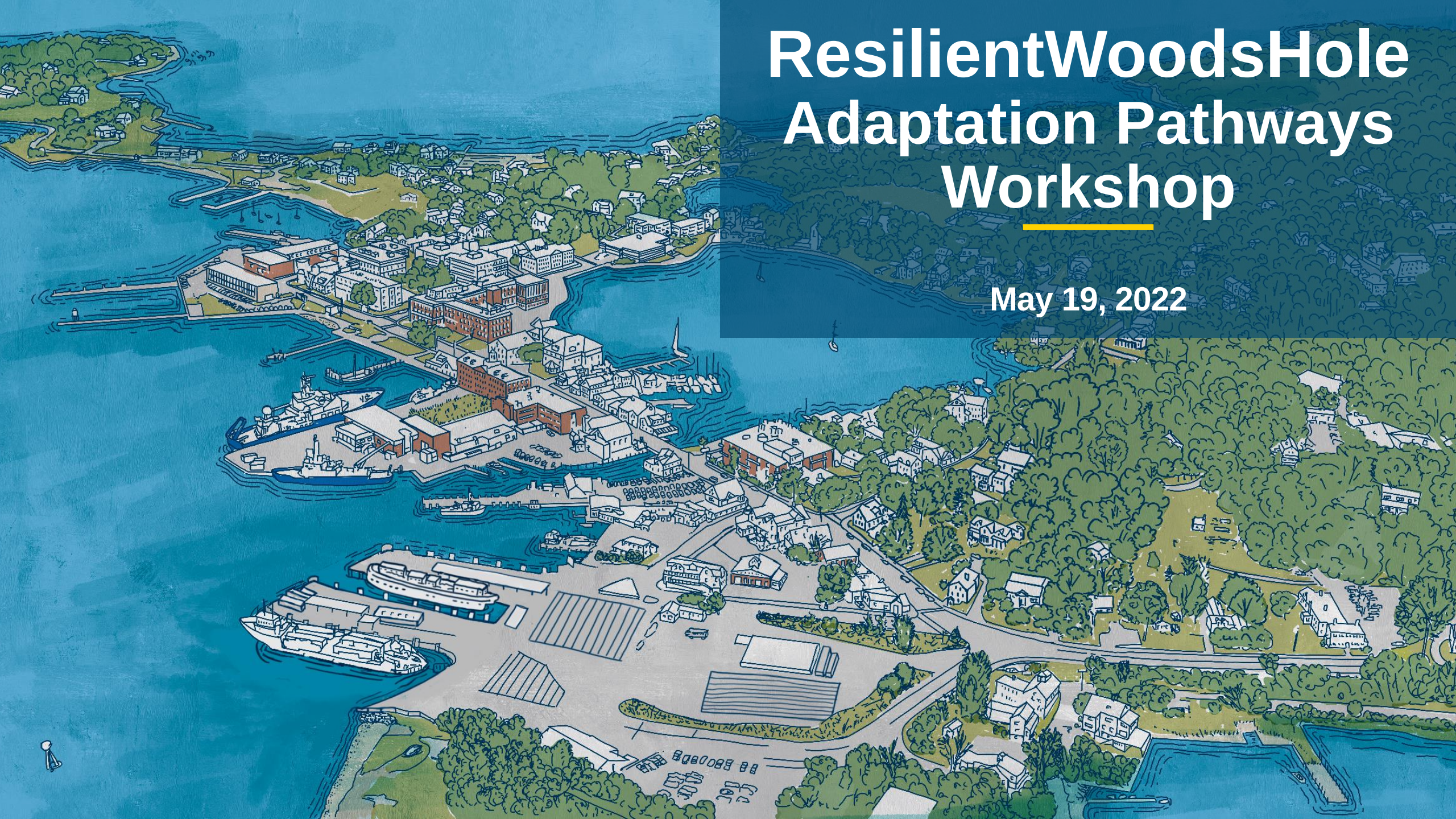


ResilientWoodsHole Adaptation Pathways Workshop

May 19, 2022

RESILIENT WOODS HOLE

Welcome

Leslie-Ann McGee
Director of Special Projects/ResilientWoodsHole Manager
Woods Hole Oceanographic Institution

AGENDA

Welcome

Review Woods Hole's Coastal Vulnerability and Project Progress
Coastal Resilience and Adaptation Options
What are Dynamic Adaptation Pathways?
Workshop Instructions and Next Steps

Question & Answer

ResilientWoodsHole Adaptation Pathways Workshop

- ***Nine (9) Coastal Management Area Stations***
  Fay Rd, Nobska Pt, Juniper Pt, Waterfront, Penzance Pt, Spencer Baird, Eel Pond & School St, Millfield and Gardiner, Gansett
- ***Review adaptation options and provide feedback***

RESILIENT WOODS HOLE

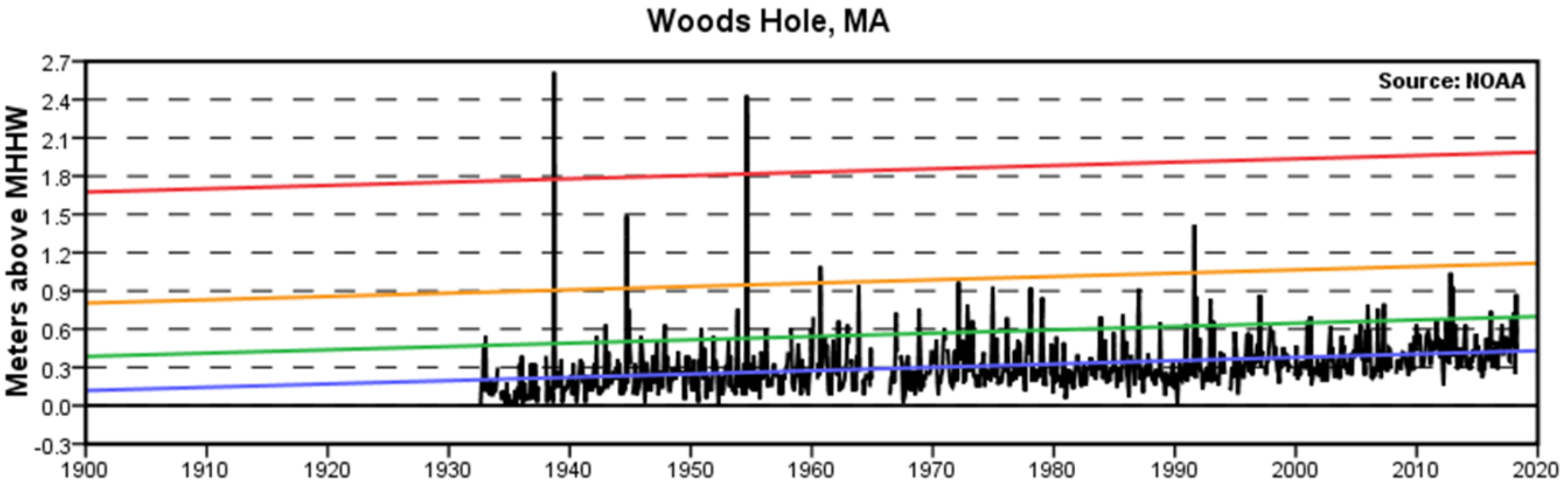
Coastal Vulnerability and Adaptation in Woods Hole

Joe Famely
Woods Hole Group

Credit: Giles W. Mead, courtesy Woods Hole Historical Museum

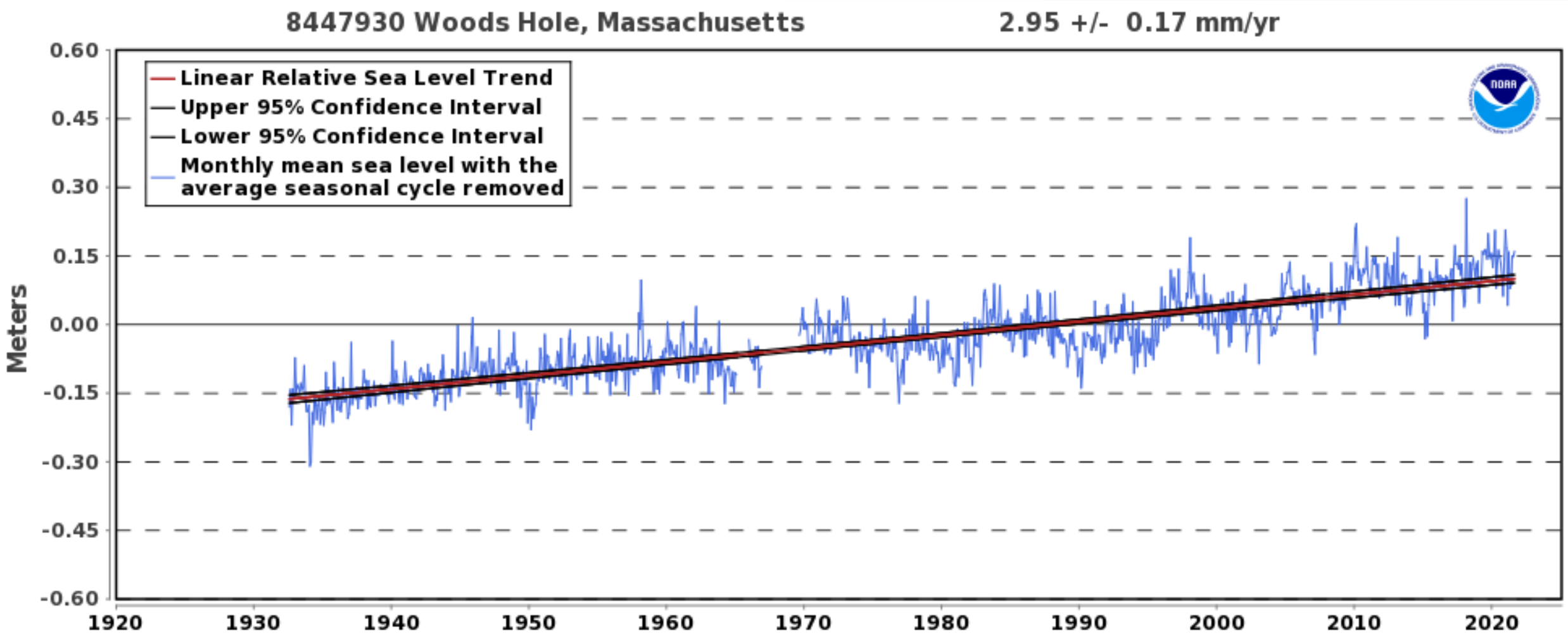
Credit: The Boston Globe

Extreme Water Levels in Woods Hole (Station 8447930)



Historical Sea Level Rise

Woods Hole Tide Gauge, Station 8447930

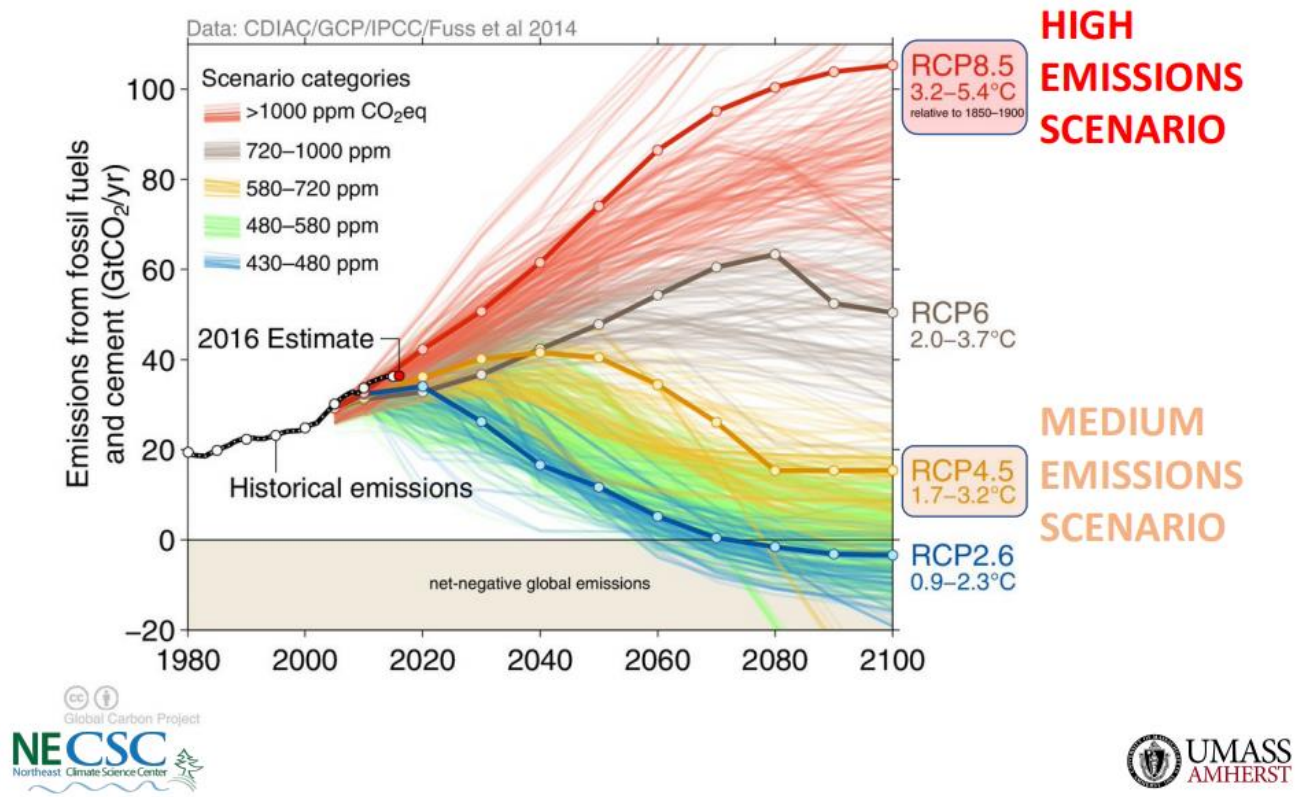


The relative sea level trend is 2.95 millimeters/year with a 95% confidence interval of +/- 0.17 mm/yr based on monthly mean sea level data from 1932 to 2020 which is equivalent to a change of 0.97 feet in 100 years.

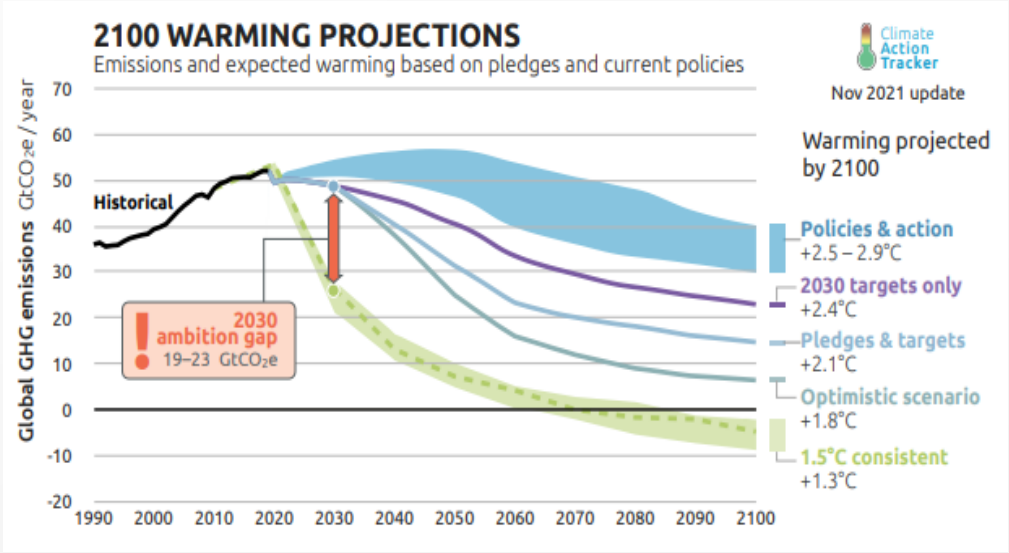
MA EOEEA Downscaled Climate Change Projections

https://resilientma.org/data/documents

WHAT MASSACHUSETTS MODELED



CURRENT TRAJECTORY (POST COP26)



https://climateactiontracker.org/

MA EOEEA Probabilistic Sea Level Rise Projections

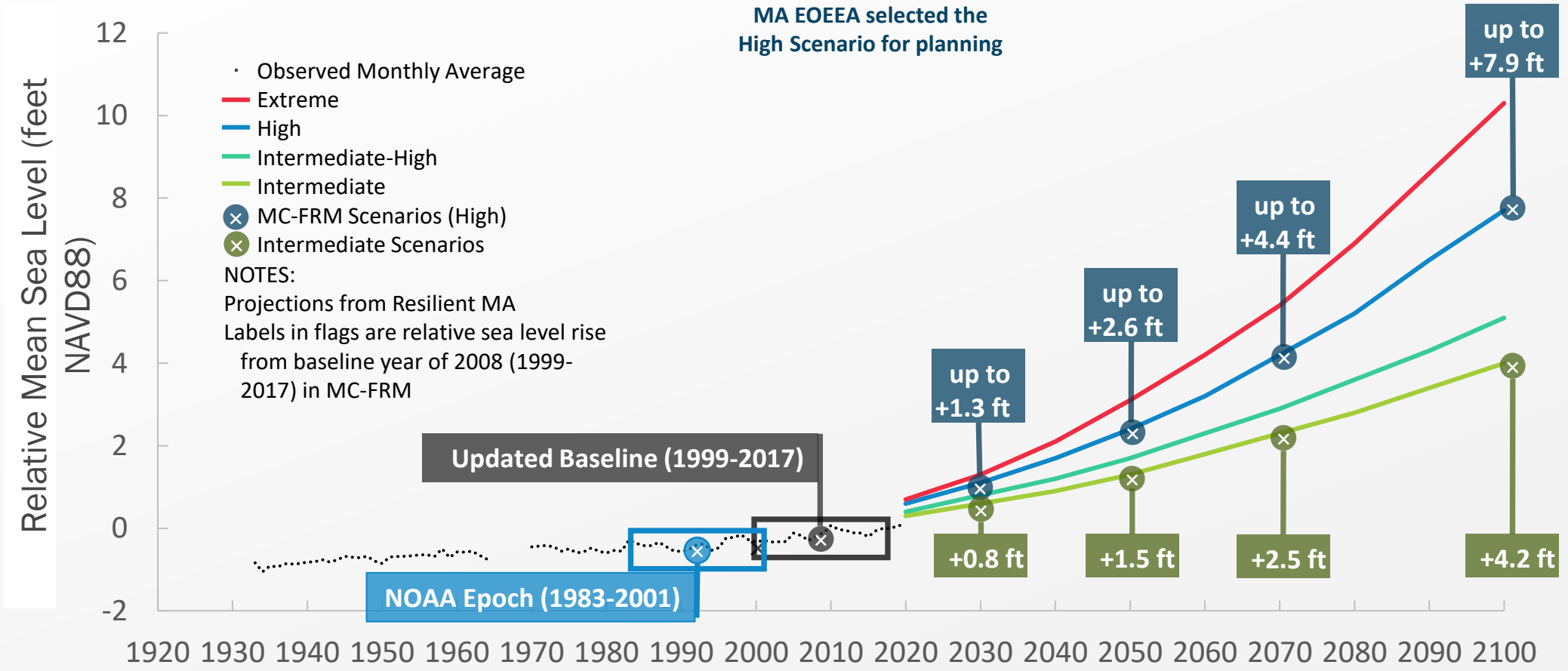
Woods Hole Tide Gauge, Station 8447930 (DeConto & Kopp, 2017)

