

NANTUCKET COASTAL RESILIENCE PLAN

FINAL REPORT

NOVEMBER 2021



COASTAL
RESILIENCE
ADVISORY
COMMITTEE



● one architecture

THE CRAIG GROUP
Your partners in preservation, planning and policy.

STOSS



Polpis Point (photo by James Hark)

November 2021

Dear Nantucket Residents, Property Owners, Visitors, and Interested Parties:

The Nantucket community has a storied history with its ability to adapt positively to a changing world. Whether it be the end of the whaling era in the late 1800's, the Great Fire of 1846 or the 1991 "No Name" Storm, Nantucket has always found ways to adapt and overcome.

Climate change is an overarching problem for Nantucket and the Coastal Resilience Plan (CRP) is part of Nantucket's response to dealing with a major consequence of climate change: sea level rise. Sea level rise is expected to worsen and exacerbate existing coastal problems of flooding and erosion in the foreseeable future. The risks for Nantucket, a maritime community, are significant. The CRP is an ambitious and forward-thinking document intended to put forward approaches to preserve our Island and its heritage as much as possible.

Having this plan in place is also fulfilling an obligation outlined in the Town's 2019 Hazard Mitigation Plan. The CRP strengthens the Town and County-wide commitment to both reducing weather- and sea level-related hazards and increasing resilience to withstand them. In recent years, the Town of Nantucket has taken a more proactive role in preparing for impact events such as severe storms, including hurricanes, and extreme high tides and flooding. The CRP in concert with other existing and developing complementary plans will lay out ways to further reduce the island's risks and losses in extreme storm events and as waters rise.

Climate change impacts are detectable on the Island and are becoming more frequent. The CRP outlines areas most at risk and provides recommendations as to solutions and approaches to mitigate these risks and keep our community viable for longer in ways that are familiar to us. There are going to be changes, both structural and policy related, to overcome and incorporate into our everyday lives. This is how we will adapt, become more resilient, and move forward.

Profound thanks to all community members who participated in the development of this plan, year-round and seasonal residents, and visitors alike. Developing this plan during the Covid-19

pandemic was especially challenging; challenges that were overcome through participation on Zoom. Though started in virtual meetings, this plan is anticipated to initiate real changes in our coastal zones through physical infrastructure, implementation of new and updated policies, and other ways to deal with rising seas. The Plan is a dynamic document which will be revisited frequently as conditions unfold. It will take a commitment from the community to accept new ways intended to help keep Nantucket, Nantucket.

C. Elizabeth Gibson
Town Manager
Town of Nantucket





“It would be irresponsible and grievous for our government and our citizens not to work together to take care of our home”

“At a minimum, the Town needs to protect its own buildings and public infrastructure. In addition, the ability just to live on the island will be impacted, so essential services the Town provides and maintains must be protected. However, there may be things we as a community choose to abandon because the cost/benefit ratio would be unacceptable.”



“There are some areas, especially low-lying, where there is no constructed real estate and which would be uneconomic to protect against significant sea level rise and/or increased storm frequency/intensity.”

Coastal storms are increasing in frequency and intensity, bringing the impacts of storm surge to the front doors of Nantucketers.

Coastal erosion of Nantucket’s bluffs, dunes, and beaches continues to progress, becoming more rapid with sea level rise, and threatening homes, infrastructure, and natural resources.

- Through 2070, over 2,300 buildings are at risk of coastal flooding and/or erosion. 84% of these buildings are residential and nearly 50% are historic.
- By 2070, nearly 30 miles of roadway are expected to be inundated by more than 6 inches of flood water during regular high tides.
- Over the next 50 years, with sea level rise, coastal flooding and erosion are expected to cause over \$3.4 Billion in cumulative damages across the island.

Nantucketers are committed to preserving the island’s one-of-a-kind character for generations to come.

To build a resilient future Nantucket that embodies the island’s unique history and characteristics, supports healthy coastal and ecological resources, and bolsters thriving communities, Nantucket must adopt the CRP’s comprehensive, adaptable, and implementable approach.

November 2021

Letter From the Coastal Resilience Advisory Committee

This Coastal Resilience Plan (CRP) focuses on the island's critical infrastructure as the highest priority for funding of resilience measures to protect the entire island. The recommendations of the CRP also include policy, regulatory, and zoning initiatives; governance best practices; and homeowner preparedness. Nantucket's near-total dependence on the Steamship Authority; the risk to our public utilities and transportation network; the lack of available land for relocation; and the unique historic character of the Downtown area in particular, were all forces shaping the recommendations of the CRP. At the same time, the community demonstrated a strong commitment to the integrity of the natural environment and the importance of incorporating natural solutions. Perhaps most important is the call for the community to work together to address the local challenges from climate change, employing all the tools and funding sources available to us.

The CRP covers the entire island with six Focus Areas identifying places where protection, adaptation, or strategic retreat opportunities need to be developed to respond to flooding, erosion, and sea level rise threats and ensure public safety and emergency access.

For the downtown area the CRP also imagines possibilities for long-term strategies, including alternatives to either protect, adapt, or relocate, so that the community can begin to consider long term goals. The three Long Term Pathways outlined in Section 7 are purely conceptual illustrations to foster conversation and encourage innovative planning. If our world is successful in reducing climate change, we hope that Nantucket may never have to choose one of these extreme solutions.

While the CRP addresses the impacts to Nantucket from climate change, the Town also will be developing a Sustainability Plan, which will address how we can tackle climate change issues from the causal side. Attention to reducing climate change will lower the cost and disruption of preparing for its impacts and should be an integral part of our coastal resilience efforts.

Our hope is that Nantucketers will feel called to take action not only on their own properties, and as a community with municipal projects, but also participate in calling for state and federal support for resilience measures and reducing climate change. One important conversation is what regulatory changes will be needed to preserve coastal communities while continuing to protect the environment.

Community outreach and education are a cornerstone of coastal resilience. Property owners should be aware of the vulnerabilities at their location so that they can choose the level of response that best suits their situation. Deciding how to pay for resilience projects, which will likely involve partnerships of private, non-profit, and public (local, state, and federal) entities, must happen in a way that equitably distributes both the burden and the benefits for property owners, across neighborhoods, and island-wide. The costs are significant and the recommended projects will require widespread support, both on and off-island, however the cost of not preparing for climate change impacts is even larger.

The delivery of this report is not an ending; it is the beginning of comprehensive coastal resilience planning for Nantucket. The CRP outlines the measures we need to take now to ensure a resilient island in the future.

We will continue to monitor the ongoing climate research and the local effects of climate change and will update the CRP as conditions change and predictions are refined.



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Interested in a quick summary of the CRP that will give you a high-level overview of the project and recommendations? Take 30 minutes and read the [Executive Summary](#).

Interested in the whole story, from A to Z, including our starting point, community engagement steps, risk analysis, and recommendations? [Start with Section 02](#).

Interested in background on the process and coastal risks that inform the CRP’s recommendations? Check out Sections [03](#) and [04](#).

Interested in learning about how we develop coastal resilience solutions, apply them in different areas, and being introduced to the CRP’s recommendations for Nantucket? Start with [Section 05](#)

Interested in recommendations for the place you care about on Nantucket? Start with Sections [06](#) and [07](#) and turn to the areas you want to know more about.

Interested in what comes next and how we’ll work together to implement the recommendations of the CRP? Head to [Section 08](#).

Need a primer on some key terms? Take a look at page 30 as well as the glossary in [Section 09](#).



Jetties, (photo by Chris Reed)

The background of the slide is a photograph of a coastal scene. On the left, there are dark, jagged rocks extending into the water. The water is a deep blue with gentle ripples. In the distance, the horizon is visible under a clear, light blue sky. The overall atmosphere is calm and natural.

SECTION 01: EXECUTIVE SUMMARY

This section provides a summary of the Coastal Resilience Plan, including the project goals, processes, and key recommendations that provide a roadmap for building near- and long-term resilience on Nantucket.

CRP Project Area



LEGEND

- Airport
- Seaport
- Marina
- Public Boat Ramp
- Ferry Route
- Critical Transportation Route
- Conservation
- Recreation
- Other Open Space
- HDC Historic District
- Mid-Island Planned Overlay District
- Madaket Overlay District
- Multi-Family Overlay District
- Town Overlay District



Project Overview

This report is Nantucket's first Coastal Resilience Plan (CRP), also referred to here as "the plan," a crucial step in the process of the Town and County of Nantucket preparing for and adapting to the combined threats posed by sea level rise, coastal flooding, and coastal erosion. The CRP provides a roadmap for reducing risk from and building resilience to flooding and erosion along Nantucket's coastline for the next 10-15 years and beyond.

The CRP study area is Nantucket County, which consists of Nantucket Island and its sister islands of Tuckernuck and Muskeget. Nantucket is approximately 48 square miles and forms the southern boundary of Nantucket Sound, approximately 30 miles from the mainland on Cape Cod, Massachusetts. The CRP recommends 40 near-term projects with pathways for long-term adaptation that build with nature to keep people safe, promote healthy and vibrant communities, and honor the cherished built and natural heritage of Nantucket.

It is not feasible to address every resilience challenge faced across the island. The CRP recommends projects at multiple scales to address Nantucket's most immediate coastal resilience needs. The strategies recommended can be implemented in the next 10-15 years as the first steps in a longer-term adaptation process to be pursued through the end of the century. These actions will require investment by both public and private stakeholders and when implemented will comprehensively build resilience island and county-wide.

The Town has completed a number of coastal resilience planning projects in recent years. These studies helped engage the community in conversations about climate change, identified key steps the Town can take to increase awareness and build

community resilience, and outlined a range of potential approaches for structural, non-structural, and nature-based risk reduction. Developed to build on and complement the recommendations from these prior studies, the goal of the CRP is to provide comprehensive, actionable, and prioritized recommendations to build coastal resilience island and county-wide.

The process of developing the CRP combined climate science, community engagement, engineering and technical analysis, urban and landscape planning and design, and implementation planning. This included examination of a range of coastal risk reduction options including structural, non-structural, and nature-based approaches. By engaging a wide range of community groups in the process, the Town is ensuring that the CRP can move forward to implementation with broad input and support. The planning process was undertaken during the COVID-19 pandemic and public health and safety was a priority throughout. The plan involved several phases of public outreach and engagement and was finalized in fall 2021.

The Town of Nantucket, through the Department of Natural Resources, has led the creation of the CRP, supported by an interdisciplinary team of consultants. A broader team of Town Departments provided guidance throughout the process, including the Administration, Planning, Public Works, Sewer, Health, Energy, and Fire and Police Departments. In addition, a number of Town Committees, Boards, and Commissions played a role in the project. The Nantucket Coastal Resilience Advisory Committee served as the primary citizen committee steering the process.

Community Engagement

Throughout the planning process, the Project Team followed a multi-pronged approach to engaging the Nantucket community, inclusive of year-round residents, seasonal residents, workers, visitors, and other people who experience the island in multiple ways. To kick off the community engagement process, the Town launched a website for the CRP, which served as a hub for detailed project information and way for the general public to get involved. Two Virtual Public Open Houses were held, one in January 2021 and one in June 2021, each of which had more than 200 registrants and 130 attendees. These events were promoted using the Town's website, social media, local events calendars, local e-newsletters, email blasts, newspaper advertisements, and attendance at Town committee and Board meetings. In addition to engaging the broader community, the CRP Project Team also conducted focused engagement with key stakeholders who will be integral to the successful implementation of the recommended projects and strategies.

The process identified a number of key priorities that help form the community's vision for a resilient Nantucket. Section 3 of the plan provides a detailed overview of the community engagement process and outcomes.

Key Priorities

- Community members emphasized Nantucket's one-of-a-kind character that must be preserved. While it is essential to protect the island from coastal hazards and climate risk, it must not be at the expense of the elements which contribute to this unique sense of place, which include Nantucket's ecological resources and habitats, the coastal viewshed and access to the water, the historic built environment and cultural landscapes.
- Ferry terminals and maritime facilities, specifically, are of unique importance to Nantucket and serve as critical infrastructure in their function as access points to supply chains such as fuel and food, as well as waste disposal.

- The CRP should prioritize protecting critical infrastructure. Transportation infrastructure, power cables and substations, water systems, data lines, water treatment facilities, maritime facilities, and the airport will all require a high level of protection. These systems are Nantucket's lifeline and community members were unanimous in highlighting the need to ensure continuity of service.
- Nature-based strategies should be implemented wherever feasible with a clear emphasis on minimizing ecological impacts and maximizing ecological and public access benefits. Preserving Nantucket's beaches and coast into the future for as long as possible should be primary goal.
- The process of advancing resilience on Nantucket should engage a diverse range of public voices and ensure that the public is educated about the issues at hand.
- The CRP must be clear and actionable, rather than serving as just a summary of knowledge. The plan should delineate responsible parties, methods of prioritizing action, and specific opportunities and options down to a hyper-local scale, while also providing resources for property owners to take action.

Community engagement was at the core of the CRP process, helping to document concerns related to coastal risks, establish a vision for Nantucket's resilient future, and reach consensus around the pathways that will be taken to achieve this future. The outcomes of the engagement informed the project in many ways, including helping define and prioritize community assets and services included in the risk analysis (as detailed in Section 4 of the plan), defining community values and priorities in the early stages of strategy development, and ultimately in shaping the final set of resilience and adaptation strategies recommended across the island, as discussed in Sections 6 and 7 of the plan.

Coastal Risks on Nantucket

The CRP draws on a detailed evaluation of the coastal risks facing Nantucket. This risk evaluation identifies areas that are at risk from coastal hazards, such as flooding and erosion, and how these hazards will change over time due to sea level rise. The results of this assessment help the community prioritize areas for adaptation and understand what types of adaptation or resilience investments may be necessary and appropriate in different areas of the island.

All future coastal hazards analyzed for the CRP incorporate the effects of sea level rise under the Commonwealth of Massachusetts-developed high scenario, consistent with the scenario recommended by Nantucket's Coastal Resilience Advisory Committee and adopted by the Select Board in 2020. This means that the analysis of future tidal flooding and future coastal flooding due to storms in 2030, 2050, 2070, and 2100 includes the projected rise in sea levels based on the best available science. Incorporating the effects of sea level rise on future coastal hazards more accurately characterizes Nantucket's increasing flood and erosion risk over time.

Risk Assessment Findings

On Nantucket risks from coastal hazards – including coastal flooding, high tide flooding, and coastal erosion – are significant and will grow over time. The findings from the risk assessment conducted for the CRP are based on the best available coastal hazard data and show coastal risks pose an existential threat to many of the buildings and services that support Nantucket's identity, economy, and wellbeing.

From now through 2070, 2,373 structures are at risk from coastal flooding and erosion, with the cumulative expected annual damages totaling \$3.4 Billion, including direct physical damage to buildings, anticipated direct and induced economic disruption to businesses, direct social disruption, including relocation costs, health costs from injuries and mental stress, and lost income due to health issues, and Federal, State, and local tax impacts. 84% of at-risk buildings are residential, accounting for 59% of the total risk, and though only 9% of at-risk buildings are commercial, they account for 34% of the total risk. Risk to structures is concentrated in historic Downtown Nantucket, which includes Brant Point.

The CRP included specific analysis of risk to essential community facilities and services. This analysis found that 34 essential community facilities (including 48 buildings) are at risk over the next 50 years, with over \$180 Million in expected damages. Each community facility was assigned a

criticality score, based on industry standards for determining a facility's importance to community safety and wellbeing, and a risk score, based on the total risk to the facility over the next 50 years. These scores were used to calculate a priority score. This method can be used to prioritize facilities for risk mitigation and adaptation based on the role they play in supporting public health and safety during and in the aftermath of a disaster. The top priority facilities based on this assessment are all located in Downtown, which heightens the urgency of providing adaptation options for this area of the island.

Top 5 At-Risk Essential Community Facilities Based on the CRP Priority Score

- Steamship Authority Terminal (Steamboat Wharf)
- Coast Guard Station Brant Point (10 Easton Street)
- Stop & Shop, Downtown (9 Salem Street)
- Hy-Line Cruises Terminal (Straight Wharf)
- National Grid Electrical Substation (2 Commercial Street)

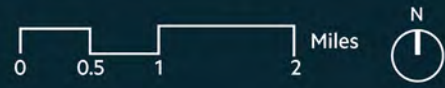
While these facilities contribute to wellbeing and safety on Nantucket, there are aspects of Nantucket's built and natural heritage that are also at risk, including many cultural and historic institutions located in Downtown and in other areas of the island. It is also important to acknowledge the significance of these places to the community in providing education and other services.

Top 5 At-Risk Historic and Cultural Institutions Based on CRP Priority Score

- Whaling Museum (13 Broad Street)
- Old Brant Point Lighthouse (10 Easton Street)
- Nantucket Aquarium (28 Washington Street)
- Artists Association of Nantucket Gallery (19 Washington Street)
- Brant Point Lighthouse (End of Easton Street)

Island-Wide Coastal Flood Risk

All coastal flood extents based on the Massachusetts Coastal Flood Risk Model (MC-FRM). Data should be used for planning purposes only.



Muskeget Island

Tuckernuck Island

Nantucket Harbor

Brant Point

Coatue

Polpis

North Shore

Madaket

Downtown

Sconset

South Shore

LEGEND

- 2030 1% annual chance coastal flood*
- 2050 1% annual chance coastal flood*
- 2070 1% annual chance coastal flood*

*The 1% annual chance event, or 100-year storm, is a benchmark used to plan for coastal flooding. Properties within the extent of the 1% annual chance event have a 1 in 4 chance of flooding over the course of a 30-year home mortgage.

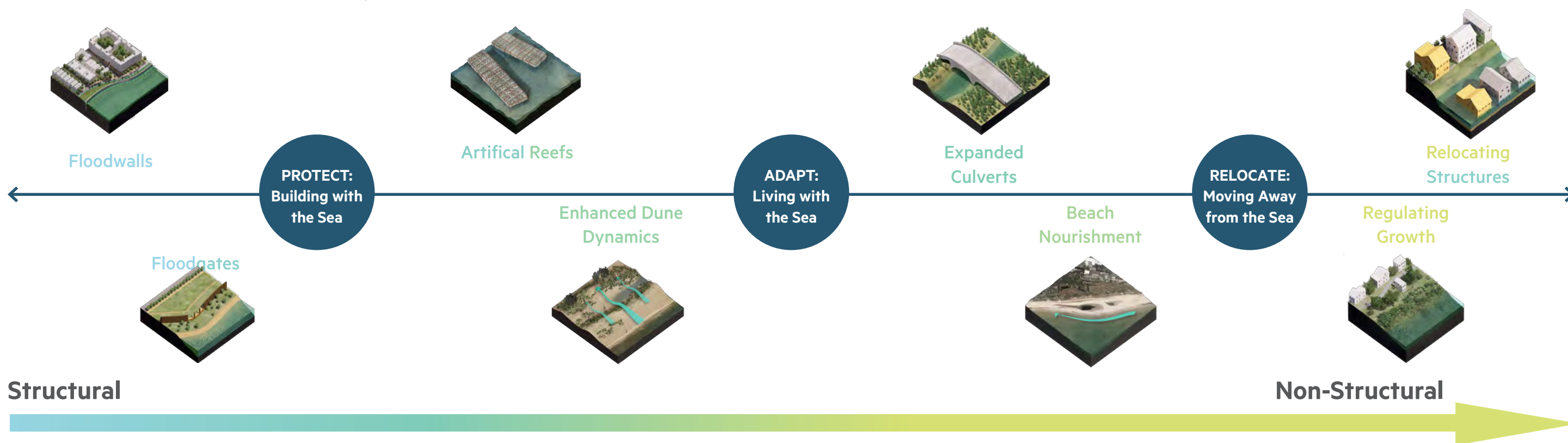
1% Annual Chance Coastal Flood						
	2030		2050		2070	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	1,051	8%	1,253	10%	1,518	12%
Roadway Loss of Service (miles)	40	15%	46	17%	54	20%
Protected Open Space (acres)	2,871	16%	3,356	18%	3,937	22%

The information provided here is just a sample of the detailed risk analysis completed for the CRP. For more detailed information on coastal risks on Nantucket, see Section 4 of the plan and review the Nantucket CRP Existing Conditions and Coastal Risk Assessment.

Coastal Resilience Framework

The early process of developing the CRP focused on establishing a vision for a resilient Nantucket and analyzing the island’s coastal risks. This information was synthesized and further evaluated to develop detailed, adaptable, and implementable resilience approaches and strategies across the island.

There are many ways to achieve resilience. Based on knowledge of the area, assessment of community preferences and priorities, and technical understanding of risk reduction techniques, the Project Team developed a Resilience Toolkit for the CRP. The Resilience Toolkit contains a spectrum of resilience building approaches that may be appropriate on Nantucket, including structural, non-structural, and nature-based approaches. These categories include approach types like flood walls, elevated roadways, expanded culverts and bridges, wetland and dune restoration, and new or amended regulations and programs. **Approaches in each of these categories are combined to create resilience strategies for different areas of the island that focus on the goals of protecting against, adapting to, or relocating from the sea. Each of these categories is explained in more detail in Section 5 of the CRP.**



This diagram summarizes how different resilience tools, including structural, nature-based, and non-structural measures, can be used to help the Nantucket community protect against, adapt to, and relocate away from coastal hazards

Island-Wide Coastal Risk Framework

For more information on the Island-Wide Coastal Risk Framework, including how risk zones are defined, check out Section 5!

The CRP's coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100, depending on the availability of data) and produced a large amount of information about Nantucket's coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment.

Using the framework, private property owners, Town officials, and other decision-makers can determine whether a particular type of resilience approach or other type of investment is appropriate given what we know about an area's

current and future coastal risk. For instance, in areas where there is extreme, near-term coastal risk due to the threat of flooding and erosion, it is likely not appropriate to invest in large capital improvement projects. In areas mid-island where the coastal risks are lower, it may be appropriate to consider opportunities for siting new critical infrastructure. In other areas along the coast where risk is more episodic and will increase over time, it may be appropriate to promote resilient design for new and existing homes, businesses, and infrastructure. The goal of the CRP and island-wide framework is not to prevent new construction across Nantucket but rather to direct future investment to areas of the island with the lowest coastal risk.

This framework divides the island into four distinct areas based on degree of coastal risk. While the framework cannot tell us what types of resilience approaches will work for specific projects, it can serve as a first lens in determining what type of approaches are generally most appropriate in each area. The Island-Wide Coastal Risk Framework serves as a guide for all of the recommendations made within this CRP. Review Section 5 of the CRP to learn more about the Island-Wide Coastal Risk Framework and how it is applied across the island.

Island-Wide and Focus Area Coastal Resilience Strategies

Drawing on the island-wide coastal resilience framework, the project team developed a suite of 40 recommended resilience and adaptation projects for implementation at multiple scales across Nantucket. These projects will require both public and private investment and are intended to work together to advance coastal resilience on Nantucket. They collectively apply across the entire County but are presented separately in Section 6 (island-wide strategies) and Section 7 (focus area strategies) of the plan.

Nantucket requires a holistic and layered approach to managing coastal risk, which includes a wide range of island-wide resilience strategies that are necessary to support and complement site-specific design strategies. Pursuing a layered approach to coastal resilience creates important redundancies that will help mitigate risks even if parts of the overall system fail.

Despite the depth and breadth of the strategies described in this plan, it is not feasible or practicable to protect or adapt every building, resource, and asset on the island. Time and resources are limited, and the Town and its stakeholders will need to make difficult decisions with respect to coastal resilience over time. The strategies presented here provide a starting point to address Nantucket's most pressing resilience challenges. Island-wide resilience strategies include governance, planning, and policy-based recommendations that will help Nantucket reduce its risk in the near-term and build capacity to implement and plan for resilience over the long-term. The focus area strategies aim to reduce coastal risks through direct investment in specific areas across the island already experiencing coastal flooding and erosion.

Island-Wide Resilience Strategies

Section 6 of the CRP covers island and county-wide resilience strategies. These strategies include a collection of resilience approaches that work together to address multi-faceted resilience issues and can be applied in multiple geographies across the county. They are critical to advancing Nantucket's resilience and cover the following topics:

- Governance and policy changes necessary to build capacity and support the implementation of focus area-specific projects
- Additional studies and planning opportunities necessary to support investment in focus areas and facilitate the implementation of structural and nature-based projects in areas not specifically addressed by the focus areas
- Changes to zoning and wetland regulations and other resilience approaches to help build resilience on private properties across the island

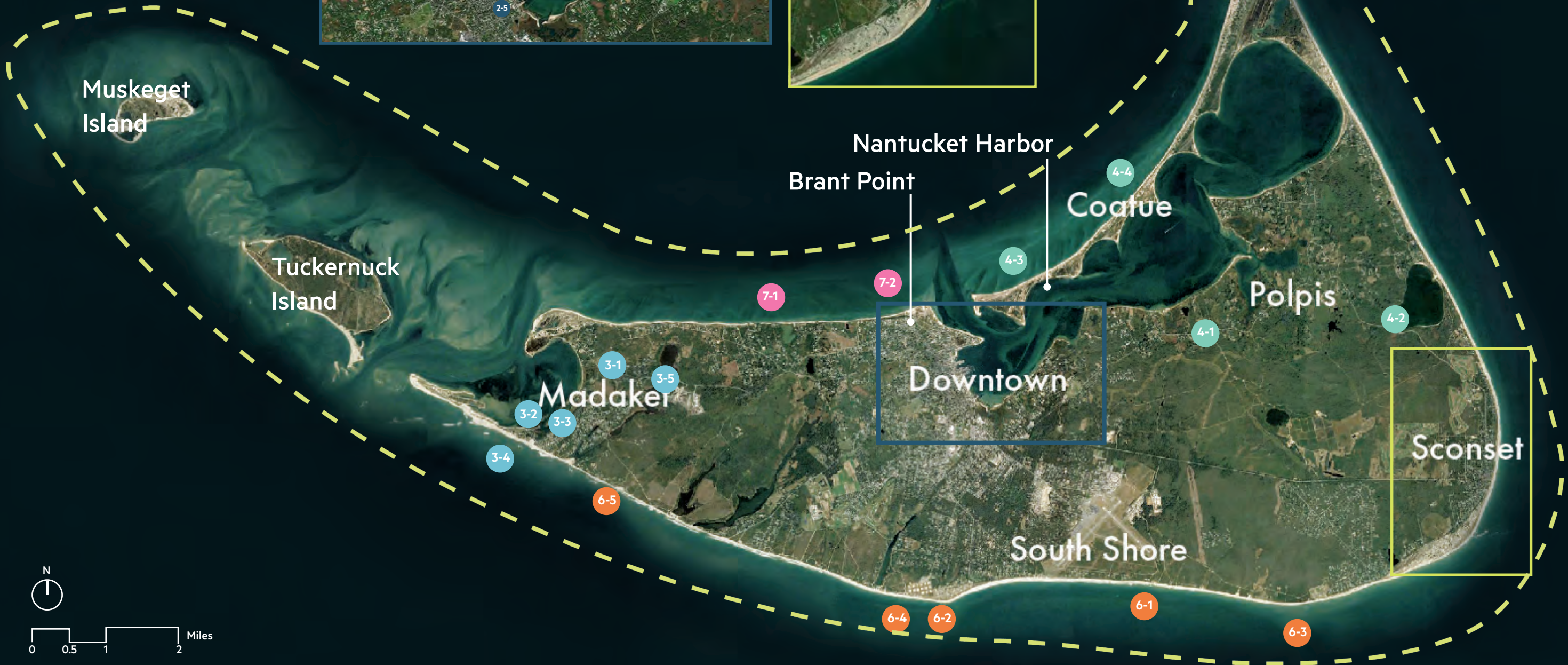
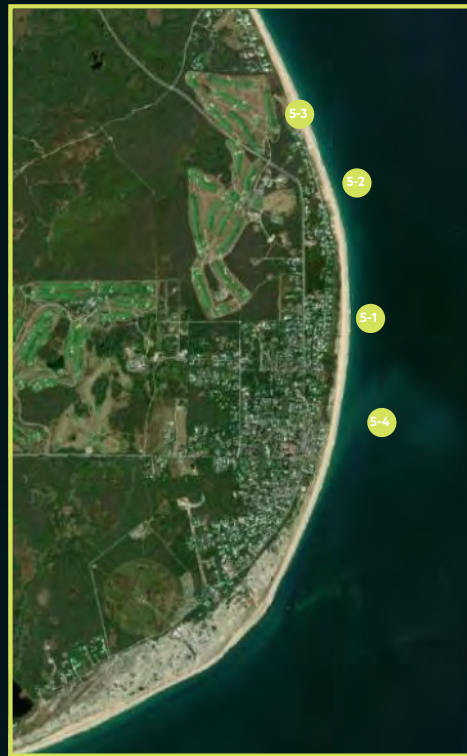
Together these island-wide strategies form a backbone for both the focus area resilience strategies described in Section 7 and Nantucket's continued resilience into the future.

Focus Area Resilience Strategies

Focus areas are defined geographies located throughout the island that are already experiencing coastal flooding or erosion, face heightened coastal risks in the future, are home to critical infrastructure, are areas of historic or cultural importance, or are otherwise a community priority for resilience building. Focus areas identified for the CRP include Downtown/Brant Point, Sconset, Madaket, South Shore, Polpis/Nantucket Harbor/Coatue, and Jetties to Eel Point.

As detailed in Section 7 of the plan, within each focus area, implementable, near-term strategic resilience opportunities have been developed. Strategic opportunities are design, engineering, and nature-based approaches, as well as pilot projects and focused planning studies, that present near-term opportunities to reduce coastal risk and build community resilience. They are projects that can begin to be implemented in the next 5-10 years and completed within the next 10-15 years as the first step in a long-term adaptation process. Each of the strategic coastal resilience strategies complements regulatory and property-scale layers of resilience, providing redundancy in the system to protect against potential damages from failure in any one element.

Island-Wide Strategies



ISLAND-WIDE RESILIENCE STRATEGIES

Title	Strategy or Project Description
Updates to Zoning By-Law	Updates to the Nantucket zoning by-law to encourage resilient design and limit growth, as appropriate, in high and priority risk areas
Updates to Wetland Ordinance and Regulations	Updates to the Nantucket wetlands by-law and regulations to encourage resilient and low impact design in resource adjacent areas while limiting impacts on resource areas
Strategic Retreat and Relocation Program	Develop and administer island-wide approach for pursuing strategic retreat and relocation in areas of priority coastal risks with an early focus on risk communication and property owner outreach and education
Coastal Resilience and Sustainability Interdepartmental Working Group	Governance approach to encourage inter-departmental collaboration and coordination on issues related to coastal resilience and sustainability
Joint Staff Review of Development Proposals	Governance approach to maximize opportunities for coordinated decision-making and consistent customer communication by Town staff, particularly for projects located in or impacting coastal areas
Coastal Resilience and Sustainability Program	Governance approach to establish a formal program with necessary resources for managing coastal resilience and sustainability projects and programs across the island
Shoreline Change Monitoring Program	Employ mobile technology and other tools to engage community members in the process of monitoring shoreline change at pilot projects and across the island
Sediment Sourcing and Transport Study	Island-wide data collection and planning approach to identify sediment sources and define sediment movement across the island at various spatial and temporal scales in order to inform the design and planning of future sediment management projects.
Stormwater Management Plan	Planning step to evaluate stormwater management issues across the island and identify recommendations for reducing stormwater flooding and improving water quality
Sediment Budget	Planning step to develop an operational sand budget for recommended shoreline projects
Stormwater By-Law Assessment	Planning step to conduct an assessment of existing by-laws for opportunities to encourage stormwater management best management practices (BMPs)
Stormwater By-Law and Regulations Proposals	Updates to stormwater management by-law and regulations to encourage best management practices (BMPs) that address water quality and quantity issues
Update locally-adopted sea level rise scenarios and Best Available Flood Hazard Data	Adopt sea level rise scenarios provide by the Commonwealth of Massachusetts and Massachusetts Coastal Flood Risk Model as the best available local flood hazard data
Community Outreach on Property Owner Resilience Best Practices	Comprehensive outreach program to at-risk home and business owners to raise risk awareness and provide guidance on best practices for reducing coastal risks for private properties.

AREA-SPECIFIC PROJECTS & OPPORTUNITIES

DOWNTOWN

ID	Title	Strategy or Project Description
2-1	Steamboat Wharf Resilience	Work with the Steamship Authority to develop adaptation plan for Steamboat Wharf with the preferred option of elevating the pier above future mean monthly high water. Building scale measures can be implemented on the wharf over time to reduce risk from coastal storms. The strategy should be integrated with the design of the Downtown Coastal Flood Barrier System (Strategy 2-2) to maintain access from Broad Street onto the Wharf. Final approach will need to be planned and design by the Steamship Authority but close coordination with Town resilience planning will be critical to a successful resilience strategy.
2-2	Downtown Neighborhood Flood Barrier - Later Project Phases	The barrier system, which includes the first phase project described as Strategy 2-6, includes a number of elements to be implemented over time to provide comprehensive effective flood risk reduction against future mean monthly high water. The elements include raised roadways, raised bulkheads, reinforced dunes, and flood walls. The overall approach recommends passive measures that are integrated with the existing built environment, while maintaining access to key waterside facilities such the Children's Beach Boat Ramp, Steamboat Wharf, Straight Wharf, and the Town Pier. Implementation of the approach can be phased over a period of 10 to 15 years, focusing on the lowest lying areas first, such as Easy Street (Strategy 2-6). As the project is implemented, stormwater management needs will need to be studied and addressed via new drainage infrastructure.
2-3	Easton Street and Hulbert Avenue Road Raising	Road raising project to prolong service life of Easton Street and Hulbert Avenue for emergency and everyday access in Brant Point.
2-4	Washington Street Extension and Consue Springs Walkway Raising	Road raising to prolong service life of Washington Street Extension and public access in Consue Springs and the Creeks.
2-5	Building Scale Resilience at 37 Washington Street	Pilot project to showcase building-scale resilience best practices on a Town-owned facility, including potentially elevation of critical systems, protection of sensitive equipment and documents, and deployable flood risk reduction measures. The first step in this recommendation is a site-specific study to determine the appropriate risk mitigation approaches for this structure.
2-6	Downtown Neighborhood Flood Barrier - Phase 1 Project	Phase 1 project to advance through feasibility and design a near-term project focused on the most vulnerable location along the planned extent of the Downtown Neighborhood Flood Barrier. The Phase 1 project should focus on the coastal segment located along Easy Street from Straight Wharf to Steamboat Wharf and may include raised bulkheads, sidewalks, and roadways.

Check out the information here and the map on the previous page for more information and the locations of area-specific projects!

MADAKET

ID	Title	Strategy or Project Description
3-1	Madaket Road Raising and Bridge Conversion	Road raising and bridge conversion to provide access and restoration.
3-2	Ames Avenue Bridge Resilience	Maintain bridge structure from coastal erosion (see project details) existing Ames Avenue if necessary.
3-3	F Street Boat Ramp	Prolong service life of the boat ramp on F Street. Consider loss of service.
3-4	Madaket Erosion Management Pilot and Ames Avenue Bridge Protection	Dune restoration and Ames Avenue intertidal dune construction as needed and maintenance of the design.
3-5	Department of Public Works Facility and Landfill Resilience	Building scale measures to reduce risk at the facility through site-specific approaches.



NANTUCKET HARBOR & COATUE

ID	Title	Strategy or Project Description
4-1	Polpis Road Raising and Bridge Conversion at Folger's Marsh	Road raising project with conversion of existing culverts with bridges, with goal of prolonging service life of Polpis Road, while advancing ecological restoration objectives for Folger's Marsh.
4-2	Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond	Road raising, expansion of culverts or replacement with bridge, and installation of living breakwaters to reduce wave exposure, with goal of prolonging service life and maintaining emergency roadway access along Polpis Road, while advancing ecological restoration objectives for Sesachacha Pond.
4-3	Coatue Erosion Management and Dune Resilience	Dune restoration and wetland creation/enhancement to reinforce narrow low-lying sections of barrier island, between Five Fingered Point and Bass Point and between First Point and Second Point, to prevent washover and/or breaching into the harbor. Monitor performance of approach to assess need for ongoing nourishment and/or adaptation to higher design elevations.
4-4	Numerical Modeling Study of Coatue Breaching	Numerical modeling study to evaluate the likelihood and consequences of Coatue breaching for the Harbor and surrounding communities, including impacts to habitat and navigation, in order to inform decisions about future adaption measures on Coatue.

SCONSET

ID	Title	Strategy or Project Description
5-1	Sconset Bluff Dune Restoration	Dune restoration and construction to mitigate bluff erosion and increase resiliency. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.
5-2	Codfish Park Dune Restoration	Dune restoration and construction to manage and slow bluff erosion. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.
5-3	Baxter Road Relocation Planning	Planning for and implementation of road relocation, including acquisition of easements, access and maintenance agreements, finalization of road alignment, and development of final designs for construction.
5-4	Sconset Bluff Nearshore Breakwaters Feasibility Study	Conduct detailed feasibility study to assess technical constraints, potential impacts, and benefits and costs of nearshore breakwaters along the Sconset Bluff.

SOUTH SHORE

ID	Title	Strategy or Project Description
6-1	Nantucket Memorial Airport Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm.
6-2	Surfside Wastewater Treatment Facility Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm. Strategic relocation alternatives for settling tanks closest to the coast at the wastewater treatment facility should be pursued in parallel.
6-3	Tom Nevers Field Erosion Management Pilot Project	Pilot program of dune restoration, sand fencing, and beach nourishment. Monitoring program to evaluate how well the pilot project performs to inform future investment in Tom Nevers Park, as well as erosion management elsewhere on the island.
6-4	Surfside Emergency Access Planning	Develop emergency access and service plan for Surfside Neighborhood to ensure access to coastal areas in event of loss of service along Nonantum and Nobadeer Avenues, particularly near Lovers Lane.
6-5	Sheep Pond Road Relocation Study	Planning step to work with property owners and Nantucket Conservation Foundation to develop and implement plan for relocation of public infrastructure on Sheep Pond Road.

NORTH SHORE JETTIES TO EEL POINT

ID	Title	Strategy or Project Description
7-1	North Shore Dune Restoration and Nourishment	Targeted dune restoration and construction to reduce risk of erosion along the North Shore, building on dune restoration strategies adopted by existing private property owners in area. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm at key locations.
7-2	Sand Pumping Feasibility Study	Study the feasibility and impacts of a sand pumping and bypass systems to connect sand sources from inlet to the North Shore.

Implementation Roadmap

All projects recommended by the CRP will require attention to implementation planning. The number and timing of implementation steps will vary by project, depending on technical complexity, scope, cost, number of affected stakeholders, and other factors. The implementation roadmap provided in the CRP will help guide coastal resilience actions across Nantucket over the next 10-15 years and beyond. The roadmap includes immediate next steps for each project, estimated costs and benefits, high level phasing plans, roles and responsibilities, potential funding programs, and stakeholders to involve in the implementation process.

The Implementation Process

The CRP includes recommendations for 40 projects to be advanced across the island, including 19 non-structural, 11 structural, nine nature-based, and one hybrid project. These projects can begin to be implemented in the next 5-10 years and should be completed within the next 10-15 years as the first step in a long-term adaptation process. The implementation process for many of these projects will be complex and take time. Each project and project type will necessitate a different timetable for bringing the plan from concept design to preliminary and final design, through permitting and construction, and ultimately to project delivery and enjoyment. For many structural and nature-based projects, the next step for the Town is to allocate or pursue funding for the next phase of project feasibility assessment, preliminary design, and continued community and stakeholder engagement, which will help refine the concepts developed through the CRP. Funding for CRP projects can come from a variety of sources, including Town capital and operations budgets, public-private partnerships, and state and federal grants.

Implementation Phasing

The coastal risks that the Nantucket community will face over the next 10-15 years are more certain than longer-term risks. Beginning to implement near-term projects over this timeframe is recommended to establish a basis for long-term adaptation.

The majority of near-term projects recommended by the CRP should be completed by 2035, though some actions may extend beyond that date due to complexity and prioritization. If sea level rises faster than the current scenarios suggest, the schedule should be accelerated. All near-term projects serve as the foundation for long-term adaption pathways, as discussed in Section 7. Because potential sea level rise later in the century is less certain, the timeframe for long-term actions should be re-evaluated periodically based on best available data.

The CRP's project phasing and prioritization plans reflect our current understanding of how coastal risks will evolve, necessary sequencing of projects that build upon one another, the urgency of the risks, and the time necessary to complete different actions.

Prioritization

01

02

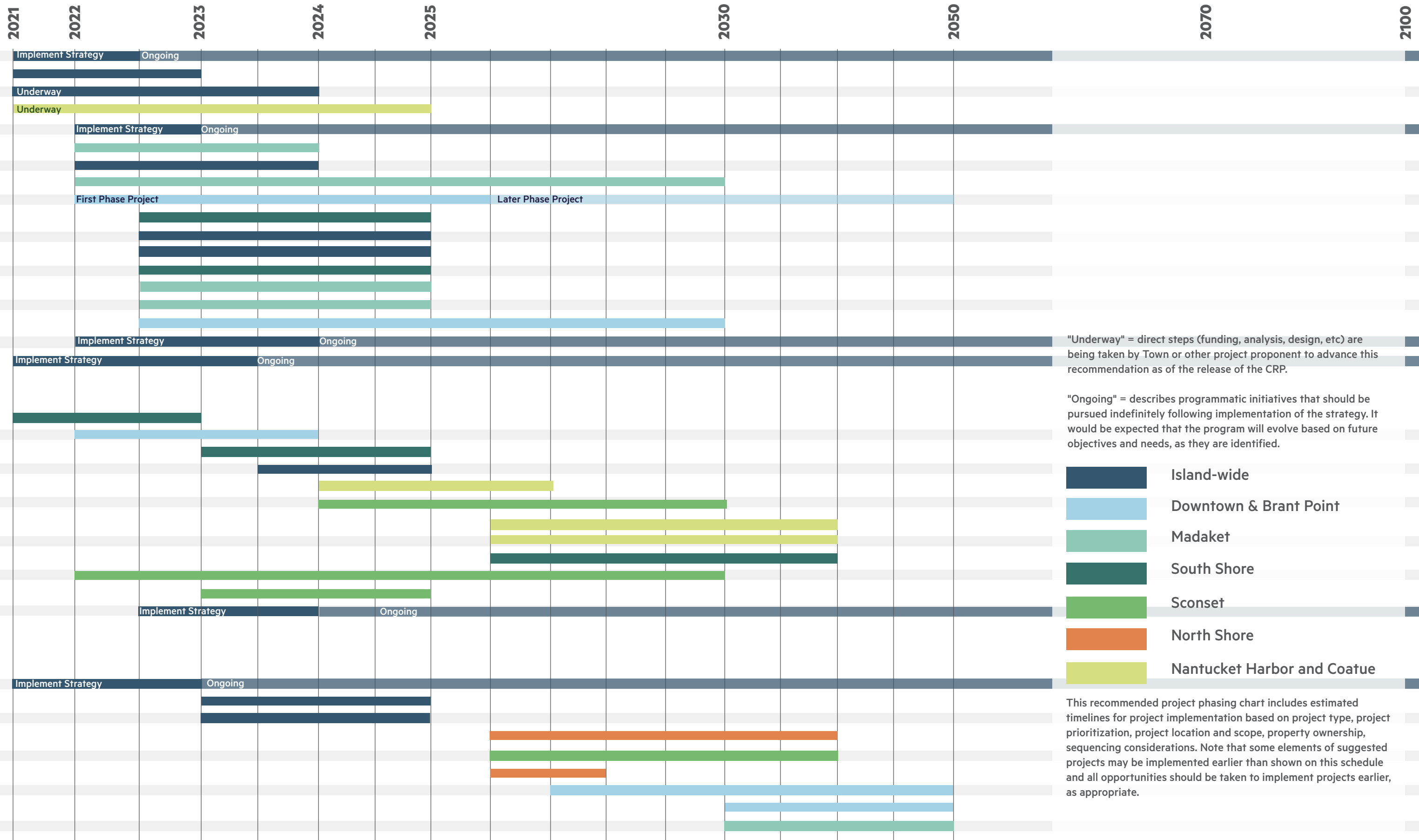
03

Near-Term Strategy or Project Title

Coastal Resilience and Sustainability Interdepartmental Working Group
Update locally adopted sea level rise scenarios and best available flood hazard data
Sediment Sourcing and Transport Study
Coatue Erosion Management and Dune Resilience
Coastal Resilience and Sustainability Program
Department of Public Works Facility and Landfill Resilience
Sediment Budget
Madaket Road Raising and Bridge Conversion
Downtown Neighborhood Flood Barrier
Tom Nevers Field Erosion Management Pilot Project
Updates to Zoning By-Law
Updates to Wetland Ordinance and Regulations
Surfside Wastewater Treatment Facility Dune Restoration
Ames Avenue Bridge Resilience
Madaket Erosion Management Pilot and Ames Avenue Bridge Protection
Steamboat Wharf Resilience
Strategic Retreat and Relocation Program
Community Outreach on Property Owner Resilience Best Practices

Sheep Pond Road Relocation Study
Building Scale Resilience at 37 Washington Street
Surfside Emergency Access Planning
Stormwater Management Plan
Numerical Modeling Study of Coatue Breaching
Codfish Park Dune Restoration
Polpis Road Raising and Bridge Conversion at Folger's Marsh
Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond
Nantucket Memorial Airport Dune Restoration
Baxter Road Relocation Planning
Sconset Bluff Nearshore Breakwaters Feasibility Study
Shoreline Change Monitoring Program

Joint Staff Review of Development Proposals
Stormwater By-Laws Assessment
Stormwater By-Law and Regulations Update
North Shore Dune Restoration and Nourishment
Sconset Bluff Dune Restoration
Sand Pumping Feasibility Study
Easton Street and Hulbert Avenue Road Raising
Washington Street Extension and Consue Springs Walkway Raising
F Street Boat Ramp



Summary of Estimated Costs and Benefits

The projects recommended through the CRP are estimated to collectively cost \$830,000,000 to \$900,000,000 over the next 15+ years with \$11,000,000 in annual operations and maintenance costs.* These estimates do not include staff and volunteer time to implement the recommendations.

Together, the projects are estimated to provide at least \$460,000,000 in quantified benefits in the form of avoided damages to buildings and avoided disruption to critical transportation routes. Due to data limitations, this total does not include quantification of all potential benefits for the recommended projects. Additional benefits described qualitatively in Section 7 include avoided disruption of service for infrastructure and public services, avoided loss of habitat and ecological services, avoided emergency response costs, and benefits accruing from non-structural projects. With additional data, some of these avoided losses could be quantified which would increase the estimated benefits of the recommended projects.

*The cost estimates provided by the CRP should be referenced for planning purposes only. They are based on information from prior studies and similar construction projects around the United States. Due to numerous uncertainties at the level of design developed for the CRP, the estimates are presented in ranges and include contingency factors of 30% [low] and 50% [high] added to the estimated capital and construction costs. In addition to the cost of materials, the estimates include allowances for the costs of design, demolition, drainage, operations and maintenance, public amenities and co-benefits, and other industry standard allowances.



Present conditions overlooking Downtown out to Coatue and Nantucket Harbor.



What do you need to know and what can you do next?

Nantucketers can act today to reduce risks to the places they care about. There is a role for everyone in the community to help reduce coastal flood and erosion risks and build resilience.

The Coastal Resilience Advisory Committee and Town will lead these efforts and should work together to pursue grant opportunities from local, State, and Federal funders, as well as opportunities to leverage local operating and capital funds toward implementation of the CRP. Most grant programs are competitive and are designed to fund specific project types. The Committee and Town can work to align recommended projects with appropriate funding programs, starting with high priority projects. Guidance on potential funding programs for the recommended projects is included with the implementation roadmap in Section 8.

The information on the following page provides additional guidance on next steps that different groups of stakeholders on Nantucket can take to help share and implement the CRP.

The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.

If you are....	What you need to know	What you can do next
<p>A resident, business owner, or property owner on Nantucket</p>	<p>Nantucket’s coastal resilience depends on you and the actions you take to make your home, business, and property safe</p> <p>The CRP recommends a variety of projects that may affect the places you care about so review the plan and stay involved in the process of refining and implementing resilience projects</p>	<p>Know your risk today and in the future</p> <p>Purchase and maintain flood insurance and prepare when a storm is forecast</p> <p>Protect your property by implementing best practices for property resilience outlined in Section 7 of the CRP</p> <p>Join the conversation by attending meetings of the Coastal Resilience Advisory Committee and participate in local decision-making processes, like Town Meeting</p> <p>Share the CRP with your friends, family, and neighbor</p>
<p>A visitor to Nantucket</p>	<p>Learn about the island, its history, and the threats that climate change poses to Nantucket</p> <p>The CRP recommends a variety of projects that may affect the places you care about so review the plan and stay involved in the process of refining and implementing resilience projects</p>	<p>Stay informed about coastal risks on Nantucket and plan trips to avoid storms that may impact the island</p> <p>Join the conversation by attending meetings of the Coastal Resilience Advisory Committee</p> <p>Share the CRP with your friends and family</p>
<p>A member of a Conservation or Advocacy Organization</p>	<p>The CRP recommends a variety of projects that will require partnership and coordination with adjacent property owners, including conservation organizations and the Land Bank</p> <p>Implementation of the CRP provides an opportunity to realize projects with many potential co-benefits including new public access to waterways and ecological restoration</p> <p>Effective implementation of the CRP will require ongoing conversations with the public</p>	<p>Carefully review the CRP and stay informed about and involved in the implementation process by speaking to Town Staff and members of the Coastal Resilience Advisory Committee</p> <p>Work with the Town to identify strategic partnership opportunities to realize projects that accomplish shared goals</p> <p>Help raise public awareness of coastal risks and the recommendations of the CRP through your networks</p>
<p>A member of a Town Committee, Commission, or Board</p>	<p>The CRP recommends a variety of projects that will require ongoing input and oversight by Town Committees, Commissions, and Boards</p> <p>Town Committees, Commissions, and Boards will need to help lead the implementation of the CRP, working in partnership with the Coastal Resilience Advisory Committee and Town staff</p> <p>Many recommended projects will require ongoing community conversations prior to implementation and Public Meetings convened by Town Committees, Commissions, and Boards offer a venue for these conversations</p>	<p>Carefully review the CRP and stay informed about and involved in the implementation process</p> <p>Speak to Town Staff and members of the Coastal Resilience Advisory Committee to learn more about how you can help</p> <p>Use Public Meetings and other methods to increase public awareness of coastal risks on Nantucket and the recommendations of the CRP</p> <p>Assist with advocating for implementation of priority projects</p> <p>Assist with finding, developing, and overseeing funding opportunities from State, Federal and private sources for project implementation</p>
<p>A member of the Town staff</p>	<p>The CRP recommends a variety of projects that affect Town-owned/managed property, infrastructure, and services across Nantucket</p> <p>Town staff will need to help lead the implementation of the projects recommended by the CRP</p> <p>Effective implementation of the CRP will require active coordination and involvement of staff across Town departments and functions</p>	<p>Carefully review the CRP and stay informed about and involved in the implementation process</p> <p>Speak to Town Staff in the Natural Resources Department to learn more about the CRP and how your department can be involved</p> <p>Share the CRP with your colleagues and partners</p> <p>Lead in advocating for implementation of priority projects</p> <p>Lead in finding, developing, and overseeing funding opportunities from State, Federal and private sources for project implementation</p>

How to Get Involved

- **Reach out to key Town staff with questions and to find out what you can do to advance coastal resilience:**

Vince Murphy

Coastal Resilience Coordinator
Natural Resources Department, Town of Nantucket
Phone: (508) 228-7200 x 7608
Email: vmurphy@nantucket-ma.gov

Holly Backus

Preservation Planner & Local Hazard Mitigation Plan Coordinator
Planning & Zoning Office, Town of Nantucket
Phone: (508) 325-7587 x 7026
Email: hbackus@nantucket-ma.gov

- **Attend public meetings of the Nantucket Coastal Resilience Advisory Committee (CRAC).**

The Committee was established by Nantucket's Select Board on April 24, 2019. This committee works with the Coastal Resilience Coordinator to oversee and finalize the Coastal Resilience Plan. The committee meets regularly and all meetings are open to the public. Stay up to date on the CRAC schedule and meeting agendas:

<https://www.nantucket-ma.gov/1391/Coastal-Resiliency-Advisory-Committee>

- **Stay up to date on other resilience and sustainability conversation on the island by keeping up to date with partner organizations.**

ACKclimate
www.ackclimate.org/

Nantucket Land Bank
www.nantucketlandbank.org/

Nantucket Land Council
www.nantucketlandcouncil.org/

Nantucket Conservation Foundation
www.nantucketconservation.org/

ReMain Nantucket
www.remainnantucket.org/

Nantucket Civic League and
member Associations
www.nantucketcivicleague.com/



The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.



Dunes (photo by Chris Reed)

SECTION 02: BACKGROUND & OBJECTIVES

This section addresses what planning for coastal resilience means for Nantucket. It defines key resilience terms and concepts and describes how the goals of the project align with community resilience priorities and ongoing planning efforts across the island.

Introducing Nantucket’s Coastal Resilience Plan

Climate change and sea level rise are already altering life on Nantucket, with sea levels rising eight inches between 1965 and 2019. As sea levels continue to rise, the community’s experience along the coastline is likely to drastically change in coming decades. These changes will create new coastal challenges and exacerbate existing issues, eroding shorelines more rapidly and making areas of the island vulnerable to flooding in ways that are not experienced today. Nantucket will need to change and adapt to these realities and the time to start that process is now.

The Nantucket Coastal Resilience Plan (CRP), also referred to here as “the plan,” is a crucial step in the process of the Town and County of Nantucket preparing for and adapting to the combined threats posed by sea level rise, coastal flooding, and coastal erosion. The CRP provides a comprehensive plan for reducing risk from and building resilience to flooding and erosion along Nantucket’s coastline. The project is based on a scope of work and process collaboratively led by the Town of Nantucket and the Nantucket Coastal Resilience Advisory Committee.

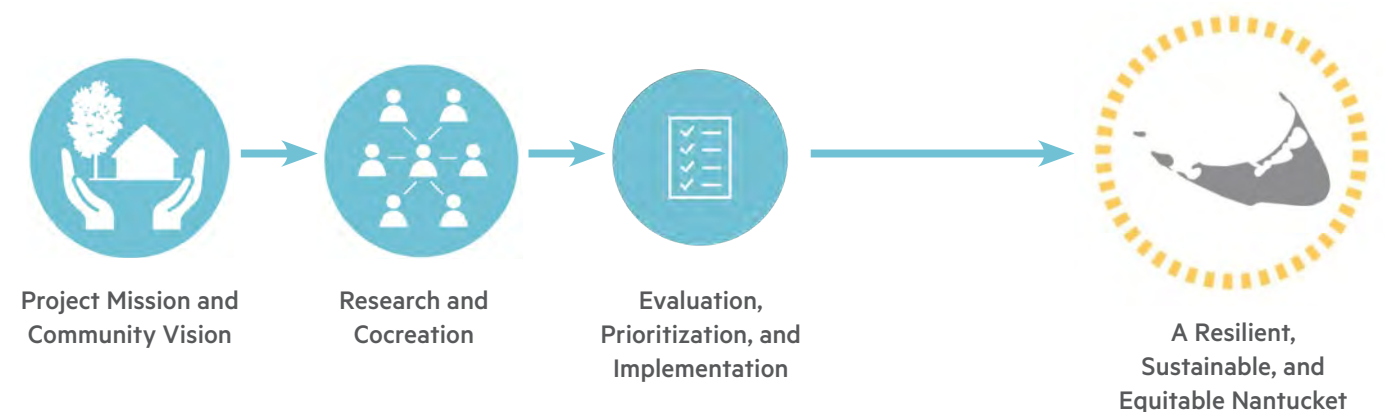
The CRP focuses on Nantucket County, which consists of Nantucket Island and its sister islands of Tuckernuck and Muskeget. Nantucket is approximately 48 square miles and forms the southern boundary of Nantucket Sound, approximately 30 miles from the mainland on Cape Cod, Massachusetts. Developing the CRP involved the analysis of vulnerability and risk across the island, examination of a range of coastal adaptation options, and recommendations for new policies, nature-based approaches, and infrastructure to build resilience. The CRP provides near- and long-term strategies that build with nature to keep people safe, promote healthy and vibrant communities, and honor the cherished built and natural heritage of Nantucket.

Why Nantucket Needs a Coastal Resilience Plan

With approximately 88 miles of shoreline Nantucket is, and always has been, highly exposed to a range of coastal hazards, most notably flooding and erosion. Depending on how someone experiences Nantucket, whether as a year-rounder, a seasonal resident, visitor, or worker, their perception of these coastal hazards is likely to vary. But everyone who knows Nantucket also knows what it means to live with the sea. The features that make Nantucket an attractive place to live and visit – the ocean, the beaches and bluffs, tidal ponds, historic character, and the ways in which humans have altered and occupied the coastline over time – are also the features that create the need for coastal resilience planning to ensure that Nantucket can continue to adapt to changing conditions and evolving risks.

By developing a coastal resilience plan—one of the key recommendations from Nantucket’s 2019 Hazard Mitigation Plan (HMP)—Nantucket has the opportunity to coalesce around common goals, build capacity around key concerns, build momentum toward immediate next steps to implement projects, and take advantage of initiatives at the Federal and State level that can help advance community objectives.

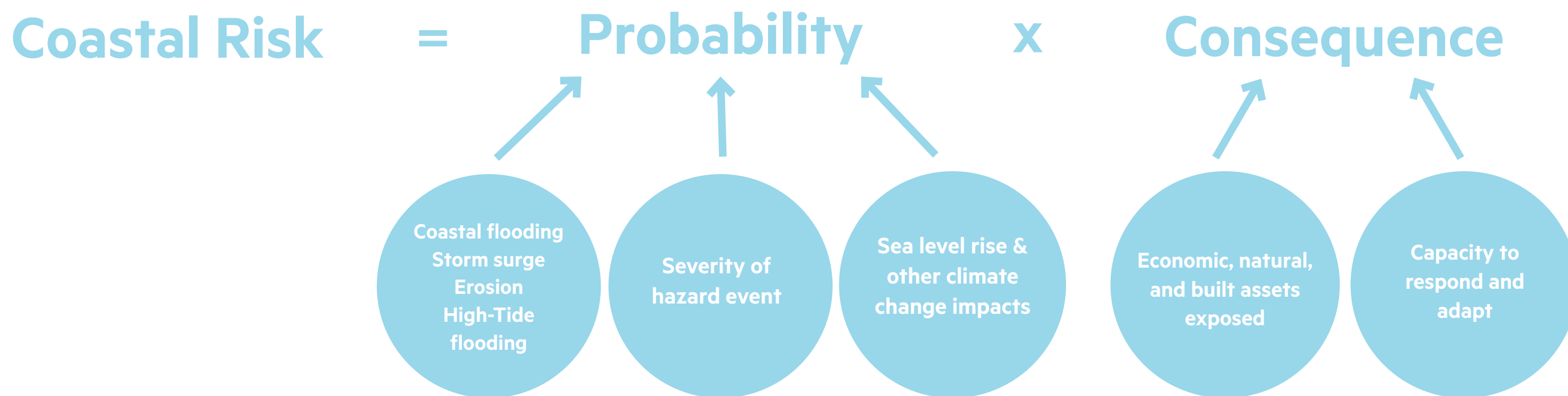
The Nantucket community has undertaken a number of coastal resilience planning projects in recent years, laying the groundwork for a comprehensive coastal resilience approach. The CRP builds on and complements these studies by tying together initiatives to develop a united vision and roadmap for advancing coastal resilience across the island.



The Project Mission Statement

The Coastal Resilience Plan draws on the cherished built and natural heritage of Nantucket to create a community-supported roadmap to implementation for a series of layered flood control and adaptation approaches that lessen the loss from storm surges and help the community adapt to rising seas and eroding coastlines. In coordination with other ongoing adaptation and sustainability initiatives, the plan addresses the whole island and county while respecting the unique characteristics of each neighborhood. Driven by the inclusive and equitable engagement of all, the plan aspires to create social, environmental, and economic benefits and value to everyone who will share in Nantucket's future.

Coastal risk is a function of the probability that an event will occur and the consequences of that event. By building resilience and adapting to risk over time, we can reduce the consequences of coastal hazards.



Resilience and adaptation reduce the vulnerability of economic, natural, and built assets and increase our capacity to respond and adapt to coastal hazards. This reduces the consequences of these hazards and our coastal risk.

CRP PROJECT GOALS

The purpose of the CRP is to develop a comprehensive island-wide and county-wide roadmap for near- and long-term resilience that reduces risk from coastal flooding and erosion exacerbated by sea level rise. The five goals described here frame the overarching focal areas for the plan, which were largely sourced from and developed through public engagement and informed by community input gathered during prior resilience planning projects.

Build coastal resilience and reduce coastal risks from flooding and erosion

The central goal of the CRP is to recommend and prioritize approaches that manage current and future coastal risk and provide a roadmap to long-term adaptation across the island and county. The type of approach, level of risk reduction, and duration of protection varies by recommendation, but each is tailored to the unique set of hazards and conditions observed across the island.

Enhance safe access to, from, and across the island

The plan recognizes that Nantucket's resilience is driven in part by the need for self-sufficiency but also by the need to prioritize safe and resilient access to, from, and across the island. Ensuring that critical supply lines for goods and services are maintained is integral to the health and wellbeing of the community, as is mobility within the island via major roadways and critical transportation routes.

Promote the health of natural ecosystems

Sea level rise threatens not just human communities, but also plant and animal communities along the coastline. Nantucket's shores are characterized by an array of ecosystems that are home to many species of plants, birds, animals, insects, and aquatic creatures, some of which are threatened or found only on Nantucket. Strategies recommended by the plan seek to build on and enhance natural processes, as feasible, to promote natural systems.

Generate waterfront public space, connectivity, and safety

Resilience is about going beyond risk reduction to create co-benefits for the community. Where feasible, the plan provides recommendations that promote safety and resilience while adding value in the form of public space or public realm improvements. In the process, the plan seeks opportunities to advance equity by prioritizing projects that serve communities most in need.

Develop implementable strategies that will result in reduction of flood and erosion risk

While recognizing the need to be creative and bring innovative approaches to the table, the plan is committed to recommending resilience approaches and projects that can be implemented while maintaining the integrity of this nationally designated historic landmark. Implementable strategies are projects that can be constructed using current technologies, are permissible under local, State, and Federal regulations, fundable through local, State, and Federal programs, and have the support of the local community and decision-makers.

Community Guiding Principles for a Resilient Nantucket

The CRP is informed by community input gathered throughout the planning process during community meetings, surveys, and open houses. During this process, several themes emerged that together establish a set of guiding principles that inform how the project goals are achieved. These principals, refined throughout the process, helped guide the implementation of project goals, the engagement process, and the criteria used to evaluate resilience strategies, as discussed in detail in Section 5.



Preserving Nantucket for Future Generations

Community members expressed shared interest in a future Nantucket that continues to embody the island's best characteristics, respects its architectural, cultural and natural heritage, and strives to become more resilient and sustainable over time for the benefit of future generations. Effective risk reduction and resilience on Nantucket will mean addressing the challenges that pose the greatest threat to the places and systems that give Nantucket its special character and drive its economy.



A Comprehensive Approach

Nantucket is home to diverse natural and human communities supported by a rich array of ecosystems and built conditions. The resilience of these systems requires a comprehensive, multi-scalar approach to reducing risk and channeling resources toward the highest priority risks and to communities most in need.



Working with Nature

Nantucket's coastlines have been shaped by coastal processes for thousands of years and will continue to be into the future. Nantucket's resilience will depend on the community's ability to work with, rather than against, nature by accepting change and adapting built systems over time. The CRP prioritizes approaches that reduce risk to human communities and also leverage and enhance natural systems.



Effectiveness and Adaptability

Effectiveness is the ability of a selected strategy to perform its intended function. With finite resources available to the Town, it is important that any resilience measures advanced by the Nantucket community are designed to be technically effective and cost beneficial. This will help use limited money and resources in ways that achieve intended goals. Further, given the trend of increasing coastal risks on Nantucket due to sea level rise, strategies should be adaptable to continue building resilience over time.



Leadership and Capacity

Every member of the Nantucket community will play a role in helping Nantucket become resilient to coastal risks. Starting with the CRP, the Town can help lead by example by enabling and encouraging pilot projects and by showcasing resilient projects on Town-owned properties. The plan should also help build knowledge and awareness in the community and recommend new processes for decision-making around resilience across the island.

The Project Team

The Town of Nantucket, through the Department of Natural Resources, has led the creation of the Coastal Resilience Plan. A broader team of Town Departments provided guidance throughout the process, including the Administration, Planning, Public Works, Sewer, Health, Energy, and Fire and Police Departments. In addition, a number of Town Committees, Boards, and Commissions played a role in the project. The Coastal Resilience Advisory Committee served as the primary citizen committee steering the process.

An interdisciplinary team of consultants supported the work, led by the engineering firm Arcadis, which includes local and global experts in coastal engineering, hydrodynamic modeling, civil and structural engineering, transportation, urban design, implementation planning, and community engagement. Additional design, engagement, planning, historic preservation, and implementation support was provided by Arcadis subconsultants Stoss, ONE Architecture and Urbanism, and The Craig Group.



The Process

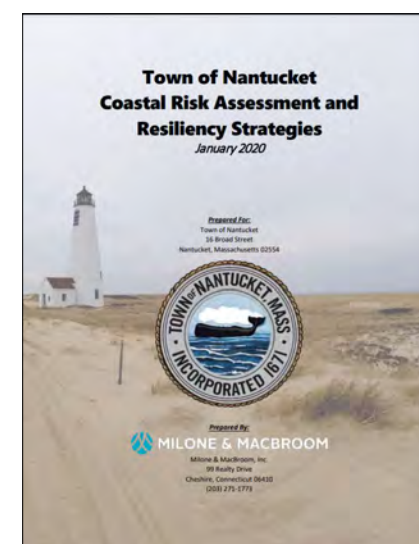
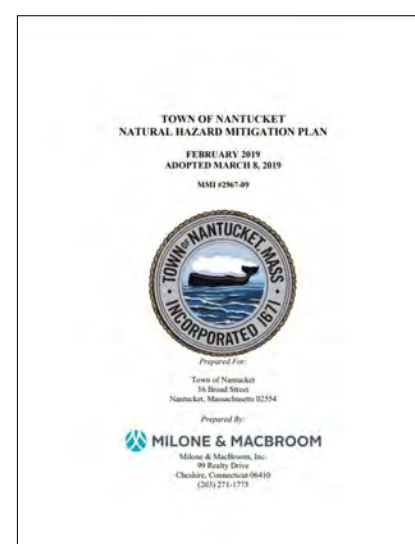
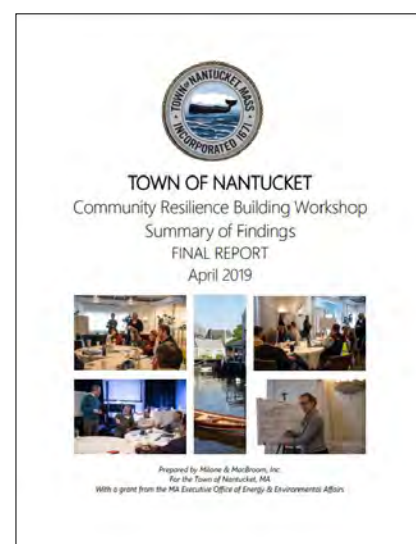
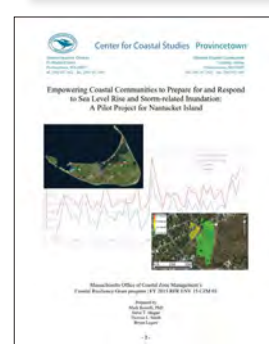
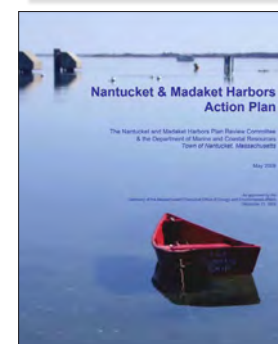
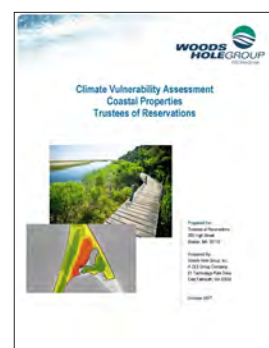
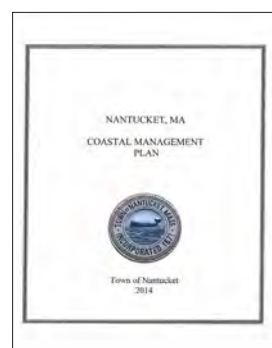
Coastal risks can never be entirely removed, but they can be managed and reduced through planning, capital investment, and changes to policies and regulations. By planning for resilience and creating pathways for adaptation, the challenges presented by sea level rise and climate change on Nantucket can create opportunities to channel resources toward more robust, reliable, and redundant systems and infrastructure that support community safety, well-being, and vibrancy today and into the future.

The process of developing this plan combined climate science, community engagement, engineering and technical analysis, urban and landscape planning and design, and implementation planning. This included examination of a range of coastal risk reduction options, including structural, non-structural, and nature-based measures considered within the context of the island's National Historic Landmark status. By engaging a wide range of community groups in the process, the Town is ensuring that the Coastal Resilience Plan can move forward to implementation with broad input and support. The planning process was undertaken during the COVID-19 pandemic and public health and safety was a priority throughout. The plan involved several phases of public outreach and engagement and was adopted in 2021. See Section 3 for additional information about the CRP planning process.



How does this plan tie into prior and ongoing planning on Nantucket?

Nantucket has completed a number of coastal resilience planning projects in recent years. These studies helped engage the community in conversations about climate change, the need to prioritize protection of culturally significant assets, and the inherent value of the environment to the island's identity and economic vitality. They also identified key steps the Town can take to increase awareness and build community resilience, and outlined a range of potential approaches for structural, non-structural, and nature-based risk reduction. The goal of the CRP is to build on and complement these studies with comprehensive, actionable recommendations for reducing risk in specific locations across the island.



2018 and earlier

2019

2020

2021

Select prior studies that inform the CRP and other ongoing efforts, including Municipal Vulnerability Plan (MVP) Summary of Findings (2019), Hazard Mitigation Plan (2019), Coastal Risk Assessment and Resiliency Strategies (2020), and Resilient Nantucket: Designed for Adaptation (2021)

The Nantucket Context

Building resilience on Nantucket requires a robust understanding of the island's history and existing conditions, from transportation networks to parks and open space. For a full overview of existing conditions on Nantucket, read the Nantucket CRP Existing Conditions and Coastal Risk Assessment.

Physical Setting

The island of Nantucket is located east of Martha's Vineyard and south of Cape Cod off the coast of mainland Massachusetts. Nantucket Island, including 88 miles of shoreline, and the Town of Nantucket are both the main features within the County of Nantucket, which includes both Tuckernuck and Muskeget Island.

The island was formed by the Laurentide Ice Sheet that was associated with the last North American glaciation, dating back to less than 25,000 years ago. The main bodies of water surrounding Nantucket include Nantucket Sound to the north, as well as the Atlantic Ocean which surrounds the east and south of the island. There are several harbors on the island, which are either semi-sheltered or completely sheltered. Nantucket Harbor and Polpis Harbor reside on the northern portion of the island. Madaket Harbor lies towards the west end of the island near Tuckernuck Island.

A History of Preservation and Conservation

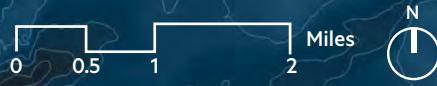
The first indigenous peoples, the Wampanoag, began to appear on Nantucket's shores approximately 12,000 years ago. They lived a semi-nomadic life on the coast, evidenced by archaeological discoveries and the Wampanoag oral traditions. In 1641, William, Earl of Sterling, deeded Nantucket to Thomas Mayhew, beginning the European settlement of the island. The first settlement, Sherburne, was located along the north shore at Capaum Harbor, now called Capaum Pond.

The Whaling Period of Nantucket, while creating a population boom, did not cause the sprawl of urban living to the interior of the Island. Instead, the lot size shrank as more people subdivided lots to create the historic, dense, rectangular lots of today. Areas that were wetlands, such as along Washington Street and Brant Point, remained relatively untouched, as well as areas that were seen as naturally significant. Nantucketers, unlike much of the United States in the 19th Century, emphasized the conservation of natural spaces and the minimal spread of human interruption to the island's natural processes.

The Nantucket Historical Association was founded in 1894 in a conscious effort to preserve the history of the island, especially since whaling, the primary economy, began its decline fifty years earlier causing people to leave Nantucket in search of opportunity. This early effort was focused on important people, such as Maria Mitchell and the Maria Mitchell Association (1902), as well as historic landscapes, such as the cobblestone streets protected by the Nantucket Protective Association (1919). While the first design guidelines for the island were agreed upon in 1937, Nantucket did not get its first historic district until 1955 when the Commonwealth of Massachusetts ruled the special legislation constitutional and declared Nantucket and Siasconset local historic districts.

The preservation and conservation movements evolved in parallel on Nantucket, particularly under the leadership of Walter Beinecke, Jr. (1918-2004). Beinecke not only assisted in founding Nantucket Preservation Trust in 1957, but also Nantucket Conservation Foundation in 1963, the same year the Conservation Commission received its enabling legislation to enforce and regulate the natural environment from the Massachusetts Wetlands Protection Act. Designated a National Historic Landmark in 1966, the Island of Nantucket was recognized as historically significant for its early efforts in architectural preservation and land conservation.

CRP Project Area



LEGEND

- Airport
- Seaport
- Marina
- Public Boat Ramp
- Ferry Route
- Critical Transportation Route
- Conservation
- Recreation
- Other Open Space
- HDC Historic District
- Mid-Island Planned Overlay District
- Madaket Overlay District
- Multi-Family Overlay District
- Town Overlay District



The Nantucket Community Today

Estimates for the effective population of Nantucket range from between 11,000 to over 17,000 year-round residents, a combination of life-long Nantucketers and those who have arrived on the island fulltime later in life. Recently released 2020 data from the U.S. Census Bureau indicates a year-round population of 14,200 residents; although there is no general consensus around this number, this is the effective population that will be used in federal funding applications for Nantucket. The island is also known for its seasonal influx of vacationers, who rent or own vacation homes on the island. By some estimates, the population on the island increases to more than 54,000 during the summer months in a normal year, though this number dropped in 2020 due to the COVID-19 pandemic before rebounding to usual levels in 2021.

Land Use & Districts

Current land use in Nantucket mainly consists of low density residential, small-scale commercial and industrial uses, and open space, much of it protected as conservation lands. Nantucket enacted the Subdivision Control Law in 1955, expanded the local historic district in 1970, and enacted Zoning in 1972. The entire island is listed as a National Historic Landmark by the National Park Service, and both the downtown area and the Siasconset neighborhoods are designated Local Historic Districts regulated by the Historic District Commission.

Wastewater, Water, & Energy Systems

Nantucket has made progress over the last decade to provide a separated sewer system for wastewater (separate from stormwater), with approximately 70 miles of sewer mains, 14 publicly owned pumping stations, and two municipal wastewater treatment facilities. Wastewater in the Town Sewer District, comprised primarily of the Brant Point, Downtown, Monomoy, and Mid-Island neighborhoods, is conveyed to Surfside Wastewater Treatment Facility (WWTF). The neighborhood of Siasconset (Sconset) has its own sewer and water district, and homes across the island outside of these sewer districts have private septic systems. Stormwater infrastructure is managed and maintained by the Department of Public Works.



