Cost-Efficient Climate Change Adaptation in the North Atlantic

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Cost-Efficient Climate Change Adaptation in the North Atlantic
Final Report

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EXECUTIVE SUMMARY

This report summarizes the work of two NOAA-funded graduate fellows research on community-level coastal flood management and climate change adaptation best practices throughout the North Atlantic region (Virginia to Maine). Guided by a steering committee composed of government and academic personnel involved with climate adaptation throughout the North Atlantic, the fellows visited coastal communities to collect information on low-cost climate change and related coastal hazard management best practices. The purpose of the work was to identify and collate cost-effective adaptation projects implemented at the municipal level, to provide NOAA with best practice information to assist with ongoing adaptation outreach.

Best practices were defined as innovative initiatives aimed at increasing resilience to coastal flooding and storm-related hazards. These best practices range from a community's efforts to decrease flood risk with systematic infrastructure designs, local climate adaptation plans, or legal mechanisms that support resilient development. Qualifying practices had to be voluntarily adopted by a local government and either not required or more stringent than state or federal law. Practices could explicitly incorporate climate change or sea level rise concerns or not. Those that did not explicitly incorporate climate change had to include coastal flooding or hazards exacerbated by climate change.

Additionally, the research aimed to identify best practice constraints or other unique conditions that determine how transferable a best practice is from one community to another. A primary goal of this work was to encourage a peer-to-peer network among community leaders to share climate change, sea level rise and flood management best practices.

Data were gathered through a search of municipal plans and codes, as well as semi-structured interviews with municipal officials and staff, conducted from July 2012 through October 2012. Follow-up surveys were conducted to gather more specific data on costs and funding sources. Two to five municipalities in each state were chosen based on a literature review in coordination with a steering committee of experts from NOAA, Sea Grant, and NGOs. Communities varied in size, from New York City with a population over 8 million, to Greenwich Township, New Jersey, just 100 miles away, with a population of about 800. The median population of our sample was 58,520**.** To be included in the study, communities had to be coastal, but varied significantly in geomorphology. Coastlines could include bays, harbors, open ocean shores, and sounds. Two of our sample communities were located entirely on barrier islands. Adaptation practices were classified on a variety of dimensions – Adaptation Strategy; Adaptation Practice; Adaptation Sub-Practice; Phase; Incorporation of Climate Change; Impact; and Standard. Approximate costs were obtained as well as funding sources for those projects that were separately funded.

Adaptation Strategy: The Intergovernmental Panel on Climate Change (IPCC) identified three types of strategies to address sea level rise from climate change: Retreat, Accommodation, and Protection (IPCC 1990). We classified adaptations as any of those three strategies and added two others – Prevention and Procedural – for those projects that did not fall into one of the IPCC categories.

- **Retreat/restoration** is defined as allowing for existing coastal ecosystems to shift landward. Examples include buyout of repetitive loss properties and transfer of development rights. These were the rarest type of adaptation found, representing only 3% of projects.

- **Accommodation** is defined as adaptations that strengthen the resilience of existing or new structures, such as freeboard requirements. 21% of projects were classified as accommodation.

- **Protection** is defined as actions taken to protect land from inundation by rising seas and storm surge, such as elevating sea walls or beach nourishment. Protection projects represent 6% of the strategies found. These are relatively rare, since these types of adaptations are often not low-cost.

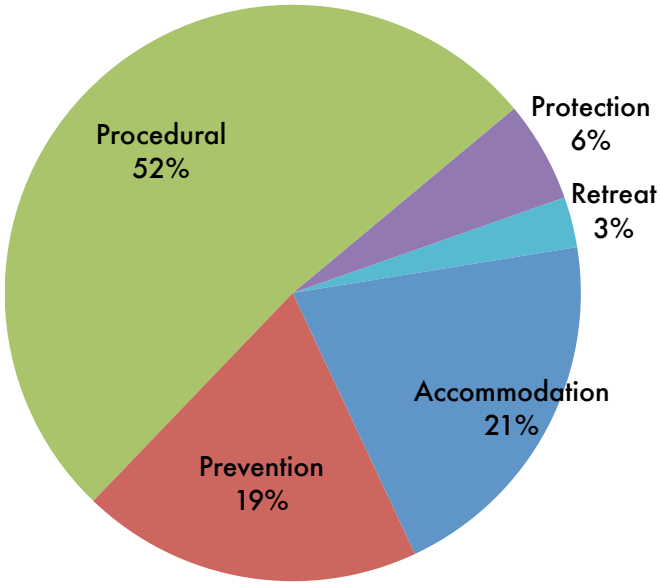

Figure 0:1 - Distribution of adaptation strategies

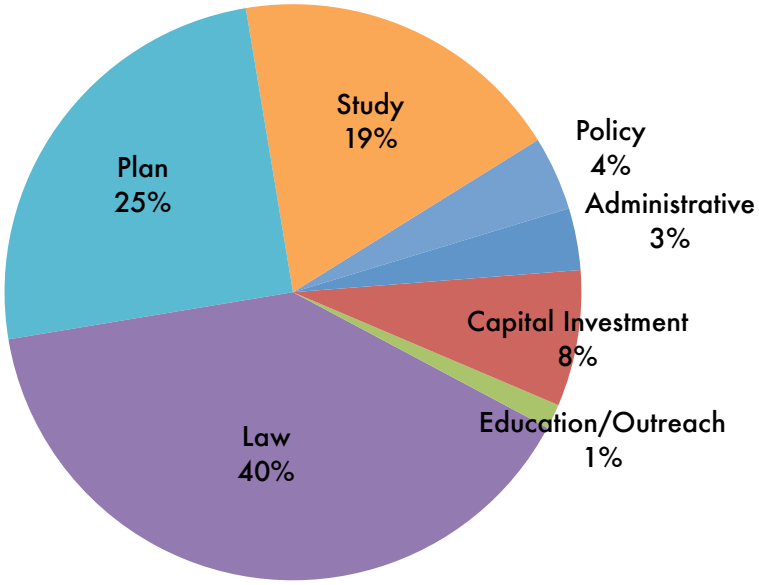

Figure 0:2 - Distribution of adaptation practices

- **Prevention**, one of the new categories, is defined as anticipatory actions taken to protect or preserve land in its natural state that prevents exacerbation of exposure to coastal hazards, such as land conservation or coastal setbacks. 19% of projects were classified as prevention.

- **Procedural** adaptations are defined as projects that aim to generate climate information, disseminate such information, or incorporate such information into other plans or policies.

Examples of procedural adaptations are projects such as studies, mapping exercises, administrative or educational programs, or those projects that incorporate climate change into a hazard mitigation or comprehensive plan. 52% of strategies were classified as procedural.

Adaptation Practice: All of the adaptations also fall into one of six "practice" categories: Plans, Studies/Pilot projects, Education/Outreach, Capital Investments, Policies, Laws and Administrative Actions.

Plans: Plans are process-driven documents that serve as guidance for future decision-making. The two major types of plans found in our sample were *Comprehensive Plans and Hazard Mitigation Plans.*

Comprehensive Plans, otherwise known as Master Plans or Land Use Plans, are statutorily defined and sometimes required in each state. They prescribe land uses and are most often implemented through the zoning and subdivision ordinance. Plans that incorporated climate change or sea level rise were referenced in our findings. The extent of such incorporation varies significantly – from mere mention to thorough incorporation in every section. In some states, plans do not have the force of law and are just recommendations. In Maine, zoning ordinances must comply with the municipality's comprehensive plan within five years of adoption. In Rhode Island, local comprehensive plans must now incorporate sea level rise and climate change by law. *Hazard Mitigation Plans,* required by the Disaster Mitigation Act of 2000, are another venue for considering and incorporating climate change issues. Towns that have done so include Barnstable, MA, Brewster, MA, Guilford, CT, New Haven, CT, and Poquoson, VA.

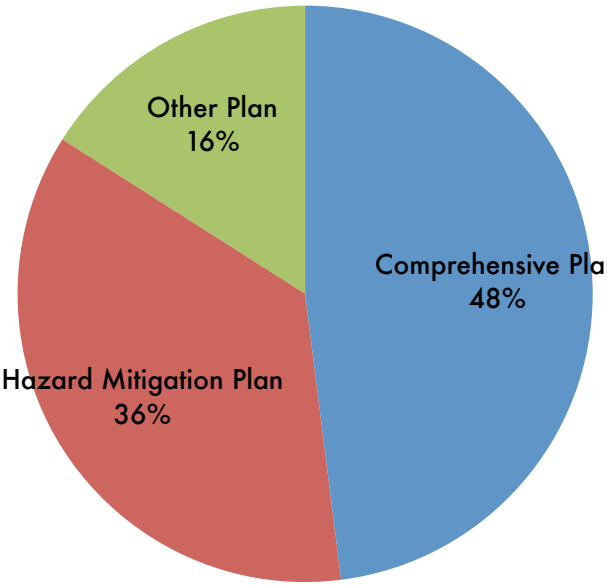

Figure 0:3 - Types of plans that towns incorporated climate change in

Other plans we found include a Comprehensive Waterways Management Plan in Hampton, VA; a Land Protection Plan in Hull, MA; an Open Space Plan in Little Silver, NJ; Local Waterfront Revitalization Plans, found in all our towns in New York; and PlaNYC, a comprehensive sustainability plan. Most projects that involve climate change plans are classified as studies/pilot projects if they were primarily the latter.