Probabilistic Crosswalk:
Confidence intervals indicate the probability (%) that SLR has not been underpredicted given various emissions and ice sheet melt contributions

High Scenario	
>99.5%	RCP 4.5
99.5%	RCP 8.5
95%	RCP 4.5 + ice
83%	RCP 8.5 + ice

Intermediate Scenario	
95%	RCP 4.5
83%	RCP 8.5
50%	RCP 4.5 + ice
<50%	RCP 8.5 + ice

MA EOEEA selected the High Scenario for planning



Woods Hole Tide Gauge (Station 8447930) Local Tidal Datums: MHHW is 1.2 FT. above MSL


ater 2030
2050
Penzance Rd
Penzance Rd
Penzance Rd
Gosnold Rd
Bar Neck Rd
Bar Neck Rd
Albatross St
Millfield St
Gardiner Rd
Woods Hole Ball Park
Buzzards Bay Ave
Whitman Rd
Hyatt Rd
High St
Quissett Ave
Quissett Ave
Woods Hole Golf Club
Woods Hole
Cow Bell Ln
Harbor Hill Rd
Mowing Way
Harbor Hill Rd
Sidney St
Eel Pond
School St
School St
Water St
Water St Waterfront Park
Great Harbor
Ram Island
Devils Foot
Steamship Authority-Woods Hole
Woods Hole Rd
Woods Hole Rd
Butler St
Church St


ater 2050
2070
Penzance Rd
Penzance Rd
Penzance Rd
Gosnold Rd
Bar Neck Rd
Bar Neck Rd
Albatross St
Gardiner Rd
Woods Hole Ball Park
Millfield St
Woods Hole
Eel Pond
Water St Waterfront Park
Water St
School St
School St
Cow Bell Ln
Harbor Hill Rd
Mowing Way
Harbor Hill Rd
Sidney St
Quissett Ave
Quissett Ave
Buzzards Bay Ave
High St
Hyatt Rd
Whitman Rd
Woods Hole Golf Club
Great Harbor
Ram Island
Devils Foot
Steamship Authority-Woods Hole
Woods Hole Rd
Woods Hole Rd
Butler St
Church St

ater 2070

2100

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

FLOOD PROBABILITY

FLOOD DEPTH

FLOOD DURATION

FLOOD VOLUMES

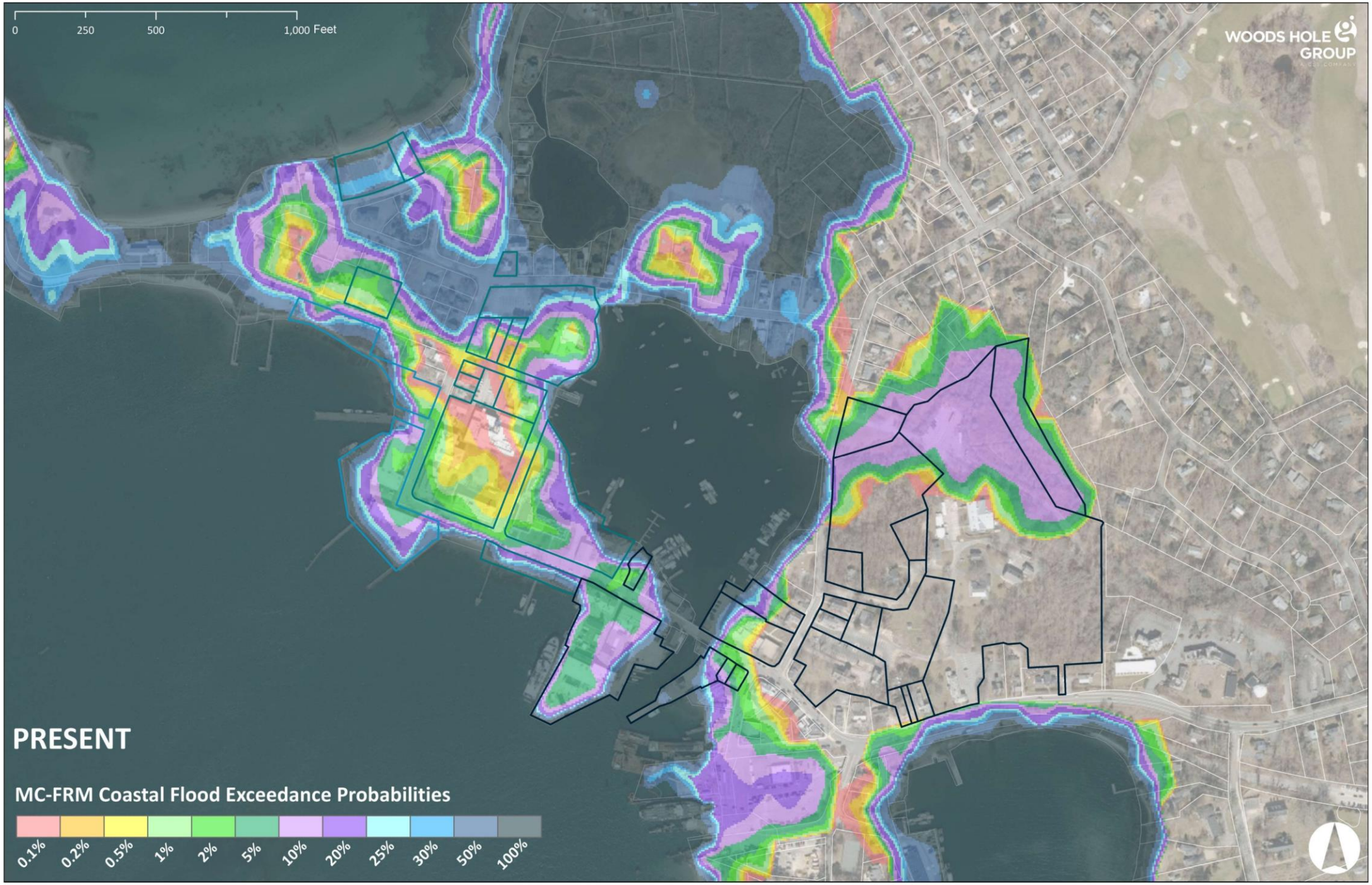
FLOOD PATHWAYS

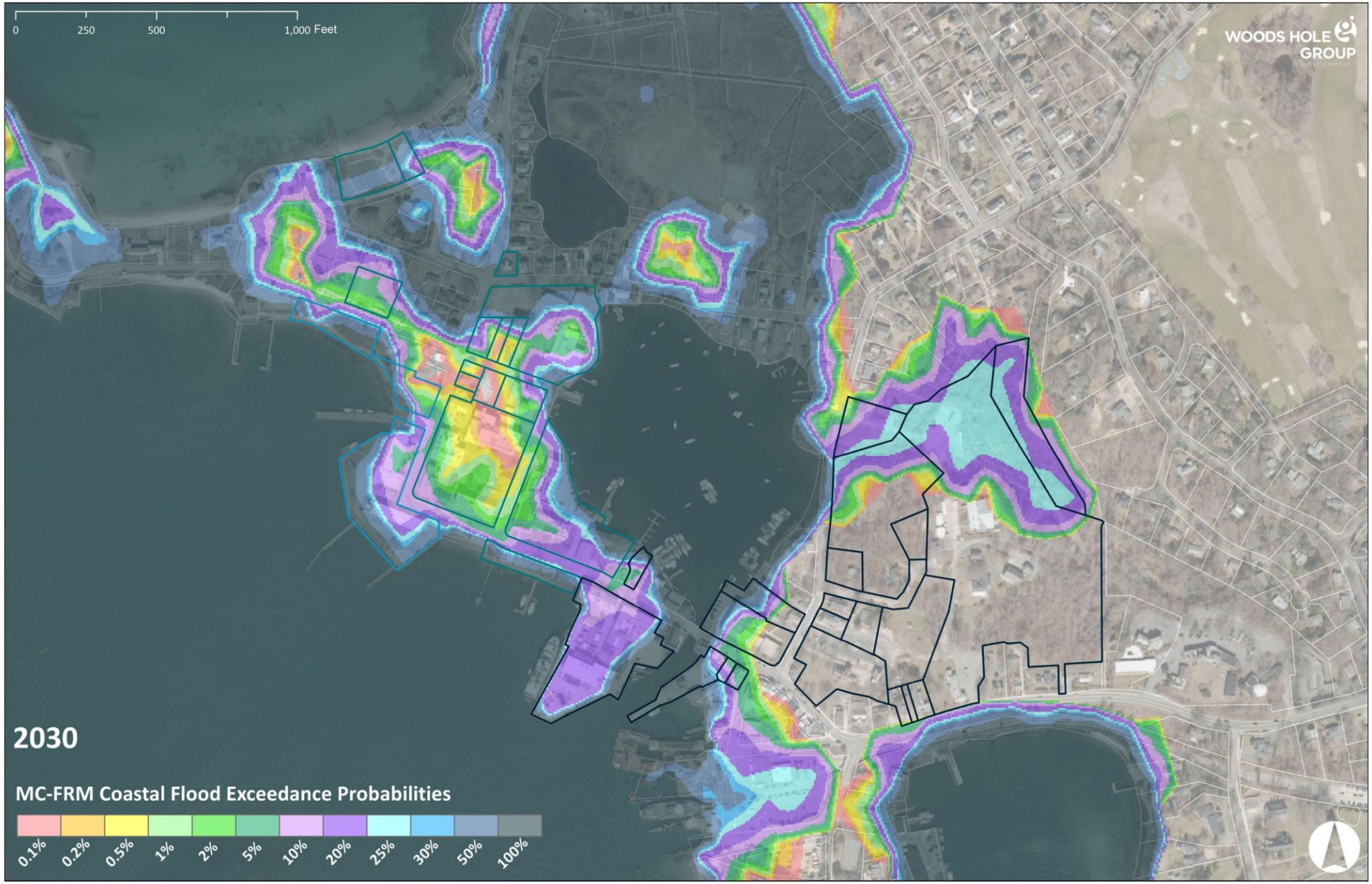
WINDS

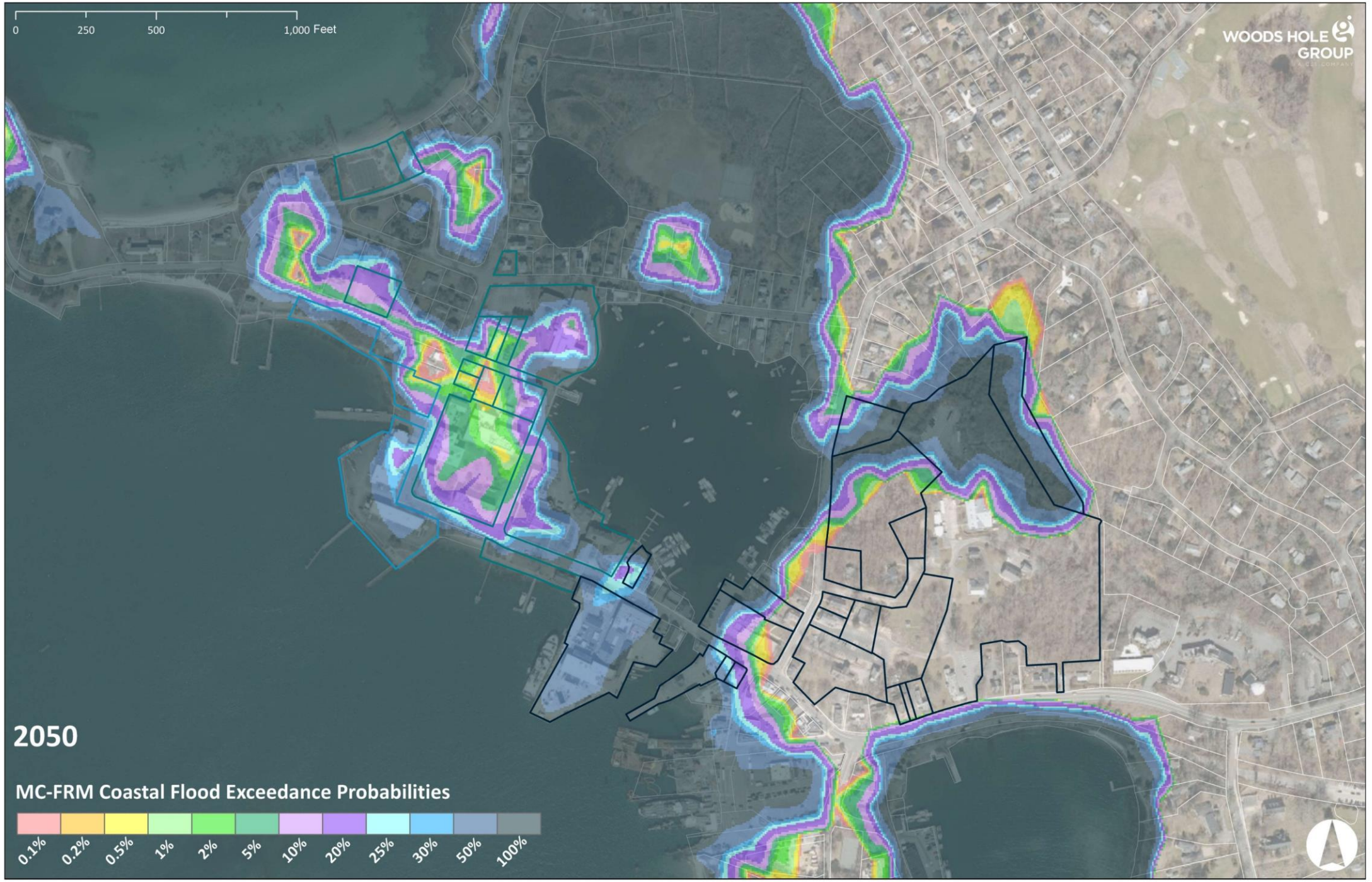
WAVES

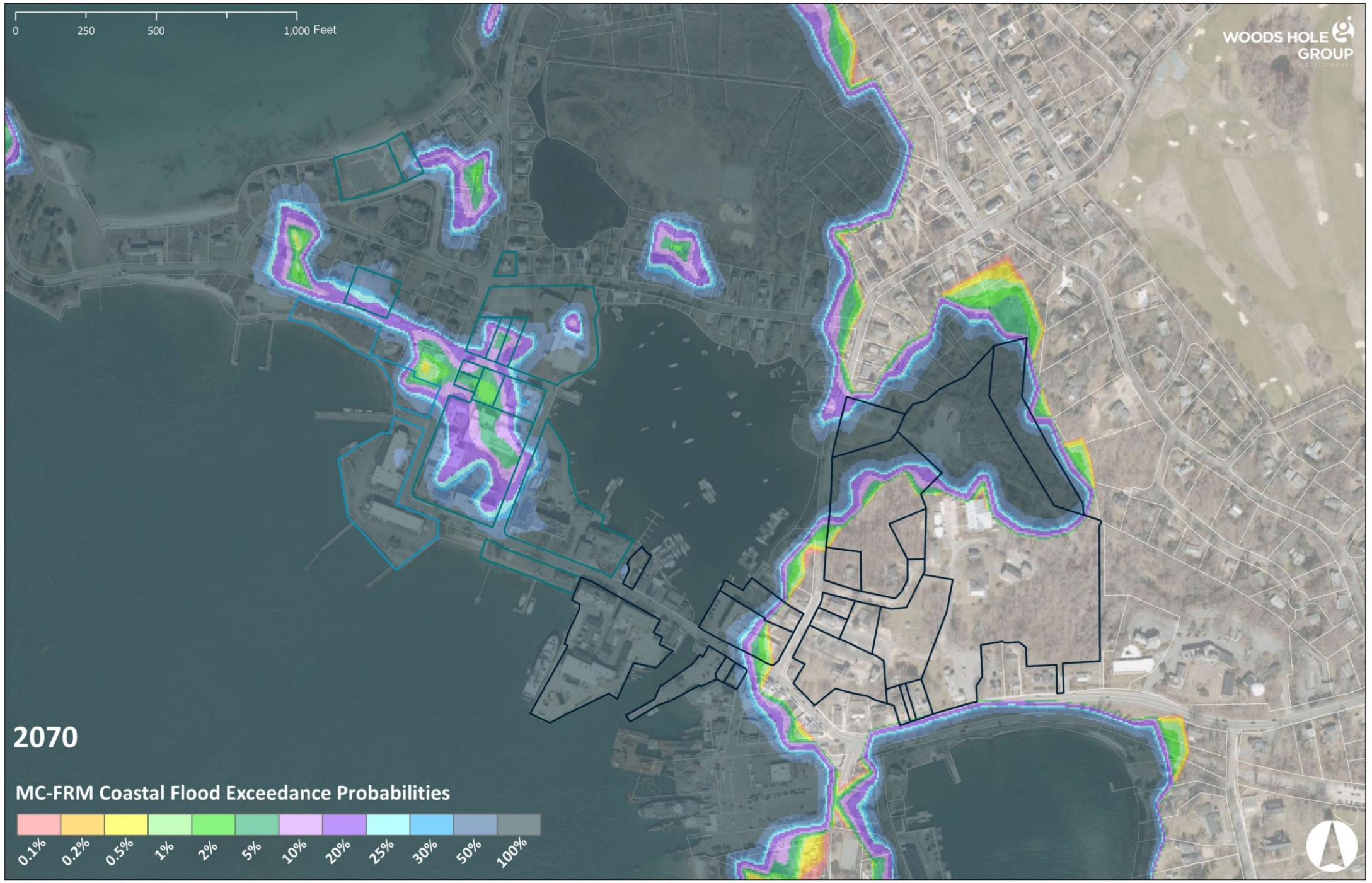
CURRENTS

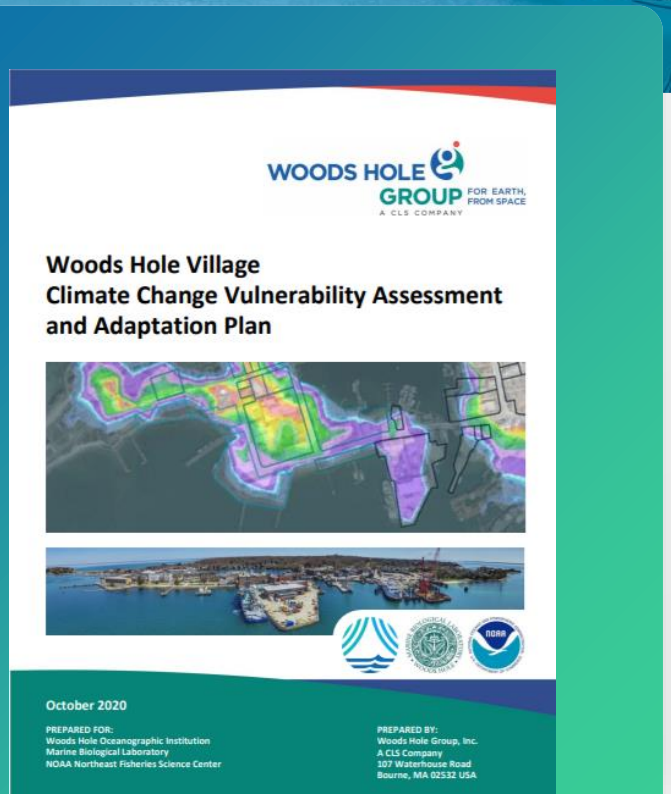
OUTPUTS


0
250
500
1,000 Feet
WOODS HOLE GROUP
PRESENT
MC-FRM Coastal Flood Exceedance Probabilities
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%


0
250
500
1,000 Feet
WOODS HOLE GROUP
2030
MC-FRM Coastal Flood Exceedance Probabilities
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%


0
250
500
1,000 Feet
WOODS HOLE GROUP
2050
MC-FRM Coastal Flood Exceedance Probabilities
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%


0
250
500
1,000 Feet
WOODS HOLE GROUP
2070
MC-FRM Coastal Flood Exceedance Probabilities
0.1%
0.2%
0.5%
1%
2%
5%
10%
20%
25%
30%
50%
100%



ResilientWoodsHole Phase 1

What are the potential impacts of climate change on scientific operations and research in Woods Hole?