Wastewater Treatment Plant (photo by Chelsea Kilburn)

The Wannacomet Water Company (WWC), a municipal department, provides potable water and fire protection to the island. Private wells are also a source of drinking water.

Nantucket receives electricity through two undersea cables, one from Hyannis and the other from Harwich, that enter the island in the Jetties area and then connect to the Candle Street National Grid substation. From the Candle Street substation, electricity is distributed to the rest of Town primarily through overhead powerlines.

Transportation Network

Transportation networks both connect the island to the mainland and allow travel within the island. People travel to and from Nantucket by boat and by air. The Nantucket Memorial Airport is a critical transportation facility serving the community, providing access to the mainland for goods and services, as well as for residents and visitors that support the island economy.

There are also four ferry lines that provide year-round mainland access. The Steamship Authority operates a vehicle and passenger ferry that transports much of the island's supplies. The Steamship Authority Dock, also known as Steamboat Wharf, is the main entry point for a majority of the food, supplies, and other resources that are utilized on the island. Although the



Nantucket Harbor (photo by James Hark)

Hy-Line ferry service transports minimal freight and supplies, the ferry service is responsible for transporting numerous passengers to and from the mainland. Freedom also offers service between Nantucket and Harwich Port, MA, and seasonal ferry service from New York and New Bedford to Nantucket is provided by Seastreak.

Nantucket is served by a network of public and private roadways. All public roadways are under local jurisdiction, except for Milestone Road which is under the jurisdiction of the Commonwealth of Massachusetts. The WAVE shuttle buses, administered by the Nantucket Regional Transit Authority, provides public transportation services along these roadways.

Community Assets & Services

The Nantucket community is served by a range of essential services located in Town-owned facilities, including fire and police from the Public Safety Facility (4 Fairgrounds Road), public health from the Public Health Office (131 Pleasant Street), Our Island Home (nursing home) (9 East Creek Road), Solid Waste Management and a range of infrastructure services supported from the Department of Public Works (188 Madaket Road), the Nantucket Sewer Department (81 South Shore Road), the Nantucket Water Company (1 Milestone Road) among many other Town facilities being studied under the Town Facilities Master Plan.

In addition to Town facilities, there are numerous private facilities, including the island's primary medical provider, Nantucket Cottage Hospital, major grocery stores, fuel farms, numerous houses of worship, and many museums and nonprofit organizations providing education, entertainment, and support to the community.

Parks & Open Space

There are over 17,000 acres of parks and open space on Nantucket, accounting for more than half of the land on the island. The majority of that open space (74%) is controlled by private and quasi-governmental entities and land trusts, including the Nantucket Conservation Foundation (Nantucket's largest landowner), Nantucket Land Bank, Trustees of Reservations, Audubon Society, and other Nantucket-based land trusts. Conservation of open space has long been one of the most important values for Nantucket residents, leading, for example, to the creation of the Nantucket Land Bank in 1983, the first such entity in the United States. The Land Bank acquires and manages land for conservation, recreation, and agriculture. In addition to privately owned

open spaces, there are 14 Town-owned parks. These open space properties provide myriad ecological benefits to animals and birds, as well as recreational trails and other resources for community benefit.

Habitats

Nantucket is fortunate to have an array of habitats and natural area types. Barrier beaches are located around the island, primarily at Coatue, Great Point, Coskata, and Haulover, and protect Nantucket Harbor from the open waters of the Atlantic Ocean and Nantucket Sound. Smaller barrier beach habitats have been formed at Smith's Point and Eel Point. These barrier beaches form seaside habitats while sand dunes immediately inland provide additional habitat and natural protection for upland communities. Salt marshes are also commonly located on the back side of the barrier beach dune system. The sandplain grasslands are upland plant communities found primarily on the southern part of the island where meltwater from the glaciers deposited fine sand and debris. 95% of the world's sandplain grassland is found on Nantucket. Coastal heathlands are located in the central and northern areas of the island on nutrient poor sand and gravelly soils and are comprised of many of the same plants as the sandplain grasslands but are not dominated by grasses. Both of these habitats were unique to North American coastlines, and now a majority of the remaining grasslands and heathlands are found on Nantucket and Martha's Vineyard. On Nantucket, scrub oak and pitch pines are common species that have invaded the grasslands and heathlands and caused overgrowth. There are four notable great ponds on the island. Long Pond is connected to Hither Creek and has a minor tidal influence, Hummock Pond and Miacomet Pond are freshwater ponds, and Sesachacha Pond is a brackish pond. Other habitats on the island include hardwood forests, farmlands, cranberry bogs, ponds, and bogs.



Scallops at Madaket Marine (photo by Sonny Xu)



Coastal Erosion (photo by Sonny Xu)



SECTION 03: THE COASTAL RESILIENCE PLANNING PROCESS

Community engagement is the backbone to Nantucket's coastal resilience process. This section describes those efforts including two community open houses and a virtual survey.

Introduction

Developing the Nantucket CRP involved multiple phases of mapping, research, technical and policy analysis, community engagement, development and refinement of resilience strategies, alternatives evaluation, prioritization of alternatives, adaptation pathway development, and implementation phasing. Each step is important in creating a robust CRP that addresses the objectives of the community and can serve as a foundation for immediate next steps and long-term resilience strategy implementation.

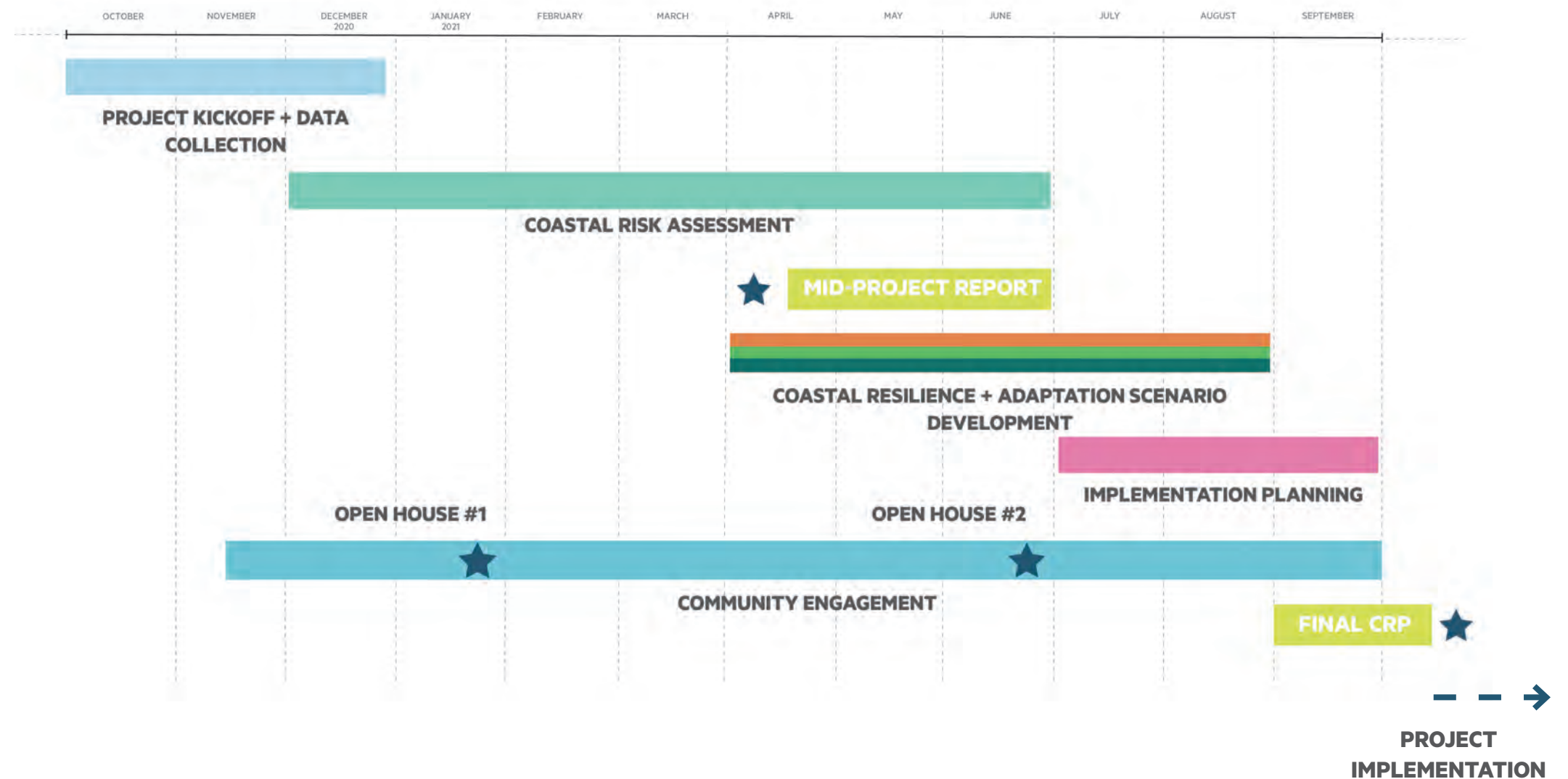
The planning process began in October 2020 with project kick-off, information gathering, and existing conditions analysis. These steps informed the coastal risk assessment and the launch of the resilience strategy development phase of the project. In the summer and fall of 2021 the resilience and adaptation strategies were finalized, and implementation planning concluded the

planning process. Though information from all phases of the project is included in this report, it focuses on the development of resilience and adaptation strategies and implementation recommendations. Additional details on the earlier project phases can be found in the Nantucket CRP Existing Conditions and Coastal Risk Assessment.

Community engagement was the backbone of the CRP process. By engaging a wide range of community groups in the process, the Town is aligning recommendations to community values and objectives and helping ensure the plan can move forward into the implementation phase based on broad input and support.

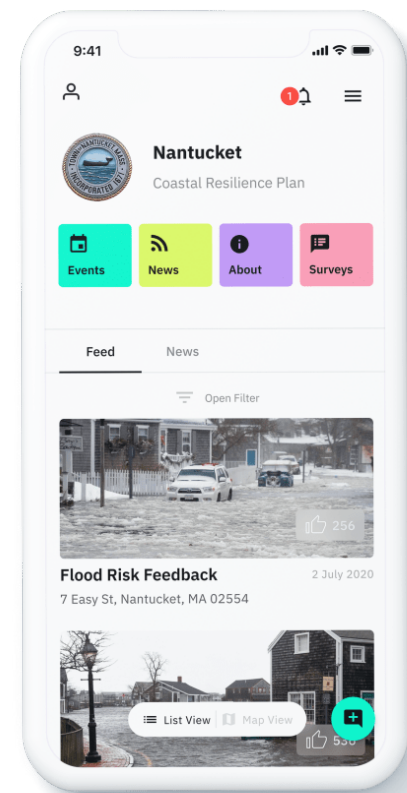
Planning During the COVID-19 Pandemic

The planning process extended through the COVID-19 pandemic that began in 2020. This placed limitations on the Town's ability to host in-person community engagement activities and created new challenges in bringing a full range of stakeholders to the table. Public health and safety were a priority throughout the process, and the Project Team looked for creative ways to engage the community while adhering to local and state COVID-19 guidance and restrictions. Most meetings were hosted virtually, including two community open houses. In addition, a project website was maintained with up-to-date information on the project. A mobile application was also launched, providing another way for community members to learn about and provide input to the process.



ENGAGING THE NANTUCKET COMMUNITY

Community engagement was fundamental to creating a CRP that meets the goals and priorities of the Nantucket community and has a broad coalition of support for implementation over the near- and long-term.



The community engagement process for the CRP included four phases over the course of the project, including:

- A listening tour during the early phase of the project to understand priority objectives and concerns
- Community-wide engagement to define a long-term vision and strategic priorities for Nantucket’s coast
- Community-wide engagement to present and vet preliminary recommendations
- Engagement around the finalization and launch of the plan to help continue momentum toward early implementation steps

The community engagement process had four primary goals:

- Engaging and collecting input on Nantucket’s future from a diversity of voices and perspectives across the island
- Empowering the community with information and knowledge to support informed decision-making and building capacity for each individual to play a part in Nantucket’s resilience
- Creating a platform for collaboration and two-way engagement on the evaluation of risk and co-creation of resilience strategies
- Identifying and cultivating champions to drive implementation following the completion of the plan

Community-Wide Engagement

The Project Team conducted detailed project briefings and interviews with 150+ staff and community members across 22 departments, boards, commissions, and organizations over the course of the project. These meetings helped calibrate project goals and recommendations to multiple organizational perspectives and interests, helped define feasible resilience strategies, and informed implementation strategies. A list of over 100 stakeholder groups was maintained with key stakeholders including the following groups shown in the diagram to the right.

Throughout the process, the Project Team followed a multi-pronged approach to engaging Nantucket's broader community, inclusive of year-round residents, seasonal residents, workers, visitors, and other people who experience the island in multiple ways. To kick off this process, a website was launched for the CRP, serving as a hub for detailed project information and opportunity for the general public to get involved. Two Virtual Public Open Houses were held, one in January 2021 and one in June 2021, each of which had more than 200 registrants and 130 attendees. These events were promoted using the Town's website, social media, local events calendars, local e-newsletters, email blasts, newspaper advertisements, and attendance at Town committee and Board meetings.



Screenshot of zoom audience from Public Open House #1

*Including many civic league member associations

**Including representatives from multiple conservation and preservation organizations

— Non-Profit Organization — Town Agency/Body — Conservation + Resilience Organization

Nantucket CRP Open Houses

Open House #1: January 28th, 2021

The first Open House for the Nantucket CRP was held the evening of January 28, 2021 on Zoom. The structure of the event included a presentation introducing the CRP and core resilience concepts, in addition to structured small group discussions and a Q&A with members of the public. Interactive small group discussions focused on several key questions, including:

- What areas concern you the most as related to flooding and erosion?
- What steps have you taken to mitigate flooding and erosion?
- What do you value most about living on Nantucket? What would you want to keep the same? What would you be willing to change?
- What do you want to see for yourself and further generations?

Key Takeaways

Through small group discussions in Open House 1, the community's top resilience priorities became clear. Open House participants repeatedly identified preserving Nantucket's one-of-a-kind character for generations to come and protection of critical infrastructure as top priorities. Participants also indicated a clear preference for implementing nature-based strategies wherever possible and seeking to minimize ecological impacts while maximizing benefits to the natural environment and public access. An adaptable and dynamic plan, with clear and actionable recommendations that are informed by a diverse range of public voices and implemented by a collaborative multi-departmental Town entity emerged as the overarching goal for the CRP and its planning process.

Nantucket CRP

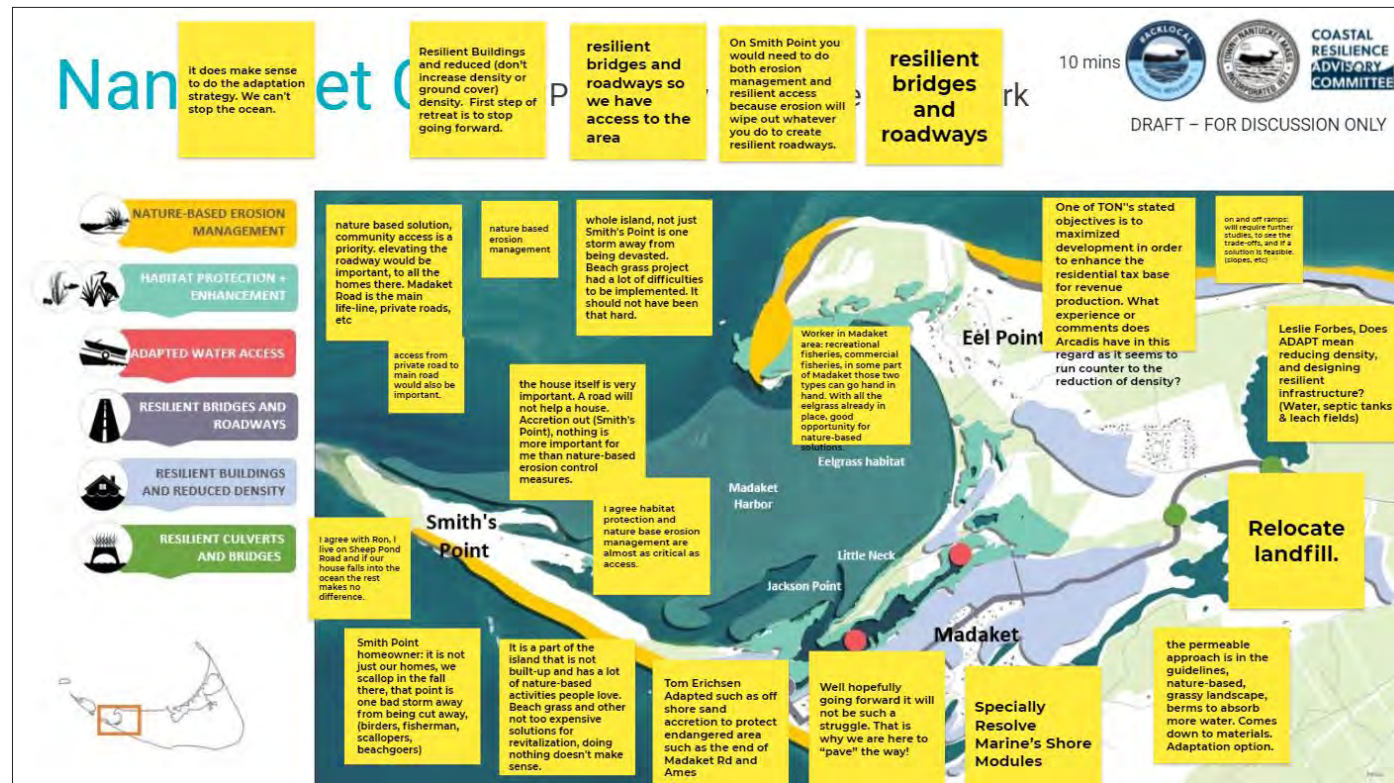
Topic 2: Community Priorities + Vision 15 minutes

-What do you value most about living on Nantucket? What would you want to keep the same? What would you be willing to change?

Nantucket CRP

Topic 2: Community Priorities + Vision 15 minutes

-What do you value most about living on Nantucket? What would you want to keep the same? What would you be willing to change?



Open House #2: June 24th, 2021

The second Open House for the Nantucket CRP was held the evening of June 24, 2021 on Zoom. The structure of the event was similar to the first open house but was focused on presenting and co-developing preliminary recommendations.

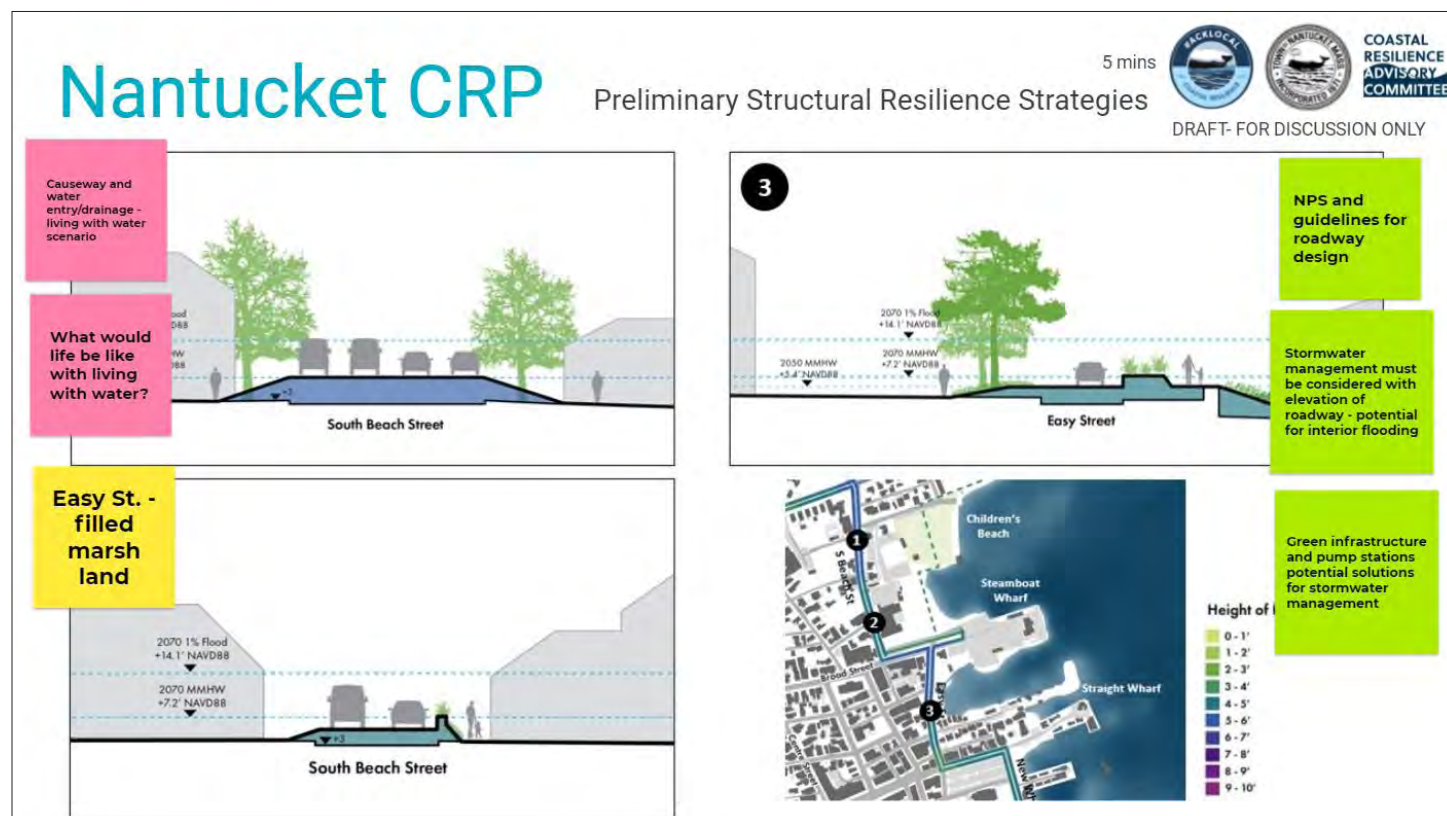
Interactive small group discussions focused on reviewing preliminary resilience recommendations for geographic focus areas and collaboratively discussing input to help refine the approaches. The focus areas included Downtown, Madaket, Siasconset (Sconset), Nantucket Harbor including Coatue, and the South Shore.

Key Takeaways

Interactive small group discussions during Open House 2 focused on providing feedback on preliminary resilience approaches for each of the focus areas. Feedback varied across focus areas but generally tended to echo the sentiments heard during the first Open House and in the virtual survey. Feedback for each focus area was compiled after the event and used to further refine the final recommendations included in this CRP. Across all focus areas, several island-wide priorities emerged including:

- Access and operation of ferry
- Sediment transport study
- Dredging and sediment management plan
- Policies to prevent development in risky areas
- Reduction of regulatory barriers to action, clearer process for approval
- Policies to make implementation of nature-based solutions easier
- Flexibility in local ordinances
- Restore natural resources, minimize impacts on natural resources
- Coastal resilience strategies with co-benefits

Recommendations included in Sections 6 and 7 directly address each of these priorities.



Virtual Survey

In the weeks leading up to the second open house, a pre-open house virtual survey was shared with the Nantucket community through email, social media, newsletters and more. 93 people responded to the survey, providing the Project Team with valuable insight into community preferences with respect to risk reduction priorities and resilience approaches.

Survey responses also showed that many Nantucketers are either already taking action to reduce their flood and erosion risk or plan to do so in the next 10 years. However, in order to make their home or business more resilient, survey respondents reported needing more information, resources, and guidance. A number of the CRP deliverables have been developed to help meet this need.

Nantucketers Taking Action

- **25% of respondents are already taking action to reduce their coastal flood risk**
- **27% of respondents have personally invested in flood or erosion protection**
- **Over 60% of individuals and neighborhoods would take action if emergency services couldn't reach them or their electricity/other utilities were affected**
- **77% of respondents believe island-wide action should be taken if the ferry is inoperable due to coastal flood and erosion**
- **Nearly 40% of survey respondents plan to invest in flood or erosion protection in next 10 years**

OVERWHELMING
CONSENSUS THAT
THE TOWN NEEDS
TO TAKE ACTION

"It would be irresponsible and grievous for our government and our citizens not to work together to take care of our home"

"At a minimum, the Town needs to protect its own buildings and public infrastructure. In addition, the ability just to live on the island will be impacted, so essential services the Town provides and maintains must be protected. However, there may be things we as a community choose to abandon because the cost/benefit ratio would be unacceptable."

PUBLIC RESOURCES
& CRITICAL
INFRASTRUCTURE
SHOULD BE
PRIORITIZED FOR
RESILIENCE ACTION





RECOGNITION
THAT THERE ARE
SOME COASTAL
PROCESSES THAT
CAN'T BE STOPPED--
INVESTMENTS SHOULD
CONSIDER THIS & BE
MADE STRATEGICALLY

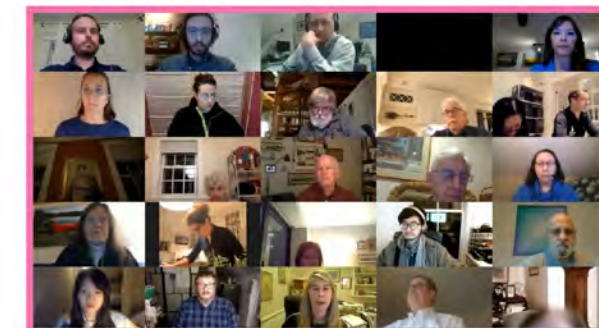
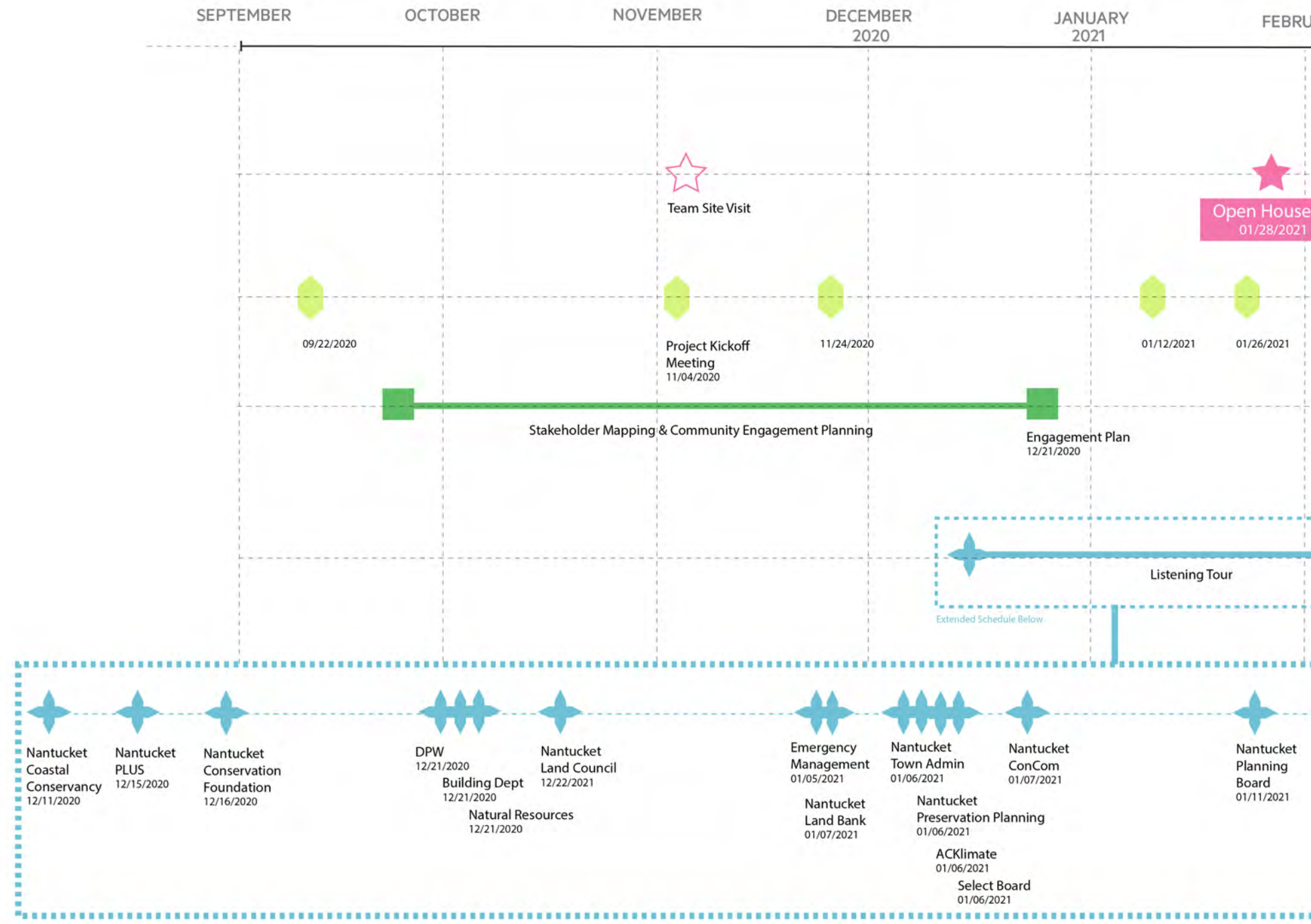
"There are some areas, especially low-lying, where there is no constructed real estate and which would be uneconomic to protect against significant sea level rise and/or increased storm frequency/intensity."

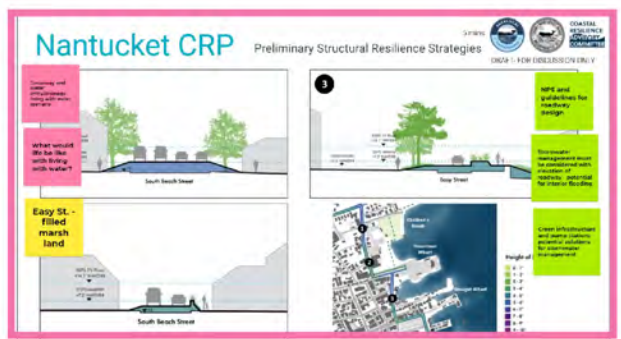
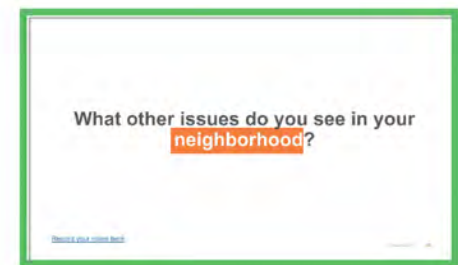
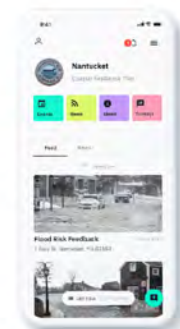
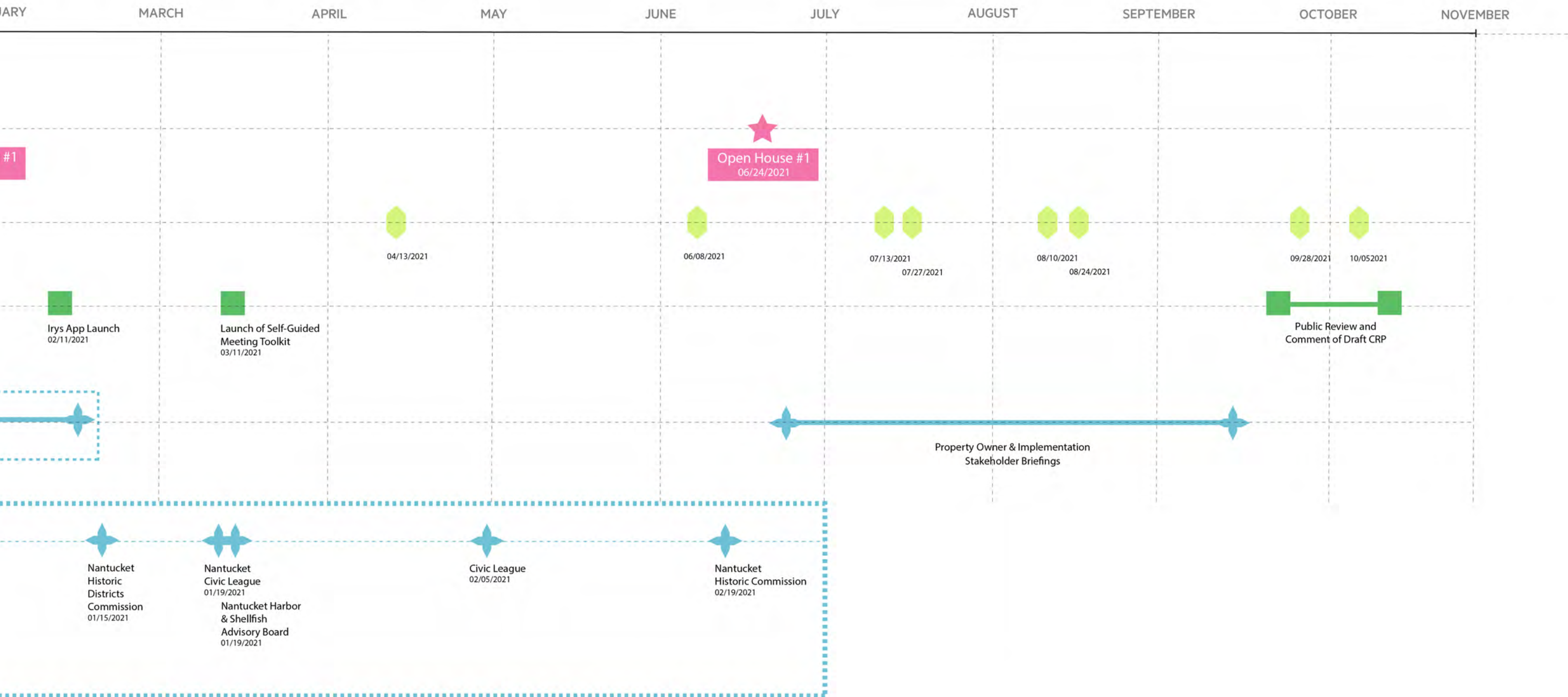
Additional Community-Wide Engagement

Outreach to the Nantucket community also made use of several other engagement opportunities, all intended to keep the community informed and facilitate a two-way dialogue as the planning process progressed. These engagement opportunities included regular email blasts keeping the community informed of project updates, the launch of the Irys mobile phone application, and the development of a virtual meeting toolkit downloadable in both Spanish and English for anyone to host and facilitate conversations about Nantucket’s resilient future with their friends, neighbors, colleagues, and community.

Additionally, regular presentations were given by the Project Team at public virtual meetings of the Coastal Resilience Advisory Committee. These virtual public meetings were another venue for sharing information with the Nantucket Community and seeking feedback on the CRP’s draft recommendations. In total, the Project Team presented at 13 CRAC meetings over the course of the project.

-  Public Open House, *virtual*
-  Coastal Resilience Advisory Committee (CRAC) meeting, *virtual*
-  Public resource
-  Stakeholder Interview, *virtual*





A number of key themes emerged through the community engagement process including common challenges faced by people on the island, core tensions that continually arise and must be accounted for in implementing coastal resilience strategies, and key priorities that form the backbone of the community's vision for a resilient Nantucket.

Community Engagement Themes

KEY CHALLENGES

- The effects of flooding and erosion are increasingly being felt by the public as they give rise to numerous public safety issues in areas previously not thought to be at risk.
- There is a need for increased public awareness and understanding about the flooding and erosion hazards Nantucket faces, how this could impact people directly, as well as what can be done about it, the lack of which often leads to widespread unpreparedness, resistance to change, and panic when storm events strike.
- Town staff reported that additional capacity is needed to take on the responsibilities a comprehensive, island-wide resilience and sustainability approach will require. There are many ongoing parallel efforts and plans related to resilience without a central Town-led entity or coordinated process for implementation.
- Property owners and residents face a number of barriers to implementation of site-specific mitigating measures, including slow and complicated permitting processes as well as a lack of funding opportunities compounded with the high cost associated with such measures.

KEY TENSIONS

- Project stakeholders emphasized that a spirit of compromise is essential, as not everything will be viable to protect given increasing erosion and sea level rise, and prioritization will be necessary.
- Policy and regulatory strategies, such as updated land use and zoning requirements, will play a critical role in Nantucket's future resilience in relation to the built environment. However, certain aspects of local zoning bylaws and building codes are controlled by the Commonwealth and more stringent rules and regulations cannot always be implemented by the Town.
- Current private development practices and norms conflict with a future built environment that is resilient. Given these norms, any approach that aims to restrict development is likely to be met with significant opposition and must be carefully crafted to encourage resilient development.

Community Engagement Themes



- Community members emphasized Nantucket's one-of-a-kind character that must be preserved. While it is essential to protect the island from coastal hazards and climate risk, it must not be at the expense of the elements which contribute to this unique sense of place, which include Nantucket's ecological resources and habitats, the coastal viewshed and access to the water, the historic built environment and cultural landscapes.
- Ferry terminals and maritime facilities, specifically, are of unique importance to Nantucket and serve as critical infrastructure in their function as access points to supply chains such as fuel and food, as well as waste disposal.
- The CRP should prioritize protecting critical infrastructure. Transportation infrastructure, power cables and substations, water systems, data lines, water treatment facilities, maritime facilities, and the airport will all require a high level of protection. These systems are Nantucket's lifeline and community members were unanimous in highlighting the need to ensure continuity of service.
- Nature-based strategies should be implemented wherever feasible with a clear emphasis on minimizing ecological impacts and maximizing ecological and public access benefits. Preserving Nantucket's beaches and coast into the future for as long as possible should be a primary goal.
- The process of advancing resilience on Nantucket should engage a diverse range of public voices and ensure that the public is educated about the issues at hand.
- The CRP must be clear and actionable, rather than serving as just a summary of knowledge. The plan should delineate responsible parties, methods of prioritizing action, and specific opportunities and options down to a hyper-local scale, while also providing resources for property owners to take action.

Community engagement was at the core of the CRP process, helping to document concerns related to coastal risks, establish a vision for Nantucket's resilient future, and reach consensus around the pathways that will be taken to achieve this future. The outcomes of the engagement informed the project in many ways, including helping define and prioritize community assets and services included in the risk analysis (as detailed in Section 4), defining community values and priorities in the early stages of strategy development, and ultimately in shaping the final set of resilience and adaptation strategies across the island, as discussed further in Sections 6 and 7.

Here's What we Heard

Coastal resilience approaches must be carefully tailored to respect and complement Nantucket's heritage and cherished historic character.

Particular attention should be paid to the essential services and facilities that Nantucketers depend on to maintain quality of life.

The CRP should prioritize natural resilience, using nature-based approaches and green infrastructure as much as possible to reduce risk and restore ecosystems.

Here's How we Incorporated it

The CRP includes guidance on approaches property owners can take to adapt their homes and businesses to coastal risks. Special attention is paid to how recommended steps can comply with local design guidance for historic structures.

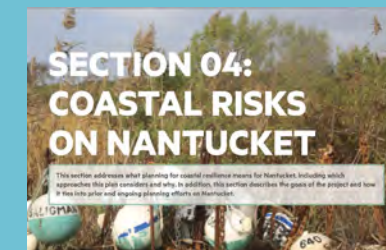
The CRP developed projects for near-term implementation based on a comprehensive assessment of risk to critical facilities across the island. Based on this, priority projects focus on resilience measures at Steamboat Wharf, Surfside Wastewater Treatment Facility, and the Department of Public Works Facility.

Recommendations island-wide focus on maximizing opportunities for softer, nature-based approaches, including dune restoration, ecological restoration, and long-term wetland migration.

Check it out Here!



See section 7 (page 122)



See Section 4 (page 54) for the risk assessment and Section 7-Downtown (page 136), Madaket (page 166), and South Shore (page 218)



See Sections 6 and 7 for the CRP's resilience recommendations including island-wide approaches and focus area strategies

Long Term Vision

*Nantucket community engaged for this project want to see a **future Nantucket** that continues to embody the island's unique characteristics, whose coastal and ecological resources thrive and are accessible to all, that has redundancy for energy and other critical systems, that continues to support a **vibrant and diverse community**, that is **affordable and supports economic security** for year-round residents, that is more sustainable and leaves a smaller negative environmental footprint, and that is **open-minded and flexible** in its approach to adapting to climate change. Nantucket should be a place for today's young people and future generations to enjoy in the future, even if some aspects of today's Nantucket will need to change in order to adapt to new conditions. The CRP can help pave the way for this future by providing a **comprehensive, adaptable, implementable island-wide approach to resilience** that also accounts for various hyper-local conditions appropriately.*



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SECTION 04: COASTAL RISKS ON NANTUCKET

This section summarizes the coastal hazards facing Nantucket today and how they will change in the future. In addition, this section describes the likely impacts of these hazards.



Sea level rise will increase the risk associated with each of these coastal hazards over time.

Overview of Coastal Risks on Nantucket

Nantucket is, and always has been, highly exposed to a range of coastal hazards, most notably flooding and erosion. By the end of this century, climate change will increase the frequency and severity of coastal hazards impacting Nantucket. As sea levels rise, high tide flooding will happen more often, coastal flooding will reach new areas (varying geographically depending on elevation and presence of coastal banks), and coastal erosion may progress more rapidly.

Risk is the potential for a hazard to have negative impacts. In terms of coastal hazards like flooding and erosion, coastal risk is the potential for flood water or shoreline change to cause damage and disruption to buildings, assets, and systems. Coastal risk assessments help us understand and quantify the ways that coastal hazards will impact the systems, services, and structures that support the way of life that Nantucket cherishes. With climate change and sea level rise, the risk associated with high tide flooding, coastal flooding, coastal erosion, and groundwater table rise will increase.

The CRP draws on a detailed evaluation of the coastal risks facing Nantucket. This risk evaluation identifies areas that are at risk from coastal hazards such as flooding and erosion and how these hazards will change over time due to sea level rise. The results of this assessment help the community prioritize areas for adaptation and understand what types of adaptation or resilience investments may be necessary and appropriate in different areas of the island.

This section summarizes coastal hazards and risks on Nantucket. Review the Nantucket CRP Existing Conditions and Coastal Risk Assessment report for the full risk assessment methodology and results.

Coastal Hazards

Risk assessment begins with an evaluation of hazards. The CRP focuses on natural hazards driven by coastal processes on Nantucket. Coastal hazards are natural events that threaten lives, property, and other assets. The island is affected by four primary types of coastal hazards: high tide flooding, coastal flooding, coastal erosion, and groundwater table rise. Each of these hazards impacts Nantucket today to various degrees, but will become increasingly frequent, damaging, and disruptive in the decades ahead due to sea level rise. Understanding the hazards to which Nantucket is exposed and the likelihood or probability of exposure over time helps the community evaluate the degree of risk for buildings, assets, infrastructure, and systems.



Coastal Flooding

Higher sea levels mean that coastal flooding will be deeper and can extend further inland in low-lying areas.



Coastal Erosion

Rising sea levels and more frequent and/or intense storms may increase the rate of coastal erosion in many places.



High Tide Flooding

With sea level rise, high tides are even higher and flooding happens more frequently.



Groundwater Table Rise

As sea levels rise, the groundwater table will also rise, resulting in groundwater ponding and flooding - even in areas that are not along the coast.

Image credits, from top right: bluff erosion (Trevor Johnson), Easton Street marsh (Trevor Johnson), Downtown 'sunny day' flooding (Vince Murphy), flooding in Downtown (Vince Murphy)

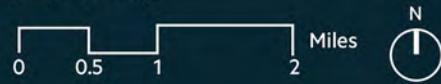
Island-Wide Exposure to High Tide Flooding

	2030*		2050*		2070*		2100*	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	364	3%	615	5%	806	6%	1,292	10%
Roadway Loss of Service (miles)	10	4%	20	7%	29	11%	45	17%
Protected Open Space (acres)	1,710	9%	2,229	12%	2,878	16%	4,054	22%

*decades shown based on data availability, not consistent across coastal hazards

Island-Wide High Tide Flood Risk

All water elevations based on projected mean monthly high water under a high sea level rise scenario and relative to NAVD88. Data should be used for planning purposes only.



Muskeget Island

Tuckernuck Island

Nantucket Sound

Atlantic Ocean

Nantucket Harbor

Brant Point

Coatue

Nantucket Harbor

Polpis

North Shore

Madaket

Downtown

Sconsset

South Shore

LEGEND

- 2030 High Tide Flooding (4.13 ft)
- 2050 High Tide Flooding (5.43 ft)
- 2070 High Tide Flooding (7.23 ft)
- 2100 High Tide Flooding (10.83 ft)

High Tide Flooding

High tide flooding, often referred to as “nuisance” flooding or tidal flooding, is defined by the National Oceanic and Atmospheric Administration (NOAA) as flooding that leads to public inconveniences, such as road closures, overwhelmed storm drains, and deterioration of public infrastructure such as roads. High tide flooding is becoming increasingly common as sea levels rise and land subsides in coastal communities like Nantucket. Higher sea levels and subsiding ground levels result in a greater likelihood that high tide will overtop existing bulkheads and other coastal structures leading to flooding of inland areas.

Nantucket is already experiencing nuisance flooding in certain locations, particularly on Easy Street in Downtown, where a 2020 Town report and presentation (High-Tides and Flooding on Easy Street: A progress report and key findings) documented a six-fold increase in the frequency of tidal flooding over the last 40 years. Tide gauge records indicate that since 1963 Nantucket Harbor has experienced an average of 0.14 inches of sea level rise per year. The NOAA tide gauge for Nantucket is located on Steamboat Wharf and is one of only a few locations in Massachusetts with localized tracking of historic sea level rise. NOAA also notes that Nantucket is projected to experience higher levels of sea level rise than the global average, which is consistent with similar sea level rise projections provided by the Massachusetts Coastal Flood Risk Model (MC-FRM) produced by the Commonwealth of Massachusetts, as discussed later in this section.

Coastal Flooding

Coastal flooding is defined as the inundation of low-lying land by seawater, often as a result of storm surge. As a storm approaches the coast, strong winds push water towards land and cause a rise in the water level, or storm surge. Sea level rise and the possibility for an increase in the frequency and/or the intensity of storms due to climate change can be expected to increase the risks from coastal flooding on Nantucket. Higher sea levels will cause flooding to be deeper and extend further inland in low-lying coastal areas.

Coastal flooding can result in significant damage and disruption to homes, businesses, infrastructure, and ecosystems. With six inches of flooding, roadways become unsafe for travel. Just one inch of flooding within a home can damage or destroy the flooring material, the bases, entire walls, electrical equipment, and furniture, rendering a house uninhabitable for extended periods of time. Waves associated with coastal storms can severely damage buildings and infrastructure located along the coast, particularly where there is a sandy substrate. Waves and the associated currents also erode shorelines, which can undermine building foundations and destroy roads and other forms of infrastructure.



‘Sunny day’ flooding in Downtown (photo by Vince Murphy)



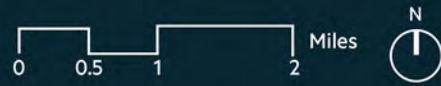
Coastal flooding in Downtown Nantucket, December 2020 (photo by Vince Murphy)

Island-Wide Exposure to 1% Annual Chance Coastal Flood						
	2030*		2050*		2070*	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	1,051	8%	1,253	10%	1,518	12%
Roadway Loss of Service (miles)	40	15%	46	17%	54	20%
Protected Open Space (acres)	2,871	16%	3,356	18%	3,937	22%

*decades shown based on data availability, not consistent across coastal hazards

Island-Wide Coastal Flood Risk

All coastal flood extents based on the Massachusetts Coastal Flood Risk Model (MC-FRM). Data should be used for planning purposes only.



LEGEND

- 2030 1% annual chance coastal flood*
- 2050 1% annual chance coastal flood*
- 2070 1% annual chance coastal flood*

*The 1% annual chance event, or 100-year storm, is a benchmark used to plan for coastal flooding. Properties within the extent of the 1% annual chance event have a 1 in 4 chance of flooding over the course of a 30-year home mortgage.

Coastal Erosion

Erosion is a geological process in which earthen materials are worn away and transported by natural forces, such as wind and water. With Nantucket’s shoreline composed primarily of glacially deposited and compacted sandy soils, it is and has always been susceptible to coastal erosion. Portions of the island’s shorelines, particularly along the South Shore, have already eroded more than one hundred feet inland in just the past decade. Sea level rise and the potential for more frequent and/or intense storms is expected to increase the rate of erosion in most coastal locations, including Nantucket.

Erosion can happen over long periods of time, seasonally, or during a storm event. During storm events, a lot of erosion can happen in a short time, causing large changes to the coastline. This is called episodic erosion. Different types of shorelines experience different types of erosion. For example, sandy beaches and dunes generally erode seasonally and during storms but are also regularly replenished by natural processes. Bluffs are generally eroded during significant storm events but once the bluff is eroded, there is no recovery or natural replenishment. It should be noted that some bluff erosion factors, like wind, precipitation, and runoff, may be more constant than episodic. Additionally, structures, such as residences on cliff tops, increase the bearing weight which can contribute to cliff slope failure. Property owner landscaping practices like replacement of stabilizing vegetation with shallow root species such as grass can also accelerate bluff erosion.

Island-Wide Exposure to Coastal Erosion						
	2030*		2050*		2100*	
	# Exposed	% Island-Wide	# Exposed	% Island-Wide	# Exposed	% Island-Wide
Structures	113	1%	329	3%	860	7%
Roadway Loss of Service (miles)	6	2%	12	4%	33	12%
Protected Open Space (acres)	312	2%	678	4%	1,754	10%

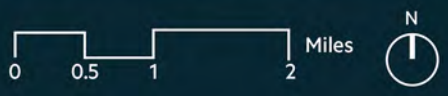
*decades shown based on data availability, not consistent across coastal hazards



Coastal erosion (photo by Vince Murphy)

Island-Wide Coastal Erosion Risk

All coastal erosion extents are based on FEMA Region 1 Coastal Erosion Study for Nantucket County (2019). Data should be used for planning purposes only.



LEGEND

- 2030 Erosion
- 2050 Erosion
- 2100 Erosion

Groundwater Table Rise

Groundwater table (or water table) rise is the increase of groundwater levels underneath a landmass, primarily driven by an increase in sea levels. Near the shoreline, the groundwater table in unconfined aquifers typically fluctuates with daily tides. As sea level rises, the water table will likely rise as well, and, for lower-lying regions with a shallow depth to the water table, this could mean that the groundwater may eventually pond above the land surface, causing inundation even though the area is not along, or directly connected to, the shoreline. The increased groundwater table could create new wetlands and expand others, change surface drainage, expand saturated soil conditions, and/or inundate the land, depending on local topography. Flooding may be especially intense seasonally when high tide coincides with large rainfall events.

A rising groundwater table can cause destabilization of soils and building foundations, subsidence, as well as infiltrate underground utilities. This can result in significant structural damages as soils lose their capacity to bear weight, and cause corrosion and other operations and maintenance challenges for subsurface utilities and foundations.

Precipitation

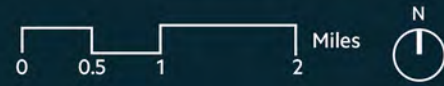
Precipitation is an important consideration when assessing impacts from coastal flooding and sea level rise. Climate change projections for the Commonwealth of Massachusetts indicate that precipitation (including both rainfall and snowfall) patterns are changing, and more significant changes in the amount, frequency, and timing of precipitation in future years are anticipated. Increases in total rainfall can impact the frequency of flooding events, especially in areas where stormwater and drainage infrastructure has not been adequately designed to manage the increased flows. In addition to chronic flooding in low lying areas due to high tides, sea level rise will also impact the ability of the stormwater system to provide adequate drainage as outfall pipes will be submerged more frequently, causing drains to surcharge during heavy rainfall events. This is problematic when stormwater flows onto streets and properties, impacting traffic and resulting in property damage. This study does not include a detailed analysis of stormwater impacts but the potential for future increases in precipitation to exacerbate coastal and nuisance flooding is taken into consideration within the recommended resilience strategies.



Potential Groundwater Emergence on Brant Point, November 2020 (photo by Trevor Johnson)

Depth to Groundwater, 2050

Depth to groundwater mapping based on publicly available data from USGS groundwater wells. Data should be used for planning purposes only.



LEGEND

- 0 ft depth to groundwater
- 0-2 ft depth to groundwater
- 2-4 ft depth to groundwater
- 4-6 ft depth to groundwater
- 6-8 ft depth to groundwater
- >8 ft depth to groundwater

Coastal Hazard Data Sources and Scenarios

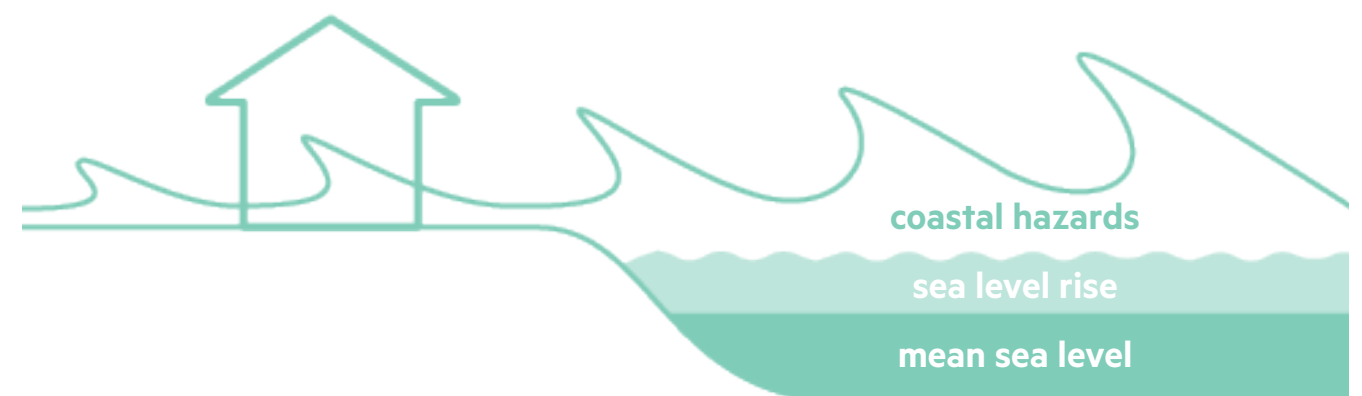
Many datasets are available for assessing coastal hazards on Nantucket from a variety of local, State, Federal, and private sources. Nantucket has previously drawn on a range of flood risk modeling and mapping to evaluate exposure to coastal hazards, including the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs) and associated Flood Insurance Study (FIS), as well as studies undertaken by local and regional experts, such as the stormtide pathways analysis prepared by the Center for Coastal Studies in Provincetown.

This section outlines the recommended “best available” coastal hazard datasets for Nantucket, as well as the scenarios adopted for the purposes of the CRP. According to the International Panel on Climate Change, a scenario is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast but rather one alternative of how the future can unfold. While it is appropriate to adopt a set of scenarios for planning purposes, science is an iterative process and climate science in particular is influenced by a range of variables that may change over time. Through the Coastal Resilience Advisory Committee (CRAC), the Town has committed to regularly monitoring evolving scientific consensus on projected sea level rise and updating plans based on the best available information.

All future coastal hazards analyzed for the CRP incorporate the effects of sea level rise under the high scenario developed by the Commonwealth of Massachusetts, consistent with the scenario recommended by CRAC and adopted by the Select Board in 2020. This means that the analysis of future tidal flooding and future coastal flooding due to storms in 2030, 2050, 2070, and 2100 includes the projected rise in sea levels based on the best available science. Incorporating the effects of sea level rise on future coastal hazards more accurately characterizes Nantucket’s increasing flood and erosion risk over time.



Over time, sea level rise increases the risk associated with coastal hazards. The CRP incorporates sea level rise into all future coastal flooding scenarios.



Coastal Risks and Sea Level Rise



Sea Level Rise

The analysis of tidal and coastal flooding for the CRP draws on State-specific sea level rise projections developed by the Commonwealth of Massachusetts in 2018. The Town, based on a recommendation from CRAC, has adopted a policy using the high scenario for sea level rise provided by NOAA for planning purposes. The CRP recommends adopting the sea level rise scenarios provide by the Commonwealth as the best available, most up-to-date relative sea level rise projections for Nantucket. Relative sea level rise projections are localized projections downscaled from regional and international projections using approaches consistent with the International Panel on Climate Change (IPCC), the 2017 National Climate Assessment, and the Global and Regional Sea Level Rise Scenarios for The United States (NOAA). The methodology includes a probabilistic assessment of future sea levels using medium (Representative Concentration Pathway 4.5) and high (Representative Concentration Pathway 8.5) greenhouse gas concentration scenarios with considerations for two methods of estimating ice sheet loss based on expert elicitation and process-based numerical models. A full overview of the methodology is available in the Massachusetts State-wide and Major Basins Climate Projections report.

The CRP will utilize the high scenario from the Commonwealth’s projections for the purposes of evaluating risk of high tide flooding. This scenario is extremely unlikely to be exceeded under a high greenhouse gas emissions pathway and thus provides an appropriately conservative approach for long-term planning on Nantucket.

Relative Mean Sea Level for Nantucket, MA (feet NAVD88)					
Scenario	Probabilistic Projections	2030	2050	2070	2100
Intermediate	Unlikely to exceed (83% probability) given a high emissions pathway	0.7	1.5	2.4	4.2
Intermediate-High	Extremely unlikely to exceed (95% probability) given a high emissions pathway	0.9	1.8	3.0	5.2
High	Extremely unlikely to exceed (99.5% probability) given a high emissions pathway	1.2	2.5	4.3	7.9
Extreme <small>(Maximum physically plausible)</small>	Exceptionally unlikely to exceed (99.9% probability) given a high emissions pathway	1.4	3.1	5.5	10.5

Sea level rise projections for Nantucket adopted by the Commonwealth of Massachusetts. Elevations given in feet NAVD88 relative to the year 2000.



Tidal Flooding

Tidal flooding analysis for the CRP uses mean monthly high water (MMHW) as the tidal level representative of nuisance flooding. Mean monthly high water is the average of the highest monthly tide levels across a defined time period.

The frequency of traditional daily tidal datums (e.g., mean higher high water or mean high water) is too extreme to be considered “nuisance.” For example, tidal flooding of a street on a daily basis is not a nuisance, it is a significant disruption to everyday life. By examining mean monthly high water, decision makers are able to understand potential future nuisance issues and address them through mitigation or adaptation actions before the flooding increases in frequency and becomes disruptive. MMHW is typically exceeded 25-35 times a year and is meant to approximate an identified tipping point of 30 flood events per year.



Coastal Flooding

The Commonwealth of Massachusetts, through the Department of Transportation, is in the process of producing the Massachusetts Coastal Flood Risk Model (MC-FRM) drawing on robust numerical modeling across a range of storm and future climate conditions. MC-FRM represents the best available coastal flood hazard data for Nantucket. The dataset provides state-wide high resolution

coastal flood data, including stillwater flood elevations, wave data, and Design Flood Elevations (DFEs), for a range of annual exceedance probability storms (0.1%, 0.2%, 0.5%, 1%, 2%, and 5%) for 2030, 2050, and 2070. Future sea levels are determined using the Commonwealth of Massachusetts’ adopted sea level rise projections, based on the high scenario. Additional information on the methodologies used in developing MC-FRM can be found in the Nantucket CRP Existing Conditions and Coastal Risk Assessment.

While the assessment of coastal risk for this study analyzed impacts from the full range of potential storm intensities that may impact Nantucket, planning scenarios focus on the 1% annual chance event (commonly referred to as the 100-year storm). Properties within the extent of the 1% annual chance event have a 1 in 4 chance of flooding over the course of a 30-year home mortgage. The 1% annual chance event is a benchmark used by FEMA and other public agencies for planning purposes and provides a starting point for risk mitigation planning.

Nevertheless, it may be appropriate to plan for flood events with higher or lower probabilities depending on the application, as described in greater detail later in this report. The flood elevations provided by FEMA on Flood Insurance Rate Maps (FIRMs), or flood maps, do not account for sea level rise and may underestimate risk. MC-FRM incorporates sea level rise and is the best available coastal hazard data for the CRP.

KEY MC-FRM DEFINITIONS

Stillwater Flood Elevation

a modeled water surface elevation that includes the effects of tides, storm surge, and wave setup. Wave setup is an increase in mean water levels due to breaking waves. Stillwater elevations are available based on MC-FRM for 2030, 2050, and 2070.

Design Flood Elevation (DFE)

The Design Flood Elevation represents the goal level of flood risk reduction for an area, building, or asset. MC-FRM DFEs include the stillwater flood elevation and wave crest elevation but do not include freeboard. Freeboard (see below) can be added to this elevation for specific uses based on local factors such as exposure, criticality, risk tolerance. The MC-FRM represents the best available coastal flood hazard data for Nantucket and is recommended for use along with FEMA flood maps and Massachusetts Building Code to establish the basis for DFEs.

Freeboard

Freeboard is an additional amount of height above the expected elevation of flooding used as a factor for safety. Freeboard is often defined in increments of one, two, or three feet and is determined based on risk tolerance and criticality.



Coastal Erosion

The response of shoreline change rates to sea level rise is currently a topic of ongoing research, however, most opinions expect the rate of shoreline erosion to increase with sea level rise. The Nantucket-specific erosion study completed by FEMA in 2019 provides basic projections for future erosion hazards and includes factors for sea level rise using a methodology based on historic observed erosion rates (feet of erosion per year). The dataset includes projected erosion hazard areas for 2030, 2050, and 2100 based on a range of sea level rise scenarios. The study uses NOAA sea level rise scenarios developed in 2012 for the United States National Climate Assessment. While the FEMA study includes a number of assumptions and requires additional refinement based on future data collection, these data nevertheless provide the best available future-looking coastal erosion projections for Nantucket and are appropriate for comprehensive planning purposes. The future refinement of resilience strategies through the design process and any subsequent site-specific exposure assessments should include more detailed modeling of potential erosion concerns for the given location.



Groundwater

Existing information on groundwater for Nantucket is provided by United States Geological Survey (USGS). USGS manages 10 groundwater wells across the island. USGS well depths vary from approximately 21 to 100 feet deep. The groundwater assessment conducted for this study uses data publicly available from USGS and then projects future groundwater emergence due to sea level rise using Massachusetts's high sea level rise scenario for Nantucket.

The Town's public water supply does not use the upper-most drinking water aquifer. Nantucket's hydrogeology is complex, and the Town's public water supply uses water from a deeper and confined aquifer.



Coastal erosion (photo by Rennie Jones)

Total Coastal Flood and Erosion Risk to Buildings



Muskeget Island

Tuckernuck Island

Nantucket Sound

Atlantic Ocean

Nantucket Harbor

Brant Point

Coatue

Nantucket Harbor

Polpis

North Shore

Madaket

Downtown

Sconsset

South Shore

LEGEND

1% Annual Chance Flood*

2030 1% annual chance coastal flood*

2050 1% annual chance coastal flood*

2070 1% annual chance coastal flood*

*The 1% annual chance event, or 100-year storm, is a benchmark used to plan for coastal flooding. Properties within the extent of the 1% annual chance event have a 1 in 4 chance of flooding over the course of a 30-year home mortgage.

Total Quantitative Risk

- < \$500k
- < \$1.0 Million
- < \$2.5 Million
- < \$5.0 Million
- < \$10 Million
- < \$50 Million

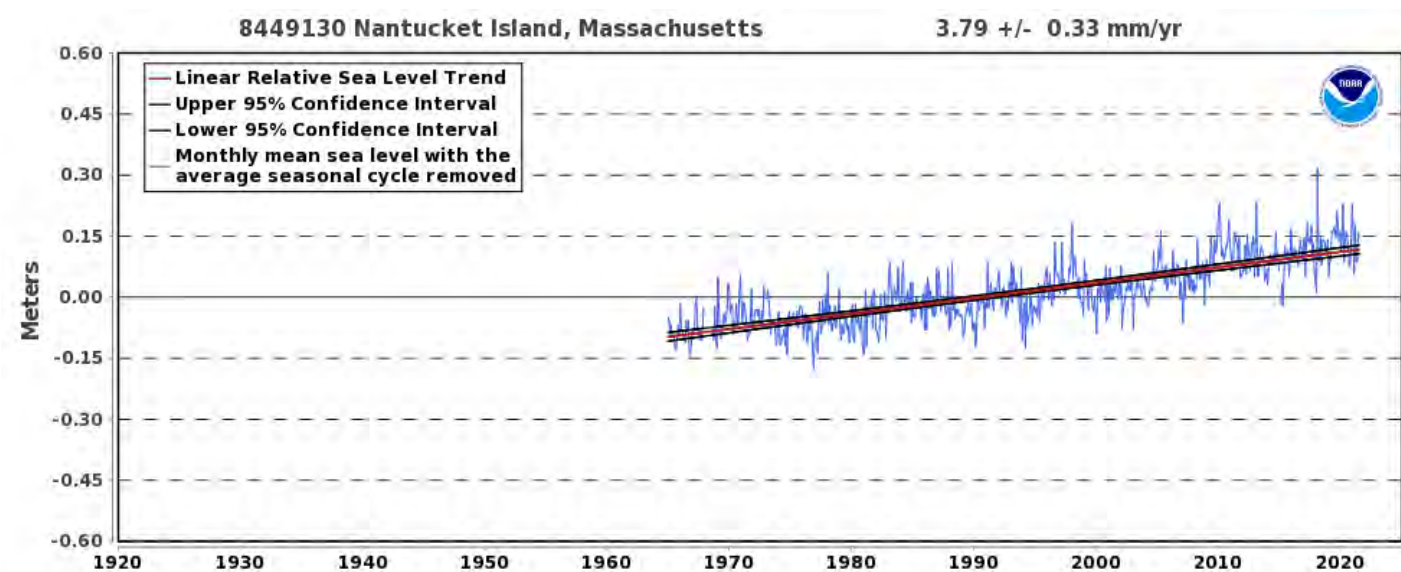
Coastal Risk Assessment

Understanding and communicating coastal risk will help Nantucket take intentional and proactive steps towards reducing and adapting to this risk. The overarching goal of the coastal flood and erosion risk analysis is to quantify and understand the risk to buildings, infrastructure, assets and services, and natural resources on Nantucket under a scenario in which no actions to reduce risk are taken by either the Town or private property owners. The results provided in this plan are updated from those included in the Nantucket CRP Mid-Project Summary Report due to the use of updated flood hazard data from MC-FRM and inclusion of a wider range of storm events.

What does the coastal risk assessment include?

For structures, like homes and businesses, risk is presented in terms of direct physical damage to buildings and contents, impacts to residents, and economic losses to workers, businesses, and the Town. The methods used for the analysis account for increasing risk over time by estimating each structure's risk due to flooding and erosion through 2070, assuming up to 4.3 feet of sea level rise by that decade per the Commonwealth's high scenario. The assessment is based on outputs from MC-FRM, including the 5% (20-year), 2% (50-year), 1% (100-year), 0.5% (200-year), 0.2% (500-year), and 0.1% (1,000-year) annual chance storms for present-day (2020), 2030, 2050, and 2070. Risk is then interpolated for each year between 2020 and 2070 to develop a full understanding of the changing risk including the chance of flooding and anticipated depth of flooding in and around the structure. In addition to the number of structures that might be affected over time due to various flood events, expected cumulative losses are calculated and communicated in net present value. For linear infrastructure, such as roads and sewers, and other resources, such as parks and open space, risk is assessed based on exposure to coastal hazards and potential loss of service under various flood and erosion scenarios. Based on the analysis, areas of concentrated risk can be identified to help inform the location of structural and nature-based resilience approaches and/or implementation of non-structural approaches. The risk analysis results are also used to help communicate risk to the public, as well as to evaluate the cost effectiveness of resilience projects and strategies.

Risk to structures on Nantucket is provided in dollar values to summarize expected cumulative losses from today to 2070 due to both flooding and erosion. This analysis includes all flood and erosion scenarios, based on available data, that could impact a structure each year. The dollar values provide a basis for comparing expected losses to the cost of potential interventions to prevent those losses.



Historic SLR at NOAA tide station 8449130 Nantucket Island, Massachusetts

Tide gauge records indicate that since 1963 Nantucket Harbor has experienced 0.14 inches of sea level rise per year. The NOAA tide gauge for Nantucket is located on Steamboat Wharf and is one of only a few locations in Massachusetts with localized tracking of historic sea level rise. NOAA also notes that Nantucket is projected to experience higher levels of sea level rise than the global average, which is consistent with similar sea level rise projections provided by the Massachusetts Coastal Flood Risk Model (MC-FRM) produced by the Commonwealth of Massachusetts, as discussed earlier in this section.

COASTAL RISK ON NANTUCKET

Risk Assessment Findings

Risk from coastal hazards on Nantucket is significant and will grow over time. The findings from the risk assessment are based on the best available coastal hazard data and show coastal risks pose an existential threat to many of the buildings and services that support Nantucket's identity, economy, and wellbeing.

The information provided here is an estimate of risk over time on Nantucket if no further actions are taken to reduce or manage risk due to coastal flooding and erosion.

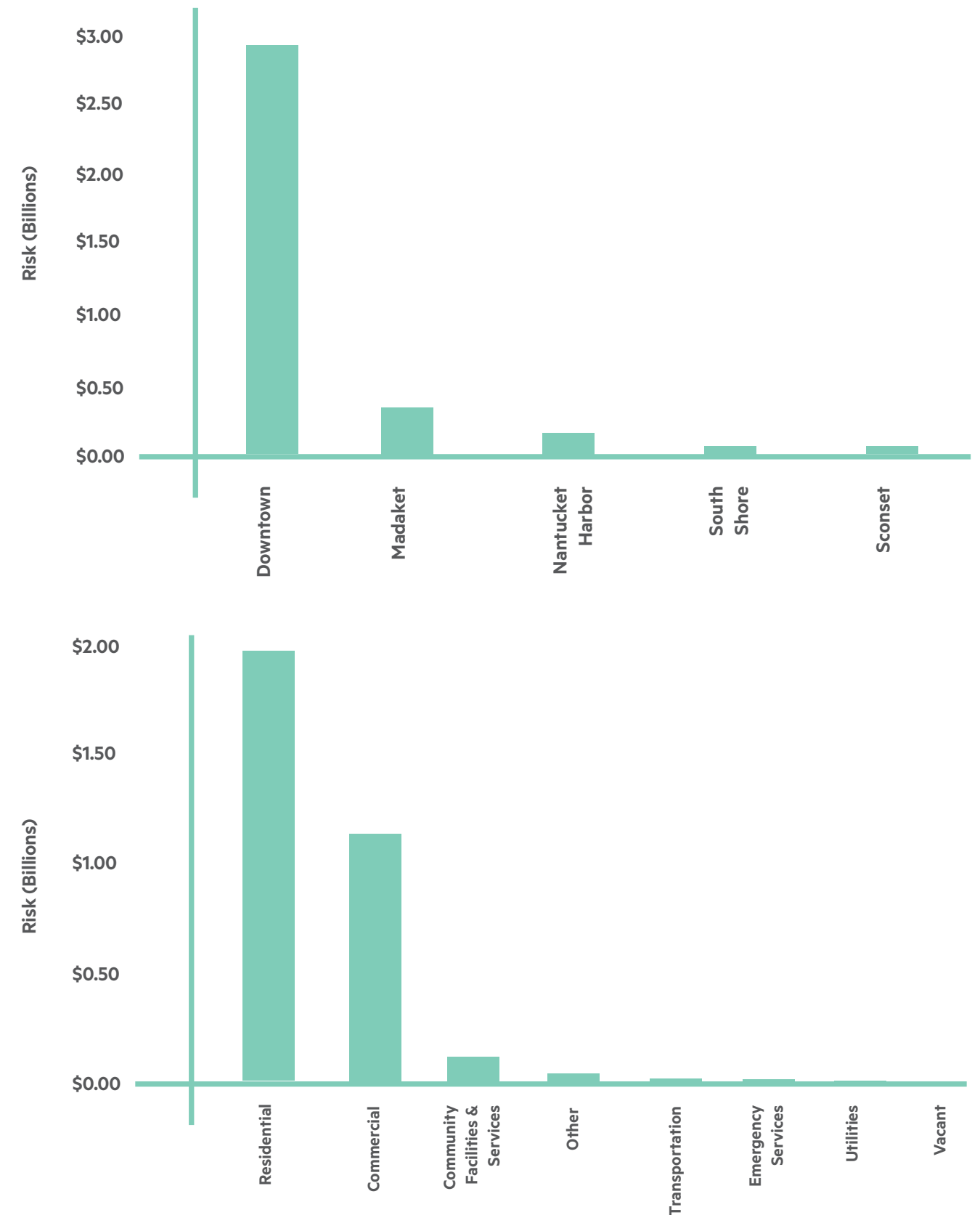
Buildings

From now through 2070, 2,373 structures are at risk from coastal flooding and erosion, with the cumulative expected annual damages totaling \$3.4 Billion, including direct physical damage to buildings, anticipated direct and induced economic disruption to businesses, direct social disruption, including relocation costs, health costs from injuries and mental stress, and lost income due to health issues, and Federal, State, and local tax impacts.

84% of at-risk buildings are residential, accounting for 59% of the total risk, and though only 9% of at-risk buildings are commercial, they account for 34% of the total risk. At least 9% of buildings are tourism-related, including hotels, restaurants, transportation facilities, and other buildings that support tourism, accounting for 35% of the total risk.

Nantucket is a National Historic Landmark and has two local historic districts that are of primary importance to the community. While Nantucket's landmark status and historic character are defined by more than buildings, this analysis found that the risk to buildings that are designated or identified as historic structures is very significant. Buildings located in the two local historic districts (Downtown and Siasconset) or included in the Massachusetts Historical Commission inventory of buildings represent at least 81% of the total risk on Nantucket and 49% of the buildings at risk. The expected damage to these buildings between now and 2070 totals \$2.8 billion.

Buildings and Structures Damage by Location and Use Category



Essential Facilities

Essential community facilities and services, including the public safety building, ferry terminals, police stations, schools, grocery stores, places of worship, and more, are the heart of Nantucket. These types of structures and places, and the services they provide, are vital to community health and wellbeing and are integral to the successful recovery of the community after a major disaster. Of the identified community services and assets, 34 essential community facilities (including 47 buildings) were examined and found to be at risk over the next 50 years, with over \$180 Million in expected damages. Each community facility was assigned a criticality score and a risk score as part of this study, and those were used to calculate a priority score. This score can be used to prioritize facilities for risk mitigation and adaptation.

Top 5 priority assets:

- Steamship Authority (Steamboat Wharf)
- Coast Guard Station Brant Point (10 Easton Street)
- Stop & Shop, Downtown (9 Salem Street)
- Hy-Line Cruises Terminal (Straight Wharf)
- National Grid Electrical Substation (2 Commercial Street)

Infrastructure

Transportation systems, including roadways, sidewalks, water crossings (bridges and culverts), the airport, and ferry terminals are essential to mobility and everyday life on Nantucket and to the island's resilience. Not only do these systems enable people to move around the island as they travel to and from work, to visit the homes of friends and family, or to purchase groceries, they also serve as mode of access to the mainland, a key dependency that ensures an uninterrupted flow of the goods and services on which residents and visitors rely upon.

