Low-lying Roads: Mashpee

Project funded by the Municipal Vulnerability Preparedness Program

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**
- **Identify priority road segments for design and permitting**

Agenda

- Project Overview – CCC
- Vulnerability and Risk Assessment – WHG
- Results of Low-Lying Roads Screening & Prioritization – WHG
- Discussion – CCC & WHG
- Next Steps – CCC
- Workshop concludes ~ 6:30 pm

Low-Lying Roads 2

5

TOWNS

Chatham
Falmouth
Harwich
Mashpee
Provincetown

- 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

Hazards

Storms, Sea Level Rise, & Flooding


Wixon Dock, Harwich Police


Lieutenants Island Bridge

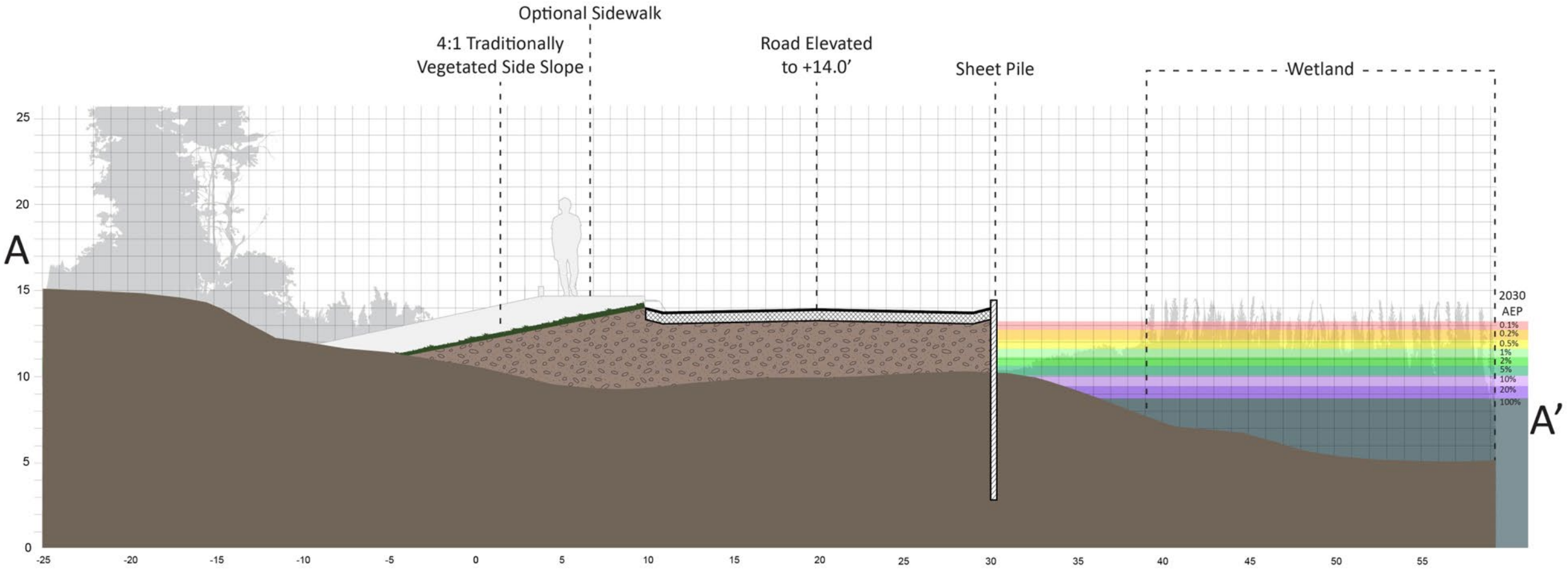

Provincetown East End, webcam

Adaptation Strategies

- Gray Infrastructure, or Traditional Engineering Structures
- Green Infrastructure, or Nature-based Solutions
- Other approaches – Hybrid, Planned Relocation, Abandonment

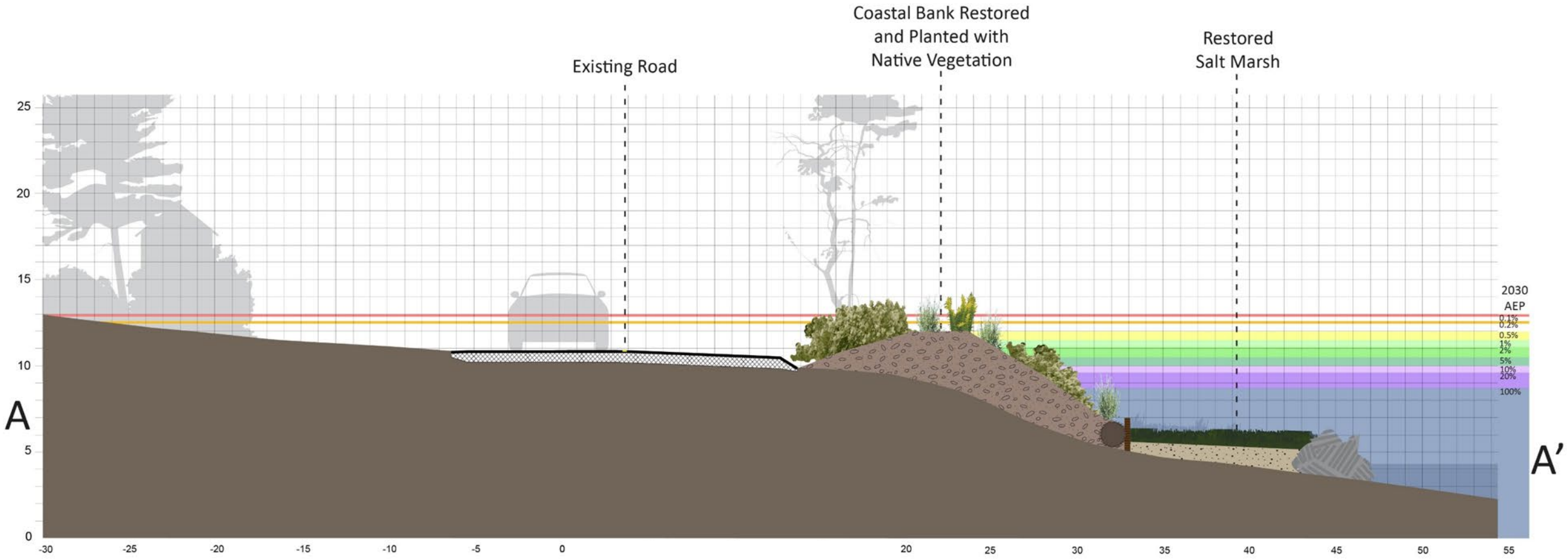
ADAPTATION STRATEGIES

GRAY/TRADITIONAL ENGINEERING



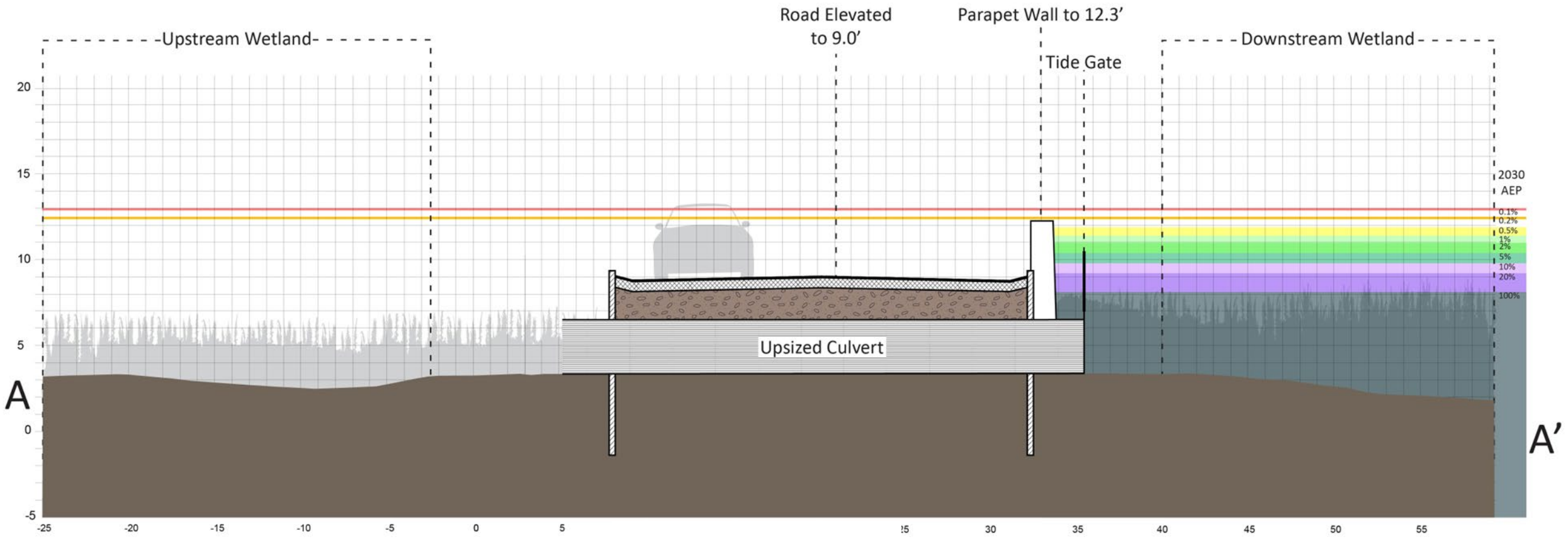
ADAPTATION STRATEGIES

GREEN/NATURE-BASED SOLUTIONS



ADAPTATION STRATEGIES

HYBRID APPROACHES



PROJECT TIMELINE & ELEMENTS

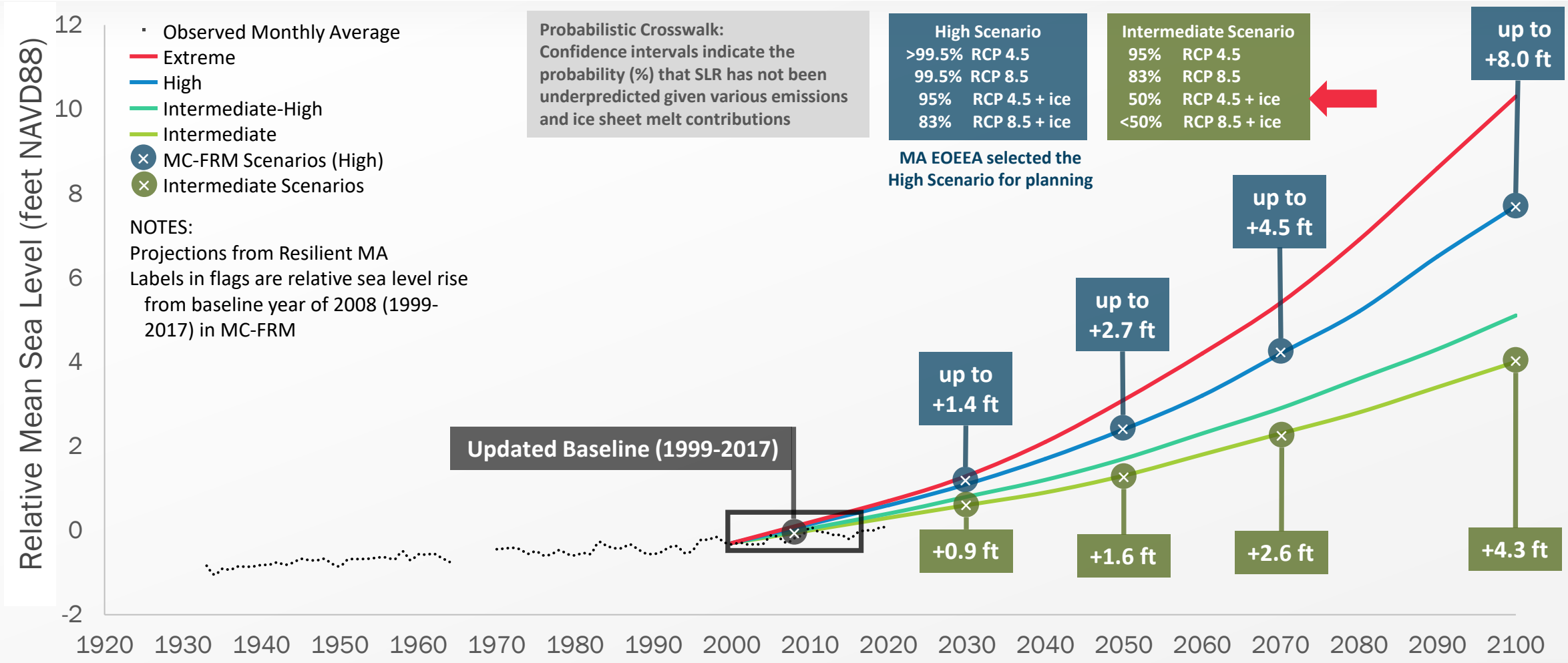
March 2023	April 2023	May 2023	Summer 2023	Spring 2024
Vulnerability Assessment: Roads and Bridges 3 Future Time Horizons - 2030, 2050, 2070	Criticality Assessment: Prioritize Roadway Segments	1st Workshop: Vulnerable & At-Risk Roads	Roadway analysis & solutions ID	2nd Workshop: Present alternatives