Climate Change Vulnerability Assessment (WHOI/MBL/NOAA)

https://resilientwoodshole.org/news-and-events/#reports

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WHOI/MBL/NOAA Climate Change Vulnerability Assessment

Climate Vulnerability Assessment – Asset Profile

Iselin

Asset Type: Buildings
Critical Elevation (CE): 6.08 FT. NAVD88
Threshold Description:
North Alvin high bay 130D Door - systems at grade
Room 138 (prior survey)

Probability of Exceedance Summary Table

Probability	Present		2030		2050		2070	
	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE
%	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.
0.1	10.7	4.62	11.8	5.72	14.5	8.42	16.6	10.52
0.2	10	3.92	11.1	5.02	13.7	7.62	15.7	9.62
0.5	8.8	2.72	10	3.92	12.6	6.52	14.6	8.52
1	8.1	2.02	9.3	3.22	11.8	5.72	13.8	7.72
2	7.4	1.32	8.6	2.52	10.9	4.82	12.9	6.82
5	6.5	0.42	7.7	1.62	9.8	3.72	11.8	5.72
10	5.8	-	7	0.92	9	2.92	10.9	4.82
20	5	-	6.2	0.12	8	1.92	9.9	3.82
25	4.7	-	5.9	-	7.7	1.62	9.6	3.52
30	4.5	-	5.7	-	7.4	1.32	9.3	3.22
50	3.7	-	4.8	-	6.4	0.32	8.3	2.22
100	2.1	-	3.3	-	4.6	-	6.4	0.32

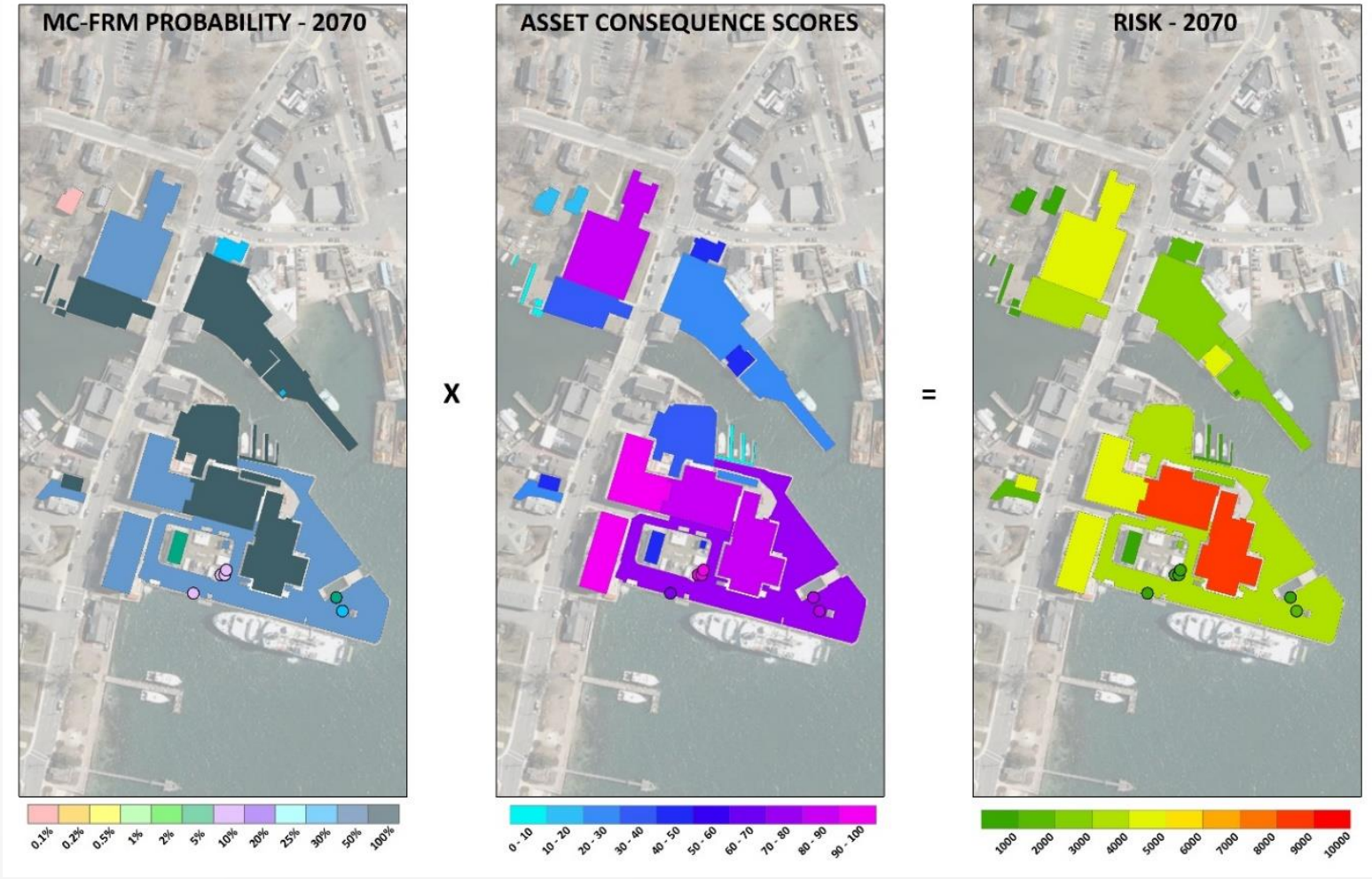
Consequence of Exceedance

	Direct Impacts			Mission Impairment				
	Service Loss Extent	Service Loss Duration	Cost of Damage	Research & Applied Science	Operations & Economic Activity	Education & Outreach	Sum	Consequence Score
Scores	4	4	3	3	4	2	20	83

Risk of Exceedance

Time horizon	Probability of Exceedance	Consequence Score	Risk Score	Risk Rank
Present	5	83	417	8/36
2030	20		1667	4/36
2050	50		4167	-
2070	100		8333	-

WOODS HOLE GROUP



WHOI/MBL/NOAA Climate Change Vulnerability Assessment

Climate Vulnerability Assessment – Asset Profile

Lillie Laboratory

Asset Type: Buildings
Critical Elevation (CE): 5.17 FT. NAVD88
Threshold Description:
Loading dock slab entry from 2017 ELV CERT
Additional CEs:
Lillie Fuel Tank (5.30 FT. NAVD88), Lillie/MRC Junction Box (9.33 FT. NAVD88),
Lillie Transformer (9.89 FT. NAVD88), Lillie/MRC Meter Box (11.37 FT. NAVD88)

Probability of Exceedance Summary Table

Probability	Present		2030		2050		2070	
	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE
%	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.
0.1	10.6	5.4	11.7	6.5	14.3	9.2	16.6	11.4
0.2	9.8	4.6	11.0	5.8	13.5	8.4	15.7	10.5
0.5	8.9	3.7	10.0	4.8	12.5	7.3	14.6	9.4
1	8.2	3.0	9.3	4.1	11.6	6.5	13.8	8.6
2	7.5	2.3	8.6	3.4	10.8	5.7	12.9	7.7
5	6.5	1.3	7.7	2.5	9.7	4.5	11.8	6.6
10	5.8	0.6	7.0	1.8	8.9	3.7	10.9	5.7
20	5.0	-	6.2	1.0	7.9	2.8	9.9	4.7
25	4.7	-	5.9	0.7	7.6	2.4	9.6	4.4
30	4.5	-	5.7	0.5	7.3	2.1	9.3	4.1
50	3.7	-	4.8	-	6.3	1.2	8.3	3.1
100	2.1	-	3.3	-	4.6	-	6.4	1.2

Consequence of Exceedance

	Direct Impacts			Mission Impairment				
	Service Loss Extent	Service Loss Duration	Cost of Damage	Research & Applied Science	Operations & Economic Activity	Education & Outreach	Sum	Consequence Score
Scores	4	4	4	4	4	3	23	96

Risk of Exceedance

Time horizon	Probability of Exceedance	Consequence Score	Risk Score	Risk Rank
Present	10	96	958	6/54
2030	30		2875	3/54
2050	50		4792	2/54
2070	100		9583	1/54

WOODS HOLE GROUP

X

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WHOI/MBL/NOAA Climate Change Vulnerability Assessment

Climate Vulnerability Assessment – Asset Profile

Gear Shed

Asset Type: Buildings
Critical Elevation (CE): 5.09 FT. NAVD88
Threshold Description:
Grade at bay door (LiDAR)

Probability of Exceedance Summary Table

Probability	Present		2030		2050		2070	
	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE	Flood Elevation	Depth Over CE
%	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.	FT. NAVD88	FT.
0.1	10.7	5.61	11.8	6.71	14.5	9.41	16.6	11.51
0.2	10	4.91	11.1	6.01	13.7	8.61	15.7	10.61
0.5	8.8	3.71	10	4.91	12.6	7.51	14.6	9.51
1	8.1	3.01	9.3	4.21	11.8	6.71	13.8	8.71
2	7.4	2.31	8.6	3.51	10.9	5.81	12.9	7.81
5	6.5	1.41	7.7	2.61	9.8	4.71	11.8	6.71
10	5.8	0.71	7	1.91	9	3.91	10.9	5.81
20	5	-	6.2	1.11	8	2.91	9.9	4.81
25	4.7	-	5.9	0.81	7.7	2.61	9.6	4.51
30	4.5	-	5.7	0.61	7.4	2.31	9.3	4.21
50	3.7	-	4.8	-	6.4	1.31	8.3	3.21
100	2.1	-	3.3	-	4.6	-	6.4	1.31

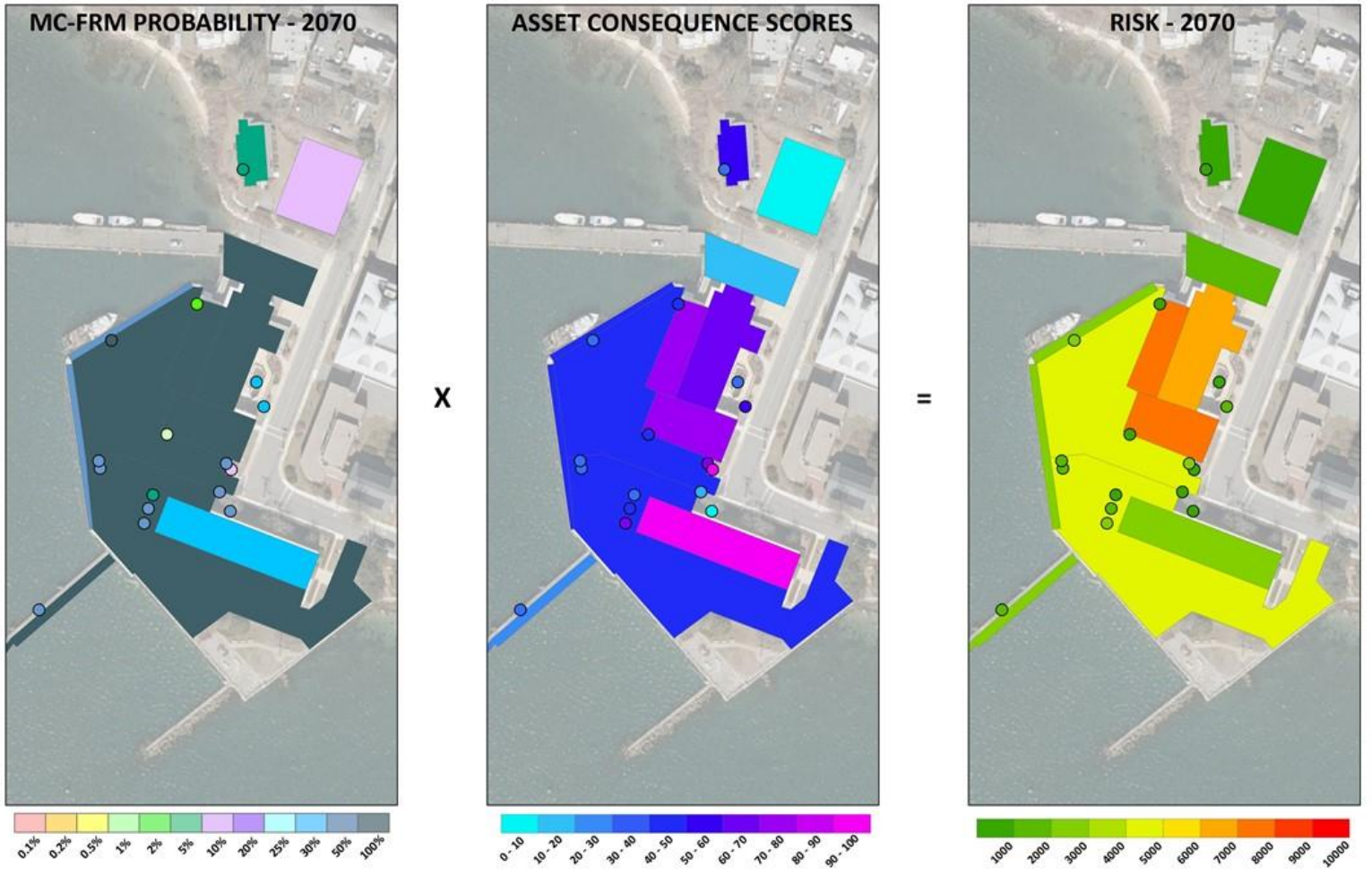
Consequence of Exceedance

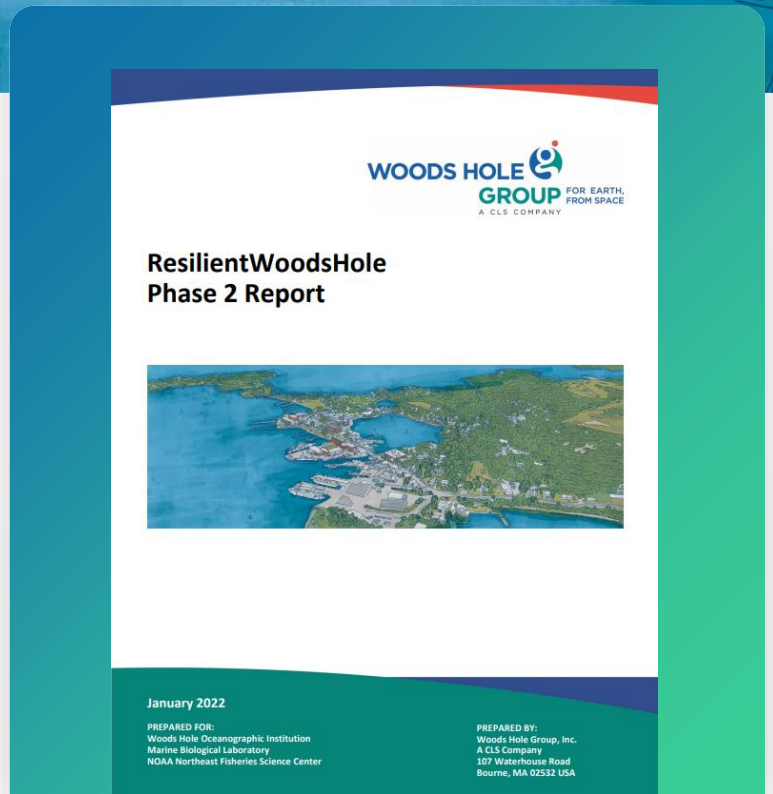
	Direct Impacts			Mission Impairment				
	Service Loss Extent	Service Loss Duration	Cost of Damage	Research & Applied Science	Operations & Economic Activity	Education & Outreach	Sum	Consequence Score
Scores	2	4	4	3	3	1	17	71

Risk of Exceedance

Time horizon	Probability of Exceedance	Consequence Score	Risk Score	Risk Rank
Present	10	71	708	3/27
2030	30		2125	2/27
2050	50		3542	3/27
2070	100		7083	2/27

WOODS HOLE GROUP





ResilientWoodsHole Phase 2

What are the potential impacts of climate change on the broader Woods Hole community?