Studies and pilot projects: (19% of adaptations) often result in stand-alone documents that issue recommendations, and are sometimes woven into a climate change plan. They are often collaborative efforts with multiple partners including universities, state coastal management agencies, and NGOs. They usually employ modeling to determine risks and often include a vulnerability assessment. Examples include the Greenwich Township, N.J. Coastal Community

Vulnerability Assessment Tool as well as the Climate Change Adaptation Project in Barnstable, MA, and other New England towns led by the Consensus Building Institute, the Massachusetts Institute of Technology, and the National Estuarine Research Reserve System.

Ideally, studies should be tied into planning efforts. Some communities have incorporated climate change information generated by a study into other municipal plans. Guilford, CT, participated in a Nature Conservancy and Yale University project called the Community Coastal Resiliency Plan. It subsequently incorporated the information gathered into its Comprehensive Plan of Conservation and Development as well as its Hazard Mitigation Plan. Bowers, DE, participated in the Vulnerability Assessment and Delaware Coastal Resiliency Action Plan and is planning to comprehensively rezone the town to allow the commercial district to relocate to a less vulnerable part of town. Other towns that have incorporated climate information generated from pilot projects into their comprehensive plans include Greenwich, CT, and Marshfield, MA. Some towns—such as East Hampton and Southold, NY, and York, ME, have incorporated or referenced climate change in their plans although they have not participated in a formal study. East Hampton, NY, Southold, NY and York, ME, are examples of communities that have done this.

Education and outreach programs that were profiled in our sample were small in number (1% of actions) but can be big in impact. Many towns do required outreach as part of their climate, comprehensive, or flood mitigation planning processes, but the town of Greenwich, CT, and Portsmouth, VA, have exemplary outreach efforts that go far beyond required minimums.

Capital investments (8% of adaptations) most often involve financing the construction or maintenance of a green or gray infrastructure project. Examples include Bowers, DE, which bought out a repetitive loss property and converted it into Main Street Park with a bocce ball court; Poquoson, VA, constructed all new pump stations above the 100-year flood level; Little Silver, NJ, installed a flood gauge warning system; Scarborough, ME, established an open space fund; and Ocean City, NJ, self-funded the maintenance of its beach renourishment and protection project.

Policy adaptations, representing 4% of our sample, are wide-ranging in scope. They include executive orders or administrative actions, such as the adoption of engineering standards for public works that incorporate climate considerations in Groton, CT; Poquoson, VA's 4.5 ft. elevation standards for new roads; the City of New York Department of Parks and Recreation's inclusion of climate adaptation measures in their high-performance guidelines describing best practices for planning, design, construction, and maintenance of city parks; and the establishment of a coastal advisory committee in Marshfield, MA.

Laws are the most common type of adaptation, representing 40% of those found. Laws, which at the local level are often called ordinances or bylaws, create mandatory expectations of compliance. They are enforced by city administrative staff and the courts, and result in some type of penalty for failure to comply. In the context of climate change adaptations, they most often apply to building and zoning codes. Examples include shoreline setbacks, freeboard elevation requirements, dune and wetland conservation ordinances, cluster ordinances, and

shoreline hardening restrictions. The most stringent example of a freeboard elevation ordinance was found in Ocean City, MD, which requires up to 5.5 feet in FEMA-designated "V"[1] zones.

Administrative actions are those activities taken by a government that involve process. Examples include appointment of a waterways grants manager in Hampton, VA; establishment of a permanent mitigation planning team in Lewes, DE: a FEMA cooperative mapping project taken on by New Castle County, DE; and the establishment of coastal erosion districts in East Hampton, NY which are a mechanism for residents to self-fund beach infrastructure projects.

Projects were also classified by whether they explicitly incorporated climate change. About half of the projects were found to have explicitly incorporated climate change. The enforceable adaptations in the form of local laws and ordinances most often do not specifically incorporate climate change information, since most respond to discernible risks such as flooding This may also be a legacy of traditional flood management model ordinances and state and federal law frameworks. Many times, however, these are tied together, in that climate change studies recommend actions to reduce flood damage expected to be worsened by projected sea level rise, for instance, by increasing required freeboard in flood hazard areas.

Adaptation projects were also grouped into four enforcement strengths, called Impact. Lastly, projects were classified by whether they were completely unique to the municipality or were implementations of a state or federal law that was more stringent than required. This category describes the Standard of the adaptation.

We found that systematic incorporation of climate change concerns into formal community planning, management, and infrastructure design is in a nascent stage. Yet we found innovative climate change and flood management practices in every state in the region, and in diverse municipalities with varying demographic and geographic characteristics. Our findings demonstrate that many communities have been acting in myriad innovative ways with unique local solutions to adapt to worsening coastal hazards, sea level rise, and climate change. The devastation wrought by Superstorm Sandy and Hurricane Irene indicate that communities are still highly vulnerable, yet the storms have also created a potential watershed moment regarding willingness to adopt innovative adaptations. We hope that raising awareness of these best practices in leading North Atlantic communities can inspire discussion and action in communities that are now considering how to better protect themselves.

[1] Coastal areas with a 1% or greater chance of flooding and an additional hazard associated with storm waves.

1. INTRODUCTION

The purpose of this research and report was to provide NOAA with best practice information to assist with ongoing adaptation outreach in the region. Consistent with that charge, this report was designed to facilitate easy access and use of the management information that the fellows collected and organized. Two main outreach information products are contained in this report:

1. *List of local climate change and related coastal hazard management best practices*. All potential best practices found during the research were included in a table with basic descriptive information.

2. *Case studies*. From the adaptation table containing the population of best practices, a set of towns were selected for case studies to document how a best practice got started and to report adaptation details using a cost-effectiveness perspective.

The full adaptation table is included in the appendix of this report, and the case studies are included as main sections. The full table is organized by adaptation type, and tables extracted from the full table are organized by town and included in each respective case study section. The case studies include a replicated format and stand-alone portable documents that can be shared in hardcopy or electronically.

1.1. **Background**

The devastation wrought by Hurricane Sandy has galvanized public discourse about the impact of climate change on coastal communities and has dramatically increased awareness—among citizens and officials alike—of vulnerability to coastal hazards. However, such hazards are a reality that many towns have been dealing with for decades, and the science on the increasing risk has been warning of such an event for nearly as long.

Since it was first identified 30 years ago, (Barth and Titus 1984; Milliman, Broadus and Gable 1989) sea level rise as a result of global warming has been looming as the most pernicious threat to coastal communities' future (Dasgupta et al. 2009; Nicholls et al. 2007). Sea level rise is expected to occur because of (1) the thermal expansion of seawater as it warms and (2) the melting of land-based ice; small glaciers, the Greenland ice sheet, and the West Antarctic ice sheet (Meehl et al. 2007).

As noted by the Intergovernmental Panel on Climate Change in 1996, "Anticipated climate changes will greatly amplify risks to coastal populations." It stated, "By the end of the century, a 2-5-fold increase in rates of global sea level rise could lead to inundation of low-lying coastal regions, including wetlands, more frequent flooding due to storm surges, and worsening beach erosion" (IPCC 1996).

The litany of impacts caused by climate change underscores the reality that mitigation cannot supplant adaptation. Article 11 of the Kyoto Protocol also commits parties to promote and facilitate adaptation to address climate change. As early as 1995, in its second assessment report,

the IPCC also emphasized the importance of adaptation as "a very powerful option for responding to climate change" (IPCC 1995).

As defined by the IPCC, adaptation is "adjustment in natural or human systems to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities. Adaptation has been defined as a process whereby individuals and communities respond to "actual or expected climactic stimuli or their effects" (IPCC 2001, p. 72).

Various types of adaptation can be distinguished. *Anticipatory adaptation* that takes place before the impacts of climate change are felt. *Autonomous adaptation*, also known as *spontaneous adaptation*, does not constitute a conscious response to climactic stimuli but is triggered by ecological changes and by market changes in human systems (Smit et al. 2000). *Planned adaptation* is the result of deliberate policy decisions, based on an awareness that conditions have changed or are about to change and that action is required to return to, maintain, or achieve a desired state. Urban and regional systems will likely experience all three types of adaptation as the climate changes, but the spontaneous adaptive measures are likely to be very costly and disruptive. Planned adaptation is clearly much preferable.

The challenges of effective adaptation are extremely complex and likely to be politically difficult both at the local and higher levels of government, but it is at the local level where the impact of climate change is most likely to be felt and dealt with. It is in cities and local communities where the impacts of climate change will be felt; their police and fire departments are the first responders in a crisis, and it is municipally determined urban form and transportation networks that will prevent the worst impacts of climate change.

The little previous research on local climate adaptation planning has indicated that the practice is not widespread. Wheeler (2008) found that municipalities had generally been prioritizing climate mitigation over adaptation. His study of all of the climate change plans in all states with climate planning documents and all cities of over 500,000 that are members of the Cities For Climate Protection campaign concluded, "[m]ost plans do not address adaptation to a changing climate" (p. 481). He reported than only 6 of 29 states and 5 of 35 cities mentioned the subject of adaptation in their climate planning documents, and nearly all raised the subject as a topic for further research, and also concluded that the first generation of climate plans were inadequate in implementation.

