

Low-Lying Roads Project

Fall 2021- June 2023

Project funded by:
Municipal Vulnerability Preparedness Program
Economic Development Administration

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

- 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

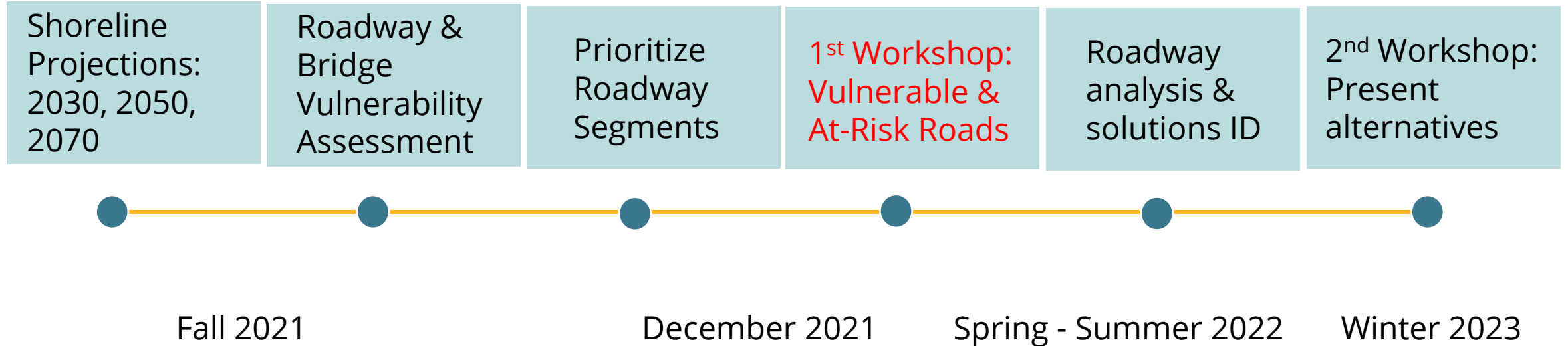


Adaptation Strategies



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

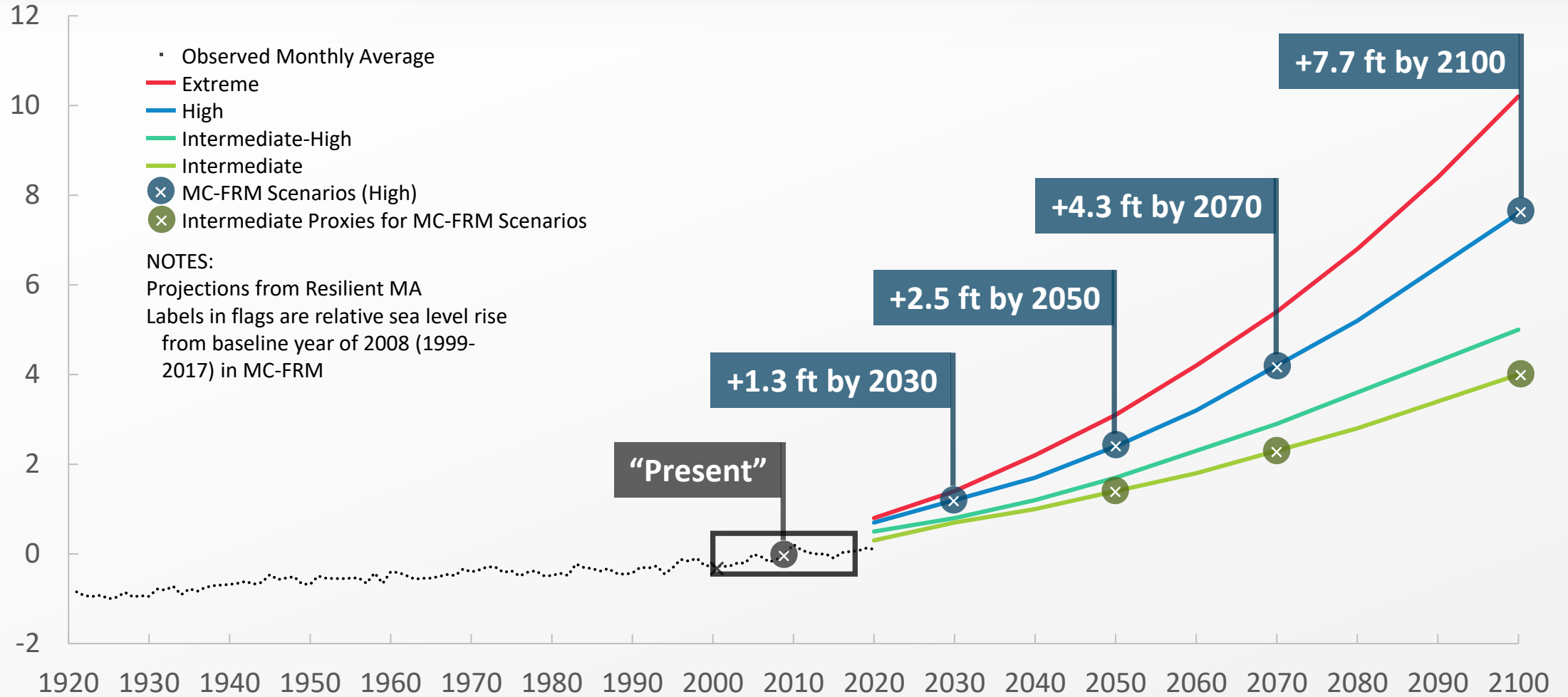
PROJECT TIMELINE & ELEMENTS



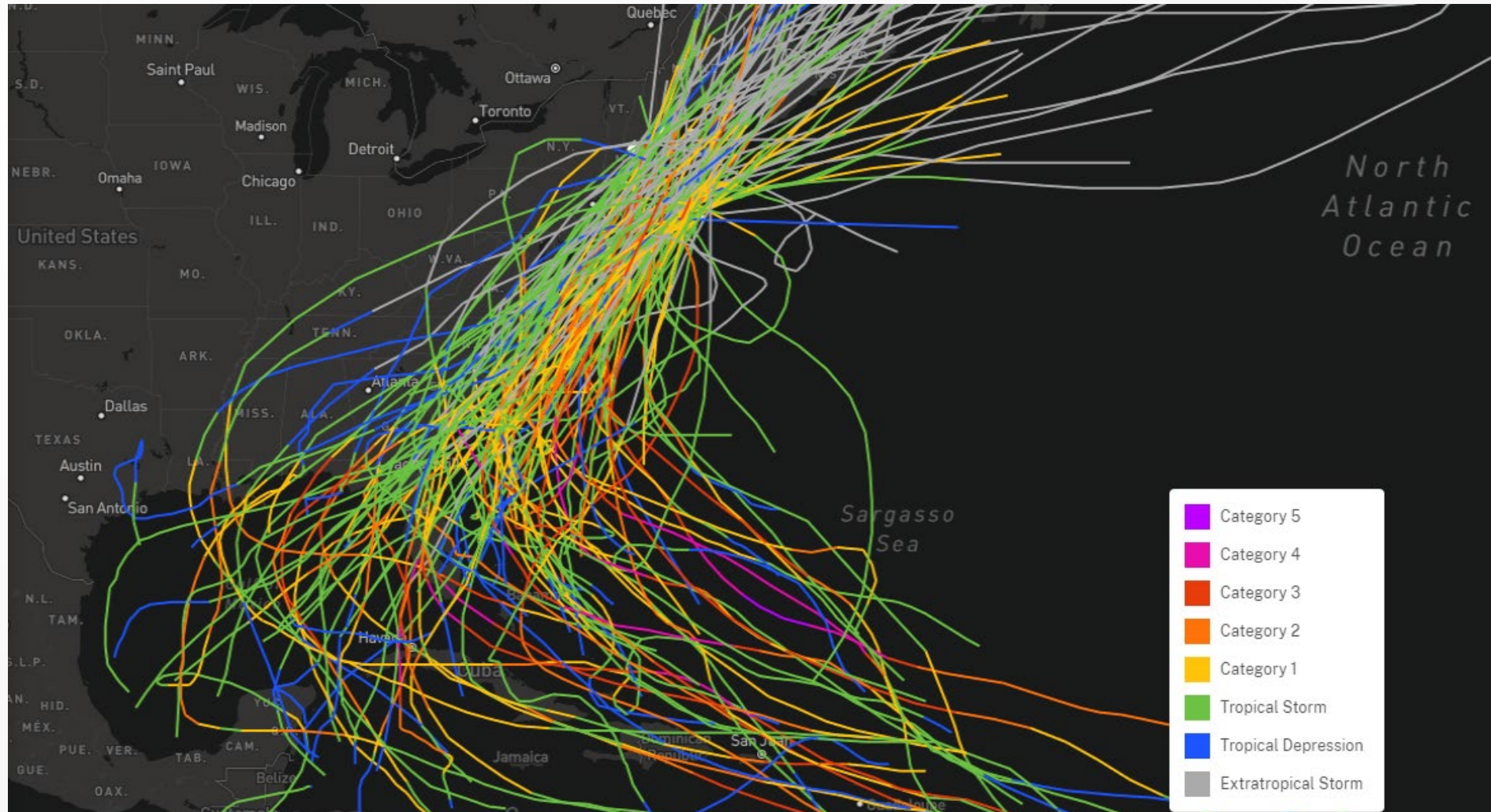
MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM NORTH (DeConto & Kopp, 2017)

Relative Mean Sea Level (feet NAVD88)



Tropical / Extra-tropical Storms



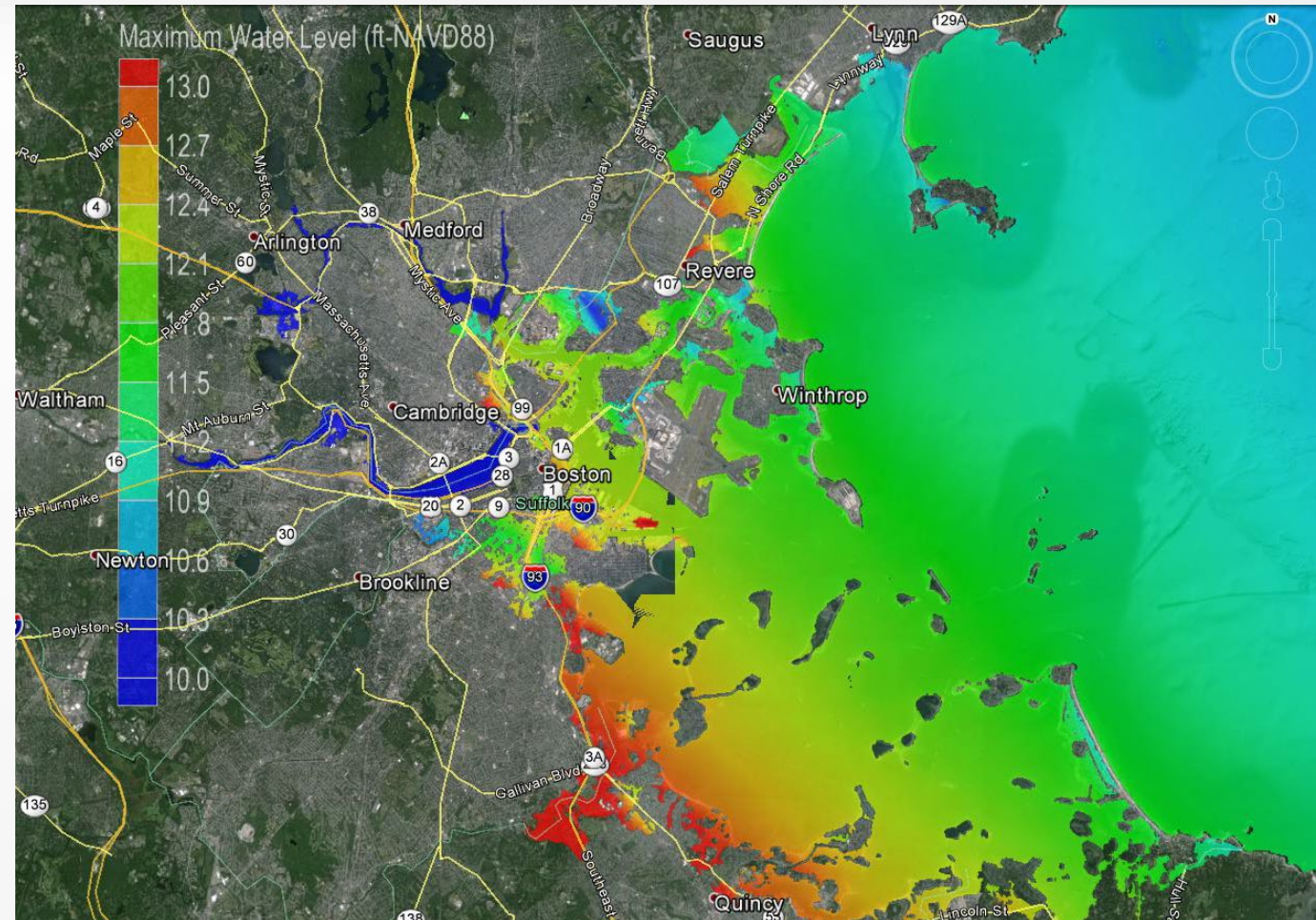
NOAA National Ocean Service

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:
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Katherin McArthur, MassDOT
Steven Miller, MassDOT
Chris Watson, M.Sc., UMass Boston

