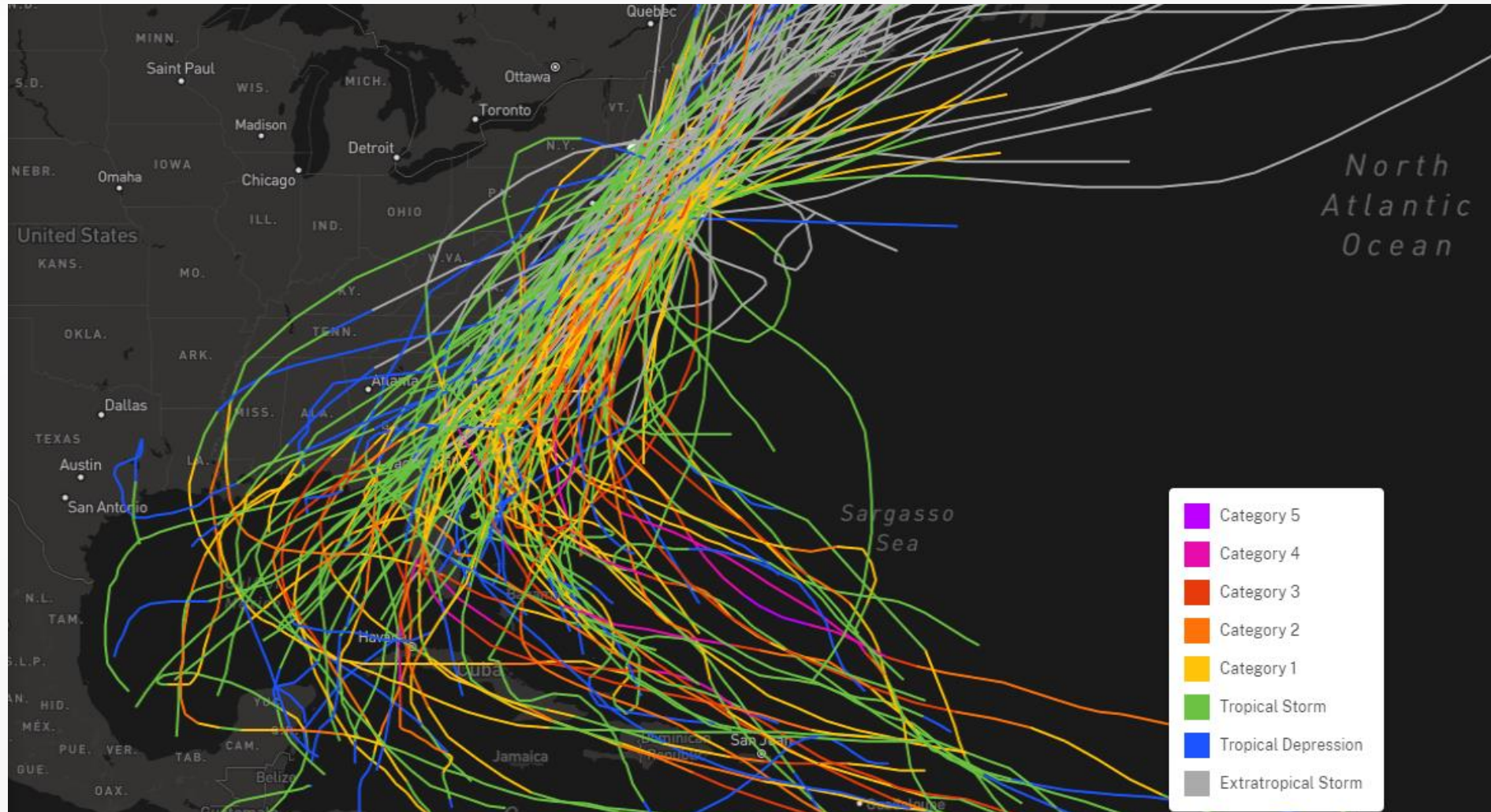
# MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM SOUTH (DeConto & Kopp, 2017)

Relative Mean Sea Level (feet NAVD88)

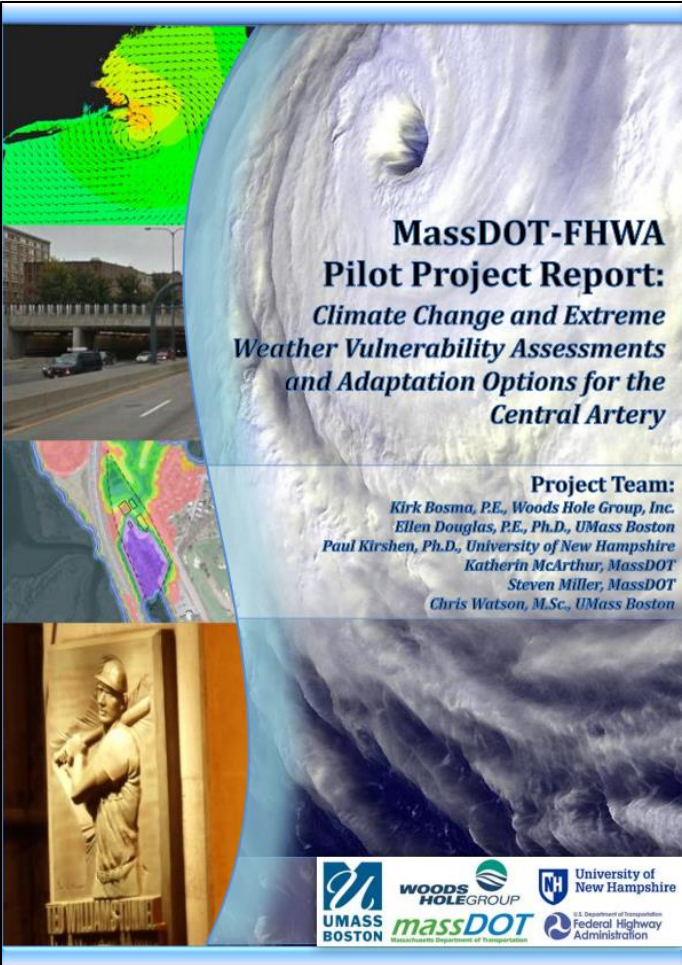


# Tropical / Extra-tropical Storms



NOAA National Ocean Service

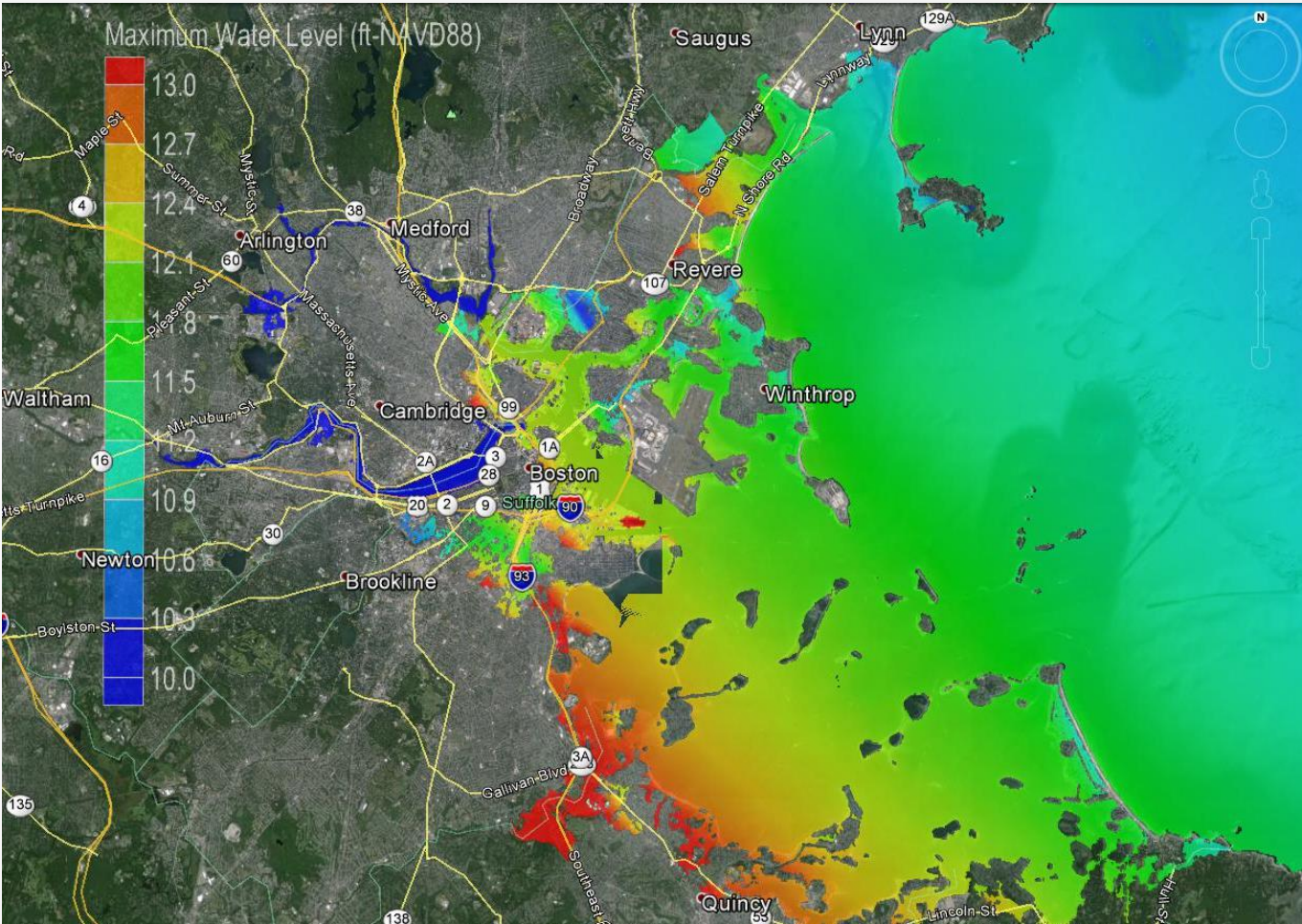
# Why Hydrodynamic Modeling? Why Probabilistic?



