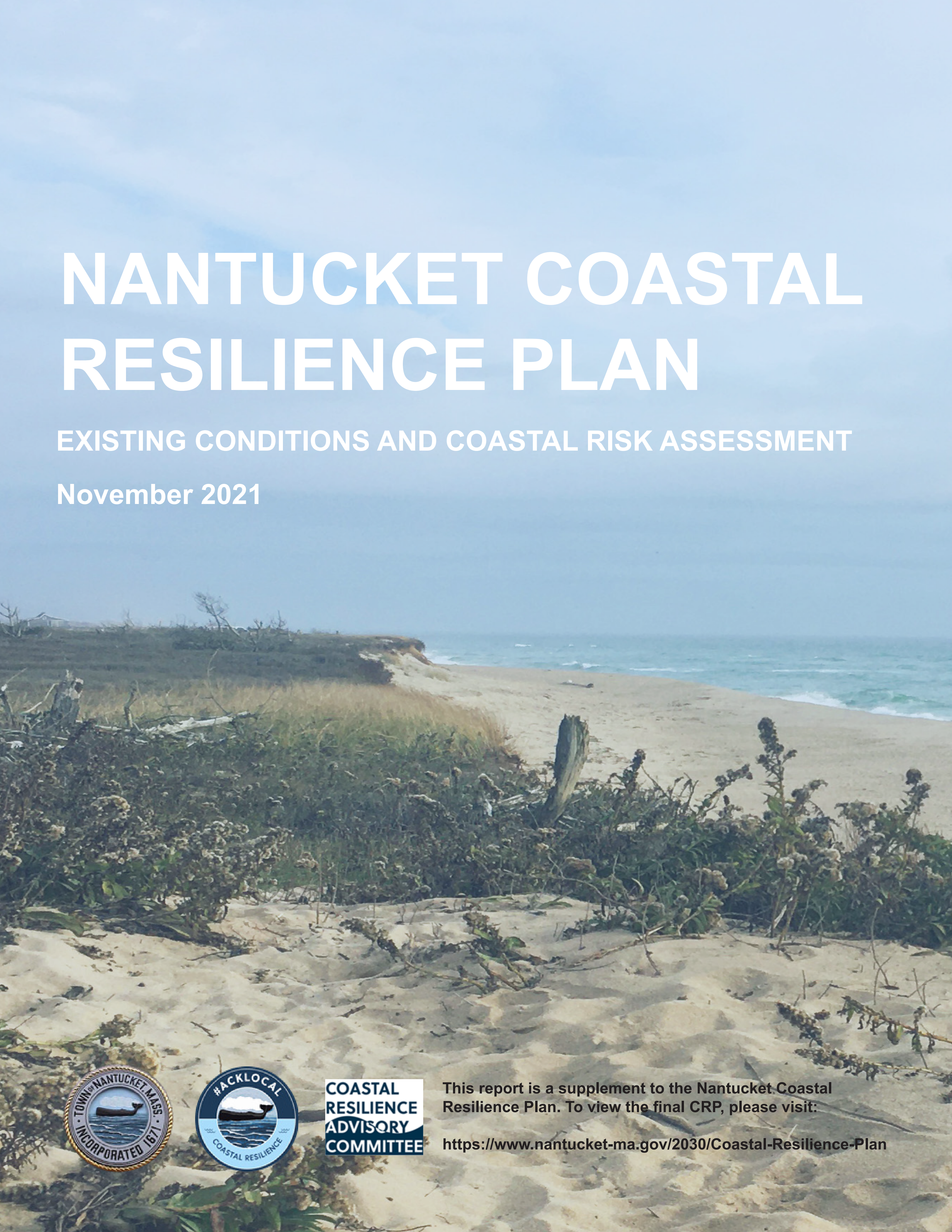

NANTUCKET COASTAL RESILIENCE PLAN

EXISTING CONDITIONS AND COASTAL RISK ASSESSMENT

November 2021

This report is a supplement to the Nantucket Coastal Resilience Plan. To view the final CRP, please visit:

https://www.nantucket-ma.gov/2030/Coastal-Resilience-Plan

Nantucket Coastal Resilience Plan

Existing Conditions and Coastal Risk Assessment Report

November 2021

This report is a supplement to the Nantucket Coastal Resilience Plan (CRP). It provides a detailed overview of existing built, social, and environmental conditions on the island; the findings of the community engagement process undertaken to the midpoint of the project in April 2021; and the results of the island-wide coastal risk assessment.

To review the complete Coastal Resilience Plan, please visit the project website:

https://www.nantucket-ma.gov/2030/Coastal-Resilience-Plan

COASTAL RESILIENCE ADVISORY COMMITTEE

ARCADIS

STOSS

one architecture

THECRAIGGROUP

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Acronyms and Abbreviations

ACS – American Community Survey

ADCIRC – Advanced Circulation Model

AEP – 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.

ASCE – American Society of Civil Engineers

BLS – Below Land Surface

CRB – Community Resilience Building

CRP – Nantucket Coastal Resilience Plan

Exposure – Situation of populations, property, ecological resources, infrastructure, or other assets within hazard-prone areas.

FAA – Federal Aviation Administration

FDC – Flood Design Class

FEMA – Federal Emergency Management Agency, primarily responsible for disaster response and recovery following Federal declared state of emergency.

FIRMS – Flood Insurance Rate Maps. The official map of a community on which FEMA has delineated both the special hazard areas and the risk premium zones applicable to the community.

FIS – Flood Insurance Study. A compilation and presentation of flood risk data for specific watercourses, lakes, and coastal flood hazard areas within a community. When a flood study is completed for the National Flood Insurance Program, the information and maps are assembled into an FIS

GIS – Geographic Information System

HDC – Historic District Commission

HMP – Hazard Mitigation Plan

HVRI – Hazards & Vulnerability Research Institute

MC-FRM – Massachusetts Coastal Flood Risk Model, a dataset developed for the Massachusetts Department of Transportation to assess coastal flood risk to transportation systems at risk to future sea levels and coastal storms. Considered Best Available Flood Hazard Data for coastal Massachusetts.

MHC – Massachusetts Historical Commission

MHHW - Mean Higher High Water, or the average of the higher high-water height of each tidal day observed over the National Tidal Datum Epoch.

MMHW – Mean Monthly High Water, or the average of all monthly maximum tidal high-water heights in predicted astronomical tide levels.

MVP – Municipal Vulnerability Plan

NACCS – North Atlantic Coast Comprehensive Study

NHESP – Natural Heritage & Endangered Species Program

NOAA – National Oceanic and Atmospheric Administration

NRTA – Nantucket Regional Transit Authority

PIN – Preservation Institute Nantucket

Projection and Scenario - According to the International Panel on Climate Change (IPCC), in general usage, a projection can be regarded as any description of the future and the pathway leading to it. However, a more specific definition for the term "climate projection" is used by the IPCC when referring to model-derived estimates of future climate. A "scenario" is a coherent, internally consistent and plausible description of a possible future state of the world. It is not a forecast; rather, each scenario is one alternative image of how the future can unfold. A projection may serve as the raw material for a scenario, but scenarios often require additional information (e.g., about baseline conditions). A set of scenarios is often adopted to reflect the range of uncertainty in projections. (IPCC)

RCP – Representative Concentration Pathway, or scenario estimating future concentrations of greenhouse gases used by the Intergovernmental Panel on Climate Change (IPCC).

SLR – Sea Level Rise

SOP – Standard Operating Procedure

SoVI – Social Vulnerability Index

Subsidence – Gradual settling or sudden sinking of vertical land surface elevation, exacerbating the effects of sea level rise.

UNSWAN – Unstructured Simulated Waves Nearshore

USACE – United States Army Corps of Engineers

USC – University of South Carolina

USGS – United States Geological Survey

WWC – Wannacomet Water Company

1 Introduction and Executive Summary

1.1 Scope of this Document

This report, first delivered in April 2021 and updated in October 2021, is a supplement to the Nantucket Coastal Resilience Plan (CRP). It provides a detailed overview of existing built, social, and environmental conditions on the island; the findings of the community engagement process undertaken to the midpoint of the project in April 2021; and the island-wide coastal risk assessment. The report draws on a range of prior Town-led plans and studies, data from Town departments and State agencies, significant input from the Nantucket community, and detailed analysis of the risks that coastal hazards will pose to Nantucket over the coming decades.

To review the complete Coastal Resilience Plan, please visit the project website:
https://www.nantucket-ma.gov/2030/Coastal-Resilience-Plan

1.2 The Nantucket Coastal Resilience Plan

Launched in Fall 2020, the Nantucket Coastal Resilience Plan ("CRP") is a crucial step in the Town and County of Nantucket's process of preparing for and adapting to the combined threats posed by sea level rise, coastal flooding, and coastal erosion. The CRP provides a plan for building resilience to and reducing risk from flooding and erosion along Nantucket's coastline. The process involves analysis of risk and vulnerability across the island, examination of a range of coastal resilience options, and recommendations for new policies and investments in structural, nature-based, and non-structural approaches. The CRP provides detailed implementation guidance for projects recommended for the coming 10-15 years, as well as details on longer-term adaptation pathways. Throughout the process, the Project Team, led by the Town of Nantucket Natural Resources Department and Coastal Resilience Advisory Committee, has worked in close partnership with the Nantucket community and other groups committed to advancing coastal resilience on Nantucket. The final CRP was delivered in October 2021.

CRP Project Area

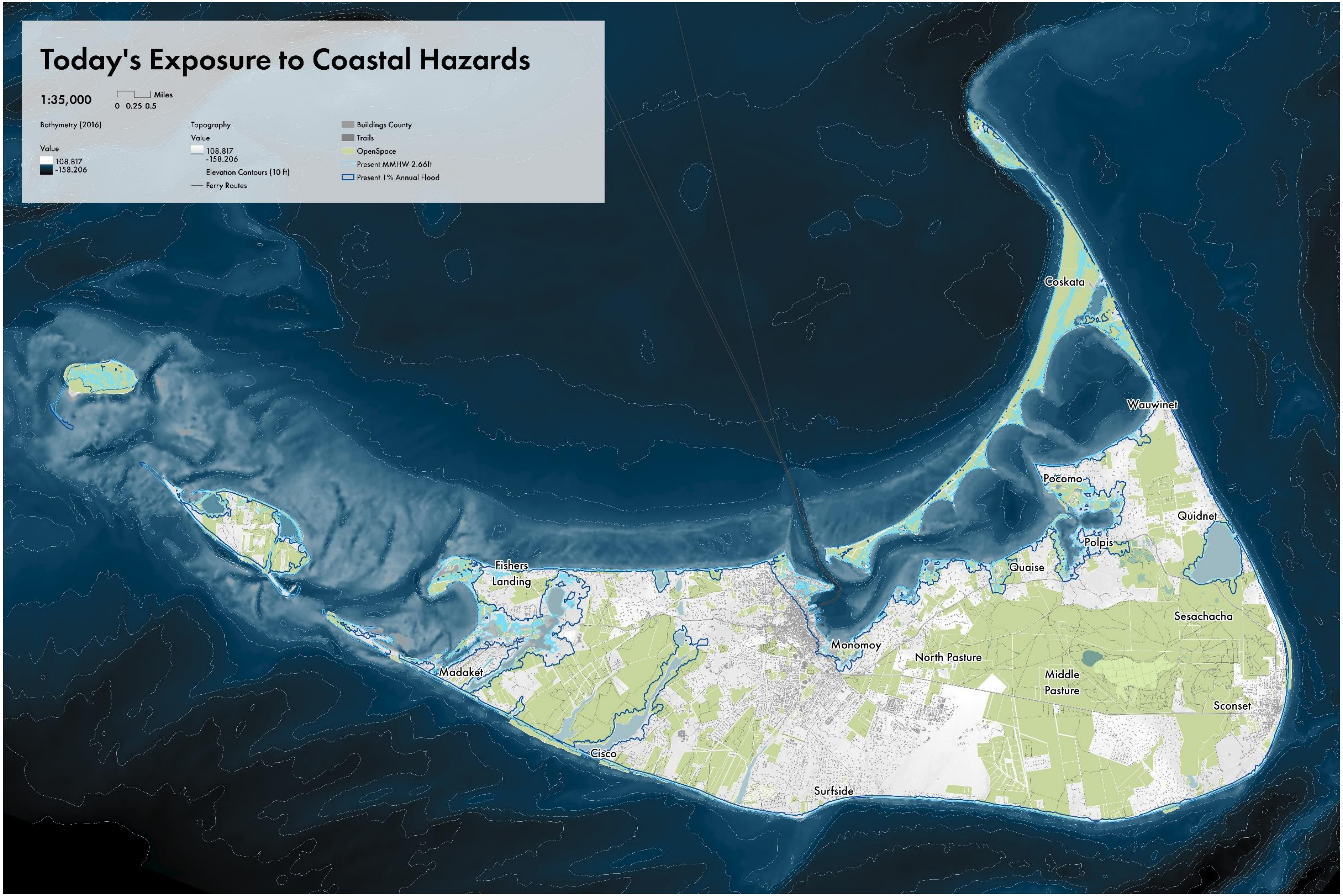
Nantucket County consists of Nantucket Island and its sister islands of Tuckernuck and Muskeget. Together, Nantucket comprises roughly 48 square miles located in Nantucket Sound approximately 30 miles from the mainland on Cape Cod, Massachusetts. Elevations range from sea level to 111 feet above sea level.

The CRP is an all-island, all-county plan focusing on the entire 88 miles of coastline. The project area encompasses an array of built and natural conditions, from the historic town centers in Downtown and Siasconset (also referred to as "coastal" and "'Sconset"), to bays and tidal estuaries, to natural coastal bluffs along the South Shore, to the sparsely populated islands of Tuckernuck and Muskeget. **Figure 1 and Figure 2** on the following pages show the project study as well as overview of the coastal hazards facing Nantucket today and in the future.

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.*

Figure 1 and Figure 2. (next two pages) Maps showing the project study area and exposure to coastal hazards, including flooding from mean monthly high water (MMHW), coastal storms, and coastal erosion today and in 2070



Today's Exposure to Coastal Hazards
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
Ferry Routes
Buildings County
Trails
OpenSpace
Present MMHW 2.66ft
Present 1% Annual Flood
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Sesachacha
Monomoy
North Pasture
Middle Pasture
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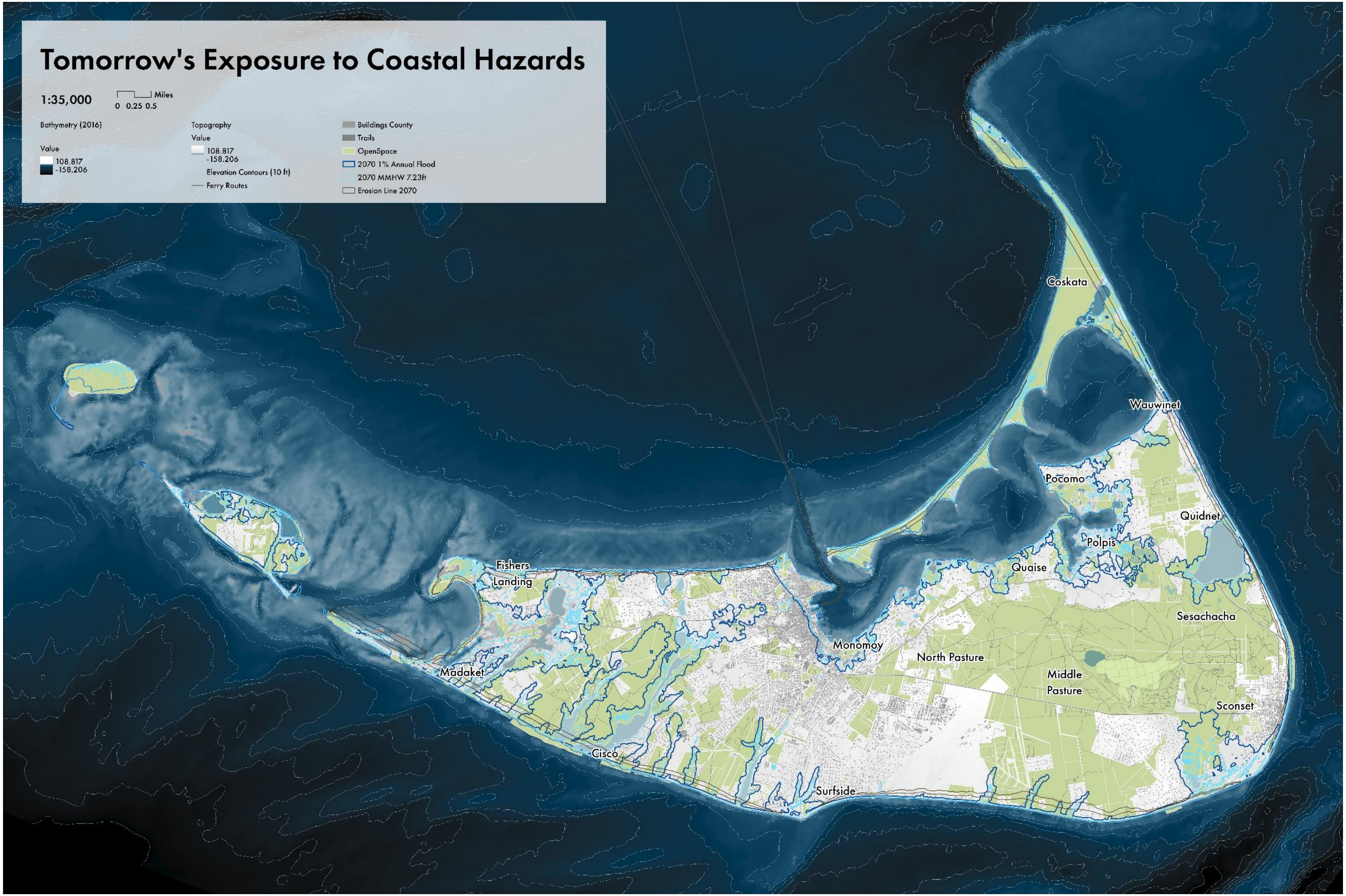
Madaket
Cisco
Surfside


Tomorrow's Exposure to Coastal Hazards
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
Ferry Routes
Buildings County
Trails
OpenSpace
2070 1% Annual Flood
2070 MMHW 7.23ft
Erosion Line 2070
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Sesachacha
Monomoy
North Pasture
Middle Pasture
Madaket
Sconset
Cisco
Surfside

Project Team

The Town of Nantucket, through the Department of Natural Resources, is leading the creation of the Coastal Resilience Plan. A broader team of Town Departments will provide 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 will play a role in the project. The Coastal Resilience Advisory Committee serves as the primary citizen committee steering the process.

An interdisciplinary team of consultants supports 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 is provided by Arcadis subconsultants Stoss, ONE Architecture and Urbanism, and The Craig Group.

1.3 Overview of Coastal Risk and Resilience Concepts

Coastal risks can never be entirely removed, but they can be reduced through planning, capital investment, and changes to policies and regulations. While hazard mitigation planning and disaster preparedness have been part of local, state, and federal planning for decades, the increasing coastal risks projected to occur with climate change and sea level rise have led many coastal and inland communities to draw on the related concepts of resilience and adaptation. By planning for resilience and creating pathways for adaptation, the challenges presented by sea level rise and climate change can create opportunities to channel resources toward more robust, reliable, and redundant systems and infrastructure that support community safety, well-being, and vibrancy into the future.

Resilience

Resilience is the ability of communities and systems to withstand, recover from, and adapt to shocks and stresses. The CRP focuses on the resilience of Nantucket's coastal areas, specifically, and any use of the term "resilience" herein refers to "coastal resilience," unless stated otherwise. The CRP will help turn climate challenges, such as sea level rise, into opportunities for reducing risk, enhancing ecosystems, and building community.

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.

Understanding Risk, Consequence, Vulnerability, and Criticality

It is important that a community understand the factors that contribute to flood and erosion risk in order to make informed decisions regarding the appropriate actions to mitigate risk and build resilience. The concepts introduced below are used in the CRP to help quantify and prioritize coastal risks on Nantucket, as will be discussed in **Section 5 Coastal Risk and Exposure Analysis**. Risk can be calculated at any scale by multiplying the probability that an event, such as flooding or erosion, will occur by the consequences of that event (see **Figure 3**). This equation can be applied to a single facility/structure or to a community overall. Adaptation and resilience are the approaches we used to reduce the consequences of hazards over time.

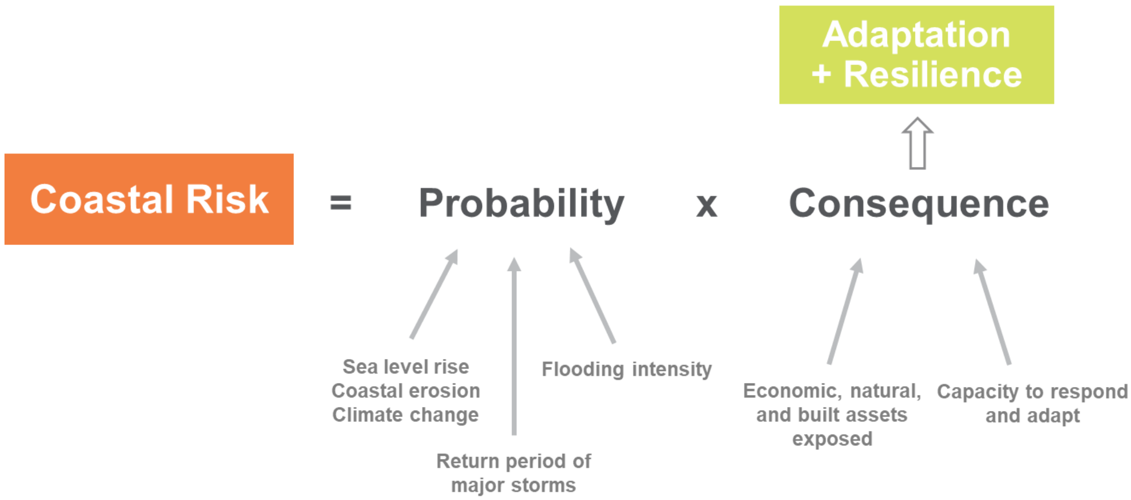


Figure 3. Coastal risk is a function of the probability that event will occur and the consequences of that event. By adapting to risk over time, we can reduce consequences and build community resilience.

The probability of flooding is generally correlated with the associated depth of flooding. As the expected magnitude of a flood event increases, the probability of occurrence decreases. The greater the magnitude of an expected storm, the less likely the event is expected to occur. For example, a storm such as Winter Storm Grayson in 2018 or the No Name Storm of 1991, both of which caused widespread impacts on Nantucket, would be expected to have a lower likelihood of happening in a given year compared to a storm with lesser impacts, such as the types of Nor'easters that pass by Nantucket on an annual basis. Nevertheless, even high-probability (frequent) flood events can result in significant loss if a community is not prepared. The probability of flood events of various magnitudes (often described in terms of annual exceedance probability (AEP) or the chance of a certain flood depth and magnitude being met or exceeded in a given year) can be identified using a variety of sources. Many communities rely on the FEMA Flood Insurance Rate Maps but in some cases, including Nantucket, other locally available flood hazard models, such as the North Atlantic Coast Comprehensive Study or Massachusetts Coastal Flood Risk Model can be referred to as the "best available" flood hazard information.

The probability of a flood event occurring also depends on the frame of reference. For example, a 1% annual chance of flooding today translates to a roughly 25% or 1 in 4 chance of flooding over the course of a 30-year home mortgage.

The consequence of flood impacts could include many factors, ranging from property damage to regional economic loss, which might occur because of industry disruption and small business collapse. For certain critical facilities, consequences increase with the importance of a facility to the community, particularly as the community prepares for, responds to, or recovers from a storm. A primary driver of flood or erosion-related consequences is continued growth of a community and associated infrastructure in vulnerable areas. Refocusing growth outside of floodplains or erosion hazard areas can reduce risk and better enable implementation of coastal adaption approaches.

Vulnerability is another important concept related to consequence. In the simplest terms, vulnerability refers to the characteristics of a facility or community that increase susceptibility to impacts from flooding. Example factors that contribute to flood vulnerability include age and condition of buildings and infrastructure, construction type, location, structure and grade elevations, land uses, as well as site flood probability and type of flooding. For example, a single-story timber house with a basement would likely be more vulnerable to the impacts of flooding than a two-story masonry house with an elevated first floor, even if both structures were located in areas with the same likelihood of flooding.

Criticality refers to the relative importance of a facility or service. The American Society of Civil Engineers (ASCE) Standard 24 on Flood Resistant Design and Construction is often used to assign criticality for facilities, as well as to help prioritize facilities for mitigation. State building codes, including Massachusetts', will often translate ASCE standards into risk classes based on importance to community life and safety, with the most critical facilities, such as hospitals, emergency response facilities, and critical transportation routes, ranking highest. Often there are specific standards enforced through code that need to be met for the most critical facilities and decision-makers should consult the applicable codes and standards to understand these requirements. Criticality can also be assigned based on locally driven values and needs. For example, on Nantucket the infrastructure supporting access to mainland – ferry terminals, wharfs, and airports -- takes on a level of criticality that they may not have in other locations. The importance of assigning criticality is in helping local decision-makers prioritize facilities, systems, and assets for mitigation investment. Risk to critical facilities on Nantucket is discussed in greater detail in **Section 5 Coastal Risk and Exposure Analysis.**

1.4 Recent and Ongoing Coastal Resilience Studies that Inform the CRP

Nantucket has undertaken a number of coastal resilience planning projects in recent years. The goal of the CRP is to build on and complement these studies, not to duplicate or supplant work that has already been done. The most relevant recent and ongoing resilience studies are summarized below.

Municipal Vulnerability Plan (MVP) Summary of Findings (2019)

The Municipal Vulnerability Preparedness program is led by the Commonwealth of Massachusetts and provides cities and towns with funding and technical assistance for planning and project implementation to advance community climate resilience. Participation in the program involves two steps. First, communities may apply for funding to complete a vulnerability assessment and develop action-oriented resiliency plans driven by a highly participatory community process. Once the community has developed its plan, it is certified as an MVP community by the Commonwealth and is eligible to apply for MVP Action grant funding to help fund implementation of the plan and/or additional studies.

The MVP process on Nantucket engaged stakeholders through a Community Resilience Building (CRB) workshop to document input from the community on the island's strengths and weaknesses related to climate change and actions that can be taken to advance community resilience. The final MVP Summary of Findings report was completed in April 2019.

There were several top-priority actions recommended through the MVP planning process, most notably the creation of municipal Resilience Coordinator position, the development of resilience plans for travel routes to and from the mainland, and resilience planning for the community's critical infrastructure systems. The prioritized actions outlined in the Summary of Findings establish a basis for understanding community priorities on Nantucket and also opens funding opportunities through state Action Grants for near-term projects that may be recommended by the CRP.

Hazard Mitigation Plan (HMP) (2019)

The natural Hazard Mitigation Plan for Nantucket investigated ways to reduce damage from likely hazards, maintain the islands emergency response capabilities, and protect the existing town infrastructure and other resources from natural disasters. It aimed to establish a platform for informing the public about risk, increasing access to funding sources, and improving the post disaster recovery responses. In the most recent iteration of the HMP, completed in 2019, the main areas of focus included: access to the mainland, isolation within the island, historic resources, power supply resilience, and adaptation to climate change.

The HMP listed priority mitigation actions. These mitigation actions pertain to multiple hazards including earthquakes, wildfires, and hurricanes. Completed recommendations from the HMP that the CRP can utilize include:

- Become an MVP community
- Complete hydrologic study of the Fulling Mill Brook Watershed
- Consider suitability of Schools as Emergency Shelters
- Assess vulnerability of historic structures
- Develop Comprehensive Stormwater Management Plan
- Develop standard operating procedure (SOP) for opening and closing of Children's Beach Tide Gate

Coastal Risk Assessment and Resiliency Strategies (2020)

Building on both the MVP planning process and the HMP, the Resilience Assessment and Strategies study aimed to assess Nantucket's resilience to the threats posed by rising sea levels, including storm surge, coastal flooding, and erosion. Specifically, the intention of the report was to:

- Formally Assess Risk and Vulnerability using GIS mapping
- Present a menu of tools to achieve resilience goals
- Identify policy changes necessary for implementing recommended resilience tools

The Coastal Risk Assessment and Resiliency Strategies study provided a preliminary assessment of island-wide risk and vulnerability, as well as an overview of actions that can be taken to reduce risk and improve resilience. The toolkit provides a foundation from which the CRP can build. The suite of resilience measures included:

- Shoreline protection
- Community Infrastructure protection
- Property protection
- Regulatory Tools
- Procedural Tools
- Public & Institutional Tools

The recommendations were modeled around the three basic adaptation approaches: retreat, accommodation, and protection. The adaptation framework also serves as a starting point for the CRP resilience framework.

Resilient Nantucket: Designed for Adaptation (2021)

Based on recommendations from the HMP, the Town moved forward with the development of resilient design guidelines upon receipt of a Municipal Vulnerabilities Preparedness Action Grant from the Commonwealth. These supplemental design guidelines to the well-established, model design guidance "Building with Nantucket in Mind" provides standardized guidance from the National Park Service on adapting historic buildings and sites to flooding.

In addition, the MVP grant is supporting the compilation of a resilience "toolkit" to provide information on flood risk, flood preparedness, flood insurance, flood recovery, and flood adaptation alternatives for historic properties, cultural sites, and the island's larger cultural landscape. Multiple partners are working together on this project to further public awareness regarding the challenges of climate change. The *Resilient Nantucket Toolkit* offers technical assistance and funding resources to assist private and public sector property owners and organizations with their adaptation efforts and support the implementation of the HMP goals, objectives, and actions. The Resilient Nantucket Guidelines and Toolkit serve as important resources for historic property owners on Nantucket and can be accessed via the project website.

1.5 Key Findings of this Report

This report documents findings from the first half of the CRP process and focuses on the following topics:

- **Existing Conditions** – Understanding Nantucket's context in order to situate future plans for coastal resilience and adaptation in a thorough understanding of the island's history and the natural and built systems that support life on Nantucket
- **Community Engagement** - Engaging the Nantucket community in the CRP process and asking key questions about community priorities and visions to help orient the plan's preliminary recommendations in a direction that is consistent with community values and objectives
- **Risk Evaluation** - Assessing and quantifying the risks that flooding and erosion pose to Nantucket today and how these risks will increase over time due to projected sea level rise in order to focus coastal resilience and long-term adaptation plans and to help substantiate CRP implementation

Sea levels have increased eight inches of between 1965 and 2019 on Nantucket. These changes are already altering life on the island, as flooding becomes more frequent and erosion more drastic, and the community's experience of the coastline is likely to continue to shift in the decades to come. **As documented in this report, coastal risks to homes, businesses, infrastructure, and natural resources will increase across the island through the end of the century. Action will need to be taken to adapt to these realities.**

Nantucket Context

The aspects that make Nantucket an attractive place to live, work, and visit, the characteristics that give it its "island-ness" – the ocean, beaches and bluffs, harbors and bays, historic character, and the ways in which humans have altered and occupied the coastline over time – are also the aspects that create the need for coastal resilience planning to ensure that Nantucket can continue to adapt to changing conditions and evolving risks. Life on Nantucket is not the same as it is on the mainland and the systems and infrastructure that support quality of life for the community must be carefully designed, operated, and maintained to support community wellbeing. These existing systems include the transportation infrastructure that people use to travel to, from, and across the island, food and water systems, healthcare facilities, utilities parks and open space, and ecosystems. Many of these systems and places are at risk today and in the future due to impacts from coastal hazards. These risks are described in greater detailed below.

Interim Community Engagement

Through the first phases of the engagement process, the community raised several **common challenges** faced by people on the island, **core tensions** that continually arise and must be accounted for in implementing coastal resilience strategies, **key priorities** that form the backbone of the community's vision for a resilient Nantucket, and **long-term visions** toward which the CRP should set its aims.

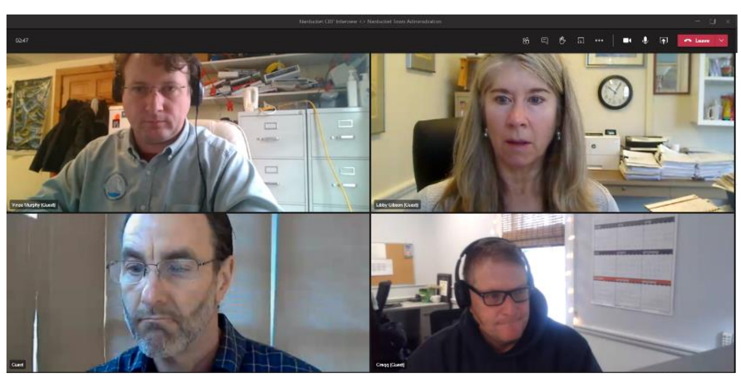


Figure 4. Virtual interview between the Project Team and Nantucket Town Administration Staff

Common challenges the community faces include:

- Increasing flooding and erosion hazards causing widespread impacts
- A need for greater public awareness and understanding of the issues
- Understaffed and underfunded Town capacity
- Lack of a centralized entity or coordinated approach to resilience
- Barriers to implementation of site-specific mitigating measures
- Challenges with aligning efforts with sustainability and climate mitigation co-benefits
- Existing data gaps and other data challenges

Core tensions noted by the community include:

- A need for compromise, as not all areas will be viable to protect and not all desired strategies will be feasible
- Misalignment of policy and regulatory needs at the local level and regulations at the Commonwealth level
- Maladaptive development practices and norms
- Tensions between approaches historic/aesthetic preservation and energy/food resilience

The community's key priorities include:

- Maintaining Nantucket's one-of-a-kind character
- Implementing nature-based strategies wherever feasible, minimizing ecological impacts
- Protecting critical infrastructure
- Ensuring continuity of service at ferry terminals and maritime facilities
- Engaging a diverse range of public voices
- Developing a clear and actionable CRP

The community's long-term visions include:

- A future Nantucket that continues to embody the island's best characteristics and strives to become more resilient and sustainable
- A comprehensive, island-wide approach to resilience
- An adaptable and dynamic CRP that evolves over time
- Greater Town leadership in implementing and governing for resilience
- A multi-departmental approach to resilience

Coastal Risk and Exposure

Risk from coastal hazards on Nantucket is significant and will grow over time. These risks threaten the aspects of Nantucket that give it its character, sustain its economy, and ensure health and safety for residents and visitors. The key findings from the risk and exposure assessment based on the available coastal hazard data are summarized below. The results included in this report show a significant increase in quantified risk compared to the preliminary results provided in the mid-project report. This is due to the use of updated flood hazard data for this report and the final CRP. These new data include a wider range of modeled coastal storm events than previously available. Additional discussion of these findings is provided in **Section 5 Coastal Risk and Exposure Analysis.**

If no flood or erosion mitigation is implemented on Nantucket,

- **From now through 2070, 2,373 structures** are at risk from flooding and erosion, with the cumulative expected annual damages totaling **$3.4 Billion**, including:
  - **$2.8 Billion** in **direct physical damage** to buildings

- **$310 Million** in **direct economic disruption** to businesses in the study area
- **$250 Million** in **direct social disruption**, including relocation costs, health costs from injuries and mental stress, and lost income due to health issues
- **$110 Million** in **indirect and induced economic losses**

- Of the $420 Million in economic losses, $**51 Million represents federal, state, and local tax impacts**
- **84% of at-risk buildings are residential, accounting for 57% of the total risk, and though only 9% of at-risk buildings are commercial, they account for 33% of the total risk**
- **At least 49% of at-risk buildings are historic and account for 81% of the total risk**
- **At least 9% of buildings are tourism-related, accounting for 34% of the total risk**
- **34 community facilities are at risk, with roughly $180 Million in expected damages. Many of these facilities are essential to community safety and wellbeing.**
- **From now through 2100, the following infrastructure and services may be exposed and at risk of loss of service:**
  - **10 miles of public and private roadway** may be out of service[1] at mean monthly high water by 2030, **20 miles** by 2050, **29 miles** by 2070, and **45 miles** by 2100, resulting in impaired access across the island
  - **6 miles of public and private roadway is vulnerable to erosion** by 2030, **33 miles** by 2100, also resulting in impaired access across the island
  - **By 2030, public roadways leading to the Steamship authority wharf could experience a frequent loss of service at mean monthly high water. By 2050, the Steamship authority wharf will be completely cut off from surrounding roadways at mean monthly high water.** This poses a significant risk to access to and from the island, as well as critical supply lines.
- **From now through 2100, the following open spaces and natural resources will be exposed and at risk of loss of service and/or changes to the ecosystem**
  - **312 acres of public open space** is vulnerable to erosion by 2030 and up to **1,754 acres** could be vulnerable by 2100, reducing opportunities for recreation and enjoyment for the community
  - **719 acres of priority natural communities** could be impacted by mean monthly high water by 2030, **926 acres** by 2050, **1,187 acres** by 2070, and **1573 acres** by 2100, resulting in potential changes to these ecosystems
  - Up to **268 additional acres** of wetland resource areas compared to today may be submerged by mean monthly high water by 2030, **424 additional acres** by 2050, **645 additional acres** by 2070, and **1,055 additional acres** by 2100. Without plans for marsh migration or other mitigation steps, these resources may be impaired or lost.