Future high tide flooding poses a significant risk to roadways and essential infrastructure on Nantucket due to the frequent high water and loss of service that could result. By 2070, up to 29 miles of public and private roads on Nantucket (11% of island-wide roads), including at least 9 miles of Town-maintained roadways, will flood with more than 6 inches of water at high tide, including critical arterial transportation routes like Madaket Road and Polpis Road. Also by 2070, 54 miles of public and private roads (23% of island-wide

roads) will be exposed to the 1% annual chance flood and 23 miles of public and private roads (9% of island-wide roads) will be at risk of loss due to erosion. These figures include 19 miles and 5 miles of Town-maintained roadways, respectively.

Flooding and erosion also pose risks to essential transportation facilities that provide access to and from the island for people, goods, and services. By 2030, public roadways leading to the Steamboat Wharf could experience a frequent loss of service at mean monthly high water. By 2050, the Steamboat Wharf will be completely cut off from surrounding roadways at mean monthly high water. Primary buildings at Nantucket Airport are not at risk of flooding or erosion, but the airport could experience damage and disruption to the approach and southern end of runway 6-24 and other airport infrastructure due to flooding and erosion by 2100.

Open Space and Natural Resources

Publicly accessible open space, owned by both private and public entities, provides many benefits to the Nantucket community, including aquifer protection, wildlife habitat, recreation, and increased property values. However, much of the island's open space will be at risk as sea levels continue to rise and erosion worsens. Erosion poses the most direct risk due to the potential for loss of open space land area and public access but impacts to access and changes in ecological habitat also threaten public enjoyment, community wellbeing, ecosystem health. By 2070, up to 1,239 acres of protected open (7% of island-wide open space) space could be lost or altered due to erosion. 2,878 acres of open space (16% of island-wide open space) will be impacted by the flooding during mean monthly high water, though some of these areas may be lost to erosion prior to being exposed to tidal flooding. Wetlands make up much of the open space on Nantucket and sea level rise will alter these environments over time. Up to 645 additional acres of wetland resource areas compared to today may be submerged by mean monthly high water by 2070, leading to habitat changes and potential loss in these areas.

For more detailed information on coastal risk on Nantucket, please review the Nantucket CRP Existing Conditions and Coastal Risk Assessment.



Coastal dunes on Nantucket (Photo by Chris Reed)

SECTION 05: ISLAND-WIDE COASTAL RESILIENCE FRAMEWORK

This section describes how the information summarized in Sections 2, 3, and 4 is synthesized and further evaluated to develop comprehensive, adaptable, and implementable resilience approaches and strategies across Nantucket. It includes an overview of primary approaches and tools that the community can use to build coastal resilience and introduces the island-wide framework for applying different resilience approaches in different locations based on risks from coastal flooding, tidal flooding, and erosion. As a result of the framework described in this section, the ultimate recommendations of the CRP were developed, as detailed in Sections 6, 7, and 8.

Nantucket faces existential, & increasing, coastal risks

Coastal storms are increasing in frequency and intensity, bringing the impacts of storm surge to the front doors of Nantucketers.

Coastal erosion of Nantucket's bluffs, dunes, and beaches continues to progress, becoming more rapid with sea level rise, threatening homes, infrastructure, and natural resources.

With sea level rise, Nantucketers across the island are more frequently experiencing the increasing impacts of coastal flooding and erosion.

Through 2070, over 2,300 buildings are at risk of coastal flooding and/or erosion. 84% of these buildings are residential and nearly 50% are historic. By 2070, nearly 30 miles of roadway are expected to be inundated by more than 6 inches of flood water during high tide. Over the next 50 years, with sea level rise, coastal flooding and erosion are expected to cause over \$3.4 Billion in cumulative damages across the island.

Everyone on Nantucket, regardless of where they live or work, will need to plan for and adapt to the impacts of sea level rise on the places and systems that support safety and wellbeing on the island.



Present conditions overlooking Downtown out to Coatue and Nantucket Harbor

Nantucket's future is resilient

Nantucketers are committed to preserving the island's one-of-a-kind character for generations to come. At the same time, they recognize that many of the characteristics that make Nantucket unique, such as the coastal viewshed, access to the water, and historic buildings and landscapes, are the same characteristics that make it vulnerable to coastal hazards.

Protecting critical infrastructure, such as the ferry terminals and critical transportation routes, is a priority across the island. Where feasible, Nantucketers prefer implementing nature-based resilience approaches and green infrastructure to minimize ecological impacts and maximize benefits to the natural environment and public access.

Nantucketers recognize that it will not be viable to protect everything, and prioritization will be necessary to build resilience. Compromise is essential to protect the island from increasing coastal hazards while supporting healthy and resilient social, cultural, and natural environments.

To build a resilient future Nantucket that embodies the island's unique history and characteristics, supports healthy coastal and ecological resources, and bolsters thriving communities, Nantucket must adopt a comprehensive, adaptable, and implementable approach.

The time to act is now

While coastal flooding and erosion cannot be prevented from happening, Nantucketers can act today to reduce damage to the places they care about. Island-wide there is a role for everyone in the community to help reduce coastal flood and erosion risks and build resilience.

This CRP provides a comprehensive, adaptable, and implementable approach to begin building resilience on Nantucket.



The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or near-term recommendation.

Moving from Information to Action

The process of developing a comprehensive resilience plan for Nantucket involved multiple steps from establishing a vision for a resilient Nantucket, analyzing the island's coastal risks, creating a toolkit of potential resilience actions, and crafting implementable resilience approaches and strategies.

Sections 2, 3, and 4 of this report provided a comprehensive overview of:

- The context and goals for the Nantucket CRP
- What we learned through community engagement and a shared vision for a resilient Nantucket, and
- Nantucket's coastal risks today and in the future.

Section 5 describes how the information summarized in Sections 2, 3, and 4 is synthesized and further evaluated to develop comprehensive, adaptable, and implementable resilience approaches and strategies across the island. As a result of implementing the Island-Wide Resilience Framework described in this section, the ultimate recommendations of the CRP were developed. Sections 6, 7, and 8 detail these recommendations which include island-wide strategies (Section 6), strategic near-term resilience approaches and long-term adaptation pathways (Section 7), and implementation steps (Section 8).

How can Nantucket Build Resilience?

Resilience is about more than reducing risks from coastal flooding and erosion. Building resilience on Nantucket will require equitable, adaptable, multi-layered, and multi-purpose strategies that add value to the community beyond reducing risk. Developing resilience strategies for Nantucket was an iterative process informed by the project team's technical expertise and understanding of Nantucket's risk, community feedback, evaluation, and prioritization.

The Resilience Toolkit catalogues the wide range of resilience approaches that may be appropriate on Nantucket. These approaches were combined into strategies tailored to address Nantucket's risks and priorities at different scales. The strategies were then further refined through community engagement and evaluated based on the Island-Wide Coastal Risk Framework, focus area context, and evaluation criteria, to be discussed in greater detail later in this section.

APPROACH

a resilience approach is a specific tool that can be applied or project that can be implemented to build resilience. Example resilience approaches include raising a roadway, relocating properties, and installing a living shoreline.

STRATEGY

a resilience strategy is a tactical collection of resilience approaches that work together to address the multi-faceted resilience issues facing a specific area. Resilience strategies may apply at different scales, from island-wide to the project-scale. Section 6 includes island-wide resilience strategies while Section 7 describes resilience strategies for different focus areas across Nantucket.

There are many ways to achieve resilience. Based on our knowledge of the area, assessment of community preferences and priorities, and technical understanding of risk reduction techniques, the project team developed a Resilience Toolkit for the CRP. The Resilience Toolkit contains a spectrum of resilience building approaches that may be appropriate on Nantucket. These approaches are described on the following pages. The recommendations in Sections 6 and 7 incorporate resilience approaches from across this spectrum.



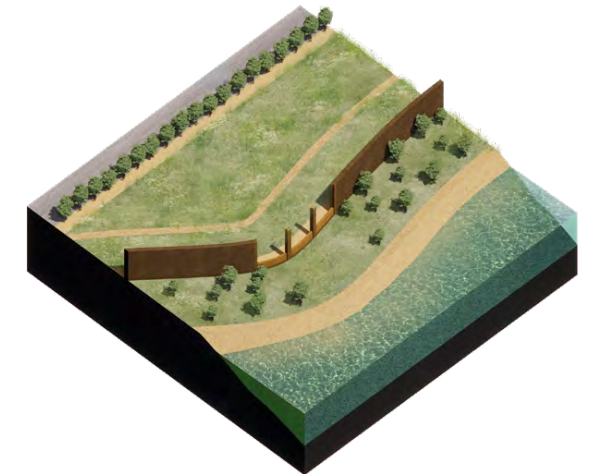
PROTECT: RESISTING THE SEA

To resist the sea means to protect against coastal risks by implementing approaches that seek to keep water out, reduce its force, or to minimize erosion. The types of resilience tools that can be used to implement this type of approach include structures such as flood walls, gates, berms, sea walls, bulkheads, and other hard structures.

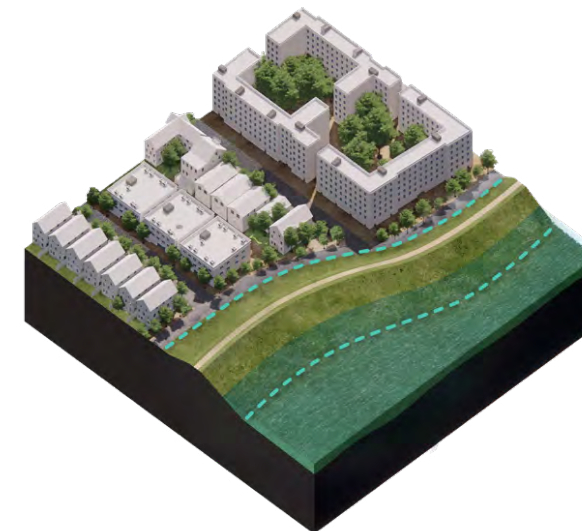
While new infrastructure to protect from flooding and erosion can be designed to minimize negative impacts on the environment, when compared to other options these approaches tend to interfere more with natural systems, alter existing landscapes and infrastructure, and can be costly, so they are best suited for areas that are densely settled or have critical infrastructure where the impacts and expenditure are justified.



CONSTRUCTING FLOODWALLS*



CONSTRUCTING DEPLOYABLE BARRIERS*



CONSTRUCTING BERMS AND LEVEES*



CONSTRUCTING BULKHEADS*

*Image courtesy ONE

^Image courtesy EcoShape and ONE

ADAPT: LIVING WITH THE SEA

To live with the sea means adapting to coastal risks by implementing approaches that reduce or slow the impacts of flooding and erosion by altering buildings and infrastructure to withstand hazards. It also includes increasing adaptive capacity through education and changes to personal and community behavior.

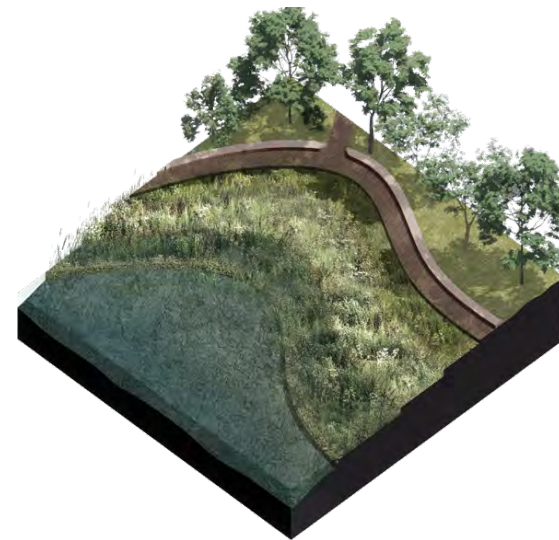
While an adapt approach is often desirable because it has fewer impacts on the community and on natural systems than other strategies may, these approaches also come with residual risk and often depend on individual action and behavior, such as private investment in homes and businesses and adherence to emergency evacuation orders. An adapt approach is broadly applicable in places where risk occurs episodically or where a protection approach is not desirable, feasible, or cost effective.



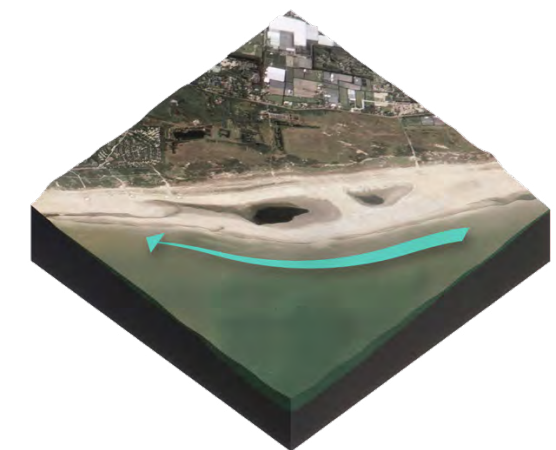
RAISING CRITICAL SYSTEMS



EXPANDING CULVERTS/
INCREASING HEIGHT OF
BRIDGE*



CREATING TIDAL PARKS^



BEACH NOURISHMENT^

RELOCATE: MOVING AWAY FROM THE SEA

Moving away from the sea means retreating from coastal risks by implementing policy and programmatic approaches that manage investment in hazardous areas or relocate at-risk communities and assets. Retreat can mean limiting new development, increasing setbacks, relocating structures, or moving an entire community to upland areas.

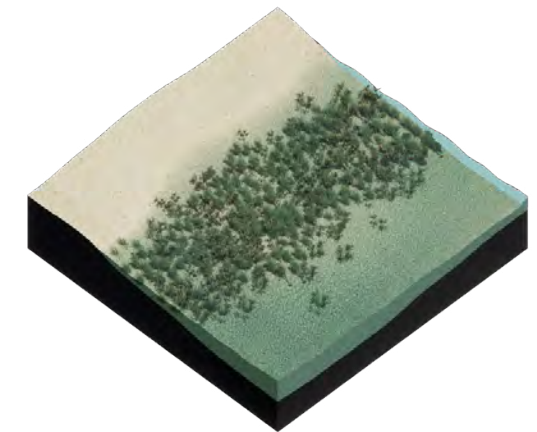
Because of concerns over displacement, retreat must be implemented thoughtfully but may be appropriate in areas where unmanaged risk will lead to uncontrolled relocation and displacement over time.

*Image courtesy ONE

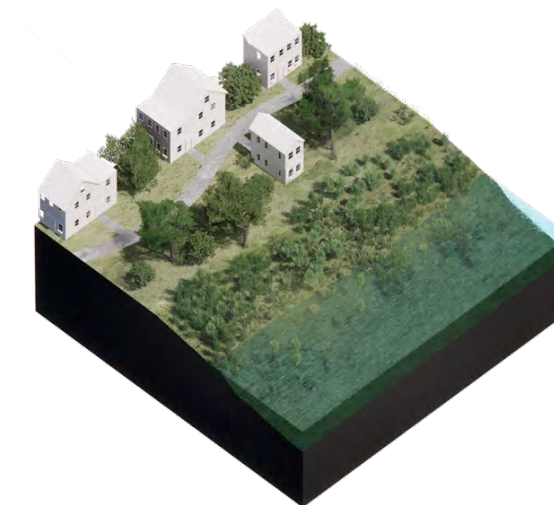
^Image courtesy EcoShape and ONE



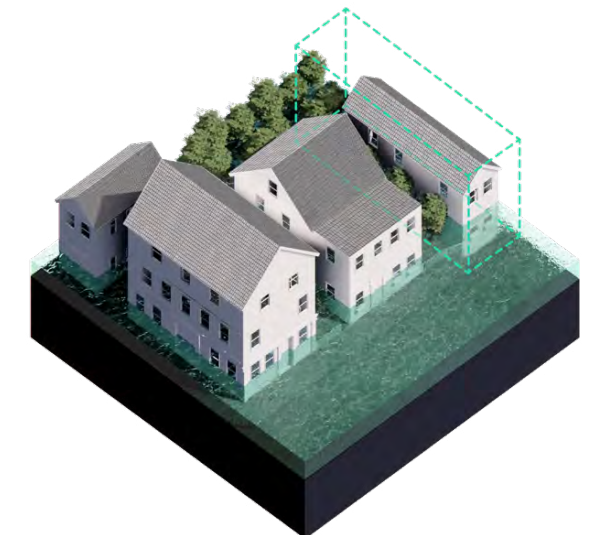
RELOCATING BUILDINGS*



ECOLOGICAL RESTORATION^



ACQUIRING LAND FOR
PRESERVATION*



IMPLEMENTING BUYOUTS*

NATURE-BASED, NON- STRUCTURAL, & STRUCTURAL RESILIENCE APPROACHES

The resilience approaches in this toolkit fall within three categories: nature-based, non-structural, and structural. Comprehensive resilience strategies often incorporate approaches from all three of these categories.

Nature-based approaches:

include a range of water and erosion management techniques that help rainfall infiltrate the ground and/or use vegetation and other natural features to reduce coastal flooding and erosion, as in natural conditions. Nature-based features can also be incorporated into structural approaches to provide ecological benefits to hardened shorelines and infrastructure.

Non-structural approaches:

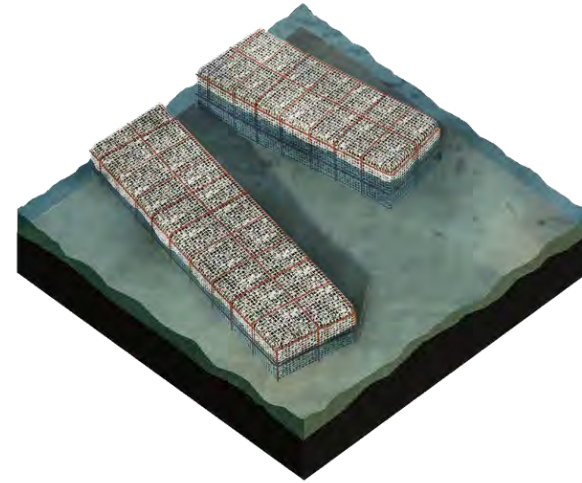
encompass a wide array of programmatic, land use, and policy approaches that manage flood and erosion risk, largely without influencing or obstructing the natural direction and flow of flood waters or sediments. These actions may directly reduce flood risk to individual homes, businesses, and public facilities by encouraging the adoption of certain building and site scale structural measures. Approaches in this category also include efforts to engage community members to promote awareness of risk and educate individuals on actions they may take to adapt to coastal risk.

Structural approaches:

provide flood and erosion risk mitigation through engineered methods, such as through flood walls, berms, bulkheads, raised streets, and drainage infrastructure, that alter the natural flow of flood waters or sediments. These approaches are engineered for the specific purpose of controlling water or sediments but can be designed to incorporate nature-based features.



Floodwalls



Artificial Reefs[^]



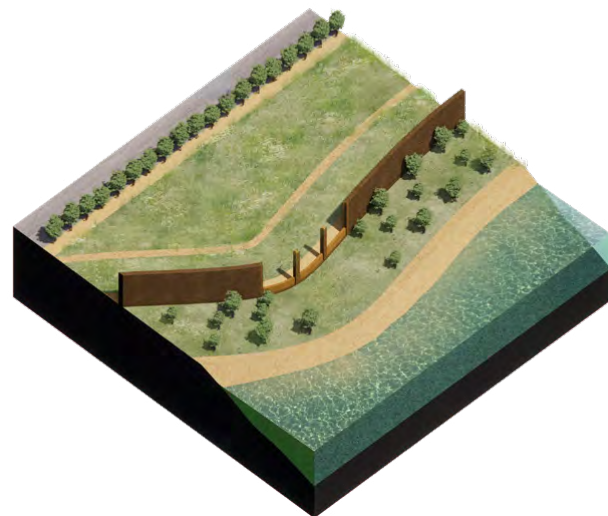
Expanded Culverts^{*}

**PROTECT:
Building with
the Sea**

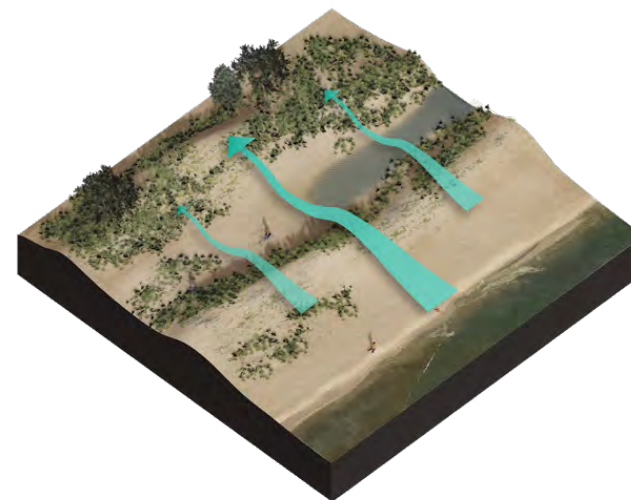
**ADAPT:
Living with
the Sea**



Floodgates



Enhanced Dune
Dynamics[^]



Non-Structural

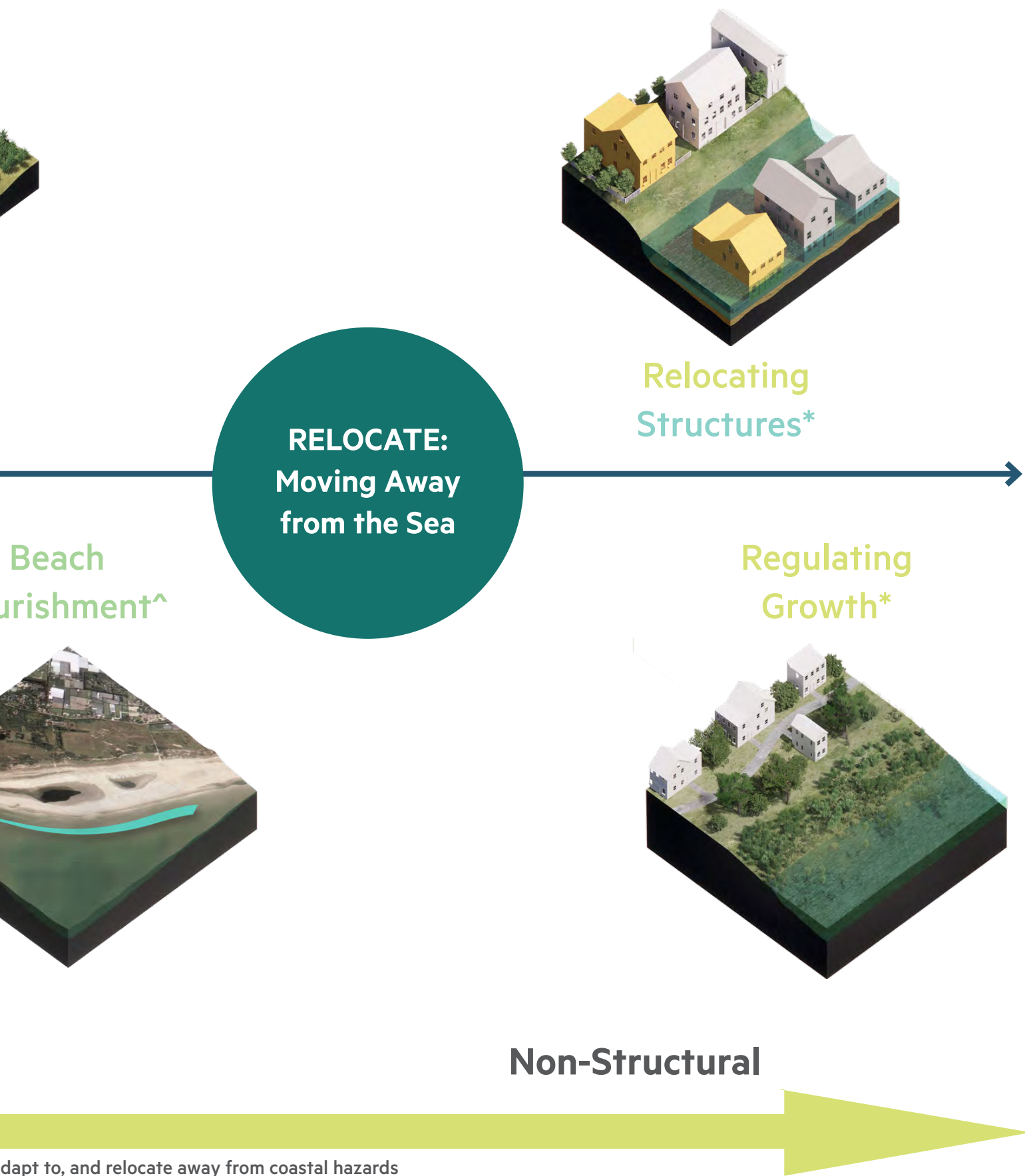


Structural

*Image courtesy ONE

[^]Image courtesy EcoShape and ONE

This diagram summarizes how different resilience tools, including structural, nature-based, and non-structural measures, can be used to help the Nantucket community protect against, a



Comprehensive, Implementable, & Adaptable Resilience Approaches and Strategies

The Resilience Toolkit provides a suite of potential resilience approaches that could be implemented across Nantucket. However, additional assessments are needed to determine where, how, and in what combination these approaches should be implemented to create a comprehensive resilience strategy.

To determine the recommended resilience strategies for Nantucket, three lenses were applied. These were:

Island-Wide Coastal Risk Framework

The Island-Wide Coastal Risk Framework is a way of breaking the island into different geographies based on the results of Nantucket’s coastal risk assessment to aid in decision-making around appropriate resilience approaches

Project Context Considerations

Project context considerations include an assessment of location-specific details that may help determine the preferred resilience strategy for a given area. This may include considerations of geography, scale, and local stakeholder preferences.

Evaluation Criteria

Evaluation criteria for the CRP help establish a consistent guide for comparing and ranking resilience strategies and were developed with input from stakeholders.

Island-Wide Coastal Risk Framework

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. As our understanding of coastal hazards and risks evolves, so too should this framework. Best available data and innovative resilience tools and approaches should be incorporated as they become available.

Using the framework, private property owners, Town officials, and other decision-makers can determine whether a particular type of resilience approach is appropriate given what we know about the relevant project area’s current and future coastal risk. For instance, shoreline in areas where there is extreme, near-term coastal risk due to the threat of flooding and erosion it is likely not appropriate to invest in large capital improvement projects. In areas mid-island where the coastal risks are lower, it may be appropriate to consider opportunities for siting new critical infrastructure. In other areas along the coast where risk is more episodic and will increase over time, it may be appropriate to promote resilient design for new and existing homes, businesses, and infrastructure. The goal of the CRP and island-wide framework is not to prevent new construction across Nantucket but rather to direct future investment to areas of the island with the lowest coastal risk.

This framework divides the island into four distinct areas based on risk, as described in the chart below.

While the framework cannot tell us what types of resilience approaches will work for specific projects, it can serve as a first lens in determining what type of approaches are generally most appropriate in each area. The Island-Wide Coastal Risk Framework serves as a guide for all of the recommendations made within this CRP. Recommended resilience strategies island-wide (Section 6) and within focus areas (Section 7) are consistent with the framework and resilience tools and approaches recommended for each risk area.

Moving forward, the Island-Wide Coastal Risk Framework should be used as a decision-making tool early in the resilience planning and design process to encourage sound future investment. This framework is applicable to any potential policy, plan, or project that may be affected by coastal hazards today or in the future and should be used to inform capital planning. Consistent use of this framework for key decisions by Town officials and private actors will allow Nantucket to be proactive in reducing risk in Priority Action Areas, limiting additional risk in High and Moderate Coastal Risk Areas, and realizing potential opportunities in Lower Coastal Risk Areas. As Nantucket makes decisions relating to risk and resilience, and our understanding of sea level rise and other climate change impacts evolves, this framework should be iteratively refined.

Decision-makers should keep in mind that Nantucket is also vulnerable to other hazards in addition to coastal flooding and erosion. Risk due to other hazards, such as extreme precipitation, drought, and heat, should be considered before implementing any policy, plan, or project on Nantucket.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards before 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.
Hazard Exposure**	Priority Action Areas include: <ul style="list-style-type: none"> Severe repetitive loss and repetitive loss properties** already impacted by flooding, and Areas likely to be exposed to a combination of: <ul style="list-style-type: none"> High-tide flooding by 2030 Erosion potential by 2030 Assuming up to 1.2 feet of sea level rise by 2030 	High Coastal Risk Areas are likely to be exposed to a combination of: <ul style="list-style-type: none"> High-tide flooding by 2050 Erosion potential by 2050 Assuming up to 2.5 feet of sea level rise by 2050 	Moderate Coastal Risk Areas are likely to be exposed to a combination of: <ul style="list-style-type: none"> 1% annual chance flood event by 2070 Erosion potential by 2100 Assuming up to 7.9 feet of sea level rise by 2100 	Lower Coastal Risk Areas are likely NOT EXPOSED to: <ul style="list-style-type: none"> 1% annual chance flood event by 2070 Erosion by 2100 Assuming up to 7.9 feet of sea level rise by 2100
Applicable Resilience Tool Categories	Non-structural	Nature-Based Non-Structural Structural	Nature-Based Non-Structural Structural	Nature-Based Non-Structural Structural
Recommended Near-Term Resilience Approaches	Strategic retreat and relocation Reduce existing density Risk management through building-scale and nature-based approaches in the event that timely retreat is not possible	Strategic retreat and relocation Limit future density Manage growth and capital investment Adapt to live with water and/or erosion using structural and nature-based approaches	Adapt to live with water and/or erosion Protect against flooding and/or erosion Monitor change in risk	Monitor change in risk Comprehensive land-use and capital planning

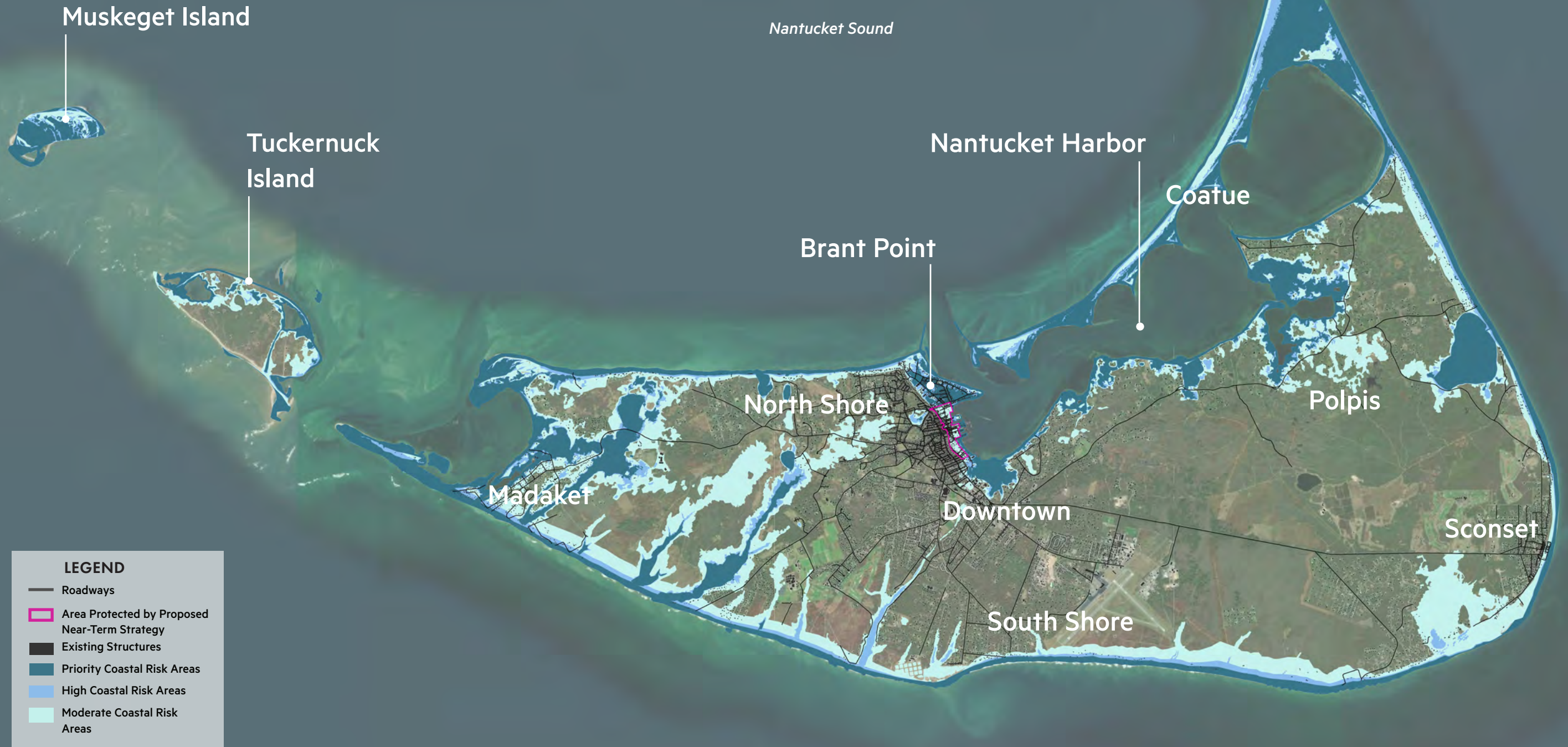
*All tiers were developed based on the most recent, best available coastal flood hazard data as described in Section 4 (pages 54-71). As our understanding of future coastal hazards and risk evolves, this framework should be iteratively refined to incorporate the best available data and most appropriate resilience tools and approaches.

^Extreme, High, Moderate, and Lower coastal risk areas may also be exposed to lower probability, higher consequence coastal hazard events. Though these events are less likely to happen, if they were to happen the impacts to Nantucket would be severe. This highlights the importance of proactive risk reduction across the island as resources allow.

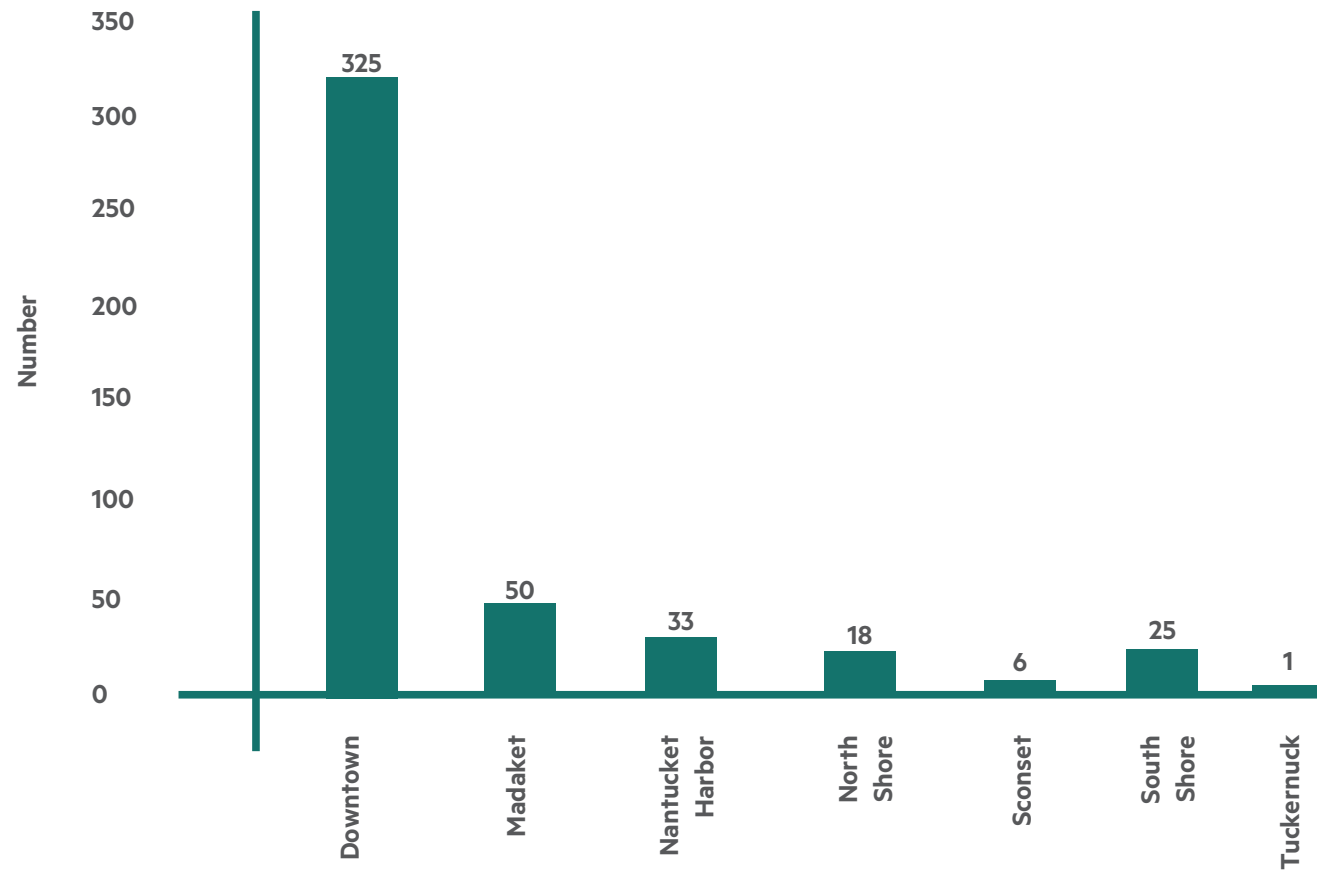
** Severe Repetitive Loss and Repetitive Loss properties are designated by FEMA. See the National Flood Insurance Program Flood Insurance Manual for definitions.

Island-Wide Coastal Risk Framework

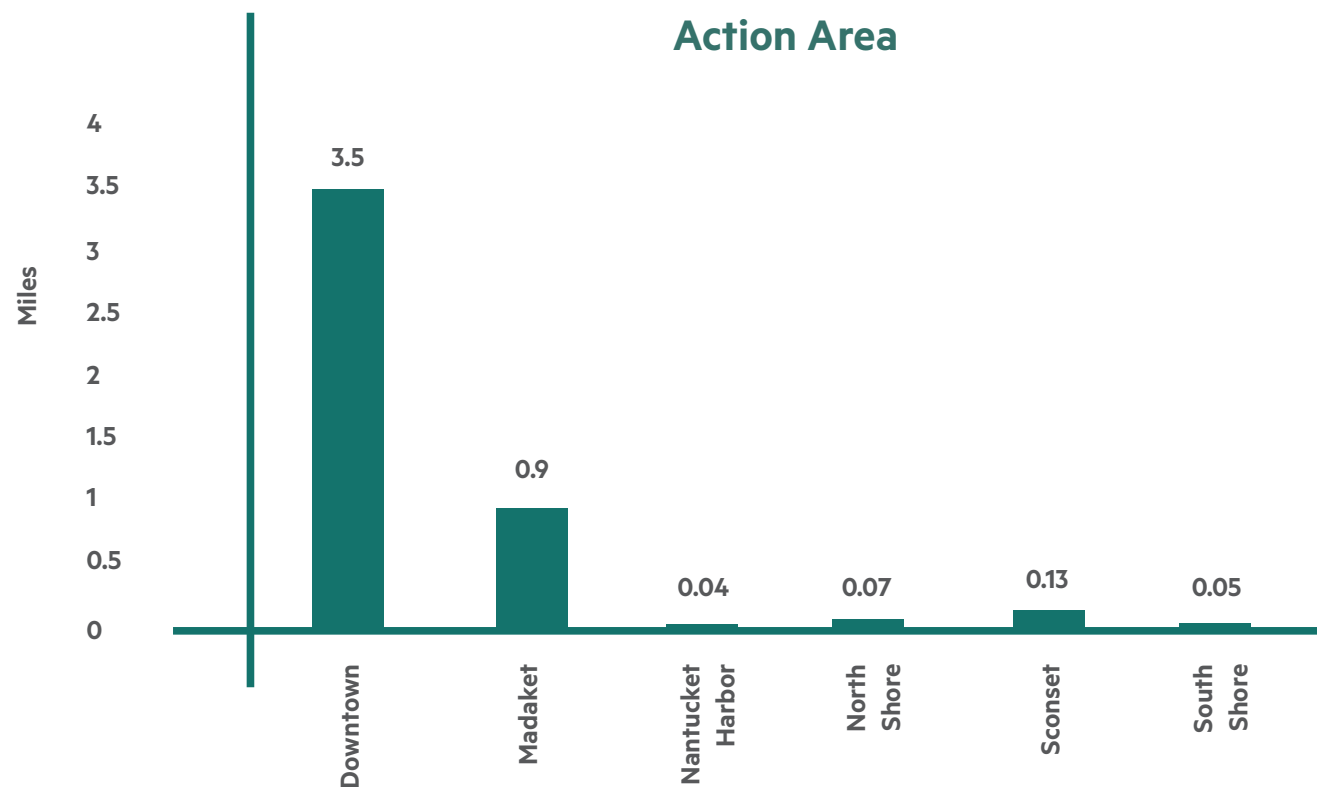
This map shows the geographies identified in the coastal risk framework. See the table to the left for more information about how these areas are defined.



Structures within Priority Action Area



Miles of Public Roadway within Priority Action Area



The table and charts on this page provide summary data on coastal risk exposure in different areas identified through the Island-Wide Coastal Risk Framework

Island-Wide Exposure by Risk Area			
Risk Area	Structures Exposed (#) [^]	Historic Structures (%) ^{**}	Public Roadways Exposed (miles) [~]
Priority Action Area of Extreme Coastal Risk	458	74	4.7
High Coastal Risk Area	801	66	7.8
Moderate Coastal Risk Area	2,236	55	24.4
Lower Coastal Risk Area	10,887	23	91

^{*}Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

^{**}Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

Project Context Considerations

After determining the appropriate resilience approaches using the Island-Wide Coastal Risk Framework and developing a proposed resilience strategy for a geography or project, an evaluation of context-specific considerations is conducted. Evaluating context considerations incorporates expert judgement and community priorities to ensure that resilience strategies proposed are plausible from a technical and political standpoint. During this phase of the evaluation, the project team had iterative conversations with stakeholders and subject matter experts to answer questions such as:

- *Is the proposed resilience strategy technically plausible?*
- *Does the proposed resilience strategy make sense given the scale of the problem?*
- *Could the proposed resilience strategy be effective at reducing coastal risk in this area?*
- *Does the proposed resilience strategy address the priority community concerns for this geography?*
- *Could the proposed resilience strategy be supported by applicable stakeholders?*
- *Are there any additional considerations the proposed resilience strategy should integrate?*
- *Could the proposed resilience strategy be enhanced to include additional community co-benefits?*

Evaluation Criteria

Once the proposed resilience strategies are determined to be technically possible and have preliminary community support, evaluation criteria are used to help establish a consistent guide for comparing and ranking the proposed strategies. The evaluation criteria for the CRP were developed with input from stakeholders. They also build on criteria developed for other efforts such as the Hazard Mitigation Plan, including the STAPLEE (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) evaluation method adopted by FEMA for assessing project feasibility. Community members provided feedback on the categories most important to them at Open House 2. Participants chose effectiveness as the most important category, followed by feasibility, ecological and public health benefits, equity and quality of life, and value creation.

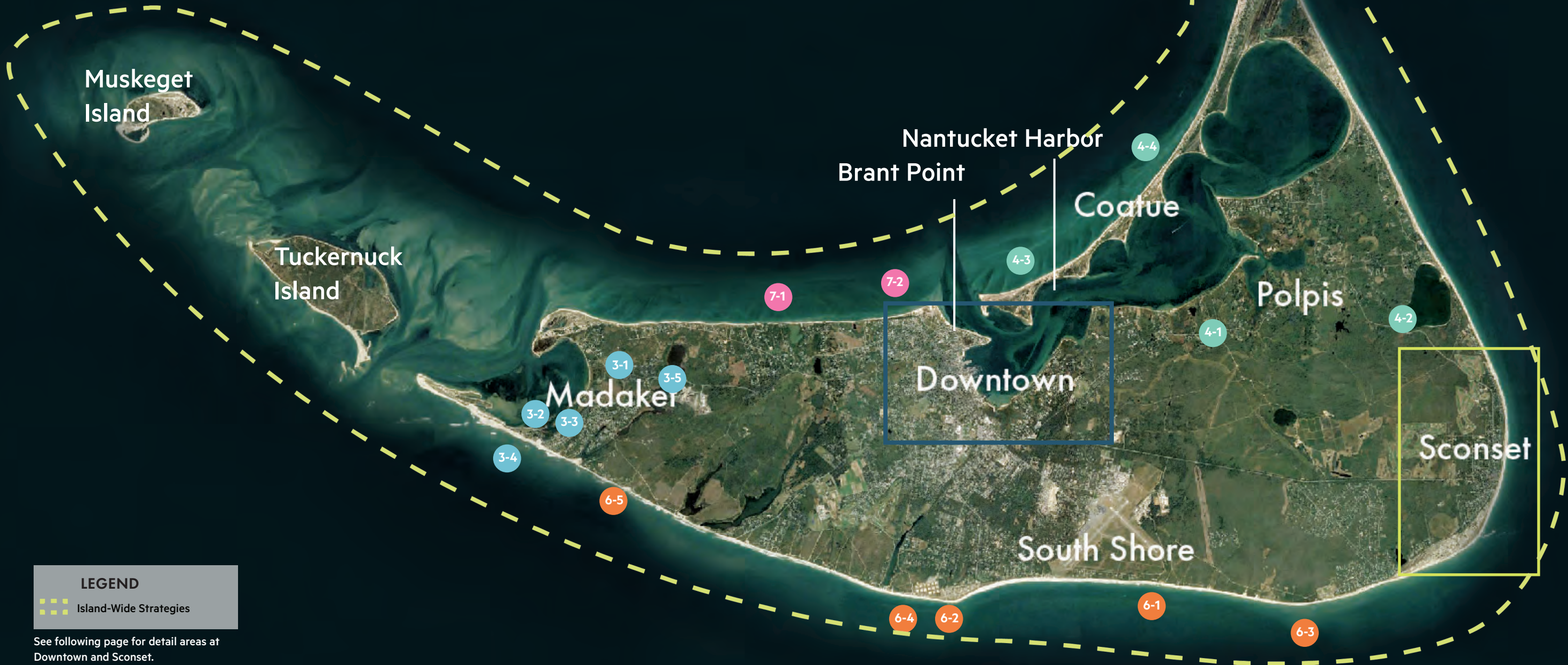
Each strategic opportunity presented in Section 7 includes a summary of its performance across these criteria.

CATEGORY	CRITERIA
 <p>EFFECTIVENESS & ADAPTABILITY</p> <p>Does the resilience strategy reduce coastal risks to homes, businesses, critical facilities, and infrastructure over the intended horizon of protection and can the strategy be adapted to future risks?</p>	<p>Reduction in flood or erosion impacts Reduction in risk for residents Passivity Protection of critical assets Horizon of flood risk reduction (today, 2030, 2050, 2070, 2100) Average design life Adaptability and flexibility</p>
 <p>IMPLEMENTATION FEASIBILITY</p> <p>Can the resilience strategy be implemented given technical, regulatory, funding, community support, and operations and maintenance considerations?</p>	<p>Community Perspectives Constructability Permitting requirements and regulatory considerations Replicable Funding Time to implementation Operation and maintenance Consistent with design standards</p>
 <p>ECOLOGICAL & PUBLIC HEALTH</p> <p>How does the resilience strategy affect the health of natural and human communities over time?</p>	<p>Water and air quality benefits Habitat creation and protection Public health benefits Alignment with natural systems</p>
 <p>EQUITY & QUALITY OF LIFE</p> <p>Does the resilience strategy help improve community wellbeing and protect community heritage and assets?</p>	<p>Recreational benefits Protection of local historic and cultural assets Education and community development Protection of community places (affordable housing, community centers, etc) Community partnerships</p>
 <p>VALUE CREATION</p> <p>What potential for new opportunities and economic value does the resilience solution generate for the community?</p>	<p>Impact on public realm Catalyze funding and investment Impact on tourism industry Impact on local tax revenues Impact on property values</p>

Strategies and Projects



Island-Wide Strategies



LEGEND
Island-Wide Strategies

See following page for detail areas at Downtown and Sconset.

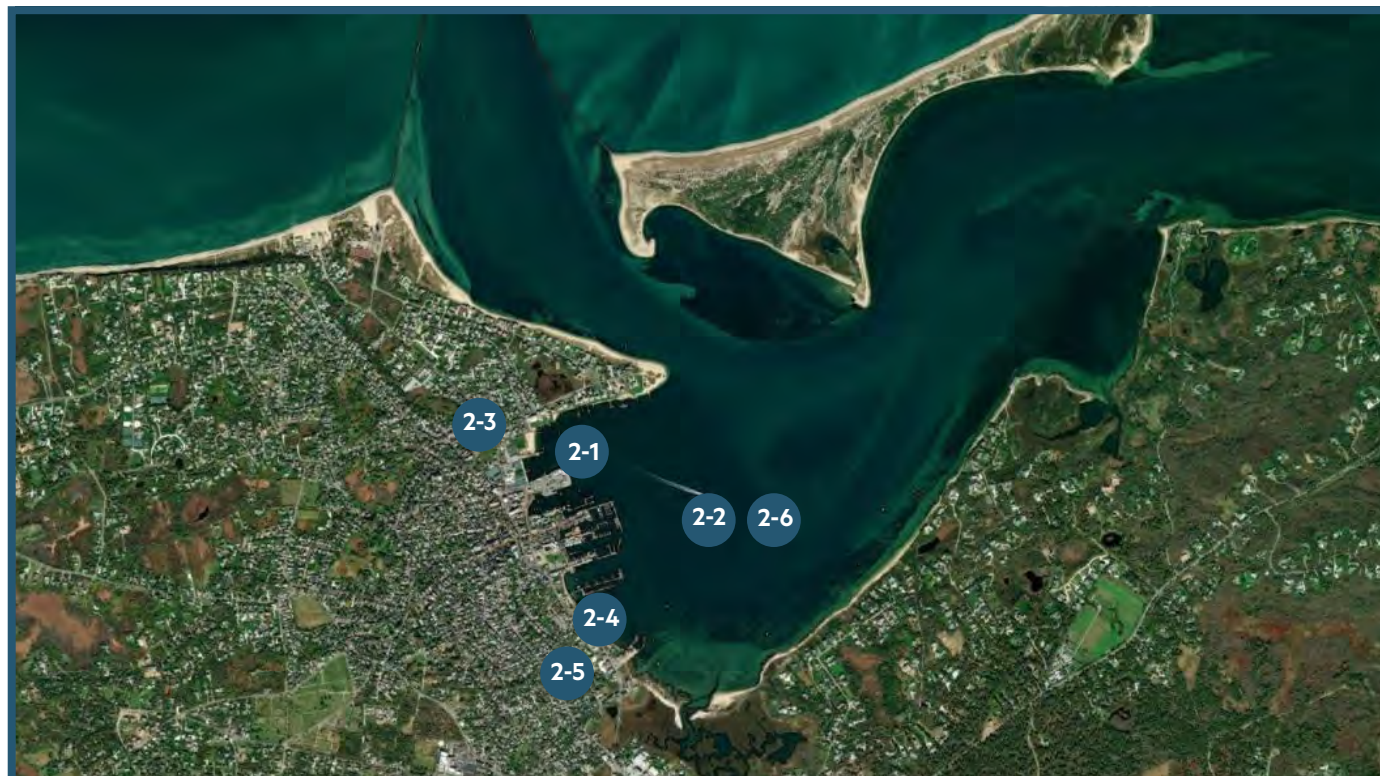
Summary of Recommendations

After applying the Island-Wide Coastal Risk Framework, discussing context considerations with community members during engagement event, consulting engineering and subject matter experts, and ranking potential resilience strategies based on the evaluation criteria, the Project Team—composed of the Town of Nantucket and an interdisciplinary team of consultants—developed 40 recommended strategic resilience opportunities for Nantucket. These recommendations are detailed in Sections 6 and 7 of the report. Taken together these recommendations propose an island-wide approach for reducing coastal risk and building resilience across Nantucket. Other recommendations may be considered as new information is obtained based on additional analysis, community and stakeholder input, and changing conditions.

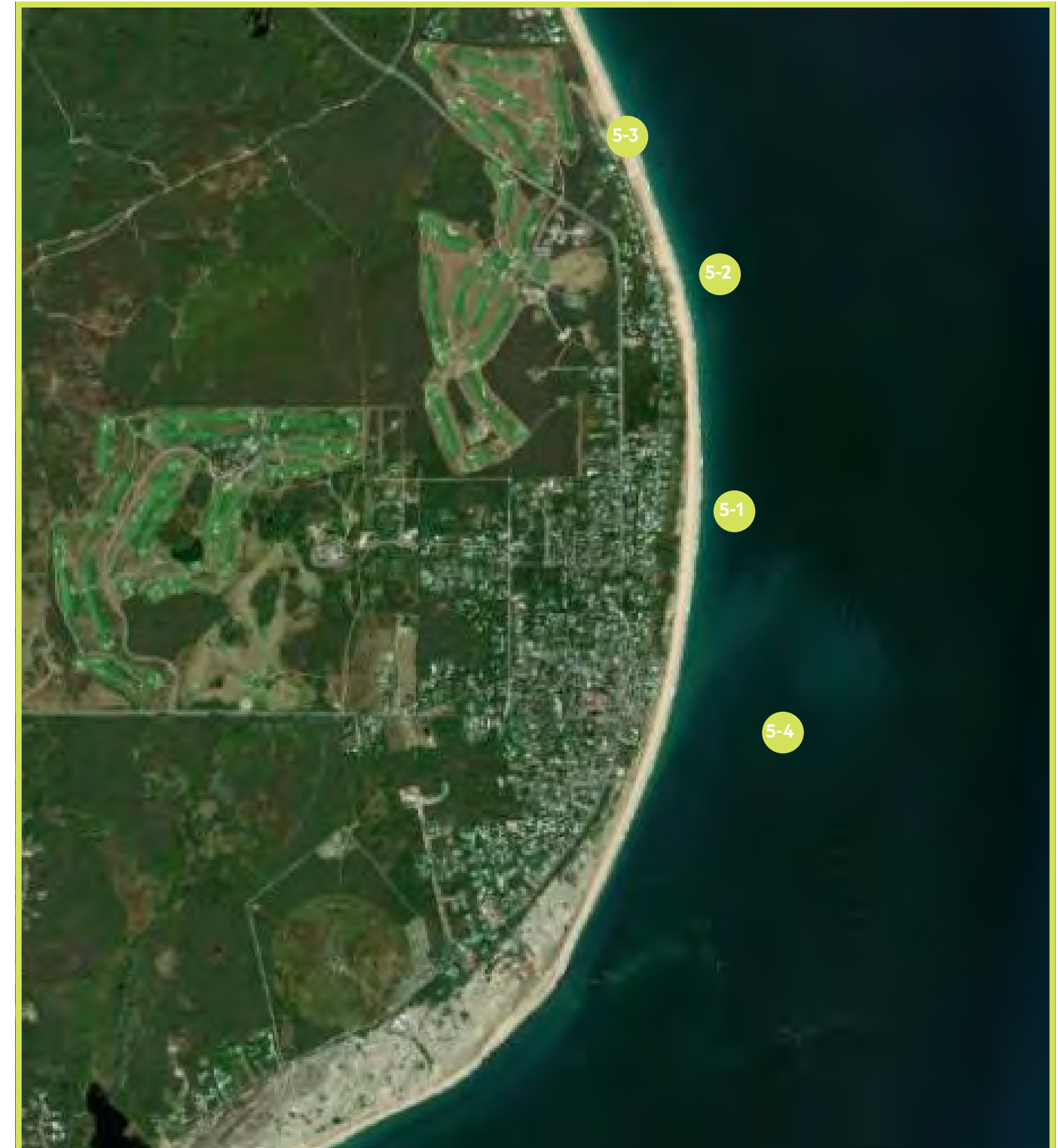
The maps on this page show the location of the 40 recommended strategic resilience opportunities. The numbers in each circle correspond to a project listed and summarized on the next two pages.

Section 6 details recommendations that may apply island-wide, including on Tuckernuck and Muskeget Islands, while Section 7 describes recommendations for specific near-term strategies and projects within focus areas across the island. Often, the island-wide recommendations complement and support the long-term success and adaptation of the near-term, project-based focus area recommendations. Island-wide recommendations are also the primary means of building coastal resilience in areas not specifically addressed by the focus area recommendations. Section 8 identifies how these recommendations can be prioritized and implemented in the near-term.

Enlargement- Downtown



Enlargement- Sconset



ISLAND-WIDE RESILIENCE STRATEGIES

Title	Strategy or Project Description
Updates to Zoning By-Law	Updates to the Nantucket zoning by-law to encourage resilient design and limit growth, as appropriate, in high and priority risk areas
Updates to Wetland Ordinance and Regulations	Updates to the Nantucket wetlands by-law and regulations to encourage resilient and low impact design in resource adjacent areas while limiting impacts on resource areas
Strategic Retreat and Relocation Program	Develop and administer island-wide approach for pursuing strategic retreat and relocation in areas of priority coastal risks with an early focus on risk communication and property owner outreach and education
Coastal Resilience and Sustainability Interdepartmental Working Group	Governance approach to encourage inter-departmental collaboration and coordination on issues related to coastal resilience and sustainability
Joint Staff Review of Development Proposals	Governance approach to maximize opportunities for coordinated decision-making and consistent customer communication by Town staff, particularly for projects located in or impacting coastal areas
Coastal Resilience and Sustainability Program	Governance approach to establish a formal program with necessary resources for managing coastal resilience and sustainability projects and programs across the island
Shoreline Change Monitoring Program	Employ mobile technology and other tools to engage community members in the process of monitoring shoreline change at pilot projects and across the island
Sediment Sourcing and Transport Study	Island-wide data collection and planning approach to identify sediment sources and define sediment movement across the island at various spatial and temporal scales in order to inform the design and planning of future sediment management projects.
Stormwater Management Plan	Planning step to evaluate stormwater management issues across the island and identify recommendations for reducing stormwater flooding and improving water quality
Sediment Budget	Planning step to develop an operational sand budget for recommended shoreline projects
Stormwater By-Law Assessment	Planning step to conduct an assessment of existing by-laws for opportunities to encourage stormwater management best management practices (BMPs)
Stormwater By-Law and Regulations Proposals	Updates to stormwater management by-law and regulations to encourage best management practices (BMPs) that address water quality and quantity issues
Update locally-adopted sea level rise scenarios and Best Available Flood Hazard Data	Adopt sea level rise scenarios provide by the Commonwealth of Massachusetts and Massachusetts Coastal Flood Risk Model as the best available local flood hazard data
Community Outreach on Property Owner Resilience Best Practices	Comprehensive outreach program to at-risk home and business owners to raise risk awareness and provide guidance on best practices for reducing coastal risks for private properties.

AREA-SPECIFIC PROJECTS & OPPORTUNITIES

DOWNTOWN

ID	Title	Strategy or Project Description
2-1	Steamboat Wharf Resilience	Work with the Steamship Authority to develop adaptation plan for Steamboat Wharf with the preferred option of elevating the pier above future mean monthly high water. Building scale measures can be implemented on the wharf over time to reduce risk from coastal storms. The strategy should be integrated with the design of the Downtown Coastal Flood Barrier System (Strategy 2-2) to maintain access from Broad Street onto the Wharf. Final approach will need to be planned and design by the Steamship Authority but close coordination with Town resilience planning will be critical to a successful resilience strategy.
2-2	Downtown Neighborhood Flood Barrier - Later Project Phases	The barrier system, which includes the first phase project described as Strategy 2-6, includes a number of elements to be implemented over time to provide comprehensive effective flood risk reduction against future mean monthly high water. The elements include raised roadways, raised bulkheads, reinforced dunes, and flood walls. The overall approach recommends passive measures that are integrated with the existing built environment, while maintaining access to key waterside facilities such the Children's Beach Boat Ramp, Steamboat Wharf, Straight Wharf, and the Town Pier. Implementation of the approach can be phased over a period of 10 to 15 years, focusing on the lowest lying areas first, such as Easy Street (Strategy 2-6). As the project is implemented, stormwater management needs will need to be studied and addressed via new drainage infrastructure.
2-3	Easton Street and Hulbert Avenue Road Raising	Road raising project to prolong service life of Easton Street and Hulbert Avenue for emergency and everyday access in Brant Point.
2-4	Washington Street Extension and Consue Springs Walkway Raising	Road raising to prolong service life of Washington Street Extension and public access in Consue Springs and the Creeks.
2-5	Building Scale Resilience at 37 Washington Street	Pilot project to showcase building-scale resilience best practices on a Town-owned facility, including potentially elevation of critical systems, protection of sensitive equipment and documents, and deployable flood risk reduction measures. The first step in this recommendation is a site-specific study to determine the appropriate risk mitigation approaches for this structure.
2-6	Downtown Neighborhood Flood Barrier - Phase 1 Project	Phase 1 project to advance through feasibility and design a near-term project focused on the most vulnerable location along the planned extent of the Downtown Neighborhood Flood Barrier. The Phase 1 project should focus on the coastal segment located along Easy Street from Straight Wharf to Steamboat Wharf and may include raised bulkheads, sidewalks, and roadways.

Check out the information here and the map on the previous page for more information and the locations of area-specific projects!

MADAKET

ID	Title	Strategy or Project Description
3-1	Madaket Road Raising and Bridge Conversion	Road raising and bridge conversion to provide access and restoration.
3-2	Ames Avenue Bridge Resilience	Maintain bridge structure from coastal erosion (see project details) existing Ames Avenue if necessary.
3-3	F Street Boat Ramp	Prolong service life of the boat ramp on F Street. Consider loss of service.
3-4	Madaket Erosion Management Pilot and Ames Avenue Bridge Protection	Dune restoration and Ames Avenue intertidal dune construction as needed and maintenance of the design.
3-5	Department of Public Works Facility and Landfill Resilience	Building scale measures to reduce risk at the facility and site-specific approaches.



NANTUCKET HARBOR & COATUE

ID	Title	Strategy or Project Description
4-1	Polpis Road Raising and Bridge Conversion at Folger's Marsh	Road raising project with conversion of existing culverts with bridges, with goal of prolonging service life of Polpis Road, while advancing ecological restoration objectives for Folger's Marsh.
4-2	Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond	Road raising, expansion of culverts or replacement with bridge, and installation of living breakwaters to reduce wave exposure, with goal of prolonging service life and maintaining emergency roadway access along Polpis Road, while advancing ecological restoration objectives for Sesachacha Pond.
4-3	Coatue Erosion Management and Dune Resilience	Dune restoration and wetland creation/enhancement to reinforce narrow low-lying sections of barrier island, between Five Fingered Point and Bass Point and between First Point and Second Point, to prevent washover and/or breaching into the harbor. Monitor performance of approach to assess need for ongoing nourishment and/or adaptation to higher design elevations.
4-4	Numerical Modeling Study of Coatue Breaching	Numerical modeling study to evaluate the likelihood and consequences of Coatue breaching for the Harbor and surrounding communities, including impacts to habitat and navigation, in order to inform decisions about future adaption measures on Coatue.

SCONSET

ID	Title	Strategy or Project Description
5-1	Sconset Bluff Dune Restoration	Dune restoration and construction to mitigate bluff erosion and increase resiliency. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.
5-2	Codfish Park Dune Restoration	Dune restoration and construction to manage and slow bluff erosion. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.
5-3	Baxter Road Relocation Planning	Planning for and implementation of road relocation, including acquisition of easements, access and maintenance agreements, finalization of road alignment, and development of final designs for construction.
5-4	Sconset Bluff Nearshore Breakwaters Feasibility Study	Conduct detailed feasibility study to assess technical constraints, potential impacts, and benefits and costs of nearshore breakwaters along the Sconset Bluff.

SOUTH SHORE

ID	Title	Strategy or Project Description
6-1	Nantucket Memorial Airport Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm.
6-2	Surfside Wastewater Treatment Facility Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm. Strategic relocation alternatives for settling tanks closest to the coast at the wastewater treatment facility should be pursued in parallel.
6-3	Tom Nevers Field Erosion Management Pilot Project	Pilot program of dune restoration, sand fencing, and beach nourishment. Monitoring program to evaluate how well the pilot project performs to inform future investment in Tom Nevers Park, as well as erosion management elsewhere on the island.
6-4	Surfside Emergency Access Planning	Develop emergency access and service plan for Surfside Neighborhood to ensure access to coastal areas in event of loss of service along Nonantum and Nobadeer Avenues, particularly near Lovers Lane.
6-5	Sheep Pond Road Relocation Study	Planning step to work with property owners and Nantucket Conservation Foundation to develop and implement plan for relocation of public infrastructure on Sheep Pond Road.

NORTH SHORE JETTIES TO EEL POINT

ID	Title	Strategy or Project Description
7-1	North Shore Dune Restoration and Nourishment	Targeted dune restoration and construction to reduce risk of erosion along the North Shore, building on dune restoration strategies adopted by existing private property owners in area. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm at key locations.
7-2	Sand Pumping Feasibility Study	Study the feasibility and impacts of a sand pumping and bypass systems to connect sand sources from inlet to the North Shore.



Flooding Downtown (photo by Trevor Johnson)



SECTION 06: ISLAND-WIDE STRATEGIC RESILIENCE OPPORTUNITIES

This section describes strategic opportunities for coastal resilience on Nantucket that apply island wide, including recommended changes to regulations and by-laws, changes to Town processes and governance, erosion and stormwater management approaches that can be pursued across Nantucket, and necessary studies and data collection steps.

Introduction

Nantucket requires a holistic and layered approach to managing coastal risk, which includes a wide range of island-wide resilience strategies that are necessary to support and complement site-specific design strategies. Pursuing a layered approach to coastal resilience creates important redundancies that will help reduce risks even if parts of the overall system fail.

Drawing on the island-wide coastal resilience framework described in Section 5, this section describes strategic opportunities for coastal resilience on Nantucket that apply island-wide. These include recommended changes to regulations and by-laws, changes to Town processes and governance, and general erosion and stormwater management approaches and data collection needs. Section 7 builds on these island-wide recommendations with detailed location-specific recommendations across the island, as well as recommended best practices for property owners to build resilience on private properties.

Island-Wide Resilience Strategies

Island-wide resilience strategies are strategic opportunities for coastal resilience on Nantucket that may apply across the entire island. These strategies include a collection of resilience approaches that work together to address multi-faceted resilience issues and can be applied in multiple geographies, including areas not specifically addressed through focus area strategies in Section 7. This includes areas of the county where specific infrastructure strategies are not planned at this time but where coastal resilience can be advanced by implementing recommended island-wide approaches, such as on Tuckernuck and Muskeget Islands and on Great Point.

Strategies detailed in this section serve as the backbone for the near-term strategic opportunities recommended for each focus area in Section 7 and include:

- Governance and policy changes necessary to support focus area-specific projects
- Additional studies and planning opportunities necessary to support focus area-specific projects
- Approaches to help facilitate the implementation of structural and nature-based projects
- Strategies that complement site-specific designs with zoning changes and other resilience approaches to holistically build resilience across the island
- Opportunities to build resilience in areas of the island where specific infrastructure strategies are not currently planned

Together these island-wide strategies form the basis for both the focus area strategic opportunities described in Section 7 and Nantucket's long-term resilience.

Key Terms for Understanding CRP Recommendations

Focus Areas

Focus areas for this plan were developed through the identification of project goals and priorities, assessment of coastal risks, and community feedback. Focus areas are defined geographies located throughout the island that are already experiencing coastal flooding or erosion, face heightened coastal risks in the future, are home to critical infrastructure, are areas of historic or cultural importance, or are otherwise a community priority for resilience building. Focus areas identified for this CRP include Downtown/Brant Point, Sconset, Madaket, South Shore, Polpis/Nantucket Harbor/Coatue, and Jetties to Eel Point. Within each focus area, implementable, near-term strategic opportunities have been developed and are described in Section 7.

Near-Term Strategic Opportunities

Strategic opportunities are design, engineering, and nature-based approaches, as well as pilot projects and focused planning studies, that present near-term opportunities to reduce coastal risk and build community resilience. They are projects that can begin to be implemented in the next 5-10 years and completed within the next 10-15 years as the first step in a long-term adaptation process. Each strategic opportunity is presented with details on the design concept, resilience issues it addresses, evaluation of benefits, design standards, estimated costs, and implementation process. Maintaining the integrity of Nantucket as a nationally designated historic landmark is a priority across the near-term strategic opportunities. In some areas, strategic opportunities emphasize emergency access and ecological restoration, while managing land use and development in risk-prone areas. In other areas, designs optimize limited space available for flood protection infrastructure to reduce risk to essential facilities and economic centers. All strategic opportunities complement island-wide regulatory and property-scale layers of resilience, providing redundancy in the system to protect against potential damages from failure in any one element.

Long-Term Adaptation Pathways

Adaptation pathways are long-term opportunities for adapting strategic opportunity projects to increased sea level rise over time. Multiple pathways are often available for a given geography or project based on what conditions are observed and forecast, and how our understanding of, or tolerance for, risk changes.

Regulatory and Governance Strategies

Coastal resilience strategies must follow Town, State, and Federal regulations and policies. Many environmental regulations were implemented decades ago to protect important natural resources or to implement comprehensive planning goals. They do not always consider the need for design interventions or policy approaches to promote coastal resilience, or the consequences of climate change, warming oceans, sea level rise, or pollution caused by flooding. As our understanding of sea level rise evolves, we have an opportunity to update regulations to include resilience at all scales of development, from individual buildings to neighborhoods, while maintaining the original mission of these regulations. Coastal resilience and environmental protection are not mutually exclusive goals, and the Nantucket community can work together with local policymakers and state officials to make and suggest updates to existing regulations that can enhance resilience and community wellbeing. Updates to Town regulatory mechanisms, planning policies, and processes, in particular, can allow for more efficient implementation of the Nantucket CRP.



Nantucket Wetlands (Photo by Chris Reed)

KEY CONSIDERATIONS FOR NEW OR REVISED LOCAL BY-LAWS & REGULATIONS

- Any new or revised by-laws and regulations must be legal under State and Federal law and be approved by the State Attorney General
- Ongoing community engagement focused on potential changes to Town policies, by-laws, and regulations is crucial to generating collective understanding and support for any proposed changes
- Nantucket Town Meeting will need to pass new or revised by-laws
- New or revised by-laws and regulations must seek to minimize administrative burden or come with additional resources and capacity for administration and enforcement
- New or revised by-laws and regulations must be enforceable by Town

Zoning and Land Use Regulations

Nantucket's zoning by-law (Chapter 139) controls the location, size, and use of buildings and other structures by organizing the island into districts outlining specific regulations and design standards within those districts. Nantucket's current zoning maintains the island's low-density residential character along much of its coastline. Existing zoning regulations ensure that future development is consistent with this low-density character by limiting most uses to residential (including primary, secondary, accessory, and tertiary dwellings) across much of the island, with the exception of Downtown and Mid-Island where higher density residential, commercial, and mixed-use structures are permitted. Much of the island is conserved as permanently protected open space, which can never be developed regardless of the applicable zoning district. Local wetland regulations further limit the potential for development along the coastline, as discussed in more detail later in this section. Design review processes and Historic District Commission requirements also shape the appearance and location of development across the island.

To help advance long-term coastal resilience on Nantucket, additional provisions can be considered for incorporation into the zoning by-law. The goals of these changes are to 1) shape land-use and development regulations that reduce barriers for home- and business-owners implementing resilience measures on private properties in coastal hazard areas and 2) limit the potential for future densification in areas that are at extreme coastal risk, unsafe for human occupation, or not suited for future infrastructure investment. The changes are presented separately here based on the coastal risk zones to which they apply. The coastal risk areas are defined in Section 5 as part of the Island-Wide Resilience Framework.

Current Regulations and Opportunities

The Flood Hazard Overlay District (FHOD) of the Town's zoning by-law embodies the National Flood Insurance Program (NFIP) flood damage prevention standards. The FHOD applies to all areas that correspond to FEMA's Special Flood Hazard Areas delineated on Nantucket County's Flood Insurance Rate Maps. The Special Flood Hazard Areas are identified using historic flood information and modeling, and do not consider predicted climate changes such as sea level rise and more frequent and intense storm events. The Flood Resistant Design and Construction provisions of the Massachusetts Building Code also reference FEMA's Special Flood Hazard Areas.

Until higher standards and dynamic flood risk are incorporated into the Massachusetts Building Code, Nantucket can enforce more stringent floodplain management regulations and standards through the land use and dimensional requirements in the zoning code, through conditional use requirements for development in the floodplain, and through the Planning Department and Planning Board's review processes. With the release of FEMA's Risk Rating 2.0 in late 2021, NFIP premium rates will be revised to more accurately reflect risk and buildings erected to higher standards are likely to qualify for lower rates under this structure. While the process of implementing changes to local by-laws and regulations can be politically complex, policy changes have overall lower costs and greater resilience benefits over time compared to most structural solutions. The actions in this section are listed in terms of complexity of implementation from technical, administrative, and political perspectives.

All changes are recommended approaches for advancing coastal resilience on Nantucket, but each will need to be discussed as part of a public process through the Nantucket Planning Board and Planning & Economic Development Commission prior to the development and adoption of by-law revisions.

Zoning Recommendations For Areas of Moderate Coastal Hazard

Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas, approaches to adapt or protect against flooding are appropriate. Changes in coastal risk should be monitored and decisions made accordingly. Section 5 includes more information on considerations related to Moderate Coastal Risk Areas.

Minimum Changes

Nantucket should adopt the provisions included in the Massachusetts 2020 model floodplain by-law in order to continue participation in the National Flood Insurance Program (NFIP). This model by-law includes mandatory updates to the current Flood Hazard Overlay District (FHOD) in Nantucket's zoning by-law.



The Commonwealth has issued guidance and FAQs on the model floodplain by-law and State staff are available to help support local communities in the process of updating their by-law.

For more information, visit mass.gov/guides/floodplain-management

Incorporate a requirement that project proponents subject to Town approvals must demonstrate how their building and site plan will manage a 1% annual chance flood elevation including wave action with 4.3 feet of sea level rise (expected by 2070) or 7.9 feet of sea level rise (expected by 2100) depending on the type and anticipated life of the structure. This approach has been used successfully in other communities to encourage private developers to build to higher standards when not required to under Building Code. This strategy can be paired with incentives for building to a higher standard of resilience, such as reduced permitting fees, expedited permit reviews, and relaxed height restrictions. For historic properties, special exceptions may be necessary due to limitations on the degree to which properties in local historic districts may be elevated. Designs for historic properties should comply with the guidance provided in Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines.



The Commonwealth's Resilient MA Action Team has developed a digital Climate Resilience Design Standards Tool that includes a methodology for screening proposed projects for climate risks and recommended climate resilience design standards. The Town of Nantucket may consider requiring that new development utilize this screening tool to inform climate resilient design decisions.