Extended Climate Change Vulnerability Assessment (Woods Hole residential community, businesses, roadways, lifelines), supplemental adaptation planning (WHOI/MBL/NOAA) and initial outreach.

https://resilientwoodshole.org/news-and-events/#reports

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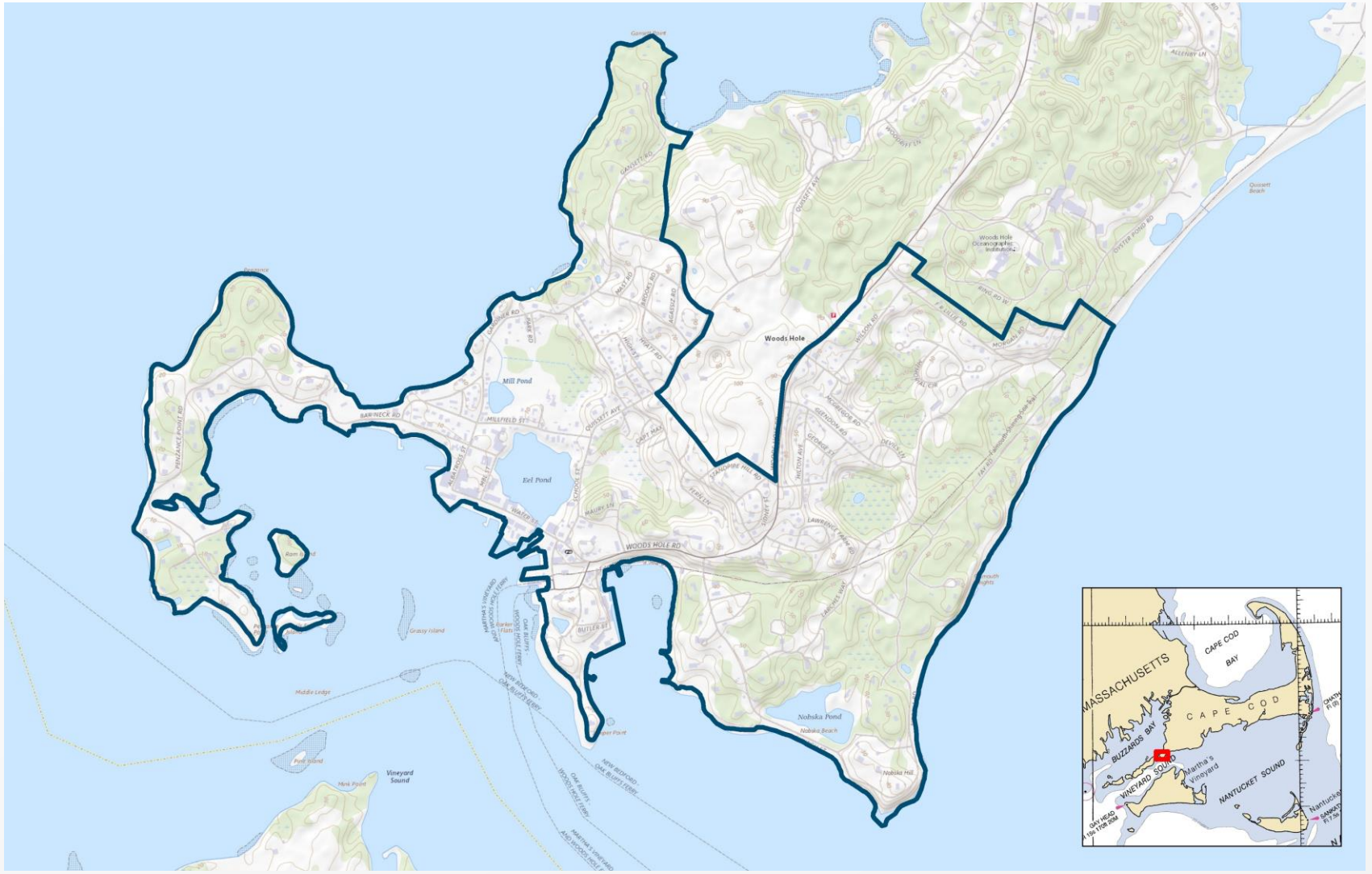
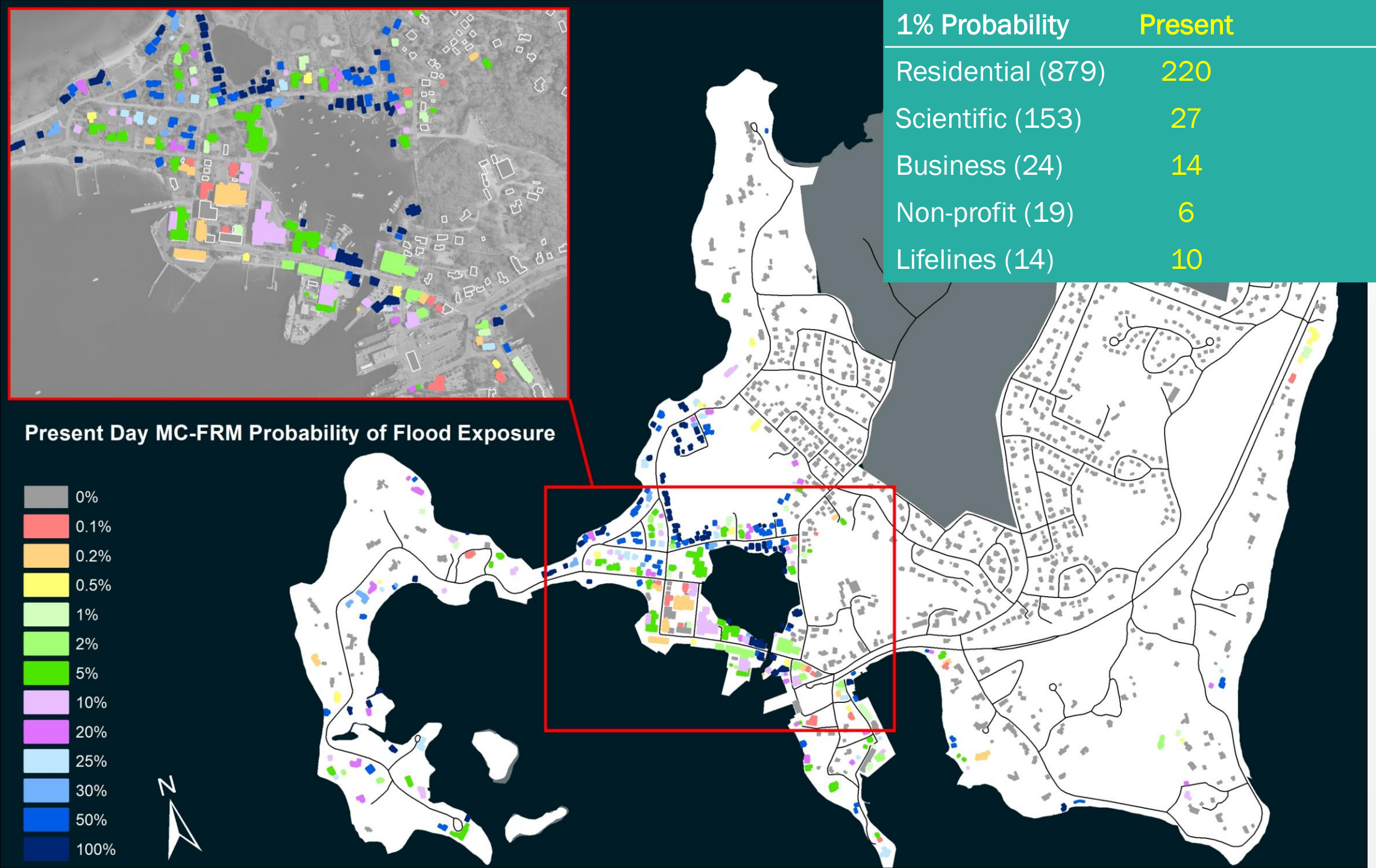
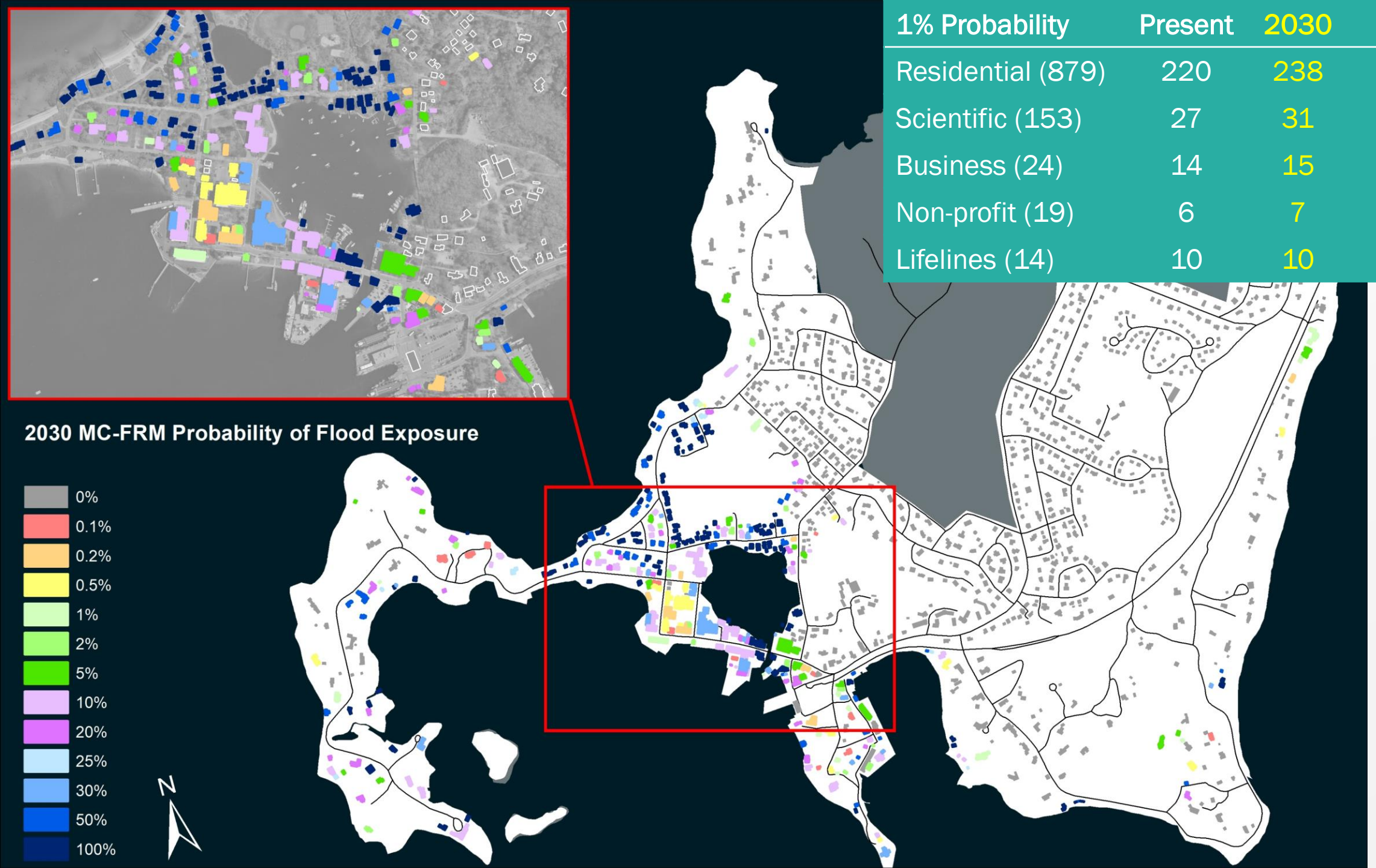
ResilientWoodsHole Study Area



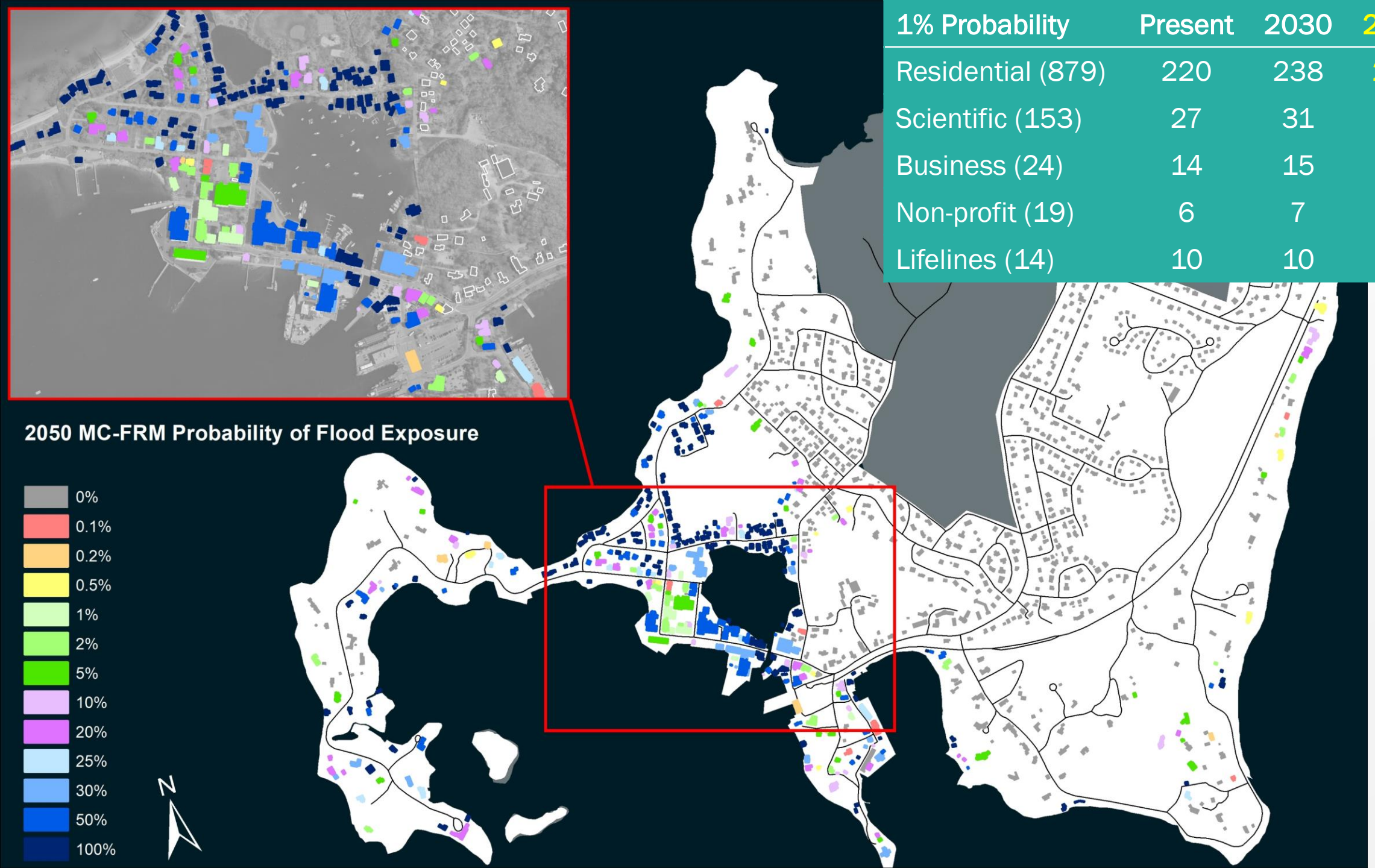


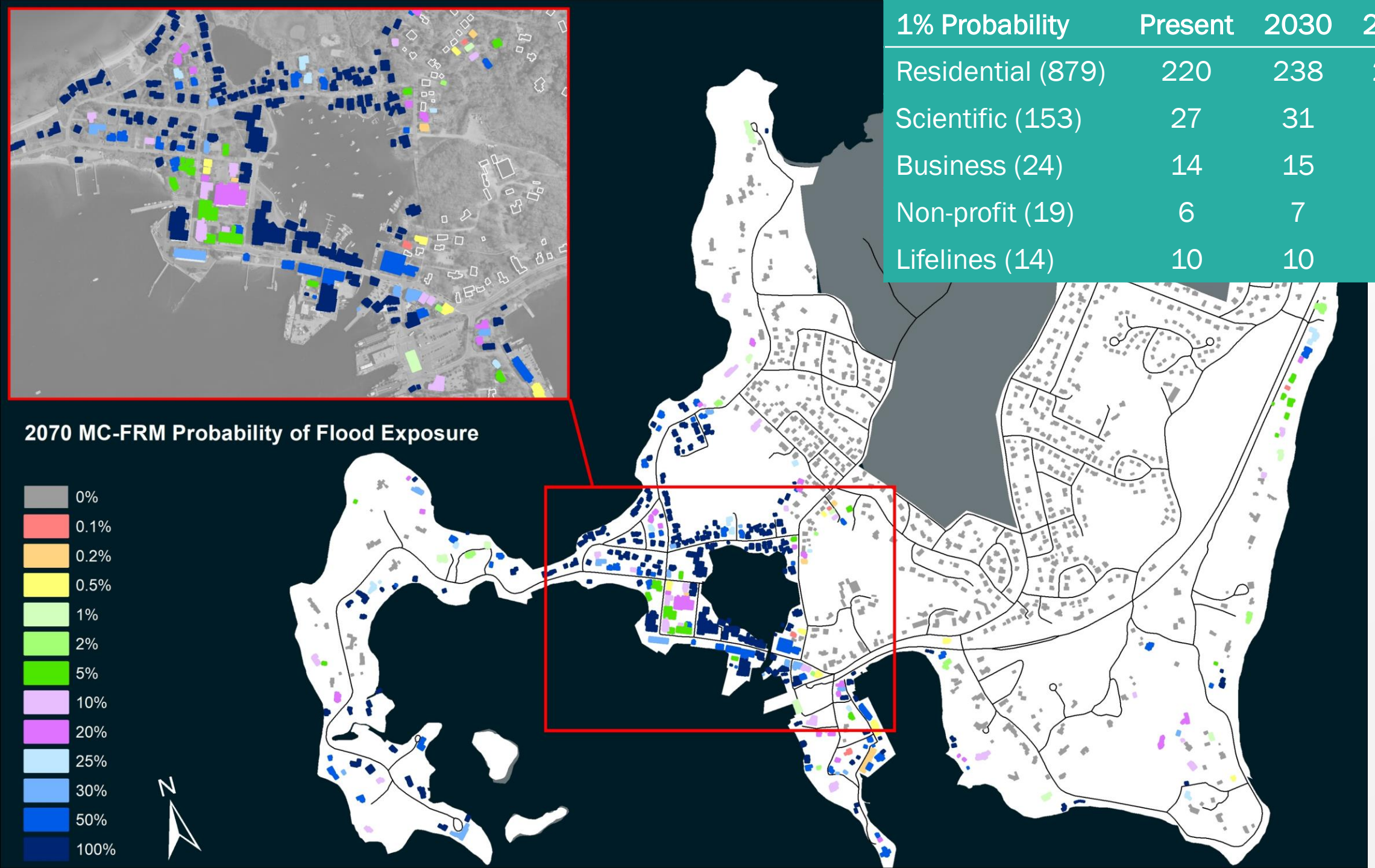
1% Probability	Present
Residential (879)	220
Scientific (153)	27
Business (24)	14
Non-profit (19)	6
Lifelines (14)	10



