



# Planning and Land Use Services

Building ▪ Energy ▪ Historic District Commission ▪ Planning Board ▪ Zoning Board of Appeals

February 28, 2019

Select Board  
16 Broad Street  
Nantucket, MA 02554

To the members of the Nantucket Select Board & Nantucket Planning & Economic Development Commission:

As you are aware, Town of Nantucket staff have been working with consulting firm Milone & MacBroom over the past 18 months to update our Hazard Mitigation Plan. The original plan was adopted by the Board of Selectmen in 2007.

In 2017, the Town of Nantucket received a grant from MEMA (Massachusetts Emergency Management Agency) to help prepare this necessary update. The 2019 Hazard Mitigation Plan identifies long-term strategies for risk reduction, implementation approaches, and builds partnerships for risk reduction between the Town and the public. The updated plan will allow MEMA, FEMA, and local Emergency Management with information to help guide them in the event Nantucket has a natural disaster. In addition, upon the formal adoption of the updated plan, the Town of Nantucket will be eligible to receive Federal Grants for Hazard Mitigation Projects that have been addressed in the update.

While we were in front of the Board for local adoption on February 13<sup>th</sup>, the plan was not approved due to concerns from some members of the public. Staff had a public review session on February 26<sup>th</sup> to which a couple members of the public were in attendance. From this meeting, staff compiled several changes, provided the changes to MEMA, and under advisement of MEMA, have been incorporated into the updated plan. These changes include: restructuring how the SBPF project was discussed; rewording the sentence on Sea Level Rise; adding a few sentences to the executive summary about erosion being a primary risk, the definition of Repetitive Loss Properties, and adding two research recommendations (outlined in the body of the plan) as priority.

With these changes, as acknowledged by MEMA, staff is delighted to present the updated 2019 Town of Nantucket's Hazard Mitigation Plan. Upon adoption a final approval by FEMA, the next steps are to implement the prioritized mitigation actions outlined in the updated plan and facilitate our annual reviews of the plan annually. As the Town's Local Hazard Mitigation Plan Coordinator, I look forward to working with the rest of Town staff to accomplish the goals of the plan.

Sincerely,

Holly E. Backus  
Land Use Specialist  
Town of Nantucket

**TOWN OF NANTUCKET  
NATURAL HAZARD MITIGATION PLAN**

**FEBRUARY 2019  
ADOPTED MARCH 6, 2019**

**MMI #2967-09**



*Prepared For:*

Town of Nantucket  
16 Broad Street  
Nantucket, Massachusetts 02554

*Prepared By:*



Milone & MacBroom, Inc.  
99 Realty Drive  
Cheshire, Connecticut 06410  
(203) 271-1773

## EXECUTIVE SUMMARY

### *Town of Nantucket Hazard Mitigation Plan Update, 2019*

The Town of Nantucket has prepared this Hazard Mitigation Plan (HMP) to identify natural hazards and risks, infrastructure vulnerabilities, existing capabilities, and activities that can be undertaken by the community to prevent loss of life and reduce property damages associated with identified hazards. It represents actions and priorities that should be considered and addressed in the following five years (2019 to 2023) and will be updated on a regular basis. The Federal Disaster Mitigation Act of 2000 requires local communities to have a FEMA-approved mitigation plan in order to be eligible to receive Pre-Disaster Mitigation Program grants and Post-Disaster Hazard Mitigation Grant Program funds under the Hazard Mitigation Assistance program. This Plan will also help Nantucket identify projects and activities eligible for funding from other sources including a range of State of Massachusetts grants and the Town's Capital Improvement funds.

The Nantucket Planning & Land Use Services (PLUS) Office, with assistance from the Nantucket Emergency Management Agency, will administer this HMP under the authority of the Board of Selectman. Holly Backus, Land Use Specialist at PLUS, will be the Local Coordinator of the Hazard Mitigation Plan, and the Chief of Police and Emergency Management Director (a single position) will be the deputy Local Coordinator. PLUS will coordinate with responsible departments and ensure that the recommendations of this HMP are considered or enacted.

