Gap Analysis of the Nantucket Hazard Mitigation Plan

An Interactive Qualifying Project
submitted to the Faculty of
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfillment of the requirements for the
degree of Bachelor of Science

by
Benjamin Amado
Madeline Kasznay
Ryan Smith

Date:
10 December 2020
Report Submitted to:

Gregg Tivnan
Nantucket Town Manager's Office
Chuck Larson
Nantucket Strategic/Special Projects Office
Dominic Golding
Worcester Polytechnic Institute

This report represents the work of WPI undergraduate students submitted to the faculty as evidence of completion of a degree requirement. WPI routinely publishes these reports on its website without editorial or peer review. For more information about the projects program at WPI, please see http://www.wpi.edu/academics/ugradstudies/project-learning.html.

Abstract

The Nantucket Town Manager's office tasked us to identify gaps between the 2019 Hazard Mitigation Plan (HMP) and existing town plans, policies, and procedures. We found that clear and consistent application of the HMP is difficult because it affects a wide array of town departments with a diversity of overlapping functions and responsibilities that are not always clearly demarcated and no single department has the authority to implement its recommendations. We recommend the town update its plans and policies for better integration with the HMP, hire a floodplain manager and one or more town engineer(s), and consider expanding the Sustainability Working Group to involve more departments, such as the Department of Public Works.

Executive Summary

The Nantucket Town Manager's Office asked us to develop a comprehensive assessment of the town's bylaws, regulations, and codes related to hazard damage prevention, to ensure consistency between the 2019 Hazard Mitigation Plan and all documents and departments relevant to infrastructure or development projects in the town. The town is required to perform such a gap analysis to make sure that the town has a coordinated and effective approach to mitigate the adverse impacts of natural hazard events.

We accomplished this goal through the following objectives:

1. Review Nantucket's plans, policies, and legislation related to hazard mitigation.
2. Conduct case studies of town buildings and infrastructure to identify inconsistencies in the plans, policies, and legislation and their application in managing hazards.
3. Examine how other towns have implemented their Hazard Mitigation Plan.
4. Propose how to rectify inconsistencies and ambiguities by modifying the HMP and/or existing laws, policies, and processes.

From our research, we conclude that a comprehensive implementation of the HMP is difficult to achieve because it affects a wide variety of departments that all have overlapping responsibilities and functions that aren't always clear. There is a bewildering set of town plans, policies, and bylaws that intersect with the goals and recommendations of the HMP. The plans, policies, and bylaws have grown organically over many years which has created policy, procedural, and jurisdictional conflicts as well as grey areas of uncertainty. Holly Backus and PLUS have been given the responsibility to administer the HMP but lack the power to implement or enforce few of the HMPs recommendations directly. There is often little coordination or oversight of separate hazard mitigation projects, especially those conducted by different entities at different times (such as the Easy Street bulkheads), which leads to less effective hazard mitigation.

Based on our findings and conclusions we have six recommendations.

1. **We recommend the creation of a position for floodplain manager to serve as a key point of contact for all information relating to the floodplain.** This person would oversee any project within the floodplain to improve the flow of information and enhance consistency in application of the HMP. A floodplain manager also opens up the possibility for more FEMA grants due to the added expertise that having someone in this position would provide. This would result in reduced flood insurance prices for homeowners.
2. **We recommend creating a position for a Town Engineer or an Engineering Department.** This position would provide the town with more consistency in regard to the technical aspect of any project in the town. This person or department would oversee projects on the island from an engineering perspective, and coordinate with the

engineering consultants. This would ensure that every project on the island is meeting a specific standard of engineering design quality and construction quality.

3. **We recommend the expansion of the Sustainability Workgroup to include a member from DPW.** This workgroup contains town staff members from various different departments including Town Administration, Planning and Land Use Services, and Natural Resources. This workgroup could be more effective if it contained a member from DPW as it is a large department with a lot of reach. Expanding the workgroup to include more departments such as the DPW means that each member of the group can advocate for sustainable practices within their own departments, through the development of department-specific plans and projects. This will in turn create a larger town-wide focus on sustainability, and the workgroup can serve as a place for coordination and communication between departments.
4. **We recommend giving additional regulatory powers to the Coastal Resiliency Advisory Committee, CRAC, and the Conservation Commission, ConComm.** This recommendation will ensure that there is more regulation along Nantucket's coastline. We recommend that CRAC be given the authority to advise ConComm in addition to their current role of advising the select board. ConComm currently enforces the Wetlands Protection Act but could be given more regulatory power enabling them to also regulate more general projects along the coast. The Conservation Commission will also play a critical role in the enforcement of recommendations in the Coastal Resiliency Plan, which is being developed by CRAC and follows up on actions listed in the Hazard Mitigation Plan.
5. **We recommend updating Building with Nantucket in Mind.** An ongoing project "Resilient Nantucket" is attempting to strike the delicate balance between adapting buildings to withstand hazards, and ensuring that these measures do not tarnish the historic integrity of the buildings. This project will serve as an addendum to "Building with Nantucket in Mind". Though this is an ongoing effort, it seems as though this type of project is exactly what Nantucket needs in order to prepare itself for future flooding events, coastal erosion and sea level rise, while also protecting the valuable historic character of the island.
6. **We recommend updating Rules and Regulations Regarding the Subdivision of Land**. This document was last updated in 1999, and states that "flood prone" areas are defined as those listed on the Department of Housing and Urban Development's Flood Hazard Boundary maps from 1974. It is in great need of an update to keep in line with the current needs of Nantucket.

We make these recommendations with the understanding that budgetary constraints may limit the likelihood of all of the recommendations becoming a reality. We feel that these recommendations will go a long way in losing the gaps that we found during the course of this study.

Acknowledgements

We would like to thank our sponsors Gregg Tivnan and Chuck Larson for their continued support throughout our project. Without their help guiding us through our project would not have been possible.

We would also like to thank our project advisor Dominic Golding who always had excellent and timely feedback and who always answered our questions.

We would like to thank the people we interviewed.

- Holly Backus
- Vince Murphy
- Paul Murphy
- Jeff Carlson
- Rob McNeil, P.E.
- Kate Hanley
- Jennifer Wolfe
- Leslie Snell
- Lauren Sinatra

Your expertise was invaluable. We would also like to give special thanks to Holly Backus and Vince Murphy who we interviewed twice.

Authorship

Section	Wrote	Edited
Abstract	**(RS, MK)**	**(BA)**
Executive Summary	**(MK, BA)**	**(BA)**
Introduction	**(MK)**	**(BA)**
Background	**(BA,MK,RS)**	**(BA,MK,RS)**
Hazard Mitigation Plans	**(MK)**	**(RS)**
Benefits of Hazard Mitigation Planning	**(MK)**	**(RS)**
Drafting a Hazard Mitigation Plan	**(MK)**	**(RS)**
The Nantucket Hazard Mitigation Plan	**(MK)**	**(BA)**
Drafting the Nantucket Plan	**(MK)**	**(BA)**
Hazards in The Nantucket Plan	**(BA)**	**(BA)**
Hazard Mitigation Plan Use and Implementation	**(BA)**	**(RS)**
Department of Planning and Land Use Services	**(RS)**	**(MK)**
Department of Public Works	**(BA)**	**(MK)**
Coastal Resiliency	**(RS)**	**(MK)**
Conservation Commission	**(RS)**	**(MK)**
Historic District Commission	**(RS)**	**(BA)**
Plans and Reports Relating to the Hazard Mitigation Plan	**(RS)**	**(MK)**
Zoning Bylaws	**(RS)**	**(MK)**
Open Space Plan	**(MK)**	**(RS)**
Town Master Plan	**(MK)**	**(RS)**
Sustainability Report	**(MK)**	**(RS)**
Climate Action Plan	**(MK)**	**(RS)**
Coastal Risk Assessment and Resiliency Strategies	**(MK)**	**(BA)**
Wetlands Protection Act	**(RS)**	**(BA)**
Coastal Management Plan	**(RS)**	**(BA)**

Community Resilience Plan	**(RS)**	**(BA)**
Building with Nantucket in Mind	**(RS)**	**(MK)**
Conclusion	**(BA)**	**(RS)**
Methodology	**(BA,MK,RS)**	**(BA,MK,RS)**
Objective 1: Review Policies and Plans Related to Hazard Mitigation	**(RS)**	**(MK)**
Objective 2: Conduct Case Studies	**(BA)**	**(MK)**
Case Study Selection	**(BA)**	**(BA)**
Identifying Possible Adaptation Methods	**(MK)**	**(RS)**
Interviewing Officials	**(MK)**	**(BA)**
Proposing Methods to Rectify Inconsistencies	**(RS)**	**(RS)**
Findings and Results	**(BA,MK,RS)**	**(BA,MK,RS)**
Building with Nantucket in Mind	**(RS)**	**(MK)**
Rules and Regulations Governing the Subdivision of Land	**(RS)**	**(MK)**
Coastal Resilience Plan	**(RS)**	**(MK)**
The Finance Office at 37 Washington St	**(MK)**	**(BA)**
The Bulkheads on Easy St	**(MK)**	**(BA)**
Millies Bridge (Ames Avenue Bridge)	**(MK)**	**(BA)**
Potential Solutions	**(BA)**	**(BA)**
Building in the Floodplain	**(MK)**	**(RS)**
Enforcing the Hazard Mitigation Plan	**(RS)**	**(BA)**
Floodplain Manager	**(MK)**	**(RS)**
Town Engineer	**(BA, RS)**	**(MK)**
Sustainability Workgroup	**(RS)**	**(RS,MK)**
Conclusion	**(BA)**	**(BA)**
References	**(MK)**	**(RS)**
Appendix A	**(MK)**	**(BA)**
Appendix B	**(BA)**	**(BA)**

Table of Contents

Abstract……i
Executive Summary……ii
Acknowledgements……iv
Authorship……v
1. Introduction……1
2. Background……3
2.1 Hazard Mitigation Plans……3
2.2 Benefits of Hazard Mitigation Planning……4
2.3 Drafting a Hazard Mitigation Plan……5
2.4 The Nantucket Hazard Mitigation Plan……5
2.4.1 Drafting the Nantucket Plan……5
2.4.2 Hazards in The Nantucket Plan……7
2.4.3 Hazard Mitigation Plan Use and Implementation……7
Department of Planning and Land Use Services……9
Department of Public Works……10
Coastal Resiliency……10
Conservation Commission……10
Historic District Commission……12
2.5 Plans and Reports Relating to the Hazard Mitigation Plan……12
Zoning Bylaws……12
Open Space Plan……13
Town Master Plan……13
Sustainability Report……14
Climate Action Plan……14
Coastal Risk Assessment and Resiliency Strategies……15
Wetlands Protection Act……15
Coastal Management Plan……16
Community Resilience Plan……16
Building with Nantucket in Mind……16
Conclusion……17
3. Methodology……18
3.1 Objective 1: Review Policies and Plans Related to Hazard Mitigation……18
3.2 Objective 2: Conduct Case Studies……18
3.2.1 Case Study Selection……19
3.2.2 Identifying Possible Adaptation Methods……21
3.2.3 Interviewing Officials……21
3.3 Proposing Methods to Rectify Inconsistencies……24
4. Findings and Results……25
Building with Nantucket in Mind……26
Rules and Regulations Governing the Subdivision of Land……28
Coastal Resilience Plan……29
4.1 Case Studies……30
4.1.1 The Finance Office at 37 Washington St……31
4.1.2 The Bulkheads on Easy St……33
4.1.3 Millies Bridge (Ames Avenue Bridge) ……36

4.2 Interviewing Officials……..……..38
4.3 Potential Solutions……..…...38
4.3.1 Building in the Floodplain…….……38
4.3.2 Enforcing the Hazard Mitigation Plan……...……..38
4.3.3 Floodplain Manager…….……..43
4.3.4 Town Engineer……..……..…43
4.3.5 Sustainability Workgroup…….…...…..45
5. Conclusion……48
6. References…….……50
Appendix A: Interview Preamble……...53
Appendix B: Compilation of Hazards Which Pose a Threat to Nantucket……54

List of Figures

Figure 1: Map of Downtown Nantucket Areas Under Threat From Coastal Flooding at Water Level 1.8 Mean Higher-High Water

Figure 2. Map of Nantucket Areas Under Threat From Erosion

Figure 3. Map of Nantucket Areas Under Threat From Wildfires

Figure 4. Diagram of the Nantucket Town Government

Figure 5. Flowchart of the 'What if' Scenario of 37 Washington St.

Figure 6. Flowchart of the 'What if' Scenario of Millie's Bridge

Figure 7: 37 Washington St shown on a FEMA flood map of Nantucket

Figure 8: Flooding on Easy St. at Broad St. 10/2/2019

Figure 9: Easy St. Bulkheads with sizes of the duckbills

Figure 10: Map of the Bulkheads and Outfalls around Easy St.

Figure 11: FEMA Erosion Map Showing Millie's Bridge and Smith Point

Figure 12: Nantucket Town Organizational Chart with new positions highlighted

List of Tables

Table 1. List of the FEMA Recommended Tasks to Draft a Hazard Mitigation Plan

Table 2. Description of Possible Case Studies

Table 3: Key Findings from Each Interview

Table 4: Overview of the Case Studies

1. Introduction

As an island off the coast of Massachusetts Nantucket is vulnerable to a number of natural hazards, especially tropical storms and hurricanes in the summer and fall and Nor'easters in the winter. Each of these storms present their own challenges. Hurricanes and other tropical storms bring flooding rain as well as storm surges and high winds, and winter storms bring not only flooding but also layers of snow and ice. The town must ensure it is equipped to handle the challenges posed by these storms, and town officials are increasingly concerned about the effects of climate change. Not only will climate change promote more frequent and intense storms throughout the year, but it will also lead to rising sea levels, causing more frequent flooding and enhanced erosion of Nantucket's coastlines.

Given these concerns, the town has begun to take action in an attempt to improve their hazard mitigation planning and overall resiliency, which is their ability to withstand hazardous events and rebuild quickly after they occur. One way they have done this is through the drafting of an updated Hazard Mitigation Plan (HMP) in 2019. This plan which follows the format laid out by FEMA, and requires approval from them and the Massachusetts Emergency Management Agency (MEMA), set out to identify all the natural hazards the island faces, assess the town's capability to manage those hazards, and provide the town with a set of recommendations for how to minimize the effects of said hazards. The town attempted to connect the plan with a number of its other community planning efforts, such as the zoning bylaws and numerous area plans across the island, identifying them in the plan itself and acknowledging their influence when relevant. This was done to ensure that the actions and priorities presented in the HMP would be considered by the town over the course of the next five years, at which point the plan would once again be updated. However, the sheer number of bylaws, plans and other policies instituted by the town means there may be overlapping recommendations and inconsistencies across the town's guiding documents.