Preston, Westaway and Yuen (2010) looked at 57 adaptation plans from Australia, the U.K. and the U.S. and evaluated them against 19 planning processes identified from existing guidance documents for adaptation planning. Their results indicated that adaptation plans are underdeveloped and they suggest there are gaps in planning. They found that local governments almost three quarters of adaptation options are "focused on low-risk knowledge acquisition and capacity-building measures" instead of "specific actions to reduce vulnerability that could prove more costly, controversial or difficult to implement..." (p. 428) and concluded that there were "significant deficiencies in climate change preparedness, even among those nations often assumed to have the greatest adaptive capacity." (p. 407)

Tang, Brody, Quinn and Chang (2010) looked at 40 recently adopted climate adaptation plans, and found that although there was a high level of awareness in the plans and moderate analysis capabilities, there were limited actions taken in the realm of climate change. Their analysis also suggested, counter to previous research, that experience with hazards did not lead to greater participation in climate change planning.

The components of adaptive capacity have been identified by researchers. Of those that concern us in this context of local governments, they include elements such as flexible and appropriate institutions and access to climate information - that local governments generally can not procure on their own (Yohe and Tol, 2002; Janssen and Ostrom, 2006; Smit and Wandel, 2006).

A number of studies of local government action have indicated that action at higher levels of government have significant impact on local capacity to manage climate change adaptation. (Naess et al., 2005; Urwin and Jordan, 2008).

Baker (2012), studying municipal adaptation plans in Australia, found that local governments are increasingly aware of climate change impacts but questioned the effectiveness of devolving adaptation planning without addressing structural and procedural barriers, indicating a significant role for integrated planning from the federal through to state and local governments.

The Federal Government has also recognized the significance of local governments in implementing adaptations and mitigating its risk. As early as 1990 it recognized the significance of climate change and sea level rise on coastal communities when it amended the Coastal Zone Management Act of 1972 and specifically required that states anticipate and address sea level rise in their plans. More recently, President Obama signed an Executive Order (EO 13514), establishing the Interagency Climate Change Adaptation Task Force and tasking it with developing a report to strengthen policies that better prepare the nation for climate change. The Task Force released a progress report in October 2010 and in October 2011. One of the key areas the report addressed was building resilience in local communities and providing accessible climate information and tools to help decision-makers manage climate risks. (White House Council on Environmental Quality 2010). The report itself advocated the central role of localities in its description of "an effective mantra for adaptation: Think globally, work regionally, act locally" (p. E-3). The report also supported the need for adaptation to be tailored to local conditions, "Because impacts, vulnerability, and needs vary by region and locale, adaptation will be most effective when driven by local or regional risks and needs" (p. 21). The 2011 report stated that "the Federal Government must work in partnership with local, state, Tribal, and regional authorities as it develops and implements adaptation strategies, since most adaptive actions will occur at the local level" (White House Council on Environmental Quality 2011; p. iv).

To that end, the latter report discusses the Federal Government's efforts to "develop strong partnerships, enhance regional coordination of climate science and services, and provide accessible information and tools to help decision makers develop strategies to reduce extreme weather impacts and climate risks" (White House Council on Environmental Quality 2011).

In 2013, the Government Accountability Office (GAO) added Climate Change to its list of High Risks. (GAO High Risk Report 2013). The report recognizes that while some adaptation measures are high cost, "there is a growing recognition that the cost of inaction could be greater" (p. 62). The report encourages the Federal Government to reduce its fiscal exposure to risk by better managing climate change, and again emphasizes the role that state and local governments have in meeting these goals. "The federal government annually invests billions of dollars in infrastructure projects that state and local governments prioritize and supervise," such as zoning decisions and how to build roads and bridges (p.69). The report stated that "State and local authorities are responsible for the planning and implementation of many types of infrastructure projects, and decisions at these levels of government can drive the federal government's fiscal exposure."

Fankhausera, Smith, and Tol (1999) were early researchers who laid out a framework for the nature of how systems can begin to incorporate climate change adaptation. They indicate that climate change needs to be accounted for in long-lived projects and investments sensitive to rapidly changing climate parameters such as buildings and infrastructure. They call out planning as being an especially essential element of anticipatory adaptation because it is inherently forward looking and puts investment projects into a programmatic context. Challenges, however, abound. "Having the ability to adapt requires that there is room to change behavior." And, as they say, "changing behavior may be constrained by law, politics, morality, or custom" (p. 74).

Research has also demonstrated that individuals and communities are much more likely to respond to experiences of current climate variability, such as a recent flood or damage from a hurricane, than to expected or future climactic change (Adger, et al. 2009; Moser and Dilling 2004; Paton et al. 2001). Harnessing benefits that both respond to current climate hazards and adapt the community to climate change will be an essential component to achieve meaningful adaptation.

In realization of this political reality, we chose to incorporate both strategies that explicitly respond to climate change and those that respond to the expected impacts of climate change alone, such as increased flooding.

Thirty years ago, James Titus (1984) wrote *Planning for Sea Level Rise Before and After a Coastal Disaster*. He outlines a historical shift from accommodating erosion to protection and engineering structures as development increased on our ocean shores in the wake of economic growth following World War II. In a prescient observation he stated: "Although sea level is not expected to rise rapidly until after 2000, resort communities may have to consider its consequences much sooner. After the next major storm, in particular, homeowners whose properties are destroyed will decide whether and how to rebuild; and local governments will decide whether or not to let all of them rebuild, and which options are appropriate to address the storm-induced erosion." (p. 253)

Despite the challenges, communities are awakening to the realization of their vulnerability and many have begun to take bold steps to begin to adapt. The challenging work of determining best practices for planning interventions will be different in every community. As Preston et al.

(2010) observe, there is a significant need to "maintain regard for the highly localized and contextual nature of climate vulnerability and appropriate adaptation responses." (p. 427)

Even though the process of adapting to climate change will be highly localized, communities have much to learn from each other. Although communities in the Northeast United States are fiercely independent and protective of their home rule, many realize they cannot face such a challenging endeavor alone. Building knowledge about the impacts of climate change is often beyond the capabilities of many local governments, and experience in neighboring jurisdictions is considered extremely valuable to community leaders as they attempt to craft their own adaptation policies. To that end, this report aims to improve understanding of what climate adaptive actions are taking place in the North Atlantic region and to expand knowledge of effective and low-cost adaptations to facilitate the transfer of these best practices from one community to another. Adaptation will not be simple and it involves many tradeoffs – but the capacity and will to do so is clear; many are already imagining a bold future of sustainable, resilient coastal communities.

1.2. Study Area

Two to five towns in each state in the North Atlantic were chosen based on a literature review and internet searches in coordination with a steering committee of experts from NOAA, Sea Grant, and NGOs. The size of communities varied, from New York City with a population over 8 million, to Greenwich Township, New Jersey, just 100 miles away, with a population of about 800. The median population of our sample was 58,520**.**

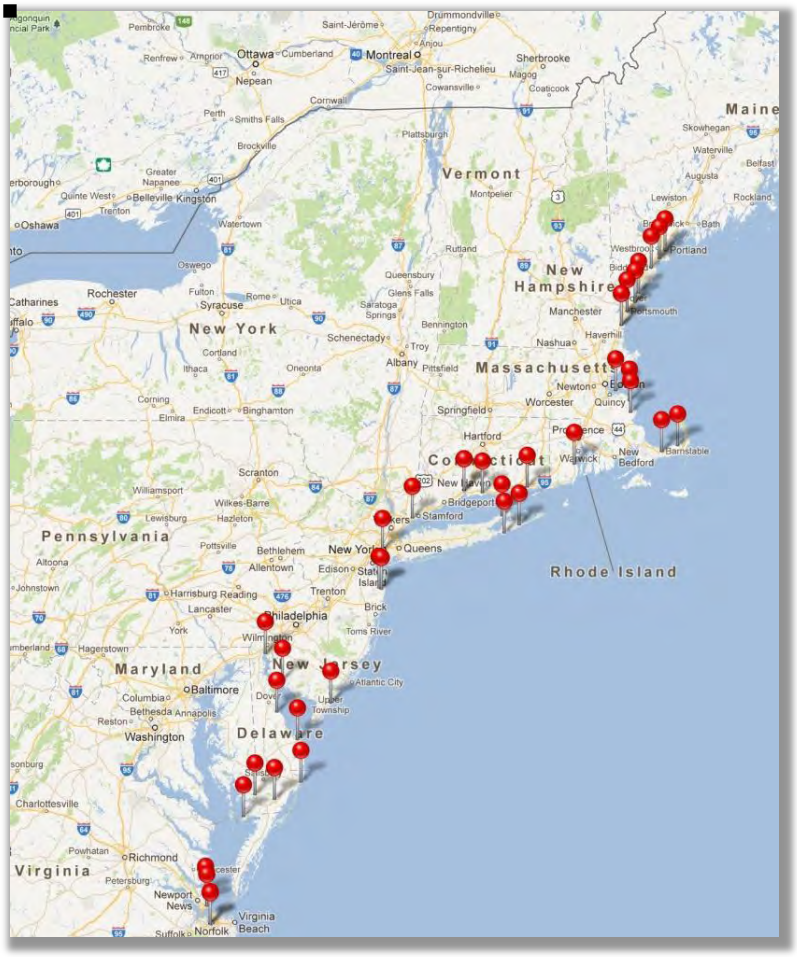

Figure 1:1 - Study Area Map

Communities had coastlines that included bays, harbors, open ocean, and sounds. Two of our sample communities—Sea Isle City, NJ, and Ocean City, MD—were located entirely on barrier islands. The most common were communities located on bayfronts. One municipality, New York City, includes all coastal geomorphologies: barrier islands, including the Rockaways and Coney Island, harborfronts, such as Lower Manhattan; oceanfront not on barrier islands, such as Staten Island's south shore; bayfronts, including areas in Queens and Brooklyn on the Jamaica Bay; and soundfronts, including the southern shore of the Bronx and the north shore of Queens.