For more information, visit resilientma.org/rmat_home/designstandards/

Additional Changes In addition to the minimum recommended changes, coastal risk management can also be advanced through the zoning by-law and permitting process by:

Excluding necessary flood protection elements, required access to elevated buildings, structures for elevated mechanicals, and other resilience measures, from gross floor area and lot coverage calculations

Changing the definition of building height to exclude uninhabited space used for flood risk mitigation, such as wet floodproofing



Disallowing or imposing Special Permit restrictions on essential/critical Facilities and high-risk structures, such as hospitals, schools, assisted living facilities, and Town administrative offices in areas subject to the 1% annual chance flood with 4.3 feet of sea level rise (expected by 2070) or 7.9 feet of sea level rise (expected by 2100) depending on the type and anticipated life of the structure

More Complex Changes for Moderate Coastal Risk Areas



Establish recommended Design Flood Elevations (DFE) based on a selected sea level rise increment, such as 4.3 feet (expected by 2070) or 7.9 feet of sea level rise (expected by 2100), above the minimum elevations required by Massachusetts Building Code. The DFE would represent the new minimum for lowest occupiable floor and critical systems for residential uses or flood proofing for non-residential structures. The DFE should be based on the higher elevation dictated by FEMA, Massachusetts Building Code, or MC-FRM. Additional freeboard, as described in Section 4, should be added to the selected DFE based on the criticality of the proposed structure. For historic properties, special exceptions may be necessary due to limitation on the degree to which properties in local historic districts may be elevated. Designs for historic properties should comply with the guidance provided in Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines.



Expand the Nantucket Flood Hazard Overlay District to an inland geography that incorporates the future floodplain including sea level rise. All changes recommended for moderate coastal risk areas would apply in this expanded district geography. The extent of the future-looking Flood Hazard Overlay District can be defined in one of two ways:

1

Adoption of local “Best Available Flood Hazard Data” that includes mapping of future floodplains and flood elevations based on sea level rise projections. These data can be provided by the MC-FRM but would need to be formally adopted by Town policy and be made publicly accessible to project proponents. Town staff may need training and other resources to administer and enforce these new requirements.

2

Another option that may be easier to administer within existing Town capacity is to reference the 0.2% annual chance (500-year) floodplain on the adopted FIRMs as a proxy for future flood risk. The 0.2% annual chance floodplain extends beyond the 1% annual chance floodplain where the Flood Hazard Overlay District currently applies and would capture an area that is likely to be subject to future coastal flooding. BFEs are not provided for the 0.2% annual chance floodplain but a target elevation above grade or datum can be established as a DFE for this area.



*Relative elevations have been exaggerated for the purposes of illustration.

This diagram compares different levels of flood protection for at-risk structures. The left side of the diagram shows the level of protection currently required by Massachusetts Building Code. The right shows how additional elevation can be encouraged based on best available flood hazard data to arrive at the recommended Design Flood Elevation.

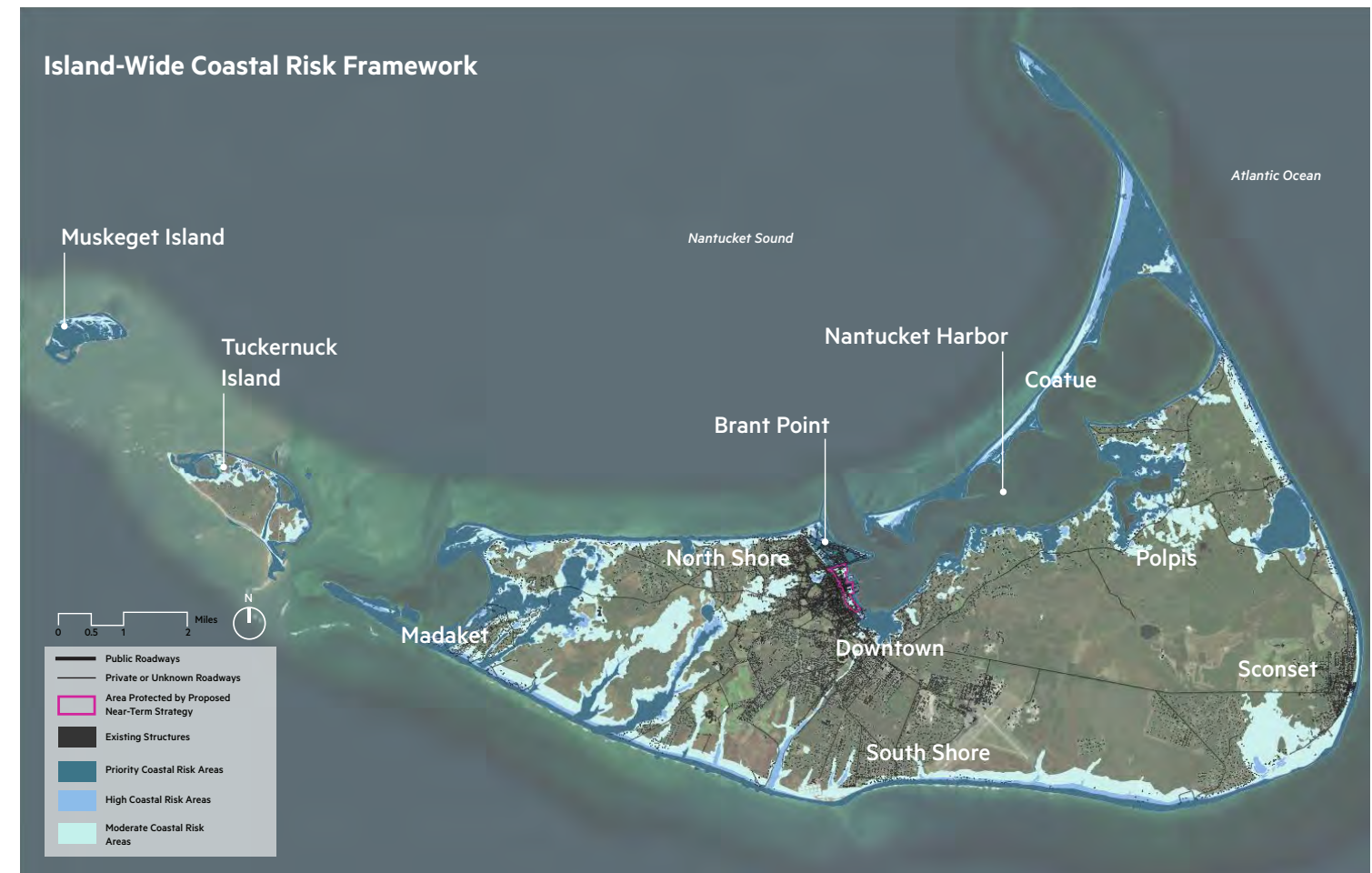
Zoning Recommendations For Priority Action and High Coastal Risk Areas

Priority Action and High Coastal Risk Areas face extreme coastal risks today or within the next three decades. Density should be proactively reduced and action should be taken to manage future investment in these areas to reduce the immediate and longer-term threat to people, property, and livelihoods. Section 5 includes more information on considerations related to Priority Action and High Coastal Risk Areas.

Minimum Changes



Where development review or approval is required, establish protocol for Planning staff and Planning Board review of development proposals within Priority Action and High Coastal Risk Areas for consistency with long-term planning goals of reduced density and development. This protocol should include sharing information with the project proponent regarding coastal risks to which they may be exposed, any applicable changes to long-term capital planning in their area, and project review that requires project proponents to demonstrate that all feasible steps have been taken to minimize risk to life and property. For new developments and substantial improvement projects in these coastal risk areas, the Planning Board should receive formal sign off and input on proposed plans from PLUS, the Town Engineer, DPW, Sewer Department, building inspector, coastal resilience coordinator, historic preservation staff, conservation agent, and other critical departments.



This map shows the coastal risk areas identified in the Island-Wide Coastal Risk Framework, including Priority Action and High Coastal Risk Areas. Additional information on these areas is provided in Section 05.

More Complex Changes for Priority Action and High Coastal Risk Areas

Additional changes can be made to the Nantucket zoning by-law to manage growth and reduce future density in areas subject to extreme and high coastal hazard. The goal of these measures is reducing the number of dwellings and people residing in areas that may be unsafe for long-term occupation and where the Town will face challenges in delivering infrastructure and services due to coastal risks. Options for recommended changes are included to the right.

There are multiple ways these limits could be implemented through the zoning by-law, including through the creation of a Special Coastal Risk Overlay District, by rezoning Priority Action and High Coastal Risk Areas to a lower-density district within the zoning by-law, by adopting new special permit requirements in these areas, or by extending the existing island perimeter restrictions inland based on a defined, rolling distance from mean high water.

The Town can also explore the designation of Districts of Critical Planning Concern. This tool has been used on Cape Cod and Martha's Vineyard to pause certain types of development in specified areas. Nantucket could use this tool to temporarily limit development in areas of high coastal risk and allow time for further land use planning.



Recommendation

- Limiting new residential uses to single-family detached dwellings, with no permitted secondary, tertiary, or accessory dwelling units
- Make all structures subject to Special Permit
- Limiting lot coverage for overall development to the greatest extent practical, ideally below 20%
- Prohibiting accessory uses that increase impervious cover including pools and other outbuildings
- Increasing minimum lot size to encourage aggregation of lots and reduce overall residential density within an area
- In coordination with local wetland regulations, require maximum practical setbacks from mean high water
- Impose reporting requirements that the property is located in an area of high coastal risk and that residential retreat is likely in the future.

Additional Resources

The Metropolitan Area Planning Council provides detailed guidance and examples for Massachusetts communities interested in advancing climate resilience through land use strategies. The resource highlights regulatory language and policy examples from MAPC's 101 communities and beyond.



Additional Considerations

Creating a new Overlay District or adopting additional provisions within the existing Flood Hazard Districts Overlay District may cause confusion for some project proponents. The Flood Hazard Districts Overlay District would remain the regulatory tool for administering NFIP requirements. If the Town pursued entrance into the Community Rating System (CRS), adopting these provisions would allow the Town to administer the NFIP floodplain management program within future flood zones and obtain CRS credits for instituting higher standards. This approach requires the justification

of the sea level rise projections and future flood inundation areas as the Best Available Flood Hazard Data. It is important to note that flood insurance requirements would still be based on the FEMA Special Flood Hazard Area to prevent property owners from overpaying premiums for future flood risk. Further, all recommended changes will require additional outreach to communities potentially impacted by the changes to generate awareness, refine recommendations based on community and developer perspectives, and build support for changes that can be adopted by Nantucket Town Meeting.

Wetlands Regulations

Nantucket's wetland ordinance and regulations protect natural areas and their buffers from encroachment and impacts. These regulations can help ensure that buildings and infrastructure are located and designed to minimize impacts to natural resources. To help advance long-term coastal resilience on Nantucket, additional provisions can be considered for incorporation into the local wetland regulations. The goals of these changes are to 1) shape land-use and development regulations that account for changes in wetland resources areas due to sea level rise and 2) reduce barriers to the implementation of coastal resilience projects that have overwhelming public benefits.

Current Regulations & Opportunities

Nantucket's local Wetlands Ordinance (Chapter 136) and Wetlands Protection Regulations govern inland and coastal wetlands to protect wetland resources, coastal banks, beaches, water quality, flood control interests, and wildlife habitats and fisheries, and provide storm damage prevention and pollution prevention. Proponents of projects within or adjacent to wetlands resource areas must submit a Notice of Intent (NOI) to the Nantucket Conservation Commission and obtain an Order of Conditions from the Commission prior to beginning work. The Town's wetlands ordinance and regulations meet and exceed the state Wetlands Protection Act regulations (310 CMR 10.00).

Climate change and sea level rise will likely cause significant changes to wetlands resources, expanding some inland wetlands and inundating coastal land. Existing regulations could prohibit implementation of fill projects meant to address more frequent tidal flooding and prevent degradation of the shoreline. The Town's current ordinance and regulations do not currently address climate change and sea level rise's impacts on natural resources as they were adopted prior to widespread understanding of the threat posed by sea level rise. Because wetlands regulations oversee construction and fill in the floodplain, many coastal resilience strategies will require an Order of Conditions. The following proposed updates to the Town's Wetland ordinance and regulations may provide additional protections for wetland resources and help expedite review and approval of the coastal resilience design strategies recommended through the CRP.

All changes are recommended approaches for advancing coastal resilience on Nantucket but each will need to be discussed as part of a public process through the Nantucket Conservation Commission and other local Boards and Commissions prior to the development and adoption of by-law and regulatory revisions.

Minimum Changes



Establish Climate Change and Coastal Resilience as an interest and purpose of Nantucket's wetland ordinance and regulations to signal to potential applicants and members of the Conservation Commission the importance of integrating climate change considerations into project proposals and designs.

More Complex Changes



Land subject to coastal storm flowage (LSCSF) boundaries and regulations (Section 2.10)

LSCSF means land subject to inundation caused by coastal storms up to and including the 1% annual chance flood event, surge of record, or storm of record, whichever is greater. The State and Town of Nantucket use the 1% annual chance flood zone delineated on FEMA's Flood Insurance Rate Maps (FIRMs) to define LSCSF resource areas, which are based on historic rather than predictive flooding. The boundaries of LSCSF will expand over time with sea level rise, but projects permitted today are not required to consider those future flood conditions.

Waiver of Requirements

Performance requirements under the Nantucket Wetland Protection Regulations empower the Conservation Commission to place limitations on projects that may adversely impact a resource area. Where impacts are proposed, the Order of Conditions would issue a requirement to minimize or mitigate those impacts, such as limiting excavation and fill. Such conditions may require relocation of structures or wholesale redesign of a project. This is appropriate in many contexts but may place restrictions that limit the Town's and private property owners' ability to implement coastal resilience projects that serve public interests, such as district-scale flood protection, road elevation, or erosion mitigation.



Recommendation

Establish new jurisdictional area including areas adjacent to Land Subject to Coastal Storm Flowage to include land subject to future coastal storm flowage (LSFCSF) with performance standards intended to minimize changes to natural floodplains, ensure resilient development, and encourage Low Impact Design. Land subject to future coastal storm flowage can be defined using the same parameters as adopted for zoning (as discussed under recommended zoning by-law changes) or reference a separate geography such as the 1% annual chance floodplain with 4.3 feet of sea level rise (expected by 2070) or 7.9 feet of sea level rise (expected by 2100). Specific performance standards can be established for developed and undeveloped resource areas in the LSFCSF. For example, projects in the developed LSFCSF resource area may have less stringent fill restrictions than in undeveloped resource areas. Another performance standard for the current LSCSF areas may require projects in the future floodplain geography to be designed with adaptive flexibility over time to prevent exacerbation of current and future flood conditions.



Recommendation

Revise the local wetland regulations to include a waiver provision in Section 1.03.F to balance potential adverse impacts with value added by the project. Waiver conditions can refer to projects that, while adversely impacting resource areas, provide "overwhelming public benefit" or where located on private property "use nature-based approaches to build coastal resilience consistent with Town plans and objectives and enhance ecosystems." Examples of overwhelming public benefit include creation of open space and other public amenities, reduced stormwater runoff, flood damage prevention, reduced shoreline erosion, remediation of existing environmental contamination and prevention of new releases of contaminants. The goal is to enable the Town and private property owners to pilot or implement solutions that advance coastal resilience and inform future strategies while limiting negative impacts to resource areas. The Conservation Commission should carefully consider the provisions of the waiver to encourage its appropriate and limited use in the advancement of projects with clear benefits that align with the goals of this CRP and resilience overall. The waiver should require sufficient technical and alternatives analyses that demonstrate the need for the project and identify opportunities for on-site mitigation through the creation of new wetland areas, rain gardens, or natural retention areas. Projects that provide on-site ecological benefits through nature-based design and materials should be given high priority for the waiver exemption.

Additional Considerations



Language for new or revised by-laws should be streamlined, containing the legal authority to adopt and enforce accompanying regulations. Technical requirements, design and performance standards, and procedural language should be housed in the regulations. This structure provides flexibility for the Town as planning priorities, technology, and the development landscape within the Town change. In addition, all recommended changes will require additional outreach to communities potentially impacted by the changes to generate awareness, refine recommendations based on community and developer perspectives, and build support for changes that can be adopted by Nantucket Town Meeting and Conservation Commission members.

Massachusetts Building Code

Current Regulations & Opportunities

The Massachusetts Building Code (780 CMR), administered by the Board of Building Regulations and Standards (BBRS) and enforced locally through Planning and Land Use Services, provides minimum standards for flood-resistant buildings within FEMA's flood zones. The 9th edition of the Building Code came into effect in 2018, which includes provisions of ASCE 24-14, Flood Resistant Design and Construction. The Building Code does not include key standards that could increase the resilience of new building such as increased freeboard requirements and does not consider future flood projections based on sea level rise. The Town is limited in its ability to impose new, more stringent requirements through the building code. The Town may join other municipalities and not-for-profit organizations in advocating at the state level for more stringent building codes that include requirements intended to mitigate risk to buildings from future flood risks.



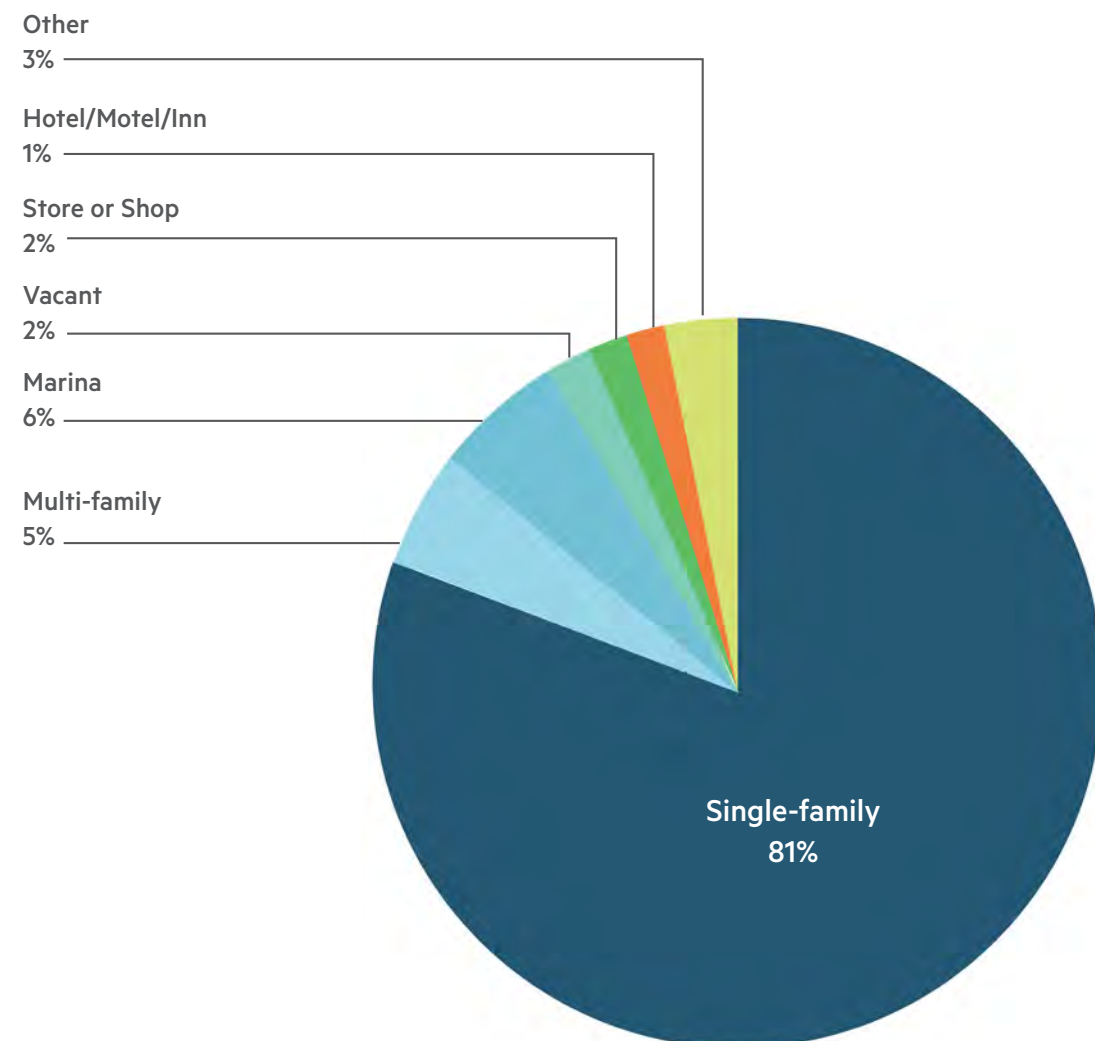
Downtown Nantucket (photo by James Hark)

Planning for Strategic Retreat and Relocation

Nantucket's Priority Action Areas are identified by the Island-Wide Coastal Risk Framework as severe repetitive loss and repetitive loss properties (as designated by FEMA) and areas likely to be exposed to high tide flooding, erosion, and up to 1.2 feet of sea level rise before 2030. In total, there are over 450 structures and nearly 5 miles of publicly owned roadways within the Priority Action areas on Nantucket. 81% of structures within Priority Action Areas are single-family homes and 74% are historic. These areas face immediate coastal risks today, as illustrated by the ongoing situation along Baxter Road and in some areas of the South Shore where severe erosion has forced emergency relocation of buildings and infrastructure.

While many of the non-structural zoning and regulatory changes outlined in the following pages can help reduce future new construction in Priority Action Areas, they do not address the imminent threat coastal hazards pose to existing structures, utilities, communities, and other assets within these areas. There is not sufficient time or resources available to protect assets in Priority Action Areas through capital-intensive structural approaches. If a structural approach were feasible in these areas, it is not likely to be cost-beneficial given the high costs and relatively limited risk reduction benefits due to the extreme nature of the hazards. Additionally, while nature-based approaches may help slow erosion and dampen the impacts of coastal flooding on existing structures in these areas, they cannot effectively eliminate the extreme coastal risk in Priority Action Areas.

Structures within Priority Action Areas by Land Use



As described in Section 7, pages 136-165, structural protection of Priority Action Areas in the Downtown core is justified given the density of critical facilities and economic, social, cultural, and historic assets in the area.

One of the most effective ways to reduce risk in Nantucket's Priority Action Areas is to strategically remove structures, utilities, and other assets from extreme risk areas. This approach, sometimes called managed retreat, is not new to Nantucket. In 2007 the Sankaty lighthouse was moved 400 feet inland to protect it from the eroding coastline. In several instances across the island, private property owners have moved their homes back from the coastline to reduce their risk.

Within the Priority Action Areas, one-off, sporadic retreat of cultural and historic landmarks and private properties will not be sufficient to reduce the community's risk. The risk to these areas is extreme today and will grow more extreme in the future. With climate change, Nantucket will face increasingly severe coastal hazards, likely expanding the inland extent of the Priority Action Areas over time. To reduce extreme coastal risks effectively, efficiently, and equitably today and in the future, the CRP recommends establishing a Town-led Island-Wide Strategic Retreat and Relocation planning effort, starting with a robust community outreach and engagement process. Equity within neighborhoods and across the island should be a key consideration in the design of both the outreach and engagement process and the larger retreat and relocation planning effort.

The objective of Island-Wide Strategic Retreat and Relocation planning effort is to reduce risk in Priority Action Areas with extreme coastal risk where other structural, non-structural, and nature-based approaches are not feasible or will not effectively reduce coastal risks. The retreat and relocation process will take time and needs to involve many community discussions. This is why the program should begin with a Town-led community outreach process to share information on coastal risks and begin a dialogue around options for property owners.



Scosset Bluffs (photo by Trevor Johnson)

ISLAND-WIDE STRATEGIC RETREAT & RELOCATION OBJECTIVES

The Island-Wide Strategic Retreat and Relocation planning effort is the first step in a series of conversations and assessments that will need to occur as a retreat and relocation program is implemented through time. The CRP highlights the areas of the island where this planning effort should focus in the next 5 to 10 years – Priority Action Areas – and recommends key considerations and approaches that could be integrated into the effort. Regardless of the approach and timing of the effort, it is of paramount importance that it begins with outreach and engagement to property owners in Priority Action Areas to convey the degree of coastal risk and begin conversations about adaptation options.

The strategic retreat and relocation planning process should:

- Be rooted in robust, transparent conversations and meaningful engagement with affected property owners and other stakeholders
- Support a multi-faceted, ongoing risk communication effort to inform property owners and other stakeholders of their coastal risks and retreat and relocation options
- Address the need for an equitable process that channels resources and opportunities to disadvantaged members of the community
- Identify stakeholder preferences with respect to the use of the term “managed retreat” or alternatives (strategic retreat, community-led retreat and relocation, etc.)
- Emphasize the voluntary nature of retreat and relocation
- Include a legal analysis of relevant state and federal precedent and case law
- Identify existing funding sources and consider innovative funding mechanisms
- Identify immediate opportunities for retreat of Town-owned assets and critical infrastructure currently within Priority Action Areas
- Establish a technically and legally defensible methodology to prioritize structures, utilities, and other assets within Priority Action Areas for relocation
- Assess suite of strategic relocation tools to recommend the most appropriate applications across the island

- **Develop strategic, actionable recommendations and implementation pathways that consider:**
 - **Community capacity to administer a retreat and relocation program**
 - **Opportunities to incorporate retreat and relocation policies and programs into existing policies, programs, and planning efforts**
 - **Cost-benefit analyses**
 - **Technically and legally defensible rationale, triggers, or thresholds for action**
 - **Funding**
 - **Potential legal issues**

- **Consider opportunities to preserve tax revenue through relocation to suitable, lower risk areas on Nantucket and other programs or policies**
- **Identify suitable, lower risk areas for relocation through a site suitability analysis as part of larger island-wide comprehensive land-use planning**
- **Identify opportunities for the adaptive reuse of areas that have been retreated from**
- **Identify thresholds for expansion of Priority Action Areas over time**

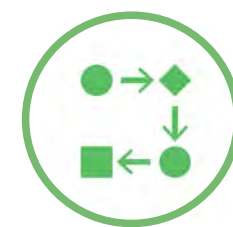
A robust strategic retreat and relocation planning process will give Nantucketers an opportunity to start a conversation about what Nantucket could look like with retreat from the most exposed coastal areas. Often these conversations focus on the areas that will be left behind or retreated from. While this is an important piece of the puzzle, the CRP recommends expanding the conversation to include discussion of where structures, utilities, communities, and other assets will go and how that will be accomplished. Retreat and relocation are complementary processes and should be discussed together to realize their full benefit.

Incorporating discussion around relocation is critical to realize many of the potential opportunities within a retreat and relocation context. By addressing questions like where, when, why, and how people will relocate early in the process, Nantucket can start to garner public support for retreat and relocation planning. For example:



Knowing community preferences can help develop programs to incentivize relocation to lower risk areas on the island. Strategic capital improvements in lower risk areas can make them more attractive to those relocating.

Creating opportunities for Nantucketers with lower risk tolerance to relocate when they feel it is appropriate gives stakeholders a choice in retreat and relocation decision-making and may result in greater program support.



Developing retreat and relocation programs that are not wholly dependent on Federal funding allows retreat and relocation to be proactive. Non-federally funded programs are generally more flexible, can be administered more efficiently, and can be designed to best meet the needs of the community.

Assessing community preference for and planning for adaptive reuse of retreat areas can establish community-supported amenities that add value in extreme risk areas.

Tools for Strategic Retreat and Relocation

There is no one-size-fits-all solution to strategic retreat and relocation. Through the planning process described and robust community engagement, the full suite of programmatic and policy-based strategic retreat and relocation tools should be evaluated to determine which are most appropriate across Nantucket. Different tools may be appropriate in different geographies and across different time periods. This section highlights some of the strategic retreat and relocation tools that may ultimately be incorporated into Nantucket's Island-Wide Strategic Retreat and Relocation Plan.



Setbacks, Rolling Easements, and Buffers

In coastal areas, a setback is the required distance a structure must be located behind some baseline (such as mean high water). Setbacks help keep development away from extremely vulnerable areas. Setbacks can be tailored to individual properties based on the size of the proposed development or structure, the location of the baseline relative to the proposed structure, or the level of risk facing the structure over a given

time period. Standard setbacks can also be applied. Nantucket's existing wetland regulations and Island Perimeter Restrictions provide a strong starting point for discussions around addition setback requirements. Rolling easements are a type of setback in which the baseline moves inland as sea level rise and coastal erosion cause the coastline to move inland. Rolling easements can encourage retreat over time by requiring any structure seaward of the baseline to be relocated. Buffers require property owners to leave some portion of their property undeveloped to preserve their natural protective functions. Setbacks and buffers are most relevant to new construction but can be a useful tool in managed retreat by incorporating sea level rise and erosion rates. They are generally more feasible in rural areas and places with larger lot sizes that allow for a setback or buffer and do not prevent all development on the lot.

On Nantucket, setbacks, rolling easements, and buffers could be used in High and Moderate Coastal Risk areas to limit future coastal risk to new development.



Buyouts and Acquisition Programs

Historically, voluntary buyout and acquisition programs have been funded by FEMA and the Department of Housing and Urban Development (HUD) in response to a disaster. During a buyout or acquisition, the government purchases property from a willing seller, demolishes existing structures on the property, and prohibits future development on the property in perpetuity through deed restrictions or a conservation easement. Buyouts may be one useful tool in the context of strategic retreat, though may be challenged by the high real estate values on Nantucket. Any strategy incorporating buyouts should, at a minimum, consider:

Federally-funded buyout programs have caps on funding available, must be cost beneficial on a structure-by-structure basis, and generally require a 25% local cost share. Given the high property values on Nantucket, there will be significant local cost even if a federal funding is secured. Innovative local funding streams will be necessary. Impervious surface cover fees, stormwater fees, water and sewer bills, and property taxes have all been used by local governments to help fund phased buyouts.

Severe repetitive loss and repetitive loss properties are eligible for a 90% federal cost share under FEMA's Flood Mitigation Assistance (FMA) grant program.

Federally-funded buyout programs do not fund maintenance of the buyout areas in perpetuity.

Strategic partnership with Nantucket's network of conservation organizations and land trusts could help meet the objectives of these organizations while encouraging ecological restoration and maintenance of buyout areas in perpetuity.

Federally-funded buyout programs are complex and may take many years to administer.

Buyouts and acquisitions can be privately or locally funded.

Local land trusts or foundations can purchase extreme risk properties and foster ecological restoration of protective coastal habitats.

As the Nantucket Islands Land Bank continues to acquire property, the organization could prioritize acquisitions that provide a high risk reduction value in addition to meeting the organization's other objectives.



Transfer of Development Rights

Transfer of Development Rights programs use market-based incentives to shift development away from high risk areas (sending areas) and encourage it in preferred, lower risk areas (receiving areas). Using zoning by-laws, local governments can designate sending and receiving areas. Transfer of Development Rights programs use credits that can be bought and sold on the open market. Through the buying and selling of these credits, owners of property in sending areas are compensated for choosing not to develop some or all of their land and development in receiving areas is encouraged through zoning flexibility or other benefits.

Though Transfer of Development Rights programs have historically been used to protect coastal ecosystems, they are not generally used in the strategic retreat context. Changes to local laws enabling Transfer of Development Rights programs should consider the legal authority of local governments to use such programs for retreat.



Land Swaps

An approach already used on Nantucket, land swaps are a way to trade high risk properties for lower risk properties. Buildings and infrastructure located on high risk properties can be moved to lower risk properties as a result of the swap.

Removing existing development from Priority Action Areas with extreme coastal risk can allow the inland migration of coastal ecosystems on these properties, which has ecological benefits. Publicly- or privately-owned unprotected open space on Nantucket could be used for relocation.

Land swaps may have more support than buyout programs because participants know where they will be moving to.

Land swaps may help governments avoid spending money on property buyouts and can reduce future spending on infrastructure and utility maintenance in higher risk areas.



Life Estates, Future Interests, and Leasebacks

Life estates and future interests transfer ownership of a property to the government upon death or some other triggering event such as the rise of mean high tide to a certain level. Leasebacks allow governments to lease acquired properties to the property's original owner or a third party to generate revenue and reduce maintenance costs. Life estates and leasebacks can encourage property owners to participate in buyouts by guaranteeing them additional time in their home.

Resources and References

Land Use and Wetlands

The Metropolitan Area Planning Council provides detailed guidance and examples for Massachusetts communities interested in advancing climate resilience through land use strategies. The resource highlights regulatory language and policy examples from MAPC's 101 communities and beyond.



CLIMATE RESILIENT LAND USE STRATEGIES

MAPC >> RESOURCES >> ENVIRONMENT >> CLIMATE RESILIENT LAND USE STRATEGIES

BACKGROUND

Why address climate resilience through land use planning?

Major Federal and State Regulations that Impact Land

Land use regulations can be a powerful tool to provide climate resilience. From floodplain and wetlands restrictions, to tree protection and water conservation, to design standards and zoning, communities are using their regulatory authority to address the growing impacts of rainstorms, sea level rise, heat, and drought.

Regulatory language and policies specifically crafted to address climate risk are still relatively uncommon. But many communities have adopted language that reduces vulnerability to climate impacts.

Strategic Relocation

- Georgetown Climate Center – Managed Retreat Toolkit
- Climigration Network – Lead with Listening: A Guidebook for Community Conversations on Retreat
- Massachusetts Coastal Zone Management – Case Study: A Cape Cod Community Prevents New Residences in Floodplains
- Barnstable County, Cape Cod Cooperative Extension, and Woods Hole Sea Grant – Coastal Homeowner Buyout Forum
- Metropolitan Area Planning Council - Peggotty Beach Retreat Feasibility Study
- State of Hawaii – Assessing the Feasibility and Implications of Managed Retreat Strategies for Vulnerable Coastal Areas in Hawaii



County to Hold "Coastal Homeowner Buyout" Forum on April 21

COASTAL HOMEOWNER BUYOUT FORUM
APRIL 21

For Immediate Release

County to Hold "Coastal Homeowner Buyout" Forum on April 21

April 7, 2021 – Barnstable, MA. | On Wednesday, April 21, Barnstable County will hold a "Coastal Homeowner Buyout Forum" to outline federal assistance programs available for homeowners who currently live in high-risk areas and may be interested in relocating. The information presented in this forum will be relevant to properties located anywhere in a floodplain, not just coastal or waterfront. The forum will be held via Zoom from 4:00 – 6:00 PM.

ASSESSMENT OF FEASIBILITY OF MANAGED RETREAT IN HAWAII

The Office of Planning Coastal Zone Management Program (OP-CZM), under the partnership of the Ocean Resources Management Plan (ORMP), commissioned a project to assess the feasibility and implications of managed retreat strategies for vulnerable coastal areas in Hawaii.

Managed retreat is one of three main adaptation strategies to sea level rise and other coastal hazards. The other two are accommodation and protection. Much is known about accommodation and protection but managed retreat is still novel to Hawaii. Managed retreat essentially means shifting development inland from the coast either by the physical movement of structures or changing the restrictions and management of nearby coastal areas.

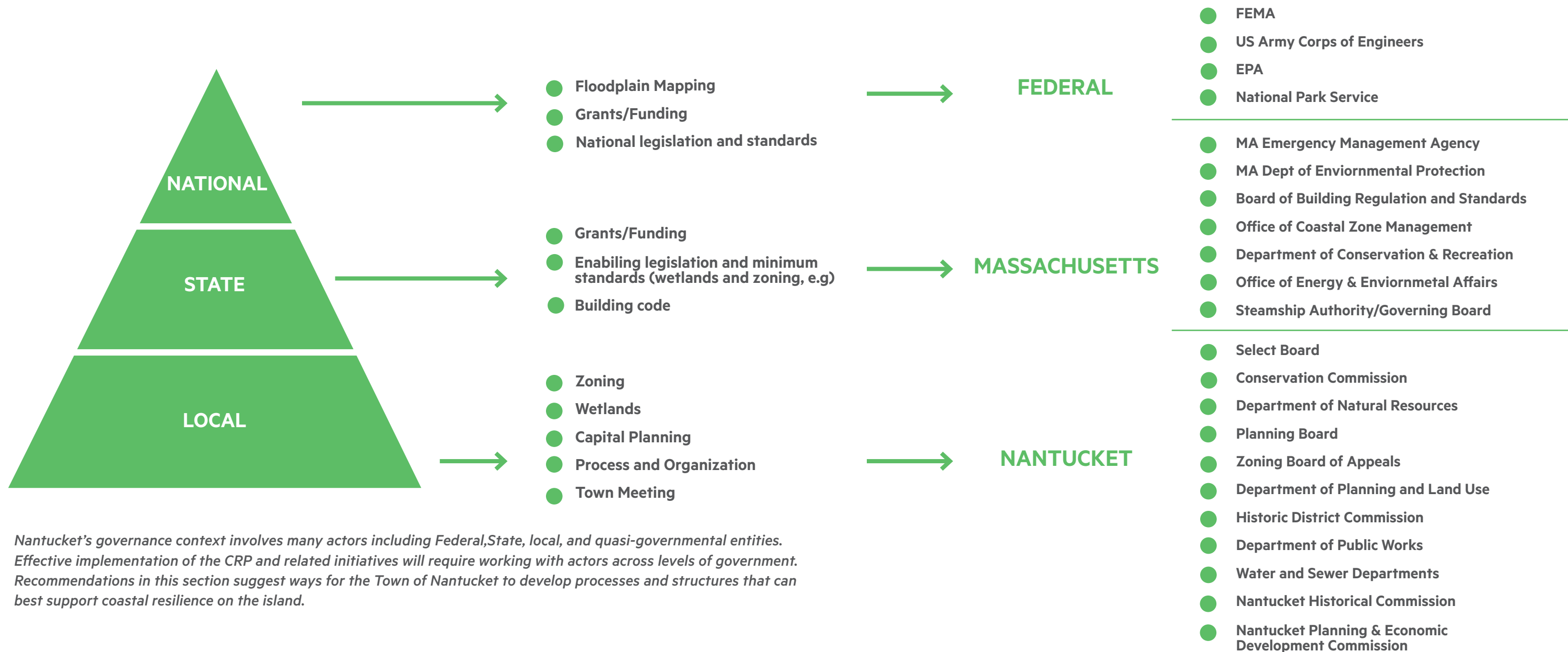
Accommodation involves adapting existing structures and systems to allow them to better withstand changing conditions. An example of accommodation is elevating a structure on piles to greater tolerate more extreme wave inundation.

Protection strategies include both hard and soft solutions. Hard methods of protection safeguard an area or a system in its existing location to withstand impacts from changing conditions. Examples of hard protection include seawalls, rock revetments and other hard structures to hold back the advance of the sea. Beach nourishment is an example of a soft protection solution. Sand is collected from some other source and spread onto the beach to widen it.

Governance

Nantucket has implemented a number of governance changes in recent years that help build the community’s capacity to undertake coastal resilience planning and implementation. These include participation in the Municipal Vulnerability Preparedness (MVP) and Community Resilience Building process, creation of the Coastal Resilience Coordinator position in the Natural Resources Department, and formation of the Coastal Resilience Advisory Committee as the primary citizen-led body advising on issues of coastal resilience. Each of these steps was crucial in leading to the development of the CRP. The adoption of the CRP will be the next step in a long-term process of coastal resilience planning and implementation in the decades to come. This process will create even greater demands on current Town staff and volunteers responsible for key decisions and oversight of complex capital

and policy projects. The 2018 Town of Nantucket Staffing Study (Novack Consulting Group) included a comprehensive analysis of human resources needs, highlighting the strains placed on existing resources by a growing and seasonally fluctuating population. The recommendations provided below build on this study and focus on Town governance and process improvements that can help ensure a sustainable management structure for high importance projects and initiatives related to coastal resilience and sustainability and create opportunities for communication and collaboration across Town departments, boards, and commissions, while facilitating coordinated decision-making across internal and external stakeholders.



Nantucket’s governance context involves many actors including Federal, State, local, and quasi-governmental entities. Effective implementation of the CRP and related initiatives will require working with actors across levels of government. Recommendations in this section suggest ways for the Town of Nantucket to develop processes and structures that can best support coastal resilience on the island.

Coastal Resilience and Sustainability Interdepartmental Working Group

Nantucket has significant coastal, stormwater, sewer, transportation, and energy infrastructure systems with unique interdependencies owned and maintained not only by a constellation of Town Departments but also by various public utilities, private companies, and State and Federal agencies. For example, Steamboat Wharf is controlled by the Steamship Authority, a quasi-governmental state authority, regulated in part by the U.S. Coast Guard, dependent on navigational channels maintained by the U.S. Army Corp of Engineers, and is accessed via Town-owned roadways. While bringing non-Town entities to the table to discuss coastal resilience is a challenge, the Town nevertheless has the ability to organize its working groups and programs related to resilience in a way that best serves local interests and enables coordinated communications with external partners.

By reestablishing and formalizing the Coastal Resilience and Sustainability Interdepartmental Working Group the Town can proceed with implementation of the CRP and related endeavors based on a formal, predictable forum for Town staff and leadership to meet, discuss, and decide on issues related to long-term coastal resilience and sustainability. The Working Group would also be the primary venue for working with State, Federal, and private partners who maintain or have oversight of infrastructure that Nantucket depends on for its resilience.

Additional Considerations

In early September 2020, the Town reconvened the internal sustainability working group for interdepartmental staff. The new working group serves as a foundation for the recommendations and can be adapted, as necessary, to fulfill the mission outlined in this section.

Key Objectives of Working Group

- Jointly vet and discuss proposed policies and regulations for consistency with Town objectives, processes, and capacities related to coastal resilience and sustainability
- Jointly review and discuss capital planning and capital designs for consistency with adopted Town objectives and policies related to coastal resilience and sustainability
- Jointly review and discuss Town planning initiatives with implications for coastal resilience and sustainability
- Serve as primary staff steering committee for all Town-led coastal resilience and sustainability planning initiatives
- Serve as primary Town body coordinating communications with State and Federal agencies on issues related to coastal resilience and sustainability, such as Steamship Authority, National Grid, MassCZM, MassDEP, US Army Corp of Engineers, US Coast Guard and others as relevant
- Develop reports on activities to the Coastal Resilience Advisory Committee

Organizational Details

- Chaired by Assistant Town Manager for Strategic Projects, Special Projects Manager, or designee
- Participation by one designated staff person from each relevant Town Department including Administration, Town Engineer, Natural Resources, Buildings, PLUS, DPW, Airport, Fire/Police, Sewer, and Water
- Meets regularly and as needed with mandatory attendance by all parties
- Plays an advisory role but discussion and decisions should be tracked for institutional knowledge and documentation over time

Joint Staff Review of Development Proposals

A range of Town Departments, Boards, and Commissions have oversight or advisory functions related to development and capital planning on Nantucket. This governance structure is not unique to Nantucket but the multiple levels of review necessary to bring a project from the planning to implementation stage, whether publicly or privately sponsored, has the potential to delay necessary actions and lead to confusion among public stakeholders. Since effective implementation of the CRP will depend, in part, on the actions that private property owners take to implement resilience measures for their homes and businesses, it is important that Town officials be coordinated in their review and responses on private proposals in coastal hazard areas. By formalizing a process for joint staff review of development and building proposals the Town can help expedite the review process, collaboratively problem-solve around

key tensions and conflicts between local regulations and processes and the proposal and communicate a consistent set of feedback to project proponents. While this recommendation applies to staff review which can be organized through internal administrative procedures around scheduling, it may also be prudent to consider joint review of proposals by relevant elected or appointed boards and commissions such as the Planning Board, Conservation Commission, and Historic Districts Commission.

Key Objectives of Working Group

- **Jointly review and discuss private development proposals with potential implications for coastal resilience and sustainability**
- **Ensure coordinated review of private development proposals for consistency and make recommendations for changes based on staff review to private development project for consistency with Town coastal resilience and sustainability plans and policies, such as the CRP, zoning by-law, and wetlands regulations**
- **Provide clear, coordinated guidance to project proponents on requested revisions based on joint staff review**
- **Develop reports and recommendations for process improvement to the Town Coastal Resilience and Sustainability Interdepartmental Working Group**
- **Provide formal sign off on projects in Priority and High Coastal Risk Areas prior to issuance of a special permit, building permit, or certificate of occupancy**

Organizational Details

- **Participation by relevant technical staff from appropriate Town departments, including but not limited to PLUS, Natural Resources, and DPW**
- **Meets regularly and as needed with mandatory attendance by all relevant parties**
- **Meetings can be workshop format to enable discussion of complex issues and concerns**
- **Additional technical advisors may participate as needed**

Coastal Resilience and Sustainability Program Model

The adoption of the CRP will be a major milestone in Nantucket’s resilience-building process. It will launch the next phase of planning and implementation that will entail a variety of operational and administrative needs. It is important to plan for these needs as part of the plan itself in order to establish the foundation for successful implementation of priority recommendations, ongoing stakeholder and community engagement, and planning next steps. Transitioning to a program model can help establish a sustainable long-term approach for maintaining, funding, and implementing the CRP. While the program model may not entail significant structural or personnel

related shifts in the way the Town operates, it will necessitate the addition of new administration and IT processes, development of detailed strategies and plans, and ongoing maintenance and reporting. Building these capacities will help the Town manage a growing portfolio of coastal resilience projects, communicate progress to stakeholders, and aid in meeting complex reporting requirements for State and Federal grants that may provide funding for resilience projects.

Key Objectives of Resilience Program

- **Develop and maintain a tracking system for all coastal resilience projects including location, implementation timelines, project status, and key project needs**
- **Develop and maintain a funding database to identify and track local, state, and federal funding opportunities for applicable projects**
- **Develop 1-, 3-, and 5 – year funding strategies for coastal resilience and sustainability projects. Fund projects by working with Town staff to develop funding and finance applications to State, Federal, and private entities, as well as local budget requests for projects and require local matches for grants**
- **Lead updates to key coastal resilience and sustainability plans, including the Coastal Resilience Plan**
- **Lead or coordinate with community and stakeholder engagement around key coastal resilience plans, policies, and initiatives**
- **Establish and maintain strategic partnerships with private and public entities**
- **Maintain regular touchpoints with related staff and functions, in coordination with the Town Coastal Resilience and Sustainability Working Group**

Organizational Details

- **Program led by the Town Coastal Resilience Coordinator with additional support staff and resources. The program is likely to grow over time and may require the additional of new staffing or skillsets over time.**
- **Participation and input by relevant technical staff from appropriate Town departments**
- **The program may necessitate need for additional IT capabilities for mapping and tracking of projects, record keeping, and communications**
- **The program may necessitate need for additional staff training**
- **CRAC plays key advisory role on program development and progress**

Island-Wide Erosion and Sediment Management

Nantucket has identified the need for a comprehensive island-wide approach to sediment management. This section outlines approaches for erosion and sediment management that address island and county-wide needs. The approaches outlined here inform both site-specific erosion management projects described in Section 7 and areas along Nantucket's coast that are not identified as strategic near-term opportunities, such as Tuckernuck and Muskeget Islands. The recommendations in this section fall into two categories:

Priority Recommendations for Implementation of the CRP

Near-term strategic opportunities that should be completed within the next 10-15 years and will inform erosion and sediment management island- and county-wide

Recommended Sediment and Erosion Management Approaches

Toolkit of sediment and erosion best management practices that are recommended in Section 7 and are likely appropriate in other erosion-prone areas island-wide



Dune planting (photo by Irene Watts)

Priority Recommendations for Implementation of the CRP

In order to implement the erosion management recommendations of the CRP effectively, additional data collection and analysis is necessary. Specifically, sediment sourcing, sediment transport, and sediment budgeting analyses are recommended in addition to ongoing monitoring and evaluation. These analyses will help inform the design and construction of site-specific erosion management projects described in Section 7 and inform erosion and sediment management county-wide. The sediment sourcing and transport study and sediment budgeting efforts are highly dependent on one another and should be undertaken in parallel to inform future efforts.

Federal and state funding may be available to support these activities. Regional Sediment Management (RSM) is a U.S. Army Corps of Engineers (USACE) program intended to support a systems approach to sediment management practices for coastal, estuarine, and inland environments. This program promotes efficient, economically viable and environmentally sustainable solutions for sediment management. RSM can support planning, engineering, construction, and operation. Coordination with the USACE New England District (NAE) is required to pursue this funding. It should be noted that the only present Federal project on Nantucket is the navigation channel and turning basin in the Harbor. Other potential federal partners include FEMA and USGS.

Sediment Sourcing and Transport Study

Most erosion management approaches require sand as a resource, and it has been identified through community engagement for the CRP that sediment availability and cost are concerns that need to be addressed. Present sand sources include upland resources as well as navigation and harbor dredging. A relic flood shoal near Madaket has also been identified as a potential source of sand for dune restoration nearby. Exact sediment volumes for the erosion management projects recommended in Section 7 have not been identified at this level of design, but it is anticipated that the upland sources and navigation dredging will likely not be sufficient to meet the sediment volume requirements of the proposed projects. Therefore, additional sand source locations should be investigated. Previous work in 2006 identified several shallow shoals as potential sand sources or borrow sites. Potential borrow sites considered as part of the 2006 effort include Tuckernuck Shoal, Handkerchief Shoal, Quidnet Rip, Nantucket Shoals, Great Point Shoals, Sankaty Head Shelf and the Bass Rip Shoal (Epsilon, 2006). These shoals may be revisited as a starting point for additional analysis. Borrow site analysis should include grain size and volume determination, cost, as well as studies of potential impacts to fisheries, habitat, and archaeological resources. Costs

related to sand mining vary with water depth, distance, oil prices and dredging methods. More detailed cost estimates can be developed in later design and sand source exploration phases.

It is recommended that the Town coordinate with the Bureau of Ocean Energy Management (BOEM) regarding their ongoing efforts to build a national offshore sand inventory through the Marine Minerals Information System. In addition to identifying additional sand sources, the Town will need to identify a suitable location(s) for storing sand before it is used for projects. Storage is needed while dredged sand is dewatered, sampled and tested, and graded.

An island-wide sediment transport study should be performed to understand the movement of sediment on Nantucket at various spatial and temporal scales. A product of this effort would be a sediment budget that can inform proposed shore protection projects. One of the interests of the study may be to understand seasonal variability in sediment transport directions and quantities. This understanding will provide a clearer lens to evaluate the performance of any of the proposed shoreline protection projects. It will also aid in design of these projects and further inform sand sourcing efforts through better understanding the relationship between the shoals and the shoreline or nearshore bar features. Longer term variations on decadal scales may not be available due to data limitations but should be explored to the extent of supportive data. Data sources that this study would require include repeated topography and bottom topography data combined with aerial imagery. Analysis may include the use of numerical models to assist in developing sediment transport pathways and magnitudes in response to changes in the magnitude and direction of waves.

Sediment Budget

The island-wide sediment transport study and comprehensive monitoring will support the development of an operational sediment budget for recommended shoreline projects. A sediment budget is an engineering tool that accounts for sediment sources and sinks in a local or regional area with specified boundaries and different time periods. “Budgets allow estimates to be made of volume rate of sediment entering and existing a defined region of the coast and the surplus or deficit remaining in that region” (Rosati, 2005).

A sediment budget would be constructed in a GIS-based system such as the Sediment Budget Analysis System (SBAS) or similar framework for formulating, documenting, and calculating sediment budgets. SBAS is a product of USACE Coastal Inlets Research Program (CIRP).

Shoreline Change Monitoring and Evaluation Programs

Comprehensive monitoring of sediment management approaches pre, during, and post construction supports informed management activities. This comprehensive approach should ideally be performed island-wide to elucidate the coastal processes and support development of a sediment budget. Opportunities for remote sensing through satellites, cameras, drones and LIDAR have increased as these technologies become more cost effective with recent advancements. A brief description of a comprehensive monitoring approach is described here.

Topography/Bottom Topography

An island-wide topography/bottom topography survey may be considered to establish a baseline understanding of land and underwater surface features. Topography is a detailed map of the surface features of land. Bottom topography is a detailed map of the surface features of land underwater. This baseline can be used to evaluate the performance of the proposed projects through comparison to future surveys of the project site and surrounding area. Bottom topography surveys may lead to a better understanding of various shoals that may be investigated for borrow sources. Project specific surveys should be performed more frequently at an increased resolution to properly observe the localized processes and effects of erosion management. Project specific surveys should be performed before, during, and after construction at 3, 6, and 9 months. After that period, bi-annual monitoring can be performed to capture seasonal variability of project components such as beach nourishment and dunes. Monitoring can also provide information of the response of adjacent beaches to the project to monitor for updrift or downdrift changes.

Survey techniques and approaches should be evaluated by the survey team to find the most robust and cost-effective approach. Island-wide characterization of the topography and repeated surveys will support determination of sediment transport pathways at various timescales and a sediment budget. It should be noted that surveys in successive years will be required to develop changes in rates through time.

Waves and Currents

The south shore and eastern facing shorelines of Nantucket would have the greatest benefit of nearshore wave and current measurements. The area near Madaket would also benefit from wave and current monitoring.

Oceanographic instrumentation is a valuable tool for monitoring directional waves and currents and supporting numerical modeling efforts. However, implementation can be cost prohibitive and maintenance intensive for long term or permanent stations. For larger pilot projects, short term deployments over a fortnight or slightly longer to capture tidal variations is recommended. Numerical models to compute sediment transport quantities and morphology change greatly benefit from in situ measurements for performance, calibration and confidence.

Bottom mounted acoustic doppler current profilers (ADCP) have the capability to provide estimates of suspended sediment load through the use of the backscatter information. However, this will require specialized water column sampling and laboratory processing. Remote sensing of waves and surface currents is also possible through the use of high frequency (HF) radar stations. These stations can provide near real time monitoring of waves and currents that can provide information to boaters and fishing community.

Sand Sampling

A literature review should be conducted to understand sediment sizing and variability alongshore and cross shore. Detailed sediment texture information is used to inform sediment transport and morphological numerical modeling. It can also be used in particle tracking model applications. Areas lacking sediment data should be identified and limited sampling should be performed. A strategic partnership with an academic institution can be advantageous to save costs for both sampling and processing of sediment to develop grain size distributions. Sediment sampling may be necessary for specific projects to inform design and life cycle.

Recommended Sediment and Erosion Management Approaches

The CRP recommends a comprehensive approach to sediment management across the island, including a selection of targeted approaches for managing erosion and improving resilience in key locations as discussed in greater detail in Section 7. The recommended strategies described here draw on established best practices to create a toolkit that incorporates stakeholder feedback and feasibility considerations. The approaches below may be implemented island- and county-wide, as appropriate, and are components of the strategies described in Section 7. The sediment sourcing, transport, and budget studies recommended will provide additional information necessary to identify the appropriate combination of sediment and erosion management approaches for each specific erosion-prone area throughout the county.

Dune Restoration and Building

Dune building is an important tool to improve coastal resiliency at many areas and different shoreline types on Nantucket. “Shore protection strategies such as beach and dune nourishment are used to reduce flooding, wave impact, and erosion during storm events” (USGS, 2021). Dunes are built to a specific elevation and massing to meet a design wave or storm surge criteria. Vegetation is an important component in dune building as mature vegetation assists in trapping windblown sand within the dune system and may assist in continuing to build the dune. Dunes can be constructed completely with sand or be reinforced with a core material. As sand-only dunes rely primarily on their mass to resist wave attack (by eroding during storms) a large dune system may be required to resist intense storms. Adding a core of either natural or synthetic material can increase the dune’s ability to resist storm waves without adding significantly more mass. In Section 7 this is referred to as a hard core reinforced dune. The sand covering the core may erode during storm events, but the core material will resist design wave conditions. Both systems will require sand replenishment after storms to maintain full functionality.

Dune building can be applied to a variety of locations along Nantucket, including on Coatue and along the South Shore and Sconset coastlines, as in a rehabilitation approach to shorelines that presently contain low lying vegetated dunes. Dunes can also be constructed in front of bluff features to reduce the likelihood of bluff toe erosion during storm events.

Beach Nourishment

Beach nourishment can be described as placing “...large quantities of good quality sand on the beach to advance it seaward” (Dean, 2002). Direct placement of material on the beach has been widely used in the United States and globally. Beach nourishment is intended to accomplish several goals (Dean, 2002), including:

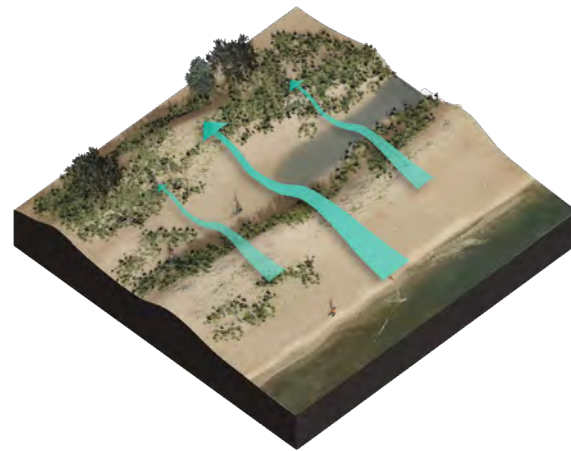
- Increasing beach width
- Increasing recreational area
- Improving storm protection through reducing nearshore wave energy and adding sacrificial material to be eroded during storms
- Adding habitat for endangered species.

Beach nourishment can improve coastal resiliency by adding sacrificial sand to the beach. Sand will be eroded during a storm and either transported offshore into the bar system or displaced alongshore. Sand that ends up in the bar system has the capability to return to the beach during periods of lower wave energy.

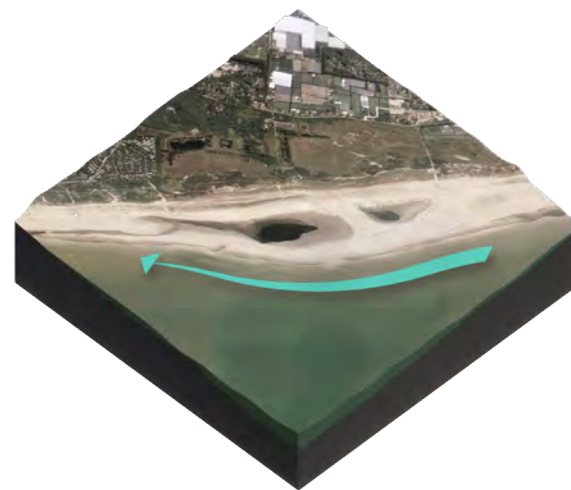
The sand motor or engine constructed along the Delftland coast in the Netherlands is an innovative approach to beach nourishment. This project placed over 20 million cubic meters (~26 million cubic yards) on the shoreline and winds, waves, and tides distribute the sand alongshore.

Renourishment intervals and life cycle are determined during project design. As part of this comprehensive approach, proposed beach nourishment projects should be incorporated into the island-wide sediment budget.

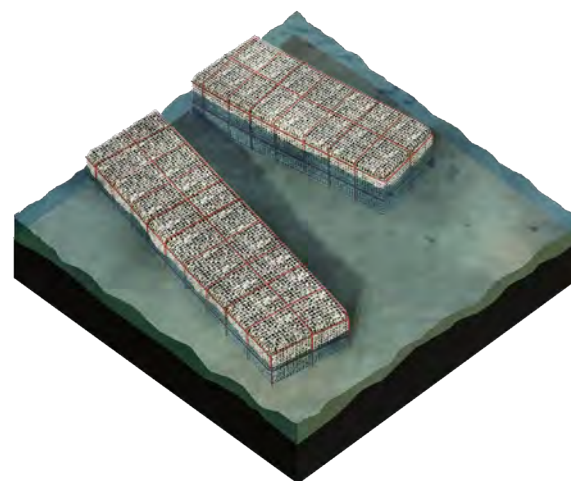
Beach nourishment is appropriate for most areas of Nantucket and likely to be combined with other sediment management approaches. For example, in narrow shoreline areas, beach nourishment may be required in order to allow a dune system to be installed.



DUNE RESTORATION & BUILDING



BEACH NOURISHMENT



WAVE ATTENUATION

Toe Stabilization

Toe stabilization refers to protecting the lower portion of a bluff from direct wave energy. Waves can undercut the bluff causing episodic collapse. Unlike beaches and dunes, bluffs were formed by glacial action and cannot be rebuilt once lost. Toe protection can take several forms and should be chosen based on the wave energy and exposure of the shoreline as well as the desired life span of the project. Natural toe protection measures are most appropriate for areas with lower wave energy. Geotextiles and harder toe stabilization (rocks, armoring), though not proposed through the CRP based on near-term permitting constraints and a lack of stakeholder support, are most appropriate in areas with high wave energy and critical infrastructure. Selection of toe stabilization type will incorporate a combination of site needs, engineering guidance, stakeholder input and regulatory requirements.

Nearshore Berms

A nearshore berm is a submerged sand berm that is constructed parallel to the shore and can act as either a feeder berm or a stable berm. A feeder berm is intended to provide a source of sand to a beach and migrates onshore through wave action. One of the advantages of this approach to beach nourishment is avoiding constructing directly on the beach which in some environments may have a negative impact on sensitive bird species and turtle nesting. In this sense, nearshore berms have the potential to expand the construction window. Research is ongoing to update and further refine design guidance for this method of shore protection. Cost, constructability, and regulatory requirements will be considered during feasibility studies.

Wave Attenuation

Wave attenuation refers to structures (breakwaters, reefs) that are intended to reduce wave energy impacting the shoreline. This can be achieved with nearshore breakwaters or submerged reefs. It should be noted these approaches work best in shallow water for construction and cost purposes. Nearshore breakwaters can be constructed either emergent or submergent depending on performance goals and desired shoreline response. These structures can work with beach nourishment projects to encourage the placed material to remain in place. Attenuating waves can also encourage sediment deposition by slowing longshore sediment transport. It should be noted that these structures can be submerged from storm surge and thereby limiting their effectiveness to reduce wave energy impacting the shoreline during storm events.

Sand Bypass System

A sand bypass or sand transfer system provides a means of moving sand around an impediment such as jetties, water intakes/culverts, or dredged inlets. This system is intended to reestablish the flow of sediment that would occur naturally. This approach would be best suited to the north shore adjacent to the western jetty of the entrance to Nantucket Harbor. Shoals develop on the inlet side of the jetty that could be mined by the sand bypass system and transferred westward downdrift ideally beyond the groin field. These shoals develop with tidal currents flowing through the inlet and depositing sediment near the jetties. Sand bypass system pumps the sand from a shoal or other depositional feature and moves the material to the desired shoreline. Generally, the material is left for coastal processes to distribute the material alongshore or can be performed episodically and graded. One example system exists at Indian River Inlet, Delaware and are being considered or have been installed at other locations in the US.

Stormwater Management and Interior Drainage

Climate change projections for Massachusetts indicate that precipitation (including both rainfall and snowfall) patterns are changing, and more significant changes in the amount, frequency, and timing of precipitation in future years are anticipated. The Northeastern United States has experienced the most dramatic increases in precipitation intensity. Increases in total rainfall and rainfall intensity can impact the frequency of flooding events, especially in areas where stormwater and drainage infrastructure has not been adequately designed to manage the increased flows.

In addition to chronic flooding in low lying areas due to high tides, sea level rise will also impact the ability of the stormwater system to provide adequate drainage as outfall pipes will be submerged more frequently, causing drains to surcharge during heavy rainfall events. This is problematic when stormwater flows onto streets, impacting vehicular traffic and emergency vehicles, as well as onto properties, resulting in property damage. Additionally, some coastal defense measures can change surface flow drainage patterns and therefore final designs for coastal resilience strategies will need to take inland stormwater management into account, to ensure that stormwater can be discharged or stored properly during a storm.

Inland stormwater approaches that need to be considered as part of the design of coastal resilience strategies include tide gates on both public and private outfalls, stormwater storage techniques (both green and gray infrastructure), and enhanced stormwater system maintenance. These approaches should be integrated into the Town's existing capital improvement planning and operations and maintenance procedures.

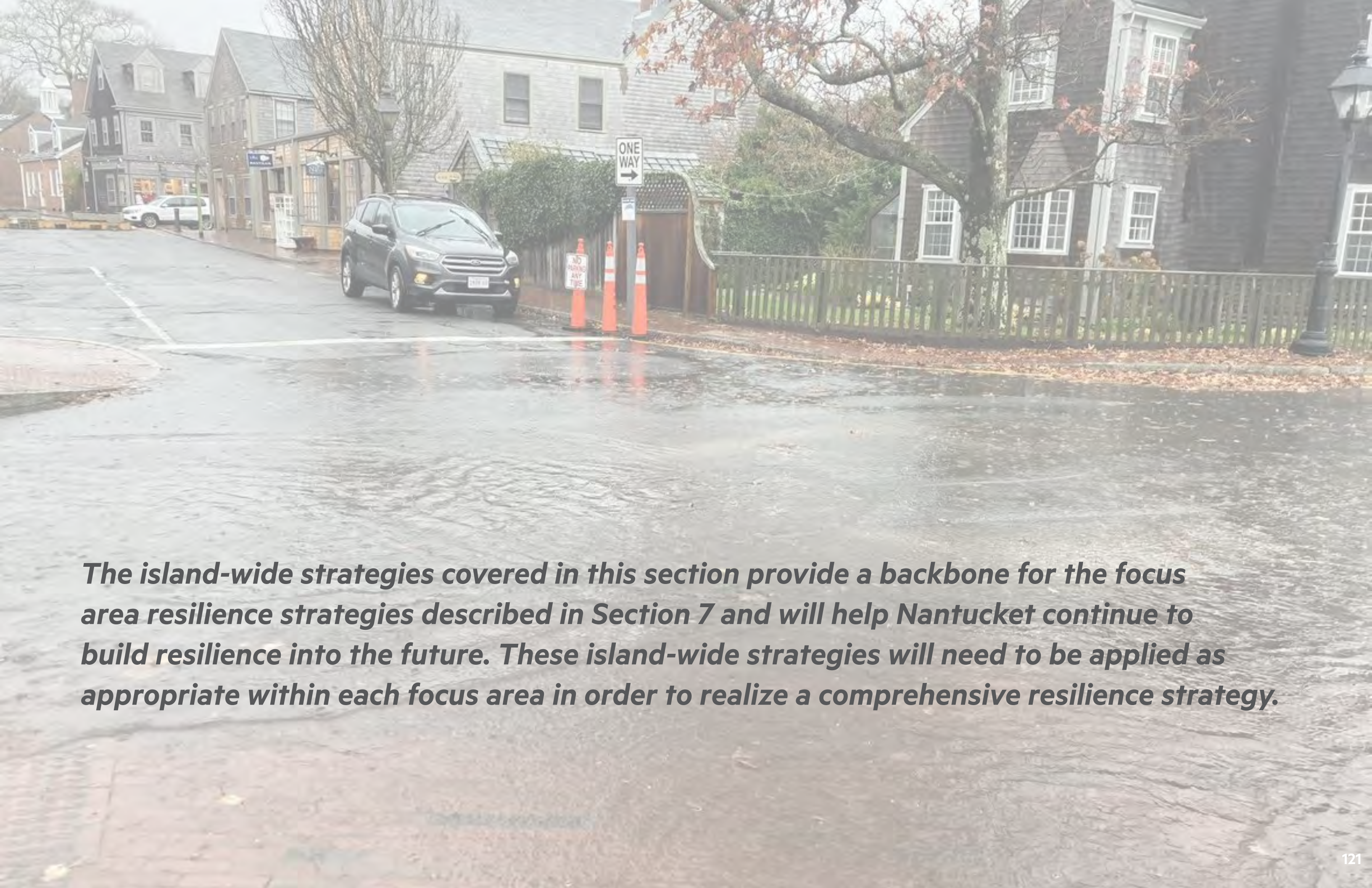
The Town may also wish to develop a detailed Stormwater Management Plan that includes:

- ***Inventory and condition assessment of public stormwater infrastructure***
- ***Identification of chronic stormwater flooding areas and issues***
- ***Community engagement throughout the planning process***
- ***Development of alternatives and concepts for addressing identified chronic stormwater flooding issues***

- ***Recommendations and capital plan for addressing infrastructure maintenance and improvements***
- ***Recommendations and capital plan for addressing chronic stormwater flooding areas***

The Town may also implement additional changes to local by-laws and regulations, including:

- A local by-law assessment for opportunities to better manage stormwater through development projects, including review of the zoning by-law and wetlands ordinance and regulations.
- Creation and adoption of a local stormwater by-law and regulations. A Town-wide stormwater management by-law can be developed encouraging best management practices (BMPs) that address water quality and quantity issues. Typically, a stormwater by-law would require development and redevelopment project proponents to address stormwater runoff from their sites during construction and in perpetuity. Stormwater regulations promulgated under the Stormwater Management By-law would require best management practices such as capturing, retaining, and infiltrating (where possible) runoff on site to alleviate additional burden on the Town's infrastructure and mitigate potential for new stormwater flooding as a result of development. These regulations should also be developed to be consistent with the goals of the CRP.



The island-wide strategies covered in this section provide a backbone for the focus area resilience strategies described in Section 7 and will help Nantucket continue to build resilience into the future. These island-wide strategies will need to be applied as appropriate within each focus area in order to realize a comprehensive resilience strategy.



Smith's Point (photo by James Hark)



SECTION 07: STRATEGIC COASTAL RESILIENCE PROJECTS & OPPORTUNITIES

This section describes near-term strategic design opportunities for coastal resilience on Nantucket, including recommended location-specific projects for reducing risks from flooding and erosion across the island. Strategies are presented for Downtown and Brant Point, Madaket, the South Shore, Sconset, Nantucket Harbor and Coatue, and the North Shore from the Jetties to Eel Point. Long-term adaptation pathways for each strategy provide a series of actions that may be taken to adapt to evolving risk over time. The section begins with an overview of private property owner best practices that will apply in all areas of the island.

Introduction

The diverse natural and built character of Nantucket requires a comprehensive resilience approach that is not only multifaceted but also responsive to the unique conditions of each location. A comprehensive approach to coastal resilience on Nantucket means taking action at multiple scales, from measures that may apply or be undertaken at the island-wide scale, as described in Section 6, to measures that must be designed for specific locations. Drawing on the island-wide coastal resilience framework described in Section 5 and the island-wide strategies described in Section 6, this section describes near-term strategic opportunities for coastal resilience on Nantucket and the long-term adaptation pathways that may be taken to adapt to evolving risk over time.

A number of projects are recommended for each of the focus areas identified through the island-wide evaluation, including Downtown and Brant Point (page 136), Madaket (page 166), South Shore (page 218), Sconset (page 206), Nantucket Harbor and Coatue (page 186), and the North Shore from the Jetties to Eel Point (page 232). In addition, this section begins with an overview of best practices that property owners across Nantucket, within and outside of focus areas, can use to increase coastal resilience.

Recognizing that it is not feasible to address every resilience challenge faced across the island, these focus areas and projects were chosen to address Nantucket's most immediate coastal resilience needs. These projects that can begin to be implemented in the next 5-10 years and completed within the next 10-15 years as the first step in a long-term adaptation process. Maintaining the integrity of Nantucket as a nationally designated historic landmark is a priority across the near-term strategic opportunities. The estimated life expectancy and duration of protection afforded varies by project type and is summarized for each project, but engineers and designers will need to evaluate the design and useful life for each project during the design process outlined in Section 8. Each of the focus area strategies complements the regulatory and property-scale layers of resilience, providing redundancy in the system to protect against potential damages from failure in any one element. When implemented together with island-wide recommendations, these projects create an integrated resilience strategy for the island. Through subsequent design processes and additional evaluations, the projects suggested should incorporate and adapt to changing conditions observed on the island, as outlined in the long-term adaption pathways provided for each focus area.

Evaluation Criteria

Each focus area strategy includes a summary of how it scored according to the project's evaluation criteria. Strategies score differently across the island, but the strategies recommended here are those that scored highest in each focus area when compared to other types of strategies. Scoring is based on a five-point spectrum, with a score of one meaning the strategy is highly undesirable or has the least favored positive impact for that criterion and five meaning the strategy has a highly desirable or most favored positive impact for that criterion. In Section 8, all recommended projects are prioritized based on criticality for the community, recommended sequencing, risk reduction benefits, and other factors.

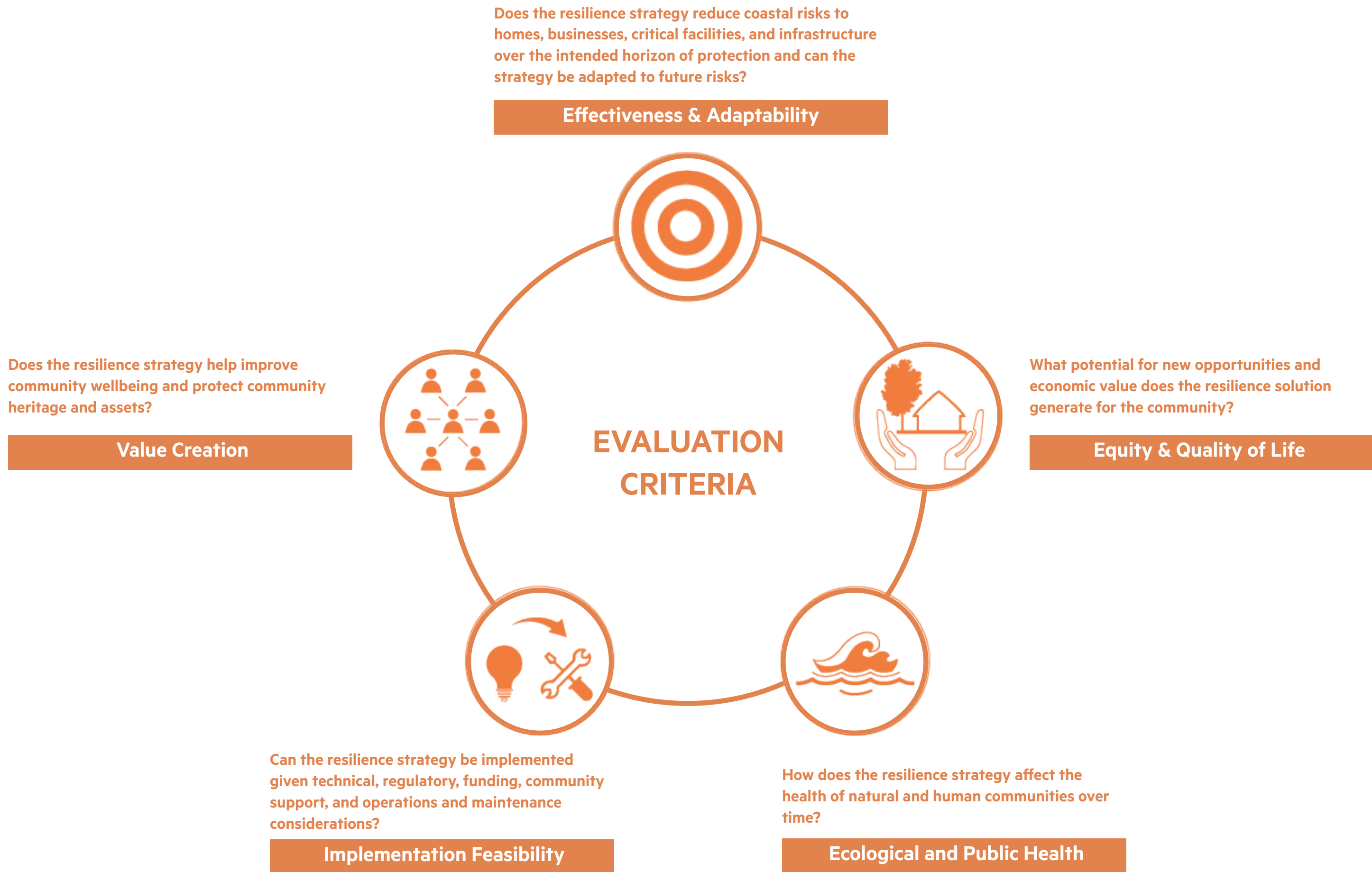
Developing Design Flood Elevations

The CRP includes Design Flood Elevations (DFEs) for each structural project recommended through this plan, as detailed in this section. The DFE represents the goal level of coastal risk reduction for the project. The recommended DFEs are for planning purposes only and will need to be confirmed through the project design process based on site surveys and detailed analysis. The DFEs provided in the CRP are based on MC-FRM and future tidal elevations including sea level rise. DFEs intended to reduce risk from coastal flooding include the stillwater flood elevation and wave crest elevation. Freeboard, an additional amount of height above the expected elevation of flooding used as a factor for safety, can be added to this elevation, as appropriate, based on local factors such as exposure, criticality, risk tolerance.