Accordingly, the Nantucket Town Manager's Office has asked us to develop a comprehensive assessment of the town's bylaws, regulations, and codes related to hazard damage prevention, to ensure consistency between all documents and departments relevant to infrastructure or development projects in the town. The town is required to perform such a gap

analysis to make sure that the town has a coordinated and effective approach to mitigate the adverse impacts of natural hazard events.

Our overall goal was to identify whether there were inconsistencies between the Town of Nantucket's 2019 Hazard Mitigation Plan and other Nantucket plans, policies and regulations, and to propose possible ways to resolve these inconsistencies. We accomplished this goal through the following objectives:

1. Reviewed Nantucket's plans, policies, and legislation related to hazard mitigation.
2. Conducted case studies of town buildings and infrastructure to identify inconsistencies in the plans, policies, and legislation and their application in managing hazards.
3. Examined how other towns have implemented their Hazard Mitigation Plan.
4. Proposed how to rectify inconsistencies and ambiguities by modifying the HMP and/or existing laws, policies, and processes.

In order to complete these objectives, we conducted extensive background research on many Nantucket plans and policies, illustrating their relationship with the HMP through the use of case studies as a means to implement each policy. We also interviewed several town officials to gather firsthand knowledge of issues associated with the HMP's implementation.

2. Background

The Town of Nantucket has more than 100 municipal bylaws, policies and programs, all of which have their own spheres of influence on island life and the function of its government. These pieces of legislation address a wide range of issues, and because they have been introduced over the course of many years, it has created a complex situation where it is hard to ensure that all Nantucket policies are consistent with one another, and the lines of authority and responsibility can sometimes become blurred as a result. The town has mechanisms by which conflicting legislation can be addressed, such as an examination of bylaws by the Town Council prior to voting at town meeting, but the process is susceptible to human error and the town does not have the time and resources to examine the potential conflicts among every new bylaw or amendment. Add onto this the fact that Nantucket is constantly developing new policies and plans to address the needs of the day, such as the Hazard Mitigation Plan or Coastal Management Plan, and the inconsistencies can arise in unexpected ways. This is precisely why the town would like an analysis to determine if there are any inconsistencies, or gaps, between the newly developed Hazard Mitigation Plan and existing town bylaws, policies, and programs.

In this section of our paper we discuss hazard mitigation plans in general, the Nantucket Hazard Mitigation Plan in particular, and other town plans and policies that are related to the HMP. When we discuss HMPs in general we will cover who requires them, why they are required, and what is the recommended drafting process. We then discuss the hazards outlined in the Nantucket HMP, the uses of the plan, and the departments in the town government most involved with the HMP. Lastly, we discuss many of the town plans and policies that are related to the town implementation of the HMP.

2.1 Hazard Mitigation Plans

The Disaster Mitigation Act of 2000 requires state and local governments to develop hazard mitigation plans to be eligible to receive FEMA mitigation project grants. The purpose of the act is to reduce the loss of life, property damage, economic disruption, the costs of rebuilding, and human suffering associated with natural disasters primarily through funding for hazard mitigation. FEMA has five grant programs: the (1) Hazard Mitigation Grant Program (HMGP), (2) Post Fire Grant Program, (3) Flood Mitigation Assistance (FMA) Program, (4)

Building Resilient Infrastructure and Communities (BRIC) Program, and (5) Pre-Disaster Mitigation (PDM) Program. The Hazard Mitigation Grant Program is available to project locations that have been declared a major disaster by the President. None of the other grants have this requirement, although to be funded by the FMA program, affected buildings must be insured by the Flood Insurance Program (FIP). The PDM program is being phased out by the BRIC program ("Hazard Mitigation Grant", FEMA). The Massachusetts Emergency Management Agency (MEMA) also offers grants to towns with hazard mitigation plans, and the Massachusetts Office of Energy and Environmental Affairs offers the Municipal Vulnerabilities Program (MVP) to assist with community resilience planning.

Most Hazard Mitigation Plans in Massachusetts were developed between 2005 and 2011 and should have been updated every 5 years since then. Updating the plan gives continued and expanded access to certain FEMA grants. The Nantucket plan was originally adopted in 2007, but the updating process did not begin until 2017 and the revised plan was adopted in March of 2019.

2.2 Benefits of Hazard Mitigation Planning

Hazard Mitigation Plans benefit a community in many ways, such as reducing loss of life, reducing damage to municipal property and infrastructure, lowering disaster costs to a community, and educating the public about appropriate hazard responses. A plan will have a comprehensive risk assessment with an action plan that can be implemented by the community. It also gives the state and federal government information to guide an emergency response. Financially, the main benefit is that a town with an HMP becomes eligible for the FEMA and MEMA grants. Grants typically fund about 75% of a project cost, with the remaining matching funds from the local government. Projects that may be eligible for these grants can be listed in the local Hazard Mitigation Plan which streamlines the approval process.

Hazard mitigation projects can take a couple of different forms, but they all work together to make a stronger and more resilient community. The six main categories of projects are (1) prevention, (2) structural, (3) natural resource, (4) property protection, (5) public education, and (6) emergency services. A prevention project is defined as a project that uses codes (e.g., building codes) and regulations (e.g., zoning) to prevent losses. Structural projects

are physical projects, such as building a new bridge or wall. Natural resource projects are conservation projects that also work to mitigate hazards (e.g., coastal marsh restoration). Property protection is a type of project that makes a public property more resistant to losses. Public education is outreach to the community about hazards. An emergency services project would work with state and/or local organizations to improve their ability to handle disaster situations. Each of these types of projects work well in different situations and may work best when combined in an integrated fashion.

2.3 Drafting a Hazard Mitigation Plan

FEMA has established several requirements for HMP approval (see Table 1). These requirements cover the planning process, risk assessment, mitigation strategy and local adoption. In the planning process there must be open public involvement that also allows input from important outside agencies. The risk assessment must detail all natural hazards in the region and their past or future impact on the community. The mitigation strategy section of the plan must analyze a comprehensive range of actions to mitigate hazards and include a specific action plan. The plan must be approved and adopted by the local government and must be updated every five years. Beyond these requirements FEMA has guidelines on how to draft a HMP. In the FEMA handbook on Local Hazard Mitigation Planning, there are nine tasks that must be completed to draft a Hazard Mitigation Plan (Table 1). This handbook is just a guideline, but it does give insight into how FEMA (2013) thinks these plans should be created.

2.4 The Nantucket Hazard Mitigation Plan

The next three subsections will cover the specifics of the Nantucket Hazard Mitigation Plan. This includes how the plan was drafted 92.4.1), what hazards are covered in the plan (2.4.2), and which departments of the town government are most affected by the HMP (2.4.3).

2.4.1 Drafting the Nantucket Plan

The initial meeting to begin drafting the original Nantucket Hazard Mitigation Plan was held in July 2006. After several meetings to gather information and set up the project team, the town held a meeting for public comment and a later meeting with key stakeholders. The draft

Table 1. List of the FEMA Recommended Tasks to Draft a Hazard Mitigation Plan (FEMA, 2013).

Task 1	Determine the Planning Area and Resources	Determine what area of land will be covered by the plan, including what local jurisdictions will be involved, as many plans are multi-jurisdictional.
Task 2	Building the Planning Team	Gather representation from everyone who should be involved and create a working schedule to meet.
Task 3	Create an Outreach Strategy	Outreach first to stakeholders and then to the public.
Task 4	Review Community Capabilities	Some important capabilities include planning and regulatory, administrative and technical, financial, and education and outreach.
Task 5	Risk Assessment	This process involves describing hazards, identifying community assets, analyzing risks, and summarizing vulnerability, and this is the step where many of the hazards are identified and much of the data is collected.
Task 6	Develop a Mitigation Strategy	Composed of goals, actions, and an action plan. Goals are what the plan hopes to achieve, actions are the steps that must be taken to reach those goals, and an action plan is how those goals are prioritized.
Task 7	Keeping the Plan Current	By monitoring implementation, evaluating effectiveness, and updating the plan.
Task 8	Review and Adopt the Plan	This involves sending the plan to the state and FEMA for review and once approved local adoption by the community.
Task 9	Create a safe and Resilient Community	This involves turning the adopted plan into action for the community.

plan was released for comment in March of 2007 and was revised in July of that year. FEMA subsequently revised its regulations, however, requiring that coastal towns update their HMP every five years in order to continue to receive funding. Accordingly, in 2017 the town of Nantucket commissioned the consulting firm Milone and Macbroom, Inc. to update the 2007

Hazard Mitigation Plan. The updated plan was officially adopted by the town in March 2019. Notably, the updated plan included a new section on sea level rise, shoreline change, and erosion.

2.4.2 Hazards in the Nantucket Plan

The Nantucket Hazard Mitigation Plan classifies eight major hazards as threats to the island (Milone and Town of Nantucket, 2019, p. ii). The Plan defines and assesses each of these hazards, looking into not only their historic impact on the island, but also identifying areas most susceptible to each of the hazards, and proposing mitigation strategies to lessen the impact on high-risk areas. Appendix B lists the hazards, affected areas, and proposed mitigation strategies, and Figures 1-3 below identify areas that are susceptible to some of those hazards. These maps show the areas on Nantucket most likely to be affected by flooding, erosion, or wildfires. Figure 1 shows a close up view of the areas downtown that are threatened by coastal flooding. Some of the areas that are threatened by flooding are low-lying wetlands with little development while others are highly developed areas containing critical infrastructure and valuable property. Figure 2 shows the major areas of erosion on the island. Smith point has a long-term erosion rate of 11.68 ±1.41 feet per year and a short term rate of 5.31 ±8.04 feet per year. (Milone & Town of Nantucket, 2019, Section 6-3-2). Finally, Figure 3 outlines the areas on the island most likely to be affected by wildfires. These areas are mostly cleared land, brush land, and golf courses. Most of these areas are low risk although there are some houses within the wildfire zone.

2.4.3 Hazard Mitigation Plan Use and Implementation

The Nantucket Planning & Land Use Services (PLUS) Office, with assistance from the Nantucket Office of Emergency Management, will administer this HMP under the authority of the Board of Selectmen. Holly Backus was a Land Use Planner at PLUS during the process of updating the HMP and was promoted to Preservation Planner late 2019, and is the Local Coordinator of the Hazard Mitigation Plan. The Chief of Police and Emergency Management Director (a single position) also assists local coordination. The Local Coordinator, with assistance from Town Administration will coordinate with responsible departments and ensure that the recommendations of this HMP are considered or enacted for annual and long-term capital planning. Figure 4 shows the organization's structure of Town of Nantucket Government

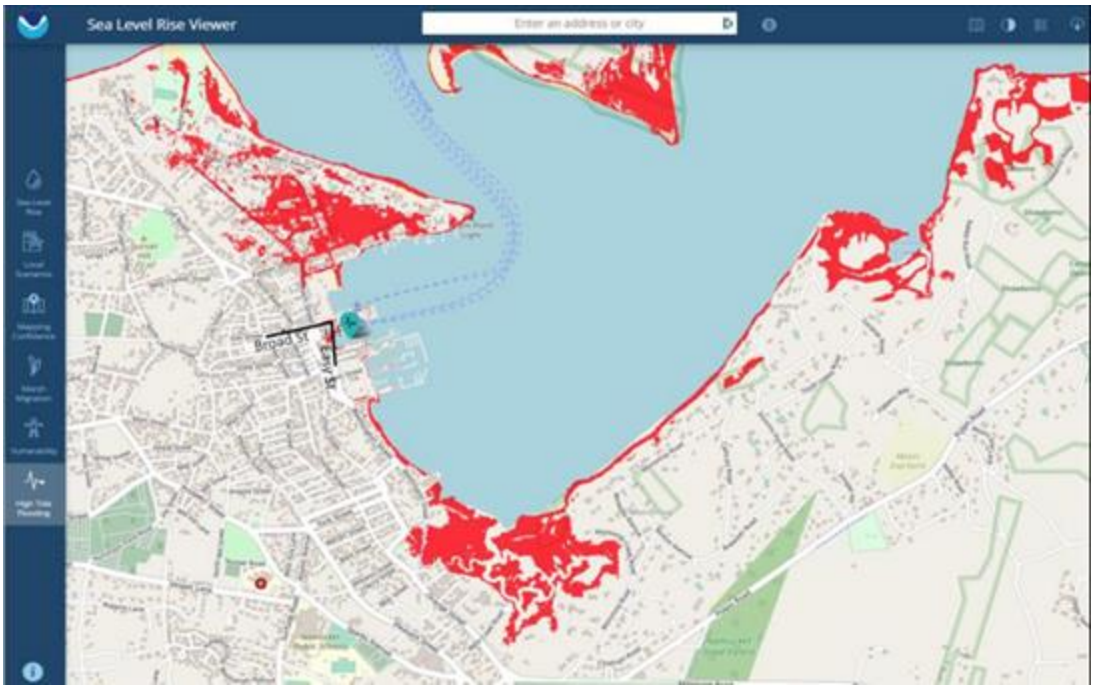

Figure 1. Map of Downtown Nantucket Areas Under Threat from Coastal Flooding at Water Level 1.8 Mean Higher-High Water (MHHW) (Larson, 2020).

