

ABSTRACT

Title of Thesis: “HOI TOIDE” SUSTAINING ADAPTATIONS AND
MANDATING ACTION IN FLOOD-PRONE
HISTORIC COMMUNITIES

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As projections for sea level rise continue to build, communities across the globe are already facing the damaging effects of increased flooding, shoreline erosion and storm surge. The United States in particular, with a significant concentration of historic and cultural resources located along its populated coastal areas, must begin to adapt, or face losing these valuable properties along with entire historic communities. Adaptation to the effects of sea level rise will require many steps and many stakeholders, even among the smallest communities. Amidst the many challenges associated with adaptation, it will also be vital to consider the preservation and the integrity of the historic and cultural resources that will be affected by the changes. Therefore, questions regarding cultural value and integrity must be discussed prior to urgent action being taken.

My thesis question reads, “How can small, coastal communities plan and prepare for the effects of sea level rise without sacrificing the integrity of their cultural resources or historic characteristics?” There are four major factors that must be considered in order

to make informed decisions regarding a plan; collaborative identification of historic and cultural resources, historically sensitive adaptation strategies, sustainable sources of funding, and community-based planning. Small, historic communities must first ensure that all historic and culturally significant properties are accounted for and inventoried prior to any adaptive action taking place, as change can permanently alter the integrity of associated properties. Likewise, adaptation strategies must be sensitive to the historic environment in order to protect the resources without sacrificing historic characteristics of a building, structure or landscape. With limited federal assistance for sea level rise adaptation, communities must also begin to explore ways to fund adaptation and resilience strategies. This will require innovative and creative thinking to ensure sustainability of entire communities. Incorporating these large scale tasks on a community wide level will require full scale community planning, which must also incorporate local values and local participation in order to be successful.

My findings conclude that adapting small, historic communities to withstand the effects of sea level rise require participation of all residents, not only municipal planners. The work of adapting to a changing environment will be ongoing as projections for sea level rise continue to increase. There will also be a need for constant change and updates to plans as more information is gathered about the effects. Definitively, coastal residents must begin now to adapt for life with regular flooding and living with a consistent high tide.

Subject Headings:

Historic communities, community planning, sea level rise, adaptation, flooding, shoreline erosion, storm surge, integrity, historic property, cultural heritage, historic districts, coastal, beach nourishment, funding.

“HOI TOIDE”
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FLOOD-PRONE HISTORIC COMMUNITIES

Keri L. Ragland

Thesis submitted to the Faculty of Goucher College in
partial fulfillment of the requirement for the degree of
Master of Arts in Historic Preservation

2017

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CHAPTER I

THE EFFECTS OF SEA LEVEL RISE

Introduction

Places along the coastline have always been susceptible to flooding, storm surge and coastal erosion. Over the past century, however, the rate at which these destructive events are occurring has escalated. As a consequence of climate change, melting ice sheets and glaciers are resulting in rising sea levels. In addition, an increase in global temperatures is causing the ocean water to warm, resulting in thermal expansion that contributes to sea level rise. Just in the last century, the global sea level has risen about eight inches on average.¹ Further, scientists have high confidence that global temperatures will continue to rise for decades to come.² Many scientific projections indicate that the sea level will rise another one to four feet by the end of this century. Despite current world-wide mitigation attempts, the global sea level is still expected to continue to rise over the next several centuries. This is due to the time it will take for the Earth's surface to respond to the technological solutions intended to slow climate change.

In 2007, the Intergovernmental Panel on Climate Change projected that the average global sea level will likely rise between 19 and 59 centimeters (7 and 23 inches) by the year 2100.³ This projection indicates that the direct effects felt by sea level rise, which consist of more frequent flooding, increased storm surge and coastal

erosion, will continue. Already, these effects are being experienced on a global level, affecting the lives of residents living in coastal communities. Places like Venice, Italy and Norfolk, Virginia are regularly experiencing flooded streets and in some cases, regular inundation of neighborhoods at an increased rate. In response to these visible effects as well as the escalated sea level rise projections forecast over the next century, communities along coastal areas must begin to prepare and adapt for continued flooding, or accept the probability of gradual destruction from the rising waters.

Along the Eastern Coast of the United States, the rate of the rising sea is three to four times higher than the national average.⁴ In the mid-Atlantic region from New York to North Carolina, tide-gauge observations indicate that relative sea level rise rates were higher than the global mean average. The tide-gauge rates generally ranged between 2.4 and 4.4 millimeters per year, which suggests a projected 0.3 meters (one foot) during the twenty-first century.⁵ This enhanced rate is second only to the Gulf area, in places such as New Orleans, which is experiencing about 2.5 times greater sea level rise than the global norm.⁶ If proven to be correct, these projections could create massive flooding and inundation of the coastlines, engulfing portions of cities and towns. This alarming rate suggests an increased need for urgent adaptation in the affected areas.

Furthering the potential for devastation, the U.S. National Hurricane Center has recognized a trend of increasing storms. Its 2011 study, which covered the years from 1900 to 2010, concluded that nine of the ten most damaging hurricanes on record occurred within that last decade.⁷ This suggests that while the sea levels are rising, the potential for damaging storms is also increasing. A combination of these two elements

spells out hazardous conditions for any community located on or near the U.S. coastline. John Englander, author of *High Tide on Main Street*, predicts that unprepared cities will result in hundreds of millions of people displaced by the end of the century. Englander explains, “Erosion and sea level rise are not noticeable most days. What commands our attention is when the ocean makes its way into our communities and onto main street. This can happen gradually, as occurred in these island communities, or dramatically during extreme tides and storms.”⁸

Climate Indicator	Climate Change Risk	Impact on Cultural Resource
Increased global temperature	<ul style="list-style-type: none"> • Extreme weather events • Permafrost melt • Increased freeze-thaw cycle • Higher relative humidity • Stronger wind patterns • Species shift 	<ul style="list-style-type: none"> • Accelerated rusting in submerged and littoral archeological resources • More rapid decay of organic materials • Faster deterioration of newly exposed artifacts and sites • Increased rate of chemical decay of collections • Increased crystallization of efflorescent salts due to increased evaporation rates, leading to increased rates of structural cracking, deterioration • Damage to foundations • Reduced access to marine hunting grounds due to shifting sea ice • Changes in historic/ culturally significant vegetation patterns
Precipitation Change	<ul style="list-style-type: none"> • Saturated soils • Flooding • Drought 	<ul style="list-style-type: none"> • Increased exposure from vegetation loss and erosion • Destabilization of wetland or waterlogged sites • Exposure of submerged sites due to lower water levels in lakes • Erosion of supporting ground around structure • Increased pressure to relocate or elevate structures and/or surrounding structures • Loss of landscape features • Damage to structures • Increased risk of post-flood subsidence • Impacts from post-flood mitigation
Sea level rise	<ul style="list-style-type: none"> • Inundation and flooding • Increased storm surge height • Increased coastal erosion • Higher water table • Salt water intrusion 	<ul style="list-style-type: none"> • Submersion of coastal sites • Increased post-flood cracking due to associated ground heave and subsidence • Increased pressure to relocate or elevate structures • Loss of coastal sites and artifacts • Loss of culturally significant symbols, plants, and animals • Loss of or limited access to culturally important sites • Increased rusting, corrosion, and salt deposits

Table 1: Projected impacts of climate change on cultural resources. Sea level rise in particular could result in the loss and destruction of significant historic sites and artifacts. [National Park Service, *Coastal Adaptation Strategies Handbook*. Report, 2016]

Englander expanded on the topic, stating, “Hurricane Katrina gave the U.S. a sense of what suddenly relocating a million people looks like.”⁹ Although Hurricane Katrina is an extreme case, the possibility of another storm of a similar magnitude is increasing. As

the effects of sea level rise such as this surface into a reality, the United States must begin planning for hazardous conditions and preparing communities to withstand regular coastal flooding.

Sea Level Rise and Cultural Heritage

Climate change poses an especially acute problem for managing cultural resources because they are unique and irreplaceable — once lost, they are lost forever. If moved or altered, they lose aspects of their significance and meaning. Every year, we lose irreplaceable parts of our collective cultural heritage, sometimes before we even know they exist.

- National Park Service Director, Jonathan B. Jarvis¹⁰



Fig. 1: A group of people in 1950 pose for a photo on the only dry land left of Sharps Island. [Photograph courtesy of the Hanks family, chesapeakequarterly.net, accessed April 7, 2017.]

Home to many of our nation's earliest cities and oldest towns, the Mid-Atlantic States are becoming inundated at an increased rate. As these important coastlines are disappearing, much of our cultural history is in danger of perishing along with them

(Table 1). The cities of Boston, Newport, Charleston, Annapolis, Norfolk and even New York are regularly threatened by the effects of sea level rise that consist of increased flooding, storm surge and coastal erosion. Among the cities, valuable landmarks, historic districts and other places of historic and cultural significance are located within the vulnerable areas.

On May 20, 2014, the Union of Concerned Scientists (UCS) released a report that listed 30 historic sites at risk due to environmental factors, including sea level rise.

A few among those listed as in danger of flooding were the historic settlement of Jamestown, Virginia; the Harriet Tubman Underground Railroad and National Monument in Cambridge, Maryland; and the Cape Hatteras Lighthouse in Buxton, North Carolina.¹¹ The report paints a bleak picture of what could become of our local, state and national historic resources in a very short time span. It suggests that children of the next few generations may never know some of the iconic landmarks that we today associate with cultural heritage. Therefore, in order to best preserve our history and our national identity, immediate action must be taken to protect our vulnerable and valuable coastal communities.

Loss of Communities

In the United States, nearly 40% of the population lives along high population-density coastal areas.¹² This puts a significant portion of U.S. citizens in vulnerable and potentially dangerous situations. Already, communities in several states on both sides of the country are facing issues of lost or increasingly damaged buildings, roadways and other types of infrastructure. In 2012, Hurricane Sandy storm surges measured above

14 feet, caused \$62 billion in damage in the United States.¹³ The same storm caused an estimated \$19 billion in damage to New York City subways and also damaged or destroyed hundreds of homes and businesses. As the sea level continues to increase, these types of events are expected to become more frequent.

Even without the devastating results of massive storms, entire islands in the Chesapeake Bay have started to disappear (Fig. 1). In 1962, Sharps Island, once 700 acres, became completely inundated. Similarly, the last house on Holland Island, which once held 60 homes, was lost to the Bay in 2010.¹⁴ Other islands that have either been deserted or have already disappeared include Poplar, Barren, Hambleton, Royston, Cows, Punch, Herring, Powell, Swan and Turtle Egg Island.¹⁵ (Fig. 2)



Fig. 2: A boy from Tangier Island floats in the flooded streets. [Storm, Christian, *Business Insider*, “The Twilight of Tangier: What it’s like to Live on an Island that’s Disappearing Because of Global Warming,” accessed March 14, 2017.]

Tangier Island, populated by a historic community that still speaks its own distinct Elizabethan dialect, is projected to become uninhabitable by the year 2050.¹⁶ The specific dialect, also known as “hoi toide”, is a combination of the traditional accent and the coastal nature of its speakers. It is now common only in a limited number of small islands in the South Atlantic United States, stretching from Tangier Island, Virginia to Ocracoke Island, North Carolina. As the sea level continues to rise, these islands as well as their unique culture are in danger of becoming extinct as residents and property owners are forced to relocate. Professor Michael S. Kearney of the University of Maryland predicts that an area the size of Washington, D.C. is being lost in the Chesapeake Bay every century.¹⁷ This fact alone should provoke an immediate effort to preserve and protect our rare and endangered cultural resources.

Statement and Discussion of Hypothesis

My thesis question is “How can small, coastal communities plan and prepare for the effects of sea level rise without sacrificing the integrity of their cultural resources or historic characteristics?” There are several overlapping elements that must be put into action in order to answer this multi-layered question. For the purpose of this thesis research, the term “historic community” will be defined as a place that contains historic significance or cultural value for the group of people who live there. The level of significance or value could vary greatly from place to place and may also differ for individuals within the same community. Small communities have been chosen as a focus of this thesis analysis because such small cities, towns and municipal areas are vital to interpreting the core values of America, yet their importance is sometimes

overlooked due to their small populations, traditional occupations and limited budgets. For the purpose of this thesis, I am using urban cluster as defined by the U.S. Census Bureau as the definition for a small community with the understanding that some of the communities referenced are in rural areas. An urban cluster is a community with at least 2,500 people but fewer than 50,000.¹⁸ As we face potential loss of significant national cultural heritage, such types of smaller communities may not receive adequate assistance without the required planning, adaptation or funding. With these time consuming obstacles evident, it is even more essential that small historic, coastal communities begin immediately the process of planning for and adapting to the effects of a rising sea.

Adapting entire communities to living with regular flooding and increased coastal erosion will not be an easy task. However, amidst the disarray of large scale adaptations, it will still be important to consider preservation as a priority and the integrity of historic resources that could be affected by adaptation approaches. Every change to a historic site or community could negatively affect the integrity of the property.¹⁹ Retaining the authenticity without sacrificing the integrity of the historic resource as a whole will be essential in maintaining its historic value. This is a position that may not be considered by municipal or disaster response officials when implementing emergency or even planned adaptation actions. Therefore, it will be wise to plan for adaptation of historic communities in advance rather than to react after an emergency, which commonly occurs without forethought of the consequences.

My supposition for this thesis research is that there are four major factors that must be considered in order to make informed decisions regarding a plan of action for

sea level rise adaptation in small historic communities. These include collaborative identification of historic and cultural resources between preservation professionals and the community, sensitive adaptation techniques performed on historic structures and the historic landscape, sustainable funding from local sources and community-based long-term planning.

Chapter Summaries

Identification of Cultural and Historic Resources

Chapter II of this thesis analysis discusses the steps necessary to thoroughly identify which sites, buildings, landscapes and general places hold significance within the community. This will include recognized historic sites, as well as places of cultural significance. State, local and national registers, community-based input, surveys, and local inventories are tools that will help to determine what and how many historic and cultural resources exist in addition to how they are valued by the community.

This chapter also discusses identification of places that are not essentially historic, yet are vital components of the community's way of life. These significant properties or places could be aspects of the environment that make the community unique, desired, or attractive such as beautiful open beaches or a vibrant fishing industry. These "sacred places" are in reality incredibly significant to the cultural atmosphere of a community and should be valued to the same degree as a historic site.

Lastly, this second chapter also provides information on defining which of these significant properties are endangered by the sea level rise effects of storm surge, increased flooding and coastal erosion. Several available contacts as well as online tools

can be consulted to determine vulnerability. Open access to such information will allow municipalities to determine vulnerability of resources within a specific projected time frame, allowing them to determine priority areas and the necessary next steps.

Adaptation Strategies

The third chapter will focus on how sea level rise adaptation strategies can be appropriately applied to protect historic resources without sacrificing the integrity or important features of a building, structure or landscape. Specific examples from cities and small communities as well as historic sites are explored that present a general scope of the feasible adaptation options. Adaptation approaches will focus on physical structures such as seawalls, bulkheads and dune replenishment as well as water retention areas and other forms of green adaptation.

Chapter III thoroughly discusses how adaptations can affect the integrity of a historic community by compromising aspects such as “location,” “design,” “materials,” “workmanship,” “feeling,” “association,” and “setting” factors that can determine National Register eligibility. Any change to the built or immediate environment could damage the eligibility of a historic property for listing or could compromise its current status. Examples of appropriate adaptation strategies include cases from Grand Isle, Louisiana; the Quinault Nation in Washington State; and Norfolk, Virginia.

Adaptation approaches, “Protect,” “Avoid,” “Accommodate,” “Abandonment” and “Retreat” as well as some of their associated costs are also reviewed. Chapter III further suggests which strategies are ideal during various periods in the adaptation process and why some systems may work better than others depending on the locality

and community values. The concept of adaptation as a constant process, rather than a one-time solution, is an underlying theme.

International Studies and Mitigation Funding

Chapter IV answers the question of how the sea level rise adaptation strategies discussed in the previous chapter could be funded by a small community. This chapter addresses the general associated costs for adaptation including funding for other expenses associated with creating a successful, well thought out and approved adaptation plan. In addition to community-wide adaptations, funding sources are also identified to help individuals take proactive action for protecting their own properties, such as assistance with moving structures. Specific examples of successful funding initiatives in coastal communities like New York, San Francisco and some international cities are provided. The discussion also includes what options are currently available for communities from federal grants. The chapter highlights the new and innovative options that communities have begun to consider for funding adaptation approaches.

Community-based Adaptation Funding

This fifth chapter reviews sea level rise preparedness plans and similar documents from specific coastal communities. The cities of Boston, Annapolis, Alexandria and Norfolk are examined, among many others. To emphasize the need for protection of resources outside of the built environment, the Climate Change Adaptation Plan for the Swinomish Indian Tribe is among those included in the reviewed documents. Together, these plans advocate the need for inclusion and swift action to protect our country's heritage. The examples and their success within the

respective communities help to develop the framework of planning guidelines for the follow chapter.

Creating a Community Sea Level Rise Adaptation Plan

Chapter VI explores the specific steps that should be considered in regard to community planning that will affect the historic character and association of the area as well as its significance to the community. Concentration is placed on community participation. Establishment of a plan, such as a Hazard Mitigation Plan, Climate Change Preparedness Plan or an Adaptation Plan is a major focus and goal for this chapter. This chapter also identifies who needs to be involved in the community-wide adaptation effort and any outreach procedures that should be followed to ensure that all essential parties are involved in the decision making process.

Research Methods

The majority of my thesis research was conducted through online investigation of available resources. Much of the information chosen to include in this thesis analysis is directly related to communities and historic sites along the East Coast. However, various appropriate major U.S and international examples are also provided to suggest how those cases could be applied towards other communities.

Publications from the Secretary of the Interior were reviewed and considered in order to decipher acceptable standards for changes to historic property. This includes the *National Register Criteria for Evaluation* as well as the *Standards for Rehabilitation, Restoration, Preservation and Reconstruction*. The *Guidelines for the Treatment of Historic Properties* and *Treatment of Cultural Landscapes* were also

reviewed. These standards were used to suggest appropriate guidelines that must be followed to retain integrity and were then directly applied towards the thesis hypothesis.

Additional publications by the U.S. Federal Government that study the effects of climate change on the environment were explored. In 2016, the National Park Service (NPS) released a *Coastal Adaptation Strategies Handbook*. The document provides detailed information regarding the changes that national parks are making on a continuous basis to adapt to our changing climate. In many of those cases, sea level rise is a dynamic issue. Information from this document is used extensively throughout this thesis analysis in regard to adaptation strategies, their associated costs and how changes can affect the integrity of protected landscapes and historic sites.

In 2005, the Federal Emergency Management Agency (FEMA) released a study, *Integrating Historic Property and Cultural Resource Considerations into Hazard Mitigation Planning* which emphasizes the need to protect cultural resources from environmental dangers, such as the effects of flooding associated with sea level rise. The FEMA document further expresses the need to protect cultural places of importance after major hazardous events. Information from the guidebook is used broadly throughout this thesis analysis in reference to identification of cultural resources as well as planning strategies.

Also correlating with identification of cultural resources, a significant portion of Chapter II is associated with local appreciation. Using the 1989 article, *Sacred Places: A Return to Manteo*, the concept of “sense of place” in small communities is thoroughly explored. The article explains how different places, patterns, and associations that are vital to a community’s well-being can be identified as important but may not have

proper recognition through conspicuous forms such as historic registers. To determine vulnerability associated with frequent flooding and sea level rise, multiple online sources are suggested for consultation, which provide visual tools that can be used to evaluate a specific location. These sources include Geoscience News, Climate Central and the National Oceanic and Atmospheric Association websites.

CHAPTER II IDENTIFICATION OF ENDANGERED HISTORIC AND CULTURAL RESOURCES

Introduction

Before implementation of adaptation strategies can begin, it will be important to first identify which historic and cultural resources will need protection from the effects of sea level rise. Increased flooding, storm surge and shoreline erosion are the catastrophic effects that could cause harm to the integrity of historic properties. These historic and cultural resources are what represent the special characteristics and features that provide cultural depth and appreciation within communities. By identifying these resources, residents are able to further recognize that these locations hold value and that they should be retained and preserved for future generations to enjoy. In order to best exhibit appropriate stewardship, these resources and their potential hazards should be identified and included in community planning to promote preservation.

The National Park Service, an agency of the U.S. federal government, provides extensive information on the identification and treatment of historic and cultural properties. Through documents published by the U.S. Secretary of the Interior, the NPS provides access to federal standards and guidelines. These include *Secretary of the Interior's Standards for Identification* and *Secretary of the Interior's Standards for Evaluation*. This chapter will discuss how to apply these standards in coordination with other government documents, such as the *Federal Emergency Management Agency's*

Guidebook for Integrating Cultural Properties into Hazard Mitigation Planning to appropriately identify, evaluate and list historic and cultural properties within a community. Places of social culture imperative to community health and lifestyle, known as “sacred structures”, will also be highlighted as valuable resources that communities should plan to preserve. In addition, this chapter will also discuss resources that can be used to identify potential environmental hazards to these historic properties in relation to the effects of sea level rise.

Historic Registers

In communities throughout the United States, there are national, local and state wide registers, or listings, of historic places. These registers and their associated criteria function to assist with nominating and defining eligible historic properties and other sites of cultural significance. The most well-known historic register, the National Register of Historic Places, is the official list of the United States’ nationally recognized structures, sites, objects and districts that embody the historical and cultural foundations of the nation. The National Register was authorized under the 1935 Historic Sites Act and expanded under the National Historic Preservation Act of 1966 as a way of identifying and planning for the protection and collecting of historic sites across the country. It is managed and maintained by the National Park Service, a branch of the U.S. Department of the Interior. Currently, there are more than 90,000 individual sites listed in the National Register, with several of them obtaining multiple properties. The National Register represents all corners of the country, with almost every county in the United States exhibiting at least one historic property.²⁰

Information about listed historic sites and other properties are readily available and easily searchable online from the National Park Service website.²¹ Digital nomination forms are not yet available for every state; however paper copies are accessible from state archives or the respective State Historic Preservation Office (SHPO). In 2017, digital nomination forms are not yet available on the National Register website for Arkansas, Illinois, Massachusetts, Michigan, Missouri, North Carolina, New York, Pennsylvania, Ohio, Texas, or Virginia. Accessing this publicly accessible information is a convenient first step in beginning to search for state and nationally recognized historic and cultural properties.

Prior to receiving approval for listing, each eligible National Register property is carefully evaluated and officially nominated through a specific process based on the *National Register Criteria for Evaluation*.²² The evaluation consists of examining the appropriate age, significance and aspects of integrity which the historic resource must possess. Generally, a property must be at least 50 years old to be considered eligible for listing in the National Register, although this is not a firm rule and there are notable exceptions. The *National Register Criteria for Evaluation* also requires that the nominated property have an established period or point of significance to the history of the nation. Criteria then specifies if a property is associated with either historic events of local, state and national importance, significant persons from the past, if it embodies distinctive or artistic characteristics of a period or artist, or if it is likely to yield information from the past, such as is usually the case in archaeology.²³

In addition, the criteria also call for the property to possess specific aspects of integrity. Explicitly set, the seven defined aspects of integrity include design, location,

setting, materials, workmanship, feeling and association.²⁴ As a result, the national criteria and process of evaluation suggest a template from which most State Historic Preservation Offices as well as local preservation commissions derive their own standards for evaluation. Today, the *National Register Criteria for Evaluation* is also a tool used by the preservation community throughout the country to resolve contingent restoration treatments that may disrupt the value of historic properties. This prevents suggested treatments from affecting the integrity of a historic or cultural property. Specific measures for these treatments as set in the *Secretary of the Interior's Standards for Treatment of Historic Properties*.²⁵

In order to proceed with a nomination, each nomination form must first be approved by the State Historic Preservation Officer (SHPO). The SHPO will then approve the property for the respective state register. In most states, the same criteria are used to evaluate resources for the state register as for the National Register. In Virginia, nomination forms are approved by the Virginia Board of Historic Resources and the Virginia State Review Board in quarterly meetings. Communities that wish to nominate properties for the historic register should reference the “How to Complete the National Register Registration Form” document available from the National Park Service website.²⁶ The process for nomination can be time consuming, depending on the amount of necessary documentation. No fee or charge is incurred to nominate a property on a state or national level. However, consultants may be engaged to do some research.

In addition to the honor of listed status, there are other monetary benefits to listing a historic property. Inclusion of a property to the National Register renders it eligible to be considered for grants-in-aid from the Historic Preservation Fund (HPF). The HPF

offers funding to support State Historic Preservation Officers, to preserve some of America's most iconic historic sites and also to revitalize communities and create opportunities for economic growth. In addition to eligibility for this funding, listing in the National Register also includes incentives for deductions in federal and state tax credits, which can be used towards rehabilitation or restoration treatments for certain historic structures.

Notably, National Register listing is only honorific. The National Register of Historic Places alone requires no specific guidelines or rules that require retention of integrity of features as there is no official federal enforcement.²⁷ Secretary of the Interior Standards and Guidelines must be followed only if the property owner is applying for grants, tax credits, or other incentives that require special or specific care of a historic property. Properties can be removed from the register if the integrity is compromised; however, further repercussions would depend only on state or local standards.

Design Guidelines

In some communities, inclusion specifically in a local register may encompass design guidelines that at times could be strict. Listed properties may be mandated to adhere to specifications, depending on the local commission or set parameters. These guidelines usually address changes or alterations made to the property and are meant to protect the visual integrity. They are also intended for use by property owners to consult before making decisions about rehabilitation or new construction projects that will be sensitive to their property's historic character. Such guidelines usually intend to preserve

the Feeling, Association and Design of a historic environment while permitting the owners to complete necessary adaptive changes.

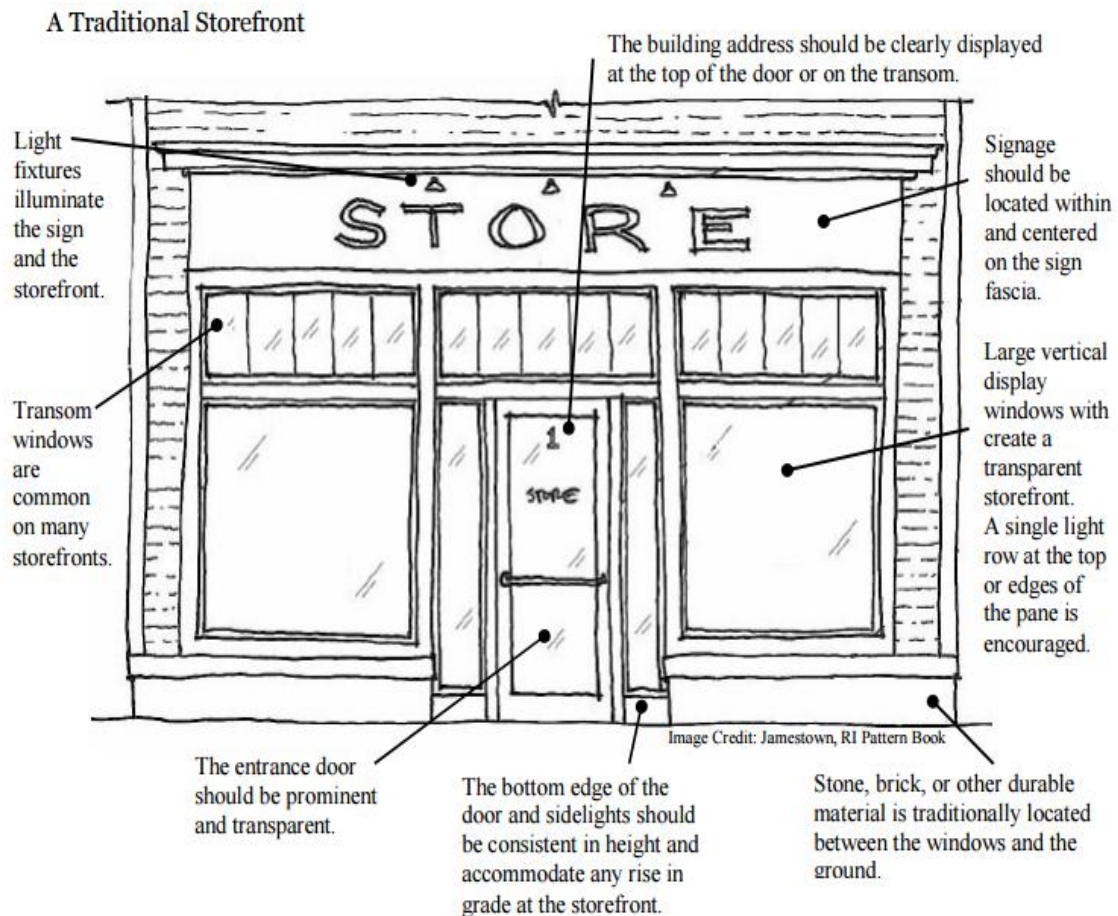


Fig. 3: The Town of Barnstable, Massachusetts has specific design guidelines for historic storefronts in the historic district. [Hyannis Main Street Guidelines, accessed March 31, 2017.]

Each locality will have different specifications for how they regulate the treatment of listed historic properties. To reiterate, these are outside of the National Register regulations. The *Downtown Historic District Design Standards and Guidelines* for Juneau, Alaska have distinct requirements for rehabilitation that vary between contributing and non-contributing historic properties. The design guidelines for colors are very specific, but not unusual to find in smaller towns. An example from Juneau's guidelines read, "A

single color scheme shall be used for the entire exterior so upper and lower floors and subordinate masses of a building are seen as components of a single structure. Generally, one muted color is used as a background, which unifies the composition. One or two other colors are usually used for accent, to highlight details and trim.”²⁸

Juneau’s guidelines also walk the reader through choosing an appropriate treatment for building components and distinct *Criteria for Replacing Historic Features*. The Town of Barnstable, Massachusetts, which is located near Cape Cod, also provides very specific design guidelines for commercial properties along their Hyannis Main Street Waterfront Historic District. (Fig. 3) The Barnstable guidelines specify the types of lighting, display and materials that should be used on historic storefronts. Although these design guidelines are in place to protect the integrity of the historic street, to some property owners, these designs could appear to be a negative aspect of inclusion in a historic district. To avoid penalties, it is best that all applicable design guidelines, restrictions or requirements are investigated thoroughly before alterations to any historic property are conducted. In these cases, changes could require prior approval by a local commission or historic preservation review board.

Certified Local Governments

Registration on a local, state or national historic register is the most common way that communities can publicly recognize historic resources. However, it is possible that not every community has a current or operating historic register. To encourage preservation, communities recognized as Certified Local Governments (CLG) are required to have a local register of historic resources. The CLG program is a partnership among

local, state and federal governments to help communities save irreplaceable historic characteristics found throughout the country by committing to historic preservation. “The program was intended to give local governments a formal role in the national historic preservation program, and, in particular, the National Register nomination process.”²⁹ There are several benefits for a locality to becoming certified. These include funding towards carrying out activities like surveys, National Register nominations, design guidelines or structural assessments. Certified Local Government status also includes general support from the State Historic Preservation Office.

In many ways, the Certified Local Government program encourages participation throughout the community in order to create a more inclusive and well-rounded support system for historic preservation. As a result, the duties associated with CLG status are equally as beneficial to the community as the assistance gained from the state.

In order to qualify for CLG status, Federal regulations require local governments to:

- 1) enforce appropriate State or local legislation for the designation and protection of historic properties;
- 2) establish an adequate and qualified historic preservation review commission by State or local legislation;
- 3) maintain a system for the survey and inventory of historic properties;
- 4) provide for adequate public participation in the local historic preservation program; and
- 5) satisfactorily perform the responsibilities delegated to them under the Act.³⁰

As mandated, a CLG must survey the area and keep an inventory of historic properties. CLG status can help a community incorporate preservation planning into their overall development plans through assistance that includes professional services, local input and by acknowledging the regulations put into place for protection of valued historic

places. Any community interested in or concerned about preservation in their area should strongly consider CLG status to help promote and protect their valued resources.

Historic and Cultural Properties

Despite the efforts put towards nominating historic properties, it is possible – and even most likely - that not all of the historic resources in a locality have been identified and listed in the local, state or national registers. Such a task would require a thorough survey of the area with years of research and access to all public and private property in the community. As this is unlikely, many historic resources in particular are not officially listed. Often, owners are either unaware of the significance of their property or are unwilling to make it known to officials.