**MassDOT-FHWA  
Pilot Project Report:  
Climate Change and Extreme  
Weather Vulnerability Assessments  
and Adaptation Options for the  
Central Artery**

**Project Team:**  
Kirk Bosma, P.E., Woods Hole Group, Inc.  
Ellen Douglas, P.E., Ph.D., UMass Boston  
Paul Kirshen, Ph.D., University of New Hampshire  
Katherin McArthur, MassDOT  
Steven Miller, MassDOT  
Chris Watson, M.Sc., UMass Boston

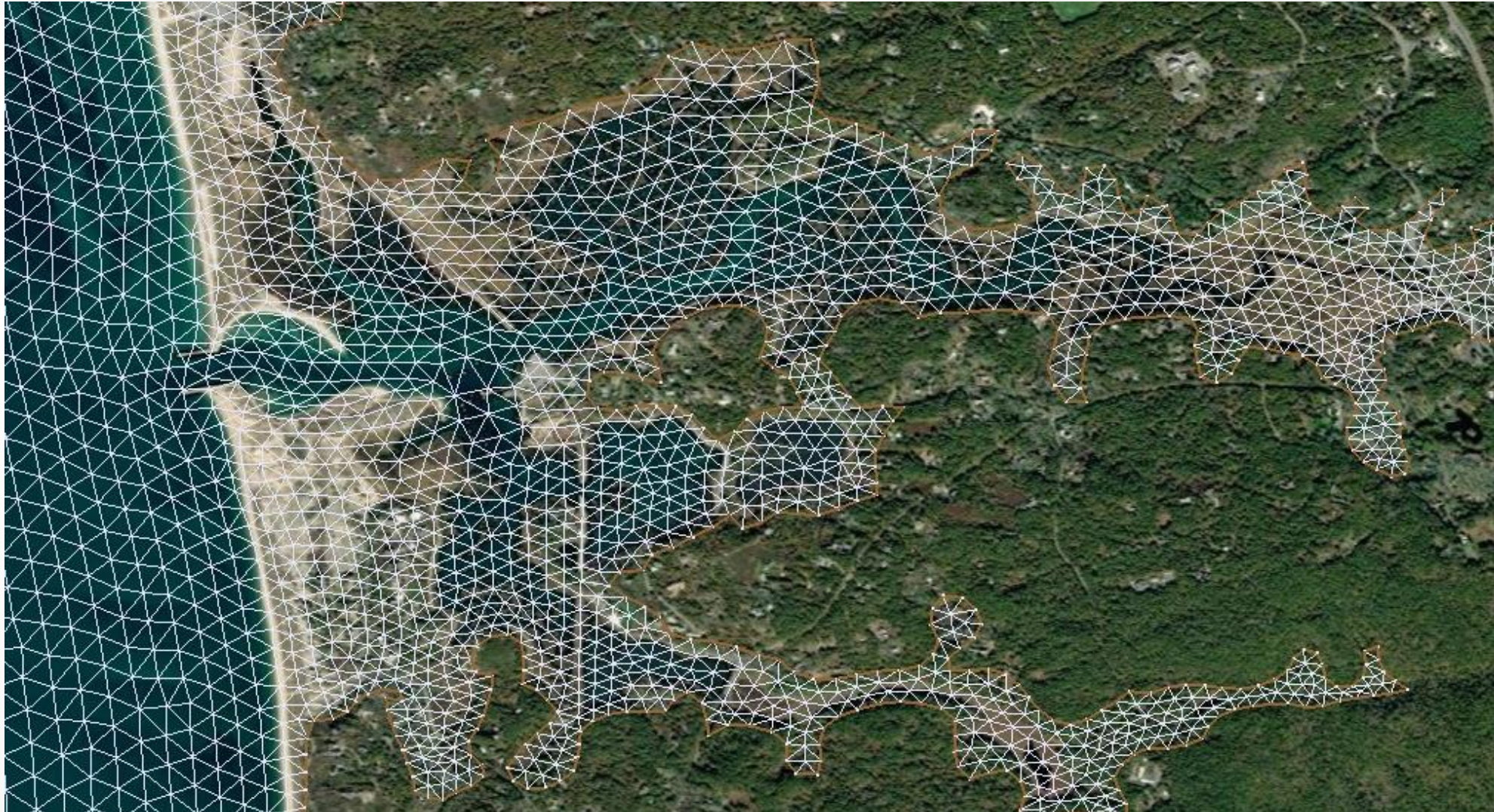
Logos for UMass Boston, Woods Hole Group, University of New Hampshire, and U.S. Department of Transportation Federal Highway Administration.



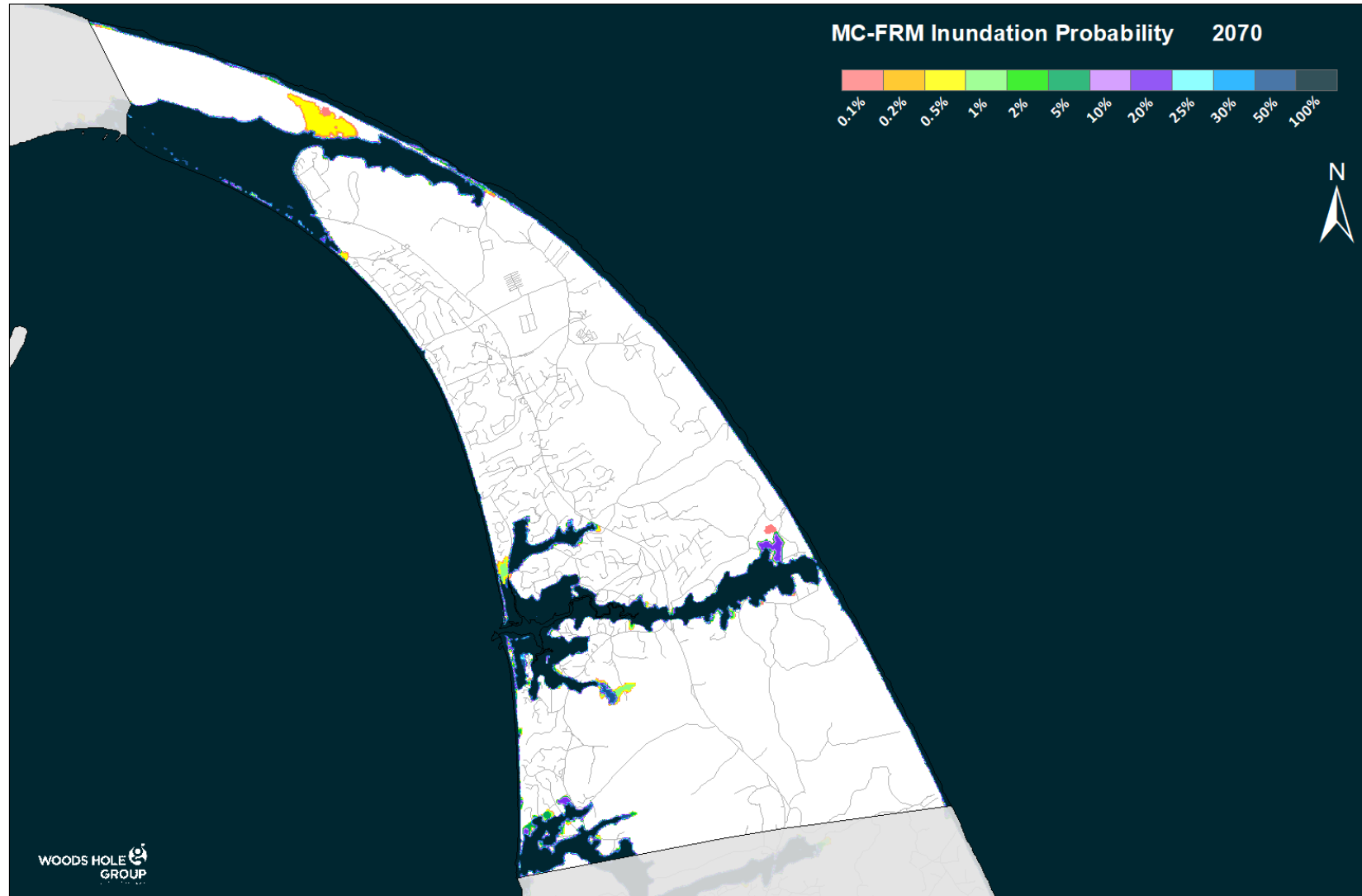
# Massachusetts Coast Flood Risk Model (MC-FRM)