1% Probability	Present	2030
Residential (879)	220	238
Scientific (153)	27	31
Business (24)	14	15
Non-profit (19)	6	7
Lifelines (14)	10	10

1% Probability	Present	2030	2050
Residential (879)	220	238	257
Scientific (153)	27	31	44
Business (24)	14	15	17
Non-profit (19)	6	7	7
Lifelines (14)	10	10	11





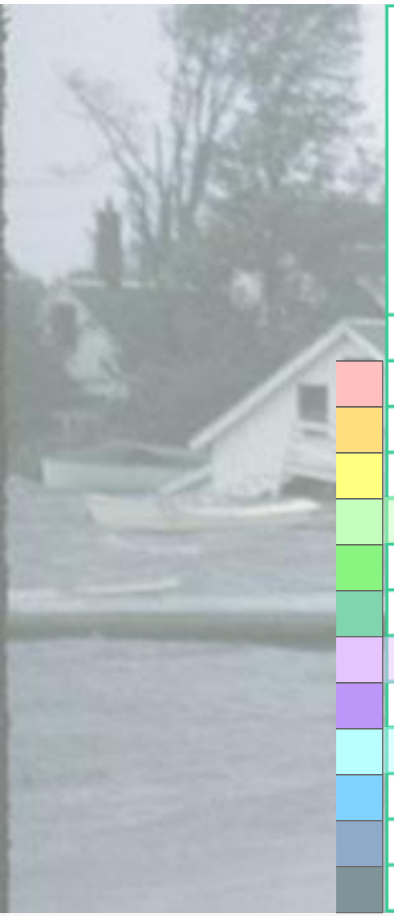
1% Probability	Present	2030	2050	2070
Residential (879)	220	238	257	281
Scientific (153)	27	31	44	44
Business (24)	14	15	17	18
Non-profit (19)	6	7	7	7
Lifelines (14)	10	10	11	12

Counts of Buildings Exposed to Projected Flooding

1% annual chance event has a 9.6% chance of occurring in a 10-year period

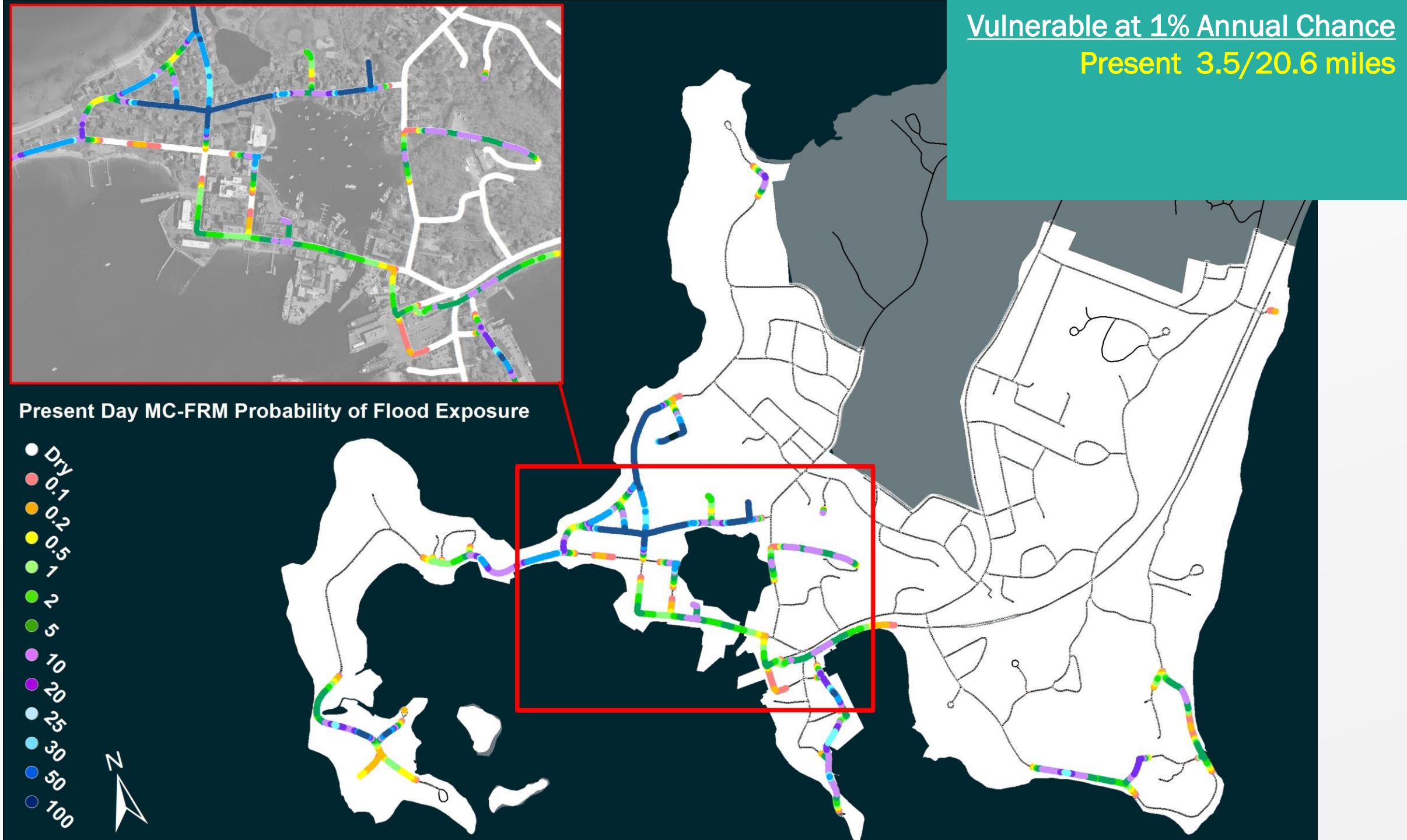
10% annual chance event has a 65.1% chance of occurring in a 10-year period

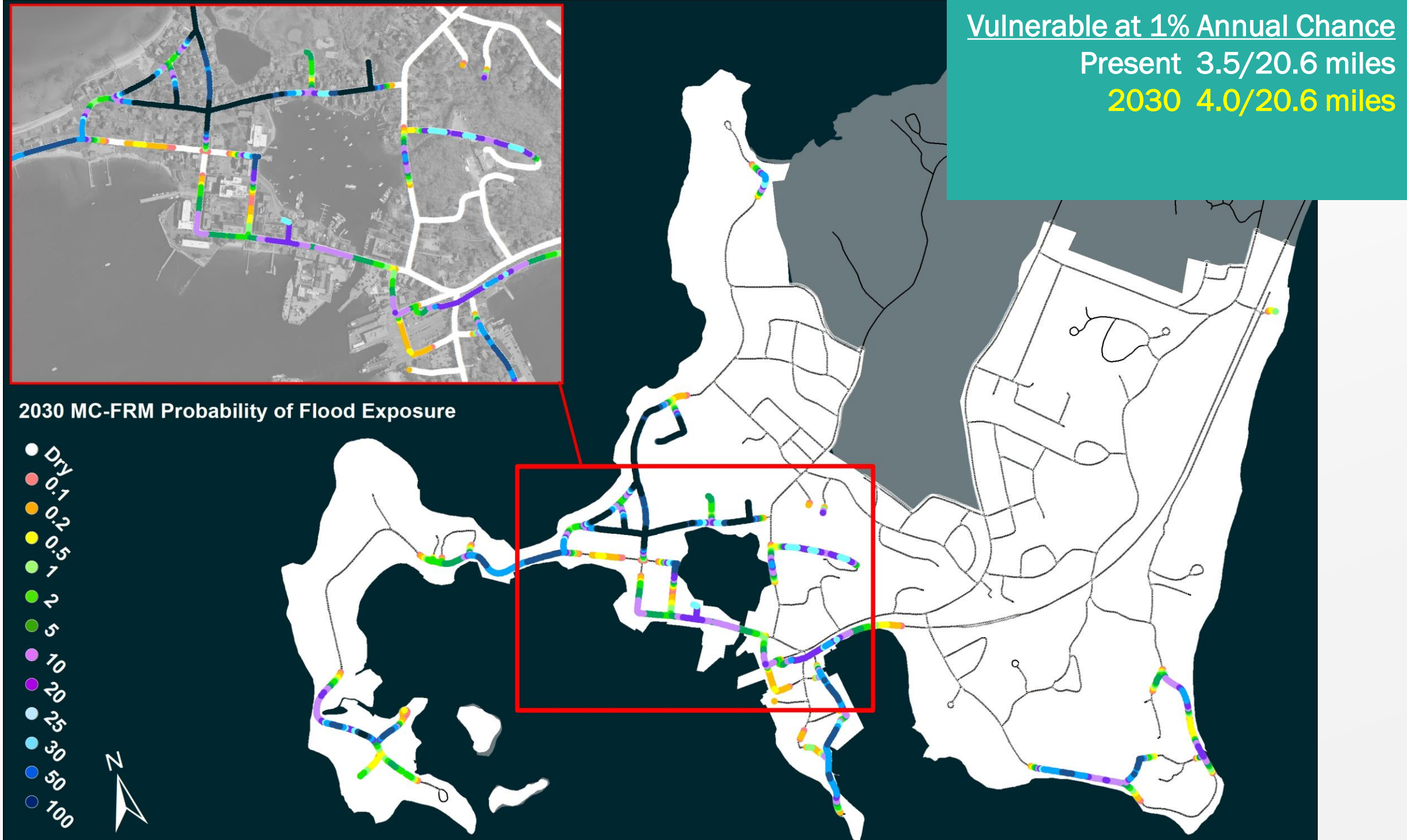
25% annual chance event has a 94.4% chance of occurring in a 10-year period

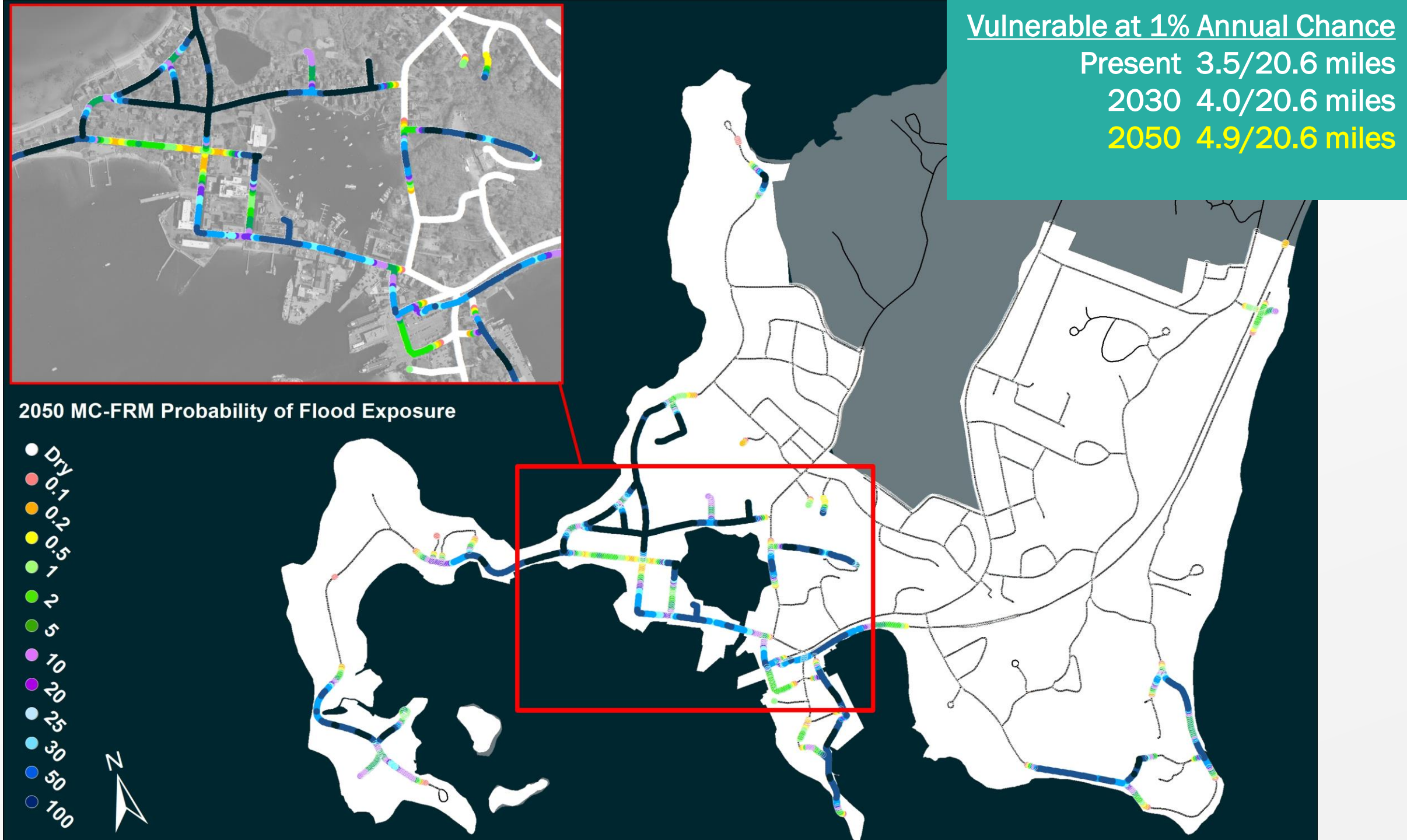


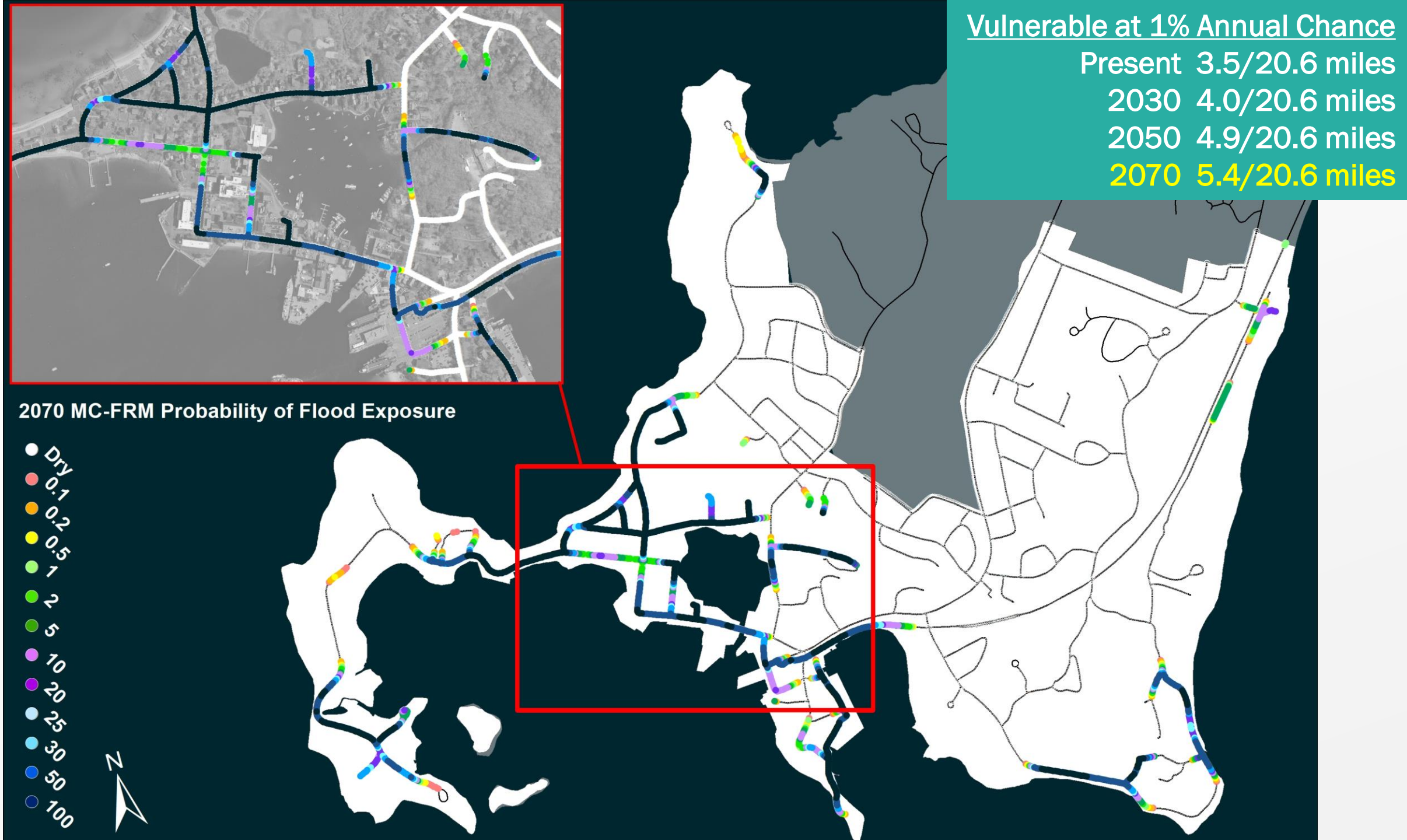
	Present					2030					2050					2070				
	WHOI-MBL-NOAA	Lifelines	Business	Residential	Non-Profit	WHOI-MBL-NOAA	Lifelines	Business	Residential	Non-Profit	WHOI-MBL-NOAA	Lifelines	Business	Residential	Non-Profit	WHOI-MBL-NOAA	Lifelines	Business	Residential	Non-Profit
0%	117	3	6	634	12	110	3	6	616	12	107	1	6	604	12	104	0	5	590	12
0.1%	36	11	18	245	7	43	11	18	263	7	46	13	18	275	7	49	14	19	289	7
0.2%	33	10	16	237	7	41	11	17	253	7	44	12	18	270	7	48	14	19	286	7
0.5%	28	10	15	230	7	36	10	15	251	7	44	11	18	265	7	46	13	19	285	7
1%	27	10	14	220	6	31	10	15	238	7	44	11	17	257	7	44	12	18	281	7
2%	25	7	14	211	6	28	10	15	225	7	37	11	17	256	7	44	11	18	273	7
5%	19	6	12	205	5	25	8	14	217	6	32	10	15	243	7	44	11	17	265	7
10%	8	5	12	178	4	23	7	12	203	5	29	10	15	219	7	37	11	17	250	7
20%	1	4	10	162	4	10	6	12	178	4	24	9	14	206	5	32	10	15	232	7
25%	1	2	8	137	4	8	4	9	151	4	24	8	12	180	4	30	10	15	210	6
30%	1	1	7	120	4	8	4	9	143	4	24	7	11	170	4	30	10	15	200	5
50%	1	1	6	110	4	1	3	7	132	4	15	6	11	158	4	26	10	13	190	5
100%	1	0	6	55	3	1	0	6	94	4	1	3	8	122	4	19	6	12	153	4