In some instances, property owners may be reluctant to register their properties for the fear of losing certain property rights. There are several myths surrounding historic preservation that deter individuals from agreeing to register their property. These myths include beliefs that listing a property will result in a reduction in property values, the loss of freedom to demolish or alter a property, the general fear of invasion of privacy and that owners could be obligated to pay various acquired expenses and fees associated with upkeep of the property. Although such concerns are largely false, specifics on limitations will again vary depending on the locality. Subsequently, the misunderstanding surrounding historic preservation may prevent known historic structures from being publicly listed.

Occasionally, either the State Historic Preservation Office or a local historic preservation commission may obtain lists, or may be aware of properties that are eligible

for listing, but have not yet been formally nominated. The nomination process takes time, research and initiative in order to move forward, which may slow a nomination. Despite this hurdle, the preservation community should strive to identify as many historic and cultural properties in their community as possible. By having knowledge of their existence at best, planners and preservationists can begin to take action towards protecting their significant and valuable resources.

In addition to acquiring information about the locations of historic properties from already established historic registers, there are other tools available to assist with the identification of historic resources. Inventories, interviews and surveys are effective methods that can be used to gather information and also to identify potential properties from within the community. Using these sources, identification of historic resources is determined from the ground up, which may take a great deal of planning within itself.

Largely derived from FEMA's booklet, *Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning: State and Local Mitigation Planning How-To Guide*, the following section will discuss in detail ways that identification strategies which directly involve the community may be implemented.

Creating a Team

Before any work can be completed, there must be a designated team or special workgroup that will be facilitating the entire project. To insure consistency, the core of the team should remain throughout the entire preservation and planning project. For the intention of this thesis analysis, the assumption will be that small, coastal communities are likely to be working with limited resources and limited staff. Therefore, it can be

surmised that the team will likely consist of municipal workers, volunteers, preservation advocates, professional consultants and a town planner, among others. It is possible that not all members of the team may be fully versed in historic preservation practices.

Size of the team and specialty of each member will vary depending on the locality and must also be specific to the needs of the community and specific to the goals of the project. The amount of time and money to complete the identification process as well as the later planning and adaptations process will all need to cater towards the types and extent of resources that are available. A small community with limited funding will likely need to rely on a large group of volunteers from within the local population. Communities may be able to stretch out the identification process into a few years if there are limited estimated endangered resources. In contrast, a more densely populated coastal town with several historic resources on the waterfront may need to consult preservation professionals or independent consultants in order to assist with expediting the process. Especially in areas where the effects of sea level rise are actively damaging infrastructure and resources, the time frame for this step may be limited. The decisions for adequate team members will be distinct to each circumstance and may need to be altered if the extent of the project changes.

Developing Historic Context

The first step in the initial planning process will be to establish a “historic context” to use as a base for evaluating potential properties throughout the community.³¹ This step is identified as the first standard in the *Secretary of the Interior’s Standard’s for Preservation Planning*. “The development of historic contexts is the foundation for

decisions about identification, evaluation, registration and treatment of historic properties.”³² The standards further identify historic context as the cornerstone of the planning process of which the goals are to identify, evaluate, register and treat the full range of properties. “The use of historic contexts in organizing major preservation activities ensures that those activities result in the preservation of the wide variety of properties that represent our history, rather than only a small, biased sample of properties.”³³ Several periods of significance may exist within one community. Therefore, historic contexts may be broad and overlap or be specific to certain categories of properties.

The process should begin with collecting existing information surrounding the known history of the community. This will include information on any historic resources that have already been identified through existing inventory such as a local, state or the National Register. History of the known historic and cultural landscape, their defining features or characteristics, use of the landscape and use of natural resources are factors that should be identified.

Qualitative information such as literature on prehistory, known social and environmental impacts to the area and folklore or oral histories may all lead to relevant information that could reveal new significant places or property. Initial and current forms of commerce, transportation, engineering and culture will likewise be relevant as they could reveal settlement patterns that may lead to further identification of archaeology sites or forgotten structures and places of importance. Characteristics of a particular architectural style known to the region are important elements that should be classified and recorded in detail. Official and historic documents such as land use plans, deeds and

other legal records should be collected as they may reveal pertinent information regarding a historic site or the persons that lived there.

Community leaders should actively reach out to collect information on their area. Special interest groups, local advocacy groups or similar organizations may have relevant information on the history of the area and may be able to pinpoint specific places in the community that could reveal historic or cultural importance. Drawing from knowledgeable professionals from neighboring preservation or academic communities could also be a valuable tactic used to gather common resources or to gain assistance with a specific investigation.

Distinguishing the historic context from the full history of a place will involve establishing relevant geographic limits. It will be important to not only define geographic boundaries with current boundaries as they are likely to not coincide with historical borders. Examples include political, municipal or other contemporary land perimeters. Boundaries for prehistoric concepts will have little association with current political, state or other local boundaries and these will be beneficial to not create false limitations. Minimizing the scope of the research by only searching for county or town information may result in oversight of valuable information.

It will also be important to identify and omit potential bias in the historic perspective, both inside and outside of the community. Such bias could be unintentional but could drastically alter the interpretation of the historic context. For example, field surveys from a third party may reveal significant information about a site, but a municipal government may choose to ignore the information. This could occur if a location is believed to include archaeological evidence; however, local government decides that

development of the site will be more valuable than exploring the historic potential. By choosing to not act on the information, it could be presumed by the community that the site is not historically significant. For this reason, in depth research regarding a locality should be conducted, rather than relying on only one source. Without a full disclosure of the circumstances, significant information could be overlooked.

After the research is conducted, all available significant historic evidence should be consolidated into a single, accurate narrative. Once the historic context is established, a timeline should then be defined into a period of significance. In general, the period of significance should identify patterns, events and persons of historic or cultural value. Also discussed may be significant trends in the settlement or development of the community, any aesthetic or artistic values in architecture or other works of craftsmanship or cultural interests of the community including both tangible and intangible culture. It will be helpful to keep these basic concepts in mind as it can be easy to get bogged down in detailed research. There may be an advantage to setting a limit and returning to add more comprehensive information later as time permits or as more resources become available. This strategy will also allow the investigation to continue, assuming that there is a reasonable time constraint for research, identification and treatment of the historic properties before the necessary adaptations can be applied.

Collecting Data

Once all historic context and reference material is documented and reviewed, the process of surveying the community for historic properties can begin. This section will discuss methods in which members of the community can be engaged in the identification

process. This community engagement will help to ensure that not only is the identification groundwork covered, but also that there is open communication and transparency among the local planners and the preservation community as well as the local residents and property owners.

Depending on the size of the community, there may be historic resources invisible to the average passerby or some of which the property owners are aware but they may have no knowledge of the potential significance. Therefore, the preservation team should reach out to active community members or small groups that may be interested in assisting with the identification process. Depending on the urgency and scope of the work, planners may want to either engage as many volunteers as possible, or rather to choose only those with specific expertise. This decision will be entirely specific to the needs of the community dependent upon time, funding and other factors.

Community Engagement

In small communities especially, there is likely to be more tasks that need attention than a limited group can manage. As the planning team works to develop a system for identification within the community, it may be appropriate to consider incorporating local residents as volunteers to expedite the process. Engaging the public will also help to facilitate open communication and create awareness of the importance of historic preservation within the community.

Either the planning department or a sponsoring organization should make an effort to reach out to all property owners in the area to make them aware of the project. The team should also openly explain the survey and inventory process that may be unfamiliar

to local residents as well as the intended outcome of the preservation project. This open communication will promote transparency and may also spark a general understanding of historic preservation, genealogy or other interests that could benefit the well-being and awareness of the community. Information should be conveyed through lectures, workshops, seminars, informal meetings and other forms of digital and physical communication like websites, social media and hotlines. Conducting an informative session discussing the historic significance of the community and the types of properties that are correspondingly significant may be a beneficial initial discussion.

In order to design the most effective form of public involvement and outreach, neighborhood leaders should be consulted. Posts in the newspapers, flyers in the mail, or signs left on boards at the post office or community centers could catch the attention of interested citizens. Advantage should be taken of digital communication formats such as local government websites and social media. The plea for public participation and eventual word of mouth may create a sense of excitement surrounding the project and encourage locals to participate. By creating a positive and open environment on the receiving end, it is more likely that once-reluctant residents, property owners and other tax payers may begin to warm to the advantages of preservation. Dramatic graphics may be a useful tool to communicate the benefits of historic preservation and at times, the urgency. Showing images of past natural disasters within the community such as destructive flooding of beloved historic buildings may be effective to visually communicate the message.

Meetings must be publicly announced and should be held at public locations such as historic societies, neighborhood or social organizations, assembly buildings, municipal

government buildings or similar sites. Locations for meetings may need to be set in neutral environments depending on the sensitivity of the subject within in the community. In places where preservation may carry a negative connotation, meeting in an area comfortable to the residents may help them feel more open to discuss their concerns.

Once the available information on known historic resources is reviewed, a questionnaire could then be passed out to members of the community that would request their assistance with furthering the identification process. Options could include sending out questionnaires or inquiries in order to acquire information about potential resources for listing. This strategy will invite residents to share knowledge about their own properties without having to make it publicly known. The questionnaire should be made available to be filled out in multiple forms, both online and on paper. For convenience, local newspapers should have a tear-out form that can be mailed back or dropped off in a convenient location.

Outreach will involve not just engaging the immediate residents and property owners, but seeking input from other types of local communities and interest groups as well. Involving persons with common interests such as archivists, preservation activists, historians, planners, archaeologists, folklorists or other professions outside of the community may bring in additional expertise and an unbiased worldview to the table. Reaching out to groups such as colleges, universities, non-profit organizations, museums or historic societies is likely to also spark interest and may be a valuable source of volunteers. Local Native American tribes should also be consulted as they may be aware of prehistoric events or may have a spiritual relationship with the landscape that should also be recorded. Association with Native American cultural practices may also render a

property eligible for Traditional Cultural Property (TCP) status, which would increase the chance for National Register listing. If this type of significance is applicable, communities should seek consultation through their State Historic Preservation Office.

Once the appropriate volunteer groups and individuals are determined, the planning team can then decide to further educate them on identification procedures. Training will depend on whichever identification system the planning team will pursue. A workshop for the purpose of training volunteers in how to use the inventory worksheets or conduct surveys may be a convenient next move.

Surveys

The National Park Service suggests four different types of surveys that can be used to identify historic or cultural resources.³⁴ A “windshield survey” is the technique of literally driving around the community and noting the general descriptions of the buildings and other structures through physical attributes such as style, period and methods of construction. A “walkover survey” consists of a general inspection of the landscape and is the most likely method of revealing information important in archaeology or landscape design. This type is also helpful to determine characteristics of structures not directly visible from public roadways.

A third type, known as a “general study survey” is a course that includes reviewing all historic information inclusive of maps, photographs or other plans in order to gain a general understanding of the community’s environment and where potential historic or cultural resources are likely to be located. A fourth type, known as an “intensive study” is expected to reveal precise information with a thorough inspection of multiple properties.

The intensive study should produce all of the information needed to evaluate the property for inclusion into the inventory or local register. Comparable intensive surveys are usually supported through funding from state or local sources and are unlikely to be possible for all interested communities or similar types of groups. Due to the comprehensive nature of intensive studies, this type of survey is expected to require a significant amount of time to complete. In contrast, sea level rise adaptation planning is usually met with time constraints to adopt policies and implement changes prior to further damage occurring. Therefore, an intensive survey is not suggested for communities that are experiencing immediate deterioration. Additional types of surveys include “random”, “stratified” and “systematic survey” approaches. Aerial, subsurface and underwater techniques may also be applied towards these methods. Further, the *Secretary of the Interior’s Guidelines for Identification* suggest completing a “reconnaissance survey”.³⁵ This could be helpful in identifying what kinds of resources or sources of information do not appear to be present within the immediate area.

The length of time for a typical survey can vary dramatically from weeks to months and may even extend to years depending on the scope and number of surveyors involved. In the event that a survey is being completed in a short period of time, it is possible that a less in-depth analysis may be needed in order to meet possible time constraints such as the impending hazard of rising flood waters. It may be effective to approach the survey on an area-by-area basis, incorporating all possible properties within the reasonable limitations and moving forward. This is a similar technique to checking off one block at a time. In this case, it will be in the planner’s best interest to begin surveying areas closest to the shoreline.

A phased survey could also be effective by completing an initial survey intended to gather surface data and then to return for more detailed information based on where information is most likely to present itself. In the event that there are known areas where endangered historic resources are located, or areas of the landscape that are more vulnerable to flooding, a strategy could be to first begin an inventory of those places. The remainder can then be inventoried as time permits. A detailed schedule will be mandatory to ensure that the project stays focused and on track for any later expected planning objectives.

One means of completing the historic survey may be conducted through a methodical and thorough walk-through of the entire community. Depending on the size of the community, this may be done on foot, or through various other methods. It is likely that only public areas or those properties visible from public areas will be accessible for this type of survey. Beginning first with any particular or precise locations that may have been identified in the historic context as yielding potential resources, the remainder of the surveying could be completed through a visual assessment. By flagging structures that may portray a particular architectural detail or landscape features that are reminiscent of a distinct period in history, inventory of the community will slowly evolve into a rich source of data that can later be more precisely evaluated and compared against known historic sites in the area.

Technology

Current tools and recent advances in preservation technology will be useful when attempting to identify, analyze and map historic and cultural resources. Geographic

Information Systems (GIS) in particular will be vital for mapping significant sites. This science uses geographic coordinates to map, store, and display data on precise locations. This tool is extremely useful for planners, engineers, telecommunications and many other professional fields. In reference to this thesis analysis, GIS will be distinctly useful for mapping historic resources to overlay with data in comparison to sea level rise projections. Many organizations, including the National Park Service, currently use this feature to analyze potential hazards to historic resources.



Fig. 4: Aerial view of kayakers over the Triangle Shipwrecks in Kill Devil Hills, NC. [Outer Banks Drone, accessed March 26, 2017.]

Other technologies will be essential in identifying resources that are no longer visible to the naked eye. LIDAR, laser scanning, ground penetrating radar, photogrammetry and survey inventory programs for laptops and tablets are other examples of new technologies that can benefit documentation of historic evidence. These tools may

assist in identifying forgotten historic roadways, undocumented historic structures, archaeological evidence such as post holes and planting patterns or other distinctive patterns significant to the historic context. In addition to these advanced tools, a general fly over the area by airplane could reveal previously unnoticed evidence such as the underwater archaeological remains of sunken ships, abandoned piers or other evidence of coastal features not visible from the shoreline (Fig. 4). Staying up to date on what technology can offer preservation has allowed researchers in the field to continuously discover new information on various objects, buildings and historic sites.

Inventory

Inventory worksheets, whether paper or digital, are an important tool when conducting visual and walk-through surveys. Especially when working with large groups and volunteers, worksheets will help to prevent valuable information from being overlooked, with understanding that distractions of working in the field are likely to occur. Basic worksheets should include entries for a general description, precise location, condition, character defining features, visual signs of integrity, current and historic uses, suggested periods of significance and a photograph of the property. It will be important to also include descriptions of secondary buildings, landscape features, the general setting, known or suspected archaeology sites and any other art or artifacts of relevance to the site.

Worksheets should be individualized based on community-specific criteria or any other distinct details needed to be collected within the locality. In the event that environmental factors play an increased role in the integrity of historic resources, it will also be forethoughtful to identify the visual or suspected environmental hazards on the

inventory worksheet as well. Properties located along the shoreline or suspected to be submerged by high tide should be noted. This will facilitate the following process of identifying which resources are located in hazard areas. Later, these notes will be compared with sea level rise projections specific to the area to determine ultimate vulnerability.

Completion of inventory worksheets will also assist with the eventual evaluation process which will determine whether properties meet the specified criteria for register listing based on historical, architectural, archaeological or cultural significance. In order to evaluate the property, its significance within the historic context must be defined and there must be sufficient information regarding the appearance, condition and associative values of the property.³⁶ This will be best conducted by teams of individuals who are familiar with the history of the community and are also versed in evaluating historic features significant to the area. Additionally, the evaluation must be performed by persons of qualifying education, training or experience as suggested in the *Secretary of the Interior's Standards for Evaluation*.³⁷ Communities should seek consultation from the State Historic Preservation Office or a local landmarks commission before moving forward with evaluation.

Once all surveys are complete and an inventory is established, methods should be set to ensure that record keeping is consistent and that the full list is made available to the public. “The results of identification activities should be reported in a format that summarizes the design and methods of the survey, provides a basis for others to review the results, and states where information on identified properties is maintained. However,

sensitive information, like the location of fragile resources, must be safeguarded from general public distribution.”³⁸

The *Secretary of the Interior’s Standards for Evaluation* state that only the results of evaluation must be available to the public.³⁹ This means that only those properties that were evaluated and are found to retain the appropriate significance and integrity for listing to a register must be published. However, it is in the best interest of the local preservation office and the planning department to retain and archive information on all historic properties, including those that are not officially listed. Such information should be kept to refer planning decisions and also to archive regarding the historic context of the community. As discussed previously, property owners may decide to not list their property for several reasons, but this does not mean that the significance of their property should be ignored by municipal officials.

The *Secretary of the Interior Standards for Identification and Evaluation* should be closely followed for the duration of the identification process. In addition to physical publications, The National Park Service provides on their website information regarding carrying out these standards. The website also maintains specific bulletins on carrying out such standards on varying property types and other distinct situations. Communities should seek out information available from the National Park Service and other sources to ensure that they are following best practices in the field for conducting surveys, recording and reporting information and incorporating best practice procedures.

Sacred Places

In addition to traditional historic resources, it will be imperative to the culture of

the community that the places which hold social or local cultural significance are also identified and protected. It will be just as vital, especially in times of emergency, such as destructive flooding, to ensure that the places essential to the daily life of the community are recognized and receive the proper adaptations for protection. These seemingly non-significant places will become symbols of strength and normalcy after a disaster.

Places like community centers, houses of worship or the corner coffee shop are often essential to the social life of the community. Where locals go every day to meet, pick up food or to check in with their neighbors can become known as “sacred places” within the local environment. These places may not be historic or conventionally beautiful or have physical characteristics that would normally bring pride to a community. However, people in small towns often find pride in attributes that are exclusive to their lifestyle. Their existence becomes important to the overall vitality of the community through cultural and social values. If these places were to disappear or be destroyed, an absence would be felt that could affect the overall health or social culture of what makes the community unique.

In 1990, Randolph T. Hester, a professor of Landscape Architecture and Environmental Planning at the University of California, Berkeley, wrote an article for *Small Town Journal*, highlighting the importance of sacred spaces in small communities. The article, titled “The Sacred Structure in Small Towns: A Return to Manteo, North Carolina”⁴⁰, discusses his journey to understanding the significance of “insignificant” places in a small, coastal community located along the Outer Banks. Hester found that cultural preoccupation with placelessness and topophilia suggest that we do value some places over others. These highly regarded “sacred places” are ones that exemplify and

reinforce everyday life patterns and rituals of community life. The community is able to self-identify with them. As a result, their loss would also destroy something valuable to the community's well-being.

Hester was initially hired by the Town of Manteo, North Carolina in the early 1980's to assist with town planning and to increase economic prosperity after years of decline in what was once an area rich with tourism. He used grassroots community development to revive and promote the small village charm and the failing indigenous industries. With his findings, Hester highlighted the natural beauty and the unique, rural and coastal past of the community to create a folk culture that locals could again be proud of. Without creating a "phony folk culture,"⁴¹ he helped residents identify and preserve their valued lifestyles and landscapes. Once identified, the important social patterns and places referred to as "sacred structures" inspired the plan for community's revitalization.

Hester found that non-conscious attachment to place could be a powerful factor in community planning, explaining that people can invest cultural memory in certain parts of the landscape. After first conducting a survey to discover the important places within the community, he discovered that his team observed completely different locations than the residents had predicted. The team quickly acknowledged that activities like exchanging gossip at the post office, hanging out at the docks, and visiting the shoreline to witness fishing and the change of the tides were cultural attributes. Lifestyle and landscape in the Town of Manteo were intertwined. "Daily ritual had place specificity and the cultural dependence on places seemed more widespread than reported in our interviews."⁴²

Despite the outreach, it became evident that the places of importance were subconscious. For Hester, this verified that assumptions are not always accurate and

interviews alone may not reveal all relevant information. Even when interviewed, locals often referred to places of high tourist visitation as places that they also highly valued. Observations, in this case, were what lead to the identification of the real cultural and social places of significance.

Hester also collected data from a survey in the local newspaper. The survey included questions that evaluated whether the residents valued attachment to places more than they valued the economic benefits of tourism. This produced a ranked and weighted list of significant places. To the astonishment of some, the social places ranked higher than some churches and cemeteries. Subsequently, the places listed then became known as the “sacred structures.” It then became evident that people wanted these places protected and that locals were willing to sacrifice economic gain to save them because they held a higher value than dollars.

A map of Manteo’s sacred structures, similar to a land use plan, was then produced by the team. The sacred structures consisted of humble places and “hole-in-the-wall” locations that provided a space for daily routine and are universally unappealing to the common passer-by. “They are familiar, homey and homely.”⁴³ Even the locals took them for granted and only reacted after they became threatened by change or development intended to attract more tourism. “The Sacred Structure map depicted important social patterns and cultural settings more effectively than any other planning document.”⁴⁴ Ironically, the places were not identified in the zoning ordinance, visual inventory or on any historic sites. Identification of the sacred structures allowed residents to rationalize their gut feelings about development plans. In one particular case, the town convinced

developers to infill an area that would enhance the sacred spaces rather than raise the buildings for a larger scale commercial development.

Hester points out that it is easy for our society to accept a cultural sense of place, or cultural importance in what we consider “primitive cultures”. Village centers and special community structures are understood as having importance in indigenous cultures. However, it seems difficult for westernized cultures to recognize the same sense of sacredness within their own communities. He further remarked that some residents had also expressed shame for their sacred places. Tourists coming to the town had often asserted that they were disappointed that their visit didn’t reflect the Williamsburg-style historic community that they were expecting. As Manteo continued to decline, so did upkeep of the high visitation areas, which continued to make local haunts appear to be scars on the cultural landscape. Once Hester’s list was made public and others realized that their neighbors felt similarly about the sacred structures, the community began to cherish them as a collective group.

At the end of the project, the people of Manteo made decisions to sacrifice changes that would have increased tourism for those that would instead preserve the sacred structures that were significant to the community. For Manteo, identification of the sacred places was key to allowing the locals to be successful and grow without destroying the existing sense of their beloved community. Protecting the sacred structures further allowed the community to maintain its identity while also permitting the mandatory change that would safeguard the town’s future.

Accordingly, identification of social and cultural places can be essential to the health and vitality of a small community. It may not be necessary to conduct an

independent study to separate the historic from the cultural resources. In Hester's case, observation became the most useful tool. However, including questions regarding potential sacred places in the same questionnaire that addresses historic resources may help to hasten the process. Simply by becoming aware that the cultural sacred spaces exist will be valuable in reviving a community should devastation strike. As a cultural resource, these sacred places should also be incorporated into long-term planning. Ideally, these sacred spaces should receive equal attention and protection when deciding means of adaptation strategies.

Endangered Resources

After historic and cultural resources within the community have been identified, the next undertaking should be to identify which properties are situated within hazardous areas. Properties that may be damaged by flooding, storm surge or coastal erosion will be of particular concern. The FEMA guidebook, *Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning: State and Local Mitigation Planning How-To Guide*, also known as FEMA 386-6, suggests several steps for identifying which historic resources are located in hazardous areas. It also provides tips for risk assessment. The FEMA 386-6 guidebook suggests first identifying all environmental hazards that may affect the community. However, for the purpose of this thesis research, only the effects of sea level rise (storm surge, more frequent flooding and coastal erosion) will be addressed.

With these types of hazards in mind, communities should gather and compile data into a hazard profile that is specific to historic and cultural properties. Data must be

community- specific and should include information such as local topology, geography, floodplain areas, land use plans and restrictions, water runoff or other infrastructure limitations that may be impacted. With this collected data, communities can fabricate a hazard profile map. The map can then be overlaid with a map that includes the inventory of the community's historic and cultural resources. This will create an easily read, visual assessment of the endangered properties within hazard areas that will allow planners to view the potential danger zones and move forward with identifying the most vulnerable properties. Information regarding historic and cultural resources in the community should already be included in a GIS database so that they may be easily updated with hazard information. The FEMA 386-6 guidebook provides additional and detailed information on putting together a community-specific hazard profile. Planners should seek out this information as needed.

Planners may wish to take additional steps to include extra layers of information in their hazard profile mapping system. This could help communities better prepare for varying magnitudes of inundation. Since there are multiple factors that should be considered and each category could create varying timelines of loss, preparing for different degrees of flooding may be the best approach for preparedness. Layers for one, two and three feet of sea level rise could help localities determine potential losses over time. Within each variation of overlay, it can then be determined which properties are likely to accrue the most amount of damage at the fastest rate.

Easily accessible sources of information for projecting sea level rise are available online. Although sea level rise projections vary depending on the location and sources of data, the suggested maps can be a good source of information for a general idea of what to

expect. Nonetheless, it will always be best to incorporate locally-specific data whenever it is available. Sea level rise projections can vary from region to region and also can depend on other locally specific environmental factors such as frequency of storms and percentage of beach erosion. Unfortunately, it's unlikely that small communities can fund such specific data for themselves. Available state, regional and national projections should still allow municipalities to develop a sound, yet not precise, interpretation of what to expect.

The Geoscience News and Information website⁴⁵ exhibits one large global sea level rise projection map that can be used for general information. "It is intended to provide a visual impression of which geographic areas might be flooded if global warming and climate change continue unabated."⁴⁶ The map allows the user to zoom in almost anywhere on the globe to see how sea level rise will inundate certain areas. Based on varying increments, the user can change the inundation map from zero meters of sea level rise up to sixty meters. The website also has a quick reference for major cities and regions of particular interest including New York, New Orleans, Florida, San Francisco, Washington D.C., the Nile Delta, The Netherlands and Venice. The Geoscience News site uses a collaboration of Google and NASA data to determine projections.

The National Oceanic and Atmospheric Association's (NOAA) Office of Coastal Management has a program called Digital Coast which offers several tools, training and information regarding sea level rise. Their website also has a mapping tool with a sea level rise viewer that assists with visualizing community-level impacts from coastal flooding. The range for inundation is up to six feet above the average level of high tides. The site allows users to see photo simulations of how future flooding may impact local landmarks. The sea level rise viewer also includes data related to water depth,

connectivity, flood frequency, socio-economic vulnerability as well as wetland loss and migration. There is also an option to download inundation layers and access web map services for custom GIS applications.

The Digital Coast map and data are updated on a regular basis with statistics from the NOAA. In August 2016, South Carolina, North Carolina, Virginia, Maryland, Delaware, New Jersey and New York were remapped with new elevation data based on post-Sandy LIDAR from NOAA.⁴⁷ Currently, the map-able data is only accessible for the mainland United States and the immediate areas. The Digital Coast inundation maps only extend through the coastal areas and tributaries that connect to the sea and do not address flooding that may be present in inland rivers or other central areas of the country. The map is extremely user-friendly, permitting the ability to zoom in to specific areas and visualize inundation levels. This information could help small communities predict their risks and develop a timeline based on broad information.

A third option for mapping sea level rise inundation is through Climate Central.⁴⁸ Their website provides tools for sea level rise analysis called the “Surging Seas Risk Finder”. Quite versatile, the website promises detailed information, down to a neighborhood scale. “The tool also provides statistics of population, homes and land affected by city, county and state, plus links to factsheets, data downloads, action plans, embeddable widgets, and more.”⁴⁹ Rather than providing a general map from the beginning, their website prompts the user to enter a place in the coastal areas of the U.S. such as a city or county. Their data automatically includes a visual map of social vulnerability from low to high income, which they explain can compound coastal risk.

The color-coded map allows the risks to be easily identifiable. Places in red are deemed the most vulnerable. As an example, a vulnerability risk map pulled for the coastal county of Dare, North Carolina results in a 61% risk of at least one flood over 4 feet taking place between 2017 and the year 2050. Additional information reports that about 12,000 people in Dare County live on exposed land below 4 feet.

Climate Central data can further identify vulnerability statistics for the county's endangered buildings, infrastructure, and land contamination risks. Dare's information reports that there are about 11,000 homes, 12 government buildings, two medical facilities, and nine public safety facilities, six houses of worship, one public school and one public library in immediate danger of being inundated by four feet of flooding. Inundation may result in \$35 million of property value loss within 260 square miles of land. Further, the data reports that there are 435 miles of roads at risk including local, state, secondary and federal highways. There are 18 endangered EPA listed sites, including five hazardous materials facilities and three hazardous waste sites. Also provided is a breakdown of how likely a flood four feet or more through the current tide line is likely to occur. Conveniently, the website offers pdf downloads that display all of this mentioned information into a local fact sheet or report. Also available is a fact sheet based on state-wide data.

Although not locally derived data, the information provided from Climate Central's Risk Finder produces an impressive product of useful information. The data can easily be applied towards a local map to identify which historic or cultural resources appear to be within a danger zone. Further, the generated statistics and reports may prove to be useful when convincing skeptical parties of the reality sea level rise and how it will

certainly affect their future. This type of data, similar to this Dare County report, can be pulled for other specific towns or cities and could be an extremely valuable source of information of which small communities should take advantage.

Risk Assessment

Following the FEMA 386-6 guidebook suggestions, the next step should estimate and specifically identify expected economic and structural loss caused by the potential environmental hazards. Using the hazard profile map as a tool, more data can be gathered to determine the number and the value of assets that will be potentially lost or heavily damaged. To help compile data, the guidebook suggests to group properties by type. Examples include groupings by age, period of construction, material type, function, square footage or design styles. Incorporating information on the overall percentage of historic resources lost, the percentage of housing lost, loss of commercial space or any other vital type of infrastructure could prove useful for planning and preparation purposes.

This technique will help to re-group data so that it is understandable and relatable on a larger scale. By comprehending information which expresses major impacts to recognizable resources and infrastructure, municipal governments and other groups are more likely to react. For example, data could suggest that within one community, 35% of the historic resources, 25% of housing and 50% of the wooden structures built before 1950 are in danger of being destroyed by flood waters within the next 30 years. Data this alarming should prompt immediate action. Another suggested tactic is to translate this data into estimated financial and economic loss, for which FEMA provides detailed worksheets and helpful hints on generating.⁵⁰ Creating an additional inventory of all suspected

endangered properties - both historic and non –historic may also encourage local legislators to create a policy or to move forward with adaptation approaches.

Estimating the economic loss to a structure will also include the replacement value. This will require uncommon calculations in relation to historic structures. The FEMA guidebook acknowledges that, “While several methods exist for determining a fair market value for historic properties, especially buildings, no established method is available for determining a replacement value for historic properties.”⁵¹ It is difficult to put a numerical value on the craftsmanship of historic properties, especially considering that the original materials and quality of workmanship is no longer available for replication or may vary significantly within the region. It may be necessary to work with a knowledgeable professional appraiser to determine appropriate property values. Insurance policies may be helpful to consult, but again may not communicate the full value of the property.

By creating data that incorporates as much economic value as possible, it is more likely that the numbers will gain attention from other governmental groups, pushing them to act or to assist with the cause. It will be in the best interest of time to input all related information on potential losses into a digital database that can be used to run queries and reports on the material. This will make all documentation easily accessible and easily updated as variations in sea level rise impacts and projections change over time. Sharing this information and making it accessible to the appropriate parties will further facilitate cooperation and aid in expediting a course of action.

In addition to gathering local information for the hazard profile, communities should also be aware of programs and technologies that can further assist with the hazard

documentation process. FEMA's Mitigation Division recently released HAZUSMH MR1 (HAZUS-Multi-Hazard Version 1.1), an updated and revised version of HAZUS-MH. This is a powerful risk assessment software program that is used for analyzing potential losses from floods, hurricanes, winds, and earthquakes. The program includes a Building Inventory Tool, an Inventory Collection Survey Tool and a Flood Information Tool to assist with the assessment process. Federal, Tribal, State, and local government agencies and the private sector can order HAZUS-MH free-of-charge from the FEMA Distribution Center. Small communities in particular with limited access to advanced software may want to consider using this technology to help collect and store information specific to their local needs.

Conclusion

Completing the steps in this chapter opens the door for small historic communities to begin planning for adaptation action. Adapting communities to withstand the effects of sea level rise cannot begin without first understanding the full historic context and what resources the area has to offer. As discussed, demonstrating the full history of a community through listed historic and cultural resources is an ongoing task and one of the many obstacles of historic preservation. Many steps and multiple stakeholders are commonly involved in the process to fully inventory and document a historic place. Additionally, completing this accomplishment will help local residents gain a sense of identity and commonality with their neighbors as well as an appreciation for the history of their community.