Please visit the Coastal Resilience Plan website to review the complete Nantucket Coastal Resilience Plan

[1] Loss of service for roadways is defined as being subject to more than 6 inches of inundation, the depth of water at which it is unsafe to drive to a small passenger car

2 Overview of Nantucket

Estimates for the effective population of Nantucket range from between 11,000 to over 17,000 year-round residents, a combination of life long Nantucketer's and those who have arrived on the island fulltime later in life, locally known as "wash ashores." 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. The island is also known for its seasonal influx of vacationers, who rent or own vacation homes on the island, returning each season to the one-of-a-kind beaches and other coastal environs that characterize Nantucket. By most 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. The aspects that make Nantucket an attractive place to live and visit, the characteristics that give it its "island-ness" – 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 aspects that create the need for coastal resilience planning to ensure that Nantucket can continue to adapt to changing conditions and evolving risks. This section provides an overview of Nantucket with a focus on the people, places, histories, and services that provide the foundation for the community's future resilience.

2.1 Life on the Coast

By virtue of its location, history, and geomorphology, Nantucket is and always has been highly exposed to a range of coastal hazards, most notably flooding and erosion. Depending on how one experiences Nantucket, as a year-rounder, a seasonal resident, visitor, or worker, one's perception of these coastal hazards is likely to vary, but everyone who knows Nantucket also knows what it is to live not just beside, but also with, the ocean. Climate change and sea level rise are already altering life on Nantucket, with eight inches of rise between 1965 and 2019 (**Figure 5**), and the community's experience of the coastline is likely to drastically change in the decades to come. It will exacerbate and create new coastal challenges, eroding shorelines more rapidly and making areas of the island vulnerable to flooding in ways that are not experienced today. The Nantucket of today will need to change and adapt to these realities.

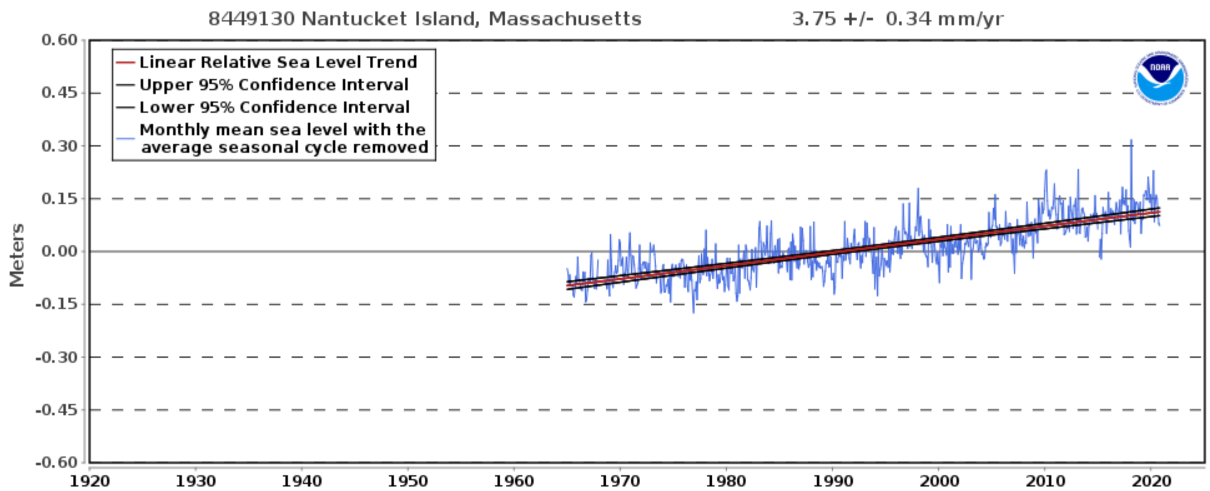


Figure 5. Historic SLR at NOAA tide station 8449130 Nantucket Island, Massachusetts

Recent Storms Events

Memories of significant storm events are ever present in the minds of Nantucketer's, from the No Name storm of 1991 to the more recent events. Two major Nor'easter storms impacted the island in 2018. Both Winter storm Grayson and Winter Storm Riley caused water levels to rise in Nantucket Harbor, approaching the level of the 100 year or 1% annual chance storm, a marker of a major coastal flood event. As just one example of the cascading ways in which such an event can disrupt daily life, the extreme cold coupled with the high stormwater caused a sewer force main from the downtown area to fail and discharge sewage into the harbor, impacting water quality and the health of the fishery on which many Nantucket residents rely for income. The two storms led to storm tides that were among the highest ever recorded for Nantucket. Even more recently, the passing Hurricanes Paulette and Teddy in 2019 hundreds of miles offshore led to erosion on the South Shore with the loss of 140-plus feet of beach on the south shore in just a month. Several winter storms during the fall and winter of 2020 and 2021 had major impacts across the island as well, leading to flooding in downtown and significant erosion along the south shore.

2.2 Environmental History of Nantucket

Physical Setting and Climate

The Town of Nantucket is located east of Martha's Vineyard, and south of Mainland Massachusetts Cape Cod area. Nantucket Island and the Town of Nantucket are both the main features within the County of Nantucket which includes both Tuckernuck and Muskeget Island. Nantucket also features 88 miles of shoreline which is a primary attraction for tourists in the summer months.

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. As the glacier pushed south to the existing location of Nantucket, piles of clay, silt and sand, known as moraines, were deposited ahead of the glacier to form the high points on the island. These current-day locations include the cliffs at Sankaty Head, Folger Hill, Shawkemo Hills, and Sauls Hills.

Notable features on the island include high bluffs at Sankaty Head and the Nantucket Cliffs. The Sankaty Head bluffs are located on the eastern end of the island near Siasconset, while the Nantucket cliffs are located at the northern edge near the Jetties, Brant Point, and Downtown.

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, with some being semi-sheltered and others 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.

Nantucket's climate is characterized by distinct seasons with average temperatures ranging from the low 30s in January to the upper 60s in July. Nantucket experiences an average precipitation of about 43 inches per year, with snowfall ranges between 12 to 24 inches per year. Massachusetts average annual precipitation has been increasing for over a decade, and Nantucket has been on par with this increase. Models predict that each season will bring an increased precipitation amount to Nantucket, compared to previous years. Climate change projections for Massachusetts indicate that precipitation patterns are changing, and more significant changes in the amount, frequency, and timing of precipitation in future years are anticipated.

Figure 6. (next page) Map showing the existing topography and bathymetry of Nantucket, including major water bodies Nantucket Sound, the Atlantic Ocean, Nantucket Harbor, Madaket Harbor. Note the relationship between the island's low-lying coastal areas in Downtown, Madaket, Eel Point, and around Polpis Harbor, and the 1% annual chance floodplain.

Nantucket Island Topography and Bathymetry
1:35,000
0 0.25 0.5 Miles
Contours
Elevation Contours (10 ft)
Bathymetry (2016)
Value
108.817
-158.206
1% Annual Chance Or 100-Year Storm
Topography
Value
108.817
-158.206
Inland Water Bodies
Atlantic Ocean
Northern Nearshore
Trap/ Pot Waters Area
Nantucket Sound
Nantucket
Harbor
Polpis
Harbor
Tuckernuck
Island
Madaket
Harbor

2.3 Historical Perspectives

Nantucket Emerges, Indigenous Peoples, European Colonization

Nantucket emerged as the last of the Laurentide Ice Sheet retreated leaving behind the hills, valleys, creeks, and ponds that are a hallmark of Nantucket's natural beauty. 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, evidence 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 European settlement, Sherburne, was along the north shore at Capaum Harbor, now called Capaum Pond. The tides shifted sand closing off the harbor and causing the settlement to relocate to where it is today by 1720.

Whaling Period and Conservation Conscious

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, tight, 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. Nantucketer's, 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. This can be partly attributed to land for sheep grazing, but also to the Whaling Period itself. Whaling was the economic driver and revolved around economic core areas such as the Town of Nantucket and Siasconset. This does not mean that agriculture and animal husbandry was uncommon, especially since ships arriving could bring the goods the island needed. By the end of the Whaling Period, there were 111 farms of various sizes producing barley, corn, potatoes, and cranberries (U.S. FWS). As the Whaling Period began its decline, focus did turn to agriculture and animal husbandry, but it was not the economic driver as the Island searched for a new identity.[2]

Identity in Conservation and Preservation

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, the same year the Vieux Carre in New Orleans was established as a historic district, Nantucket did not get its first historic district until 1955 when the Commonwealth ruled the special legislation constitutional and declared Nantucket and Sconset local historic districts. Nantucket joined a handful of historic cities that had already established historic district zoning in an effort to protect their historic resources. Massachusetts then created a state-wide enabling statute – Historic District Act (1960) – to empower municipalities to establish their own local historic districts. It was not until after the passage of the National Historic Preservation Act in 1966 that a national method for historic designation was established and state-enabling authority granted in all states.

The preservation and conservation movements moved 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 Wetland Protection

[2] Much of the preceding information drawn from Pauline Chase-Harrell and Brian Pfeiffer, "Nantucket Historic District", National Register of Historic Places Nomination Form (Washington, DC: U.S. Department of the Interior, National Park Service, 2018).

Act. Designated a National Historic Landmark in 1975, the Island of Nantucket, was recognized as historically significant for its early efforts in architectural preservation and land conservation. This significance as a leader in the early preservation movement led to Nantucket serving as home to the University of Florida's Preservation Institute Nantucket (PIN), the oldest preservation field school in the United States. PIN students continue the documentation of Nantucket's built and natural history, but now with a sense of urgency anticipating the impacts of climate change, rising tides and eroding coastlines on this fragile, unreplaceable Island community.

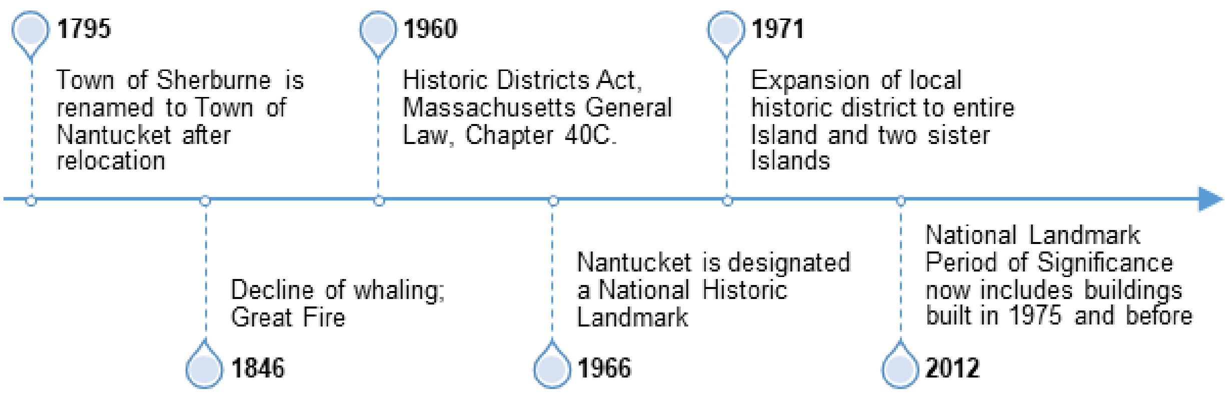


Figure 7. Summary timeline of key dates in Nantucket's history and preservation movement

2.4 Nantucket Today

The Nantucket Community

Recently released 2020 data from the U.S. Census Bureau indicates a year-round population of 14,200 residents on Nantucket. However, local estimates and detailed analyses by Nantucket Data Platform indicate a permanent population of up to 17,200 residents, including adults and children. According to the 2018 ACS 5-Year estimates, the most year-round population-dense part of the island is the central-southern census tract (census tract 9502) consisting roughly of the Cisco and Miacomet neighborhoods. On an average Saturday in July, however, the vast majority of Nantucket's effective population–inclusive of visitors–typically concentrates in the Downtown and Brant Point neighborhoods. A high seasonal residential population–estimated at an additional 11,000 at 100-percent occupancy by Nantucket Data Platform's study–and high volume of seasonal visitors, particularly in July and August can cause the effective population of the island to swell to over 54,000 in the summer months.

Systems and Services that Support Quality of Life on Nantucket

Whether one is a lifelong resident, a more recent arrival, a seasonal visitor, business owner, a worker, or a combination thereof, life on Nantucket is characterized by the unique needs and conditions of living 30 miles out to sea. Life on Nantucket is not the same as it is on the mainland and the systems and infrastructure that support quality of life for the community must be carefully designed, operated, and maintained in order to continue to support community wellbeing. These systems and infrastructure include the transportation infrastructure that people use to travel to and from and across the island, food and water systems, healthcare facilities, energy, parks and open space, and natural ecosystems. This section details the key systems that support quality of life on Nantucket and the risks to which will be discussed in **Section 5 Coastal Risk and Exposure Analysis.**

Transportation

The Town is comprised of transportation networks that 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 as it provides access to the mainland for goods and services, as well as for residents and visitors that support the island economy. The airport has been operated and maintained by the Town's Airport Commission for over 60 years. According to data from the Town, the airport sees approximately 100-125 thousand commercial passengers each year. While the Airport Commission is responsible for ensuring the airport is in good working condition, the Federal Aviation Administration (FAA) is in charge of controlling and ensuring the safety within Nantucket's airspace. As will be discussed in **Section 5 Coastal Risk and Exposure Analysis**, erosion, and to a lesser degree flooding, along the southern shore of the island threatens airport infrastructure.

There are also multiple ferry lines that provide year-round access to the island. Both the Hy-Line Cruises and Steamship Authority use high-speed passenger catamarans for their services with trips from the mainland. The Steamship Authority also operates a vehicle and passenger ferry with a two-and-a-half-hour travel time from Hyannis. 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 Hy-Line ferry service transports minimal freight and supplies, the ferry service is responsible for transporting numerous passengers to and from the mainland and into Straight Wharf. In addition to the previously listed ferry services, the Freedom Cruise Line departs from Harwich Port, MA and the high-speed ferry with Seastreak arrives at the island after leaving from New York City, NY or New Bedford, MA. There are community concerns regarding isolation from the mainland from temporary loss of ferry services, along with air travel, due to high winds and an increase in storm intensity. In addition to these ferry terminals, there are numerous private docks located across the island and official and unofficial public boat ramps with varying facilities. These are located at Children's Beach (the only official public boat launch in Nantucket Harbor and/or Polpis Harbor), Washington Street Extension, Polpis, Walter Barrett's Pier, and Byron Coffin Pier (also known as Jackson's Point Pier). These amenities support recreational boating and the fishing industry.

Nantucket is served by a network of public and private roadways and bridges. All public roadways are under local jurisdiction, except for Milestone Road which is under the jurisdiction of the Commonwealth of Massachusetts. The Nantucket Regional Transit Authority shuttle buses, also known as the WAVE, provides transportation services amongst these roadways. There are also four taxi companies and numerous car rental agencies that provide services for mobility around the island. Major roadways in the downtown area include Washington Street, Easy Street, and Broad Street. These critical public roadways in Downtown provide access to the ferry terminals. To the east side of the island, Madaket Road is also a critical public roadway as it is the only critical transportation route from Madaket Village and Smith Point to central areas of the island. Hummock Pond Road is also a critical transportation route and provides inland access from Cisco. To the west, Polpis Road is the main arterial connecting the Polpis area to Downtown and it also extends through Quidnet and into the Siasconset neighborhood. The section of Polpis Road along the southwest edge of Sesachacha Pond is prone to flooding during high wind events and when the pond is not drawn down during springtime. If Polpis Road and Milestone Road, both of which are critical transportation routes, simultaneously flooded, the Siasconset neighborhood would be isolated. In the Siasconset neighborhood, Baxter Road provides access to private homes, Sankaty Head Lighthouse, and the bluffs in this area, and is exposed to erosion risk. **Figure 8** shows the location of the primary transportation systems and facilities on Nantucket.

Figure 8 (next page) Map showing the primary transportation systems and facilities on Nantucket, including primary routes and critical transportation routes, local roads, and facilities to support travel to and from the island, such as Steamboat Wharf and Nantucket Memorial Airport.


Transportation
0
0.5
1
Miles
N
Airports
Seaports
Marinas
Public Boat Ramps
Ferry Routes
Bus Stops
Critical Transportation Routes
Road Access
Public paved
Public unpaved
Private paved
Unknown paved
Private unpaved
Muskeget Island
Muskeget Island Airport
Tuckernuck Island
Tuckerneck Airport
Nantucket Sound
Inter-Island Hyannis-Nantucket
Harwich Port-Nantucket
Coskata
Wauwinet
Wauwinet Road
Squam
Coatue
Pocomo
Nantucket Harbor
Quidnet
Quidnet Road
Polpis
Sesachacha Pond
Shawkemo
Quaise
Jetties
Brant Point
Steamship Authority
Old North Wharf
Hy-Line Cruises
Shimmo
Eel Point
Fishers Landing
Eel Point Road
Cliff Road
Madaket Road
Town Pasture
Downtown
Nantucket Town Pier
Madaket Harbor
Madaket Marine
Long Pond
Madaket
Polpis Road
Hoicks Hollow
Sesachacha
Codfish Park
Monomoy
Orange Street
North Pasture
Middle Pasture
Old South Road
Milestone Road
Sconset
Sankaty Road
Nantucket Memorial Airport
Tom Nevers Road
Tom Nevers
Hummock Pond
Hummock Pond Road
Miacomet Road
Surfside Road
Surfside
Cisco
Smooth Hummocks
Atlantic Ocean

Land Use and Districts

Land use in coastal areas helps inform the evaluation of risk and also the set of coastal resilience and adaptation approaches that might be appropriate for a given area, based on land use type, density of development, or environmental character. As part of a coastal resilience strategy, land use changes may be necessary to address increasing risk, shifting patterns of land use from historic patterns to account for evolving hazards. Current land use in Nantucket mainly consists of low density residential, small-scale commercial and industrial uses institutional, and open space, much of it protected as conservation lands. 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 Council. New residential development on the island is largely limited to new single-family homes. Due to a combination of zoning, wetland protection regulations, and the prominence of protected open space, new development is not common directly adjacent to the shoreline in most areas. Nevertheless, many private residences exist in flood and erosion prone areas, as will be discussed in **Section 5 Coastal Risk and Exposure Analysis.**

Commercial uses are primarily located in the Downtown and Mid-Island. The Mid-Island area has been identified by the Town as a potential location for future commercial growth. There is relatively little planned major development, aside from residential construction, outside of Mid-Island and Downtown.

Schools, municipal buildings, healthcare facilities, and additional institutional use buildings, along with primary transportation centers, are concentrated in the more densely populated areas of Downtown and Mid-Island. Land uses and districts across Nantucket are provided in **Figure 9** and **Figure 10.**

Historical District and Landmarks

As stated previously in **Section 2.3 Historical Perspectives,** the Old Town Nantucket and Village of Siasconset was part of the legislation solidifying the constitutionality of historic districts within the Commonwealth in 1955. This is before the National Historic Preservation Act of 1966 which recognized the national preservation movement which began in earnest with the preservation of Mount Vernon by the Mount Vernon Ladies Association in 1853.

The two local historic districts of Nantucket Town and the Village of Sconset consisted of their downtown urban areas which set a period of significance for buildings built prior to 1850, anything outside of the period is considered non-contributing. In 1971 the district was expanded to include the entirety of the Town of Nantucket, not just the Old Town. In 1966, the Nantucket Historic District was designated a National Historic Landmark, which was later expanded to the entire Island and two sister Islands.

The most recent updates to the National Historic Landmark designation expand the period of significance to 1975, therefore any building built on, or prior to 1975 is contributing to the Landmark’s historic significance. It also recognizes that the historic built environment was created in response to the natural environment. Therefore, below we list the landmarks of both as one cannot be separated from the other.

Urban cores of Nantucket Town and the Village of Siasconset—both were recognized in early preservation efforts as essential to the culture and essence of the Island. They also have unique topography, Siasconset placed upon a cliff and the last remains of a traditional whaling village, and Nantucket Town placed inside an amphitheater-like bowl with the harbor as the stage. There are many buildings and locations within each that are essential to telling the story of the Island, and prioritization to protect these resources is necessary in climate action and preparedness planning.

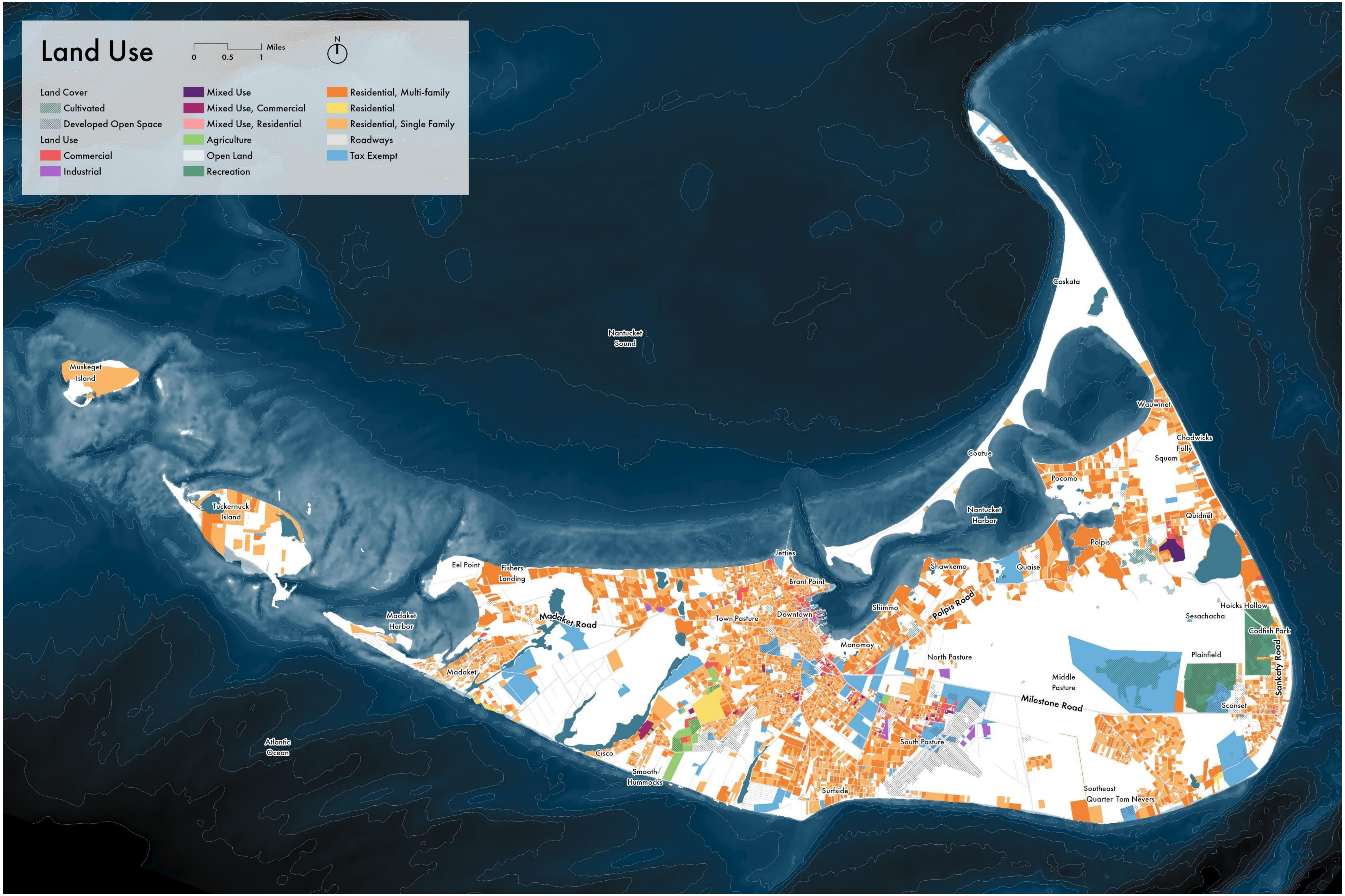
Madaket—Inside the recognized bounds of Madaket are a few contributing elements of the Landmark’s historic context, its cultural landscape. First, it was where contact was made between the European settlers and indigenous Wampanoag in the late fall or early winter of 1659. It is also home to the earliest public works project-

Madaket Ditch - which was dug in the 1660s as a cooperative project between the Wampanoag and settlers to provide better fishing. It supported an intangible heritage of harvesting Alewives and eels, but this fishing heritage is at risk of being lost. It is also known for important people such as Madaket Millie (1907-1990), who began a lifelong mission of rescuing people off the coasts of Nantucket starting at the age of ten. She was honored by the U.S. Coast Guard for seventy-eight years of service and awarded the Meritorious Public Service Commendation.

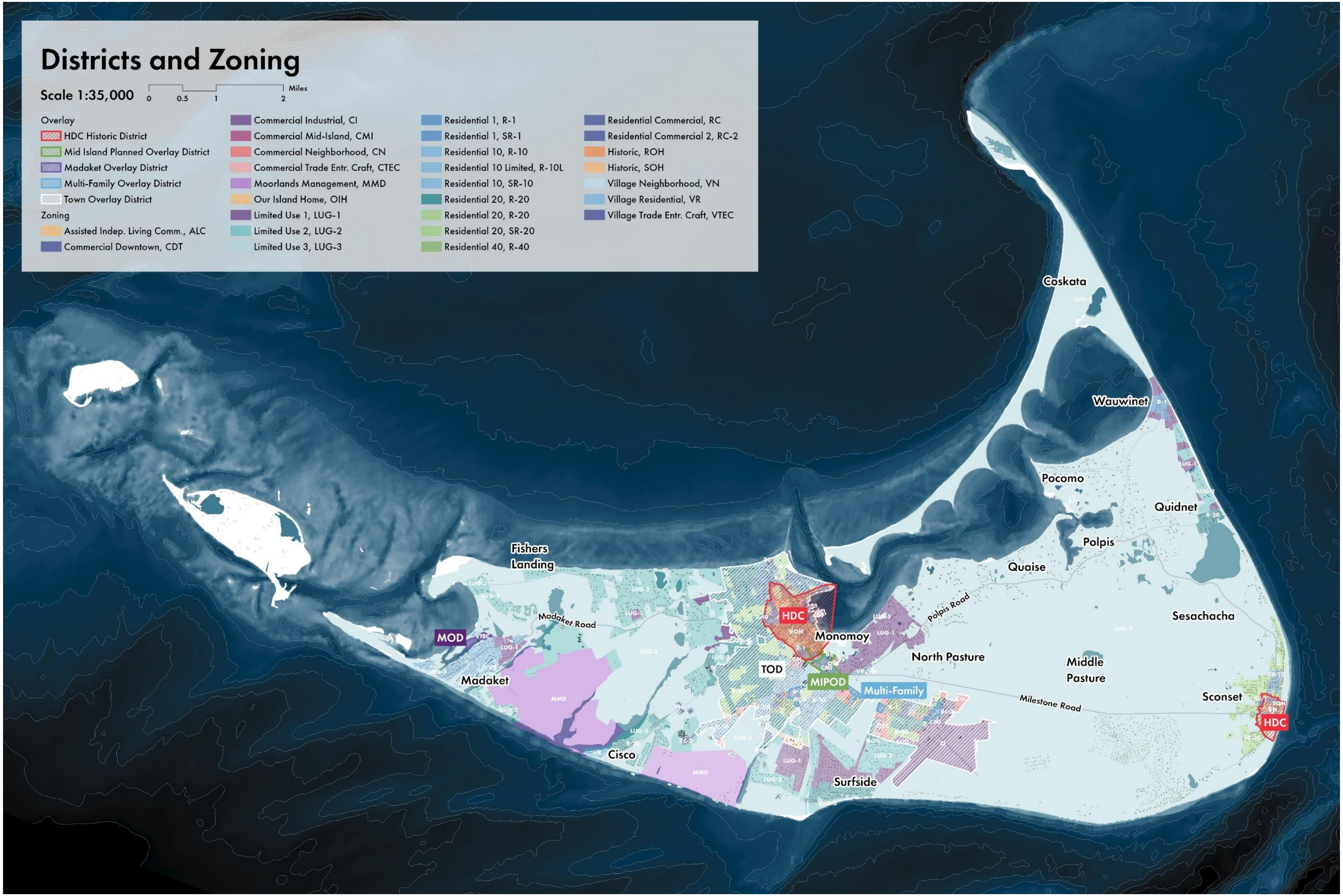
Terminal Moraine—much of Nantucket's landscape was shaped by the last Glacial Maximum 21,000± years ago. The hills and higher elevations, such as Altar Rock, were where the ice rested, and the ponds in this area, such as Sesachacha, were formed when ice under the sand melted and created a depression. The southern portion of the Island, such as the Moors, Hither Creek, Long Pond, and Madequecham Valley were outwash plains that formed as water poured off the ice sheet as it retreated. These areas are home to protected species of flora and fauna, as well as globally protected landscapes such as heathlands and sandplain grasslands.

Figure 9. (next page) Map showing the location of primary land uses by parcel across Nantucket

Figure 10. (following page) Map showing the location of zoning and historic districts across Nantucket



Land Use
Miles
0
0.5
1
N
Land Cover
Cultivated
Developed Open Space
Land Use
Commercial
Industrial
Mixed Use
Mixed Use, Commercial
Mixed Use, Residential
Agriculture
Open Land
Recreation
Residential, Multi-family
Residential
Residential, Single Family
Roadways
Tax Exempt
Nantucket Sound
Muskeget Island
Tuckernuck Island
Coskata
Wauwinet
Chadwicks Folly
Squam
Coatue
Pocomo
Nantucket Harbor
Quidnet
Polpis
Jetties
Eel Point
Fishers Landing
Brant Point
Shawkemo
Quaise
Madaket Harbor
Madaket Road
Town Pasture
Downtown
Shimmo
Polpis Road
Hoicks Hollow
Sesachacha
Codfish Park
Monomoy
North Pasture
Plainfield
Madaket
Middle Pasture
Milestone Road
Sankaty Road
Sconset
Atlantic Ocean
South Pasture
Cisco
Smooth Hummocks
Surfside
Southeast Quarter
Tom Nevers



Districts and Zoning
Scale 1:35,000
0 0.5 1 2 Miles
Overlay
HDC Historic District
Mid Island Planned Overlay District
Madaket Overlay District
Multi-Family Overlay District
Town Overlay District
Zoning
Assisted Indep. Living Comm., ALC
Commercial Downtown, CDT
Commercial Industrial, CI
Commercial Mid-Island, CMI
Commercial Neighborhood, CN
Commercial Trade Entr. Craft, CTEC
Moorlands Management, MMD
Our Island Home, OIH
Limited Use 1, LUG-1
Limited Use 2, LUG-2
Limited Use 3, LUG-3
Residential 1, R-1
Residential 1, SR-1
Residential 10, R-10
Residential 10 Limited, R-10L
Residential 10, SR-10
Residential 20, R-20
Residential 20, R-20
Residential 20, SR-20
Residential 40, R-40
Residential Commercial, RC
Residential Commercial 2, RC-2
Historic, ROH
Historic, SOH
Village Neighborhood, VN
Village Residential, VR
Village Trade Entr. Craft, VTEC
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Madaket Road
Polpis Road
HDC
Monomoy
Sesachacha
MOD
North Pasture
Middle Pasture
TOD
MIPOD
Multi-Family
Madaket
Milestone Road
Sconset
HDC
Cisco
Surfside
MMD

Wastewater, Water, and Energy Systems

Wastewater

According to the Town of Nantucket Sewer Department Capacity, Management, Operation and Maintenance (CMOM) Program Manual Nantucket has a separated sewer system for wastewater, with approximately 70 miles of sewer mains, 14 publicly owned pumping stations, and two municipal wastewater treatment facilities. Wastewater in the Towner Sewer District, comprised primarily of the Brant Point, Downtown, and Monomoy neighborhoods, is conveyed to Surfside Wastewater Treatment Facility (WWTF). The Surfside WWTF collects flows from four sub-areas and provides biological treatment for a daily flow of up 7.7 million gallons per day (MGD). The second municipal wastewater facility treats wastewater flows for the Siasconset Sewer District. The Siasconset WWTF was designed to provide treatment for a daily flow of up to 0.43 MGD. The average daily flows that are conveyed to the plant fluctuates significantly due to the seasonal population changes in this neighborhood and wet weather flows from precipitation events. Businesses and homeowners that are not in either of the two sewer districts rely primarily on septic systems for wastewater treatment and distribution.

The Town developed a CMOM Program to enhance the sanitary sewer system operation and reliability and help mitigate sanitary sewer overflows (SSO). SSOs release untreated sewage to waterbodies when the sewer system is overwhelmed with increased flow and exceeds the designed capacity. These overflows can lead to poor water quality if the overflows are recurring and adds additional health hazards to flood risk and existing social vulnerabilities. Nantucket is complying with the requirements of the Environmental Protection Agency for preventing sewer overflows and back-ups.