Logos:
UMASS BOSTON | WOODS HOLE GROUP | University of New Hampshire | U.S. Department of Transportation Federal Highway Administration



Massachusetts Coast Flood Risk Model (MC-FRM)

INPUTS



SEA LEVEL
RISE



TROPICAL / EXTRA-
TROPICAL STORMS



LANDSCAPE



ELEVATION



CHANGING
CLIMATE

PROBABILISTIC /
HYDRODYNAMIC
MODEL



Includes relevant physical processes:
sea level rise, tides, storm surge, wind, wave setup
/ run-up / overtopping, future climate scenarios

Future version to incorporate coastal erosion



FLOOD
PROBABILITY



FLOOD
DEPTH



FLOOD
DURATION



FLOOD
VOLUMES



FLOOD
PATHWAYS



WINDS



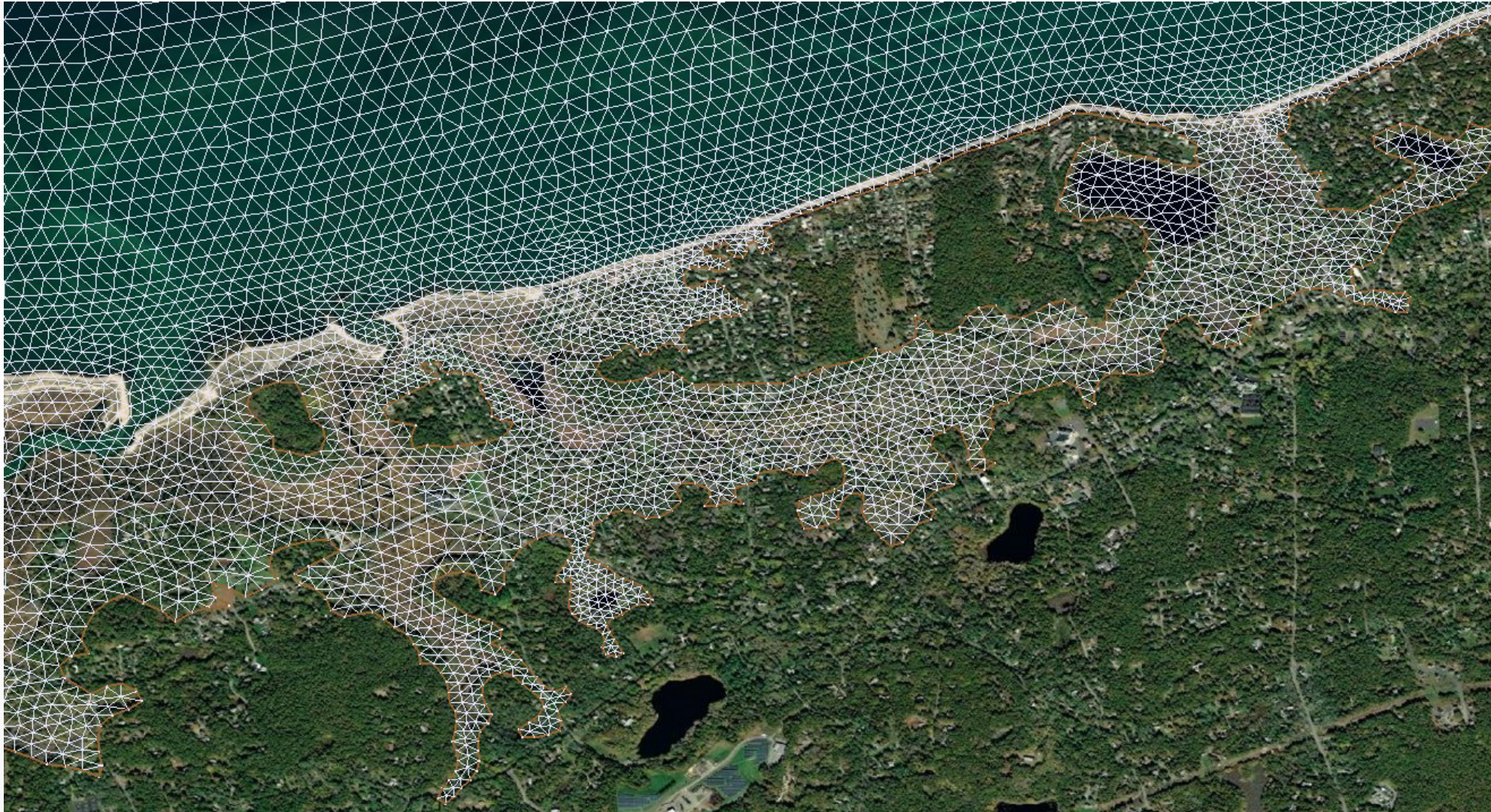
WAVES



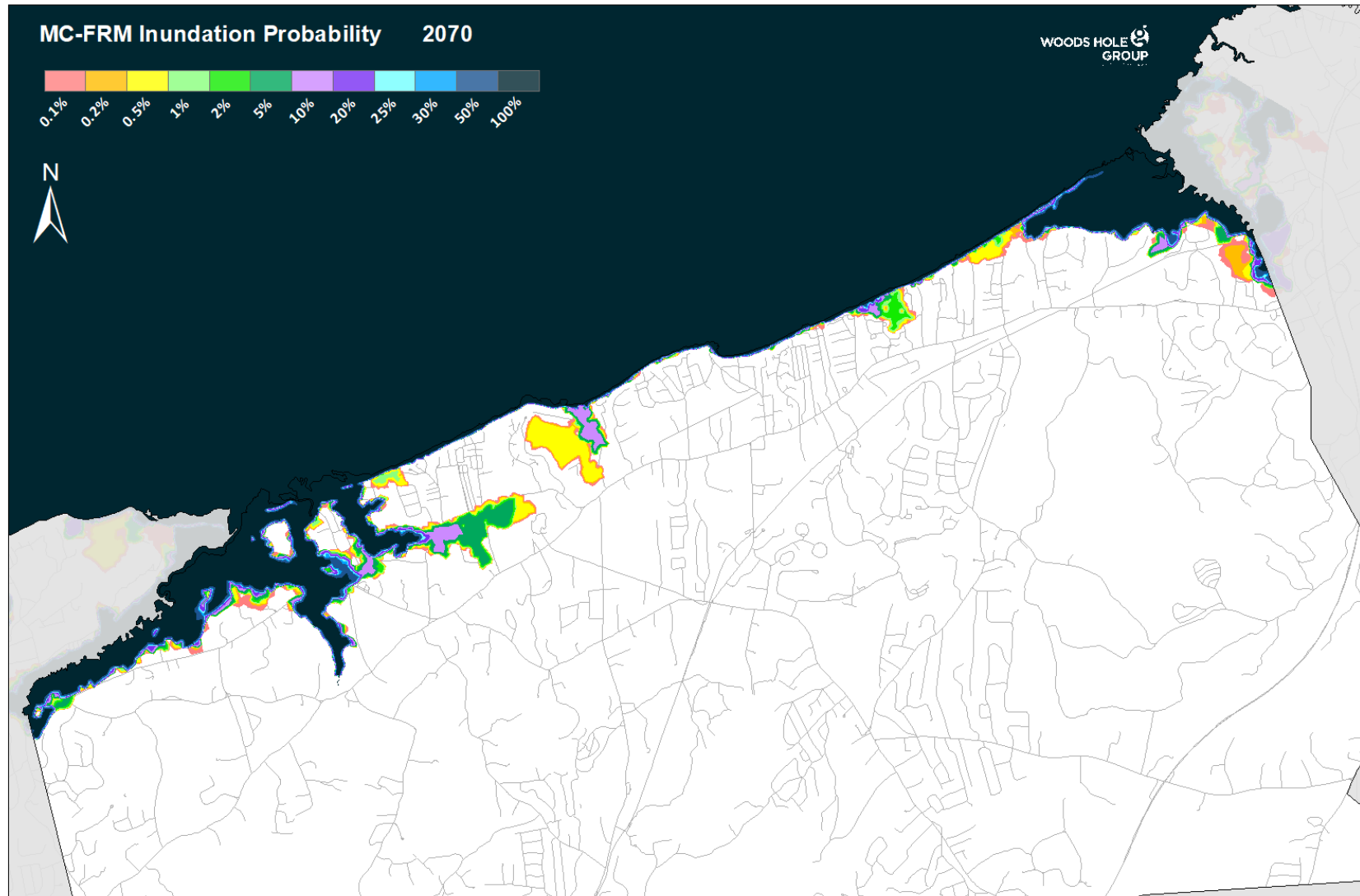
CURRENTS

OUTPUTS

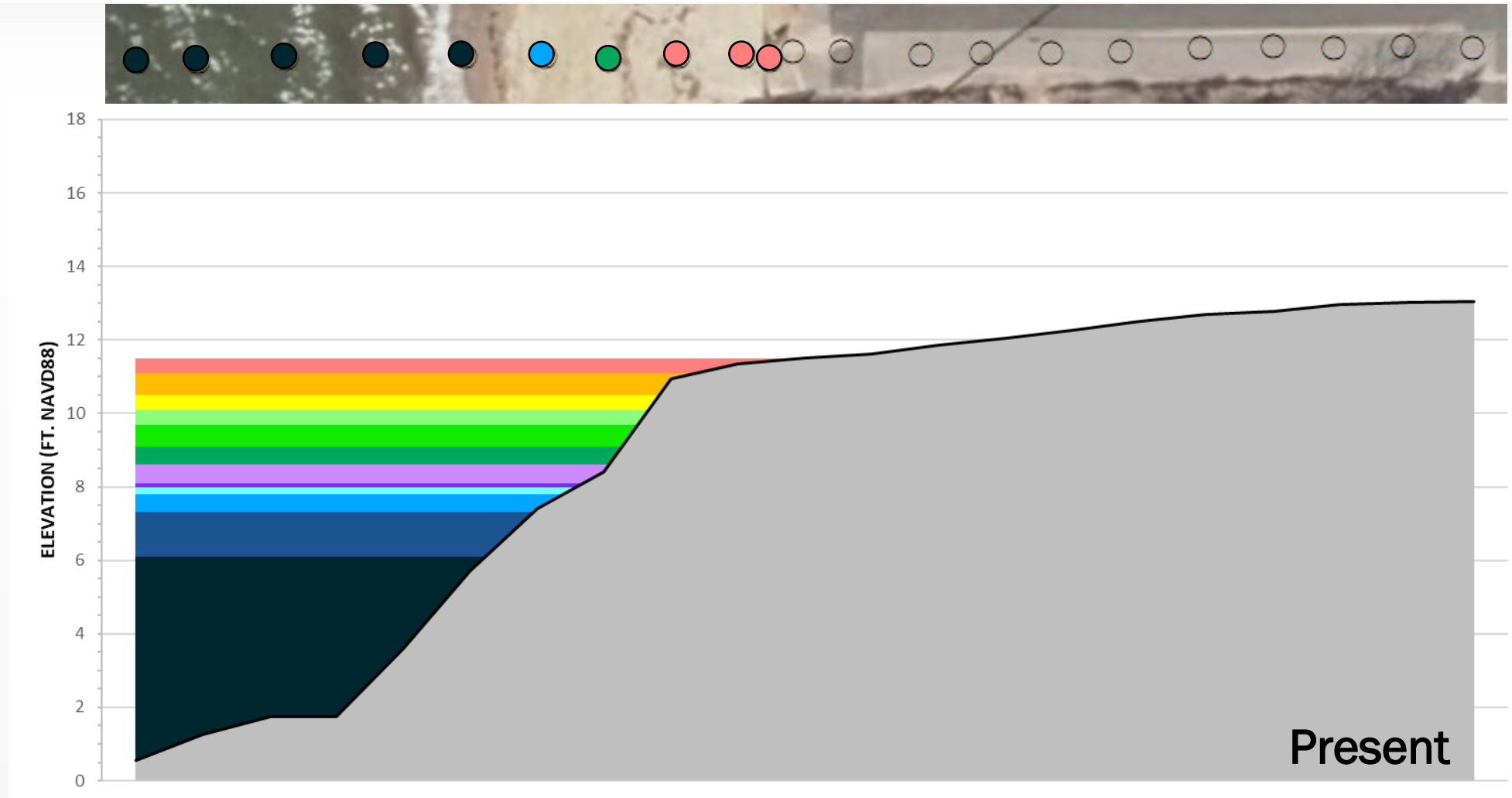
MC-FRM Resolution - Brewster



MC-FRM Coastal Flood Exceedance Probability – Brewster

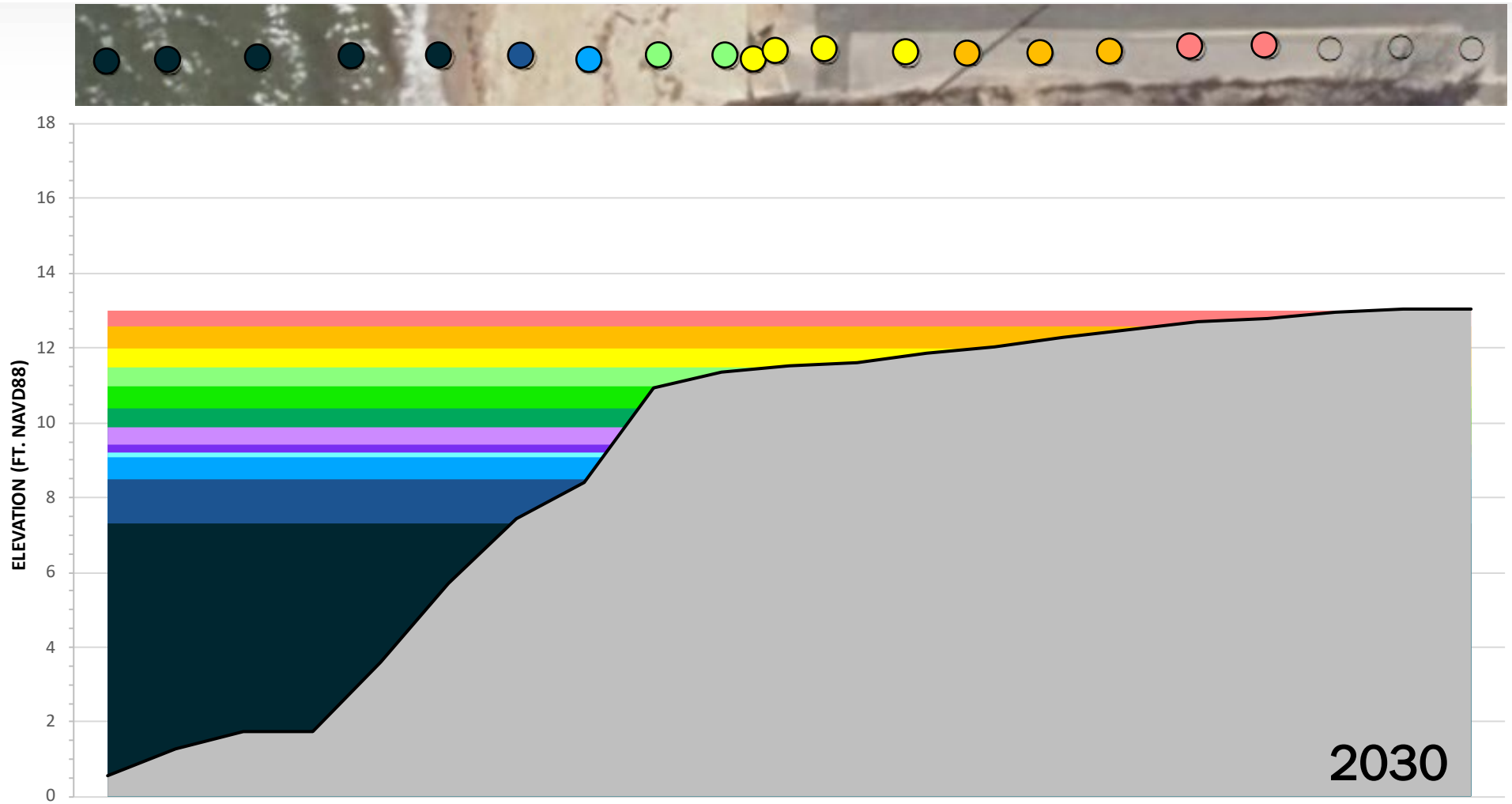


Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY

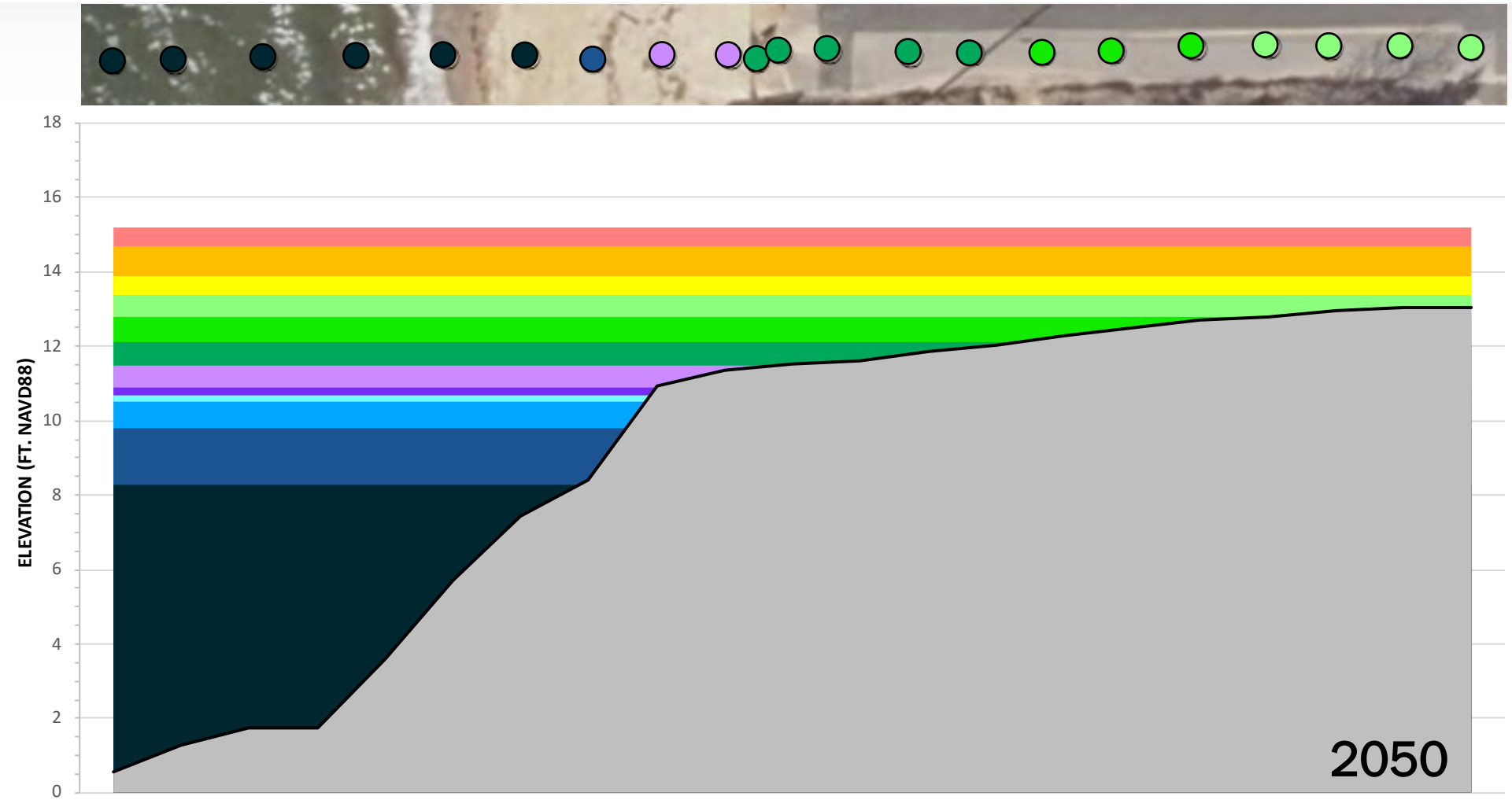
Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY



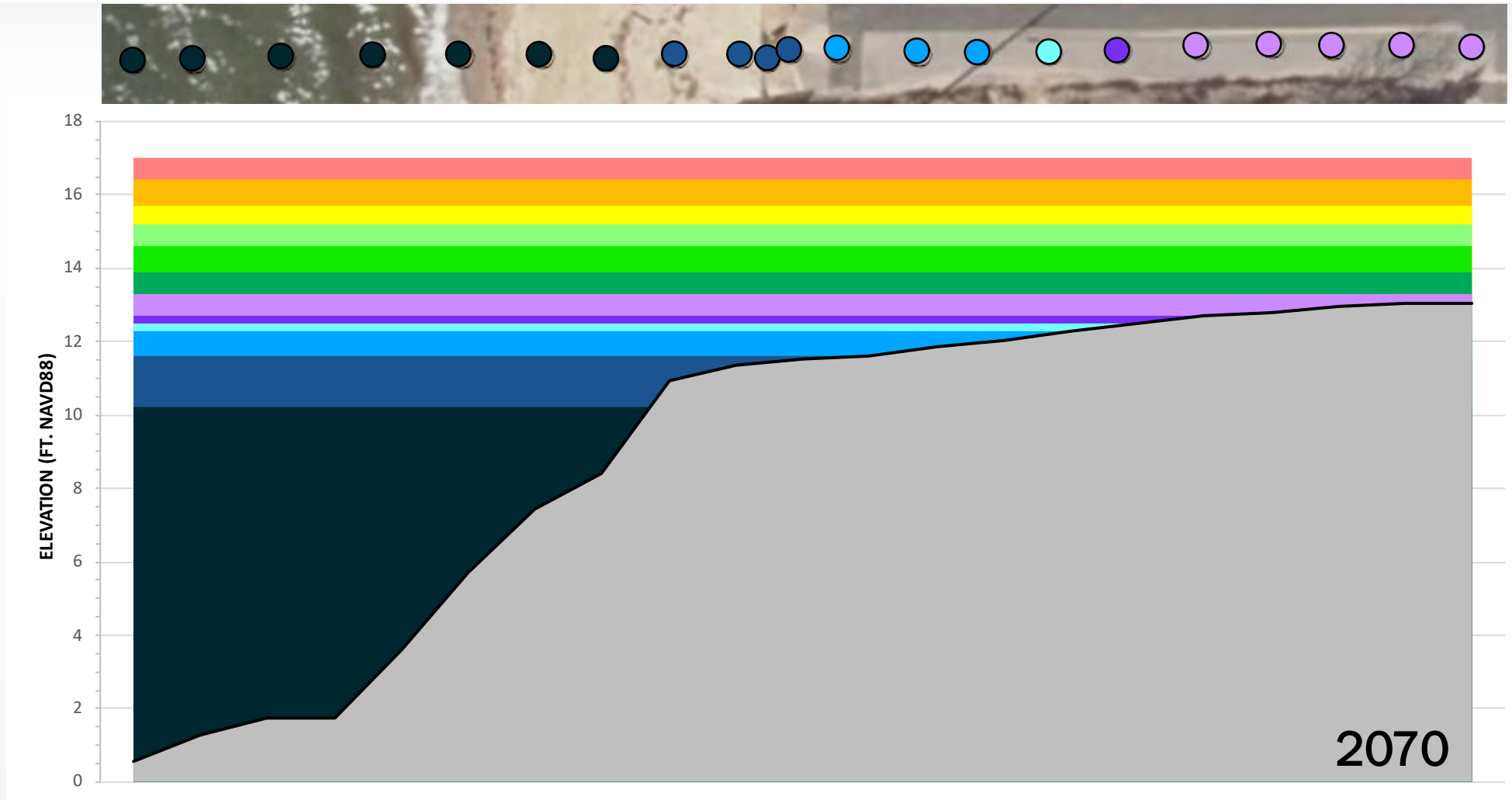
Cape Cod Low Lying Roads Vulnerability Assessment Methods



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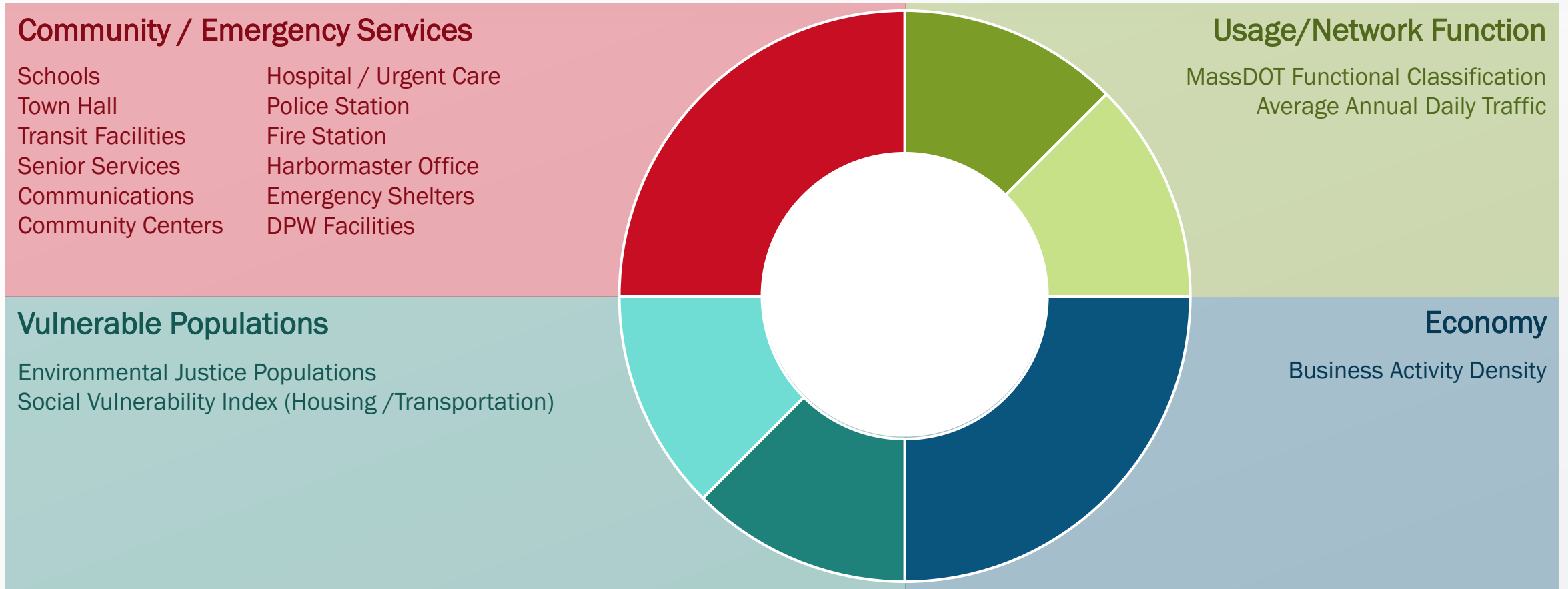
Cape Cod Low Lying Roads Vulnerability Assessment Methods



COASTAL FLOOD EXCEEDANCE PROBABILITY

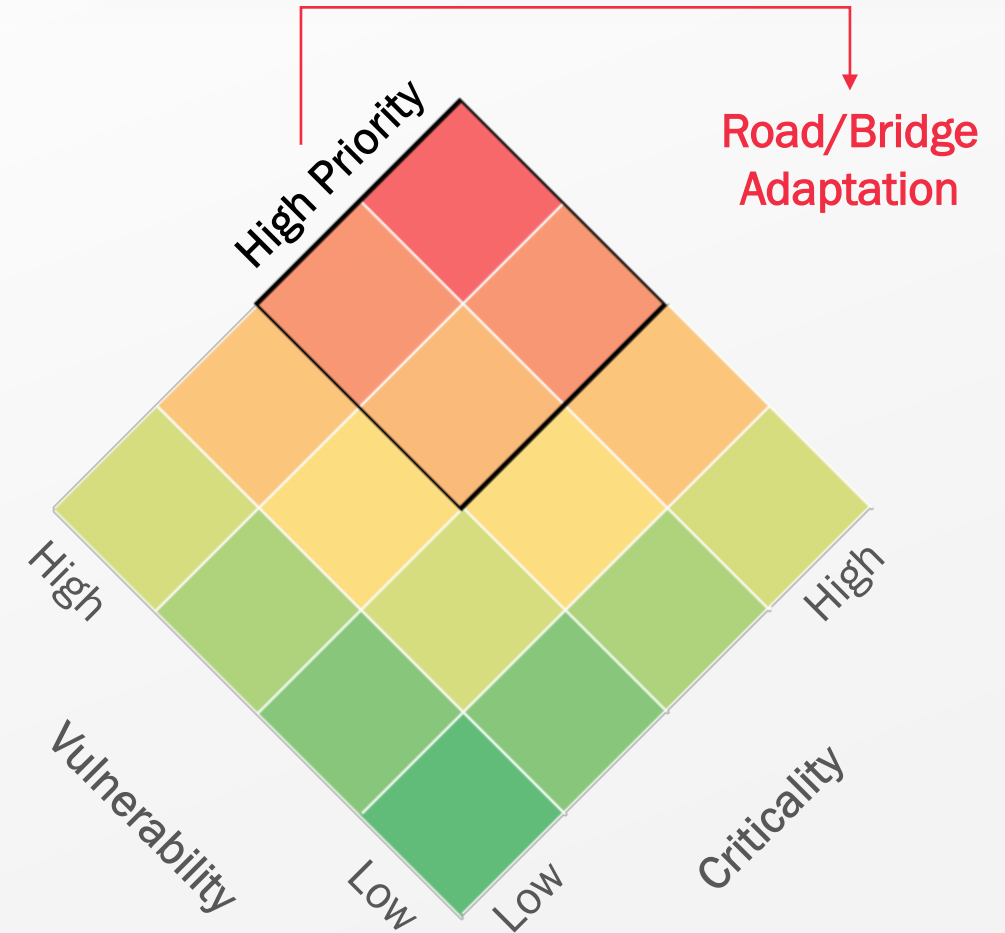


Cape Cod Low Lying Roads Criticality Scoring Framework

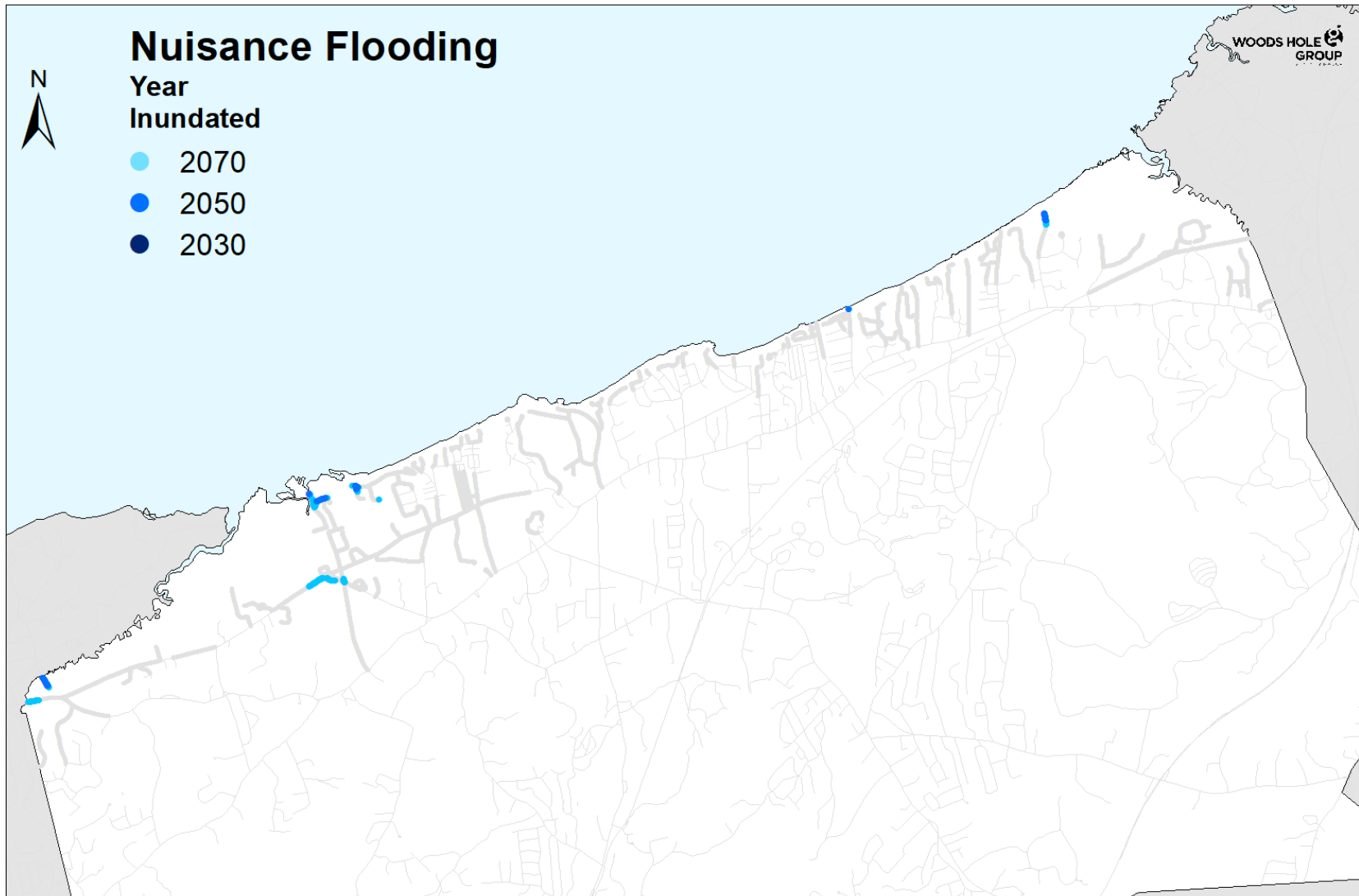


Cape Cod Low Lying Roads Risk Assessment Approach

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 (Brewster)