The average median per capita income of all our sample communities was $36,588 and the average median household income was $63,240. Median household income varied from just under $27,000 in Crisfield, MD (a fishing community on the Chesapeake Bay), to just over $125,000 in suburban Greenwich, CT. The economic base and character of communities were also determined. Percentage of seasonal housing was used to determine the degree of seasonality in a community. Towns with greater than 20% of their housing as seasonal were considered primarily summer communities. On average, 18% of the housing stock in our profiled towns was seasonal. New Castle City and County, DE, and Portsmouth, VA— primarily suburban and urban places—had the lowest seasonal housing component, with 0.3%; Poquoson, Norfolk, and Hampton, VA—all in the Hampton Roads metropolitan area—had less than 1% seasonal housing. On the other end of the spectrum, in Ogunquit, ME, Sea Isle City, NJ, and Ocean City,

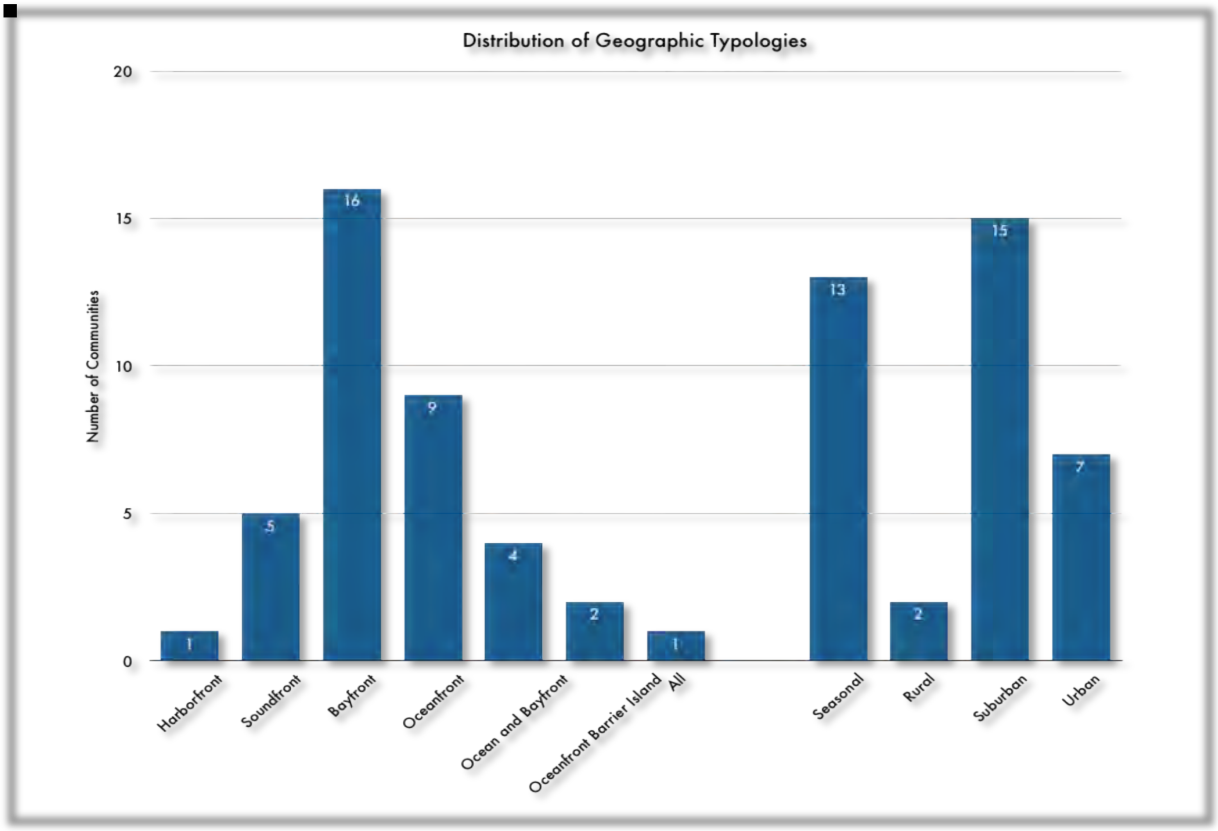

Figure 1:2 - Distribution of Geographic Typologies

MD, seasonal housing represented more than 70% of the housing stock. Thirteen communities were classified as seasonal, 15 as suburban, seven as urban, and two as rural.

Of particular relevance for flood resilience policy, there was a significant variation in tenancy patterns. Over 80% of residences were owner-occupied in Ogunquit, ME, and Little Silver, NJ, whereas only 8.5% and 12% were owner-occupied in the seasonally-dominated communities Ocean City, MD, and Sea Isle City, NJ, respectively. Demographically, our communities ranged from those with over 60% minority populations in New York City and New Haven, CT, to minority populations of less than 4% in Ogunquit and York, ME, and Sea Isle City, NJ. Of all communities studied, the average minority population was 15%.

2. PROJECT DESIGN AND METHODS

2.1. Goals and Objectives

The primary goal of this project was to develop content for regional NOAA outreach efforts by encouraging a peer-to-peer network among community leaders to share flood management best practices. The focus was on identifying and collating management projects and other activities implemented at the municipal scale that could be viewed as low-cost and therefore attractive to potential adopting communities.

2.2. Research Process

Unit of analysis. The study focused on municipal-scale management activities to document projects that local leaders could most readily engage with and consider pursuing. Recognizing that local adaptation activities do not occur in a void, significant efforts were made to identify and document related state, federal, academic, and other programs that provide context and a fuller understanding of observed local actions. In addition, because many local management activities are encouraged or supported by external sources, identifying the primary organizations involved helped identify funding sources and project objectives, which allowed initial cost-benefit assessments to be made.

Data collection protocol. Each profiled community was visited by one or both of the fellows to conduct in-person interviews with municipal elected officials and staff. Others affiliated with the projects, such as committee and board leaders and academic researchers, joined the meetings. Information was gathered in a semi-structured interview format, and details were supplemented by community plans and codes, as well as documents shared by the steering committee, community members interviewed, and internet and other archival research sources.

A list of interviews conducted and interview guide material developed for the study are included in the appendix.

Data selection criteria. The best practices inventory was guided by the following criteria:

- Selected communities were those known to be taking a leadership role or otherwise advanced in activity relating to climate change and coastal flood hazards. To identify the sample of communities selected, the research team relied significantly on steering committee knowledge, as well as independent literature and internet searches.

- Local governments vary in their names and scope of legal authority and organization in the various states. However, all are independent governing bodies with an executive and legislature. Included in our study are cities, towns, townships, boroughs, and counties.

- To meet the definition of a local best practice, an observed policy, project, program, or behavior had to be duly adopted or engaged in by a local government. In addition, the practice needed to be an independent unique activity, supersede a state or federal

requirement, or be a voluntary partnership with higher levels of government or other partners.

- Each activity had to either be directly responsive to or have an impact on climate change or related coastal flood hazards, such as sea level rise and erosion. Inland flood mitigation actions and stormwater issues were noted but not emphasized.

- Given the significant and common challenges climate change poses to local flood managers throughout the region, activities that attempt to incorporate climate change information were noted specifically. Other management best practices were noted but not emphasized.

- The management practice needed to be viewed by local managers as cost-effective.

Fieldwork protocol –

NOAA/Sea Grant
Cost-Efficient Climate Change Adaptation in the North Atlantic Project

Table 2.1. Fieldwork Interview Instrument

Type	Question
General	We know that climate change and its associated impacts - rising sea levels, increased severe storms, and flooding have been identified as an emerging problem for many coastal communities.; Is this something that seems to be relevant in your community? Is this something that you see the elected officials of this community concerned about? Is it something your community members are concerned about?
Policy and Programs	Is this something that seems to be relevant in your community? Is this something that you see the elected officials of this community concerned about? Is it something your community members are concerned about? One of the goals of this project is to identify and measure best practices in each community. We are specifically looking for a low-cost practice that supersedes state and/or federal requirements (FEMA/Coastal Management, etc.)
Motivations	Direct - Have you adopted any regulations as a direct result of concerns about CC and SLR? Incidental - Have you adopted any of these or any other regulations or code changes incidental to CC or SLR (e.g. because of concerns about flooding) that have the effect of adapting to CC and SLR?
Plans	Has the town/city drafted a climate change plan? Do you have a local hazard mitigation plan? A. When was it last updated? B. If yes, has cc or SLR been incorporated into it?
Coastal Zone Setback	Do you have coastal zone setback requirements which exceed state law? How does the setback exceed state law?
Wetland Setback	Do your coastal wetland regulations meet or exceeded state law?
Comprehensive Plan	Do you have an adopted comprehensive plan? If yes, has cc or SLR been incorporated into it?
FEMA/Flood Hazard Management	A) Does the county participate in the CRS? B) Does the county meet or exceed FEMA flood elevation requirements? Do you have a freeboard requirement? In what zone does this apply? C) Is your zoning and/or comprehensive plan integrated with FEMA flood hazard zone maps? D) What percentage of the county is in the 100 year floodplain?
Shoreline Armoring	Do you have municipal regulations controlling shoreline hardening that are different from or go beyond state code?
Climate Change Projections	Have you considered or do you include climate change projections in any aspects of town governance?
Specific Adaptations	Coastal Flood Management -What is your town doing to mitigate coastal flood hazard risk and related hazards/risks (e.g. erosion, wetland loss, and potential sea level rise)? -What coastal hazard management programs, projects, or other activities would you highlight as best practices, from which other towns could learn? Specific Programs or Activities – background and cost effectiveness Getting the story behind a best practice What's the name of the project/practice? Why do you think it's a best practice? Do you think it would work in another town? Why would you recommend another town do something similar? How did this project get started in this town? Why here as opposed to another town?