Project Cost Estimates and Benefits

Planning level cost estimates are provided with each recommended project in this section, with additional estimates for island-wide studies and strategies provided in Section 8. These estimates are based on information from prior studies and similar construction projects around the United States. Due to numerous uncertainties at this stage of design, the estimates are presented in ranges and include contingency factors of 30% [low] and 50% [high] added to the estimated capital and construction costs. In addition to the cost of materials, the estimates include allowances for the costs of design, demolition, drainage, operations and maintenance, public amenities and co-benefits, and other industry standard allowances. These estimates can be used for planning purposes to understand the magnitude of anticipated project costs. Subsequent stages of design and engineering will help collect additional information that enables more detailed cost estimation for each project. Section 8 provides additional background on cost estimation.

A summary of estimated benefits is also provided for each structural and nature-based project. Where possible, benefits are quantified using standard methodologies from FEMA and U.S. Army Corp of Engineers. In cases where data limitations prevent quantification of benefits, a qualitative description of benefits is provided.





PROPERTY OWNER BEST PRACTICES

Working towards coastal resilience on Nantucket will require all residents and businesses to take action. To encourage resilience at the scale of individual properties and buildings, this section covers best practices property owners can use to adapt to coastal risks. By adopting these best practices, property owners can make their homes and businesses safer and reduce Nantucket's overall coastal risk.

Overview

Over the next 50 years, coastal flooding and erosion are expected to cause \$3.15 Billion in damage to 2,238 privately owned structures. In fact, damages to private properties account for 95% of all risk to structures on Nantucket. . Coping with flooding and erosion are realities of life on Nantucket but, we can act today to reduce damage to the places that we care about. On Nantucket, there’s a role for everyone in the community to help reduce coastal flood and erosion risks and build resilience. These best practices have been developed to help private property owners across the island reduce their coastal flood and erosion risks.

There are many ways that private property owners can adapt by reducing or mitigating the coastal risks to their home or business. While this best practice guide does not include every possible coastal flood and erosion risk reduction option, it is intended to provide private property owners with suggestions about where to start. Many of the approaches included here are retrofits that are most relevant to existing structures. In siting new construction, private property owners should consider flood and erosion risk to their property today and in the future. The Island-Wide Coastal Risk Framework, detailed in Section 5, should be used as a starting point to determine where it is most appropriate to site new construction.

Coastal flooding is not the only type of flooding on Nantucket. Anywhere it can rain, it can flood. Many of the flood risk reduction measures here can help reduce damage caused by all types of flooding including freshwater flooding from stormwater runoff.

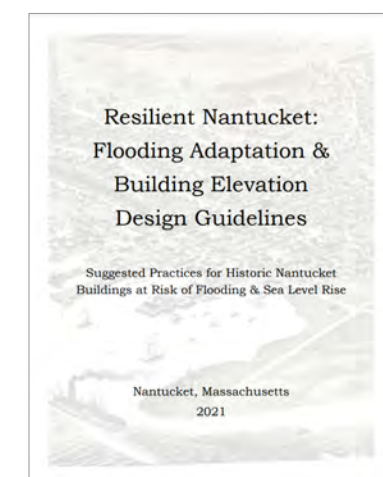
Private property owners should keep in mind that many of the coastal flood adaptation approaches included here will need to be tailored to their unique property and its flood risk. The best way to reduce risk to a specific property depends on a variety of factors including the type(s) of flooding or erosion it is exposed to, the type of property and structure(s), the property owner’s risk tolerance, priorities, and resources, as well as any historic considerations.

Before making any changes to their property, home and business owners should consult with the Town of Nantucket Planning and Land Use Services and local professionals such as insurance agents, architects, engineers, contractors, and other experts. Changes made on private property must comply with applicable Federal, State, and local building codes and standards. Additionally, capital intensive strategies may require permits.



If you own a historic property keep an eye out for notes like this one – there are special considerations when reducing flood risk at historic properties. Nantucket Island, along with its sister islands Tuckernuck and Muskeget, are designated as a National Historic Landmark (NHL) District. New construction or changes to any existing building or structure on Nantucket must be reviewed by the Nantucket Historic District Commission (HDC). This includes floodproofing modifications that impact the architectural character or environmental setting of the property.

For specific guidance on appropriate coastal risk reduction approaches for historic properties, refer to the Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines and contact the Town of Nantucket Preservation Planner and Local Hazard Mitigation Plan Coordinator for more information.



TOP 5 WAYS TO REDUCE YOUR FLOOD RISK TODAY

Sometimes it can be hard to know where to start when reducing your property's flood risk. This checklist includes five relatively easy, low effort ways to reduce risk to your property today and in the future. The items on this checklist can be completed in just a few hours and generally do not require any specialized expertise, permits, or resources. Every private property owner on Nantucket is encouraged to complete this checklist.



Know your risk today and in the future

Knowing what your coastal risk is today and how it may change in the future is the first step to flood resilience.

The best source for information about your **current** flood risk is the Federal Emergency Management Agency (FEMA) Flood Insurance Rate Maps (FIRMs), or flood maps. These maps can be found on the Town's Online Mapping Portal or FEMA's Map Service Center. FEMA's flood maps are regulatory and show the Special Flood Hazard Area (SFHA) or the area that would be affected by a 1% annual chance flood today. Properties within this area have at least a 1 in 4 chance of flooding over the course of a 30-year mortgage and are considered at a high risk of flooding.

With climate change, flood risk on Nantucket is increasing over time. The best source of information about your **future** flood risk is the Massachusetts Coastal Flood Risk Model (MC-FRM). Flood maps developed using MC-FRM will also soon be available on the Town's Online Mapping Portal. When implementing flood risk reduction measure on your property, it is recommended that you consider the future level of flood risk.



Purchase and maintain flood insurance

As a property owner it is important to protect your investments by insuring your home or business and belongings.

However, most standard home and business insurance policies do not cover flood damage. All property owners should purchase flood insurance, either through the National Flood Insurance Program (NFIP) or a private insurer. Though there are coverage limits under the NFIP, additional coverage may be available through private insurance. The Small Business Administration encourages business owners to consider purchasing a flood insurance policy that will reimburse for business disruptions in addition to physical loss.

Flood insurance is required for all properties in the SFHA, or high risk flood zone, that have a federally-backed mortgage. However, over 25% of flood insurance claims come from properties outside of the high risk area. So, even if your property has not experienced a flood in the past, or is not located right along the coastline, it may still be at risk of flooding. Properties in lower risk areas, such as mid-island, are eligible for flood insurance coverage at lower rates.

Flood insurance policies do not automatically renew and must be renewed every year. Set a reminder to renew yours annually!



Prepare

In the days and hours before a possible flood event, there are many small things you can do to be better prepared for a flood.

- Protect your valuables – move your important documents, valuables, business stock or inventory, and family heirlooms to a safer location, ideally on an upper floor. Consider using a watertight container for valuables and storing copies of important documents online.
- Create a list of your belongings – documenting your belongings can help with processing insurance claims. Taking pictures of high-value items or doing a video tour of your home or business is recommended.
- Secure objects outdoors – things like lawn furniture, children’s toys, external fuel tanks, and bicycles should be secured before a flood. During a flood these items can turn into floating debris and cause additional damage.
- Deploy temporary flood barriers – temporary flood barriers such as sandbags, inflatable floodwalls, and portable flood gates can help minimize damage.
- Give your septic system a day off – Septic systems rely on the ground for treatment. When heavy rains saturate the ground, there is less capacity for the soil to process flow from your septic system. During heavy rains try to reduce flow from your system by taking fewer showers, doing less laundry or flushing your toilet less frequently.

Temporary flood barriers and fastening devices should be installed so that they do not cause damage, alter or otherwise impact the distinctive materials, features, and spaces of the property.

Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg. 60



Install a backflow valve and/or sump pump

In some areas on Nantucket, flooding can cause sewage to back up through drainage pipes in your property, causing a potential health hazard.

A sewer backflow valve can be installed to prevent this back up. Backflow valves are recommended for properties on both septic and sewer systems. A sump pump can be installed to pump groundwater away from your property and protect against basement seepage and flooding. Before installing a sump pump, be sure to check the regulations for sump pump discharge. A licensed plumber should install these devices. As sea levels rise, the groundwater table on Nantucket is also rising. This means that basement flooding due to groundwater seepage may become more likely during flood events.



Protect your windows and doors

Doors and windows are common points of failure during a coastal storm.

When they are broken, wind, water, and debris can enter your property and cause serious damage. Storm shutters and high-impact glass can prevent glass from breaking. Different types of deployable barriers that require human intervention can also be installed at entry ways, ranging from low cost options like sandbags to more complicated approaches like sliding gates.

New shutters should be appropriately sized to cover the window opening and should be in a historical style appropriate for Nantucket. The addition of storm windows and doors is encouraged to protect historic materials.

Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg. 46

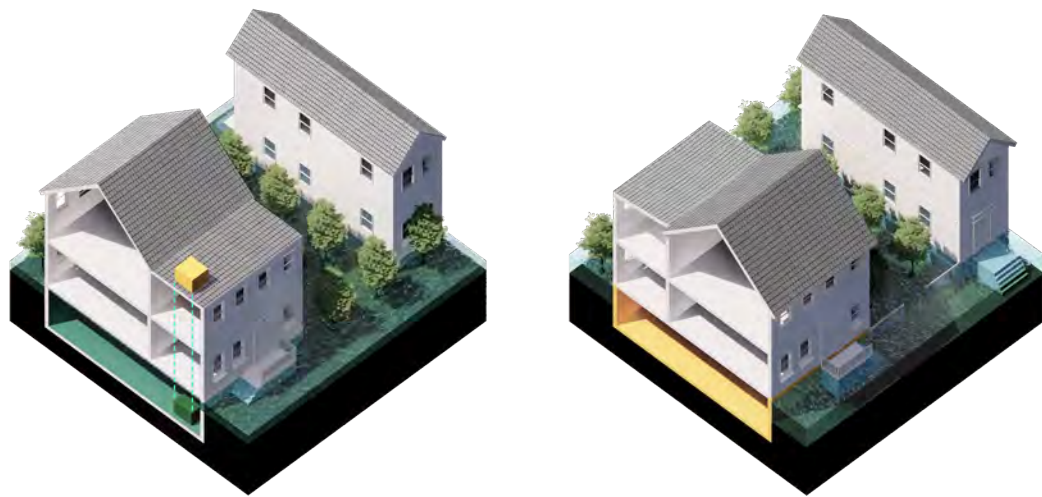
All property owners on Nantucket should implement the items on this checklist. While buying flood insurance and installing storm shutters will reduce your risk today, these measures are just the first steps to building resilience.

ADDITIONAL RISK REDUCTION APPROACHES FOR PRIVATE PROPERTIES

The following menu outlines possible steps property owners can take to build resilience, some of which may also reduce your flood insurance costs. However, not all of these options will be appropriate for every property. Deciding the best way to protect your property will depend on a number of factors such as the type(s) of flooding it is vulnerable to, your property's physical characteristics, what level of flood risk you are willing to accept, and what your flood risk reduction priorities are.

Simple Coastal Risk Reduction Approaches

Options that be easier to implement



- Elevate appliances and utilities
- Seal foundation and basement walls
- Use flood-resistant building materials in interiors
- Install flood vents

More Complex Coastal Risk Reduction Approaches

Options that tend to be higher cost and more complicated to implement. Though these approaches have higher associated costs and require more resources, they may also have relatively large risk reduction benefits.



- Reduce impervious surfaces
- Raise first floor level
- Fill basement
- Anchor home or business
- Elevation
- Relocation
- Dry floodproofing for non-residential structures

Continue reading to learn more about each of these approaches including relevant historic considerations.

Simple Coastal Risk Reduction Approaches: Options to may be easier to implement

<p>Use Flood-Resistant Building Materials in Interiors</p>	<p>Use ceramic tile or other flood-resistant material instead of carpeting and wooden flooring.</p> <p>Use flood-resistant materials such as lime plaster, concrete or pressure-treated wood for interior walls and ceilings.</p> <p>Use metal or other flood-resistant materials in doorways and window frames.</p>	<p>Historic properties that flood repeatedly should retrofit basements and ground floor interiors with flood-resistant materials. However, this does not mean removing and replacing material is always the preferred option when it comes to original historic materials. “Some traditional materials perform as well as recommended modern flood-damage resistant materials and should be retained.” For example, lime plaster allows moisture that may have been absorbed during a flood to evaporate and resists mold growth naturally.</p> <p><i>Guidelines on Flood Adaptation for Rehabilitating Historic Buildings, pg. 58</i></p>
<p>Install Flood Vents</p>	<p>Flood vents are small, permanent openings that allow floodwater to flow through and drain out of enclosed space such as garages and crawlspaces and reduce the risk of serious structural damage. Flood vents should be kept clear of debris so that they work effectively during a flood. Flood vents are required by FEMA for properties being built in high-risk flood zones but can also be added to existing structures.</p>	<p>Flood vents should be compatible in design and placement and should blend in with the property’s foundational material.</p> <p><i>Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg.79</i></p>
<p>Elevate Appliances and Utilities</p>	<p>Utilities and appliances inside and outside of the structure should be elevated above the future flood levels. Outside of the structure, utilities and service equipment such as air conditioning condensers, generators, heat pumps, and water meters can be raised and anchored using pedestals or platforms. Outdoor fuel tanks should also be elevated and anchored so that they do not float and become a hazard during a flood. Inside the structure, you may consider moving appliances such as washers and dryers from the basement to an upper floor. Electrical system components such as fuse and breaker boxes, outlets, switches and wiring can also be elevated above future flood levels by a licensed electrician.</p>	<p>Utilities mounted on the exterior of a historic building should not be readily visible from the street or public right-of-ways and should be screened with appropriate landscaping to remain consistent with Nantucket’s traditional designs.</p> <p><i>Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg. 52</i></p>
<p>Seal Foundation and Basement Wall</p>	<p>Foundation cracks should be closed with an appropriate material, and basement walls should be sealed with waterproofing compounds to avoid seepage.</p>	<p>Waterproofing or sealing of basements and foundations should not result in the removal or alteration of original historic materials.</p> <p><i>Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg.60</i></p> <p>It is critical that the waterproofing product “be thoroughly researched before applying it to a historic building. Waterproof coatings are vapor impermeable and can trap moisture in the wall or on the interior wall surface and cause deterioration or damage to historic materials.”</p> <p><i>Guidelines on Flood Adaptation for Rehabilitating Historic Buildings, 2021, pg.47</i></p>

More Complex Option: Options to tend to be higher cost and more complicated to implement. Though these approaches have higher associated costs and require more resources, they may also have relatively large risk reduction benefits.

Reduce Impervious Surfaces

Water runs off impervious surfaces, such as asphalt, very quickly. Pervious surfaces like natural green spaces can help absorb some of this water during a flood and can reduce erosion of beaches and dunes. Note that reducing impervious surfaces is most effective in reducing flood risk due to precipitation. For commercial properties, parking lots offer an opportunity to reduce impervious surfaces. Rain gardens, bioswales and pervious pavements are some of the approaches available that allow the ground to absorb more water. Check out this brochure for a list of Nantucket’s native plants.

The Resilient Nantucket Design Guidelines encourage the introduction of natural features to replace hard spaces on historic properties. Natural features should not introduce water into the foundation and should have proper drainage.

Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg.42

Raise First Floor Level

In some structures with higher ceilings, it may be possible to raise the height of the interior first floor to avoid flooding. This may be easier to implement in commercial properties than in homes due to the design characteristics of these structures on Nantucket.

“This treatment can have a significant impact on historic buildings with intact, character-defining first-floor spaces. Generally, the first floor contains many of the building’s character-defining interior spaces, features, and materials. Depending on the historic integrity of the building before the adaptation begins, such changes can result in the loss of historic character.”

Guidelines on Flood Adaptation for Rehabilitating Historic Buildings, 2021, pg.100

Fill Basement

The basement of some structures can be filled to effectively raise the lowest floor elevation of the structure. This guarantees that all valuables are located above ground level. However, many basements on Nantucket have been converted into living space, so the benefits of flood risk reduction should be weighed against the loss of livable space.

Anchor Home or Business

Structures that may be exposed to deep flooding should be anchored to their foundation to prevent the structure from moving or floating during flood events.

Anchoring a structure is recommended to decrease the chance of floating or even blowing away. Guidelines on Flood Adaptation for Rehabilitating Historic Buildings also recommends anchoring a structure to the foundation “to prevent movement or collapse of the historic building.”

Guidelines on Flood Adaptation for Rehabilitating Historic Buildings, 2021, pg. 48

Elevation

Elevation is one of the most effective ways to reduce flood risk. The lowest floor of elevated structures should be above the future flood level and spaces below this flood level should be limited to non-occupiable uses. You should work with local officials and licensed professionals to determine the right design options for elevating your home or business.

Historic properties can be elevated. The Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines include detailed recommendations for elevating historic properties. Note that parking beneath a house is not appropriate for elevation projects in the historic district.

Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines, 2021, pg.89

Relocation

Relocation of structures away from extreme risk areas can significantly reduce risk due to coastal flooding, erosion, and sea level rise. On Nantucket, there is a history of buildings being relocated on the island. Property owners interested in relocating structures should consult with the Town and licensed professionals as appropriate. In determining where to relocate your structure(s) future coastal flood risks should be taken into consideration. If building a new structure on your property, try to site it outside of flood and erosion-prone areas if possible.

Historic properties should only be relocated as a last resort to avoid demolition. Consult the *Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines* for more information.

Dry Floodproofing

Dry floodproofing includes approaches that prevent flood water from entering a building and causing damage. Dry floodproofing is not generally recommended for residential structures but may be appropriate for non-residential structures when elevation and relocation are not cost-effective or feasible. Dry floodproofing is not recommended in areas where expected flood depths are greater than three feet. If considering this approach, it is important to consult a licensed engineer to determine the feasibility of this approach for your structure. Dry floodproofing may include:

- Impermeable exterior walls
- Additional flood resistance for core utilities and critical interior areas
- Sealants for door and window openings
- Flood shields for openings in exterior walls
- Internal drainage and backflow valves
- Deployable flood protection

Dry floodproofing is appropriate for historic structures. Chapter 8 of the *Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines* details considerations for dry-floodproofing historic structures.

Erosion Management Best Practices

In addition to adapting properties for flood risk, owners of property located immediately along the coast should implement best practices to manage and mitigate the rate of coastal erosion. Successful long-term erosion mitigation projects are generally larger in scale, reduce risk to more than one property, and require coordination among neighbors as well as relevant Federal, State, and local authorities. While action on a single property will not eliminate threat of erosion, taking the steps described here can help mitigate erosion and maintain the protection provided by bluffs, banks, and dunes. All private property owners should do their part to:

- Maintain existing native vegetation
- Refrain from walking or driving on dunes or bluff tops
- Contribute to Town-sponsored erosion monitoring programs

The most effective step property owners can take to reduce erosion from their properties is to reduce the amount of stormwater flowing from their property onto coastal bluffs, dunes, and beaches. When runoff from rainfall events and snow melt meets unvegetated coastal areas it dislodges sand, soil, and other sediments, contributing to erosion along the coastline. By controlling runoff, property owners can help reduce one of the factors that contributes to coastal erosion. There are several approaches private property owners can take to reduce runoff. These include:



Redirect Stormwater

With the help of licensed professionals, stormwater can be redirected to reduce the potential for flooding and erosion. These approaches may have special permitting considerations so before making any changes to your property, consult with the Town of Nantucket Planning and Land Use Services. Techniques to redirect stormwater include:

Construct a vegetated berm to slow stormwater and redirect runoff away from the shoreline.

Drainage pipes can be installed to direct stormwater away from structures and the shoreline.

Sites can be regraded to direct the flow of water away from erosion prone areas. This may include creation of a berm, swale, or channel.



Remove or Reduce Impervious Surfaces (also see last section)

Reduce impervious surfaces by limiting the size of driveways and patios. Note that the soils under lawns tend to compact, creating impervious surfaces. Replacing lawns with longer grasses, shrubs, and other native vegetation can greatly increase the ability of yards to absorb water.

Replace pavement and concrete with pervious surfaces such as permeable pavers and natural landscapes that can absorb more water.

Install vegetated buffers with native plantings on your property to help stabilize the top of a bluff or a bank. Native plants are more effective at stabilization than typical lawns and grasses.

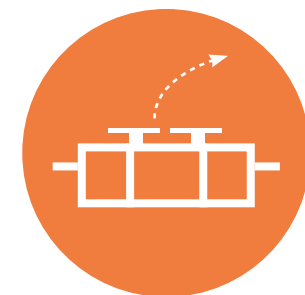


Retain Stormwater

Reduce lawn watering to limit runoff, prevent saturating soils and retain natural permeability.

Capture roof runoff by installing rain barrels. Large amounts of rainwater and snow melt can run off roofs and into downspouts. This water can be directed into rain barrels and reused for irrigation or other purposes.

Install rain gardens and vegetated swales on your property. Vegetated swales and rain gardens are vegetated depressions in the ground that can be used to slow, filter and redirect water. Plants used in vegetated swales and rain gardens should tolerate both wet and dry conditions.



Relocate Septic and Sewer Systems

Erosion can pose a threat to septic and sewer systems in addition to other infrastructure on your property. Septic and sewer systems, and any components of those systems, should be moved away from erosion prone areas before they are affected.

Additional Flood and Erosion Risk Reduction Resources for Private Property Owners

Local

Nantucket Resilience Toolkit

Resilient Nantucket: Flooding Adaptation & Building Elevation Design Guidelines

Improving Coastal Resilience at Home

State

resilient MA

Massachusetts Coastal Zone Management StormSmart Coasts Publications

Coastal Landscaping in Massachusetts

Controlling Overland Runoff to Reduce Coastal Erosion

Landscaping to Protect your Coastal Property from Storm Damage and Flooding

Planting Vegetation to Reduce Erosion and Storm Damage

Who to Contact and What to Do Before Building or Rebuilding

Raise Your Home, Lower Your Monthly Payments

Massachusetts Homeowner's Handbook to Prepare for Coastal Hazards

National

FEMA: Protect Your Home from Flooding: Low-Cost Projects You Can Do Yourself

FEMA: Protect Your Property from Natural Hazards Brochures

FEMA: Reducing Flood Risk to Residential Buildings That Cannot be Elevated

FEMA: Floodproofing Non-Residential Buildings

FEMA: Homeowner's Guide to Retrofitting

FEMA: Coastal Construction Manual

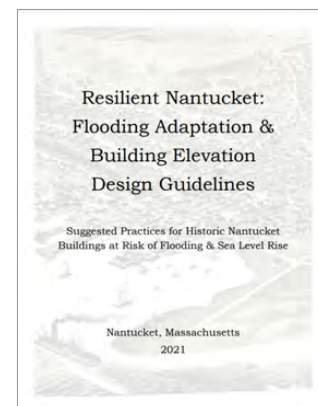
Ready.gov: Business Continuity Planning Suite

National Park Service: Guidelines on Flood Adaptation for Rehabilitating Historic Buildings

For more information, contact:

Vince Murphy
 Coastal Resilience Coordinator
 Natural Resources Department, Town of Nantucket
 Phone: (508) 228-7200 x 7608
 Email: vmurphy@nantucket-ma.gov

Holly Backus
 Preservation Planner & Local Hazard Mitigation Plan Coordinator
 Planning & Zoning Office, Town of Nantucket
 Phone: (508) 325-7587 x 7026
 Email: hbackus@nantucket-ma.gov





DOWNTOWN & BRANT POINT

*To preserve and enhance quality of life in Downtown, this **PROTECT and ADAPT** strategy recommends a series of structural approaches that reduce risk to the neighborhood's core while prolonging the service of critical transportation facilities and corridors. Private property owner implementation of building-scale adaptation measures addresses risks from major storms. Long-term scenarios provide adaptation pathways that seek to transform Downtown in the face of increasing coastal risks by the end of the century.*

Area Overview

Nantucket's Historic Downtown area serves as the economic locus of commercial and tourist activity on Nantucket. Together with the peninsula just north of Downtown known as Brant Point, these areas are located on the westernmost edge of Nantucket Harbor and immediately southwest of the harbor's mouth. The Downtown neighborhood is a working waterfront and is home to Nantucket's public ferry terminals, numerous active wharfs and piers, Town Offices, the Town Archives building, Nantucket's Whaling Museum, and multiple landmarks, in addition to a thriving commercial hub. A large number of these structures are located over water or directly adjacent to it and are therefore highly vulnerable to inundation, now and into the future.

Slightly north of Downtown, the Brant Point peninsula is a low-lying—and therefore highly physically vulnerable—largely residential neighborhood composed of single-family homes, also host to the Nantucket U.S. Coast Guard facility. Coastal beaches and tidal flats at Brant Point, Children's Beach, and Francis Street Beach help define the unique waterfront experience across the broader area.

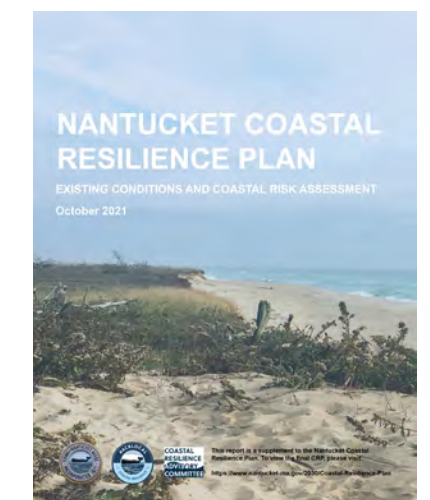
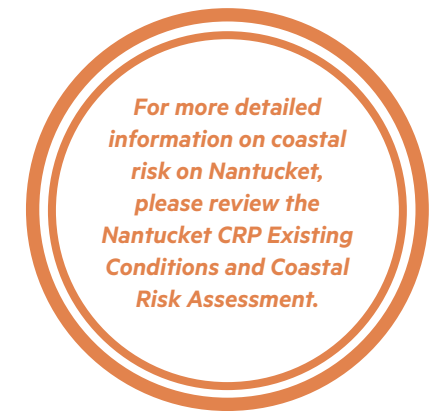


From left to right: Goose Pond (photo by Chris Reed), Steamboat Wharf (photo by Rennie Jones), and Brant Point (photo by Chris Reed)

Summary of Resilience Challenges

The key coastal resilience challenges in Downtown and Brant Point include:

- Damage and disruption to businesses, community institutions, and essential services from flooding, particularly in the core of downtown where these structures are concentrated
- Damage and disruption to critical infrastructure, including Steamboat Wharf and an electrical substation
- Damage and disruption to private residences from flooding, particularly in Brant Point
- Loss of service on roadways and critical access corridors, including along Easy Street, Washington Street, and streets leading to Steamboat Wharf
- The combined impacts that flooding may have on overall community character, history and heritage, including architectural landmarks, streetscapes, and other defining physical characteristics of the Downtown
- Breach of barrier beach systems at Coatue, which could impact Harbor navigation, habitat, economic vitality, and exacerbate coastal flooding
- Loss of eelgrass and shellfish habitat within the harbor due to sea level rise and other climate impacts



Protected infrastructure,
Trevor Johnson



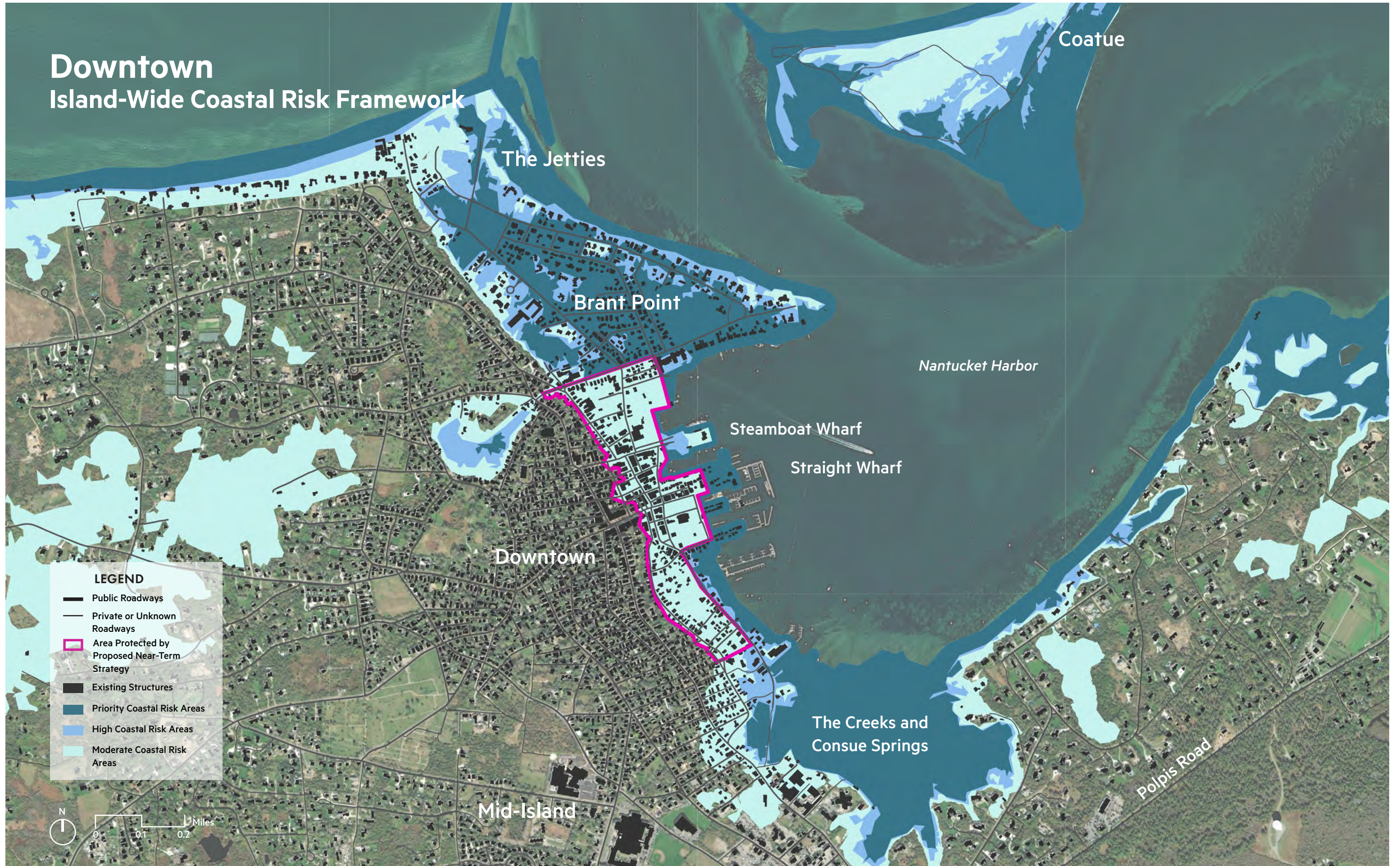
Children's Beach Pump
Station, Trevor Johnson

Overview of Coastal Risk Downtown

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	<p>Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.</p>	<p>High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.</p>	<p>Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.</p>	<p>Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.</p>

Downtown Island-Wide Coastal Risk Framework



LEGEND

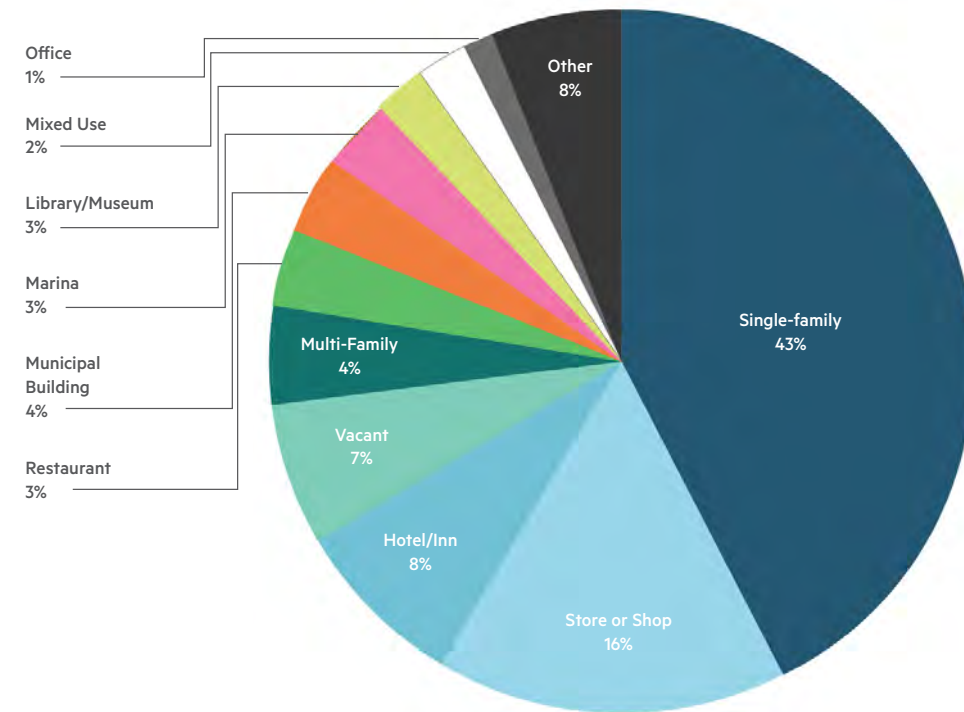
- Public Roadways
- Private or Unknown Roadways
- Area Protected by Proposed Near-Term Strategy
- Existing Structures
- Priority Coastal Risk Areas
- High Coastal Risk Areas
- Moderate Coastal Risk Areas



As shown in the map on page 148, large areas of Downtown and Brant Point are within the Priority Action Areas and High Coastal Risk Areas. The proposed Downtown Neighborhood Flood Barrier described later in this section, has the potential to reduce this risk by protecting 2.5 miles of public roads and 230 structures within the Nantucket Historic District from the 2070 high tide flooding level (mean monthly high water). Potentially protected structures include eight municipal buildings and five critical facilities including an electricity substation, grocery store, telephone exchange station, and community center. The vast majority of structures protected by the proposed barrier are single-family homes.

While the proposed barrier will reduce the risk of flooding up to the level of high tide flooding in 2070, it will not eliminate all risk of flooding in this area. Additional drainage infrastructure may be needed behind the barrier to reduce the impacts of groundwater table rise and stormwater flooding. Owners of public and private property behind the barrier should also implement building-scale adaptations to further reduce their risk to flooding during larger storm events.

In Brant Point and other low-lying areas outside of the Downtown Neighborhood Flood Barrier, there are 325 structures within Priority Action Areas and 85% of these structures are historic. Additionally, 3.5 miles of public roadways are within the Priority Action Areas. By 2070, over 950 structures and 9 miles of public roadways will likely be exposed to coastal hazards in these areas.



Structures Protected by Proposed Near-Term Downtown Barrier by Land Use

Downtown & Brant Point Exposure by Risk Area			
Risk Area	Structures Exposed (#)**^	Historic Structures (%)**	Public Roadways Exposed (miles)~
Priority Action Area	325	85%	3.5
High Coastal Risk Area	439	85%	4.17
Moderate Coastal Risk Area	954	85%	9.05

Number of exposed structures and roadways assumes protection from coastal hazards by the Downtown Neighborhood Flood Barrier. The extent of the protected area is shown on page 148.

*Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

**Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

^A structure is assumed to be exposed to the highest risk tier its footprint intersects.

~Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

Strategy Overview

To address each of the resilience challenges identified through this study and prior studies completed by the Town and other partners, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. As will be described, different types of approaches are suggested in different areas depending on the issue(s) addressed.

Infrastructure & Buildings

The first priority for Downtown Nantucket is maintaining access to and from the island for people and supplies via Steamboat Wharf. The Wharf is both the most essential and most at-risk facility on Nantucket. Both it and the access roads leading to it, especially Broad Street and Easy Street, are vulnerable to frequent flooding and loss of service by 2050 and are likely to be impacted by more severe coastal storms before then. The resilience strategy for Steamboat Wharf entails elevating the wharf above the elevation of mean monthly high water in 2100 (DFE of 12.0 feet NAVD88). The recommended design elevation of the wharf was selected in order to maintain everyday service for emergency access and ferry operations while minimizing physical and visual impacts on the character and experience of Downtown. Although the Wharf would remain vulnerable to flooding from coastal storms, building scale adaptations can reduce damage and disruption to the facility so that operations can be restored as quickly as possible following a storm event. This recommendation is the highest priority for the Nantucket community and will necessitate the Steamship Authority working closely with Town officials to assess the project's feasibility and undertake the implementation process.

To maintain essential access to the wharf, a number of roadways controlled by the Town, including Broad Street and Easy Street, also need to be elevated. By elevating Broad Street above flood levels, emergency access to this area of Downtown can also be maintained into the future. Raising roadways Downtown will require attention to maintain cross-street access and access to adjacent properties. In addition to Steamboat Wharf, a similar elevation strategy is recommended for other wharfs and docks on the Downtown waterfront including Straight Wharf, where the Hy-Line Ferry terminal is located, and the Town Dock at the Nantucket Boat Basin. The Town dock may either be redesigned and further elevated at the end of its current design life or converted to a floating dock structure if sufficient water depth exists in the future.

The elevation of the roadways leading to Steamboat Wharf will also create a segment of the recommended neighborhood-scale line of structural flood defense intended to reduce the impact of coastal flooding and mean monthly high water through 2070, assuming 7.2 feet of relative sea level rise. The risk of flooding in Downtown is widespread and significant, totaling 300 buildings and \$940M dollars of damage. The recommended strategy is intended to mitigate the effects of frequent flooding in the Downtown both today and in the long-term, reducing risk to priority community assets located there and maintaining everyday functions that are threatened by sea level rise. The Downtown Neighborhood Flood Barrier project can be implemented in phases over time. Phase 1 of the project should focus on reducing risks along the low-lying and highly vulnerable area along Easy Street from Straight Wharf to Steamboat Wharf.

The Downtown Neighborhood Flood Barrier incorporates several different resilience approaches, including raised roadways serving as berms on Easton Street, New Whale Street, Commercial Street, Washington Street, and Francis Street; raised bulkheads along Easy Street and on the waterfront at the Nantucket Yacht Club, reinforced dunes at Children's Beach, and integrated flood walls and berms in strategic locations where additional space enables coastal defense structures with a wider footprint. Pages 148-149 show typical sections for the alignment under three different conditions to illustrate how the line of protection can be integrated within the Town's existing appearance and character. The recommended next step for this project is further feasibility assessment and preliminary design to refine the conceptual designs developed through the CRP. This will enable more detailed evaluation of options and community discussion around viable approach alternatives.

In some areas, such as Straight Wharf and along Washington Street, there are multiple options for the location of the proposed Downtown Neighborhood Flood Barrier. In general, the line of protection can be located either at the water's edge or slightly inland. Inland options are more likely to be permitted under existing Federal, State, and local regulations but provide less risk reduction to homes and businesses. Options at the water's edge provide the maximum benefit to the community but may not be permissible and have the potential to interfere with habitat and natural systems. In both cases, private property owners and other stakeholders will need to work together to implement the approaches since the project would cross multiple public and private properties. New infrastructure in public rights-of-way may also have impacts on abutting property owners' access to roadways and sidewalks, which will need to be further analyzed and mitigated through the design process. This study offers several alignment options, as shown on pages 148 and 149, that offer viable paths forward for near-term implementation, including ongoing discussion with stakeholders and affected property owners.

The DFE of the Downtown Neighborhood Flood Barrier (7.5 feet NAVD88) was selected to reduce long-term impacts to everyday quality of life in Downtown from frequent flooding without impairing the character or experience of the area in the way that higher elevations of protection would.

Because the level of protection offered by the proposed project would not protect against all coastal flooding, particularly flooding caused by large storms, both public and private property owners throughout Downtown will need to adapt their properties using the toolkit of best practices described in greater detail on pages 126-135. These measures also provide additional levels of protection for properties that add redundancy against any failures in the neighborhood wide strategy.



Top: Swing-hinged gate stored in recessed wall.
PS Flood Barriers

Middle: Activated flip-up barrier protecting entrance-way. PS Flood Barriers

The recommended flood resilience approaches for Downtown may incorporate different types of gates and barriers that require human installation or action before a storm. These types of approaches are called “deployables.” Deployables can be appropriate for areas where access to and from buildings and properties needs to be maintained during dry conditions. These approaches can be used to reach higher levels of flood protection at key locations or at the entrances to businesses and other structures. Deployable measures are generally less reliable than other passive approaches, such as berms, walls, and dunes, and have greater operations and maintenance demands, so it is best to limit their use as part of a flood protection plan as much as feasible.

Infrastructure & Buildings, continued

The Town Finance Department Building at 37 Washington Street represents an opportunity for the Town to pilot and showcase building-scale resilience and stormwater management best practices, including elevation of critical systems, protection of sensitive equipment and documents, and deployable flood risk reduction measures, among other approaches. These strategies can be implemented immediately to protect the facility from flooding in the near-term. The Town may also explore relocation of the Finance Department to a structure located in a low risk area, using the 37 Washington Street structure for other functions that require proximity to the harbor. Even if used for a different function, 37 Washington Street still presents an opportunity to showcase building-scale resilience and stormwater management best practices.

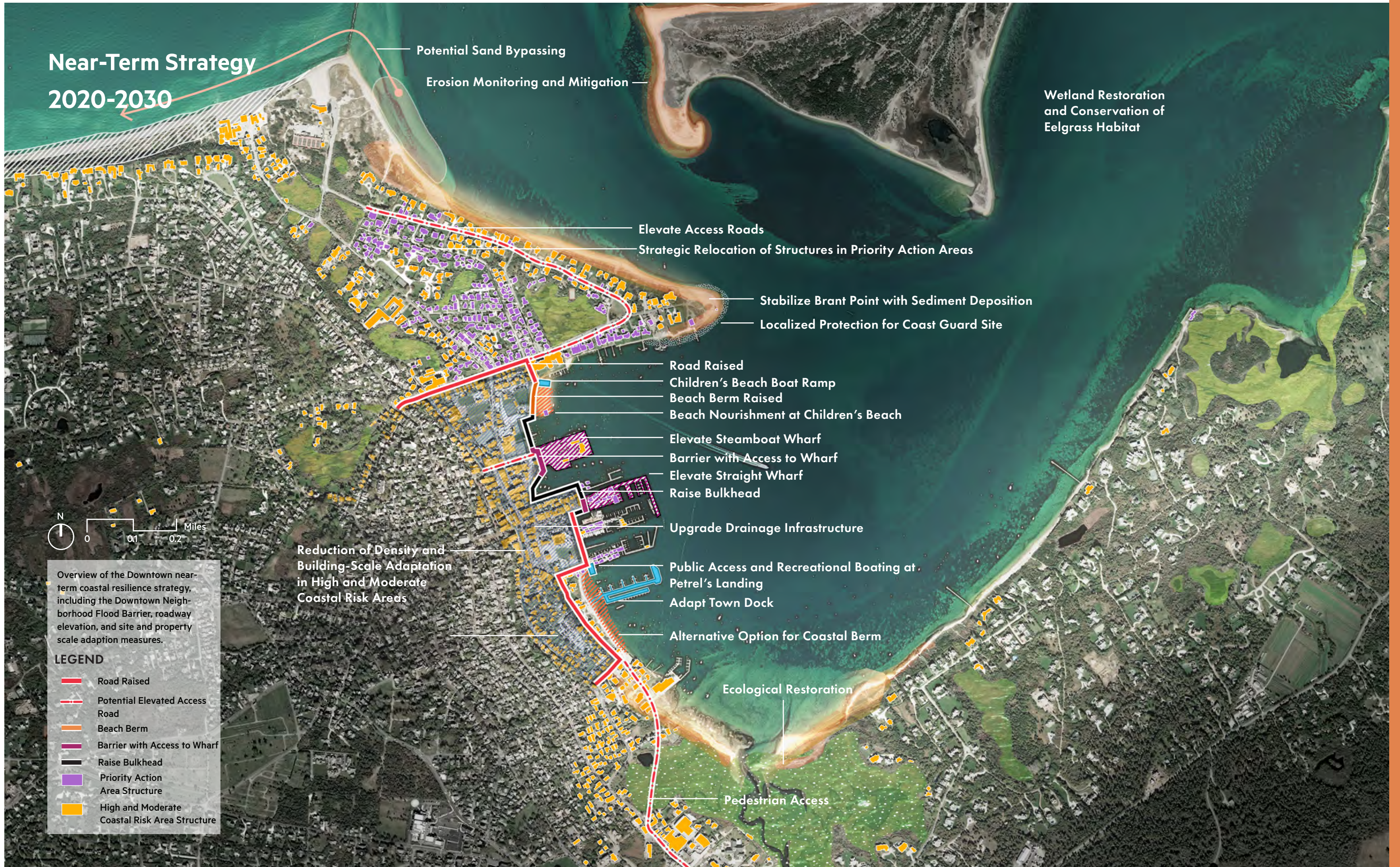
An additional consideration is stormwater drainage in Downtown and upland areas that drain to the area. While the Downtown area already experiences flooding in streets, yards, and other low-lying areas during intense rainfall events, the implementation of coastal defense measures has the potential to exacerbate these issues by changing surface flow drainage patterns. Sea level rise will also reduce the ability of existing outfalls to discharge if located below future tides. Therefore, interior drainage systems will need to be included in the implementation plan, designs, and cost for the Downtown Neighborhood Flood Barrier, which may include additional green infrastructure such as rain gardens, bioswales, and other retention approaches, as well as additional pumping capacity and tide gates at outfalls. The cost estimates for the proposed Downtown Neighborhood Flood Barrier includes an allowance for new drainage infrastructure.

In Brant Point and Monomoy, additional actions are recommended to maintain everyday and emergency access. In Brant Point, the strategy includes elevating Easton Street and Hulbert Avenue above mean monthly high water through 2070, assuming 7.2 feet of relative sea level rise. This approach is intended to maintain longer-term emergency access to the neighborhood while private residences remain there. The raised public rights-of-way will likely affect abutting property owners' access to roadways and sidewalks and thus the design process will require ongoing consultation between the Town and impacted property owners to identify ways to

mitigate these impacts. In Monomoy, adaptation of Washington Street Extension and the footpath adjacent to Consue Springs and The Creeks will be necessary to maintain long-term public access.

In both Brant Point and Monomoy, the proposed elevated access routes do not provide flood protection for inland private buildings. Therefore, for these areas to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. This could include a number of steps, from elevation of the structure, to wet floodproofing, to relocation in some cases. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate to reduce their risk. Private property owners may also choose to participate in a collective solution that involves raising the shoreline to defend against flooding. This solution would very costly, highly complex, may face regulatory challenges, and would require participation by every waterfront property owner to be effective.

Near-Term Strategy 2020-2030



Overview of the Downtown near-term coastal resilience strategy, including the Downtown Neighborhood Flood Barrier, roadway elevation, and site and property scale adaption measures.

LEGEND

- Road Raised
- Potential Elevated Access Road
- Beach Berm
- Barrier with Access to Wharf
- Raise Bulkhead
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure

Natural Resources & Erosion Management

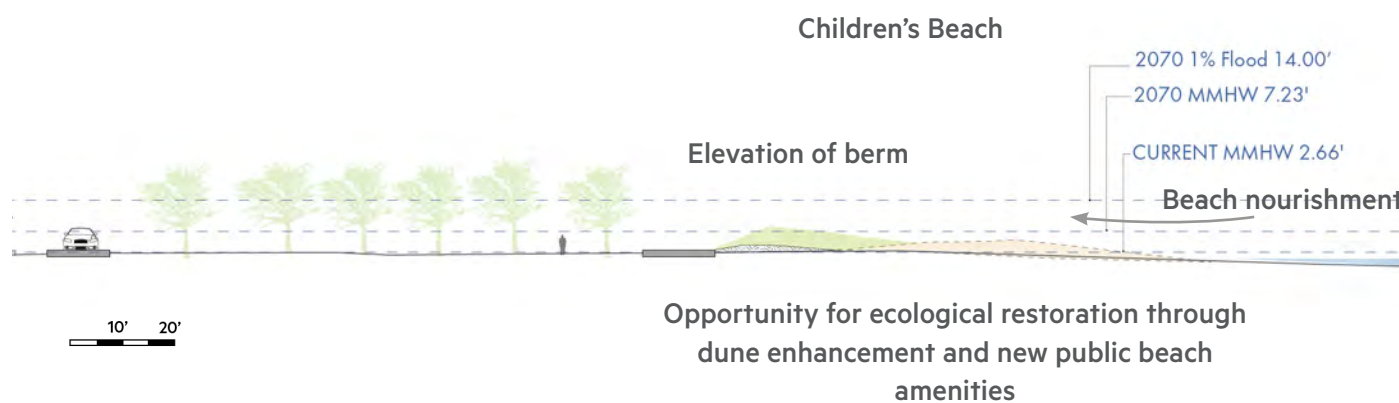
A number of steps are also recommended to mitigate the potential impacts of sea level rise and erosion on natural resources and habitat near Downtown. The Brant Point peninsula helps shelter Nantucket Harbor from large ocean waves and erosion management, including continued nourishment, dune building, and planting, is proposed to maintain this protective function. Similar recommendations for Coatue are included in the Nantucket Harbor strategy in the section of the plan. Another consideration related to the erosion management approach in the Harbor is the need to maintain appropriate depths for maritime navigation within the Harbor. A dredging plan which include prioritization and beneficial reuse of dredge spoils is therefore recommended for Nantucket Harbor. At the wetland area known as The Creeks, a long-term resource management plan is recommended to determine the best course of action, including accretion and salinity modeling to determine if long-term wetland enhancements may be necessary or appropriate.

Opportunities for Co-Benefits

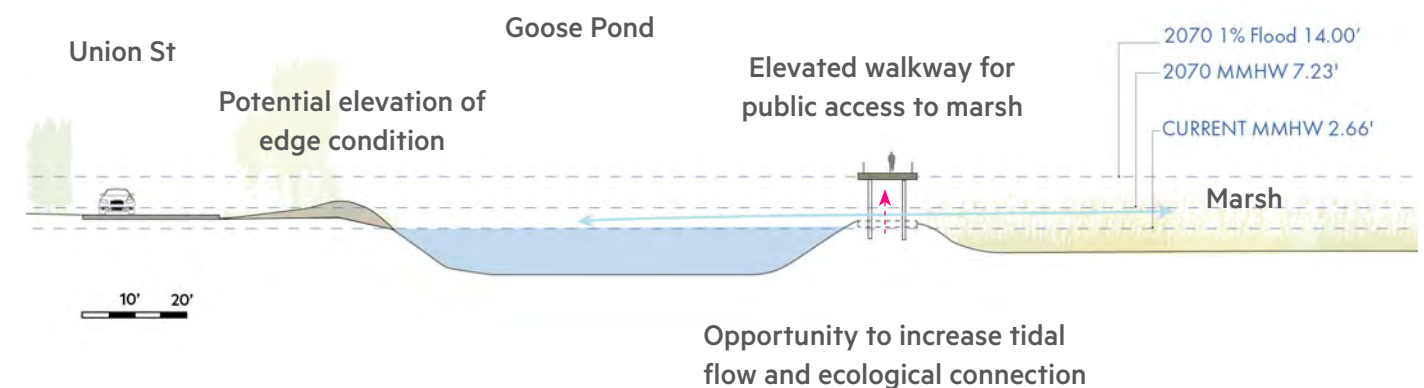
Co-benefits are features of a resilience strategy that address other community goals and needs in addition to coastal risk reduction. The resilience strategy for Downtown includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including new improve public boating access, new waterfront parks, and pocket parks that also retain and filter stormwater.

The map to the right illustrates potential opportunities in Downtown and Brant Point for new green infrastructure.

Children's Beach

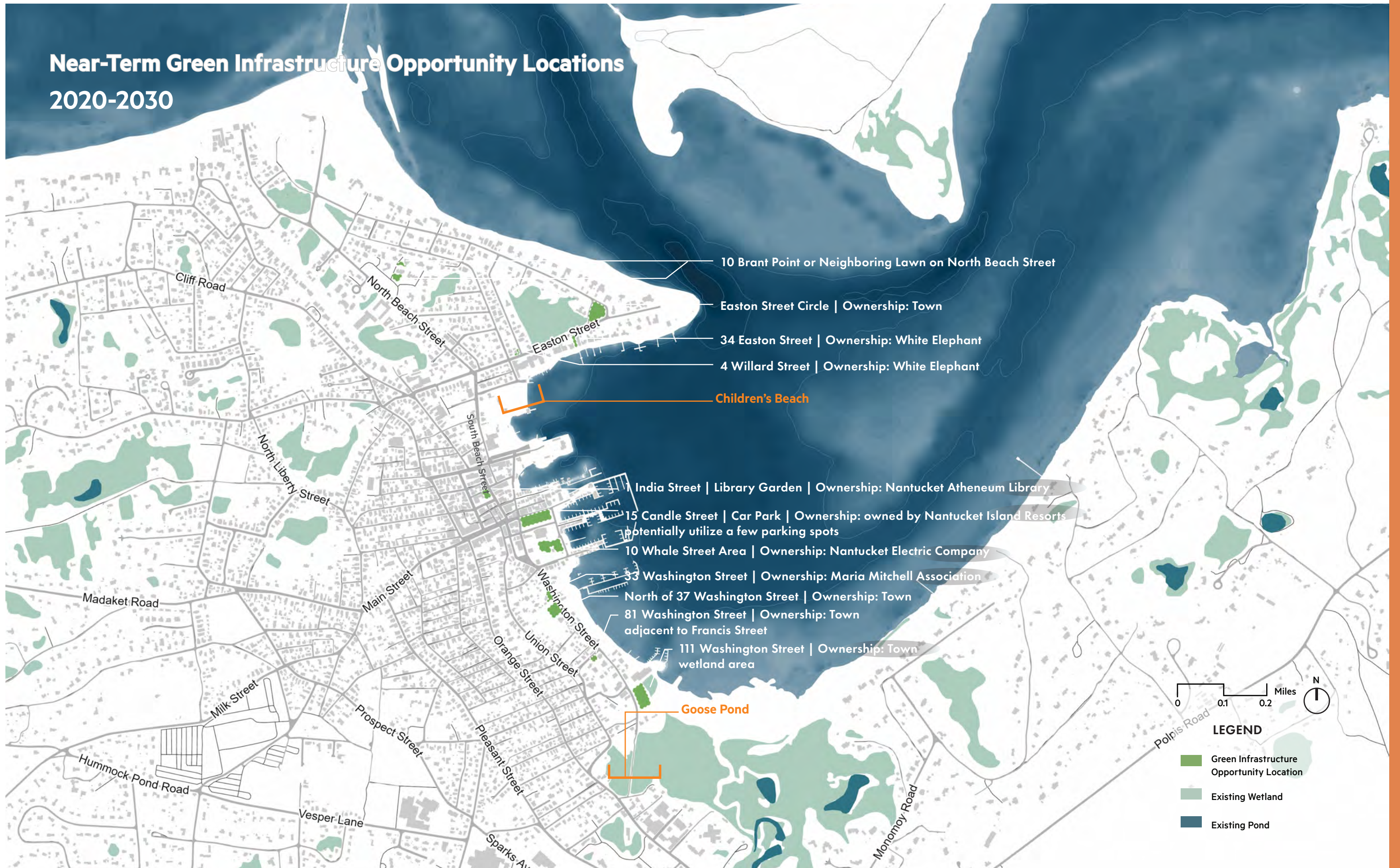


Goose Pond



These sections show example profiles of the Downtown Neighborhood Flood Barrier at Children's Beach and the Consue Springs Walkway Raising project. The location of the sections is indicated in orange on the map to the right. These concepts are illustrative and will be refined through future project design phases.

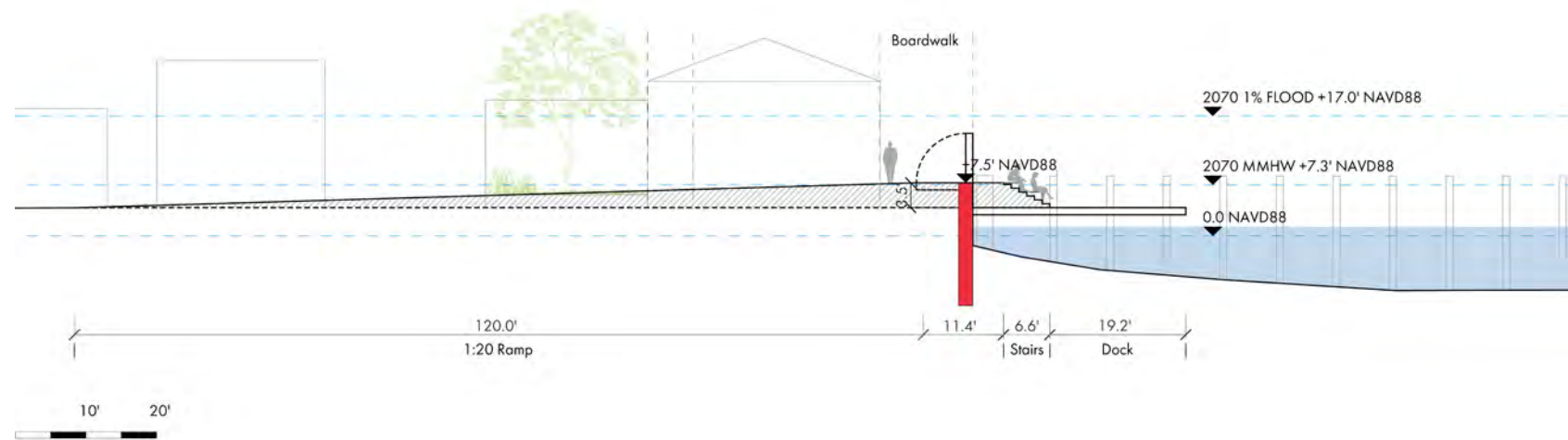
Near-Term Green Infrastructure Opportunity Locations 2020-2030



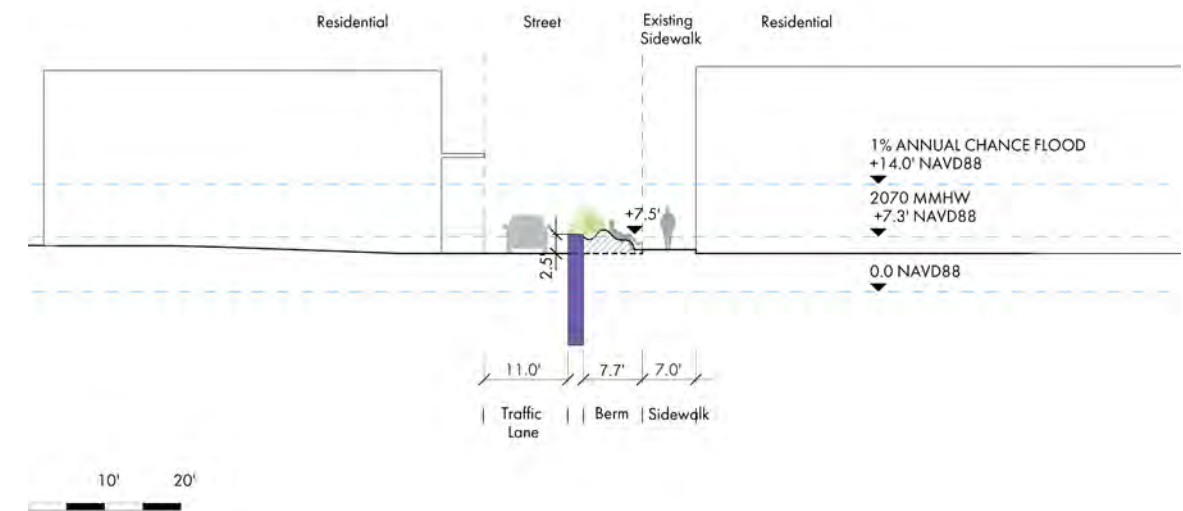
Downtown Neighborhood Flood Barrier Alignment Alternatives



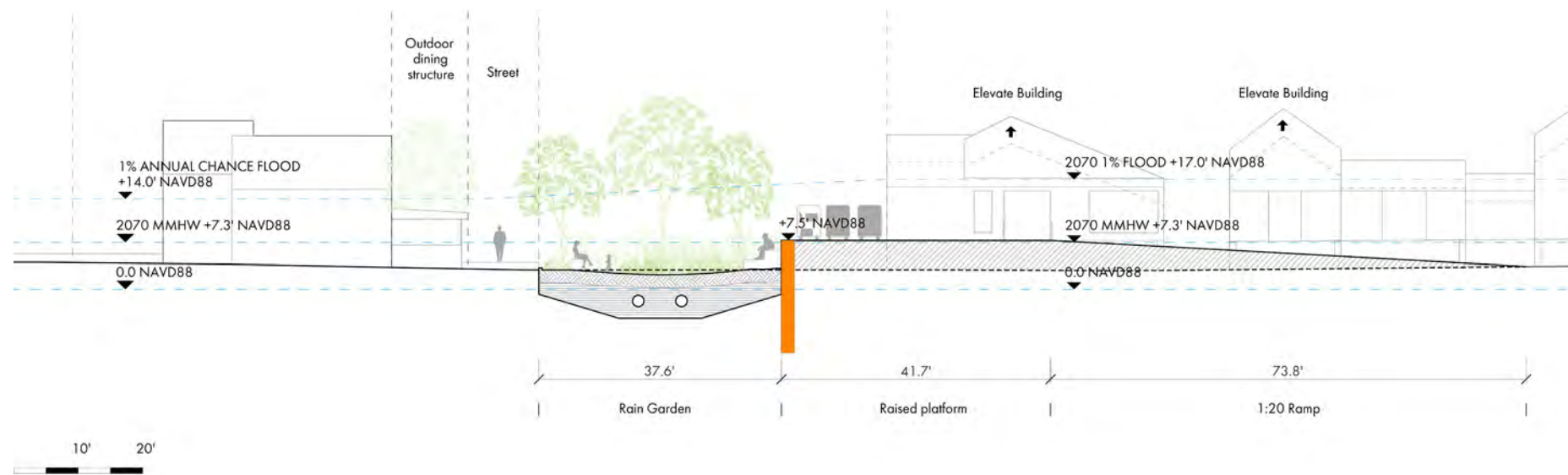
WATER'S EDGE



PUBLIC RIGHT OF WAY



INLAND OPEN SPACE



The map on the facing page shows alternative alignment options for the Downtown Neighborhood Flood Barrier. These alternatives will help inform community discussions about different design strategies. Three potential design strategies are shown on this page. In general, the line of protection created by the barrier can be located either at the water's edge or slightly inland within the public right of way or on private property. Inland options are more likely to be permitted under existing Federal, State, and local regulations but provide less flood risk reduction to homes and businesses. Options at the water's edge provide the maximum benefit to the community but may not be permissible and have the potential to interfere with habitat and natural systems. In both cases, private property owners and other stakeholders will need to work closely together to implement the approaches since the project would cross multiple public and private properties. The next step of the design process for this project should include ongoing engagement with property owners and more detailed technical evaluation to determine the preferred alternative.

Recommended Project Summary

The following projects are recommended in the Downtown as part of the coastal resilience strategy, including the anticipated benefits, level of protection, priority, duration of performance, estimated cost, and potential co-benefits for each.

Steamboat Wharf Resilience

Description	Work with the Steamship Authority to develop adaptation plan for Steamboat Wharf with the preferred option of elevating the pier above future mean monthly high water. Building scale measures can be implemented on the wharf over time to reduce risk from coastal storms and enable rapid restoration of operations after a storm. The strategy should be integrated with the design of the Downtown Neighborhood Flood Barrier described below to maintain access from Broad Street onto the Wharf. Final approach will need to be planned and design by the Steamship Authority but close coordination with Town's resilience planning will be critical to a successful island-wide resilience strategy.		
Resilience Objective & Level of Protection	Maintain everyday service at ferry terminal to the elevation of mean monthly high water (MMHW) in 2100 (11.0 feet NAVD88). The new elevation is 2 to 7 feet above the existing elevation of the wharf. This plan will reduce risk from long-term tidal flooding as well as more severe storms in the next 10-20 years.		
Duration of Performance	70-80 years, depending on timing of implementation	Priority	First
Estimated Cost	Capital Costs: \$87M Capital Costs with Contingencies: \$110M-\$120M Annual Operations and Maintenance: \$1.3M		
Estimated Benefits	\$19M in avoided direct physical, economic, and social damages to buildings. Additional benefits not quantified include reducing the long-term risk of disruption to ferry service due to flooding at Steamboat Wharf.		
Co-benefit Opportunities	New terminal facilities and improved access to and from the ferry Potential to add new public amenities as part of wharf elevation and redesign		

Downtown Neighborhood Flood Barrier

Description	The barrier system includes a number of elements that will need to be implemented over time to provide comprehensive, effective flood risk reduction to the recommended elevation (see below). The elements include raised roadways, raised bulkheads, reinforced dunes, and berms. Deployable gates may be necessary in select locations, but the overall approach recommends passive measures that are integrated with the existing built environment, while maintaining access to key waterside facilities such as the Children's Beach Boat Ramp, Steamboat Wharf, Straight Wharf, and the Town Pier. The approach can be implemented in phases over a period of 10 to 15 years. In the near-term, Phase 1 of the project should focus on reducing risks to the low-lying and highly vulnerable area along Easy Street from Straight Wharf to Steamboat Wharf. As the project is implemented, stormwater management needs will need to be studied and addressed via new drainage infrastructure. Additionally, as part of the Downtown strategy, the Town can pilot and showcase best practices for building-scale resilience at 37 Washington Street.		
Resilience Objective & Level of Protection	Reduce flood risk from frequent tidal flooding in the Downtown core, with benefits to essential public facilities and services, to 7.5 feet NAVD88, just above the elevation of mean monthly high water (MMHW) in 2070. The design strategy should incorporate the ability to adapt the infrastructure to higher elevations in the future, as appropriate.		
Duration of Performance	40-50 years, depending on timing of implementation	Priority	First
Estimated Cost (all phases)	Capital Costs: \$120M Capital Costs with Contingencies: \$150M - \$170M Annual Operations and Maintenance: \$1.9M		
Estimated Benefits	\$320M in avoided direct physical, economic, and social damages to buildings. Additional benefits not quantified include reducing the long-term risk of service disruptions for roadways and utilities, as well as reduction in flood risk to critical and community facilities, such as the National Grid electrical substation and Town Hall.		
Cobenefit Opportunities	Adaptation of the Town dock to higher elevations or conversion to a floating dock New waterfront resilient public access on Nantucket Land Bank property at Petrel's Landing (New Whale Street and Commercial Street) Streetscape improvements via rain gardens, bioswales, and other green infrastructure to manage stormwater Potential for local jobs and workforce development during construction		

Easton Street and Hulbert Avenue Road Raising

Description	<i>Road raising project to prolong service life of Easton Street and Hulbert Avenue for emergency and everyday access to residences in Brant Point</i>	
Resilience Objective & Level of Protection	<i>Prolong service life of Easton Street and Hulbert Avenue for emergency access in Brant Point to 7.5 feet NAVD88, just above the elevation of mean monthly high water (MMHW) in 2070. Elevated roadway will tie into the Downtown Neighborhood Flood Barrier at the intersection of Easton Street and South Beach Street.</i>	
Duration of Performance	<i>40-50 years, depending on timing of implementation</i>	Priority <i>Third</i>
Estimated Cost	<i>Capital Costs: \$100M Capital Costs with Contingencies: \$130M - \$140M Annual Operations and Maintenance: \$1.6 M</i>	
Estimated Benefits	<i>Not quantified for this study. Qualitative benefits include reduced risk of loss of service of roadways and other infrastructure in Brant Point</i>	
Cobenefit Opportunities	<i>Potential for wetland enhancements and stormwater retention at the Nantucket Conversation Foundation-owned marsh and other green open spaces on Easton Street</i>	

Washington Street Extension and Consue Springs Walkway Raising

Description	<i>Road raising to prolong service life of Washington Street Extension for emergency and everyday access as well as public access in Consue Springs and the Creeks</i>	
Resilience Objective & Level of Protection	<i>Prolong service life of Washington Street Extension and public access in Consue Springs to 7.5 feet NAVD88, just above the elevation of mean monthly high water (MMHW) in 2070. Elevated roadway and pathway will tie into the Downtown Neighborhood Flood Barrier at the intersection of Washington Street Extension and Francis Street.</i>	
Duration of Performance	<i>40-50 years, depending on timing of implementation</i>	Priority <i>Third</i>
Estimated Cost	<i>Capital Costs: \$47M Capital Costs with Contingencies: \$58M - \$65M Annual Operations and Maintenance: \$720K</i>	
Estimated Benefits	<i>Not quantified for this study. Qualitative benefits include prolonging public access to Consue Springs natural area</i>	
Cobenefit Opportunities	<i>Wetland enhancements and improved tidal exchange at Consue Springs</i>	

Conceptual Examples of Resilience Strategies in Downtown and Brant Point

These visuals are intended to show how a subset of the strategies recommended in this section might appear if constructed. They do not depict any particular streets and are intended to show typical Nantucket streetscapes. These visuals are not meant to be final designs but rather to illustrate one way conceptual solutions could be realized to reduce flood risks in Downtown and Brant Point. They can be used to help inform further community discussions about the appropriate appearance of coastal resilience structures.



Conceptual example of a road raising strategy in a residential neighborhood, such as Brant Point. This long-term strategy to sustain emergency access to the neighborhood can be combined with elevation and other resilience upgrades to private residences to mitigate the risks from high tide flooding and groundwater emergence.

Conceptual example of the road raising strategy during a flood event. This strategy provides continued service on the road to 7.5' NAVD88.



Conceptual design of the Downtown Neighborhood Flood Barrier intended to reduce risk from future high tide flooding. This example shows a typical street condition, similar to Washington Street in Downtown. This is one way that a road elevation could serve as a barrier to flooding and be integrated within the character and experience of the Downtown streetscape.





















Conceptual design of the Downtown Neighborhood Flood barrier during a flood event. The barrier is designed to protect against future flooding up to 7.5' NAVD88.

Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for Downtown and Brant Point. Reducing coastal risk on private properties in both areas will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance, increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Changes to zoning and wetland regulations recommended on pages 96-102 will also be necessary to promote resilience in the area, such as providing allowances and incentives to implement adaptation measures on private property. In Brant Point and other low-lying areas outside of the Downtown Neighborhood Flood Barrier that are in Priority and High Coastal Risk Areas, strategic acquisition of priority properties is recommended to reduce density over time. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

Evaluation Criteria	Most Desirable Impact			
Effectiveness & Adaptability				
Implementation Feasibility				
Ecological & Public Health				
Equity & Quality of Life				
Value Creation				

Near-Term Strategy 2020-2030



Elevate Access
Roads

Strategic Relocation of Structures
in Priority Action Areas

Children's Beach
Boat Ramp

Elevate Steamboat
Wharf

Stabilize with Sediment

Elevate Straight
Wharf

Priority Enhancement and
Stabilization of Existing Dunes

Wetland Restoration and
Conservation of Eelgrass Habitat

Erosion Monitoring and Mitigation

Raise Bulkhead

Barrier with Access
to Wharf

Public Access and
Recreational Boating at
Petrel's Landing

Adapt Town Dock

Upgrade Drainage
Infrastructure

Road Raised

Reduction of Density and
Building-Scale Adaptation
in High and Moderate
Coastal Risk Areas

Conceptual rendering of the
Downtown near-term coastal
resilience strategy.

Long-Term Adaptation Pathways

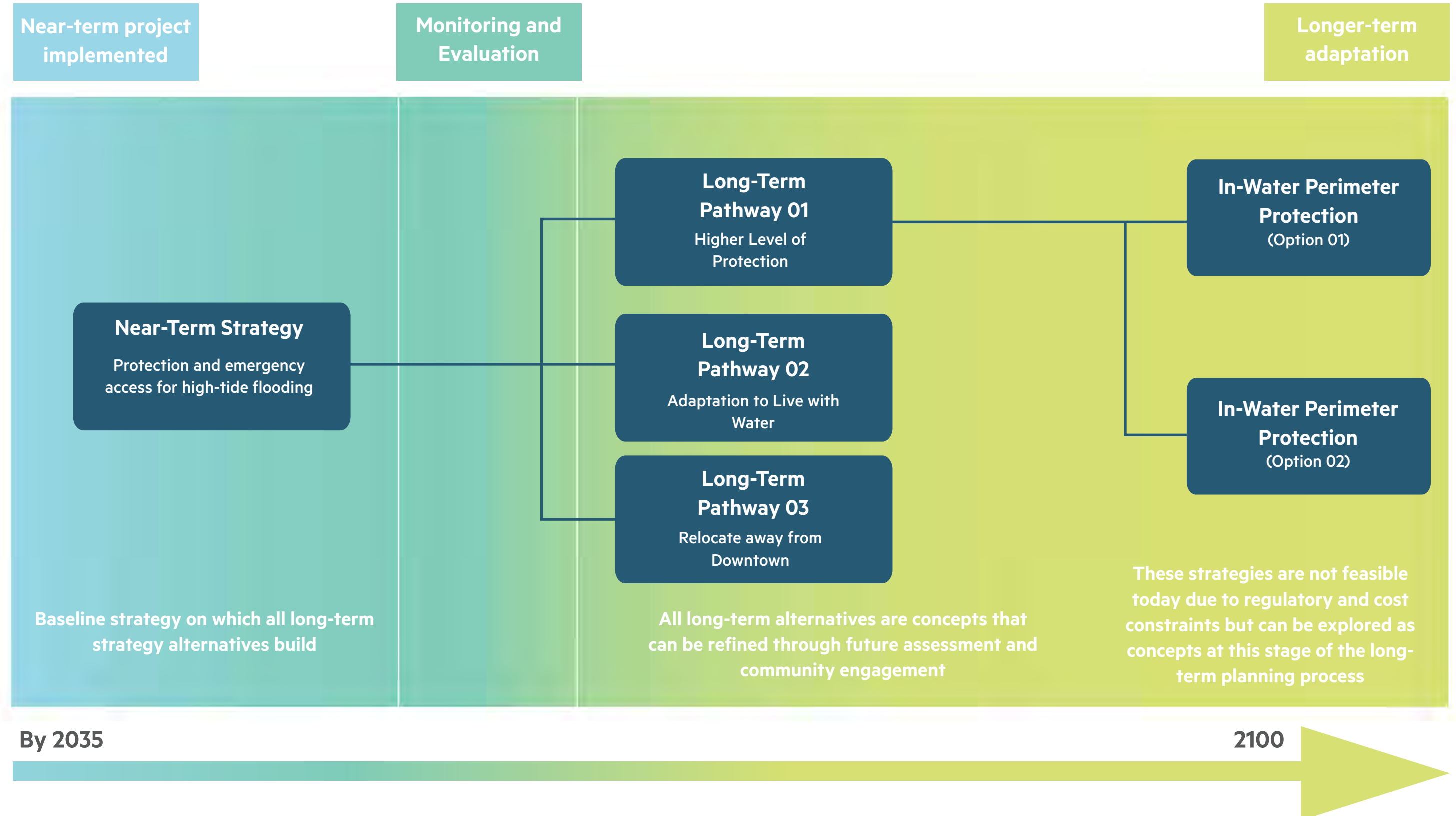
The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathways for Downtown provide viable pathways for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science, and evaluate future adaptations to the near-term projects.