This HMP is an update to the previous Nantucket HMP, adopted in 2007. Information sources used to update this version of the plan included:

- Project initiation meeting on September 18, 2017.
- Public meeting on October 23, 2017.
- Public meeting geared toward stakeholders was held on November 27, 2017.
- Interviews with Town staff and others were held by phone between December 4 and December 12, 2017.
- A public online-survey between October 20 and December 15, 2017.
- Feedback from Town staff on winter storm events in early 2018.

Key changes since the previous edition of the HMP include the following:

#### **Vision**

In meetings with municipal staff, a plan vision was developed. The vision of this Hazard Mitigation Plan is "To mitigate the detrimental impacts of natural hazards to Nantucket while maintaining and enhancing the Island's quality of life, historic essence, aesthetic beauty, and natural and habitat resources."

#### **Goals**

The previous HMP's eight goals have been reclassified as objectives aimed at achieving five new, central goals. The new goals are:

five of the top ten flood elevations measured in Nantucket history occurred in the first three months of 2018. The top ten historic flood crests are summarized below (source: NOAA), with 2018 events bolded. All values in feet NAVD88.

1. 5.78 feet on 10/30/1991 - Perfect Storm
2. **5.27 feet on 01/04/2018 - Winter Storm Grayson**
3. **5.12 feet on 01/27/2015 - Winter Storm Juno**
4. **4.69 feet on 03/03/2018 - Winter Storm Riley**
5. **4.61 feet on 03/03/2018 - Winter Storm Riley**
6. 4.58 feet on 12/12/1992 - nor'easter
7. **4.53 feet on 03/02/2018 - Winter Storm Riley**
8. 4.48 feet on 01/03/2014 - blizzard
9. 4.25 feet on 01/02/1987 - nor'easter
10. **4.25 feet on 01/30/2018 - blizzard**

### Community Profile

The Town of Nantucket consists of 48 square miles of land and approximately 88 miles of shoreline and includes the islands of Nantucket, Tuckernuck, and Muskeget. Key physical features include high bluffs, long systems of beaches and dunes, several north-south trending elongated ponds that are typically cut off from the ocean by narrow beaches, extensive moorlands, and numerous areas of tidal wetlands. Nantucket does not have many non-tidal fresh watercourses.

Nantucket's main population and economic centers are located in the Downtown/Brant Point, 'Sconset, Madaket, and Mid-Island Areas; ongoing development is focused mostly on the Mid-Island area. 55% of the total land area of Nantucket is conservation land. The Town is home to between 10,172 (according to the 2010 Census) and 17,200 (according to the Nantucket Data Platform) permanent residents, with seasonal tourism boosting the population to over 46,000 at times. The Island is accessible via two ferry lines that dock in the Downtown, and the airport.

### Natural Hazard Profile

Natural hazards addressed in this Plan include inland flooding, coastal flooding, hurricanes and tropical storms, shoreline change and erosion, summer storms and tornadoes, winter storms, wildfires, and earthquakes. The effects of climate change, including rising sea levels and intensifying precipitation extremes, are also discussed within the context of each hazard. For each of these natural hazards, the Plan presents risk-locations, likelihood of occurrence, and potential for loss of life and property, with the understanding that a particular type of damage can be caused by a variety of hazard effects, which in turn can be caused by a variety of hazard events (for example, the hazard event of a hurricane and a winter storm can each cause the hazard effect of both high wind and high precipitation, and either of those can cause tree limbs to fall on utility lines and take out power).

The primary hazards for Nantucket are coastal flooding, **erosion**, shoreline change, and high winds. The Downtown and Brant Point neighborhoods, along with Madaket and Codfish Park, are

particularly at risk to coastal inundation. Erosion is a major concern along the southern shore of the Island, where it threatens key airport and wastewater treatment infrastructure, and in ‘Sconset on the eastern end of the Island. High winds are a concern across the entire Town.

### Flooding

There are very few inland watercourses on Nantucket that pose a risk of flooding; these are:

- ❑ Phillips Run
- ❑ Sesachacha Pond (areas west and southwest of the pond)
- ❑ Miacomet Pond Tributary

Flooding in areas that are not along watercourses but are unable to support effective gravity drainage to an outfall is a more significant problem. This type of flooding, often called flash-flooding or urban flooding, is common in the more developed areas of the Island including the Downtown and Mid-Island neighborhoods, and in particular Airport Road, Raceway Road, and Somerset Road. Loss of access due to flooded roads is also a concern, in particular in ‘Sconset.