Who were the key players involved with initiating this project and who led the effort?
Who benefits and who pays? Are there multiple towns involved?
Who else should I talk to get project specifics?
Project Cost
How much did the project cost initially (dollar amount)? How did the project cost compare to the original estimated cost?
Who funded the project?
How much does this project cost to maintain annually (dollar amount)?
Do you consider the project to be low cost? Why or why not?

3.3. Program Effectiveness
3.3.1. What are the goals of the project? What does it intend to accomplish?
3.3.2. Do you think this program is effective? How might it be changed?
Will it be effective in the future? Why or why not?
3.3.3. Can you give examples of specific behavioral, structural, legal, or other institutional adjustments (e.g. zoning) that have resulted from this program?
3.3.4. In what ways is the program low cost compared to observed benefits? In what ways is it expensive?
3.3.5. What should have been done differently for more effectiveness or to save money?
3.3.6. What other lessons have been learned implementing the program or project? What would you recommend to a neighboring community if they were to adopt the best practice?
4. Specific Programs or Activities – best practice assessment
4.1. Environmental Effects and Risk-based Management
4.1.1. Does the project/program include assumptions of a changing climate in any respect? Yes/no.
4.1.2. If yes, how specifically does the project/program account for the possibility of a changing climate?
4.2. Monitoring Program Effectiveness
4.2.1. Is monitoring for effectiveness built into the project or program design?
4.2.2. If yes, what do you use as a baseline and what metrics do you use to measure effectiveness?
5. Repackaging and Best Practice Transferability
5.1. Constraints and Limitations to Consider
5.1.1. What constrains and/or limits implementing the program/project? How were/are these challenges overcome?
5.1.2. What are the principal constraints or limitations that you think would prevent a neighboring community from adopting the best practice?
6. Next Steps
6.1. Best Practice Next Steps
6.1.1. Where does the project go from here? What are the future plans?
6.2. Following Up
6.2.1. May we follow up if have additional questions?
6.2.2. Who else should we talk to about this project?

2.3. **Definitions**

All of the adaptation practices were categorized on a number of different dimensions. The dimensions and their categories are presented on the following table:

Strategy	Retreat	Accommodation	Protection	Prevention	Procedural

Practice Type	Administrative	Plan	Study, Pilot Project	Capital Investment	Law	Policy	Education/ Outreach
Subtype		Comprehensive Plan, Hazard Mitigation Plan, Floodplain Management Plan, Comprehensive Plan, Green Infrastructure, Other		Infrastructure (Green/Gray)	Building, Zoning, Green Infrastructure	Building, Zoning, Infrastructure	

Explicit Incorporation of Climate Change	Yes	No

Phase	Proposed	In Progress	Completed	Implemented

Impact	Recommendation	Mandatory	Incentive

Independence of Action	Above Required	Unique

ADAPTATION CATEGORY DEFINITIONS

1. Strategy (Retreat, Accommodation, Protection, Prevention, Procedural)

In 1990, the Intergovernmental Panel on Climate Change (IPCC 1990) identified three types of strategies to adapt to sea level rise: retreat, accommodation, and protection.

Retreat (Restoration) –Measures taken to "restore" natural ecosystems. The word retreat has negative connotations, and it may feel threatening and defeatist by communities facing difficult questions about their survival in the face of climate change and sea level rise. Retreat has been defined in the literature as "allowing for existing coastal ecosystems to shift landward." Restoration/Retreat is the least common type of adaptation taken because it involves high costs, both economic and political. Examples in our survey include targeted buyouts of repetitive loss properties, transfer of development rights programs that shift development away from shorelines, and purchase of development rights programs.

Accommodation –adaptations that strengthen the resilience of existing or new structures but do not attempt to prevent flooding or the advance of the sea. Examples of accommodation are freeboard ordinances, foundation requirements, flexible height limits to allow for building elevation, or allowing the placement of utilities on the roofs of buildings.

Protection –actions taken to protect land from exacerbating coastal hazards such as flooding. These may be adjustments to hard structures such as elevating dikes and sea walls or soft

solutions including beach nourishment projects. Because of the acknowledgement that backyard structures tend to cause damage to the natural coastal geology and often result in the destruction of wetlands, beaches, mud flats, and other coastal habitat, governments at all levels have been discouraging or prohibiting new hard structures. However, communities whose coasts are already mostly hardened see strengthening these structures as an important component to adaptation. Actions such as elevating roads or bridges were also classified as protection.

Although we identified many adaptations as falling within the three categories above, one of the key findings of our research is that this widely cited classification system is inadequate. Many adaptations—in fact, the most common type of adaptations we found—do not fit within these three, and hence we propose two additional types: prevention and procedural.

Prevention - actions taken to protect or preserve land in its natural state that prevent exacerbation of coastal hazards. Although it could be subsumed under retreat, prevention connotes a very different type of adaptation—one that is anticipatory rather than reactionary. It implies action taken to prevent worsening of exposure to hazards compared to action taken to reverse damage that has already occurred. In our study, actions such as land conservation programs, coastal setbacks, and wetlands buffers are defined as prevention. We found far more prevention actions than any other type of implemented adaptation.

Procedural - projects such as studies, mapping exercises, administrative or educational programs, or those projects that incorporate climate change considerations into other administrative processes. By far the largest number of adaptations found were of this type, indicating that communities are actively gathering data and incorporating information into planning and other procedures.

2. Status - (Implemented, Completed, In-Progress, and Proposed)
Status connotes the phase of implementation of the adaptation.

Proposed - a project that is beyond conception and may have partial support or funding but has not yet begun.

Completed - an action that is finalized but has not yet been implemented. Some administrative actions, such as incorporating climate change into a comprehensive plan, are described as competed, in the sense that the plan is formalized, because implementation cannot easily be determined.

Implemented **-** actions that have been demonstrably completed (e.g., infrastructure projects built) or laws that have been passed and are in effect and enforceable.

In Progress **-** projects that are funded and currently underway.

Explicit Incorporation of Climate Change **- (Yes, No)**
Describes whether a project includes specific mention or was designed to be responsive to evidence of a changing climate, including projects that respond directly to sea level rise. .

Yes - Project mentions, is based on, or responds to climate change or sea level rise specifically.

No - Project has an impact on climate resilience but does not specifically respond to or incorporate climate change, such as flood protection and land preservation. Many types of adaptations, particularly local ordinances, fall into this category

3. Practice Type (Administrative, Plan, Study/Pilot Project, Capital Investment, Law, Policy, Education/Outreach) and Subtypes

Administrative - activities taken by a government that involve process, such as the establishment of a committee.

Plan – projects that involve drafting a new plan specific to climate change or those that incorporate climate change or sea level rise into an existing plan, such as a comprehensive or hazard mitigation plan. Some Studies/Pilot Projects involve drafting a plan, but are primarily classified as the former.

Subtypes: Comprehensive Plan, Hazard Mitigation Plan, Green Infrastructure, Other Plans

Study/Pilot Project - projects that engage research to create knowledge about the impacts of climate change. These are often partnerships or multi-organizational efforts that involve non-profits, universities, state coastal programs, and municipalities.

Capital Investment - projects that use capital funds to invest in (typically) infrastructure to increase resilience. Funds can be received through taxes and fees, or obtained through grants.

Subtypes: Green Infrastructure, Gray Infrastructure

Law - a duly enacted and enforceable local bylaw or ordinance passed by the elected body of the local government that regulates private actions and provides for penalties for violation.

Subtypes: Building, Zoning, Green Infrastructure,

Policy - actions taken to impact internal municipal activity or decision-making.

Education/Outreach - projects to help build knowledge among homeowners and local residents.

Building - regulates building codes or standards, such as freeboard.

Comprehensive Plan - involves required or voluntary comprehensive land use planning document for the community.

Hazard Mitigation Plan - project involves an all-hazards mitigation plan.

Infrastructure (Gray) - projects that use hard or soft infrastructure approaches to build resiliency, such as beach replenishment, stormwater upgrades, or elevating bulkheads.

***Infrastructure (Green)* -** projects that use natural systems to build resiliency, such as the establishment of an open space fund or repetitive loss buyouts.

4. Impact (Recommendation, Incentive, Mandatory)

***Recommendation* -** the outcome of the project is a set of recommendations that do not have force of law.

***Incentive* -** project influences subsequent actions by proving some type of special benefit.

***Mandatory* -** requires action by force of law.

6. Independence of Action (Unique, Above Required)

Unique - action is distinct to the community and not otherwise required by law, although many involve other communities or agencies as partners. Actions such as local waterfront revitalization plans in New York are considered unique because they are completely voluntary, although the state sets standards and approves the plans.