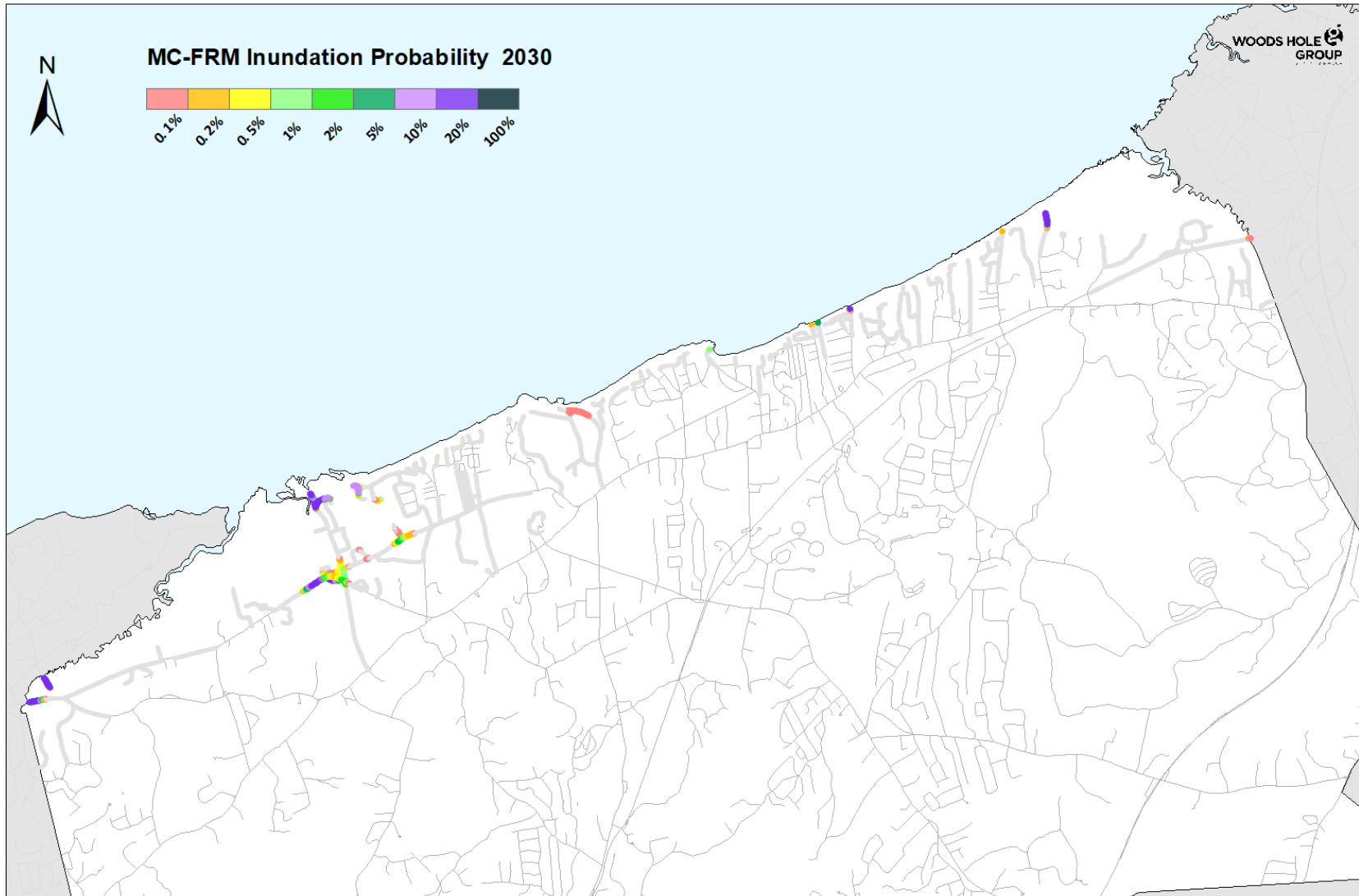


Road Miles 2030
0/24.8

Road Miles 2050
0.2/24.8

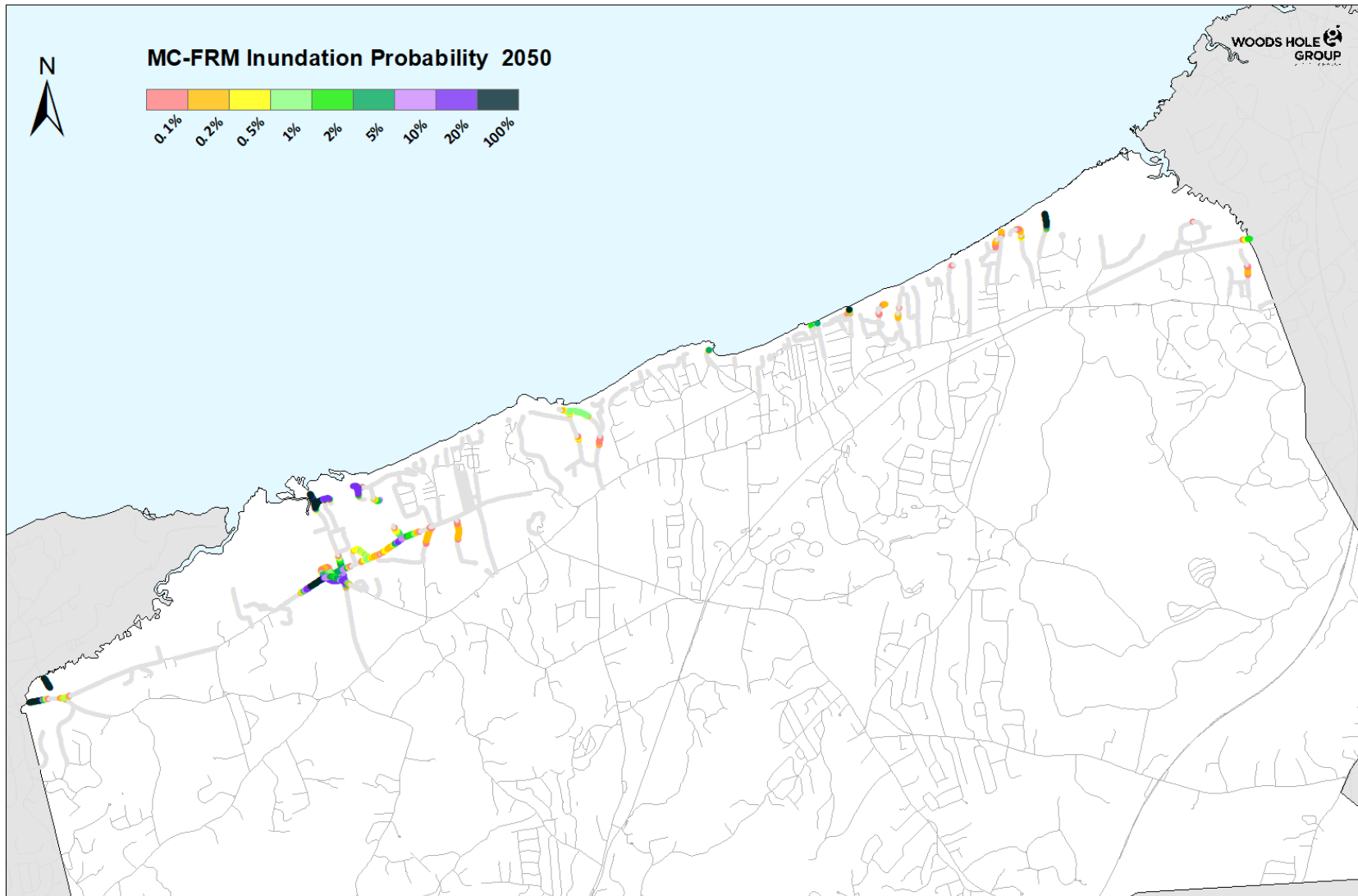
Road Miles 2070
0.64/24.8

Low Lying Roads 2030 Inundation Probability (Brewster)



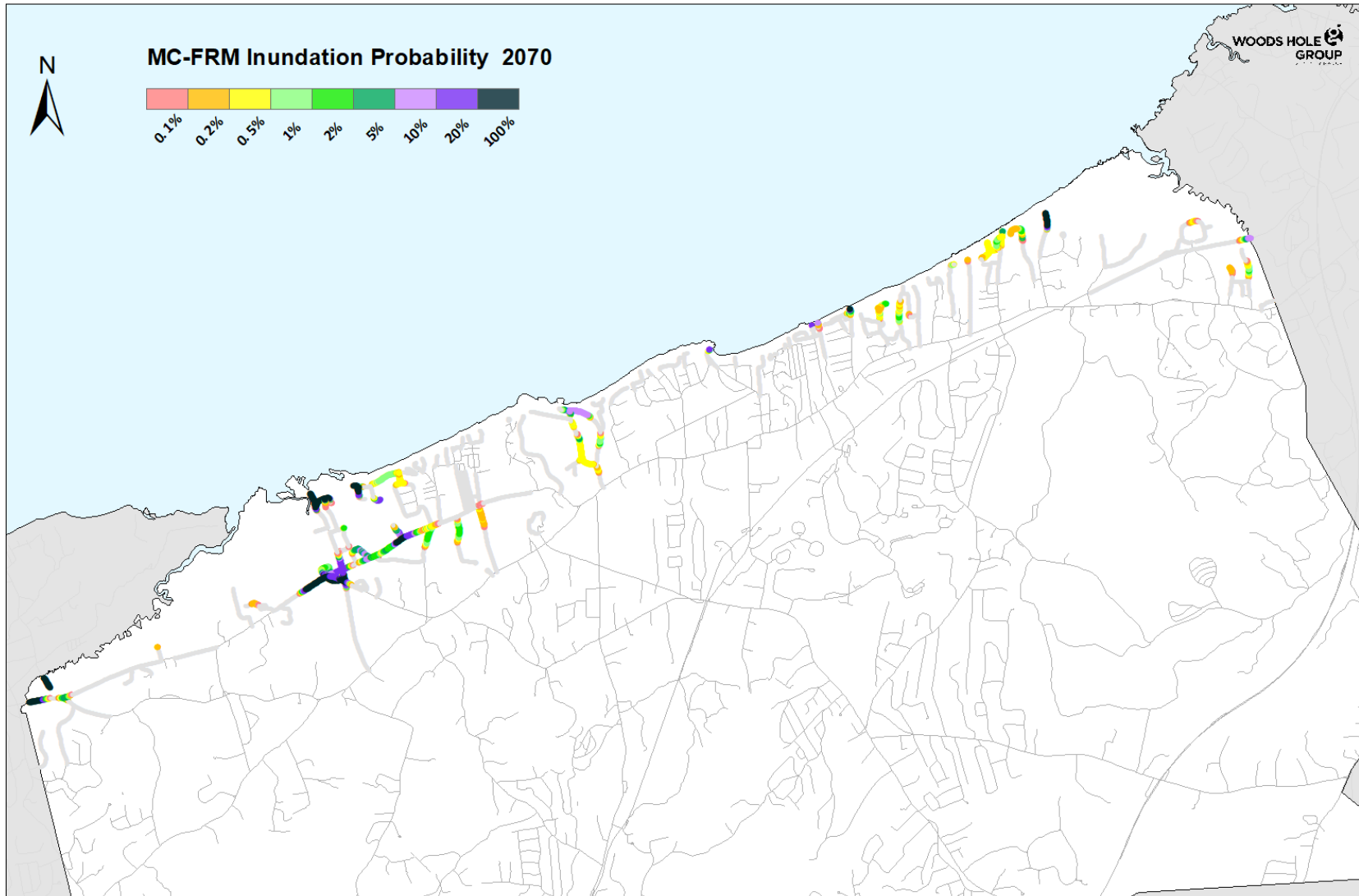
	%	Road miles
	0.1	2.1
	0.2	1.7
	0.5	1.5
	1	1.3
	2	1.1
	5	0.9
	10	0.7
	20	0.5
	100	0.0