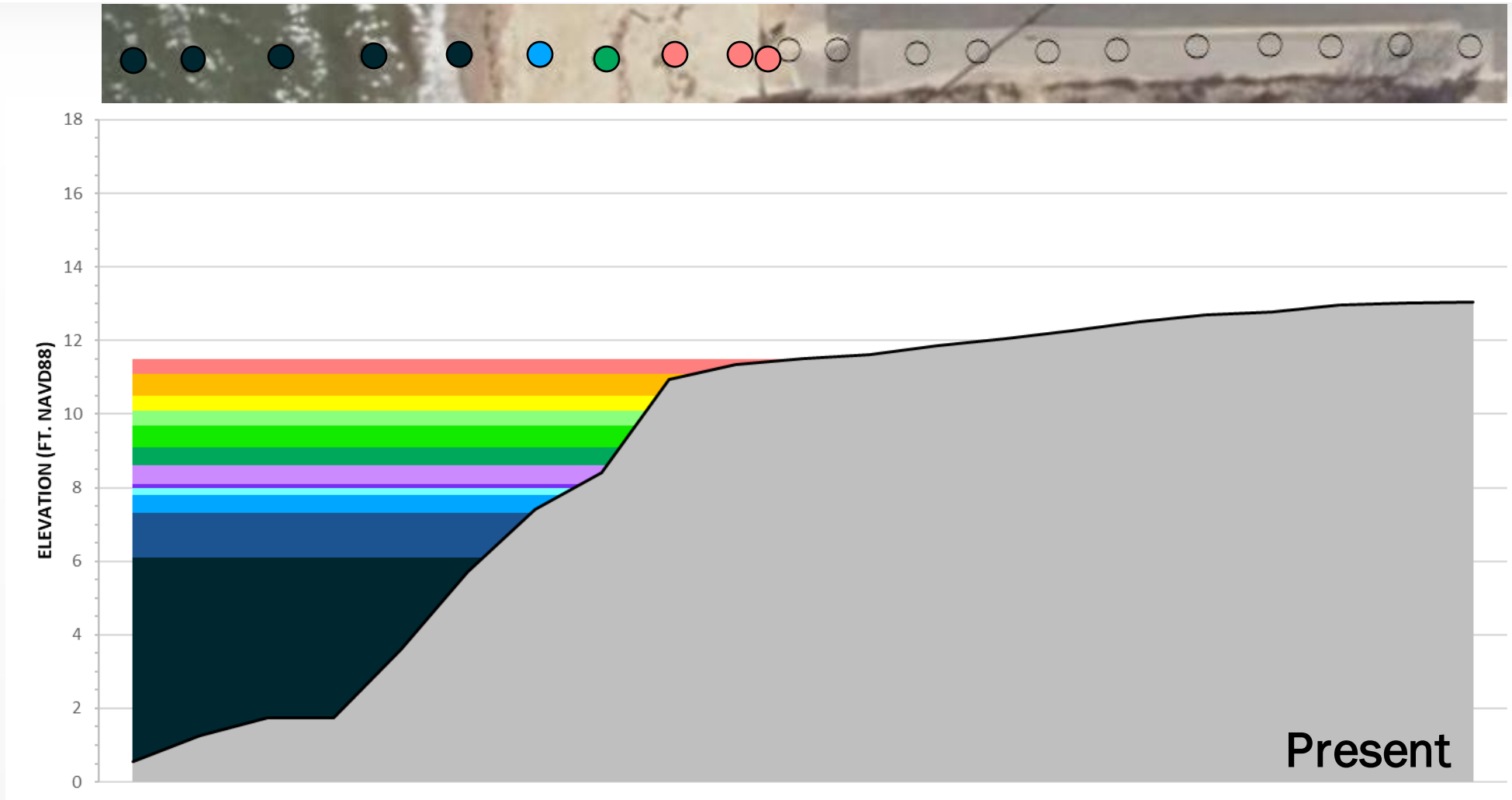
# MC-FRM Resolution - Truro



# MC-FRM Coastal Flood Exceedance Probability – Truro



# Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY



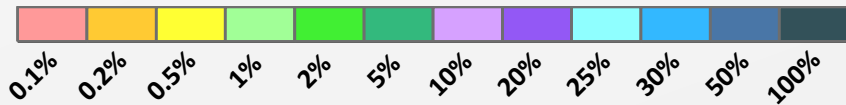


# Cape Cod Low Lying Roads Vulnerability Assessment Methods



2030

COASTAL FLOOD EXCEEDANCE PROBABILITY

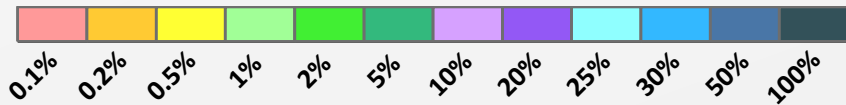


# Cape Cod Low Lying Roads Vulnerability Assessment Methods



2050

COASTAL FLOOD EXCEEDANCE PROBABILITY

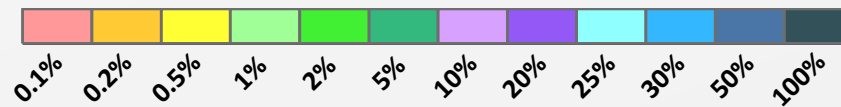


# Cape Cod Low Lying Roads Vulnerability Assessment Methods

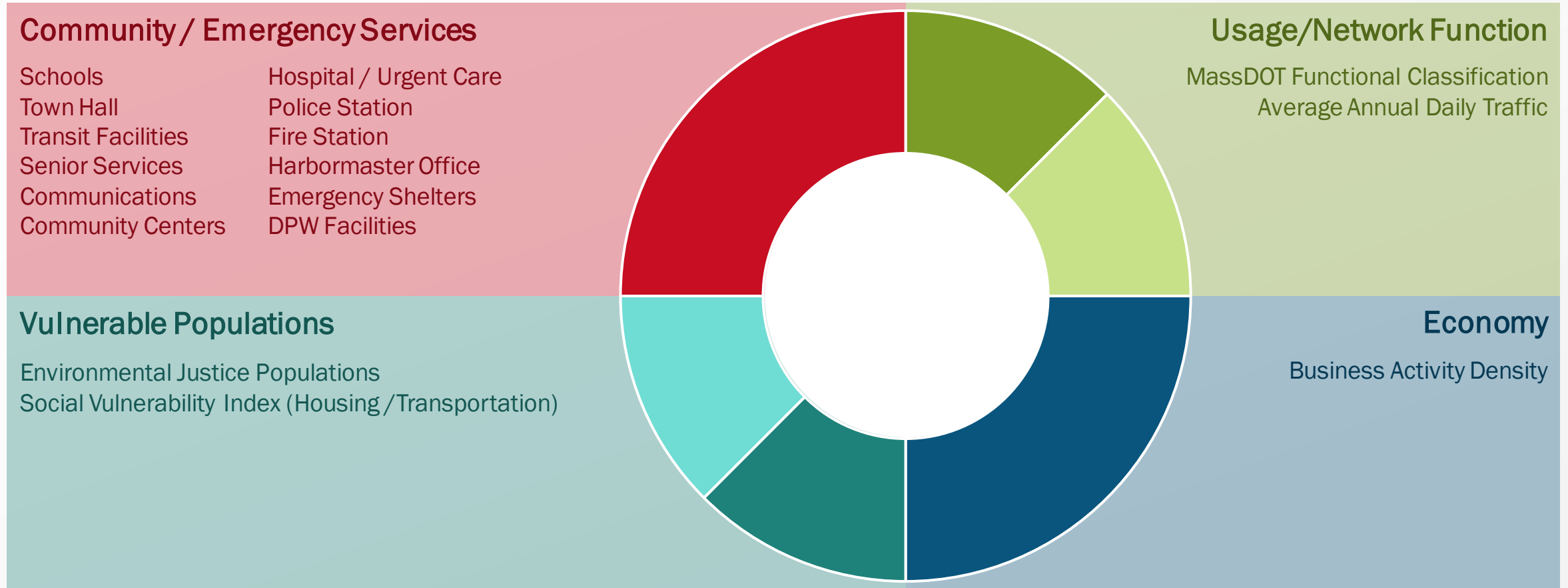


2070

COASTAL FLOOD EXCEEDANCE PROBABILITY

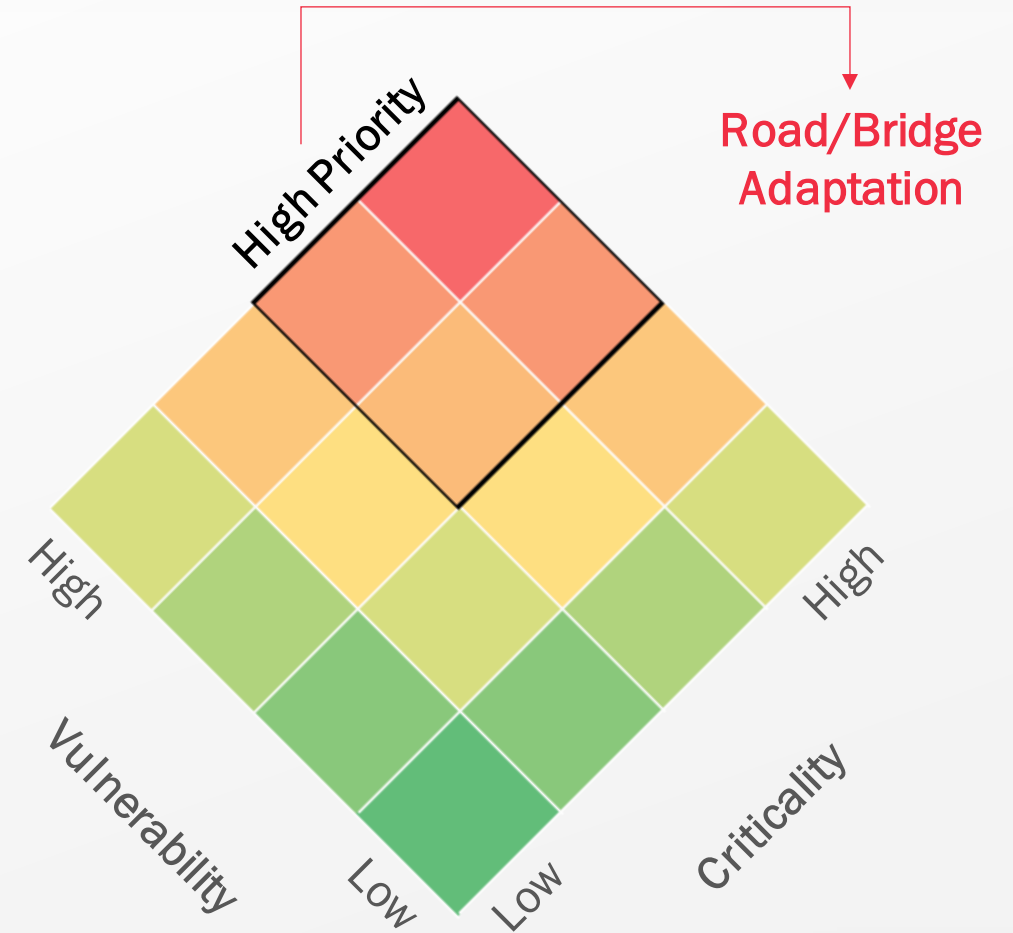


# Cape Cod Low Lying Roads Criticality Scoring Framework

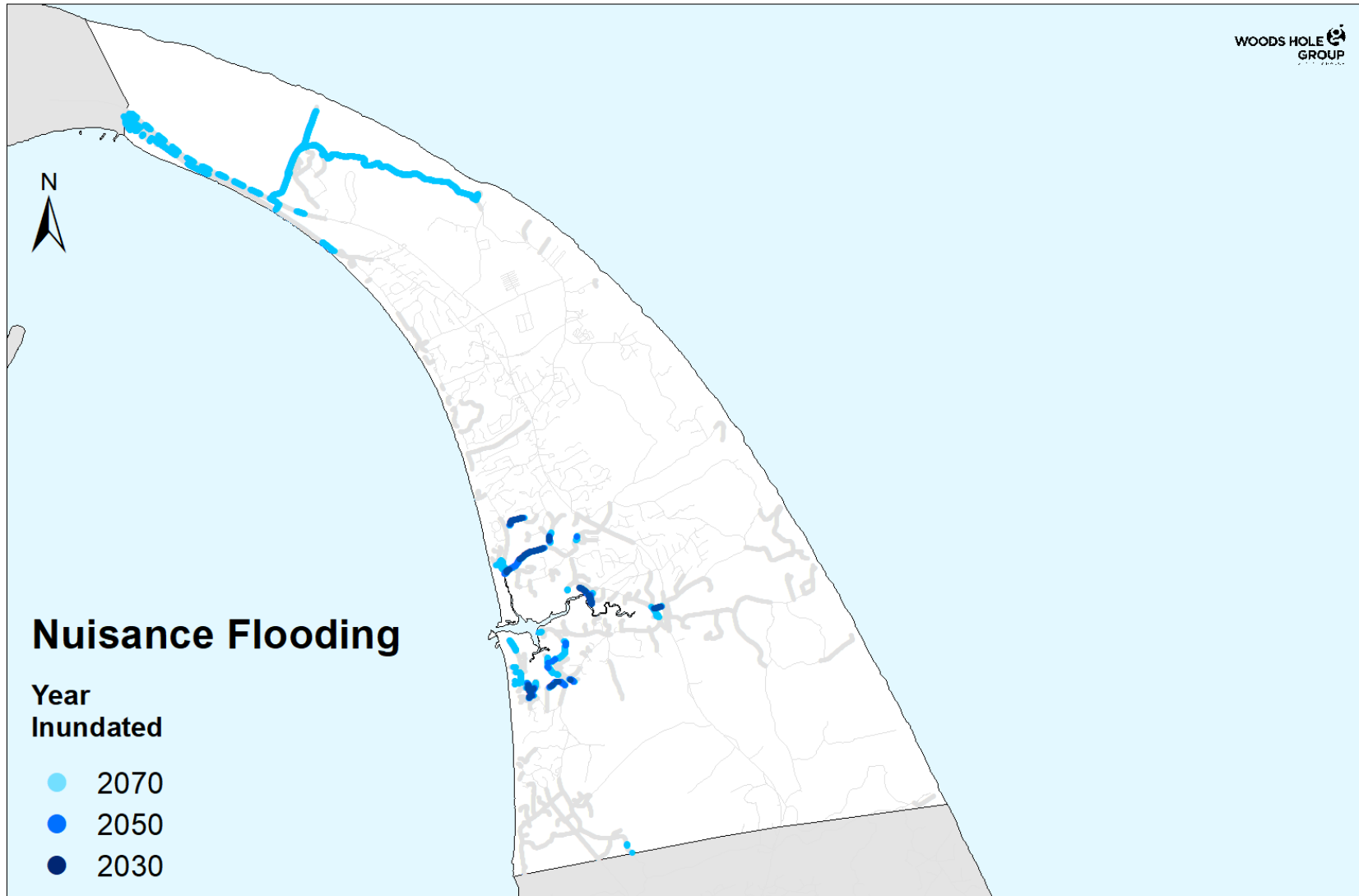


# Cape Cod Low Lying Roads Risk Assessment Approach

1. Extract roadway/bridge critical elevations (CEs)
  - › From LiDAR at 20m interval along surface