Public outreach will undoubtedly play a vital role throughout the entire preservation planning process. Assistance from local residents will be needed to complete the inventory process, to partake in questionnaires, to provide feedback and to give overall support towards historic preservation and the many additional movements that will follow. Any variation of local planning will always need local backing in order to be successful. By incorporating residents and local tax payers from the beginning, there is a greater chance that adaptation projects will move forward with limited conflict.

Determining the potential risks and which valued resources need immediate attention will help the planning team make careful decisions regarding the next steps in the preservation process and how they should be implemented. Creating assessment tools, such as a hazard profile, will not only help community leaders with planning, but it will also provide residents with visual affirmation of the potential threats. Such tools may help to communicate the urgency to react. By completing these initial information gathering steps, preservation planners can then begin to think about specific adaptations approaches and how they can affect the overall well-being and integrity of the community and its historic features.

The steps listed in this chapter will particularly benefit smaller communities who may not already have some of this information available to them. In larger cities, there is a higher possibility of an established local register or inventory of the known historic properties. In contrast, small communities may be starting their adaptation process with limited to no inventory of their significant properties. Due to limited budgets, planners and other municipal workers of small towns are often doing the work of multiple staff positions. Therefore, these professionals are less likely to have exact knowledge of

specific preservation procedures or that guidelines, documents and other resources that are precisely designed to assist them with identification exists. In addition, communities with limited staff may not be aware of the risks associated with sea level rise or the multitude of resources that are available online to precisely help them identify sea level projections for their area. In these instances, the information provided in this second chapter is an essential base for small communities to use and establish before moving forward with adaptation planning.

CHAPTER III ADAPTATION STRATEGIES

Introduction

In direct response to the effects of sea level rise, adaptations must be performed to save historic properties and other vulnerable resources along the coastline that are susceptible to flooding, shoreline erosion and storm surge. In a broad sense, adaptation can be defined as “adjusting” to new conditions by taking steps to moderate and cope with the effects of sea level rise.⁵² In regard to historic properties, there are several components that should be considered before any adaptive change is implemented. Adaptation strategies should seek to preserve not just the physical materials and design of an object or a structure itself but also to preserve other components of a historic resource that convey its integrity such as the feeling, association, location and setting.

It can be argued that any change, no matter how minor, will affect the integrity of a historic property. On the contrary, climate change has contributed to an increasingly wavering environment, which is a valued historic aspect of integrity in itself. If the preservation community does nothing to react, the setting of the historic environment will continue to change and affect the integrity of a place regardless of human intervention. As an example, the association between a historic resource and the neighboring water line or the road way and other contributing structures will change as they are covered with water and sand. Eventually the entire feeling that is reminiscent of the significant historic era

will be completely different when there is limited original vegetation or landscape features left to interpret the space. No matter how we react or do not react to the effects of climate change, there will be damage to the original context of historic and cultural resources.

Therefore, the entire process of adaptation is a grey area. There is not a single answer or solution to any of the varying problems associated with the need for adaptation. However, that does not mean that the preservation community should give up or allow these changes to occur without intervention. Still, it must do what is necessary to prepare and protect valuable resources from destruction. The act of preservation does not mean to freeze a place to a moment in time, but rather means to manage the necessary change that must take place over time. The proposed preservation must include both minimal changes and larger adaptations in reaction to the wavering environment.

Presented in this chapter are selected adaptation strategies implemented on historic and cultural resources that will be introduced and examined. It should be understood that there are additional possibilities of adaptation strategies and methods that could be used and explored in addition to, or in conjunction with these mentioned. Examples of the implementation of the chosen strategies will also be presented at the end of this chapter. Cases will include brief examples from National Parks Service historic sites as well as small communities throughout the United States.

National Register Criteria and Adaptation

The National Register Criteria for Evaluation states that in addition to the historic significance of a property, it must also retain a level of integrity in order to be considered eligible for nomination. Further, the document specifies seven “aspects” of integrity,

defined as Association, Feeling, Setting, Location, Design, Materials and Workmanship.⁵³ These aspects, typically used to evaluate a historic property for nomination to the National Register of Historic Places, can also be used to evaluate the appropriateness of treatments or adaptations to a property. By deciding how an adaptation will affect the integrity of a historic resource, evaluation can further be determined if the change will affect the eligibility for a property's listing in the National Register. If it is determined that a treatment would negatively affect the integrity of a historic property, it should be avoided. Drastic changes to the integrity could result in de-listing of the property. As discussed in the previous chapter, although there is no disciplinary action, de-listing of a National Register property could affect the eligibility for financial support and other incentives, like historic tax credits, that come with the honor of owning historic property. In addition to the integrity of individual properties, applying adaptations can also negatively affect the integrity of landscapes, historic districts and other properties of historic or cultural importance in the same manner.

Adaptation Approaches and Methods

Whichever adaptation action that is decided upon must integrate both cultural and natural resources in order to protect and overcome potential damage. Especially in small coastal communities, where the natural environment and the local way of life are integrally linked, the two must be addressed together. However, as noted previously, no matter which strategy is decided, there will be some variable degree of sacrifice towards the integrity of the property. Accordingly, decisions must reflect local community values

in order to secure the best understanding of the environment and the value of historic resources within the community.

AVOID	ACCOMMODATE	PROTECT	RETREAT
Short-Term <ul style="list-style-type: none"> • Increase set-back distances • Identify opportunities for voluntary conservation easements 	Short-Term <ul style="list-style-type: none"> • Improve evacuation plans • Flood-proof at-risk structures 	Short-Term <ul style="list-style-type: none"> • Identify beaches with high erosion rates • Inspect dams and dikes 	Short-Term <ul style="list-style-type: none"> • Identify areas of high vulnerability
Medium-Term <ul style="list-style-type: none"> • Implement conservation easements • Monitor set back compliance 	Medium-Term <ul style="list-style-type: none"> • Require elevation of new homes to 18 inches above base flood elevation 	Medium-Term <ul style="list-style-type: none"> • Replenish beaches • Conduct necessary repairs of dams and dikes 	Medium-Term <ul style="list-style-type: none"> • Create a special fund for purchase of frequently flooded structures • Implement rolling easements
Long-Term <ul style="list-style-type: none"> • Continue monitoring set back compliance • Monitor conservation easements 	Long-Term <ul style="list-style-type: none"> • Construct new drainage systems 	Long-Term <ul style="list-style-type: none"> • Increase height of dikes 	Long-Term <ul style="list-style-type: none"> • Purchase frequently flooded areas from willing sellers and remove structures • Monitor rolling easement compliance

Table 2: Delaware uses the adaptation approaches of Avoid, Accommodate, Protect and Retreat. These approaches and their associated actions are represented in the table. [Love, et al., *Preparing for Tomorrow's High Tide: Recommendations for Adapting to Sea Level Rise in Delaware*, 2012]

There are different adaptation approaches that can be adopted to prepare communities for the impacts of sea level rise (Table 2). Various sources have categorized the types of strategies into different groupings as a means of organizing the different methods used for adaptation. The approaches may be referred to as other names or types as there is an overlap in the specific actions depending on the sources and also depending on interpretation (Table 3).

In this chapter, the adaptation approaches of Protect, Avoid, Accommodate and Retreat will be discussed in detail along with selected examples. These are general selections that could be implemented to protect and stabilize the historic environment and

the landscape directly surrounding a cultural or historic resource. In some examples, there will also be discussion of how the choices could directly affect the integrity of historic properties as well as some suggestions for achieving results that are more sensitive to the historic environment.

PROJECT TYPE	PROTECT	ACCOMMODATE	RETREAT
NAVIGATION	<ul style="list-style-type: none"> • Upgrade and strengthen existing primary structures • Expand design footprint and cross section of existing structures (e.g., bridges), including raising for clearance and access • Add structures to protect backshore areas (e.g., dikes) • Improve resilience of backshore facilities 	<ul style="list-style-type: none"> • Upgrade drainage systems • Increase maintenance and dredging • Adjust channel location and dimensions • Modify operational windows • Flood proof interior infrastructure • Add sediment to shoreline or underwater morphology 	<ul style="list-style-type: none"> • Relocate interior harbor infrastructure due to relative sea level rise or fall • Abandon harbor/port • Re-purpose project area
COASTAL STORM DAMAGE REDUCTION	<ul style="list-style-type: none"> • Upgrade and strengthen existing structures • Expand design footprint and cross section of existing structures • Dune/beach restoration or enhancement 	<ul style="list-style-type: none"> • Increase shoreline protection maintenance • Sediment management • Beach nourishment/ vegetation • Upgrade and modify drainage systems and infrastructure • Flood proof buildings, modify building codes, and implement building setbacks 	<ul style="list-style-type: none"> • Relocate buildings and infrastructure • Land-use planning and hazard mapping • Modify land use
FLOOD RISK REDUCTION	<ul style="list-style-type: none"> • Upgrade and strengthen existing structures • Expand design footprint and cross section of existing structures • Construct levees or implement flood-proofing measures • Add secondary structures • Dune/beach restoration or enhancement 	<ul style="list-style-type: none"> • Increase maintenance of flood risk protection features • Upgrade and modify infrastructure • Improve natural shoreline resilience (vegetation) • Flood proof buildings • Implement building setbacks 	<ul style="list-style-type: none"> • Relocate buildings and infrastructure • Land-use planning and hazard mapping • Modify land use
ECOSYSTEMS	<ul style="list-style-type: none"> • Construct drainage systems • Construct shoreline protection structures, dikes or cells • Construct tidal gates, install salt water intrusion barriers 	<ul style="list-style-type: none"> • Accept changes to ecosystems • Sediment management • Change water extraction • Freshwater injection /diversion • Modify land use • Migrate landward 	<ul style="list-style-type: none"> • Allow/facilitate habitat conversion • Prohibit hard defenses • Ecosystem migration • Abandon ecosystem

Table 3: A Florida guidebook suggests limiting adaptation approaches to only Protect, Accommodate and Retreat. This table demonstrates the associated actions of those approaches. [*Adaptation Action Areas: A Planning Guidebook for Florida's Local Governments*, August 2015]

Protect

Protection adaptation strategies focus on protecting land from inundation, erosion, or storm-induced flooding through the construction of various structures such as seawalls,

jetties, groins, living shorelines, bulkheads, and beach nourishment. Fabrication of these structures helps to preserve a fixed shoreline. The California Coastal Commission describes this approach as, “Protection strategies refer to those strategies that employ some sort of engineered structure or other measure to defend development (or other resources) in its current location without changes to the development itself.”⁵⁴ However, such choices may provide only a short-term solution to the long term impacts of sea level rise. Hybrid approaches to protecting shorelines can also be used to “retain some of the storm-resistance of a hard structure, while also maintaining some of the features of natural shorelines.”⁵⁵

Soft Armoring

The Protection strategies can be further divided into the category of “Hard Armoring” and “Soft Armoring”. Soft armoring techniques are also man-made barriers; however they either replenish or mimic the natural environment. Examples include natural solutions like living shorelines and wetlands restoration or man-made alternatives that elevate the landscape such as beach nourishment or dune creation.⁵⁶ Usually, soft armoring is considered more environmentally friendly than the hard armoring counterpart as it involves fewer destructive infrastructures by using natural features to buffer coastal areas. These natural techniques are often used in rural places, recreational areas and parks in order to preserve the organic setting of the environment. A hybrid approach between these two armoring approaches is a common strategy. In these cases dune construction may be used along with groins and jetties to protect further erosion of the shoreline.

Beach Nourishment

Protection of beaches can occur through periodic placement of sand along the shoreline to build up the distances between the ocean and the dunes. Sand placed on the beach can be dredged from offshore sand deposits or brought in by truck from inland sources, often referred to as “truck-haul”. These beach nourishment projects (sometimes called beach restoration or beach fill) help to prevent or slow beach erosion and shoreline migration that are caused, in part, by sea level rise and storm impacts.

However, nourishment is only a short term solution as erosion and shoreline migration can still occur on nourished beaches. The rate of erosion can be greatly impacted by coastal storms such as hurricanes and nor’easters. Strong storms can even undo thousands of dollars of beach nourishment within days. Sustaining a nourished beach and its dune system requires continuing maintenance through subsequent nourishment projects at regular intervals, which comes at a significant cost that is usually paid for with public funds.

An area that is constantly battling beach erosion by means of beach nourishment is the Outer Banks of North Carolina. The Town of Duck, a small community located on the Outer Banks, released in May, 2013, a thorough analysis of local studies and reports to address the problem of shoreline erosion along its coast. To better organize the data, one study in particular broke down areas of the beach lining the town into ten distinct segments. These segments ranged between 1,000 and 14,000 feet of shoreline. According to the study, Segment 7, which consisted of roughly 5,000 feet of shoreline, obtained the most substantial average loss of 4.82% a year.⁵⁷ Further analysis estimated that 36 structures, including both residential and commercial buildings, were to be impacted or

possibly completely wiped off of the landscape within the next 50 years.⁵⁸

As a result of these projections, the town's report then discussed potential management alternatives to address the shoreline erosion and storm damage vulnerability.

Discussed were various types of beach nourishment, including up to 50 years of storm damage reduction, meant to mitigate the projected effects of beach erosion for the next half a century. Financial projections for each option were then presented in a variety of intervals and situated in charts for comparison (Table 4).

Plan	Project Extent	Volume of Sand (CY)	Sand Source	Re-Nourishment Interval	Cost (x \$1,000,000)
Dune Replenishment	Segment 7 (5000 Feet)	30,000	Upland/ Truck Haul	1 Year	0.94
Beach Replenishment	Segment 7 (5000 Feet)	120,000	Upland/ Truck Haul	1 Year	1.75 - 1.85
Long-Term Erosion Mitigation Project	Segments 7 & 8 (13,000 Feet)	828,200	Offshore/ Dredge & Fill	5 Years	13.04 - 14.96
1 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	1,260,800	Offshore/ Dredge & Fill	5 Years	17.42 - 20.35
5 & 10 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	1,610,200	Offshore/ Dredge & Fill	5 Years	20.88 - 24.62
20 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	2,090,800	Offshore/ Dredge & Fill	5 Years	25.64 - 30.49
25 Year Storm Damage Reduction Project	Segments 7 & 8 (13,000 Feet)	2,313,200	Offshore/ Dredge & Fill	5 Years	27.84 - 33.21
50 Year Storm Damage Reduction Project	Segments 4, 7, & 8 (17,000 Feet)	2,935,800	Offshore/ Dredge & Fill	5 Years	34.00 - 40.82

Table 4: The Town of Duck considered several options including cost and longevity before deciding upon the proper beach nourishment strategy. [Town of Duck North Carolina, "Erosion and Shoreline Management Feasibility Study," May 2013.]

Based upon the analysis, “Dune Replenishment by Truck Hall” is the least expensive option for erosion mitigation. This would add 30,000 cubic yards to the most endangered Segment 7, would cost an estimated \$815,000 and would only provide one year of erosion mitigation.⁵⁹ Beach restoration would spread twice the amount of 60,000 cubic yards across Segment 7, cost \$1.5 to \$2 million, and again only provide one year of mitigation. The *Erosion Mitigation and Storm Damage Reduction Plans* using dredging each had estimations based on longer intervals of time. These spanned for five, ten and then 25 years. The most costly, the 25-year Storm Damage Reduction project, which would cover 2,313,000 cubic yards, spanning over both Segment 7 and Segment 8, was estimated between \$25.5 million to \$30.25 million.⁶⁰ It is noted in the report that none of the shoreline replenishment plans would be funded by federal dollars. Subsequently, it was further estimated that this suggested 25-year plan would cost oceanfront property owners of Segment 7 and Segment 8 a total of \$4,491 per year, and non-oceanfront owners \$631 per year, each for 5 years.⁶¹ Beach restoration can be completed usually within a few weeks and is therefore a relatively quick fix for mitigation

Although each segmented area varied, the financial costs for this single, small oceanfront town are alarmingly high. Depending on the average income, paying an additional \$4,500 a year for five years in taxes could be devastating to some families. In some cases, this could push owners to sell their beachfront properties, creating a trend of vacant buildings that could further damage the local economy. If these same estimates were applied to cities and towns along the entire eastern seaboard, it could become financially devastating on a national level. The financial burden is simply not sustainable for the average, tax-paying citizen. This is especially true considering that beach

nourishment is a short-term solution that will need regular maintenance. The strategy of beach nourishment, therefore, may be best used in conjunction with other adaptations or used to buy time in the short term while other strategies are explored (Fig. 5).



Fig. 5: Beach nourishment at Assateague Island National Seashore in 2002 added sediment and widened the beach. Photograph by NPS. [National Park Service, *Coastal Adaptation Strategies Handbook*. 2016]

Dune Management

Dune management, or dune replacement, is often accompanied by beach restoration. The dunes, which are built-up deposits of sand, are best used when placed on the inland side of the beach in order to further protect infrastructure from damage. Dunes are a naturally occurring form of protection in a coastal environment; however they are susceptible to erosion due to storm surge, wave action and other environmental and human related factors.

Dunes can be stabilized by planting specific native vegetation in order to create stability within the mound. Sand fencing can also be an effective tool, both by helping to keep sand on the surface of the dune to withstand frequent winds and also to keep pedestrians from walking over them. Weighted footprints can be destructive to the dunes, breaking down the heavier, compact interior sand and making the overall structure more susceptible to erosion. There are several dune management guides available such as the *New Jersey Sea Grant Consortium Dune Manual* and *The Dune Book*, which can provide additional and specific tactics for retaining dune structure and creating a more stable barrier along the shoreline.⁶²

Alternatively, dunes as well as beach nourishment may create a false sense of security. Having a wider beach or substantial dune barriers may present the false image of a healthy beach with limited vulnerabilities to environmental stressors. In the event that there is a push to increase development, the beachfront area may display a desired, secure area when in reality the location is entirely unsuitable for additional construction. Depending on the area, one intense storm could wipe out half of the beach and perforate the dune barriers and begin to destroy additional infrastructure and inland resources. Therefore, appropriate policies should be in place, such as development management, along with these types of protection adaptations that can work together to further protect and preserve the landscape.

Although dune management as a natural structure can aesthetically be a very desirable strategy for coastal landscape preservation, it can impact watershed views. This in turn may affect some aspects of integrity for historic or cultural landscapes as well as historic buildings. On the other hand, even if dunes do not occur naturally in an area, they

are an organic creation that are usually temporary and can be easily removed, leaving the remaining historic landscape largely intact. Like beach nourishment, dunes are an expensive strategy that will require constant replenishment. They create a rapid change to the beach but are also a short term approach. Dredging the sand to create dunes can also cause damage to the aquatic environment, possibly disturbing environment needed for local fish, oysters and other wildlife to thrive. This in turn could affect the livelihood of the local fishing or other industries, depending on the location of the dredging. Another factor that must be considered is the sediment. Again, depending on where the dredging is taking place, the sand may not be compatible with the existing beach. This could disturb the vegetation or wildlife that are unaccustomed to the new type of sediment, as it will ultimately be eroded. Further, sand that is too fine could be blown or washed away at a faster rate, accelerating the need to repeat the process.

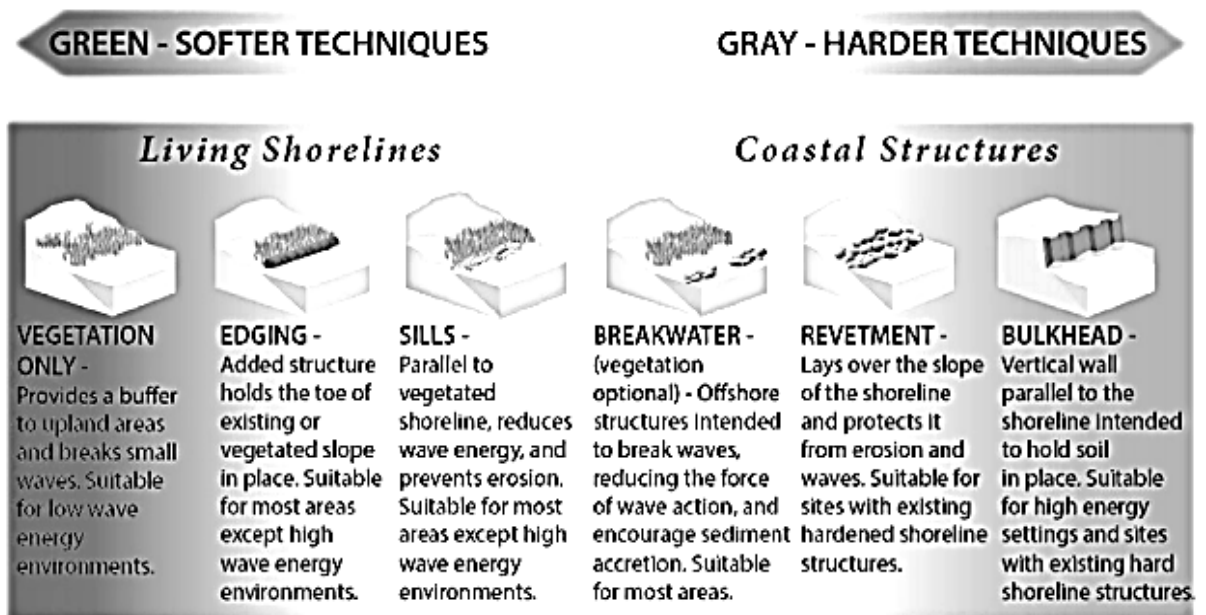


Fig. 6: Soft Armoring, such as living shorelines, usually work with the natural landscape while Hard Armoring, such as seawalls, require physical engineering of structures. [National Park Service, *Coastal Adaptation Strategies Handbook*. 2016]

Hard Armoring

Hard Armoring includes engineered structures such as onshore or offshore bulkheads, breakwaters, sea walls, dikes, tide gates, or storm surge barriers that defend against wave impacts and flooding. These structures usually have a visible and more negative effect on the historic environment (Fig. 6). The use of hard armoring may also impede the shoreline's ability to migrate over time, resulting in production of smaller beaches, causing limited recreational areas. Additionally, the use of hard armoring, while intended to slow erosion in a particular area, can accelerate erosion on adjacent shoreline.

Hard armoring is also more likely to have a detrimental effect on the natural environment and surrounding ecosystems. Fabricated structures could limit the natural process and flow of nutrients that seagrass, salt marshes and coral reefs may depend upon. Consequently, these plants naturally help to stabilize beaches and decelerate erosion rates. However, this does not suggest that hard armoring strategies are poor choices. There are more drastic circumstances in which hard adaptations are the best options for protecting the built environment. Examples include protection of heavily populated urban areas where, due to erosion and development up to the shoreline, there is minimal dry land available to incorporate other strategies. In such a case, the shoreline may have already eroded up to the edge of major infrastructure such as buildings and roads and there is no feasible option remaining except for physical barriers to protect from further inundation.

Dikes

Dikes are an example of hard armoring. These are elevated earthen or rock structures that are constructed parallel to a shoreline to prevent flooding and permanent

inundation in the low-lying areas behind the structure. These structures can be designed to include tide gates that manage the flow of water in and out of the low-lying areas behind the dike for storm protection and habitat purposes. To ensure continued protection, dikes must be inspected and maintained on a routine basis. Due to the significant investments required, construction and maintenance of dikes can be cost prohibitive for some communities.

Additionally, dikes may not be the best options for coastal shorelines. The structures may obstruct the pristine view of the ocean and are likely to significantly reduce wave action, obscuring the possibility for some recreational activities such as surfing or wave boarding. Depending on the community, diminishing types of recreation could put a damper on tourism, ultimately impacting the economy. Therefore, dikes may be best used to prevent flooding in wetland areas or those that do not have significant wave action.

Seawalls and Bulkheads

Seawalls are structures that exist on the land and are built parallel to coastal shorelines (Fig. 7). Their primary purpose is to protect the resource behind the seawall from wave action and erosion. They are commonly constructed with a vertical, stepped, or curved face using stone, steel, concrete, or wood. Seawalls are an effective strategy to protect the landscape and buildings behind them and may be a good choice for resources that are unable to be moved. However, they are considered hard adaptations and will permanently alter the feeling and setting of the shoreline. If the accessibility or the viewshed of the shore is an important feature of a historic resource, a seawall may not be an appropriate adaptation. Further, the design of the wall, depending on the proximity of

other built structures, will need to be sensitive to and compatible with the design and materials of the nearby historic resources.



Fig. 7: A seawall protects Fort Warren on Georges Island at Boston Harbor Islands National Recreation Area. [National Park Service, *Coastal Adaptation Strategies Handbook*. 2016]

As sea levels rise, seawalls will need to be heightened accordingly and will require increased maintenance in order to be effective. This is due to the fact that seawalls will receive repetitive damage from wave action and erosion on a continuing basis. These structures do accrue some problems due to creating a separation of the landscape. One such example may include preventing rainwater from draining out of the protected area, thus creating a structural issue on the both sides. Also, as sea levels rise and the beaches shrink, seawalls will prevent people from enjoying recreational opportunities since the beach cannot migrate. Overall, seawalls are very effective barriers but are in the long run

best used if the shoreline itself is not a significant feature.

Bulkheads are very similar to seawalls in design. As vertical partitions running parallel to the coast, they retain the upland soils while also protecting the embankment from wave action and erosion. Bulkheads are commonly made with rock-filled timber cribs and gabions, concrete blocks or armour stone units.⁶³ As with any barrier, intense storms can, over time, weaken the walls, causing them to fail. When waves hit a seawall or bulkhead, they are reflected downward, increasing scouring and erosion at the base of the wall. Therefore, recurring beach nourishment is often needed when bulkheads are located in areas with high wave action, such as the ocean front. As some of the wave force is reflected, these strategies may also cause erosion on the down-drift side of the structure. Therefore, it will be important to consider the condition and importance of the neighboring shorelines as well.

Revetments

Revetments are submerged structures that are usually made of rock or rubble. They are placed on a slope or embankment to protect the area directly behind them from the effects of waves, strong currents and other aggressive factors. Revetments are a type of armor meant to diminish the impacts of the waves and to decelerate shoreline erosion. They are commonly constructed using armor stone, articulated concrete mattress or rip-rap.⁶⁴ Other materials may include gabions, placed concrete, pre-cast concrete blocks or grout-filled bags.⁶⁵

Revetments, although ideal for diminishing wave action, may not always be the best choice for an open coastal landscape. The rubble that makes up the structure can look

deliberate and out of place, affecting the integrity of a pristine environment. Rocks and the other materials that make up the revetment structure could be occasionally washed into the shoreline. This may become a nuisance for pedestrians or others enjoying recreational activities along the beach.

Depending on the use of the shoreline, revetments can be an appropriate strategy for protecting other types of infrastructure such as roadways that are regularly washed out. They are unlikely to affect the viewshed from transportation routes, such as highways or bike paths and other inland locations. Made of natural materials, revetments can be an effective and sensitive choice to defending terrain that has a slight elevation.

Jetties and Groins

Jetties are hard structures that extend perpendicular from the shoreline. Their purpose is to limit sediment deposits and prevent inlet migration by decreasing wave energy along the beach front. Groins are shorter than jetties and are often constructed in groups (Fig. 8). Their purpose is to trap and retain sand in order to build a beach on the up drift side of the structures.⁶⁶ These can be constructed from several different types of materials including stone, timber, steel and concrete. Jetties primarily work well together by helping to maintain an inlet, allowing the beach to build on the up-drift and prevent sediment from depositing into the inlet and making it impassable. However, as sea levels rise, it is more likely that both of these types of structures will become submerged.

Although effective, both jetties and groins are incredibly destructive to the natural flow of the shoreline, preventing it from migrating or freely building up. Their entire purpose is to disrupt the natural erosion process and redistribute the sand in another

location. Visually, the structures are not appealing and are likely to affect the integrity of the landscape. However, these choices may be appropriate depending on what resources need to be protected. In this circumstance, it may be best to evaluate which resources are most important to a community. As an example, disrupting one beach out of many may be a fitting sacrifice if the preservation of an adjacent inlet is essential for boat passage to continue contributing to a local fishing industry. Such decisions will be extremely difficult and need to be assessed on a local level with consideration of community values and behaviors.



Fig. 8: Steel sheet-pile groin at the former location of the Cape Hatteras Lighthouse. Photograph by NPS [National Park Service, *Coastal Adaptation Strategies Handbook*. 2016]

Breakwaters

Breakwaters are also useful structures for breaking up the energy and impact of

damaging waves. The formations are made of various materials such as rocks or concrete blocks and are kept off of the shoreline, parallel to the beach. They can be built up higher to receive more wave impact or submerged in order to lessen their visual appearance. Breakwaters are commonly used in marinas to reduce the impact of waves on boats and piers. They can help to reduce the force and height of waves, which also helps to stabilize wetlands. The wetlands work by allowing a marsh habitat to form as another layer of environmental protection along the shore. Alternatively, some breakwater designs can decrease water circulation, preventing oxygen and other nutrients from being deposited near plant growth. This in turn could negatively affect the local ecosystem. This effect can be prevented by creating open areas between the breakwaters, which will still allow limited water to flow through.

Fortunately, breakwaters are not expected to be drastically affected by sea level rise impacts since their adaptive nature allows them to be built up as projections for water levels change.⁶⁷ However, they can reduce the use of the water for recreational use, such as surfing or other water sports. Breakwaters are also likely to cause navigational issues, since their presence blocks the waterway from the beach to the open ocean. This strategy is best used in areas where wave action is causing the most damage and residents are willing to sacrifice some use of the waterway to reduce regular damage.

Avoid

Avoidance is a second adaptation approach that seeks to limit new development or infrastructure in areas that are particularly vulnerable to sea level rise. Typically, this works by redirecting development to less vulnerable areas.⁶⁸ Applying avoidance

strategies can help minimize liability in areas that may be impacted by flooding, storm surge and beach erosion. This will potentially decrease negative impacts to homes, businesses and infrastructure, while maintaining certain land uses. Some of these suggested methods can also allow for protected wetlands to naturally migrate landward in response to rising tides. This permits them to continue to provide natural buffers for the shoreline by absorbing the energy of storms and decreasing erosion.⁶⁹

Transferable Development Rights (TDR)

This Avoidance strategy is intended to limit new development altogether or to reduce the allowed development density within hazardous areas. A TDR program is a market tool a community can use to achieve land preservation by allowing one landowner to sever development rights (the “sender” or sending lot or area) in exchange for compensation from another landowner who wants their development rights to increase (the “receiver” or receiving area). The receiving area is allowed to have increased intensity or density (Table 5).

This tactic could help to protect a particularly vulnerable area, such as beach front property or consistently flooded wetland area, from being further developed. By stopping development in a particularly vulnerable area, the community is taking a proactive approach to reduce overall loss from environmental damage. Anytime private infrastructure is inundated by flood waters, claims are made from flood insurance. Over time, constant claims force insurance providers to raise premiums for an entire area, affecting all tax payers in the locality. Transfer of Development Rights allows a community to reflect development to a more suitable area, such as one that is less

vulnerable to flooding. A TDR does not necessarily decrease overall development, and therefore does not reduce potential for growth; it only redirects it to a more stable location that is better for the entire community.

Florida Examples of Transferable Development Rights
Monroe County, Florida , which includes the Florida Keys and large parts of Everglades National Park and the Big Cypress National Preserve, uses a TDR program to protect environmentally sensitive areas by retiring development rights on private vacant land. Most of the rights transferred to date have come from the middle and lower Keys and have gone to receiving areas in the middle and upper Keys where they are used to supplement allowable densities for single-family residential subdivisions and allowable floor-areas for commercial development.
The City of Palmetto uses density transfers to protect wetlands. Developers are allowed to increase development densities on the upland portions of their sites at the rate of one unit per acre for every four acres of wetlands that remain undeveloped.
The City of Tallahassee's Environmental Management Ordinance encourages density transfers on sites situated within areas zoned as conservation and requires them in areas zoned as preservation. If there is no room for density transfer, development is allowed only at very low densities.

Table 5: Florida has several coastal locations that utilize Transferable Development Rights. [Adaption Action Areas: Policy Options for Adaptive Planning for Rising Sea Levels, November 2013]

A TDR program can also protect historic resources by managing development that could negatively affect the historic environment. This is an Avoidance adaptation strategy that restricts new structures from being built that could increase the rate in which the effects of sea level rise are felt by undermining other adaptation attempts. If more buildings are constructed along a vulnerable shoreline, the construction process could disrupt other adaptations that are already in place. Dunes are likely to be destroyed from construction equipment and vehicles, protective vegetation can be uprooted and the pilings from the foundation may accelerate beach erosion in the immediate area. As mentioned

previously, new development could also mean that the community would inherently support the risky construction by sharing an increase in insurance premiums. As more structures are built in a vulnerable area, the potential for damage increases. Decreasing development is a responsible way to manage risks for the future, allowing emphasis to be put on preserving the most valuable historic resources within a community.