Nantucket has 1,136 buildings located within coastal FEMA flood hazard zones (AE and VE zones), including a number of critical facilities. Particularly at-risk areas include Downtown and Brant Point, Madaket, Polpis and Wauwinet, and Codfish Park in ‘Sconset.

In addition to the risk of severe storm flooding represented by FEMA flood hazard zones, Nantucket is concerned about two less-severe forms of flooding, which they define as follows:

- ❑ **Nuisance Flooding** is a combination of poor local storm water drainage and high tides that cause flooding to a depth of several inches in some location a few times per year. Nuisance flooding can occur on days without precipitation or high winds and is sometimes referred to as “sunny day flooding.”
- ❑ **High Tide Flooding** is caused when higher-than-normal tides, typically related to storm events, flood low-lying areas. These events are less frequent and more extensive than nuisance flooding, and cause inconveniences such as road closures, overwhelmed drainage systems, and compromised infrastructure.

Nantucket’s capabilities to mitigate flooding include **participation in the National Flood Insurance Program** (the most recent FIRM and FIS for Nantucket was made effective August 5, 2014), **regulations and codes** that restrict development near hazard areas and require buildings be built to certain standards, and ongoing **Drainage System Upgrades**, especially a long-term upgrade of the downtown drainage infrastructure. Nantucket’s land conservation organizations own, and continually pursue acquisition of additional, coastal land that will be preserved as **open-space**, decreasing the exposure of residents to coastal hazards

### Sea Level Rise, Shoreline Change, and Erosion

The entire shoreline of Nantucket is vulnerable to sea level rise, shoreline change, and erosion. Areas of particular concern include ‘Sconset, the Island’s southern shore near Madaket, and Cliff

**Table ES-1: Annualized Loss Estimates for All Hazards**

Source	Annualized Estimated Loss						
	Inland Flood	Coastal Flood	Hurricane	Summer Storms	Winter Storm	Wildfire	Earthquake
HAZUS-MH <sup>1</sup>	no annual	no annual	\$10,026,000	-	-	-	-
PA & NFIP <sup>2</sup>	\$11,597	\$411,705	\$521	-	\$74,497	-	-
NCEI <sup>3</sup>	\$714	\$16,143	\$7,857	\$194	\$21,905	-	-
State HMP <sup>4</sup>	-	-	-	-	-	\$2,000	\$40,802
Town Estimates <sup>5</sup>	-	-	-	\$524	-	\$8,699	-

**Mitigation Strategies and Actions**

Nantucket has an appropriate variety of formal and informal hazard mitigation capabilities. The Plan update identifies and assesses these existing capabilities and proposes new strategies that address identified gaps in current mitigation efforts. An updated list of mitigation strategies and actions that the Town will attempt to achieve over the next five years is also included. This list of actions was prioritized through a combination of municipal input and used of the “STAPLEE” method, as outlined in FEMA planning documents such as Developing the Mitigation Plan (FEMA 386-3) and Using Benefit-Cost Review in Mitigation Planning (FEMA 386-5). STAPLEE stands for the "Social, Technical, Administrative, Political, Legal, Economic, and Environmental" criteria for making planning decisions. Each proposed mitigation strategy was evaluated according to each of the STAPLEE criteria and quantitatively assigned a score. The top-priority actions are listed in Table ES-2.

It is understood that not all mitigation actions may be able to be completed in the next five years depending on the ability to obtain grant funding, availability of local funding and staff time, and/or permission from pertinent property owners. Nantucket plans to conduct an annual Hazard Mitigation Plan maintenance process to review the status of proposed mitigation actions.

*In addition to these top-priority actions, the Town plans to focus on the two actions “Implement a project to map the near shore sand and sediment transport to develop a sand-budget model for monitoring island wide coastal erosion. Side scan sonar will be used to measure bathymetry in extremely shallow water, between 0 and 20 ft. deep. Mapping in high resolution monitors the movement of sand shoals and identifies location of marine habitat on the sea floor” and*

<sup>1</sup> HAZUS-MH is FEMA's loss estimation methodology software for flood, wind, and earthquake hazards.