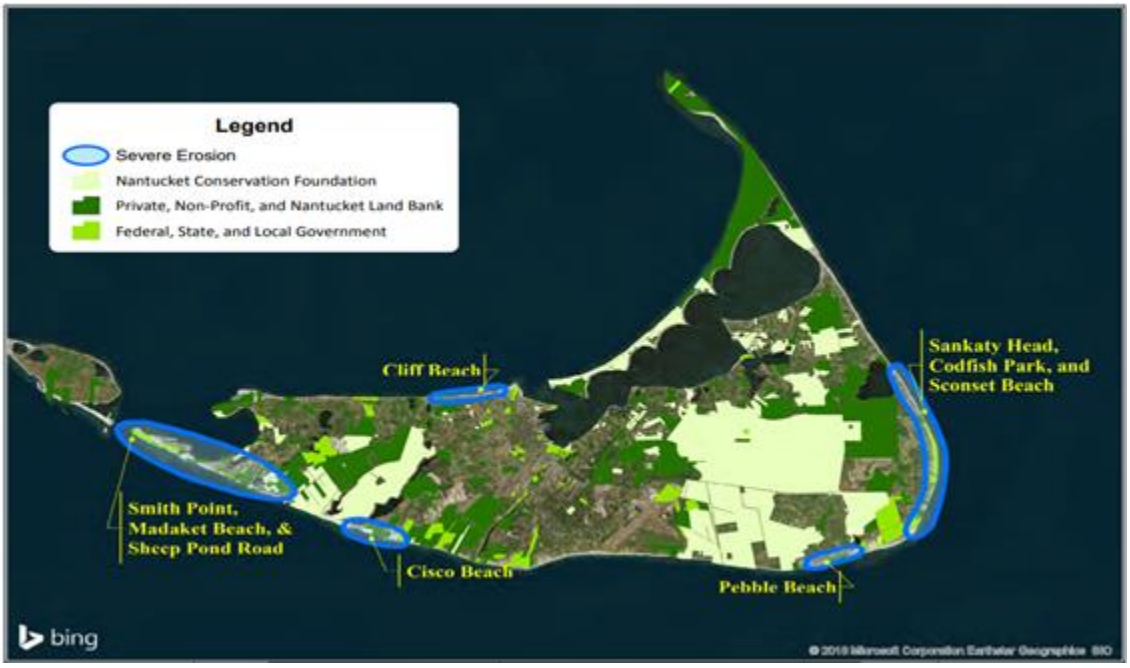

Figure 2. NOAA Map of Nantucket Areas Under Threat From Erosion (Milone and Town of Nantucket, 2019, Section 6-2).

Figure 3. Map of Nantucket Areas Under Threat from Wildfires (Milone and Town of Nantucket, 2019, Section 9-4).

structure, and we highlight below the roles of some of the most important town offices and boards in the implementation of the Hazard Mitigation Plan.

Department of Planning and Land Use Services

PLUS, the Department of Planning and Land Use Services, consists of the Planning and Zoning Appeals Boards, as well as the Building Department and Historic District Commission. This department supervises all forms of land development on the island, as the Planning Board building would require, which include zoning bylaws, historic district requirements, and geographic restrictions put in place through policies such as the Hazard Mitigation Plan. For example, the Planning Board may not issue a permit for development on an area of land that is at high risk for flooding or erosion. This further illustrates the HMP's role as a "filter" for town projects, as an HMP that is widely followed and strongly enforced by the town will influence where and when the Planning Board is willing to issue permits.

Department of Public Works

The Nantucket Department of Public Works, or DPW, is a large department with many responsibilities. The DPW is responsible for road work, maintenance on public buildings, fleet maintenance of DPW vehicles, tree maintenance, engineering reviews, wastewater treatment, sewers, and solid waste disposal. Due to how involved this department is for maintaining the infrastructure of the island, they are influential in hazard mitigation. In 2009 and 2015, outside consultants analyzed the structure of the department to identify potential improvements in operations, and their suggestions included building a new facility to house the fleet of vehicles that the DPW is responsible for enabling them to have a better response time. The DPW is responsible for the maintenance and safety of many things on the island and are constantly looking for new ways to efficiently do the work of the department.

Coastal Resiliency

The town recently took a number of steps to adapt its coastal regions from threats such as sea level rise, establishing the Coastal Resiliency Advisory Committee in April of 2019. This committee works in tandem with the Coastal Resiliency Coordinator (hired in July 2019) to develop a plan that addresses issues facing the coastal community, environment and historical landmarks. It is also the responsibility of the committee to identify areas in which their plan overlaps with other Town policies, including the HMP. This would likely be the case in efforts to mitigate the effects of coastal flooding and storm surges.

Conservation Commission

The Nantucket Conservation Commission was established by the town in 1963, following their adoption of the Massachusetts Wetlands Protection Act, which mandated the creation of the Commission to oversee projects that border on both coastal and inland wetlands, and gives the Commission permitting powers over these projects. The Act classifies several specific areas under the authority of the Commission, including coastal beaches, dunes and banks, as well as inland banks, beaches and bodies of water including ponds, creeks and streams. The Commission also has the power to regulate activities up to 100 feet away from wetlands, in the area defined as the “buffer zone.”

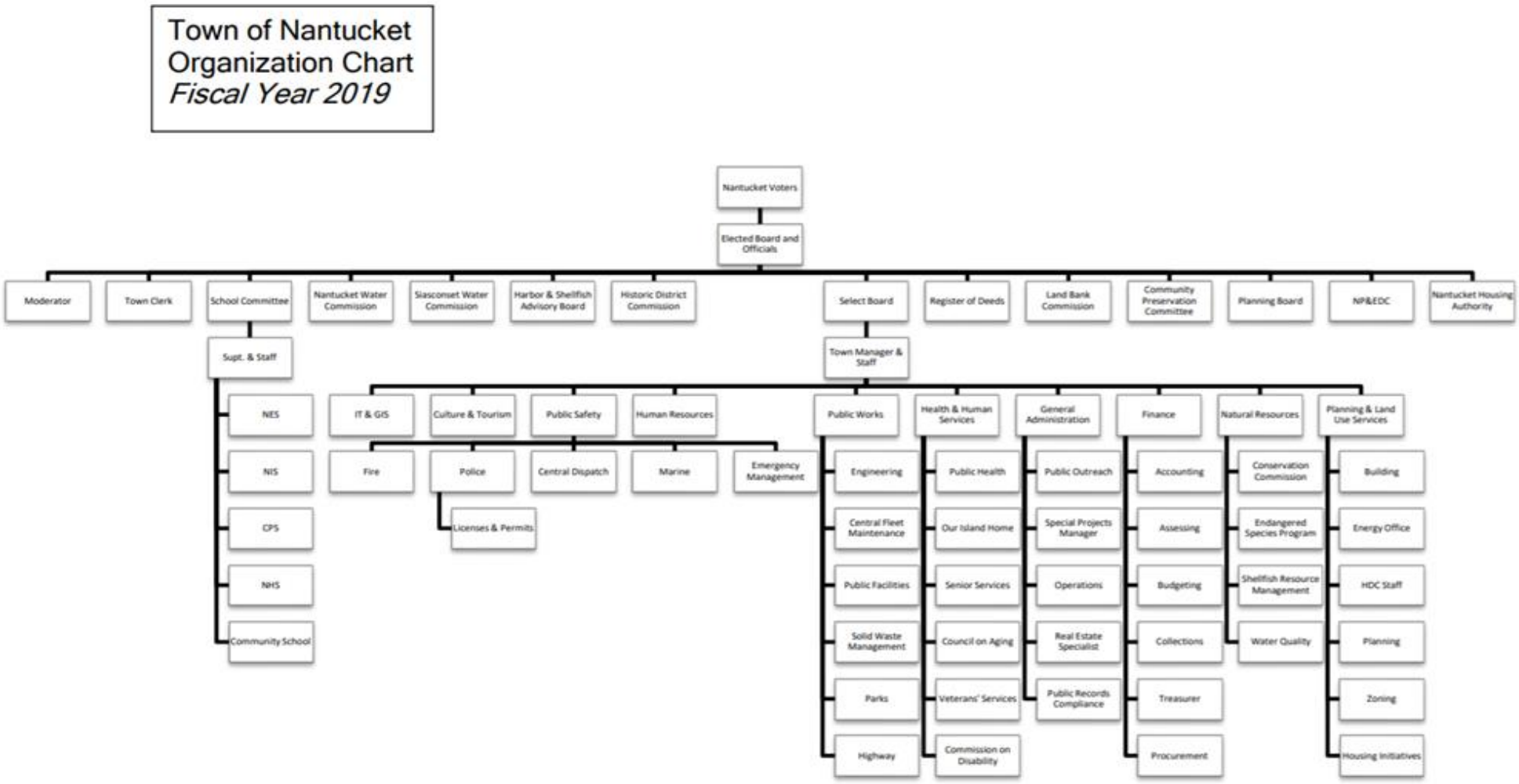

Figure 4. Diagram of the Nantucket Town Government (Retrieved from 2019 Town of Nantucket Annual Report).

Historic District Commission

The island of Nantucket is recognized as a National Historic Landmark, and the town also has two "Core Historic Districts" in the downtown and 'Sconset areas. Maintaining the historic character of the districts and the island is crucial, and this duty falls on the Nantucket Historic District Commission (HDC). This commission is composed of several town members, and their purpose is to ensure that any structure built on the island is consistent with the standards required to maintain Nantucket's historic character. These standards are outlined in the document "Building with Nantucket in Mind," which will be detailed further in Section 2.5. The HDC issues permits for all types of construction on the island, including hazard-mitigation related projects, so mitigation strategies must take into account the necessary steps required to receive HDC approval.

2.5 Plans and Reports Relating to the Hazard Mitigation Plan

As an approved official planning document for the Town, the Nantucket Hazard Mitigation plan should meld seamlessly with numerous other town policies, codes, bylaws, and plans. Future town policies and plans must also conform to and reinforce the HMP as well. The following are some of the town policy and planning documents that may be most closely related to the Hazard Mitigation Plan, and were either subsequently updated following the adoption of the plan, are themselves supplementary to the plan, or are important pieces of legislation that shape implementation of the plan. Section 2.9 of the HMP notes some of these documents as plans, regulations and documents that the HMP must "be consistent with, build off of, and inform." (Milone and Town of Nantucket, 2019, Section 2-23)

Zoning Bylaws

The Town's Zoning Bylaws have myriad implications for any potential land development project. For the Hazard Mitigation Plan to be implemented, its directives must be seamlessly integrated with the Zoning Bylaws. For example, the Town Code spells out a number of requirements proposals must meet in regard to flooding. The bylaws establish a Flood Hazard Overlay District (FHOD) as "an overlay district to all other districts," which serves to prevent any personal injury or property damage, as well as ensure the protection of critical utilities and

other infrastructure." (Code of the Town of Nantucket). The document then goes on to spell out the number of steps that must be taken for a project to be approved in a zone within the jurisdiction of the FHOD, which is determined by the most up-to-date data on flood zones from FEMA. These proposals must limit possible flood damage to the proposed project itself as well as other nearby public utilities, and establish sufficient drainage to further mitigate the damage that can be done from flooding. If proposals involve the rerouting of a body of water, the laws provide a list of communities, officials and agencies that must be notified of this, from neighboring communities to the Massachusetts Department of Conservation and Recreation and FEMA. Flood management measures in the newest version of the Hazard Mitigation Plan must direct proposals through the same channels spelled out in the bylaws, for flooding and any other hazard; otherwise, different avenues may result in inconsistent requirements, and the creation of a "gray area" where the town has no clear mandate on how to move forward.

Open Space Plan

The purpose of the Open Space and Recreation Plan is to provide a guide and a set of recommendations for public land conservation within the town. The first Open Space and Recreation Plan was written in 1987, the next was written in 1992, and this most recent version was written in 2007. As this plan is intended to be updated every 5 years it is out of date, but it still can be useful when compared to the HMP. When this plan was written, 60% of the land on Nantucket was identified for conservation. The plan includes analysis of the town's natural resources, an inventory of conservation and recreation lands, an analysis of the communities open space needs, and a plan to meet those needs. This is the plan for a good amount of land on Nantucket which may not be in line with the most recent version of the HMP. Furthermore, mitigation projects that involve the relocation of buildings or other pieces of infrastructure would have to be compliant with the plan.

Town Master Plan

The Town Master Plan outlines the long-term decision making regarding the physical development of the town. The Town Master Plan essentially lays out the future of the town in areas such as housing, economic development, and conservation. Based on this, it is crucial that this plan aligns with the Hazard Mitigation Plan. Conflicts between the Town Master Plan and

the Hazard Mitigation Plan will result in certain elements of the Hazard Mitigation Plan being circumvented. The Nantucket Master Plan was adopted in April 2009 and is currently under revision. The purpose of the Nantucket plan was to provide legal reasons for zoning changes, allowing the community to be in compliance with state laws, and update and refine the Comprehensive Community Plan of 2001. The plan was designed to be updated in ten to twenty years with certain parts updated more frequently. Much like the Open Space plan, this too is out of date but still a useful resource. The town also has a number of neighborhood area plans, which perform the same function as the Master Plan on a smaller scale, for specific parts of the island including Madaket, Mid-Island, 'Sconset, Tom Nevers, Surfside and Naushop Crossing.

Sustainability Report

After the update of the Hazard Mitigation Plan in spring 2019, the Town of Nantucket hired Kim Lundgren Associates, INC. to conduct an initial sustainability assessment for the island. The goal of this assessment was to create a project planning framework to guide future growth and development in Nantucket while also promoting community preservation, inclusivity, resilience, and good governance. The draft report, dated December 2019, defines each of these terms, and adds subcategories underneath them. This report also gives a rubric for grading many different types of projects on sustainability based on its framework. The draft report was under town-wide review at the time of the COVID-19 pandemic and has been delayed. This report may be modified somewhat prior to formal adoption by the town.

Climate Action Plan

This plan was drafted because it was the third step required for Nantucket to be part of the Cities for Climate Protection Campaign. This plan was designed in 2011 as a way for Nantucket to reduce its carbon emissions to 10% less than they were in 2000 by 2020. This plan first analyzed Nantucket's current emissions and found the biggest sources of emissions to be transportation, followed by heating. Given those sources of emissions, it then set a series of goals that would help to lower emissions. Each goal includes a set of policies that could be implemented to get more people to use the lower emissions system. The plan was never adopted in the town because of concerns about assumptions made in the plan. The Town now has reworked the content from the Climate Action Plan to make the Energy Reduction Plan which

was approved in November 2019 and focuses on reducing the energy use in Nantucket from municipal buildings for the next five years. This plan was needed to complete the steps for Nantucket to be designated as a Massachusetts Green Community which it became in February 2020. Another part of being a Green Community is that the island must adopt the stretch code. This code is a new set of rules that new buildings must follow for example more energy efficient windows. This code is something that should be considered when updating the HMP.