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

MA EOEEA Probabilistic Sea Level Rise Projections

MC-FRM SOUTH (DeConto & Kopp, 2017)



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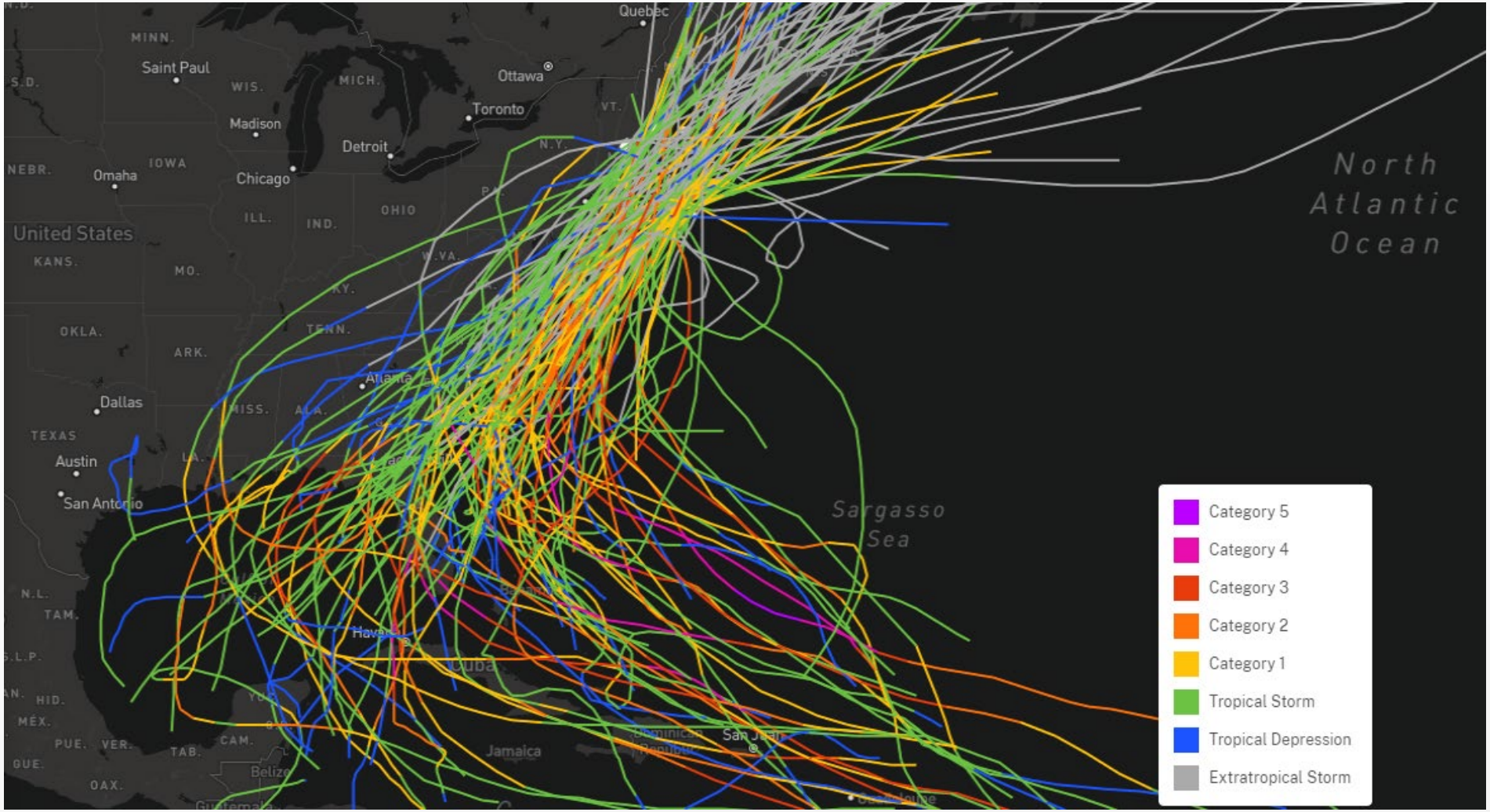
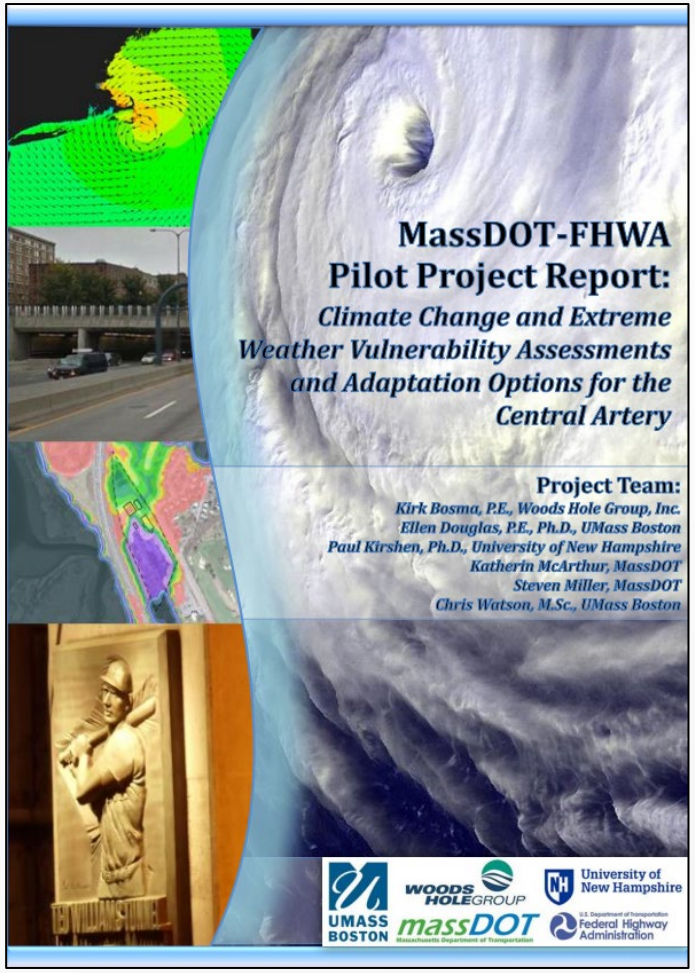
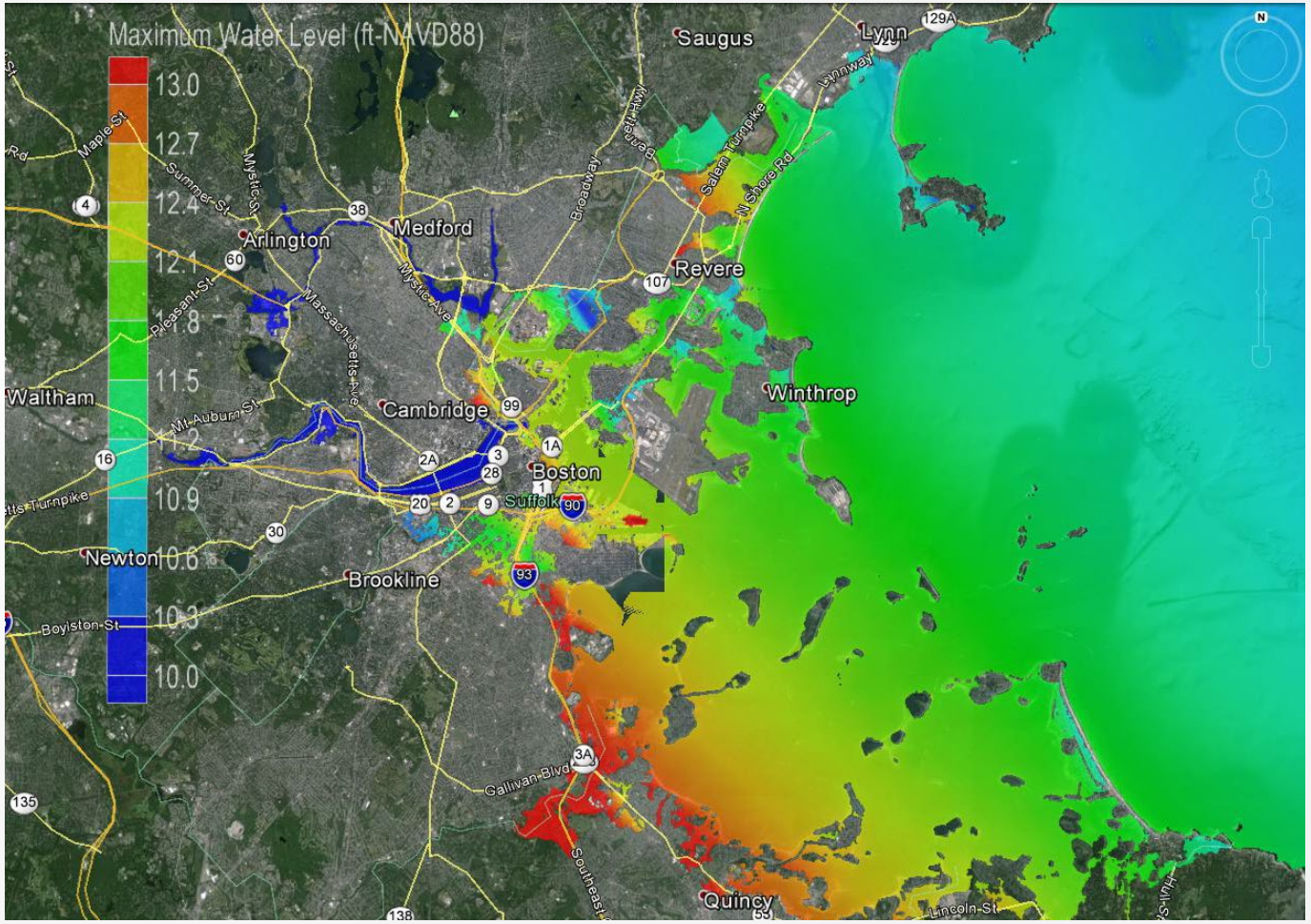
Tropical / Extra-tropical Storms



NOAA National Ocean Service

Why Hydrodynamic Modeling? Why Probabilistic?





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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