Easements:

Conservation easements are voluntary landowner agreements that establish deed restrictions on land to prevent future development. Easements are instrumental in maintaining undeveloped open space, which helps to interpret the original setting, association and feeling of a historic property. These preserved open spaces can also help reduce flooding and storm water runoff. They can promote groundwater recharge by also creating more surface area for the soil to retain water.⁷⁰ Easements can also allow for future wetland migration necessary to accommodate sea level rise. Land preservation organizations in New York and Maryland have easements creating buffers specifically for allowing wetlands and beaches to naturally migrate landward.

Setbacks

Setbacks are state, county or local regulations that can direct new development away from areas that experience impacts from inundation, beach erosion, and advancing coastal flood boundaries. These regulations require development to be constructed a distance from the shore; either by a set distance or by an established multiple of the annual average erosion rate. North Carolina requires new structures to be set back from the

primary dune based on the current erosion rate times 30 years for easily moveable homes, or 60 years for large immovable structures.⁷¹

Accommodate

“Accommodation strategies refer to those strategies that employ methods that modify existing developments or design new developments to decrease hazard risks and thus increase the resiliency of development to the impacts of sea level rise.”⁷² These strategies acknowledge the long-term effects of sea level rise to an area, while implementing short-term measures to maintain the existing use. They attempt to decrease the risks of sea level rise impacts without employing potentially costlier protection strategies.

Examples include elevating and retrofitting existing structures, performing drainage modification and implementing green infrastructure or using other methods and materials to strengthen the structure. On a community scale, examples include land use designations, zoning ordinances or other planning strategies to enforce protection of natural areas. There are negative impacts of accommodation. Examples include blocked historic view sheds due to elevated structures. Updates to original pile-supported structures may also over time interfere with the natural shore protection or coastal process as the shoreline continues to recede.

Retrofitting

Historically, in many coastal communities, homes and other structures were built specifically to be compatible with the natural environment in which they were constructed. In flood prone areas, buildings were often raised off the ground onto piers or posts in order

to avoid damage from high water. When possible, homes were oriented facing the water to allow for air movement under the house and to assist with cooling during the warmer months. Shutters were placed on windows and doors to offer shade during the hottest part of the day and also as protection during storms. Design elements such as these often served multiple purposes that over time may have been lost or forgotten.⁷³ As modern materials become cheaper and more readily available, contractors may be reluctant to use the original types of materials or design techniques that are historically appropriate and therefore better suited for the structure to survive in a specific environment.

Despite this push-back, it is important to remember that the traditional materials will nearly always be the best sources of fabric for repairs and alterations of historic buildings. Many historic buildings, especially along the coastlines, were once built with old growth trees. This makes them stronger and more durable to storms and damaging wind than common modern materials. Similarly, as historic materials deteriorate and are replaced, there is likelihood that the new material will not be similar in strength or durability. This disrupts the buildings ability to work as a system. Even menial changes could compromise the strength or function of the overall structure.⁷⁴

As the environment changes, the best uses of materials and how they interact with their immediate environment will likewise need to change in order to best service the building as a system. One means of preparing for the imminent change is through retrofitting. This strategy will assist a building and its systems with responding to potentially destructive environmental impacts through structural reinforcement. Examples of retrofitting may include upgrading or stabilizing the roof, the foundation and the windows in order to protect against environmental stresses. This may also be necessary in

order to comply with modern building codes and standards. Some changes may require an architect or engineer in order to ensure code compliance.

Factors such as aesthetics, cost, future risk and accessibility should be considered before determining the best retrofit for a building. As mentioned before, it will also be vital to view the building as a whole system. Any alternation could affect the natural system or health of the building as all aspects must work together to function properly. It will also be important to look at drainage around the property, to secure porches or other additions that may pull away in a storm as well as securing usable shutters. It is unlikely that any one retrofit will be enough to protect the building from inundation or other damage. In accordance with the *Secretary of the Interior Standards for Preservation*, it is best to repair rather than to replace original materials. Likewise, it is best only to replace with “like materials” that have the same characteristics so that they will react similarly to the environment.⁷⁵

Overlay Zones

An overlay zone is an area applied over one or more established land uses or zoning districts to establish additional, higher standards, or criteria for development in addition to those of the underlying land use or zoning district. This could be strategic in implementing specific adaptation standards for areas most vulnerable to the effects of sea level rise. Often, overlay zones are used to implement conservation districts and are sometimes referred to as “historic district lite” meaning that the design requirements and ordinances are much less restrictive and less specific than traditional historic districts.

An overlay district does not replace standard zoning regulations, but can instead add an additional layer of protection to the specified area from residential, commercial and environmental impacts affecting the historic integrity of a particular neighborhood. Some property owners may view an overlay district as a form of additional restrictions, limiting their ability to use and capitalize their property. Therefore, it is common that when establishing these zones, they also come with some sort of incentive for the property owners, such as reduced property taxes.

Overlay districts can be implemented in a variety of different ways dependent upon local code, such as a Neighborhood Conservation Overlay District (NCOD). These can vary from entirely resident-driven organizations, where public meetings are held for any major or minor design review and decisions are made by a commission composed of residents from within the district. Or, they could be formulated almost entirely without resident input, as is the process in Chapel Hill, NC, where a decision is made within the planning department with no design review or hearing.⁷⁶

What is most intriguing about Conservation Districts is that they can be as specific or as broad as the neighborhood is comfortable in agreeing upon. NCOD's can be adopted that are just as restrictive and protective as traditional historic districts, or simply as a tool to implement a few specific architectural details.

Through the development of neighborhood plans, residents are required to think about the qualities of their neighborhood that makes it special. They must also think about what is wrong and how those wrongs can be corrected. By being in the driver's seat, residents have come to appreciate their own neighborhoods and, correspondingly, have chosen to accept necessary restrictions on their own properties for the benefit of the community overall.⁷⁷

In regard to increased flooding, storm surge and coastal erosion, overlay districts can be used to implement restrictions that that will better help homes and business to prepare for sea level rise impacts over time. As buildings require regular maintenance, a regulation could require updates that would make the structure better suited to withstand storm surge. They could also require increased vegetation be planted in more vulnerable areas or that restrictions be placed to assist with dune management. Strict mandates could also require that buildings become elevated or secured with pile foundations.

Elevation

Elevating structures involves raising a building's foundation or first floor to a level that accommodates for projections of increased flooding and storm surge for the area over a specific time. Elevation of a building can be implemented on an individual basis or as part of a comprehensive program for a local community. According to FEMA, elevating a structure higher than the locally required lowest floor elevation provides additional protection against flood and storm surge damage and can result in decreases in the cost of federal flood insurance.

First floor elevation is usually determined by the Base Flood Elevation (BFE) for a particular area. The BFE is “the height which experts have determined has a 1% chance of being reached or exceeded in any given year” by flood waters.⁷⁸ This information can be obtained from the National Flood Insurance Program (NFIP) and is based on research that considers past flood elevations from local bodies of water and other factors. The research, however, does not consider projections for sea level rise. FEMA recommends that the lowest horizontal structural member of the building should exceed the BFE by a minimum

of one foot. It is also possible that local officials may require raising existing buildings to a Design Flood Elevation (DFE) which may exceed the BFE requirements.

Flooding can affect the foundation of a building by saturating the soil which anchors it to the ground. Damage from inundation can infiltrate the full system of a home or structure, causing damage to the materials as well as the furnishings of the building. Water can also damage a building by increasing pressure to the foundation and can facilitate damage from debris moving through the water. This puts pressure on the foundation, foundation walls and piles or posts.

The process of elevating or raising a building requires that the structure be physically lifted off of its foundation, temporarily secured, and then re-placed onto a new, higher, foundation. This suggests significant risk to the structure and should only be completed by professionals and only when deemed absolutely necessary. Whether the building was originally masonry, masonry veneer, or frame construction, the new foundation may need to be made of a different material depending on the conditions of the environment since the new foundation will be open and regularly exposed to flooding.

The height of the new elevation of the structure will depend on a few factors. The height required by the Flood Insurer will be dependent upon the flood plain and whether the home is being adapted for a 100, 500 or other variation of flood year. Also to be considered are any height restrictions for the neighborhood or zoning area, as there may be a limitation in residential areas. If any elevation of the building is occurring at all, it is suggested by FEMA that it be raised at least one full story, so that the new, vacant space can be used for parking, storage or building access.⁷⁹ However, “If you are elevating a house that has been substantially damaged or is being substantially improved, your

community's floodplain management ordinance or law will not allow you to have a basement, as defined under the NFIP.”⁸⁰

Owners of historic properties should first discuss any changes with their SHPO or local historic preservation commission to ensure that elevating the building is a safe and appropriate option. Alterations to the historic characteristics could result in a building's loss of integrity and ultimately de-listing from the historic register. Elevating a building could change any or potentially all of the seven elements of integrity; location, design, setting, materials, workmanship, feeling or association. The process of elevation can permanently alter not only the integrity of individual buildings, but also the integrity of entire historic districts. Historic Districts may incorporate several homes, business and other properties which all are associated with the historic design. Even if one property owner has funding to raise their building, the project may be not approved due to its impact on the remaining structures in the historic district. Raising one building could change the cohesive design, setting, feeling and association of the entire street.

In response to the massive destruction of Hurricane Katrina, the Mississippi Development Authority (MDA) issued *Elevation Design Guidelines for Historic Homes in the Mississippi Gulf Coast Region* to assist historic home owners with making decisions to safeguard their homes while also being sensitive to its historic integrity (Fig. 9-10). The guidebook presents specific examples for ensuring that elevation does not change the feeling of a historic street or the association between a house and its historic neighbors. The MDA suggest that only minimal changes in elevation or location should occur and only when deemed absolutely necessary for the protection of the structure due to frequent flooding. The document states that, “The property owner must understand that their



Fig. 9: Adjoining properties in Pascagoula illustrate the challenges of contrasting elevations. [Mississippi Development Authority, *Elevation Design Guidelines for Historic Homes in the Mississippi Gulf Coast Region*.]



Fig. 10: Landscape screening can assist with making the visual signs of building elevation less obvious, minimizing the effects on historic integrity. [Mississippi Development Authority, *Elevation Design Guidelines for Historic Homes in the Mississippi Gulf Coast Region*.]

property needs to continue to retain its historic integrity after rehabilitation and elevation...”⁸¹ The design guidelines also identify historic character as not only defined by architecture, but also by spacial features, topography, setback, orientation, viewsheds and vegetation, among other factors. “Landscaping and plantings play a significant role in creating the character of the historic districts in Coastal Mississippi, and also reflect the regional climate.”⁸² Therefore, retaining the spacial relationship with neighboring historic homes is a vital design component.

The suggestions for covering up the visual impacts of elevation through landscape screening can become innovative works of design. The MDA suggests using a design consultant to assist with creating alternative treatments to the landscape which will minimize the visual effects on historic properties. Examples from the guidebook include planting patterns of shrubs and small trees around the perimeter of an elevated structure that will complement the landscape and also cover the obvious pillars with which the building is raised. This tactic can be visually successful, but should still be completed in a simultaneous fashion as the other associated buildings along the street.

Retreat

Retreat strategies are those that relocate or remove existing development out of hazard areas and limit the construction of new development in vulnerable areas.⁸³ Retreat adaptation strategies allow for natural shoreline migration through land conservation and the removal of structures that prevent shoreline movement such as dikes, berms and bulkheads. This adaptation approach may occur as an unplanned response after a severe storm or as a proactive response to avoid the long-term costs associated with increased

impacts from sea level rise. For existing structures, retreat strategies are usually employed after other adaptation strategies have been found to be ineffective. The strategy of retreat is often a difficult decision and usually results in the loss of some aspects of integrity, such as setting, location and association.

Managed Retreat

The process of managed retreat involves planning for projected increases in sea levels by relocating vulnerable buildings, infrastructure and public facilities before significant inundation occurs. Managed retreat usually requires considerable time to plan and to implement the process. It also requires significant consideration of the economic and social impacts of relocating homes, businesses and public facilities. This strategy has become a hot topic, especially in the historic preservation community. Managed retreat was used to address erosion and sea level rise by the National Park Service when it relocated the Cape Hatteras Lighthouse further inland in 1999.

Retreat will potentially involve leaving behind dynamic features of the landscape which may be significant to the integrity of a historic resource. The process can be very difficult to perform and there is an increased amount of risk involved depending on the stability of the building. The decision should not be taken lightly. In the circumstance where loss of a historic building itself is likely, the sacrifice to move it away from its historic environment may be the only way to save a building from losing it completely to the elements.

Due to the restrictions outlined in the National Register Criteria for Evaluation, relocation could cause a historic property to be removed from the Register or to become

ineligible for initial nomination. In addition to the existence of the Criteria for Evaluation, there are also Criteria Considerations, which describe more detailed specifications as to what will or will not qualify a historic property for nomination. These Considerations explain that usually, properties which have been moved from their original location are afterwards ineligible to be listed. The only exception to this rule is addressed in Criterion (b) of the Considerations, which states that a moved structure will only qualify if it is, “A building or structure removed from its original location but which is primarily significant for architectural value, or which is the surviving structure most importantly associated with a historic person or event.”⁸⁴ Relocation, therefore presents a dangerous problem for preservationists who strive to nominate properties for local, state and national recognition. However, policy may change in the future, as relocating buildings due to environmental change is becoming more common among historic sites.

Rolling Easements

Rolling easements are used to ensure that coastal development does not interfere with the natural migration of shorelines as they move inland due to the effects of sea level rise. These can be implemented in several ways, including development of state or local legislation, placement of conditions on development permits or through voluntary agreements. These land use restrictions are usually developed with reference to a tide line, or other natural features that allow the resource to be moved with natural coastal processes. Therefore, as the sea level rises and the natural features move, the associated development or land use restrictions “roll” inland and allow for natural shoreline erosion and wetland migration to occur over a lengthy period of time (Fig. 11).

Rolling easements are used in Texas, Maine, Rhode Island, and South Carolina, where development permits are conditioned to include a clause to relocate a structure when it becomes threatened from erosion. While rolling easements may be less costly than measures that could achieve similar goals, to be effective, easements would need to be established well before impacts occur. Having these strategies in place could help a historic community begin to plan for the future. It potentially will involve several retreat projects, but if planned in advance, could be financed and the appropriate measures set in place to make the process run smoothly and effectively.

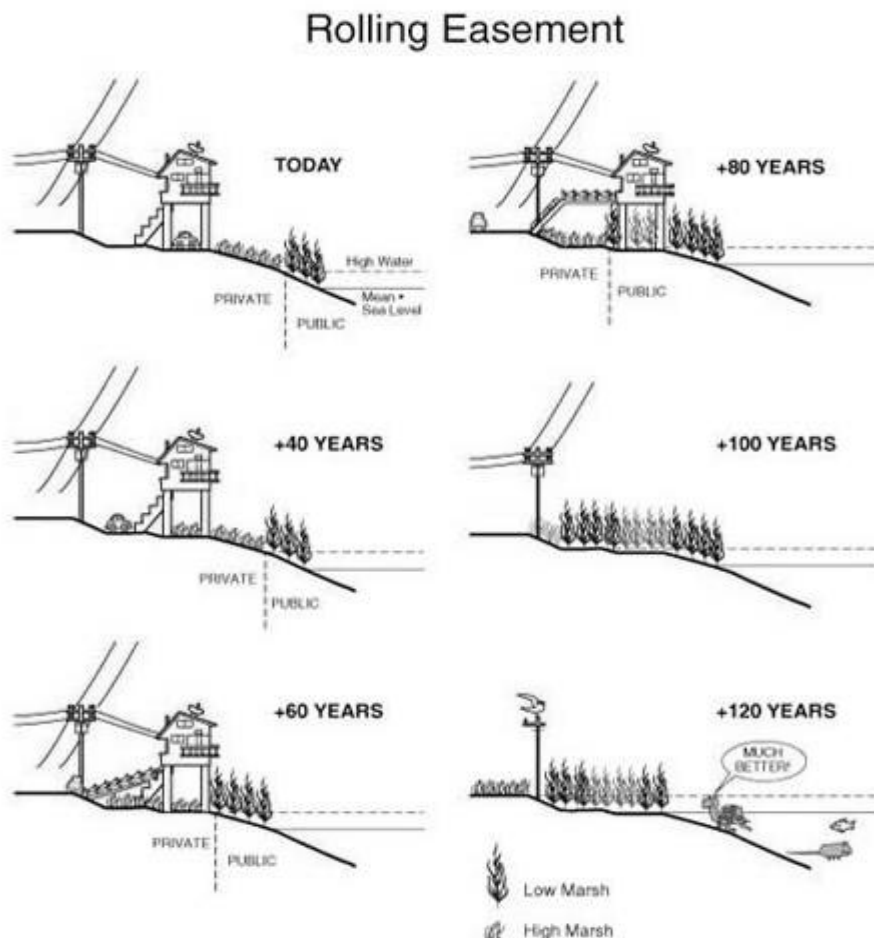


Fig. 11: Visual explanation of how a rolling easement works over time. [Titus, James, "Rising Seas, Coastal Erosion, and the Takings Clause," 1998]

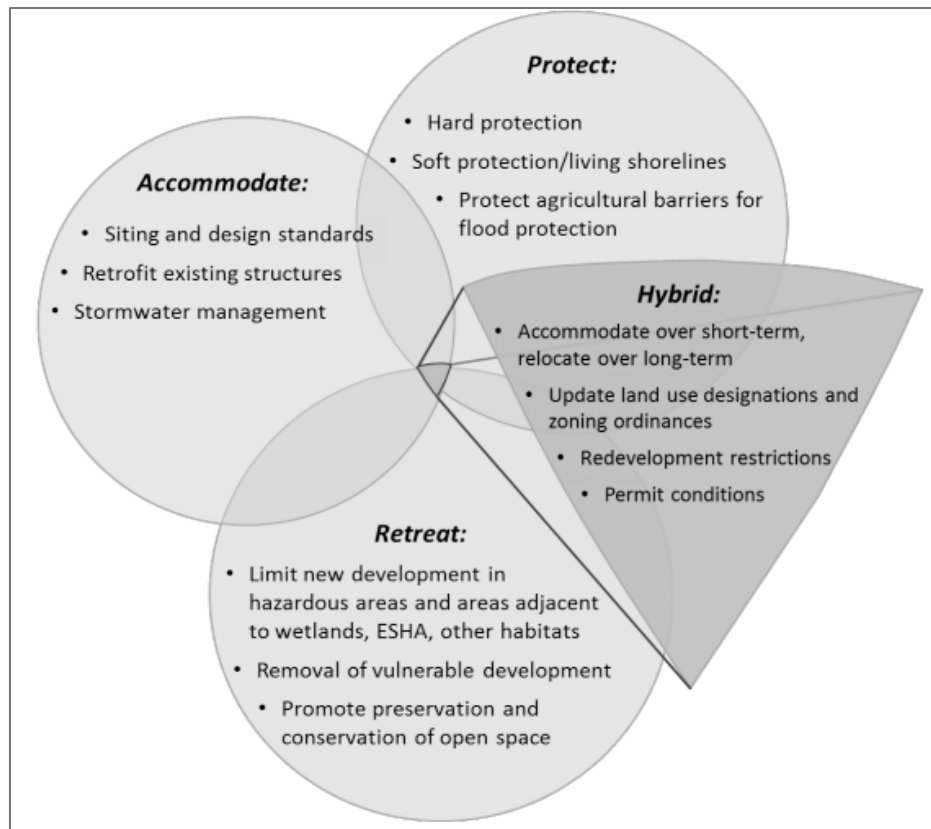


Table 6: Examples of overlapping adaptation approaches [California Coastal Commission, *Sea Level Rise Policy Guidance*, 2015]

Land Acquisition

Land acquisition by government entities, communities, businesses or non-profit organizations entails the purchase of vulnerable parcels for permanent protection and management, thereby allowing the shoreline processes to occur naturally. Consent from the landowner to sell to the government or a conservation group is required for land acquisition programs. After purchase, the land can be managed as open space, public parks, or other passive infrastructure and is protected through conservation easements. Prioritization of properties for acquisition should include properties that have suffered severe repetitive losses due to storms; structures that are repeatedly damaged or destroyed;

properties that have important habitats, such as wetlands and are located in vulnerable areas; and properties where all other strategies are not cost effective to implement. These programs can be an effective strategy for moving people and development away from vulnerable areas, but they do transfer management costs from the private property owner to the public. Therefore, there are many factors that must be considered before any adaptation strategy is adopted. As demonstrated in Table 6, there are benefits and consequences to each approach.

No Action

A no-action approach will be the default action for those who do not proactively plan ahead for the effects of sea level rise. By consciously or unconsciously choosing to not consider future sea level rise scenarios in planning or engineering design, decision-makers risk unintentionally pursuing a strategy of unplanned retreat. Unplanned retreat occurs when property, infrastructure and habitat losses from incremental erosion and inundation from sea level rise or a catastrophic flooding event are imminent or have already occurred, leaving few viable options for alternative protection, accommodation or avoidance strategies.⁸⁵

Essentially, this process consists of leaving properties behind without any intervention to be slowly consumed by the elements. Depending on the magnitude, features of structures or the interior of buildings may be salvaged. Often, No Action is accompanied by facilitated demolition or a thorough documentation of the property before allowing it to be destroyed. This allows the history of the property to be preserved through interpretation and other forms of documentation.

The National Park Service document, *Coastal Adaptation Strategies Handbook* also suggests full interpretation of the adaptation as an appropriate action that should be incorporated into existing interpretation. This is an interesting stance that would both bring awareness to the environmental issues of climate change as well as preservation as a proactive action to manage change.

Adaptation Option	General Cost	Benefits	Disadvantages/Impacts
Onshore, Shore-Parallel Structures	\$2,000 – \$3,000/ft (\$6562-\$9843/m)	Reduce upland erosion	Disrupts natural processes; causes erosion; impacts habitat
Shore-Perpendicular Structures	Groins: \$250 – \$6,500/ft (\$820-\$21,325/m) Jetties: \$16,000/ft (\$52,493/m)	Groins: Widen beach Jetties: Limit sediment flow and wave energy in inlet	Disrupt natural processes (longshore transport); cause downdrift erosion; cascading effect of installation (groins); hinder inlet migration (jetties)
Breakwaters	Initial: \$16,000/ft (\$52,493/m) Annual maintenance: over \$500/ft (\$1640/m)	Reduce force and height of waves; allow accretion landward of structure	Navigation hazard; disrupt natural processes; cause downdrift erosion; no high water protection
Beach Nourishment	\$300 – \$1,000 ft (\$984-\$3,281/m) per linear foot or between \$5 and \$30 (\$3.80 and \$23 per cubic meter) per cubic yard of sand	Increase beach sand volume/width; reduce wave energy near infrastructure; protection from moderate water rise; can promote tourism, rapid visible change	Temporary solution; does not reduce or eliminate erosion; sand compatibility limitations; impacts on wildlife on beach and at borrow sites; disrupts natural beach processes; can encourage increased development in high-risk areas
Sand Fencing	Inexpensive	Support natural vegetation growth (and sand accumulation); reduce wind stress and salt spray	Can create debris and safety hazards when destroyed
Living Shorelines	Initial: \$1,000 ft (\$3,281/m) Annual maintenance: \$100/ft (\$328/m)	Provide habitat; dissipate wave energy; slow inland water transfer	No upland flood protection; vegetation survival can be limited; hybrid techniques that include hard structures disrupt sediment processes
Redesign the Structure	May be lower than complete removal or relocation; adaptive maintenance costs can increase with redesign	Prolong accessibility; postpone need to find new site for structure; allow historical structure to remain in associated landscape	Pilings can be undermined by erosion or affected by groundwater; means of access may change
Relocate	\$800 – \$40,000/ft (\$2625-\$131,234/m)	Long-term solution, reduced maintenance needs; allow natural processes	Lack of appropriate relocation site; loss of historical context; size limitations
Abandon in Place	Reduced short-term maintenance costs	Reduced maintenance needs; can eliminate need for protective structures	Deterioration over time; attractive nuisance; loss of historical value; potential for introduction of hazardous materials

Table 7: Summary of select adaptation options and their costs, benefits and impacts. [National Park Service, *Coastal Adaptation Strategies Handbook*. 2016]

As flooding, storm surge and coastal erosion becomes more frequent, eventually planners, park service officials and other leaders may begin to realize that they cannot adapt or save all of the vulnerable historic resources. This recognition will lead to the need to make decisions about the historic resources that have been left behind. The most appropriate action may be to interpret the change and continue to make changes for short term vulnerability while continuing to explain the effects of climate change.

Limitations

It is highly probable that some communities will find themselves in a situation where they cannot save all of their threatened historic and cultural resources. Depending upon time, funding, manpower and other factors, it may be unfeasible to protect, salvage or relocate every single significant property within a community. In this circumstance, planners and the preservation community will need to make decisions to determine which properties they can or should save over others. These decisions, although extremely difficult, will need to be determined on a case by case basis. The result should be determined based on time constraints, funding and logistics or complications around the adaptation process. If the decision is made that ultimately some properties of significance must be left behind, public input and community values must also be considered. Residents should be questioned on which properties they value most within the community. The local community will need to have counsel on any historic properties that could be purposefully allowed to deteriorate.

With so many factors to consider, a methodical process should be established in order to ensure that a fair evaluation of the endangered properties is being implemented. It

may then be in the best interest of the community to establish a matrix with which to evaluate the properties. The suggested matrix will need to be individualized for each specific community. There should be an established system that is specific to the community's needs and values, especially when considering salvage priorities. What is important to one community may not be significant to another. Similarly, one community may have difficulty with implementing adaptation strategies versus another strategy.

As an example, I have developed a hypothetical matrix that can be applied for this particular circumstance. The example matrix is comprised specifically for Dare County, which is located in the coastal Outer Banks of North Carolina. The suggested matrix specifically considers factors that are important and relevant to the community and organizes them into a point system. Using the adaptation strategy of Retreat, the Dare County Matrix is designed to solely evaluate the historic buildings in Dare County that are listed in the National Register in order to determine which properties would be most feasible to relocate based on the community-specific factors.

The matrix allows one point if a property falls within a specific category. The matrix criteria are listed as:

1. The structure is associated with a historic event significant to American history.
2. The structure is associated with a historic event significant to local or state history.
3. The structure is associated with the life of a significant individual relevant to American history.
4. The structure is associated with the life of a significant individual relevant to local or state history.
5. The structure embodies distinctive features of architectural significance or artistic value.
6. The structure will specifically attract tourism to the effect of stimulating the local economy.

7. The structure is currently in use or has been rehabilitated to provide a dual-use to residents or visitors.
8. The structure is also associated with another aspect significant to the Outer Banks, such as environmental or wildlife conservation.
9. The structure is currently significant to a local industry by providing jobs or is associated with the local lifestyle.
10. The structure bears a quality that makes it more equipped for relocation.

The criteria were determined based on the National Register Criteria for Evaluation, which is evident in the first five criteria. The matrix was further adapted based on the specific circumstances found in Dare County. The Outer Banks are a chain of barrier islands that were historically resort towns, dependent on tourism to retain their lifestyle and for the livelihood of the permanent residents. Tourism, therefore, is still today the main industry for most of the small towns that make up the Outer Banks. In 2013, domestic tourism in Dare County generated \$953.04 million and attributed to more than 11,750 jobs within the county alone.⁸⁶ Dare County depends heavily on the revenue derived from this industry and will need to ensure such revenue continues in order to secure its economic status and the economic security of its citizens. It would therefore be essential that any historic structures that may contribute to the economy be retained. Likewise, a structure's significance to the local job market, such as hotels, restaurants or grocery markets, is always an important factor to retain, especially in smaller communities. The importance of these aspects in the community is reflected in criterion 6 and criterion 9 of the matrix.

Additionally, real estate is a valuable resource on a barrier island. Therefore, it became important that structures which may contain a dual use, such as a hotel and a restaurant, or a museum as well as retail store, would also be beneficial to the

community. This is reflected in criterion 7. Due to the expense of relocating buildings, a structure which is easily moved would be more cost effective to retreat or salvage. As an example, a home which is already on stilts verses a home on a concrete slab would be one factor that would make it easier and cheaper to relocate. Criterion 10, therefore, could earn a property an extra point from the matrix if it would save time and resources by being easily moved.

The specifics of this matrix will need to be configured for each individual community or neighborhood, depending on their particular values and available resources. Creating a matrix as a point system is merely a suggestion for a means of organizing the many factors that will need to be considered. Funding will generally be the deciding factor in many cases, but this process could still be beneficial for communities to establish salvage priorities in the wake of a major disaster or related event.

Implementation of Adaptations on Historic Resources

Many places throughout the United States have begun to react to the effects of sea level rise and have begun planning and implementing adaptation strategies. The following section will present examples of how some of these historic sites and communities have chosen to adapt in response to frequent flooding, constant erosion and storm surge related to sea level rise. The National Park Service in particular has identified properties that are endangered due to the effects of sea level rise. Although not all are small coastal communities, the examples from the NPS explain specific cases of adaptation planning and implementation on historic and cultural resources that could be directly applied

toward coastal communities. Additional examples from international cities will be briefly discussed in the following chapter on Financial Strategies.

Quinault Nation

The Quinault Indian Nation (QIN) in the state of Washington plans to relocate the entire lower portion of its village due to increasingly frequent flooding. In March, 2014, the seawall that protected the village of Taholah was breached by storm surge, resulting in the entire lower portion of the village being flooded. “We have been experiencing an increasingly dangerous situation with sea level rise and intensified storms,” said Quinault President Fawn Sharp. The seawall was temporarily repaired by the U.S. Army Corps of Engineers, but flooding continued to occur, washing out a main road in early 2015. These events served as harbingers of the ever-present threat of flooding and the growing risk from climate change impacts.

Leadership of the QIN then made the difficult decision to relocate the entire lower portion of the village to higher ground. With assistance from grants, a master plan for the relocation was initiated by 2016. The plan involved two components: a risk assessment based on an inventory of existing conditions and active engagement of all segments of the Quinault community. Village-wide meetings were convened, as well as door-to-door and online surveys. This was initiated to gain an understanding of the conditions, community aspirations, and perceptions of risk within the community. The master plan was designed to maintain the integrity of the community by incorporating needs for housing, infrastructure, business, administration, public health and safety, transportation, utilities, schools, and recreational facilities.⁸⁷

Further, the QIN recognizes that Taholah is a small isolated community and will therefore be among the last to receive emergency aid in the event of a disaster. Leaders therefore decided to also include emergency measures into their plan that will go into effect after major environmental events such as backup power, emergency water supplies and armoring of the wastewater facilities. The Quinault Indian Nation has put action into place to not only protect themselves from the imminent effects of sea level rise but also to protect their cultural practices and properties that are valued within the community.

Grand Isle, Louisiana

The coastal areas of Louisiana are regularly pummeled by massive storms in addition to having one of the highest rates of relative sea level rise in the world, losing hundreds of acres of land per year to the Gulf of Mexico. The community of Grand Isle, Louisiana, one of the most densely populated barrier islands, has implemented a combination of several adaptation strategies to protect the increasingly exposed land as well as homes and businesses. “From neighborhood-scale efforts to plant vegetation along dunes, to sponsored programs that build oyster reefs, to engineering projects completed by state and federal agencies, individuals and communities are taking action to preserve and enhance their coastal environment.”⁸⁸

One engineered adaptive example is a series of breakwaters installed just offshore by the U.S. Army Corps of Engineers. The long, low walls were constructed to absorb the impact of strong waves, reducing the potential for erosion before the waves hit the shoreline. Engineers have also built two parallel levees along Grand Isle’s beach, constructed to resemble natural dunes. The levees are covered with natural vegetation

which helps them to hold sand in place. The vegetation helps the structure to blend in to the natural environment. “Even as residents and businesses recognize the continual rise of ocean waters and make long-term plans for dealing with their disappearing land, engineered structures that mimic natural systems can help extend the life of Louisiana’s shoreline as it exists today.”⁸⁹

Dunes in coastal New Jersey

In contrast to hard engineered structures, other regions have decided to use natural barriers as their chosen adaptation strategy. When Hurricane Sandy hit New Jersey in 2012, neighborhoods that sat inland of the crowded, developed shoreline also received the full brunt of the storm’s waves and storm surge. The result of heavily developed areas had robbed the environment of its ability to naturally build up a protective defense from storm damage. In other less developed areas, where natural beach dunes were still in place, damage was noticeably less pervasive.