Above Required - action exceeds minimum required by law (such as municipal freeboard requirements in Maine, where the state sets a minimum of 1 foot of freeboard), or the inclusion of climate change in a comprehensive plan (such as in Connecticut, where plans are required by state law).

COMMUNITY TYPOLOGIES

Coastal Geography - (Oceanfront, Bayfront, Soundfront, Harborfront, or both Bay and Oceanfront)

The predominant geography was identified. Communities that had two distinct shores could be considered both, but towns entirely on barrier islands were classified separately as such. Only one community, Portsmouth, NH, was classified as harborfront since the largest body of water it fronts is otherwise a river.

Oceanfront **-** community has an open ocean shoreline. Communities fronting an open coastal bay, such as the Saco Bay in Maine, were characterized as oceanfront. Communities on barrier islands are both ocean and bayfront.

Bayfront **-** communities with coastal frontages only on sheltered bays (e.g., Delaware Bay and Chesapeake Bay).

Soundfront **–** Merriam-Webster defines a sound as "A long broad inlet of the ocean generally parallel to the coast," "a long passage of water connecting two larger bodies," or "separating a mainland and an island." The only soundfront communities in our study fronted the Long Island Sound either in New York or Connecticut.

Harborfront – One community in our study only fronted a harbor – a sheltered body of water, in this case, with an outlet to the Atlantic Ocean just a few miles downriver.

Type - (Seasonal, Suburban, Urban, or Rural)

Seasonal **-** communities with more than 20% of their housing reported as seasonal based on census data.

Suburban - metropolitan communities not the center of their urbanized area.

Urban - metropolitan communities that have a primary downtown or commercial district in their urban areas.

Rural – Low-density, primarily agricultural or resource-based communities.

3. BEST PRACTICE RESULTS

3.1. MAINE

3.1.1. OGUNQUIT, ME

Population Density	299/ sq. mi.
Form of Government	Town
Category	Oceanfront Seasonal
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
56591	44732	83.1	892	-5.3%	97.0	2%	2%	71.8

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	Zero	None
Redefined Mean High Water to increase margin over current observations by 4 feet	Implemented	Yes	Procedural	Mandatory	Unique	Zero	None
Sea Level Rise Study (Sewer District)	Completed	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	Other

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POPULATION AND GEOGRAPHY

Located on the Wells Bay, Ogunquit is a well-known summer tourist destination in York County, Maine. The town is bordered by the towns of York, Wells, and the Atlantic Ocean to the east. Ogunquit has an area of 4.3 square miles of which 0.2 miles is water. According to the comprehensive plan, the town, "despite its diminutive size, is bursting with special places that define the community." Among those places include the Marginal Way, a unique seaside trail with cliffs and spectacular views that connects Ogunquit Beach and Perkins Cove. Ogunquit is also home to a number of notable cultural amenities including the Ogunquit Playhouse. It has a vibrant historical downtown area as well as farms, woodlands and seacoast, and is a popular destination among members of the LGBTQ community.

Its census reported population was 892, but almost 72% of the housing stock is reported as seasonal, indicating a much larger summertime population. The community is wealthy and white. Of the year-round population, minorities only represent 2% and the median household income is over $56,000.

COASTAL ISSUES

Ogunquit has 97 acres of coastal wetlands that are at risk from coastal flooding, and some flooding already occurs in the Perkins Cove neighborhood. However, due to topography, most of Ogunquit's building stock appears relatively insulated from direct coastal flooding impacts. Predicted impacts to the built environment under a 2 foot sea level rise scenario are localized and minimal.

The town decided to focus its attention on the sewer district plant, as it was identified as a major asset at risk from sea level rise, and has indeed already been experiencing significant flooding, most recently during the Patriot's Day Storm in 2007. The Ogunquit Sewer district pump station could be at risk after 1 meter of sea level rise.

ADAPTATIONS

Comprehensive Plan Incorporates Climate Change

Ogunquit is taking a comprehensive approach to preserving its unique qualities. Its comprehensive plan promises that Ogunquit Beach will "continue to be the premier ocean beach in Maine and the dune system will have been protected." In addition, the plan indicates that

rivers and streams will be preserved, its rural areas will be protected development, and its historic pedestrian-oriented downtown will be enhanced and expanded. (p. 5-2)

The plan identifies sea level rise as a risk in its natural and marine resources section. It says that sea level rise would have the most significant effect on coastal flooding. It suggests that the town's floodplain ordinance might need to be revised in light of these concerns (p. 4-3).

The plan recommends that future development not be permitted in floodplains and that "existing development and incompatible land uses should not be allowed to expand and should be amortized for their eventual elimination, to the maximum extent feasible" (p. 4-6).

The plan recommends the town adopt a policy "to require detailed consideration of appropriate climatological factors including the potential for sea level rise, in the design and siting of all future development" (p. 6-4).

It recommends the town implement the policy in the following ways:

A. Require all land uses...in areas subject to predictable storm tides and flooding appropriate steps be taken to avoid such likely damages.
B. Continue to require that applicants for the approval of development proposals submit appropriate if ration regarding how climactic factors, energy conservation and human comfort have been considered in project planning.
C. Modify the land use regulations in coastal areas to reflect the potential for sea level rise and require that development proposals in these areas be sited and designed to accommodate this possibility. (p. 6-4).

Shoreline Setbacks

The town is using a unique legal method to increase its shoreline setback without changing the setback itself, but rather by amending the definition of normal high water upon which the setback is based.

The highest annual tide predicted for the region is generally about 7 feet above mean high water. By amending its definition of "normal high water" to 11 feet above mean sea level, the town includes a margin of about 4 feet for sea level rise, which is also 2 feet higher than the FEMA 100-year designated floodplain.

The adopted language reads as follows:

> In the case of land adjacent to tidal waters, the normal high water line shall be considered to be the contour line at an elevation of 11.0 feet above mean sea level as determined by a land surveyor based on the nearest USGS benchmark. (Town of Ogunquit, ME, Town Code, Art. 2, Definitions, p. 24)

Ogunquit Sewer District Study

The town of Ogunquit received an NROC & GOMA Coastal Resilience Grant through the New England Municipal Coastal Resilience Grants Program.

The Ogunquit Sewer District recently undertook a study to specifically look at the impacts of sea level rise, storm surge, and flooding at its wastewater treatment plant. The plant provides secondary treatment for approximately 1.28 mgd of sanitary waste water and operates 12 pumping stations and 20 miles of sewer lines. In 2011, the Maine Geological Survey, the Southern Maine Regional Planning Commission, and the town collaborated on the Coastal Hazard Resiliency Tools project. The town identified its WWTP as at risk and the MGS prepared simulations projecting sea level rise for the plant.

Figure 3.1.1:1 - Ogunquit's treatment plant is located just over the primary dune

The study was undertaken because of the significant risks to the plant, its aging infrastructure, and regulatory concerns. The plant has experienced significant flooding in the past, particularly during the Patriot's Day Storm in 2007. It is located in a coastal sand dune system and within the coastal barrier resource system. The study was based on projections of 1 foot of SLR by 2050 and 3.2 feet by 2100.

The analysis showed that by 2050 the access road to the plant would flood in the 100-year storm, and by 2100 a 100-year storm would inundate the site and be close to inundating the outside process tanks. Given projected sea level rise, the risk analysis concluded that there is no practical solution that allows the plant to be viable on the current site beyond 2052. The plan concluded that "even under the best scenarios, there appears to be no practical long-term solution that would feasibly allow the town to continue utilizing the WWTP site beyond 2032-2052 given current projections." Major flooding would shut the plant down, cause the beach to be closed, and cause significant public health and image issues for the town, which relies on tourism and its image of an environmentally conscious, attractive community.

The sewer district is considering all options to deal with the projected issues, including moving to a new site, or shutting the plant down and regionalizing with another utility. Eroding dunes and the sea wall will become more susceptible to failing during storms and it is estimated that the dune will deteriorate completely within the next 50 years.

3.1.2. SCARBOROUGH, ME

Population Density	270/ sq. mi.
Form of Government	Town
Category	Suburban Oceanfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
72805	34083	69.9	18919	1.08	94.9	1%	5.9%	8.6

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Cluster Zoning Ordinance required in coastal zone	Implemented	No	Prevention	Mandatory	Unique	Low (< $10,000)	None
Flood Ordinance Notification Provisions	Implemented	No	Procedural	Mandatory	Unique	Very Low (< $1,000)	None
Growth Management Ordinance/Residential Development Cap	Implemented	No	Prevention	Mandatory	Unique	Very Low (< $1,000)	None
Open space fund	Implemented	No	Prevention	NA	Unique	NA	Other
Saco Bay Regional SLR Working Group	In Progress	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	State

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POPULATION AND GEOGRAPHY

Scarborough is located 7 miles south of Portland and is in the Portland-South Portland-Biddeford metropolitan statistical area. Scarborough has recently endured significant changes in its land use and population, as growth from the Portland area has spread in its direction.

Its population in 1990 was 12,518, growing to 16,970 by 2000 and 18,919 by 2010, , with a population density of 270 persons per square mile. Its growth rate is among the most rapid of any community in our study. The town has a median per capita income of $34803. The town is 94% white non-Hispanic. Blacks comprise .5% of the population and Hispanics just over 1%, making Scarborough one of the least diverse communities in our survey.