Low Lying Roads 2050 Inundation Probability (Brewster)



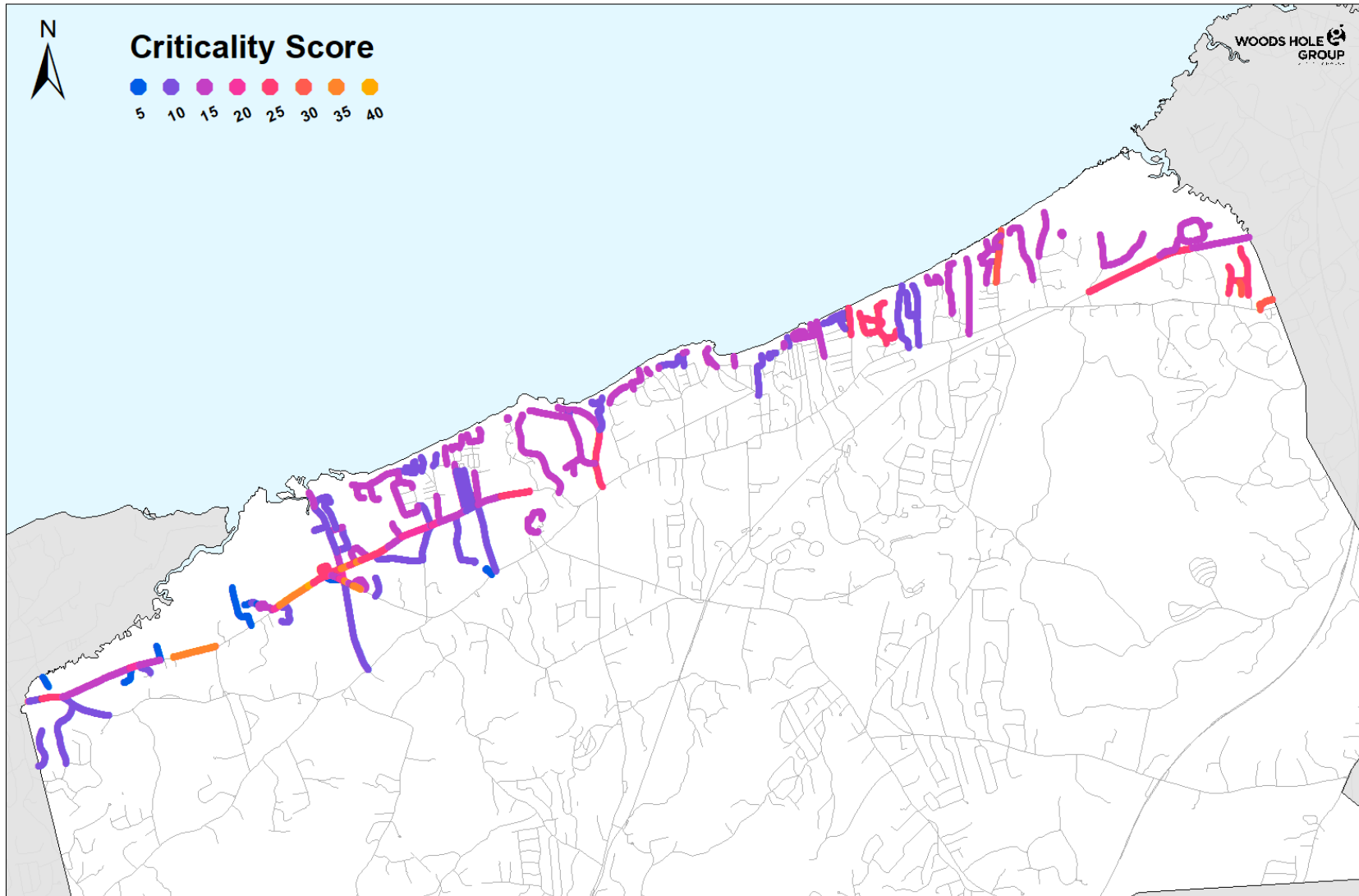
	%	Road miles
	0.1	3.4
	0.2	3.0
	0.5	2.4
	1	2.1
	2	1.7
	5	1.5
	10	1.3
	20	0.9
	100	0.5

Low Lying Roads 2070 Inundation Probability (Brewster)

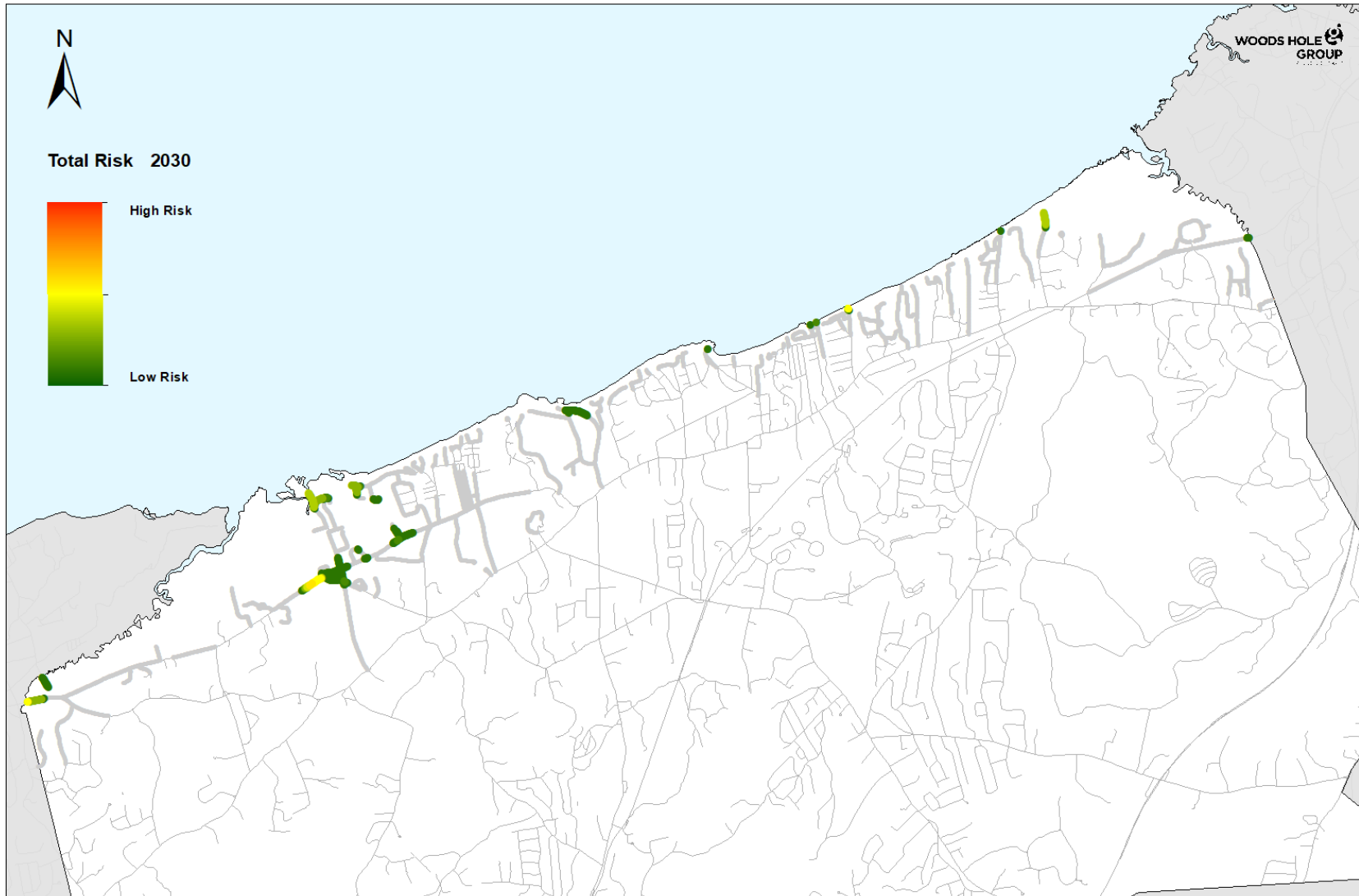


	%	Road miles
	0.1	5.6
	0.2	5.3
	0.5	4.6
	1	3.5
	2	2.9
	5	2.3
	10	2.1
	20	1.7
	100	1.0

Low Lying Roads Criticality Scoring (Brewster)

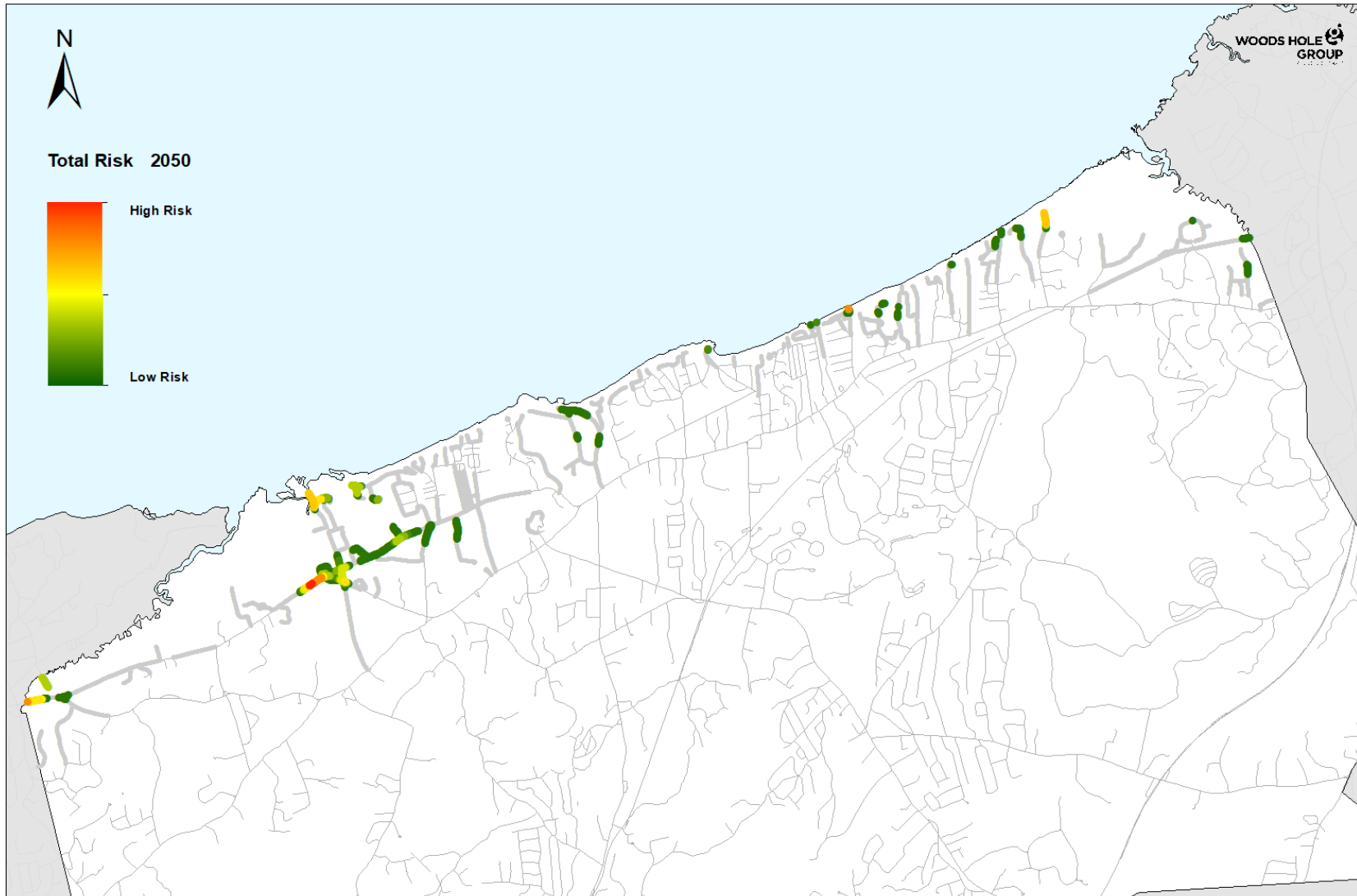


Low Lying Roads 2030 Risk Results (Brewster)