There are multiple long-term planning pathways for Downtown and Brant Point, all building on the recommended near-term strategy. Each of these pathways will require additional detailed study and ongoing community engagement with a variety of stakeholders, including property and business owners, employees, residents, water dependent users, interested conservation and environmental organizations, and regulators, among others.

We call these three alternative long-term adaptation pathways “scenarios” because many factors will need to change in order for the alternatives to be implemented. These include changes to current regulations, which would not allow several of these alternatives to be constructed today, and changes in public sentiment, which would likely consider these approaches impossible or undesirable today. Nevertheless, sea level rise is projected to accelerate in the decades ahead and long-term planning should not wait. These scenarios are thus provided as ideas that the community can continue to explore and discuss as pathways for creating a Nantucket for future generations. Ongoing engagement and study for these scenarios should be conducted in parallel with the implementation of the recommended near-term strategy described in this section.

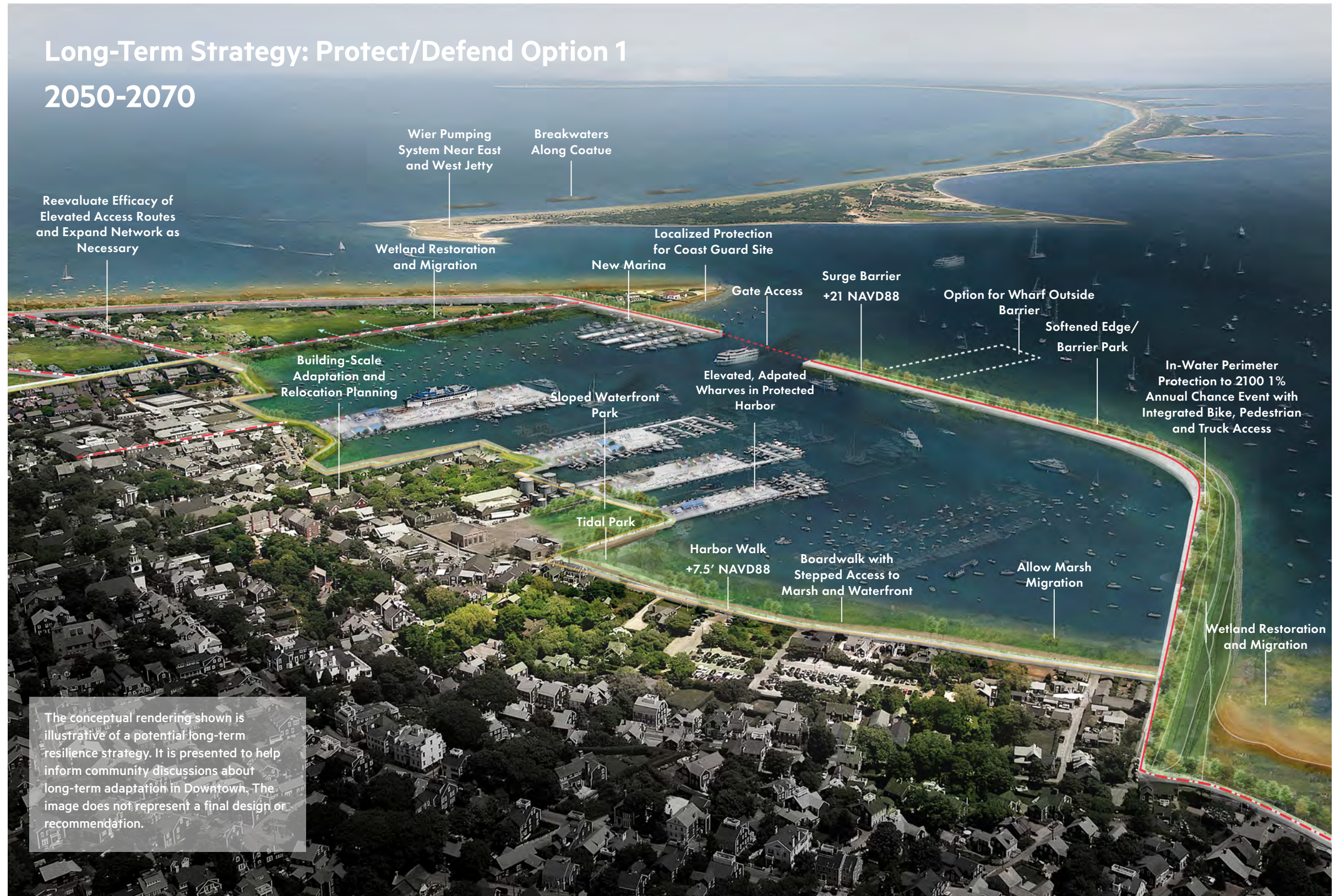
One important note is that each scenario could include relocation of Steamboat Wharf to an alternative site, either within the Downtown or to another area of the island. The Nantucket Natural Hazard Mitigation Plan recommends identifying an alternative site and navigation channel for a new terminal in case the existing terminal is unable to function. This step is considered long-term in nature for the CRP given the complexity of identifying a suitable location, acquiring land, and physically constructing the terminal and navigation channel. In any scenario, close coordination with the Steamship Authority is recommended in order to identify a feasible approach for flood risk reduction and continued service for the terminal.

Long-Term Adaptation Pathway (2035-2100)



Long-Term Adaption Pathway 1: Harbor Barrier System

This long-term adaption scenario involves constructing a coastal storm surge barrier in the Harbor. There are multiple options for the location of the barrier. While placement at the mouth of Harbor between the Jetties and Coatue may at first appear to be the optimal location for such an investment, our evaluation suggests that other conceptual alignments are more feasible based on the combined goals of limiting environmental impacts, navigational interference, and cost. These recommended conceptual alignments are described in more detail on pages 158-160. Both barrier concepts would provide neighborhood-wide storm surge protection to the design elevation of the estimated 2100 1% annual chance storm, including 7.9 feet of sea level rise, although the area that is protected varies. Because the barrier will need to include a gate for access into the inner harbor for boats, shoreline adaption is still necessary to address future tidal flooding. During major storm events, this gate would close, and boats would not operate. The recommended Downtown Neighborhood Flood Barrier protects against future high tide flooding and can be adapted to a higher elevation as needed in the future.



Long-Term Strategy: Protect/Defend Option 1 2050-2070



LEGEND

- Road Raised and Surge Barrier
- - - Potential Elevated Access Road
- Harbor Walk and Barrier
- Road Raised Alternative 2
- Road Raised Alternative 3 Berm

The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.

Long-Term Strategy: Protect/Defend Option 2 2050-2070



Establish Relocation Policies

Wier Pumping System
Near East and West Jetty
to Move Sediment from
Channel to Downdrift Beaches

Wetland Restoration
and Conservation of
Eelgrass Habitat

Reevaluate Efficacy of Elevated Access Routes
and Expand Network as Necessary

Wetland Restoration and Migration

Stormwater Best
Management Practices

Wetland Restoration
and Migration

Beach/Sediment

Gate Access

Option for Wharf Outside Barrier

Elevated, Adapted Wharves
in Protected Harbor

In-Water Perimeter
Protection to 2100 1%
Annual Chance Event with
Integrated Bike, Pedestrian
and Truck Access

Harbor Walk

Building-Scale
Adaptation
and Relocation
Planning

New Marina

Beach/Sediment

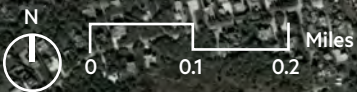
Soft Recreational/
Ecological Shoreline

Stormwater Best
Management Practices

Ecological Tourism
Walkway, Kayaking

Wetland Restoration
and Migration

Establish Relocation Policies



LEGEND

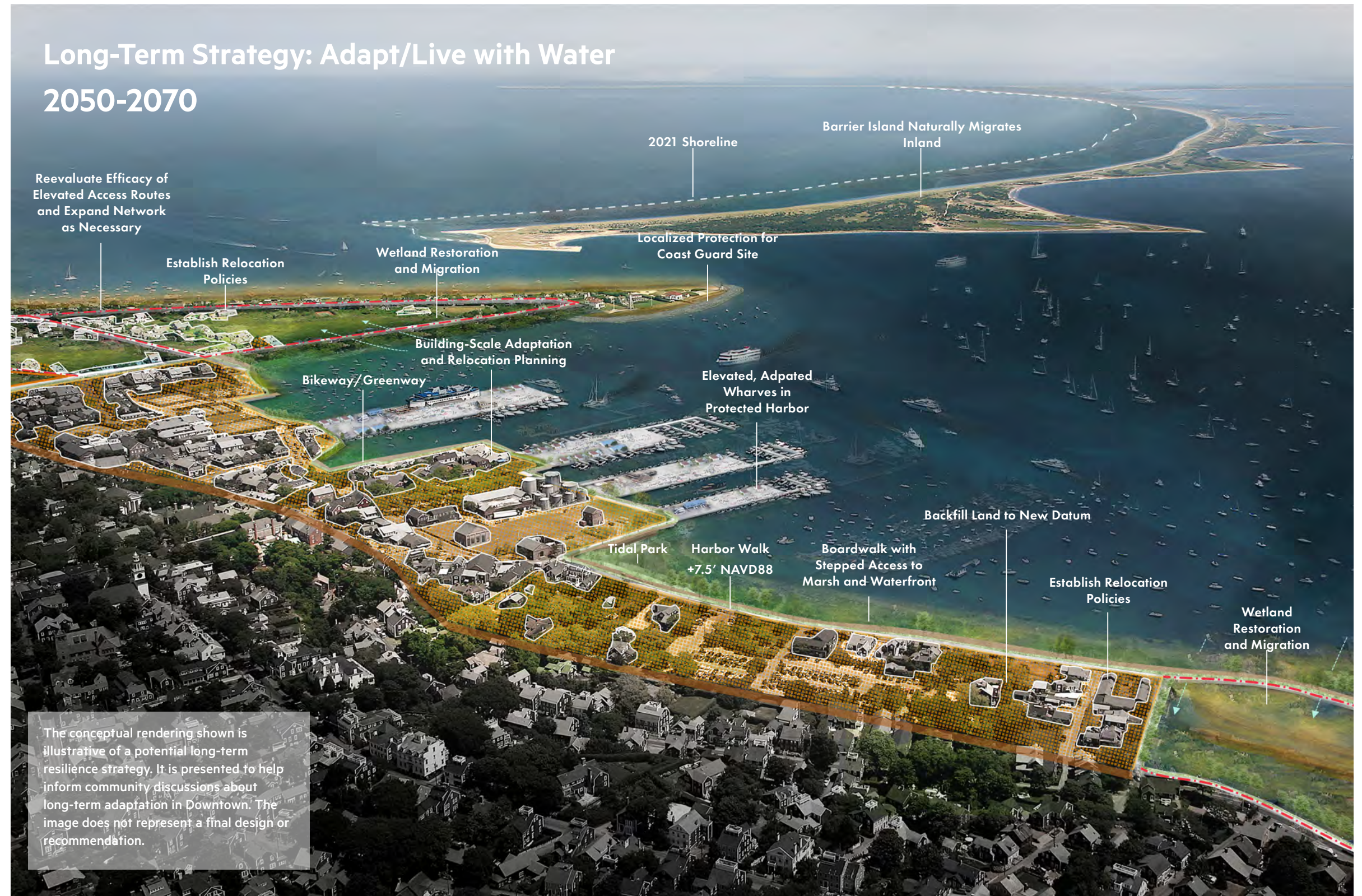
- Road Raised and Surge Barrier
- Potential Elevated Access Road
- Harbor Walk and Barrier
- Reevaluate Efficacy of Elevated Access Road

The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.



Long-Term Adaption Pathway 2: Adapting to Live with Water

This long-term adaption scenario involves elevating the Downtown core, including all structures and surface infrastructure, to a new higher elevation. In this scenario, risk of tidal flooding and groundwater table rise is reduced at the new established grade, with additional coastal defense structures or building scale protections necessary to address coastal flooding from lower frequency, more severe storms. This scenario can build on the recommended Downtown Neighborhood Flood Barrier system to establish the new coastal edge and retention wall for the elevated downtown area. The maps on this page and the next visualize the key elements of this scenario. In Brant Point and near Consue Springs, this scenario would entail reductions in the number of buildings, elevation of all remaining buildings, and raised roadways, with marsh migration and restoration. Page 152 shows a conceptual image of typical Brant Point streetscape based on this scenario.



The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.

Long-Term Strategy: Adapt/Live with Water 2050-2070



Establish Relocation Policies

Barrier Island Naturally Migrates Inland

Reevaluate Efficacy of Elevated Access Routes and Expand Network as Necessary

Wetland Restoration and Migration

Localized Protection for Coast Guard Site

Wetland Restoration and Migration

Option to Backfill Land & Elevate Buildings Systematically or Individually

Elevated, Adapted Wharves

Building-Scale Adaptation and Relocation Planning

Barrier becomes new Ground-Level Datum and Harbor Walk

Backfill Land to New Datum & Elevate Buildings Behind Barrier Systematically or Individually

Reevaluate Efficacy of Elevated Access Routes

Wetland Restoration and Migration

Establish Relocation Policies



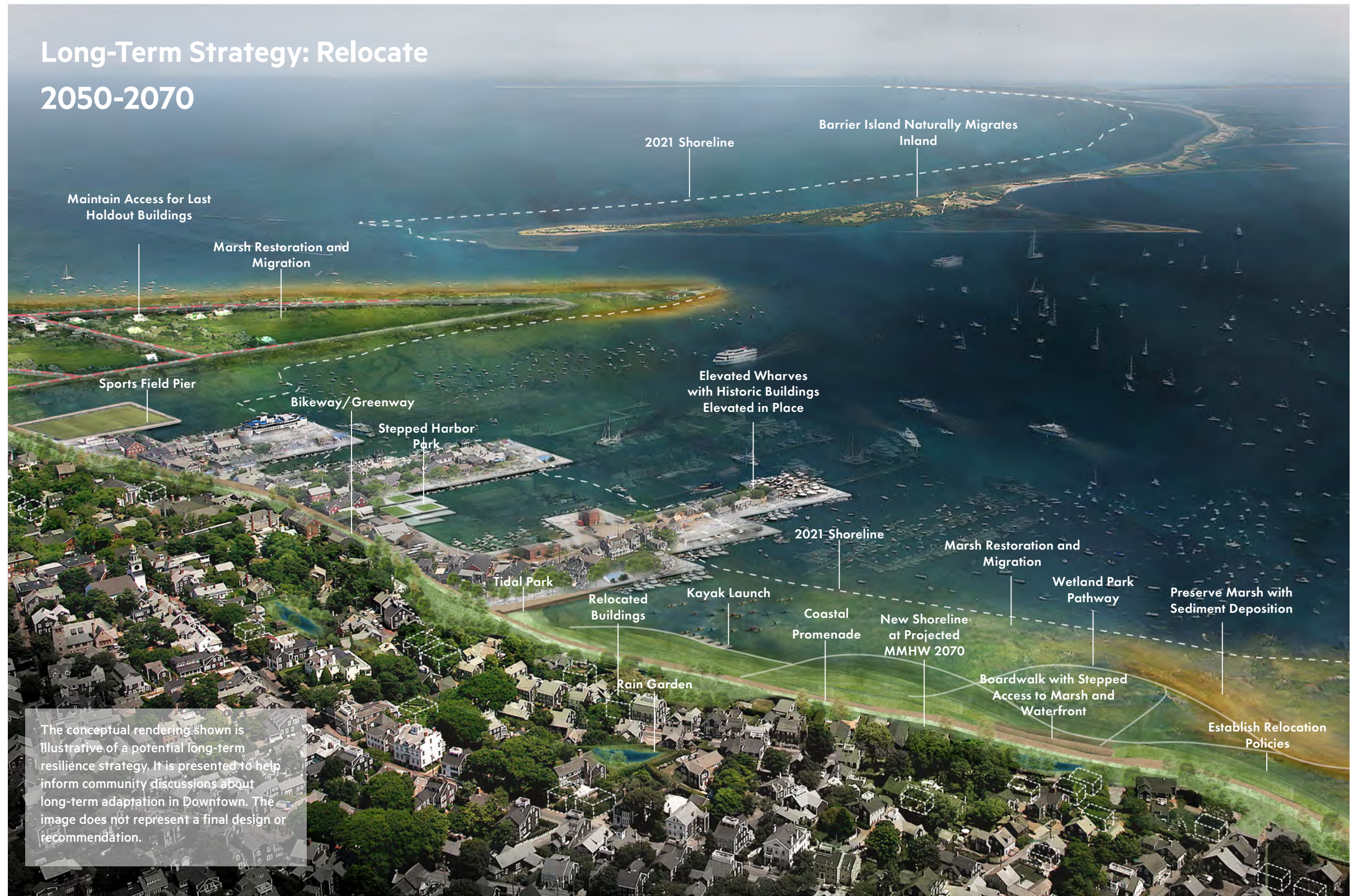
LEGEND

- Potential Elevated Access Road
- Harbor Walk Backfilled to New Datum

The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation.

Long-Term Adaption Pathway 3: Relocating

This long-term adaption scenario involves relocating all uses currently in the Downtown and Brant Point to lower risk areas of the island. This wholesale transformation of the Downtown would necessitate identifying suitable locations for the current uses in Downtown with particularly attention to environmental justice goals and the needs of historically disadvantaged populations for whom relocation could exacerbate existing inequities. Some existing uses in Downtown may be moved to high ground located on the bluffs surrounding the harbor, forming a new downtown center on high ground. The conceptual renderings of the scenario shown on this page and the next include the potential for new waterfront structures extending outboard from the new shoreline. These wharfs and piers could include ferry terminals, as well as other uses and buildings, such as historic landmarks and key water-dependent uses. Aside from risk reduction to the community, an additional benefit with the relocate scenario is the opportunity for significant ecological restoration in Downtown and Brant Point as sea levels rise and the existing developed Downtown and Brant Point areas are returned to nature.



Long-Term Strategy: Relocate 2050-2070



Erosion 2070

Establish Relocation Policies

Barrier Island Naturally Migrates Inland

MMHW 2070

Wetland Restoration and Migration

Maintain access roads for last holdout buildings

Wetland Restoration and Migration

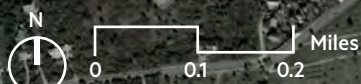
Coastal Promenade

Elevated Wharves Connected to New Coastal Promenade

Elevate Historic Buildings in Place

Building-Scale Adaptation

Establish Relocation Policies



LEGEND

- Coastal Promenade
- Elevated Wharves

The conceptual rendering shown is illustrative of a potential long-term resilience strategy. It is presented to help inform community discussions about long-term adaptation in Downtown. The image does not represent a final design or recommendation



MADAKET

An **ADAPT** strategy prioritizes extending the useful life of critical infrastructure in Madaket, maintaining access to private properties and water access points along Madaket Road. Enhancement of marsh habitats and pilot projects for nature-based erosion management slow the risks associated with flooding and erosion to buy time for strategic relocation of highly vulnerable properties. Private property owner implementation of building-scale adaptation measures addresses risks from major storms.

Area Overview

Located at the westernmost side of the main island, Madaket is characterized by its attractive beaches and tide pools as well as a wealth of areas of ecological importance including salt marshes, creeks, coastal wetlands, and eelgrass and mussel beds, which support a variety of habitats. The neighborhood surrounding the harbor houses numerous residential structures, many of which are at high risk due to flooding and erosion. Though the harbor is dredged and in-use, the amount of maritime activity seen there is limited compared to Nantucket Harbor and mostly consists of recreational and limited commercial uses.

Connected to the rest of the Madaket neighborhood by the Ames Avenue or “Millie’s” Bridge, Smith’s Point forms the southwestern corner of the main island. Smith’s Point largely consists of barrier beaches and salt marshes and has very minimal development and no paved roads. Flooding and erosion pose a significant threat

to the several dozen residences on Smith’s Point. For these homes, the Ames Avenue Bridge—which is also at-risk due to flooding and erosion—serves as critical infrastructure as the only point of access.

Beyond Smith’s Point are the sister islands of Tuckernuck and Muskeget, also part of Nantucket County. Muskeget is uninhabited but provides wildlife habitat and recreation during the summer months. Tuckernuck has approximately 30 homes that are occupied seasonally.

Further inland, up Madaket Road along Long Pond to North Head Long Pond, residences, roads, bridges, and the Town landfill and Department of Public Works Facility could also be exposed to the impacts of flooding in the future.

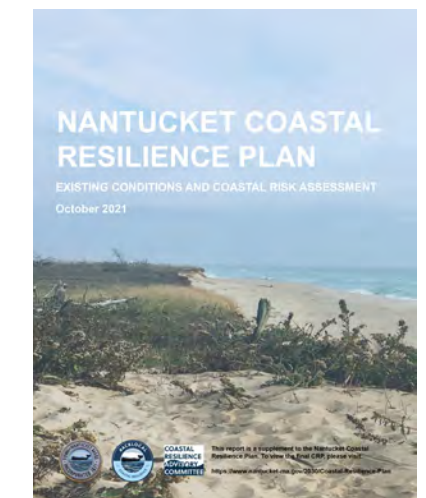
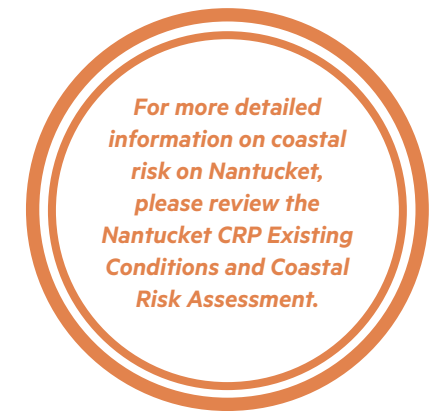


Jackson Point Boat Ramp, Ames Avenue Bridge, Madaket Marine (photos by Sonny Xu)

Summary of Resilience Challenges

The key coastal resilience challenges in Madaket include:

- Expected loss of access on critical roadways, specifically Madaket Road which serves as the main public access corridor and critical transportation route for the area
- Loss of bridge service at the Ames Avenue bridge, which is the only access point to Smith's Point
- Loss of eelgrass and shellfish habitat in Madaket Harbor due to sea level rise and potential breaching between Smith's Point and Esther's Island
- Loss of habitat and long-term tidal exchange through culverts on Madaket Road
- Erosion of the coastline across the focus area, especially at Smith's Point and adjacent to the intersection of Ames Avenue and Madaket Road
- Loss of public water access points at Jackson Point and F Street boat ramps
- Damage and disruption to private residences



Examples of
vegetation found in
Madaket
(photos by Sonny Xu)



Overview of Coastal Risk in Madaket

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.

In Madaket, 50 structures and nearly 1 mile of public roadways are within the Priority Action Area. 60% of structures within the Priority Action Area are historic. In the strategy described below, immediate action is recommended to reduce risk in this area.

Exposure Risk in Madaket			
Risk Area	Structures Exposed (#) ^{*^}	Historic Structures (%) ^{**}	Public Roadways Exposed (miles) [~]
Priority Action Area	50	60%	0.9
High Coastal Risk Area	115	56%	2.27
Moderate Coastal Risk Area	410	39%	6.27

^{*}Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

^{**}Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

Madaket Island-Wide Coastal Risk Framework



Strategy Overview

To address each of the resilience challenges identified through this study and prior studies completed by the Town and partners, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. As will be described, different types of approaches are suggested in different areas depending on the issue(s) addressed.

Infrastructure & Buildings

Maintaining everyday and emergency access to the Madaket area is a priority. Two specific stretches of Madaket Road will be vulnerable to flooding during mean monthly high water by 2030, resulting in loss of essential services to the area. To address this impact, the CRP recommends elevating Madaket Road, to create a resilient transportation corridor between Downtown and Mid Island and Madaket. By elevating Madaket Road to the elevation of mean monthly high water projected for 2070, assuming 4.3 feet of sea level rise, emergency access to the area can be maintained into the future. When the road is elevated, replacement of existing culverts at 1st and 2nd bridges with bridge structures is suggested to maintain the natural flow of water in the area, especially between Long Pond and North Head of Long Pond. Additional analysis will be necessary to determine the potential flooding impacts of culvert replacement. This project can be pursued in partnership with surrounding property owners, including the Linda Loring Nature Foundation. Alternative access for emergency vehicles during the elevation of Madaket Road should be considered when planning for this project. An ongoing engineering study of Massasoit Bridge is identifying rehabilitation and replacement alternatives to prolong the life of the bridge, providing one alternative transportation route. The strategy recommended by the CRP is consistent with long-term plans recommended by a 2019 Town-led Madaket Culverts Evaluation. As noted in the 2019 Town-led Madaket Culverts Evaluation, the culvert at North Cambridge Street is also vulnerable to the impacts of climate change and will likely require replacement as it reaches the end of its useful life. The CRP focuses on the replacement of existing culverts at 1st and 2nd bridge given the large population served and criticality of Madaket Road for emergency access.

In addition to Madaket Road, elevating F Street to maintain access to the boat ramp is a priority for maintaining access to the water for recreational and commercial fishing. The ramp would also need to be adapted by raising the elevations of the boat ramp top and roadways used for accessing the boat ramps. The Jackson Point boat ramp should continue in operation but is expected to experience significant risk due to frequent tidal flooding in the next decade. Once this loss of service becomes disruptive, the Town should examine consolidating the boat ramps at the upgraded F Street Boat Ramp. Through this strategy, the Town will maintain access to Madaket and boating access to the Harbor and to Tuckernuck and Muskeget through 2070.

The Department of Public Works facility and landfill at 188 Madaket Road is an essential Town facility at risk of coastal flooding. Building scale resilience and operational resilience planning are recommended for the facility to reduce risk of damage and ensure operational continuity in the event of a flood. Planned upgrades to the facility should consider coastal flooding impacts expected over the design life of the facility. This resilience planning should include assessment of deployable flood protection options for buildings, hardening and redundancy for critical systems, procedures for the relocation of vehicles and other equipment to high ground on the site, workforce planning in the event of a major disaster, and protection of bulk storage areas.

For Madaket to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. This could include a number of steps, from elevation of the structure, to wet floodproofing, to relocation in some

cases. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate to reduce their risk. In some areas of Madaket, identified as Priority Action and High Coastal Risk Areas, it is also appropriate to begin reducing density through policies and programs. Reducing density in Madaket could mean a number of things including changes to zoning regulations for future development, increases in setbacks for buildings and other structures, and acquisition and/or relocation of buildings, as described in Section 6. The Town should begin outreach to property owners in these areas immediately to communicate the degree of risk and conduct ongoing engagement regarding options for private property retreat and relocation. This is particularly urgent for properties located in Smith's Point where both flooding and erosion threaten properties and access in the near-term.

Natural Resources

Habitat protection and enhancement is also a priority in Madaket, including wetlands surrounding the harbor and Hither Creek and the eel grass population in the harbor. Protecting and enhancing these habitats has several important benefits including reducing flood and erosion risks and supporting fish and shellfish populations. Some of the ways the marsh and eelgrass habitat could be protected and enhanced include changes to make room for natural migration of resources, sediment enhancements to enable wetlands to “keep up with” sea level rise, development limits to reduce encroachment on the wetlands, and shoreline stabilization to reduce erosion impacts. In Madaket, there is room to allow the marsh to migrate further inland as sea levels rise. This open space should be preserved over the long-term via the Town's zoning and wetland regulations, as described in Section 6. Active management of these marshes such as adding material, strategic ditch remediation, and increasing their elevation, as appropriate, can also help them to keep up with rising seas. Additional study along with hydrologic and salinity modeling can help inform design strategies for ecological restoration and wetland resilience.

Erosion Management

Managing erosion along the beach in Madaket is important to protect public infrastructure, such as Madaket Road, Ames Avenue, and the Ames Avenue Bridge, that provides public access to Madaket and Smith's Point. Managing erosion in this area will also help ensure future safe navigation from Madaket Harbor. The shoreline is characterized by low-lying vegetated dunes with an elongated spit of land extending from Smith's Point to Esther's Island. Enhancing the dunes in this area can help manage erosion but will not stop the natural coastal process from continuing. A recommended pilot project consisting of restored natural dunes with vegetation and potentially sand fencing can help build the beach and protect nearby homes and infrastructure. The goal of the pilot project is to monitor performance of the approach while other island-wide studies, such as a sediment transport study, are ongoing. Enhancing dunes through nature-based approaches will require continual maintenance, including nourishment, so sand sourcing and cost must be considered during the preliminary design phase of the project.

Opportunities for Co-Benefits

Co-benefits are features of a resilience strategy that address other community goals and needs in addition to coastal risk reduction. The resilience strategy for Madaket includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including new public boating access, ecological restoration, and community education.

Madaket Road Project Summary

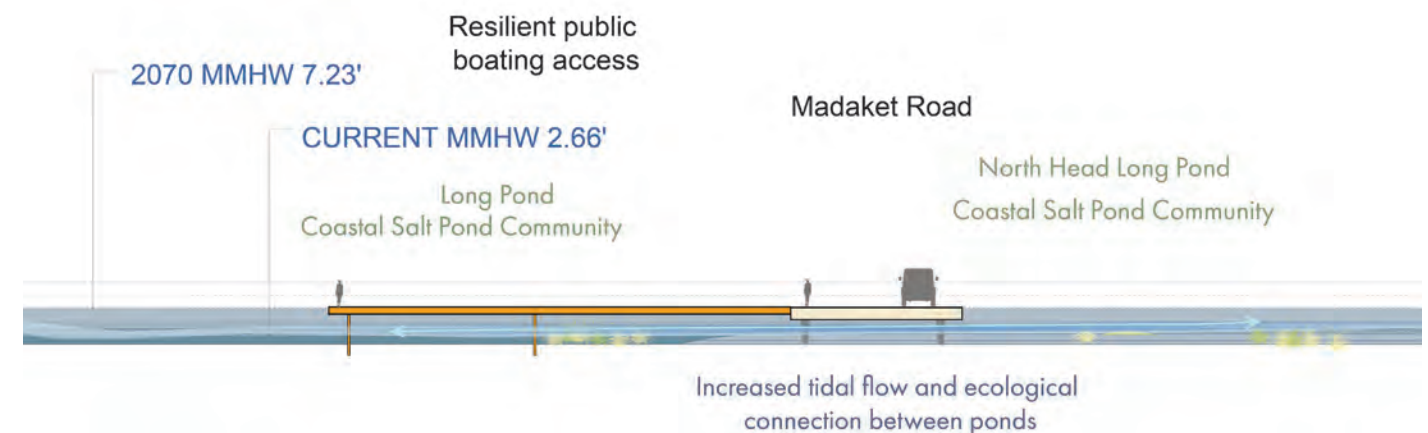
Below are the projects recommended for Madaket as part of the coastal resilience strategy, including the anticipated benefits, estimated costs, level of protection, urgency, and duration of performance for each.

Madaket Road Raising and Bridge Conversion

Description	Road raising and replacing existing culverts with bridges		
Resilience Objective & Level of Protection	Prolong service life of Madaket Road to provide emergency and day-to-day access to and from Madaket up to 7.5 feet NAVD88, just above the elevation of mean monthly high water (MMHW) in 2070, while advancing ecological restoration objectives for Long Pond.		
Duration of Performance	40-50 years	Priority	First
Estimated Cost	Capital Costs: \$29M Capital Costs with Contingencies: \$36M - \$40M Annual Operations and Maintenance: \$440K		
Estimated Benefits	\$6.2M– \$17.6M in avoided traffic delays and disruption. Additional benefits not quantified include reduced risk of loss of access for emergency vehicles and potential ecological restoration.		
Cobenefit Opportunities	<p>Potential for addition of new public boating access on Long Pond</p> <p>Improved long-term tidal exchange between Madaket Ditch, Long Pond, and North Head Long Pond</p> <p>Potential for long-term wetland enhancements and ecological restoration</p> <p>Opportunities for new public access and connectivity along Madaket Road</p> <p>Opportunity to partner with local conservation organizations to advance resilience and ecological restoration projects</p>		

Department of Public Works Facility and Landfill Resilience

Description	Building scale resilience and operational resilience planning to reduce risk of damage and limit disruption to core operations at the facilities. The first step in this recommendation is a site-specific study to determine the appropriate risk mitigation approaches for the facility.		
Resilience Objective & Level of Protection	Reduce risk of damage and ensure continuity of operations by protecting existing DPW structures to elevation of 1% annual chance storm in 2050 (12.5 feet NAVD88) and develop operational resilience plan including actions to protect or relocate rolling assets, workforce, and bulk storage areas.		
Duration of Performance	20-30 years	Priority	First
Estimated Cost	Study: \$150K-\$300K		



Section A-A*





The diagrammatic section above is an example profile of the Madaket Road Raising project as shown on the map to the right. Concept will be refined through future project design phases.

Madaket Near-Term Strategy

LEGEND



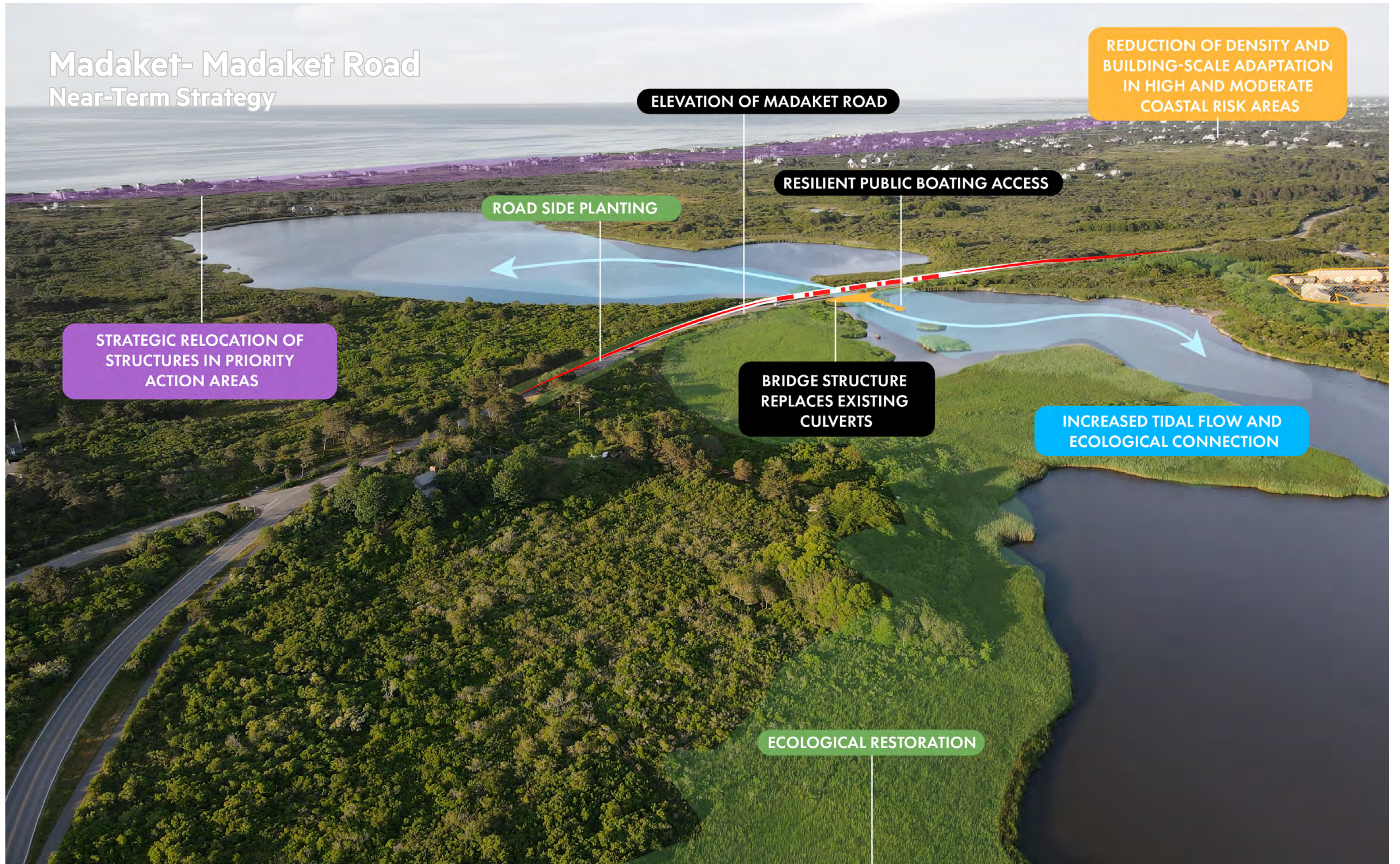
- 01 Ecological Restoration
- 02 Increased tidal flow and ecological connection
- 03 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 04 Strategic relocation of structures in Priority Action Areas
- 05 Building scale resilience and operational resilience planning at Dept. of Public Works
- 06 Elevation of Madaket Road
- 07 Resilient public boating access
- 08 Bridge structure replaces existing culvert

-  Road Raised
-  Bridge
-  Priority Action Area Structure
-  High and Moderate Coastal Risk Area Structure

*See facing page for section diagram



Madaket- Madaket Road Near-Term Strategy



REDUCTION OF DENSITY AND BUILDING-SCALE ADAPTATION IN HIGH AND MODERATE COASTAL RISK AREAS

ELEVATION OF MADAKET ROAD

RESILIENT PUBLIC BOATING ACCESS

ROAD SIDE PLANTING

STRATEGIC RELOCATION OF STRUCTURES IN PRIORITY ACTION AREAS

BRIDGE STRUCTURE REPLACES EXISTING CULVERTS

INCREASED TIDAL FLOW AND ECOLOGICAL CONNECTION

ECOLOGICAL RESTORATION

Smith's Point and Ames Avenue Strategy Summary

Ames Avenue Bridge Resilience

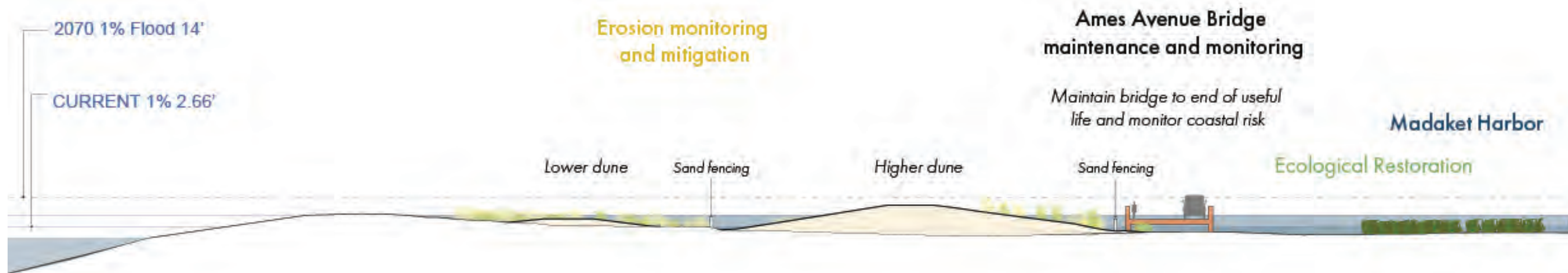
Description	Dune restoration (see Madaket Erosion Management Pilot and Ames Avenue Bridge Protection project in this section) to mitigate risk to bridge. Continue maintenance and monitoring of existing Ames Avenue Bridge, with future elevation or relocation, if necessary, based on service population.	
Resilience Objective & Level of Protection	Maintain existing bridge to end of useful life and protect from coastal storms through creation of dunes to elevation of the 1% annual chance event in 2050 (14.0 ft NAVD88). The bridge is currently projected to lose service in 2050s due to regular tidal flooding and should be continually evaluated for elevation or conversion to pedestrian-only access based on service population.	
Duration of Performance	10-30 years. To be determined through monitoring and maintenance of pilot project.	Priority First
Estimated Cost & Benefits	See Madaket Erosion Management Pilot and Ames Avenue Bridge Protection project	

F Street Boat Ramp

Description	Prolong service life of public boat ramp providing access to Madaket Harbor and Tuckernuck and Muskeget Islands by elevating the top of the boat ramp, surrounding infrastructure, and access from F Street. Consolidate Madaket boat ramps in this location once loss of service is experienced at Jackson Point boat ramp.	
Resilience Objective & Level of Protection	Prolonging service life of the boat ramp for public use to elevation of mean monthly high water in 2070 (7.5 feet NAVD88)	
Duration of Performance	40-50 years	Priority Third
Estimated Cost	Capital Costs: \$3.7M Capital Costs with Contingencies: \$4.5M - \$5.1M Annual Operations and Maintenance: \$57K	
Estimated Benefits	Not quantified for this study. Qualitative benefits include prolonging public boating access from Madaket to Hither Creek, Madaket Harbor, and Tuckernuck and Muskeget Islands	
Cobenefit Opportunities	Opportunities to increase boat ramp capacity and include additional facilities and amenities as part of adaptive design, such as vehicle parking or fish cleaning stations	

Madaket Erosion Management Pilot and Ames Avenue Bridge Protection

Description	Dune enhancement along shoreline from Madaket Road / Ames Avenue intersection to Esther's Island. Natural dune construction techniques of sand and vegetation with fencing is appropriate.		
Resilience Objective & Level of Protection	For most of shoreline, pilot approach to reduce risk of breaching and erosion to 2% annual chance storm in 2030 (10.0 to 11.0 feet NAVD88). For section protecting Ames Avenue Bridge, protect to 1% annual chance storm in 2050 (14.0 ft NAVD88).		
Duration of Performance	10-30 years. To be determined through monitoring and maintenance of pilot project.	Priority	First
		Estimated Cost	Capital Costs: \$70M Capital Costs with Contingencies: \$86M - \$96M Annual Operations and Maintenance: \$1.1M
Cobenefit Opportunities	\$51M in avoided building replacement cost. Additional benefits not quantified include reduced risk of loss of service for roadways and other infrastructure, as well as ecological restoration benefits.		
Cobenefit Opportunities	Community engagement and capacity building in development and implementation of pilot project, including community-based plantings, maintenance, and monitoring Dune restoration has potential to enhance habitat along beach and protect habitat in Madaket Harbor		



Section B-B*

The diagrammatic section above is an example profile of the Madaket Erosion Management Pilot project, as shown on the map to the right. Concept will be refined through future project design phases.

Madaket Near-Term Strategy

Madaket Harbor

Jackson Point

Smith's Point

Ames Avenue

Moderate Risk Area

High Risk Area







Priority Action Area

Low Risk Area

Starbuck Road

Madaket P

LEGEND

- 01 Ecological Restoration
- 02 Dune restoration pilot project
- 03 Strategic relocation of structures in Priority Action Areas
- 04 Maintenance and monitoring of Ames Avenue Bridge
- 05 Dune restoration to protect Ames Avenue Bridge
- 06 Erosion monitoring and mitigation
- 07 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 08 Elevation of F Street
- 09 Adaptation of F Street boat ramp
-  Road Raised
-  Maintenance of Bridge for Access
-  Priority Action Area Structure
-  High and Moderate Coastal Risk Area Structure
-  Area of Dune Restoration
-  Area of Ecological Restoration



06

01

09

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07

02

Madaket- Ames Bridge Near-Term Strategy

REDUCTION OF DENSITY AND BUILDING-SCALE ADAPTATION IN HIGH AND MODERATE COASTAL RISK AREAS

ECOLOGICAL RESTORATION

MAINTENANCE AND MONITORING OF AMES AVENUE BRIDGE

DUNES FOR PROTECTION OF AMES AVENUE BRIDGE

DUNE RESTORATION PILOT PROJECT

STRATEGIC RELOCATION OF STRUCTURES IN PRIORITY ACTION AREAS



EROSION MONITORING AND MITIGATION

Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for Madaket. Reducing coastal risk on private properties will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance, increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Changes to zoning and wetland regulations recommend on pages 96-102 will also be necessary to promote resilience in the area. There are 165 structures located in Priority Action and High Coastal Risk Areas where land use approaches can be combined with strategic acquisition of priority properties to reduce density in the highest risk areas. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

Evaluation Criteria	Most Desirable Impact
Effectiveness & Adaptability	
Implementation Feasibility	
Ecological & Public Health	
Equity & Quality of Life	
Value Creation	



This image shows a conceptual rendering of the Madaket Erosion Management Pilot and Ames Avenue Bridge Protection projects. The image is intended to illustrate an example of how the project could look and is not intended to show the final design. The location and appearance of the projects would be further refined through additional community engagement and design steps.

Creation to Reduce Risk to Bridge

nes

Sand Fencing

Secondary Dune

TO THE BEACH / OCEAN →

2070 1% Flood (14')

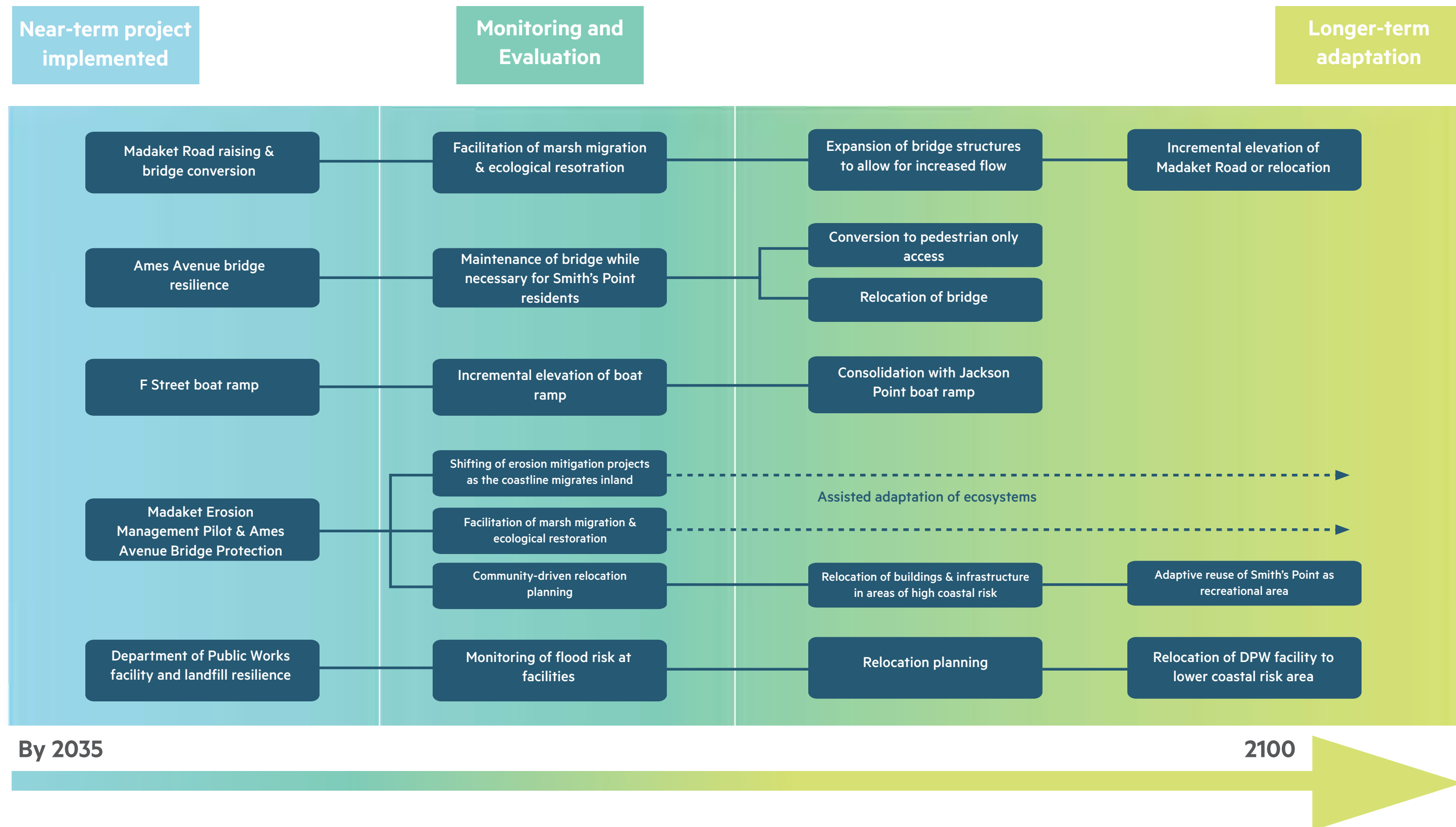


An aerial photograph of a coastal town, likely Madaket, showing a large body of water, marshland, and residential buildings. The town is situated along the water's edge, with a prominent road and several boat ramps. The surrounding area is a mix of developed land and natural wetlands.

Long-Term Adaptation Pathways

The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathway for Madaket provides a viable pathway for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science and evaluate future adaptations to the near-term projects. Potential future actions to account for increasing risk include expansion of the bridge structures on Madaket Road to allow increased flow along with incremental elevation of Madaket Road and the F Street boat ramp as future flood projections become more certain, inland migration of priority zones for relocation and retreat, removal of infrastructure and structures in priority risk zones, relocation or consolidation of the Jackson Point boat ramp and adaptive reuse of Smith's Point as a natural area for recreation with access converted to pedestrian only via the Ames Avenue bridge, and shifting of erosion management projects inland with the coastline. Additionally, the Town may explore long-term relocation of the Department of Public Works facility at 188 Madaket Road due to increasing risk of coastal flooding after 2050. Natural ecosystems should also be monitored for impacts from sea level rise with necessary actions taken to assist in the adaptation of wetlands and other ecosystems over time.

Long-Term Adaptation Pathway (2035-2100)



NANTUCKET HARBOR & COATUE

*This **ADAPT** strategy recommends a spectrum of natural and physical approaches to manage erosion and protect assets from flooding. The strategy prioritizes extending the useful life of critical transportation infrastructure in the area and maintaining emergency access to private properties along Polpis Road. Enhancement of marsh habitats and nature-based erosion management mitigate the risks associated with flooding and erosion to buy time for strategic relocation of highly vulnerable properties. Private property owner implementation of building-scale adaptation measures addresses risks from major storms. This strategy also recognizes the critical importance of Nantucket Harbor and Coatue and recommends an additive and adaptable strategy to respond to sea level rise as effects become more severe over time.*

Area Overview

Nantucket Harbor supports a vast array of maritime activity and includes the island’s main channel, which serves as the island’s primary mode of maritime access, including supply routes and emergency access. This area includes the entire northeast portion of the main island wrapping around the Harbor, inclusive of the area south of the Harbor alongside Polpis Road past Polpis Harbor to Sesachacha Pond, north through Wauwinet to the Pocomo Peninsula, all the way up to Great Point, and the entire Coskata-Coatue Wildlife Refuge. Most of these areas are low-density or uninhabited, as in the case of Coatue, where unpaved roads make up the majority of the existing built infrastructure. A number of residences and roads near Sesachacha Pond are at risk of flooding from the pond, and coastal flooding poses a risk to some parts of the

southern stretch along Polpis Road. Erosion also poses a risk to the area with future erosion extents extending further inland to the north of Sesachacha Pond. In general, Nantucket Harbor is characterized by a wealth of ecologically important salt marshes and eelgrass beds that support waterfowl, fish, and other habitats. Barrier beaches at Coatue Point, Wauwinet, and the Creeks help protect the harbor and its rich natural resources.

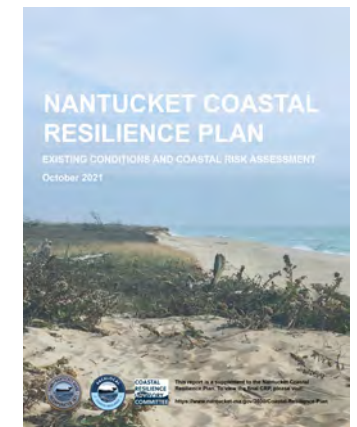
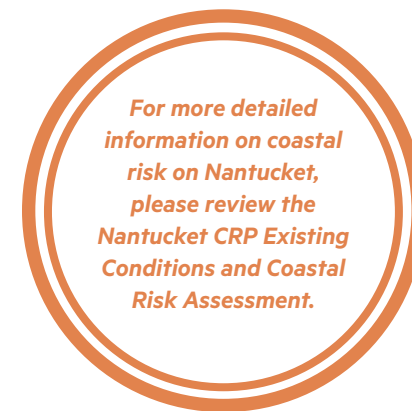


From Left: Sesachacha Pond, Polpis Harbor (photos by James Hark)

Summary of Resilience Challenges

The key coastal resilience challenges in and around Nantucket Harbor include:

- Potential for overtopping and breaching of barrier beaches, both on Coatue and at the Haulover on Great Point Beach
- Damage and disruption to private residences located along the interior of the Harbor, including in Polpis Harbor
- Loss of roadways and critical access along Polpis Road, notably by Sesachacha Pond and at Folger’s Marsh
- Loss of eelgrass and shellfish habitat in Nantucket Harbor and impacts to salt marshes around the Harbor



Overview of Coastal Risk in Nantucket Harbor & Coatue

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.

In Nantucket Harbor and Coatue, 33 structures are within the Priority Action Area and 73% of these structures are historic. By 2070, 289 structures and nearly 3 miles of public roads will likely be exposed to coastal hazards. The near-term strategy recommended in the following pages will help reduce coastal risk in Nantucket Harbor and Coatue.

Nantucket Harbor & Coatue Exposure by Risk Area			
Risk Area	Structures Exposed (#) ^{*^}	Historic Structures (%) ^{**}	Public Roadways Exposed (miles) [~]
Priority Action Area	33	73%	0.04
High Coastal Risk Area	99	54%	0.24
Moderate Coastal Risk Area	289	34%	2.92

*Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

**Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

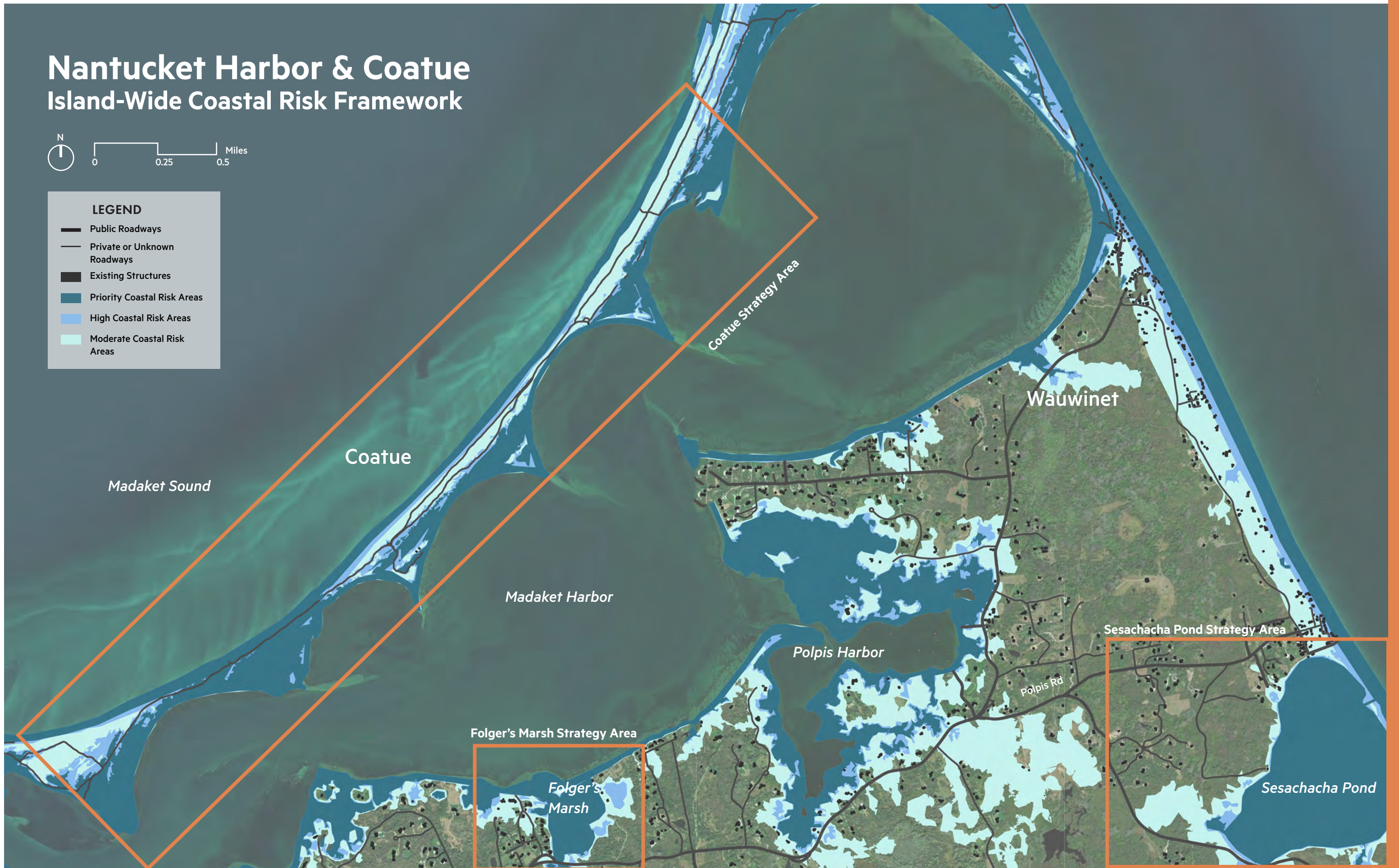
[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

Nantucket Harbor & Coatue Island-Wide Coastal Risk Framework



LEGEND

- Public Roadways
- Private or Unknown Roadways
- Existing Structures
- Priority Coastal Risk Areas
- High Coastal Risk Areas
- Moderate Coastal Risk Areas



Strategy Overview

To address each of the resilience challenges identified through this study and prior studies completed by the Town and other stakeholders like the Nantucket Conservation Foundation and Trustees of Reservations, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. As will be described, different types of approaches are suggested in different areas depending on the issue(s) addressed.

Infrastructure & Buildings

Maintaining everyday and emergency access along Polpis Road is a priority. Two specific stretches of Polpis Road will be vulnerable to flooding during mean monthly high water by 2050 resulting in loss of essential service to the area. To address this impact, the CRP recommends elevating Polpis Road to create a resilient transportation corridor from Sankaty, Polpis, Wauwinet, and surrounding areas. When the road is elevated, replacement of the existing culvert at Folger's Marsh with a bridge structure is suggested to maintain and improve the natural flow of water in the area. Along Sesachacha Pond, the road elevation should be combined with the addition of new and expanded culverts or a bridge structure, nature-based wave attenuation structures within the pond to reduce wave impacts to the road and wetland habitats, and potentially new public access along the pond in partnership with Massachusetts Audubon Society. Given the significant capital investment required to implement these strategies in both areas, the infrastructure should be designed to the elevation of the 2070 1% annual chance storm including 4.3 feet of sea level rise. Although not exposed to flooding during mean monthly high water by 2050, low-lying sections of Wauwinet Road are identified for risk mitigation in the Nantucket Natural Hazard Mitigation Plan. To ensure access to areas served by this public roadway, the Town should continue to monitor flood risks and pursue implementation of the HMP recommendations.

For the area to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. This could include

a number of steps, from elevation of the structure, to wet floodproofing, to relocation in some cases. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate to reduce their risk. Some areas along Nantucket and Polpis Harbors, and along the ocean facing beaches to the east, are identified as Priority Action and High Coastal Risk Areas. In these locations it is appropriate to begin reducing density through policies and programs. Reducing density could mean a number of things including changes to zoning regulations for future development, increases in setbacks for buildings and other structures, and acquisition and/or relocation of buildings, as described in Section 6. The Town should begin outreach to property owners in these areas immediately to communicate the degree of risk and conduct ongoing engagement regarding options for private property retreat and relocation.

Erosion Management

Managing erosion along Coatue is important to reduce the risk of breaching of the barrier beach system. Coatue is a unique coastal feature that is in itself an important ecological resource and also acts as a barrier island sheltering the elongated Nantucket Harbor. Breaching has the potential to increase flood risk to public infrastructure and buildings along the Harbor, including in Downtown, and contribute to sediment accretion within the harbor which can have significant impacts on eelgrass habitats, shellfish fisheries, and navigation. To reduce the risk of breaching in these areas, enhancement and stabilization of existing dunes is recommended through the creation of natural dunes and ongoing nourishment. These strategies should be prioritized at two areas of particular concern on Coatue where existing elevations are critically low. These locations are between Five Fingered Point and Bass Point and between First Point and Second Point. Dune enhancement strategies should be designed and located to limit the potential for sediments to move into the Harbor and impact eelgrass habitats. Wetland enhancement strategies on the Harbor side of Coatue should also be advanced to further stabilize the land mass and reduce the risk of breaching at narrow locations. The Town should pursue all strategies for Coatue in partnership with the Nantucket Conservation Foundation and Trustees of Reservations, building on and supporting ongoing resilience efforts by both organizations. In conjunction with these physical strategies, the Town should pursue a numerical modeling study to simulate breaching and overwash of Coatue and potential areas along Great Point. This effort will evaluate the likelihood and consequences that breaching of Coatue and adjacent barrier beaches could have for the Harbor and surrounding communities, including impacts to habitat and navigation, in order to inform decisions about future adaptation measures on Coatue and Great Point.

Natural Resources

Habitat protection and enhancement is also a priority around Nantucket Harbor, including the numerous wetlands surrounding the harbor, eel grass areas in the harbor, and barrier beach system on Coatue. Protecting and enhancing these resources has several important benefits including reducing flood and erosion risks and supporting fish and shellfish populations. Folger’s Marsh is one of the priority resources in the area. The conversion of the existing culvert on Polpis Road at Folger’s Marsh to a bridge structure is intended to improve tidal flow and enable gradual upland migration of the marsh with sea level rise. Some of the other ways the marsh and eelgrass habitat could be protected and enhanced include other land-use changes to make room for natural migration of resources, sediment enhancements to enable wetlands to “keep up with” sea level rise, development limits to reduce future encroachment on the wetlands, and shoreline elevation enhancements on Coatue to reduce the potential for breaching leading to rapid sedimentation of the Harbor along with other impacts. Additional analysis of hydrology, sediment accretion rates, and salinity can help inform design strategies for wetland and eelgrass resilience.

Opportunities for Co-Benefits

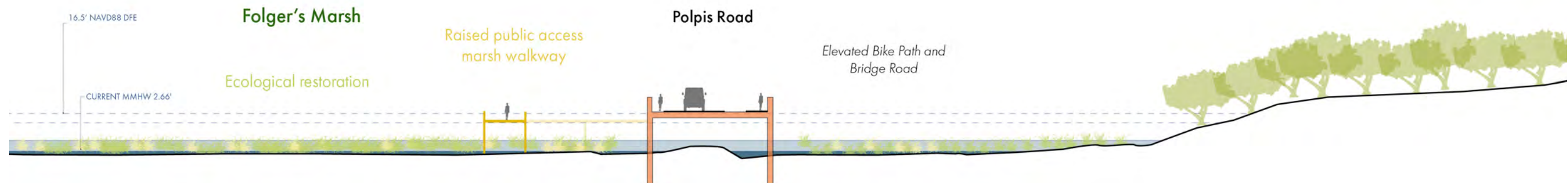
Co-benefits are features of a resilience strategy that address other community goals and needs beyond coastal risk reduction. The resilience strategy for Nantucket Harbor and Coatue includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including new public access to the water, ecological restoration, and community education.

Recommended Project Summary

The following projects are recommended in Nantucket Harbor and Coctue as part of the coastal resilience strategy, including the anticipated benefits, estimated cost, level of protection, priority, and duration of performance for each.

Polpis Road Raising and Bridge Conversion at Folger's Marsh

Description	Road raising and replacing existing culvert with bridge structure		
Resilience Objective & Level of Protection	Prolong service life and maintain emergency roadway access along Polpis Road to 1% annual chance flood with 4.3 feet of sea level rise (16.5 feet NAVD88, expected by 2070), while advancing ecological restoration objectives for Folger's Marsh		
Duration of Performance	40-50 years	Priority	Second
Estimated Cost	Capital Costs: \$15M Capital Costs with Contingencies: \$18M - \$21M Annual Operations and Maintenance: \$230K		
Estimated Benefits	\$5.8M - \$14.3M in avoided traffic delays and disruption. Additional benefits not quantified include reduced risk of loss of access for emergency vehicles and potential ecological restoration.		
Cobenefit Opportunities	Possible addition of new public walkways and access along Folger's Marsh with opportunities for community education and programming Improved long-term tidal exchange between Folger's Marsh and interior wetland areas which can facilitate ecological restoration		



Section C-C*

The section above is an example profile of the Polpis Road Raising and Bridge Conversion at Folger's Marsh, as shown on the map to the right. Concept will be refined through future project design phases.

Folger's Marsh

Island-Wide Coastal Risk Framework

Fulling Mill Creek

Folgers Marsh

Nantucket Shipwreck Museum

Low Risk Area

Moderate Risk Area

High Risk Area

Priority Action Area

Polpis Road

Polpis Road

LEGEND



- 01 Ecological Restoration
- 02 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 03 Increased tidal flow and ecological connection
- 04 Possible marsh walkway for public access and education
- 05 Elevation of Polpis Road and bike path
- 06 Bridge structure replaces existing culvert
- Road Raised
- Bridge
- Potential Public Walkway
- High and Moderate Coastal Risk Area Structure



Folger's Marsh Near-Term Strategy

REDUCTION OF DENSITY
AND BUILDING-SCALE
ADAPTATION IN HIGH
AND MODERATE COASTAL
RISK AREAS

ECOLOGICAL RESTORATION

INCREASED TIDAL AND
ECOLOGICAL FLOW

POTENTIAL RAISED PUBLIC ACCESS
MARSH WALKWAY

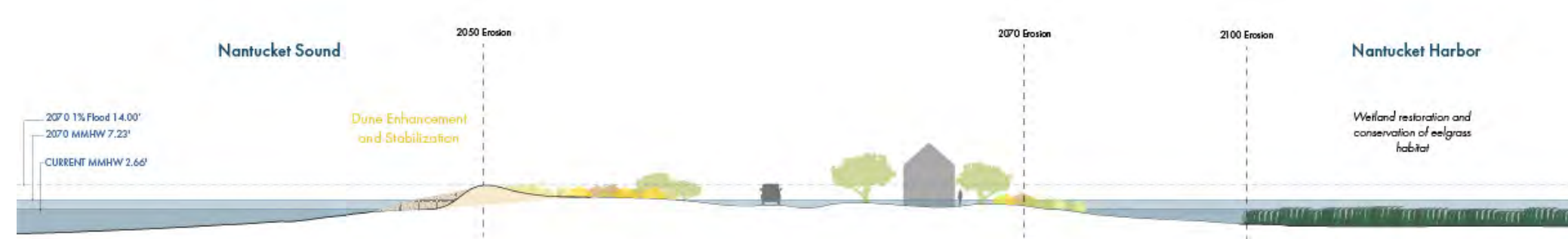
ECOLOGICAL RESTORATION

BRIDGE REPLACES
EXISTING CULVERTS

ELEVATION OF POLPIS ROAD
AND BIKE PATH

Coatue Erosion Management and Dune Resilience

Description	<p>Reinforce and build elevation at narrow low-lying sections of the barrier island, between Five Fingered Point and Bass Point and between First Point and Second Point, to prevent washover and/or breaching into the harbor. Monitor performance of approach to assess need for ongoing nourishment and/or adaptation to higher design elevations. Wetland enhancement strategies on the Harbor side of Coatue should also be advanced to further stabilize the land mass and reduce the risk of breaching at narrow locations. In conjunction, apply numerical modeling techniques to simulate breaching and overwash of Coatue and potentially Great Point and the Haulover. This effort will evaluate the likelihood and consequences of Coatue, Great Point, and Haulover breaching for the Harbor and surrounding communities in order to inform decisions about future adaption measures on Coatue.</p>		
Resilience Objective & Level of Protection	<p>Reduce likelihood of breaching and overtopping of Coatue to elevation of 2% annual chance flood with 2.5 feet of sea level rise (13 - 14.0 feet NAVD88).</p>		
Duration of Performance	30 years	Priority	<p>First</p> <p>Estimated Cost Capital Costs: \$30M Capital Costs with Contingencies: \$36M - \$41M Annual Operations and Maintenance: \$450K Numerical Modeling Study: \$100K-\$250K</p>
Estimated Benefits	<p>Not quantified for this study. Qualitative benefits include ecological restoration and potential for reduced long-term flooding impacts in the Harbor as well as reduced impacts to fisheries, habitat, and navigation.</p>		
Cobenefit Opportunities	<p>Opportunities to protect habitat in Nantucket Harbor</p> <p>Opportunities for wetland enhancement and ecological restoration</p> <p>Opportunities to prolong life of private conservation lands providing continuous access along Coatue</p>		



Section D-D*

The diagrammatic section above is an example profile of the Coatue Erosion Management and Dune Resilience Project, as shown on the map on the next page. Concept will be refined through future project design phases.

Coatue Near-Term Strategy

LEGEND



- 01 Erosion monitoring and mitigation
- 02 Enhancement and stabilization of existing dunes
- 03 Wetland restoration and conservation of eelgrass habitat
- 04 Sediment transport study area
- 05 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 06 Strategic relocation of structures in Priority Action Areas

-  Priority Action Area Structure
-  High and Moderate Coastal Risk Area Structure
-  Area of Dune Restoration



Coatue Near-Term Strategy

WETLAND RESTORATION AND
CONSERVATION OF EELGRASS HABITAT

EROSION MONITORING AND MITIGATION

SEDIMENT TRANSPORT STUDY

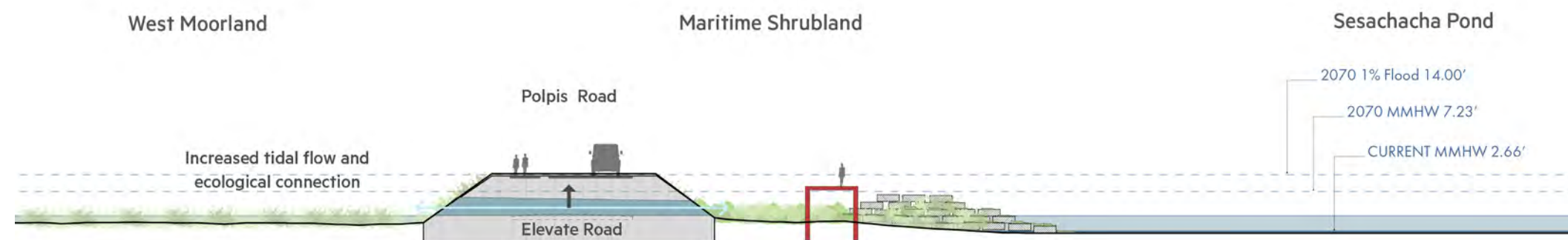
ENHANCEMENT AND
STABILIZATION OF EXISTING DUNES

BREACHING AND OVERWASH
MODELING ANALYSIS



Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond

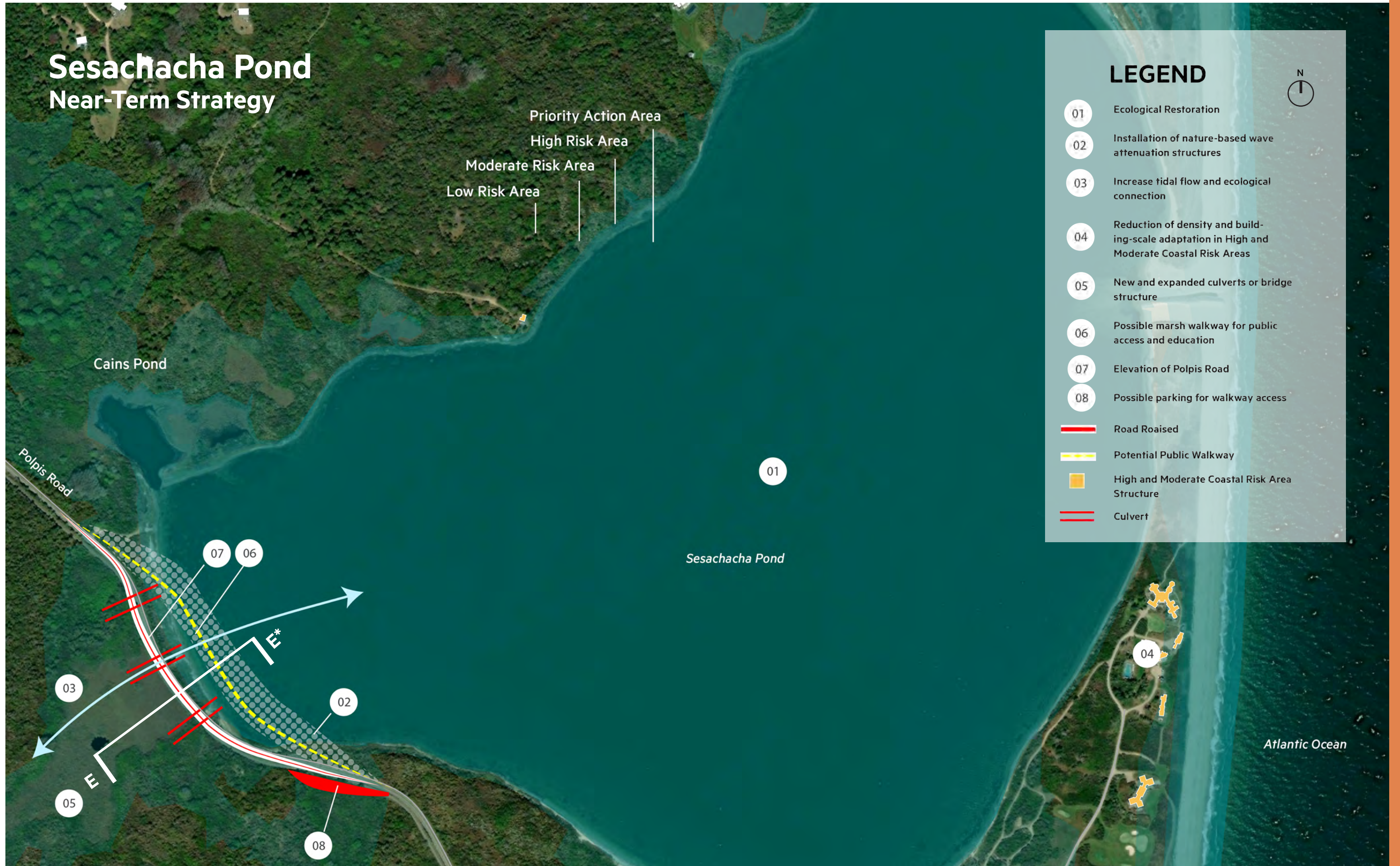
Description	Road raising, expansion of culverts or creation of bridge, and installation of nature-based breakwaters to reduce wave exposure		
Resilience Objective & Level of Protection	Prolong everyday service life and maintain emergency roadway access along Polpis Road to elevation of the 1% annual chance flood with 4.3 feet of sea level rise (19.5 feet NAVD88, expected by 2070), while advancing ecological restoration objectives for Sesachacha Pond		
Duration of Performance	40-50 years	Priority	Second
Estimated Cost	Capital Costs: \$33M Capital Costs with Contingencies: \$40M - \$45M Annual Operations and Maintenance: \$500K		
Estimated Benefits	\$3M - \$11M in avoided traffic delays and disruption. Additional benefits not quantified include reduced risk of loss of access for emergency vehicles and potential ecological restoration.		
Cobenefit Opportunities	<p>Possible addition of new public walkways and access along Sesachacha Pond with opportunities for community education and programming</p> <p>Improved long-term tidal exchange between pond and interior wetland areas which can facilitate ecological restoration</p> <p>Habitat creation and enhancement through living breakwaters approach</p>		



Section E-E*



The section above is an example profile of the Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond project, as shown on the map to the right. Concept will be refined through future project design phases.