OUTPUTS

- FLOOD PROBABILITY
- FLOOD DEPTH
- FLOOD DURATION
- FLOOD VOLUMES
- FLOOD PATHWAYS
- WINDS
- WAVES
- CURRENTS

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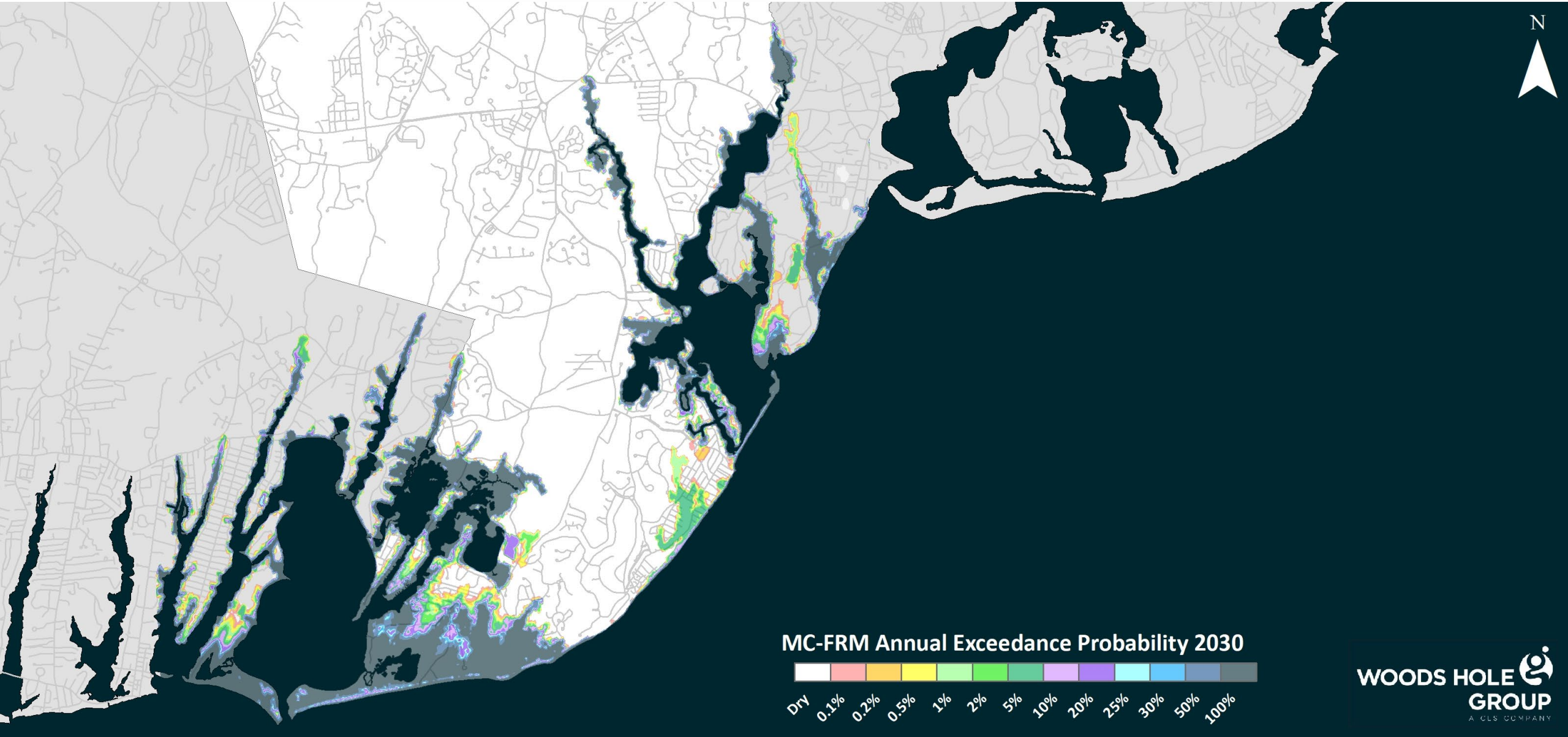
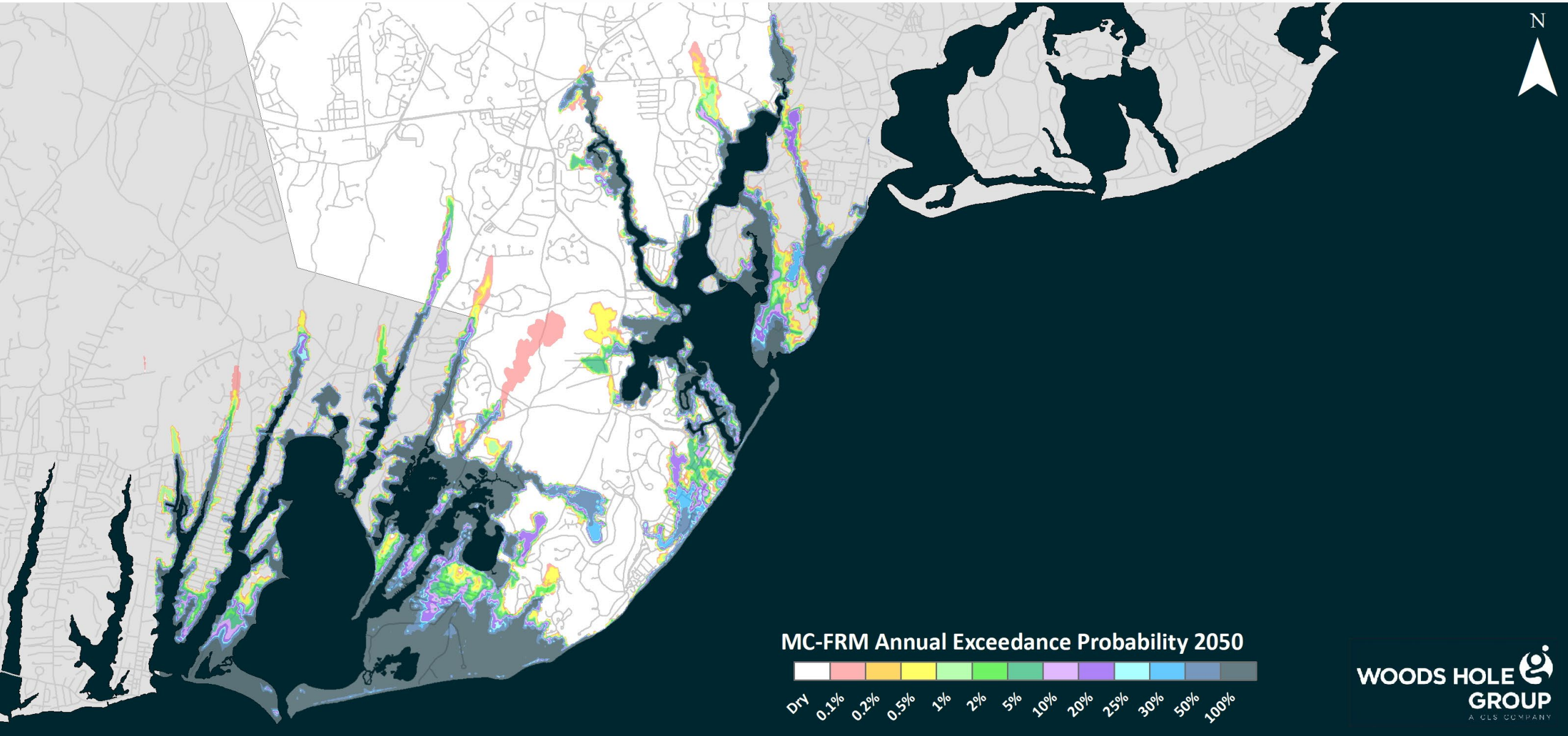
MC-FRM Resolution - Mashpee

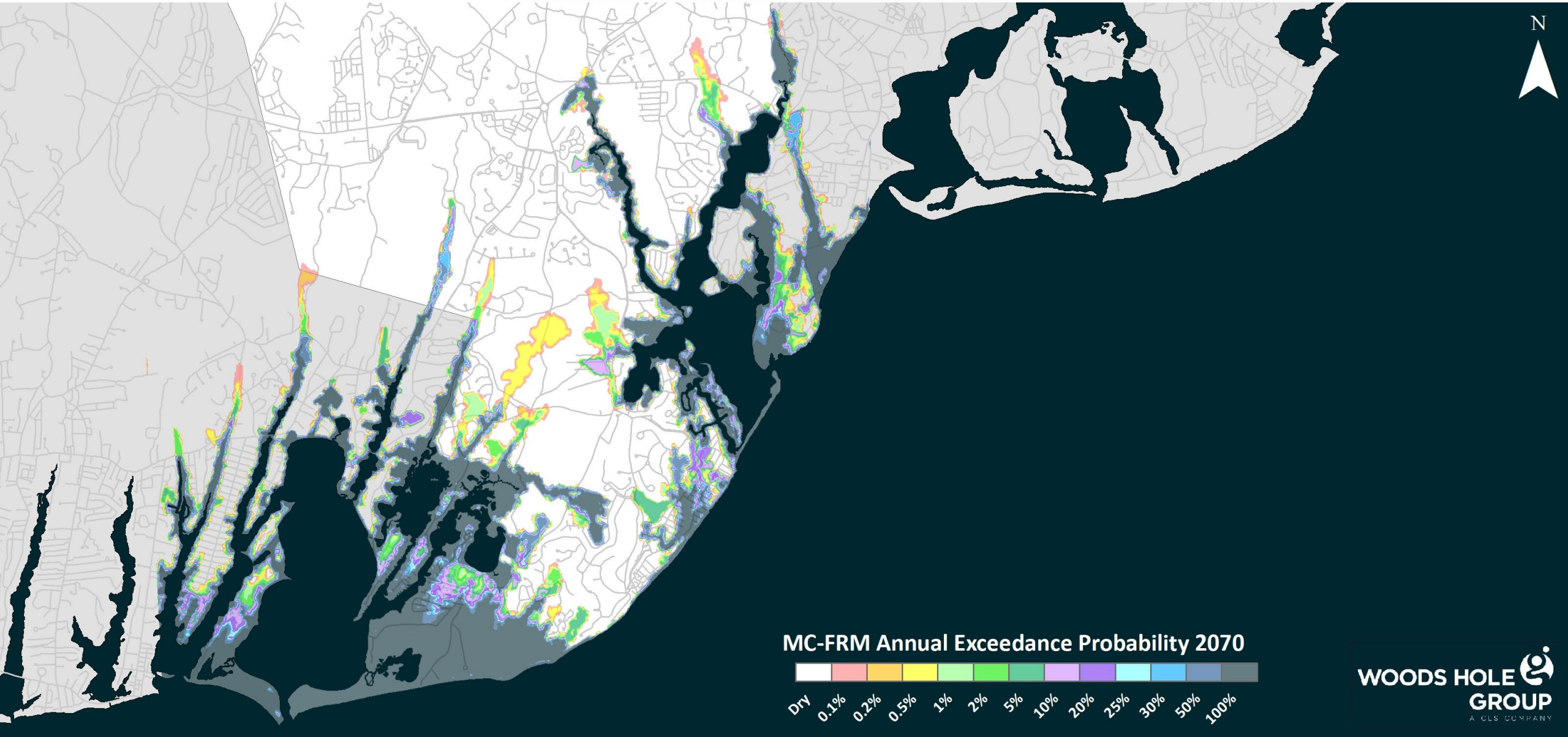
MC-FRM Annual Coastal Flood Exceedance Probability – 2030



MC-FRM Annual Coastal Flood Exceedance Probability – 2050



MC-FRM Annual Coastal Flood Exceedance Probability – 2070



MC-FRM Annual Exceedance Probabilities

	0.1%	1/1000
	0.2%	1/500
	0.5%	1/200
	1%	1/100
	2%	1/50
	5%	1/20
	10%	1/10
	20%	1/5
	25%	1/4
	30%	1/3.33
	50%	1/2
	100%	1/1

Image source: amazon.com/stores/Brybelly

Image source: dicegamedepot.com

Image source: dicegamedepot.com

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Cumulative Probability

AEP	Return	Cumulative Probability (P_e) of 1 or more events occurring over:			
		10-yrs	25-yrs	50-yrs	100-yrs
0.1%	1/1000	1.0%	2.5%	4.9%	9.5%
0.2%	1/500	2.0%	4.9%	9.5%	18.1%
0.5%	1/200	4.9%	11.8%	22.2%	39.4%
1%	1/100	9.6%	22.2%	39.5%	63.4%
2%	1/50	18.3%	39.7%	63.6%	86.7%
5%	1/20	40.1%	72.3%	92.3%	99.4%
10%	1/10	65.1%	92.8%	99.5%	100%
20%	1/5	89.3%	99.6%	100%	100%
25%	1/4	94.4%	99.9%	100%	100%
30%	1/3.33	97.2%	100%	100%	100%
50%	1/2	99.9%	100%	100%	100%
100%	1/1	100%	100%	100%	100%

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Massachusetts Coast Flood Risk Model

SUMMARY

- Hydrodynamically modeled projections
- Sea level rise and storm surge – combined
- Annual chance of flooding under 2030/2050/2070 climate conditions

QUESTIONS?

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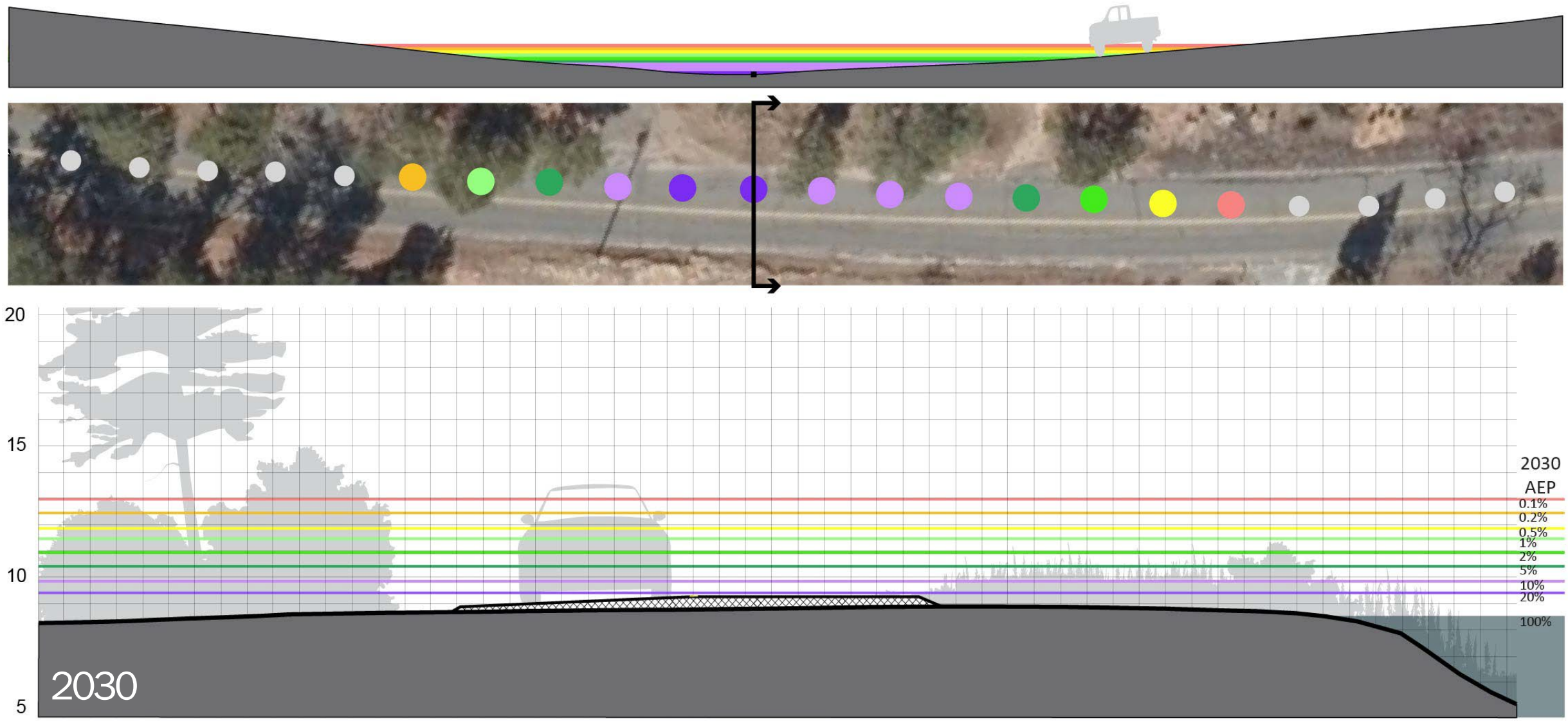
Cape Cod Low Lying Roads Vulnerability Assessment Methods