Coastal Risk Assessment and Resiliency Strategies

This strategy focused report created a set of resources Nantucket can use to address the current and future social, economic, and ecological resilience of the Town's shoreline to the impacts of sea level rise and anticipated increases in the frequency and severity of storm surge, coastal flooding, and erosion. The final report was completed by Milone and MacBroom Inc., in January 2020 after the approval of the HMP and MVP Report, and builds upon the work of both projects. It developed strategies to improve the resilience of the town in the event of increased sea level rise, flooding, storm surges and erosion. This plan analyzed risk in a scale from extreme risk to minimal risk- this was done to each neighborhood of Nantucket for each type of asset or system in that neighborhood. The plan goes into analyses of strategies to ensure the resilience of the community, suggesting a number of different policies and solutions. It does this by breaking down types of strategies in specific detail and listing benefits of the policies. It compares types of solutions and lists specific solutions under that broader type of solution. The plan also lists a recommendation for each type of infrastructure. The plan also lists the resources available, including grants from FEMA programs within the state of Massachusetts, and Federal grant resources.

Wetlands Protection Act

The Massachusetts state government has adopted several regulations regarding the protection and conservation of wetlands across the Commonwealth. This act also declares that projects must consider effects on flood and erosion control as well as storm damage prevention in addition to their effect on wetlands. This act establishes a number of requirements for projects in specifically defined areas, including "Coastal Beaches," "Coastal Dunes," "Coastal Banks," "Land Subject to Flooding," etc. For example, the Act prohibits the construction of bulkheads to

protect any structure built after August of 1978, but allows already existing bulkheads and other structures to be repaired if it is determined that there is no other way to control the hazards of erosion or flooding. The duty of making this determination falls on the town's Conservation Commission, a group established by this Act with the sole purpose of administering and enforcing the regulations in the Wetlands Protection Act.

Coastal Management Plan

Nantucket's Coastal Management Plan was prepared, but never adopted, in 2014, with the goal of giving the town greater control over coastal activities, as well as establishing a number of principles and plans of action for hazard mitigation-related events. Some of these principles include the activation of groups like the DPW in response to storm-damaged infrastructure and the creation of a system to identify hazardous structures and debris. This plan also recommends a set of actions for several self-identified sectors along the Nantucket coastline, many of which are designed to combat coastal flooding and shoreline change (Milone and Town of Nantucket, 2019, Section 2-36).

Community Resilience Plan

The Community Resilience Plan was developed in 2019 with the Massachusetts Vulnerability Preparedness Program (MVP). Nantucket is a MVP certified community and thus eligible for special state funding for hazard mitigation and resilience projects. This document was based on a community resilience building workshop which the town held with potential stakeholders to discuss these issues. The document lists potential hazards, community assets and vulnerabilities. The document then details recommendations to improve resilience and priorities for MVP grant funding.

Building with Nantucket in Mind

This document was created in 1995 by the Nantucket Historic District Commission to serve as a common reference point to maintain the historical and architectural integrity of buildings on Nantucket. The document outlines the design criteria and specifications that guide the HDC approval process.

Conclusion

Essentially, the goal of this project is to address potential gaps between the Hazard Mitigation Plan and existing Nantucket town policies and legislation. The background section is meant to provide important context and insight to some of these town policies, as well as the Hazard Mitigation Plan, to begin identifying certain gaps. The methods section focuses on the process that will actually be used in this project in order to identify and expose these gaps.

3. Methodology

The goal of our project was to identify whether there were inconsistencies between the Town of Nantucket's 2019 Natural Hazard Mitigation Plan and other Nantucket plans, policies and regulations, and to propose possible solutions to these inconsistencies. We accomplished this goal using the following objectives:

1. Reviewing Nantucket's plans, policies, and legislation related to hazard mitigation and community resilience.
2. Conducting case studies of town buildings and infrastructure to identify inconsistencies in the plans, policies, and legislation and their application in managing hazards.
3. Proposing how to rectify inconsistencies and ambiguities by modifying the HMP and/or existing laws, policies, and processes.

3.1 Objective 1: Review of Policies and Plans Related to Hazard Mitigation

We conducted a review of the Hazard Mitigation Plan, as reported in the background section. The HMP identifies several town policies, plans, and laws that intersect with the HMP and also identifies some potential policy gaps. We also reviewed other available plans such as the Coastal Management Plan, Town Master Plan, Cobblestone Street Plan, and others, including the laws and policies flagged by the HMP itself.

3.2 Objective 2: Conducting Case Studies

While the HMP identifies some of the legislation, policies, and plans that pertain to hazard mitigation and also indicates some policy gaps, the HMP admonishes the town to conduct a gap analysis to identify other inconsistencies in town procedures and plans. After consulting with our sponsor, we determined that conducting a set of case studies of existing town properties and infrastructure might be an effective way to identify and clarify these inconsistencies. This objective entailed several interrelated tasks, including:

- Selecting a set of cases for in-depth study
- Evaluating selected cases
    - Conducting background research on existing conditions
    - Assessing hazard threats
    - Examining ‘what if’ scenarios to identify policy gaps and inconsistencies
- Interviewing officials and other stakeholders

3.2.1 Case Study Selection

We brainstormed with our sponsors to identify a potential set of case studies. We identified several important criteria for the selection of the cases. Each case involved a town building or critical piece of infrastructure at substantial risk from one or more natural hazards identified in the HMP. Each case also presents a different set of circumstances that invokes different policies, plans, and laws. Table 2 compiles these case studies, providing a description of each building or other piece of infrastructure, the hazards that threaten it, and the pros and cons of using each as a case study for this project. The first three examples in this table (the finance office at 37 Washington Street, the Easy Street Bulkheads and Millie’s Bridge), are the primary focus of our project, while the others are related projects that we could cover in greater detail with more time.

The building at 37 Washington St. is the town’s financial office, and it is a critical piece of town infrastructure that is under threat from multiple hazards. Adaptations to this building would likely trigger many different reviews in the town government. All structures on the island require permitting from both PLUS and the Historic District Commission, and if adaptations to this building would adversely affect nearby wetlands, such as the Creeks, the Conservation Commission would then get involved as well.

Easy St is the main transport route to the steamship, which is used by trucks that bring supplies to the island from the mainland. When the street floods, trucks have to use alternate routes from the Steamship ferry. There are also many other homes, businesses, and utilities on this street, which makes it a prime candidate to expose the gaps between the HMP and other town policies and bylaws.

Table 2. Description of Possible Case Studies

Case Study	Description	Main Hazards	Main Issues	Advantages	Disadvantages
37 Washington St. (Finance Office)	Financial building on Washington St. Important town building	Severe flooding, wind damage, inundation	Flooding poses a risk to the building. Washington St is a main route for trucks and emergency vehicles. Damage or loss of financial records and office equipment.	Major town building, affected by multiple hazards. Adaptations would involve permitting from several departments	
Easy St.	Crucial access way for trucks going to the mainland to bring supplies for the island.	Massive flooding	Main route for trucks going to the steamship. Street becomes impassable during flooding	There are many homes and utilities on this street. Crucial route for the town.	Land bank property not integrated
Millie's Bridge	Bridge that connects Smith's Point to the rest of the island.	Erosion and wave damage	Destruction of this bridge would completely cut Smith's Point off from the island.	Lots of permitting	No infrastructure here outside of the bridge.
Children's Beach Concessions Stand	Concessions stand on Children's Beach. Open only during the summer	Minor to major flooding in the winter.	Potential flood damage to the building	Very relevant, as solutions were recently discussed	Not a significant piece of town property
Sea St. Pumping Station	Pumping station on Sea Street. Critical piece of infrastructure	Minor flooding	Potential damage to a critical piece of infrastructure	Critical piece of infrastructure.	Recently renovated
Harbormaster Building	Debate on whether or not to move this building	Major flooding and wave damage	High damage risk. Harbormaster building needs to be at the harbor	Critical infrastructure	Controversial topic, as there was significant debate on this

Millie's Bridge is a bridge on Ames Ave in Madaket that connects Smith's Point to the rest of the island. The bridge is in danger of eroding away and there has been substantial debate in town already about the available options from rebuilding the bridge to relocating it.

3.2.2 Identifying Possible Adaptation Methods

After choosing a case study, we gathered more information about each particular project. We began with the HMP itself, where some of our potential case studies, such as Millie's Bridge, are specifically mentioned. We also researched the hazards specific to the case study, and identified what the HMP says about those hazards. We then considered the different mitigation strategies detailed in the HMP for our project's hazards. For each mitigation strategy, we researched the different permits, policies and people that would be triggered for involvement. The process for the Washington Street finance office is illustrated in Figure 5. First we considered if the building was considered historic, as any modifications would then require the approval of the Historic District Commission. Similarly if it was within 100 feet of a wetland it would need approval by the Conservation Commission. We then looked at possible options to make this building more adapted to flooding and therefore compliant with the HMP. Each of our projects has unique circumstances and requires their own unique processes. For example, the Millie's Bridge case study focuses on the threat of erosion in that area. As can be seen in figure 6 a more passive mitigation strategy is being employed and inspections and maintenance on the bridge with every other option as a last resort. Developing and following these flow charts allow us to identify the relevant legislation and boards, committees, etc. that would play a role in any adaptation that took place, which in turn will make it possible to see where there are conflicts and inconsistencies in policies and plans.

3.2.3 Interviewing Officials

We conducted interviews with town members who have extensive knowledge about the selected case studies. The interviews provided information about the history of each case, the nature of the problems identified, potential solutions that had been or might be considered and also shed light on the gaps and inconsistencies that exist in the review, permitting, and implementation process. The purpose of the interviews was to supplement the information provided in town legislation and other documentation. Interviewees were able to provide specific

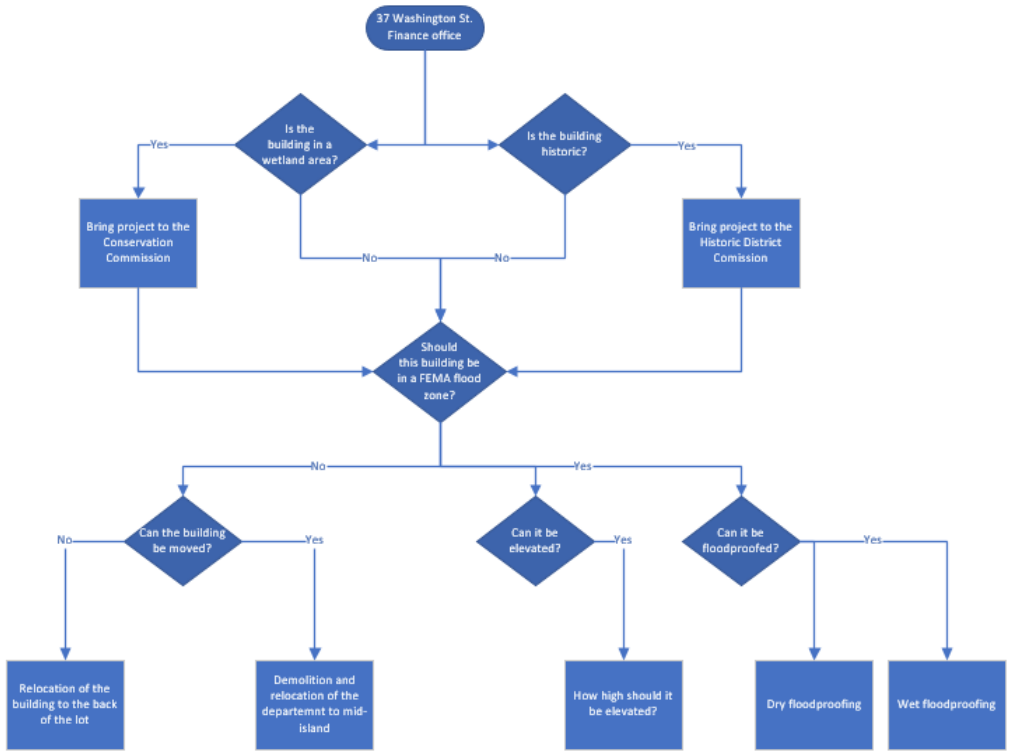

Figure 5. Flowchart of the 'What if' Scenario of 37 Washington St.

accounts of what areas of the island are at risk to certain hazards, details about the logistics involved with a proposed solution, and lessons learned from previous hazard mitigation projects. These interviews also allowed us to determine the level of communication and coordination between the various departments and groups in the town government. We were able to identify how well versed certain groups were with the Hazard Mitigation Plan itself, and how much they incorporated the plan and its recommendations into their projects. These interviews allowed us to identify any gaps that were the result of a lack of coordination, where certain departments were not considering the strategies outlined in the HMP or other sustainability recommendations.

Our interview process was mainly determined by the information we discovered from our case studies. This information guided who we decided to talk to, which included people from the department of Planning and Land Use Services (PLUS), the Conservation Commission, and the Historic District Commission. For each interview we read a preamble, found in Appendix A, that informs the interview candidate that the interview is voluntary, and as such it can be ended at any time. The preamble also requests permission to record the interview and to quote the interviewed

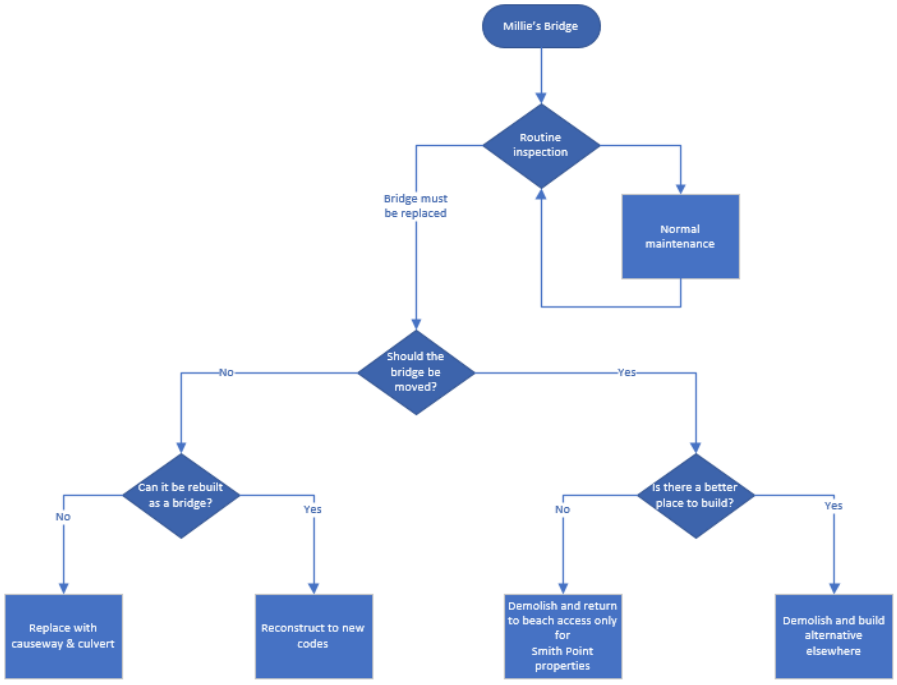

Figure 6. Flowchart of the 'What if' Scenario of Millie's Bridge

party directly in the final report. If the person interviewed preferred not to have the conversation recorded, we instead took detailed notes of the information we obtained during the interview

Though we used a general list of questions for all of our interviews, there was some variation depending on who we were speaking with, and what specific information they may have had regarding policies, permits, etc. for each case study. We used the case studies as a framework to ask questions that would reveal potential gaps. A few of the main people we interviewed were PLUS Preservation Planner and Local HMP Coordinator Holly Backus, Coastal Resilience Coordinator Vince Murphy, and Deputy Director of Planning Leslie Snell. Another method we used to expand our list of potential interviews is known as snowballing. Through conducting an interview with one person, and asking that person to suggest other people we should look to get in contact with, we were then able to contact those people, and continue this process a number of times to widen our pool of interviewees. Since we mostly interviewed town government officials, they were able to point us in the right direction. Snowballing was not

the main way we went about collecting our data, but it was a useful method that allowed us to gather as much information as possible.