Water

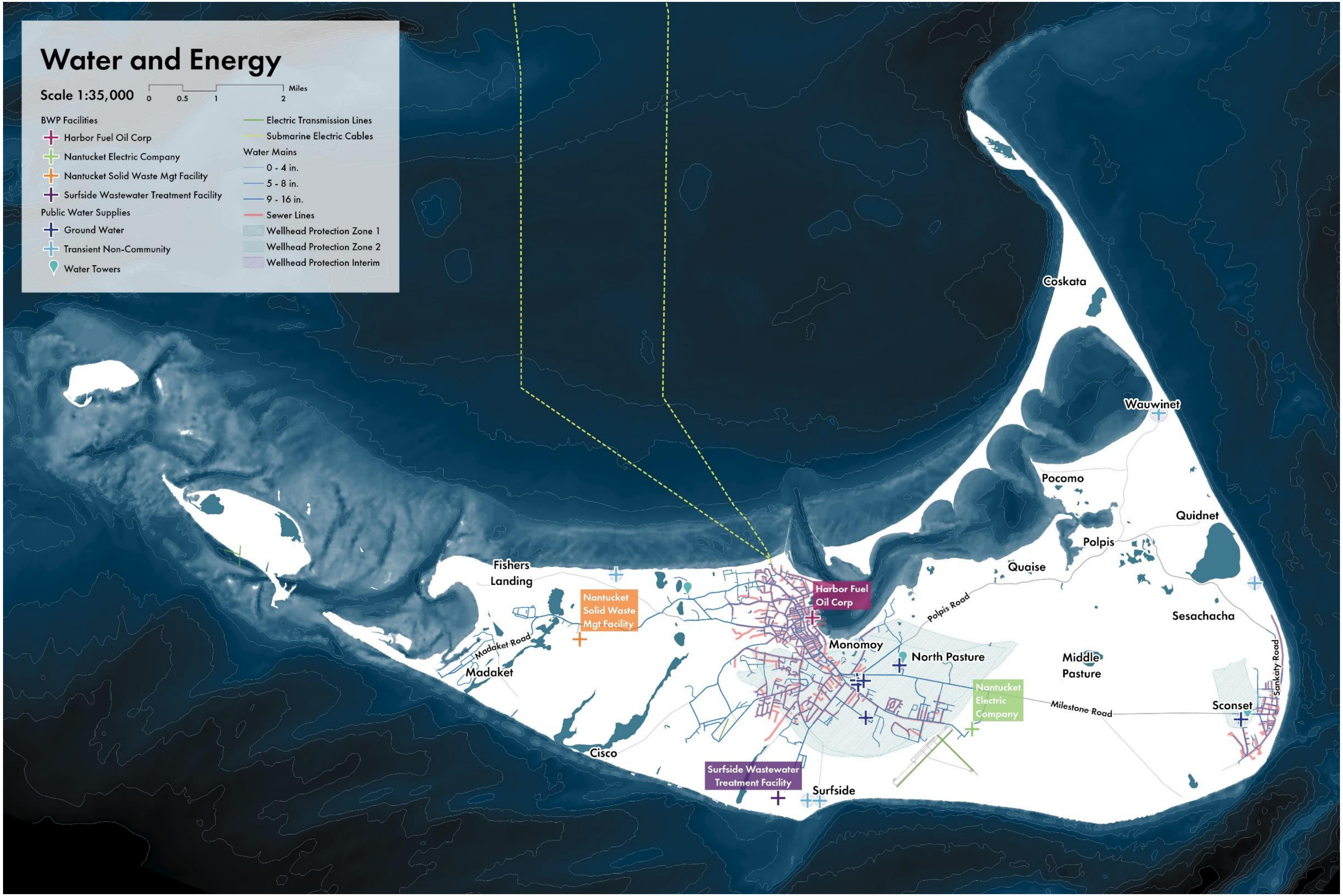
The Wannacomet Water Company (WWC), a municipal department, provides potable water and fire protection to the island. Private wells are also another source of drinking water. The WWC is overseen by two separate elected commissions and the Siasconset service area continues to have its own commission. The WWC collects its water from five wellfields, with four located in the central part of the island and one in Siasconset. In order to limit the risk of contamination of the water sources, wellhead protection districts and regulations around these wellfields have been established.

Energy

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. Some locations receive electricity through underground powerlines. Transformers are located throughout the island.

The fuel tank farm, located on Industry Road, is operated by Harbor Fuel Corporation and provides gasoline, propane, diesel, and heating oil to the community. In summer of 2019, the fuels from the old tank farm located at the Downtown waterfront were transported to the new tank farm in a less populated and developed area to reduce risks to the population. The facility is a now outside of the floodplain and more accessible during storm events. Fuels are delivered to the tanks at the farm by tanker trucks that arrive at Steamboat Wharf.

Figure 11. (next page) Map showing the location of known Town-owned or regulated water and energy systems on Nantucket.


Water and Energy
Scale 1:35,000
0
0.5
1
2
Miles
BWP Facilities
Harbor Fuel Oil Corp
Nantucket Electric Company
Nantucket Solid Waste Mgt Facility
Surfside Wastewater Treatment Facility
Public Water Supplies
Ground Water
Transient Non-Community
Water Towers
Electric Transmission Lines
Submarine Electric Cables
Water Mains
0 - 4 in.
5 - 8 in.
9 - 16 in.
Sewer Lines
Wellhead Protection Zone 1
Wellhead Protection Zone 2
Wellhead Protection Interim
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Sesachacha
Fishers Landing
Harbor Fuel Oil Corp
Nantucket Solid Waste Mgt Facility
Polpis Road
Monomoy
North Pasture
Middle Pasture
Sankaty Road
Madaket Road
Madaket
Nantucket Electric Company
Milestone Road
Sconset
Cisco
Surfside Wastewater Treatment Facility
Surfside

Community Assets and Services

A range of community assets and services support quality of life on Nantucket. Community assets and services are the places and benefits that are often taken for granted but that are integral to the safety and security of a population. These range from everyday establishments such as grocery stores and pharmacies, to places of learning and knowledge such as libraries and schools, to emergency services, such as fire and police. These assets and services are important in every community but on an island are even more critical as community lifelines. Major assets and services identified for this plan are shown in **Figure 12.**

The Nantucket community is served by range of essential services located in Town Facilities, including fire and police from the Public Safety Facility (4 Fairgrounds Road), public health from the Public Health Office (3 East Chestnut Street), a range of infrastructure services supported from the Department of Public Works (188 Madaket 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, Stop n' Shop (2) and Bartlett's Farm, numerous houses of worship, and many museums and nonprofit organizations providing education, entertainment, and support to the community.

Nantucket's resilience is in large measure a function of how resilient these facilities and services that support life on the island are. Without these places, quality of life would be significantly diminished, and, in some cases, the safety and wellbeing of the community are severely compromised. The Coastal Resilience Plan will evaluate risks to the assets and services and seeks opportunity to protect and enhance the value and benefit they bring to the community.

Figure 12. (next page) Map showing the location of community facilities and services, including utilities, emergency services, community facilities, and public amenities such as boat ramps on Nantucket


Community Assets and Services
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
Ferry Routes
Buildings County
Trails
OpenSpace
2070 1% Annual Flood
Airport
Transportation
Community Facilities and Services
Emergency Services
Utilities
Sewer
Mains
TransmissionLines
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Sesachacha
Monomoy
North Pasture
Middle Pasture
Sconset
Madaket
Cisco
Surfside

Parks and Open Space

Open space is one of the primary features that define the character and identity of Nantucket, as well as its desirability as a place to live and visit. Access to open and green space is an important indicator of overall community health and can be a driver of community resilience, particularly where open space provides multiple health, ecological, and risk reduction benefits. Much of the protected open space on Nantucket is under the stewardship of private conversation organizations, such as the Nantucket Conservation Foundation, Trustees of Reservations, Audubon Society, and other Nantucket-based land trusts. The Nantucket Land Bank also acquires and manages land for conservation, recreation, and agriculture. More than half of the land on Nantucket is protected open space. These properties provide myriad ecological benefits to animals and birds, as well as recreational trails and other resources for community benefit. Major parks and open space properties are shown in **Figure 13.**

In addition to privately owned open spaces, there are 14 Town-owned parks, including:

- Passive park properties (Coffin Park, Mill Hill Park, and Consue Springs)
- Active parks (Winter Park, Nobadeer Athletic Complex, Delta Fields, and Tom Nevers Park)
- Neighborhood pocket parks (Lincoln Circle and Hulbert Avenue & Easton Street Circles)
- Beach properties (Dionis, Jetties, Children's, Fisherman's, Surfside)

The Town has been in the process of planning for its parks and open spaces in order to better serve community needs. In winter 2020, the Parks and Recreation Master Plan was published, including a needs assessment that identified a number of concerns. These concerns ranged from insufficient active recreation facilities for the communities growing needs, to lacking resources for operations and maintenance of existing facilities, to more consistent oversight of field uses.

Like the rest of the country and world, life on Nantucket has been significantly altered by the global pandemic. The pandemic and the need for social distancing has likely changed how community members see the role of open space in their daily lives. Improved access to open space and coastal resilience are often compatible objectives. The Coastal Resilience Plan will evaluate risks to Town parks and protected open space and seek to make recommendations for coastal resilience that add open space benefits for the community.

Figure 13. (next page) Map showing the location public and private protected open spaces and parks on Nantucket

Parks and Open Spaces
1:35,000
0 0.25 0.5 Miles
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
2070 1% Annual Flood
Ferry Routes
Buildings County
Trails
Open Space
Public-Non-Profit
Public-Town-Owned
Public-Federally-Owned
Public-State-Owned
Private Non-Profit
Other
Cranberry Bog
DIONIS BEACH
LINCOLN CIRCLE
JETTIES BEACH
COFFIN PARK
HULBERT AVE. AND EASTON STREET CIRCLE
CHILDREN'S BEACH
MILL HILL PARK
CONSUE SPRINGS
NOBADEER
DELTA FIELDS
WINTER PARK
ATHLETIC COMPLEX
FISHERMAN'S BEACH
SURFSIDE BEACH
TOM NEVERS PARK

Habitat and Natural Resources

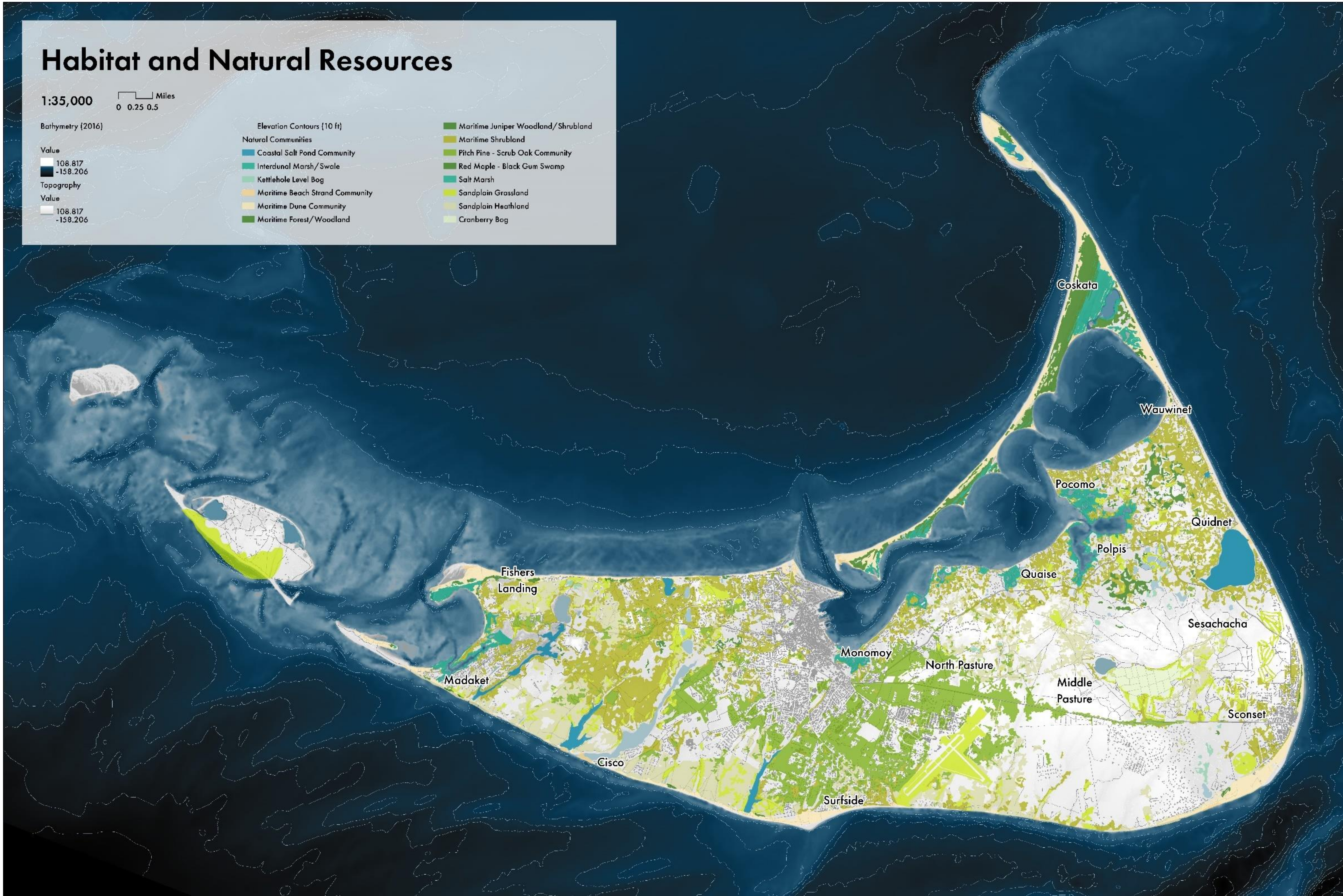
The island's natural habitats and resources contribute to Nantucket's natural beauty, biodiversity, and support quality of life for the community. As a relatively small island, Nantucket is fortunate to have an array of habitats and natural area types. Barrier beaches are located around the island, primarily 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 Point and Eel Point. While the barrier beaches form the seaside habitats in locations, just inland sand dunes provide additional habitat, as well as 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 comprised of many of the same plants as the sandplain grasslands but are not dominated by grasses and are located in the central and northern areas of the island on nutrient poor sand and gravelly soils. Both of these habitats were unique to the 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. Other natural communities on the island include hardwood forests, pond, and bogs.

Natural resources such as wetlands and coastal floodplains provide protection from flooding, but their health and longevity are threatened by sea level rise. State and local regulations have been established to protect wetland resource areas from development and other factors so that they may continue to provide natural flood protection, diminish wave action, and also provide habitat for many species of plants and animals.

The priority Natural Communities and wetland resource areas identified for this plan are shown in **Figure 14.**

Threatened and endangered species of plants, birds, insects, and other animals are supported by the habitats and protecting these species and habitats is a priority for the community. Many of these species and habitats are found throughout the 16,000 plus acres of conservation land on Nantucket. These conservation lands, with a majority being open to public use, are vital to Nantucket's identity, attracting residents and visitors for activities including birdwatching, hiking, boating, fishing, swimming, and environmental education.

Figure 14. (next page) Map showing the location of priority Natural Communities and wetland resource areas on Nantucket


Habitat and Natural Resources
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
Natural Communities
Coastal Salt Pond Community
Interdunal Marsh/Swale
Kettlehole Level Bog
Maritime Beach Strand Community
Maritime Dune Community
Maritime Forest/Woodland
Maritime Juniper Woodland/Shrubland
Maritime Shrubland
Pitch Pine - Scrub Oak Community
Red Maple - Black Gum Swamp
Salt Marsh
Sandplain Grassland
Sandplain Heathland
Cranberry Bog
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Sesachacha
Fishers Landing
Monomoy
North Pasture
Middle Pasture
Madaket
Sconset
Cisco
Surfside

3 Engaging the Community

Community engagement is fundamental to creating and implementing the CRP. 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 in partnership with the Coastal Resilience Advisory Committee to help continue momentum toward early implementation steps

This section summarizes the community engagement process as of the project mid-point in April 2021. For a full overview of the community engagement process during the CRP, please review the complete Coastal Resilience Plan: https://www.nantucket-ma.gov/2030/Coastal-Resilience-Plan

3.1 Community Engagement Plan

At the outset of the planning process, the Project Team developed a Community Engagement Plan that documented the overall goals, schedule, and engagement approach for the CRP. It outlined the Project Team's approach to reach community groups and stakeholders during the CRP process while adhering to social distancing and public health guidelines established by the Town and State during the COVID-19 pandemic. **Figure 15** shows the community engagement schedule through the conclusion of the process.

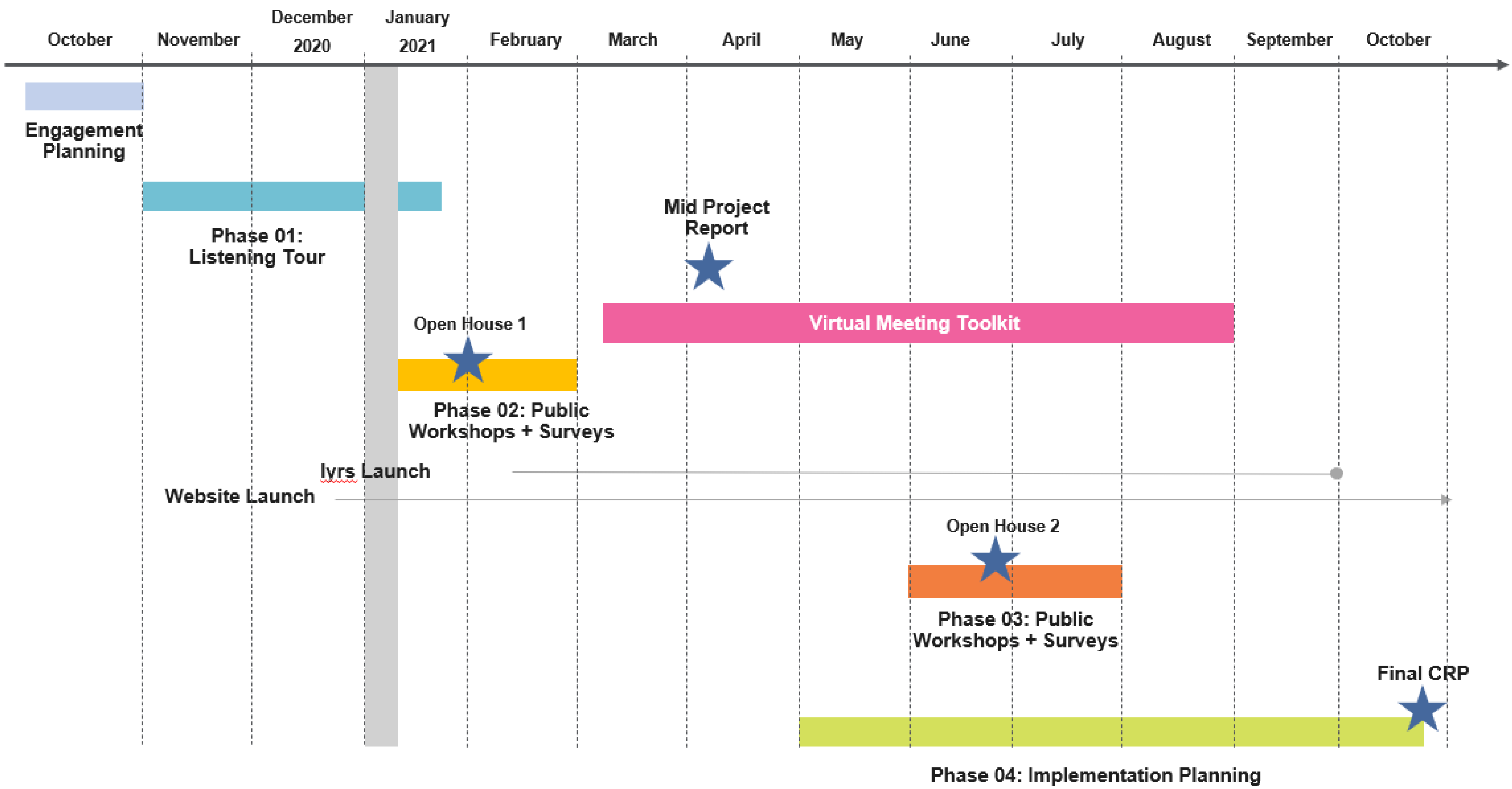


Figure 15. Community Engagement Schedule for the Nantucket Coastal Resilience Plan

3.2 Community Engagement Process Interim Findings

Listening Tour

From November 2020 to January 2021, the Project Team conducted a listening tour consisting of detailed project briefings and interviews with key stakeholders on Nantucket. The goals of the listening tour are summarized below.

- Identify key questions that require deeper understanding through ongoing engagement
- Collect need-to-know information on risks and vulnerabilities
- Understand what is important to the community
- Build consensus on the goals of the CRP
- Create relationships with key groups

The Project Team conducted detailed project briefings and interviews with 125+ staff and community members across 21 departments, boards, commissions, and organizations as part of the listening tour, including:

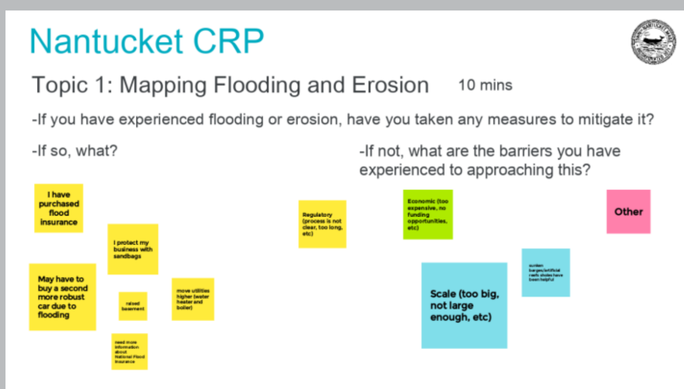
- ACKlimate Nantucket
- Coastal Resilience Advisory Committee
- Department of Public Works
- Emergency Management
- Harbor Master's Office
- Harbor and Shellfish Advisory Board
- Historic District Commission
- Nantucket Civic League, including many civic league member associations
- Nantucket Conservation Commission
- Nantucket Coastal Conservancy
- Nantucket Conservation Foundation
- Nantucket Historical Commission
- Nantucket Island Chamber of Commerce
- Nantucket Land Bank
- Nantucket Land Council
- Natural Resources Department
- Planning and Land Use Services
- Planning Board
- Remain Nantucket
- Select Board

Community-Wide Engagement

Since January 2021, the Project Team has been undertaking 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. The key objectives of this process are to:

- Generate broad awareness on and off island of the planning process
- Discuss the long-term coastal resilience vision for Nantucket
- Generate shared understanding of risks and resilience concepts
- Review areas of concern related to coastal flooding and erosion
- Ensure the community knows how to stay informed and involved

To kick off this process, a website for the CRP was launched, serving as a hub for detailed project information and ways to get involved for the general public. A Virtual Public Open House was held on January 28, 2021, which saw 160+ attendees. This 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.



Nantucket CRP Open House on January 28th, 2021

The first Open House for the Nantucket CRP was held on the evening of January 28, 2021. Due to Town and State public health guidance and to ensure health and safety for all, the event was convened virtually using Zoom. Over 200 people registered for the event and over 160 attended. The event promoted in advance using the Town's website, social media, a local events calendar, local e-newsletters, email blasts, and attendance at Town committee and Board meetings. 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.

Highly 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?

The images at left provide samples of the input collected during the breakouts.

A video of the Open House can be view here: [Virtual Public Open House]

The Project Team has since leveraged the high level of engagement from the Virtual Open House event to follow-up regularly with e-mail blasts keeping the community informed on project updates. Town staff and members of the Coastal Resilience Advisory Committee have also been working with the Project Team to expand the reach of the engagement to members of the community to have not been regularly engaged in prior planning efforts.

Additionally, in collaboration with Irys, the Project Team launched and promoted the Irys App for iOS and Android devices in early February 2021 as a tool to help facilitate two-way engagement throughout the development of the CRP. As of late March, the app has been downloaded by 85 users. The Irys App allows users to:

- Provide feedback throughout the development of the Nantucket Coastal Resilience Plan. Users can choose from providing input by location, providing input by category, and responding to survey questions
- Find opportunities to participate in future Nantucket Coastal Resilience Plan events
- Track project progress and view information about project developments
- Follow community input and interact with other community members

Figure 16. The Virtual Meeting Toolkit is a downloadable resource for anyone who wants to learn about, discuss, and provide input to the Coastal Resilience Plan. An easy-to-use form enables everyone to quickly provide ideas and priorities to the Project Team

On March 11, 2021, the Project Team released an additional set of engagement tools for public use: a Virtual Meeting Toolkit and Resilience Storytelling Cards. The Virtual Meeting Toolkit (**Figure 16**) was downloadable for anyone to use to host and facilitate conversations about Nantucket's resilient future with their friends, neighbors, colleagues, and community. The toolkit is designed to be highly accessible (available in both English and Spanish), providing self-explanatory presentation materials, FAQs, and detailed instructions for providing feedback to the Project Team.

3.3 Key Findings and Takeaways

What We've Heard: Major Themes

Through the listening tour and community-wide engagement process, the Project Team heard the community raise several **common challenges** faced by people on the island, **core tensions** that continually arise and must be accounted for in implementing coastal resilience strategies, **key priorities** that form the backbone of the community's vision for a resilient Nantucket, and **long-term visions** toward which the Coastal Resilience Plan should set its aims. The key challenges, tensions, priorities, and long-term visions which the Project Team heard from Nantucket stakeholders and the public are briefly summarized below.

Key Challenges

- The effects of **flooding and erosion hazards** are increasingly being felt by the general public as they give rise to numerous public safety issues in areas previously not thought to be at risk, in addition to the known areas of immediate concern such as Downtown, Madaket, Brant Point, and other areas. Sea level rise is increasing the potential for loss of critical infrastructure, ecological resources and habitats, public access, and economic value throughout the island, in addition to impacts to property and business owners. Intermittent loss of roadways and access across the island when it floods is a concern, as are the chronic flooding issues that sea level rise will increasingly pose in the future. Inadequate stormwater drainage in some places exacerbates these concerns as increased stormwater flooding compounds the risk of flooding, particularly Downtown.

- 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 lead to widespread unpreparedness, resistance to change, and panic when storm events strike.
- Town staff indicated that the Town government is **understaffed and underfunded** in general and specifically in relation to the scale of action needed to address increasing coastal risks. Additional capacity is needed to take on the responsibilities a comprehensive, island-wide resilience approach would require, and to monitor everything going on across the island that have implications for Nantucket's future resilience.
- There are many ongoing **parallel efforts and plans** related to resilience without a central entity or coordinated process tying them into cohesion.
- 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.
- Although many stakeholders believe it is critical to pursue **sustainability and climate mitigation** co-benefits as an integral part of any resilience or climate adaptation effort, the fluidity and ambiguity of the concept of sustainability have made it challenging to align key entities around a common definition and understanding. This has presented obstacles to both public education about and implementation of sustainability initiatives that must be part and parcel of any resilience approach.
- Existing **data gaps** in and other data challenges with the island's infrastructure mapping present as obstacles to developing a comprehensive, island-wide resilience approach.

Key Tensions

- In general, 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. For example, while multi-beneficial nature-based strategies are broadly favored amongst the general public, there are likely to be spaces and places where such strategies may not be feasible. Relocation and acquisition strategies for private property will also be important to consider in specific circumstances but will have to be considered alongside their potential economic and social impacts.
- **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, current zoning bylaws and building codes are controlled by the Commonwealth and more stringent rules and regulations cannot be implemented by the Town. This presents a tension in setting higher standards in Nantucket while contending with limitations imposed at a higher scale of governance.
- Current **development practices** and norms conflict with a future built environment that is resilient. Private property owners continue to operate independently–often building in coastal areas facing erosion hazards at their own risk–and are not incentivized to relocate their developments until they experience the full effects of coastal hazards, resulting in reactive planning. Given these existing 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.
- Various stakeholders noted tensions between two key island-wide goals that are essential to any resilience effort: **historic and aesthetic preservation, and energy and food resilience**. Community members and project stakeholders highlighted the importance of both–the critical need to maintain Nantucket's historic and aesthetic character, as well as the need for Nantucket to pursue alternatives to its existing reliance on delivery of fuel and food, which can be at risk if access points and other

transportation infrastructure are inundated. However, sustainable approaches to energy and food resilience and redundancy are often seen as inimical to aesthetic preservation.

Key Priorities

- Community members and project stakeholder continually emphasized that the island of Nantucket has a **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 landscape, and–critically–community diversity and strong social bonds between year-round residents. These elements also lend themselves to a thriving year-round economy on which many residing both on and off the island depend for their livelihoods.
- **Nature-based strategies** should be implemented wherever feasible with a clear emphasis on minimizing ecological impacts and maximizing ecological and public access benefits. Proposed gray infrastructure and hard-armoring strategies should be kept to a minimum. The community would like to work to preserve Nantucket's beaches and coast into the future for as long as possible.
- 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 and strategies to prepare for sea level rise, tidal events, and freezing weather. These systems are Nantucket's lifeline and community members were unanimous in highlighting the need to ensure continuity of service.
- **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. Community members and project stakeholders continually cited accessibility to the island as a major concern due to increased storm frequency and sea level rise with impacts not only to supply of critical resources, but also for commuters and visitors.
- It is critical that the CRP process engage a **diverse range of public voices** and ensure that the public is educated about the issues at hand. The process should be inclusive and reflective of all voices–not just the loudest or wealthiest–in order to generate a community-wide vision for Nantucket's future, and should serve to generate public discussion and get people in the spirit of compromise. Consensus-building is of critical importance.
- 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.

Long-Term Visions

- In general, community members and project stakeholders 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 is self-sufficient in its reliance on energy, food, 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 should pave the way for a **comprehensive, island-wide** approach to resilience that also accounts for various hyper-local conditions appropriately.

- The CRP should be designed to be **adaptable and dynamic in the long-run**, incorporating an inherent flexibility into its structure to accommodate long-term changes and updates as Nantucket further evolves its approach to island-wide resilience.
- The Town should work to lead by example in implementation with **public projects**, setting a high standard for resilience in municipal properties. A centralized entity focused on resilience could go a long way in achieving this vision.
- A **multi-departmental approach** involving improved communication, collaboration, and file-sharing between Town bodies is a long-term goal for many project stakeholders.

4 Coastal Hazards 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. This section provides an overview of the types of coastal hazards addressed through the CRP, as well as key terms and data sources that are used to understand the risks they pose to Nantucket.

4.1 Overview of Coastal Hazards

Risk assessment begins with an evaluation of hazards. 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.

Definition of Coastal 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.

Figure 17. "Sunny Day" tidal flooding on Easy Street in Downtown Nantucket, November 2020

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 (e.g., roads). This type of flooding is becoming increasingly common as sea levels rise and land subsides in coastal communities, resulting 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 concerns 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 (SLR) 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 SLR than the global average, which is consistent with similar SLR projections provided by the Commonwealth of Massachusetts. As sea levels continue to rise, high tide flooding will become an increasingly common and disruptive occurrence across Nantucket without further action to mitigate its impacts.

Figure 18. Coastal flooding in Downtown Nantucket, December 2020

Coastal Flooding

Coastal flooding is defined as the inundation of low-lying land by seawater – often as a result of storm surge. Coastal flooding can occur via multiple pathways, including direct flooding and/or overtopping or breaching of an existing barrier, such as a bulkhead. Climate change, with its associated rise in sea levels, as well as the possibility for an increase in the frequency and/or the intensity of storms and changes in wave climates, can be expected to increase the risks from coastal flooding in most coastal locations, including Nantucket.

Nantucket has previously drawn on a range of flood risk modeling and mapping to evaluate exposure to coastal flooding, including FEMA's Flood Insurance Rate Maps (FIRMs) and associated Flood Insurance Study (FIS) and studies undertaken by local and regional experts, such as the stormtide pathways analysis prepared by the Center for Coastal Studies in Provincetown. The Town's 2020 Coastal Risk Assessment and Resiliency Strategies Report provides an overview of the coastal flood modeling produced for the North Atlantic Coast Comprehensive Study (NACCS) conducted by the United States Army Corps of Engineers (USACE). Based on the robust modeling and the inclusion of a wave setup component in the NACCs data, the report recommends that "figures from the NACCS study should be used for resiliency planning unless more updated water level figures are released in the future." The Commonwealth of Massachusetts 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. These data will be recommended as best available for coastal areas of Massachusetts. More detail on this dataset is included below in **Section 4.2 Coastal Hazard Data Sources**.

Coastal flooding resulting from storm surge can result in significant damage and disruption to homes, businesses, infrastructure, and ecosystems. With six inches of flooding, roadways become unsafe for travel. Waves associated with storms can severely damage buildings and infrastructure located along the coast. Waves and the associated currents also erode unprotected shorelines, which can undermine building foundations and destroy roads and other forms of infrastructure.


Figure 19. Coastal erosion impacting a private access road, September 2020

Coastal Erosion

Erosion is a geological process in which earthen materials are worn away and transported by natural forces, such as wind and water. Climate change, with its associated rise in sea levels, as well as the possibility for an increase in the frequency and/or the intensity of storms and changes in wave climates, can be expected to increase the risks of coastal erosion in most coastal locations, including Nantucket.

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 have already lost more than one hundred feet of coastline depth in just the past decade, and, with SLR, the erosion process is anticipated to accelerate.

Shoreline and dune erosion rates are influenced at several time scales; periodic storm events can cause erosion at orders of magnitude higher than longer terms rates. One important factor is that both sandy beach and dune erosion typically follows a pattern of erosion (storm or seasonal) followed by a period of recovery during which the beach is naturally replenished. Conversely, bluff erosion is generally episodic, occurring during significant storm events and once the bluff slope is eroded, there is no recovery. It should be noted that some bluff erosion factors, like wind, precipitation, and runoff, may be more constant and not 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.

Figure 20. Potential Groundwater Emergence on Brant Point, November 2020

Groundwater Table Rise

Groundwater table (or water table) rise refers to the increase in the level of groundwater underneath a landmass, such as the Island of Nantucket, primarily driven by an increase in sea levels. According to the United States Geological Survey (USGS), coastal water tables will rise as groundwater levels are pushed up by landward intrusions of seawater due to SLR. This consequence of SLR is even more noteworthy in regions with shallow water tables, as SLR can push the water table above the surface, resulting in a phenomenon called groundwater emergence.

Near the shoreline, the groundwater table in unconfined aquifers typically fluctuates with daily tides. The tidal influence on the groundwater table decreases with distance from the shoreline. 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 at, 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.

Figure 21. Stormwater flow and ponding in streets in Downtown Nantucket, November 2020

Precipitation

Precipitation is an important consideration when assessing impacts from coastal flooding and SLR. 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, SLR 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, as well as onto properties, resulting in property damage. This study will consider the potential for projected increases in precipitation to exacerbate coastal and nuisance flooding. Additionally, some coastal defense measures can change surface flow drainage patterns and therefore interior drainage systems will need to be accounted for in the design and costing of proposed flood defense infrastructure.

4.2 Coastal Hazard Data Sources

Many datasets are available for assessing coastal hazards on Nantucket, provided by a variety of local, state, federal, and private sources. As part of this study, an extensive review of the available datasets was conducted to reach a recommendation for the "best available" datasets for the purposes of the CRP. This section outlines the recommended best available coastal hazard datasets for Nantucket.

Sea Level Rise Projections and Scenarios

Rising sea levels will exacerbate high tide flooding, coastal flooding, groundwater table rise, and coastal erosion. Although a significant degree of uncertainty exists around the amount of future SLR that can be expected over what time horizon, for planning and design purposes it is often necessary to select specific SLR projections and scenarios based on an evaluation of available data, long-term needs, and risk tolerance. The selected projections must be frequently reevaluated in light of new information.

The analysis of tidal and coastal flooding for the CRP draws on State-specific SLR projections developed by the Commonwealth of Massachusetts in 2018. While the Town draws on SLR projections from National Oceanic and Atmospheric Administration (NOAA) for its interim SLR policy recommended by the Coastal Resilience Advisory Board and Select Board, the data provide by the Commonwealth provide the most up-to-date relative SLR projections for Nantucket. These localized projections are 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 (RCP 4.5) and high (RCP 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 can be reviewed is the Massachusetts Statewide and Major Basins Climate Projections report (March 2018). **Figure 22** compares the State and NOAA SLR curves and highlights the degree of uncertainty surrounding SLR projections, particularly for long-term projections.