COASTAL FLOOD EXCEEDANCE PROBABILITY

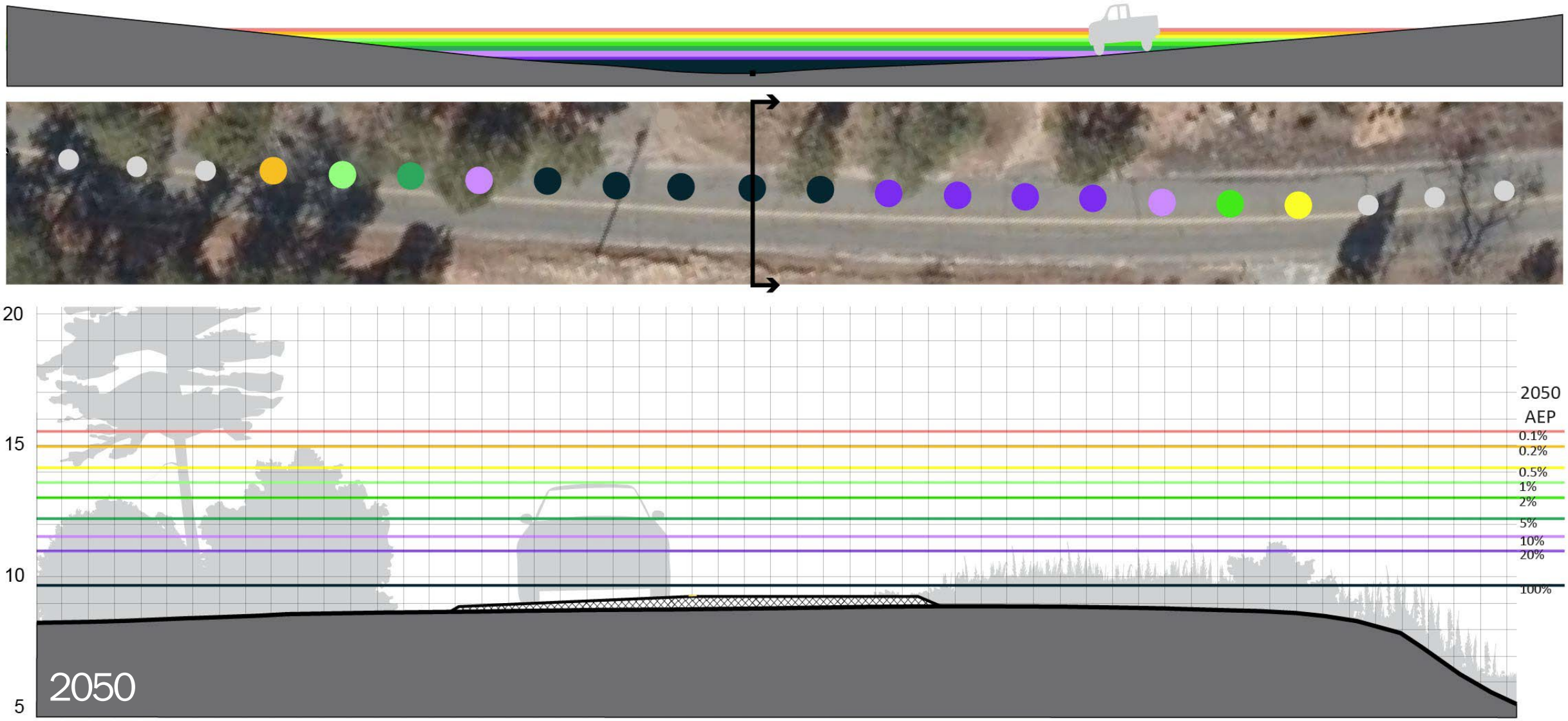
Cape Cod Low Lying Roads Vulnerability Assessment Methods

COASTAL FLOOD EXCEEDANCE PROBABILITY



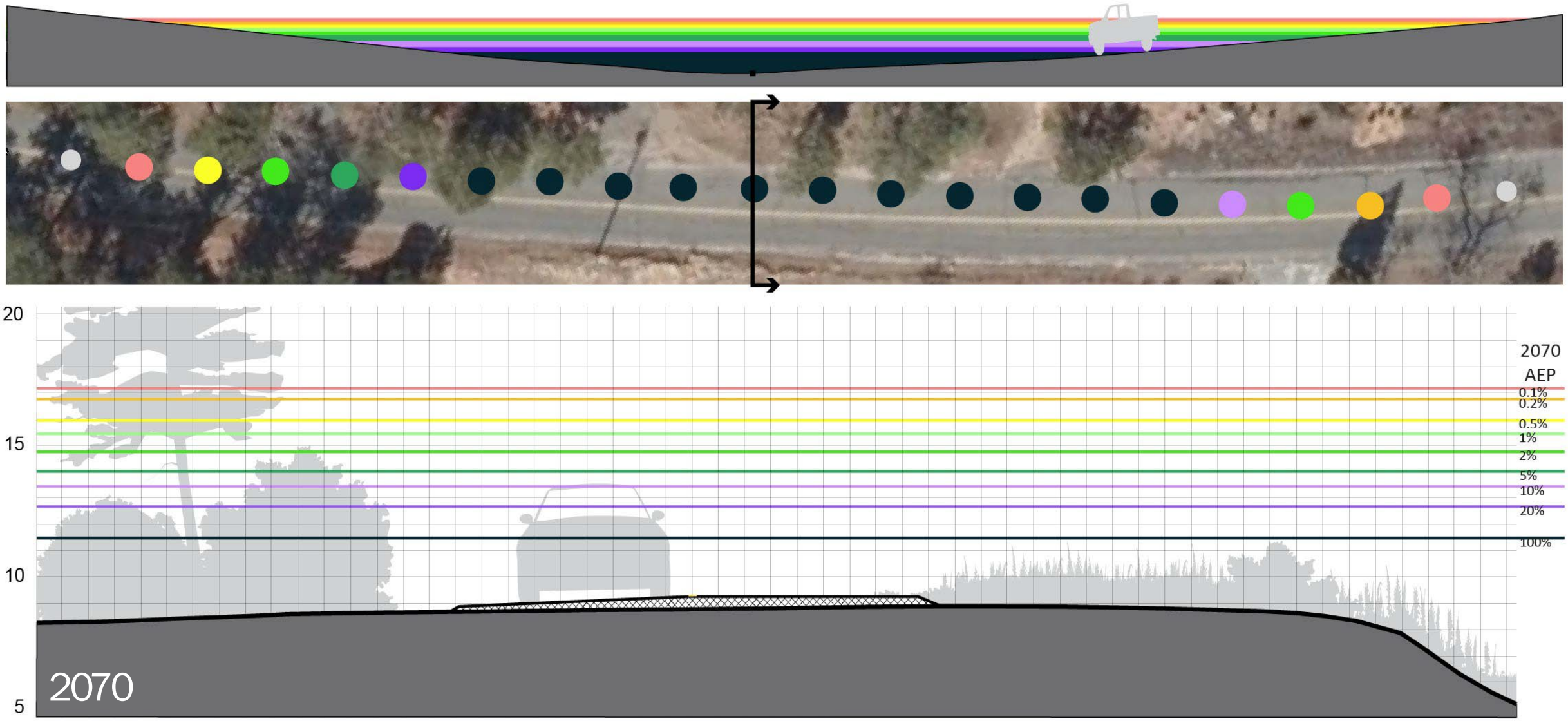
Cape Cod Low Lying Roads Vulnerability Assessment Methods

COASTAL FLOOD EXCEEDANCE PROBABILITY



Cape Cod Low Lying Roads Vulnerability Assessment Methods

COASTAL FLOOD EXCEEDANCE PROBABILITY



Cape Cod Low Lying Roads Criticality Scoring Framework

Community / Emergency Services

Schools
Town Hall
Transit Facilities
Senior Services
Communications
Community Centers
Hospital / Urgent Care
Police Station
Fire Station
Harbormaster Office
Emergency Shelters
DPW Facilities

Usage/Network Function

MassDOT Functional Classification
Average Annual Daily Traffic

Vulnerable Populations

Environmental Justice Populations
Social Vulnerability Index (Housing /Transportation)

Economy

Business Activity Density

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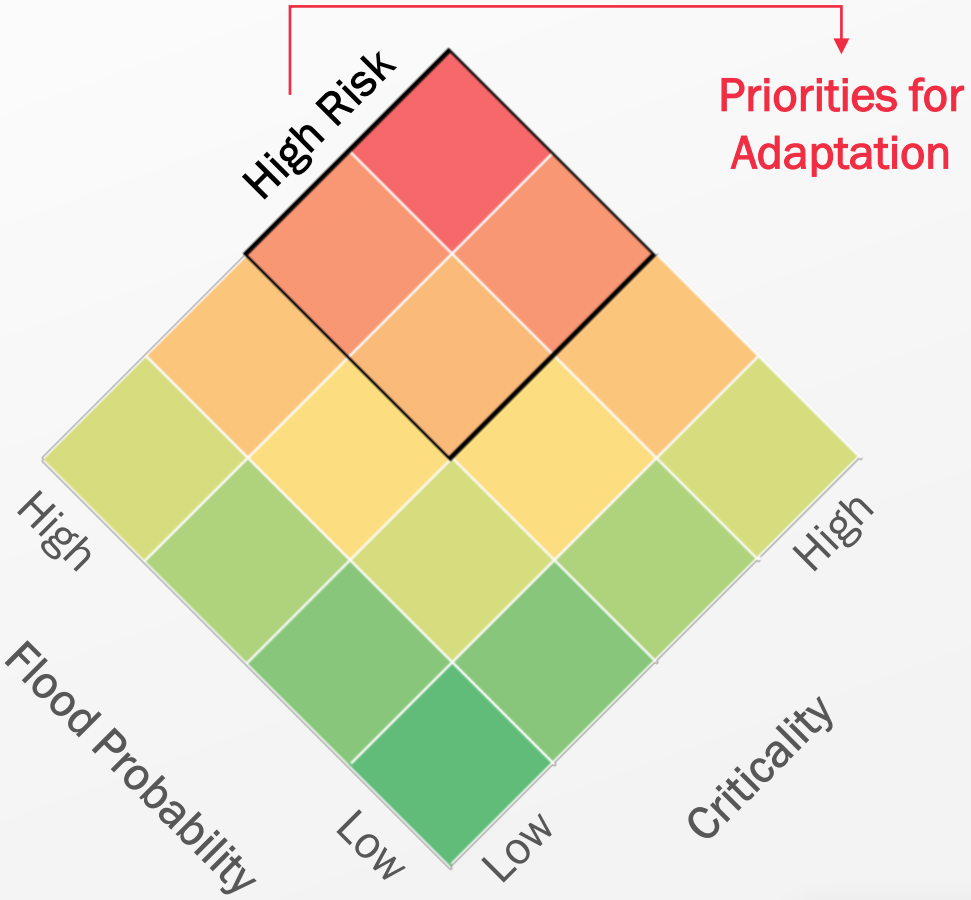
Cape Cod Low Lying Roads Risk Assessment Approach

1. Extract roadway/bridge critical elevations (CEs)
2. Compile 2030/2050/2070 MC-FRM water surface elevations (WSEs)
3. Compare CEs to WSEs to determine flood probability
4. Score road segment criticality
5. Probability * Criticality = Risk
6. Prioritize high-risk road segments for community consideration