2. Compile 2030/2050/2070 MC-FRM water surface elevations (WSEs)
  - › 0.1%, 0.2%, 0.5%, 1%, 2%, 5%, 10%, 20%, 100%
3. Compare CEs to WSEs to determine vulnerability
  - › Highest probability WSE exceeding CE
4. Score road segment criticality
  - › Usage/Network Function
  - › Economy
  - › Vulnerable Populations
  - › Community and Emergency Services
5.  $\text{Probability} * \text{Criticality} = \text{Risk}$
6. Prioritize high-risk road segments for community consideration



# Low Lying Roads Nuisance Flooding (Truro)



Road Miles 2030

0.9/44.2

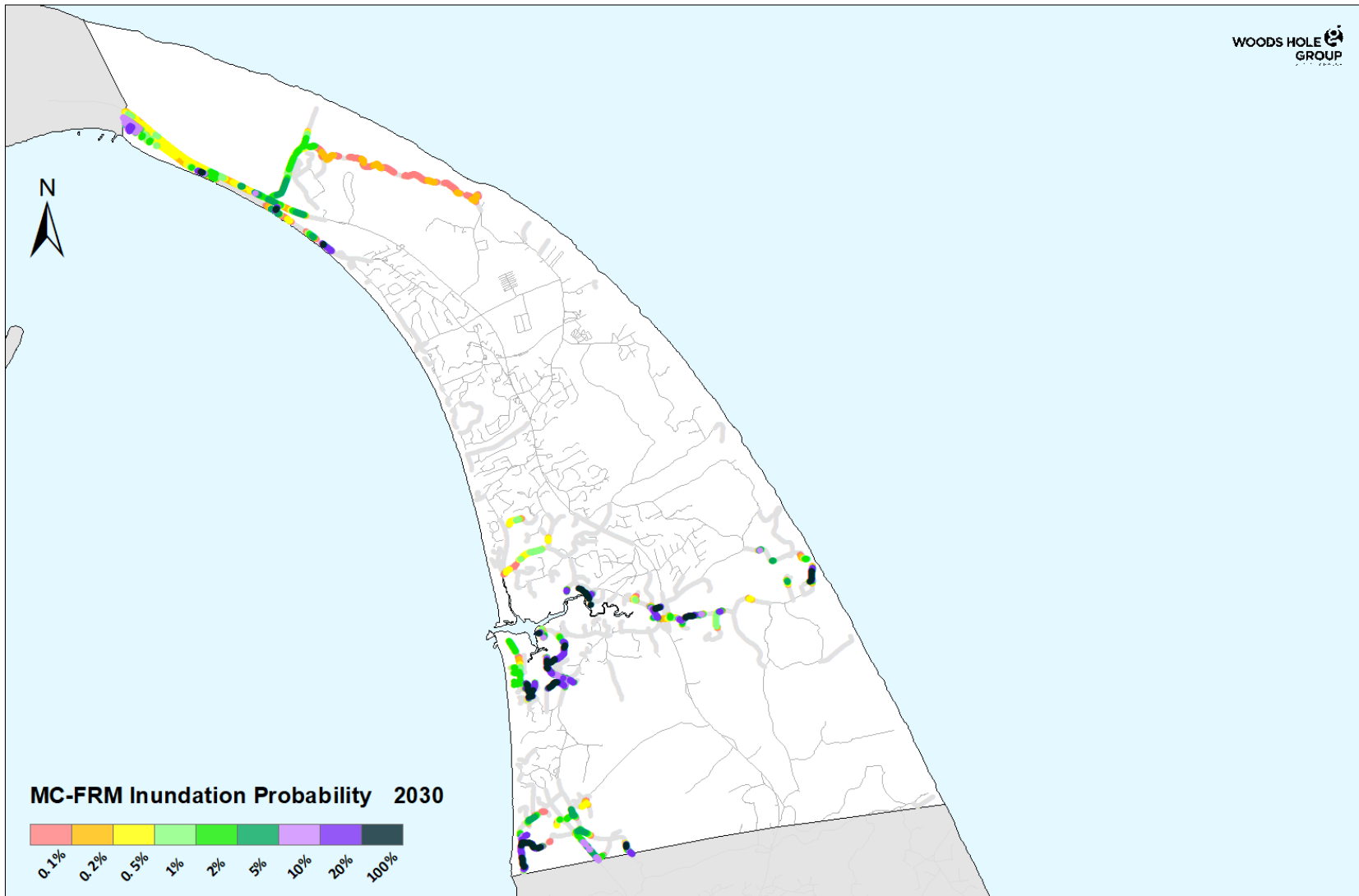
Road Miles 2050

1.5/44.2

Road Miles 2070

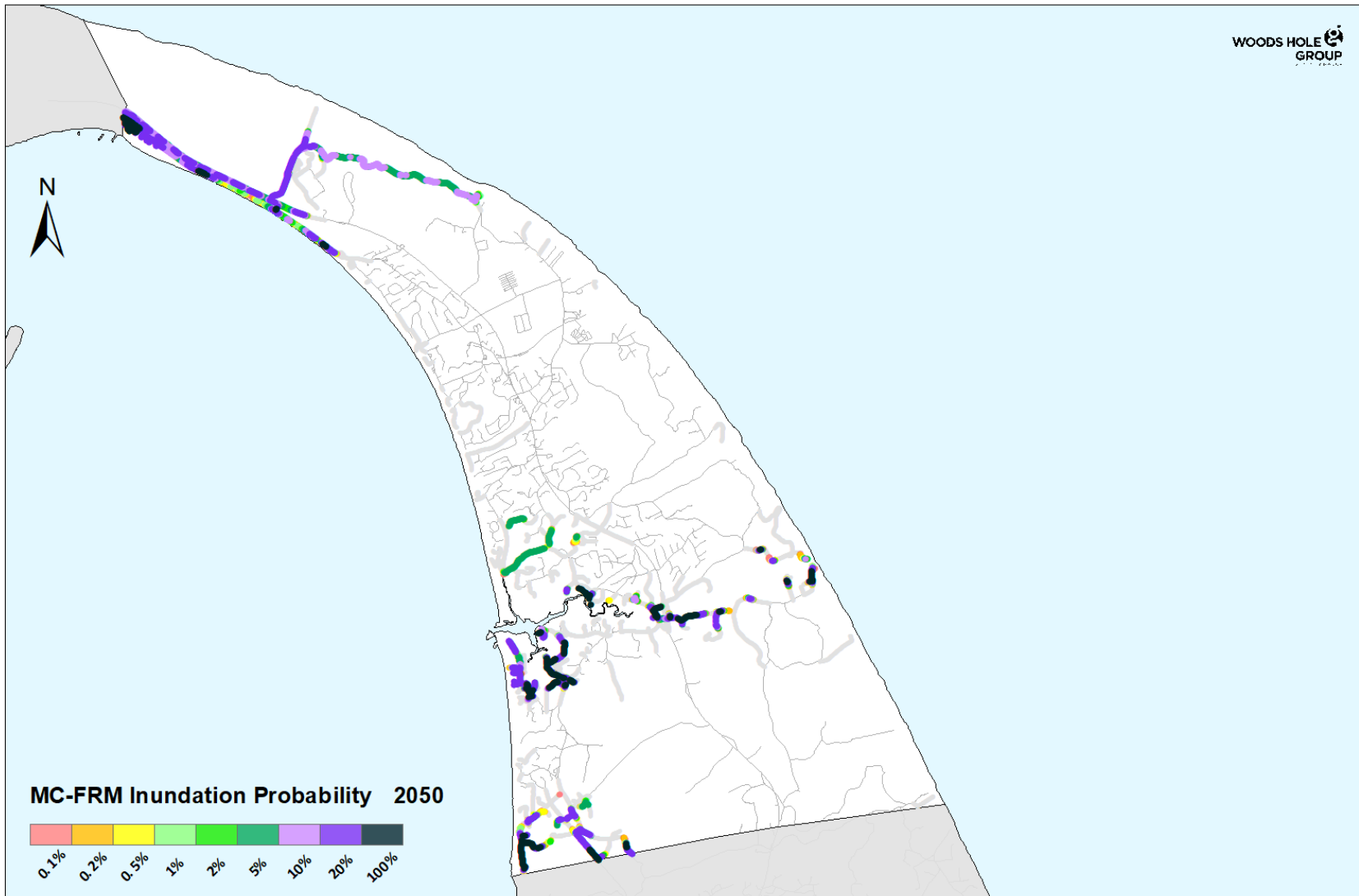
8.8/44.2

# Low Lying Roads 2030 Inundation Probability (Truro)



| %   | Road miles |
|-----|------------|
| 0.1 | 14.4       |
| 0.2 | 12.6       |
| 0.5 | 10.6       |
| 1   | 8.2        |
| 2   | 6.8        |
| 5   | 4.9        |
| 10  | 3.6        |
| 20  | 2.5        |
| 100 | 1.1        |