<sup>2</sup> Public Assistance (PA) reimbursements and NFIP (National Flood Insurance Program) claim payments. Note that PA funding is only granted for public projects, while NFIP claims are only granted for private property; therefore, the two are considered as a single unit (“PA & NFIP”).

<sup>3</sup> The National Centers for Environmental Information (NCEI) maintains a database of historic storm events across the country.

<sup>4</sup> The State Hazard Mitigation Plan includes loss estimates developed from a variety of sources.

<sup>5</sup> Additional estimates were developed through personal communication with municipal officials.

**Table ES-2: Top Priority Mitigation Actions**

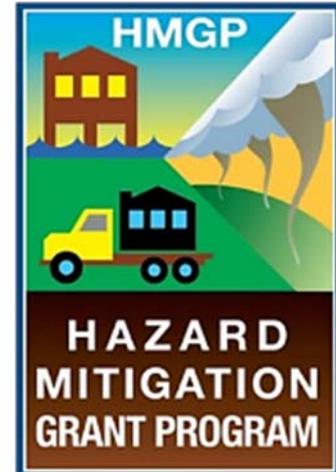
Action Code	Strategy	Hazards Mitigated						
		Inland Flood	Coastal Flood	Hurricane	Summer Storm	Winter Storm	Wildfire	Earthquake
SC1	Complete the Community/Coastal Resilience Plan and Become an MVP Community	X	X	X	X	X	X	X
F10	Participate in a limited public-private partnership with Nantucket Engineering & Survey to complete a study of the Fulling Mill Brook watershed, in particular the hydrologic conditions at Polpis Road, to identify alternatives for improvements to this area.	X	X	X	X	X		
WF2	Complete mutual aid agreement with the NCF, Nantucket Land Council, Nantucket Land Bank, and/or Massachusetts Audubon Society for firefighting assistance.						X	
A5	Review the Nantucket Intermediate School and the Elementary School and determining their abilities to serve as emergency shelters.	X	X	X	X	X	X	X
A10	Conduct a targeted hazard vulnerability assessment of historic structures and offer technical assistance to property owners.	X	X	X	X	X	X	X
F6	Develop a comprehensive storm water management plan that addresses needs and priorities to reduce flooding and improve drainage. Include a funding model and possible revenue sources to sustain ongoing maintenance and capital improvements. The Plan should review policy and regulations that govern the discharge of water into the Town's ROW and those that have direct connection to the Town's storm drainage system. The rising sea level and water table is leading to more sump pumps discharging into the drains or on the roadway.	X	X	X	X	X		
F19	Relocate important hard-copies of Town records (including Finance Department records and Health Department records) to a new storage location outside of the SFHA (currently located on Washington Street)	X	X					
F25	Develop a protocol or formal Standard Operating Procedure for opening and closing of the tide gate at Children's Beach boat ramp. Work with local citizens to make sure they are aware of the protocol.		X					
WS1	Develop local capacity for housing emergency equipment and personnel in Madaket village during a storm, in case of isolation due to road closure.			X	X	X		

*“Implement a project to map the harbor floors (Madaket, Polpis and Nantucket) to measure and monitor sediment transport. Information will be used to develop dredging and disposal plan, as well as the Harbor management Plan. Side scan sonar will be used to measure bathymetry in extremely shallow water, between 0 and 20 ft. deep.”* These two actions will help position the Town for improved erosion and sand management in relation to beach nourishment and other projects that may arise.

Hazard Mitigation Grant Program (HMGP)

The HMGP is authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act. The HMGP provides grants to States and local governments to implement long-term hazard mitigation measures after a major disaster declaration.

The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. A key purpose of the HMGP is to ensure that any opportunities to take critical mitigation measures to protect life and property from future disasters are not "lost" during the recovery and reconstruction process following a disaster.