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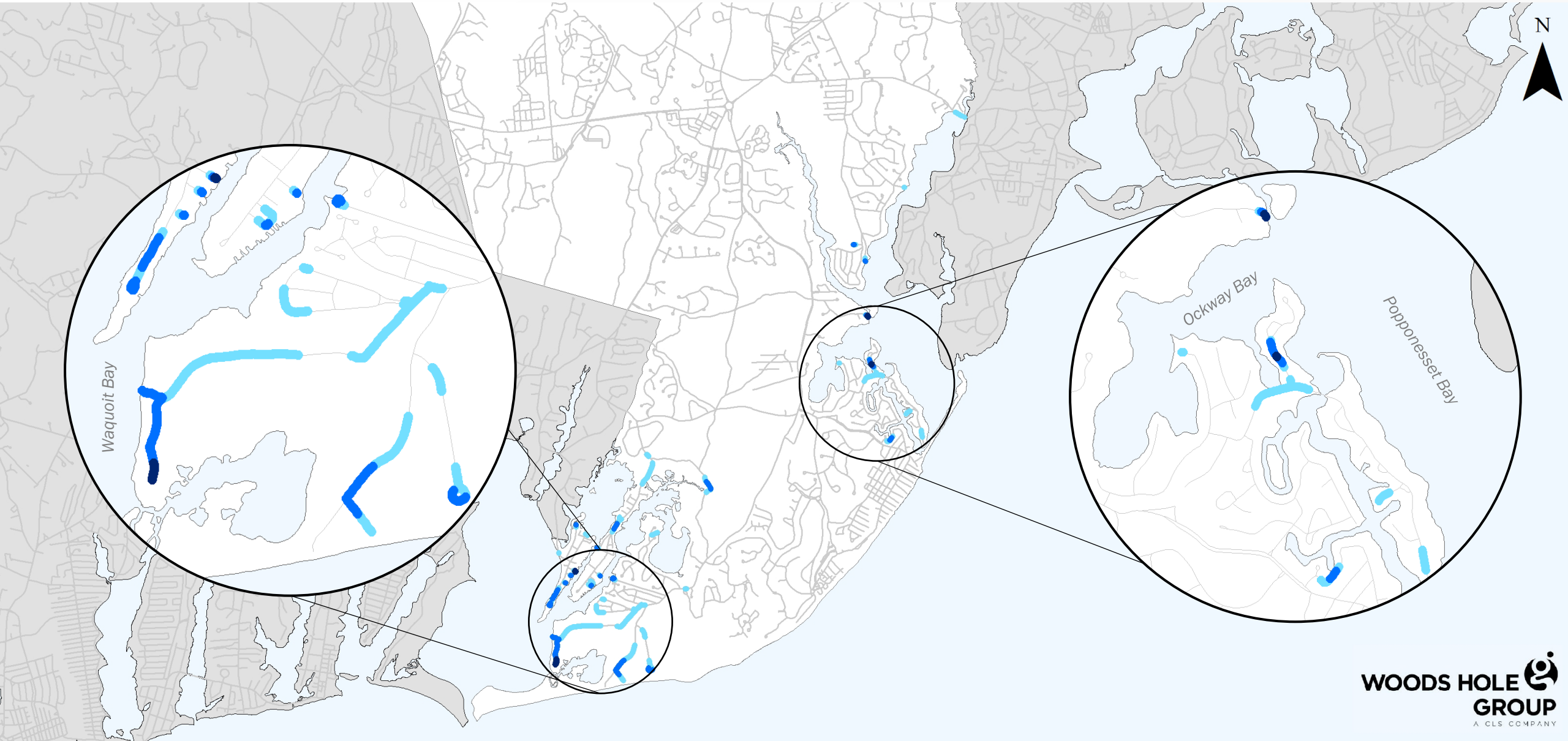
Low Lying Roads Nuisance Flooding

Road Surface Elevations Below MHW

- 2070 (3.5 mi)
- 2050 (1.0 mi)
- 2030 (0.1 mi)



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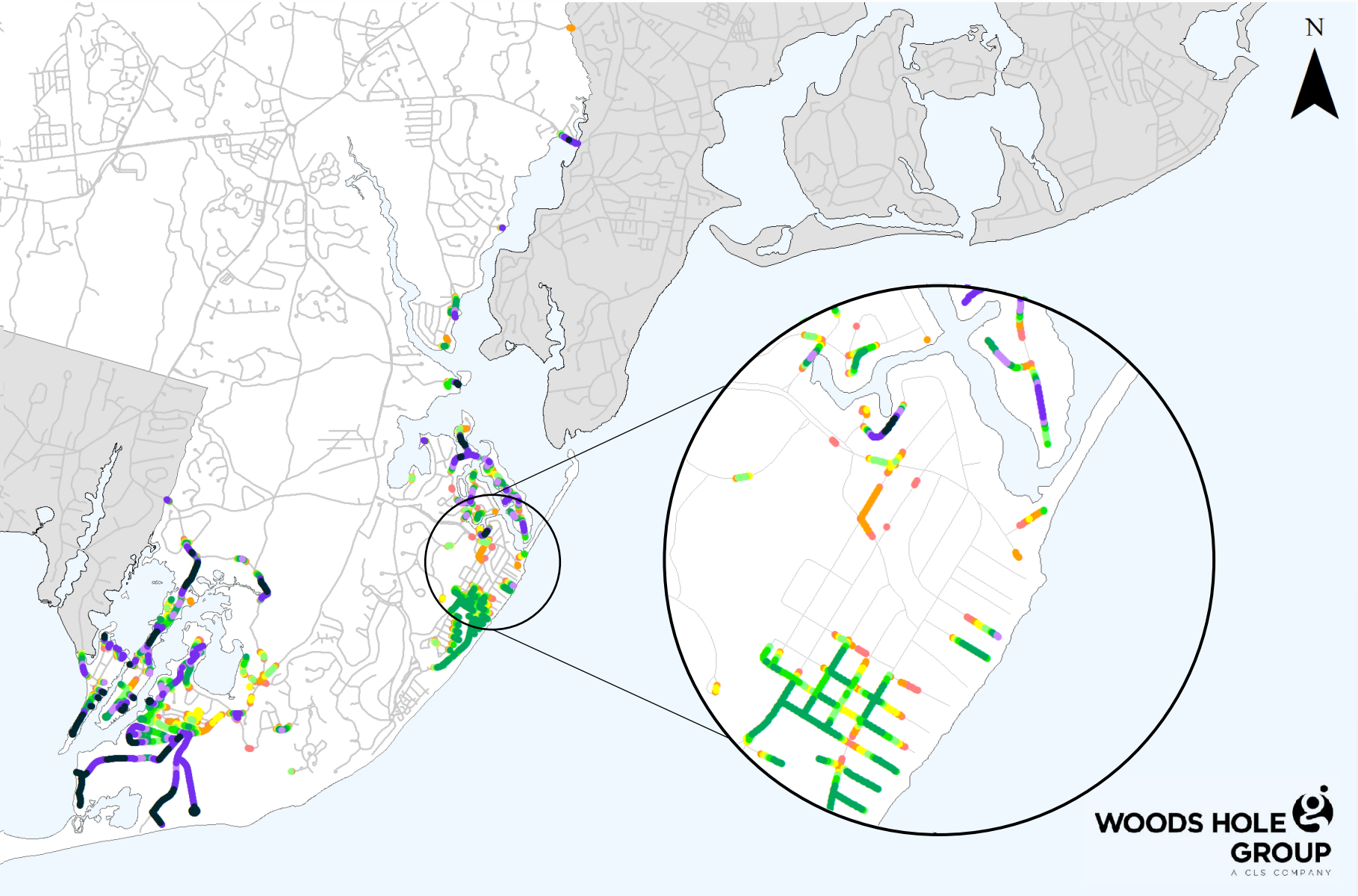
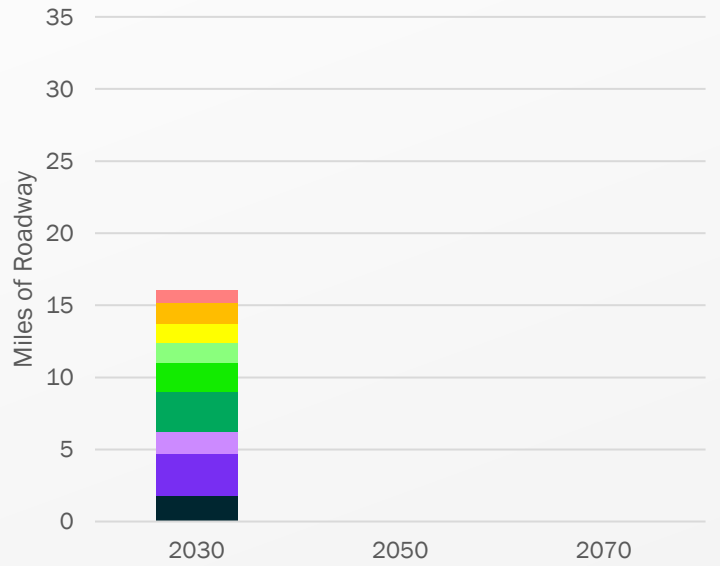
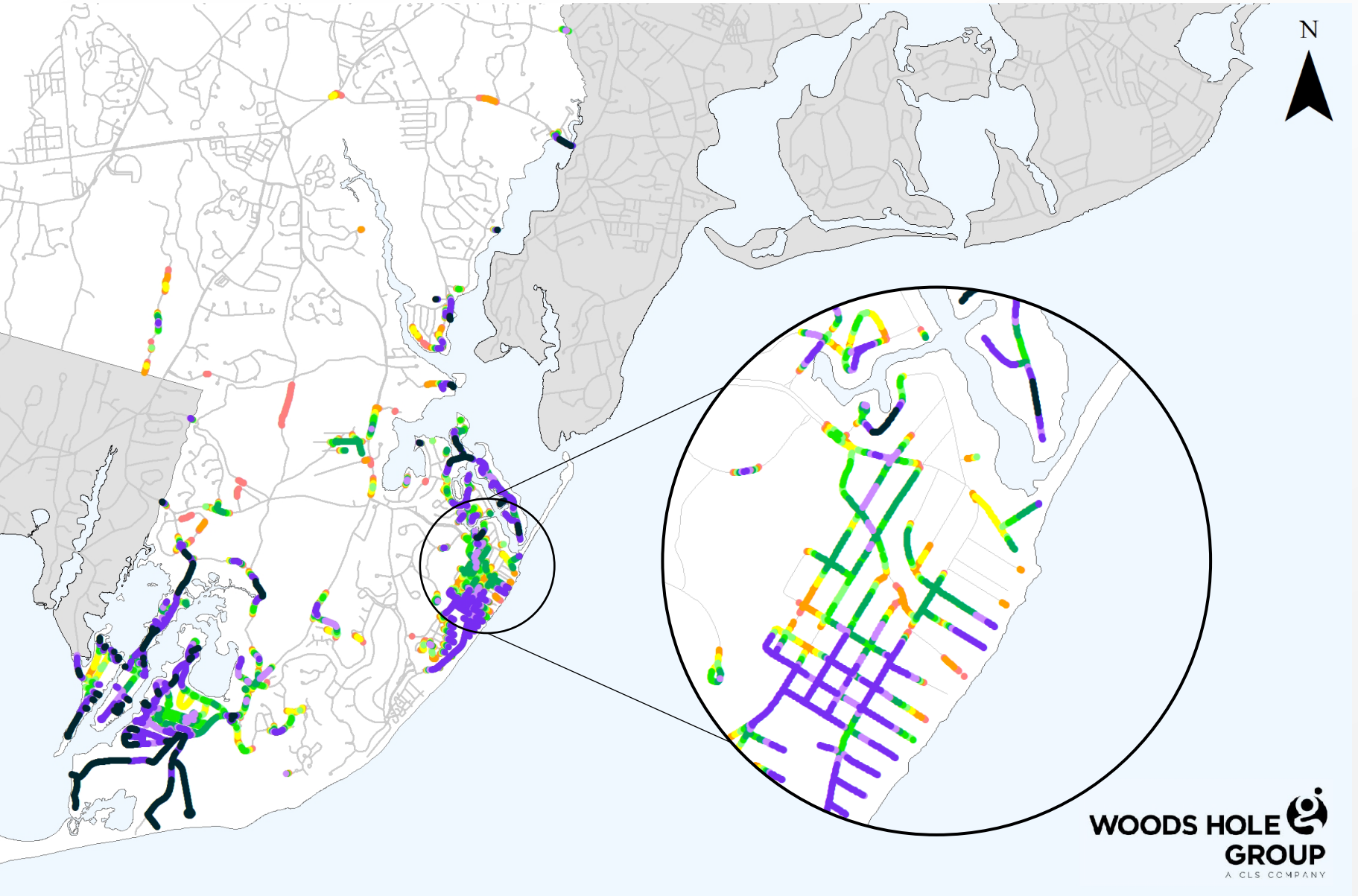
Low Lying Roads 2030 Flood Probability (Annual Exceedance Probability)