3.3 Proposing Methods to Rectify Inconsistencies

Our final deliverables consist of a set of observations and recommendations regarding the gaps we have identified. The overall goal of this project was to identify inconsistencies and ambiguities between the HMP and other town laws and policies, and our final report contains a set of gaps we have found through our research, case studies and interviews. Though the HMP does have an initial list of overlapping legislation and potential gaps that must be addressed, our project identified more gaps that were not initially identified by the plan, both in terms of legislation itself as well as gaps in the town government structure, such as the need for the town to establish new positions or departments. In addition to alerting the town of these gaps, we also are providing them with recommendations for how to resolve the inconsistencies we discover, just as the HMP does with the gaps it identifies.

4. Findings

At the onset of this project, we began a search for all bylaws, policies and plans relevant to the Hazard Mitigation Plan, in an attempt to determine the level of integration between all of these documents. By reading through all these documents, in addition to our conversations with our sponsors and officials in various other departments, we identified where and how this integration process can be improved.

First and foremost, it was inherently difficult for the town to ensure that the new HMP would be appropriately considered and implemented seamlessly following implementation. The Nantucket Planning & Land Use Services (PLUS) Office has the responsibility to administer the HMP, and Holly Backus, Preservation Planner, was tasked to coordinate HMP implementation with other pertinent departments. This is, however, a Herculean task because the HMP touches so many other departments and entails so many town policies and plans. For example, the Wetland Protections Act is interpreted and implemented by the Conservation Commission, while Building with Nantucket in Mind is the focus of the Historic District Commission, and the zoning bylaws are developed and implemented by PLUS. With all of these regulatory bodies following their own guiding documents, it is difficult to introduce a new document with new guidance, as the departments with the power to implement them are instead going to focus enforcement on the regulations specific to their jurisdiction. The Conservation Commission must act on any project that is within a certain distance of a wetland, even if this project would potentially have positive hazard mitigation effects. Likewise, the Historic District Commission may not permit a certain type of construction if it would detract from the historic character of the island, regardless of the proposed benefits. The HMP does not take precedence over any of these other policies and plans, and thus the document itself is not as influential as it could be.

Nantucket's government has a number of different groups with unique interests, and a number of policies and plans for which they lobby. The Hazard Mitigation Plan, while focused primarily on the island's sustainability, has valuable insight and recommendations that have implications across all branches of the government. This in turn means that the HMP and its recommendations should be at least acknowledged and taken into some consideration by the many departments in the government. The policies and plans which guide these groups should

therefore be well-integrated with the HMP, and provide the town with opportunities to push forward its sustainable practices. However, the fact that these other plans were either created at a time when hazard mitigation was not at the forefront of as many members of the community, or created when a hazard mitigation plan was not in place at all, means that Nantucket now finds itself having difficulty ensuring that the 2019 HMP is considered in a number of town projects. This issue is likely to persist unless and until older plans are amended to include current hazard mitigation ideas, or unless the Hazard Mitigation Plan's recommendations are themselves enforced by some regulatory body.

The HMP is a guide for planning, not a set of regulations to be enforced. If the plans that guide certain bodies to make decisions reference the HMP directly, and take into account its recommendations, the HMP may then be applied more robustly. However, some of these plans have been in place for quite some time, and were either influenced by the outdated Hazard Mitigation Plan, or did not consider any HMP whatsoever. We will cover some of these plans, the gaps they present, and the possibilities for how to integrate the recommendations of the HMP in the following sections.

Building with Nantucket In Mind

An example of a document which could present an opportunity for HMP integration is "Building with Nantucket In Mind". This document outlines all of the necessary design standards for building on the island, which allow the island to preserve its integrity as a National Historic Landmark. Though this document is undoubtedly important, it could be a challenge to combine these guidelines with the hazard mitigation strategies that the HMP suggests. The building guidelines were created in 1995, and while this is understandable considering that historic building requirements have not changed since then, the phrase "hazard mitigation" is not found within the document. This a sign that hazard mitigation was not a priority of the island at the time, and from that perspective, this plan is a missed opportunity for the town to operationalize the HMP through the inclusion of its recommendations.

The Historic District Commission, understandably, prioritizes the historic character of the island in its regulations, and may be less concerned with hazard mitigation, especially if a certain project would involve the creation or modification of a structure. However, they could institute

specific policies regarding the flood-proofing of buildings on the island, similar to those used by the Secretary of the Interior. This would be a particularly useful development, as the HMP states that 46 of the island's "repetitive loss" properties are considered historic structures. A more straightforward and Nantucket-specific set of regulations for the protection of these structures would be a major step towards ensuring they remain standing for future generations, and are thus able to preserve the island's historic character. These regulations could be a companion to Building with Nantucket in Mind, and would provide the town with a clear set of rules for how to proceed in future hazard mitigation projects in the historic districts and across the island.

Efforts to develop historic preservation guidelines or regulations like these are currently being developed by a MVP funded project known as Resilient Nantucket, which Holly Backus, local HMP coordinator and Preservation Planner, is participating in. This recently created project is attempting to strike the delicate balance between adapting buildings to withstand hazards, and ensuring that these measures do not tarnish the historic integrity of the buildings and streetscapes. This project will create a toolkit for property owners as well as the general public which will serve as an addendum to "Building with Nantucket in Mind" which will cover floodproofing, the National Flood Insurance Program, and the Community Rating System. Holly Backus is taking steps to include other town entities relevant to this project such as the Conservation Commission and Coastal Resiliency Advisory Committee. Though this is an ongoing effort, it seems as though this type of project is exactly what Nantucket needs in order to prepare itself for future flooding events, coastal erosion and sea level rise, while also protecting the valuable historic character of the island. Similar efforts are being made by other historic towns, such as St. Augustine, Florida. We spoke with Jennifer Wolfe, the Historic Preservation Planner in St. Augustine, and she informed us that the city is currently developing guidelines for the adaptation of its historic buildings, so that private homeowners can more easily understand how to improve the resiliency of the building, without harming the historic integrity of the building or the surrounding area in the process.

As Resilient Nantucket's attempts show, the idea that the town may want to add preservation-focused guidelines to Building with Nantucket in Mind is not an argument that the Historic District Commission should relax its requirements and sacrifice the island's historic character. Rather, it is only stating that the Commission should attempt to make clear its stance

on what it would or would not support regarding the modification or construction of structures to mitigate hazards posing a threat to the structures themselves, or to the island as a whole. Though we have not directly spoken to any member of the Historic District Commission, we have gained a sufficient amount of knowledge through watching a number of HDC meetings, and we have supplemented that knowledge through conversations with other town members. This information has given us a clear picture of the HDC's role in the process of permitting town projects and their importance to the island at large. We fully understand that the Commission is solely focused on Nantucket's designation as a National Historic Landmark, and that hazard mitigation efforts must be cognizant of this issue, respect the decisions of the Commission and develop projects that meet their level of satisfaction. It is our hope that a clearer set of rules regarding specific hazard mitigation projects such as floodproofing will be beneficial to all parties, as it allows the HDC to provide the town with a general set of requirements, creating a more efficient permitting process by eliminating some of initial hurdles that may have otherwise arisen.

Rules and Regulations Governing the Subdivision of Land

In our attempts to identify all the relevant documents to this project, we also discovered a document titled "Rules and Regulations Governing the Subdivision of Land," in a tab on the Nantucket Government website, under the Planning Board section. This document would be an important one to include HMP recommendations, as it could prevent buildings and other structures from being erected in flood-prone areas, or areas under threat from erosion. However, this plan was last updated in 1999, and states that "flood prone" areas are defined as those listed on the Department of Housing and Urban Development's Flood Hazard Boundary maps from 1974. The appropriate reference for use today is the 2014 FEMA Flood Insurance Study (FIS) and Flood Insurance Rate Map (FIRM) products.

As is the case with the HDC and Building with Nantucket in Mind, the Planning department could update its zoning and subdivision regulations to take into account coastal and inland threats that may put new structures at risk. This would undoubtedly be a lengthy project, but with the coast constantly changing and always under threat of flooding and erosion, it is likely that this will need to be done at some point in the future. The fact that the town's subdivision regulations were last updated in 1999 means that the experience of the last 20 years

of coastal events are not documented, and this only increases the need for changes and an updated version of the regulations. A new version of this document, and a commitment by the town to continue to publish updated versions in a timely manner, may help to prevent the development of structures in at-risk areas. The HMP lists these regulations as a critical piece of regulating development in flood zones, and new regulations published after the HMP's release will only serve to strengthen their relationship with one another.

Coastal Resilience Plan

In the HMP's section on existing plans and regulations, one of the plans that is mentioned is the Coastal Resilience Plan. However, this plan had not yet been completed at the time of the HMP's creation, and the plan is still in development at the time of this project. However, the initial report, the Coastal Risk Assessment and Resiliency Strategies report, has extremely comprehensive recommendations. Its recommendations include revised zoning to allow for managed retreat, elevation requirements, relocation of municipal facilities, and prohibitions on new shoreline construction. In terms of the relative importance between existing plans and the HMP, the completed Coastal Resilience Plan will be one of the most important. This plan, developed by a consulting firm with the assistance of the Nantucket Coastal Resilience Advisory Committee (CRAC), will be a valuable tool to develop the town's overall resilience policies, particularly with regards to climate and sea level rise. Through the Coastal Resilience Plan, Nantucket will be able to identify high-priority projects, leverage the ability to apply for state and federal grants, and provide the town more opportunities to take on resilience-focused projects. The HMP states that the Coastal Resilience Plan will contain an implementation plan for town plans including the HMP, so the completion and success of this plan is critical to future integration efforts for the HMP and all other town plans. It is our hope that the Coastal Resilience Plan will introduce a pathway for recommendations laid out in the HMP to produce tangible results, through adoption of these strategies into town codes and an overall strengthening of the HMP's power as a planning document.

As was the case with possible updates to Building with Nantucket in Mind and the Rules and Regulations Governing the Subdivision of Land, the duty of ensuring that the Coastal

Resilience Plan, and subsequently the HMP, are properly integrated and given the necessary strength fall on the members and departments of the government which have regulatory power.

Nantucket has taken steps to introduce coastal resilience into its overall mindset, through the creation of groups such as CRAC and the establishment of a Coastal Resilience Coordinator. However, as the name of the committee suggests, CRAC only functions in an advisory role, lobbying other groups to take the resilience point of view, without themselves having the power to control what happens on the island. In our conversations with the current Coastal Resilience Coordinator, Vince Murphy, he informed us that CRAC is tightly linked with the Conservation Commission. While this is certainly a positive step in promoting coastal resilience, it also means that any CRAC suggestions must also be established as the position of the Conservation Commission before they can be adopted by the town. This would appear to establish an extra hurdle in the process of instituting hazard mitigation and coastal resilience methods, as the priorities of CRAC and the Conservation Commission are similar but not identical. If, for example, a coastal resilience method regarding the drainage of flood-prone areas was at risk of eliminating a wetland, the Conservation Commission would likely step in to ensure that the wetland was protected, in accordance with the charges of the Commission outlined in the Wetlands Protection Act. This is not to say that the priorities of the Commission are in any way inferior to those of CRAC; it is simply an example to highlight a potential gap in the implementation of hazard mitigation strategies and policies.

4.1 Case Studies

As mentioned in the methods, we decided that it would be easier to understand how the policies and departments in the Nantucket government worked together by using real-life case studies as examples of the process in action. Through these examples, we identified where there were issues, inconsistencies or ambiguities in the process, and used these gaps as the basis for our recommendations. Table 3 below outlines the major case studies used in this project, and the gaps found as a result of our research.

Table 3: Overview of the Case Studies

Case Study	Gaps found in each case study
37 Washington St.	No absolute mechanism to stop or regulate building in the flood zone beyond the state building code. Need regulations and/or guidelines on flood proofing on new and renovated buildings.
Easy St. Bulkheads	No communication or consistency between adjacent bulkhead projects and general lack of a consistent town review of engineering projects (by a professional engineer) in general.
Millie's Bridge (Ames Ave)	Every option of providing access to Smith's point brings inherent risk from hazards

4.1.1 The Finance Office at 37 Washington St.

The Finance Office at 37 Washington St. was built in the 1970's and is an important piece of municipal infrastructure. This building is currently located in the FEMA flood zone as can be seen in Figure 7 and was considered to be a good case study because of the nearby Harbormaster Building, which was another recent town project. The Harbormaster building is across the street from the Finance Office and was substantially refurbished following an intense debate about various options, including whether the building should be relocated out of the flood zone. This building, due to its intended function, had to be on the harbor, but the Finance Office has no such need. We also identified Washington St. itself, as it is an important route for trucks to travel the island and floods often. There was some discussion of a way to elevate the road to keep it functioning as critical infrastructure. Given all of the context surrounding this building,

and through discussion with town officials, we settled on a few options to harden the Finance Office. The possible solutions we considered were elevation, floodproofing and relocation.