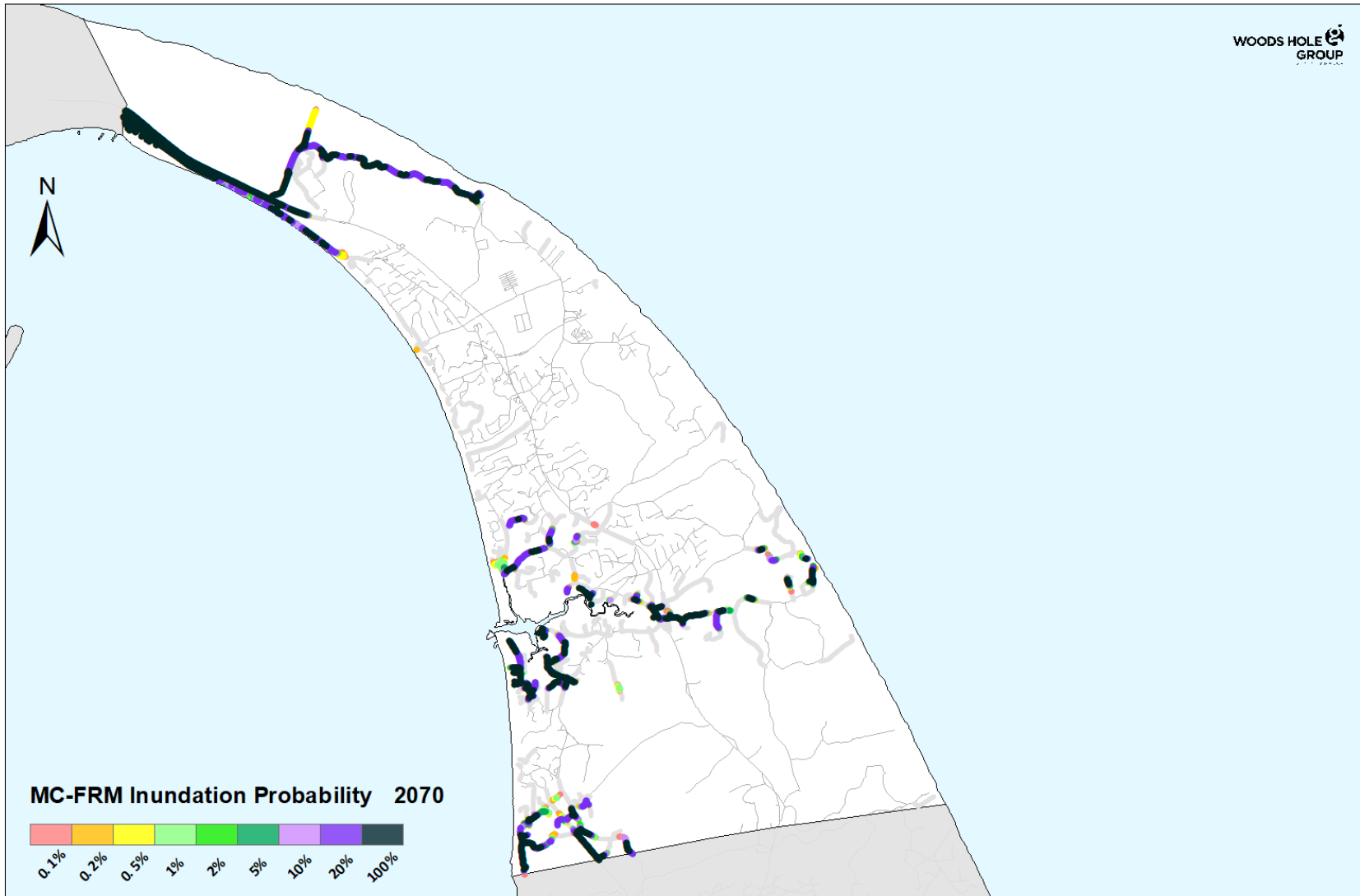
# Low Lying Roads 2050 Inundation Probability (Truro)



| %   | Road miles |
|-----|------------|
| 0.1 | 17.0       |
| 0.2 | 16.7       |
| 0.5 | 16.2       |
| 1   | 15.6       |
| 2   | 15.1       |
| 5   | 14.4       |
| 10  | 11.5       |
| 20  | 8.2        |
| 100 | 3.0        |