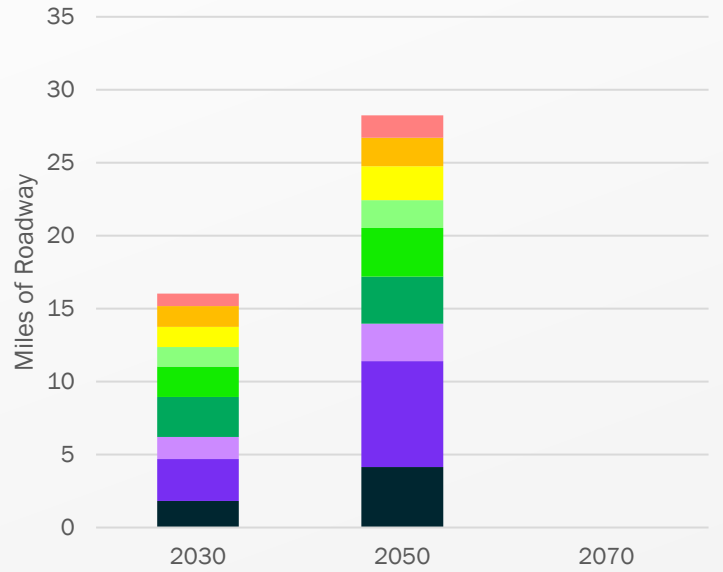




Flood Probability	Total Road Miles
0.1%	16.1
0.2%	15.2
0.5%	13.8
1%	12.4
2%	11.1
5%	9.0
10%	6.2
20%	4.7
100%	1.8

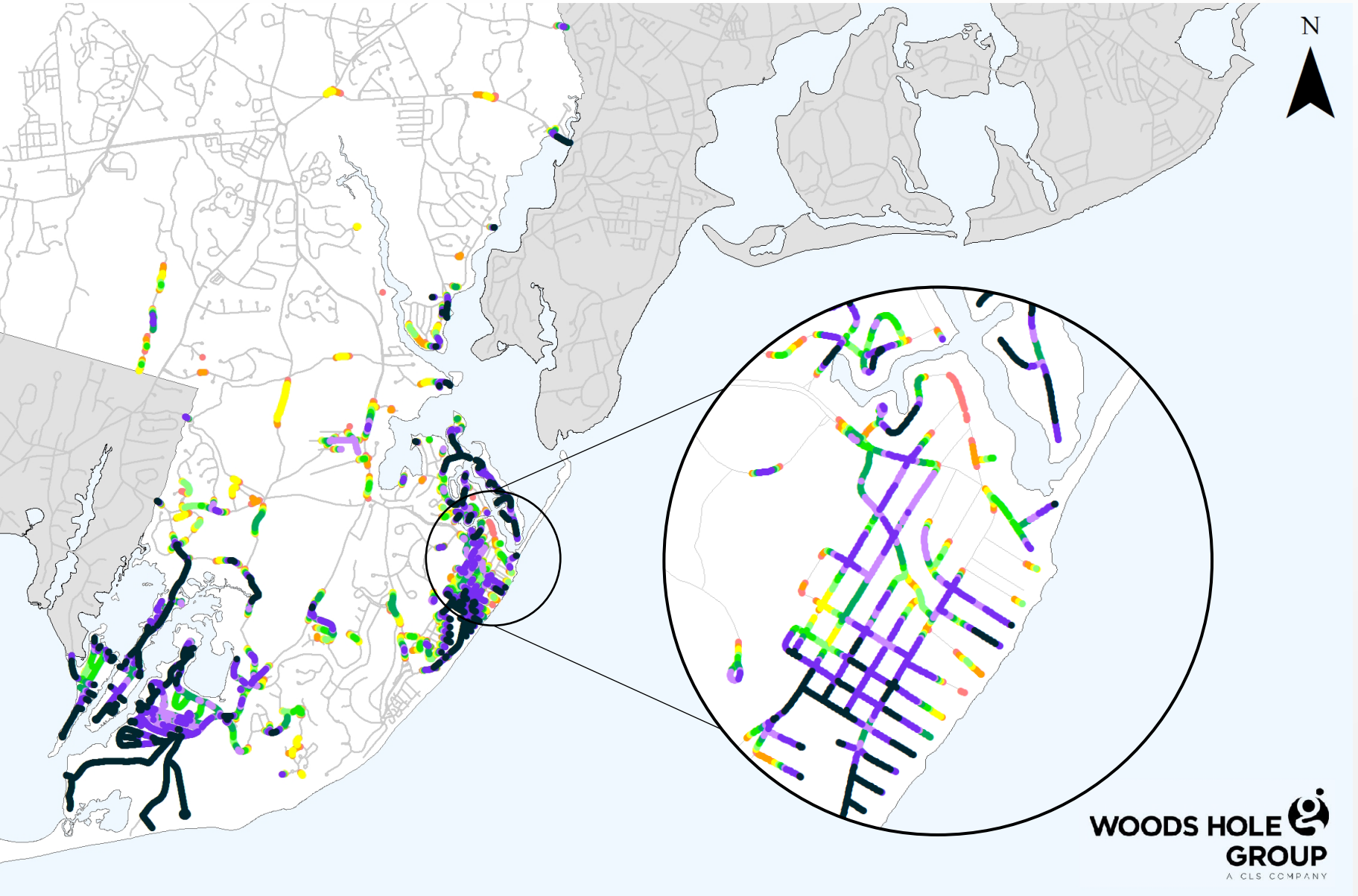
Low Lying Roads 2050 Flood Probability (Annual Exceedance Probability)

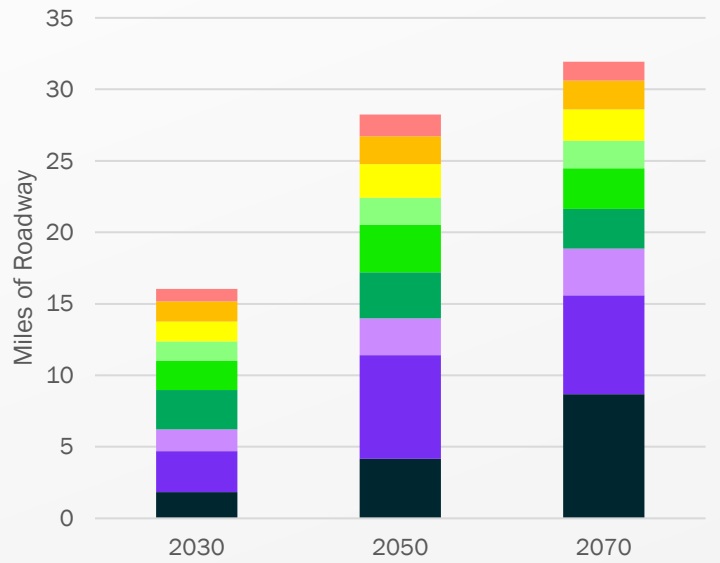




Flood Probability	Total Road Miles
0.1%	28.1
0.2%	26.6
0.5%	24.7
1%	22.4
2%	20.5
5%	17.2
10%	14.0
20%	11.4
100%	4.2

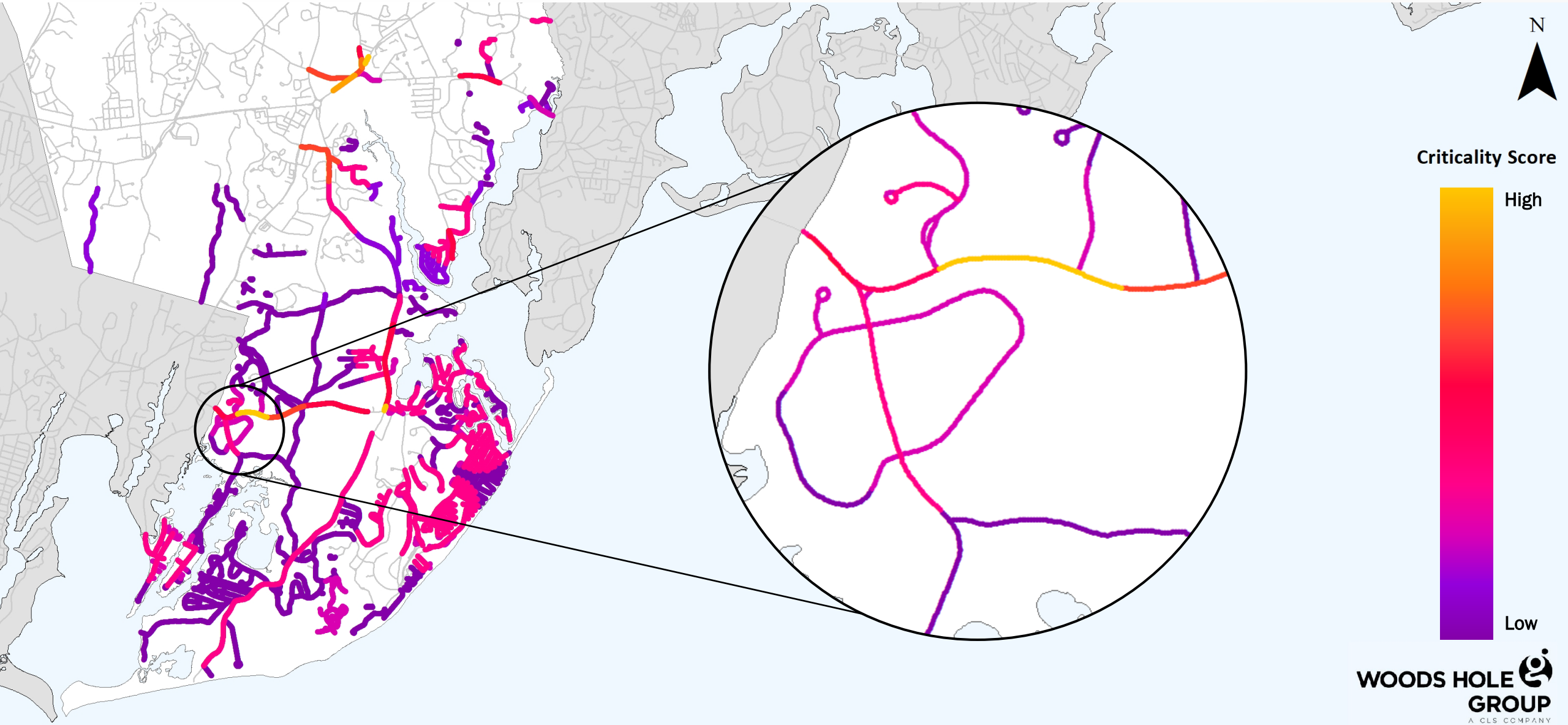
Low Lying Roads 2070 Flood Probability (Annual Exceedance Probability)





Flood Probability	Total Road Miles
0.1%	32.0
0.2%	30.7
0.5%	28.7
1%	26.5
2%	24.6
5%	21.7
10%	18.9
20%	15.6
100%	8.7