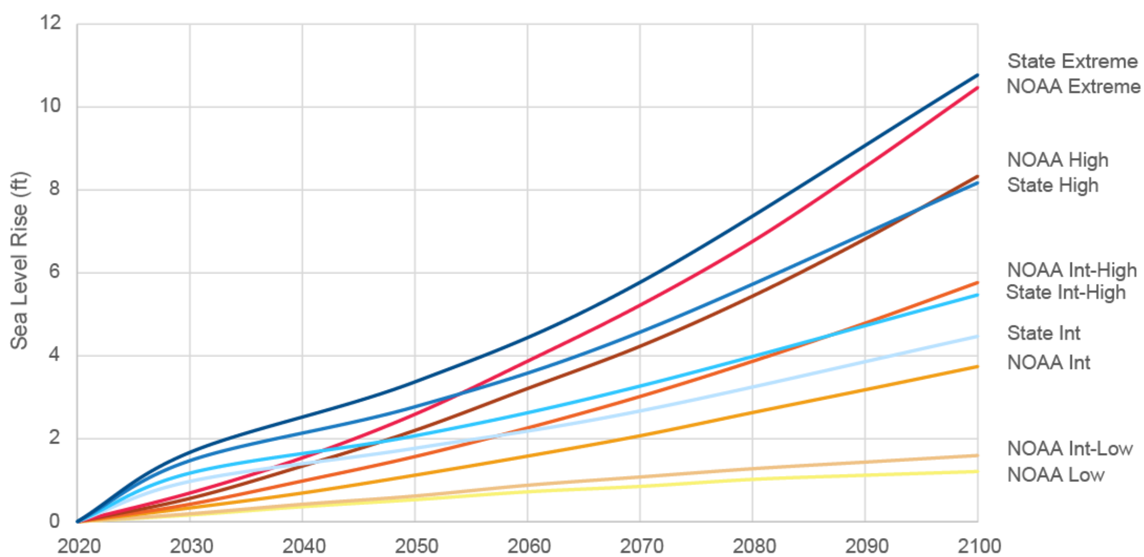


Figure 22. Nantucket SLR projections for NOAA and Massachusetts State methodologies normalized to 2020.

In addition to selecting a set of SLR projections, an individual SLR scenario should also be established for planning and design purposes. The Town has expressed a desire to plan for a **high SLR scenario** from NOAA in the interim SLR Policy recommended by the Coastal Resilience Advisory Committee to the Select Board. The CRP project team concurs with the use of this scenario and, based on this, the CRP will utilize the high scenario from the Commonwealth's projections.

The recommended adoption of the Commonwealth's high scenario is based on current science and knowledge around anticipated SLR, science and knowledge that are rapidly evolving. Because of the likely future variability in SLR projections as new data and techniques emerge, it is recommended that the Town continually monitor the state of the science and update plans and designs as appropriate based on the latest published, peer-reviewed results.

Based on the high scenario for future SLR provided by the Commonwealth, the CRP uses mean monthly high water (MMHW) as the tidal level representative of nuisance flooding. 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 floods per year.

Coastal Flooding

Several available datasets from federal, state, and regional entities can be used to examine exposure to coastal flooding, but most are not sufficient for coastal resilience planning due to limited consideration of future conditions, spatial extent, and/or the range of storm intensities.

The Massachusetts Coastal Flood Risk Model (MC-FRM) represents the best available flood hazard data for Nantucket as it is most recent, has the highest spatial resolution, and considers the widest range of present and future storms. This dataset was developed for the Massachusetts Department of Transportation (MassDOT) to assess coastal flood risk to transportation systems, has already been used in local vulnerability assessments across the Commonwealth, and will be the recommended best available flood hazard data for coastal Massachusetts by the Resilient Massachusetts Action Team. 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 coastal storms (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]) for 2030, 2050, and 2070. Future storms include projected SLR under the Commonwealth's high scenario. Projections for 2100 are not available for the CRP.

MC-FRM's numerical modeling uses dynamic coupling of the Advanced Circulation Model (ADCIRC) for water levels and velocities, and Unstructured Simulated Waves Nearshore (UNSWAN) for wave generation and transformation. Modeling also considers wave runup and overtopping along coastal structures for determining inland ponding elevations. Future sea levels are determined using the Commonwealth of Massachusetts' adopted SLR projections, based on the high scenario. Exceedance probability is based on a Monte Carlo simulation of a suite of historic and synthetic storms. The model mesh allows for coarse resolution of the entire Atlantic Ocean and fine resolution (up to 2-3m) along the shoreline statewide.

Coastal Erosion

The response of shoreline change rates to SLR is currently a topic of ongoing research, however, most opinions expect the rate of shoreline erosion to increase with SLR. The erosion study completed by FEMA in 2020 provides projections for future erosion hazards and includes factors for SLR using a methodology based on historic observed erosion rates (feet per year of erosion). 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 recommended by the CRP and any subsequent site-specific exposure assessments should include more detailed modeling of potential erosion concerns for the given location.

Groundwater Table

Existing information on groundwater for Nantucket is provided by United States Geological Survey (USGS). USGS manages 10 groundwater wells across the Island. Well depths vary from approximately 21 to 100 feet deep. The most recent measurements were on December 16, 2020, with water tables varying from as shallow as 5.42 feet below the land surface ("BLS") on the western part of the Island in Madaket, to 44.23 BLS near Nantucket Memorial Airport. The groundwater assessment for the Nantucket CRP leverages the data publicly available from USGS.

5 Coastal Risk and Exposure Analysis

Risk is the potential for a hazard to have negative impacts. In terms of flooding and erosion, this means the potential for water or shoreline change to create damage and disruption to buildings, assets, and systems. Coastal risk represents the interaction between coastal hazards, where people live and work, and the systems and structures that support the way of life that Nantucket cherishes. Climate change is going to increase coastal risks over the coming century and beyond, due to sea level rise, more intense and frequent storms, as well as other factors not directly considered as part of this study.

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. Additional information on the methodologies and assumptions used for the risk analysis is provided in **Appendix A**. This analysis is based on the coastal flood hazard data from MC-FRM available as of July 2021.

5.1 Goals of the Analysis

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 are taken by either the Town or private property owners to reduce risk. For structures, this information 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 in 2020, 2030, 2050, and 2070, assuming 4.3 feet of sea level rise by 2070. Risk is then interpolated for each year between 2020 and 2070 to develop a full understanding of the changing risk. Expected cumulative losses are calculated and communicated in net present value at various scales, from defined geographical areas to individual structures. For linear infrastructure, such as roads and sewers, and other resources, such as parks and open space, risk is presented in terms of exposure and anticipated 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 coastal resilience infrastructure and/or adoption of new regulations. The risk analysis results are also used to help communicate risk to the public, as well as to help evaluate the cost effectiveness of resilience approaches and designs.

Risk to structures on Nantucket is provided in dollar values (net present value with a 3% discount rate) 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 date, that could impact a structure each year. The dollar values provide a basis for comparing expected losses to the cost of interventions to prevent those losses.

Coastal Risk Analysis Goals

Goal 1: Understand and help communicate risk to buildings, infrastructure, community assets and services, and natural resources across Nantucket due to coastal flooding and erosion today and in the future.

Goal 2: Help make the case for investments in coastal resilience by quantitatively assessing the impact of coastal flood and erosion damage if no flood protection or erosion control infrastructure is built**.**

Goal 3: Understand long-term exposure to and losses from flooding and erosion across the island.

5.2 About the Quantitative Risk Assessment

The quantitative risk analysis is based on an assessment of the expected damages from a range of flood events and erosion scenarios for the entire island of Nantucket if no actions are taken by the Town, residents, or businesses to reduce this risk. The assessment is based on outputs from the Massachusetts Coastal Flood Risk Model, 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.[3] The data sources for the hazards addressed through the analysis are described in **Section 4.2 Coastal Hazard Data Sources.**

By having data for the same annual exceedance probability flood events over time, analysts develop an understanding of how risk to a structure increases due to rising sea levels and other factors related to climate change. Using this approach, the available flood hazard scenarios were used to extrapolate future annual exceedance probabilities for a range of flood events. For instance, today's 1% annual exceedance probability flood is likely to happen much more frequently in the future, meaning that the annual probability of flooding increases over time. The methods used for this risk analysis account for this by calculating each structure's risk of flooding at different depths each year to develop a full understanding of the risk over time. Properties that are flooded so frequently that they may be unusable if mitigation actions are not implemented are also identified, and the impact of the loss of those properties is quantified as a one-time full building loss. Similarly, properties that are exposed to erosion in 2030, 2050, or 2070 are also considered unusable and incur a one-time loss.

Risk through 2070 is assessed under the no action scenario, which determines losses if no flood protection measures are implemented. These losses can be compared to the losses under the recommended solution alternatives that do involve flood protection or erosion reduction measures.

[3] Coastal flood hazard data from MC-FRM are not available for 2100 as of the development of this report

Key Definitions for Understanding Quantitative Risk

The glossary below defines a number of terms used in the following section in reference to risk quantification.

Direct Physical Damages are the sum of the damages to buildings and their contents.

Direct Economic and Social Disruption includes economic losses such as output (which includes wages paid, business income, taxes on production and imports, and other property income) as well as social disruption costs such as the cost of mental stress, injury, lost productivity, and relocation.

Total Direct Losses are the sum of direct physical damages and direct economic and social disruption.

Indirect and Induced Losses are calculated for the area to give greater insight into the regional economic impacts.

- **Indirect Economic Losses** are due to business-to-business purchases in the supply chain.
- **Induced Economic Losses** are due to effects stemming from household income spending, after removal of taxes, savings, and commuter income.

Total Losses are the sum of direct, indirect, and induced losses.

Output represents the value of industry production, which includes employee compensation, proprietor income, taxes on production and imports, and other property income.

Infrastructure and service loss impacts are not quantified in dollar values. Any values referencing infrastructure (such as transportation) are in reference to industry impacts, not service loss or damage to unique structures.

Exposure represents as assessment of people, property, assets, and infrastructure exposed to a hazard and often represented quantitatively though counts of buildings, people, and/or infrastructure exposed.

Risk Assessment Case Study

How Risk is Calculated for Single Family Homes

Out of the 2,373 structures at risk from flooding and erosion on Nantucket (see **Section 5.4 Key Findings**), a vast majority (about 85%) are residential properties. A typical vulnerable residential property is a two-story, single-family home, with roughly 2,000 square feet of livable area.

This example illustrates how the risk assessment works for a typical residence. The given property is not exposed to the 1% annual chance floodplain today, but by 2030, with projected sea level rise, is expected to experience a flood depth of 1.5 feet for the same magnitude storm. Based on depth-damage functions provided in the NACCS report and other federal tools, such FEMA's HAZUS and BCA Toolkit software, along with local valuations of construction costs, the owner of this property might expect to incur approximately $300 thousand in damages from this flooding. Most of that cost would be due to direct physical damage, including $140 thousand of damage to the building itself, and an additional $150 thousand to the contents of the building. The property owner could expect to incur additional $10 thousand in displacement costs, such as per-diem lodging and meals, for the anticipated 70 days they may be relocated while their home is being repaired. Another $3 thousand in other impacts may also be incurred, due to injuries, lost productivity, and costs for mental health treatment of post-disaster trauma. By 2070, with projected sea level rise, flood waters from the 1% annual chance event may increase to nearly 3 feet within this same residence, causing around $450 thousand in total damages.

Knowing the anticipated costs of this risk is the first step to understanding how to reduce this risk in a way that is cost effective. However, this property owner may not feel comfortable making decisions based on risk from a single event that has a relatively low probability of occurring in any given year. For instance, it may seem difficult to justify investing $100 thousand in flood protection for a property today to prevent $300 thousand in damages that might occur years from now, especially with the uncertainty in knowing when such an event may occur. For this reason, a property owner may want to know, on average, how much damage they might expect to incur in any given year due to the cumulative annual probability of experiencing a flood. This cumulative probability and associated damages will increase over time due to sea level rise.

Calculating annual risks requires considering the depth of flooding and resulting damages from the six storm events analyzed (the 5%, 2%, 1%, 0.5%, 0.2%, and 0.1% annual chance storms) each year. For this example property, the total annual expected damage in 2030 might be roughly $2,000, increasing to $10,500 by 2070 because of the increased probability of flooding. Understanding the risk for given years then allows us to calculate the sum of all risk over a given period, in this case from today through 2070. By applying a discount rate (3%), we can estimate the value of future costs in terms of present dollars. Using this approach, the property owner finds that they can anticipate around $85 thousand dollars in cumulative damages and other impacts over the next fifty years due to flooding. A solution that both reduces future flood risk and costs less than $85 thousand might then be a more appropriate solution than a $100 thousand upfront investment.

Individual property owners generally do not perform their own personal benefit-cost analyses to protect their homes and the analysis conducted for this study should be viewed as an estimate of expected damages, not a prediction. Nevertheless, at the neighborhood or island-wide scale, knowledge of these cumulative damages across multiple properties of different types and uses can help inform several important public objectives, as discussed in the next section.

5.3 How to Use and Understand the Results of the Coastal Risk Analysis

The results of the coastal risk analysis presented below can be used in a variety of ways to inform risk-based decision-making and coastal resilience planning. Before presenting the results of the analysis, it is helpful to first put the analysis in the appropriate context and describe how the results can and will be used for the CRP and other purposes to advance resilience and adaptation objectives on Nantucket.

For General Planning

The primary purpose of the coastal risk analysis performed for the CRP is to inform general planning. The results of the analysis can be used in a variety of ways for planning projects, including public communication of coastal risks, prioritization of areas for additional analysis and intervention based on concentrated coastal risk, understanding of risk for specific structures, assets, or services, and as the basis of developing cost-effective approaches for reducing risk through policy or structural changes. The analysis can also be used to guide general land use planning and policy changes to align development and environmental regulations with present and future coastal risks.

For Scenario Development and Prioritization

An important result of the risk analysis is a data-driven understanding of how risk and exposure will change over time, both in terms of the depth and extent of flooding and changes to the shoreline due to erosion. These changes in risk over time allow Town policymakers and review bodies to better understand what may happen if no actions are taken to reduce risk over time. This no action scenario provides the basis for developing additional scenarios that do involve investments in coastal risk reduction and adaptation. Because the results of the analysis are presented in terms of dollars, the benefits that various adaptation scenarios provide can be quantified in terms of loss avoidance. This in turn can be used to prioritize projects based on effectiveness and benefits, along with other considerations and community input.

For Capital Planning

The risk analysis can also be used for the purposes of understanding the risk to specific assets or infrastructure systems, such as roadways, bridges, sewers, and public buildings, and to areas where these assets and systems may be planned in the future. Town staff and other review bodies can use the results of the analysis to prioritize assets and infrastructure for adaptation or relocation based on the timing and degree of risk exposure. This information can also be integrated as a screening tool within the current Capital Improvement Planning processes to create alignment between capital expenditure, infrastructure needs, and present and future coastal risks.

For Addressing the Needs of the Most Vulnerable

Historical legacies of disinvestment, inequities in access to quality jobs, housing, and healthcare, and barriers to participation in public processes mean that some Nantucket residents and visitors are more vulnerable than others to the immediate and long-term impacts of flooding and erosion. By combining the results of the coastal risk analysis with information on factors that may contribute to social or economic vulnerability, interventions can be targeted for areas that best advance risk reduction for those most in need.

5.4 Key Findings

Risk from coastal hazards on Nantucket is significant and will grow over time. These risks threaten the aspects of Nantucket that give it its character, sustain its economy, and ensure health and safety for residents and visitors. The key findings from the risk and exposure assessment based on the available coastal hazard data are summarized below. The results included in this report show a significant increase in quantified risk compared to the preliminary results provided in the mid-project report released in April 2021. This is due to the use of updated flood hazard data for this report and the final CRP. These new data include a wider range of modeled coastal storm events than previously available.

If no flood or erosion mitigation is implemented on Nantucket,

- **From now through 2070, 2,373 structures** are at risk from flooding and erosion, with the cumulative expected annual damages totaling **$3.4 Billion**, including:
    - **$2.8 Billion** in **direct physical damage** to buildings
    - **$310 Million** in **direct economic disruption** to businesses in the study area
    - **$250 Million** in **direct social disruption**, including relocation costs, health costs from injuries and mental stress, and lost income due to health issues
    - **$110 Million** in **indirect and induced economic losses**
- Of the $420 Million in economic losses, $**51 Million represents federal, state, and local tax impacts**
- **84% of at-risk buildings are residential, accounting for 57% of the total risk, and though only 9% of at-risk buildings are commercial, they account for 33% of the total risk**
- **At least 49% of at-risk buildings are historic and account for 81% of the total risk**
- **At least 9% of buildings are tourism-related, accounting for 34% of the total risk**
- **34 community facilities are at risk, with roughly $180 Million in expected damages. Many of these facilities are essential to community safety and wellbeing.**
- **From now through 2100, the following infrastructure and services may be exposed and at risk of loss of service:**
    - **10 miles of public and private roadway** may be out of service[4] at mean monthly high water by 2030, **20 miles** by 2050, **29 miles** by 2070, and **45 miles** by 2100, resulting in impaired access across the island
    - **6 miles of public and private roadway is vulnerable to erosion** by 2030, **33 miles** by 2100, also resulting in impaired access across the island
    - **By 2030, public roadways leading to the Steamship authority wharf could experience a frequent loss of service at mean monthly high water. By 2050, the Steamship authority wharf will be completely cut off from surrounding roadways at mean monthly high water.** This poses a significant risk to access to and from the island, as well as critical supply lines.
- **From now through 2100, the following open spaces and natural resources will be exposed and at risk of loss of service and/or changes to the ecosystem**

[4] Loss of service for roadways is defined as being subject to more than 6 inches of inundation, the depth of water at which it is unsafe to drive to a small passenger car

- **312 acres of public open space** is vulnerable to erosion by 2030 and up to **1,754 acres** could be vulnerable by 2100, reducing opportunities for recreation and enjoyment for the community
- **719 acres of priority natural communities** could be impacted by mean monthly high water by 2030, **926 acres** by 2050, **1,187 acres** by 2070, and **1573 acres** by 2100, resulting in potential changes to these ecosystems
- Up to **268 additional acres** of wetland resource areas compared to today may be submerged by mean monthly high water by 2030, **424 additional acres** by 2050, **645 additional acres** by 2070, and **1,055 additional acres** by 2100. Without plans for marsh migration or other mitigation steps, these resources may be impaired or lost.

5.5 Coastal Risk and Exposure Analysis

This section details the results of the quantitative and qualitative coastal risk analysis. The results are presented in categories that correspond to buildings, infrastructure, and services that support quality of life on Nantucket and sustain it as a community. In addition to quantitative and spatial data, each section presents a brief synopsis of how the risk presented relates to lived experience and potential impacts to health and safety of the population, as well as the unique factors that given Nantucket its character and identity.

Risk to Buildings

At a Glance

- **2,373** structures at risk from flooding and erosion, with **$3.3 billion** of damage expected in next 50 years
- **84%** of at-risk buildings **are residential**, accounting for **57% of the total risk,** and though only **9%** of at-risk buildings **are commercial**, they account for **33% of the total risk**
- **At least 49%** of buildings are historic, with **$2.8 billion** in expected damages
- At least 9% of buildings are tourism-related, with $1.1 billion in expected damages
- **34** community facilities at risk, with $**180** million in expected damages

There are nearly 13,000 buildings on Nantucket. Coastal risks pose an existential threat to many of the buildings that support Nantucket's identity and economy. Over **2,373 structures are at risk of flooding or erosion, totaling $3.4 billion in expected damage over the next 50 years**. Of these, **93% are residences or commercial structures**, meaning that coastal risks will directly and significantly impact the places people on Nantucket live, work, and visit. Also at risk are **34 community facilities totaling roughly $180 million in expected damages.** These structure support services that Nantucket relies on for overall community health and wellbeing.

One of the chief goals of the coastal risk assessment is to quantify the risk to buildings and structures on Nantucket due to coastal flooding and erosion. This analysis covered all buildings larger than 500 square feet across all use types and locations, including private residences, Town-owned buildings, shops, restaurants, offices, and others. Based on a comprehensive building inventory developed using the Town's GIS and assessor's data, analysts determined the number of buildings and structures that are at risk of flooding and erosion from now through 2070.

The flooding analysis estimated the present value of cumulative expected damages over that time frame based on building type and depth of flooding. Direct damages include physical damages, which represent the sum of the damages to buildings and their contents, along with economic and social disruption, which includes economic losses such as wages paid, business income, and other property income, as well as social disruption costs such as the cost of mental stress, injury, lost productivity, and relocation. The methodology for calculating these metrics is described in Appendix A, and the results are summarized below by risk type in **Table 1**.

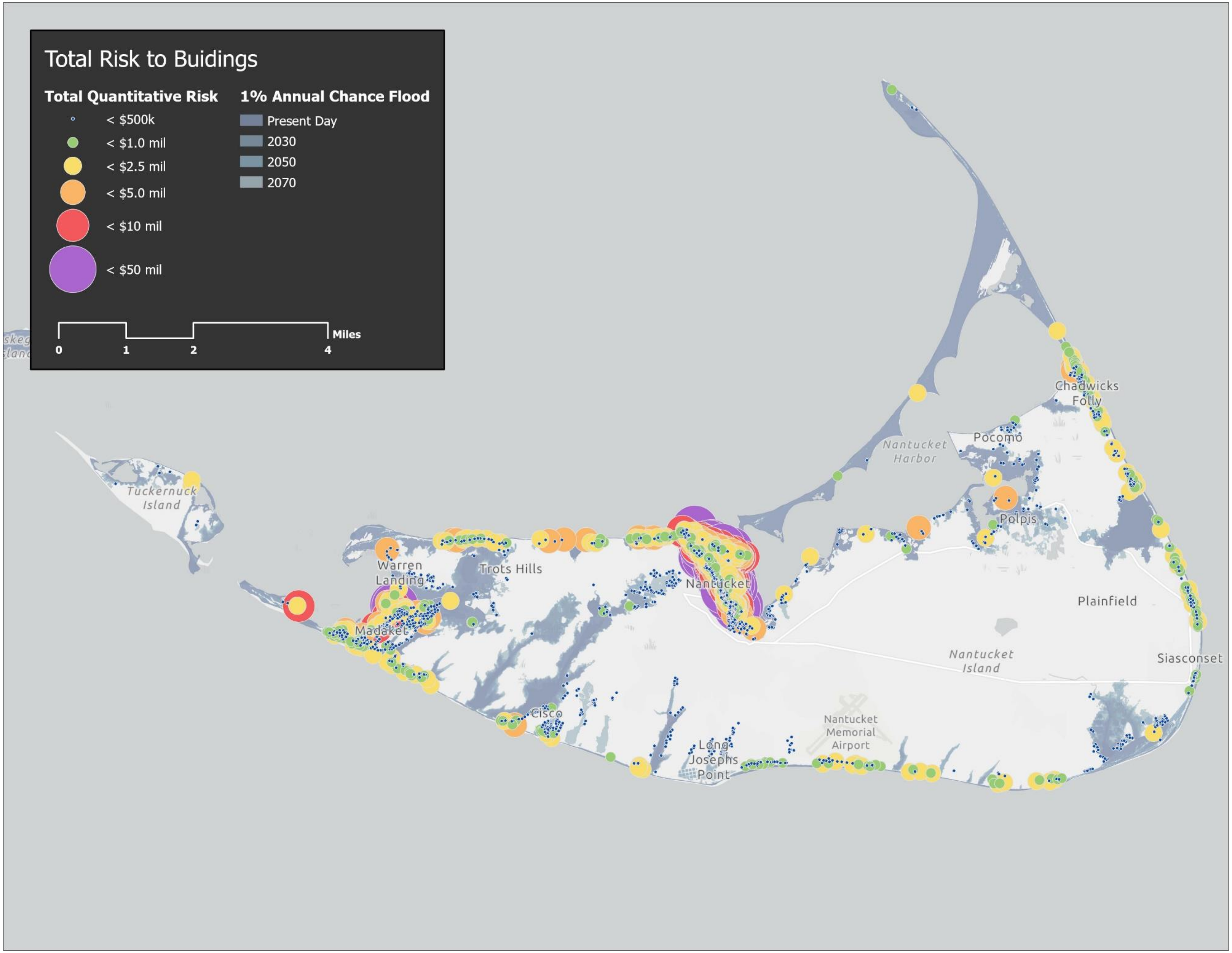
The results in Table 1 indicate that flooding is the primary driver of risk to structures on Nantucket, with 1,729 buildings at risk of flooding at a total risk of $2.9 Billion. There are an additional 286 buildings at risk of erosion, but not flooding, through 2070 with a total risk of $190 Million. Lastly, 358 buildings are at risk of flooding and erosion, totaling $240 Million. In the cases where a building is at risk of flooding and erosion, annual flood risk is accrued until the building is projected to be lost to erosion, at which point the building is considered a total loss.

The direct economic losses create cascading impacts to business-to-business purchases in the supply chain (known as indirect economic losses), along with impacts to household income spending (known as induced economic impacts). The economic impact also takes a toll on federal, state, and local tax revenue. The indirect and induced losses add an additional $110 million of losses, bringing the total losses over the next fifty years up to $3.4 billion. **Figure 23** provides a map of total risk to buildings across Nantucket. The size of the graduated circles correlates to the degree of risk to each building, with each circle representing one building. Overlapping circles indicate areas with a high degree of concentrated risk. The building with the highest total cumulative risk on Nantucket ($40 million) is the Stop and Shop supermarket at 9 Salem Street.

Table 1. Direct Risk by Hazard Type - Present Value Losses, No Action Scenario. 2020-2070, 3% Discount Rate

Category	Direct Physical Damage	Direct Economic and Social Disruption	Total Risk	Building Count
Flooding Only	$2,400,000,000	$490,000,000	$2,900,000,000	1,729
Erosion Only	$170,000,000	$18,000,000	$190,000,000	286
Flooding and Erosion	$210,000,000	$35,000,000	$240,000,000	358
Total	$2,800,000,000	$550,000,000	$3,400,000,000	2,373

Figure 23. (next page) Map showing total risk to buildings across Nantucket and flood and erosion hazard areas. The size of the graduated circles correlates to the degree of risk to each building, highlighting areas of concentrated risk.



Total Risk to Buidings
Total Quantitative Risk
< $500k
< $1.0 mil
< $2.5 mil
< $5.0 mil
< $10 mil
< $50 mil
1% Annual Chance Flood
Present Day
2030
2050
2070
Miles
0
1
2
4
Tuckernuck Island
Warren Landing
Madaket
Trots Hills
Cisco
Nantucket
Nantucket Harbor
Pocomo
Polpis
Chadwicks Folly
Plainfield
Siasconset
Nantucket Island
Nantucket Memorial Airport
Long Josephs Point

Figure 24 shows a breakdown of the buildings and structures risk by use category, while **Figure 25** describes risk by damage type, and **Figure 26** summarizes risk by neighborhood. The most at-risk buildings are private residences (1,988, 84%). Commercial structures, mostly located in Downtown, are the second most impacted use (217, 9%). Direct physical damage (to buildings themselves and the contents inside) is the largest driver of risk. **Figure 27** provides a map of total risk to buildings across Nantucket by year of exposure to the 1% annual chance flood or erosion hazards. The size of the graduated circles correlates to the degree of risk to each building, highlighting areas of concentrated risk. The color of the circle helps show how flood exposure increases over time.

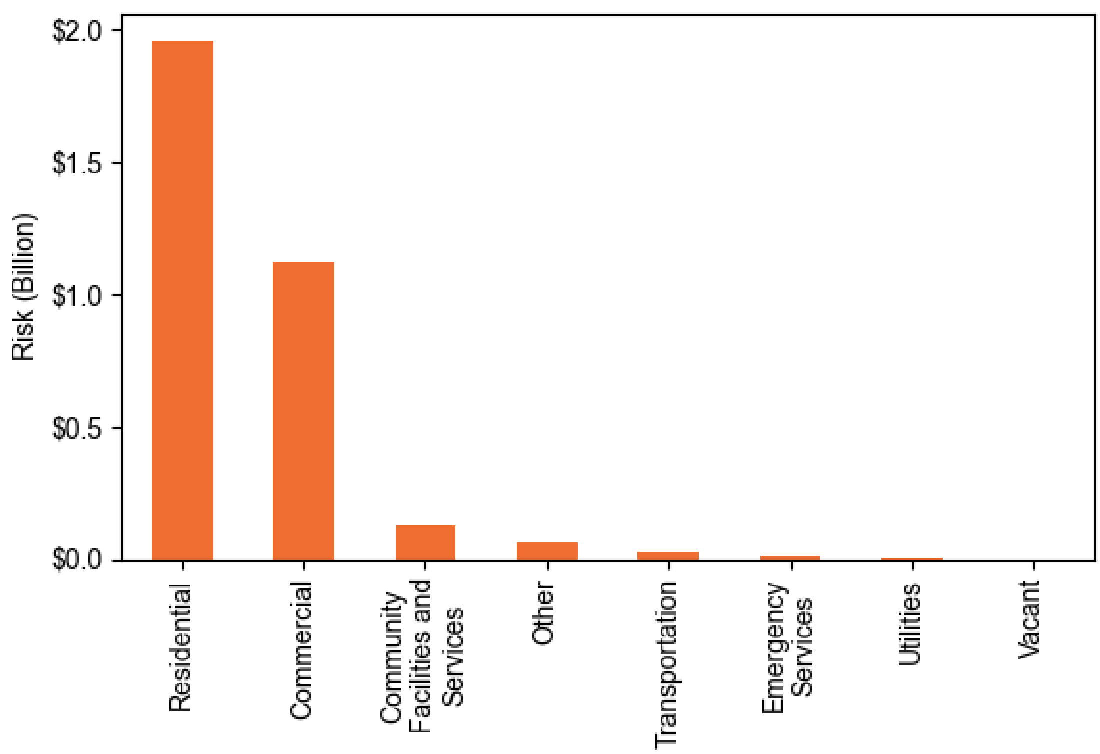


Figure 24. Buildings and Structures Damage by Use Category

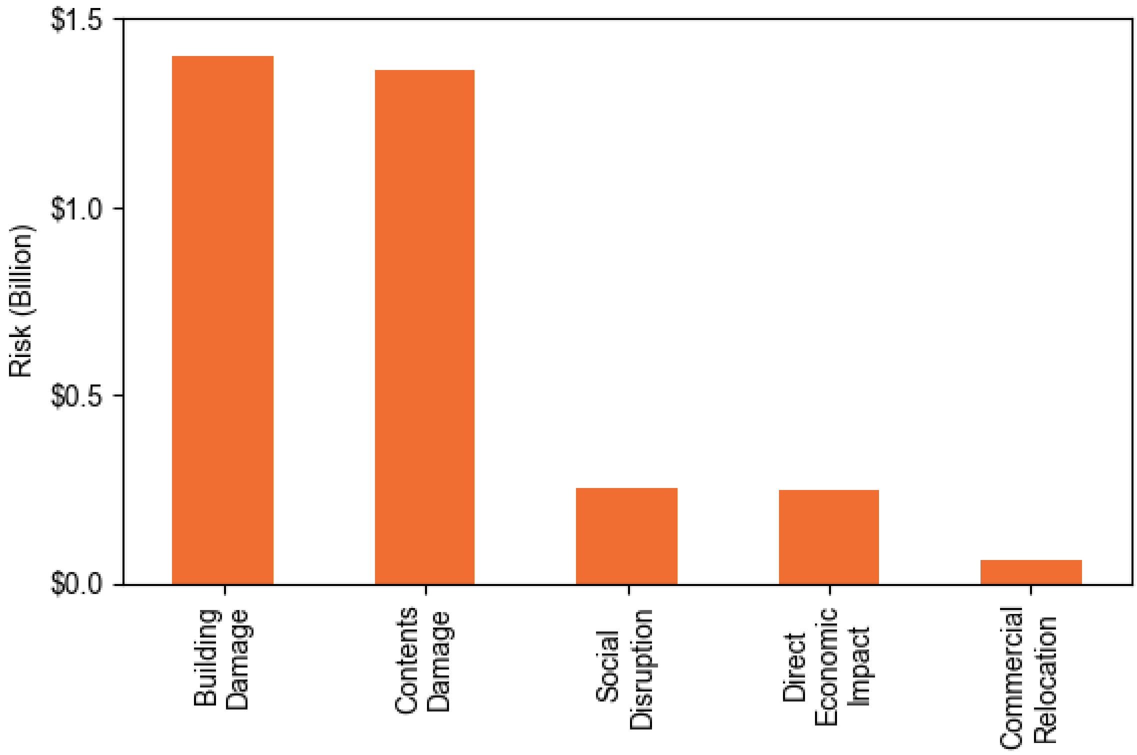


Figure 25. Buildings and Structures Damage by Damage Type

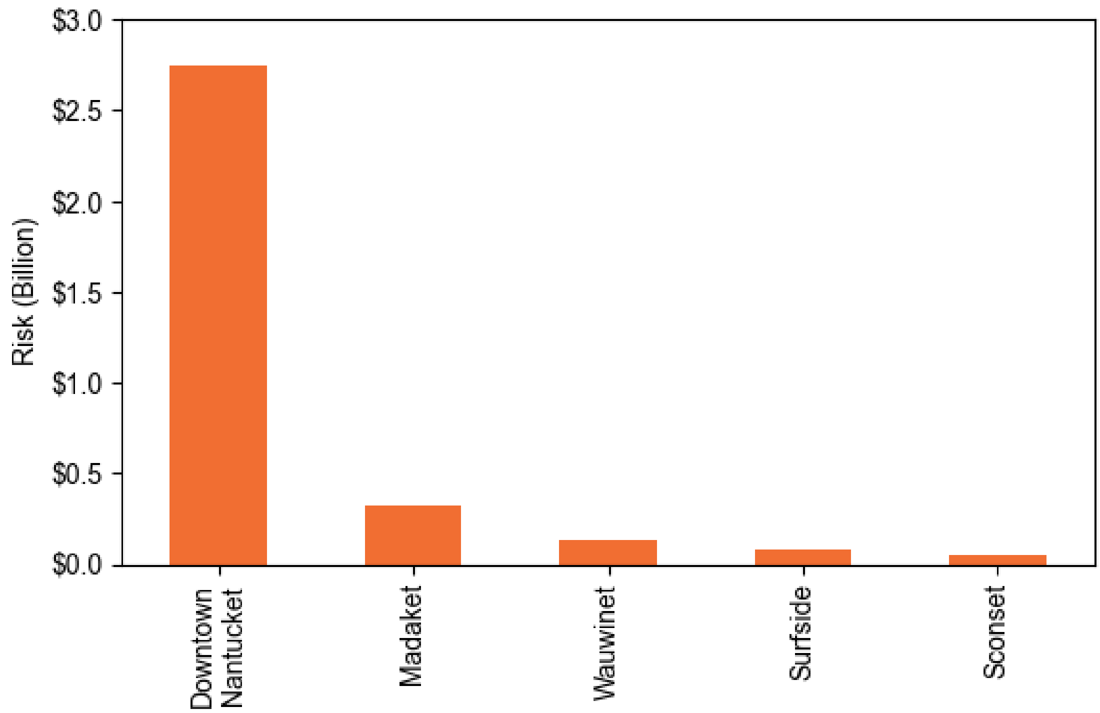
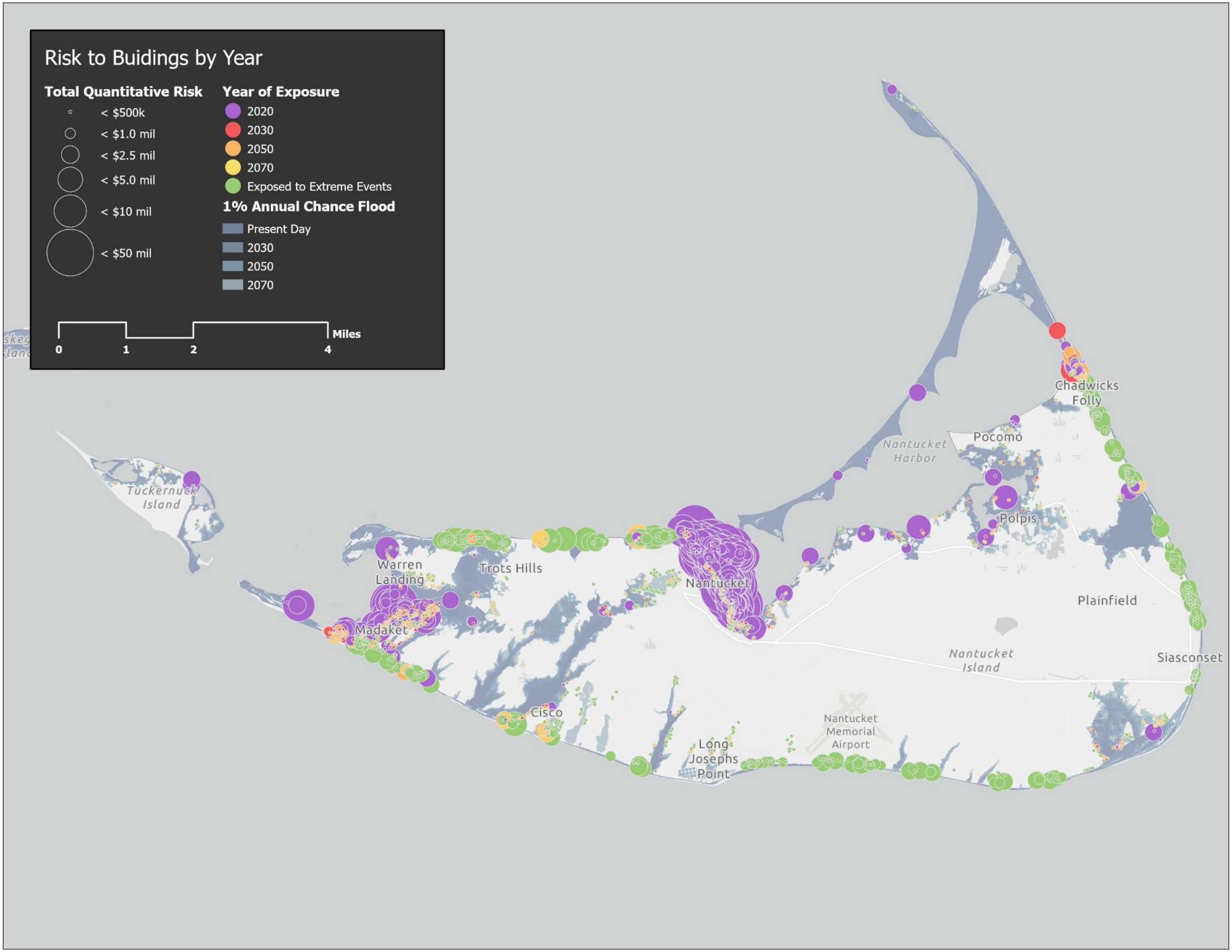


Figure 26. Buildings and Structures Damage by Neighborhood

Figure 27. (next page) Map showing total risk to buildings across Nantucket by decade of exposure to the 1% annual chance flood or erosion hazards. The size of the graduated circles correlates to the degree of risk to each building, highlighting areas of concentrated risk. The color of the circle helps show how flood exposure increases over time. Green circles represent structures at risk of floods with a lower than 1% annual chance of occurring in a given year.