Sesachacha Pond Near-Term Strategy

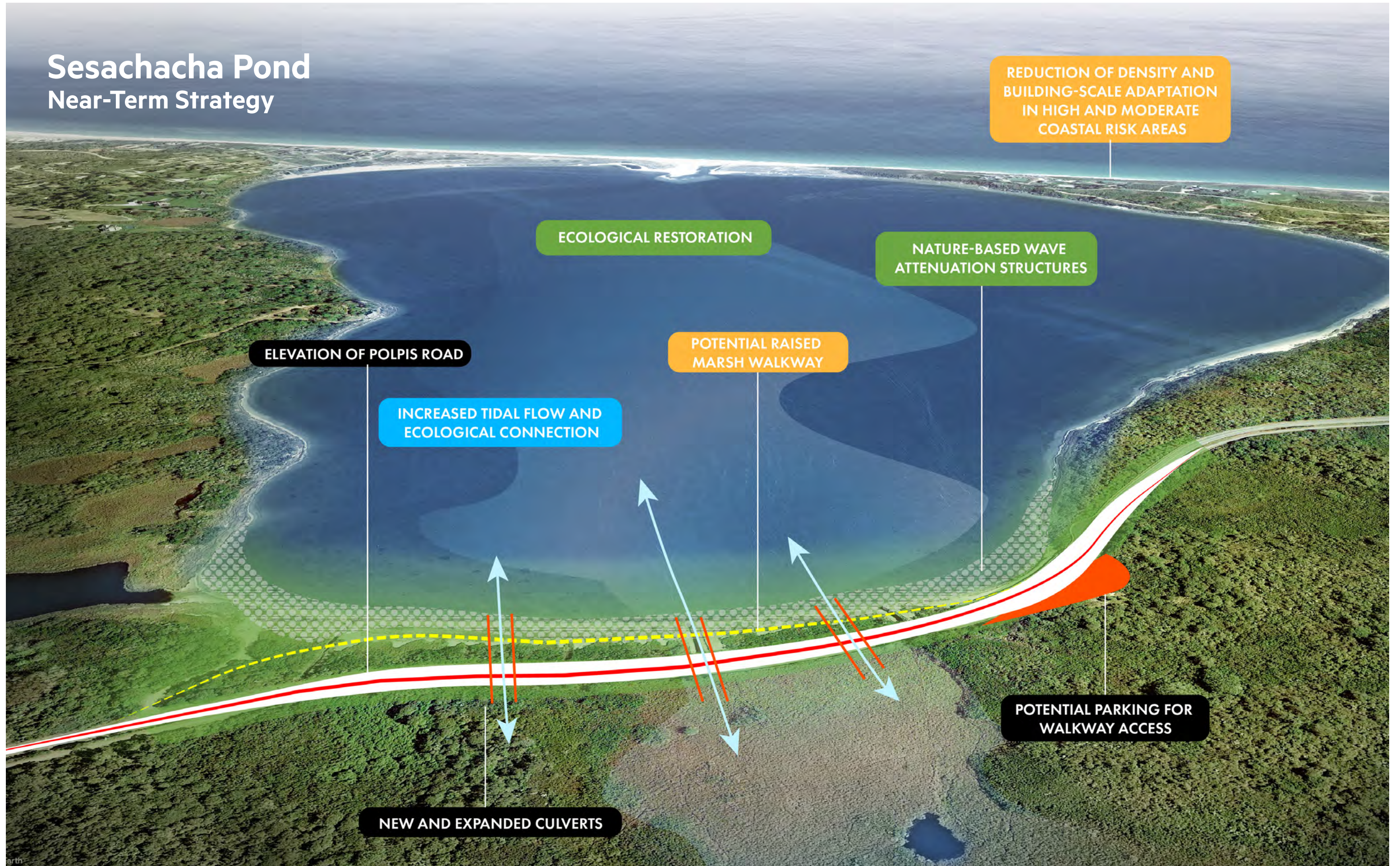


LEGEND



- 01 Ecological Restoration
- 02 Installation of nature-based wave attenuation structures
- 03 Increase tidal flow and ecological connection
- 04 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 05 New and expanded culverts or bridge structure
- 06 Possible marsh walkway for public access and education
- 07 Elevation of Polpis Road
- 08 Possible parking for walkway access
-  Road Roaised
-  Potential Public Walkway
-  High and Moderate Coastal Risk Area Structure
-  Culvert

Sesachacha Pond Near-Term Strategy





















Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for developed areas surrounding Nantucket Harbor, Polpis Harbor, and Sesachacha Pond. Reducing coastal risk on private properties will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance, increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Changes to zoning and wetland regulations recommend on pages 96-102 will also be necessary to promote resilience in the area. There are 132 structures located in Priority Action and High Coastal Risk Areas where land use approaches can be combined with strategic acquisition of priority properties to reduce density in the highest risk areas. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

Evaluation Criteria	Most Desirable Impact			
Effectiveness & Adaptability				
Implementation Feasibility				
Ecological & Public Health				
Equity & Quality of Life				
Value Creation				

Sesachacha Pond

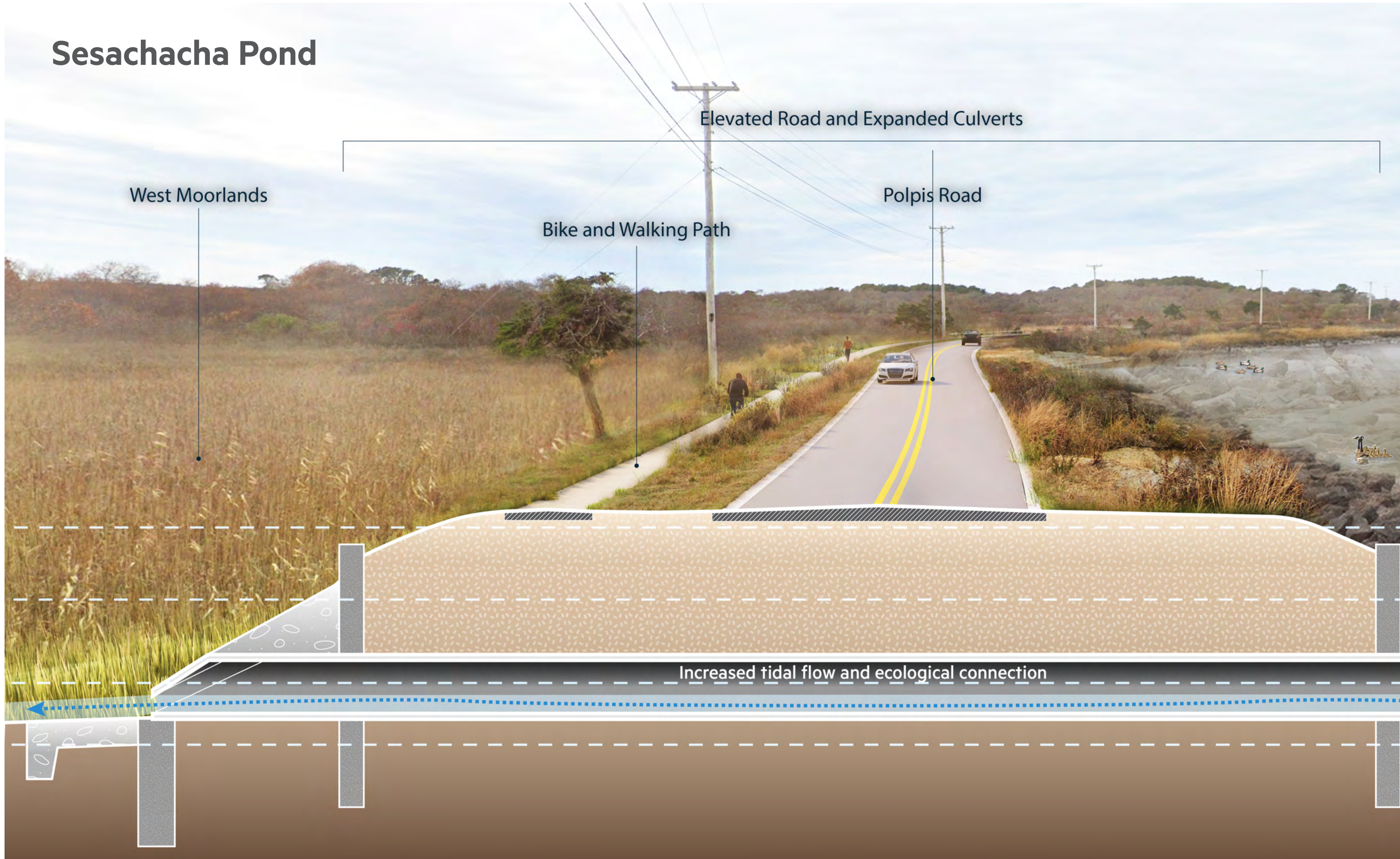
Elevated Road and Expanded Culverts

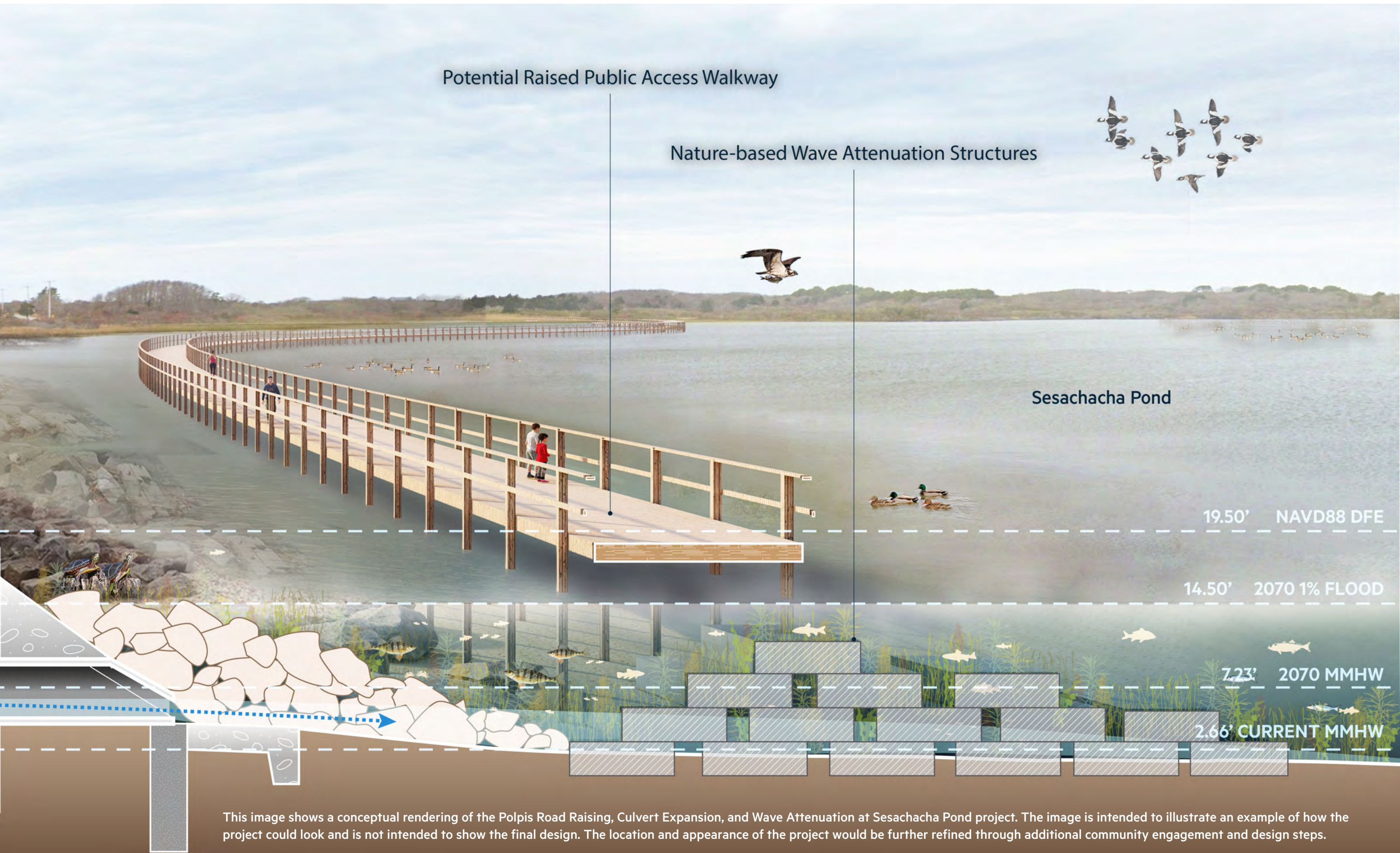
West Moorlands

Bike and Walking Path

Polpis Road

Increased tidal flow and ecological connection



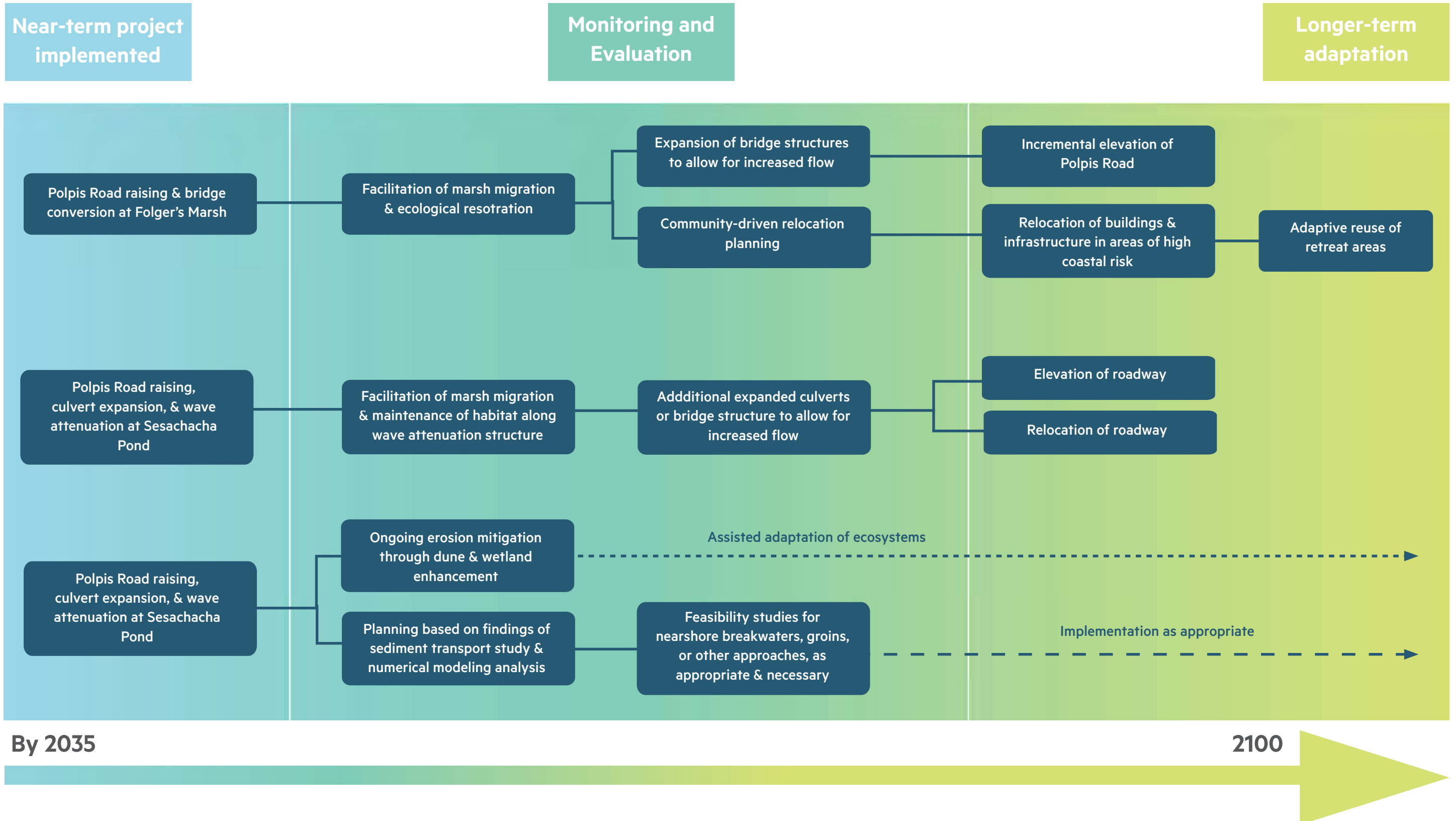




Long-Term Adaptation Pathways

The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathway for Nantucket Harbor and Coatue provides a viable pathway for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science, and evaluate the need for future adaptations to the near-term projects. Future actions to account for increasing risk may include changes to near-term projects and new projects based on additional studies. On Polpis Road at Sesachacha Pond, additional expanded culverts or bridges may be necessary to allow increased flow between the pond and interior wetland areas. Relocation of the road or further raising of the road to a higher elevation may also be necessary in the future if coastal flooding in the pond increases in frequency or intensity due to breaching of the beach. At Folger's Marsh, future adaptations may include expanding the bridge length to enable greater tidal exchange and wetland migration or further raising of the roadway to a higher elevation. Throughout the area, priority zones for relocation and retreat will move inland over time with sea level rise which will entail removal of infrastructure and structures in new priority risk zones. On Coatue, long-term adaptation actions should be based on the findings of studies recommended by the CRP, including a Sediment Transport Study and numerical modeling to understand the potential for breaching and overwash. Based on the results of these studies, it may be appropriate to consider additional measures to reinforce and enhance sediment accretion along Coatue, including feasibility studies for nearshore breakwaters or groins. Through the area, but especially at critical resource areas like Folger's Marsh, natural ecosystems should be monitored for impacts from sea level rise with necessary actions taken to assist in the adaptation of wetlands and other ecosystems over time.

Long-Term Adaptation Pathway (2035-2100)



An aerial photograph of the Sconset coastline. The image shows a series of white, multi-story houses built on a sandy bluff overlooking the ocean. The bluff is eroded, with visible layers of sand and sparse vegetation. The ocean is dark blue with white waves crashing against the shore. In the background, a large body of water, Sesachacha Pond, is visible under a cloudy sky.

SIASCONSET

*There are a variety of approaches that can be taken to reduce risk and build resilience in Sconset. This **ADAPT** strategy prioritizes extending the life of existing private buildings and public and private infrastructure through nature-based erosion management to mitigate the risks associated with flooding and erosion and buy time for strategic relocation of highly vulnerable properties. Private property owner implementation of building-scale adaptation measures addresses risks from major storms and helps manage erosion risk.*

Area Overview

Siasconset—known to many as Sconset—makes up much of the east side of the island, running from Sesachacha Pond south to Tom Nevers Pond. This neighborhood is particularly popular amongst tourists, especially the Sconset Bluff Walk along the coast as well as the Siasconset Historic District. Similar to the South Shore, flooding does not pose a particularly notable risk in this area, but erosion continues to pose a significant hazard, threatening many homes and roadways. Sconset's Historic District, historically a fishing village, consists of a small town center surrounded by homes. Also located in Sconset, and potentially at risk due to erosion, are the former settling ponds for Sconset Wastewater Treatment Plant.



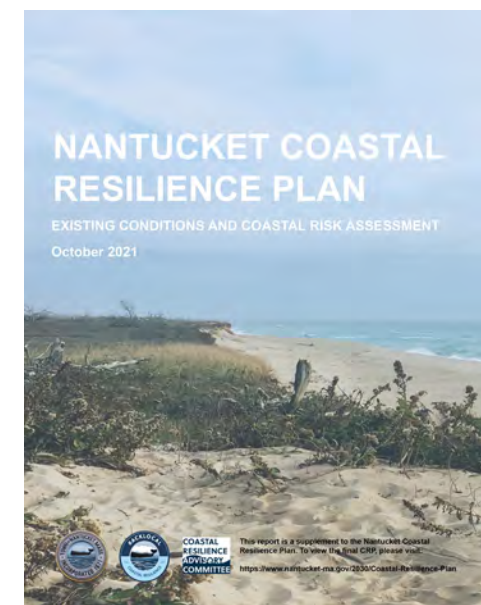
Sconset Bluff (photo by Jennifer Kelly Lachmayr)

Summary of Resilience Challenges

The key coastal resilience challenges in Sconset include:

- Erosion of the coastline, with impacts to private residences, open space, utilities, and public roadways
- Loss of access and services to homes due to erosion
- Bluff erosion impacting public access to and along the beach
- Erosion and flooding at low-lying residential areas, including Codfish Park

For more detailed information on coastal risk on Nantucket, please review the Nantucket CRP Existing Conditions and Coastal Risk Assessment.



Overview of Coastal Risk in Sconset

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.

In Siasconset, 6 structures are within the Priority Action Area and 83% of these structures are historic. By 2070, 193 structures and nearly 2 miles of public roadways in Sconset will likely be exposed to coastal hazards. The near-term strategy recommended to the right will help reduce coastal risk in Siasconset.

Sconset Exposure by Risk Area			
Risk Area	Structures Exposed (#) [^]	Historic Structures (%) ^{**}	Public Roadways Exposed (miles) [~]
Priority Action Area	6	83%	0.13
High Coastal Risk Area	40	58%	0.63
Moderate Coastal Risk Area	193	57%	1.96

^{*}Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

^{**}Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

Sconset Island-Wide Coastal Risk Framework



Strategy Overview

To address each of the resilience challenges identified through this study and other studies, including the Baxter Road Long Term Planning study, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. The approaches recommended for Sconset were developed with protection and adaptation of the local historic district in mind and are sensitive to the historic character of the community.

Erosion Management for Infrastructure and Buildings

Erosion is the primary concern facing Sconset and managing its impacts on private property and public infrastructure is a priority in the area. The Baxter Road Long Term Planning study focused on alternatives analysis for technically feasible approaches to address bluff and toe erosion in the area of the Sconset bluff from Butterfly Lane to Sankaty Lighthouse, resulting in recommended adaptation approaches for that stretch of shoreline. Outside of this stretch, measures to mitigate and manage erosion are recommended by this plan, with specific focus at the low-lying Codfish Park neighborhood where the risks from flooding and erosion are particularly imminent. The recommended near-term strategy for the area includes dune restoration and construction on the beaches fronting Codfish Park and the bluff area south of Butterfly Lane, with ongoing sand placement using direct nourishment.

As explained in greater detail within the Baxter Road Long Term Planning study, maintenance and monitoring of existing toe protection measures as well as dune restoration and nourishment are preferable in the area north of Codfish Park where low-lying coastal dunes transition to coastal bluff. Dune restoration with vegetation will help manage erosion risks in these areas providing time for long-term planning focused on the relocation of buildings and infrastructure. When compared to other soft alternatives like Coir Logs, dunes are preferred due to our ability to design and engineer the solution to provide effective protection over a designated period to the desired level of protection. Dunes also have the capability of adding material to the littoral system. It is possible that erosion in one area can help mitigate erosion in another area through sediment transport, and this potential benefit can be clarified

by the Sediment Transport and Sediment Budget studies suggested in Section 6. Material selection should be performed based on anticipated wave energy, shoreline type, and design storm level. The stretch of bluff to the south of Butterfly Lane and just north of it has not experienced as significant erosion as the northern reaches along Baxter Road and the frontal dune system largely remains. Restoring and maintaining these dunes will help prolong their function in protecting the bluffs located just inland from more severe erosion.

For more information on the Baxter Road Long Term Planning Study, review the Summary of Findings Memo available on the Town's website.

<https://nantucket-ma.gov/2122/Baxter-Road-Engineering-Feasibility-Asse>

The Baxter Road Long Term Planning Study recommends near-term actions including maintenance and monitoring of the existing toe protection measures with dune nourishment along the bluff in accordance with the permit that has been issued for the system. Dune restoration, beach nourishment, planting and stabilization of the bluff face, and homeowner best management practices are also recommended. In parallel, given the imminent risk to buildings and infrastructure in this area, the Town should plan for and begin implementing the relocation of Baxter Road, while also engaging stakeholders in discussions around an acceptable timeline for retreat and relocation of structures. The existing toe protection

system in place along portions of the bluff should remain until planning for road relocation and retreat is complete. Recommendations in the CRP are intended to be consistent with the recommendations of the Baxter Road Long Term Planning Study.

At Codfish Park, additional dune restoration is necessary to help delay erosion impacts to this community. Implementing the recommended continuous dune system along the shoreline in front of the neighborhood also provides some flood protection against coastal storms. These efforts will reduce risk to private residences and to vulnerable public roadways such as Codfish Park Road and Gully Road.

In addition, a study is recommended to assess the feasibility and potential benefits and costs of a near-shore breakwater system. Nearshore breakwaters are located in-water just off the shoreline and are intended to break waves before they reach the beach. The elevation of the structures is determined by the desired level of protection. Protection against large storms would mean that the structures extend several feet above the normal high tides. However, breakwater systems can reduce the effects of waves on the coastline and assist in maintaining dunes and encouraging sediment deposition on the shore. These structures are complex and costly to build so additional study is needed to determine their potential benefits along the Sconset coast.

While these recommended actions can help mitigate erosion in Sconset, ultimately they are only delaying the long-term impacts of erosion and providing time to plan for the long-term relocation of vulnerable buildings and infrastructure.

For the Sconset to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. For flood vulnerable properties, particularly in Codfish Park, this could include a number of steps, from elevation of the structure, to wet floodproofing, to relocation in some cases. Homeowners with properties that are vulnerable to erosion should adopt best practices such as maintaining vegetation,

reducing runoff, and minimizing impacts to dunes and bluff tops. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate to reduce their risk. Some areas along the Sconset bluff, particularly along the northern reach of Baxter Road, are identified as Priority Action and High Coastal Risk Areas due to near-term erosion risk. In these locations it is appropriate to begin reducing density through policies and programs. Reducing density could mean a number of things including changes to zoning regulations for future development, increases in setbacks from the bluff top for buildings and other structures, and acquisition and/or relocation of buildings and infrastructure, as described in Section 6. Reducing density in Sconset through policies and programs is an additional recommendation made by the CRP to mitigate coastal risk in Sconset. This recommendation is intended to complement the recommendations of the Baxter Road Long Term Planning Study. The Town should begin outreach to property owners in these areas immediately to communicate the degree of risk and conduct ongoing engagement regarding options for private property retreat and relocation.

Opportunities for Co-Benefits

Co-benefits are features of a resilience strategy that address other community goals and needs in addition to coastal risk reduction. The resilience strategy for the Sconset includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including opportunities for community engagement and education.

Recommended Project Summary

The following projects are recommended for Sconset as part of the coastal resilience strategy, including the anticipated benefits, estimated costs, level of protection, priority, and duration of performance for each.

Sconset Bluff Dune Restoration

Description	<i>Dune restoration and construction to provide toe protection to manage and mitigate long-term bluff erosion. Natural dunes with vegetation are appropriate given less urgent risk in areas south of Butterfly Lane. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.</i>		
Resilience Objective & Level of Protection	<i>Manage and mitigate erosion at base of coastal bluff. Design elevation 2% annual chance storm with 2.5 feet of sea level rise (12.5 to 13.0 feet NAVD88)</i>		
Duration of Performance	<i>10 years with ongoing performance monitoring and maintenance</i>	Priority	<i>Third</i>
Estimated Cost	<i>Capital Costs: \$12M Capital Costs with Contingencies: \$14M - \$16M Annual Operations and Maintenance: \$180K</i>		
Estimated Benefits	<i>Not quantified for this study. Qualitative benefits include reduced long-term risk of erosion impacts to private residences and public infrastructure in Sconset.</i>		
Cobenefit Opportunities	<i>Dune restoration can provide new and enhanced habitat Potential to enhance public access and width of beach with nourishment Monitoring of project can employ mobile technology to crowd-source images and data that can build community awareness and help inform long-term management approaches</i>		

Codfish Park Dune Restoration

Description	<i>Dune restoration and construction to manage and mitigate erosion. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.</i>		
Resilience Objective & Level of Protection	<i>Manage and mitigate erosion and reduce coastal flood risk to Codfish Park neighborhood. Design elevation 2% annual chance storm with 2.5 feet of sea level rise (12.0 to 13.0 feet NAVD88)</i>		
Duration of Performance	<i>10 years with ongoing performance monitoring and maintenance</i>	Priority	<i>Second</i>
Estimated Cost	<i>Capital Costs: \$15M Capital Costs with Contingencies: \$19M - \$21M Annual Operations and Maintenance: \$240K</i>		
Estimated Benefits	<i>\$7M in avoided building replacement cost. Additional benefits not quantified include reduced risk of loss of service for roadways and other infrastructure, and prolonged beach access.</i>		
Cobenefit Opportunities	<i>Dune restoration can provide new and enhanced habitat Potential to enhance public access and width of beach with nourishment Monitoring of project can employ mobile technology to crowd-source images and data that can build community awareness and help inform long-term management approaches</i>		

Sconset

Near-Term Strategic Opportunities

LEGEND

- 01 Elevated dune walkways for beach access
- 02 Dune restoration
- 03 Beach nourishment
- 04 Dune enhancement as toe protection
- 05 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 06 Strategic relocation of structures in Priority Action Areas
- 07 Homeowner erosion best management practices
- 08 Baxter Road Relocation Planning
- 09 Baxter Road Long Term Planning Study
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure
- Area of Dune Restoration



Baxter Road Relocation Planning

Description	<i>Planning for and implementation of road relocation, including acquisition of easements, access and maintenance agreements, finalization of road alignment, and development of final designs for construction.</i>		
Resilience Objective & Level of Protection	<i>Plan for risk to Baxter Road by proactively implementing alternative access for private residences and Sankaty Head Lighthouse.</i>		
Duration of Performance	<i>N/A</i>	Priority	<i>Second</i>
Estimated Cost	<i>Capital Costs with Contingencies: \$25M - \$30M Annual Operations and Maintenance: \$600K</i>		
Estimated Benefits	<i>Not quantified for this study. Qualitative benefits include reduced risk of loss of service for roadway and other infrastructure.</i>		

Sconset Bluff Nearshore Breakwaters Feasibility Study







Description	<i>Conduct study to assess feasibility, potential impacts, and benefits and costs of nearshore breakwaters along the Sconset Bluff</i>		
Resilience Objective & Level of Protection	<i>Reduce the wave energy impacting the shoreline behind the structure and encouraging sediment deposition to mitigate erosion. The level of protection would be assessed through the feasibility study.</i>		
Duration of Performance	<i>N/A</i>	Priority	<i>Second</i>
Estimated Cost	<i>Feasibility Study: \$600K - \$800K</i>		

Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for Sconset. Reducing coastal risk on private properties will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance (where applicable), increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Best management approaches to reduce erosion are also essential, including efforts to reduce runoff, maintain vegetation, and limit impacts to dune systems. Changes to zoning and wetland regulations recommend on pages 96-102 will also be necessary to promote resilience in the area. There are 46 structures located in Priority Action and High Coastal Risk Areas where land use approaches can be combined with strategic acquisition of priority properties to reduce density in the highest risk areas, such as in Codfish Park and along the northern stretch of Baxter Road. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

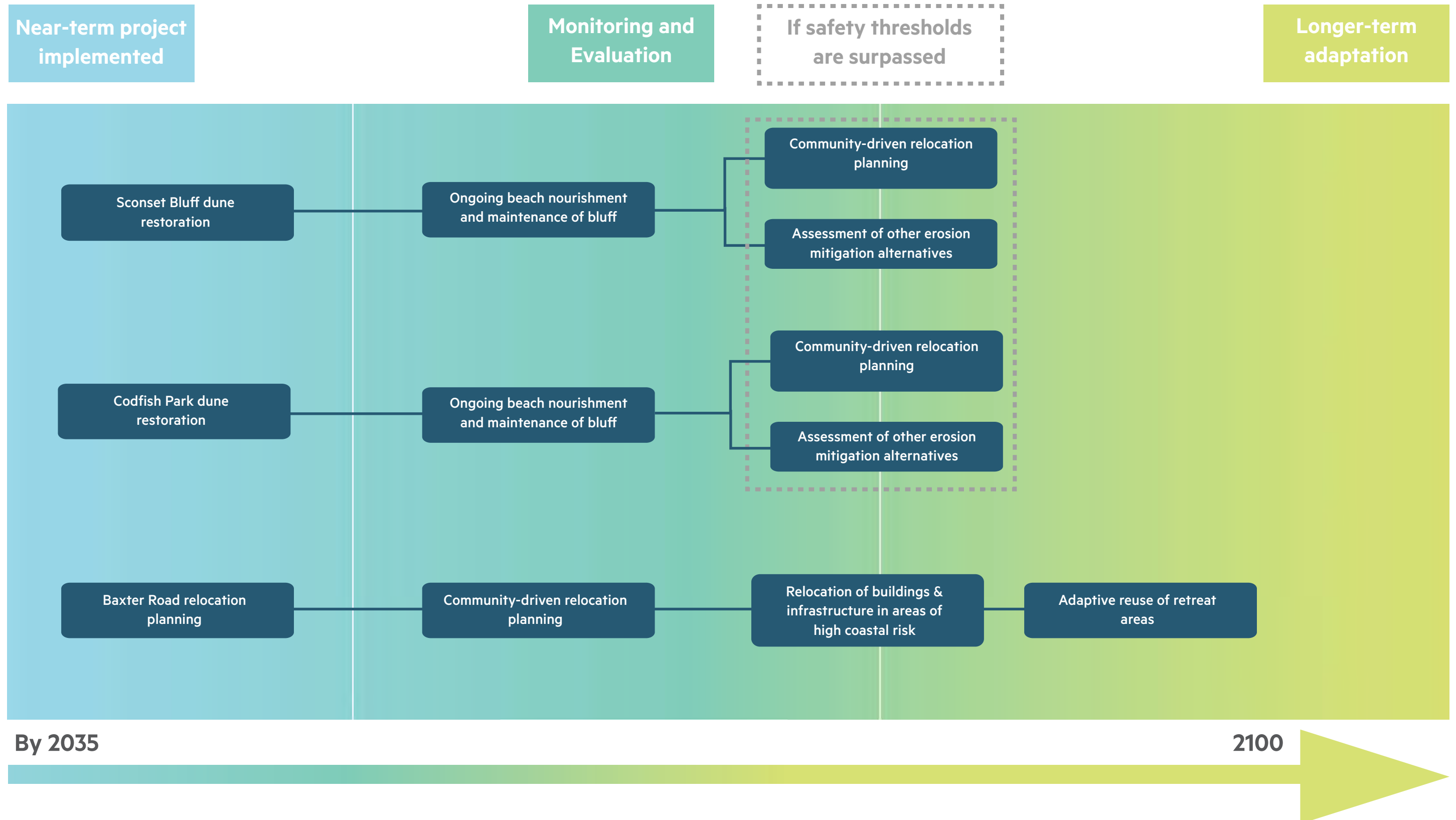
Evaluation Criteria	Most Desirable Impact				
Effectiveness & Adaptability					
Implementation Feasibility					
Ecological & Public Health					
Equity & Quality of Life					
Value Creation					

An aerial photograph of a coastal town, likely Sconset, showing a large body of water in the background and the ocean in the foreground. The town is built on a narrow strip of land, with houses and buildings visible. The sky is overcast with grey clouds. The text is overlaid on the image, providing information about long-term adaptation pathways for the town.

Long-Term Adaptation Pathways

The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathway for Sconset provides a viable pathway for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science, and evaluate the need for future adaptations to the near-term projects. Future actions to account for increasing risk in Sconset will include changes to existing projects. Throughout the area, priority zones for relocation and retreat will move inland over time with sea level rise and erosion hazards which will entail removal of infrastructure and structures in new inland priority risk zones. To facilitate the long-term needs for relocation, planning should begin today including the recommended planning for the relocation of portions of Baxter Road. This also includes outreach to property owners located within the moderate risk areas to clarify the long-term risks and the Town's resilience strategy for the area. Simultaneously, actions to limit any further densification in the area through regulatory changes recommended in Section 6 should be implemented. Ongoing performance monitoring of the recommended near-term erosion management actions will help identify thresholds for future action based on safety concerns; however, public infrastructure for emergency access should be maintained as long as private residences remain.

Long-Term Adaptation Pathway (2035-2100)



SOUTH SHORE & AIRPORT

*This hybrid **PROTECT** and **ADAPT** strategy recommends nature-based and structural approaches to manage erosion and reduce risks to essential facilities and transportation infrastructure in the near-term. Building level adaptations reduce risks from coastal flooding. A pilot project for nature-based erosion management at Tom Nevers Field mitigates the risks associated with erosion and helps the community learn while doing. Private property owner implementation of building-scale adaptation measures addresses flood and erosions risks from major storms.*

Area Overview

Nantucket's South Shore runs from Sheep Pond Road—just east of Madaket—east past Clark Cove, Cisco Beach, and Hummock Pond, through Miacomet and Surfside, past the Nantucket Memorial Airport, and to Tom Nevers Beach. This broad swathe of Nantucket is lined with beaches and is largely characterized by high rates of erosion but an overall relatively low risk of flood impacts. Erosion poses a significant hazard to critical infrastructure in this area—especially the Surfside Wastewater Treatment Facility and the Airport runway—as well as to residential structures, roadways, and coastal bluffs. East of the Airport, in the Tom Nevers residential neighborhood, parts of the main road have already been lost to erosion. Density of residential and commercial development varies across the South Shore but is particularly high in the stretch between Miacomet Pond and Surfside Beach. The Cisco neighborhood further west has also lost parts of the main road due to erosion. This neighborhood supports a variety of recreational activities such as surfing, biking, and golfing and is home to various beloved local institutions such as Bartlett's Farm and Cisco Brewers.



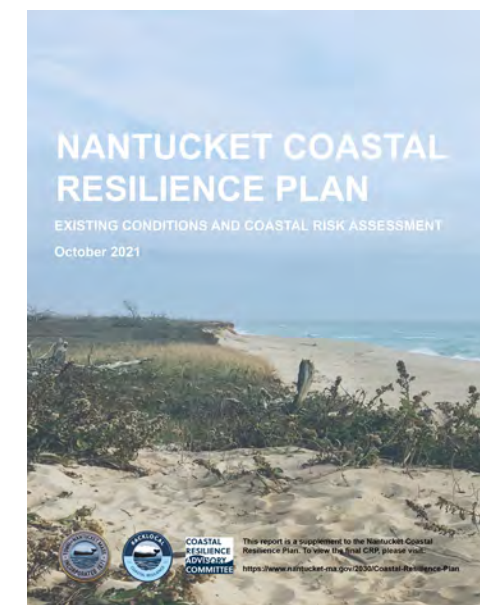
Settling Beds along coast at Surfside Waste Water Treatment Facility (photo by Chelsea Kilburn)

Summary of Resilience Challenges

The key coastal resilience challenges on the South Shore include:

- Erosion of the coastline, with impacts to private residences, open space, and public infrastructure, including roadways and Tom Nevers Field
- Erosion and flooding at critical infrastructure including Nantucket Memorial Airport and the Surfside Wastewater Treatment Facility
- Coastal flooding impacts leading to damage and disruption at private residences

For more detailed information on coastal risk on Nantucket, please review the Nantucket CRP Existing Conditions and Coastal Risk Assessment.



Overview of Coastal Risk in South Shore

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.

In the South Shore, 25 structures are within the Priority Action Area. By 2070, 259 structures and nearly 4 miles of public roadways in South Shore will likely be exposed to coastal hazards. The near-term strategy recommended following will help reduce coastal risk in South Shore.

Risk Area	Structures Exposed (#) ^{*^}	Historic Structures (%) ^{**}	Public Roadways Exposed (miles) [~]
Priority Action Area	25	0%	0.05
High Coastal Risk Area	68	4%	0.35
Moderate Coastal Risk Area	259	7%	3.86

*Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

**Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

South Shore Island-Wide Coastal Risk Framework









Nantucket
Memorial Airport

Surfside
Wastewater
Treatment Facility

Details on strategic resilience opportunities in this area are provided on pages 224-225.

Details on strategic resilience opportunities in this area are provided on pages 226-227

LEGEND

-  Public Roadways
-  Private or Unknown Roadways
-  Existing Structures
-  Priority Coastal Risk Areas
-  High Coastal Risk Areas
-  Moderate Coastal Risk Areas

Atlantic Ocean



Strategy Overview

To address each of the resilience challenges identified through this study and prior studies completed by the Town, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. As will be described, different types of approaches are suggested in different areas depending on the issue(s) addressed.

Infrastructure and Buildings

Protecting critical facilities is a resilience priority on the South Shore. Measures to manage and mitigate erosion are recommended along the coast at the Surfside Wastewater Treatment Facility and Nantucket Memorial Airport to reduce the risks to both of these facilities. The strategy includes dune restoration and construction on the beaches fronting the two facilities with ongoing sand placement using direct nourishment or, if feasible given the sediment transport direction, a near-shore underwater sand berm designed to naturally nourish the beach. Given that both the treatment facility and airport are essential to community wellbeing on Nantucket, it is appropriate to recommend hard core or reinforced dunes, as described in Section 6 on pages 118-119. If there is sufficient upland area identified during the preliminary design phases, the project may evaluate an alternative locating the hard core dune concept further inland to minimize wetland impacts on the beach.

At Tom Nevers Field a pilot erosion management project is recommended to mitigate erosion. The Town's 2020 Parks and Recreation Master Plan includes recommended improvements to the facilities to add amenities and make the park more accessible. The recommended improvements include resilience approaches along the coast to reduce erosion. The first phase of project includes a new facilities and beach access on the southwestern portion of the site. The CRP recommends that implementation of a pilot erosion management project precede any further capital improvements to the park in order to evaluate the efficacy of the recommended erosion management approaches before investing in new park facilities. The pilot project would consist of restored vegetative dunes, sand fencing, and beach nourishment. Ongoing

monitoring of how well the pilot project performs will inform future investment at this site, as well as erosion management approaches elsewhere on the South Shore.

For the South Shore to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. This could include a number of steps, from elevation of the structure, to wet floodproofing, to relocation in some cases. Homeowners with properties that are vulnerable to erosion should adopt best practices such as maintaining vegetation, reducing runoff, and minimizing impacts to dunes and bluff tops. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate to reduce their risk. Some areas along the South Shore are identified as Priority Action and High Coastal Risk Areas due to the potential for near-term erosion impacts. In these locations it is appropriate to begin reducing density through policies and programs. Reducing density could mean a number of things including --- changes to zoning regulations for future development, increases in setbacks for buildings and other structures, and acquisition and/or relocation of buildings and infrastructure, as described in Section 6. The Town should begin outreach to property owners in these areas immediately to communicate the degree of risk and conduct ongoing engagement regarding options for private property retreat and relocation.

Erosion Management

While specific erosion management projects are necessary to reduce risk to specific properties on the South Shore, additional steps can be taken to better understand and help manage erosion risk along the entire shoreline. This includes additional studies, such as sediment transport modeling to evaluate coastal dynamics and patterns, targeted dune construction and nourishment, and relocation of infrastructure. Section 6 (pages 115-119) includes a description of erosion management approaches that may be employed along the South Shore. Town resources should be prioritized for management approaches that reduce risk to public infrastructure, particularly critical facilities as described above. Focused infrastructure relocation and access planning is recommended for Sheep Pond Road, including outreach to property owners on relocation opportunities. Similar planning is recommended in Surfside, where outreach to property owners on relocation opportunities should be pursued in Extreme Risk areas and emergency access planning is necessary to ensure access if Nonantum and Nobadeer Avenues experience a loss of service. It should be noted that recommended projects at the wastewater treatment facility and airport have the potential to feed sediment transport systems that will help nourish down-drift beaches on the South Shore. Beach access is also an important concern along the South Shore. Near-term priorities include ongoing management of access points and relocation or reconfiguration of the Cisco Beach parking lot.

Opportunities for Co-Benefits

Co-benefits are features of a resilience strategy that address other community goals and needs beyond coastal risk reduction. The resilience strategy for the South Shore includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including opportunities for community engagement and education, habitat enhancement, and improved public access.



Existing beach and dunes adjacent to the Surfside Wastewater Treatment Facility (photo by Trevor Johnson)

Recommended Project Summary- Surfside Wastewater Treatment Plan

This and the following pages include projects recommended on the South Shore as part of the coastal resilience strategy, including the anticipated benefits, estimated costs, level of protection, urgency, and duration of performance for each.

Surfside Wastewater Treatment Facility and Nantucket Memorial Airport Dune Restoration

Description	<p>Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate given risk to critical facilities. Location of dune concept on beach or upland area should be determined through preliminary design phase. Project may include need for ongoing nourishment or installation of near-shore underwater sand berm. Strategic relocation alternatives for settling tanks closest to the coast at the wastewater treatment facility should be pursued in parallel.</p>	
Resilience Objective & Level of Protection	<p>Prolong the service life of critical infrastructure with dune construction. Design elevation to the 1% annual chance storm with 4.3 feet of sea level rise (16.0 to 18.0 feet NAVD88, expected by 2070)</p>	
Duration of Performance	<p>40-50 years with ongoing performance monitoring and maintenance</p>	Priority First/Second
Estimated Cost	<p>Surfside Wastewater Treatment Facility Dune Restoration Capital Costs: \$27M Capital Costs with Contingencies: \$33M - \$38M Annual Operations and Maintenance: \$420K</p> <p>Nantucket Memorial Airport Dune Restoration Capital Costs: \$20M Capital Costs with Contingencies: \$25M - \$28M Annual Operations and Maintenance: \$310K</p>	

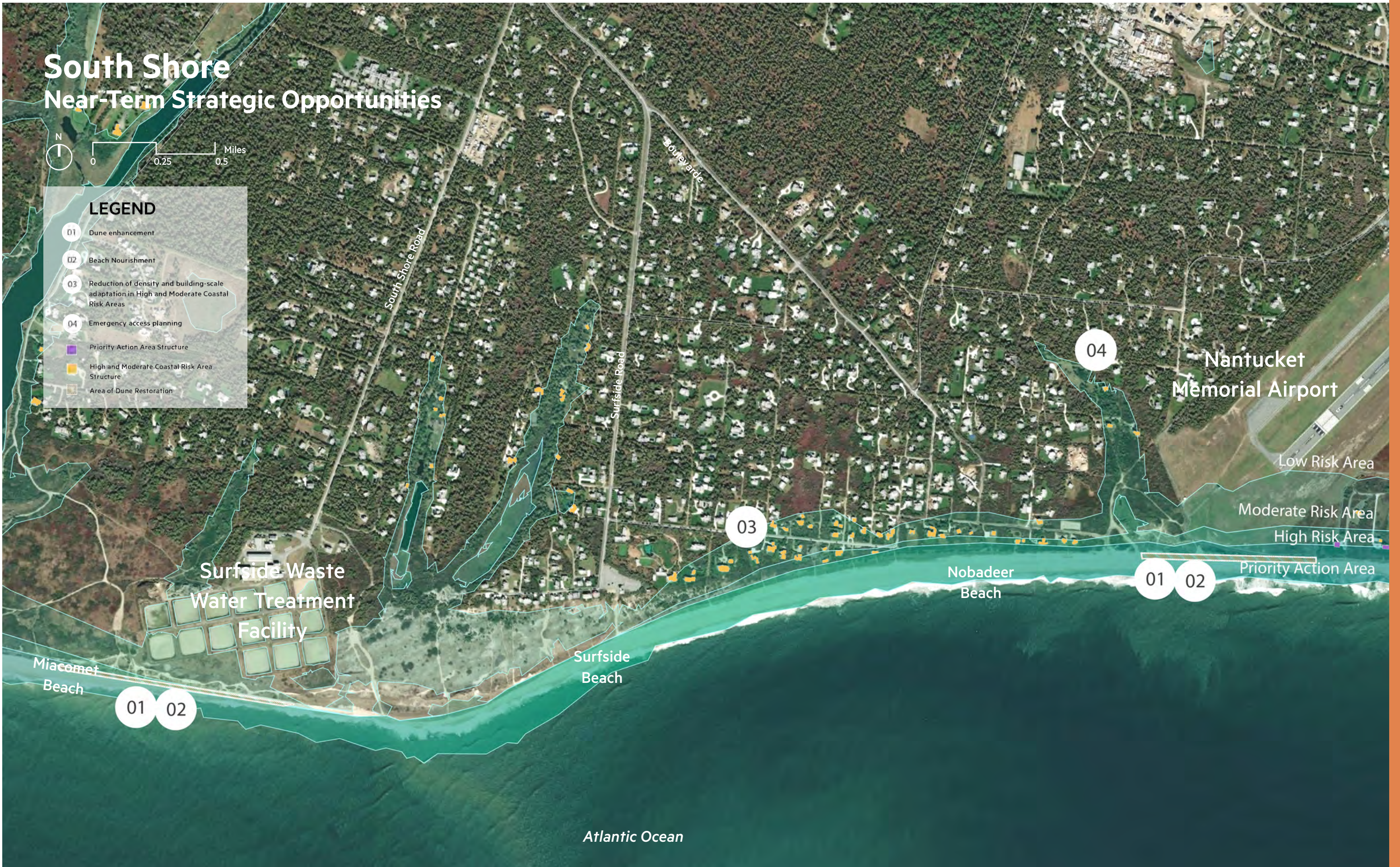
Estimated Benefits:	<p>Not quantified for this study. Qualitative benefits include long-term mitigation of risk to infrastructure and assets at both facilities, which could reduce the risk of loss of service for wastewater treatment and air travel.</p>
Cobenefit Opportunities	<p>Dune restoration can provide new and enhanced habitat</p> <p>Potential to enhance public access to Nobadeer Beach as part of restoration project</p> <p>Monitoring of project can employ mobile technology to crowd-source images and data that can build community awareness and help inform long-term management approaches</p>

South Shore Near-Term Strategic Opportunities



LEGEND

- 01 Dune enhancement
- 02 Beach Nourishment
- 03 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 04 Emergency access planning
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure
- Area of Dune Restoration



Recommended Project Summary- Tom Nevers Field

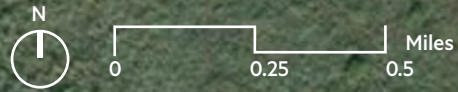
Tom Nevers Field Erosion Management Pilot Project

Description	<i>Pilot program of restored vegetated dune, sand fencing, and beach nourishment. Monitoring program to evaluate how well the pilot project performs to inform decision-making around future investment and capital improvements in Tom Nevers Park, as well as erosion management elsewhere on the island.</i>	
Resilience Objective & Level of Protection	<i>Reducing risk to existing Tom Nevers Field while testing approaches for long-term risk reduction. Pilot project designed to the elevation of 1% annual chance flood with 1.2 feet of sea level rise (11.0 feet NAVD88)</i>	
Duration of Performance	<i>To be determined through monitoring and maintenance of pilot project</i>	Priority <i>First</i>
Estimated Cost	<i>Capital Costs: \$13M Capital Costs with Contingencies: \$16M - \$18M Annual Operations and Maintenance: \$200K</i>	
Estimated Benefits:	<i>\$7.1M in avoided building replacement costs based on existing park uses. Additional benefits not quantified include reduced risk of loss of service for park in current condition or, if pursued, with planned capital improvements.</i>	
Cobenefit Opportunities	<p><i>Addition of new public walkways and access from Tom Nevers Park to beach, including potential wooden boardwalks extending over dune systems to minimize impacts of foot traffic on dunes</i></p> <p><i>Monitoring of project can employ mobile technology to crowd-source images and data that can build community awareness and help inform long-term management approaches</i></p>	



Existing beach and dunes adjacent to Tom Nevers Field (photo by Trevor Johnson)

South Shore Near-Term Strategic Opportunities



LEGEND

- 01 Dune restoration
- 02 Elevated dune walkway for beach access
- 03 Erosion monitoring to inform park design strategy
- 04 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure
- Area of Dune Restoration



Recommended Project Summary- Surfside

Sheep Pond Road Relocation Study

Description	<i>Focused technical study and community outreach to develop plan for relocation of public infrastructure on Sheep Pond Road, including the road. Plan should assess feasible alternatives for relocation of the road, alternative access modes, or retreat from the area.</i>		
Resilience Objective & Level of Protection	<i>Develop proactive plan for access and long-term retreat along Sheep Pond Road due to risk of coastal erosion.</i>		
Duration of Performance	<i>N/A</i>	Priority	<i>Second</i>
Estimated Cost	<i>Town staff and volunteer time</i>		

Surfside Emergency Access Planning




















Description	<i>Develop emergency access plan for Surfside Neighborhood to ensure access to coastal areas</i>		
Resilience Objective & Level of Protection	<i>Identify emergency access corridors in case of loss of service along Nonantum and Nobadeer Avenues. Prioritize access along Pequot Street and Boulevard.</i>		
Duration of Performance	<i>N/A</i>	Priority	<i>Second</i>
Estimated Cost	<i>Town staff and volunteer time</i>		

Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for developed areas along the South Shore. Reducing coastal risk on private properties will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance, increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Best management approaches to reduce erosion are also essential, including efforts to reduce runoff, maintain vegetation, and limit impacts to dune systems. Changes to zoning and wetland regulations recommend on pages 96-102 will also be necessary to promote resilience in the area. There are 93 structures located in Priority Action and High Coastal Risk Areas where land use approaches can be combined with strategic acquisition of priority properties to reduce density in the highest risk areas, such as along Sheep Pond Road, Surfside, and Tom Nevers. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

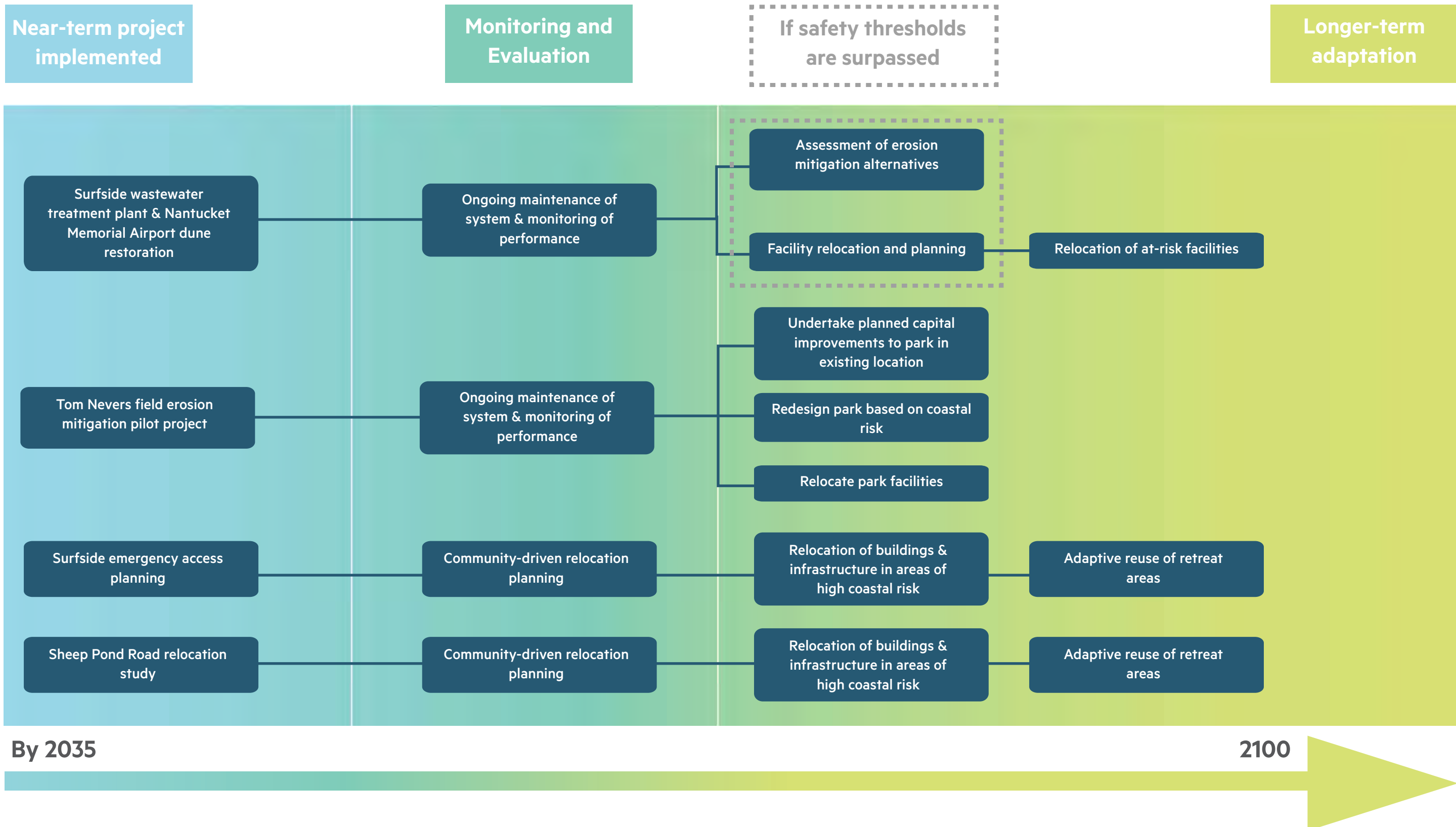
Evaluation Criteria	Most Desirable Impact				
Effectiveness & Adaptability					
Implementation Feasibility					
Ecological & Public Health					
Equity & Quality of Life					
Value Creation					

An aerial photograph of a coastal town. In the foreground, a paved road curves from the bottom left towards the center. To the right of the road, a sandy beach meets the ocean. The ocean is a deep blue, with white waves breaking on the shore. In the middle ground, several houses are scattered across a grassy area. Some are white with dark roofs, while others are more rustic. In the background, a large body of water, possibly a pond or a small lake, is visible, surrounded by more houses and vegetation. The sky is a pale, clear blue.

Long-Term Adaptation Pathways

The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathway for the South Shore provides a viable pathway for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science, and evaluate the need for future adaptations to the near-term projects. Future actions to account for increasing risk on the South Shore will include changes to existing projects and potentially new projects. Throughout the area, priority zones for relocation and retreat will move inland over time with sea level rise and erosion hazards which will entail removal of infrastructure and structures in new inland priority risk zones. At Tom Nevers Field, evaluation of the pilot erosion management project will inform the long-term approach. If the pilot is effective at managing erosion over a five-year period, capital improvements could proceed in a phased approach, but it is recommended that the park design minimize hardscaping and other structural elements, such as parking and pavilions, in the area of the park that is vulnerable to erosion before 2050. If evaluation of the pilot indicates continuing risk to the park, the Town should consider either a more robust erosion management approach in the area, such as reinforced dunes, or relocation of the park facility. At the wastewater treatment facility and airport, erosion management approaches are expected to mitigate erosion and reduce vulnerability but long-term planning for facility relocation or adaptation should continue. For the airport this may entail shifting the existing runway location inland. For the wastewater treatment facility, relocation of settling ponds inland should continue to be explored, along with ongoing maintenance and potential further reinforcement of the shoreline.

Long-Term Adaptation Pathway (2035-2100)



An aerial photograph of a coastal residential area. The image shows several large, multi-story houses with gabled roofs, some with swimming pools, situated on a hillside. A winding road curves through the property. In the background, a large body of water, possibly a bay or inlet, is visible, with a sandy beach and a jettty extending into the water. The sky is a mix of blue and orange, suggesting a sunset or sunrise. The text 'NORTH SHORE FROM THE JETTIES TO EEL POINT' is overlaid in large, white, bold, sans-serif font across the top and middle of the image.

NORTH SHORE FROM THE JETTIES TO EEL POINT

*This **ADAPT** strategy prioritizes extending the life of existing private buildings and public and private infrastructure through nature-based erosion management. This approach will help delay the risks associated with erosion and buy time for strategic relocation of highly vulnerable properties. Private property owner implementation of building-scale adaptation measures addresses risks from major storms and helps manage erosion risk over time.*

Area Overview

Nantucket's North Shore stretches from the Jetties—just northwest of Brant Point—west alongside the Nantucket Cliffs, through Dionis to Eel Point, Nantucket's northwestern edge. Much of this area is characterized by single-family homes, a wealth of natural resources, and eroding bluffs at several points along the shoreline. Despite the relatively low direct threat to existing buildings, several public and private roadways are at high risk of long-term flooding and storm surge, which could severely impact access to some homes, especially in Eel Point which is at a particularly low elevation. The coast in this area includes salt marshes, eelgrass beds, and habitat including shellfish, finfish, waterfowl, and marine mammals.

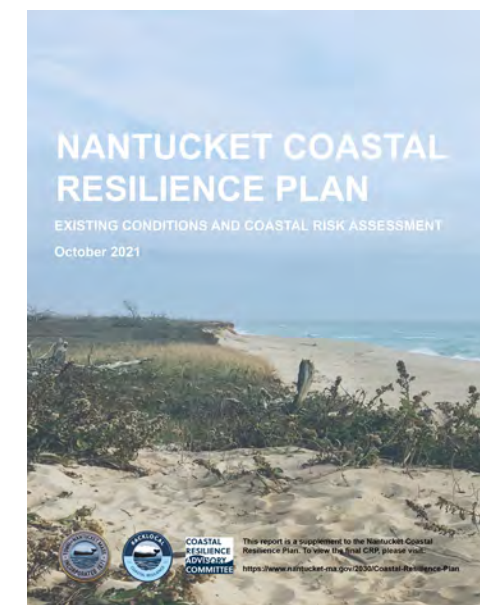
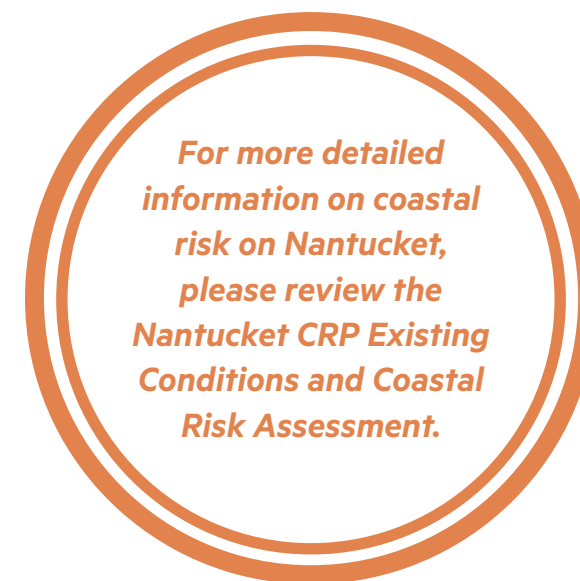
Summary of Resilience Challenges

The key coastal resilience challenges on the North Shore, from the Jetties to Eel Point, include:

- Erosion of the coastline, with impacts to private residences, open space, and private infrastructure including roads
- Coastal flooding impacts leading to damage and disruption at private residences
- Flooding along Madaket Road impacting access to the area from Warrens Landing Road



Jetties Beach (photo by Chelsea Kilburn)



Overview of Coastal Risk in North Shore

Coastal risk can be complicated. The CRP’s coastal risk assessment considered multiple hazards (high tide flooding, coastal flooding from storms, and coastal erosion) across several time frames (present day, 2030, 2050, 2070, and 2100) and produced a large amount of information about Nantucket’s coastal risk and how it will change over time. The Island-Wide Coastal Risk Framework is a decision-making tool developed to guide near-term resilience decisions made on Nantucket based on the results of the risk assessment. This framework divides the island into four distinct areas based on risk, as described in the chart below.

	Priority Action Areas of Extreme Coastal Risk	High Coastal Risk Areas	Moderate Coastal Risk Areas	Lower Coastal Risk Areas
Risk Summary	Priority Action Areas face extreme coastal risks today or within the next decade. Density should be proactively reduced in these areas to reduce the immediate threat to people, property, and livelihoods. Due to the extreme coastal risk, large structural investments are not recommended in these areas due to prohibitive maintenance costs and limited potential benefits.	High Coastal Risk Areas may be exposed to coastal hazards within the next 30 years, or the lifetime of a typical mortgage. Due to the imminent and growing risk, large structural investments are not recommended in these areas under most circumstances, except where necessary to ensure public safety.	Moderate Coastal Risk Areas may be exposed to coastal hazards by 2070. In these areas approaches to adapt or protect against flooding may be appropriate. Changes in coastal risk should be monitored and decisions made accordingly.	Lower Coastal Risk Areas are not likely to be exposed to coastal hazards by 2070. Comprehensive planning is recommended to strategically optimize opportunities in lower risk areas.

In the North Shore, 18 structures are within the Priority Action Area and one-third of these are historic. By 2070, 102 structures will likely be exposed to coastal hazards. The near-term strategy recommended following will help reduce coastal risk in the North Shore.

Risk Area	Structures Exposed (#) ^{*^}	Historic Structures ^{**} (%)	Public Roadways Exposed (miles) [~]
Priority Action Area	18	33%	0.07
High Coastal Risk Area	37	24%	0.11
Moderate Coastal Risk Area	102	15%	0.31

^{*}Number of structures exposed to moderate risk is inclusive of structures exposed to extreme and high risk. Number of structures exposed to high risk is inclusive of structures exposed to extreme risk.

[^]A structure is assumed to be exposed to the highest risk tier its footprint intersects.

^{**}Historic structures are structures in the Downtown or Siasconset Historic Districts or inventoried by the Massachusetts Historical Commission.

[~]Mileage of roadway exposed to moderate risk is inclusive of roads exposed to extreme and high risk. Mileage of roadway exposed to high risk is inclusive of roads exposed to extreme risk.

North Shore

Island-Wide Coastal Risk Framework



LEGEND

- Public Roadways
- Private or Unknown Roadways
- Existing Structures
- Priority Coastal Risk Areas
- High Coastal Risk Areas
- Moderate Coastal Risk Areas

Nantucket Sound

Madaket Harbor

Eel Point Road

Cliff Road

Madaket Road

Madaket Road

Strategy Overview

To address each of the resilience challenges identified through this study and prior studies completed by the Town and other partners, a set of recommended resilience strategies is identified for near-term implementation by the Town, property owners, and other stakeholders. As will be described, different types of approaches are suggested in different areas depending on the issue(s) addressed.

Infrastructure, Buildings, and Erosion Management

Erosion is the primary coastal risk along much of the North Shore. Measures to manage and mitigate erosion are recommended along the coast. The strategy includes development of a comprehensive sediment management approach from the west jetty to Eel Point, including vegetated dune restoration and strategic sand placement, either directly via nourishment or via a submerged near-shore sand berm. Sediment placement should be focused on locations downdrift from shoreline armoring structures which currently interfere with sediment transport, as suggested on page 238. At the same time, the Town should conduct a feasibility study for a sand pumping and by-pass system at the Jetties. The system could be used to pump sand from borrow sources within the inlet or connect the sediment transport system between Coatue, across the Jetties, to the North Shore. The recommended sediment transport study will provide important data for this study and should be completed first. The Town should also develop an inventory of all existing shoreline protection projects, including bulkheads, seawalls, groins, sand fencing, and other measures and their history. The Town may consider regulatory measures to restrict repair and reconstruction of these structures if they are damaged or reach the end of their useful life. They may also consider requiring compensatory sediment mitigation for structures that impede natural sediment transport processes.

For the North Shore to be resilient, homeowners will also need to take action. On private property, home and business owners will be responsible for adapting their own properties using the toolkit of best practices for property owners described earlier in Section 7. This could include a number of steps for properties at risk of flooding, from elevation of the structure, to wet floodproofing, to relocation in some cases. Homeowners with properties that are vulnerable to erosion should adopt best practices such as maintaining vegetation, reducing runoff, and minimizing impacts to dunes and bluff tops. Some property owners may be willing to accept more or less risk than others and can decide when and how it is most appropriate

to reduce their risk. Some areas along the North Shore are identified as Priority Action and High Coastal Risk Areas due to near-term erosion risk. In these locations it is appropriate to begin reducing density through policies and programs. Reducing density could mean a number of things including changes to zoning regulations for future development, increases in setbacks for buildings and other structures, and acquisition and/or relocation of buildings and infrastructure, as described in Section 6. The Town should begin outreach to property owners in these areas immediately to communicate the degree of risk and conduct ongoing engagement regarding options for private property retreat and relocation.

Access is another concern along the North Shore. The area is primarily served by private roads, including much of Eel Point Road west of Ranger Road and Warrens Landing Road. Private property owners should continue to maintain these roads at their current elevation while they serve private residences, while monitoring erosion risk. Inland relocation of certain roadway segments or abandonment of the roadway may be necessary. In this case, alternative access routes can be maintained along Warrens Landing Road or from publicly-owned portions of Eel Point Road, though overall travel distances will increase under this scenario. Access to Eel Point from Madaket Road will be prolonged by the roadway resilience project recommended in the Madaket section of the CRP (pages 166-185).

Opportunities for Co-Benefits

Co-benefits are features of a resilience strategy that address other community goals and needs in addition to coastal risk reduction. The resilience strategy for the North Shore includes a number of opportunities for co-benefits that can be pursued through project design and implementation, including opportunities for community engagement and education.

Recommended Project Summary

The following projects are recommended along the North Shore as part of the coastal resilience strategy, including the anticipated benefits, estimated costs, level of protection, priority, and duration of performance for each.

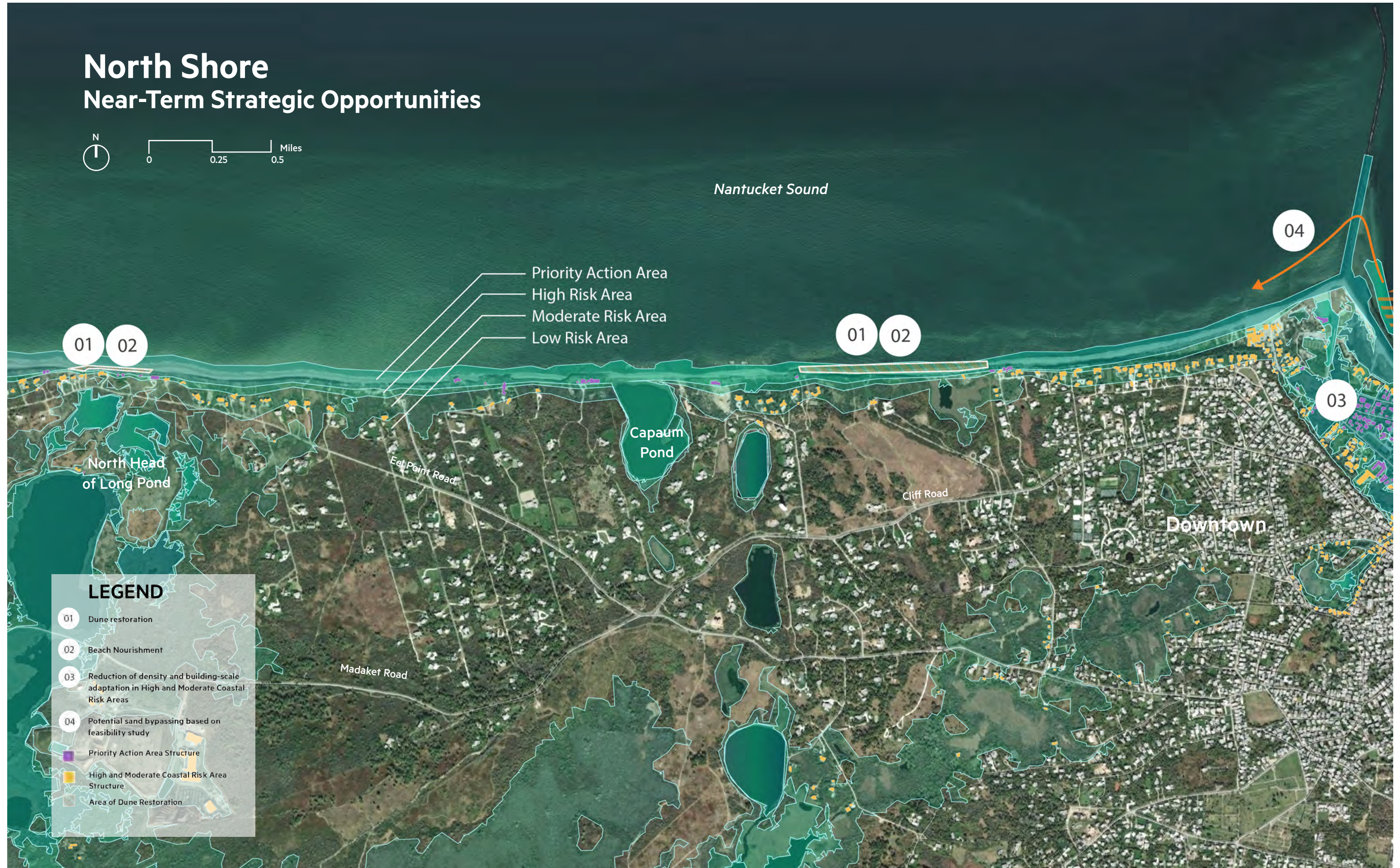
North Shore Dune Restoration and Nourishment

Description	<i>Dune restoration and construction to reduce risk of erosion along the North Shore. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm at key locations.</i>		
Resilience Objective & Level of Protection	<i>Delay and manage erosion risk. Design elevation to the 2% annual chance storm with 1.2 feet of sea level rise (10.0 to 12.0 feet NAVD88)</i>		
Duration of Performance	<i>10-30 years. To be determined through monitoring and maintenance of pilot projects.</i>	Priority	<i>Third</i>
Estimated Cost	<i>Capital Costs: \$27M Capital Costs with Contingencies: \$34M - \$38M Annual Operations and Maintenance: \$420K</i>		
Estimated Benefits	<i>\$16M in avoided building replacement costs based on existing park uses. Additional benefits not quantified include reduced risk of loss of service or damage to roadways and other infrastructure.</i>		
Cobenefit Opportunities	<i>Dune restoration can provide new and enhanced habitat</i> <i>Potential to enhance public access by increasing the width of the beach in certain locations</i> <i>Monitoring of project can employ mobile technology to crowd-source images and data that can build community awareness and help inform long-term management approaches</i>		

Sand Pumping Feasibility Study

Description	<i>Study the feasibility and impacts of a sand pumping and by-pass systems to connect sand sources from inlet and along Coatue to the North Shore.</i>		
Resilience Objective & Level of Protection	<i>Determine viability of sand pumping system to enhance beach width and elevation on North Shore without impacting other areas such as the harbor inlet and Coatue</i>		
Duration of Performance	<i>N/A</i>	Priority	<i>Third</i>
Estimated Cost	<i>Feasibility Study: \$100K - \$250K</i>		

North Shore Near-Term Strategic Opportunities



LEGEND


















- 01 Dune restoration
- 02 Beach Nourishment
- 03 Reduction of density and building-scale adaptation in High and Moderate Coastal Risk Areas
- 04 Potential sand bypassing based on feasibility study
- Priority Action Area Structure
- High and Moderate Coastal Risk Area Structure
- Area of Dune Restoration

Policy and Regulatory Approaches

Several of the island-wide regulatory and programmatic approaches recommended in Section 6 must be implemented as part of the resilience strategy for developed areas along the North Shore. Reducing coastal risk on private properties will mean that individuals should implement flood and erosion resilience best practices recommended through property owner guidance on pages 126-135. Low cost steps include purchasing flood insurance, increasing risk awareness, and having an emergency preparedness plan, as well as physical approaches like installing barriers in doors and windows and elevating essential mechanical systems. Best management approaches to reduce erosion are also essential, including efforts to reduce runoff, maintain vegetation, and limit impacts to dune systems. Changes to zoning and wetland regulations recommend on pages 96-102 will also be necessary to promote resilience in the area. There are 55 structures located in the Priority and High Coastal Risk Areas where land use approaches can be combined with strategic acquisition of priority properties to reduce density in the highest risk areas. Reducing density is a long-term process that will take time and require additional community outreach and engagement.