Figure 7: 37 Washington St shown on a FEMA flood map of Nantucket (FEMA Flood Map Service Center)

The first possible solution we discussed with town officials was the elevation of the Finance Office. The building itself has a slab-on-grade foundation. This type of foundation is a poured concrete slab which the building is built up from. This type of foundation is not typical for buildings on Nantucket and makes the elevation of the finance office much harder. However, if this were not the case, the elevation of the building would be a good solution. In our conversation with Holly Backus, she said that many buildings in the area had been elevated and that the HDC tends to approve the lifts provided the building still looks historically appropriate. She mentioned that one of the ways that this can be done is by putting siding over the raised sections. The Finance Office is not a historic building but as this project is being written the "Resilient Nantucket" MVP project is identifying the approaches to raise or protect historic buildings from flood damage while still maintaining the contribution to the historic character of the island.

One of the other things that was considered as a possible solution for the Finance Office was floodproofing the building. The HMP recommends wet or dry floodproofing only for non-residential structures (Milone and Town of Nantucket, 2019, 3-72). Although "Resilient Nantucket" which is an ongoing project will allow all structures to use these methods of floodproofing. Dry floodproofing is the process of hardening the structure in such a way that water cannot enter, such as sealing the basement off from water or adding a removable water wall in front of the doors to the structure. Though this process would ideally create a watertight building, it is not without its drawbacks. In our conversation with Vince Murphy, the Coastal Resiliency Coordinator, he said that this method creates a difference in pressure between the outside and inside of the structure that must be considered. This would likely require an engineered solution. The other option, wet floodproofing, lets water into the structure through flood vents or other means. This eliminates the issue of pressure but everything critical, for example utilities and documents, must be moved above the design flood elevation. Nantucket does not have any specific regulations on either wet or dry floodproofing or a trigger to begin to explore the floodproofing of either new buildings or renovations.

The last thing that we considered was relocating the Finance Office, moving it further inland and away from the FEMA flood zone. This, however, has the same problem as elevating the building, in that the slab-on-grade foundation could hinder the move. When we discussed this with town officials the consensus was that moving buildings on Nantucket has been a fairly common event, and still continues to be a feasible solution. There is another option of moving the department functions to another building further inland. This would protect the important town records held within the building. The town might want to lead by example and move or floodproof their offices near the coast. As this happens PLUS may want to incentivize moving businesses and homes inland and regulate the construction along the coast. Of course, as part of the coast erodes and sea levels rise there will be less land to retreat to.

4.1.2 The Bulkheads on Easy St.

Easy St. is a single-lane, one-way street that is a vital connection between Steamship Wharf and Straight Wharf. This street experiences storm and non-storm related flooding as can be seen below in Figure 8**.** The bulkhead storm water outfalls on Easy St. are designed to prevent

backflow from the ocean into the drainage pipes. Currently, these bulkhead outfalls do this through duckbill check valves that can be seen in Figure 9. Within the last few years, these duckbill valves have become deformed, which has significantly compromised their ability to mitigate flooding. The duckbills are different sizes and the 12” duckbill was the most compromised of the three. The initial report was done on this in July 2020, and the town is still considering solutions. This highlights the need for a system to look back at these projects and consistently monitor and reevaluate them.

Figure 8: Flooding on Easy St. at Broad St. 10/2/2019 (Larson, *High-Tides and Flooding on Easy Street* 2020)

The bulkhead on Easy St. was built by the town, but it is not the only bulkhead in the area. Adjacent to the Town bulkhead to the west, there is another bulkhead built by the Land Bank. The Land Bank is a quasi-governmental agency but there was little communication or coordination between the projects. This led to the bulkheads being built at different heights from each other, in a way that impedes their ability to properly function and protect the area. In addition to high-tide flooding of Easy St., there is a similar amount of high-tide flooding along

Figure 9: Easy St. Bulkheads with sizes of the duckbills (Larson, *High-Tides and Flooding on Easy Street* 2020)

lower Broad St., at Steamship Wharf. The storm drain outfall for the Broad St. drainage system does not have any backflow device and leaves the area unprotected. In other words, even when the outfalls at the Town bulkhead are working properly to prevent backflow, the area will continue to flood due to the backflow and flooding on lower Broad St. Figure 10 below shows the outfalls in the Easy St. area. The blue circle on the map shows the location of the Easy St. bulkheads, the green circle shows the location of the bulkheads built by the Landbank, the red circle shows the location of the outfall at Steamship wharf and the yellow circles are other outfalls along that street. This map really gives an indication of how close these different bulkheads and outfalls are to each other and really emphasizes the need for consistency.

This example illustrates that the town needs to have a coordinated effort along the downtown shoreline to ensure that not just one project is working correctly, but that all of the projects work together to mitigate hazards. They must also consider the future of these projects to determine if or when they will need to be replaced. Looking beyond that, the street itself may need to be raised, or the town will have to create an alternate route for ferry traffic. In a broader sense, the town needs to be able to coordinate projects across public and private properties and stage planning responses considering what mitigation efforts will need to be in place on the street

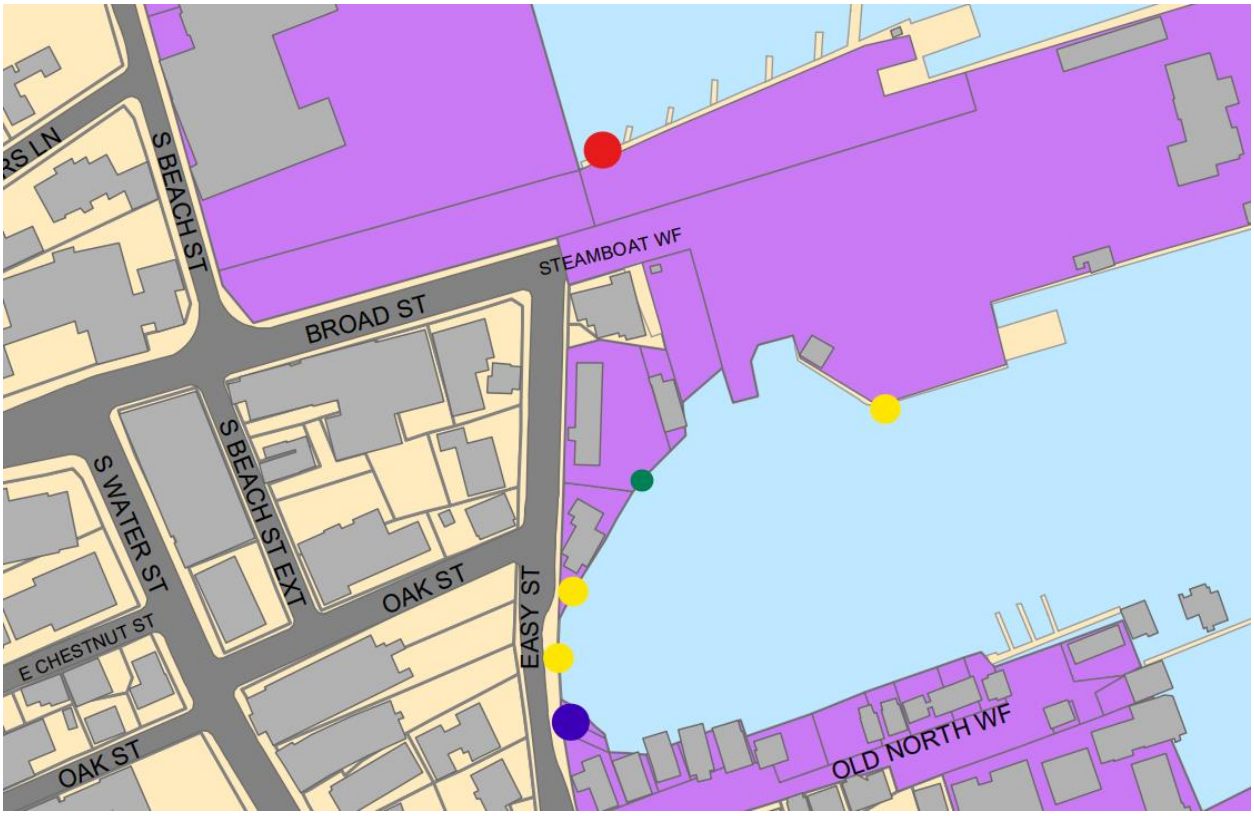

Figure 10: Map of the Bulkheads and Outfalls around Easy St. (*Town of Nantucket - GIS Mapsheet Harbor Overlay District* 2008) and (Earth Tech, INC, 2005)

in the future. Our potential solution for the issue of bulkheads was a town bylaw that regulates their height, and a possible larger-scale solution could be the creation or elevation of a town-wide engineer role (licensed professional engineer) to review projects like these bulkheads from an engineering design perspective.

4.1.3 Millie's Bridge (Ames Avenue Bridge)

Millie's Bridge or its official name Ames Avenue Bridge was our third and final case study. The extensive repair or replacement of Millie's Bridge would require much coordination between DPW and the Conservation Commission to handle all of the necessary permitting. The general upkeep of the bridge is handed by DPW and the bridge is regularly inspected by the state as part of the bridge management program. This bridge is the only road connection between Smith point and the rest of the island. However, Smith Point is heavily affected by erosion; living there in 30-50 years may not be feasible. This can be seen in Figure 11 showing the

FEMA coastal erosion hazard maps at an intermediate low sea level rise prediction. In the map below, Millie's bridge is located at the bottom right. The yellow areas of the map are the areas predicted to have eroded by 2030, the red areas are predicted to have eroded by 2050, and the purple are by 2100. This means even at a slightly lower sea level rise scenario Smith Point will be heavily eroded by 2050. Would the town want to spend money on a bridge that might not be needed in the near future? We discussed other options for providing access to the homes on Smith Point including building a causeway and having only beach access by car. The causeway while possibly more resilient would also have the same budget issues as repairing or replacing the bridge. Giving car access only by beach gives people access to their homes but emergency vehicles and other service vehicles needed for tasks like pumping out a septic system wouldn't be able to cross the beach. None of these solutions are ideal but given the rate of erosion on Smith Point the options are limited.

Figure 11: FEMA Coastal Erosion Map Showing Millies Bridge and Smith Point at intermediate low sea level rise predictions (FEMA)

4.2 Interviewing Officials

Throughout the course of our project we interviewed many town officials in Nantucket and other towns. Both who we interviewed, and the content of our interviews were directed by the case studies we used. Through this process we were able to gain insights on the gaps in the implementation of the HMP as well as the level of communication between departments on these topics. Table 4 below details the people we interviewed and the key findings from each of those interviews.

4.3 Potential Solutions

The following section will go into detail about the recommendations we have made based on the data we collected from the interviews we have conducted over the course of this study. In this section we will go over the recommendations we have made and the justification for each of these recommendations.

4.3.1 Building in the Floodplain

As we saw when looking into our case study at 37 Washington St. there is currently no town mechanism that holistically regulates building in FEMA flood zones. The HMP suggested that Nantucket "Increase cooperation between the Nantucket Conservation Commission, Planning Board, Building Department, and Health Department with regard to controlling growth and development in inland flood zones." (Milone and Town of Nantucket, 2019, 3-74) In the HMP this action is listed as complete but through our research we found that it might need to be reexamined. There will also need to be a mechanism to enforce the regulations outlined in the Coastal Resilience Plan when it is completed.

4.3.2 Enforcing the Hazard Mitigation Plan

Building on the discussion of the case studies with various interviewees, it became clear to us that one of the major gaps in the HMP is the lack of clarity regarding who has the power to enforce its recommendations. Holly Backus has a coordinating role and can bring different parties (HDC, NRD, NEO, etc.) together to discuss how to coordinate the HMP with other policies and programs, but she has no enforcement powers. CRAC, as previously mentioned, has

Table 4: Key Findings from Each Interview

Name	Title, office	Date	Key Findings
Holly Backus	Preservation Planner, PLUS	10/16/2020	Need a consistent message about elevating structures, bulkheads, etc. Need a consistent message between historic guidelines and resilience Need HDC approval before one can construct any building on Nantucket Nantucket has been moving buildings for hundreds of years
Vince Murphy	Coastal Resilience Coordinator, Natural Resources	10/30/2020	A new town bylaw would solve the bulkhead issue Could potentially use beach access to get from Smith's Point to the rest of the island but wouldn't be able to get emergency vehicles to Smith's Point Conservation Commission is triggered when any wetland areas are involved in a project CRAC mostly gives advice to the select board There's a challenge with making a building flood proof while maintaining the historical character of the island
Paul Murphy	Building Commissioner, PLUS	11/11/2020	Certain houses on historic listing that are exempt from floodproofing and other hazard mitigation efforts People can build in these high-risk erosion areas at their own risk If the project funding is more than 50% of the building's value, and you're in a floodplain, you'll have to raise the building

Jeff Carlson	Natural Resources Director, Natural Resources	11/16/2020	Conservation Commission need permitting for project within 100ft of wetland Homeowners have to consider where the water will go if they floodproof their lot Conservation Commission will take advice from CRAC about how to proceed The DPW went overboard with repairing the wall protecting Polpis Road at Sesachacha Pond, so Conservation Commission had to issue a stop work order
Rob McNeil, P.E.	DPW Director, DPW	11/20/2020	Bridges typically are inspected by the state including Millies Bridge The town must consider if it makes sense to spend $5 million dollars for a bridge that would last 75 years when that area isn't expected to be there in 40 years Engineering services for the town need to be a whole department rather than just a single town engineer DPW could be an ideal place for a sustainability office
Kate Hanley	Town of Concord Director of Sustainability	11/25/2020	The sustainability department in Concord is located in the Town Manager's Office. They handle MVP grants but have a focus on reducing carbon emissions Sustainability Directors are people with a wide array of backgrounds
Jennifer Wolfe	St. Augustine Historic Preservation Planner	12/1/2020	St. Augustine doesn't have a sustainability department, but has policies and programs dedicated to sustainability They have two people in their DPW who handle most of the work on sustainability within the city. They also have three licensed city engineers St. Augustine has recognized the need to adapt their historic buildings to withstand flooding via elevating. They're still working on a general guideline for how high the buildings should be elevated

Leslie Snell	Deputy Director of Planning, PLUS	12/2/2020	PLUS is trying to move the commercial focus to mid island where there isn't the same flood issues like they have downtown Large projects have a coordinated review with any departments that would have a role in that project Engineering requirements for specific boards may be very different and require expertise in different areas
Sustainability Workgroup	Holly Backus, Preservation Planner Vince Murphy, Coastal Resilience Coordinator Lauren Sinatra, Energy Coordinator	12/3/2020	Part of the problem with sustainability is that it's a massively ambiguous term so it's difficult to narrow it down to a single definition A workgroup seems to be better than another siloed department Need to expand the workgroup to include a DPW engineer Want CRAC to report to and make recommendations to ConComm as well as the Selectboard Want CRAC to potentially be an oversight committee

an advisory role without oversight or enforcement powers. The Conservation Commission has oversight and enforcement powers, but has not typically been involved in hazard mitigation per se, and has no real role outside of wetlands protection. This means that while the Commission could theoretically enforce the HMP in areas affected by flooding, erosion and sea level rise, it would not have jurisdiction over hazards such as wildfires or earthquakes. We have looked into two possible solutions to ensure oversight over these coastal projects; either having the Conservation Commission take on additional responsibilities, or giving the Coastal Resiliency Advisory Committee regulatory power.