Now, shore communities in New Jersey are recognizing the benefits of preserving or enhancing the natural infrastructure that the dune systems offer. Instead of pursuing costly engineering solutions or beach replenishment programs to mitigate vulnerability, some towns have opted to work with nature by rebuilding the once naturally occurring dunes. Similarly, they are also planting beach grasses and installing and maintaining sand fences to help hold the sand in place to control pedestrian traffic. Their strategies have also included modifying paths to the beach so they are angled rather than perpendicular to the beach in order to reduce the opportunity for either wind or waves to move sand from the dune directly inland. Caitlyn Kennedy of NOAA explains that, “Natural infrastructure

projects along coasts and rivers across the country illustrate a variety of ways that nature-based infrastructure can help mitigate the effects of extreme weather and rising sea levels. These projects offer multiple benefits including cost-effectiveness, ability to continue adapting to changing conditions, improving habitat for fish and wildlife, and inspiring strong local support.”⁹⁰ Dune management is a strategy that can also work collaboratively with other adaptations such as the previously mentioned levees or by reducing development along the shoreline in the interim.

Dry Tortugas, Florida

The National Park Service has released roughly a dozen case studies regarding climate change plans and adaptations within U.S. National Parks.⁹¹ One study discusses the dilemma of Dry Tortugas National Park, located about 70 miles west of Key West in Florida. The Park also contains cultural resources that are at an increased risk of the effects of sea level rise such as tropical storm intensity and long-term sustainability. Although adaptation strategies have not yet begun, NPS officials are working to make decisions on mitigating these effects over time through strategic planning.

The historic Fort Jefferson of Dry Tortugas National Park is deteriorating. Composed of unreinforced masonry and coral concrete faced with brick, the structure has six sides and three tiers exposed to the elements. Additionally, it is surrounded by a 70 foot wide wet moat which currently sits just six feet above the low water line and three feet above high tide. Originally designed to keep would-be attackers at bay, the moat is now in direct line of being submerged by the sea. Integral to the site design, the moat also needs repairs in many places. Architecture of the fort itself is comprised of iron

components embedded within the masonry. Due to the salt water environment, the iron has rusted and expanded. This has resulted in the brick pulling apart and has caused serious structural damage to the walls as large sections have collapsed into the moat.

Park officials are now questioning the appropriate level of investment in repairs to the cultural resources given the bleak global sea level rise projections, among other hurdles. Removal of the corroded iron components is now underway and intermittent stabilization has occurred since the 1960s. The availability of funding has guided the majority of the needed preservation. The estimated cost to finish just the stabilization of the fort by 2018 is just under \$12 million.⁹²

Moving forward, officials are following the National Park Service Climate Change Response Strategy and the National Park Service Climate Change Action Plan to address projected consequences of climate change and as a framework to develop adaptation plans.⁹³ Dry Tortugas officials have been referring to data from the Intergovernmental Panel on Climate Change as well as the Southeast Atlantic Coastal Ocean Observing System to create local projections. Their objective seems to be to operate the park as they have been while also increasing resilience to climate change. Further adaptation strategies for the protection of Fort Jefferson have not yet been reported by NPS. “Planning for future repairs to the fort and the moat wall require budget foresight, structural vulnerability analysis, careful historic preservation considerations, and continued incorporation of climate change projections, particularly with respect to local sea level rise and storm intensity.”⁹⁴

Fort Pulaski National Monument, Georgia

The historic revetment around Cockspur Lighthouse at Fort Pulaski National Monument has for the past 30 years, been eroding away. A portion of the original wooden foundation is now exposed to shipworm damage and severe structural damage is expected to occur within the next few years. With preservation of the structure scheduled to occur, officials have decided to install a granite revetment that will mitigate the impact of waves on the timber piling.

The modification will be further adapted to protect the lighthouse from the next 20 years of sea level rise projections. It will also be constructed to allow for future adaptation to accommodate faster rates of sea level rise over time. The park has identified global sea level rise projections from the IPCC, historic rates calculated by NOAA, and trends in local water level monitoring data collected around the park.⁹⁵ This physical adaptation is an excellent example of officials taking response to needed preservation and adapting for the future. By taking the extra step to plan and prepare with the scientific data associated with climate change, Cockspur Lighthouse will now be more effectively suited to weather future changes than other vulnerable cultural resources. This enhances the structure's likelihood to be preserved for future generations to learn from and to enjoy.

Cape Hatteras Lighthouse, North Carolina

In 1999, the National Park Service decided to relocate the historic lighthouse at Cape Hatteras National Seashore. The lighthouse, built in 1803, is a culturally significant structure and one of the most visited attractions in the park. Located in the barrier island chain of the Outer Banks, the shoreline has been subjected to rapidly increasing erosion.

After decades of maintenance, ongoing erosion had threatened the base of the lighthouse to the point that the ocean was within 120 feet.

The official report from the National Park Service states, “Twice in the past fifty years a decision was made to abandon the Cape Hatteras Lighthouse to the forces of nature; and twice the decision was changed.”⁹⁶ Throughout the years, the NPS made multiple attempts to restore the sand along the beaches. In the 1930’s, the Civilian Conservation Corp (CCC) erected sand fencing along much of the North Carolina coastline, including along Cape Hatteras.⁹⁷ In 1966 the National Park Service funded a beach replenishment project directly in front of the lighthouse; and in 1969 and 1970, three groins, designed specifically to trap sand from washing away, were installed along the beach by the U.S. Navy station located adjacent to the lighthouse.⁹⁸ In 1982, a six million dollar project was funded to surround the lighthouse with a seawall and retaining structures.



Fig. 12: The Cape Hatteras Lighthouse before and after relocation. [Quine, Katie, “How the Cape Hatteras Lighthouse was Moved,” May 4, 2016]

Eventually the decision was made that the lighthouse as well as the historic keeper's quarters should be moved back, away from the impending sea (Fig. 12). The decision was difficult and depended upon public support and funding to be accomplished. Slowly, the building was lifted from its original location and moved 2,900 feet diagonally across the landscape. The structure was lifted with hydraulic jacks and pulled to the new site using a series of rails and dollies. The feat began on June 17, 1999 and ended less than a month later on July 9, 1999, with the lighthouse securely placed onto its new foundation. The historic buildings surrounding the lighthouse were also moved back into positions relative to their original distance from the primary structure. John Knowlton, Facility Manager of the Cape Hatteras National Seashore recalled that,

The Lighthouse Society placed a ring of granite stones, each engraved with the name of a lighthouse keeper, to mark the former position of the lighthouse. Although the original plan called for the stones to be left in place, continued over wash and burial of the stones led to negotiations between the Lighthouse society, a Congressional Representative, and NPS to uncover and move the stones.⁹⁹

The actions at the Cape Hatteras National Seashore are an example of adapting to the environment while still retaining as many aspects of integrity as possible. The relocation of the lighthouse became a community event and the hundreds of thousands of visitors who come each year to see and to climb the building are made aware of its historic move. Especially along barrier islands, where the shoreline is constantly moving and changing, local preservation officials will have to make similar decisions on how to adapt and interpret change without diminishing integrity or the values that make each cultural resource important.

Chesterfield Heights, VA – Historic Community

In 2014, Wetlands Watch of Norfolk, Virginia partnered with Virginia Sea Grant to complete a design that included nature-centric adaptation solutions for a neighborhood in the Norfolk area. The goal for William Stiles, Director of Wetlands Watch, was to develop adaptation approaches that could actually be implemented in the immediate area. Stiles was inspired after he found that when looking at examples from post-Katrina and Sandy communities, their designs were not appropriate for the topography of Virginia's coastline. "Some were too conceptual, too long-term, or at too large a scale to be applicable."¹⁰⁰

With an award from the Virginia Sea Grant Program, Wetlands Watch further partnered with the College of William and Mary Law School's Coastal Policy Clinic and the Virginia Institute of Marine Science's Center for Coastal Resource Management and they began work on a community-scale, street level design for sea level rise adaptation. The group settled on the community of Chesterfield Heights which is comprised of nearly 900 people living in 500 structures in mostly single family homes. The historic neighborhood is located along the Elizabeth River and was platted in 1904, with National Historic Register listing in 2003. Chesterfield Heights is a predominantly African-American neighborhood with a median household income of \$32,000. The community was chosen due to its position in the flood plain, with historic flooding that had gotten more frequent. Residents had begun to complain about flooded streets, flooded basements and continued erosion of the shoreline.

As the design team began drawing up concepts, they were aware of how the standard practice of elevating houses would affect the historic status of the community by

changing the relationship of the houses to the street, among other factors. The neighborhood's status as a historic district and the sensitivity to a changed environment became a conscious concern when suggesting adaptation strategies. Students working on the project also explained the value of "porch culture" in the neighborhood, which would be sacrificed if homes became elevated.¹⁰¹



Fig. 13: Under-street and front lawn cisterns designed for Chesterfield Heights. [Stiles, William, et al., *Tidewater Rising Resiliency Design Challenge*, 2016]

In response to the flooding streets, and with historic preservation in mind, the team conceived of using a series of under-street cisterns with permeable pavers, distributed along key roads and intersections in the neighborhood. The cisterns were also proposed for the front of homes, which would be covered by soil and graded from the street. Their overall strategy was to hold the rainfall water on the land so as not to exceed the capacity of the sea level rise-challenged storm water system, which was frequently inundated by undersized pipes. This developed into an urban bio-retention system, under-street cisterns, basement cisterns and an innovative system of collecting and holding rain water from rooftops. In addition, the design called for a living shoreline to protect the 2,200 foot shoreline and to expand the benefits of using the local ecosystem. The innovations called for some adjustments such as the use of a Tideflex one-way valve system to prevent

backflow up the storm water pipes. Further observation recommended the use of bio retention ponds to collect water off of the streets and to slow down the release towards the river and the piping systems.

Directly related to the historic structures, the group suggested use of basement cisterns. Residents had already indicated that they did not use their basements for storage due to the increased flooding. Since so many of the older homes already had basements and most of them with brick floors, which permitted drainage, the adaptation could be less invasive.

The students then worked with structural engineers and historic restoration masons to develop the concept that would become called “Base-terns.” The Base-terns would be separate and sealed from the living space to prevent mold. Basement windows were to be installed that would allow for the mandatory drying-out process to occur. The base-terns would be further sealed so that backflow would not occur but also open on the bottom, allowing water to slowly filter back into the ground.

The engineering team at Old Dominion University ran the models proposed by the group through computer systems and found that the addition of these low impact development design features would reduce flooding volumes during a nor’easter storm by over 90%. In addition, the designs removed significant phosphorus and nitrogen from storm water, contributing to clean water by capturing the “first flush” of rainfall that holds the highest concentration of pollutants. The estimated cost of the low impact designs (not including the living shoreline) was estimated to be \$900,000. In comparison, the estimated cost for only replacing the existing pipe infrastructure would be \$705,000. Despite the price increase, residents found the reduced pollution choice to be a more

attractive investment. The signature brick paving design that would allow for water to filter through the streets was also an appealing idea that could provide the community with a distinct sense of identity.

In January, 2016, Virginia was awarded \$120 million which was partially used to implement the designs for Chesterfield Heights.¹⁰² The successful design process also opened doors within the community and began the conversation for adaptation. The group found that public input was absolutely mandatory and that full cooperation from the municipal government would be essential in suggesting the adoption of said changes.

Choosing Adaptation Strategies

Decisions regarding choosing an adaptation approach will need to be based on factors that are specific to the community. Planners have many aspects to consider, especially considering that each strategy will result in both positive and negative consequences. To help with this process, FEMA Guidebook 386-6 suggests applying three different methods for evaluating mitigation actions.

The first suggested method is to apply the “preservation hierarchy”, which consists of choosing options with the least possible negative impacts to the character defining features of the historic or culturally significant property. This method will need to be completed on an individual and locally specific basis depending on the challenges that are posted in each area. However, this method only considers impacts to the historic environment and may not recognize community values or other impacts that the strategies may have on the economic or ecological environments.

Second, the guidebook suggests to consider the Social, Technical, Administrative, Political, Legal, Economic and Environmental (STAPLEE) criteria.¹⁰³ Appendix C in the FEMA guidebook promises to guide the reader through a STAPLEE analysis as they relate to historic properties and cultural resources. In short, the FEMA analysis poses a series of questions based on the topic by means of a scored worksheet. A plus (+) or minus (-) is indicated depending on a favorable or unfavorable outcome. The result should give the user a scored outcome with which to objectively identify the most favorable decisions.

The third FEMA suggestion is through a basic benefit-cost analysis, which will help to determine which projects would be the most cost effective for a specific community. Guidebook 386-6 also provides information on gaining a free CD included in a “Mitigation BCA Toolkit” that will assist with explaining how to carry out a benefit-cost analysis. The toolkit includes software, technical manuals, training courses and other supporting documents. A general understanding of the risks involved as well as some other additional information on the area is needed in order to complete the full analysis.

Communities can establish other methods that they may wish to use to evaluate their adaptation options. There is no “correct” or one way of doing so. With so many locally-based factors to consider, it would be impossible to implement one method with which to make these decisions. As with many other aspects of community planning, local residents and tax payers should play a large role in deciding which adaptation strategies are most appropriate.

Conclusion

Through the examples presented in this chapter, it should be clear that there is no single answer approach to adaptation. As communities begin to develop solutions to withstand the effects of sea level rise, each circumstance will need to be addressed individually by valuing and incorporating the unique identity of the area and its residents. In addition, no adaptation strategy intended to lessen the effects of sea level rise should be considered a permanent solution. The natural environment is constantly changing. Therefore, there is no guarantee that adaptation techniques will be successful in perpetuity. As with any historic resource, upkeep and maintenance of adaptation infrastructure will be one of the best strategies against deterioration and loss of integrity.

What community planners should take from this information is that for each action, there is a reaction, either in the frame of integrity or as a response from the environment. This is why so many stakeholders need to be involved, as there will undoubtedly be a degree of loss involved with any change and each point of view should be discussed and weighed carefully. Together, the community must consider which aspect of loss is greater. The consideration may pose questions such as: which is greater, the potential loss of a piece of property and its contributing building due to shoreline erosion, or the association of the building to the shoreline and its historically significant location within the community? Either choice will potentially diminish integrity and require additional interpretation to address the change.

Many of the examples used in this chapter are from national parks or historic areas rather than historic communities specifically as it was difficult to find examples of historic communities partaking in sea level rise adaptation on a community-wide level. With

limited complete models, it will also be difficult for the first wave of small communities to have a clear idea of what to expect from their proposed community-wide adaptations.

However, as more historic communities begin to take on this immense task, they can learn from each other and share specific success stories, allowing the adaptation movement to progress forward at a faster pace.

CHAPTER IV

INTERNATIONAL STRATEGIES AND SEA LEVEL RISE ADAPTATION FUNDING

Introduction

For decades, scientists have been suggesting that preparation for the effects of sea level rise will become mandatory for all vulnerable cities along coastlines and in flood plains across the globe. In 2017, it is evident as major disasters become more frequent that some communities have already passed the point of simply preparing for anticipated future flooding. As numerous roads, residences, businesses and places of importance are continuously washed out; endangered communities are regularly dealing with loss of property and infrastructure. Now that the waters are literally at the doorsteps of many concerned citizens, ideas for planning have finally begun to stir in many U.S. coastal communities. Likewise, the effects of sea level rise are a global issue. As the temperature of the planet continues to rise, the repercussions over the last few decades have begun to wreak havoc in all corners of the earth. Reaction around the world, however, is varied and dependent on time, money and other available resources.

In particular, the effects of sea level rise have pushed major cities into creating massive adaptation efforts in order to protect themselves from heavy flooding. Despite the global movement, the United States is comparatively behind on responding to the problem. Unfortunately, this is largely due to insufficient funding and a mindset that is more reactive than proactive. There has not been a large movement from the U.S. federal

government to recognize the devastating risks associated with sea level rise. In response, the U.S. government has initiated funding and other resources to assist only after disaster strikes, as with events like Superstorm Sandy. This type of approach does not promote preparedness to help prevent future storms from causing more destruction.

Finding sources of adaptation funding has become a major roadblock for many states, cities and small communities. Funding from the federal government is limited and competitive to receive. Additionally, there is simply not enough federally allocated money to assist with all essential adaptation and mitigation efforts. As a result, some municipalities are taking action into their own hands and discovering creative ways to raise funds and provide financing for their communities. Actions such as these may become necessary for more small communities to adopt in order to finance adaptation strategies before the effects of sea level rise become too overwhelming.

International Strategies

The Netherlands

In the Netherlands, in a place where 26% of the land lies below sea level, sea level rise is viewed seriously and is considered a national security issue.¹⁰⁴ Inundation by flooding could devastate large portions of the country, resulting in loss of property and lives. The sense of urgency is accompanied by millions of dollars in innovative adaptation and mitigation strategies that are spent on a regular basis. Captain Maarten Lutje Schipholt, National Liaison Representative of The Netherlands to Supreme Allied Command Transformation in Norfolk, remarked on the American strategy, “In America it

is still in the area of disaster relief. We wait until it hits us – and perhaps it'll hit you every 3 or 10 years – and then you repair the damage.”¹⁰⁵

Despite this U.S. reactive stance to sea level rise, other countries have been successfully battling the rising waters for decades and even centuries. Tim Folger, author for National Geographic noted, “While visiting the Netherlands, I heard one joke repeatedly: ‘God may have built the world, but the Dutch built Holland.’”¹⁰⁶ This proactive approach has not only protected Dutch citizens from destructive flooding, but has also won over other international cities with their unparalleled innovation and engineering. Today, the Dutch are often sought for consultation by American cities such as Norfolk, Virginia and Miami, Florida to assist with sea level rise planning.



Fig. 14: Maeslantkering storm surge barrier. [Holland.com, accessed January 28, 2017]

In the 1990s, Rotterdam, a city in the Netherlands, constructed Maeslant, which is the biggest mobile barrier in the world. The barrier was made to protect the harbor and

city from rising flood waters that occur from several intersecting rivers and waterways in the area (Fig. 14).

Physically, the structure is massive. The steel lattices are twice the size of the Eiffel tower and lie on either side of the channel that connects Rotterdam to the North Sea.¹⁰⁷ Also referred to as the “Maeslantkering”, the structure is essentially a surge barrier, which is able to close only when needed. This flexibility allows the usual tides to ebb and flow naturally and does not intrude on regular transportation. When a storm surge is detected, a warning to the city and nearby ships is sent out, allowing residents to prepare. Within hours, the city can be fully protected from flooding and up to three meters of storm surge. While the current projected global rate is expected to increase sea level rise by at least one meter within the next 100 years, Rotterdam expects to be sufficiently protected.

The Dutch predict that the Maeslant barrier should protect the city from everything up to a one in a 10,000 year storm. Such precautions may seem excessive, but based on the increasingly dangerous projections of sea level rise, preparation cannot be overstated. Perspectively, the levees that protected New Orleans before Hurricane Katrina were only built to stand a one in 100 year storm.¹⁰⁸ Although the City of New Orleans was aware of flood risks, the city was still unprepared for the power of Katrina, which left the city devastated. Financially, the Dutch seem willing to pay for protection ahead of time rather than to take the chance for additional damage, even the risks that may be statistically unlikely. An engineer employed at the Maeslant barrier, Peter Persoon, estimates that if The Netherlands actually were flooded, damage would likely

cost at least 700 billion euros. “If you instead spend every year one billion euros, you spread the bill over 700 years. That’s, I think, the Dutch way.”¹⁰⁹

In addition to massive structures such as barriers, dikes and levees, which are meant to stop the forces of nature in their tracks, the Dutch are also finding ways to work with the changing environment. Near The Hague, they are developing “sand engines” which are built to allow the North Sea shore to sculpt its own defensive sea wall against erosion. Also referred to as the “zandmotor”, the sand engine creates a manmade peninsula of sand that is then redeposited by the natural flow of the tides and the currents. This is in contrast to constantly adding sand to the beaches, which needs to be redone annually. The project started only two years ago, but seems to be working. Jan Mulder, a coastal morphologist with Deltares, an independent institute, remarked that already dunes have begun to grow naturally on beaches where there was once only open water.¹¹⁰ Mulder further explains that as the sea level rise projections increase, they can simply increase the amount of sand that needs to be naturally redeposited.

Floating Pavilions are also a new experiment. These domed floating buildings bob on a platform of Styrofoam, concrete and high-tech cushions. Persoon explains, “There’s no way you can build [new] buildings unless they are floating.”¹¹¹ This may be the new reality of living on today’s coastal edges, especially in places that are already adapting the entire landscape. Residents will need to find ways to adapt to living with and on the rising waters.

To fund these major projects, the Dutch government has set aside up to one billion euros a year through the year 2100, as part of the national budget.¹¹² The situation is not only viewed as a national security issue, but also a potential financial opportunity

that could draw in more businesses and create new innovations that could be exported to other countries. In this circumstance, the adaptation budget could be viewed as an investment opportunity as well. Jos van Alphen, from the Delta Commission Office, noted that local communities are on board with the plan as well. “This is due to the fact that schemes to improve local areas with parks and recreational areas have been built into the plans, but also because there is a great deal of trust in the government to deal with the flood defenses as necessary.”¹¹³

England

A similar adaptation approach is taking place in the city of London, England (Fig. 15). The Thames Barrier, which has been in place since 1984, was financed by pledge of Parliament.¹¹⁴ At present, there is a need to plan for the number of repairs and upkeep needed to maintain the barrier. In 2011, London Mayor Boris Johnson adopted a plan for adaptation strategies that would address concerns about persistent flooding, drought and extreme heat waves that were occurring in the city. He proclaimed, "Either we can grow gills, or we'll need to think of other ways of adapting."¹¹⁵ The final report of the plan titled, “Managing Risks and Increasing Resilience,” proposes 34 initiatives to protect the city. Examples include managing the risk of flooding, increasing the amount of parks and vegetation in the city and retrofitting more than one million homes by 2015. The city of London’s plan does not detail the expected cost to implement the proposed adaptations. However, the management plan for the Thames River alone could cost the city about \$2.3 billion within the first 25 years.¹¹⁶



Fig. 15: The Thames Barrier is one of the largest moveable flood barriers in the world. [Mansfield, Katie. "London on emergency flood alert as Thames Barrier is raised to protect capital." February 10, 2016.]



Fig. 16: The MOSE gates are controlled in segments, allowing the water channel to still be accessible by boats before completely raised. [*La Voce Di Venezia*. June 5, 2014.]

Italy

The city of Venice, Italy has also created a massive barrier structure similar to the Thames Barrier. The Italian project, titled MOSE (MOdulo Sperimentale Elettromeccanico, or Experimental Electromechanical Module), has a budget of 5.4 billion euros and is intended to protect the city of Venice and the Venetian Lagoon from massive flooding.¹¹⁷ The barrier systems consist of several rows of mobile gates, installed at three separate inlets that are able to isolate the water of the Lagoon from the Adriatic Sea. The gates will be able to be opened and closed separately to control the flow of water as needed (Fig. 16). Together, the gates will be able to protect the city from a three meter high tide.¹¹⁸ In a city that is accustomed to regular flooding and has learned to accommodate their routines based on the tides, paying a precautionary large sum of money in advance to protect them overtime seemed like an obvious choice. A recent cost benefit analysis revealed that the barriers will more than pay for themselves in 50 years through the reduction of maintenance and repair costs caused by the annual floods.¹¹⁹ Once the project is complete and the barriers are up, Venice will be the only city in the world that is fully protected from the projected one meter of sea level rise by 2100.

The Cost of Adaptation

The costs of adaptation may vary greatly depending on a variety of factors; the specific location, the size or length of a structure and availability of materials. The National Park Service Coastal Adaptations Handbook suggests that the common cost for planning and installation of shore-parallel engineering, such as seawalls and revetments is

around \$2,000 to \$3,000 per linear foot.¹²⁰ Specifically referencing structures built within national parks, it is also noted that several projects have topped \$10,000 per linear foot. Repair and replacement of deteriorating seawalls, revetments and bulkheads can be more expensive than new construction.¹²¹

Hard Armoring

The Coastal Adaptations Handbook further presents numerous examples for costs of adaptation and repair work done throughout national parks. In Chapter 8: *Protecting Infrastructure: Costs and Impacts*, short references to these projects can be found. As an example, seawall repair to Ellis Island in 2010, which spanned 5,500 linear feet, was completed at a cost of \$20.9 million. The approximate cost per foot is given at \$3,800/ft. The cost of groin construction, repair and replacement is estimated to range from \$250 to \$6,500 per linear foot, mostly dependent on material. Jetties are more expensive and require more maintenance since they need to be extended over time as the shoreline retreats. Costs will vary depending on erosion rate, labor and other considerations. The initial construction of breakwaters can cost up to \$10,000 per linear foot with an annual maintenance cost of over \$500 per linear foot, assuming a 50-year project life.¹²²

In 2010, the North Carolina Coastal Resources Commission initiated a project to consider terminal groin construction along the state's coastlines.¹²³ A study, summarized in Table 8, displays the general estimated costs of installation and repair. The group further studied the location of Oregon Inlet, NC, where terminal stone groins along with a revetment were constructed on the south side of the inlet in 1991. At that time, the cost

of the project was \$13.4 million. The group determined that in 2009, the cost would be equivalent to \$26.3 at an estimated \$8,410 per foot.

Construction Material	Price Per Linear Foot	Price Per Linear Meter
Rock and Stone	\$1,200–\$6,500	\$3,937–\$21,325
Concrete and Steel Sheet Pile	\$4,000–\$5,000	\$13,123–\$16,404
Timber	\$3,000–\$4,000	\$9,843–\$13,123
Geotextile	\$250–1,000	\$820–\$3,281

Table 8: Estimated costs of adaptation construction materials. [National Park Service. “Coastal Adaptation Strategies: Case Studies,” 2016.]

Soft Armoring

The cost of beach nourishment is greatly dependent on environmental and location factors. Overall, this method is known to be extremely expensive and must be regularly replenished. Statistics show that 26% of replenished U.S. Atlantic Coast barrier island beaches effectively disappear in less than one year.¹²⁴ Further, 62% of replenished beaches last between two and five years and only 12% remain for more than five years.¹²⁵ However, the “quick fix” appeal that rapidly restores the shoreline makes this choice very attractive. Associated costs will include dredging (if necessary), transport and placement. Expenses are commonly between \$300 and \$1,000 per cubic foot of beach.

Another soft adaptation method of adding vegetation, such as seagrass, has an initial construction cost of up to \$1,000 per linear foot. In addition, the annual maintenance costs may be up to \$100 per linear foot.¹²⁶ Costs will vary depending on

types of vegetation, labor and other associated costs like edging or sill that may be needed for construction in wetland areas.

In 2002, on Assateague Island, Maryland, a one-time beach nourishment project widened the beach by 100 feet and cost \$13.2 million. Sediment was dredged and treated from nearby waters and placed just seaward of the mean high water line. The total volume replaced on the Assateague beach was just 1,832,000 square yards. A similar project on the same island has been ongoing since 2004 on the North End Beach to restore sediment. Twice a year, sand is dredged from an inlet delta and is deposited a few miles to the south, allowing the sand to naturally drift towards the North End Beach. Between 2004 and 2010, the project has moved nearly two million yards of sediment at a rate of about 188,345 square yards per year. The cost of constant monitoring, dredging and placing the sand is estimated to be about \$2 million annually.

In Perdido Key, Florida, an area heavily impacted by Hurricane Ivan in 2004, their shoreline has since become extremely eroded. In 2011, three million square yards of sand was used to restore two miles of shoreline, costing about \$14.5 million. Similarly, in 2013, beach nourishment was also conducted at Ocean City Beach in New Jersey, which was affected by Hurricane Sandy. The project took place over three months and placed 1.8 million square yards of sand along 2.3 miles of the beach. Originally estimated to be \$11million, the expenses were raised to cost about \$18 million. This required supplemental financing from the Sandy Disaster Fund.

It is likely that when making decisions on adaptation strategies, a combination of both hard and soft adaptation strategies will need to be used to increase effectiveness. As an example, sand fencing is relatively inexpensive, easy to install and does not often

require permits.¹²⁷ However, it may need to be combined with hard adaptations such as revetments or groins to be most effective. “Planning for hybrid projects must consider the lifespan of the living component and the possibility that the living component will fail and the hard structure will remain.”¹²⁸

Retreat

Costs associated with relocation of endangered structures can be very expensive, but are usually a one-time event. The Coastal Adaptations Handbook estimates that the costs of structure relocation for National Park Service owned properties range from \$800 to \$40,000 per linear foot of movement. This depends greatly on the size of the structure as well as the method of relocation.

For decades, the NPS has been relocating endangered lighthouses along the coastline. Their available information provides several estimates for the “Retreat” strategy, but may not be directly applicable for all relocated buildings, since the height and weight of the lighthouses increases the overall cost. Additionally, the final costs for some major projects are outdated and would need to be converted to reflect present day inflation. For example, relocation of the Block Island Southeast Lighthouse in Rhode Island was completed in 1993 at the cost of only \$2 million.¹²⁹ It was moved about 300 feet and took place over a period of 19 days. Similarly, the Highland Lighthouse in Cape Cod was relocated for about \$1.54 million in 1996 and the Nauset Lighthouse, also in Cape Cod, was moved for only \$253,000. A current project at Herring Cove Beach in Cape Cod to relocate several small structures was estimated in 2013 to cost \$4.5 million.¹³⁰ The project has not yet been completed.

Financial Benefits

In 2000, a group called Beaches 2000 conducted a comprehensive management plan for the protection of Delaware's Atlantic coastline. Consisting of representatives from the Governor's Office, the Delaware Geological Survey and the state environmental protection agency, Delaware Department of Natural Resources and Environmental Control (DNREC), the goal was to ensure that the state's important natural resources and tourist attractions continued to be available to the citizens of Delaware, as well as the out-of-state visitors. The group scrutinized decisions between replenishment and retreat, weighing the pros and cons and developed a cost benefit analysis of the two adaptation strategies.

By conducting surveys, Beaches 2000 discovered that an individual would be willing to pay on average \$3.01 per day to use the recreational areas of the beach.¹³¹ With beach replenishment, an individual's willingness-to-pay for their day on the beach rose by \$0.69. Given the many beaches to choose from, visitors may opt to visit a wider coastal area with more recreation opportunities than a narrower, non-nourished shoreline. The group further discovered that replenishment of beaches had raised property values in some areas and increased development density in others. They recommended that zoning be changed to discourage development in high-risk coastal areas.

The group concluded with specified and locally specific recommendations for Delaware's 24 miles of coastline. They recommended beach nourishment in heavily visited and developed areas. A beach erosion plan was recommended for state-owned parklands along the coast, allowing the shoreline to gradually retreat. Transportation and safety infrastructure was recommended to be rebuilt after any damage is sustained in a

way that recognizes the vulnerability of certain areas to storms and erosion. A moveable building setback line was also suggested to protect beaches and sand dunes. Their suggestion also advocated for landowners to donate conservation easements to assist with preserving the natural beaches.

Overall, there was a conscious concern over funding and how the adopted strategies would affect tax payers. The group boldly suggested that communities that have accessible beaches should be required to contribute 50-75% of the construction and maintenance costs for replenishment projects on their beaches. The conclusion of the findings resulting in the state adopting replenishment plans only for specific beaches. It is unclear if the remaining recommendations were further addressed.

Available Federal Mitigation Funding

In the United States, there has not been as strong of a movement by the federal government to combat the effects of climate change in comparison to other international countries. Although not viewed seriously as a national security issue, the federal government does currently fund some grants for planning and post-disaster events through various entities that can be applied for on a competitive basis. These organizations offer both financial and technical assistance to advance local adaptation and mitigation efforts. The most direct form of financial aid, which will be discussed in this section, comes from the FEMA. In 2017, the FEMA Disaster Relief Funding budget request was reportedly just \$7.3 billion for the year.¹³²

FEMA Grants

FEMA provides several Hazard Mitigation Assistance Grant Programs to protect

life and property from natural disasters. However, individuals are not solely eligible to apply for these federal opportunities. Applications must be sponsored by a state, territory, federally-recognized tribe, local community or private non-profit foundation. In addition, FEMA requires state, tribal and local governments to develop and adopt approved hazard mitigation plans as a condition for receiving certain types of non-emergency disaster assistance. The mitigation plans must be approved by the Director of FEMA. It is recommended that the mitigation plans should also be consistent with a comprehensive plan or strategy already adopted by the state in order to ensure fluidity during a disaster.

FEMA's Hazard Mitigation Grant Program (HMGP) assists in implementing long-term hazard mitigation measures. However, the program is not appropriate for communities that have not yet experienced a disaster as it is only available to applicants following the devastation of a major disaster. The intention is to reduce or eliminate long term risk of repeated damage. Although this program is helpful for some communities that were unable to adapt quickly enough to avoid damage, it again represents the U.S. common stance of only reacting after a disaster. HMGP funding is generally only 15% of the total amount of Federal Assistance provided to an applicant following a major disaster.