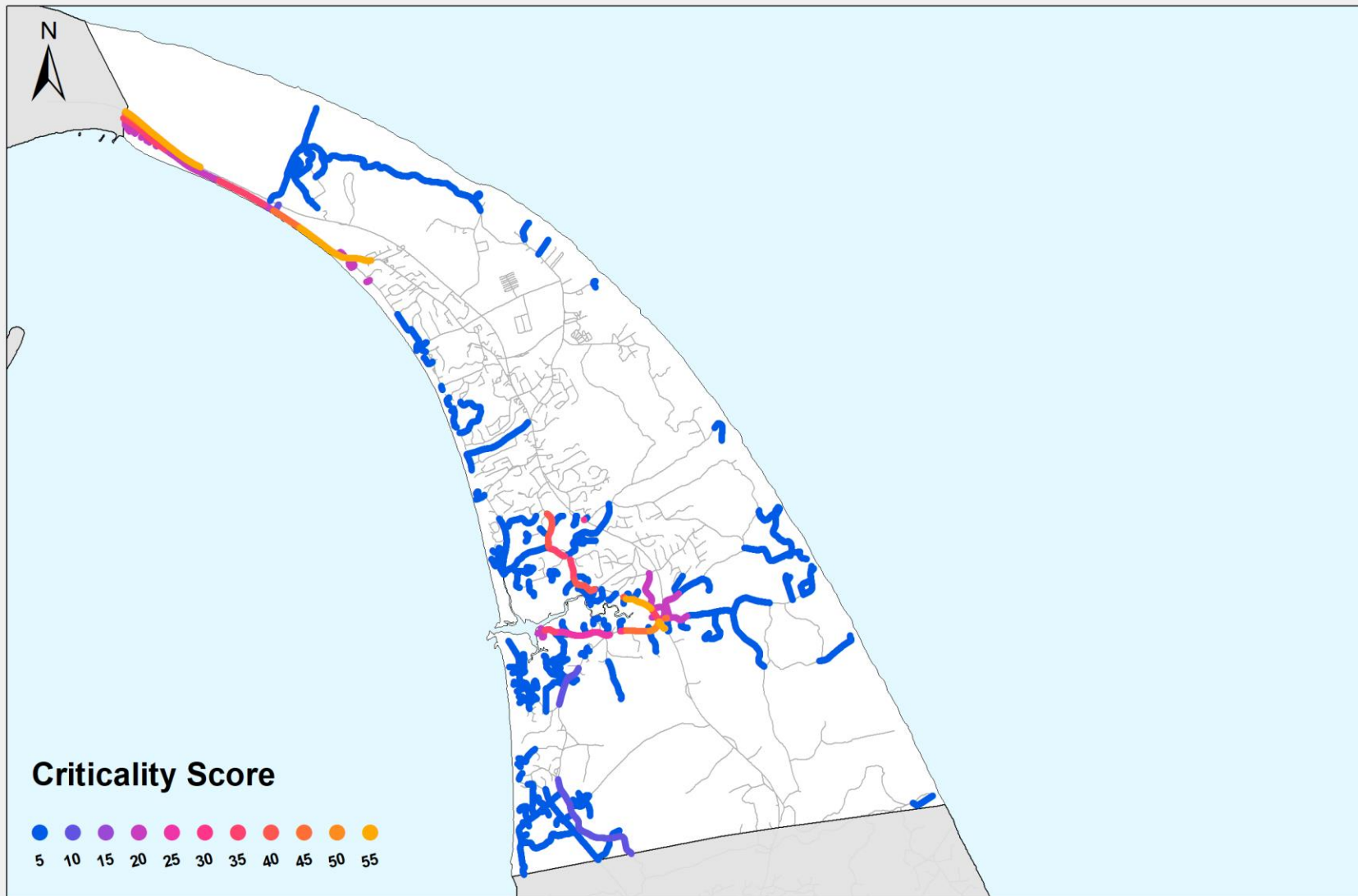


# Low Lying Roads 2070 Inundation Probability (Truro)

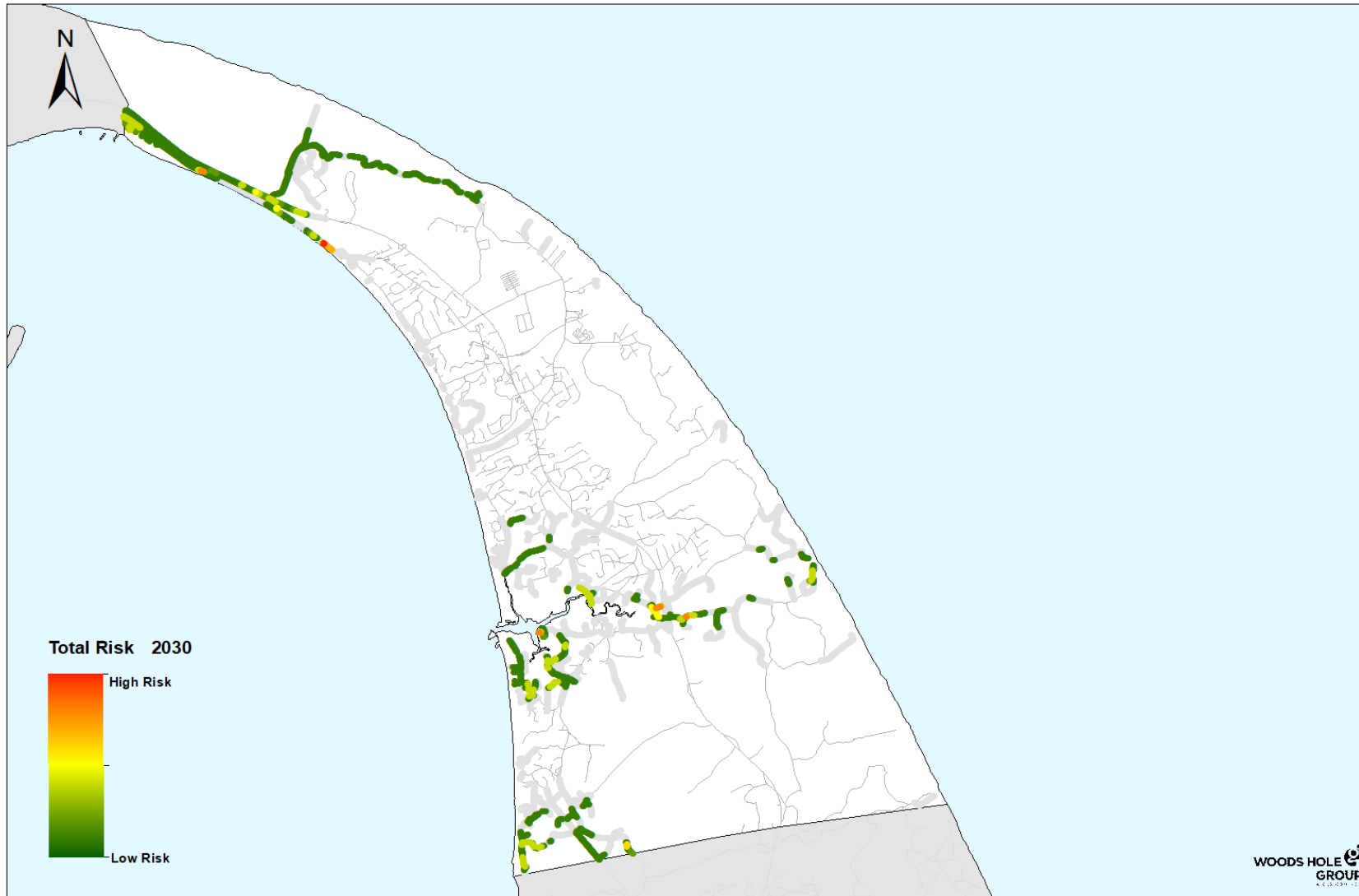


| %   | Road miles |
|-----|------------|
| 0.1 | 19.1       |
| 0.2 | 18.8       |
| 0.5 | 18.4       |
| 1   | 17.7       |
| 2   | 17.1       |
| 5   | 16.6       |
| 10  | 16.0       |
| 20  | 15.3       |
| 100 | 10.9       |