Low Lying Roads Criticality Scoring



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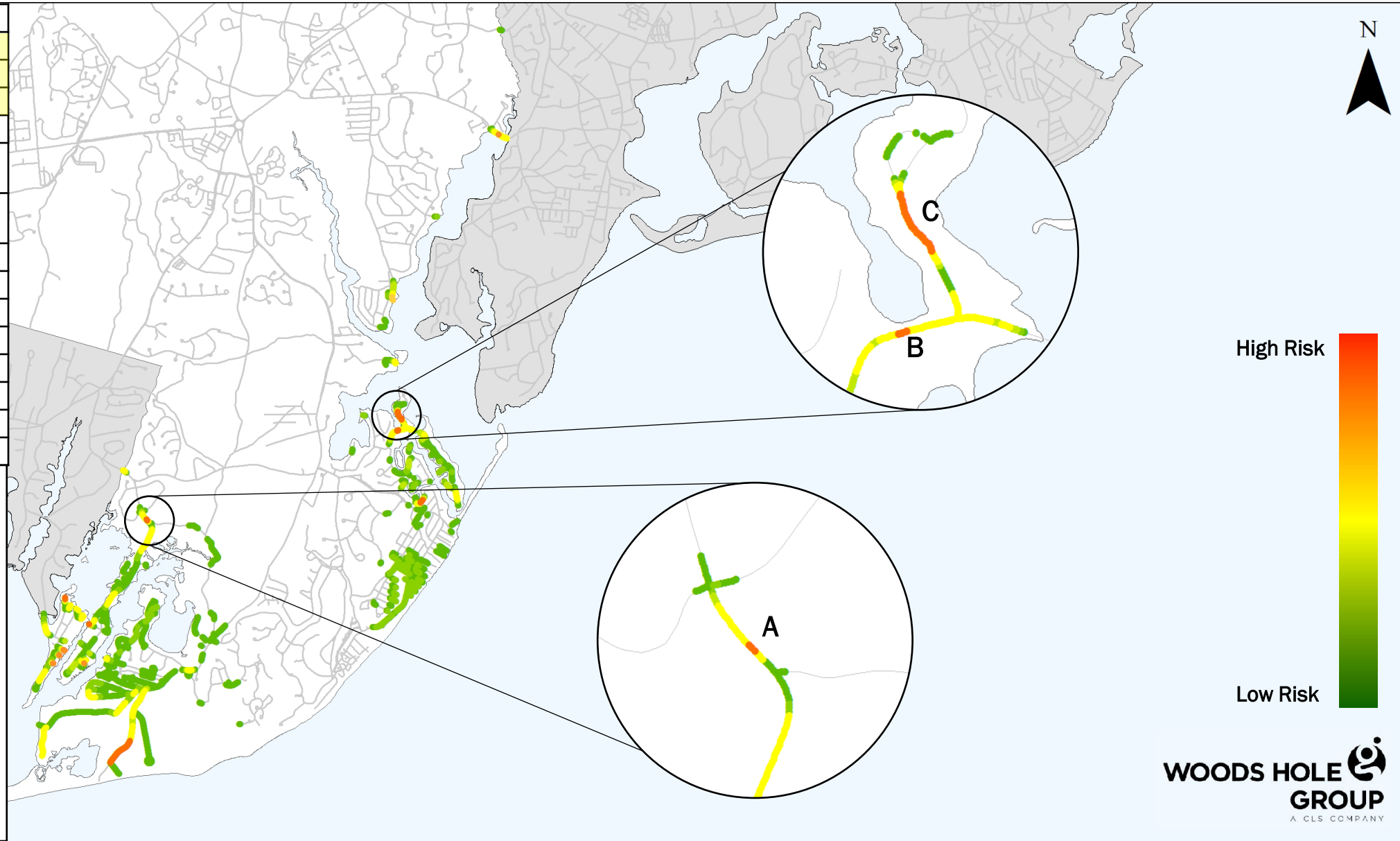
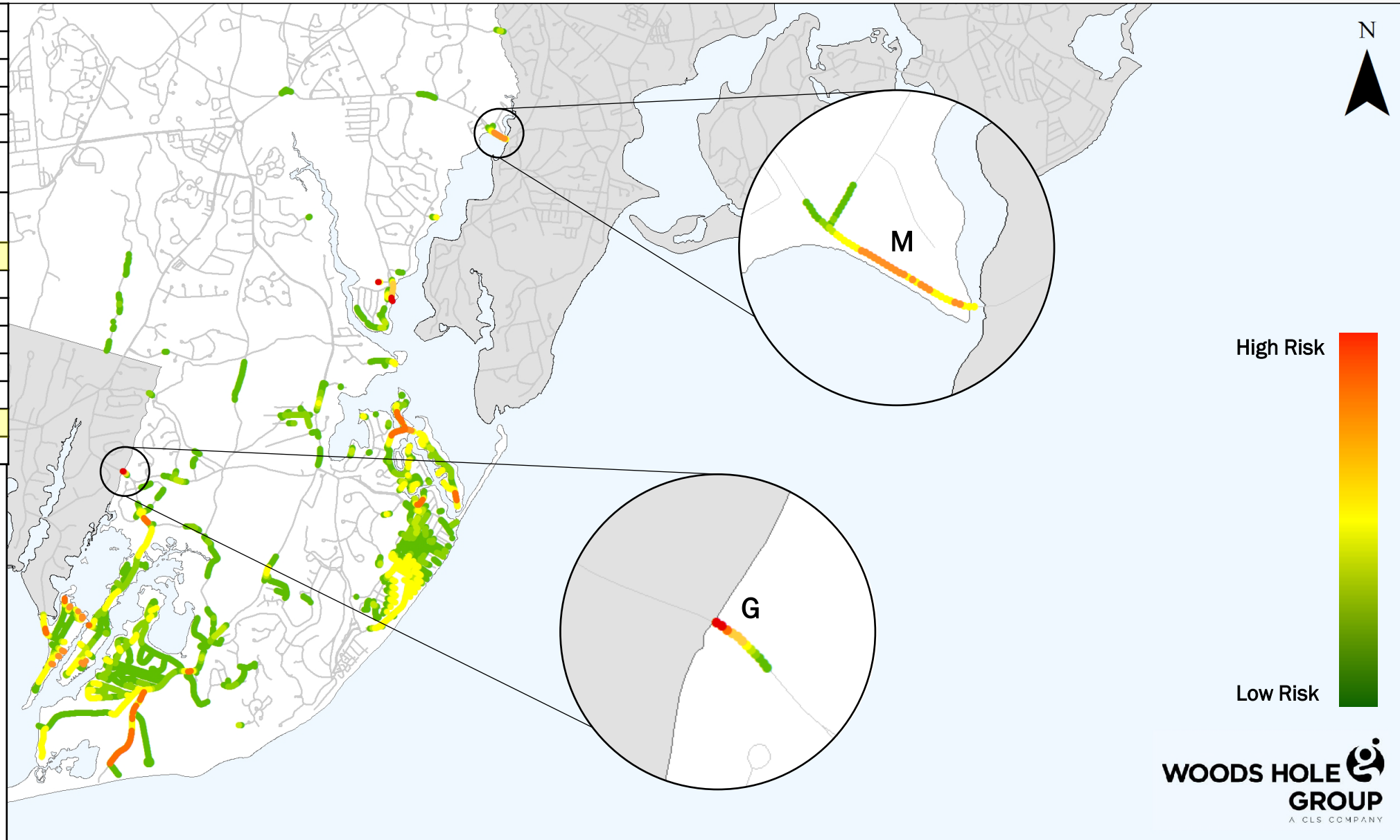
Low Lying Roads 2030 Risk Results

	High Risk Road Segments
A	Monomoscoy Rd North
B	Popponesset Island Road
C	Daniels Island Road
D	Spoondrift Way
E	Great Oak Road at Mashpee Town Beach
F	Mashpee Neck Road at Baker Boat Ramp
G	Red Brook Road at Falmouth Town Line
H	Monomoscoy Road - South
I	Monomoscoy Road - Middle
J	Sipps Road at Waqouit Public Landing
K	Seconsett Island Road at Hamblin Pond
L	Great Oak Road at Jehu Pond
M	Quinaquisset Avenue at Santuit River
N	Shore Drive at Deans Pond



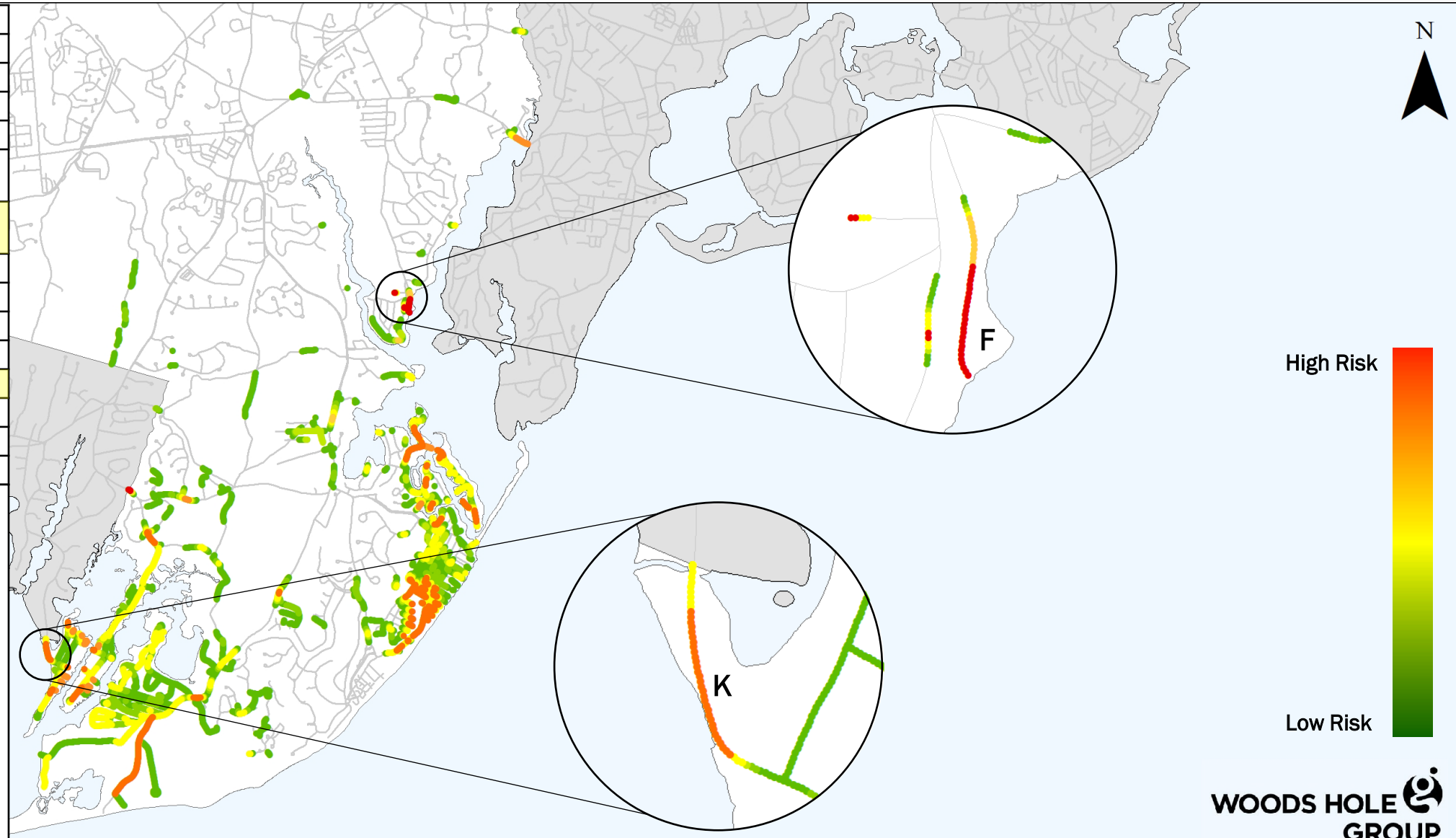
Low Lying Roads 2050 Risk Results

	High Risk Road Segments
A	Monomoscoy Rd North
B	Popponesset Island Road
C	Daniels Island Road
D	Spoondrift Way
E	Great Oak Road at Mashpee Town Beach
F	Mashpee Neck Road at Baker Boat Ramp
G	Red Brook Road at Falmouth Town Line
H	Monomoscoy Road - South
I	Monomoscoy Road - Middle
J	Sipps Road at Waqouit Public Landing
K	Seconsett Island Road at Hamblin Pond
L	Great Oak Road at Jehu Pond
M	Quinaquisset Avenue at Santuit River
N	Shore Drive at Deans Pond



Low Lying Roads 2070 Risk Results

	High Risk Road Segments
A	Monomoscoy Rd North
B	Popponesset Island Road
C	Daniels Island Road
D	Spoondrift Way
E	Great Oak Road at Mashpee Town Beach
F	Mashpee Neck Road at Baker Boat Ramp
G	Red Brook Road at Falmouth Town Line
H	Monomoscoy Road - South
I	Monomoscoy Road - Middle
J	Sipps Road at Waqouit Public Landing
K	Seconsett Island Road at Hamblin Pond
L	Great Oak Road at Jehu Pond
M	Quinaquisset Avenue at Santuit River
N	Shore Drive at Deans Pond



Summary of High Priority Road Segments

	Road Name	Length (ft)	Description	AEP 2030	Criticality Score		2030 Risk Score		Tidal Flooding Length (ft)		
									2030	2050	2070
A	Monomoscoy Rd North	640	Connector Rd between Meadowbrook Rd & Amy Brown Rd	100%	16		1600				140
B	Daniels Island Road/Popponesset Island Rd*	1340	Daniels Island Road/Popponesset Island Road	100%	16		1600				920
C	Daniels Island Road*	960	N-S road spine in coastal neighborhood	100%	16		1600		40	400	640
D	Spoondrift Way*	540	Spoondrift Way behind Poppo. Beach Community House	100%	16		1600			160	340
E	Great Oak Road at Mashpee Town Beach	1140	Great Oak Road leading to Mashpee Town Beach	100%	16		1600			580	1140
F	Mashpee Neck Road at Baker boat ramp	680	Road segment leading to Edward Baker Boat Ramp	20%	26		520			40	160
G	Red Brook Road at Falmouth Town Line	140	Connector Rd at Falmouth line between Ostrom Rd & Monos. Rd	20%	20		400				
H	Monomoscoy Road - South	1140	Roadway between Child's Rd and Hamblin Rd	100%	4		400			280	700
I	Monomoscoy Road - Middle	1460	Roadway between Amy Brown Rd and Point Rd	100%	4		400				1020
J	Town Landing Road*	600	Road Leading to Waqouit Public Landing	100%	4		400			140	300
K	Seconsett Island Road at Hamblin Pond	740	Coastal road fronting Hamblin Pond	20%	16		320				40
L	Great Oak Road at Jehu Pond	340	Connector to between Tie Run and Quinns Way	20%	16		320				100
M	Quinaquisset Ave at Santuit River (Bridge)	660	Road & bridge at Barnstable line and over Santuit River	10%	13		130				340
N	Shore Drive at Deans Pond*	2160	Shore Drive fronting Deans Pond	5%	16		80				