The Pre-Disaster Mitigation (PDM) grant, also offered through FEMA, is another program that provides funding specifically for hazard mitigation planning and projects. These grants are awarded on an annual basis with a goal of reducing overall risk to the population and structures. It is also focused on reducing reliance on federal funding in future disasters, therefore representing a proactive approach to responding to disaster

flooding. The program also provides opportunities for raising public awareness about reducing future losses before disaster strikes. However, the PDM grants are quite competitive and are awarded yearly through Congressional appropriations. This indicates a sort of “waiting game” for unsuccessful applicants, which is counterproductive to the overall urgency of the mitigation needs.

Finally, FEMA’s Flood Mitigation Assistance (FMA) is perhaps the most direct option for communities seeking mitigation funding. It is a program that provides funds for projects to reduce or eliminate the risk of flood damage specifically to buildings that are insured under the National Flood Insurance Program (NFIP). The funding is not available to individual applicants but only to eligible local governments who apply for assistance on their behalf. Again, it is appropriated by Congress annually and subject to a FEMA approved Hazard Mitigation Plan. The approved plan, therefore, must address protection against flood losses to structures for which contracts for flood insurance are available. The FMA Grant Program is focused on mitigating repetitive loss properties in order to reduce insurance claims. Funds can be used towards demolition, relocating, or raising structures. Financing can also be used by municipalities to acquire land located in areas having special flood hazard or those substantially damaged by flood, to be available for public use. Major flood projects such as dikes, levees, seawalls, groins or jetties are not eligible for funding under this program.

However, there are stipulations to these programs. Specifically for the FMA program, in a single year, the sum of the amount of mitigation assistance provided during any five year period cannot exceed \$10 million to any state or \$3.3 million to any community. Applicants may receive up to 75 percent of eligible mitigation activity costs,

with 15 percent allotted towards management costs. FEMA may contribute up to 100 percent of the federal cost share for properties that regularly obtain flood related damage. In addition, the sum of the amounts of financial assistance to any one state and all of its communities cannot exceed \$20 million. Based upon the numbers that were needed in order to protect Rotterdam and Venice, the cap placed by the FMA grant does not allow for effective mitigation on a grand scale. In Fiscal Year 2016, the total amount of funds distributed under the FMA Grant Program will be \$199 million. This is not nearly enough financial assistance to mitigate the destruction that is caused throughout the country by frequent flooding on a yearly basis.

A study by Wetlands Watch, a non-profit organization in Norfolk, Virginia calculated the amount of funding that would be needed by FEMA in order to protect the endangered properties in their area. In Hampton Roads alone, there is over \$430 million dollars in unmet mitigation costs for private structures that have experienced flood insurance losses. This number means that it would take FEMA between 78 and 188 years to meet the financial needs of all property owners. These rates are sure to increase exponentially as the effects of sea level rise are increasingly causing more damage and flood waters continue to creep further inland.

Additional Federal Assistance

Federal government grants are also offered through the United States Environmental Protection Agency (EPA), the Department of Housing and Urban Development (HUD) and the Department of Transportation (DOT), that may be used towards hazard mitigation. The U.S. Department of Housing and Urban Development

offers a Community Development Block Grant (CDBG) Disaster Recovery Program that provides flexible grants to presidentially declared disaster areas. The CDBG Disaster Recovery grants often supplement disaster programs of FEMA and are available to states, local governments, Indian tribes and other designated disaster areas who have unmet recovery needs. Funding can be used towards buying damaged properties, debris removal, rehabilitation of buildings and constructing public facilities such as streets, neighborhood centers and drainage systems.¹³³ In order to qualify for a disaster recovery grant, funded activities must either benefit persons of low and moderate income, aid in the elimination of slums and blight, or meet another serious health or welfare need of the community. State and local governments must also submit an Action Plan before receiving funds.

State and Community Movements towards Resiliency

Recently, many cities and communities in the United States have become creative in their need to find alternative funding sources outside of what the federal government can offer. As a result, several localities have begun searching for ways to self-fund in order to protect their valued resources from further flood damage. The result has been successful in some circumstances and only hopeful in others as new ideas are just being initiated. What's important to note is that these ideas are in many cases pioneering. Their short and long-term success remains to be seen, however, there is hopefulness in their sustainability.

New York City

New York City has recently proposed, “A Stronger, More Resilient New York,” which includes more than 250 initiatives to reduce the city’s vulnerability to the effects of flooding and storm surge. Despite a proactive title, nearly 80% of the \$19.5 billion plan will go towards damage caused by Superstorm Sandy in 2012 and to needed updates to those areas that were directly affected in 2012. The fact that New York is still struggling to recover from the massive flooding that occurred five years ago is an indicator of the urgency in addressing suggested adaptation issues and retrofitting existing infrastructure in preparation. The remainder of the money proposed in New York’s 438 page plan will go towards building floodwalls and restoring swamplands, dunes and other types of natural soft flooding protection.

The New York plan lays out a detailed estimation of costs for the many levels and variety of projects involved. Overall, the City is predicting the public price tag to be near \$14 billion and to accrue over a ten year period.¹³⁴ This number includes both government funded projects as well as funds acquired from the taxpayers. The plan suggests that acquiring said funds may happen indirectly, such as raising utility taxes. Another suggestion has been a “Resiliency Assurance Charge” (RAC) on property and casualty insurance policies within the city. “This insurance includes automobile, homeowner, general liability, commercial multi-peril, and certain other forms of insurance.”¹³⁵ The State Department of Financial Services predicts that due to the number of premiums, even a small surcharge of 1.5% could be enough to fill the \$5 billion financial gap between their financing sources. “This surcharge would translate to just over a dollar a month for a homeowner’s insurance policy with a \$1,000 annual

premium. “¹³⁶ There are similar models that exist in vulnerable areas such as Florida, Louisiana and Texas.

The surcharges and tax increases are arguably justifiable on a large scale. By funding large-scale projects ahead of the storm, there is a greater chance that costly losses, inconveniences and injuries can be minimized or completely avoided. This idea is mirrored in several of the previously discussed international strategies. It is imperative that the federal government begin to assist communities and major cities on a larger scale. The current process of assistance is so lengthy and competitive that it is almost a hindrance. It encourages communities to apply and wait for the government to react after a disaster rather than to be proactive and seek resiliency financing. The effects of sea level rise are indeed a United States national security issue as it pertains to natural disasters. The time is past due that our politicians recognize the danger and the potential for crisis. Perhaps by modeling policy and strategy after the international cities that have been adapting for centuries, the U.S. can move forward with a plan that is proved to work.

San Francisco

An innovative funding option has recently been approved by San Francisco Bay Area voters. In June, 2016, voters approved an unprecedented parcel tax that would raise hundreds of millions of dollars over the next several decades toward sea level rise mitigation. Labeled as a “parcel tax”, at least 2/3 of voters within the nine county Bay Area were needed to approve the change. It was later approved with 69%. The new tax will cost \$12 per year for each parcel of property owned in the area. The project is

estimated to raise \$25 million a year for 20 years.¹³⁷ The money will be put directly towards restoring the marshlands and protecting wildlife through adaptation strategies and will also include pollution clean-up. These innovations will result in a doubling of tidal marshland to a total of 80,000 acres. Despite these efforts, this number still does not come close to the 200,000 acres of wetlands that were prevalent before major development began in the 1840s. Still, the initiative is promising. John Upton reports that, “This is an historic measure that shows that the region is unified about caring about the bay, and about the environment for the future.”¹³⁸

Several local newspaper articles also point out that there may be an additional financial incentive for lawmakers to protect the area. Major corporations such as Facebook and Cisco have headquarters in the Bay Area. Without such major companies, San Francisco would suffer from job loss, loss of tax revenue and several other resources. The benefits for retaining corporations such as these could be gathered into reports that may persuade other coastal cities, along with notable corporations, to invest in their current tax base. This may create a financial initiative for cities to begin adaptation planning and may also encourage major businesses to begin individual adaptation projects that could be mutually beneficial. Carl Guardino, CEO of the Silicon Valley Leadership Group, has recently expressed interest in preparing for sea level rise. “We are also concerned about the risk of sea level rise over time, or a storm that could cause flooding in unprecedented fashion. Either way we want to be prepared for it.”¹³⁹ This leadership group, along with the Save the Bay and the Bay Area Council has already raised \$700,000 toward a campaign with hopes to raise up to \$5 million towards sea level rise adaptation efforts.¹⁴⁰

Spending of the parcel tax funds will be guided by the San Francisco Bay Restoration Authority, which is overseen by state officials. Dave Pine, a San Mateo county lawmaker who serves as chair of the Restoration Authority, stated that the money resulting from the tax, although impressive, is still only about one third of what is expected to be needed to restore all of the 35,000 acres of publically owned marshland in the area.¹⁴¹ State and Federal funding will still be sought in the future. Despite the fact that this project seems to be generally centralized toward environmental needs, it is important to note that the success of this concept could be an example for other sea level rise mitigation needs on the East Coast. Looking at the expected exponential income of the parcel tax, the concept could easily be suggested for area in need of large sums of initial funding in order to tackle massive mitigation strategies or at the least to get pioneer planning projects off the ground.

Connecticut

On the opposite side of the country, Connecticut has begun planning for Resiliency Funding as a means of long-term mitigation funding. The program, called “Shore Up Connecticut” is a low interest loan program, run by the Housing Development Fund. It is intended for homeowners and small businesses in the coastal floodplain of the state specifically as a means of elevating their structures and utilities. The proposed residential elevation projects must raise the buildings to meet the 500-year Base Flood Elevation (BFE) plus one additional elevation foot of freeboard. Protection for flood mitigation and wind-proofing can also be financed by this program.

There are several stipulations to ensure that the program is beneficial to both borrowers and the state. Borrowers can request between \$10,000 and \$300,000 with a 15-year term at a 2.75% fixed interest rate. There are no monthly or interest payments for the first 12 months, however there is a 1% origination fee. Eligible properties must be subject to coastal flooding of either primary or secondary single family homes or small rental properties. Businesses with fewer than 100 employees and in good standing with state agencies are also eligible for the loan. Initially, the Connecticut Department of Housing has provided \$2 million in funding with hopes of an additional \$25 million to be approved by legislation for the revolving fund.

Aside from Connecticut's original Shore Up program, the state also offers several other funding opportunities that could be used for residential properties for various types of mitigation needs. Although not all directly tied to sea level rise, these funding sources can be useful in preparing for the many possible disasters that are associated with climate change. The concept of these programs may spark an interest in other municipalities and state where they can be adapted to various community specific needs.

Connecticut has also endorsed a new tool called Resilience Bonds. This is a financial means by which smaller or limited budget governments can increase both protection and insurance against disasters. Shalini Vaijahala, a nonresident senior fellow with the Metropolitan Policy Program, explains that, "The idea is to link insurance coverage that public sector entities can already purchase (such as catastrophe bonds) with capital investments in resilient infrastructure systems (such as flood barriers and green infrastructure) that reduce expected losses from disasters."¹⁴² Municipalities may invest the bond monies into infrastructure updates or capital improvements that would overall

reduce their insurance premiums. The local governments will, in turn, return the money they should be saving back to the investor. This essentially allows the government to borrow money from private investors towards mitigation adaptations.

Communities in Connecticut are also taking advantage of federal opportunities. In early 2016, the town of Old Saybrook, Connecticut was awarded a \$125,000 planning grant from the Connecticut Department of Housing, which was supported through the US HUD Community Development Block Grant Disaster Recovery Program. “HUD provides flexible grants to help cities, counties, and States recover from presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations.”¹⁴³ The planning grant will fund the development of the town’s coastal resiliency study and infrastructure assessment and also update the Town’s Natural Hazards Mitigation Plan. Although these funding opportunities are extremely beneficial in the initial process to begin planning hazard mitigation, there is clearly greater difficulty in discovering direct funding for mitigation actions and adaptation responses.

Virginia

Inspired by Connecticut’s creative Shore Up program, Virginia also has begun to fund a program that could be a sustainable source of adaptation funding. However, it is currently without any actual initial funding, and it may remain that way for several years. In April, 2016, Governor Terry McAuliffe signed legislation that established the Virginia Shoreline Resiliency Fund. However, getting money for the fund from the legislature or either through a state bond issue could take up to three or four years.¹⁴⁴

The proposed revolving loan fund will assist homeowners and business owners in making alterations to their property in order to mitigate the effects of sea level rise. The main difference between this program and Connecticut's (which makes Virginia's quite original) is that is not intended to assist with current flood threats, but rather has been established specifically to "mitigate future flood damage."¹⁴⁵ Wetlands Watch Director, William Stiles and Senator Lynwood Lewis of the Virginia Eastern Shore worked together to develop the legislation.

This program was designed partially in response to the 2014 report published by the Wetlands Watch of Norfolk, Virginia suggesting that the current wait to receive FEMA money through claims made with the National Flood Insurance Program could take up to 188 years due to backlogged paperwork. Many people in the Norfolk region, therefore, have no chance of receiving assistance in their lifetime. This is of particular concern as the Hampton Roads area is second only to New Orleans as the United States metro area at greatest risk to climate change. William Stiles, the Director of Wetlands Watch has openly voiced his frustration and believes there are tools that Virginia can use to speed up the funding process. Stiles says that, "With state and regional revolving loan funds and creative mortgages we can convert our sea level rise liability into a job creation asset. And with this economic activity, we can attract new design and engineering efforts to develop even better solutions, maybe incubating a new economic sector."¹⁴⁶ Although the program is in its infancy, the concept is promising due to the success of the sister Shore UP Connecticut program.

Other State Programs

Local communities have also become creative in recognizing opportunities for other projects means of mitigation funding. In the northern Atlantic region, the Maine Coastal Program (MCP) has begun awarding money to 11 municipalities and county projects in order to revive the waterfront area. On August 4, 2016, the MCP which is part of the Department of Agriculture, Conservation and Forestry, announced that all of the projects will include collaboration and partnerships. Further, it will be mandatory that each grantee provides a minimum of 25 percent in matching funds or services. The funds will provide support for the coastal economy through projects that increase public access to the coast, support shellfish harvesting, and identify pollution sources that result in coastal beach closures, revitalize coastal downtowns and identify key island transportation assets at risk from rising sea levels.

Although these funds are not directly available for sea level rise mitigation, the grants are a move towards protecting the commerce of the coastline. This idea could be used by coastal communities to indirectly assist with sea level rise mitigation. Especially, in areas where climate change or sea level rise are not popular terms, the concept of reviving the waterfront areas and boosting the economy is likely very attractive. Projects such as securing vulnerable fishing piers, building up the beaches for tourism or adapting major highways for increased traffic or storm water mitigation are all potential ideas that could satisfy both targets. As each community's mitigation needs may vary, it is possible that by simply improving, updating or stabilizing infrastructure, communities will be able to reduce their risks of sea level rise or storm surge damage.

Every opportunity for mitigation funding should be utilized, even if the benefits appear minor.

Conclusion

It is evident that the U.S. federal government has truly fallen short of the needs of the people in regards to swift and appropriate sea level rise adaptation, as well as providing funding sources for vulnerable citizens. The effects of sea level rise are indeed a United States national security issue as it includes the impacts of natural disasters. As a result, our vital coastal infrastructure, including significant cultural heritage, is being threatened with potential destruction. The time is past due that our politicians recognize the dangers and the potential for crisis. By passing effective local, state and federal legislation, as well as supporting programs such as resilience bonds and revolving loan funds that will be immediately available to individuals, communities and other groups can begin applying the necessary adaptation strategies. In order for any changes to move forward in protecting our coastlines, more financing must be available on a regional, state and national level.

In the event that federal funding is not available, states and municipalities must apply creative financing methods for adaptation. Further, it may be in the best interest of small communities to begin to search for methods of self-funding or resiliency funding that will ensure that adaptation strategies are sustainable. Participation on a wider level, such as state or regional would provide a larger base from which to draw funding, however, waiting for higher government to take interest and to become involved may take too long to mobilize. This chapter emphasizes the urgency to react on a national

level; however, small communities should begin long-term financial planning for themselves in order to ensure adaptation is not prolonged.

In the event that initial funding is awarded from a federal or private grant, infrastructure will need to be constantly monitored and maintained, which will require a regular money source, which the community is required to sustain. As erosion increases and flooding becomes more frequent, communities will need to plan not only for immediate but also for future adaptations, even after initial changes and adaptation strategies are met. By being fiscally prepared to take action against environmental threats, both long and short term, communities will become more stable and able to protect themselves and their most valued historic and cultural resources.

CHAPTER V COMMUNITY-BASED ADAPTATION PLANNING

Introduction

Communities must plan in order to make informed choices about their future. Planning helps them to create places where people want to live, work and visit and also helps to maintain good health and well-being for their residents. In addition, planners must anticipate growth within a community, maintaining a healthy balance between protecting valued aspects of the built and natural environment while also permitting development and prosperity. A planner should also be aware of and respond to the values that are essential to a community.¹⁴⁷ Incorporating these aspects will be essential in developing careful and thorough sea level rise adaptation plans that will protect the historic and cultural resources in a community.

When planning for major change, such as adapting to the effects of sea level rise, planners must gather multiple resources, professionals and other stakeholders to create an effective, sustainable and agreeable document. This process is not dissimilar to the preparations for comprehensive plans. Comprehensive plans are generally comprised of goals, objectives, and policies that are intended to guide the future development of a community. Such documents typically cover the first 5-year and 10-year period occurring after the plan's adoption.¹⁴⁸ The same outline of strategies and tactics associated with comprehensive planning should be applied to adaptation planning. A

document intended for sea level rise adaptation planning must also incorporate current plans and policies while likewise suggesting implementation strategies for adaptation, which could involve major changes. The period of time for which an adaptation plan in particular should span will vary depending on the community. Based on the current global mean sea level (GMSL) rise, which is projected to be between .3 and 2.5 meters by 2100, most communities should expect to revisit their plan within the following several years or decades after adoption to observe any escalating changes.¹⁴⁹

Examples of Adopted Plans

In recent years, some U.S. communities have begun to either create full adaptation plans or to at least incorporate sea level rise adaptations strategies into existing documents. This chapter section will discuss examples from a selection of these communities with a concentration on adaptations that specifically address historic and cultural resources. Some examples highlight adaptation strategies while others demonstrate unique situations or points of interest that pertain to how the community is reacting to the effects of sea level rise. In some instances, communities are taking an aggressive, hands-on approach that could be inspiring to other communities that are just beginning the planning process. These chosen examples emphasize that each community is unique in its circumstances and that others will need to reach conclusions that work for their specific community at a local level.

Florida

The State of Florida published in 2012 a document titled, *Disaster Planning for Florida's Historic Resources*, to mitigate disasters and to specifically

protect the state's historic resources. From the beginning, the plan accentuates the importance of historic preservation and the benefits that Florida will gain from continuing to support preservation. Providing related data, the plan states that 123,000 jobs were generated from historic preservation activities with more than \$657 million in state and federal taxes gained from spending on historic preservation activities and more than \$3.7 billion spent in Florida by tourists visiting historic sites.¹⁵⁰

Florida is particularly vulnerable to hurricanes, flooding, storm surge and coastal erosion. As a result, planners have put together a document to move forward with adaptation actions and to rehabilitate historic infrastructure, allowing for communities and local economies to rebound after disasters. Florida's strategies include identifying potential historic resources, evaluating their significance and then developing tactics to help protect their most significant resources. The Florida plan also highlights specific national, state and local programs, documents and contacts that should be consulted to assist with planning and developing sea level rise adaptation strategies that are sensitive to the historic environment. These references include the National Historic Preservation Act, the *Secretary of the Interior's Guidelines for Archaeology and History Preservation*, the National Environmental Policy Act (NEPA), the Florida Master Site File, the State Historic Preservation Officer (SHPO) and Tribal Historic Preservation Officer (THPO) as well as Florida's Main Street Program and local ordinances and historic preservation organizations.

The plan further discusses issues and common concerns associated with historic preservation disaster planning in order to bring more attention to the topic. These concerns include inadequate incorporation of historic preservation into local plans, lack

of coordination between local government emergency management functions and few local processes with which to identify historic sites of concern, such as survey and inventory methods. The plan also identifies inadequate training of responders and the lack of expertise among responders to practice handling historic preservation issues. However, Florida's document specifically addresses the needs associated with disaster response, rather than presenting an adaptation plan. If the state were to adopt and implement state-wide adaptation approaches, there would be less need to spend time and funding on responding after the destruction has occurred.

In response to the effects of sea level rise, the historic Old Town of Key West, Florida, has begun implementing adaptation strategies. In 2000, the City installed tidal control valves and storm water treatment facilities to adapt to repeat flooding in the Key West Historic District. The project was funded through FEMA Hazard Mitigation Grant Program funds and also included state and local financing. The adaptation project cost about \$350,000 and is estimated to be saving the city and affected businesses about \$140,000 a year through reduced disaster response from frequent flooding.¹⁵¹

Newport, Rhode Island

Newport is home to 548 National Register listed or National Register eligible properties located in coastal and estuarine flood zones. As mapped by FEMA, the assessed value of these resources is estimated to be over \$400 million.¹⁵² Tide gauge observations in Newport since 1930 indicate a mean trend of 2.74 mm per year of relative sea level rise which is equivalent to a change of 10.8 inches (27.4 cm) in 100 years.¹⁵³ They project that storm surge heights will increase as the sea level rises, resulting in more

properties being damaged or destroyed during a storm, including inland properties that have never before experienced flood damage.

In August, 2016, the Rhode Island Coastal Resources Management Council (CRMC) and the University of Rhode Island Coastal Resources Center (URI CRC) submitted a report addressing the need for waterfront preservation to make Newport a more resilient city through adaptation.¹⁵⁴ The Prince Historic Asset Final Report, which was submitted to the Prince Charitable Trusts, explains that:

Adaptation practices that could build resilience are often unable to meet stringent historical regulations. State agencies, municipal staff, and private sector organizations all recognize the need to align these goals of preserving historic integrity and enhancing resilience to flooding and inundation, especially considering the integral nature of these historical assets to tourism and recreation in Newport.¹⁵⁵

With results from interviews that involved a number of stakeholders from the state and Newport's public, private and community organizations associated with managing historical waterfront assets, the report compiles a number of recommendations specifically for the preservation of Newport's important historic sites. Involved in the conversations were the Rhode Island Historic Preservation and Heritage Commission, Newport-based historical preservation organizations, university researchers, architects and private historical waterfront property owners and managers. Recommendations included moving historic collections from vulnerable structures, readying properties for flooding impacts, exploring options for green infrastructure, relocating utility systems from lower levels and water proofing basements. Major adaptation recommendations included constructing a gated dam to protect large areas of Newport such as the downtown and Point area and also building a seawall.

In the report, the group identified four project goals with which to move forward: (1) to quantify the historic resources at risk of flooding and subject to flood regulations; (2) to better understand how flood regulations relate to historic properties; (3) to identify best practices for flood-risk mitigation; and (4) to identify resources available for further study. With further findings, the report identified that 2,000 National Register listed or eligible properties are at risk. The report also recognized problems with the National Flood Insurance Program (NFIP) and how potential changes could affect historic properties in Newport. The report recommends owners of historic buildings make their properties more flood resilient to the degree that historical and architectural integrity is retained with actions such as raising the main floor and wet or dry flood proofing. The report likewise cites the Mississippi Development Authority's Elevation Design Guidelines as a direct reference.

With 21 of Rhode Island's 39 cities and towns containing historic assets in coastal floodplains, Newport is taking the lead to attract resiliency-based industries to relocate to the state. Since Rhode Island's survival depends on adapting to changing hazards, they are actively seeking to attract companies that may develop new types of adaptation technologies. In addition, Newport has created a Historic District Ordinance Review Taskforce to assist with review of design requirements for proposed elevation and other retrofitting changes that will help historic buildings weather the changes. Part of the mission promises to develop policies to address sea level rise and how it affects historic properties.

Alexandria, Virginia

In February, 2012, the City of Alexandria adopted the *Alexandria Waterfront Small Area Plan*. Beginning in the Executive Summary, the plan celebrates the history and uniqueness of Alexandria, highlighting the waterfront as an area that merges both art and history to create a special place where people want to gather and explore. The plan incorporates concepts from both Alexandria's *History Plan* and Alexandria's *Art Plan* to establish a distinguished art walk along the waterfront that exhibits the City's maritime history and cultural resources. This creates a distinct sense of place that invites both visitors and residents to spend time along the waterfront.

To safeguard the shoreline from environmental hazards, the Waterfront Small Area Plan also proposes efforts to protect the waterfront from the effects of sea level rise. Situated along the Potomac River, Alexandria has experienced approximately one foot of sea level rise within the past 100 years.¹⁵⁶ Models accepted by the International Panel on Global Climate Change project that Alexandria's Potomac waterfront will further experience sea level rise of 2.3 to 5.2 feet by the year 2100.¹⁵⁷ Alexandria is regularly feeling the effects, with the lowest portion of the waterfront experiencing street flooding at least once a month. With a significant portion of the waterfront area within the 100-year floodplain, the plan specifically brings attention towards shoreline protection, flood mitigation, and safeguarding resource protection areas.

Alexandria's plan calls for naturalization of the shoreline, where possible; improvement of the condition and function of seawalls; and to reduce the need for dredging and debris removal. It also embraces forms of green infrastructure such as rain gardens and bio retention areas. The document also explains good floodplain

management practices, such as elevating structures. The Floodplain Ordinance states that any new or substantially improved construction within the floodplain have its first floor at or above the 100-year water-surface elevation. Lower floors may still be used for parking, storage or entryways but are not permitted for habitation.

The *Small Area Waterfront Plan* also references the Potomac River Waterfront Flood Mitigation Study, which recommends additional solutions to address flooding. The study recommended a combination floodwall and pedestrian walkway at an elevation of six feet. This would both protect the area from inundation as well as create a new place for pedestrians to enjoy the waterfront. The study also recommended elevating a particular street level, adding drainage improvements and a pumping system, as well as dry flood proofing individual buildings and incorporating berms into the landscaping. “Some of the recommended mitigation actions are ones which individual property owners and tenants will implement themselves, while others are City government efforts.”¹⁵⁸

The City of Alexandria released its *Energy and Climate Change Action Plan 2012-2020* in March, 2011, which continues to build on the already existing *Eco-City Charter* and *Environmental Action Plan 2030*.¹⁵⁹ Responding to sea level rise projections that were established for the area by the Environmental Protection Agency (EPA), Alexandria has established goals to reduce property damage from erosion and other flooding events. Using the *Climate Change Action Plan*, the City will update the flood management program to take into account anticipated rises in the Potomac River water levels and also to move or abandon infrastructure in hazardous areas. In addition, the City will change zoning to discourage development in flood hazard areas, establish long-term dedicated funding mechanisms such as storm water utility fees or other taxes to

maintain storm water infrastructure and also consider the use of permeable surfaces to reduce storm water runoff. To reduce shoreline erosion, the City plans to preserve ecological buffers and enhance shoreline protection where retreat is not an option. The preservation and enhancement of existing wetlands and utilization of low impact landscape practices will be conducted while also encouraging the removal of invasive species.

Annapolis, Maryland

The sea level near Annapolis, Maryland has risen by more than one foot over the past century.¹⁶⁰ This number is more than twice the global average reported in 2014 and is expected to increase exponentially. In response, Annapolis is updating its current Natural Hazard Mitigation Plan to also address the protection of cultural resources. The Cultural Resource Hazard Mitigation Plan (CR HMP) is under development in 2017.

The CR HMP will identify, assess and attempt to lessen the loss of historic resources due to sea level rise. This will include storm surge, coastal erosion, flooding and other major storm events. The team behind the plan has branded the project as “Weather It Together: Protecting Our Historic Seaport.” The plan will follow the approach recommended by FEMA’s guidebook, *Integrating Cultural Resources into Hazard Mitigation Planning*. Despite the fact that the City lacked funding to fully embrace the steps suggested in the FEMA guidebook, Annapolis Preservation Officer, Lisa Craig, pushed forward to begin the process. Craig acknowledges that the City Council did not have sea level rise as a priority in the budget considerations and that the project initially lacked technical expertise, as well as funding.¹⁶¹ Her approach suggests

that it was better to start planning than to wait for disaster to strike. In 2013, the City of Annapolis received initial funding from the National Trust for Historic Preservation, Preservation Maryland, the Maryland Historic Trust and the Maryland Department of Natural resources to begin developing the plan.

In an article for the National Trust's *Summer 2015 Forum Journal*, Craig describes her initial efforts in following the FEMA guidebook and the steps she took to continue moving forward through the process despite barriers. She describes the development as "non-linear". Over time, the City was able to gather stakeholders that included the planning department, public works and building inspections staff. This ultimately led to inclusion of the SHPO, the Main Street program and the residents association. Their federal partners now include the National Park Service, FEMA and the U.S. Army Corps of Engineers. Craig expressed the importance of engaging elected officials and community leaders in all aspects of the planning process,

In Annapolis we've conducted a work session with the City Council, given two presentations to the Public Safety Committee, and hosted a National Trust media event where our mayor, state senator and house speaker applauded the announcement of the city's designation as a National Treasure by the National Trust, showcasing our battle with climate change.¹⁶²

Craig also spoke about resources that helped them to complete initial steps in the planning process. During the identification process, the City partnered with different departments to facilitate assessments. "With expertise from our information technology office and assistance from the Annapolis Historic Preservation Commission's consulting architect, we identified 184 properties for survey and assessment within the 100-year-flood plain."¹⁶³ Craig further suggests that while the FEMA worksheets provided in the guidebook can be considered a basic "reconnaissance" level survey, the process could

present a good opportunity to partner with existing staff in other departments to complete an intensive level survey within the community. In addition to developing a new Cultural Resource Hazard Mitigation Plan, the recommendations will need to be incorporated into existing plans once the new document is adopted. Craig recommends that as the new plan is developed, planners should begin drafting amendments to the comprehensive plan, preservation ordinances, design guidelines and other documents that will need to include the new policies.

Although not yet complete as of April, 2017, Maryland's Weather Together plan is meant to be used as a model for other communities. One of the goals of the project is that it will be a template to have potential transferability to other vulnerable historic communities. "By providing to our peer communities technical assistance, a sharing of lessons learned, and an introduction to our methodology and outcomes so far, we hope to see our resiliency efforts expand into other historic coastal communities."¹⁶⁴

Portsmouth, New Hampshire

The City of Portsmouth, New Hampshire's *Climate Change Vulnerability Assessment and Adaptation Plan* was adopted in April, 2013. Although not specifically adopted to address preservation issues, Portsmouth's plan "tips its hat" to the importance of their historic and cultural resources in the community. The waterfront area in particular is known for its historic distinction and unique character. Additionally, the plan describes the difficulty in finding the balance between the need to act on adaptation strategies while also preserving the historic integrity. "It is important to consider the best and most practical measures to protect and sustain the Historic District recognizing that

there is no ‘perfect solution’ to prevent the potential impacts resulting for projected changes in climate.”¹⁶⁵

The Portsmouth Adaptation Plan mentions several times the value of the historic and cultural resources to the town and recommends that climate change adaptations should specifically provide protection for them. “Enabling these resources to become more structurally resilient or enabling the resource to be relocated will allow the City to plan for protection.”¹⁶⁶ Their proposed adaptation strategies include the three approaches of Protection, Accommodation and Retreat. Suggestions specifically include restoration of natural shorelines and dune systems, adaptive reuse for buildings and recreation areas, gradual modification of structures over time and relocation of other structures. Included in the examples are also rolling setbacks, transfer of development rights and property acquisition programs.

The plan further suggests incorporating the choice of strategy with respect of the time period for taking action. Based upon projections of sea level rise for the immediate region, Protection is recommended under current conditions through the year 2100 while Accommodation is recommended under conditions for 2050 and beyond, depending on vulnerability. Retreat, suggested to be the last resort action, should be undertaken at year 2100 conditions or earlier. The adaptation actions are further stated to be intended as a starting point, with responses subject to change as the City moves forward in refining its approach and understanding its options. Quite specifically, the plan also breaks down estimated costs for adaptation strategies based on the different neighborhoods and distinct locations around Portsmouth. The costs are further divided into the different types of projects.

As an example, Table 9 depicts costs for the central subarea of Portsmouth, specifically along Ceres Street. Protection of some buildings that includes elevation and re-routing roadways would equate to \$40,000 if the sea level rose by 7.5 feet. However, if the City waits until the sea rises to 11.5 feet, protection that includes elevating the roadway would amount to \$100,000.