Scarborough comprises an area of 70 sq. mi., 47.6 of which is land and the remainder water. Elevations range from sea level to 215 feet along Beech Ridge and east of Burnham Road. The coastal landscape, like much of Maine, has sandy beaches interspersed with outcrop of bedrock at or near the ground. (Scarborough Comprehensive Plan 2006, p. 21). With more than 3,100 acres, Scarborough is home to the largest coastal wetland system in Maine. The Scarborough Marsh estuary system "is a complex of ebb and flood tide deltas, salt marshes, tidal flats, and meandering tidal channels." (p. 14) The surface of the marsh is mostly owned and maintained by the U.S. Fish and Wildlife Service, but the edges and uplands are in private ownership. The town protects these freshwater and forested wetlands with resource protection zoning in accordance with state law.

Interstate 95 travels through the town, which is bordered by Cape Elizabeth to the northeast, South Portland to the north, Westbrook to the northwest, the towns of Gorham and Buxton to the west, and project-profiled towns of Saco and Old Orchard Beach to the south. Scarborough has been growing both as a residential community and job center. The comprehensive plan reports that there were 3,516 jobs in the town in 1980, and by 2000 there were just under 10,000. There is significant commutation to the town, with only one-quarter of all employees living in the town. Retail has grown as well, with a significant increase in the tax base. Retail has grown around the Maine Mall and medical uses have expanded on Route 1 North. An area of town called Oak Hill has also experienced extensive growth, and the town has encouraged development in the Enterprise Business Park. The town is headquarters for Hannaford supermarkets.

COASTAL ISSUES

The plan describes the town's coastline as containing "long sandy beaches, rocky headlands, working harbors, and quiet tidal marshes that reach inland for miles" (p. 4-1).

Three historic summer colonies—Pine Point, Prouts Neck, and Higgins Beach—are located in the town and, although the town has shore protection zoning and provisions in its comprehensive plan to limit growth in these areas, existing structures are predicted to be at risk under sea level rise scenarios.

Higgins Beach has been receding in a landward direction and the spit has extended to the northeast throughout known history. (Higgins Beach Management Plan, Sec. 3.4 - 3.9) A major nor'easter hit the area in 1978, which caused significant damage to Higgins Beach. A hotel and a portion of the seawall were damaged beyond repair, and many cottages and seawalls were damaged in the storm. Flooding was also a major problem especially in the low-lying area near the rear of Higgins beach. The surge overtopped the seawalls and reached cottages in the second and third row behind the beach.

Coastal storm damage resulted from:
- The location of structures too close to the beach
- The poor design and inadequate protection of some existing seawalls
- Floating debris borne by wave surge
- Flooding due to high storm tides and inadequate drainage of the beach residential area after the storm tides waned
- The inability of existing beach and dune environments to perform their natural storm wave energy absorption and flood prevention potential.

Under scenarios that modeled the existing 2010 highest annual tide (HAT), HAT plus 2 feet of sea level rise, and the storm of record (February 7, 1978), highest observed water level plus 2 feet of sea level rise, portions of the Spurwink and Scarborough River watersheds are at risk, as well as the Higgins Beach area. Under the existing HAT scenario, buildings in two areas - near the Scarborough River and in Pine Point, are at risk from flooding. (SLAWG 2011, p. 5-6) Within Scarboruugh, over 600 existing buildings—with a combined structure and land value of over $98 million—may be adversely impacted by flooding under a HAT + 2 ft scenario. Under the 1978 storm + 2 ft scenario, there are more than 1,100 potentially impacted buildings whose value exceeds $311 million. (p. 8)

ADAPTATIONS

Cluster Zoning

The town has a cluster subdivision design ordinance that is required to be used in the coastal zone. The purpose of the law is to "conserve and protect the town's freshwater wetlands, watercourses, farmlands, open space and natural features, while enabling more flexibility for residential developments to design around these natural features and resources." (Scarborough, ME. Comprehensive Plan, Sec. VII (A))

In three zoning districts, (RFM, RF and R-2), conservation subdivision design is required when:

a. The land to be subdivided contains one acre or more of wetlands.
b. Twenty percent (20%) or more of the land to be subdivided is wetlands.
c. Twenty percent (20%) or more of the land to be subdivided is within the Shoreland Zone under the Town of Scarborough Shoreland Zoning Ordinance.
d. A subdivision will alter (through lot configurations and road, driveway, and utility crossings) 4,300 square feet or more of wetland if designed and developed in a conventional layout.
e. A subdivision proposes to include two-family and/or multi-family dwellings.

The town has used the ordinance to set back coastal development and preserve vulnerable habitats. One example of implementation of the law was in the high-density storefront community of Pine Point. Through a developer agreement, the town was able to obtain beach land in exchange for higher-density lots.

Flood Ordinance

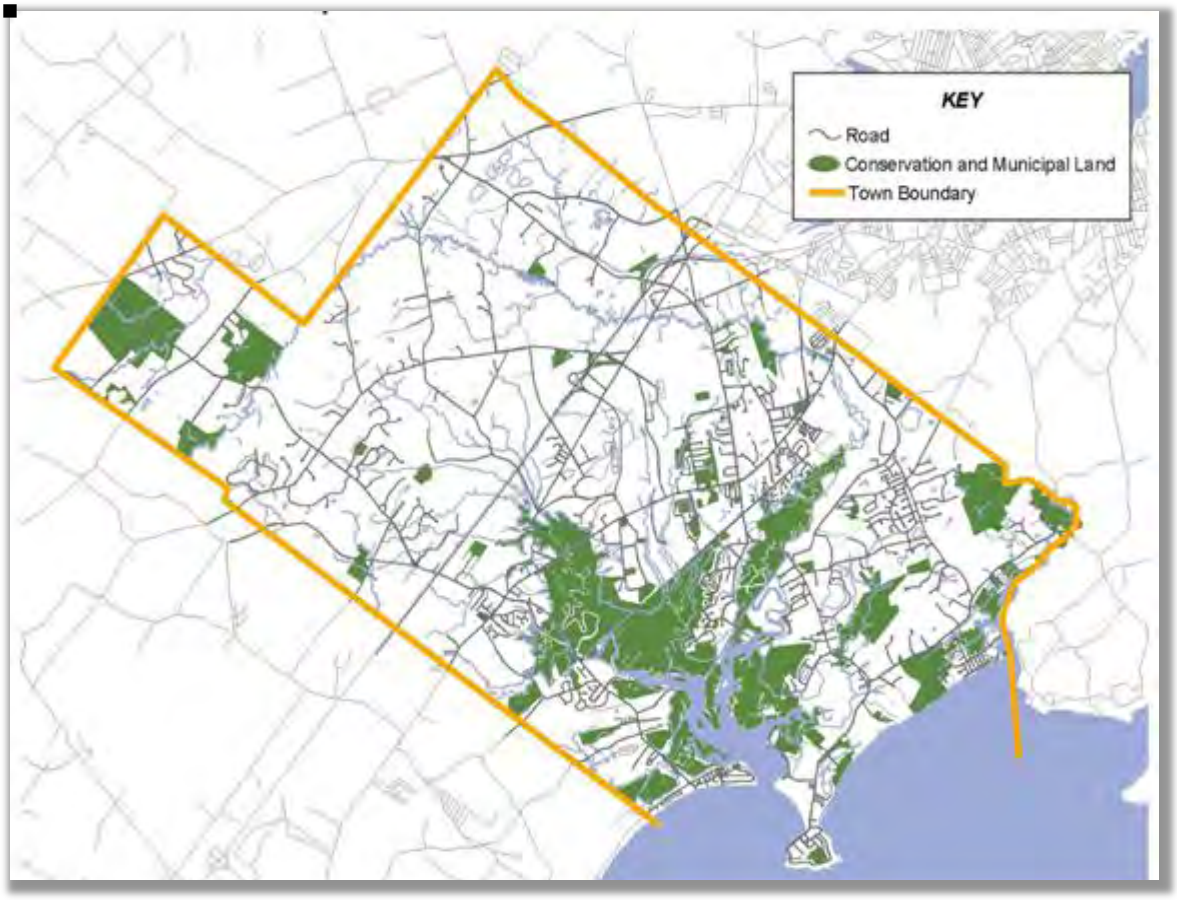

Figure 3.1.2:1 - Map depicting open space and conservation land in Scarborough. The 3,100-acre Scarborough Marsh is the contiguous area south of the town.

The town maintains a unique enforcement mechanism in its flood ordinance. It provides that its code enforcement officer shall, upon determination of a violation of the ordinance, submit a declaration to the Federal Insurance Administration, requesting a denial of flood insurance. (Scarborough, ME. Town Code, Art. XI.)

In addition, the code requires special notification to applicants who obtain a variance for construction in the floodplain. The Chairman of the Board of Appeals must notify in writing that: The issuance of a variance to construct a structure below the base flood level will result in

greatly increased premium rates for flood insurance up to amounts as high as $25 per $100 of insurance coverage; that such construction below the base flood level increases risks to life and property; and, requires the applicant to agree in writing that he or she is "fully aware of all the risks inherent in the use of land subject to flooding, assumes those risks and agrees to indemnify and defend the municipality against any claims filed against it that are related to the applicant's decision to use land located in a floodplain and that the applicant individually releases the municipality from any claims the applicant may have against the municipality that are related to the use of land located in a floodplain." (Scarborough, ME Town Code, Art. XI, F.1.)