# Low Lying Roads Criticality Scoring (Truro)



# Low Lying Roads 2030 Risk Results (Truro)



## High Risk Road Segments

Shore Rd (Rte 6A)\*

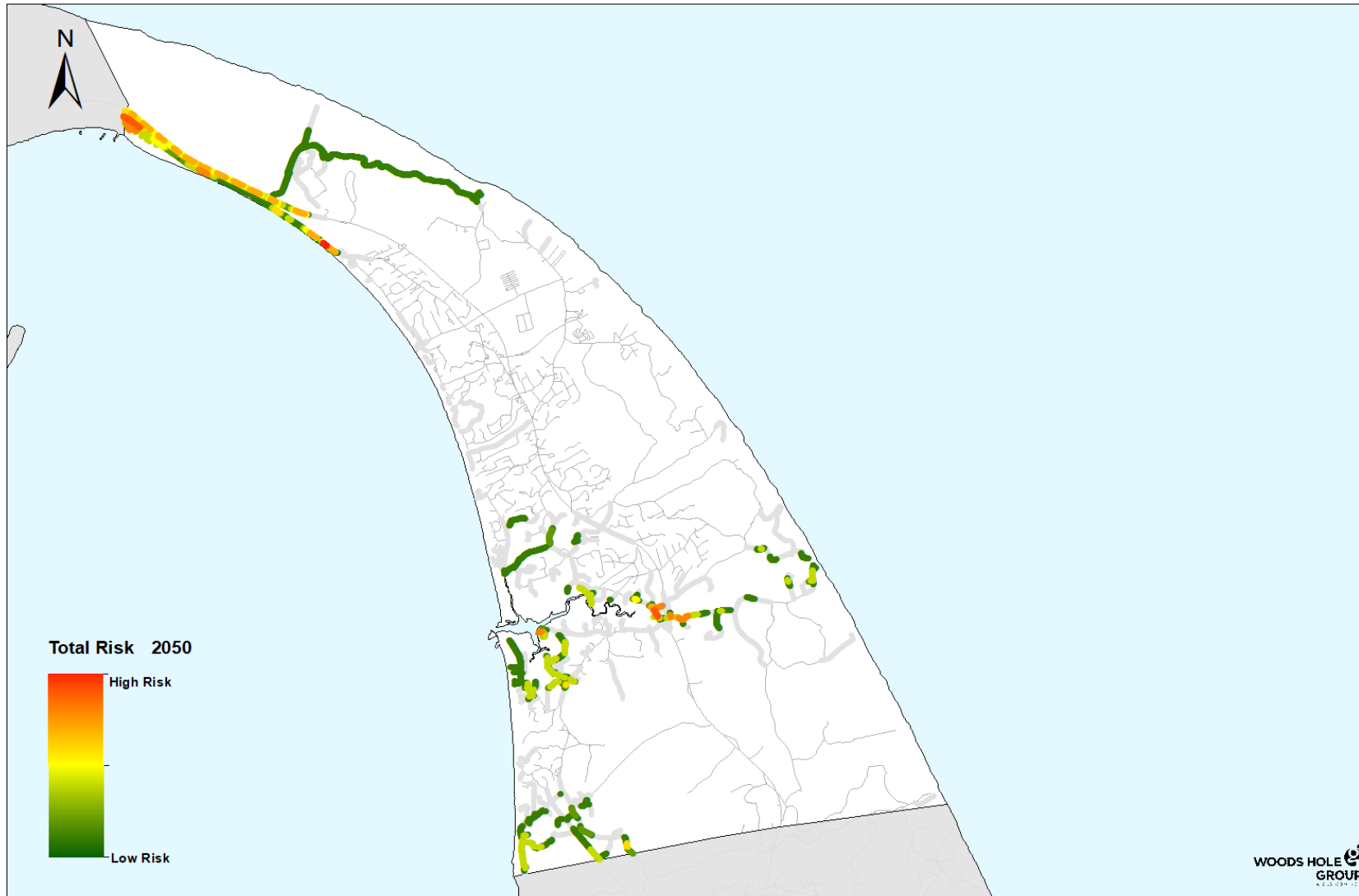
Shore Rd & Commercial Rd (Rte 6A)\*

South Pamet Rd

Old County Rd

Old Pamet Rd & Truro Center Rd

# Low Lying Roads 2050 Risk Results (Truro)



## High Risk Road Segments

Shore Rd (Rte 6A)\*

Shore Rd & Commercial Rd (Rte 6A)\*

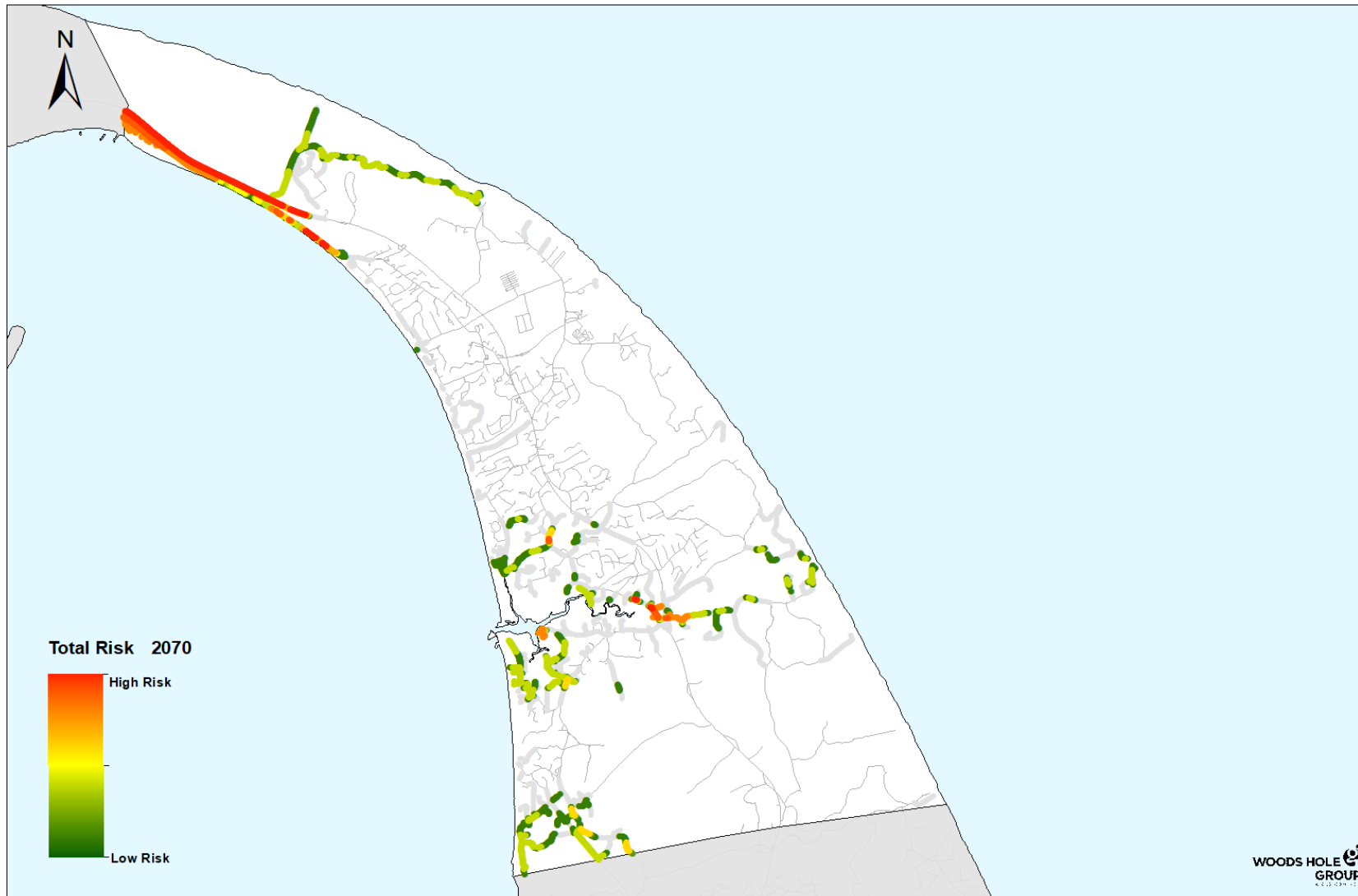
South Pamet Rd

Old County Rd

Old Pamet Rd & Truro Center Rd

Route 6 at East Harbor\*

# Low Lying Roads 2070 Risk Results (Truro)



## High Risk Road Segments

Shore Rd (Rte 6A)\*

Shore Rd & Commercial Rd (Rte 6A)\*

South Pamet Rd

Old County Rd

Old Pamet Rd & Truro Center Rd

Route 6 at East Harbor\*

Castle Rd @ Grays Ln

Shore Rd & Stotts Crossing (Rte 6A)\*

Castle Rd @ Little Pamet River

Corn Hill Rd

Fisher Rd

Shore Rd (Rte 6A)\*

Holden St

Old County Rd

South Pamet Rd

# Summary of High Priority Road Segments (Truro)

|   | Name                                   | Length (ft) | Description                                    | Segment Storm Probability (%) |         |        | Nuisance Length (ft) |      |      |
|---|----------------------------------------|-------------|------------------------------------------------|-------------------------------|---------|--------|----------------------|------|------|
|   |                                        |             |                                                | 2030                          | 2050    | 2070   | 2030                 | 2050 | 2070 |
| A | Shore Rd (Rte 6A)*                     | 2020        | Route 6A adjacent to Top Mast Resort           | 0-100                         | 0.2-100 | 10-100 |                      |      | 740  |
| B | Shore Rd & Commercial Rd (Rte 6A)*     | 5660        | Route 6A leading to Provincetown line          | 0.1-100                       | 5-100   | 20-100 |                      |      | 3760 |
| C | South Pamet Rd                         | 2500        | Large segment east of Route 6 bridge           | 0-100                         | 0.5-100 | 10-100 |                      |      |      |
| D | Old County Rd                          | 460         | Near Paradise Hollow                           | 0.1-100                       | 2-100   | 20-100 |                      |      | 80   |
| E | Old Pamet Rd & Truro Center Rd †       | 900         | Culverted road over Pamet River                | 0.1-100                       | 2-100   | 20-100 | 340                  | 400  | 1060 |
| F | Route 6**                              | 12260       | Route 6 at Eash Harbor                         | 0-10                          | 1-20    | 20-100 |                      |      | 5700 |
| G | Castle Rd                              | 240         | Intersection with Grays Lane                   | 0-1                           | 2-10    | 20-100 |                      |      |      |
| H | Shore Rd & Stotts Crossing (Rte 6A)* † | 2540        | Intersection of Shore Road and Stotts Crossing | 0-5                           | 0.2-20  | 5-100  |                      |      | 320  |
| I | Castle Rd                              | 140         | Culverted road over Little Pamet River         | 0-0.5                         | 5       | 100    | 80                   | 140  | 140  |
| J | Corn Hill Rd                           | 2400        | Access to Corn Hill Beach                      | 0-1                           | 2-5     | 10-100 | 1520                 | 2200 | 2360 |
| K | Fisher Rd                              | 640         | Access to neighborhood                         | 0.5-100                       | 10-00   | 20-100 | 440                  | 540  | 620  |
| L | Shore Rd (Route 6A)*                   | 3460        | Additional vulnerable segments of Route 6A     | 0-2                           | 0-10    | 1-100  |                      |      |      |
| M | Holden St ††                           | 1020        | Access to Head of the Meadow Beach             | 0-0.2                         | 1-10    | 20-100 |                      |      | 620  |
| N | Old County Rd                          | 600         | Culverted road and access to neighborhood      | 0.1-10                        | 2-100   | 20-100 |                      |      |      |
| O | South Pamet Rd                         | 860         | Access to Ballston Beach                       | 0-100                         | 1-100   | 10-100 |                      |      |      |

\* = Town and MassDOT roadway

\*\* = MassDOT roadway

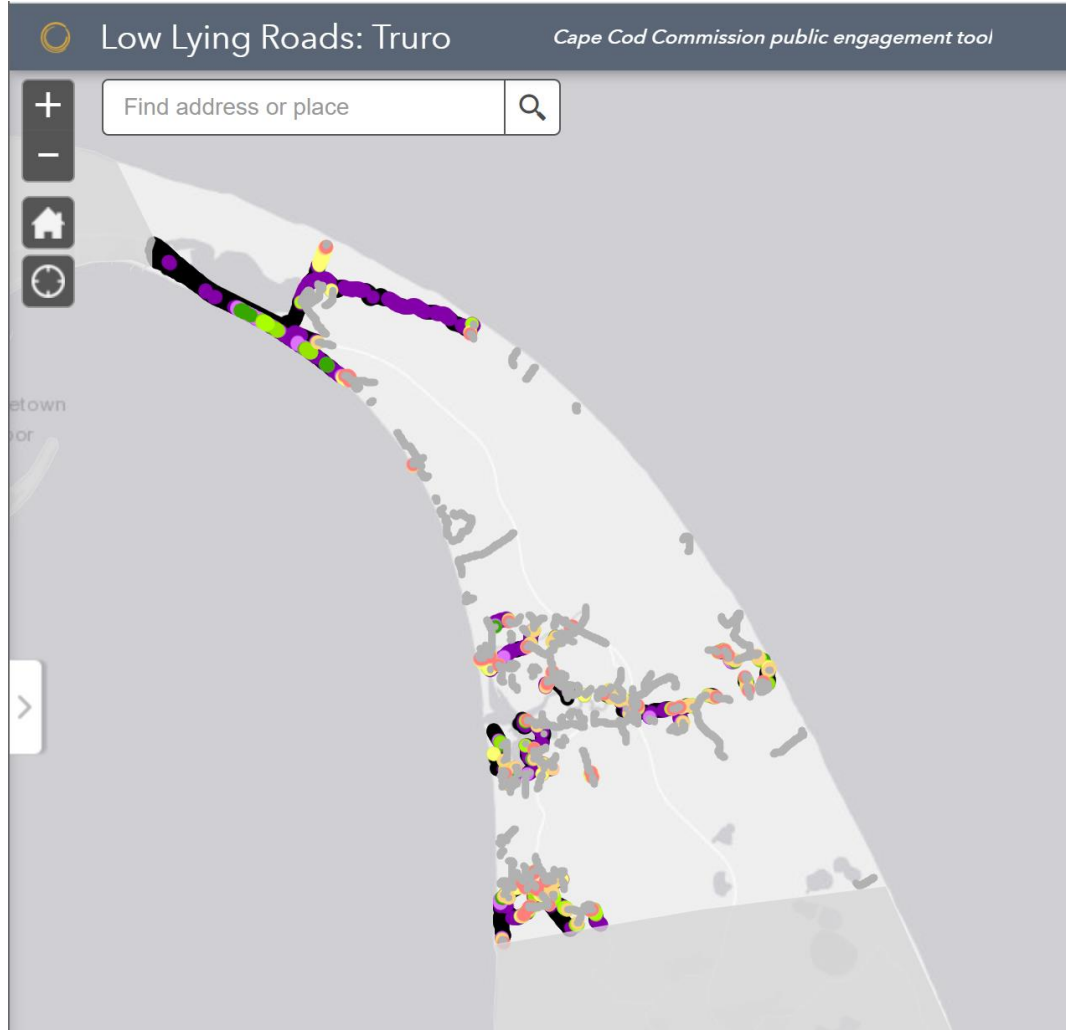
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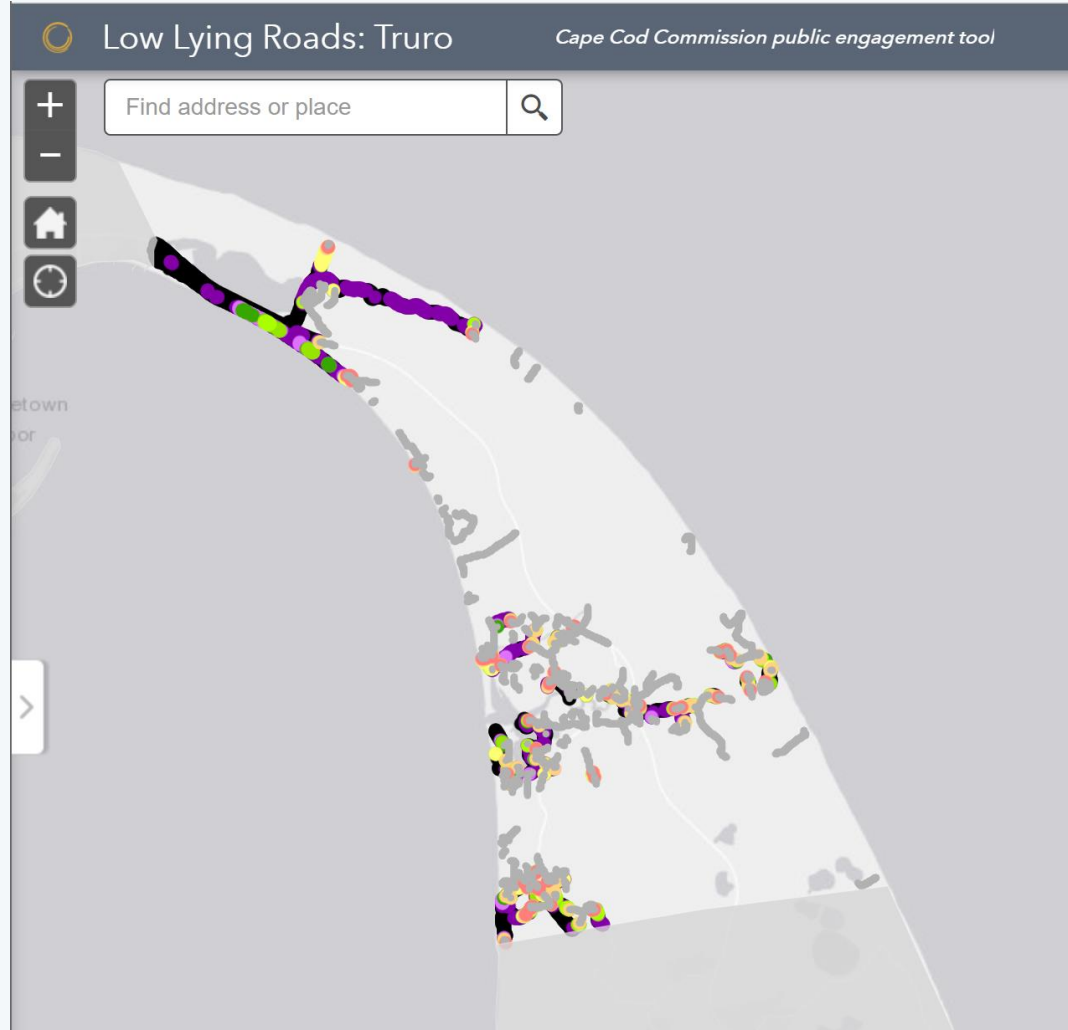
## LOW LYING ROADS

# Group Discussion



**DISCUSSION  
ORIENTATION**

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## DISCUSSION QUESTIONS

1. Are there roads that we missed?
2. How would you prioritize these roads – what local knowledge or concerns can you bring to the discussion?
3. What are the high-priority road segments?