CENTRAL SUBAREA			
7 CERES STREET AND BUILDINGS			
Scenario	Adaptation Actions	Capital Cost	Operating Cost
7.5 feet	<ul style="list-style-type: none"> Plan on flood protection of some buildings on east side or ultimate abandonment 	\$20,000 (raise buildings) Plus \$20,000 (road planning)	\$0
11.5 feet	<ul style="list-style-type: none"> Implement flood protection for all structures on east side or abandon Elevate road 	\$100,000	\$0
13.5 feet	<ul style="list-style-type: none"> Implement flood protection for all structures or abandon Plan on flood protection on west side of street Elevate road 	\$360,000	\$0
18.0 feet	<ul style="list-style-type: none"> Implement flood protection for all structures along the road or abandon Elevate road 	\$1,200,000	\$0
<i>Note: If access to Ceres Street is not critical, no real need to raise it.</i>			

Table 9: Section for Portsmouth's Plan emphasizes the exponentially increasing cost of sea level rise adaptations. [City of Portsmouth Planning Department, 2013]

Waiting further, until the water rises by 18 feet would cost the City of Portsmouth over one million dollars. Presenting this information is a strategic move to push policy makers and residents to react. The thorough Portsmouth Plan provides information on twenty two of these specific adaptation cost breakdowns. This type of effective display suggests to any stakeholders wishing to procrastinate that waiting longer will cost the City an exponentially larger amount of money. "In fact the report shows that the potential flooding impact to buildings alone would be 3 to 4 times as great as the cost of putting in place adaptation actions."¹⁶⁷

As the City of Portsmouth prepares to update the Master Plan, information from this report is intended to be reviewed and shared with residents, property owners and planners about the associated effects of sea level rise and its potential impacts on the City's valuable resources and future economics. The plan emphasizes that, "Adaptation planning and resiliency should become recurrent themes found in each of the Master Plan's functional elements."¹⁶⁸

Charleston, South Carolina

The historic town of Charleston, South Carolina has adopted a document titled, *Sea Level Rise Strategy*, completed in December, 2015. For centuries, Charleston has been battling with flooding. As early as 1837, the City recognized the need for better drainage solutions to alleviate the reoccurring problem. In 2013, City of Charleston staff, representing various areas of expertise such as engineering, planning and sustainability, began analyzing the potential impacts of sea level rise in the Charleston region. They began an initiative with the specific strategic trio of Reinvest, Respond and Ready.¹⁶⁹

The reinvestment strategy included updating the first comprehensive drainage master plan, adopted in 1984. Most recently the City has adopted a new ordinance that requires new structures and those with classified substantial improvements to be built an additional one foot above the designated base flood elevation. These moves, although modest, contrast with the fact that the state of South Carolina has no statewide plan or course of action for sea level rise mitigation or adaptation planning. The state, therefore, is able to offer little to no guidance to coastal cities on how to prepare for, adapt to or

manage resources in light of sea level rise. “As a result, cities are left to their own individual planning, funding, and staff to try to handle the issue.”¹⁷⁰

Taking the extra initiative, in 2015 the City of Charleston released a Sea Level Rise Strategy with recommendations to improve long-term resilience to sea level rise and recurrent flooding. The document provides guiding framework to protect infrastructure, ensure public safety and to maintain a thriving economy. The taskforce chose a limitation to use the range of 1.5 feet to 2.5 feet above sea level rise to plan for the next 50 years.¹⁷¹ Although below the average projections, this move was likely made to minimize resistance from parties or groups that are actively against making changes in response to climate change.

Focusing on the three resilience principles of Reinvest, Respond and Ready, the plan focuses on ways to also revive and strengthen infrastructure and public health. The “Ready” principle centers on improving planning, implementation and monitoring through improved coordination and collaboration.¹⁷² Despite the rich cultural and historic significance of the City of Charleston, the plan provides little emphasis on the protection or preservation of historic resources. The only obvious reference is found in the “Ready” action strategies, where there is a point to identify vulnerable areas which includes wetlands, cultural and historic resources. Beyond this step, there is no mention of historic importance, cultural values or heritage preservation in the plan.

The final page of Charleston’s Sea Level Rise plan dedicates a section to future commitments. One of three points promises to develop opportunities for citizens to participate in the planning process. Although in 2017, implementation of the plan is still

in the early stages, the emphasis on community input through the development of advisory committees and public awareness is inclusive and promising for the future.

Despite falling short in some areas, South Carolinians have begun other initiatives to become more sustainable. The South Carolina Businesses Against Rising Seas (SCBARS) is a local interest group consisting of businesses that will be affected by sea level rise and support sea level rise adaptation and mitigation planning by the government.¹⁷³ In order to demonstrate to people how much sea level rise would impact their community; members used blue tape to mark the projected high tide levels for 2100 on the interior and exterior of participating buildings. Signs with more information directing onlookers to their website were located next to the tape lines. Businesses also placed the blue tape with “SCBARS.org” on their windows to draw additional attention to the subject. Although the group is no longer active, it was quite successful in educating people about sea level rise, as well as demonstrating that sea level rise does matter to local citizens and small businesses in the area and those residents do, in fact, support government action against sea level rise.

Norfolk, Virginia

The City of Norfolk, Virginia has the highest rate of relative sea level rise on the East Coast. While the global average sea level rise has risen by five to eight inches in the last century, Norfolk has experienced an increase of over 14 inches since 1930.¹⁷⁴ “With 25 percent of Norfolk’s parcels [of land] already located in the 100-year floodplain, it’s clear the city will need to plan differently for the future.”¹⁷⁵ In 2014, the City of Norfolk prepared a *Coastal Resilience Strategy* to promote resilience and to create awareness.¹⁷⁶

The document is very informative of Norfolk's position on resilience and provides information on what solutions the City is seeking to provide for the community. The *Coastal Resilience Strategy* highlights four major aspects: Plan, Prepare, Mitigate and Communicate.

To create solutions, Norfolk has collaborated with research specialists in both the private and public sectors to form effective plans and policies. The City has also built critical relationships with not-for-profit organizations, higher education institutions, the faith-based community and the U.S. military. "These relationships support a true, comprehensive, community-wide approach to preparedness."¹⁷⁷ Norfolk is also partnering with the United States Army Corps of Engineers for technical and funding assistance in regards to the City's flooding plan.

Communication is critical to Norfolk's Strategy. The City emphasizes that direct and timely communication between the government and citizens is fundamental and that they actively seek input from the community. The City holds community meetings where residents, property owners and experts in various fields are able to discuss data, studies and plans about Norfolk's future. In addition, Norfolk has an awareness website that has been developed through citizen, professional and expert input.¹⁷⁸ Other forms of communication such as social media, email, local TV and radio, print media, as well as outreach presentations to business and civic groups are also used to connect the community with the available information. Norfolk partners with all 16 Hampton Roads localities to ensure preparedness. Residents are also encouraged to volunteer for the Local Emergency Planning Committee and the Community Emergency Response Team.

Norfolk's immediate and long-term adaptation solutions for flooding range from landscaping techniques that allow for adequate water drainage to complex, community-wide engineering projects. In 2007, the City initiated several flooding studies that analyzed the area watershed-by-watershed to provide solutions for specific neighborhoods. As a result, the planning and building codes were adapted for new construction and renovation that require the lowest floor of a building to be built no lower than three feet above flood level. The new codes are also predicted to help lower flood insurance rates.

The *Coastal Resilience Strategy* separates ways in which residents can directly help and what the City is doing to help with flooding. Residents and other property owners are encouraged to plant trees and install rain barrels to help soak up excess rainwater and also to incorporate landscaping techniques like rain gardens. The downtown area already has a half-mile long floodwall installed, with five tide gates and a pump station. New City-sponsored structural projects will include additional floodwalls, earthen berms, gates, pumps and elevating buildings. Norfolk is also developing a shoreline buffer project to provide the first line of defense against large storm surges and high tides. The projects are projected to cost from \$10 million to \$306 million. The document also explains that large design and construction projects cannot be funded without the federal government underwriting between 75 and 90 percent of costs.

In October, 2015, Norfolk released a similar document, simply titled, "Resilience Strategy" which focused more on development and sustainability of the local economy. The document was created to address the three major challenges facing the city: sea level rise and recurrent flooding, a shifting economy, and a need to build stronger, healthier

neighborhoods.¹⁷⁹ As a port city, Norfolk is home to a naval station, which is a major segment of the local economy. In response to the effects of sea level rise, the City is putting actions into place that will secure the area's future by redesigning and updating infrastructure that can keep up with the changing environment while also promoting growth and increasing job opportunities. The three major specified goals of the plan include designing the *Coastal Community of the Future*, creating economic opportunity by advancing efforts to grow existing industries and new sectors, and advancing initiatives to connect communities, deconcentrate poverty and strengthen neighborhoods.

In June, 2015, the City was part of a grant sponsored by the Royal Netherlands Embassy that brought in Dutch engineers, designers, landscape architects and planners to Norfolk for several days in a project called Dutch Dialogues. This education project was put into action so that Norfolk officials could learn how to implement European design and concepts for living with water into vulnerable American cities. "The outcome of the dialogues is an innovative water management solution that includes holding, absorbing, and filtering excess water in yards, streets, and new retention areas."¹⁸⁰ A document following this report has not yet been released.

Presently, in 2017, City of Norfolk is working to implement innovating infrastructure for water management as they learn to "live with water." They are exploring cost-effective green infrastructure options and seawall upgrades. Leaders are also searching for creative funding models needed to get these projects off the ground. Selected as a "Resilient City" by the Rockefeller Foundation, Norfolk is in the beginning stages of designing a new "catastrophe bond-like" product that can promote project-based risk reduction solutions.¹⁸¹ The idea is to fund major mitigation and resilient

infrastructure projects that will lower insurance coverage overtime. This allows the city to access capital for adaptation without increasing their debt. Norfolk's Budget and Strategic Planning and Finance departments are also working to identify legal and financial mechanisms to support public and private investments for innovative adaptation solutions.

Tybee Island, Georgia

Tybee Island, located about 18 miles from Savannah, Georgia is one of the first communities in the state to formally plan for sea level rise. As a low-lying barrier island, Tybee is particularly vulnerable to sea level rise, having experienced approximately a 10 inch increase since 1935.¹⁸² Their Sea Level Rise Adaptation Plan, finalized in April, 2016, specifically identifies how frequent flooding, also referred to as nuisance flooding, could impact low-lying infrastructure and other resources along the island. The plan further provides recommendations for adaptation strategies and provides a synthesis of public engagement processes.¹⁸³

Working with several other groups, the plan identifies major sea level rise impacts. Sea level rise is expected to flood the city well houses, affecting the drinking water and making waste disposal unavailable. Continued backup of storm water drainage systems is expected to periodically flood neighborhoods, roadways and yards with saltwater, potentially destroying areas of vegetation. Increased erosion along the beaches is also expected to occur. This is particularly an issue because Tybee Island is a popular tourist destination. Diminishment of the beaches could negatively affect the local economy. Flooding of US Highway 80, the only access to and from Tybee Island, could

further pose a risk to public safety, eliminating the only evacuation route from the barrier island in the case of an emergency, such as a hurricane.

After a cost-benefit analysis that included data which consolidated specific vulnerabilities facing the island, five potential adaptation strategies were chosen for consideration. Researchers also worked directly with citizens and public officials to identify adaptation actions that would make the island more resilient to environmental destruction. Together, the community decided to elevate both the well pumps as well as Highway 80. In addition to specific infrastructure retrofits, Tybee also plans to build a seawall and to enhance beach nourishment. The beach nourishment project will restore the shoreline relative to the increased sea level rise projections for 2060.¹⁸⁴ As a result of the Tybee's efforts to prepare for sea level rise, city flood insurance policy holders will receive a 25% discount on their flood insurance premiums.¹⁸⁵

The report acknowledges that more adaptation approaches will be required in the future. It also highlights extensive outreach through facilitated public input sessions, which aimed to both increase education as well as gather feedback from local residents. "A series of three town hall meetings, all open to the public and held at the Tybee Island City Hall, were a central component of the project."¹⁸⁶ Coordinators used press releases, local media coverage, flyers, email announcements, social media advertisements on the City website and several other means of communication to spread awareness of the project. During meetings, experts gave presentations on sea level rise science and adaptations and also solicited input from public officials and local citizens regarding their issues and concerns for the future on the island. Residents provided their institutional knowledge on areas vulnerable to historic flooding and provided feedback on steps they

would like to see that would encourage sustainability of their community. Together this group of various stakeholders decided upon the projected height of sea level rise to use for planning in the future. Further, the plan determined that decisions regarding the preservation of Tybee Island's rich history, which includes historic places such as Fort Pulaski National Monument (Fig. 17) and the Tybee Island Light Station and Museum, would require specific management. "Careful planning, coordination across jurisdictional boundaries, and adaptation to unanticipated changes will all be required for Tybee Island to maintain its heritage and remain a thriving community over the next several decades."¹⁸⁷



Figure 17: Fort Pulaski National Monument, located on Tybee Island, Georgia is vulnerable to the effects of sea level rise. [tybeeisland.com, accessed April 2, 2017]

In detail, the City of Tybee Sea Level Rise Adaptation Plan spells out specific steps for completing their adaptation four goals. Through the use of cost benefit analysis

and economic loss assessment, the plan successfully presented information to a variety of stakeholders to enforce the need to make immediate decisions regarding adaptation for sea level rise. The plan does not specifically spell out or identify any historic resources but several times references the importance of protecting them and their asset to the local economy as well as to the core values of the community.

Boston, Massachusetts

Climate Ready Boston is an initiative to promote preparedness and resiliency for the consequences of both short and long term climate change. The report, published in December, 2016, provides extensive analysis of resilience and adaptation initiatives as well as a long term roadmap to implement strategies. The document outlines four major factors anticipated to affect the City of Boston; extreme temperatures, sea level rise, increased precipitation and increased storm frequency and strength. The report also includes a vulnerability assessment that identifies specific neighborhoods that are more vulnerable to the effects of sea level rise based on socio-economic situations as well as public health factors.

Climate Ready Boston works in coordination with the document, *Imagine Boston 2030*, the first adopted citywide plan in fifty years.¹⁸⁸ Boston is in an uncommon circumstance as large areas of the populated land have been filled in over time to create more space for the city to expand. In the almost four centuries following the city's founding in 1630, the footprint has increased through landfill nearly 50 percent. Now, the landfilled area is occupied with wharves, parks and entire neighborhoods at an elevation above the high tide mark (Fig. 18).



Fig. 18: The City of Boston has been subject to extensive landfill projects. [Climate Ready Boston, December 2016]

In the tenth strategy outlined by the plan, “Retrofit Existing Buildings”, the document acknowledges that there are challenges with preparing historic buildings for climate change, such as educating property owners about appropriate options and also finding sources of funding. The measures that need to be taken to update or retrofit a building could negatively affect its historic character and architectural significance. A specific section in the plan states, “The City should work with property owners to promote access to the information and financial resources that they need to prepare their buildings for climate change.”¹⁸⁹ Within that strategy the plan outlines distinct initiatives to launch a “Climate Ready Buildings Education” program for property owners and users to inform them about current and future climate risks facing their buildings. It would also

include actions that they can undertake to increase their preparedness. The strategy further suggests that the City should establish a resilience audit program to help property owners identify potential resilience actions to address coastal and riverine flooding, storm water flooding and extreme heat.

A resilience audit should help property owners identify cost-effective, building specific improvements to reduce flood risk, such as backflow preventers, elevation of critical equipment, and deployable flood barriers; promote interventions that address storm water runoff or the urban heat island effect, such as green roofs or ‘cool roofs’ that reflect heat; and encourage owners to develop operational preparedness plans and secure appropriate insurance coverage.¹⁹⁰

The City also plans to identify a toolkit of financing strategies that could be used to fund retrofits for both municipal and non-municipal buildings. Their initiative should combine public, private and nonprofit capital to make retrofits accessible to Bostonians with a range of incomes. To prioritize, Boston will concentrate on developing retrofit financing pathways for buildings that provide a public benefit, have high levels of exposure or are likely to experience challenges accessing financing. These types of structures include historic buildings with acknowledgment of their importance to neighborhood character.

Swinomish Tribe, Washington

The Swinomish Indian Reservation, located on Fidalgo Island in the state of Washington, is comprised of more than 10,000 acres including roughly 2,900 acres of tidelands (Fig. 19). Accustomed to living on the shoreline, Swinomish means “people by the water.” Within the reservation there are 1,300 homes with a population of just over 3,000 residents. In October, 2010, the Swinomish tribe prepared a *Climate Change*

Adaptation Action Plan which determined the projected effects of climate change on the tribal members and the surrounding area.

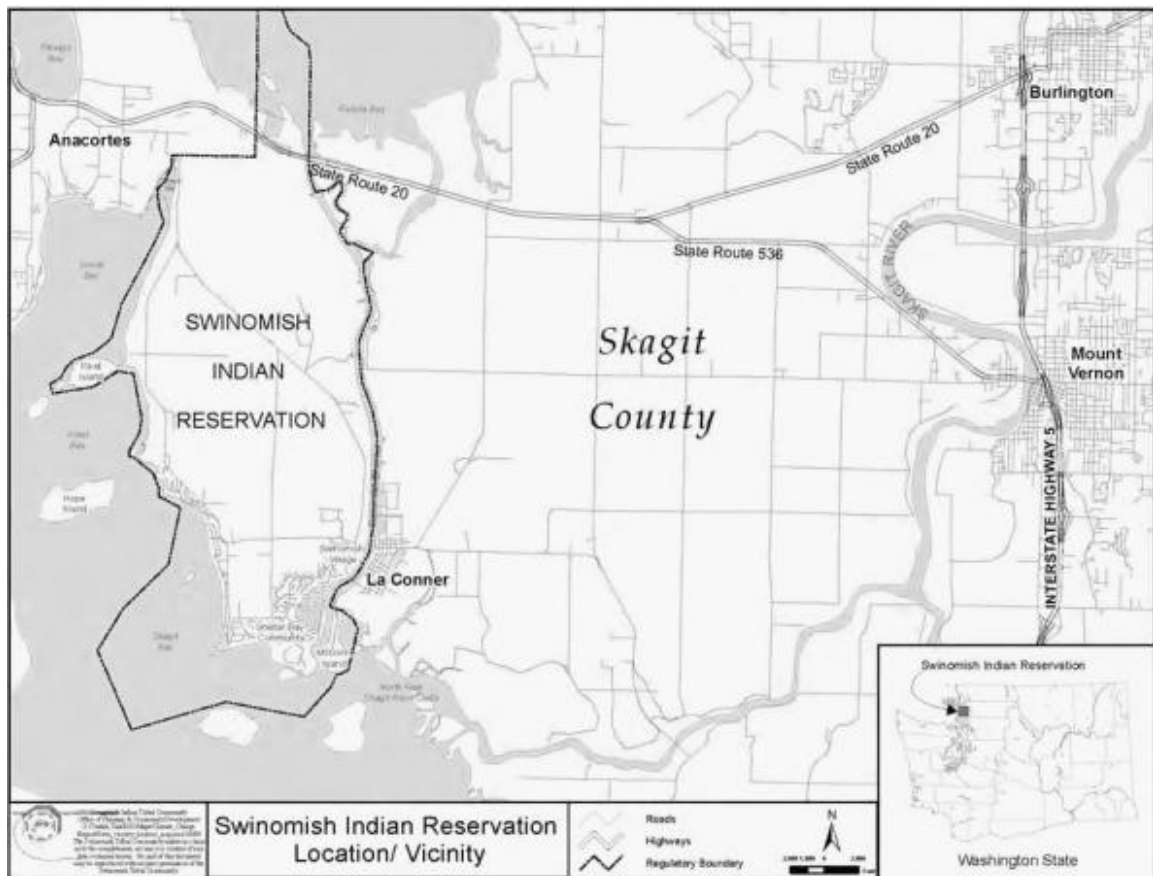


Fig. 19: Map of the Swinomish Indian Reservation. [Swinomish Indian Tribal Community, *Climate Change Adaptation Action Plan*, 2010.]

The Swinomish Climate Change Action Plan recommends adaptation strategies to better protect the tribe's endangered shoreline. Of these, removal of bulkheads and riprap is at the top of the list. According to the report, installation of a bulkhead upstream has led to increased erosion on areas of the reservation. The Tribe plans to request the removal of these structures by the current land owner to reduce shoreline migration of the beach in their traditional area. Also included in the recommendations are the raising of structures, implementation of setback changes and rolling easements, sediment input, and

land acquisition. Moving forward, Swinomish plan to work together with other tribes in the region to combat the sea level rise affects that they can control while ensuring the preservation of the cultural traditions tied with the landscape through added education.

The Action Plan also highlights cultural traditions that are presumed to be impacted from the effects of sea level rise as well as climate change. These include shellfish harvesting, salmon fishing, hunting and the gathering of native plants such as cedar and other species. With the possibility of losing the capacity to conduct their traditions, it raises the issue of community resilience and cultural sovereignty that are vital to the foundation of the tribe's overall wellness.

For the Swinomish, it is vital that the teachings of indigenous science that are directly related to knowledge of the landscape and use of the water resources is not lost or forgotten. Based upon the projected sea level rise impacts, these cultural traditions are being threatened. As explained in the Swinomish plan, their "Indigenous Knowledge" is context specific and place-based. This means that it can only be considered in relation to the specific locale and culture in which it was formulated. As the sea level continues to rise, many of the precise locations on which their teachings depend will be lost. For the Swinomish, losing the context of the landscape that is vital to their specific culture and knowledge would be devastating to the future of their tribe.

In response, the Swinomish have established tactics to help engage and educate their community on the dangers of sea level rise to their culture, while simultaneously communicating their Indigenous Knowledge. Outreach will incorporate cultural and natural resources, marine life, forests and surrounding communities; community and youth voice in action planning for adapting to the expected changes; engaging youth in

creating public education materials, sustainable community projects and use of technology to create reports; and also creating opportunities for students to receive education on environmental planning specific to climate change adaptation and to engage in policy decisions. These concepts both help to educate the community while also specifically engaging youth to ensure that they are aware of the implications and are active in promoting sustainability of the indigenous culture. By actively engaging the youth to be aware of the dangers that could affect their culture, they are able to express the importance of carrying on tradition and their place based knowledge. This allows the future generation to actively plan for continuing their Indigenous Knowledge.

Conclusion

As the sea levels continue to rise, a course of action is imminent for all coastal communities and other localities affected by storm surge, tidal flooding and shoreline erosion. Preparedness through adaptation will be our strongest weapon. With so much at risk, planners should work to adopt policies that strengthen community pride, protect property values and also encourage historic preservation. Through careful measures, historic communities such as Newport, Rhode Island and Alexandria, Virginia are taking extra steps to implement adaptation strategies that are sensitive to the historic environment. This expresses the importance of preservation within the community, considering the extra time, effort, materials and funding that is required to make appropriate and sensitive adaptations work.

An underlying theme, well represented in Norfolk's *Coastal Resilience Strategy*, is the need to incorporate not only public input but also public participation. FEMA

Guidebook 386-6 explains, “A well-planned community does not result from disparate, unrelated efforts, but from the collective and coordinated actions of many individuals and organizations over time.”¹⁹¹ While educating the public is vital for transparency, the adaptation approaches are most successful when the entire community is involved. As an example, with municipalities encouraging residents to participate in adaptation by incorporating rain gardens into their private yards or by providing local financial assistance to raise residential buildings, the actions helps to spread effective adaptation procedures throughout the entire community. Particularly in small communities, where population is comparatively low, participation from all residents, property owners and tax payers will be essential. This type of community-wide effort is what will help to protect small, historic communities and make them truly resilient to the effects of sea level rise.

CHAPTER VI CREATING A COMMUNITY SEA LEVEL RISE ADAPTATION PLAN

Introduction

Several U.S cities and towns have successfully adopted adaptations plans and incorporated them into new and existing planning documents. However, at present time, there are no official federal guidelines specifically for establishing a sea level rise adaption plan for historic communities in the United States. This leaves communities without recognizable resources to which they can refer for guidance on such a serious and timely issue. In 2017 there are limited documents which do address the impact of climate change and environmental hazards on cultural and historic resources. Two such examples include the FEMA How-to Guidebook 386-6, *Integrating Historic Property and Cultural Resource Considerations Into Hazard Mitigation Planning* and the National Park Service's *Cultural Resources Climate Change Study*. However, there is no federal document which specifically provides direction on historic and cultural resources in regards to sea level rise planning in entire historic communities. It should be noted that some localities and private organizations have individually developed similarly needed guidelines and resources, which are available to the public. Wetland's Watch, a non-profit organization based in Norfolk, Virginia has created a *Sea Level Rise Adaptation Guide* for the area as well as a Sea Level Rise Phone App that is available to the public.¹⁹² However, this type of material is usually quite specific to an area, region or

state and may be too individualized for use as a direct resource by other small communities.

Therefore, this chapter section discusses how the suggestions from the FEMA Guidebook and the *Secretary of the Interior's Standards for Preservation Planning* can work together, along with other research comprised for this thesis analysis, to establish guidelines for creating and maintaining a suggested Sea Level Rise Adaptation Plan for Historic and Cultural Resources. Guidelines such as this should be followed by coastal communities seeking to create a plan of action with which to protect their valuable resources from the effects of sea level rise.

Prior to the Plan

The topic of sea level rise can be a tricky issue in terms of political stance and public opinion. In 2012, the state of North Carolina “banned sea level rise” by banning policies based on the latest scientific projections, which estimated that the sea level would rise by 39 inches in the next century.¹⁹³ The state has afterwards been accused of “climate change denial.” Similarly in Virginia, the regional planner for the Middle Peninsula, Lawrence Lewis, has reported that two counties in the region decided not to adopt the regional Hazard Mitigation Plan for their jurisdiction due to the political interpretation of climate change and sea level rise. Instead, each disapproving county altered the plan significantly for their localities, which resulted in disapproval by FEMA and left those communities without access to FEMA funding in the wake of an emergency. Political issues such as these should reach a local compromise in order to move forward with successful planning and policies. To mediate similar issues,

terminology in planning documents may need to be changed to phrases such as “more frequent flooding” or “nuisance flooding” rather than specifically “sea level rise”.

With these potential hurdles in mind, it will be necessary for a local preservation planner to first establish an initial planning strategy with current, accurate and locally-specific information. This will provide substance to present to officials that will help to expedite the long-term planning process. The guidelines presented in these subsections will discuss research and initiatives that should be conducted before planning begins.

Consult with Professionals

Planners should first consult with available federal, regional, state, local and other resources to identify how sea level rise will impact the community. Major and online resources can be consulted when first beginning research on potential risk and vulnerability, such as Geoscience News, NASA, NOAA or Climate Central. Local organizations and professionals such as coastal scientists, geologists, and universities should also be consulted to gather and establish fundamental data specific to the area. Planners should directly reach out to federal organizations or large corporations who may be aware of specific reports or applicable research in the area. Establishing a relationship with these organizations early on may help to facilitate assistance with future projections or funding.

Planners must assemble a team in the beginning stages to assist with the short-term needs, such as research and identifying historic resources, as well as the long-term planning process to help facilitate implementation of adaptation strategies. The team must consist of local, state and regional professionals in relative fields such as

preservation, architecture, coastal science, engineering, geology or disaster management professionals. Similarly, other positions on the planning team should be filled with local volunteers, trusted leaders in the community and also municipal officials. The preservation community must be included on a local and state level. The State Historic Preservation Officer and any applicable local preservation organization will play a vital role throughout the entire planning course.

Identify Resources

Data must be collected to determine how many and what types of cultural and historic resources could be affected by the effects of rising seas. This will include information from the existing state, local and national registers as well any additional resources that may be on a local inventory. It will be important to not only identify residential, commercial, institutional and public buildings that are in vulnerable areas but also structures and places known as “sacred places” that are considered significant to the community. In addition, wildlife areas, marshlands, dunes, vegetation, or other unique features that identify the landscape and make the sense of place distinct must be preserved for economic reasons as well as for residents’ well-being. A focus on community pride and historic preservation will ensure that the integrity of a community will remain intact throughout any mandatory policy changes that affect community culture or alteration of the landscape.

Collect Data and Assess Vulnerabilities

Knowledge of the projected impact for a specific community or region must be researched using locally specific data. Research will need to be conducted to assess what

level of damage community resources can sustain during various levels of impact. Without specific reports and predictions, there is a greater risk for administering inaccurate or harmful adaptation strategies.

When time and funds allow, a vulnerability study, which identifies and ranks potential hazardous risks, should be conducted. This research must be conducted by professionals with experience in their respective field such as architects, horticulturists, marine biologists, aquatic farmers, engineers, and coastal scientists. Vulnerability for each individual resource must be properly assessed based on its current condition and expected levels of inundation. Focus should be given on sites that have already experienced inundation of flooding due to storm surge, frequent flooding and beach erosion.

Educate and Gather Input

When beginning planning preparations it will be vital to discuss opportunities for community input in the local and surrounding area. Incorporating the public in as many planning stages as possible will not only help to gather information but also ensure that the community approves of the decisions being proposed by the planning team. This process will also provide planners information on residents' and tax payer's preferences for adaptation, which will later be needed.

Engage Community Leaders

It will be essential to engage community leaders and surrounding local governments and organizations by encouraging them to become involved in the project and awareness initiatives. This will begin the process of bringing awareness to residents

and property owners regarding the potential hazards affecting the community. The community and surrounding stakeholders need to be aware of the risks and how precisely they will be affected by both the projected impacts and also any proposed adaptation actions. By incorporating a greater circle of neighboring leaders and representatives, the overall message and outreach will become stronger, more inclusive and more successful. Using the established planning team, the associated notable preservationists and other types of professionals must also be vocal and visible about the effects of sea level rise and its potential impact on the community. Engaging these stakeholders to become involved will help with both educating the public and gathering residents' valuable input.

Encourage Participation through Outreach

Planners must publicize information in as many outlets as necessary regarding the potential risks of sea level rise, the intended planning initiative, the expected adaptations and how any potential changes could affect the community. A high level of transparency will be helpful in receiving later public approval of change. It is in the best interest of property owners to become educated and know at which point they will need to take responsibility to protect their personal assets and when to anticipate changes implemented by governments in their area. Allowing community members to participate in the planning process will give them a sense of ownership about the plan that will enhance their support for the plan and its implementation.

Associated outreach, such as public meetings on the local effects of sea level rise or workshops on how to flood-proof historic residential buildings will be needed to encourage residents and property owners to both acknowledge the potential risks and

learn how to adapt. These efforts will encourage residents to work in cooperation with leaders and other community members. Public feedback from related programs will likewise educate planners on residents' concerns and may raise viewpoints that researchers did not anticipate.

Coordinate to Dispense Information

Outside of direct public workshops, planners will need to explore other forms of communication to reach residents. Examples include creating posters, sending emails, holding public meetings and using forms of social media to notify the public about the planning process and goals. Planners should consider coordinating with representatives of the community about dispensing informational materials to various offices, businesses and local haunts. More examples include handing out brochures or flyers in popular restaurants and “hang-outs”, intersections with heavy traffic and posting information on local website or social media. Postings should be concentrated at places where change or adaptation is expected to be implemented, such as entrances to beach accesses where beach nourishment is proposed to occur or along sidewalks near structures that are expected to be elevated. Most importantly, information regarding meetings where sea level rise topics will be raised or other opportunities where residents and tax payers can give input on the issues must be publicized and made available. Postings should be specific and include contact information for residents to connect with for more details and instructional material.

Plan for the future

Once all research is conducted, the data is collected and the appropriate amount of

input is compiled, preservation planners should then move forward with creating a document that pinpoints their goals, specific adaptation strategies and tactics for completing their objectives. This can be part of a greater comprehensive plan or as an individual Preservation Plan, Climate Change Adaptation Plan or a similar document that addresses the necessary changes in response to sea level rise. As the planning team moves forward, the best choice of action should become evident through defining common ground, working with the public and making decisions based on adaptations that are sensitive to the historic environment.

Develop Goals

With the available existing information, the planning team must establish a list of preservation and adaptation priorities. Priorities must incorporate local values through public input into the decision making process. The process of prioritizing areas will consider the degree to which a property is likely to endure damage or become lost, the cost of adaptation projects, sustainability of such projects and the sensitivity of the suggested treatment on the historic properties, among other factors. Additional elements will need to be considered depending on the specific situation that is individual to each community. As an example, some communities will need to promote places that provide economic sustainability to the top of the list, despite other historic or significant properties that are in imminent danger. It will be important that the decisions are locally-based and agreed upon together between the community, historic preservation professionals and all other involved stakeholders to make the best and most well rounded choices for the future and sustainability of the community.