Risk to Buildings by Year
Total Quantitative Risk
< $500k
< $1.0 mil
< $2.5 mil
< $5.0 mil
< $10 mil
< $50 mil
Year of Exposure
2020
2030
2050
2070
Exposed to Extreme Events
1% Annual Chance Flood
Present Day
2030
2050
2070
0
1
2
4
Miles
Chadwicks Folly
Pocomo
Nantucket Harbor
Polpis
Tuckernuck Island
Warren Landing
Trots Hills
Nantucket
Madaket
Plainfield
Nantucket Island
Siasconset
Cisco
Long Josephs Point
Nantucket Memorial Airport

The analysis also enables further evaluation of risk for certain groupings of structures and uses that support Nantucket's identity and economy, including tourism and historic structures, as described below.

Buildings and Structures Supporting Tourism

The tourism industry is the heart of Nantucket's economy. In addition to world-class beaches and scenery, destinations such as the Whaling Museum, local landmarks such as the Brant Point Lighthouse, and many shops and restaurants located throughout the historic downtown attract thousands of visitors annually. However, many of these destinations are located on the coast, and therefore vulnerable to flooding and erosion. While there are many unquantifiable aspects of Nantucket that make it an attractive destination, one of the ways to measure the risk that coastal hazards pose to Nantucket's future as a destination is to analyze risk to the buildings and structures that support the tourism industry. This can complement other ways of understanding this risk, such as by measuring loss of service of open spaces or roadways that people depend on when they visit Nantucket. **This analysis found that buildings containing uses directly supporting the tourism industry (e.g., hotels, restaurants, car rental shops, museums) represent approximately 34% of total risk on Nantucket and 9% of buildings at risk. Figure 28** shows a breakdown of the buildings and structures risk by use category. Damage or disruption to tourist destinations and supporting uses, whether from flooding or erosion, could have a severe impact on the local economy, especially to year-round residents who rely on tourism for income.

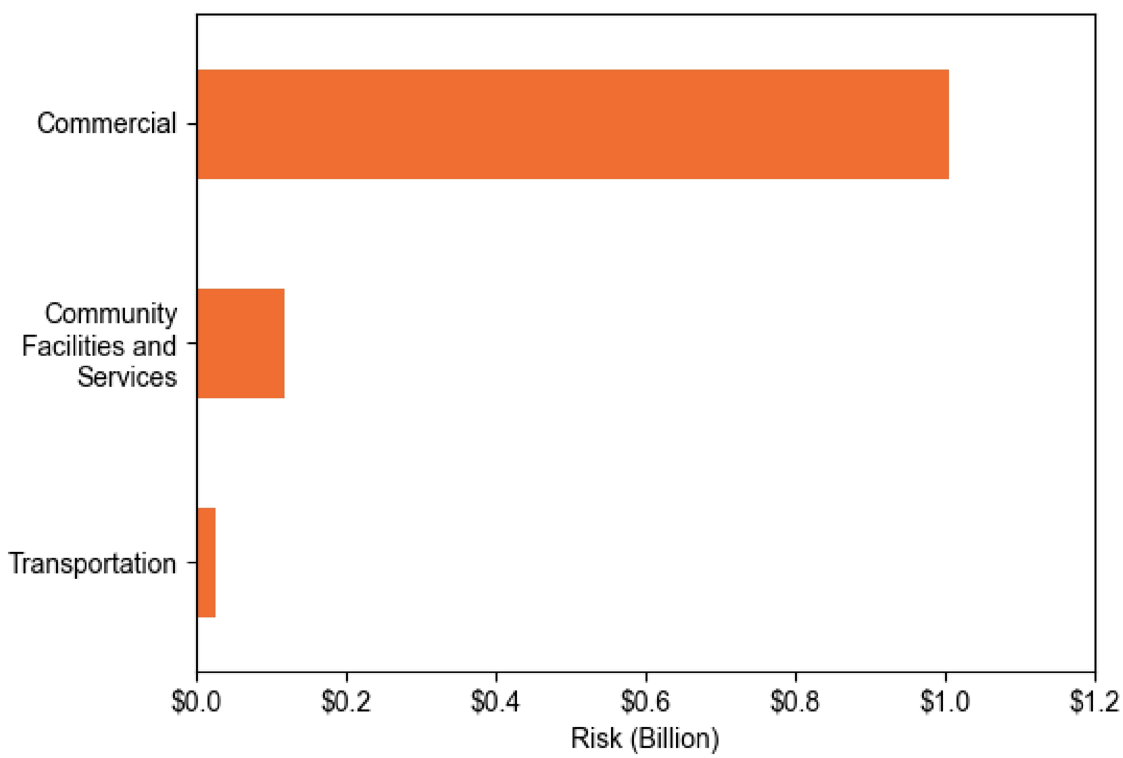


Figure 28. Expected Risk to Buildings Supporting Tourism

Historic Structures

Nantucket is a National Historic Landmark, a testament to the importance of the island to the nation's history and to the character of its built environment. Preserving this character is a top priority for the community and is currently the focus of the *Resilient Nantucket: Designs for Adaptation* project. As addressed through that project, climate change, and sea level rise in particular, raise fundamental questions about what preservation means in the context of environmental risks. While Nantucket's landmark status and historic character are defined by far more than buildings, this analysis found that the risk to buildings that are designated or identified as historic structures on Nantucket is very significant. Buildings located in the two local historic districts (Downtown Nantucket 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. Table 2** below summarized risk to historic structures.

Table 2. Expected Damage and Disruption to Historic Structures

Category	Direct Physical Damage	Direct Economic and Social Disruption	Total Risk	Building Count
Downtown Nantucket Historic District	$1,200,000,000	$310,000,000	$1,500,000,000	535
Siasconset Historic District	$7,100,000	$1,400,000	$8,500,000	34
MHC Inventory[5]	$1,100,000,000	$170,000,000	$1,200,000,000	597
Total	$2,300,000,000	$480,000,000	$2,800,000,000	1,166

[5] The Massachusetts Historical Commission inventory includes buildings, structures, and objects with the most common local, state, and federal historic designations as well as structures inventoried by MHC but not designated with one of the previous designations.

Risk to Transportation Systems

At a Glance

- By 2070, **29 miles of roads (11% of island-wide roads)** on Nantucket will flood with more than 6 inches of water at high tide, **54 miles of roads (23% of island-wide roads)** will be exposed to the 1% annual chance flood, and **23 miles of road (9% of island-wide roads)** will be at risk of loss due to erosion
- **Four bridges/culverts will likely lose service due to mean monthly high water by 2050**:
  - Madaket Rd. Bridge at Madaket Ditch
  - Madaket Rd Culvert at the Gut
  - Massasoit Bridge
  - Polpis Road Culvert at Folgers Marsh
- Primary airport buildings are not at risk of flooding or erosion, but the airport could experience damage and disruption to the runway and perimeter fencing over time due to flooding and erosion
- **Roads leading to Steamboat Wharf could lose service during mean monthly high water by 2030. By 2050, the wharf will be completely cut off from surrounding roadways at mean monthly high water.**

The largest risk to transportation on Nantucket comes from flooding at the Steamboat Wharf. By 2030, Easy Street and Broad Street leading to the wharf could partially lose service at the mean monthly high water. As one of the only means of traveling to and from the island, and a crucial link in the island's access to goods and services, it has a crucial role in any emergency scenario.

Transportation systems, including roadways, water crossings (bridges and culverts), airports, and ferry terminals are essential to 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 or friends and family, or to purchase groceries, they also serve as access to the mainland, a key dependency that ensures an uninterrupted flow of the goods and services on which residents rely. Damage and disruption to the transportation system has the potential to reduce quality of life by limiting access to the places people want or need to go and to impact health and safety where access to parts of the island could be cutoff or in the case of access to the mainland being significantly disrupted.

Roadways and Bridges

Table 3, below, summarizes the linear miles of roadway that are expected to experience loss of service due to flooding and erosion between 2020 and 2100. Loss of service for flooding is defined as being inundated by 6 or more inches of water or being exposed to loss from erosion. As shown in **Table 3**, by 2030 over 10 miles of roadway could experience reduced or loss of service at mean monthly high water. This number grows by roughly 10 miles by 2050 and again by 9 miles by 2070 for a total of 29.1 miles of roadway with lost or reduced service.

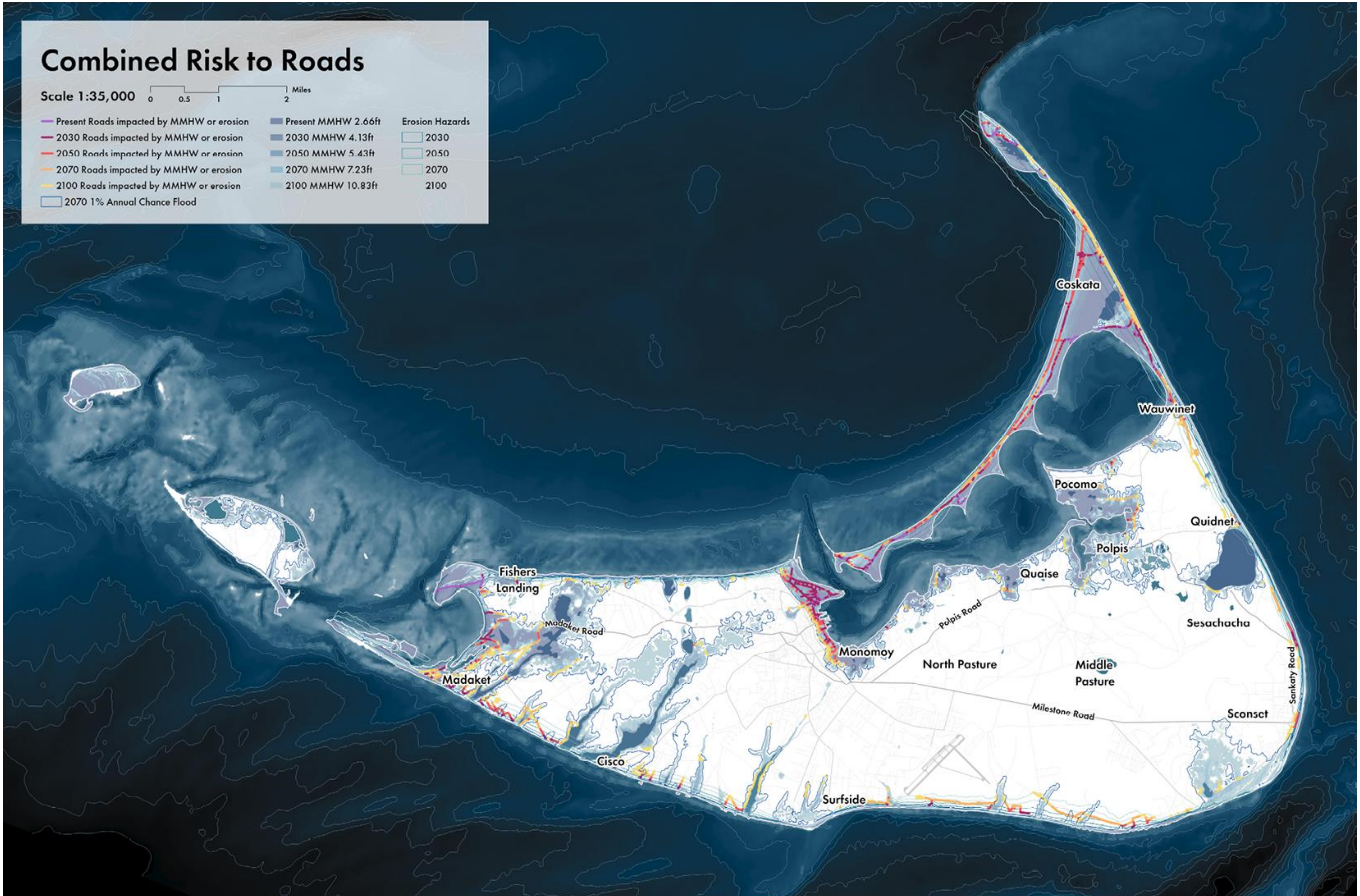
An even greater number of roadways could be damaged or experience episodic loss of service during a severe coastal flood event (1% annual exceedance probability) between now and 2070. Erosion poses another threat, with up to 23.4 miles of roadway vulnerable from loss from erosion by 2070, much of which is private but nevertheless poses significant risk to residents who rely on these roads for access to their properties.

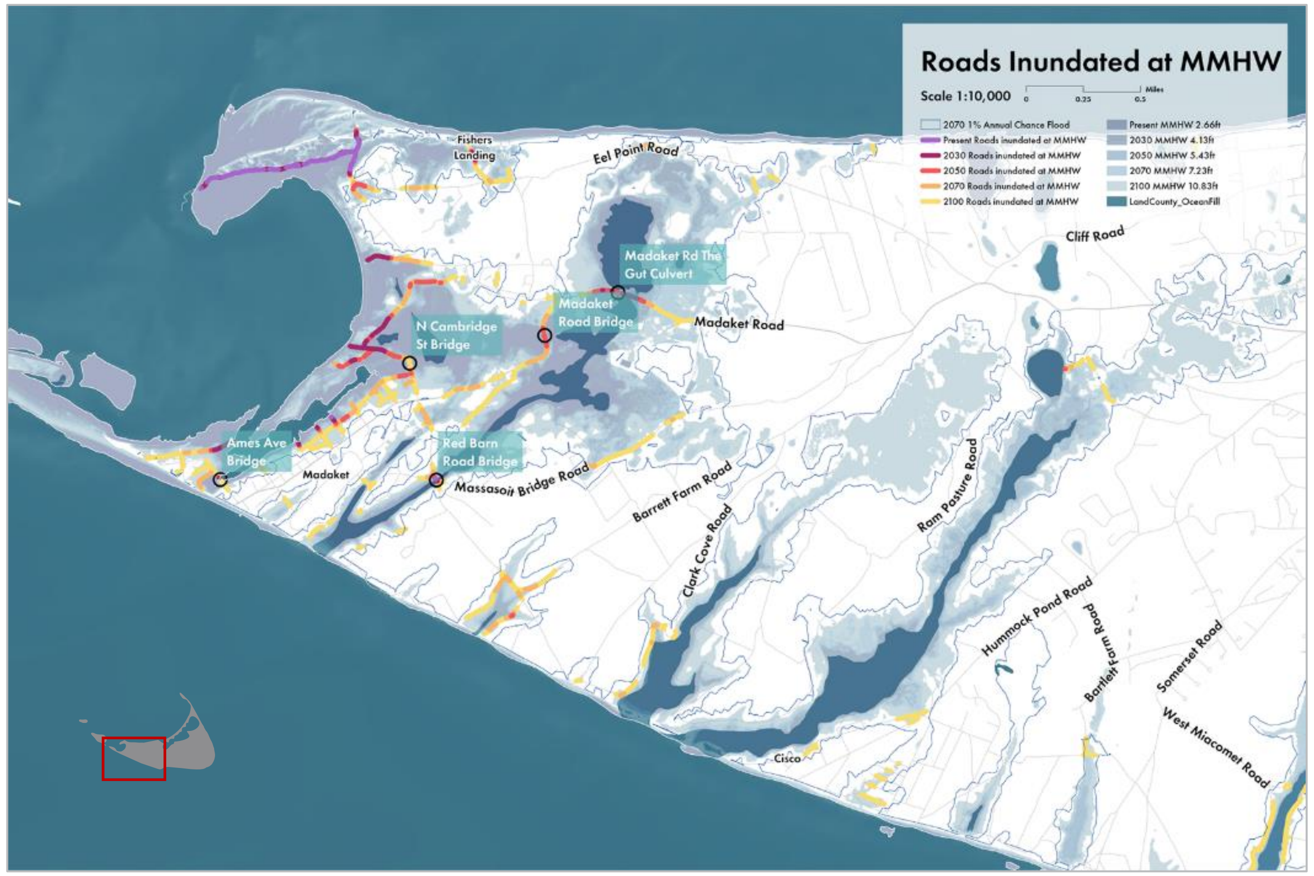
Table 3. Loss of Service for Roadways and Bridges due to MMHW, 1% annual chance storm, and erosion.

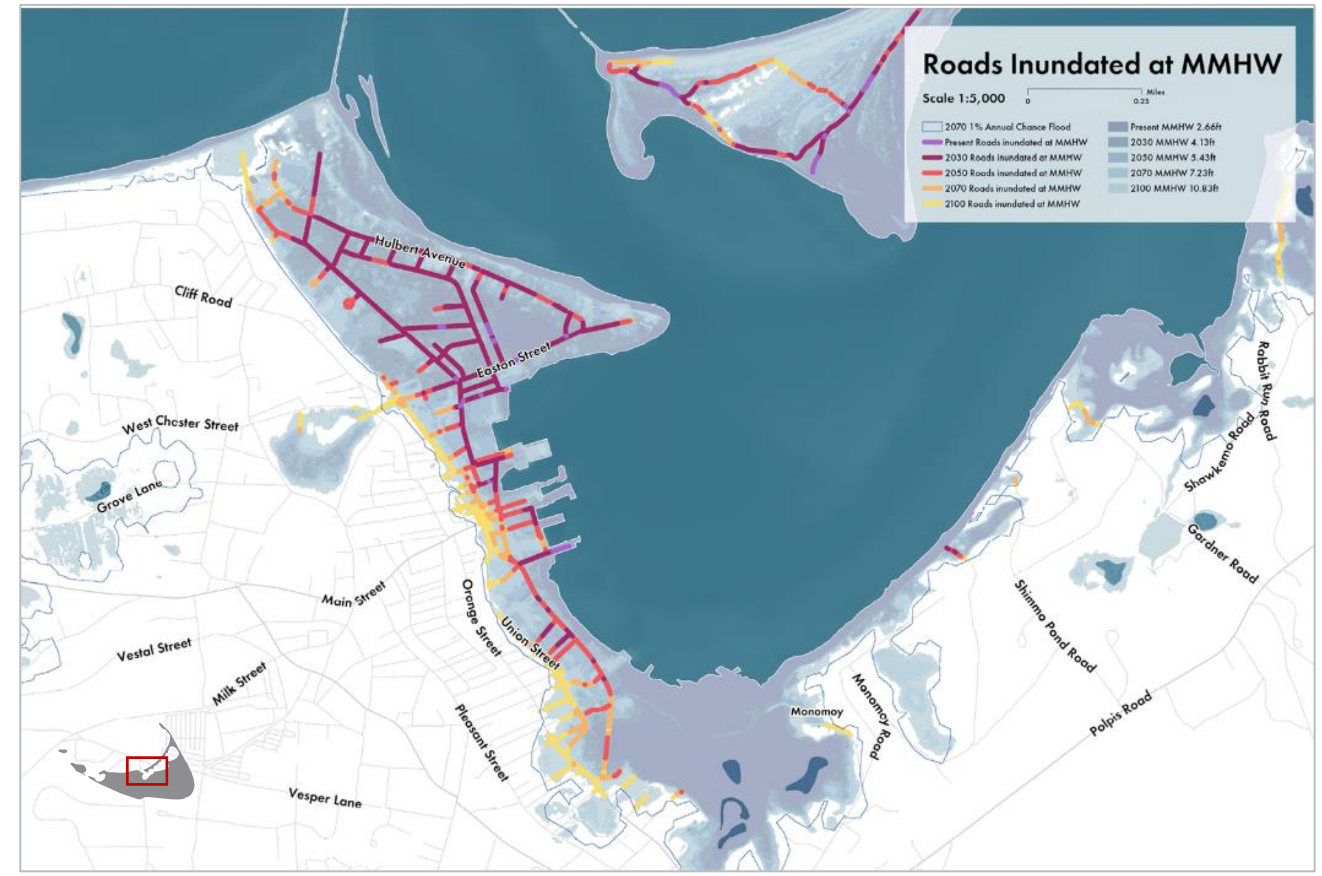
	Loss of Service at Mean Monthly High Water (miles)					**Loss of Service during 1% Annual Chance Storm (miles)**					**Loss of Service due to Erosion (miles)**			
	Today	**2030**	**2050**	**2070**	**2100**	**Today**	**2030**	**2050**	**2070**	**2100**	**2030**	**2050**	**2070**	**2100**
Public	0.1	3.9	6.4	8.9	15.6	10.5	13.3	15.4	18.5	N/A	0.6	2.5	4.6	6.8
Private	0.7	4.4	11.5	17.4	24.2	18.8	20.9	23.8	28,2	N/A	3.1	6.4	14.6	21.8
Unknown	0.9	1.8	2.4	2.8	5.6	4.8	5.8	6.5	7.3	N/A	2.0	3.4	4.2	4.6
Total at Risk	**1.7**	**10.1**	**20.3**	**29.1**	**45.4**	**34**	**40**	**46**	**54**	**N/A**	**5.7**	**12.3**	**23.4**	**33.2**
% of All Roads	**1%**	**4%**	**7%**	**11%**	**17%**	**12.5%**	**14.7%**	**16.9%**	**19.9%**	**NA**	**2%**	**5%**	**9%**	**12%**

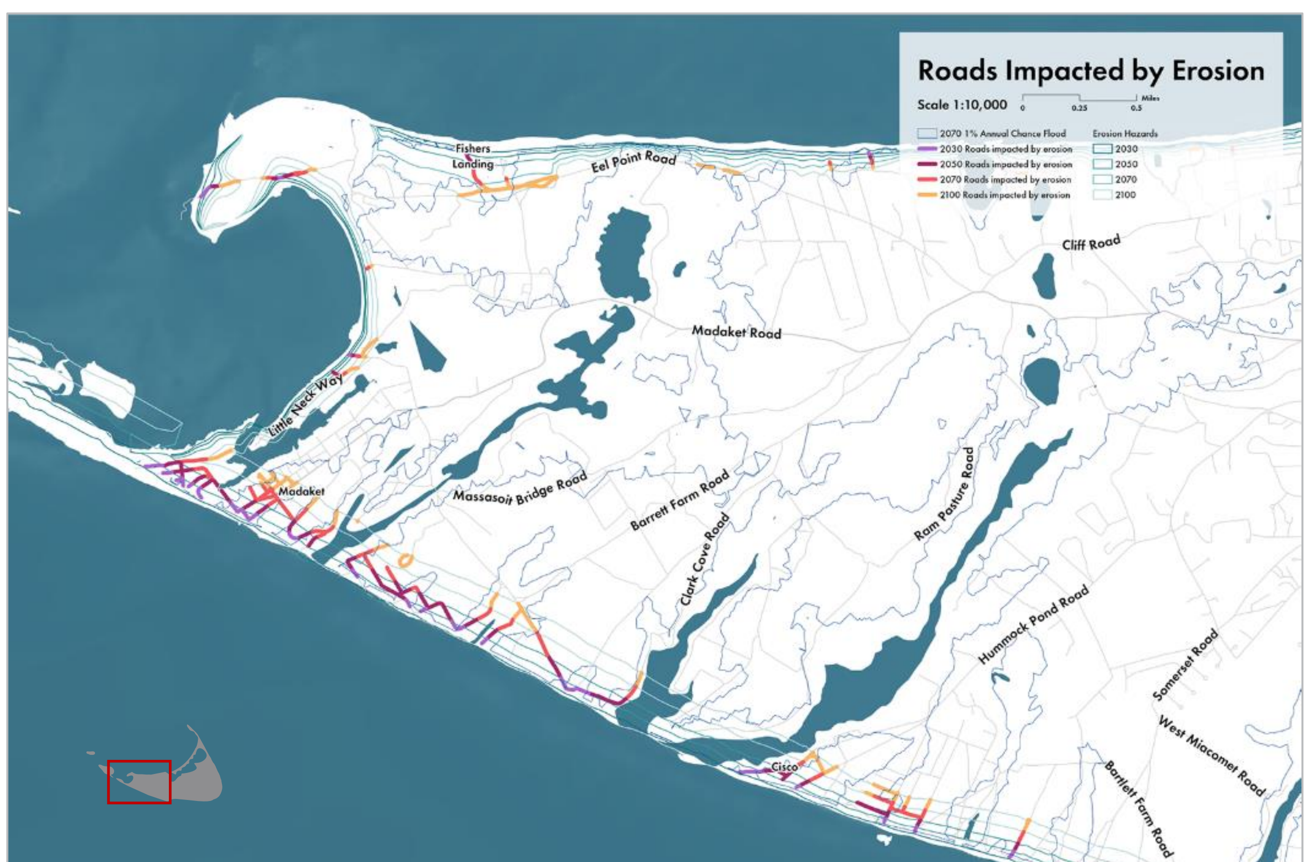
Figure 29. (next page) Map showing roadways at risk of permanent or frequent loss of service due to erosion or inundation during mean monthly high water today through 2100.

Figure 30. (following page) Inset maps showing closer views of roadways and bridges at risk of permanent or frequent loss of service due to erosion or inundation during mean monthly high water today through 2100.


Combined Risk to Roads
Scale 1:35,000
0 0.5 1 2 Miles
Present Roads impacted by MMHW or erosion
2030 Roads impacted by MMHW or erosion
2050 Roads impacted by MMHW or erosion
2070 Roads impacted by MMHW or erosion
2100 Roads impacted by MMHW or erosion
2070 1% Annual Chance Flood
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW 10.83ft
Erosion Hazards
2030
2050
2070
2100
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Madaket Road
Polpis Road
Sesachacha
Monomoy
North Pasture
Middle Pasture
Madaket
Milestone Road
Sankaty Road
Sconset
Cisco
Surfside


Roads Inundated at MMHW
Scale 1:10,000
0
0.25
0.5
Miles
2070 1% Annual Chance Flood
Present Roads inundated at MMHW
2030 Roads inundated at MMHW
2050 Roads inundated at MMHW
2070 Roads inundated at MMHW
2100 Roads inundated at MMHW
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW 10.83ft
LandCounty_OceanFill
Fishers Landing
Eel Point Road
Cliff Road
Madaket Rd The Gut Culvert
Madaket Road Bridge
Madaket Road
N Cambridge St Bridge
Ames Ave Bridge
Madaket
Red Barn Road Bridge
Massasoit Bridge Road
Barrett Farm Road
Clark Cove Road
Ram Pasture Road
Hummock Pond Road
Bartlett Farm Road
Somerset Road
West Miacomet Road
Cisco


Roads Inundated at MMHW
Scale 1:5,000
2070 1% Annual Chance Flood
Present Roads inundated at MMHW
2030 Roads inundated at MMHW
2050 Roads inundated at MMHW
2070 Roads inundated at MMHW
2100 Roads inundated at MMHW
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW 10.83ft
Cliff Road
Hulbert Avenue
Easton Street
West Chester Street
Grove Lane
Main Street
Orange Street
Union Street
Vestal Street
Milk Street
Pleasant Street
Vesper Lane
Monomoy
Monomoy Road
Shimmo Pond Road
Polpis Road
Gardner Road
Shawkemo Road
Rabbit Run Road


Roads Impacted by Erosion
Scale 1:10,000
0
0.25
0.5
Miles
2070 1% Annual Chance Flood
2030 Roads impacted by erosion
2050 Roads impacted by erosion
2070 Roads impacted by erosion
2100 Roads impacted by erosion
Erosion Hazards
2030
2050
2070
2100
Fishers Landing
Eel Point Road
Cliff Road
Madaket Road
Little Neck Way
Madaket
Massasoit Bridge Road
Barrett Farm Road
Clark Cove Road
Ram Pasture Road
Hummock Pond Road
Somerset Road
West Miacomet Road
Bartlett Farm Road
Cisco

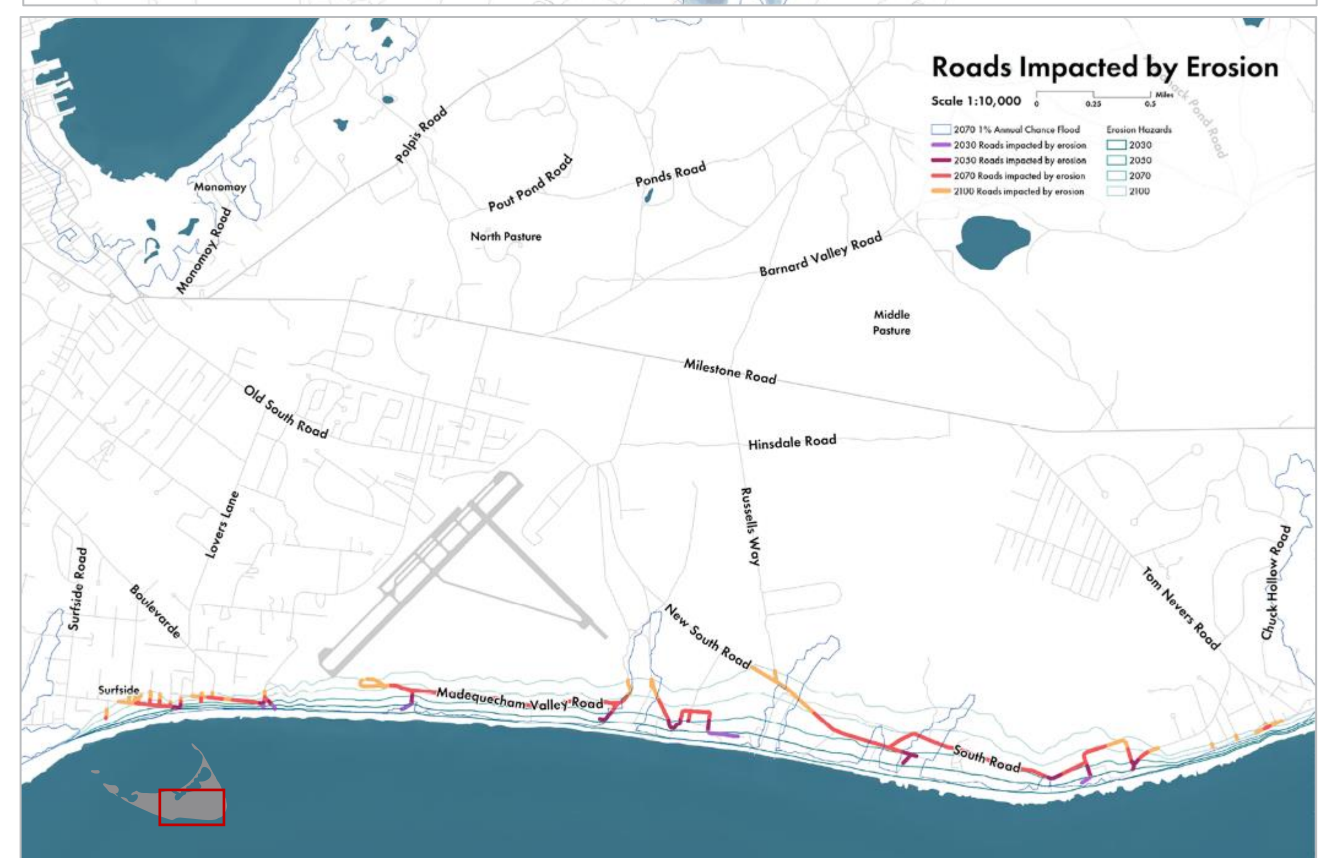

Roads Impacted by Erosion
Scale 1:10,000
2070 1% Annual Chance Flood
2030 Roads impacted by erosion
2050 Roads impacted by erosion
2070 Roads impacted by erosion
2100 Roads impacted by erosion
Erosion Hazards
2030
2050
2070
2100
Polpis Road
Monomoy
Monomoy Road
Pout Pond Road
Ponds Road
North Pasture
Barnard Valley Road
Middle Pasture
Milestone Road
Old South Road
Hinsdale Road
Lovers Lane
Russells Way
Surfside Road
Boulevarde
New South Road
Tom Nevers Road
Chuck Hollow Road
Surfside
Madequecham Valley Road
South Road

Table 4 below summarizes the timeline for expected loss of service of bridges and culverts due to flooding and erosion between 2020 and 2100. Loss of service for flooding is defined as being inundated by 6 or more inches of water on top of or on the lead up to the bridge or culvert, or being exposed to erosion. Each of these water crossing could be damaged or experience episodic loss of service during a severe coastal flood event today (1% annual exceedance probability), which has important consequences related to access to parts of the island served by these bridges during an emergency, including Madaket and Smith Point. These water crossings are also at risk of loss of service at mean monthly high water between 2030 and 2100, the consequence of which would also be reduced access to and potential isolation for parts of the island.