Flood Mitigation Assistance (FMA) Program

The FMA program was created as part of the National Flood Insurance Reform Act (NFIRA) of 1994 (42 U.S.C. 4101) with the goal of reducing or eliminating claims under the National Flood Insurance Program (NFIP). FEMA provides FMA funds to assist States and communities with implementing measures that reduce or eliminate the long-term risk of flood damage to buildings, homes, and other structures insurable under the NFIP.

The long-term goal of FMA is to reduce or eliminate claims under the NFIP through mitigation activities. Three types of grants are available under FMA. These are Planning, Project, and Technical Assistance grants.



Changes Since 2007

The Biggert-Waters Flood Insurance Reform Act of 2012 eliminated the Repetitive Flood Claims (RFC) and Severe Repetitive Loss (SRL) programs and made the following significant changes to the FMA program:

- The definitions of repetitive loss (**two or more NFIP claims of more than \$1,000**) and severe repetitive loss properties have been modified
- Cost-share requirements have changed to allow more Federal funds for properties with repetitive flood claims and severe repetitive loss properties; and
- There is no longer a limit on in-kind contributions for the non-Federal cost share.

*Effective August 15, 2013, acquisitions and elevations will be considered cost-effective if the project costs are less than \$276,000 and \$175,000, respectively. Structures must be located in Special Flood Hazard Areas (the area of the 1-percent-annual-chance flood). The benefit-cost analysis (BCA) will not be required.*

#### 4.5.1 Vulnerable Areas

This section discusses specific areas at risk to coastal flooding within Nantucket. Critical facilities and evacuation routes are identified as applicable.

##### Critical Facilities and Repetitive Loss Properties

Several critical facilities are located in coastal flood zones and are therefore at risk of flooding. These include the municipal buildings 16 Broad Street, 34 Washington Street, and 37 Washington Street; the Police Station; Our Island Home and Landmark House; the sewer pumping station on Sea Street; the Steamship Dock, all four boat ramps listed in Table 2-1, and the fuel tank farm.

Repetitive-loss (RL) properties (two or more NFIP claims of more than \$1,000) are located in 'Sconset, Madaket, along the southwest shore, and in the downtown and Brant Point area. See Table 4-1.

**Table 4-1: Repetitive Loss Properties on Nantucket**

Civic League District	Repetitive Loss Properties	Severe Repetitive Loss Properties	Total FEMA Reimbursements Paid to Repetitive Loss Properties
<b>Downtown</b>	11	0	\$559,209
<b>Brant Point</b>	38	8	\$4,071,746
<b>Madaket Conservation</b>	1	0	\$169,235
<b>Smith Point</b>	6	1	\$1,145,046
<b>Madaket Residents</b>	3	1	\$819,100
<b>Siasconset</b>	9	1	\$1,204,684
<b>Cisco/Hummock Pond</b>	1	0	\$136,337
<b>ISLAND-WIDE</b>	<b>69</b>	<b>11</b>	<b>\$8,105,358</b>

Out of the 69 RL properties on Nantucket, only four are non-residential. All four non-residential RL properties are located in Brant Point; one of the four is a Severe RL Property.

RL property-owners on Nantucket tend to be knowledgeable about the hazards their properties face. The Town will pursue actions to continue to engage those owners in mitigation activities

##### Downtown and Brant Point

The Nantucket Harbor area (including downtown and Brant Point) is considered to be the most vulnerable population with regard to coastal flooding. The prevalence of low-lying coastal land and the high building and population densities creates a dangerous potential for repeated flood damage, even with the protections provided by the sheltered harbor. Approximately 950 buildings in the downtown and Brant Point areas are located within 1% annual-chance and 0.2% annual-chance flood zones.

In the Nantucket Harbor Area, Easy Street, Easton Street at North Beach, and Washington Street are three essential access routes that frequently experience flooding, even during non-storm

### Climate/Coastal Resilience Planning

Nantucket is in the process of developing a Climate/Coastal Resilience Plan (CRP), which will be a comprehensive plan to address sea level rise, coastal storms, and a changing coastal hazard regime. The resilience planning process expected to be completed in 2019.

### Codes and Regulations

Although Nantucket does not have codes or regulations that specifically address hazards posed by sea-level-rise, important pieces are indeed in place in the form of the ordinances, codes, and regulations cited in Section 2.9 that have been enacted to minimize storm, erosion, and flood damage.