- ## High Risk Road Segments
- Route 6A (Stony Brook)*
 - Crosby Lane
 - Route 6A (Quivett Creek)*
 - Robbins Hill and Warrens Road

Low Lying Roads 2050 Risk Results (Brewster)



High Risk Road Segments

Route 6A (Stony Brook)*

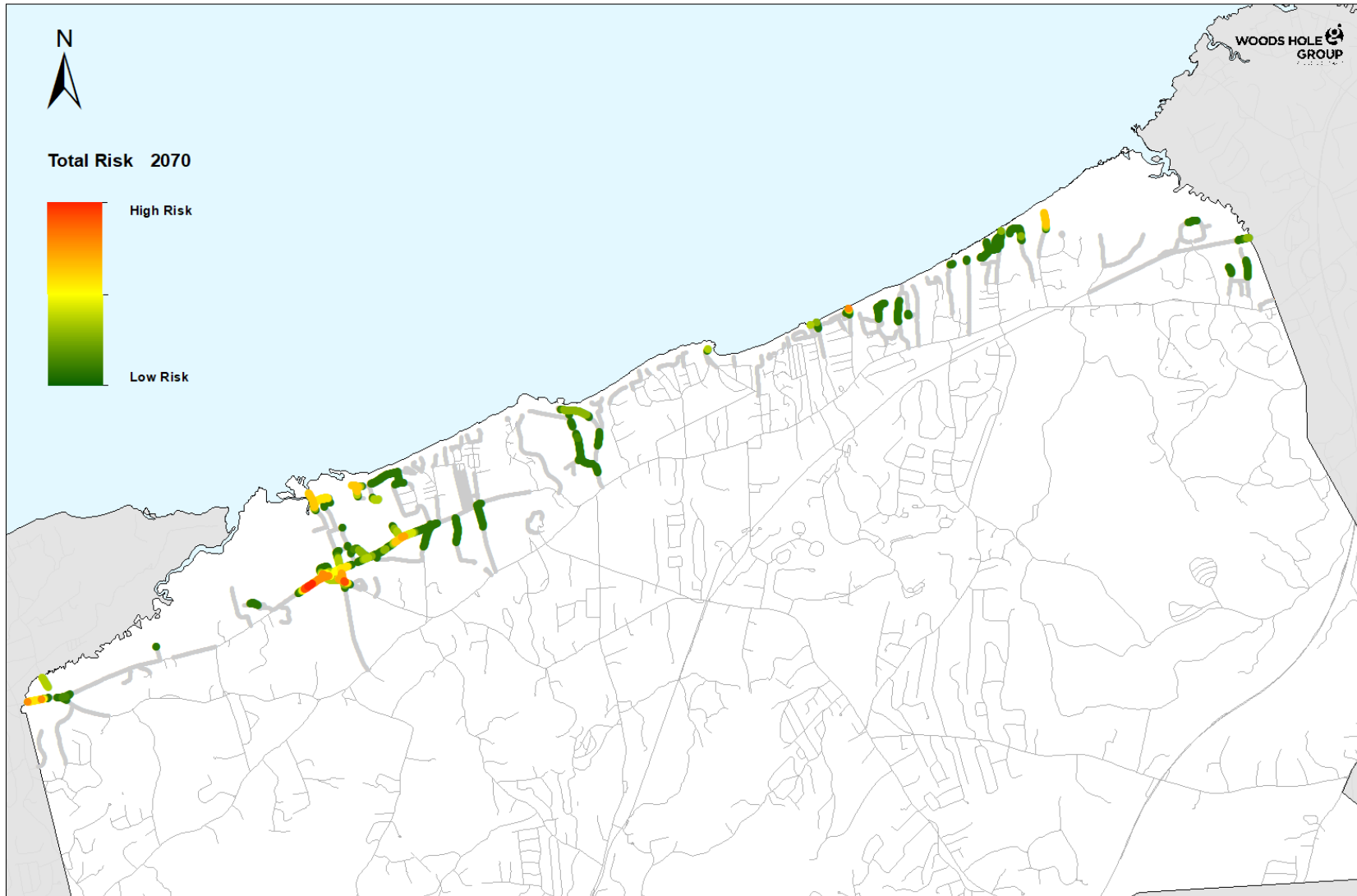
Crosby Lane

Route 6A (Quivett Creek)*

Robbins Hill and Warrens Road

Lower Road and Paines Creek Road

Low Lying Roads 2070 Risk Results (Brewster)



High Risk Road Segments

Route 6A (Stony Brook)*

Crosby Lane

Route 6A (Quivett Creek)*

Robbins Hill and Warrens Road

Lower Road and Paines Creek Road

Lower Road

Cedar Hill and Paines Creek Road

Breakwater Road

Summary of High Priority Road Segments (Brewster)

	Name	Length (ft)	Description	Segment Storm Probability (%)			Nuisance Length (ft)		
				2030	2050	2070	2030	2050	2070
A	*Route 6A (Stony Brook)	1480	Segment of Route 6A over Stony Brook	0.2-20	2-100	20-100			540
B	Crosby Lane	400	Culverted Road leading to Crosby Landing Beach	2-20	10-100	100	240		360
C	*Route 6A (Quivett Creek)	420	Segment of Route 6A at Quivett Creek	5-20	20-100	100			340
D	Robbins Hill and Warrens Road	480	Entrance to Robbins Hill Beach	2-10	20	20-100	200		380
E	Lower Road and Paines Creek Road	1440	Intersection of Lower Road and Paines Creek Rd	0.1-2	1-20	10-100			80
F	Lower Road	660	Segment in front of Bloomer Path	0.2-5	2-20	20-100			
G	Cedar Hill and Paines Creek Road	880	Private Road w/ Water and home access	5-20	20-100	100	240		780
H	Breakwater Road	720	Road with access to Breakwater Beach	0.1	1	10			

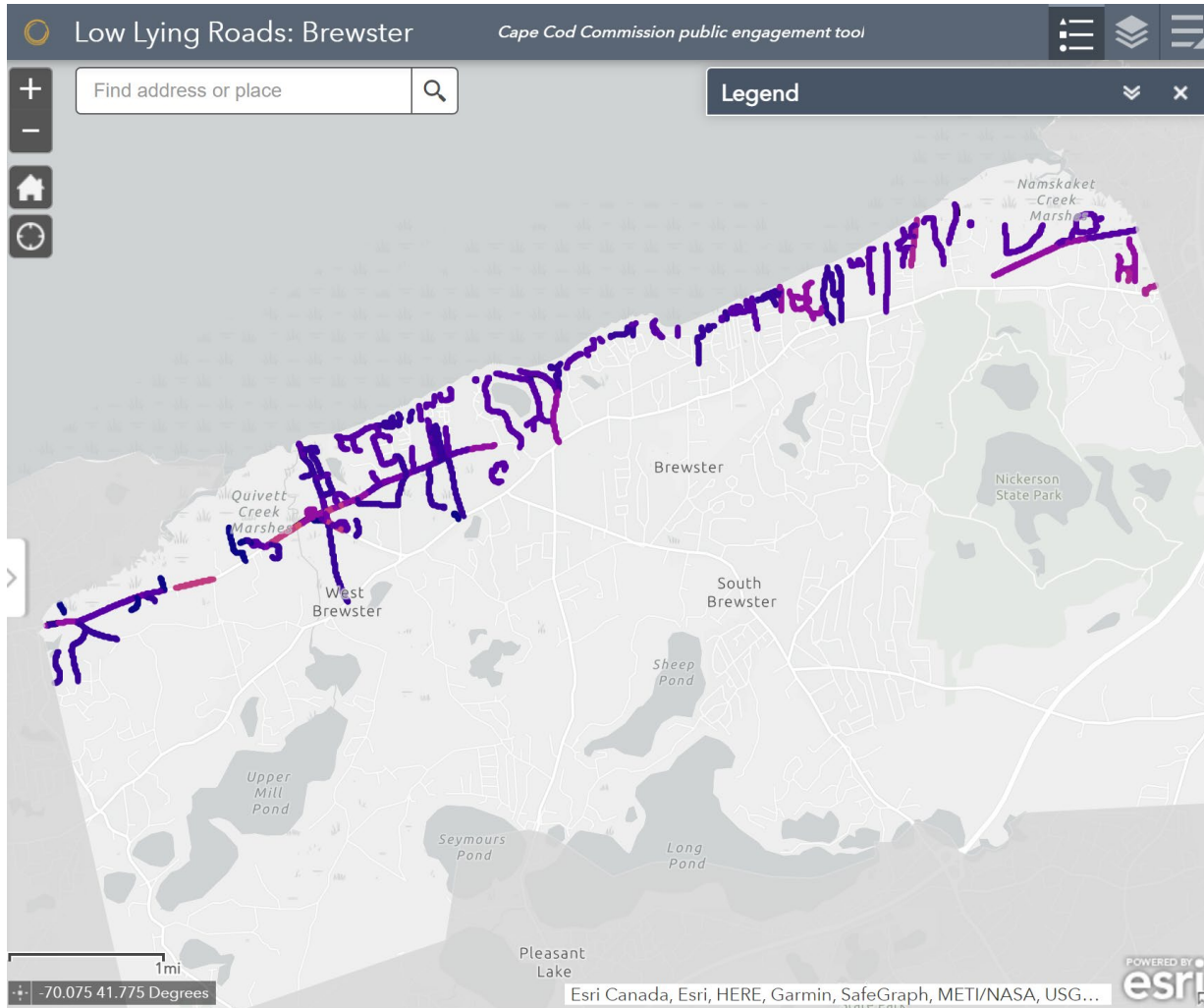
* = MassDOT roadway

Questions?