One of the solutions that we considered for this gap was expanding the responsibilities of the Conservation Commission to include the enforcement of the guidelines of the HMP and Coastal Resilience Plan. This would require greater communication between CRAC and the Conservation Commission. This would include expanding the role of CRAC to advise ConComm as well as their current role of advising the Select Board. ConComm would also need to expand the types of projects they permit and regulations they enforce. This solution makes the project planning process simpler than giving regulatory power to another group such as CRAC itself. However, this would also require a structure for communication between the boards.

In the event that the recommendations in the Coastal Resilience Plan are not taken into account by current regulatory groups, we discussed with Vince Murph the option of making the Coastal Resiliency Advisory Committee, CRAC, an oversight committee rather than advisory one. CRAC is currently drafting the Coastal Resilience Plan and would have the best knowledge of that plan and how it could be implemented. There is a model in how this could work in Falmouth which has a Coastal Resiliency Action Committee with regulatory powers. This regulatory power would give CRAC the ability to enforce the guidelines. This would require approval by the Select Board to change CRAC's status. This solution does have some drawbacks, as introducing another regulatory body into the government presents the risk that the recommendations of CRAC will conflict with those in other groups, presenting new gaps that will need to be addressed in the future. It is also likely that many voters and members of the Select Board might oppose the creation of another regulatory authority. This is why our preferred option is to allow ConComm to enforce the recommendations of the Coastal Resilience Plan, as this would streamline the regulatory process, while allowing CRAC's advice to be taken

into account. This solution creates another gap, however, in that neither CRAC or ConComm are concerned with other hazards such as earthquakes or wildfires, although these hazards are very rare on Nantucket and the HMP itself was much less concerned about them.

4.3.3 Floodplain Manager

In our discussions with our sponsors, Gregg Tivnan and Chuck Larson, we collectively came to the conclusion that there should be more oversight on critical coastal projects in several areas of the island. As stated previously, flood zones are a particular area of concern, especially as erosion and sea level rise change the boundaries of these flood zones, and as hurricanes, nor'easters and other storms pose increasing threats to the island. One of the possible mechanisms for providing oversight that came out of our conversations was the idea of a "floodplain manager." This position's primary duty would be to oversee all projects within designated floodplains. The floodplain manager would ensure that the town is in keeping with the National Flood Insurance Program and other local guidelines. They would also encourage new projects to mitigate hazards within the floodplain. If the town were to take this step, there would be several benefits. Not only does this position add another layer of oversight to town projects, appointing a floodplain manager also opens up the possibility for more FEMA grants due to the added expertise that having someone in this position would provide. This would likely also allow for a reduction in the cost of flood insurance for homeowners. This position would serve as a key point of contact for all information relating to the floodplain thus adding easier flow of consistent information. Speaking with Jeff Carlson, Director of the Natural Resources Department, we learned that he is currently training to potentially fill this role by the end of 2021.

4.3.4 Town Engineer

While a floodplain manager would be able to oversee community-wide mitigation actions within floodplains, their scope is somewhat narrow, and they are not necessarily going to be involved in the minute details of developing a project. This is important because as we have seen in our research, there has often been a lack of technical consistency between a number of town projects. As we saw in our case study analyzing the Easy St. and Land Bank property bulkheads, there was little coordination between these similar projects when establishing a design elevation.

The difference in the height of the adjacent bulkheads diminishes their ability to adequately protect that area from floods. Another example of this lack of coordination is the DPW project at Sesachacha Pond. This project was done as emergency maintenance and worked in that capacity. As a long term solution, however, its proximity to wetland areas makes it difficult for the DPW to coordinate and design a project in such a way that it will both be successful and satisfy the Conservation Commission.

Though these were some of the specific examples we looked at for this project, these case studies speak to a much broader gap in the town government; the lack of coordination and communication between all of its mitigation projects. A possible solution we discussed with Chuck Larson, P.E., the Manager of Strategic Projects, for this issue was for Nantucket to have a dedicated Town-wide Professional Engineer to support all departments (Water, Sewer, DPW, Marine, Airport, Town Administration, Building, etc.). The role of this Town Engineer would be to oversee the projects that the town undertakes, including working and coordinating with engineering consultants hired by the town. This would enable each project to be the most effective it could possibly be while working with current codes and past projects to balance the interests of all relevant departments. It would also ensure that all projects are meeting a consistent set of engineering design and construction standards, as projects would undergo a review by the Town Engineer before they are put into action.

Over the course of this project, we considered several options for the operationalization of this engineering review process. The position of Town Engineer could be separate and not strictly under any department or it could fall under the HMP or sustainability department we will propose later in this section. We have also discussed the possibility that a single town engineer wouldn't be sufficient for the island's needs and that an entire engineering department may need to be created. In our conversation with Public Works Director, Rob McNeil, P.E., he emphasized the idea of an engineering department overo a single engineer. Several other Massachusetts towns (e.g., Plymouth, New Bedford)) have an engineering department. The position of Town Engineer has been proposed by DPW as part of the Nantucket Town budget for several years but was never funded in the final town budget. Rob McNeil also brought up the idea that the appointment did not have to be attached to a single department and could function as a separate entity. Figure 12 below is a diagram which identifies the places where the positions we have

discussed may fit into the structure of the town government. In the figure below the town engineer has two possible positions highlighted in blue showing where the options are in the structure of the town government. The floodplain manager, ConComm, and CRAC are highlighted in green illustrating how all of these positions could work very closely together. Lastly highlighted in orange is a workgroup, not a new position but a group of people from several departments who will work together regularly. This group will be discussed in greater detail in the next section.

4.3.5 Sustainability Workgroup

As we have mentioned, the HMP is currently only an advisory document. None of the things stated in the HMP are requirements, and there are few mechanisms currently in place to ensure that the recommendations of the plan are acknowledged and implemented by anyone in the town. If the town wants its Hazard Mitigation Plan to become more widely and systematically implemented, it must first ensure that there are people and departments in place that will at least lobby for, if not directly implement, the HMP's suggestions. In the same way the Coastal Resilience Advisory Committee will base its recommendations on the Coastal Resilience Plan, it would make sense for the town to establish a single department whose responsibility is to implement the Hazard Mitigation Plan. In conversations with our sponsors, we learned that prior to the COVID-19 pandemic, a small working group of town officials from several departments were meeting as a small sustainability workgroup. Based on this information, it appears that a potential solution to the HMP's lack of enforceability could be to increase the size of this group to include more people from more departments.

The expansion of the sustainability workgroup would close off many of the major gaps we have identified if implemented in conjunction with the creation of a town engineer's position or engineering department and the appointment of a flood manager. This would allow a team of people to be tasked with looking at projects on the island and making sure they fall in line with the sustainability and hazard management efforts of the town. The existence of this group with several members from multiple town departments (PLUS, Natural Resources, and Town Administration), is a solution that will ensure coordination between these departments and between the town as a whole when hazard mitigation projects are undertaken. This group could

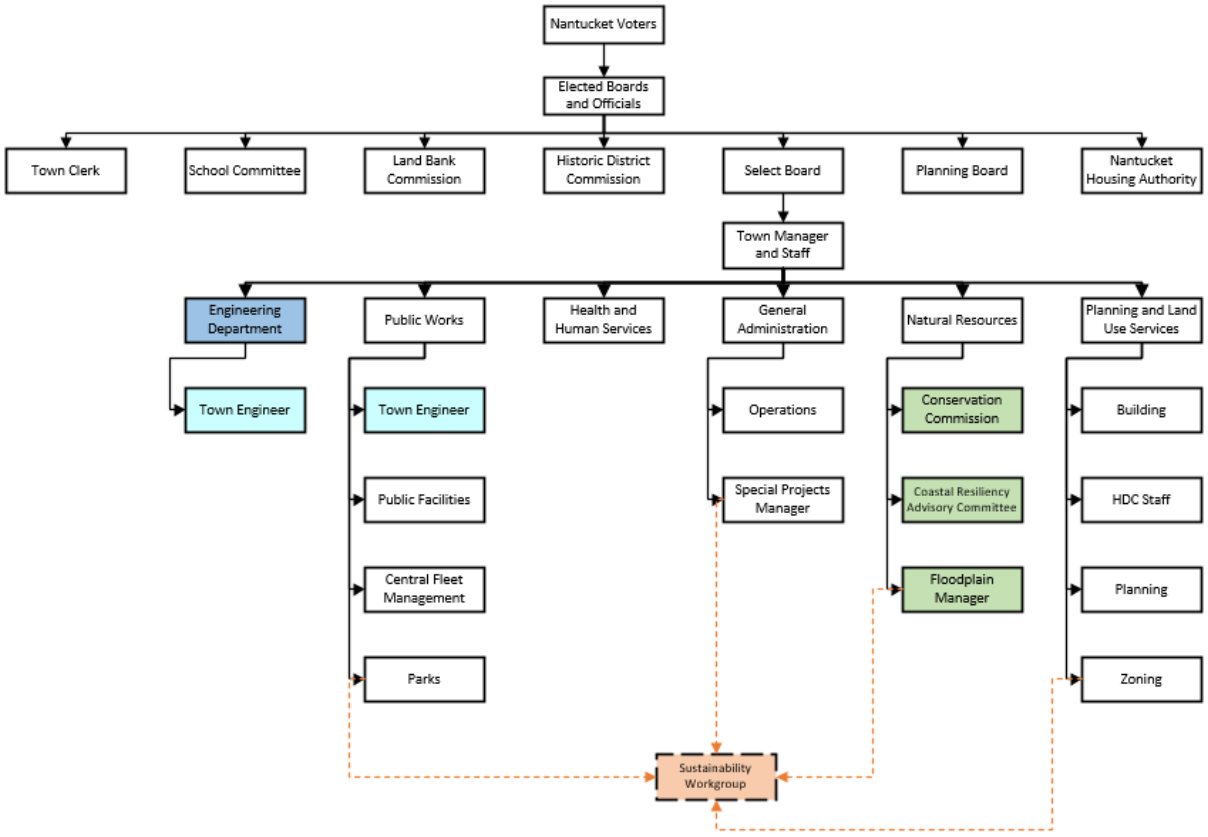

Figure 12: Nantucket Town Organizational Chart with new positions highlighted

be improved by the addition of people from other departments. A good first step would be the inclusion of a person from DPW, as they are a large far reaching department within the town.

St. Augustine, FL is a good example of distributing sustainability throughout several departments. Several other towns, such as Concord, MA, have models for a slightly different arrangement. They have a sustainability department with a staffed position of sustainability director. In conversation with Kate Hanley from Concord she stated that the best place for the sustainability office would be under the town administration as it has the most reach within the town. This would mean that the sustainability group reports directly to either the Town Manager or the Assistant Town Manager.

We also discussed the possibility of introducing a sustainability director or sustainability department into the town, rather than simply expanding the workgroup. This would ensure that there is a dedicated person in place to push for departments to adopt more sustainable practices,

and not having to rely on having people in as many departments. While this would be a more concrete way to ensure a greater focus on sustainability, the limitations of the town presently trying to introduce this position or department include potential budgetary restrictions as a result of the COVID-19 pandemic, as well as a somewhat limited scope for what this officer or department would do on a day-to-day basis. Both of these issues would need to be addressed in order for the public to support the creation and funding of this office, and so we believe that the most effective way to improve sustainable practices in the present is to expand the work group, and perhaps revisit the idea of a sustainability officer or department at another time. The workgroup can function as a self-regulating body that continues to push sustainability in their own departments, and if there prove to be deficiencies in this model, a sustainability office and perhaps a department would be a logical next step.

5. Conclusion

Our gap analysis was designed to find any areas of inconsistency between the recently developed Nantucket Hazard Mitigation Plan and any existing town legislation, such as zoning bylaws and some of their community planning initiatives, like the Town Master Plan. The purpose of this gap analysis was to determine if there was a way to improve the implementation of the recommendations made within the Hazard Mitigation Plan, and to find a way to make sure that the Hazard Mitigation Plan is being considered.

Using the interviews, and case studies we were able to draw a number of conclusions. For starters, a comprehensive and consistent application of the HMP is already difficult to accomplish. There are a number of different departments and committees with overlapping functions and responsibilities that are not always made clear. Additionally, there is a large set of town plans, policies and bylaws that continues to grow. It is difficult to keep track of all of these documents and they have a tendency to overlap and create some uncertainties about jurisdiction and some procedural confusion. Holly Backus and PLUS were ultimately the ones tasked with administering the recommendations of the HMP; however, they lack the power to actually implement any of said recommendations. Finally, there is very little coordination in hazard mitigation projects. The most obvious example would be the situation on Easy Street that was discussed earlier in this report. This lack of coordination has the potential to cripple the effectiveness of hazard mitigation projects on the island.

Based on our findings and conclusions we have six recommendations.

1. **We recommend the creation of a position for floodplain manager to serve as a key point of contact for all information relating to the floodplain.** This person would oversee any project within the floodplain to improve the flow of information and enhance consistency in application of the HMP. A floodplain manager also opens up the possibility for more FEMA grants due to the added expertise that having someone in this position would provide. This would result in reduced flood insurance prices for homeowners.
2. **We recommend creating a position for a Town Engineer or an Engineering Department.** This position would provide the town with more consistency in regard to the technical aspect of any project in the town. This person or department would oversee projects on the island from an engineering perspective, and coordinate with the

engineering consultants. This would ensure that every project on the island is meeting a specific standard of engineering design quality and construction quality.