Credit: Woods Hole Historical Museum


Vulnerable at 1% Annual Chance
Present 3.5/20.6 miles
Present Day MC-FRM Probability of Flood Exposure
Dry
0.1
0.2
0.5
1
2
5
10
20
25
30
50
100
N


Vulnerable at 1% Annual Chance
Present 3.5/20.6 miles
2030 4.0/20.6 miles
2030 MC-FRM Probability of Flood Exposure
Dry
0.1
0.2
0.5
1
2
5
10
20
25
30
50
100
N


Vulnerable at 1% Annual Chance
Present 3.5/20.6 miles
2030 4.0/20.6 miles
2050 4.9/20.6 miles
2050 MC-FRM Probability of Flood Exposure
Dry
0.1
0.2
0.5
1
2
5
10
20
25
30
50
100
N


Vulnerable at 1% Annual Chance
Present 3.5/20.6 miles
2030 4.0/20.6 miles
2050 4.9/20.6 miles
2070 5.4/20.6 miles
2070 MC-FRM Probability of Flood Exposure
Dry
0.1
0.2
0.5
1
2
5
10
20
25
30
50
100
N

Road Miles Exposed to Projected Flooding

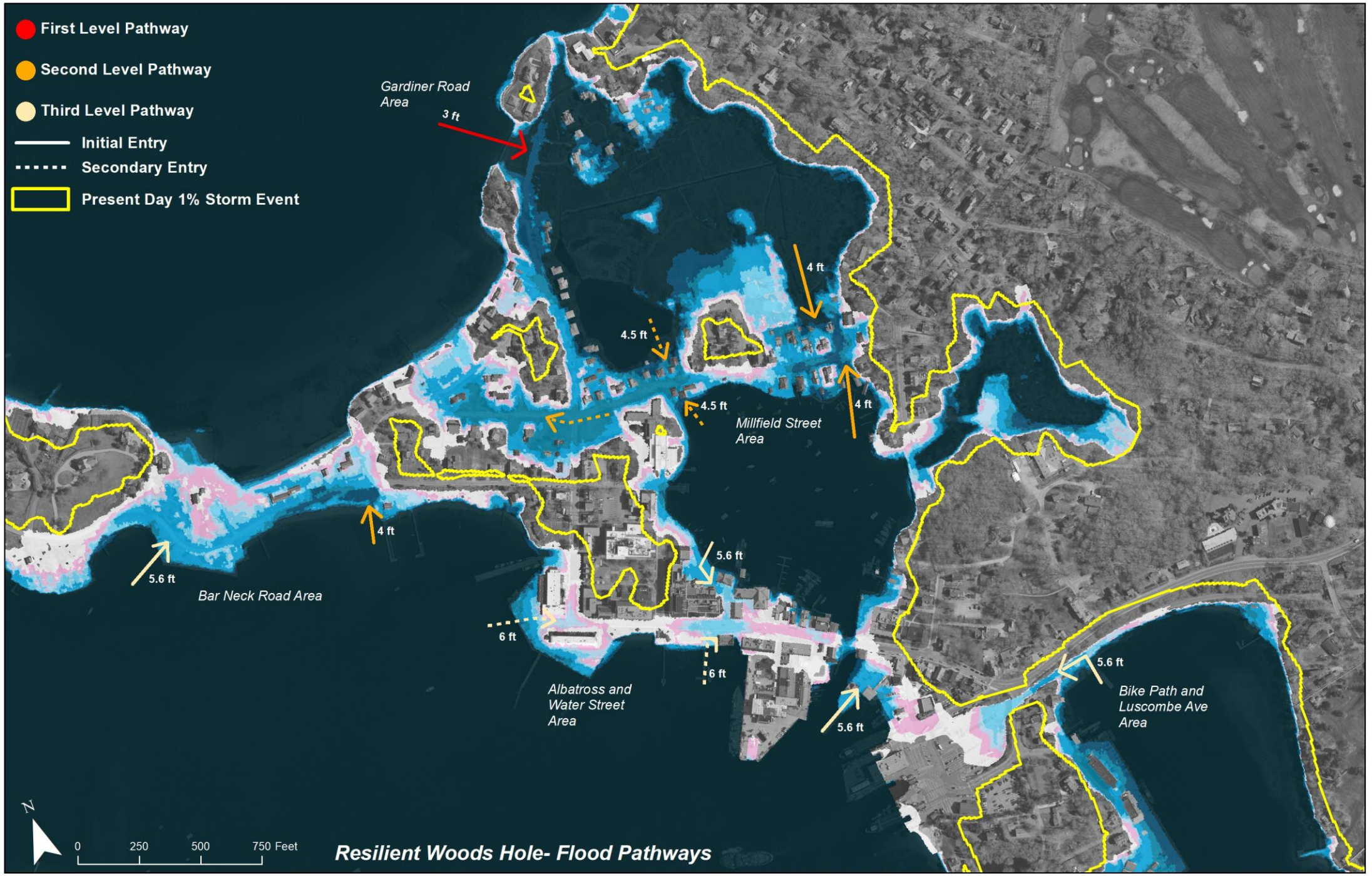
1% annual chance event has a 9.6% chance of occurring in a 10-year period

10% annual chance event has a 65.1% chance of occurring in a 10-year period

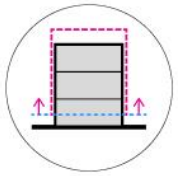
25% annual chance event has a 94.4% chance of occurring in a 10-year period

	Present	2030	2050	2070
0.1%	4.5	4.8	5.4	5.8
0.2%	4.2	4.6	5.2	5.7
0.5%	3.8	4.3	5.1	5.5
1%	3.5	4.0	4.9	5.4
2%	3.2	3.7	4.6	5.2
5%	2.7	3.3	4.2	5.0
10%	2.0	2.9	3.8	4.6
20%	1.3	2.3	3.4	4.2
25%	1.1	1.9	3.2	4.0
30%	0.9	1.7	3.0	3.8
50%	0.6	1.1	2.4	3.5
100%	0.0	0.7	1.1	2.3

Credit: Oliver B. Brown, courtesy Woods Hole Historical Museum


First Level Pathway
Second Level Pathway
Third Level Pathway
Initial Entry
Secondary Entry
Present Day 1% Storm Event
Gardiner Road Area
3 ft
4 ft
4.5 ft
4.5 ft
4 ft
Millfield Street Area
4 ft
5.6 ft
Bar Neck Road Area
5.6 ft
6 ft
6 ft
Albatross and Water Street Area
5.6 ft
5.6 ft
Bike Path and Luscombe Ave Area
N
0
250
500
750 Feet
Resilient Woods Hole- Flood Pathways

Adaptation Strategies – Building Scale

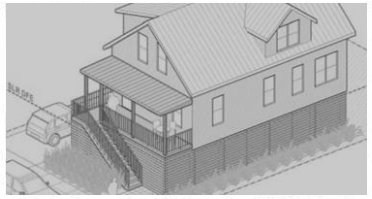


Building Form + Access

Elevate on extended foundation walls or open foundation

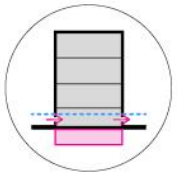
Elevate on fillI

Repurpose/Relocate Ground Floor Use



Exterior circulation to SLR-DFE

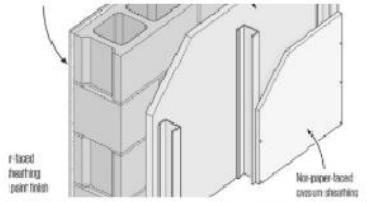
Interior circulation to SLR-DFE



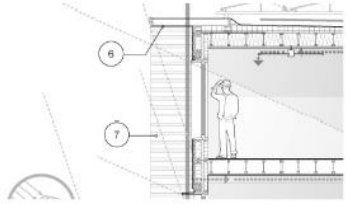
Building Adaptation

Wet Floodproofing

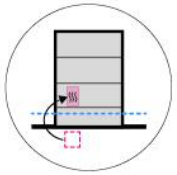
Dry Floodproofing



Flood Damage-Resistant Materials

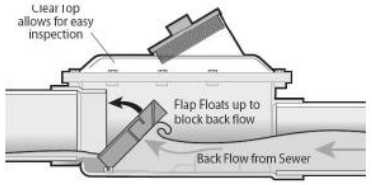


Enhanced Building Envelope



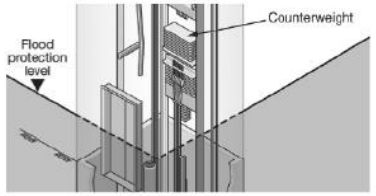
Building Systems

Protecting Critical Systems

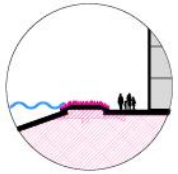


Backflow Prevention

Back-up Systems



Resilient Elevators



Site

Vegetated Berm

Deployable Barriers

Perimeter Wall

(Credit: Modified from Boston Planning & Development Agency, Coastal Flood Resilience Design Guidelines)

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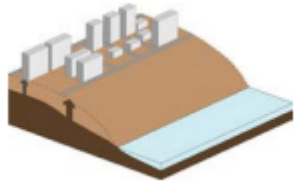
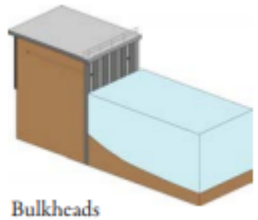
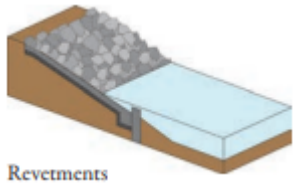
Adaptation Strategies – Landscape Scale

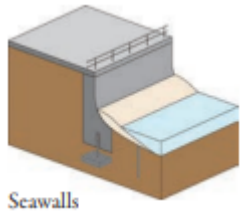
Protect (hardened infrastructure)

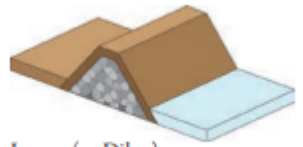

Elevation of Land and Streets

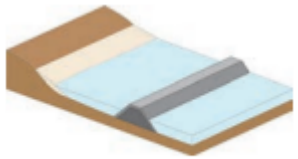

Floodwalls

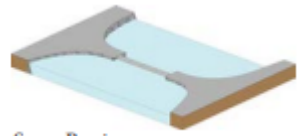

Bulkheads


Revetments

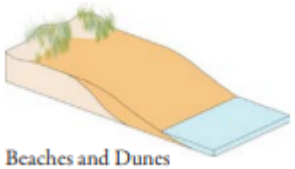

Seawalls

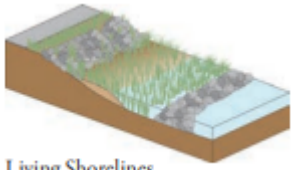

Levees (or Dikes)

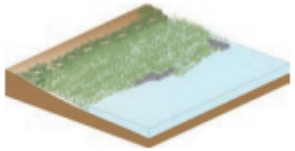

Breakwaters

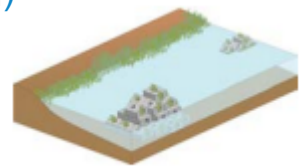

Surge Barriers

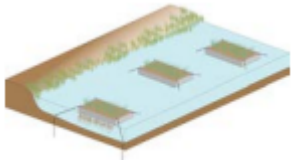
Protect (natural or nature-based infrastructure)

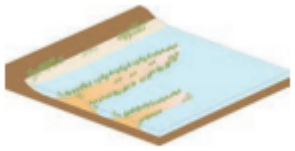

Beaches and Dunes


Living Shorelines


Constructed Wetlands


Artificial Reefs


Floating Islands


Constructed Breakwater Islands

Protect (hybrid infrastructure)


Waterfront Parks


Multi-purpose Levees

Relocate/Retreat


Strategic Retreat

(Credit: Modified from NYCPlanning, Coastal Climate Resilience Urban Waterfront Adaptive Strategies)

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Develop community-wide **understanding of local climate impacts**.

Build effective **partnerships** for Village planning and visioning.

Develop **short-, mid-, and long-term climate adaptation actions** across strategic themes.

Identify key **thresholds and transition points**, based on adaptive management

Chart **dynamic adaptation pathways** that optimize community outcomes over time, based on community preferences and scientific projections.

ResilientWoodsHole Phase 3

How can we work together to ensure the future of our vibrant and productive seaside community?

Comprehensive phased strategy for Woods Hole Village that integrates resilient design concepts and community visioning.

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2/9/22 Public Forum (135 attendees)

https://resilientwoodshole.org/

Input Map: Important Features

tinyurl.com/RWHimportant

Input Map: Adaptation and Vision

tinyurl.com/RWHadaptation

Input Map: Flooding

tinyurl.com/RWHflooding

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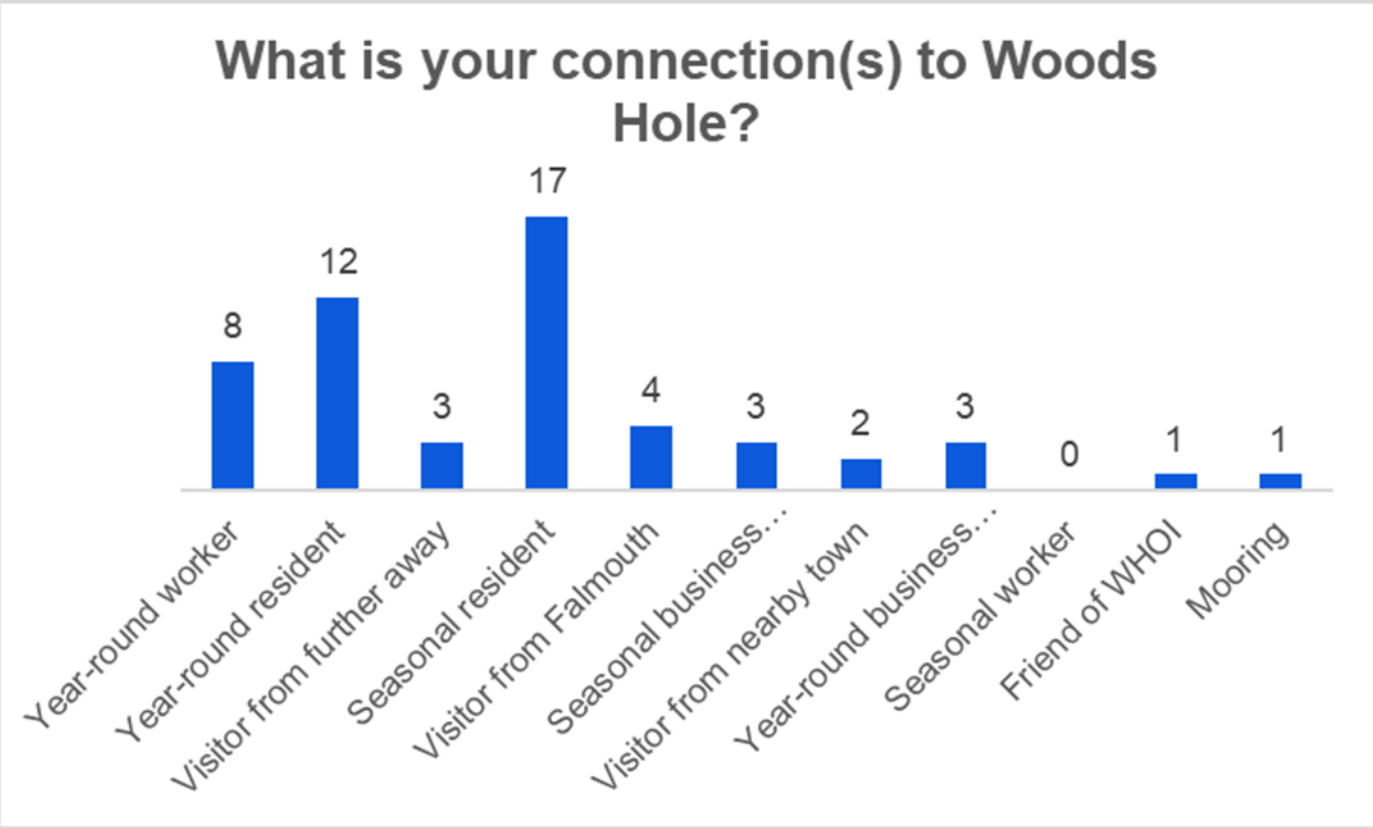
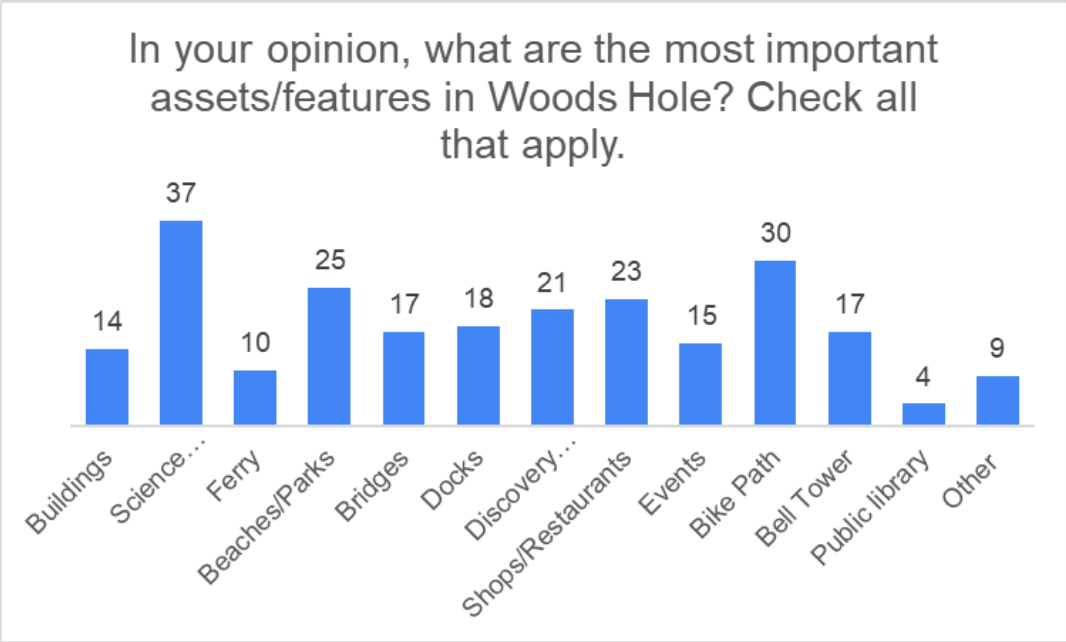
Stakeholder Survey: 41 Respondents



Stakeholder Survey: Important Features



All assets are important, but some have irreplaceable historical value, such as Woods Hole Library, Woods Hole Community Hall, Children's School of Science, Woods Hole Historical Museum, Waterfront Park and sculptures, NPR building.