# Summary of High Priority Road Segments (Truro)

|   | Name                                   | Length (ft) | Description                                    | Segment Storm Probability (%) |         |        | Nuisance Length (ft) |      |      |
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| B | Shore Rd & Commercial Rd (Rte 6A)*     | 5660        | Route 6A leading to Provincetown line          | 0.1-100                       | 5-100   | 20-100 |                      |      | 3760 |
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| F | Route 6**                              | 12260       | Route 6 at Eash Harbor                         | 0-10                          | 1-20    | 20-100 |                      |      | 5700 |
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\* = Town and MassDOT roadway

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**Breakout Groups**

# Breakout Group Discussion

## GETTING STARTED

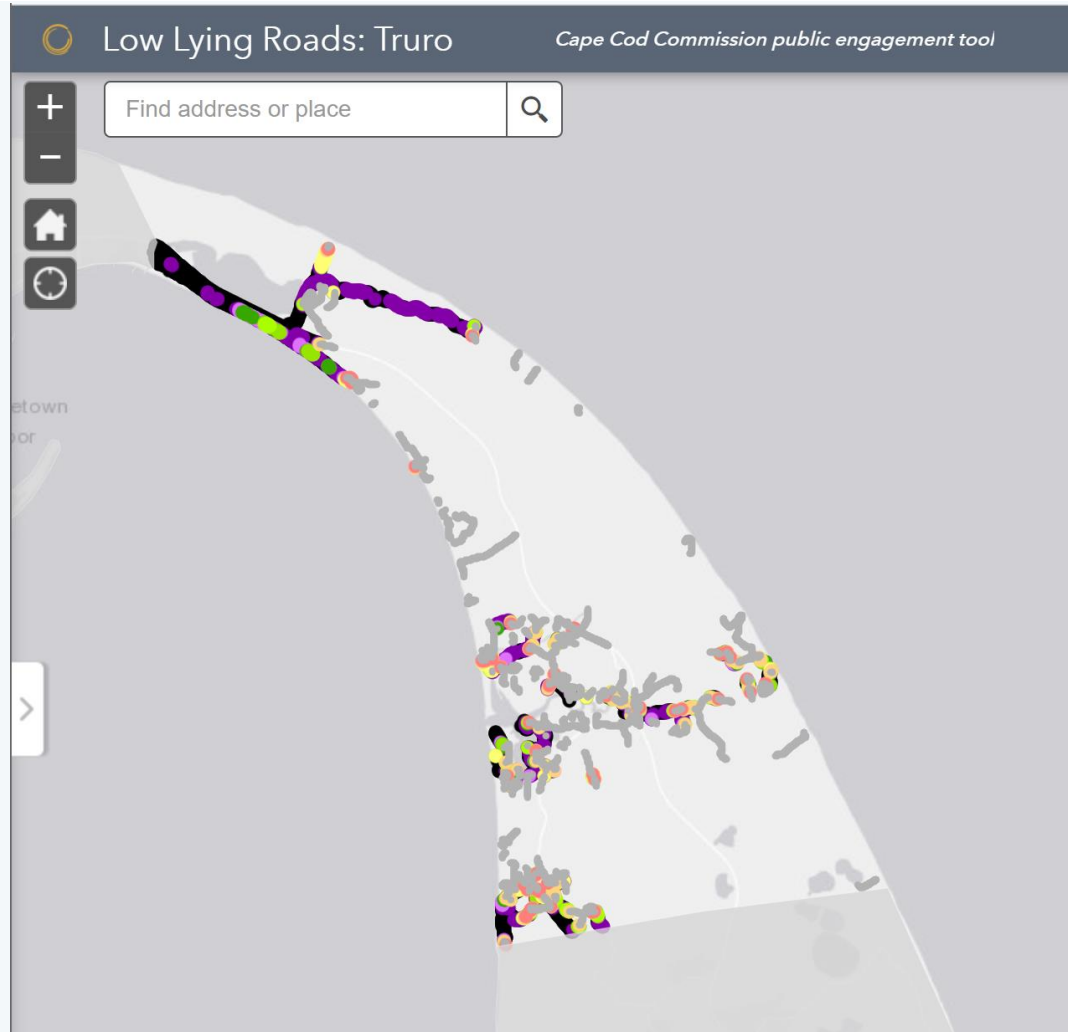
- Introductions
- Clarifying Questions

## CONSIDERATIONS...

1. Are there roads that we missed?
2. How would you prioritize these roads – what local knowledge or concerns can you bring to the discussion?
3. What are the high-priority road segments?

## LOW LYING ROADS

# Summary: Vulnerability and Risk Analysis



- MC FRM
  - Data: SLR, Storms, Tides, Elevations
  - Flood projections 2030, 2050, 2070
- Road network vulnerable to flooding
- Criticality of road network to community
- Risk = probability x criticality

# Summary of High Priority Road Segments (Truro)

|   | Name                                   | Length (ft) | Description                                    | Segment Storm Probability (%) |         |        | Nuisance Length (ft) |      |      |
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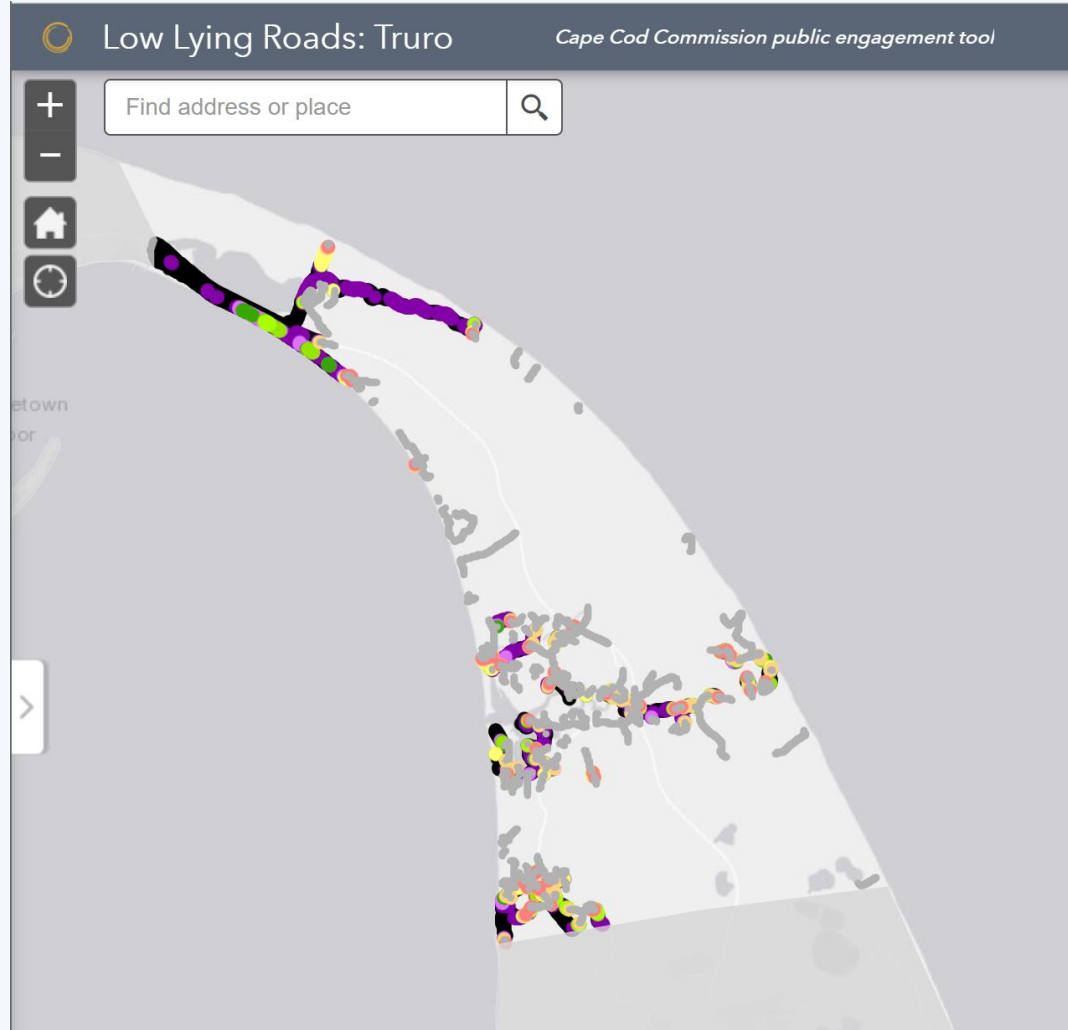
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## LOW LYING ROADS

# Group Discussion



**REPORT  
BACK**

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**SYNTHESIS**

# Low Lying Roads: Truro

Home > Work > Low Lying Roads: Truro

|                 |                  |                    |                     |
|-----------------|------------------|--------------------|---------------------|
| <b>Overview</b> | <b>Materials</b> | <b>Data Viewer</b> | <b>Top Segments</b> |
|-----------------|------------------|--------------------|---------------------|

## Overview

The Cape Cod Commission is working with 10 Cape towns, including the **Town of Truro**, to examine vulnerabilities in the roadway network and identify solutions. With funding support from the U.S. Economic Development Administration (EDA) and the Massachusetts Municipal Vulnerability Preparedness

## NEXT MEETINGS

FRIDAY

**MAR 04, 2022**

Truro Low-lying Roads Public Meeting

**START TIME:** 10:00 AM

# NEXT STEPS

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- Town staff to select 2 road segments
- Feasibility analysis
- 3 solutions + costs per segment
- Solutions available to view on Low Lying Road webpage later in 2022: <https://www.capecodcommission.org/our-work/low-lying-roads-project/>
- 2<sup>nd</sup> Workshop date TBD – winter 2023



**THANK YOU!**

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