3. **We recommend the expansion of the Sustainability Workgroup to include a member from DPW.** This workgroup contains town staff members from various different departments including Town Administration, Planning and Land Use Services, and Natural Resources. This workgroup could be more effective if it contained a member from DPW as it is a large department with a lot of reach. Expanding the workgroup to include more departments such as the DPW means that each member of the group can advocate for sustainable practices within their own departments, through the development of department-specific plans and projects. This will in turn create a larger town-wide focus on sustainability, and the workgroup can serve as a place for coordination and communication between departments.
4. **We recommend giving additional regulatory powers to the Coastal Resiliency Advisory Committee, CRAC, and the Conservation Commission, ConComm.** This recommendation will ensure that there is more regulation along Nantucket's coastline. We recommend that CRAC be given the authority to advise ConComm in addition to their current role of advising the select board. ConComm currently enforces the Wetlands Protection Act but could be given more regulatory power enabling them to also regulate more general projects along the coast. The Conservation Commission will also play a critical role in the enforcement of recommendations in the Coastal Resiliency Plan, which is being developed by CRAC and follows up on actions listed in the Hazard Mitigation Plan.
5. **We recommend updating Building with Nantucket in Mind.** An ongoing project "Resilient Nantucket" is attempting to strike the delicate balance between adapting buildings to withstand hazards, and ensuring that these measures do not tarnish the historic integrity of the buildings. This project will serve as an addendum to "Building with Nantucket in Mind". Though this is an ongoing effort, it seems as though this type of project is exactly what Nantucket needs in order to prepare itself for future flooding events, coastal erosion and sea level rise, while also protecting the valuable historic character of the island.
6. **We recommend updating Rules and Regulations Regarding the Subdivision of Land**. This document was last updated in 1999, and states that "flood prone" areas are defined as those listed on the Department of Housing and Urban Development's Flood Hazard Boundary maps from 1974. It is in great need of an update to keep in line with the current needs of Nantucket.

We make these recommendations with the understanding that budgetary constraints may limit the likelihood of all of the recommendations becoming a reality. We feel that these recommendations will go a long way in closing the gaps that we found during the course of this study.

References

ArcGIS Web Application, fema.maps.arcgis.com/apps/webappviewer/index.html?id=1bad229b053642eab9a307e528df037d.

Brief History of Energy on Nantucket. (n.d.). Retrieved September 03, 2020, from http://www.ackenergy.org/brief-history-of-energy-on-nantucket.html

Coastal Resiliency Advisory Committee. (n.d.). Retrieved September 03, 2020, from https://www.nantucket-ma.gov/1391/Coastal-Resiliency-Advisory-Committee

Town of Nantucket. *Overlay District Flood Hazard (FHD), Public Well Recharge (PWR), Multifamily (MF), Neighborhood Employee Housing (NEHOD), County Overlay District (COD) and Town Overlay District (TOD), Harbor Overlay District (HOD), Village Height Overlay District (VHOD), and Solar Energy Overlay District (SEOD).* Code of the Town of Nantucket, Division 1 Bylaws, Part II, General Legislation, Zoning. Article III, Use and Intensity Regulations, Section 139-11. Retrieved September 27, 2020 from

https://ecode360.com/11472011

Earth Tech, INC. (2005). *Drainage Outfall Evaluation Nantucket, Massachusetts* (Rep.). Nantucket, MA: Town of Nantucket.

Federal Emergency and Management Agency. *Gap Analysis Program Guidance* (2009). Retrieved September 12, 2020 from

https://www.hsdl.org/?view&did=34389

FEMA. (2011). Local Mitigation Plan Review Guide. Retrieved September 28, 2020, from https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-plan-review-guide_09_30_2011.pdf

"FEMA Flood Map Service Center: Search By Address." *View/Print FIRM: View an Image of the FIRM Panel or Print a FIRMette for Your Chosen Location. NOTE: This Is a Static Map and Has Not Been Updated since the Effective Date. Please Refer to Any Amendments or Revisions (LOMC) in the Changes to This FIRM Section.*, msc.fema.gov/portal/search?AddressQuery=37+Washington+St+Nantucket%2C+MA.

Hazard Mitigation Grants. (n.d.). Retrieved September 17, 2020, from https://www.fema.gov/grants/mitigation

Hazard Mitigation Plan Update Town of Nantucket 11/27/17 [Video file]. (2017, November 28). Retrieved September 13, 2020, from https://www.youtube.com/watch?v=yjdTgwifZUU

Larson, Charles. High-Tides and Flooding on Easy Street: A Progress Report and Key Findings. (2020, July 10). [PDF]. Town of Nantucket. Accessed 09 October, 2020. (pg. 2).

Kim Lundgren Associates Inc. (2020, February). *Nantucket Sustainability Assessment Recommendations Report* [PDF].

Lang, J. C., & Stout, K. (1995). *Building with Nantucket in mind: Guidelines for protecting the historic architecture and landscape of Nantucket Island*. Nantucket, MA: Historic District Commission.

Local Hazard Mitigation Planning Fact Sheet. (n.d.). Retrieved September 13, 2020, from https://www.fema.gov/media-library-data/1468272301025-eed10d9ec0d7bfb537ad18c036870637/Local_Hazard_Mitigation_Planning_Fact_Sheet_Final_508.pdf

Local Mitigation Planning Handbook. (2013, March). Retrieved September 16, 2020, from https://www.fema.gov/media-library-data/1590070172371-48e87ca446838ba81afc2aca995940bc/FEMA_Local_Mitigation_Planning_Handbook_508.pdf

Milone and MacBroom Incorporated and Town of Nantucket. *Town of Nantucket Coastal Risk Assessment and Resiliency Strategies* (2020). Retrieved September 12, 2020 from

https://nantucket-ma.gov/DocumentCenter/View/35045/Coastal-Risk-Assessment-and-Resiliency-Strategies-Report-January-2020-PDF

Milone & MacBroom Incorporated and Town of Nantucket. *Town of Nantucket Natural Hazard Mitigation Plan* (2019). Retrieved September 12, 2020 from

https://www.nantucket-ma.gov/1373/Hazard-Mitigation-Plan

Milone & MacBroom, Inc. (2019, January). Community Resilience Building Workshop Summary of Findings. Retrieved November 03, 2020, from https://www.nantucket-ma.gov/DocumentCenter/View/24034/Community-Resilience-MVP-Workshop-Draft-Report---March-2019

Nantucket Master Plan. (2009, April 6). Retrieved September 16, 2020, from https://www.nantucket-ma.gov/DocumentCenter/View/1281/Town-of-Nantucket-Master-Plan?bidId=

Planning & Land Use Services (PLUS). (n.d.). Retrieved September 03, 2020, from https://www.nantucket-ma.gov/230/Planning-Land-Use-Services-PLUS

Public Works. (n.d.). Retrieved September 28, 2020, from https://www.nantucket-ma.gov/237/Public-Works

Reducing Municipal Energy Consumption. (n.d.). Retrieved September 28, 2020, from http://www.ackenergy.org/reducing-municipal-energy-consumption.html

Sustainable Nantucket. (2010, July 15). *A Climate Action Plan for Nantucket Island Draft* [PDF]. Town of Nantucket http://www.ackenergy.org/uploads/3/4/9/7/3497858/climate_plan_public_draft_1_14_1__3_.pdf

Thibodeau, J. and Helios Land Design. *Town of Nantucket 2007 Open Space and Recreation Plan* (2007). Retrieved September 12, 2020 from

https://nantucket-ma.gov/DocumentCenter/View/29042/Nantucket-Open-Space-and-Recreation-Plan-2007-PDF

The Mercer Group, INC. (2009, March). Management and Operations Review of the Department of Public Works And Review of the Need for a Central Town Garage. Retrieved September 28, 2020, from https://www.nantucket-ma.gov/DocumentCenter/View/661/Management-and-Organizational-Study-of-Public-Works-2009-PDF

Town of Nantucket Energy Reduction Plan. (2019, November 22). Retrieved September 28, 2020, from http://www.ackenergy.org/uploads/3/4/9/7/3497858/nantucket_cr3_energy_reduction_plan.pdf

Town of Nantucket Pre-Disaster Hazard Mitigation Plan. (2007, July). Retrieved September 16, 2020, from https://nantucket-ma.gov/DocumentCenter/View/17104/Pre-Disaster-Hazard-Mitigation-Plan-for-Nantucket---June-2017

Town of Nantucket - GIS Mapsheet Harbor Overlay District [Map]. (2008). In (p. 1). Nantucket, MA: Town of Nantucket. Retrieved December 9, 2020, from https://www.nantucket-ma.gov/DocumentCenter/View/22562/Harbor-Overlay-District-map.

Zoning Board of Appeals. (n.d.). Retrieved September 03, 2020, from https://www.nantucket-ma.gov/287/Zoning-Board-of-Appeals

Appendix A: Interview Preamble

We are a team from Worcester Polytechnic Institute researching gaps in the implementation of the Nantucket Hazard Mitigation Plan. To do this we will be working with case studies or example projects to see how the HMP would be implemented for that project. With our research we are hoping to identify these gaps and make a plan to rectify them. Our interview with you will further our research.

Before we begin the interview, we would like to let you know that the interview is voluntary and can be stopped at any time. Is it okay with you if we take notes during this interview? Is it okay if we record this interview? Do you mind if we quote this interview in our report? Are you okay with being quoted by name or would you prefer an anonymous pseudonym?

We will send you a copy of our paper to you for review before it is finalized and published.

Appendix B: Compilation of Hazards Which Pose a Threat to Nantucket, Affected Areas and Strategies for Mitigation, as Outlined in the 2019 Hazard Mitigation Plan

Type of Hazard	Description	Areas Most Affected	Mitigation Strategies
Coastal Flooding	The inundation of land along the coast and estuarine shoreline of ocean water and wind driven waves beyond normal tides. Most serious cases of coastal flooding and water level rise are caused by storms. This phenomenon is known as storm surge. Coastal flooding is significantly more common than inland flooding.	● Brant Point, Smith Point, Muskeget Island, and Coatue/Great Point are considered to be complete inundation areas according to FEMA mapping ● Madaket Village and downtown Nantucket are also considered at risk	Current strategies include restricting building activities in high flood risk areas, acquiring and maintaining open space in flood risk areas , and building and maintaining structures to protect the coast. Specifically: ● Open space preservation, ● Stricter statewide floodplain regulation requirements ● Adoption of updated FEMA Flood Insurance Study and Flood Insurance Rate Map ● Completion of the Storm Surge & Critical Infrastructure Report
Non-Coastal Flooding	**Riverine flooding:** when channels receive too much water from rain or snowmelt and overflow. Typically a result of storms, but can also be caused by debris or ice causing a blockage.	● Downtown, Brant Point, the mid-island area, Siasconset, outlying areas are considered to be at the highest risk.	Some measures include ● regulations, codes, and ordinances ● process for installing and maintaining storm drainage systems. ● HMP checklist of municipal responsibilities in response to a coastal flooding incident.

Hurricanes/Tropical Storms	Tropical storms and hurricanes typically are accompanied by hazards such as strong winds, heavy rain, and flooding from rain and storm surges. Tropical storms ● Produce winds anywhere between 39 and 74 MPH Hurricane ● winds above 74 MPH. ● Categorized 1-5 ○ 1 being the weakest and 5 being the strongest.	● Flooding that results from these storms affects the areas mentioned previously along the coast and certain areas inland ● Powerful winds generated by a tropical storm or a hurricane will affect every part of the island.	The National Hurricane Center (NHC) provides products to warn of ● cyclone formation ● maps of wind speed ● probabilities and arrival times, ● track forecast cones, ● rainfall predictions ● flash flood potential maps ● etc To prevent harbor damage, an emphasis is being placed on removing boats before storms hit. To address wind damage, wind load requirements are a part of Nantucket building codes.
Sea Level Rise, Shore Line Change, and Erosion	Sea level rise is the phenomenon of the water level in the ocean consistently rising causing the shore line to recede further and further. Erosion ● Result of sea level rise ● Causes damage to natural structures like cliffs, shorelines, etc ● Can damage or destroy coastline structures	● The shoreline is most at risk for erosion and rising sea levels ○ This will eventually become an island wide problem. ● Figure 2 highlights areas of the island impacted by erosion.	The Coastal Zone Management Shoreline Change Project seeks to ● Educate buyers and homeowners on the risks of erosion ● They claim coastal managers, shorefront landowners, and potential property buyers need information on both current and historical shoreline trends The Climate and Coastal Resilience Plan is currently under development and will address these issues.
Summer Storms & Tornadoes	Summer storms and tornadoes are storms that can bring hazards such as powerful winds, hail, and lightening. Tornadoes ● formed by certain thunderstorms ● Categorized from F-0, the weakest, to F-5, the strongest ● Can reach wind speeds of over 300 MPH.	● The entire island is at risk ● It is possible that these storms could miss certain parts of the island	● The majority of mitigation of these types of storms relies on warning ● Warnings are issued any time a severe thunderstorm is likely to develop ● Undergrounding utilities is one way to minimize the potential damage from storms.

Winter Storms	Winter storms generally refer to blizzards ● Some of the hazards that accompany these storms include heavy snow, ice, falling tree limbs and trees, and flooding and wind damage.	● All parts of the island are at risk. ● Some of the areas mentioned in the coastal flooding section may be at an even higher risk of massive damage due to flooding from snow and from burst pipes.	● Flooding is also a concern and many of the flooding prevention steps apply ● Wind load requirements for buildings are also pertinent ● The biggest task is snow and ice removal
Wildfires	Large uncontrolled burning of wooded areas. ● Many of these have been caused by humans. ● Can occur in dry shrub and brush areas, as well as large forests	● Fires in urban and developed areas are not covered in this ● The focus is mainly on dry, undeveloped and woody areas. ● Figure 3, taken from the HMP, maps out areas at risk.	● Fire department training and maintaining adequate equipment supply are two of the main focuses of mitigation. ● Educating people on how their actions could cause these fires and the amount of damage that can be caused by these fires is also an important part of mitigation.
Earthquakes	Sudden and rapid shaking of the ground that is caused by the shifting of tectonic plates in the earth ● The Richter Scale tells us the magnitude of these earthquakes and gives us an idea of how much potential damage they could do.	● Everywhere on the island is susceptible to damage from an earthquake. ● Depending on the magnitude, certain areas may receive more damage or feel more of a shake than others.	● Structural integrity of buildings to withstand certain magnitudes of earthquakes are included in the building codes in order to minimize damage ● It is also a municipal responsibility to follow a checklist within the HMP designed to prepare people.