Community, yacht club, Community Hall, Library, Museum, Post Office, Nobska

Daily life, friends, MBL, cemetery and related church activities. might want to add science education/science school to your list

Historical, education and physical nature

The harbors Great Harbor and Eel Pond

Museum

Harbor

Baseball field

Stakeholder Survey: What do you value here?

Overall themes

- Scientific Community (intellectual diversity)
- Community/Nostalgia/Deep Ties to the Village/Energy
- History
- Natural Environment

Woods Hole is a special community in which year-round and summer residents have been there for 3 or more generations. This allows for deep ties to each other and to the community. This also promotes a vibrant, engaged community that sponsors and supports events (talks, music, film series) that are almost unparalleled in a community of this size.

The unique mix of science, natural beauty and culture

A unique blend of history, science, charm and leisure

It's a very **nostalgic place** for me. I love the small town feel, the scientific community, and the practical modesty of Woods Hole - no chain stores, no flashy businesses. I have spent my adult life thinking "maybe some day I can retire in Woods Hole" and the fact that I am now living here and may be able to for the rest of my life is amazing! I know and love every house on the walk between my family's house and Stony Beach, the bell tower, the bridge, going to watch ferries load and unload (I still do this as an adult.) I and my children have attended CSS and visited the Aquarium (still mourning Bumper and LuSeal). It just feels like a community where I want to spend my life.

nostalgic pride

Long family history in the area

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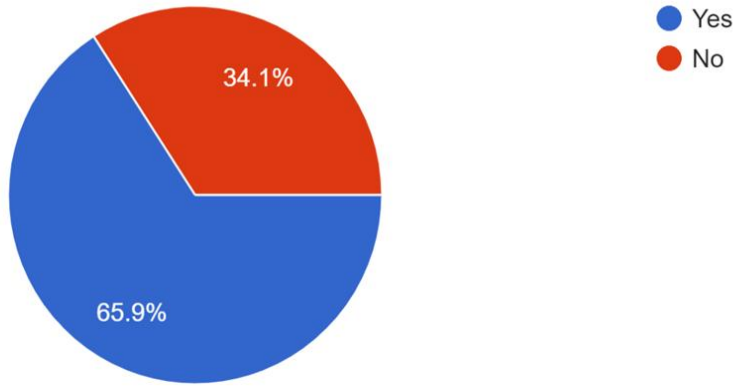
Stakeholder Survey: Experience with Flooding

Have you experienced **high tide flooding** or **coastal storm flooding** in Woods Hole?

41 responses



Impacts:

- My property is right on the water and high tide flooding eats away at the sand bank
- Localized street flooding
- Covered our dock
- Unable to drive through shoreline roads and parts of village
- On the docks.
- Eroded shoreline, killed vegetation

Common Responses:

High Tide

- Woods Hole Yacht Club and its docks
- Beaches (spec. Vineyard Sound and Stoney beach)
- Eel Pond

Coastal Storm

- Woods Hole Yacht Club and its docks
- Gardner Rd
- Millfield Street
- Mill Pond and marsh

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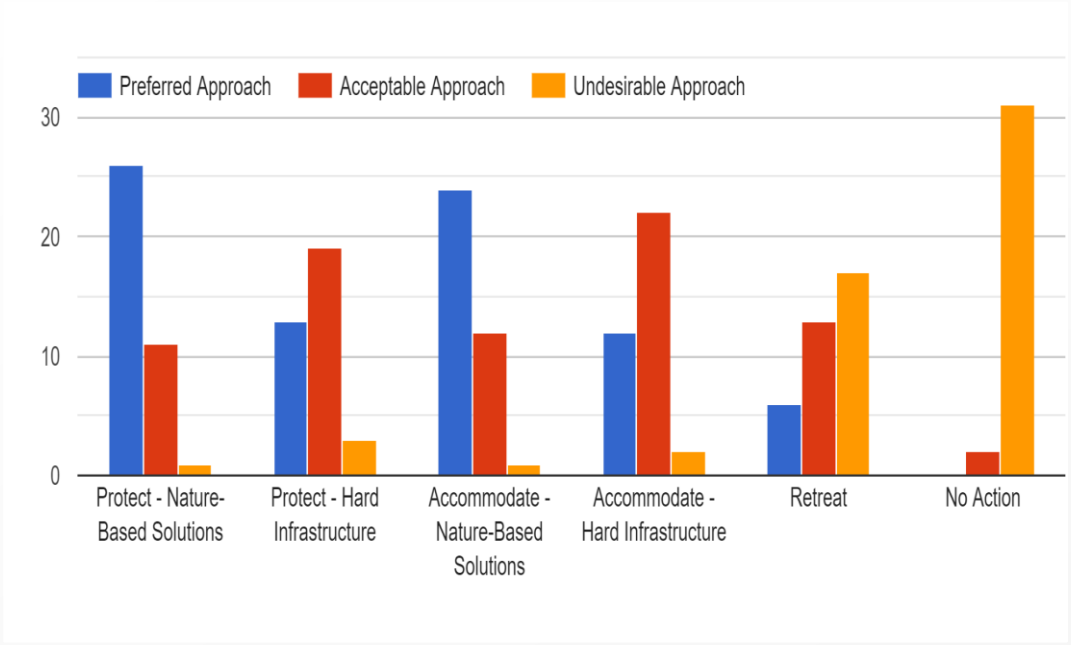
Stakeholder Survey: Adaptation Strategies



*preferences in response to storms were nearly identical to preferences in response to SLR

Nature-based solutions would build on the reasons that people come to Woods Hole in the first place -- they would increase populations of fish, shellfish, shorebirds, etc. and perhaps create new areas for visitors and residents to explore and enjoy nature. Hardening the shoreline may be necessary in spots but would make it less, rather than more, pleasant for people and useless for wildlife. Doing nothing is not an option because Woods Hole as we know it would disappear.

Hard infrastructure approaches to protection are short-term and expensive. Retreat is inevitable, just a matter of when.

It will likely take all aspects to remain resilient to the negative affect s from sea level rise and I think fortify existing costly infrastructure as we plan a phased retreat

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Stakeholder Survey: What should remain?

Overall themes

- Science Institutions need to be protected
- Utilities that help the village run protected
- Keep the golf course as is
- Tourism-based shops, events, etc should be relocated
- Non-useful infrastructure should cease to exist (playground, fields)

Science centers should stay in place to maintain the history of Woods Hole. Tourism-only shops may be able to be moved back from at-risk areas with little impact to their business if traffic could be directed inland.

Infrastructure such as water mains, sewer lines and pump stations, power lines, roads are required for the village to survive. The research institutes which provide much of the reason for the village to be, also seem critical. Features like the ball park and playground are not as unique or important to me and could be allowed to flood. I enjoy Stoney Beach but realize that it may be difficult to maintain with rising sea levels.

Science institutions. Coastal home, beaches, historical buildings, etc. can be found many places, but the scientific institutions of Woods Hole are unique and similar concentrations of oceanographic research organizations only exist at a few locations on Earth.

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Interviews: what we heard from Town/Residents/Institutions

Key Themes

residents, institutions, businesses and Town rely on one another for support, need to adapt together rather than in silos

near-term preference for solutions that enhance ability to ride out storms and rebound, rather than walls or retreat

long-term recognition that some non-water dependent functions can relocate, but not universally feasible

long-term recognition that other assets that are water-dependent or limited alternatives may need to explore protection

strong preference to maintain the existing character of the Village and maintain “third places” that facilitate innovation

identity of Woods Hole Village is tied to close-knit community, working waterfront, science, business/tourism, open space

desire to reduce traffic and congestion, which could enhance character and accessibility as well as open space

desire to increase access to and engagement with outdoors, waterfront, and institutions (community and scientific)

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Adaptation Theme: Maintain Character

Goal:

- Preserve the existing uses, historic character and community resources

Strategy:

- Leverage moderate and incremental strategies to steward the seaside community and the blue economy village identity

Representative Actions:

- wet floodproofing
- depolyable site protection strategies
- building systems protection

Adaptation Theme: Nature-based Focus

Goal:

- Use nature-based solutions to enhance resiliency and ecosystem services

Strategy:

- Where feasible, extend the effectiveness and potential longetivity of coastal green infrastructure and open space by facilitating the preservation, restoration, and migration of natural resource systems

Representative Actions:

- salt marsh migration/restoration
- beach/dune nourishment
- living shorelines

Adaptation Theme: Protect/Connect

Goal:

- Emphasize protection and maintenance of existing infrastructure and ensure vital connectivity

Strategy:

- Use hard and/or hybrid infrastructure solutions to reduce exposure of important features (municipal infrastructure, waterfront scientific assets, businesses and the residenital community) and preserve critical accessways (within Woods Hole and to the waterfront)

Representative Actions:

- seawalls
- bulkheads
- flood walls
- landscaped berms and terracing
- elevation of land/roads/buildings/infrastructure
- dry floodproofing

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Adaptation Theme: Adaptive Realignment

Goal:

- Reimagine Woods Hole through the lens of living with water

Strategy:

- Where existing uses and configurations cannot reasonably continue (increasing cost/risk from daily tides or common storms), develop a multi-phased plan to accommodate water with lateral or vertical relocation based on shared understanding of risk tolerance

Representative Actions:

- strategic elevation/relocation of buildings/infrastructure
- change in use or program
- undevelopment (retreat/buyout) for resilient open space

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Adaptation Actions: Management Areas