With priorities in place, preservation goals must then be developed. The goals should be clear, direct action statements targeted at protecting historic or cultural resources. As an example, a goal statement may be, “Our community will protect historic structures within the flood zone” or, “Endangered historic properties along the coastline will be adapted to better withstand beach erosion and sea level rise”. Following these goal statements, specific tactics and strategies will address the methods for adaptation and other necessary actions.

The number of appropriate goals will depend on the community. An area with numerous endangered historic resources may need to adopt several goals. A smaller community with limited financial and staff resources may decide to adopt fewer goal statements. There is no right or wrong number as long as the community creates goals that are achievable and fully address the severity of their situation. Once the goals are decided upon, the planning team should then review existing plans or other adopted policies and documents to ensure that the newly developed goals are compatible.

Choose Adaptation Strategies

With goals in place, specific adaptation approaches and strategies should then be discussed. There is no single or generic “best solution” for coastal adaptation. Instead, each situation must be evaluated and treated based on a community’s particular needs and projected issues. These will likely lead to the implementation of several different adaptation measures at the same and different sites in order to work most effectively with local conditions. There is no way to know for certain what the effects of sea level rise will truly be. Therefore, flexible approaches must be enforced to ensure that planners can

provide the next generation with the same range of options that are available to us today. To do so, coastal management and adaptation strategies must be reversible.

Whenever choosing an adaptation, a proper balance must be met through a thorough evaluation of the adaptation choices and alternatives. In general, a community should strive to balance cost effective mitigation for properties of lower preservation priority with less intrusive actions for properties with a higher preservation priority.¹⁹⁴ Planners should seek information on the methods proposed by the FEMA Guidebook 386-6 FEMA to gain assistance on how to proceed with narrowing their options.¹⁹⁵

Choosing adaptation strategies will also include considering their costs. Therefore planners should research and begin securing sources of funding. This will require the planning team to research grant opportunities as well as state and federal aid prospects in addition to creative funding methods such as resilience bonds or short-term taxation. It will be beneficial to identify sources that address related or multiple needs, such as affordable housing, recreation or economic revitalization in addition to adaptation measures. Through these methods, it may be possible to combine several funding sources to achieve a larger adaptation goal.

Adoption

The planning team should next work to develop an implementation strategy. This will determine who is responsible for which actions. The strategy should also define the funding mechanisms and the time frame for achieving various steps as well as completion of the adaptation strategies. This will require coordination between those involved in the planning team, contractors and various stakeholders.

The planning team, community leaders and municipal officials should continue to research sources of funding that will assist both the community and also individual residents with implementing adaptation strategies. Planners should encourage residents and tax payers to take advantage of funding opportunities, such as those that provide assistance with elevating or relocating their properties. Presenting a range of funding options will help residents feel more comfortable with the changes and will also make the adaptations more sustainable for the long-term. Including these options in the planning document from the beginning will also help residents feel like the planning team has the best interests of the community in mind.

Throughout the implementation process, planners and preservationists must continue to monitor and document progress throughout the life of the plan. Specifically in areas of historic significance, any minor change should be thoroughly documented with professional reports and photography. Proper documentation will help future generations understand why changes were made and also assist with interpretation of any lost historic value. Finally, planners must understand that planning is a continuous process and that modifications will need to be made. The planning team should continue to work together, especially as sea level rise projections continue to change, to ensure that the plan is staying on course and continuing to protect the community's historic and cultural resources.

Conclusion

The guidelines presented in this chapter are an effective summary of the pertinent information discussed throughout this thesis analysis. When used together, this material

provides numerous tools and strategies which will be essential to planners of small historic communities when moving forward with sea level rise adaptation plans and similar strategies. The guidelines incorporate information from sources that are readily available for planners, preservationists and the general public and combine the most essential steps into a single document so that they may be easily understood and implemented by communities with limited budget and staff. While there will also be specific challenges for each locality to overcome individually, these guidelines provide an outline to ensure that communities are not overlooking the essential components of a successful plan. Each step will require additional and precise strategies and tactics to carry out the plan, which should be specialized for each community.

What is innovative about this set of proposed guidelines is that they are designed to specifically address challenges that are common in small communities. Often, larger communities have ample staff with several employees in each department, each with specialized experience such as planning, historic preservation, disaster response, engineering and environmental science. In communities with limited population, several individuals are likely to be responsible for the duties of multiple positions. Therefore, these guidelines emphasize the importance of working with outside professionals, academic institutions and private organizations to gather their knowledge and tap into their expanded resources. Creating these continuing partnerships will also be essential for the sustainability of small communities when revisiting their plans over the coming decades.

Finally, small communities are noted for their family-like bond that directly or indirectly connects many members of the community. Therefore, a major undertaking,

such as adapting entire communities to withstand the effects of sea level rise, is a challenge that is likely to be met with enormous response from residents and their concern for each other's well-being. Public input and community values cannot be ignored when the majority of residents have a personal relationship with both each other and the cultural environment that stretches over the entire jurisdiction. While so much opinion could be a bit daunting, community planners should use this aspect to their advantage. By utilizing the public's passion to help shape the planning process and teaching residents and property owners to initiate historically sensitive adaptation or retrofit measures on their own properties, the engagement of small communities can be harnessed into a significant, proactive force for adaptation.

CHAPTER VII THE FUTURE OF ADAPTATION

Summary and Findings

My hypothesis for this thesis research is that there are four major factors that must be considered in order to make informed decisions regarding a plan of action for sea level rise adaptation in small historic communities. These factors are collaborative identification of historic and cultural resources, historically sensitive adaptation techniques, sustainable adaptation or resiliency funding and community-based planning. The research analyzed in this thesis supports my hypothesis. Preparing to endure the effects of sea level rise is truly a multi-step and locally-specific process in which many stakeholders must be involved. Especially in small communities, where most of the residents are actively involved in community activities and are more likely to be affected by small changes, community members must be informed and included in the decision making process. Together, these four components will allow for a historic coastal community to effectively plan and implement sensitive adaptation approaches to protect their cultural heritage from the effects of sea level rise.

During this research, I found that there are many tasks in which the community as a whole must be readily involved. During the initial inventory process to determine the number of cultural and historic resources within a community, residents, business owners and tax payers should be actively involved in order to communicate not only the location

and condition of historic properties, but also to voice collective community values. In small communities, less obvious landmarks are often the backbone of a community. Continuing protection of these resources requires community support. Additionally, residents and property owners must be available to voice their opinion regarding the value of traditional historic properties and how they should be treated or adapted to withstand sea level rise. In some cases, not every significant property will be able to be saved. Decisions on these salvage priorities must have community input with consideration to industries such as fishing, tourism and hospitality that may be significant to the residents' way of life.

Alternatively, I found that adaptation of small historic communities may place a significant financial burden upon the residents, property owners and other local tax payers. In order to fulfill the actual construction and implementation of adaptation strategies, as well as the planning process, communities must first secure funding. Long-term adaptation may require sources of funding from either taxation or other financial obligations that will directly or indirectly affect property and business owners. When grants are not available, communities must then seek creative opportunities such as resiliency bonds or low interest financing options for adaptation expenses in order to move forward with their adaptation planning.

In order for the adaptations to be successful on a community-wide level, I found that the entire community should be involved, not only the immediate properties along the waterfront. While defensive barriers and similar types of armoring are effective, it is important to consider that sea level rise is not the only threat. The effects of climate change will also contribute to flooding from more intense and frequent major storms.

This means that communities should find ways to deal with sea level rise as well as the rainfall that could lead to increased flooding and inundation of historic neighborhoods. Communities therefore will need to prepare the entire at risk population. This will mean incorporating more adaptation strategies on a larger level, such as elevating more buildings and roadways and updating infrastructure to deal with increased rainfall. This community-wide mentality can be witnessed in places such as Norfolk, Virginia and the Hampton Roads region, where the entire community is responding by building rain gardens and retrofitting existing buildings to handle flooding from various sources. By incorporating the entire community to be active in not only the municipal decision making process but also to take individual measures to adapt their own properties, the collaborative effect on the entire community can assist in protecting and preserving their cultural heritage.

Avenues for Future Research

Additional research should be conducted regarding new ways to finance sea level rise and related adaptation strategies for small communities. As expressed in Chapter IV, funding for adaptation, especially on a large scale, can be difficult to find. Although major cities such as San Francisco and New York have found success through grants and forms of taxation, this may not be a good solution for smaller communities assuming there is a smaller tax base. Forms of climate change resiliency funding that support adaptation approaches on a regional or state level may be a promising alternative option that should be further explored.

As time progresses, new and innovative adaptation strategies that involve minimal change to the historic environment or landscape should be included into planning strategies. Green infrastructure in particular is an attractive option as it creates minimal permanent change to historic properties. However, this approach, along with other soft adaptations, may weaken over time. Depending on the environmental impacts, they can be very short-term solutions. Also, the longevity of hard barriers, such as sea walls, groins and jetties is questionable. Over time, the use of this type of infrastructure may do more harm to the landscape. In several cases, beach erosion has worsened in areas near the hard barriers, as a direct result of their placement. I suggest, therefore, that studies should be conducted to investigate how to reduce the risk, or rather the long-term use, of physical barriers through either advanced engineering or other alternative methods.

Despite all mitigation attempts, the day will come for many communities where the only option left to adapt to the effects of sea level rise is to retreat from the shoreline. Unfortunately, it will be impossible to relocate all historic properties and valued aspects of the original environment. Communities will have to face extremely difficult decisions regarding which properties should be saved. Although not discussed in detail within this thesis analysis, research regarding how to make these difficult decisions as well as specific approaches for conducting this type of adaptation should be considered in the future by planners and preservationists.

Finally, assuming that many adaptation initiatives will end with retreat, there must be consideration towards interpreting the loss of the original historic environment. Relocation of entire portions of historic streets, districts and communities will drastically change aspects of the integrity. However, that does not necessarily mean that a property's

significance is lost entirely. As preservationists, we must encourage disclosure of the full history of a property, especially to discourage false assumptions about the originality of adapted changes. This means that interpretation of any adaptation, large or small, must be explained and made transparent to the public. With this future challenge in mind, research should be conducted to determine the best way to interpret both the relocated properties in their new environment and the loss of historic resources in inundated and high risk areas. This will help to both explain the history of the property as well as communicate the unfortunate effects of sea level rise.

Concluding Thoughts

The effects of sea level rise will not be uniform. Erosion, storm surge and increased flooding will vary greatly from place to place around the globe. Similarly, the projections estimated by scientists are not certain and are subject to change as more data and evidence of sea level rise is collected. James Titus of the U.S. Environmental Protection Agency explains that, “Determining whether, what, and when specific actions are justified is not simple due to uncertainty in the timing and magnitude of impacts and difficulties in quantifying projected costs and benefits [of adaptation measures].”¹⁹⁶ Therefore, the future of vulnerable coastal areas is also uncertain and communities must work together collaboratively to apply adaptation strategies.

Based upon the United States government’s current stance on this topic, the effects of sea level rise will specifically devastate the nation’s valuable cultural resources and historic communities. While federal funding does exist to help communities in crisis, most of the efforts are aimed towards reacting after disaster strikes. Consequently, the

available money for this type of “disaster relief” is inadequate to sustain the destruction that is projected to affect the majority of the United States’ coastlines. Alternatively, there are in comparison very few sources of funding to help communities prepare and implement adaptation strategies in advance of the rising floodwaters. While this presents a significant financial crisis, the method will also ensure that the historic and cultural resources affected by flooding are lost almost entirely.

The very nature of efficient preservation requires preemptive planning and consultation with multiple professionals and stakeholders prior to implementing any changes. Treatment of historic properties requires careful effort to retain and protect the significance and integrity of the property as much as possible. Every alteration could have a negative impact. For this reason, the United States Secretary of the Interior has released numerous standards and guidelines that distinctly address implementation of preservation, planning and other specific procedures on historic properties. These standards require that preservationists and conservators consider the effects of all changes to a historic property, its materials and its immediate environment to determine any negative affects towards an aspect of integrity. Ergo, the concept of treating such valuable resources only in the wake of disaster response defies all suggested treatment procedures, including the Secretary of the Interior’s Standards. In order to protect these valuable resources, there must be plans in place to protect and preserve them prior to the crisis.

Further, historic communities require extra care when implementing changes or adaptation measures intended for protection. Many properties of historic or cultural value rely on one another to interpret the story or exhibit a sense of place. In such cases,

altering one building or landscape of a single property could negatively affect the integrity of the historic setting or association of a neighboring structure. When adaptations are conducted hastily, the integrity of the entire community can become diminished at an exponential rate. It is vital that integrity is retained in order for the resources to still hold value.

Historic coastal communities must begin to plan and prepare immediately in order to preserve their historic properties and their cultural heritage. This response, when necessary, must be made without dependence upon state or federal government resources or sources of funding, as this will significantly delay the process and lead to increased destruction. Communities should now begin seeking creative ways to self-fund their adaptation to ensure the necessary adaptations are completed in time. While the tax increases and surcharges proposed in New York and San Francisco may not be appropriate for small communities, other initiatives may be based on examples from Connecticut's low interest loan program or Virginia's revolving loan fund.

The greatest lesson learned from completing this thesis analysis was that there will be no definitive conclusion to the adaptation process. As the sea level continues to rise and continues to alter the landscape and therefore the historic environment, there is no end to the battle in sight. There is no projection of if or when the global sea level will cease to rise. Scientists are only able to project possibilities of impact. With current projections increasing exponentially over the next several decades, much of the future is still uncertain. Currently, localities, states and regions are planning for projected rates of sea level rise impact with an understanding that additional planning and adjustments in adaptation will be needed again in the future. With no projectable end in sight,

communities will need to question at some point how much they can adapt or how far they can reasonably retreat without sacrificing the entire identity of their community. If this trend continues, every coastal community will find significant shoreline areas underwater. The difficulties of living in a “hoi toide” community will then be perpetual, forcing residents to leave behind their traditions, their memories and their cultural heritage. Being proactive, rather than reactive will ensure communities have a say in protecting their history and ensuring their future as the water rises.

APPENDIX I

Secretary of the Interior's Standards for the Treatment of Historic Properties: Preservation

A property will be used as it was historically, or be given a new use that maximizes the retention of distinctive materials, features, spaces, and spatial relationships. Where a treatment and use have not been identified, a property will be protected and, if necessary, stabilized until additional work may be undertaken.

The historic character of a property will be retained and preserved. The replacement of intact or repairable historic materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.

Each property will be recognized as a physical record of its time, place, and use. Work needed to stabilize, consolidate, and conserve existing historic materials and features will be physically and visually compatible, identifiable upon close inspection, and properly documented for future research.

Changes to a property that have acquired historic significance in their own right will be retained and preserved.

Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.

The existing condition of historic features will be evaluated to determine the appropriate level of intervention needed. Where the severity of deterioration requires repair or limited replacement of a distinctive feature, the new material will match the old in composition, design, color, and texture.

Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.

Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.

Preservation as a treatment

When the property's distinctive materials, features, and spaces are essentially intact and thus convey the historic significance without extensive repair or replacement; when depiction at a particular period of time is not appropriate; and when a continuing or new use does not require additions or extensive alterations, Preservation may be considered as a treatment.

APPENDIX II

Guidelines for Evaluating and Documenting Historic Aids to Navigation to the National Register of Historic Places: Integrity

The National Register traditionally recognizes a property's integrity through seven aspects or qualities: location, design, setting, materials, workmanship, feeling, and association. These qualities should also be discussed under the Statement of Significance, Section 8 of the registration form.

Location

Location is the place where the historic property was constructed or the place where the historic event took place. Integrity of location refers to whether the property has been moved or relocated since its construction. A property is considered to have integrity of location if it was moved before or during its period of significance. Relocation of an aid during its active career if the move enhanced or continued its function is not a significant loss of integrity. For example, in 1877, the 1855-built Point Bonita Light was relocated from a high bluff to a rocky promontory to improve its visibility to mariners. Aids to navigation relocated to serve new purposes after being decommissioned suffer a serious loss of integrity of location, but are not automatically precluded from listing.

Design

Design is the composition of elements that constitute the form, plan, space, structure, and style of a property. But properties change through time. Lighthouses may be raised or shortened; buildings may be added or removed from a light station; sound signal equipment and optics may change to reflect advancing technology. Changes made to continue the function of the aid during its career may acquire significance in their own right. These changes do not necessarily constitute a loss of integrity of design. However, the removal of equipment that served as the actual aid to navigation--a fog signal, lens and lamp, or the distinctive daymarkings on a tower--has a considerable impact on the property. Removal of an optic from a lighthouse, a fog horn or bell from its building, or painting over a historic lighthouse's pattern has a serious adverse effect on its design integrity. The design integrity of light stations is reflected by the survival of ancillary buildings and structures. The decision to nominate a station should include an assessment of the design integrity of the property as a complex. The loss or substantial alteration of

ancillary resources, such as keeper's quarters, oil houses, cisterns, and tramways, for example, may constitute a significant loss of design integrity.

Setting

Setting is the physical environment of a historic property that illustrates the character of the place. Integrity of setting remains when the surroundings of an aid to navigation have not been subjected to radical change. Integrity of setting of an isolated lighthouse would be compromised, for example, if it were now completely surrounded by modern development.

Materials

Materials are the physical elements combined in a particular pattern or configuration to form the aid during a period in the past. Integrity of materials determines whether or not an authentic historic resource still exists.

Workmanship

Workmanship is the physical evidence of the crafts of a particular culture or people during any given period of history. Workmanship is important because it can furnish evidence of the technology of the craft, illustrate the aesthetic principles of a historic period, and reveal individual, local, regional, or national applications of both technological practices and aesthetic principles.

Feeling

Feeling is the quality that a historic property has in evoking the aesthetic or historic sense of a past period of time. Although it is itself intangible, feeling is dependent upon the aid's significant physical characteristics that convey its historic qualities. Integrity of feeling is enhanced by the continued use of an historic optic or sound signal at a light station. The characteristic flashing signal of a light adds to its integrity. While sounds themselves, such as the "Bee-oooohhhh" of a diaphone, cannot be nominated to the National Register, they enhance the integrity of feeling. The mournful call of fog horns on San Francisco Bay is an integral part of experiencing life there.

Association

Association is the direct link between a property and the event or person for which the property is significant. A period appearance or setting for a historic aid to navigation is desirable; integrity of setting, location, design, workmanship, materials, and feeling combine to convey integrity of association.

APPENDIX III

Secretary of the Interior's Standards for Evaluation of Historic Properties

Evaluation is the process of determining whether identified properties meet defined criteria of significance and therefore should be included in an inventory of historic properties determined to meet the criteria. The criteria employed vary depending on the inventory's use in resource management.

Standard I. Evaluation of the Significance of Historic Properties Uses Established Criteria

The evaluation of historic properties employs criteria to determine which properties are significant. Criteria should therefore focus on historical, architectural, archeological, engineering and cultural values, rather than on treatments. A statement of the minimum information necessary to evaluate properties against the criteria should be provided to direct information gathering activities.

Because the National Register of Historic Places is a major focus of preservation activities on the Federal, State and local levels, the National Register criteria have been widely adopted not only as required for Federal purposes, but for State and local inventories as well. The National Historic Landmark criteria and other criteria used for inclusion of properties in State historic site files are other examples of criteria with different management purposes.

Standard II. Evaluation of Significance Applies the Criteria Within Historic Contexts

Properties are evaluated using a historic context that identifies the significant patterns that properties represent and defines expected property types against which individual properties may be compared. Within this comparative framework, the criteria for evaluation take on particular meaning with regard to individual properties.

Standard III. Evaluation Results in A List or Inventory of Significant Properties That Is Consulted In Assigning Registration and Treatment Priorities

The evaluation process and the subsequent development of an inventory of significant properties is an on-going activity. Evaluation of the significance of a property should be completed before registration is considered and before preservation treatments are selected. The inventory entries should contain sufficient information for subsequent

activities such as registration or treatment of properties, including an evaluation statement that makes clear the significance of the property within one or more historic contexts.

Standard IV. Evaluation Results Are Made Available to the Public

Evaluation is the basis of registration and treatment decisions. Information about evaluation decisions should be organized and available for use by the general public and by those who take part in decisions about registration and treatment. Use of appropriate computer-assisted data bases should be a part of the information dissemination effort. Sensitive information, however, must be safeguarded from general public distribution.

APPENDIX IV

Secretary of the Interior's Standards for Identification of Historic Properties

Identification activities are undertaken to gather information about historic properties in an area. The scope of these activities will depend on: existing knowledge about properties; goals for survey activities developed in the planning process; and current management needs.

Standard I. Identification of Historic Properties Is Undertaken to the Degree Required To Make Decisions

Archival research and survey activities should be designed to gather the information necessary to achieve defined preservation goals. The objectives, chosen methods and techniques, and expected results of the identification activities are specified in a research design. These activities may include archival research and other techniques to develop historic contexts, sampling an area to gain a broad understanding of the kinds of properties it contains, or examining every property in an area as a basis for property specific decisions. Where possible, use of quantitative methods is important because it can produce an estimate, whose reliability may be assessed, of the kinds of historic properties that may be present in the studied area. Identification activities should use a search procedure consistent with the management needs for information and the character of the area to be investigated. Careful selection of methods, techniques and level of detail is necessary so that the gathered information will provide a sound basis for making decisions.

Standard II. Results of Identification Activities Are Integrated Into the Preservation Planning Process

Results of identification activities are reviewed for their effects on previous planning data. Archival research or field survey may refine the understanding of one or more historic contexts and may alter the need for additional survey or study of particular property types. Incorporation of the results of these activities into the planning process is necessary to ensure that the planning process is always based on the best available information.

Standard III. Identification Activities Include Explicit Procedures for Record-Keeping and Information Distribution

Information gathered in identification activities is useful in other preservation planning activities only when it is systematically gathered and recorded, and made available to those responsible for preservation planning. The results of identification activities should be reported in a format that summarizes the design and methods of the survey, provides a basis for others to review the results, and states where information on identified properties is maintained. However, sensitive information, like the location of fragile resources, must be safeguarded from general public distribution.

APPENDIX V

Secretary of the Interior's Standards for Preservation Planning

Preservation planning is a process that organizes preservation activities (identification, evaluation, registration and treatment of historic properties) in a logical sequence. The Standards for Planning discuss the relationship among these activities while the remaining activity standards consider how each activity should be carried out. The Professional Qualifications Standards discuss the education and experience required to carry out various activities.

The Standards for Planning outline a process that determines when an area should be examined for historic properties, whether an identified property is significant, and how a significant property should be treated.

Preservation planning is based on the following principles:

Important historic properties cannot be replaced if they are destroyed. Preservation planning provides for conservative use of these properties, preserving them in place and avoiding harm when possible and altering or destroying properties only when necessary.

If planning for the preservation of historic properties is to have positive effects, it must begin before the identification of all significant properties has been completed. To make responsible decisions about historic properties, existing information must be used to the maximum extent and new information must be acquired as needed.

Preservation planning includes public participation. The planning process should provide a forum for open discussion of preservation issues. Public involvement is most meaningful when it is used to assist in defining values of properties and preservation planning issues, rather than when it is limited to review of decisions already made. Early and continuing public participation is essential to the broad acceptance of preservation planning decisions.

Preservation planning can occur at several levels or scales: in a project area; in a community; in a State as a whole; or in the scattered or contiguous landholdings of a Federal agency. Depending on the scale, the planning process will involve different segments of the public and professional communities and the resulting plans will vary in detail. For example, a State preservation plan will likely have more general

recommendations than a plan for a project area or a community. The planning process described in these Standards is flexible enough to be used at all levels while providing a common structure which promotes coordination and minimizes duplication of effort. The Guidelines for Preservation Planning contain additional information about how to integrate various levels of planning.

Standard I. Preservation Planning Establishes Historic Contexts

Decisions about the identification, evaluation, registration and treatment of historic properties are most reliably made when the relationship of individual properties to other similar properties is understood. Information about historic properties representing aspects of history, architecture, archeology, engineering and culture must be collected and organized to define these relationships. This organizational framework is called a "historic context." The historic context organizes information based on a cultural theme and its geographical and chronological limits. Contexts describe the significant broad patterns of development in an area that may be represented by historic properties. The development of historic contexts is the foundation for decisions about identification, evaluation, registration and treatment of historic properties.

Standard II. Preservation Planning Uses Historic Contexts To Develop Goals and Priorities for the Identification, Evaluation, Registration and Treatment of Historic Properties

A series of preservation goals is systematically developed for each historic context to ensure that the range of properties representing the important aspects of each historic context is identified, evaluated and treated. Then priorities are set for all goals identified for each historic context. The goals with assigned priorities established for each historic context are integrated to produce a comprehensive and consistent set of goals and priorities for all historic contexts in the geographical area of a planning effort.

The goals for each historic context may change as new information becomes available. The overall set of goals and priorities are then altered in response to the changes in the goals and priorities for the individual historic contexts.

Activities undertaken to meet the goals must be designed to deliver a usable product within a reasonable period of time. The scope of the activity must be defined so the work can be completed with available budgeted program resources.

Standard III. The Results of Preservation Planning Are Made Available for Integration Into Broader Planning Processes

Preservation of historic properties is one element of larger planning processes. Planning results, including goals and priorities, information about historic properties, and any planning documents, must be transmitted in a usable form to those responsible for other planning activities. Federally mandated historic preservation planning is most successfully integrated into project management planning at an early stage. Elsewhere, this integration is achieved by making the results of preservation planning available to other governmental planning bodies and to private interests whose activities affect historic properties.

GLOSSARY

Introduction

Definitions of uncommon terms related to adaptation, planning and sea level rise are available in the glossary. Sources for the terms include, *Adaptation Action Areas: A Planning Guidebook for Florida's Local Governments*, August, 2015 and *California Coastal Commission Sea level Rise Policy Guidance: Interpretive Guidelines for Addressing Sea Level Rise in Local Coastal Programs and Coastal Development Permits*, August, 2015 as well as the “Beachapedia” dictionary service provided by the Surfrider Foundation.

Terms

Accommodation

An approach that incorporates sea level rise adaptation strategies that do not act as a barrier, but rather alter the design through measures such as elevation or storm water improvements, to allow the structure of an infrastructure system to stay intact. Rather than preventing flooding or inundation, these strategies aim to reduce potential risks.

Adaptation

An adjustment in natural or human systems in anticipation of or in response to a changing environment in a way that effectively uses beneficial opportunities or reduces negative effects.

Armor stone

Various types of stone or rubble that consists different shapes and angles, commonly used to in landscapes or barriers.

Avoidance

An approach that includes sea level rise adaptation strategies which involve ensuring development does not take place in areas subject to coastal hazards associated with sea level rise or where the risk is low at present but will increase over time.

Beach nourishment

A process by which sediment (sand) lost to erosion is replaced with another source. Nourishment projects typically utilize large dredges to bring in sand from offshore sources, but sand mined inland can also be utilized through truck-haul.

Bulkhead

A wall that is constructed parallel to a shoreline to prevent erosion.

Conservation easements

A voluntary agreement between a landowner and a government or other organization that restricts certain uses of the property for a variety of purposes (habitat creation, scenic vistas, agriculture) while the property remains in private ownership.

Coastal flooding

Flooding which occurs when water is driven onto land from an adjacent body of water.

Dike

A wall generally of earthen materials designed to prevent the permanent submergence of lands below sea level or storm surge flooding of the coastal floodplain.

Downdrift

The net direction of sediment transport on a shoreline.

Dry flood-proofing

A technique which completely seals a structure from permeable floodwaters. This is usually used in conjunction with wet flood-proofing on a lower level.

Dune

A mound of sand parallel to a shoreline that can be built naturally by wind and water flow or can be constructed during beach nourishment projects.

Erosion

The wearing away of land by natural forces; on a beach, the carrying away of beach material by wave action, currents, or the wind. Development and other non-natural forces (e.g., water leaking from pipes or scour caused by wave action against a seawall) may create or worsen erosion problems.

Gabions

A cylindrical container filled with local rock, stone or similar hard materials. Used in engineering as part of a fortification.

Geographic Information Systems (GIS)

A hardware and software system that allows visualization, analysis and interpretation of geographic data.

Geotextile Fabrics

A permeable fabric used to stabilize a shoreline and decrease rate of erosion by allowing water drainage without loss of sediment.

Green Infrastructure

Refers to the use of vegetative planting, dune management, beach nourishment or other methods that mimic natural systems to capitalize on the ability of these systems to provide flood and erosion protection, stormwater management, and other ecosystem services while also contributing to the enhancement or creation of natural habitat areas.

Groin

A low wall or sturdy barrier built perpendicular from a shoreline into a waterway intended to reduce erosion by trapping sand that moves parallel to the shoreline.

Groundwater recharge

Also referred to as deep drainage or deep percolation is a hydrologic process where water moves downward from surface water to groundwater. Recharge is the primary method through which water enters an aquifer.

Hazard Profile

A description of the characteristics of place or location that make it particularly vulnerable to certain environmental hazards.

Indigenous Knowledge

Local level knowledge systems based on the immediate and surrounding history of a place from which cultural decisions are made in community planning.

Integrity

The state of or degree of being intact, unimpaired or whole with soundness of original characteristics for which the property is valued. The extent to which a property conveys or retains its historical character and significance.

The National Park Service identifies seven aspects or qualities of integrity: Feeling, Association, Location, Setting, Material, Design and Workmanship.

Inundation

The process of dry land becoming permanently drowned or submerged, such as from dam construction or from sea level rise.

Living shorelines

A structure that prevents shoreline erosion and maintains coastal processes by restoring or enhancing natural shoreline habitat through strategic placement of plants, stone, sand fill and other organic materials.

Mitigation

A set of policies and programs designed to reduce emissions of greenhouse gases.

Pile Foundation

A long, heavy timber or section of concrete or metal driven or drilled into the earth or seabed to serve as a support or protection

Preservation

The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New exterior additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.

Protection

An approach that involves “hard” and “soft” structurally defensive measures to mitigate impacts of rising seas in order to decrease vulnerability while allowing structures and infrastructure to remain unaltered.

Rain garden

A garden with a shallow depression filled with aquatic plants that easily accommodates and absorb rainwater runoff from urban areas

Resilience (community context)

The capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment. It is not a synonym for adaptation.

Resilience (ecological context)

The ability to return to a previous state after disturbance or the capacity to recover quickly from negative impacts.

Retreat

An approach which involves the actual removal of existing development, their possible relocation to other areas, and/or prevention of further development in high-risk areas in an attempt to manage sea level rise.

Revetment

A sloped retaining wall; a facing of stone, concrete, blocks, rip-rap, etc. built to protect an embankment, bluff, or development against erosion by wave action and currents.

Rip-rap

Loose rocks or stone organized to form a structural defense to reduce shoreline erosion.

Sand fencing

A barrier made of spaced wooden slats or other materials which reduces sand erosion due to wind and also promotes dune stabilization by controlling the sediment to accumulate in a desired location.

Sea-level rise

An observed increase in the average local sea level or global sea level trend caused by an increase in the volume of water in the world's oceans.

Seawall

A structure separating land and water areas, primarily designed to prevent erosion and other damage due to wave action.

Sediment Input

Grains of soil, sand, or rock that have been transported from one location and deposited at another.

Storm surge

A rise above normal water level on the open coast due to the action of wind stress on the water surface. Storm surge resulting from a hurricane also includes the rise in water level due to atmospheric pressure reduction as well as that due to wind stress.

Terminal groin

A hard structure intended to control beach erosion by catching sediment deposit on the updrift side of a beach or inlet.

Transfer of Development Rights (TDR)

A device by which the development potential of a site is severed from its title and made available for transfer to another location. The owner of a site within a transfer area may retain property ownership, but not approval to develop. The owner of a site within a receiving area may purchase transferable development rights, allowing a receptor site to be developed at a greater density.

Truck haul

Dump trucks designed to transport large loads, such as sand or similar sediment and is typically used during beach restoration or nourishment projects.

Updrift

The direction which beach material approaches along a shoreline.

Vulnerability

The degree to which a resource, asset or process is susceptible to adverse effects of climate change, including climate variability and extremes. Vulnerability is a function of

the character, magnitude, and rate of climate variation to which a system is exposed; its sensitivity; and its adaptive capacity (IPCC 2014).

Vulnerability assessment

A practice that identifies who and what is exposed and sensitive to change and how able a given system is to cope with extremes and change. It considers the factors that expose and make people or the environment susceptible to harm and access to natural and financial resources available to cope and adapt, including the ability to self-protect.

Well house

A covered structure built around the top of a well for protection.

Wet flood-proofing

A technique which incorporates permeable measures by allowing floodwaters to enter a structure or area without causing significant damage.

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