Strategy Evaluation

The table below summarizes the evaluation of the recommended coastal resilience strategy based on the project evaluation criteria assuming all components of the strategy are implemented and maintained.

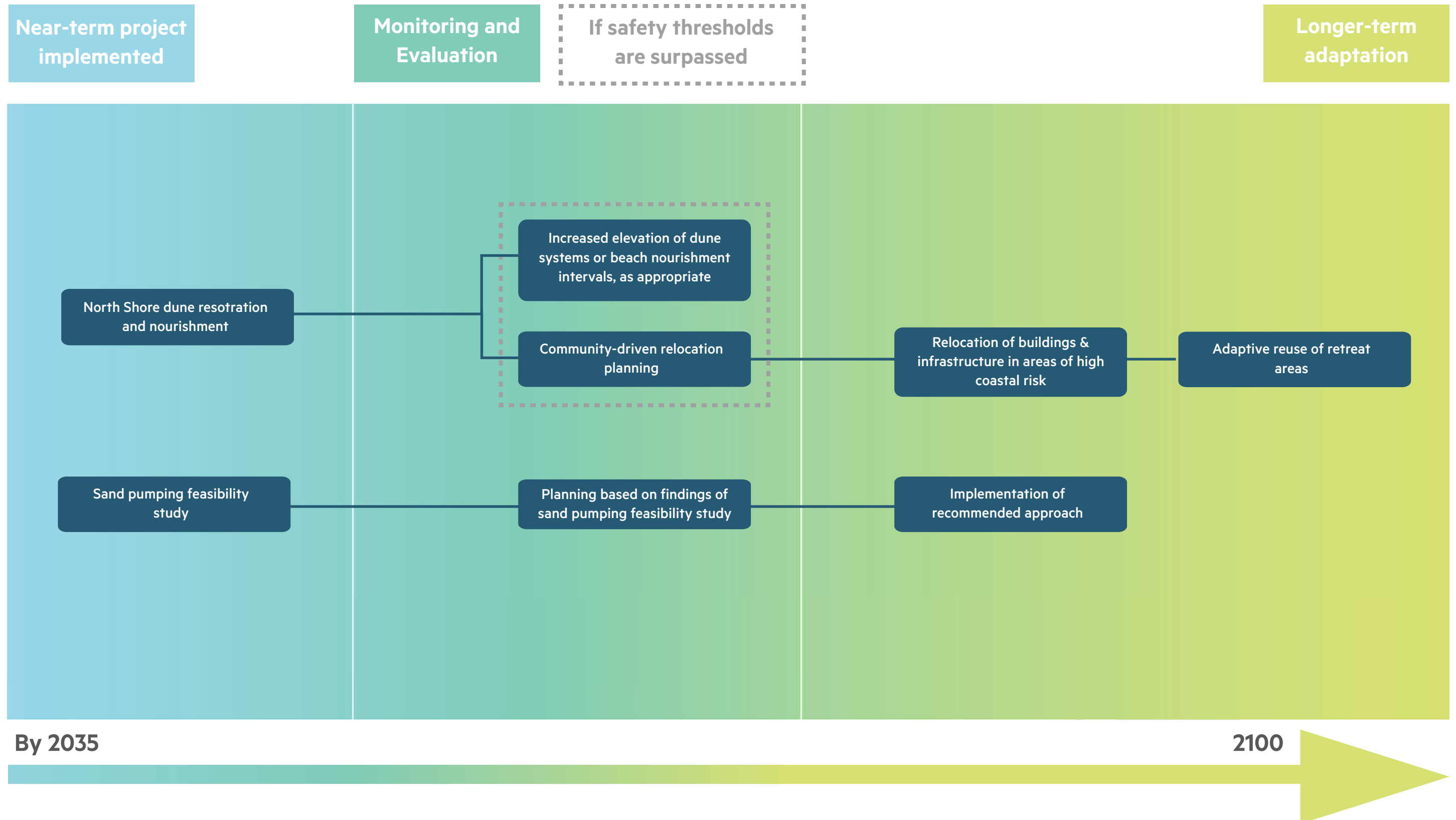
Evaluation Criteria	Most Desirable Impact			
Effectiveness & Adaptability				
Implementation Feasibility				
Ecological & Public Health				
Equity & Quality of Life				
Value Creation				

An aerial photograph of a coastal town, likely on the North Shore. The town is situated on a peninsula or near a large body of water. The landscape is a mix of residential buildings, some with swimming pools, and open, undeveloped land. A road winds through the town, and there are several cars visible. The sky is clear, and the water is calm. The overall scene is a mix of developed and natural areas.

Long-Term Adaptation Pathways

The near-term strategy presented here is recommended for implementation beginning today for completion within the next 10-15 years. The long-term adaptation pathway for the North Shore provides a viable pathway for increasing community resilience through the end of this century. In parallel with implementation of the near-term strategy, the Town should monitor changes in risk, coastal processes, and climate science, and evaluate the need for future adaptation of the near-term projects. Future actions to account for increasing risk on the North Shore will include changes to existing projects, such as increases in the elevation of dune systems or beach nourishment intervals, and potentially new projects based on the results of the sand pumping and by-pass feasibility study. In addition, throughout the area, priority zones for relocation and retreat will move inland over time with sea level rise and erosion hazards which will entail removal of public and private infrastructure and structures in updated Priority Action Areas further inland.

Long-Term Adaptation Pathway (2035-2100)





SECTION 08: PROJECT PRIORITIZATION & IMPLEMENTATION ROADMAP

This section outlines the process of implementing the recommendations of the Coastal Resilience Plan. It covers project prioritization, recommended next steps, stakeholder engagement needs, applicable regulatory assessments, and other implementation considerations for each project.

Introduction

All projects recommended by the CRP will require attention to implementation planning. The number and timing of implementation steps will vary by project depending on technical complexity, scope, cost, number of affected stakeholders, and other factors. The implementation roadmap provided in this section will help guide coastal resilience actions across Nantucket over the next 10-15 years and beyond. The roadmap includes immediate next steps for each project, cost estimates, high level phasing plans, benefit-cost information for applicable projects, roles and responsibilities, potential funding programs, and stakeholders to engage. Regulatory resilience actions recommended to help facilitate implementation of some structural and nature-based solutions are described in Section 6.

The Implementation Process

The implementation process for coastal resilience projects is complex and takes time. Each project and project type will necessitate a different timetable for bringing the plan from concept, through design and development, to ultimate delivery and enjoyment.

The CRP includes recommendations for 40 projects to be advanced across the island over the next 10-15 years. This includes 19 non-structural, 11 structural, nine nature-based, and one hybrid project. This section provides implementation guidance for the recommended projects by focus area. There are also elements of the implementation process that are not area-specific, as described below.

Decision-makers should keep in mind that Nantucket is also vulnerable to other hazards in addition to coastal flooding and erosion. Risk due to other hazards, such as extreme precipitation, drought, and heat, should be considered before implementing any policy, plan, or project on Nantucket.

Community Engagement

Implementation of all recommended projects must include ongoing engagement of stakeholders, including both those who will need to play a role in the implementation of the project and those who will be affected by the outcomes of the project. Stakeholders that should be involved throughout the implementation process may include Town departments, local, State, and Federal regulators, funders, private property owners, renters, businesses, and non-profit advocacy and conservation organizations. Strategic partnerships between public, private, and non-profit stakeholders can play a key role in advancing the implementation of coastal resilience strategies on Nantucket.

The Design Process

For structural and nature-based projects, the planning process is followed by the design process. In some cases, additional planning and community engagement is recommended prior to launching design to further refine concepts and ensure stakeholder support. For projects that are ready to advance from planning to technical design, there is an established set of stages through which a project advances to transition from conceptual design to final design and construction. The timing for each of these stages depends on the scale, complexity, and available funding for a project. Outlined below is a traditional Design-Bid-Build process. However, other delivery methods, such as Design-Build and Public Private Partnerships are also possible. Permitting coordination and related actions can occur within any of these stages:

Concept Design: 10-15 percent design

This step is the focus of the CRP. Includes scope of project, concept drawings, preliminary cost estimates, but no environmental consultations or permitting steps are complete.

Feasibility Study and Preliminary Design: 30 percent design

Further project definition including confirmation of design parameters and goals, further testing of constructability, operations and maintenance, regulatory requirements, costs, and effectiveness. Alternatives may be evaluated. Main project components are designed. Project is designed to a sufficient level of detail to begin regulatory review, with initial consultations complete, and provides clear direction for the next stage of detailed project engineering, specifications, and more detailed cost estimation.

60 percent design:

Advancement of the design and cost estimates from the feasibility study with additional technical refinement for comment and revision with stakeholders. Items which drive cost, schedule and implementation are identified, and further defined through the design process. On-going regulatory and stakeholder interaction.

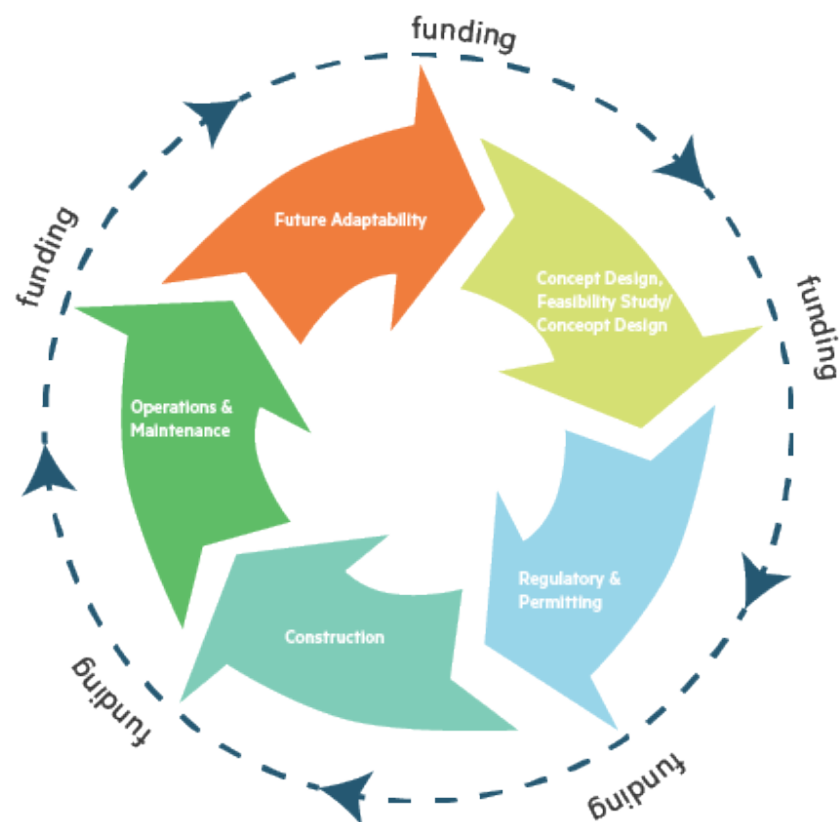
90 percent design

Project design is nearing finalization and permitting is nearing completion.

Final Design : 100 percent design

Project design documentation for construction, including bidding documents, and project is fully permitted.

The procurement and construction phase of the project follows final design. The time necessary for this phase varies widely by project type and for complex resilience projects can take multiple years. Once the project is complete, its benefits can be enjoyed by the intended users over the course of the project's design life, the period of time over which the project is designed to perform its intended function. The design life will vary depending on the project type. Many structural projects have a design life between 10 and 50 years. Regardless of the intended design life, ongoing maintenance and upkeep is critical to the effectiveness of the project and must be accounted for in budgeting for all major structural projects. Cost estimates provided for the CRP include an allowance for annual operations and maintenance needs. Funding for the implementation of CRP projects can come from a variety of sources, including Town capital and operations budgets, public-private partnerships, and State and Federal grants.



Recommended Implementation Phasing

Coastal risk on Nantucket is increasing due to sea level rise, but the long-term rate of sea level rise is uncertain. The coastal risks that the Nantucket community will face over the next 10 years are more certain. Beginning to implement recommended projects today and over the next 10-15 years is recommended to establish a basis for long-term adaptation.

The majority of near-term projects recommended by the CRP should be completed by 2035, though some actions may extend beyond that date due to complexity and prioritization. If sea level rises faster than the current scenarios suggest, the schedule should be accelerated. All near-term projects serve as the foundation for long-term adaption pathways, as discussed in Section 7. Because potential sea level rise later in the century is less certain, the timeframe for long-term actions should be re-evaluated periodically based on best available data.

The CRP's project phasing and prioritization plans reflect our current understanding of how coastal risks will evolve, necessary sequencing of projects that build upon one another, the urgency of the risks, and the time necessary to complete different actions.

Project prioritization is based on a number of considerations. All recommended projects should begin the implementation process over the next 5-10 years. But, given that time and resources are limited, certain projects may need to be prioritized based on the following factors.

- Necessity for other projects to begin
- Timing of coastal risk exposure
- Degree of risk reduction
- Funding availability
- Social, environmental, economic, and recreational co-benefits

A lower priority score (1) indicates a higher priority project based on these criteria. Projects with higher priority scores (3) are relatively lower priority. While the prioritization ranking provides a guide for Town officials and stakeholders, opportunities to speed up implementation should be taken wherever possible. Private funding may be available to speed up project implementation. Before pursuing or accepting such funding, equity implications should be thoroughly considered.

Project Phasing and Prioritization

The project phasing shown on the chart to the right is based on project type, project prioritization, project location and scope, property ownership, sequencing considerations, and includes the time expected to complete funding, design and permitting of projects, and construction or delivery. Some projects are less complex or are already in-process so can be completed sooner. Other capital projects located along waterways are likely to take longer because they are more complex to design and costly to permit and build. All timeframes are based on current conditions. The exact timeframes for specific projects will be determined through more detailed planning, design, and construction scheduling. Some projects will require private property agreements and contracts, as appropriate, and will require permitting through the Massachusetts Environmental Protection Agency, 401 Water Quality Certification, and Chapter 91, United States Army Corps of Engineers, Nantucket Conservation Commission, Nantucket Historic Districts Commission, and other permitting processes depending on the project area, as described later in this section.

Implementation Tracks

The following pages include summary tables providing area-specific implementation information for the near-term strategic opportunities. The information provided is intended to help Town staff, elected officials, key stakeholders, and the general public understand the recommended implementation considerations and next steps for each area of the island. All projects will require additional implementation planning through the project development and design process, and it is expected that the implementation roadmap will evolve over time based on emerging opportunities, changing conditions, evolving coastal risks, and new community priorities.

Prioritization

01

02

03

Near-Term Strategy or Project Title

Coastal Resilience and Sustainability Interdepartmental Working Group
 Update locally adopted sea level rise scenarios and best available flood hazard data
 Sediment Sourcing and Transport Study
 Coatue Erosion Management and Dune Resilience
 Coastal Resilience and Sustainability Program
 Department of Public Works Facility and Landfill Resilience
 Sediment Budget
 Madaket Road Raising and Bridge Conversion
 Downtown Neighborhood Flood Barrier
 Tom Nevers Field Erosion Management Pilot Project
 Updates to Zoning By-Law
 Updates to Wetland Ordinance and Regulations
 Surfside Wastewater Treatment Facility Dune Restoration
 Ames Avenue Bridge Resilience
 Madaket Erosion Management Pilot and Ames Avenue Bridge Protection
 Steamboat Wharf Resilience
 Strategic Retreat and Relocation Program
 Community Outreach on Property Owner Resilience Best Practices

Sheep Pond Road Relocation Study
 Building Scale Resilience at 37 Washington Street
 Surfside Emergency Access Planning
 Stormwater Management Plan
 Numerical Modeling Study of Coatue Breaching
 Codfish Park Dune Restoration
 Polpis Road Raising and Bridge Conversion at Folger's Marsh
 Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond
 Nantucket Memorial Airport Dune Restoration
 Baxter Road Relocation Planning
 Sconset Bluff Nearshore Breakwaters Feasibility Study
 Shoreline Change Monitoring Program

Joint Staff Review of Development Proposals
 Stormwater By-Laws Assessment
 Stormwater By-Law and Regulations Update
 North Shore Dune Restoration and Nourishment
 Sconset Bluff Dune Restoration
 Sand Pumping Feasibility Study
 Easton Street and Hubert Avenue Road Raising
 Washington Street Extension and Consue Springs Walkway Raising
 F Street Boat Ramp

Cost Estimation Note

The project team used information from prior studies and construction projects around the United States to develop planning-level cost estimates for coastal resilience structures and erosion management features, as well as non-structural studies that may necessitate technical support from outside advisors. The resulting estimates are presented with the implementation tracks on the following pages. These estimates are based on concept-level designs developed for the CRP and must account for the numerous uncertainties that exist at this stage of the design and implementation process. This means that estimated costs are presented in ranges and include contingency factors of 30% [low] and 50% [high] added to the estimated capital and construction costs. This approach is consistent with guidance from the American Association of Cost Engineering (AACE) for Class 4 study-level cost estimation.

In addition to the cost of materials, the estimates include allowances for the costs of design, demolition, drainage, operations and maintenance, public amenities, and other industry standard allowances. These costs are based on readily available data and do not reflect detailed design-level considerations for the area, such as existing underground utilities or geotechnical information. Given this, these estimates can be used for planning purposes to understand the magnitude of anticipated project costs. Subsequent stages of design and engineering will help collect additional information to enable more detailed cost estimation for each project.

Calculation of Benefits

A summary of estimated benefits is also provided for each structural and nature-based project. Where possible, benefits are quantified using standard methodologies from FEMA and U.S. Army Corp of Engineers. These benefits include avoided direct physical, economic, and social damages to buildings and disruption to transportation infrastructure. In cases where data limitations prevent quantification of benefits for this study, a qualitative description of benefits is provided. Non-quantified benefits include avoided disruption of service for infrastructure and public services, avoided loss of habitat and ecological services, avoided emergency response costs, and benefits accruing from non-structural projects.

Regulatory and Permitting

Regulatory feasibility is summarized in the implementation matrices based on existing permitting requirements and potential challenges in near-term permit approvals for coastal resilience design strategies on Nantucket. Red, yellow, and green text indicate whether a technical approach is likely to experience significant, moderate, or little-to-no difficulty when proceeding through the existing local, State, and Federal regulatory framework.

Additional information on regulatory feasibility is included on pages 264-269.



Coast Near Cisco (Photo by Rennie Jones)

ISLAND-WIDE (section 06)

Project Priority

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Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Impacts/Change
1-1	Community Outreach on Property Owner Resilience Best Practices	Comprehensive outreach program to at risk home and business owners to raise risk awareness and provide guidance on best practices for reducing coastal risks for private properties.	Non-structural	Staff and Volunteer Time	N/A	2023, Ongoing	Coastal Community
1-2	Updates to Zoning By-Law	Updates to the zoning by-law to encourage resilient design and limit investment in areas of high coastal risk.	Non-structural	Staff and Volunteer Time	N/A	2025	Planning
1-3	Updates to Wetland Ordinance and Regulations	Updates to the Nantucket wetlands by-law and regulations to encourage resilient and low impact design in resource adjacent areas while limiting impacts on resource areas.	Non-structural	Staff and Volunteer Time	N/A	2025	Natural Resources
1-4	Strategic Retreat and Relocation Program	Develop and administer island-wide approach for pursuing strategic retreat and relocation in areas of priority coastal risks with an ongoing focus on risk communication and property owner outreach and education.	Non-structural	Staff and Volunteer Time	N/A	2024, Ongoing	Natural Resources
1-5	Coastal Resilience & Sustainability Interdepartmental Working Group	Governance approach to encourage inter-departmental collaboration and coordination on issues related to coastal resilience and sustainability.	Non-structural	Staff and Volunteer Time	N/A	2022, Ongoing	Town Operations
1-6	Joint Staff Review of Development Proposals	Governance approach to maximize opportunities for coordinated decision-making and consistent customer communication by Town staff, particularly for projects located in or impacting coastal areas.	Non-structural	Staff and Volunteer Time	N/A	2022, Ongoing	Town Operations
1-7	Coastal Resilience and Sustainability Program	Governance approach to establish a formal program with necessary resources for managing coastal resilience and sustainability projects and programs across the island.	Non-structural	Staff and Volunteer Time	N/A	2023, Ongoing	Natural Resources
1-8	Shoreline Change Monitoring Program	Employ mobile technology and other tools to engage community members in the process of monitoring shoreline change at pilot projects and across the island.	Non-structural	Staff and Volunteer Time	N/A	2024, Ongoing	Natural Resources
1-9	Sediment Sourcing and Transport Study	Island-wide data collection and planning approach to identify sediment sources and define sediment movement across the island at various spatial and temporal scales in order to inform the design and planning of future sediment management projects.	Non-structural	High: \$1M Low: \$800K O&M: NA	N/A	2024	Natural Resources
1-10	Stormwater Management Plan	Planning step to evaluate stormwater management issues across the island and identify recommendations for reducing stormwater flooding and improving water quality.	Non-structural	High: \$650K Low: \$400K O&M: NA	N/A	2025	Departmental
1-11	Sediment Budget	Planning step to develop an operational sand budget for recommended shoreline projects.	Non-structural	High: \$250K Low: \$100K O&M: NA	N/A	2024	Natural Resources
1-12	Stormwater By-Laws Assessment	Planning step to conduct an assessment of existing by-laws for opportunities to encourage stormwater management best management practices (BMPs).	Non-structural	High: \$50K Low: \$20K O&M: NA	N/A	2025	Departmental
1-13	Stormwater By-Law and Regulations Update	Updates to stormwater management by-law and regulations to encourage best management practices (BMPs) that address water quality and quantity issues.	Non-structural	Staff and Volunteer Time	N/A	2025	Departmental
1-14	Update locally-adopted sea level rise scenarios and Best Available Flood Hazard Data	Adopt sea level rise scenarios provide by the Commonwealth of Massachusetts and Massachusetts Coastal Flood Risk Model as the best available local flood hazard data.	Non-structural	Staff and Volunteer Time	N/A	2022	Coastal Community

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Coastal Resilience Advisory Committee	Natural Resources	PLUS, Town Administration, Planning Board, Conservation Commission, Historic District Commission, Nantucket Historical Commission, ACKlimate, ReMain Nantucket, Civic Associations, Private Property Owners, Business Owners	Develop outreach plan and strategy to share risk information and homeowner guidance through virtual meetings, social media, direct mail, websites, partnerships, and other means.	Town Operating Budget, Town Capital Budget, MVP Action Grant, CZM Coastal Resilience Grant	N/A
Planning and Land Use Services	Natural Resources	Town Administration, Department of Public Works, Town Engineer, Planning Board, Town Counsel, Conservation Commission, Town Meeting, Private Property Owners	Develop outreach plan to inform and vet potential by-law changes with stakeholders. Begin drafting revised by-law language based on Minimum Changes recommended and other desired changes for inclusion in Town Meeting Warrant Article. Institute process-based changes that do not require by-law updates.	Town Operating Budget	GREEN
Natural Resources	Planning and Land Use Services	Town Administration, Conservation Commission, Town Meeting, Town Counsel, Private Property Owners		Town Operating Budget	GREEN
Natural Resources	Planning and Land Use Services	PLUS, Town Administration, Planning Board, Conservation Commission, Historic District Commission, Nantucket Historical Commission, ACKlimate, ReMain Nantucket, Civic Associations, Private Property Owners, Business Owners	Establish staff working group to identify role and responsibilities, identify key questions and legal authorities, and develop community outreach strategy.	Town Operating Budget, MVP Action Grant, FEMA Flood Mitigation Assistance, Land Bank, Land Trusts	N/A
Administration	Natural Resources	PLUS, Department of Public Works, Public Safety, Sewer Department, Water Company, Town Engineer, Airport	Recommendation underway. Establish charter for the working group, standard meeting agenda, and meeting schedule.	Town Operating Budget	N/A
Administration	Planning and Land Use Services	Department of Public Works, Public Safety, Sewer Department, Water Company, Town Engineer	Develop scoping document including key objectives, roles and responsibilities, standard meeting agenda, and meeting schedule.	Town Operating Budget	N/A
Natural Resources	Town Administration	Department of Public Works, Public Safety, Sewer Department, Water Company, Town Engineer, CRAC	Develop scoping document and charter for program including key objectives, roles and responsibilities, and resource needs. Discuss and vet program scope with Town leadership and other stakeholders.	Town Operating Budget	N/A
Natural Resources	Coastal Resilience Advisory Committee	Conservation Commission, Nantucket Conservation Foundation, Nantucket Coastal Conservancy, ACKlimate, ReMain Nantucket, Civic Associations, Private Property Owners	Assess current monitoring practices and opportunities and tools to streamline monitoring efforts. Based on assessment determine if efforts can be expanded by employing innovative digital and remote sensing technologies, as well as citizen science participatory approaches.	Town Operating Budget, CZM Coastal Resilience Grant, Private Funders	N/A
Natural Resources	Town Administration	Conservation Commission, PLUS, Nantucket Conservation Foundation, Nantucket Coastal Conservancy, ACKlimate, ReMain Nantucket	Make capital budget request for funding to complete the study. Develop scope and RFP for study.	Town Operating Budget	N/A
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, Planning Board, CRAC, Conservation Commission, Private Property Owners, Business Owners	Make capital budget request for funding to complete the study. Develop scope and RFP for study.	Town Operating Budget	N/A
Natural Resources	Coastal Resilience Advisory Committee	PLUS, Conservation Commission, PLUS, Nantucket Coastal Conservancy, Nantucket Conservation Foundation	Dependent on results of sediment transport study. Develop scope and RFP for study.	Town Operating Budget	N/A
Department of Public Works	Natural Resources	PLUS, Town Administration, Town Engineer, Planning Board, Conservation Commission, Private Property Owners	Develop State MVP Action Grant application to conduct assessment and update stormwater regulations. This project is not dependent on the recommended Stormwater Management Plan.	MVP Action Grant	N/A
Department of Public Works	Natural Resources	PLUS, Town Administration, Town Engineer, Planning Board, Conservation Commission, Private Property Owners		MVP Action Grant	GREEN
Coastal Resilience Advisory Committee	Natural Resources	Select Board, Department of Public Works, Town Engineer	Schedule public CRAC meeting to discuss adoption of new sea level rise scenarios and Best Available Flood Hazard Data.	Town Operating Budget	N/A

DOWNTOWN (section 07)

Project Priority

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Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Imp Cha
2-1	Steamboat Wharf Resilience	Work with the Steamship Authority to develop adaptation plan for Steamboat Wharf with the preferred option of elevating the pier above future mean monthly high water. Building scale measures can be implemented on the wharf over time to reduce risk from coastal storms. The strategy should be integrated with the design of the Downtown Coastal Flood Barrier System (Strategy 2-2) to maintain access from Broad Street onto the Wharf. Final approach will need to be planned and design by the Steamship Authority but close coordination with Town resilience planning will be critical to a successful resilience strategy.	Structural	High: \$120M Low: \$110M O&M: \$1.3M	\$19,000,000	2030	Tow
2-2	Downtown Neighborhood Flood Barrier - Later Project Phases	The barrier system, which includes the first phase project described as Strategy 2-6, includes a number of elements to be implemented over time to provide comprehensive effective flood risk reduction against future mean monthly high water. The elements include raised roadways, raised bulkheads, reinforced dunes, and flood walls. The overall approach recommends passive measures that are integrated with the existing built environment, while maintaining access to key waterside facilities such as the Children's Beach Boat Ramp, Steamboat Wharf, Straight Wharf, and the Town Pier. Implementation of the approach can be phased over a period of 10 to 15 years, focusing on the lowest lying areas first, such as Easy Street (Strategy 2-6). As the project is implemented, stormwater management needs will need to be studied and addressed via new drainage infrastructure.	Structural	High: \$170M Low: \$150M O&M: \$1.9M Note that these cost estimates include costs for the Phase 1 project (Project 2-6)	\$320,000,000	2050	Natu
2-3	Easton Street and Hulbert Avenue Road Raising	Road raising project to prolong service life of Easton Street and Hulbert Avenue for emergency and everyday access in Brant Point	Structural	High: \$140M Low: \$130M O&M: \$1.6M	Not quantified; qualitative benefits include prolonging emergency and everyday access for Brant Point	2050	Depa
2-4	Washington Street Extension and Consue Springs Walkway Raising	Road raising to prolong service life of Washington Street Extension and public access in Consue Springs	Structural	High: \$65M Low: \$58M O&M: \$720K	Not quantified; qualitative benefits include prolonging public access to Consue Springs natural area	2050	Depa
2-5	Building Scale Resilience at 37 Washington Street	Pilot project to showcase building-scale resilience best practices on a Town-owned facility, including potentially elevation of critical systems, protection of sensitive equipment and documents, and deployable flood risk reduction measures. The first step in this recommendation is a site-specific study to determine the appropriate risk mitigation approaches for this structure.	Structuvral	High: \$150K Low: \$50K O&M: NA	Not quantified; benefits are dependent on risk mitigation strategy developed through recommended site-specific study.	2024	Depa
2-6	Downtown Neighborhood Flood Barrier - Phase 1 Project	Phase 1 project to advance through feasibility and design a near-term project focused on the most vulnerable location along the planned extent of the Downtown Neighborhood Flood Barrier. The Phase 1 project should focus on the coastal segment located along Easy Street from Straight Wharf to Steamboat Wharf and may include raised bulkheads, sidewalks, and roadways.	Structural	High: \$13M Low: \$12M O&M: \$150K Note that these cost estimates are included in the costs for Project 2-2	\$120,000,000	2025	Depa

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Town Administration	Department of Public Works	Steamship Authority, Natural Resources, Department of Public Works, Town Engineer, Public Safety	Establish joint working group between Steamship Authority and Town staff to refine conceptual plans and seek funding for recommended actions.	MVP Action Grant, FEMA BRIC, FEMA HMGP, Town Capital Budget	GREEN
Natural Resources	Department of Public Works	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Nantucket Land Bank, ACKlimate, ReMain Nantucket, Civic Associations, Private Property Owners, Business Owners	Develop funding application for upcoming grant cycle under FEMA's Building Resilience Infrastructure and Communities grant program or Hazard Mitigation Grant Program for Downtown Neighborhood Flood Barrier Feasibility Study to engage Downtown stakeholders in refinement of conceptual plans to preliminary design phase of project development.	MVP Action Grant, FEMA BRIC, FEMA HMGP, Town Capital Budget	YELLOW
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Nantucket Conservation Foundation, Nantucket Land Bank, Private Property Owners, U.S. Coast Guard	Develop scope and seek funding for feasibility study to engage Brant Point stakeholders in refinement of conceptual plans to preliminary design phase of project development.	MVP Action Grant Action Grant, FEMA BRIC, FEMA HMGP, Town Capital Budget	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, Sewer Department, CRAC, Conservation Commission, Nantucket Land Bank, Private Property Owners	Develop scope and seek funding in later years for feasibility study to engage Brant Point stakeholders in refinement of conceptual plans to preliminary design phase of project development.	Town Capital Budget, Private Funders	YELLOW
Department of Public Works	Town Administration	Natural Resources, Town Engineer, PLUS, CRAC	Conduct facility risk assessment to identify and rank key vulnerabilities.	Town Capital Budget, MVP Action Grant	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Nantucket Land Bank, ACKlimate, ReMain Nantucket, Civic Associations, Private Property Owners, Business Owners	Develop scope and seek funding through MVP or other grant program for Downtown Neighborhood Flood Barrier Feasibility Study to engage Downtown stakeholders in refinement of conceptual plans to preliminary design phase of project development.	MVP Action Grant, FEMA BRIC, FEMA HMGP, Town Capital Budget	YELLOW

MADAKET (section 07)

Project Priority

- 01
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Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Imp Cha
3-1	Madaket Road Raising and Bridge Conversion	Road raising project with conversion of existing culverts with bridges, with goal of prolonging service life of Madaket Road to provide access to and from Madaket, while advancing ecological restoration objectives for Long Pond.	Structural	High: \$40M Low: \$36M O&M: \$440K	\$6,200,000 – \$17,600,000	2030	Dep
3-2	Ames Avenue Bridge Resilience	Maintain bridge for access to Smith’s Point while protecting it from coastal erosion and flooding through dune restoration (see project 3-4). Continue maintenance and monitoring of existing Ames Avenue Bridge, with future elevation or relocation if necessary based on service population.	Nature-Based	See strategy 3-4	See strategy 3-4	2025	Dep
3-3	F Street Boat Ramp	Prolong service life of public boat ramp by elevating the top of the boat ramp, surrounding infrastructure, and access from F Street. Consolidate Madaket boat ramps in this location once loss of service is experienced at Jackson Point boat ramp.	Structural	High: \$5.1M Low: \$4.5M O&M: \$57K	Not quantified; qualitative benefits include prolonging public boating access to Hither Creek and Madaket Harbor	2050	Dep
3-4	Madaket Erosion Management Pilot and Ames Avenue Bridge Protection	Dune restoration along shoreline from Madaket Road / Ames Avenue intersection to Esther’s Island. Project involves natural dune construction techniques of sand and vegetation with fencing as needed. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.	Nature-Based	High: \$96M Low: \$86M O&M: \$1.1M	\$51,000,000	2025	Natu
3-5	Department of Public Works Facility and Landfill Resilience	Building scale resilience and operational resilience planning to reduce risk of damage and limit disruption to core operations at the facilities. The first step in this recommendation is a site-specific study to determine the appropriate risk mitigation approaches for the facility.	Structural	High: \$300K Low: \$150K O&M: NA	Not quantified; benefits are dependent on risk mitigation strategy developed through recommended site-specific study.	2024	Dep

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Nantucket Conservation Foundation, Linda Loring Nature Foundation, Private Property Owners	Develop funding application for upcoming grant cycle under FEMA's Building Resilience Infrastructure and Communities grant program or Hazard Mitigation Grant Program.	FEMA BRIC, FEMA HMGP, Town Capital Budget, Mass DER Culvert Replacement Grant Program	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, CRAC, Conservation Commission, Massachusetts Audubon Society, Nantucket Conservation Foundation, Private Property Owners	Engage Smith's Point residents related to recommendations of the CRP and long-term planning for Ames Avenue Bridge.	CZM Coastal Resilience Grant, Private Funders, MVP Action Grant	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, CRAC, HSAB, Conservation Commission, Private Property Owners	Maintain existing boat ramp in state of good repair. Long-term planning to fund necessary capital improvements.	Town Capital Budget	GREEN
Natural Resources	Property Owners	Conservation Commission, CRAC, HSAB, Massachusetts Audubon Society, Nantucket Conservation Foundation	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Engage Madaket property owners and other stakeholders in project planning. Seek State and local funding to begin project design.	CZM Coastal Resilience Grant, Private Funders, MVP Action Grant	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, CRAC	Carry out Town-led facility-scale resilience assessment to identify necessary risk reduction improvements and operational changes.	Town Capital Budget	GREEN

NANTUCKET HARBOR & COATUE (section 07)

Project Priority

- 01
- 02
- 03

Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Impacts
4-1	Polpis Road Raising and Bridge Conversion at Folger's Marsh	Road raising project with conversion of existing culverts with bridges, with goal of prolonging service life of Polpis Road, while advancing ecological restoration objectives for Folger's Marsh.	Structural	High: \$21M Low: \$18M O&M: \$230K	\$5,800,000 – \$14,250,000	2035	Depart
4-2	Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond	Road raising, expansion of culverts or replacement with bridge, and installation of living breakwaters to reduce wave exposure, with goal of prolonging service life and maintaining emergency roadway access along Polpis Road, while advancing ecological restoration objectives for Sesachacha Pond.	Structural, Nature-Based	High: \$45M Low: \$40M O&M: \$500K	\$3,000,000 – \$11,000,000	2035	Depart
4-3	Coatue Erosion Management and Dune Resilience	Dune restoration and wetland creation/enhancement to reinforce narrow low-lying sections of barrier island, between Five Fingered Point and Bass Point and between First Point and Second Point, to prevent washover and/or breaching into the harbor. Monitor performance of approach to assess need for ongoing nourishment and/or adaptation to higher design elevations.	Nature-Based	High: \$41M Low: \$36M O&M: \$450K	Not quantified; qualitative benefits include ecological restoration and potential for reduced long-term flooding impacts in the Harbor as well as reduced impacts to fisheries, habitat, and navigation.	2025	Prope
4-4	Numerical Modeling Study of Coatue Breaching	Numerical modeling study to evaluate the likelihood and consequences of Coatue breaching for the Harbor and surrounding communities, including impacts to habitat and navigation, in order to inform decisions about future adaption measures on Coatue.	Non-structural	High: \$250K Low: \$100K O&M: NA	NA	2026	Natu

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Nantucket Conservation Foundation, UMASS Boston Field Station, Private Property Owners	Develop scope and seek funding from Town Capital Budget and private funders for feasibility study for refinement of conceptual plans to preliminary design phase of project development.	Town Capital Budget, Private Funders, Mass DER Culvert Replacement Grant Program	GREEN
Department of Public Works	Natural Resources	Town Administration, Town Engineer, PLUS, Sewer Department, CRAC, Conservation Commission, Private Property Owners, Massachusetts Audubon Society	Develop funding application for upcoming grant cycle under FEMA's Building Resilience Infrastructure and Communities grant program or Hazard Mitigation Grant Program.	FEMA BRIC, FEMA HMGP, Town Capital Budget, Mass DER Culvert Replacement Grant Program	YELLOW
Property Owners	Natural Resources	Conservation Commission, CRAC, HSAB, Nantucket Conservation Foundation, Trustees of Reservations, Army Corp of Engineers	Carry out recommended sediment transport study to inform project design and sediment management needs. Coordinate with Nantucket Conservation Foundation and Trustees of Reservations regarding ongoing study and opportunities for funding the project design phase.	CZM Coastal Resilience Grant, Private Funders, MVP Action Grant	YELLOW
Natural Resources	Property Owners	Conservation Commission, CRAC, HSAB, Army Corp of Engineers	Carry out recommended sediment transport study to inform project design and sediment management needs. Coordinate with Nantucket Conservation Foundation and Trustees of Reservations regarding ongoing studies along Coatue. Develop scope and seeking funding to complete numerical modeling study.	Town Capital Budget, Private Funders	N/A

SCONSET (section 07)

Project Priority

- 01
- 02
- 03

Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Impacts/Changes
5-1	Sconset Bluff Dune Restoration	Dune restoration and construction to mitigate bluff erosion and increase resiliency. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.	Nature-Based	High: \$16M Low: \$14M O&M: \$180K	Not quantified; qualitative benefits include reduced long-term risk of erosion impacts to private residences and public infrastructure in Sconset.	2030	Natural
5-2	Codfish Park Dune Restoration	Dune restoration and construction to manage and slow bluff erosion. Natural dunes with vegetation are appropriate. Project includes need for ongoing nourishment and maintenance of the dune at an interval determined through the design process.	Nature-Based	High: \$21M Low: \$19M O&M: \$240K	\$7,000,000	2030	Natural
5-3	Baxter Road Relocation Planning	Planning for and implementation of road relocation, including acquisition of easements, access and maintenance agreements, finalization of road alignment, and development of final designs for construction.	Structural	High: \$30M Low: \$25M O&M: \$600K	N/A	2030	Dependent
5-4	Sconset Bluff Nearshore Breakwaters Feasibility Study	Conduct detailed feasibility study to assess technical constraints, potential impacts, and benefits and costs of nearshore breakwaters along the Sconset Bluff .	Non-Structural	High: \$800K Low: \$600K O&M: NA	N/A	2025	Natural

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Natural Resources	Department of Public Works	Conservation Commission, CRAC, Sconset Trust, Nantucket Coastal Conservancy, Sconset Beach Preservation Fund, Private Property Owners	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Engage Sconset property owners and other stakeholders in project planning.	Town Capital Budget, CZM Coastal Resilience Grant, MVP Action Grant	GREEN
Natural Resources	Department of Public Works	Conservation Commission, CRAC, Sconset Trust, Private Property Owners	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Engage Codfish Park property owners and other stakeholders in project planning.	Town Capital Budget, CZM Coastal Resilience Grant, MVP Action Grant	GREEN
Department of Public Works	Town Administration	Natural Resources, Town Engineer, Sewer Department, Conservation Commission, CRAC, Private Property Owners, Nantucket Coastal Conservancy, Sconset Beach Preservation Fund	Commence road relocation planning through final design.	FEMA HMGP, Town Capital Budget	GREEN
Natural Resources	Town Administration	Department of Public Works, Town Engineer, Conservation Commission, CRAC, Army Corp of Engineers, Private Property Owners, Nantucket Coastal Conservancy, Sconset Beach Preservation Fund	Develop study scope and begin developing funding strategy	FEMA HMGP, Town Capital Budget	N/A

SOUTH SHORE (section 07)

Project Priority

- 01
- 02
- 03

Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Imp Cha
6-1	Nantucket Memorial Airport Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm.	Nature-Based	High: \$28M Low: \$25M O&M: \$310K	Not quantified; qualitative benefits include long-term mitigation of risk to airport infrastructure and assets, which could result in loss of service at the airport.	2035	Natur
6-2	Surfside Wastewater Treatment Plant Dune Restoration	Dune restoration and construction to reduce risk of erosion to critical infrastructure. Hard core dunes are appropriate in this location given risk to critical facilities. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm. Strategic relocation alternatives for settling tanks closest to the coast at the wastewater treatment facility should be pursued in parallel.	Nature-Based	High: \$38M Low: \$33M O&M: \$420K	Not quantified; qualitative benefits include long-term mitigation of risk to infrastructure and assets, which could result in loss of service for the WWTF.	2025	Sewe
6-3	Tom Nevers Field Erosion Mitigation Pilot Project	Pilot program of dune restoration, sand fencing, and beach nourishment. Monitoring program to evaluate how well the pilot project performs to inform future investment in Tom Nevers Park, as well as erosion management elsewhere on the island.	Nature-Based	High: \$18M Low: \$16M O&M: \$200K	\$7,100,000	2025	Natur
6-4	Surfside Emergency Access Planning	Develop emergency access and service plan for Surfside Neighborhood to ensure access to coastal areas in event of loss of service along Nonantum and Nobadeer Avenues, particularly near Lovers Lane.	Non-structural	Staff and Volunteer Time	N/A	2025	Plann Servi
6-5	Sheep Pond Road Relocation Study	Planning step to work with property owners and Nantucket Conservation Foundation to develop and implement plan for relocation of public infrastructure on Sheep Pond Road.	Non-structural	Staff and Volunteer Time	N/A	2023	Natur

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Natural Resources	Department of Public Works	Town Administration, Airport, Town Engineer, PLUS, CRAC, Conservation Commission, Nantucket Land Bank, Nantucket Conservation Foundation	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Work with Nantucket Memorial Airport staff to begin project design phase.	Town Capital Budget, CZM Coastal Resilience Grant, MVP Action Grant	YELLOW
Public Works Department	Natural Resources	Town Administration, Town Engineer, PLUS, CRAC, Conservation Commission, Nantucket Land Bank	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Work with WWTF staff to begin project design phase	Town Capital Budget, CZM Coastal Resilience Grant, MVP Action Grant	YELLOW
Natural Resources	Department of Public Works	Town Administration, Town Engineer, PLUS, CRAC, Conservation Commission	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Work with Parks & Recreation Commission and Department of Public Works to determine next steps in project planning for capital improvements to Tom Nevers Park.	Town Capital Budget, CZM Coastal Resilience Grant, MVP Action Grant	YELLOW
Planning and Land Use Services	Natural Resources	Town Administration, Department of Public Works, Public Safety, Town Engineer, CRAC, Private Property Owners	Develop scope and project plan to determine if planning study can be completed by Town staff.	Town Capital Budget, MVP Action Grant	N/A
Natural Resources	Planning and Land Use Services	Town Administration, Department of Public Works, Public Safety, Town Engineer, CRAC, Nantucket Conservation Foundation, Private Property Owners	Project underway. Continue outreach to property owners and assessment of potential land swap agreements with Nantucket Conservation Foundation.	Town Capital Budget, MVP Action Grant	N/A

NORTH SHORE
(section 07)

Project Priority

- 01
- 02
- 03

Strategy ID	Strategy or Project Title	Near-Term Strategy Project Description	Type	Estimated Cost	Estimated Benefits	Target Implementation Date	Impacts
7-1	North Shore Dune Restoration and Nourishment	Targeted dune restoration and construction to reduce risk of erosion along the North Shore, building on dune restoration strategies adopted by existing private property owners in area. Project includes need for ongoing nourishment or installation of near-shore underwater sand berm at key locations.	Nature-Based	High: \$38M Low: \$34M O&M: \$420K	\$16,000,000	2035	Nature
7-2	Sand Pumping Feasibility Study	Study the feasibility and impacts of a sand pumping and bypass systems to connect sand sources from inlet to the North Shore.	Non-structural	High: \$250K Low: \$100K O&M: NA	N/A	2027	Nature

Implementation Champion	Project Co-Lead	Other Implementation Partners & Stakeholders	Immediate Next Steps	Funding & Partnership Opportunities	Permitability
Natural Resources	Property Owners	Conservation Commission, CRAC	Carry out recommended sediment sourcing and transport study to inform project design and sediment management needs. Engage North Shore property owners and other stakeholders in project planning.	Town Capital Budget, CZM Coastal Resilience Grant	YELLOW
Natural Resources	Property Owners	Conservation Commission, CRAC, Army Corp of Engineers	Carry out recommended sediment transport study to inform project design and sediment management needs.	Town Capital Budget, USACE	N/A

Regulatory Screening

Coastal resilience strategies recommended by the CRP and other plans must follow all applicable local, State, and Federal regulations and policies.

Structural and nature-based coastal resilience design strategies on Nantucket will require local Conservation Commission approval, State level waterways and water quality approvals, project review by the Massachusetts Natural Heritage and Endangered Species Program (NHESP), Federal permits from the U.S. Army Corps of Engineers (USACE) under the Clean Water Act and U.S Fish & Wildlife Service under the Coastal Barrier Resources Act (CBRA), and in many cases, National Historic Preservation, Massachusetts Historical Commission, and Nantucket Historical Commission (NHC) and Nantucket Historic District Commission (HDC) approvals. Projects and activities within rare species habitat will require review and approval for compliance with the Massachusetts Endangered Species Act (MESA). Major projects being undertaken, permitted, or financed by a state agency will also require review under the Massachusetts Environmental Policy Act (MEPA) and by Massachusetts Coastal Zone Management. Similarly, major projects being undertaken, permitted, or financed by a federal agency will require review under the National Environmental Policy Act (NEPA). Solutions with the most significant permitting and regulatory challenges include constructed ground (placing fill material in the water or on land) and navigational solutions (flood control projects in navigable waters).

The discussion and screening matrix that follows on expected regulatory feasibility summarizes existing permitting requirements and potential challenges in near-term permit approvals for coastal resilience design strategies on Nantucket. Red, yellow, and green ratings indicate whether a technical approach is likely to experience significant, moderate, or little-to-no difficulty when proceeding through the existing regulatory framework. Future changes to regulations at the local, state, and federal level may alter these ratings. In some cases, the CRP's recommended changes to local wetland and zoning regulations may help enable permit approvals for coastal resilience projects. This screening is based on conceptual plans developed through the CRP and does not assure a given project will be permitted. Subsequent phases of project development will need to assess and respond to project-specific regulatory requirements as part of preliminary design.

Raised Roadways, Raised Piers, Culvert Replacements, Coastal Defense over Existing Land

Green Light

Raising existing roadways, bulkheads, piers, and other structures, creating park space, and incorporating berms and flood walls or flood storage are permissible activities under existing regulations if those measures are constructed over existing land or fill. Permitting requirements for seawalls, bulkheads, and other coastal defense structures vary based on location and the extent to which the proposed solution will increase the height of an existing wall feature, extend the length or width of existing features, or construct a new seawall. A USACE permit, Massachusetts Department of Environmental Protection (MassDEP) waterways license, and a wetlands Order of Conditions are required for construction of new seawalls and for some alterations to existing seawalls. Seawalls must be maintained over time and may require designs that allow for future alterations that increase the height of the seawall. Replacement of seawalls that are designated historic landmarks and are within the jurisdiction of the Massachusetts Historical Commission (MassHistoric) or the local Historic District Commission would require special attention to the material used for the replacement project and impacts to historic, cultural, and archaeological resources.

Floodproofing of Buildings/Structures

Yellow Light

The Massachusetts Building Code establishes a standard for freeboard above base flood elevations but does not permit local governments in Massachusetts to require building to a higher flood resilience standard. Standards codified through the building code are based on the historic FEMA Special Flood Hazard Area designations and do not account for sea level rise and expected increases in stormwater flow. The code allows for or requires various wet- and dry floodproofing strategies for residential and non-residential but do not address the need to consider projected sea level rise in the design of new or substantially improved or substantially damaged structures. Nantucket can encourage or incentivize building to a higher standard through its zoning and wetland regulations, but local height restrictions and dimensional requirements may unintentionally disincentivize these structural mitigation measures because they would reduce the usable space within the building. As property owners try to maximize use of the property and permitted floor area, structures could be subject to height limitations or additional fire/safety code requirements for taller buildings.

Dune Restoration (Sand Sourcing)

Yellow Light

Though these solutions are nature-based and do not propose to place fill directly into the water, Conservation Commission, USACE and DEP under the Clean Water Act and Chapter 91 will regulate the type and source of the sand to be placed on the dunes and beaches as nourishment. If dune nourishment projects are located near endangered species habitat, review under the Massachusetts Endangered Species Act is required. Time of Year and other restrictions may be placed on the project to minimize impacts to species. Some areas of Nantucket are regulated under the Coastal Barrier Resources Act (CBRA), which makes undeveloped natural coastal barriers ineligible for federal expenditures and assistance. The CBRA imposes no restrictions on actions and projects within the CBRS that are carried out with State, local, or private funding. While the CRP recommends projects within CBRA areas on Nantucket and consultation will be necessary, these activities are likely to be exempted as nonstructural projects intended to mimic, enhance, and restore natural stabilization systems.

Transportation/Navigation

Yellow Light

Existing regulations allow for non-fill based construction projects over the water, as well as navigational tide gates, but require considerable time-intensive review including sediment transport impacts, review under Harbor Masters regulations, water circulation, and fish and boat navigation, as well as ecological impacts. Expansion of culverts to bridges (10-foot span or more) will require permitting, construction, and maintenance in line with bridge infrastructure standards.

Constructed Ground, Nearshore Berms (New Fill in the Water)

Red Light

While flood protection is a water-dependent use under Chapter 91 regulations, large fill-based flood protection solutions that extend into the water are more challenging to permit. Chapter 91 categorical restrictions require minimizing the amount of fill below the high-water mark, and the USACE must determine that the solution is the “least environmentally damaging practicable alternative.” Existing USACE criteria discourages the proposed constructed ground solutions and point to landward solutions as less environmentally damaging. Fill projects will also require a variance under wetlands regulations and mitigation for the filled wetlands resources. While most recommended near-term projects purposefully avoid fill within regulated resource areas in order to improve feasibility, some long-term projects, particularly in Downtown do involve significant in-water fill. It is unlikely that an Order of Conditions could be achieved for these large-scale, long-term projects as proposed under current regulations, and if approved, the mitigation requirements could be cost-prohibitive.

				Local					
Focus Area	Strategy ID	Strategy or Project Title	Type	Nantucket Wetland Ordinance	Zoning and Land Use	Historic District Commission	Nantucket Historic Commission	MassDEP Ch. 91	MassDEP Section 401 (CWA)
Downtown	2-1	Steamboat Wharf Resilience	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
Downtown	2-2	Downtown Neighborhood Flood Barrier- Later Project Phases	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Downtown	2-3	Easton Street and Hulbert Avenue Road Raising	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
Downtown	2-4	Washington Street Extension and Consue Springs Walkway Raising	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
Downtown	2-5	Building Scale Resilience at 37 Washington Street	Structural	Depends on scale of intervention. Work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	N/A	No fill or nourishment
Downtown	2-6	Downtown Neighborhood Flood Barrier - Phase 1 Project	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
Madaket	3-1	Madaket Road Raising and Bridge Conversion	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Construction work occurring directly in the water
Madaket	3-2	Ames Avenue Bridge Resilience	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Madaket	3-3	F Street Boat Ramp	Structural	Yes, work will occur within buffer zone and/or resource areas	N/A	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
Madaket	3-4	Madaket Erosion Management Pilot and Ames Avenue Bridge Protection	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Madaket	3-5	Department of Public Works Facility and Landfill Resilience	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	N/A	No fill or nourishment

State		Federal							OVERALL Expected Regulatory Feasibility
MHC Section 27C Review (M.G.L. Ch. 9, ss. 27C)	Building Code	NHESP / MESA Project Review	Coastal Zone Management	USACE	NPS (Sec of Interior)	Advisory Council for Historic Preservation Section 106 Review	Coastal Barrier Resources Act (CBRA)		
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	Yes	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the sand sourcing	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation and selected option overlaps with CBRA boundary	YELLOW	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	Yes	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation and selected option overlaps with CBRA boundary	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	Construction work occurring directly in the water	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the sand sourcing	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	YELLOW	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation	GREEN	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the Sand sourcing	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation	YELLOW	
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	Yes	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A	GREEN	

				Local					
Focus Area	Strategy ID	Strategy or Project Title	Type	Nantucket Wetland Ordinance	Zoning and Land Use	Historic District Commission	Nantucket Historic Commission	MassDEP Ch. 91	MassDEP Section 401 (CWA)
Nantucket Harbor and Coatue	4-1	Polpis Road Raising and Bridge Conversion at Folger's Marsh	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Construction work occurring directly in the water
Nantucket Harbor and Coatue	4-2	Polpis Road Raising, Culvert Expansion, and Wave Attenuation at Sesachacha Pond	Structural, Nature-Based	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Construction work occurring directly in the water
Nantucket Harbor and Coatue	4-3	Coatue Erosion Management and Dune Resilience	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Sconset	5-1	Sconset Bluff Dune Restoration	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Sconset	5-2	Codfish Park Dune Restoration	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
Sconset	5-3	Baxter Road Relocation Planning	Structural	Yes, work will occur within buffer zone and/or resource areas	Yes, work will need to comply with local zoning and require Planning Board review	Yes, work will need approval through HDC review.	Yes, the NHC may advise the Select Board and other municipal agencies on actions	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	No fill or nourishment
South Shore	6-1	Nantucket Memorial Airport Dune Restoration	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Installation/fill underwater and likely to regulate the Sand sourcing for nourishment
South Shore	6-2	Surfside Wastewater Treatment Plant Dune Restoration	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Installation/fill underwater and likely to regulate the Sand sourcing for nourishment
North Shore	7-1	Tom Nevers Field Erosion Mitigation Pilot Project	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	While not directly filling resource area, likely to regulate the Sand sourcing
North Shore	7-2	North Shore Dune Restoration and Nourishment	Nature-Based	Yes, work will occur within buffer zone and/or resource areas	N/A	N/A	N/A	Ch. 91 Waterways - Yes, located within jurisdictional tidelands.	Installation/fill underwater and likely to regulate the Sand sourcing for nourishment

State	Federal								OVERALL Expected Regulatory Feasibility
MHC Section 27C Review (M.G.L. Ch. 9, ss. 27C)	Building Code	NHESP / MESA Project Review	Coastal Zone Management	USACE	NPS (Sec of Interior)	Advisory Council for Historic Preservation Section 106 Review	Coastal Barrier Resources Act (CBRA)		
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	Construction work occurring directly in the water	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation		GREEN
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	Construction work occurring directly in the water	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation		YELLOW
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the Sand sourcing	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	Consultation may be required if federal funding is used for implementation		YELLOW
N/A	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the Sand sourcing		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW
N/A	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the Sand sourcing		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW
If the project requires a state undertaking (funding, permitting, licensing, involvement, etc.) then, yes	N/A	Yes	Review required if federal funding/federal permitting	No fill or nourishment	If significant alterations are made, then the NPS may choose to remove historic structures, districts, or landscapes from the National Register	If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		GREEN
N/A	N/A	Yes	Review required if federal funding/federal permitting	Installation/fill underwater and likely to regulate the sand sourcing for nourishment		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW
N/A	N/A	Yes	Review required if federal funding/federal permitting	Installation/fill underwater and likely to regulate the sand sourcing for nourishment		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW
N/A	N/A	Yes	Review required if federal funding/federal permitting	While not directly filling resource area, likely to regulate the Sand sourcing		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW
N/A	N/A	Yes	Review required if federal funding/federal permitting	Installation/fill underwater and likely to regulate the sand sourcing for nourishment		If the project requires a form of federal undertaking (funding, permitting, etc.) then, yes.	N/A		YELLOW

How to Get Involved

- **Reach out to key Town staff with questions and to find out what you can do to advance coastal resilience:**

Vince Murphy

Coastal Resilience Coordinator
Natural Resources Department, Town of Nantucket
Phone: (508) 228-7200 x 7608
Email: vmurphy@nantucket-ma.gov

Holly Backus

Preservation Planner & Local Hazard Mitigation Plan Coordinator
Planning & Zoning Office, Town of Nantucket
Phone: (508) 325-7587 x 7026
Email: hbackus@nantucket-ma.gov

- **Attend public meetings of the Nantucket Coastal Resilience Advisory Committee (CRAC).**

The Committee was established by Nantucket's Select Board on April 24, 2019. This committee works with the Coastal Resilience Coordinator to oversee and finalize the Coastal Resilience Plan. The committee meets regularly and all meetings are open to the public. Stay up to date on the CRAC schedule and meeting agendas:

<https://www.nantucket-ma.gov/1391/Coastal-Resiliency-Advisory-Committee>

- **Stay up to date on other resilience and sustainability conversation on the island by keeping up to date with partner organizations.**

ACKclimate
www.ackclimate.org/

Nantucket Land Bank
www.nantucketlandbank.org

Nantucket Land Council
www.nantucketlandcouncil.org/

Nantucket Conservation Foundation
www.nantucketconservation.org/

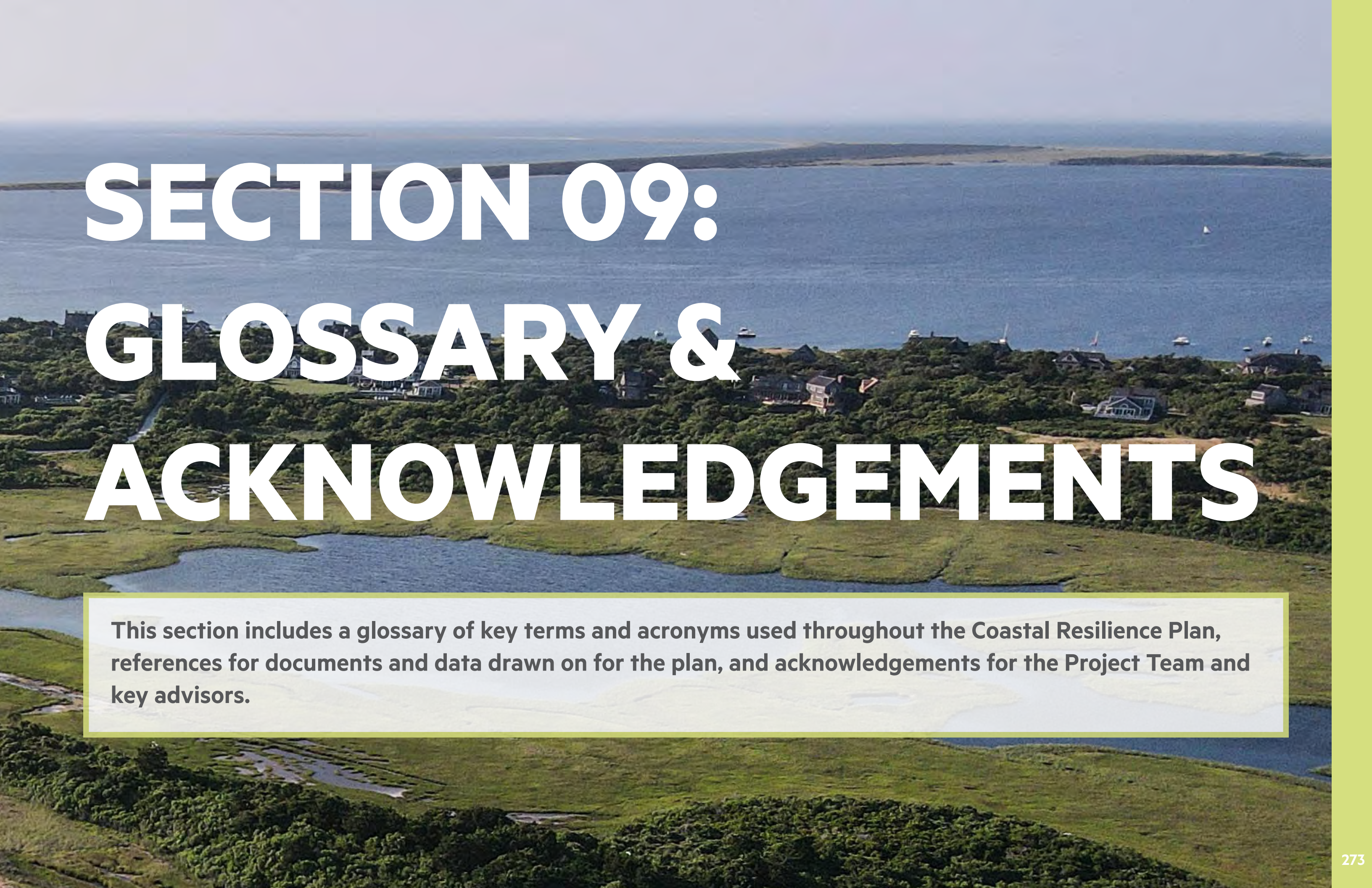
ReMain Nantucket
www.remainnantucket.org/

Nantucket Civic League and
member Associations
www.nantucketcivicleague.com/





Pocomo Salt Marsh (photo by James Hark)



SECTION 09: GLOSSARY & ACKNOWLEDGEMENTS

This section includes a glossary of key terms and acronyms used throughout the Coastal Resilience Plan, references for documents and data drawn on for the plan, and acknowledgements for the Project Team and key advisors.

1% Annual Chance Event

The 1% annual chance event, or 100-year storm, is a benchmark used by public agencies to plan for coastal flooding. Properties within the extent of the 1% annual chance event have a 1 in 4 chance of flooding over the course of a 30-year home mortgage.

A

Adaptation

Adaptation is the ongoing process by which a community may assess future climate risks and develop a roadmap of investment and action to evolve systems, capacities, and infrastructure in response to future risks and manage the uncertainties that go along with them. Adaptation involves putting in place the capacity for future modifications that may be necessary as conditions change.

Adaptation Pathways

Long-term opportunities for adapting strategic opportunity projects to increased sea level rise over time.

AEP – Annual Exceedance Probability

Annual Exceedance Probability. The probability of a flood event occurring in any year. The probability is expressed as a percentage. For example, a large flood which may be calculated to have a 1% chance to occur in any one year, is described as 1% annual chance or commonly the 100-year flood event.

Aeolian transport

The transportation of sediment by wind.

Approach

A resilience approach is a specific tool that can be applied or project that can be implemented to build resilience. Resilience approaches include raising a roadway, relocating properties, and installing a living shoreline.

ASCE

American Society of Civil Engineers

B

Beach Nourishment

The process of replenishing a beach with sand. It may occur naturally by longshore transport or be brought about artificially by the deposition of dredged materials or of materials trucked in from upland sites (USACE, 2003).

Beach Profile

A cross-section taken perpendicular to a given beach contour; the profile may include the face of a dune or sea wall, extend over the backshore, across the foreshore and seaward underwater into the nearshore zone (USACE, 2003).

Bluff Stabilization

Includes vegetation and promoting best management practices to manage surface drainage.

BMPs

Best Management Practices

Buffers

Require property owners to leave some portion of their property undeveloped to preserve their natural protective functions.

Buyout and Acquisition Programs

Program in which the government purchases property from a willing seller, demolishes existing structures on the property, and prohibits future development on the property in perpetuity through deed restrictions or a conservation easement.

C

Coastal Erosion

Geological process in which earthen materials are worn away and transported by natural forces, such as wind and water.

Coastal Flooding

The inundation of low-lying land by sea water, often as a result of storm surge.

Coastal Hazards

Coastal hazards are natural events that threaten lives, property, and other assets. On Nantucket, coastal hazards include coastal flooding due to storm surge, high-tide flooding, and erosion. Sea level rise and other climate change impacts are increasing the severity, frequency, and consequences of coastal hazards.

Co-Benefits

Features of a resilience strategy that address other community goals and needs beyond coastal risk reduction.

ConCom

Nantucket Conservation Commission

CRAC

Nantucket Coastal Resiliency Advisory Committee

CRP

Nantucket Coastal Resilience Plan

Cross Shore Transport

The movement of sediment perpendicular to shore.

CZM

Massachusetts Office of Coastal Zone Management

D

DEP

Massachusetts Department of Environmental Protection

Design Flood Elevation

The Design Flood Elevation represents the goal level of flood risk reduction for an area, building, or asset. This study uses DFEs based on the Massachusetts Coastal Flood Risk Model (MC-FRM), which include the stillwater flood elevation and wave crest elevation but not freeboard.

Design Life

The length of time during which an asset or project is expected to function within its specified design parameters.

Dynamic Equilibrium

Short term morphological changes that do not affect the morphology over a long period (USACE, 2003).

Dune Nourishment

Sand that is placed on top of the toe stabilization to provide a buffer to the toe stabilization and add material to the littoral system.

E

Exposure

Exposure tells us whether something is in direct contact with a coastal hazard. For example, many low-lying coastal areas on Nantucket are exposed to high-tide flooding. Areas mid-island are not exposed to high-tide flooding.

F

FEMA

Federal Emergency Management Agency, primarily responsible for disaster response and recovery following Federal declared state of emergency.

Flood Vents

Small, permanent openings that allow floodwater to flow through and drain out of enclosed spaces such as garages and crawlspaces and reduce the risk of serious structural damage.

Freeboard

Freeboard is an additional amount of height above the expected elevation of flooding used as a factor for safety. Freeboard is often defined in increments of one, two, or three feet and is determined based on risk tolerance and criticality.

Focus Area

Defined geographies located throughout the island that are already experiencing coastal flooding or erosion, face heightened coastal risks in the future, are home to critical infrastructure, are areas of historic or cultural importance, or are otherwise a community priority for resilience building.

G

GIS

Geographic Information System

Groundwater Table Rise

The increase of groundwater levels underneath a landmass, primarily driven by an increase in sea levels, also known as water table rise.

H

Hard Core Dune

May also be referred to as reinforced dune or structural dune. A core of either natural or synthetic material can increase the dune's ability to resist storm waves without adding significantly more mass.

High Tide Flooding (Tidal Flooding)

Flooding that leads to public inconveniences, such as road closures, overwhelmed storm drains, and deterioration of public infrastructure such as roads, often referred to as “nuisance” flooding or tidal flooding (NOAA).

I

Island-Wide Resilience Strategies

Strategic opportunities for coastal resilience on Nantucket that may apply across the entire island. These strategies include a collection of resilience approaches that work together to address multi-faceted resilience issues and can be applied in multiple geographies.

L

Land Swaps

A way to trade high risk properties for lower risk properties.

Leasebacks

Allow governments to lease acquired properties to the property's original owner or a third party to generate revenue and reduce maintenance costs.

Life Estates and Future Interests

Transfer ownership of a property to the government upon death or some other triggering event such as the rise of mean high tide to a certain level.

Littoral System

Area extending from the landward edge of the coastal upland (typically a dune) to the seaward edge of the nearshore.

Living Breakwater

A type of wave attenuation structure that incorporates coastal green infrastructure to reduce or reverse erosion and damage from storm waves and improve ecosystem health.

Living with the Sea (Adaptation Strategy)

To adapt to coastal risks by implementing approaches that reduce or slow the impacts of flooding and erosion by altering buildings and infrastructure to withstand hazards. It also includes increasing adaptive capacity through education and changes to personal and community behavior.

Longshore

Parallel to and near the shoreline; alongshore (USACE, 2003).

Longshore Drift

Movement of (beach) sediments approximately parallel to the coastline (USACE, 2003).

M

MC-FRM

Massachusetts Coastal Flood Risk Model. MC-FRM represents the best available coastal flood hazard data for Nantucket. Developed for the Massachusetts Department of Transportation, the dataset provides state-wide high resolution coastal flood data, including stillwater flood elevations, wave data, and Design Flood Elevations (DFEs), for a range of annual exceedance probability storms (0.1%, 0.2%, 0.5%, 1%, 2%, and 5%) for 2030, 2050, and 2070. Future sea levels are determined using the Commonwealth of Massachusetts' adopted sea level rise projections, based on the high scenario.

Moving Away from the Sea (Retreat Strategy)

To retreat from coastal risks by implementing policy and programmatic approaches that manage investment in hazardous areas or relocate at-risk communities and assets.

MESA

Massachusetts Endangered Species Act

MEPA

Massachusetts Environmental Policy Act

MORIS

Massachusetts Ocean Resource Information System
http://maps.massgis.state.ma.us/map_ol/moris.php

MSL

Mean Sea Level, The average height of the surface of the sea for all stages of the tide over a 19-year period, usually determined from hourly height readings.

MHHW

Mean Higher High Water. The average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch.

MMHW

Mean Monthly High Water. The average of the highest monthly tide levels across a defined time period, typically exceeded 25-35 times a year.

N

NHESP

Natural Heritage and Endangered Species Program

Nature-based Approaches

The range of water and erosion management techniques that help rainfall infiltrate the ground and/or use vegetation and other natural features to reduce coastal flooding and erosion, as in natural conditions.

NAVD88

North American Vertical Datum of 1988

Nearshore

(1) In beach terminology an indefinite zone extending seaward from the shoreline well beyond the breaker zone. (2) The zone which extends from the swash zone to the position marking the start of the offshore zone, typically at water depths of the order of 20 m (USACE, 2003).

Nearshore Berm

A submerged sand berm that is constructed parallel to the shore and can act as either a feeder berm (intended to provide a source of sand to a beach and migrates onshore through wave action) or a stable berm.

Nearshore Breakwater

Shore parallel structures that reduce the amount of wave energy reaching an area.

NEPA

National Environmental Policy Act

NFIP

National Flood Insurance Program

Non-Structural Approaches

The wide array of programmatic, land use, and policy approaches that manage flood and erosion risk, largely without influencing or obstructing the natural direction and flow of flood waters or sediments.

NHESP

Natural Heritage & Endangered Species Program

NOAA

National Oceanic and Atmospheric Administration

NOI

Notice of Intent

P

Precipitation

The process where water vapor condenses in the atmosphere to form water droplets that fall to the Earth as rain, sleet, snow, hail, etc. (NOAA).

Protect Strategy (Resisting the Sea)

To protect against coastal risks by implementing approaches that seek to keep water out, reduce its force, or to minimize erosion.

R

Resilience

Resilience is the ability of communities and systems to withstand, recover from, and adapt to shocks and stresses. Nantucket's Coastal Resilience Plan will help turn climate challenges, such as sea level rise, into opportunities for reducing risk, enhancing ecosystems, and building community.

Risk

Risk quantifies the potential negative impacts of a coastal hazard. Risk is calculated by multiplying the probability that an event, such as flooding or erosion, will occur by the consequences of that event. Risk can be calculated at any scale, from a single building to a transportation network or an entire community. Risk can also be calculated over different time frames. Resilience and adaptation are two ways to reduce the consequences of coastal hazards.

Rolling Easements

A type of setback in which the baseline moves inland as sea level rise and coastal erosion cause the coastline to move inland.

RSM

Regional Sediment Management. This program is a federally funded program that promotes a systems approach for management of sediments across coastal, estuarine and inland environments (USACE, 2021).

S

Sacrificial Sand

Sand placed on a beach that is anticipated to erode.

Sand Bypass System

Provides a means of moving sand around an impediment such as jetties or water intakes/culverts and is intended to reestablish the flow of sediment that would occur naturally.

Sediment Transport

The main agencies by which sedimentary materials are moved are: gravity (gravity transport); running water (rivers and streams); ice (glaciers); wind; the sea (currents and longshore drift). Running water and wind are the most widespread transporting agents. In both cases, three mechanisms operate, although the particle size of the transported material involved is very different, owing to the differences in density and viscosity of air and water. The three processes are; rolling or traction, in which the particle moves along the bed but is too heavy to be lifted from it; saltation, in which sand particles move over an uneven surface in a turbulent flow of air or water; and suspension, in which particles remain permanently above the bed, sustained there by the turbulent flow of the air or water (USACE, 2003).

Sediment Transport Study

Defines sediment movement at various spatial and temporal scales in order to inform the design and planning of future sediment management projects.

Setback

The required distance a structure must be located behind some baseline (such as mean high tide). Setbacks help keep development away from extremely vulnerable areas.

SLR

Sea Level Rise, the long-term trend in mean sea level (USACE, 2003)

Stillwater Flood Elevation

a modeled water surface elevation that includes the effects of tides, storm surge, and wave setup. Wave setup is an increase in mean water levels due to breaking waves.

Strategic Opportunities

Design and engineering approaches, as well as pilot projects and focused planning studies, that present near-term opportunities to reduce coastal risk and build community resilience. They are projects that can be implemented in the next five to ten years as the first step in a longer-term adaptation process.

Strategy

A resilience strategy is a tactical collection of resilience approaches that work together to address the multi-faceted resilience issues facing a specific area. Resilience strategies may apply at different scales, from island-wide to the project-scale.

Structural Approaches

Provide flood and erosion risk mitigation through engineered methods, such as through flood walls, berms, bulkheads, raised streets, and drainage infrastructure, that alter the natural flow of flood waters or sediments.

Subsidence

Gradual settling or sudden sinking of vertical land surface elevation, exacerbating the effects of sea level rise.

T

Toe Protection

Protection that is placed at the toe or base of a bluff or cliff to prevent wave erosion during storms.

Transfer of Development Rights

Programs that use market-based incentives to shift development away from high-risk areas (sending areas) and encourage it in preferred, lower risk areas (receiving areas).

U

USACE

United States Army Corps of Engineers

Useful Life

The estimated number of years an asset will be in use before needing significant reinvestment to continue performing its normal function(s). Generally, this period is longer than the intended Design Life of an asset (see definition for Design Life)

USGS

United States Geological Survey

V

Vulnerability

If something is exposed to a coastal hazard, it may be vulnerable. Different characteristics of a structure, population, or other asset may make it more vulnerable, or susceptible, to the negative impacts of flooding and erosions.

W

Wave Attenuation

Structures (breakwaters, reefs) that are intended to reduce wave energy impacting the shoreline.

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Coastal Erosion (photo by Sonny Xu)