### Infrastructure Protection

Recall from Sections 3.4 and 4.4 that DPW tracks, plans, prepares for, and responds to flooding, inundation, and/or erosion of roads and infrastructure such as the sewer pumping station and the wastewater treatment plants. At the 'Sconset WWTP, the Town must plan a new location for the effluent beds if the bluff at Low Beach erodes to within 100 feet of a permanent marker. The marker is 300 feet from the ocean and 100 feet from the beds. At the Surfside WWTP, bathymetric mapping has indicated that erosion and accretion will occur, and the shoreline will be stable for 20 to 25 years. Funding for the plant takes the life span of the plant and effluent beds into account.

### Erosion Control

With regard to pre-existing structures that were constructed to reduce erosion and stabilize shorelines, examples include the jetties at the mouth of Nantucket Harbor and numerous concrete, steel, and wood bulkheads in the harbor area.

A variety of other projects have been conducted in other areas to combat erosion, such as beach nourishment, and riprap, bulkheads, seawalls, and related structures that pre-date the regulations that no longer allow their construction. Specifically, three ongoing bank protection and beach nourishment projects are implemented at:

- Hummock Pond
- Madaket Road
- Quaise Road

Beach nourishment is described in Section 6.6.

Homes and the Sankaty Lighthouse are being moved back (retreating from the shoreline) in the eastern part of Nantucket. Private funds were raised for the lighthouse project, and private funds are typically used for home relocation.

An erosion control project on Baxter Road is a private effort protecting a portion of Baxter Road. It is a coastal engineering structure of sand-filled geotubes used in combination with sand nourishment. Plantings in the bank above further help to maintain the upper slope. While it is an

example of hybrid techniques being used for erosion control, the Commonwealth of Massachusetts does not consider a geotube to be a hybrid technique. In addition, this Hazard Mitigation Plan does not include a technical review or endorsement of the efforts. Instead, this narrative has been included to demonstrate to FEMA that efforts to address erosion are present in the Town of Nantucket.

#### 6.4.1 Capabilities Summary

In summary, the Town of Nantucket primarily mitigates sea level rise, erosion, and shoreline change hazards through implementation of erosion control projects, development of long-range shoreline change planning documents, and ongoing monitoring and public education.

Nantucket's capabilities to mitigate for shoreline change have increased since the previous edition of this HMP, in large part during the completion of coastal planning documents; these include the 2009 Nantucket Master Plan and its associated Area Plans, which address shoreline change issues, and the 2014 Coastal Management Plan, which established priorities and procedures for protecting and managing town-owned infrastructure and public access points adjacent to the coastline. Through the Town's development of a Climate/Coastal Resilience Plan, its capabilities are expected to increase further, as it will have a unified guiding document to help with future decision-making.

#### 6.5 Vulnerabilities and Risk Assessment

##### Sea Level Rise

According to the USGS publication "National Assessment of Coastal Vulnerability to Sea-Level Rise: Preliminary Results for the U.S. Atlantic Coast," the **coastal vulnerability index** of the Nantucket shoreline as related to sea level rise varies from "moderate" to "very high," depending on the location. The "moderate" score has an associated relative sea level rise projection of 2.5 to 2.95 mm/year, the "high" score translates to 2.95 to 3.16 mm/year, and the "very high" score translates to greater than 3.16 mm/year. "Very low" and "low" coastal vulnerability indices were not assigned to Nantucket. These are reserved for rocky shores such as those found in Maine.

Transportation infrastructure in Nantucket at risk to adverse effects from sea-level rise includes portions of the roads listed in Table 2-2, such as Broad Street, Washington Street, North Beach Street, South Beach Street, Easton Street, Polpis Road, Wauwinet Road, Madaket Road, Cambridge Street, Tennessee Avenue, and Codfish Park Road. Without improvements, many of these roads will have more difficulty draining due to rising base level, and will flood more frequently due to winds or even small storm surges.