Table 4. Bridges and Culverts - Expected year of loss of use due to MMHW, 1% AEP, and Erosion

Bridge/Culvert	Loss of Service at Mean Monthly High Water	Loss of Service during 1% Annual Chance Storm	Loss of Service due to Erosion
Ames Ave Bridge	2070	2020	2050
Madaket Rd Bridge at Madaket Ditch	2050	2020	N/A
Madaket Rd Culvert at the Gut	2030	2020	N/A
N Cambridge St Culvert	2070	2020	N/A
Massasoit Bridge	2050	2020	N/A
Polpis Road at Folgers Marsh	2050	2020	N/A
Polpis Road at Sesachacha Pond	2070	2020	N/A

Nantucket Airport

The Nantucket Airport is located at higher elevation relative to other areas of the island. The primary structures supporting the airport’s operations are located inland and therefore are not at risk of coastal flooding or erosion through 2100. However, some of the supporting infrastructure of the airport is at risk, including the fencing around the perimeter, paving at the end of the runway, and land area providing the runway approach. The fencing required by the FAA to surround the airport property could be inundated during mean monthly high water (MMHW) in 2100. The fencing is vulnerable to loss due to erosion by 2030 or sooner. The end of the runway paving is vulnerable to loss due to erosion by 2100. **Table 5** below summarizes the flooded or eroded area within the airport fence for current and future flooding and erosion scenarios. **Figure 31** shows areas vulnerable to loss from erosion today through 2100.

Figure 31. Map showing the projected impacts of erosion to property at Nantucket Memorial Airport

Table 5. Expected impacts to Nantucket Airport from flooding and erosion

	Inundation at Mean Monthly High Water (square feet)		Area Lost Due to Erosion (square feet)			
	2070 and earlier	**2100**	**2030**	**2050**	**2070**	**2100**
Impacted Area	0	26,383	92,440	279,198	617,308	1,539,228*

** Includes loss of paving at southern end of runway*

Steamboat Wharf - Steamship Authority

The Steamship Authority is Nantucket's strongest tie to the mainland, seeing over 620,000 passengers per year and serving as the primary means by which goods and services reach the island. Steamboat Wharf, located in downtown Nantucket at the intersection of Broad and East Street is the primary berthing location for ferries carrying people, vehicles, and supplies to and from Nantucket. Without an auxiliary docking location for Steamship Authority vessels, the Wharf is one of the most essential pieces of infrastructure on the island. The Wharf itself is higher in elevation (approximately 5.5 feet NAVD88) than the surrounding streets that provide access to it. By 2030, Easy Street may begin experiencing more frequent loss of service at mean monthly high water than it does today, as well as portions of Broad Street. By 2050, all roadways (Easy Street, Broad Street, and auxiliary access roads to Steamboat Wharf) are projected to experience loss of service during mean monthly high water. By 2070, this may be a daily occurrence. Also by 2070, the Wharf itself is projected to be subject to inundation at mean monthly high water.

The Wharf is also exposed to the 1% annual chance coastal flood today and into the future. **Table 6** shows the monetary risk to structures on the wharf from 2020-2070, with a 3% discount rate. This does not include the wharf structure itself. As will be discussed below in **Risk to Essential Community Facilities and Services,** the exposure of access to this critical lifeline, as well as of the Wharf itself, represents a significant risk to the community, with cascading impacts ranging from economic loss due to a drop in island visitors to reduced access to essential supplies, such as food, medicine, and other goods. In the context of a disaster and the subsequent recovery period, this risk becomes even more pronounced as the damage to the Wharf could hamper recovery efforts.

Table 6. Expected risk to the Steamship Authority

Community Facilities	Direct Physical Damage	Direct Economic and Social Disruption	Total Risk	Building Count
Steamship Authority	$8,300,000	$14,000,000	$22,000,000	3

Figure 32. Map showing risk of loss of service during mean monthly high water to Steamship Authority operations at Steamboat Wharf from today through 2100.

Risk to Essential Community Facilities and Services

At a Glance

- ❖ Essential community facilities are places such as emergency response, grocery stores, schools, that are essential to community safety and wellbeing
- ❖ **34 community facilities (including 48 buildings) are at risk over the next 50 years, with roughly $180 Million in expected damages**
- ❖ Each asset was assigned a criticality score and a risk score, and those were used to calculate a priority score
- ❖ **Top 5 priority assets**:
  - o Steamship Authority – Steamboat Wharf
  - o Coast Guard Station Brant Point
  - o Stop & Shop - Downtown
  - o Hy-Line Cruises - Straight Wharf
  - o Electrical Substation on Commercial Street

Community facilities and services, including the fire department, ferry terminal, police station, 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.

As shown **Table 7**, 48 total buildings across 34 facilities providing essential services to Nantucket are at risk from flooding and/or erosion by 2070, totaling roughly $180 million in expected damages. This includes anticipated impacts to services that are essential to community health and safety, such as Steamboat Wharf and fire and police stations, as well as places that bring joy and entertainment, such as the Whaling Museum. It is also important to note the risk of damage and loss of service to one of the island's two major grocery stores. While food is available from a variety of local markets spread across the island, the larger grocery stores (one located Downtown and the other Mid Island) are the primary sources of food for residents and visitors. It is imperative to understand the risk that these facilities and services face so that measures can be taken to ensure that are able to serve their functions without disruption.

Table 7. Summary of present value losses, no action scenario, 2020-2070, 3% discount rate

Community Facilities	Direct Physical Damage	Direct Economic and Social Disruption	Total Risk – Flooding and Erosion[6]	Building Count
Coast Guard	$12,000,000	$1,100,000	$14,000,000	4
College Facilities	$2,700,000	$120,000	$2,800,000	3
Ferry	$12,000,000	$14,000,000	$26,000,000	4
Fire Station	$1,400	$51	$1,500	1
Grocery Stores	$34,000,000	$10,000,000	$44,000,000	2
Libraries/Museums	$13,000,000	$540,000	$14,000,000	9
Lighthouses	$7,300,000	$2,100,000	$9,400,000	6
Long-term Care	$0	$0	$0	1
Places of Worship	$11,000	$0	$11,000	1
Police Station	$480,000	$13,000	$500,000	1
Post Office	$69,000	$1,900	$71,000	1
Power Facilities	$4,100,000	$1,000,000	$5,100,000	1
Recreation	$8,900,000	$1,300,000	$10,000,000	1
Town Administration	$2,700,000	$120,000	$2,800,000	2
Town Concessions	$38,000,000	$7,400,000	$46,000,000	4
Town Housing	$2,400,000	$170,000	$2,600,000	3
Waste Facilities	$210,000	$120,000	$330,000	4
Total	$140,000,000	$39,000,000	$180,000,000	48

As part of the risk assessment, each community asset or facility was also assigned a criticality score, calculated based on several factors. For the purposes of this study, criticality refers to the importance of an asset in the event of a disaster. For example, a hospital or fire station is vital for emergency response and recovery after a disaster so would be considered more critical than other facilities less essential for these functions. This approach to defining criticality helps prioritize facilities and services but should not be interpreted to mean that other types of facilities and services are not also essential to community well-being.

One industry-standard tool that informs this analysis is the Flood Design Class (FDC), as described in ASCE 24-14. The FDC is a number from 1-4 that determines what level of protection a building is required to have, with 4 being the highest level of protection. In this analysis, it is used as an analog for criticality to account for the importance of a structure to public safety. It is important to distinguish this type of criticality ranking, which focused on human health and safety, and other types of community priorities, such as education, community services,

[6] Note that all calculations are rounded to two significant figures. To avoid misrepresentation of totals, numbers are summed prior to rounding. For this reason, the Total Risk column may not equal the total of Direct Physical Damage and Direct Economic and Social Disruption.

historic and cultural significance, and other factors. Criticality rankings do not negate these other priorities but rather help place emphasis on facilities that are required to promote safety in the event of a disaster.

The most important factor in criticality determinations is the use of the facility in question. If a facility is involved in emergency response or public health, it will necessitate a higher criticality score, as its loss of function would impact many residents. For this analysis, we assigned each facility a primary function from this list:

- Infrastructure (6)
- Emergency Response (8)
- Public Health, Safety, Physical Well-Being (4)
- Quality of Life (3)
- Ecosystem/Environmental Health (3)

The numbers in parentheses represent the weight given to each category based on important to human life safety and wellbeing. Primary functions were given 3 points, secondary functions 2 points, and tertiary functions 1 point. The category weight was then multiplied by the function scores, summed, and multiplied by the facility's FDC. Additional points were given to facilities owned by the Town.

This criticality scoring resulted in the top 5 most critical facilities shown in **Table 8**. **Appendix B provides the complete inventory of the community assets and facilities identified through the CRP and the criticality score associated with each.**

Table 8. Top 5 facilities by criticality score

Facility	Criticality Score
Nantucket Memorial Airport	156
Steamship Authority	152
Hy-Line Cruises - Straight Wharf	152
Police Station & Public Safety Facility	144
State Police Station D-6	144

Next, using the results of the island-wide quantitative risk analysis described earlier in this section, each facility was given a risk score, in the form of a percent of total risk to all identified assets and facilities. The dollar figures used for this assessment are derived using the methodology described in Section 5.2, This step is intended to prioritize essential community facilities and services based on relative degree of risk from coastal hazards. The top five facilities by risk are shown in **Table 9**. Note that the inventory included in Appendix B includes all essential community facilities and services identified for the CRP. Many of these structures are not exposed to coastal hazards (e.g., Nantucket Cottage Hospital) and thus a risk score has not been calculated for the CRP.

Table 9. Top 5 facilities by risk score

Facility	Risk Score (% of total risk to essential community facilities and services)
Stop & Shop (downtown)	23%
Jetties Concession Building	22%
Steamship Authority	13%
Coast Guard Station Brant Point	8%
American Legion Hall	6%

The criticality scores were then multiplied by the risk scores to calculate the priority score for each facility. The top five facilities by priority are shown in **Table 10**.

Table 10. Top 5 facilities by priority score

Facility	Priority Score
Steamship Authority	19.00
Coast Guard Station Brant Point	9.76
Stop & Shop (downtown)	8.17
Hy-Line Cruises - Straight Wharf	4.43
Electrical Substation on Commercial Street	3.69

This ranking scoring of risk based on criticality can be used as framework for Town officials to use in prioritizing assets and services for risk reduction and adaptive measure, including new flood and erosion risk mitigation steps, relocation of facilities or assets, or creation of redundant systems to provide service if the primary facility or service experiences loss of function. This framework does not supplant local knowledge or other priorities and values identified for private residents and stakeholders. The framework should not be interpreted as suggesting that other structures and facilities, such as historic landmarks, are not important to Nantucket's natural and architectural heritage.

Appendix B provides a full inventory of the community assets and facilities identified through the CRP and the risk and priority score for each. Please note this appendix includes many community assets that are not in coastal hazard areas and thus do not have risk scores.

Risk to Utilities

At a Glance

- ❖ **1 substation building and 4 wastewater treatment buildings** on Nantucket are at risk of flooding due to the mean monthly high water by 2050.
- ❖ By 2100, **3.5 miles of water and sewer lines** could be lost to erosion

Flooding to subgrade infrastructure can be especially difficult to quantify, and expensive to repair and remediate, given the number of unknowns often associated with these systems. Saltwater flooding has the potential to disrupt access to these essential utilities and can accelerate deterioration, necessitating more frequent maintenance and higher operating costs. Erosions poses a more direct threat, where portions of the systems can be exposed and lost during severe events.

Nantucket is served by a variety of utilities systems, many of which are located below ground and designed to manage water. The stormwater and wastewater systems on the island are critical to both the health and safety of residents, and the health of local ecosystems.

Information on the location of the water management system on Nantucket is limited, but it is helpful to map exposure to direct more detailed analysis of specific vulnerabilities. With proper operation and maintenance, most storm sewers, water mains, and other linear utilities can withstand periodic impacts from flooding. However, drainage networks can also serve as conduits for flooding. With no backflow preventers in place, sewer outfalls and storm drains can back up with sea water, causing flooding in basements, streets, and buildings. For example, a Town-led study of tidal flooding on Easy Street in Downtown Nantucket identified the need for new duck bill tide gates to reduce the risk that water from the harbor could enter the drainage network and flood adjacent roadways.

In addition to subgrade infrastructure, some utilities, most notably the electrical grid and solid waste management, depend upon infrastructure that is located above ground in structures. Damage or disruption to these structures from either flooding or erosion can have cascading downstream and upstream impacts such as a loss of electricity to critical facilities. Impacts to solid waste management facilities can cause disruption to waste collection and disposal, which would have an outsized impact on an island the size of Nantucket.

To analyze the risk to utilities on Nantucket, analysts reviewed the following:

- Exposure of buildings and structures that provide utility services
- Counts of buildings exposed to any flooding under the scenarios below.
- Feet of linear utilities potentially exposed

Under the no action scenario, a number of facilities related to utility systems will be exposed to flooding and erosion. **Table 11** summarizes the timeline for expected loss of service due to tidal flooding and coastal flooding. Note that the tables do not convey the extent of cascading impacts to other services on the island, such as power outages, but do capture risks that lead to these cascading impacts. For example, loss of service to the electrical substation located downtown could result in loss of power over portions of the island which in turn presents additional risks, such as loss of service for facilities that do not have backup power supplies.

Table 11. Expected exposure to flooding and erosion for utility facilities

Utility	Number of Buildings	Mean Monthly High Water	1% AEP Coastal Flood	Erosion
Downtown Electrical Substation	1	2050	2020	N/A
Nantucket Solid Waste MGT Facility	4	2070	2050	N/A

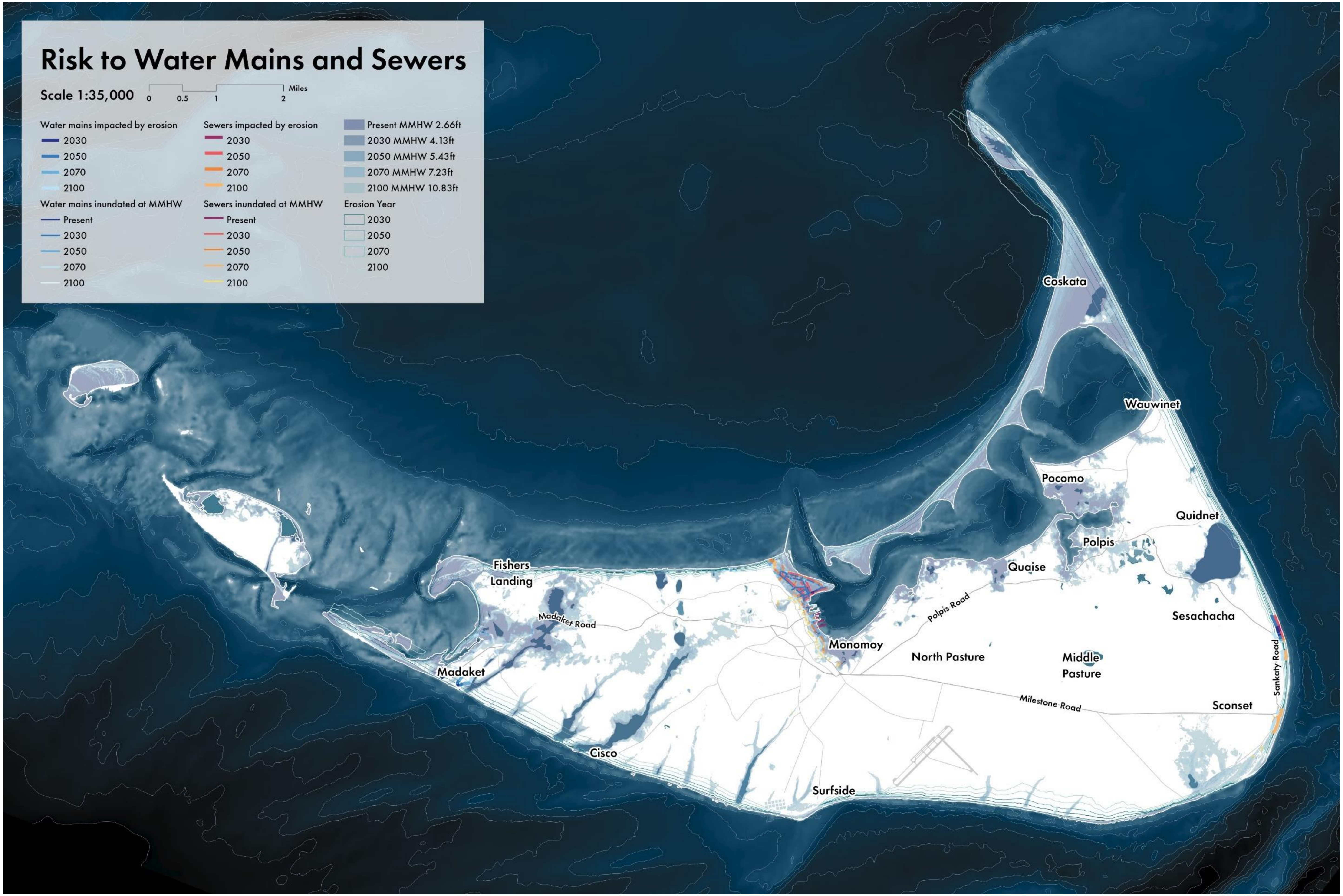
Under the no action scenario, a number of utility systems will be exposed to flooding and erosion. As noted above, these systems exist largely below grade but are included here to document potential exposure of the system or access to the system from overland flooding and/or erosion. **Table 12** summarizes the linear miles of utilities that are expected to experience loss of service due to flooding and erosion between 2020 and 2100. Loss of service for flooding is defined as being inundated by 6 or more inches of water or falling outside of a projected erosion hazard line for a given decade.

In addition, there are a 11 radio, cellular, and radar towers located across the island that support communications and navigation. All but two of these facilities are located in areas minimally exposed to coastal hazards. The first at-risk tower is a radio tower located on the Nantucket Public Works Facility Grounds (41.280669, -70.168782), which is exposed to flooding from a 1% annual chance flood today, with increasing risk into the future. The second is a Loran Station (used for navigation) located at 65 Low Beach Road (41.253406, -69.977423), which is exposed to long-term coastal flood risk from a 1% annual chance flood by 2070. Flooding at the radio tower location could impact telecommunications on Nantucket after a coastal flood event, but the island is also serviced by three additional radio towers located outside of coastal hazard areas. Risk to the Loran station is less concerning due to the long-term nature of this risk and likelihood of changes to the facility before the 2070s.

Table 12. Expected disruption to sewer and water service due to flooding and erosion

	Damage or Disruption during 1% Annual Chance Storm (linear miles)				Damage or Disruption at Mean Monthly High Water (linear miles)					Loss Due to Erosion (linear miles)			
	Today	**2030**	**2050**	**2070**	**Today**	**2030**	**2050**	**2070**	**2100**	**2030**	**2050**	**2070**	**2100**
Sewer	7.3	8.0	8.3	9.7	0.5	3.5	5.6	7.0	9.0	0.1	0.4	0.5	1.1
Water	7.9	9.5	10.5	12.1	0.3	3.5	5.8	7.4	10.9	0.2	0.7	1.3	2.4
Total	**15.3**	**17.5**	**18.8**	**21.8**	**0.8**	**7**	**11.4**	**14.4**	**19.9**	**0.3**	**1.1**	**1.8**	**3.5**

Figure 33. (next page) Map showing known Town-owned water mains and sewers exposed to flooding at mean monthly high water and erosion today through 2100


Risk to Water Mains and Sewers
Scale 1:35,000
0 0.5 1 2 Miles
Water mains impacted by erosion
2030
2050
2070
2100
Water mains inundated at MMHW
Present
2030
2050
2070
2100
Sewers impacted by erosion
2030
2050
2070
2100
Sewers inundated at MMHW
Present
2030
2050
2070
2100
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW 10.83ft
Erosion Year
2030
2050
2070
2100
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Madaket Road
Polpis Road
Sesachacha
Monomoy
North Pasture
Middle Pasture
Madaket
Sankaty Road
Milestone Road
Sconset
Cisco
Surfside

Risk to Parks and Open Space

At a Glance

- **2,878 acres of open space (16% of island-wide open space)** will be impacted by the mean monthly high water by 2070
- **3,937 acres of open space (22% of island-wide open space)** will be at risk due to the 1% annual chance storm by 2070
- **1,754 acres of open space (10% of island-wide open space)** could be disrupted by erosion by 2100

Conservation and protection of open space have long been important values to Nantucket residents. While the island has significant open space resources enjoyed by all, coastal risks will threaten these resources over time, impacting the community's health and wellbeing. Erosion poses the most direct risk due to the potential for loss of land area, but reduced access and impacts to ecological services due to coastal flooding and flooding at high tide also threatens public enjoyment, community wellbeing, ecosystem health.

There are over 18,000 acres of parks and protected open space on Nantucket. The majority of that open space (74%) is controlled by private entities and land trusts, including the Nantucket Land Bank and Nantucket Conservation Foundation (Nantucket's largest landowner). 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. This structure has resulted in roughly half of the land on Nantucket being protected open space.

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. By 2070, 2,878 acres of open space will experience disruption due to the mean monthly high water, increasing to 4,054 acres in 2100. Even more open space will be at risk during the 1% annual chance storm, as shown below.

The graphs below **Figure 34, Figure 35, Figure 36** summarize the acreage of open space that is expected to experience loss of service due to flooding between 2020 and 2100. **Figure 37** shows exposure of parks and open spaces to flooding from mean monthly high water and coastal storms today through 2100.

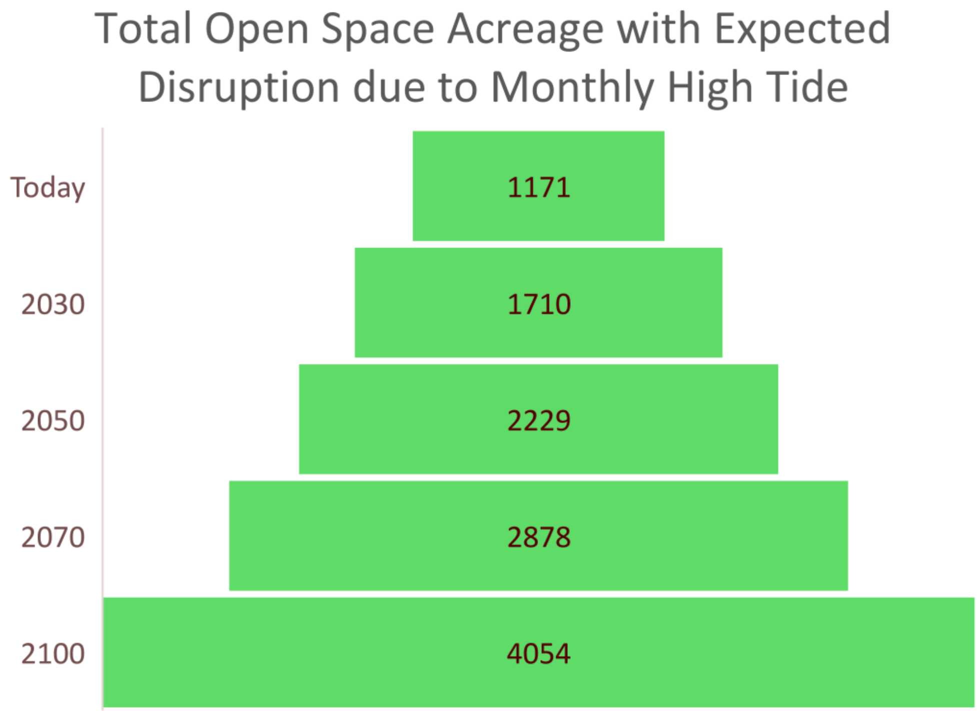


Figure 34. Open space disruption due to Mean Monthly High Water

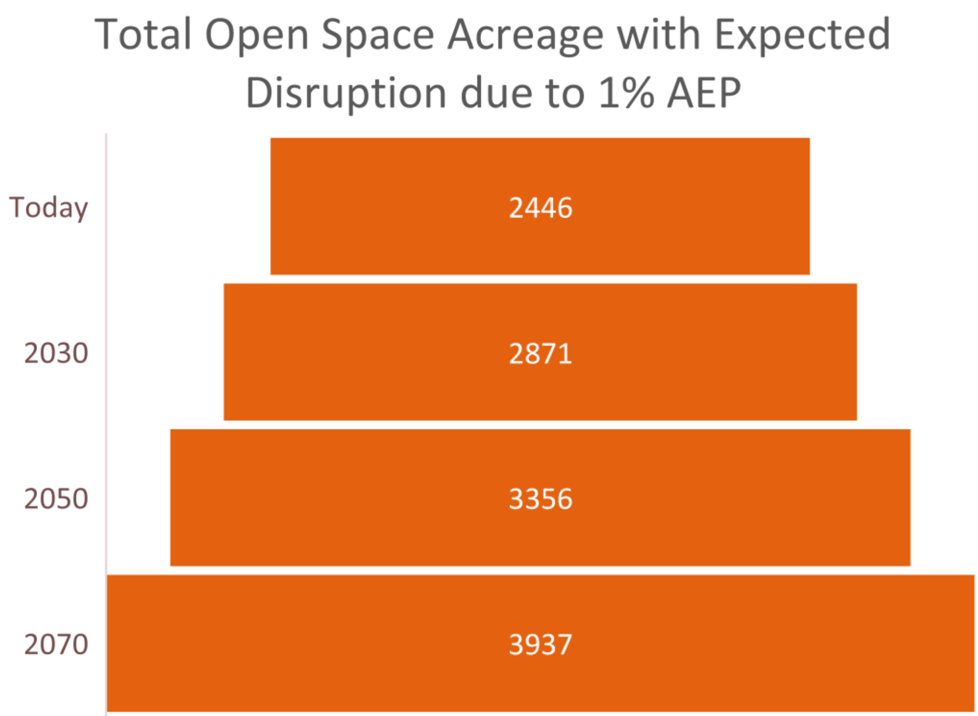


Figure 35. Open space disruption due to 1% AEP storm

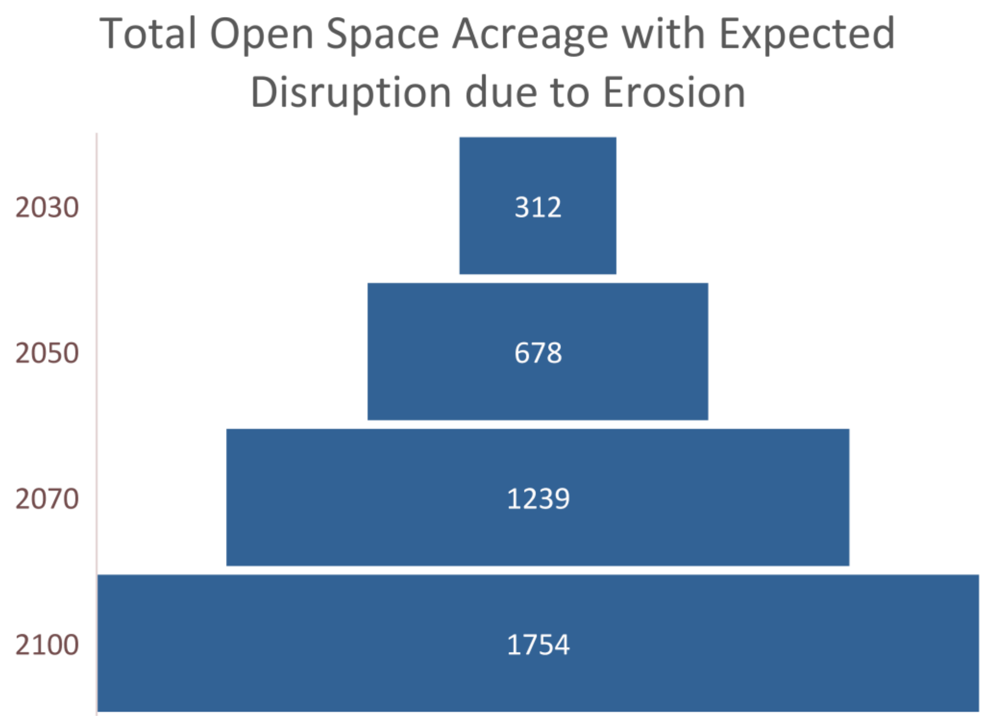
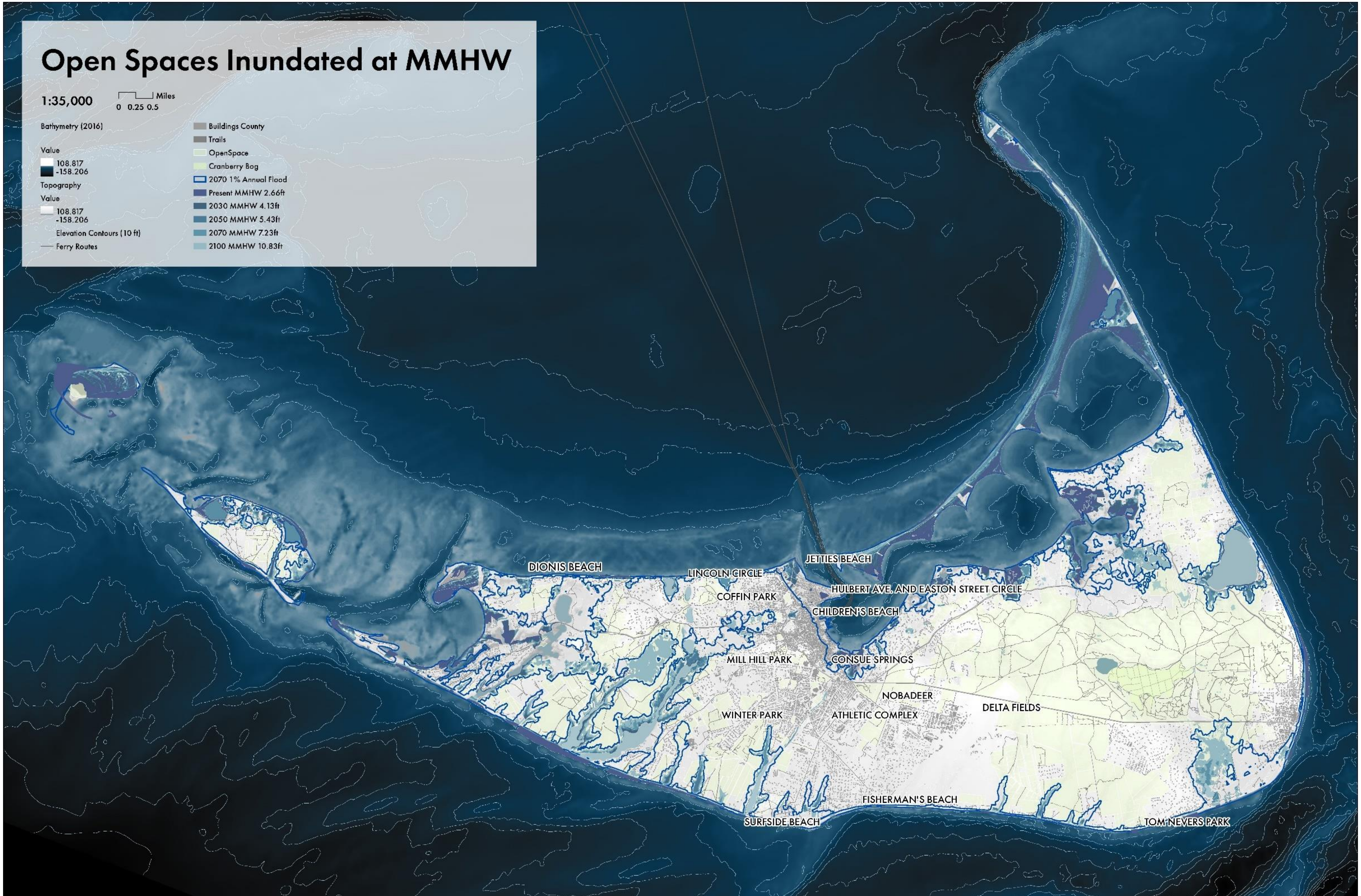


Figure 36. Open space disruption due to erosion

Figure 37. (next page) Map showing exposure of parks and open spaces to flooding from mean monthly high water and coastal storms today through 2100


Open Spaces Inundated at MMHW
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
Ferry Routes
Buildings County
Trails
OpenSpace
Cranberry Bog
2070 1% Annual Flood
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW 10.83ft
DIONIS BEACH
LINCOLN CIRCLE
JETTIES BEACH
COFFIN PARK
HULBERT AVE. AND EASTON STREET CIRCLE
CHILDREN'S BEACH
MILL HILL PARK
CONSUE SPRINGS
NOBADEER
WINTER PARK
ATHLETIC COMPLEX
DELTA FIELDS
FISHERMAN'S BEACH
SURFSIDE BEACH
TOM NEVERS PARK

Risk to Habitat and Natural Resources

At a Glance

- **1,340 acres of wetland resource area** and **1,187 acres of priority Natural Communities** will be impacted by the mean monthly high water by 2070
- **1,665 acres of wetland resource area** and **1,713 acres of priority Natural Communities** will be impacted by the 1% annual chance flood by 2070
- **241 acres of wetland resource area** and **938 acres of priority Natural Communities** will be impacted by erosion by 2100

Natural resource areas provide many benefits and ecological services for Nantucket and their protection is a priority for the community. Loss of these resources due to flooding and erosion, reduces the ecological, resilience, economic benefits they provide.

Natural resources provide many benefits and ecological services for Nantucket and their protection is a priority for the community. These benefits and services include:

- Natural buffers that stabilize shorelines and protect coastal areas from storm damage and sea level rise.
- Biogeochemical functions that improve water quality by functioning as "living filters"
- Critical to supporting health of commercial and recreational fisheries
- Critical habitat for nesting, foraging and migratory birds. This in turn supports recreational birding that brings additional tourism, commerce, and enjoyment to the Nantucket community.
- Proximity to natural amenities and associated recreational opportunities and aesthetic benefits increases property values and is one of the primary drivers of tourism to Nantucket.
- On Nantucket, the conservation of habit and natural resources has historical ties, and the significance of the island's historic areas is linked to proximity to the ocean, wetlands, and other sensitive open spaces.

Coastal flooding poses significant risk to rare habitat and especially to coastal wetlands, which are among the most susceptible ecosystems to climate change and sea level rise. Although Nantucket has strong wetland protection regulations and several conversation organizations working diligently to protect wetland ecosystems, wetlands are nevertheless already threatened due to historic and current anthropogenic disturbances (e.g., shoreline hardening, bank erosion, invasive species, and water quality degradation). In addition, the resilience of coastal wetlands and ability to adapt to sea level rise may be limited by surrounding upland land uses, decreased sediment inputs, and decreased plant productivity. This combination of forces acting on coastal wetlands could overwhelm the natural compensatory mechanisms and increase vulnerability to marsh drowning over time.

For the purpose of this report, risk to critical ecosystems was analyzed based on exposure of mapped natural communities. These areas represent various natural communities of biodiversity conservation interest in Massachusetts, drawing on records maintained in the Natural Heritage & Endangered Species Program (NHESP) database. The analysis focused on areas ranked as priority for conservation due to their rareness and/or ecological value. Wetland resource areas are mapped based on available GIS data from the Massachusetts Department of Environmental Protection and are suitable for planning level analysis for the purposes of understanding potential impacts to resource areas. This analysis includes beaches, marshes, forests, bogs, swamps, and other resource areas. As part of the next phases of the CRP planning process, data from the Sea Level Affecting Marshes Model (SLAMM) will be used to evaluate potential recommendations for wetland protection and restoration in the context of projected sea level rise.