*Private Road

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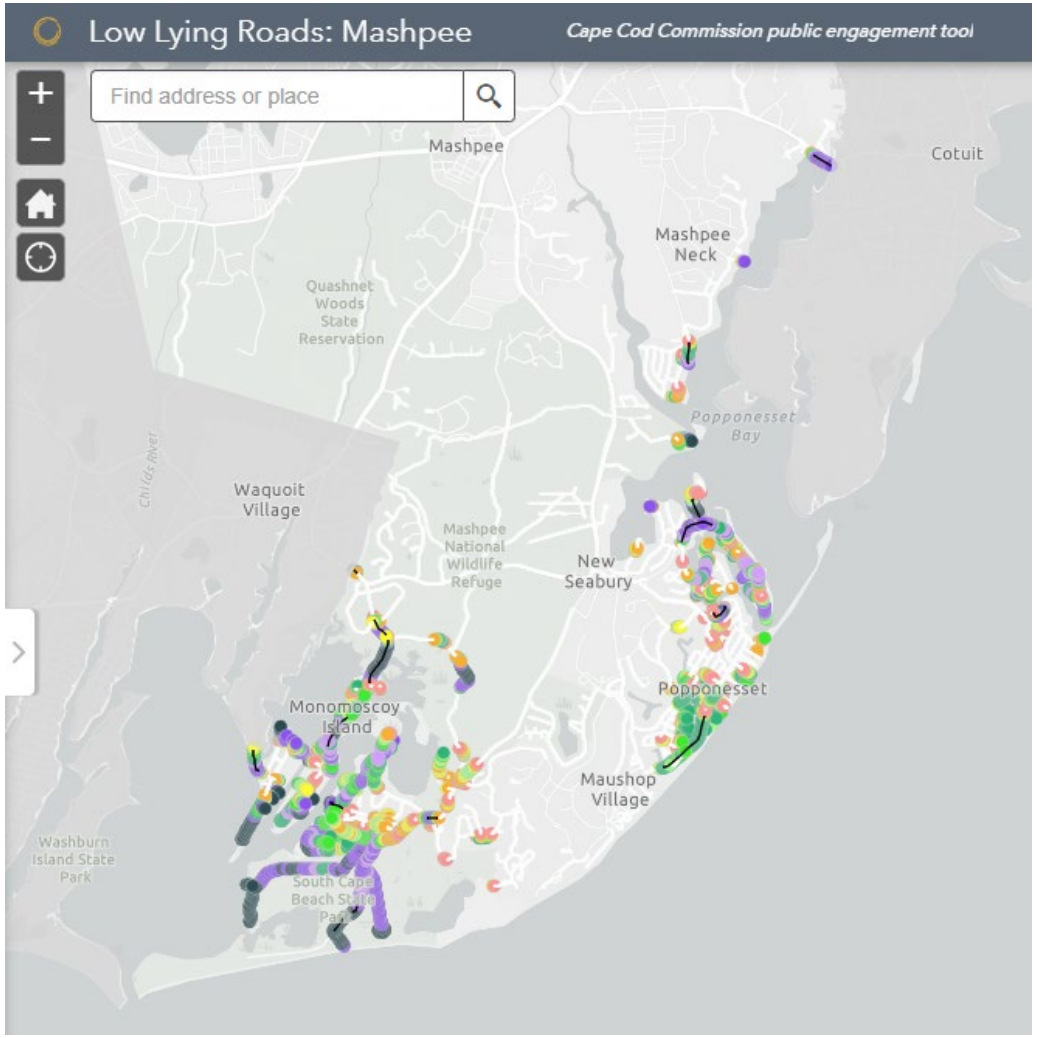
LOW LYING ROADS

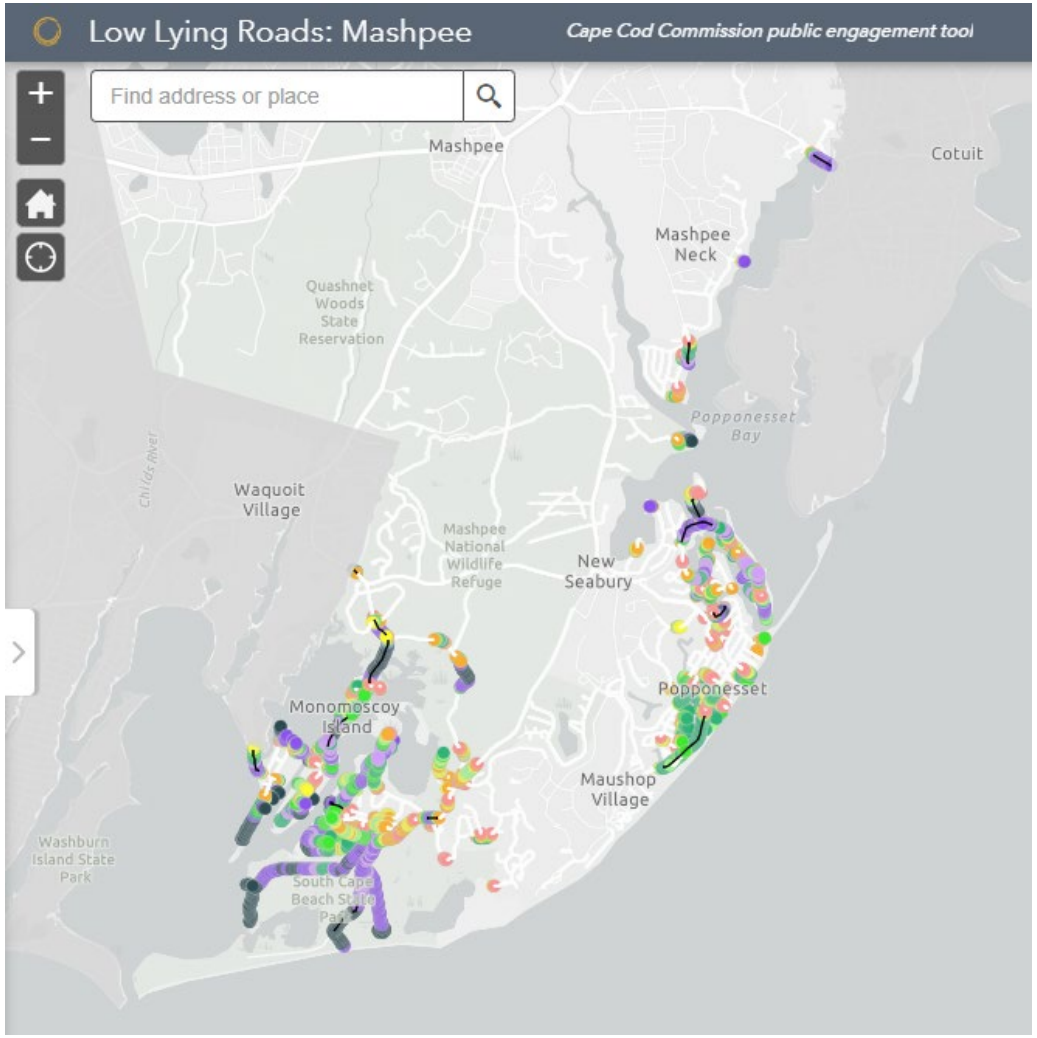
Group Discussion



DISCUSSION ORIENTATION

LOW LYING ROADS

Group Discussion



DISCUSSION QUESTIONS

1. Are you more concerned with high tide flooding or storm flooding?
2. What local knowledge or concerns can you bring to the discussion?
3. How would you prioritize these road segments?

Summary of High Priority Road Segments

	Road Name	Length (ft)	Description	AEP 2030	Criticality Score		2030 Risk Score		Tidal Flooding Length (ft)		
									2030	2050	2070
A	Monomoscoy Rd North	640	Connector Rd between Meadowbrook Rd & Amy Brown Rd	100%	16		1600				140
B	Daniels Island Road/Popponesset Island Rd*	1340	Daniels Island Road/Popponesset Island Road	100%	16		1600				920
C	Daniels Island Road*	960	N-S road spine in coastal neighborhood	100%	16		1600		40	400	640
D	Spoondrift Way*	540	Spoondrift Way behind Poppo. Beach Community House	100%	16		1600			160	340
E	Great Oak Road at Mashpee Town Beach	1140	Great Oak Road leading to Mashpee Town Beach	100%	16		1600			580	1140
F	Mashpee Neck Road at Baker boat ramp	680	Road segment leading to Edward Baker Boat Ramp	20%	26		520			40	160
G	Red Brook Road at Falmouth Town Line	140	Connector Rd at Falmouth line between Ostrom Rd & Monos. Rd	20%	20		400				
H	Monomoscoy Road - South	1140	Roadway between Child's Rd and Hamblin Rd	100%	4		400			280	700
I	Monomoscoy Road - Middle	1460	Roadway between Amy Brown Rd and Point Rd	100%	4		400				1020
J	Town Landing Road*	600	Road Leading to Waqouit Public Landing	100%	4		400			140	300
K	Seconsett Island Road at Hamblin Pond	740	Coastal road fronting Hamblin Pond	20%	16		320				40
L	Great Oak Road at Jehu Pond	340	Connector to between Tie Run and Quinns Way	20%	16		320				100
M	Quinaquisset Ave at Santuit River (Bridge)	660	Road & bridge at Barnstable line and over Santuit River	10%	13		130				340
N	Shore Drive at Deans Pond*	2160	Shore Drive fronting Deans Pond	5%	16		80				

*Private Road

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A CLS COMPANY

NEXT STEPS

- Town staff to select 2 road segments
- Site visits and feasibility analysis
- 3 solutions + costs per segment
- 2nd Workshop date TBD – spring 2024
- Materials available to view on Low Lying Road webpage: https://www.capecodcommission.org/our-work/low-lying-roads-project/

Low Lying Roads: Mashpee

Start Date: 2023

[Low Lying Roads Project Homepage](), learn more about the background and process.

Overview | **Map Viewer**

Overview

The Cape Cod Commission is working with all 15 Cape towns, including the **Town of Mashpee**, 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 (MVP) program, the Commission has contracted with the Woods Hole Group (WHG) to conduct a vulnerability assessment of roadway segments, bridges, and culverts due to flooding from the combined effects of sea level rise and storm surge.

WHG will employ the state-of-the-art Massachusetts Coast Flood Risk Model (MC FRM) to identify vulnerable road segments under different sea level rise scenarios and time scales. One output from this work is a projection of the probability and extent of

NEXT MEETINGS

MONDAY

MAY 08, 2023

Mashpee Low-lying Roads Public Meeting

START TIME: 5:00 PM

Low Lying Roads: Mashpee

Cape Cod Commission public engagement tool

ABOUT

With funding support from the Massachusetts Municipal Vulnerability Preparedness (MVP) program, the Commission has contracted with the Woods Hole Group (WHG) to conduct a vulnerability assessment of roadway segments, bridges, and culverts due to flooding from the combined effects of sea level rise and storm surge. WHG will employ the state-of-the-art Massachusetts Coast Flood Risk Model (MC FRM) to identify vulnerable road segments under different sea level rise scenarios and time scales. One output from this work is a projection of the probability and extent of flooding at defined future planning horizons, 2030, 2050, and 2070.

NAVIGATION

Click the Legend to show the map key

Open the Layers to turn on more contextual features or create new suggestions

Use the Editor to provide feedback

Change Base Maps

Bookmarks help navigate Top Vulnerable Roads

Click on a feature to see more information. You may need to click through multiple pop ups

(1 of 7)

Tell Us What You Think!

Are there roads in town that have FLOODING or EROSION issues? How high of a priority do you think it is to address

Find address or place

Waquoit Village
Red Brook
Mashpee National Wildlife Refuge
Seabrook
New Seabury
Popponesset Bay
Popponesset Island
Popponesset Beach
Popponesset
Great River Marshes
Monomoscoy Island
Seconsett Island
Jim Pond
Dean Pond
Maushop Village
South Cape Beach State Park
Flat Pond
0.4mi
-70.450 41.581 Degrees
Esri, HERE, Garmin, SafeGraph, GeoTec

Legend

Coastal Erosion Comments

Coastal Flooding Comments

Town mask

Mashpee Top Vulnerable Roads

Mashpee 2030 Inundation Probability

Prob_2030

- 100%
- 20%
- 10%
- 5%
- 2%
- 1%
- 0.5%
- 0.2%
- 0.1%
- 0

THANK YOU!