Port facilities on the water's edge are particularly vulnerable to sea level rise. Docks, piers, boat ramps, jetties, and other facilities are deliberately set at an optimal elevation relative to the water level, and therefore a rise in sea level leaves them at a less optimal elevation. However, unlike

solutions are not feasible or prudent, beach nourishment is the only means available for slowing the retreat of the shoreline. Unlike hard shoreline protection measure, beach replenishment avoids addition of potentially dangerous hard debris to the high energy coastal area.

#### Dune Management

Dune Management stabilizes these natural flood barriers to protect against surges while maintaining important natural resources. The Federal Emergency Management Agency (FEMA) describes dunes as “important first lines of defense against coastal storms” that can “reduce losses to inland coastal development.” The Lake Huron Centre for Coastal Conservation lists the benefits of dunes as including shore protection, water purification, biological diversity, erosion control, and acting as a source of sediment for natural beach replenishment.

#### Hybrid Techniques

Hybrid Techniques incorporate non-structural approaches for erosion control in combination with more traditional approaches, such as a rock structure, to support vegetation growth. Hybrid techniques are typically applied in areas of higher wave energy. **An erosion control project on Baxter Road is a private effort protecting a portion of Baxter Road. It is a coastal engineering structure of sand-filled geotubes used in combination with sand nourishment. Plantings in the bank above further help to maintain the upper slope. While it is an example of hybrid techniques being used for erosion control, the Commonwealth of Massachusetts does not consider a geotube to be a hybrid technique. In addition, this Hazard Mitigation Plan does not include a technical review or endorsement of the efforts.**

Tidal Wetland Management creates or supports the natural flood mitigation capabilities of this rare ecosystem. Tidal Wetlands have been found to reduce wave energy and decrease water surface elevations at their inland edges during storm surges. Preservation of tidal wetlands also prevent development in hazardous areas and support important habitat.

## 6.2 Hazard Assessment

Although erosion and shoreline change have long been recognized as coastal hazards, it is only recently that the chronic problem of sea level rise has been closely connected to the acute threats of erosion and shoreline change. Indeed, sea level rise will increase the incidence, severity, and adverse effects of erosion and shoreline change.

### 6.2.1 Sea Level Rise

Sea levels are currently rising along the Atlantic Coast as a result of climate change **which is attributable to greenhouse gas emissions, as well as other factors noted on Page 6-5**. Rising sea levels will inundate low areas, increase erosion of beaches and bluffs, increase the incidence of flooding from storm surges, and enable saltwater to advance upstream and intrude further into aquifers.

Rising sea level affects both the natural and the human-made environments. Future sea level rise could result in the disappearance of a large percentage of Nantucket's coastal wetlands, unless they can advance as quickly as the rising level. Saltwater advancing upstream along estuaries can alter the point at which flocculation leads to sedimentation and the creation of shoals.

As sea level rises, storm surges from hurricanes and nor'easters will reach further inland as they are starting from a higher base level. By the end of the 21<sup>st</sup> century, it is possible that a Category 1 hurricane storm surge will be similar to what is now a Category 3 hurricane storm surge.

FEMA coastal base flood elevations, which are currently at 8 to 9 feet (NGVD) depending on the location, will progressively rise. This means that the 1% annual-chance and 0.2% annual-chance flood levels will affect lands that are currently at unaffected elevations. This will exacerbate the problem of coastal and near-coastal inland flooding within Nantucket.

As sea level rises, drainage systems become less effective. Rainstorms will have the potential to cause greater flooding. Nantucket already experiences problems with inadequate storm drainage in areas such as Brant Point and downtown. As sea level rises, these areas will likely experience increased flooding.

Between 2000 and 2010, the population of Nantucket increased by 6.8%. As coastal population densities increase, greater numbers of people and assets are at risk. For example, increased storm surges due to rising sea levels has the potential to flood important low-lying arterial roadways that currently flood only infrequently.

### 6.2.2 Erosion and Shoreline Change

Nantucket Island continues along the path that started 12,000 years ago after the last glaciation, slowly giving way to the advancing Atlantic Ocean. This net loss of land is due partly to active erosion of bluffs, dunes, beaches, etc.; and partly to passive submergence caused by the natural component of relative sea level rise. The erosion and passive submergence together cause a net loss of land resulting in shoreline change.