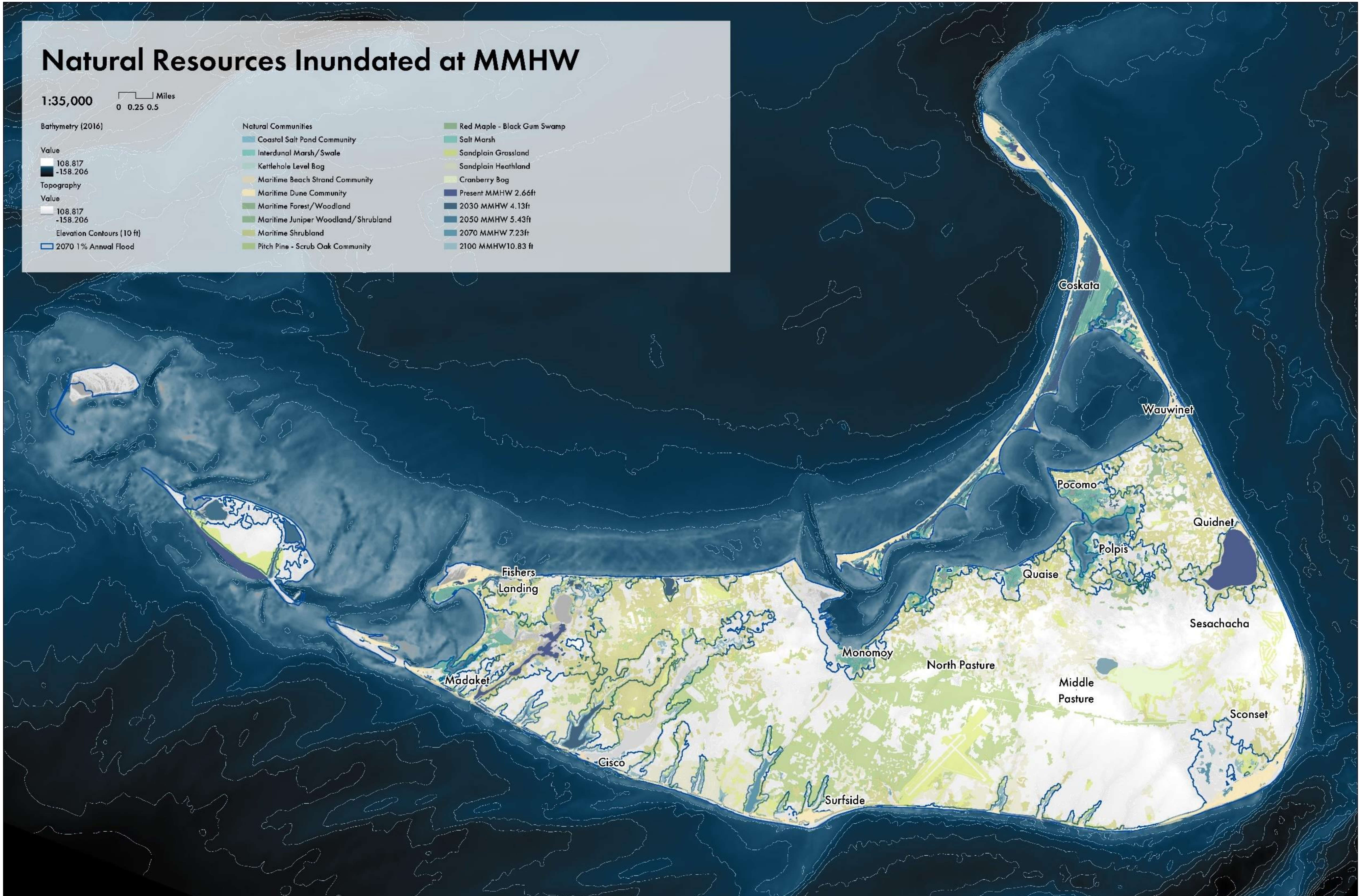
Table 13 summarizes the acreage of natural resource area that is expected to be exposed to flooding and erosion between 2020 and 2100. Much of the mapped natural resource area on Nantucket exists within floodplains today. Areas exposed to mean monthly high water today may be adapted to these present-day conditions, but with increasing rates of sea level rise, these areas may not be able to adapt quickly enough to changing tidal conditions and are thus vulnerable to drowning. By 2070, for example, up to 645 additional acres of wetland resource area will experience flooding at mean monthly high water, compared to today. 718 additional acres of priority Natural Communities could similarly be exposed to mean monthly high water by 2070. Erosion presents another risk factor to these resources, including impacts of up to 162 acres of wetland and 633 acres of Natural Communities by 2070. **Figure 38 and Figure 39** show maps of the exposure of these resources to flooding and erosion from today to 2100.

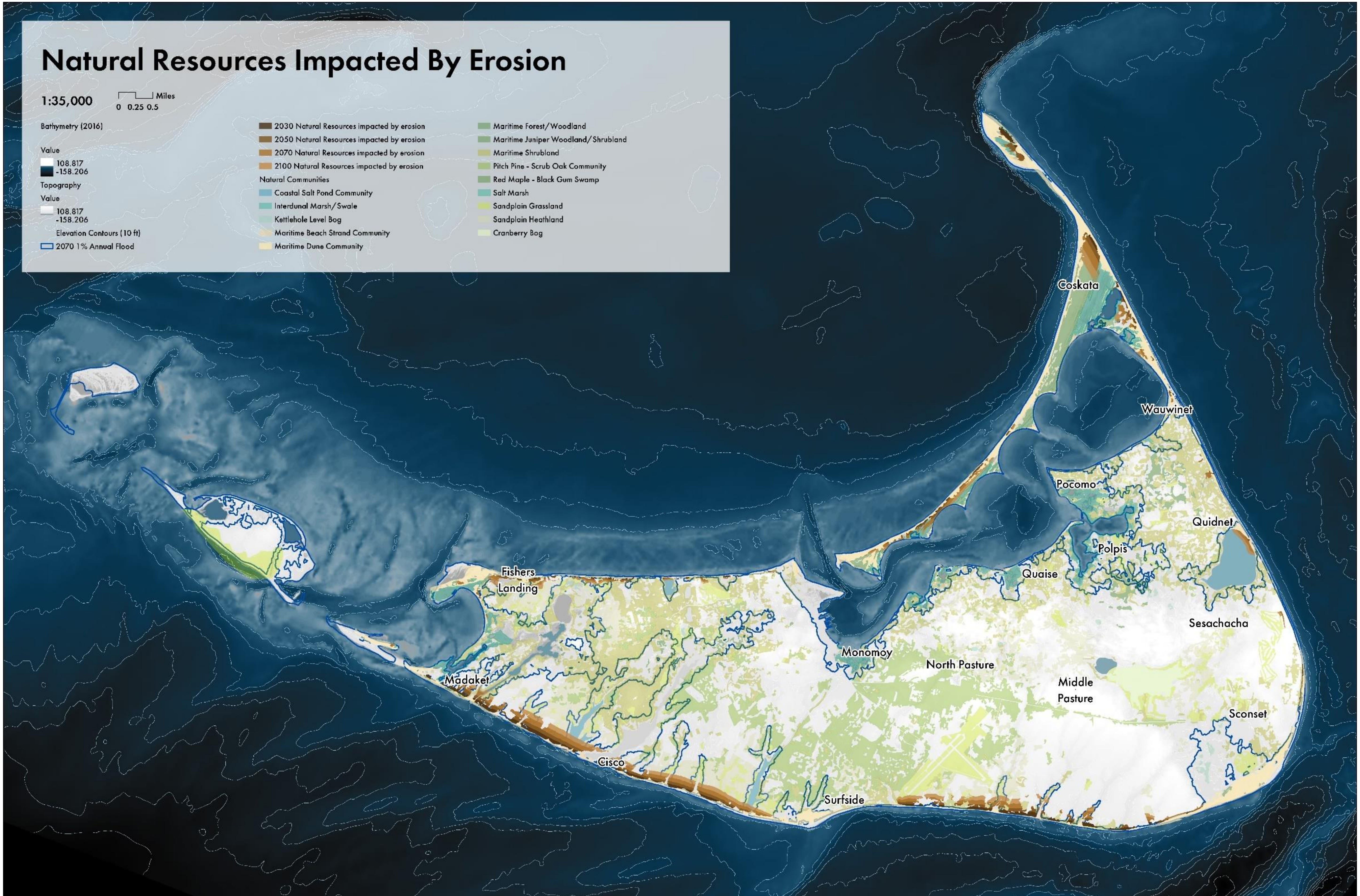
Table 13. Expected exposure of habitat and natural resources to flooding and erosion

	Inundation during 1% Annual Chance Storm (acreage)					Inundation at Mean Monthly High Water (acreage)					Loss Due to Erosion (acreage)			
	Today	2030	2050	2070	2100	Today	2030	2050	2070	2100	2030	2050	2070	2100
Natural Communities – Ranked S1 or S2	1,138	1,256	1,434	1,713	N/A	469	719	926	1,187	1,573	139	332	633	938
Wetland Resource Areas	1,202	1,336	1,484	1,665	N/A	695	963	1,119	1,340	1,750	11	54	162	241

Figure 38. (next page) Map showing exposure of natural resources, including Priority Natural Communities and wetlands, to mean monthly high water today through 2100

Figure 39. (following page) Map showing exposure of natural resources, including Priority Natural Communities and wetlands, to erosion hazards today through 2100


Natural Resources Inundated at MMHW
1:35,000
0 0.25 0.5 Miles
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
2070 1% Annual Flood
Natural Communities
Coastal Salt Pond Community
Interdunal Marsh/Swale
Kettlehole Level Bog
Maritime Beach Strand Community
Maritime Dune Community
Maritime Forest/Woodland
Maritime Juniper Woodland/Shrubland
Maritime Shrubland
Pitch Pine - Scrub Oak Community
Red Maple - Black Gum Swamp
Salt Marsh
Sandplain Grassland
Sandplain Heathland
Cranberry Bog
Present MMHW 2.66ft
2030 MMHW 4.13ft
2050 MMHW 5.43ft
2070 MMHW 7.23ft
2100 MMHW10.83 ft
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Sesachacha
Monomoy
North Pasture
Middle Pasture
Madaket
Sconset
Cisco
Surfside


Natural Resources Impacted By Erosion
1:35,000
Miles
0 0.25 0.5
Bathymetry (2016)
Value
108.817
-158.206
Topography
Value
108.817
-158.206
Elevation Contours (10 ft)
2070 1% Annual Flood
2030 Natural Resources impacted by erosion
2050 Natural Resources impacted by erosion
2070 Natural Resources impacted by erosion
2100 Natural Resources impacted by erosion
Natural Communities
Coastal Salt Pond Community
Interdunal Marsh/Swale
Kettlehole Level Bog
Maritime Beach Strand Community
Maritime Dune Community
Maritime Forest/Woodland
Maritime Juniper Woodland/Shrubland
Maritime Shrubland
Pitch Pine - Scrub Oak Community
Red Maple - Black Gum Swamp
Salt Marsh
Sandplain Grassland
Sandplain Heathland
Cranberry Bog
Coskata
Wauwinet
Pocomo
Quidnet
Polpis
Quaise
Fishers Landing
Sesachacha
Monomoy
North Pasture
Middle Pasture
Madaket
Sconset
Cisco
Surfside

Groundwater Rise

Flooding due to rising groundwater has distinct characteristics that set it apart from the more familiar flooding caused by direct overland coastal and tidal flooding. Whereas coastal storm flooding is fast and temporary, groundwater flooding tends to be slow and chronic. When SLR lifts the coastal water table, impacts can include higher corrosion rates of buried infrastructure, increased basement flooding, reduced stormwater and wastewater sewer capacity, soil contaminant mobilization, soil instability, and eventually the creation of wetlands as groundwater emerges to the surface. Based on anecdotal information, groundwater emergence is already occurring in some areas, including around the Finance Department building on Washington Street where new wetlands are forming and at 27 Washington Street.

Not only does groundwater flooding have impacts distinct from coastal inundation flooding, but it also has unique mitigation approaches. While seawalls are effective against temporary storm surge, they don not substantially impact the long-term movement of groundwater. Thus, the response options for a rising water table tend to fall into the categories of groundwater drainage/pumping, raising structures, or gradual relocation. The viability of each option is highly dependent upon local conditions. Thus, making an initial broad assessment that determines the likelihood of groundwater flooding is useful for determining what areas should be targeted for more detailed hydrogeological assessments.

The water table elevation map in this study was constructed from well data from 10 USGS wells on Nantucket Island. Monthly water level measurements were taken over multiple years for each well—most of them dating back to the 1980s. The highest water table readings (smallest depth-to-water) across Nantucket Island occurred in the spring of 1994. However, the island's water table has been fairly stable over the past 30 years but with a trend of a slowly rising water table (see **Figure 40**). Likewise, high rainfall events that substantially raise the water table are expected to occur more frequently with climate change. Thus, the highest measured reading was used as a conservative estimate.

Figure 41 shows the projected depth to groundwater today. While additional technical analysis would be necessary to fully evaluate the risks posed by groundwater table rise to structures and infrastructure, this analysis shows several areas where future groundwater will rise to within six feet of surface, potentially causing flooding in basements, low-lying areas, and corroding subsurface infrastructure. Most concerning are areas where depth to groundwater is below three feet, including the island's most low lying areas such as Downtown and Madaket, In certain pockets, such as Brant Point, it is not uncommon to see groundwater emergence today, as noted in **Section 4.1 Overview of Coastal Hazards.** Mapping of depth to groundwater for present in **Figure 41** supports this observed condition. With sea level rise, depth to groundwater is expected to decrease across the island over time, as shown in **Figure 42,** posing significant challenges for low-lying areas. By 2100, areas such as Downtown and Brant Point may experience widespread groundwater emergence.

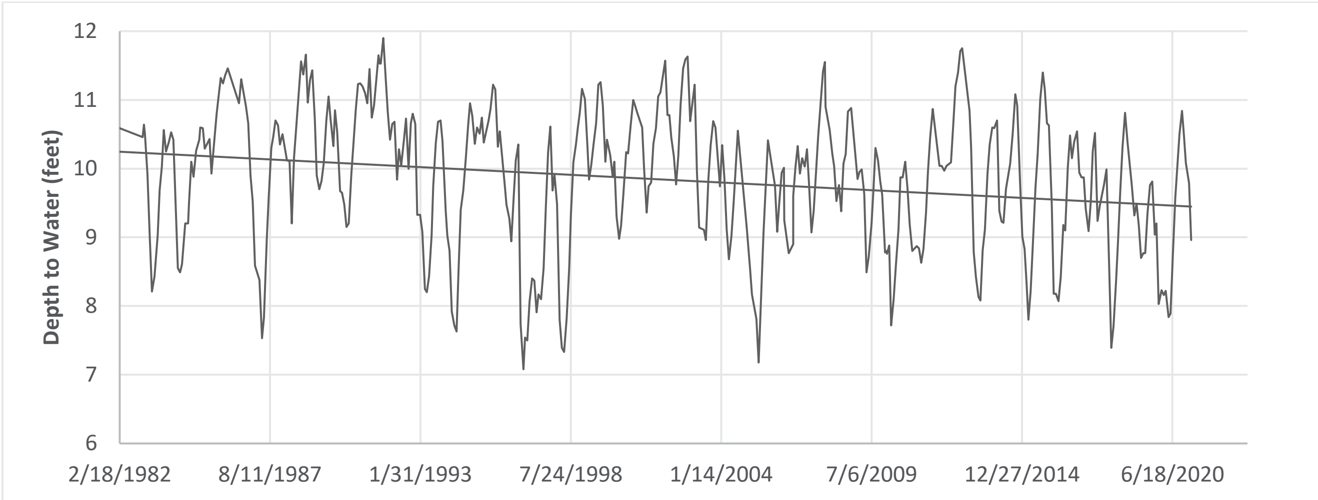
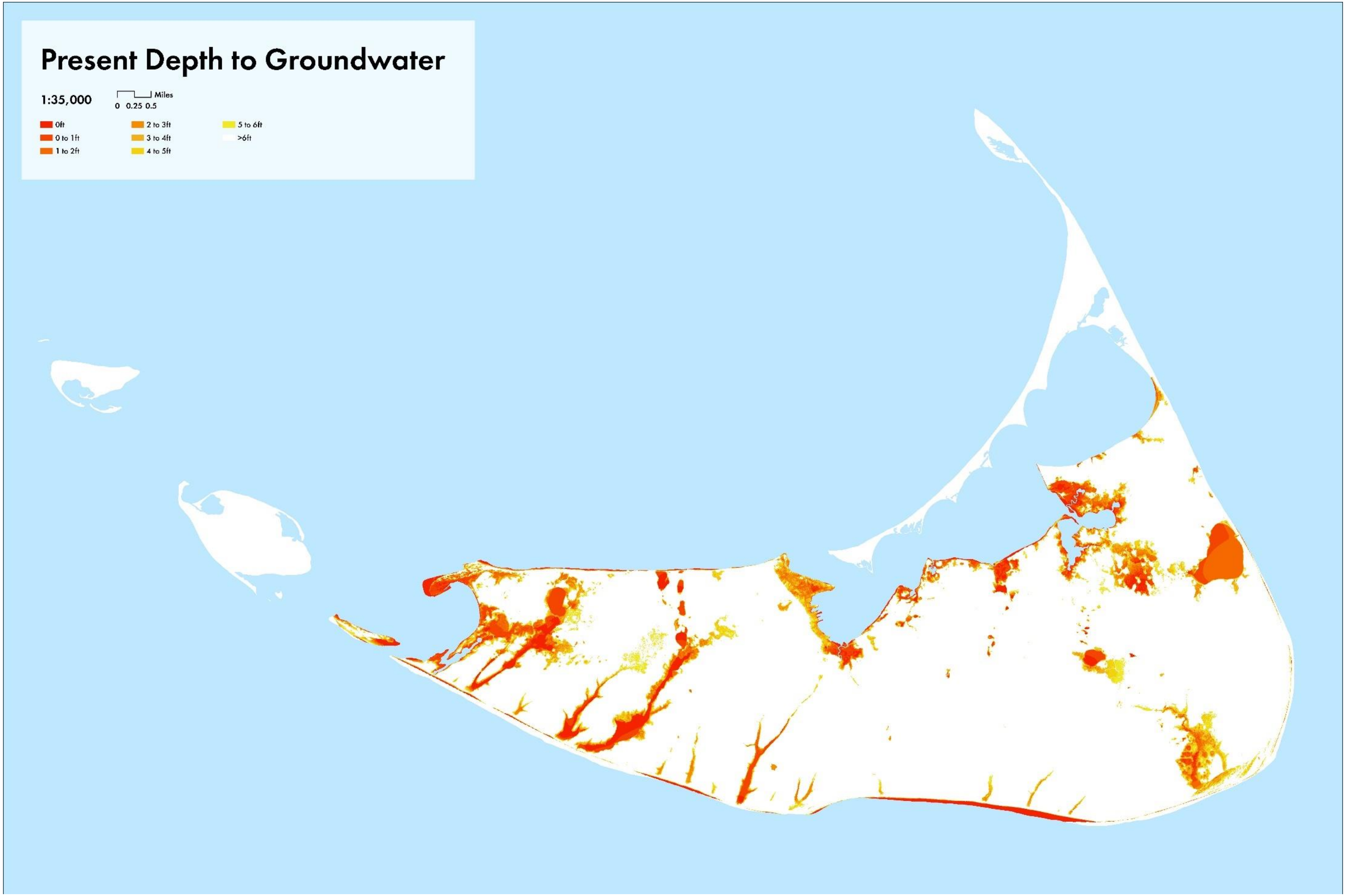


Figure 40. A graph of published monthly well data for well MA MWB 107 with a trendline showing the water table rising over time (depth to water is decreasing)

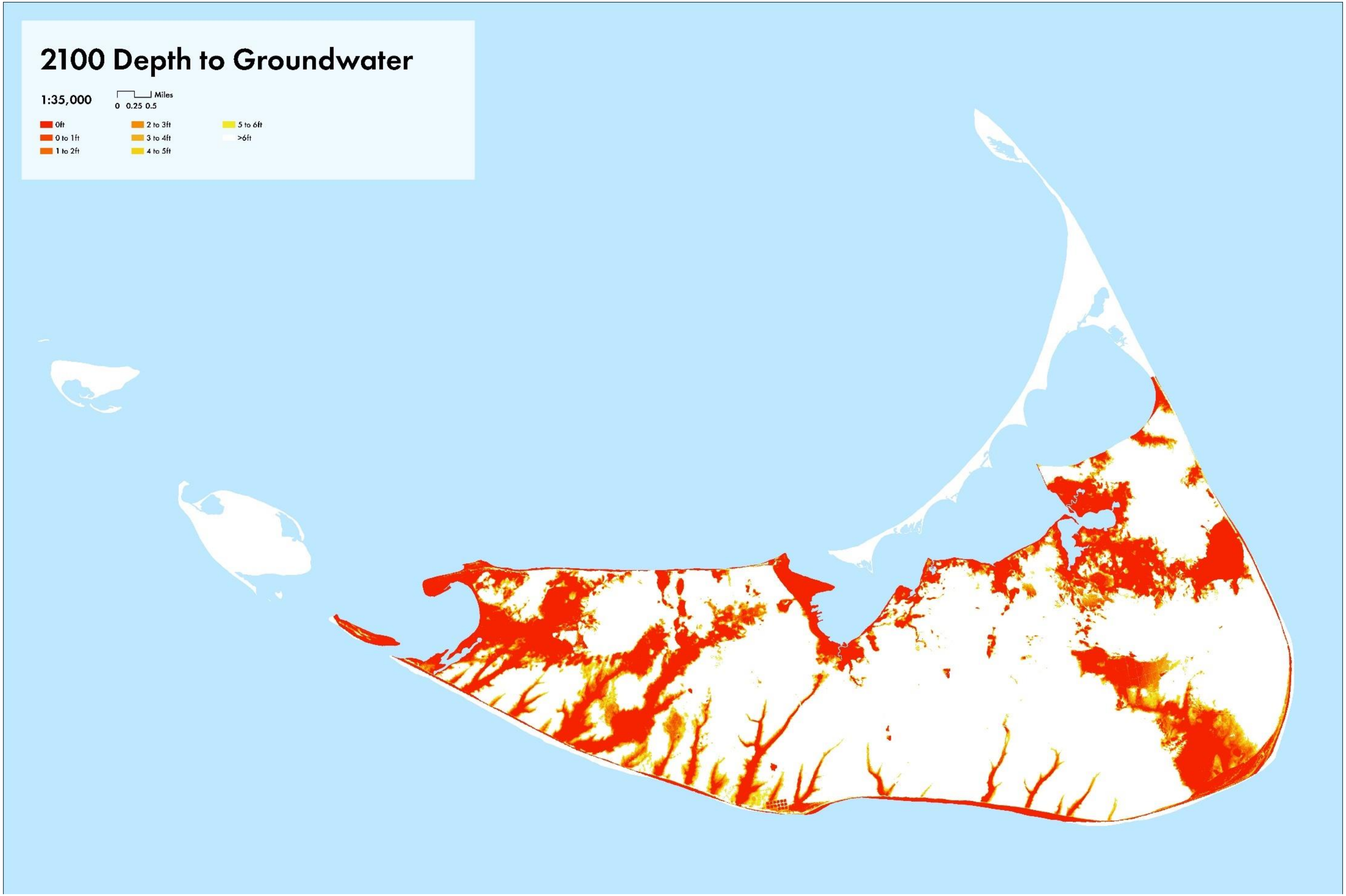
Figure 41. (next page) Map showing estimated depth to groundwater across Nantucket today

Figure 42. (following page) Map showing potential depth to groundwater with sea level rise across Nantucket in 2100



Present Depth to Groundwater
1:35,000
Miles
0 0.25 0.5
0ft
0 to 1ft
1 to 2ft
2 to 3ft
3 to 4ft
4 to 5ft
5 to 6ft
>6ft

2100 Depth to Groundwater



6 Conclusion

This report serves as a supplement to the final Coastal Resilience Plan and provides a summary of:

- Existing Conditions Mapping
- Community Engagement prior to the project mid-point
- Coastal Risk and Exposure Assessment

As documented in this report, coastal risks to homes, businesses, infrastructure, and natural resources will increase across the island through the end of the century. Action will need to be taken to adapt to these realities. The central objective of the CRP is to draw on the information and analysis included in this report to recommend proactive steps the Town and community can take to begin the long-term adaptation process.

To review the full Coastal Resilience Plan, please visit the project website:
https://www.nantucket-ma.gov/2030/Coastal-Resilience-Plan

Appendix A

Coastal Risk and Exposure Analysis Methodologies

Coastal Risk and Exposure Analysis Methodologies

Quantitative Risk Assessment

The quantitative risk analysis is based on an assessment of the expected damages from a range of flood events and erosion scenarios for the entire island of Nantucket if no actions are taken by the Town, residents, or businesses to reduce this risk. The assessment is based on outputs from the Massachusetts Coastal Flood Risk Model, 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.[1] The data sources for the hazards addressed through the analysis are described in **Section 4.2 Coastal Hazard Data Sources.**

By having data for the same annual exceedance probability flood events over time, analysts develop an understanding of how risk to a structure increases due to rising sea levels and other factors related to climate change. Using this approach, the available flood hazard scenarios were used to extrapolate future annual exceedance probabilities for a range of flood events. For instance, today's 1% annual exceedance probability flood is likely to happen much more frequently in the future, meaning that the annual probability of flooding increases over time. The methods used for this risk analysis account for this by calculating each structure's risk of flooding at different depths each year to develop a full understanding of the risk over time. Properties that are flooded so frequently that they may be unusable if mitigation actions are not implemented are also identified, and the impact of the loss of those properties is quantified as a one-time full building loss. Similarly, properties that are exposed to erosion in 2030, 2050, or 2070 are also considered unusable and incur a one-time loss.

Risk through 2070 is assessed under the no action scenario, which determines losses if no flood protection measures are implemented. These losses can be compared to the losses under the recommended solution alternatives that do involve flood protection or erosion reduction measures.

Loss Metrics

Based on the approach summarized above, the following damages are quantified in dollar amount at the structure level and are reported island wide, as well as for sub-areas to be defined through the project process.

1. *Direct Physical Damages:*
   Analysts calculated both building and contents damages value for vulnerable structures using structure and contents depth-damage functions (DDFs) from the USACE North Atlantic Coast Comprehensive Study (NACCS).
2. *Direct Economic Disruption:*
   Analysts identified chronically flooded properties for which total loss of function will occur if no project is implemented, and account for their losses separately. Direct economic disruption represents the sum of commercial relocation costs and direct business interruption losses. Commercial relocation costs consist of one-time relocation costs, lost income experienced by property owners who lease their buildings, and rental costs for displaced property owners. Direct business interruption includes losses of business income, employee compensation, and other property income.

[1] Coastal flood hazard data from MC-FRM are not available for 2100 as of the development of this report

3. *Social Disruption:*
   Social disruption captures losses due to physical injuries, mental stress, loss productivity, and residential relocation. Losses due to injuries, mental stress, and lost productivity are all calculated based on standard FEMA values applied to the exposed population. Analysts quantified the cost of physical injuries to residents from evacuation, cleanup, or repair of a damaged/destroyed home based on a scaled fraction of the value of a statistical life, equal to $15,200 per injury.[2] It is assumed based on a post-Sandy CDC report that 10.4% of the population impacted by flooding would sustain an injury.[3] Mental stress losses are quantified as the cost for 30 months of treatment for mental stress caused by the negative effects of flooding on social and economic resources, equal to $2,761 per person impacted by flooding. Lost productivity is measured as the productivity share of 30 months of work per worker impacted by flooding, equal to $9,872 per worker.[4] Residential relocation costs include per-diem costs for lodging and meals and incidental expenditures (M&IE) for the duration of displacement, based on standard federal per-diem rates for Nantucket, equal to $76 per person per day for lodging and $227 per household per day for ME&I.[5]

4. *Regional Indirect, and Induced Economic Impacts*:
   Analysts calculated regional indirect and induced economic impacts. Jobs impacts and industry output losses will be reported.

5. *Tax Revenue:*
   Analysts calculated corporate tax, personal tax, social insurance tax, and tax on production and imports at the federal, state, and local level. Tax on production and imports includes sales tax, property tax, severance tax, special assessments, excise tax, and other taxes.

6. *Loss of frequently flooded properties*:
   Analysts identified frequently flooded properties for which total loss of function will occur if no project is implemented, and account for their losses separately.

The expected annual losses for each metric, which represents the probable loss that may occur within any given year to 2070, are calculated to determine the aggregate of high-impact, low-frequency events with low-impact, high-frequency events. Expected annual loss is calculated by integrating the event-based loss estimates over the corresponding exceedance probabilities, as shown in **Figure 1**. For this analysis, integration is estimated using the trapezoidal rule. The annual loss calculation can reveal that frequent events with less severe consequences have a greater impact on risk than infrequent events with more severe consequences.

[2] 2020 FEMA standard values report, escalated to 2020 using CPI inflation calculator from BLS
[3] https://www.cdc.gov/mmwr/preview/mmwrhtml/mm6342a4.htm#
[4] FEMA BCA Toolkit; 2012 dollars escalated to 2020 using CPI inflation calculator from BLS
[5] US General Services Administration, https://www.gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-lookup/?action=perdiems_report&state=MA&fiscal_year=2021&zip=&city=Nantucket

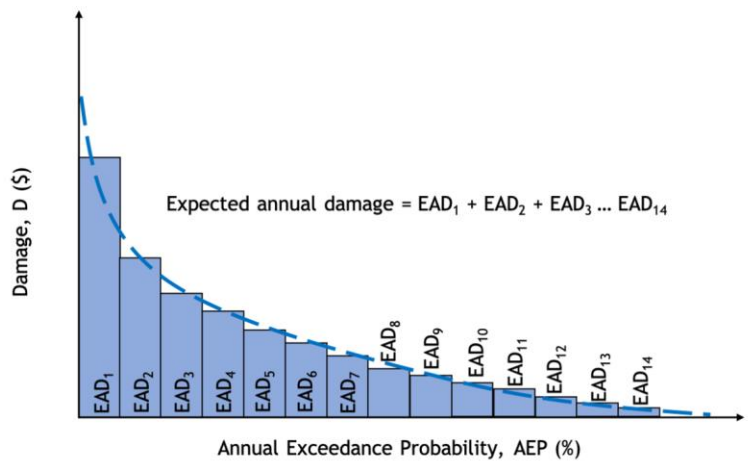


Figure 1. Annualization curve example. Source: Colorado Water Conservation Board

Risk is ultimately presented as a present value loss, which represents the cumulative expected annual losses from 2020 to 2070, discounted back to 2020 values. The discounting rate used to incorporate the time value of money is 3 percent.

Qualitative Risk Assessment

In addition to the quantitative risk analysis for buildings and structures, community assets, services, and infrastructure in the categories listed below are also mapped against flood and erosion exposure with direct impacts qualitatively discussed. The exposure analysis and mapping is used to communicate risk to these infrastructure, assets, and services and help the Town prioritize flood protection and erosion control measures, as appropriate.

- **Linear transportation infrastructure**, including roads, bridges, ferry terminals, and airports
- **Community assets and services**, including hospitals, fire stations, and cultural institutions
- **Critical Facilities**, including transportation facilities and emergency services
- **Linear subsurface utility infrastructure,** including sewers and water mains
- **Parks and open space,** including public parks and privately-owned protected open space
- **Habitat and natural resources,** including priority natural communities and wetland resource areas

In cases where structures are associated with the above services (for example, a hospital or fire station) the direct and indirect risk to the buildings serving these purposes can also be quantified in dollar figures, but not in terms of loss of service.

This qualitative risk assessment is based on the following flood and erosion scenarios to represent risk from recurrent tidal flooding, coastal flooding from a significant storm event, and projected future erosion hazard areas.

- **Tidal flooding** (Mean Monthly High Water) today and in 2030, 2050, 2070, and 2100
- **Coastal flooding** with a 1% annual exceedance probability (1 in 100 annual chance) today and in 2030, 2050, and 2070[6]

[6] Coastal flood hazard data from MC-FRM are not yet available for 2100. If this data becomes available, the 2100 horizon can be added to the coastal flood hazard analysis.

- **Coastal erosion hazard areas** in 2030, 2050, 2070[7], and 2100

Nantucket groundwater study

A water table elevation map (WTEM) was created to assess the future likelihood of groundwater flooding in Nantucket due to sea level rise (SLR). Flooding due to rising groundwater has distinct characteristics that set it apart from the more familiar flooding caused by direct overland inundation during storms and high tides. Whereas coastal storm flooding is fast and temporary, groundwater flooding tends to be slow and chronic. When SLR lifts the coastal water table, impacts can include higher corrosion rates of buried infrastructure, increased basement flooding, reduced stormwater and wastewater sewer capacity, soil contaminant mobilization, soil instability, and eventually the creation of wetlands as groundwater emerges to the surface.

Not only does groundwater flooding have impacts distinct from coastal inundation flooding, it also has unique solutions. While seawalls are effective against temporary storm surge, they don't substantially impact the long-term movement of groundwater. Thus, the response options for a rising water table tend to fall into the categories of groundwater drainage/pumping, raising structures, or gradual retreat. The viability of each option is highly dependent upon local conditions. Thus, making an initial broad assessment that determines the likelihood of groundwater flooding is useful for determining what areas should be targeted for more detailed hydrogeological assessments.

Methodology

The approach taken here is based on the method developed by Plane et al. (2019) which describes a rapid assessment method for groundwater flooding as applied to the San Francisco Bay area. This approach was also used by both Hoover et al. (2017) and Hummel et al. (2018). For example, in the Hummel et al. (2018) study, well data from the San Francisco area over a 20-year period was used to create a maximum water table elevation map for land close to San Francisco Bay. A water table surface was constructed by interpolating between groundwater monitoring wells and additional reference points at the shoreline to account for the shoreline water table being approximately at the mean tide line. SLR effects were approximated with a linear rise of water table.

The WTEM in this study was constructed from well data from 10 USGS wells on Nantucket Island. Monthly water level measurements were taken over multiple years for each well—most of them dating back to the 1980s. The highest water table readings (smallest depth-to-water) across Nantucket Island occurred in the spring of 1994. However, the island's water table has been fairly stable over the past 30 years but with a trend of a slowly rising water table (see Figure **2**). Likewise, high rainfall events that substantially raise the water table are expected to occur more frequently with climate change. Thus, the highest measured reading was used as a conservative estimate.

[7] The 2070 erosion zone was interpolated based on the 2019 FEMA Erosion Study using GIS. It is suitable for general planning and risk analysis purposes only.

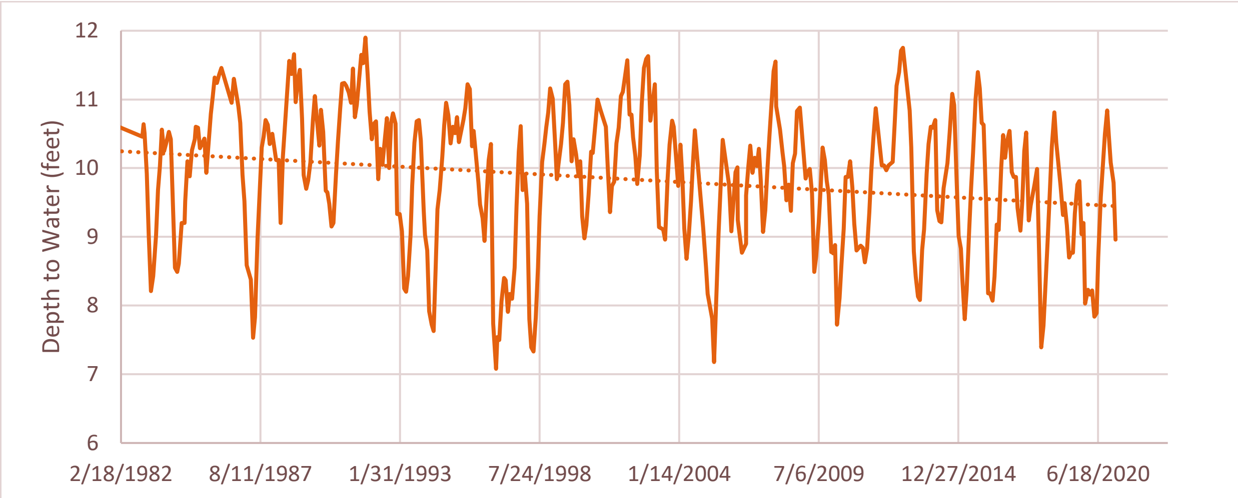


Figure 2. A graph of published monthly well data for well MA MWB 107 with a trendline showing the water table rising over time (depth to water is decreasing)

The elevation of the water table at the coast tends to be higher than mean sea level due to asymmetric tidal flow (Turner et al. 1997). That is, seawater tends to surcharge the coastal water table during high tide at a higher rate than it drains out during low tide. The result is a small offset between mean sea level and the water table at the shore. Plane et al. (2019) used a 1-foot offset at the coast to account for this phenomenon. Previous groundwater modeling has confirmed the appropriateness of this offset in sandy glacial soils of the Northeastern US.