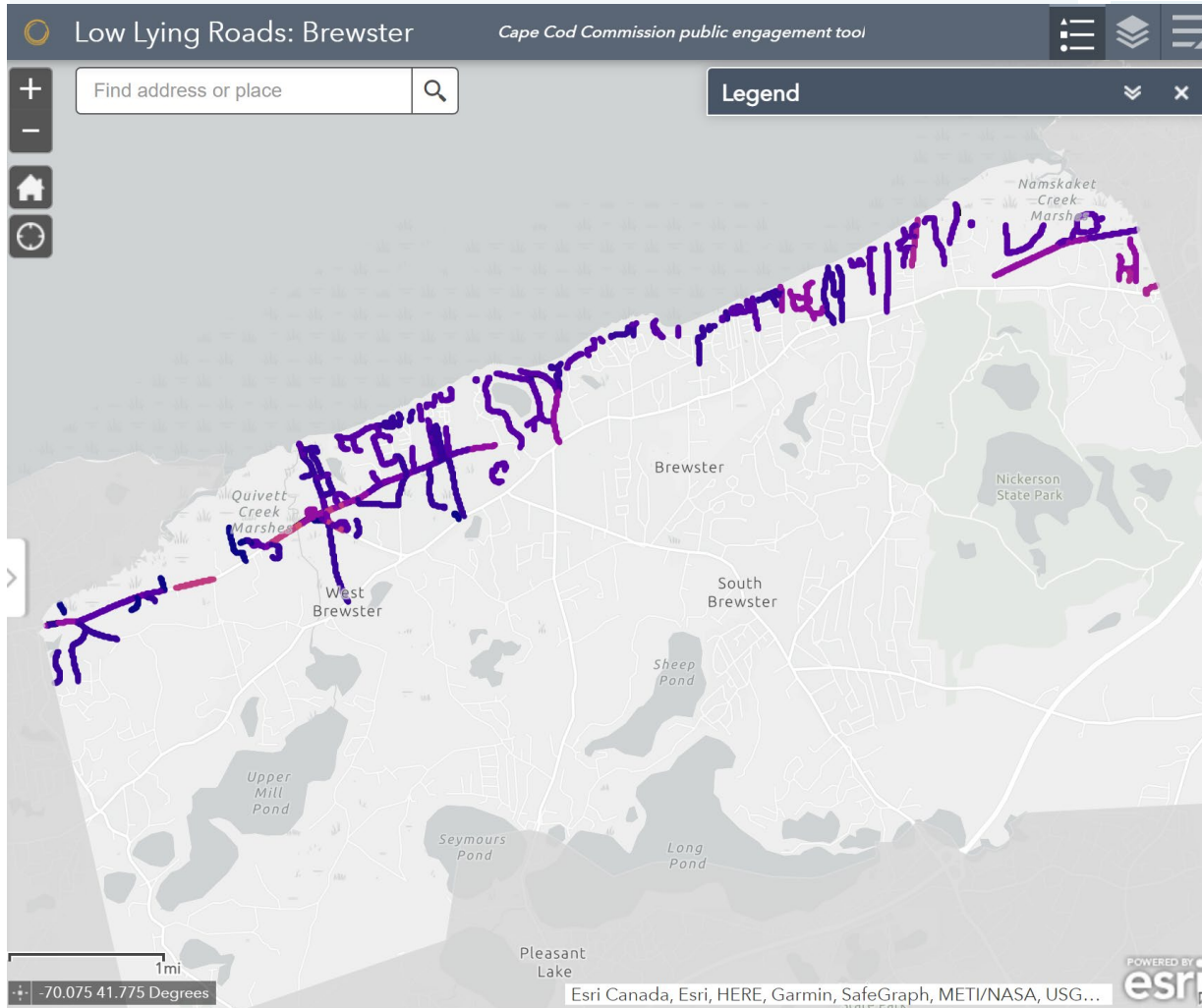
- Workshop Purpose or Objectives
- Low Lying Roads project
 - Key components
 - Vulnerability Assessment - Identify Potential Sites
 - Public Outreach and Engagement
 - Roadway Feasibility and Alternative Solutions
 - Solutions Identification
 - Timeline

LOW LYING ROADS

Group Discussion



**DISCUSSION
ORIENTATION**



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 (Brewster)

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Breakout Groups

Breakout Group Discussion

GETTING STARTED

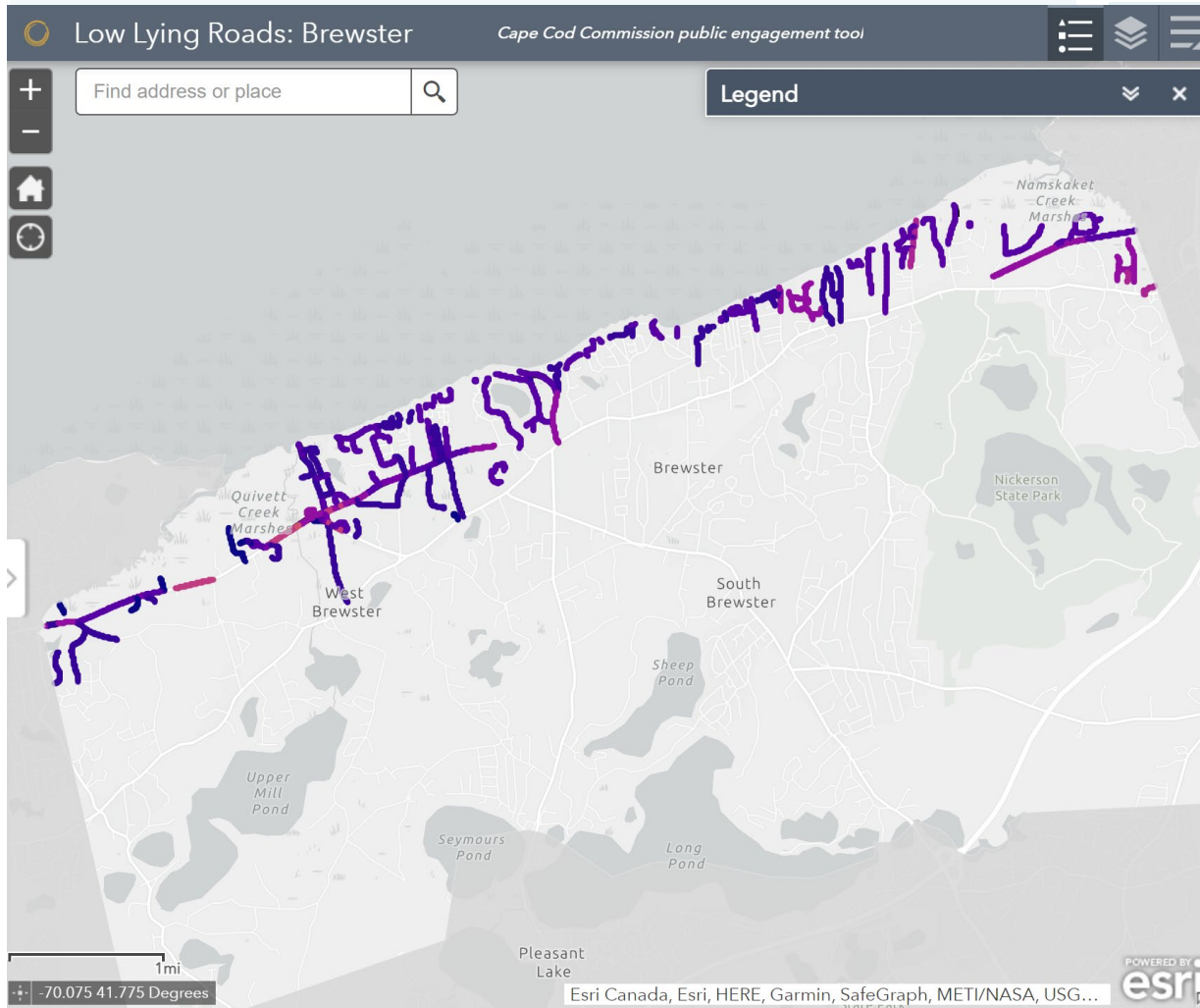
- Introductions
- Clarifying Questions

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

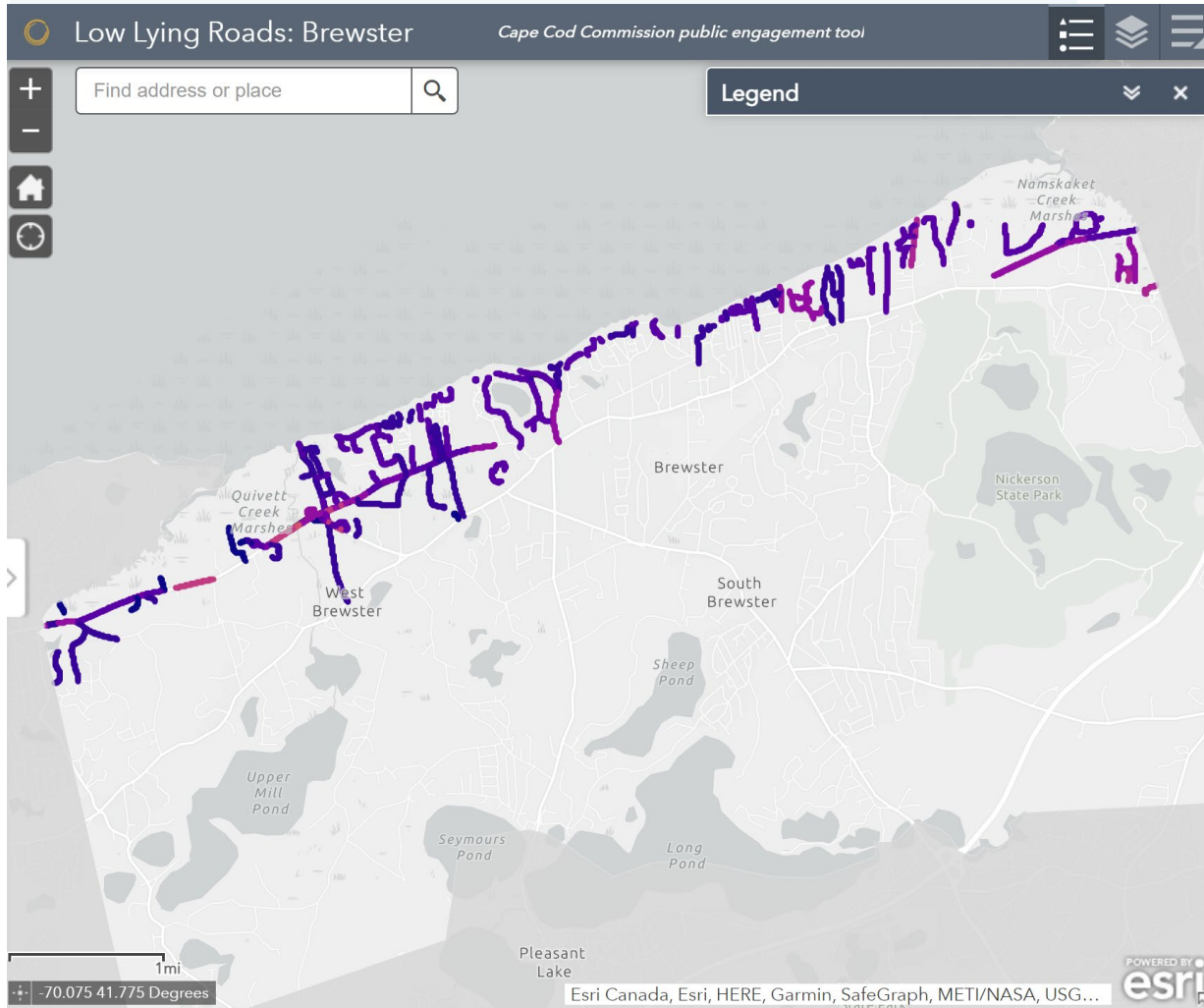
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LOW LYING ROADS

Group Discussion



**REPORT
BACK**

SYNTHESIS



Low Lying Roads: Brewster

[Home](#) > [Work](#) > [Low Lying Roads: Brewster](#)

Start Date: 2021

[Overview](#)

[Workshop Materials](#)

[Data Viewer](#)

[Top 10 Road Segments](#)

Overview

NEXT STEPS

- 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/>
- 2nd Workshop date TBD – winter 2023

THANK YOU!