Fay Road

Nobska Point

Juniper Point

Waterfront

Penzance Point

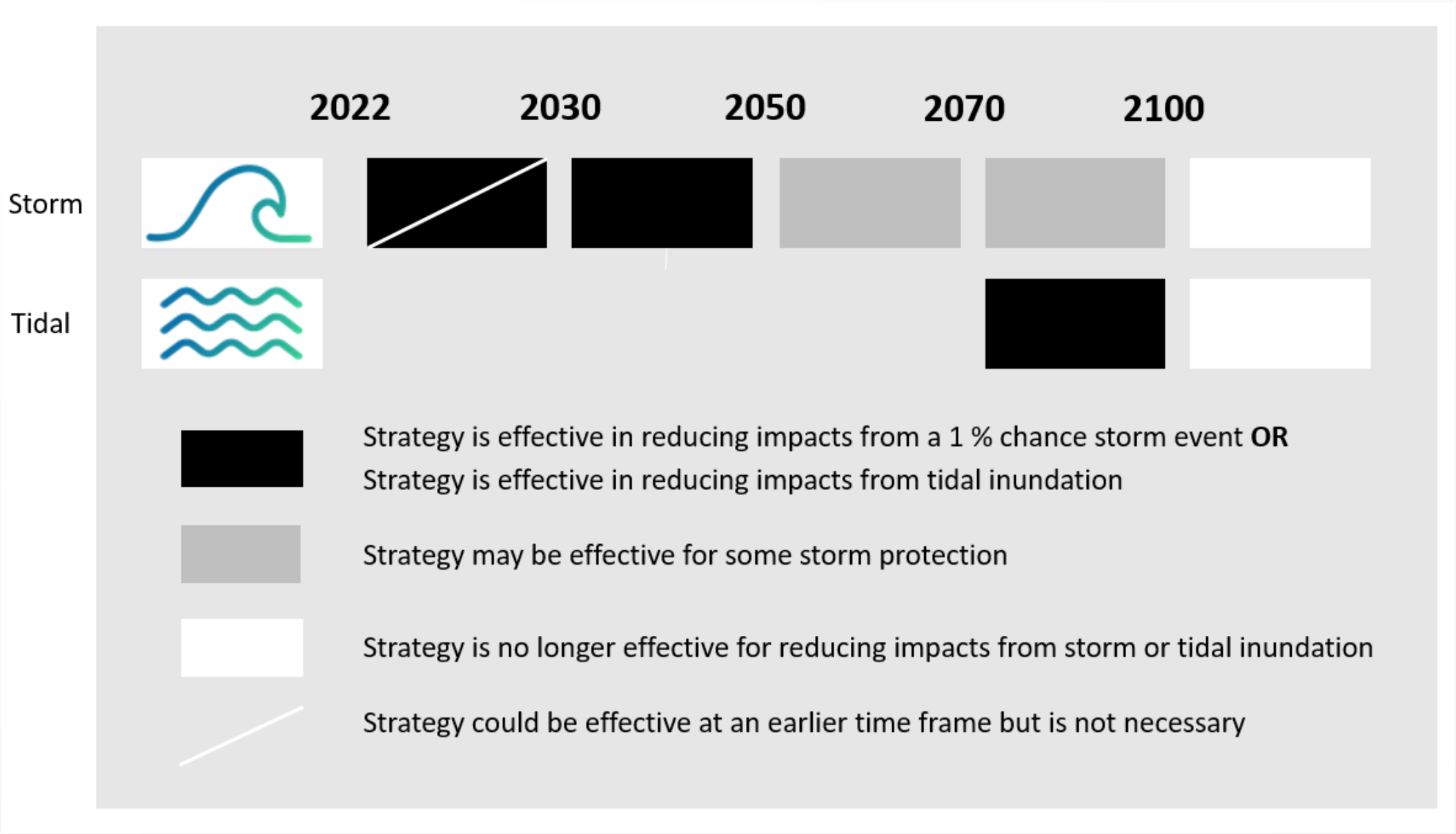
Spencer Baird

Eel Pond / School Street

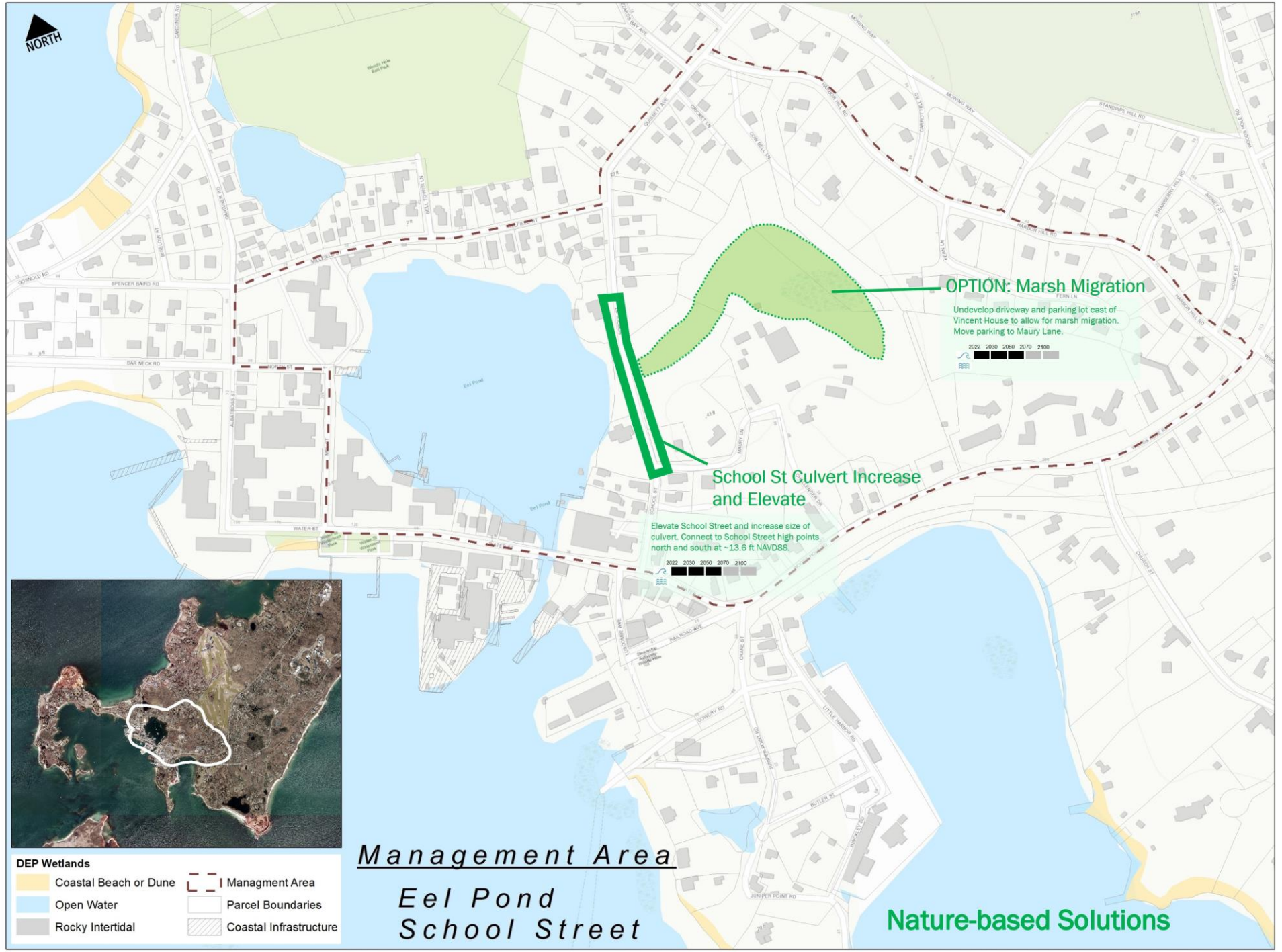
Millfield/Gardiner

Gansett

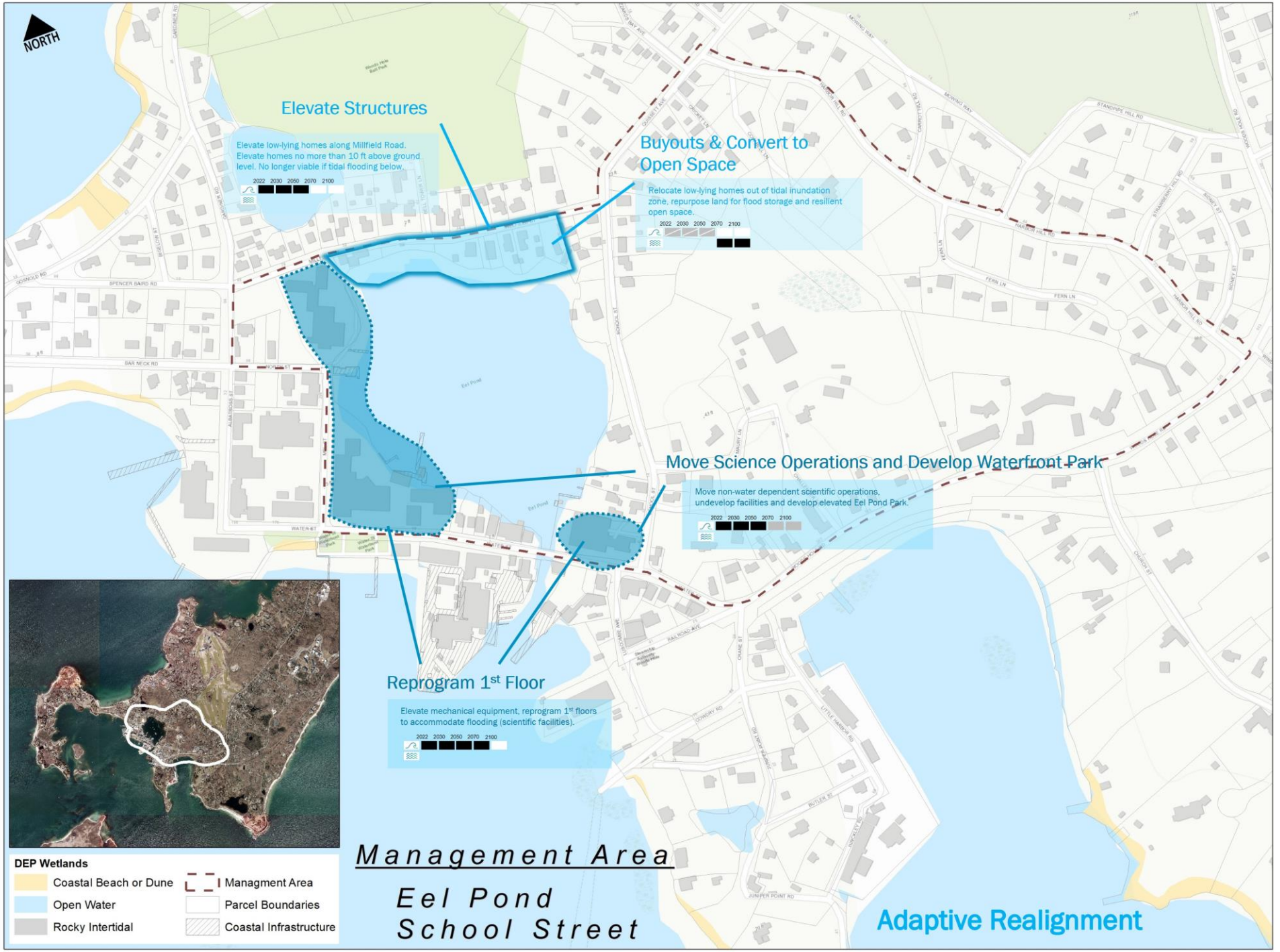
Adaptation Options Maps



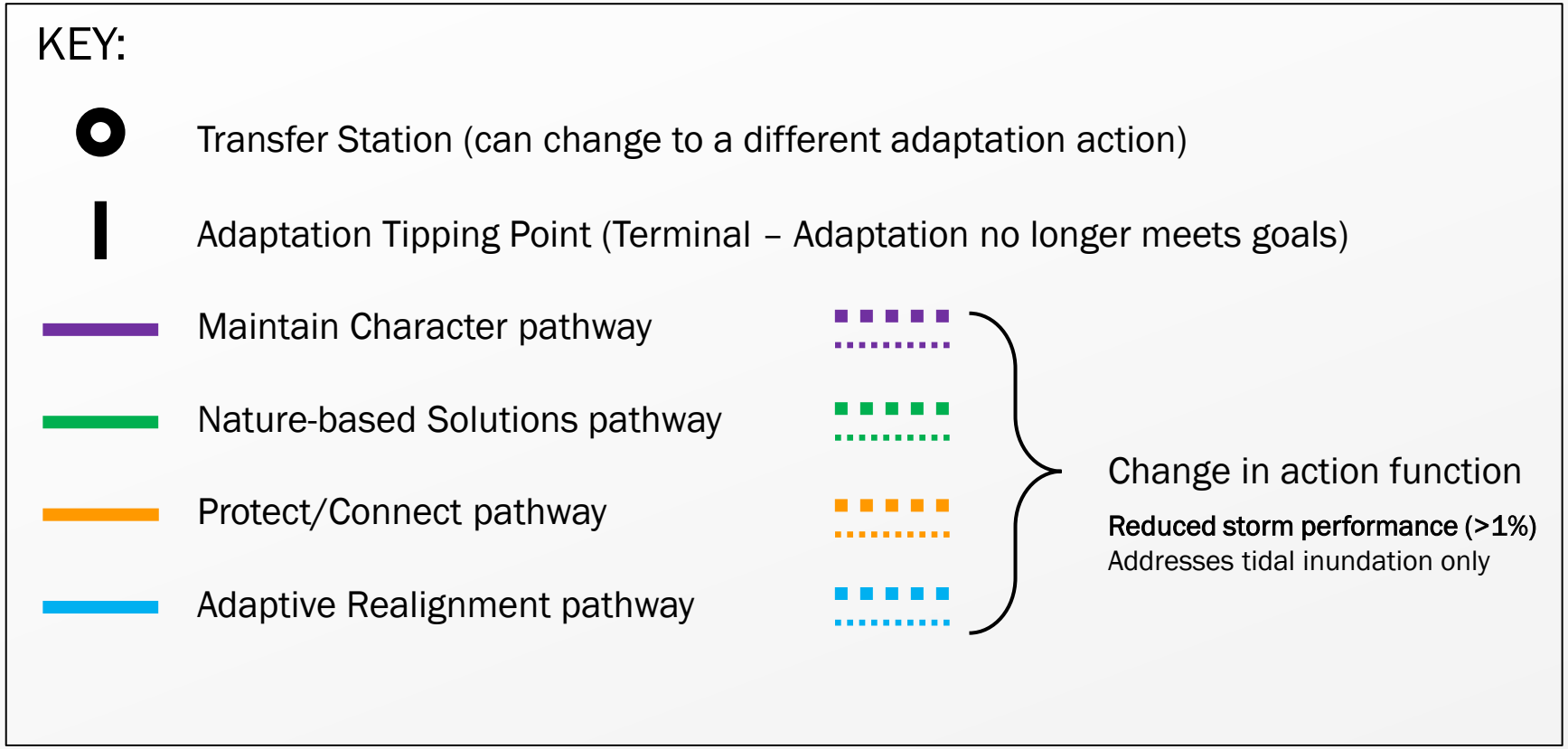

NORTH
Wet Floodproofing
Wet floodproofing low-lying homes. No longer effective if water floods 1st floor. Consider elevating and wet floodproofing if water level exceeds 18" above grade.
2022 2030 2050 2070 2100
Deployable Barriers
Deployable flood protection strategies (up to 48") for low lying Millfield St homes and structures along southwest Eel pond and Water Street. Identify location for communal storage.
2022 2030 2050 2070 2100
DEP Wetlands
Coastal Beach or Dune
Open Water
Rocky Intertidal
Managment Area
Parcel Boundaries
Coastal Infrastructure
Management Area
Eel Pond
School Street
Maintain Character


NORTH
OPTION: Marsh Migration
Undevelop driveway and parking lot east of Vincent House to allow for marsh migration. Move parking to Maury Lane.
2022 2030 2050 2070 2100
School St Culvert Increase and Elevate
Elevate School Street and increase size of culvert. Connect to School Street high points north and south at ~13.6 ft NAVD88.
2022 2030 2050 2070 2100
DEP Wetlands
Coastal Beach or Dune
Open Water
Rocky Intertidal
Managment Area
Parcel Boundaries
Coastal Infrastructure
Management Area
Eel Pond
School Street
Nature-based Solutions

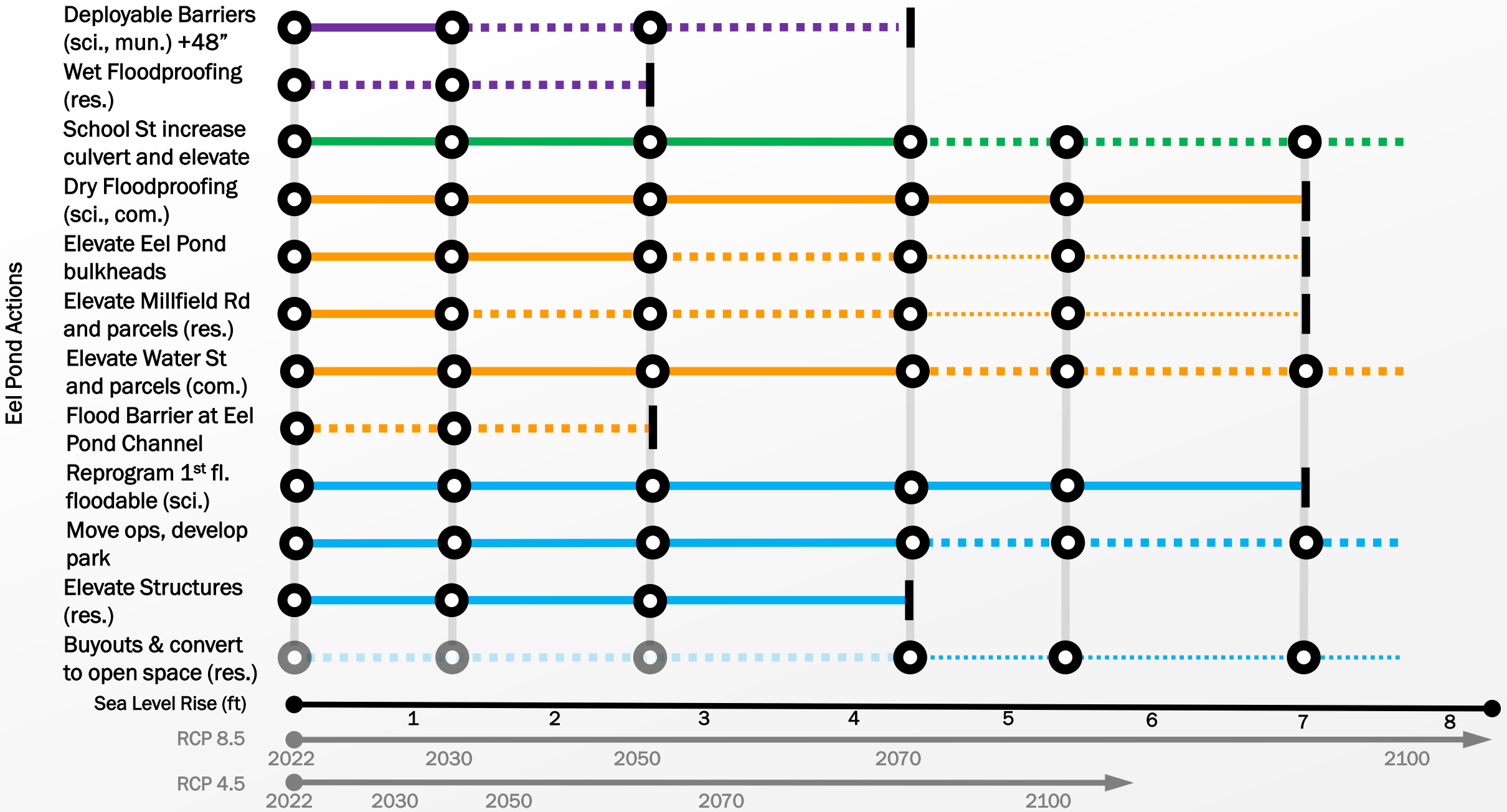

NORTH
Elevate low-lying Millfield corridor and rebuild homes with some elevation. Elevate corridor up to ~10 ft NAVD88.
2022 2030 2050 2070 2100
Elevate Millfield Road and Parcels
Elevate Eel Pond Bulkheads
Elevate Eel Pond seawalls and bulkheads (~42") backing parcels with commercial, residential and scientific use. Brings new critical elevation to ~8.5 ft NAVD88.
2022 2030 2050 2070 2100
Dry Flood Proofing
Dry flood proof structures (Scientific and Commercial). No longer viable if tidal inundation impacts the structures.
2022 2030 2050 2070 2100
Elevate Water St and Businesses
Elevate Water Street and businesses no higher than 9.5 ft NAVD88 tying into high spot on north side of water street.
2022 2030 2050 2070 2100
Flood Barrier
Construct flood control barrier at Eel Pond Channel at existing elevation of 7.75 ft NAVD88. Would need to be coordinated with other areas to prevent flanking.
2022 2030 2050 2070 2100
DEP Wetlands
Coastal Beach or Dune
Open Water
Rocky Intertidal
Managment Area
Parcel Boundaries
Coastal Infrastructure
Management Area
Eel Pond
School Street
Protect/Connect


NORTH
Elevate Structures
Elevate low-lying homes along Millfield Road. Elevate homes no more than 10 ft above ground level. No longer viable if tidal flooding below.
2022 2030 2050 2070 2100
Buyouts & Convert to Open Space
Relocate low-lying homes out of tidal inundation zone, repurpose land for flood storage and resilient open space.
2022 2030 2050 2070 2100
Move Science Operations and Develop Waterfront Park
Move non-water dependent scientific operations, undevelop facilities and develop elevated Eel Pond Park.
2022 2030 2050 2070 2100
Reprogram 1st Floor
Elevate mechanical equipment, reprogram 1st floors to accommodate flooding (scientific facilities).
2022 2030 2050 2070 2100
DEP Wetlands
Coastal Beach or Dune
Open Water
Rocky Intertidal
Managment Area
Parcel Boundaries
Coastal Infrastructure
Management Area
Eel Pond
School Street
Adaptive Realignment

Dynamic Adaptation Pathways



Eel Pond Area



Eel Pond Area

Name (optional): _____

Are you a resident of this area? YES NO

Are you a business owner or employee in this area? YES NO

	☺	😐	☹	Comments
Deployable Barriers (sci., mun.) +48”				
Wet Floodproofing (res.)				
School St increase culvert and elevate				
Dry Floodproofing (sci., com.)				
Elevate Eel Pond bulkheads				
Elevate Millfield Rd and parcels (res.)				
Elevate Water St and parcels (com.)				
Flood Barrier at Eel Pond Channel				
Reprogram 1st fl. floodable (sci.)				
Move ops, develop park				
Elevate Structures (res.)				
Buyouts & convert to open space (res.)				

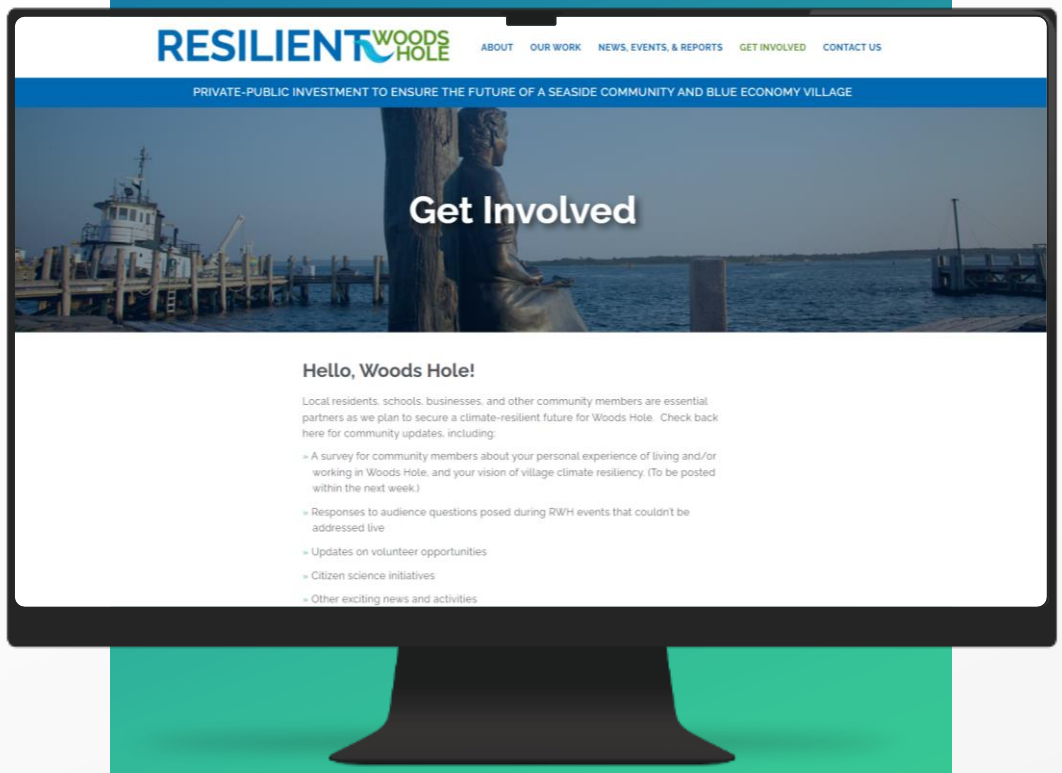
RESILIENT WOODS HOLE


RESILIENT WOODS HOLE
Next Steps

ResilientWoodsHole Phase 3 Schedule

WOODS HOLE GROUP
A CLS COMPANY

How do I engage further?



https://resilientwoodshole.org/

Input Map:
Important Features

tinyurl.com/RWHimportant

Input Map:
Adaptation and Vision

tinyurl.com/RWHadaptation

Input Map:
Flooding

tinyurl.com/RWHflooding

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RESILIENT WOODS HOLE
Questions?


RESILIENT WOODS HOLE
Coastal Management Area Stations

Workshop: Coastal Management Area Stations

Room 1 (this room)

Fay Road

Gansett

Nobska Point

Juniper Point

Penzance Point

Room 2 (next door)

Spencer Baird

Eel Pond / School Street

Millfield/Gardiner

Waterfront

WOODS HOLE GROUP
A CLS COMPANY

Credit: WHBA

Thank you

Joseph Famely

Climate & Sustainability Team Lead

Woods Hole Group

jfamely@woodsholegroup.com

508-495-6220

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