In addition to USGS groundwater monitoring wells and shoreline reference points, inland water bodies (natural ponds and streams) that were likely to intersect the water table (Winter 1999) were also included as known water table reference points. This technique has been used to map the coastal aquifer in Delaware (Martin and Andres 2008).

The water table surface was generated using a radial basis function interpolation. Such methods are preferred for water table generation with a small unevenly spaced dataset because the method can generate a smooth surface that goes through all data points and does not require measuring the highest point in the water table.

A map of the depth to groundwater was generated by subtracting the WTEM from a recent (2016) digital elevation model (DEM) of Nantucket Island (Figure **3**). SLR was accounted for by adding the expected SLR for each future scenario to this depth-to-water map under the high scenario using projections adopted by the Commonwealth of Massachusetts, as referenced in **Section 4.2 Coastal Hazard Data Sources.**

Figure 3. Current conditions depth-to-water map for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

Discussion

Depth-to-water groundwater maps created by the method described above should be used with caution. Some sources of uncertainty include:

1. Water tables can vary depending on many factors including tides, season, droughts, and heavy precipitation. The water table near the shore is often tidally influenced but also tends to be relatively stable over time because it is constrained by mean sea level. Further inland, the water table can vary by much larger amounts depending on longer term precipitation trends and any changes in groundwater pumping.
2. In general, water tables tend to mimic the surface topography. However, a lack of inland wells or surface water features at every high and low spot means that the smoothed interpolated water table surface may be overestimated or underestimated when the terrain has rapid gradient changes. Thus, hilly areas and areas with few wells have higher uncertainty. In addition, areas with “perched” water tables can make the coastal water table appear more variable; this can be difficult to judge without knowledge of the local hydrogeology and ample well data.
3. Groundwater pumping or dewatering of below-grade infrastructure (basements) can depress the local water table lower than expected to occur naturally. However, this is likely a minor contribution on Nantucket Island where soil conditions encourage rapid water movement.

While these caveats restrict the groundwater map usage, the maps still provide valuable insight regarding areas of concern that should be monitored and assessed in the future. See the following pages for maps of present-day and projected future depth to groundwater mapping

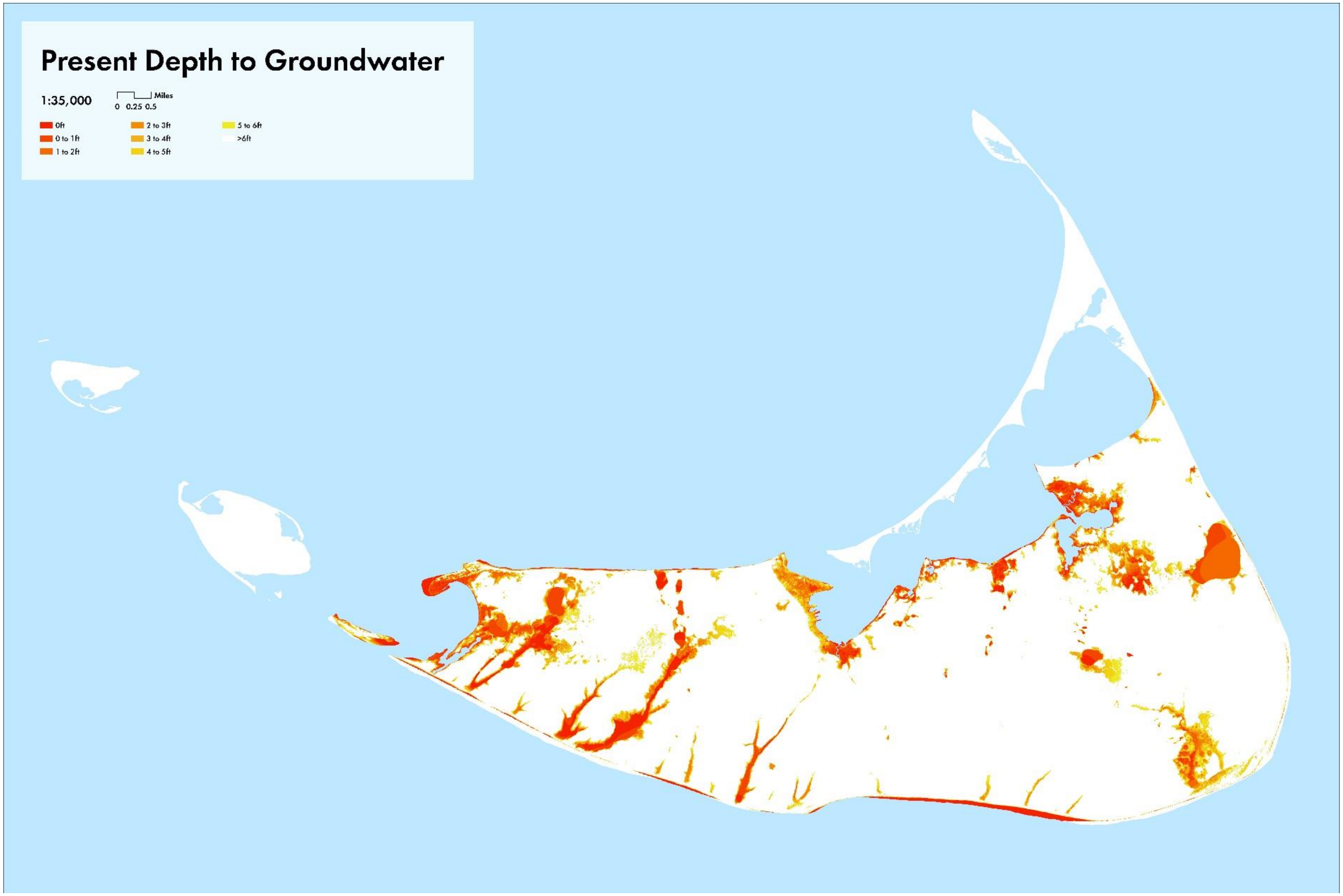


Figure 4. Current conditions depth-to-water map for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

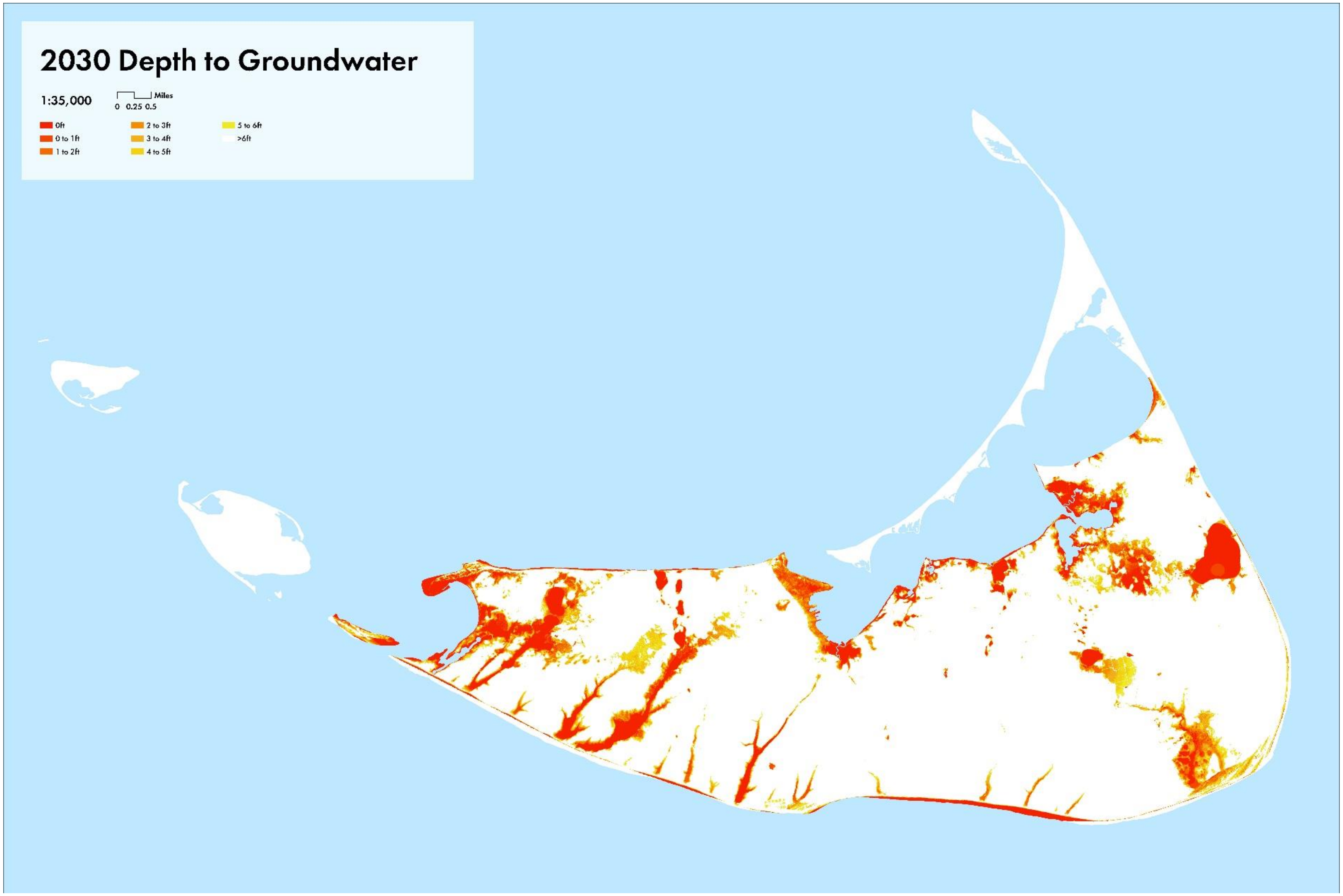


Figure 5. Estimated 2030 depth-to-water map with projected sea level rise for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

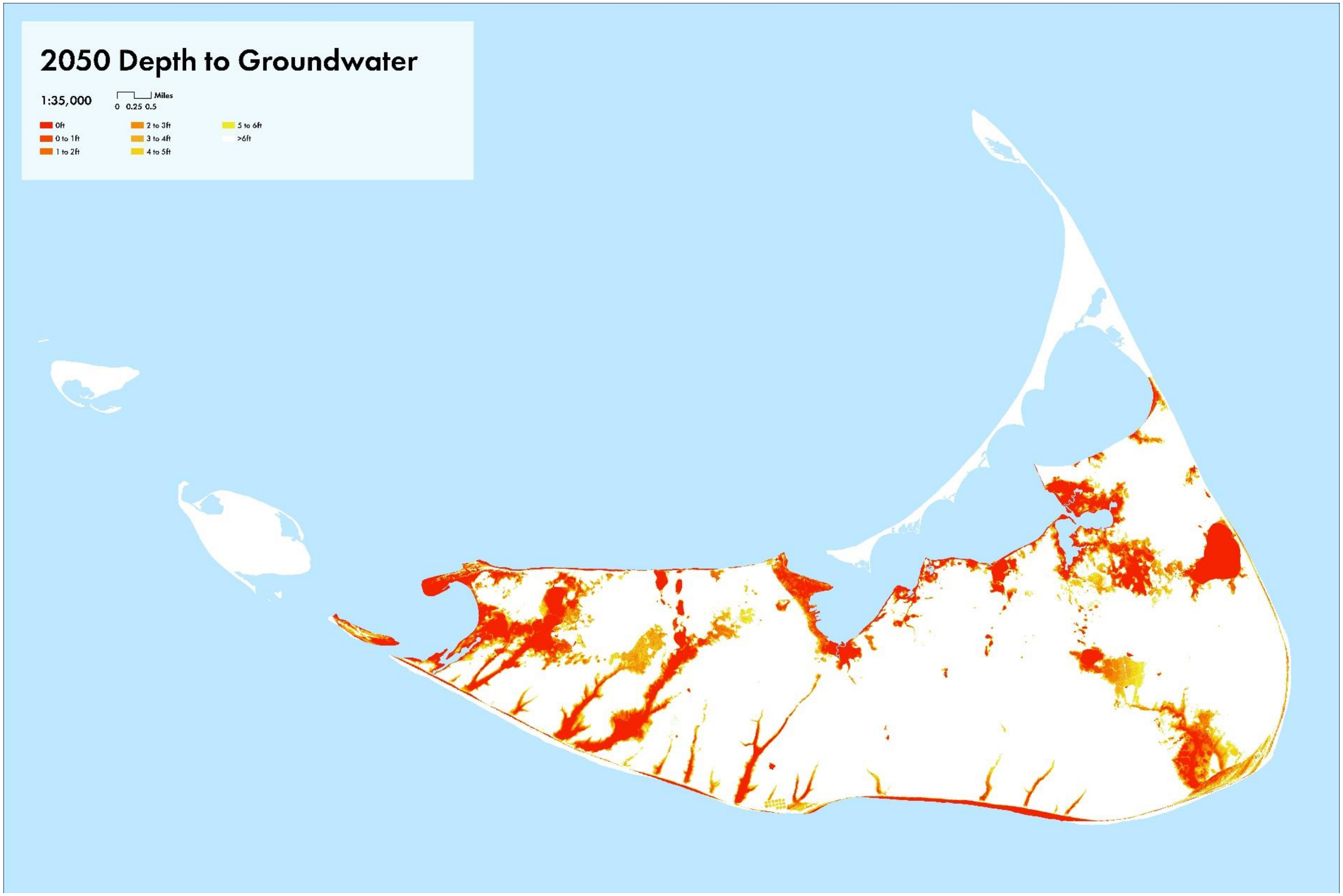


Figure 6. Estimated 2050 depth-to-water map with projected sea level rise for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

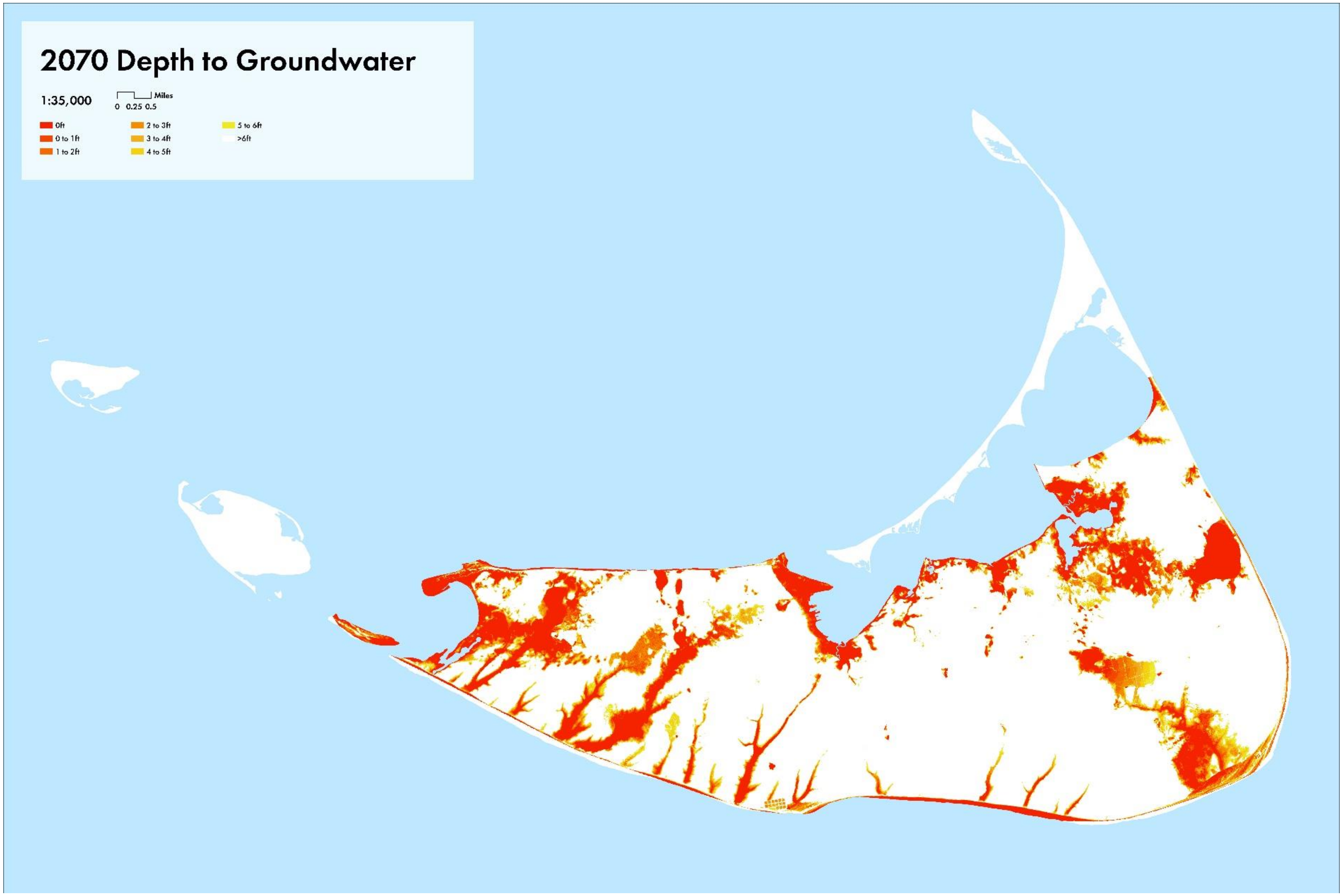


Figure 7. Estimated 2070 depth-to-water map with projected sea level rise for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

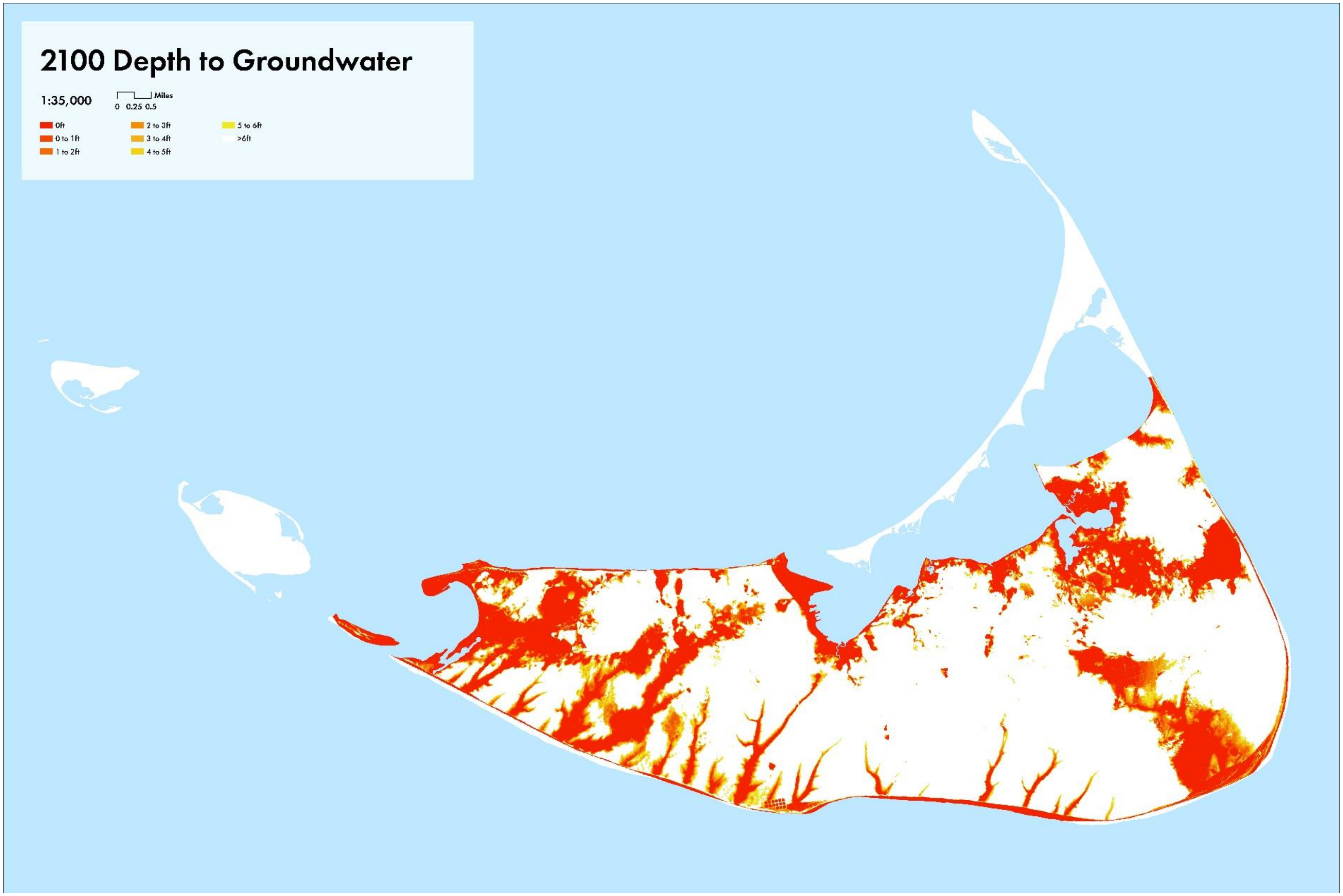


Figure 8. Estimated 2100 depth-to-water map with projected sea level rise for main portion of Nantucket Island (distance from surface to water table in feet) Unmapped portions had insufficient data, but the water table is expected to be very shallow in those areas.

Appendix B

Asset Prioritization Data

Name	Category	Subcategory	Address	Flood Design Class	Infrastructure	Emergency Response	Public Health, Safety, Physical Well Being	Community Services	Ecosystem/ Environmental Health	Tourism Flag	Town Owned?	Criticality Score	Risk Score	Priority Score
Steamship Authority	Transportation	Ferry	1 Steamboat Wharf	4	3	2		1		1		152	13%	19.00
Coast Guard Station Brant Point	Emergency Services	Coast Guard	10 Easton St	4		3	2					128	8%	9.76
Stop & Shop	Community Facilities and Services	Grocery Stores	9 Salem St	3			3					36	23%	8.17
Jetties Concession Building	Community Facilities and Services	Town Concessions	4 Bathing Beach Rd	2				3		1		20	22%	4.43
Hy-Line Cruises - Straight Wharf	Transportation	Ferry	34 Straight Wharf	4	3	2		1		1		152	2%	3.69
Electrical Substation	Utilities	Power Facilities	2 Commercial St	3	3		2					78	3%	2.24
American Legion Hall	Community Facilities and Services	Recreation	21 Washington St	3				3				27	6%	1.55
Whaling Museum	Community Facilities and Services	Libraries/Museums	13 Broad St	3				3		1		30	5%	1.46
Nantucket Food Pantry	Community Facilities and Services	Grocery Stores	10 Washington St	3			3					36	2%	0.81
University of Massachusetts Nantucket Field Station	Community Facilities and Services	College Facilities	180 Polpis Road	3			3					36	2%	0.57
Children's Beach/Grandstand Concession	Community Facilities and Services	Town Concessions	15 Harborview Way	2				3		1		20	3%	0.51
Old Brant Point Lighthouse	Community Facilities and Services	Lighthouses	10 Easton St	1			3			1	1	14	3%	0.46
Natural Resources Department	Community Facilities and Services	Town Administration	2 Bathing Beach Rd	2			2		3		1	36	1%	0.44
Sheriff Office (County) and NRTA	Emergency Services	Police Station	20 S Water St	4		2	3	1			1	128	0%	0.36
Police Deprtment Housing (Dorms)	Community Facilities and Services	Town Housing	54 Low Beach Rd	2			3	2				36	1%	0.35
Nantucket Aquarium	Community Facilities and Services	Libraries/Museums	28 Washington St	3				3		1		30	1%	0.34
Artists Association of Nantucket Gallery	Community Facilities and Services	Libraries/Museums	19 Washington St	3				3		1		30	1%	0.26
Tom Nevers Sheds	Community Facilities and Services	Town Concessions	130 Tom Nevers Rd	2				3		1		20	1%	0.21
Nantucket Solid Waste MGT Facility	Utilities	Waste Facilities	188 Madaket Rd	3	3		2	2	1		1	108	0%	0.20
Female Lifeguard Housing	Community Facilities and Services	Town Housing	109 Washington St	2			3	2				36	0%	0.17
Nantucket Cliff Range	Community Facilities and Services	Lighthouses	92 Hulbert Ave	1			3			1	1	14	1%	0.14
Nantucket Town Hall, RMV, and Superior Court	Community Facilities and Services	Town Administration	16 Broad St	2			3	2			1	38	0%	0.13
University of Florida Foundation	Community Facilities and Services	Libraries/Museums	27 Washington St	3				3		1		30	0%	0.11
Nantucket Lifesaving Museum	Community Facilities and Services	Libraries/Museums	158 Polpis Rd	3				3		1		30	0%	0.11
Brant Point Lighthouse	Community Facilities and Services	Lighthouses	Easton St	1			3			1	1	14	1%	0.08
Great Point (Nantucket) Light	Community Facilities and Services	Lighthouses	147 Wauwinet Rd	1				3		1	1	11	0%	0.04
Nantucket Atheneum	Community Facilities and Services	Libraries/Museums	1 India St	3				3		1	1	33	0%	0.03
Loran Station	Emergency Services	Coast Guard	65 Low Beach Rd	4		3	2					128	0%	0.01
Nantucket Lightship Basket	Community Facilities and Services	Libraries/Museums	49 Union St	3				3		1		30	0%	0.01
Sankaty Head Light	Community Facilities and Services	Lighthouses	Baxter Rd	1			3			1	1	14	0%	0.01
Post Office - Downtown	Community Facilities and Services	Post Office	5 Federal St	2				3			1	20	0%	0.01
St. Mary-Our Lady of the Isle	Community Facilities and Services	Places of Worship	3 Federal Street	3				3				27	0%	0.00
Madaket Fire Station	Emergency Services	Fire Station	293 Madaket Rd	4		3	2				1	132	0%	0.00
Nantucket Memorial Airport	Transportation	Airport	14 Airport Rd	4	3	2		1		1	1	156		
Police Station & Public Safety Facility	Emergency Services	Police Station	4 Fairgrounds Rd	4		3	2	1			1	144		
State Police Station D-6	Emergency Services	Police Station	83 North Liberty Street	4		3	2	1			1	144		
Nantucket Cottage Hospital	Emergency Services	Hospital	57 Prospect Street	4		3	2	1				140		
Siasconset Fire Station	Emergency Services	Fire Station	10 W Sankaty Rd	4		3	2				1	132		
Main Fire Station & Public Safety Facility	Emergency Services	Fire Station	4 Fairgrounds Rd	4		3	2				1	132		
Tuckernuck Fire Station	Emergency Services	Fire Station	NANT, 96, 4	4		3	2				1	132		
North Pasture Water Tower	Utilities	Water	43 Polpis Rd	4	3		2				1	108		
Siasconset Water Tower	Utilities	Water	50 Main Sias St	4	3		2				1	108		
North Pasture Pump Station	Utilities	Water	43 Polpis Rd	4	3		2				1	108		
Siasconset Pump Station	Utilities	Water	50 Main Sias St	4	3		2				1	108		
Surfside Wastewater Treatment Plant	Utilities	Sewer	81 South Shore Rd.	3	3		2		2			96		
Siasconset Wastewater Treatment Plant	Utilities	Sewer	57 Low Beach Rd	3	3		2		2			96		
Wannacomet Water Company Office	Utilities	Water	1 Milestone Rd	3	3		2				1	81		
Wyers Valley Pump Station	Utilities	Water	1 Milestone Rd	3	3		2				1	81		
State Forest Pump Station	Utilities	Water	21 Lovers Ln	3	3		2				1	81		
Washing Pond Water Tower	Utilities	Water	211 Cliff Rd	3	3		2				1	81		
Nantucket Electric Company	Utilities	Power Facilities	Bunker Rd	3	3		2					78		
Ames Ave Bridge	Transportation	Bridge	<Null>	3	3						1	57		
Madaket Rd Bridge	Transportation	Bridge	<Null>	3	3						1	57		
Madaket Rd The Gut Culvert	Transportation	Bridge	<Null>	3	3						1	57		
Nantucket High & Cyrus Pierce Middle Schools	Community Facilities and Services	Public School	10 Surfside Rd	3			3	2				54		
Nantucket Lighthouse School	Community Facilities and Services	Private School	1 Rugged Road	3			3	2				54		
Nantucket Elementary & Intermediate School	Community Facilities and Services	Public School	30 Surfside Rd	3			3	2				54		
Nantucket New School	Community Facilities and Services	Private School	15 Nobadeer Farm Road	3			3	2				54		
Small Friends of Nantucket	Community Facilities and Services	Daycare	21 Nobadeer Farm Rd	3			3	2				54		
Isaac Coffin Lancastrian School	Community Facilities and Services	Private School	4 Winter St	3			3	2				54		
Rising Tide	Community Facilities and Services	Preschool	16 Newtown Rd	3			3	2				54		
Children's House Montessori School	Community Facilities and Services	Preschool	7 Pheasant Dr	3			3	2				54		
Exploration Station	Community Facilities and Services	Preschool	2 S Pasture Ln	3			3	2				54		
Strong Wings	Community Facilities and Services	Private School	9 Nobadeer Farm Rd	3			3	2				54		
Bartlett's Farm	Community Facilities and Services	Grocery Stores	33 Bartlett Farm Rd	3			3			1		39		
Town Housing #5A & B	Community Facilities and Services	Town Housing	5A & B Hillside Dr	2			3	2			1	38		
Town Housing#7A & B	Community Facilities and Services	Town Housing	7A & B Hillside Dr	2			3	2			1	38		
Employee Housing	Community Facilities and Services	Town Housing	38 W Chester St	2			3	2			1	38		
Public Boat Ramp - Downtown	Transportation	Boat Ramp	<Null>	2	3					1		38		

Name	Category	Subcategory	Address	Flood Design Class	Infrastructure	Emergency Response	Public Health, Safety, Physical Well Being	Community Services	Ecosystem/ Environmental Health	Tourism Flag	Town Owned?	Criticality Score	Risk Score	Priority Score
Public Boat Ramp - F St	Transportation	Boat Ramp	<Null>	2	3					1		38		
Public Boat Ramp - Ames Ave	Transportation	Boat Ramp	<Null>	2	3					1		38		
Male Lifeguard Housing	Community Facilities and Services	Town Housing	47 Okorwaw Ave	2			3	2				36		
Preservation Institute Nantucket	Community Facilities and Services	College Facilities	11 Centre St	3			3					36		
Stop & Shop	Community Facilities and Services	Grocery Stores	31 Sparks Ave	3			3					36		
Nantucket Ice Arena	Community Facilities and Services	Recreation	10 Backus Lane	3				3		1		30		
Museum of African American History	Community Facilities and Services	Libraries/Museums	29 York St	3				3		1		30		
Nantucket Historical Association Jethro Coffin House	Community Facilities and Services	Libraries/Museums	16 Sunset Hill	3				3		1		30		
1800 House	Community Facilities and Services	Libraries/Museums	4 Mill St	3				3		1		30		
Maria Mitchell Association	Community Facilities and Services	Libraries/Museums	7 Milk St	3				3		1		30		
William Hadwen House	Community Facilities and Services	Libraries/Museums	96 Main St	3				3		1		30		
Thomas Macy House	Community Facilities and Services	Libraries/Museums	99 Main St	3				3		1		30		
Greater Light	Community Facilities and Services	Libraries/Museums	8 Howard St	3				3		1		30		
Maria Mitchell Observatory	Community Facilities and Services	Libraries/Museums	3 Vestal St	3				3		1		30		
Nathaniel Macy House	Community Facilities and Services	Libraries/Museums	12 Liberty St	3				3		1		30		
Bartholomew Gosnold Center	Community Facilities and Services	Libraries/Museums	89 Bartlett Rd	3				3		1		30		
Artists Association of Nantucket Amelia Dr	Community Facilities and Services	Libraries/Museums	24 Amelia Dr	3				3		1		30		
Maria Mitchell Association Library	Community Facilities and Services	Libraries/Museums	4 Vestal St	3				3		1		30		
The Residence at Sherburne Commons	Community Facilities and Services	Long-term Care	40 Sherburne Commons	3				3				27		
Summer Street Church	Community Facilities and Services	Places of Worship	1 Summer Street	3				3				27		
St. Paul's Church	Community Facilities and Services	Places of Worship	20 Fair Street	3				3				27		
Our Island Home	Community Facilities and Services	Long-term Care	9 East Creek Road	3				3				27		
Union Chapel at Siasconset	Community Facilities and Services	Places of Worship	18 New Street	3				3				27		
Congregation Shirat HaYam & Second Congregational	Community Facilities and Services	Places of Worship	11 Orange Street	3				3				27		
Nantucket United Methodist Church	Community Facilities and Services	Places of Worship	2 Centre Street	3				3				27		
Nantucket Worship Group	Community Facilities and Services	Places of Worship	7 Fair Street	3				3				27		
Jehovahs Witness Nantucket	Community Facilities and Services	Places of Worship	43 Milk St	3				3				27		
Christian Science Society of Nantucket	Community Facilities and Services	Places of Worship	2 Madaket Rd	3				3				27		
First Congregational Church	Community Facilities and Services	Places of Worship	62 Centre St	3				3				27		
Lighthouse Baptist Church	Community Facilities and Services	Places of Worship	4 Trotters Ln	3				3				27		
Rev Joseph Griffin Hall	Community Facilities and Services	Places of Worship	15 Cherry St	3				3				27		
Surfside Beach Concession Building	Community Facilities and Services	Town Concessions	4 Western Ave	2				3		1		20		
Delta Fields Concession	Community Facilities and Services	Town Concessions	8 Sun Island Rd	2				3		1		20		
Post Office - Airport	Community Facilities and Services	Post Office	155 Old South Rd	2				3			1	20		
Post Office - Mid Island	Community Facilities and Services	Post Office	144 Pleasant St	2				3			1	20		
Post Office - Sconset	Community Facilities and Services	Post Office	6 Main Street	2				3			1	20		
Red Barn Rd Bridge	Transportation	Bridge	<Null>	1	3						1	19		
N Cambridge St Bridge	Transportation	Bridge	<Null>	1	3						1	19		
Camp Richard	Community Facilities and Services	Recreation	47 Rugged Rd	2				3				18		
Nantucket Boys and Girls Club	Community Facilities and Services	Recreation	61 Sparks Ave	2				3				18		
Nantucket Community Music Center	Community Facilities and Services	Recreation	56 Centre St	2				3				18		
Former Fire Station	Emergency Services	Fire Station	131 Pleasant St	1			3				1	13		

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