Growth Management Ordinance

From 1990 until 2002, over 2,000 new housing units were built in Scarborough. Concerned with the town's rapid population growth, the town established a Growth and Services Committee that concluded that a town-wide residential development limit should be enacted. The town subsequently enacted such a limit and an impact fee ordinance as well, which slowed growth to 125–150 units per year. Most of this growth, due to the plan and conservation mechanisms in place, occurred outside the floodplain and the immediate coastal zone of the town.

The most recent update to the Comprehensive Plan, finalized in 2006, continues to attempt to influence the development patterns of the town in the direction of smart growth, "recommending higher density development in some parts of the designated Growth Area and limiting the rate of residential development that will be allowed in the designated Limited Growth Area." (p. 1-2)

This comprehensive planning scheme has helped reduce development in the coastal areas, floodplains, and vulnerable inland wetlands. The plan categorizes the three historic summer colonies of Pine Point, Prouts Neck, and Higgins Beach as part of the "limited growth area," because there is little vacant land, they are already developed at a density consistent with historic communities in Maine, and the town's plan limits enlargement of the residences. Scarborough Marsh as well as other wetlands and floodplains, including the Nonesuch Ricer and Spurwink River, are categorized as no growth areas.

Open Space Acquisition

The Scarborough Parks & Conservation Land Advisory Board is a standing committee and an advisory board to the Town Council. The board drafts the Acquisition Evaluation Process to evaluate potential acquisitions, consistent with the Parks and Land Conservation Bond Taskforce Report and the Land for Scarborough's Future Ordinance and advises the Town Council on land acquisitions.

The town also supports the Scarborough Land Conservation Trust, whose mission is the acquisition, preservation, and management of unique land within Scarborough for the benefit and enjoyment of the public. The trust owns 946 acres of conserved land as well as two conservation easements and one management easement.

The comprehensive plan supports the goal of integrating land conservation objectives with coastal resilience. Action C.1.e. calls for the town to "Target floodplains, riparian corridors, and buffer zones along water bodies in land protection efforts, whether through the Town of

Scarborough Parks and Conservation Land Advisory Board or other local conservation organizations, in order to maintain or restore vegetated buffers along water bodies." (p. 5-7)

Saco Bay Regional SLR Working Group

The Sea Level Adaptation Working Group (SLAWG) is a committee comprised of two members from each town in the Saco Bay region—Saco, Biddeford, Old Orchard Beach, and Scarborough.

The group completed a regional action plan in 2011 and it continues to be actively engaged in adaptation in the region. As stated in the action plan, "The purpose of the Sea Level Adaptation Working Group is to review information from the Coastal Hazard Resiliency Tools Project that has analyzed the problem of sea level rise, to create a Vulnerability Assessment for Saco Bay, and to develop and implement an Action Plan of implementation strategies for regional solutions." (SLAWG Action Plan).

The action plan and vulnerability analysis were funded by the Maine State Planning Office, the Maine Coastal Program, and NOAA. The vulnerability assessment used the best available data from local governments and state and federal agencies to identify buildings, infrastructure, and natural areas vulnerable to storms and sea level rise. Specific goals of the project include providing for public safety, protecting property, protecting the economy, preserving natural features, and promoting efficiency by working together as one region.

Further information about the SLAWG is provided under the Town of Saco.

3.1.3. SACO, ME

Population Density	480.6/ sq. mi.
Form of Government	Town
Category	Oceanfront Seasonal
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
73907	39548	49.6	12529	-0.26	97.6	1%	3.1%	31.6

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Freeboard - 3 Ft	Implemented	No	Accommodation	Mandatory	Above Required	Very Low (< $1,000)	NOAA
Saco Bay SLR Working Group	In Progress	Yes	Procedural	Recommendation	Unique	Medium (<$100,000)	NOAA
Shoreland Zoning	Implemented	No	Prevention	Mandatory	Above Required	Medium (<$100,000)	State

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POPULATION AND GEOGRAPHY

The city of Saco, located on the southern Maine coast, fronts the Saco Bay. Shaped like an L, its boundaries contain a large inland area on the west where it borders the Town of Buxton. On the north is the town of Scarborough; to its northeast and north is Old Orchard Beach. Its downtown straddles the Saco River across from southern neighbor Biddeford. Saco, along with neighboring towns, has become absorbed in the orbit of the Portland metropolitan area. The town says it,

along with Biddeford, is the banking, retail, service, and manufacturing center of southern Maine.

Saco has a diverse economy, as indicated by its equal emphasis on its beaches, fishing harbor, and high-tech industry and commercial enterprises. This balance has characterized the city for much of its history; it has long been an industrial center, with red brick mills along the Saco River.

The city is located within 20 miles of Portland and, like many of its neighbors, has been growing significantly as development spreads out from the city's center. With a population growth rate of just over 1%, Saco is a fast-growing community and is the third-fastest-growing community in our sample. Population growth has slowed from highs in the 1980s and 1990s. This suburban growth has nearly all taken place in the town's western region, away from the immediate coast.

Despite its being known for the bay of its namesake as a summer resort adjacent to Old Orchard Beach, only 5.1% of Saco's housing stock is for seasonal use.

COASTAL ISSUES

The hazard mitigation plan identifies the four most notable forms of disasters in town as coastal events, specifically hurricanes; major flooding of the Saco river; localized flooding due to intense storms; and wind and ice damage to overhead utility lines (Saco, ME. Hazard Mitigation Plan, p. i).

Saco was an early participant in FEMA's Project Impact hazard mitigation program, which it joined after experiencing significant effects from historic storms such as Hurricane Bob, the October 1992 storm, and a 19-inch rainfall storm in 1996 (p 1).

The city has been active in hazard mitigation and obtained many grants from FEMA over the past 20 years. In 1998, the city won a $100,000 grant under the Flood Mitigation Assistance Program and reported great results; it participated in the Masters of Disasters program, educating students in the schools; it undertook a $2.6 million drainage improvement project with $1.7 million in federal funds in 1998; and it won the Project Impact Star Community award in 2000.

In the section on coastal flooding, sea level rise and increase in storm intensity are mentioned as concerns for the town, particularly the Camp Ellis area.

About 35 homes, one restaurant, a few small businesses, and a pier are vulnerable to damage. The plan states that the most at-risk homes are those on conventional foundations built up against the immediate shoreline, and loss of the frontal dune would put these homes at high risk of loss. Although this has been a problem for over a century, the comprehensive plan says that the problem has been aggravated in the past three decades. Over 30 homes have been lost in that time." (Saco, Me. Comprehensive Plan 2011, p. 3-6)

Saco City Planner Bob , explained the gravity of the circumstances: "If you lived in southern Maine and there's a big enough winter or spring storm, then the odds are good that there will be

footage on a local television station of Camp Ellis and the beating it's taking … If there were going to be a Maine community most in need of taking action to prepare for future storms, it would be Saco" (Personal Communication, Oct. 15, 2012). Saco's coastline is a historic community that remains marine-industry based. The comprehensive plan says that it, "in the face of mounting development pressure in southern Maine, has managed to stay relatively undeveloped." (Comprehensive Plan, p.3-7). The plan recommends commercial development be limited to marine- and tourism-related uses and development in the beach area be limited to small-scale residential uses.

ADAPTATIONS

Sea Level Adaptation Working Group

The Sea Level Adaptation Working Group is a committee comprised of two members from each town in the Saco Bay region—Saco, Biddeford, Old Orchard Beach, and Scarborough.

The group completed a regional action plan in 2011 and it continues to be actively engaged in adaptation in the region. As stated in the action plan, "The purpose of the Sea Level Adaptation Working Group (SLAWG) is to review information from the Coastal Hazard Resiliency Tools Project that has analyzed the problem of sea level rise, to create a Vulnerability Assessment for Saco Bay, and to develop and implement an Action Plan of implementation strategies for regional solutions" (SLAWG Action Plan, p. 1)

The action plan and vulnerability analysis was funded by the Maine State Planning Office & Maine Coastal Program and NOAA. The vulnerability assessment used the best available data from local governments and state and federal agencies to identify buildings, infrastructure, and natural areas vulnerable to storms and sea level rise. Specific goals of the project include providing for public safety, protecting property, protecting the economy, preserving natural features, and promoting efficiency by working together as one region.

Principles of the group include a fair balance between retreat and engineering solutions, setting priorities and ranking projects by using cost-benefit calculations, the number of properties affected, criticality of evacuation routes, the preservation of naturals and recreational values, and the number of people served by that infrastructure.

The implementation strategies and objectives include:

- Use regional approaches to plan for sea level rise, identify funding and obtain grants, and support individual municipalities in support of grants
- Create a ranking process to prioritize and comment on projects
- Comment on coastal policy issues such as dune restoration, beach renourishment, and erosion control
- Recommend standardizing of floodplain management, building code, and shoreland zoning and standardizing review and control of water-based activities across municipalities
- Provide non-binding comments on relevant applications

- Coordinate with stormwater planning
- Coordinate with the New England Finance Center in its research on economic impacts of sea level rise
- Monitor changes to statutes and regulations

3-Foot Freeboard Requirement/Flood Protection Ordinance

Saco is the first municipality in the region to adopt a more stringent freeboard requirement than required by FEMA. The ordinance requires elevation of the structure if work involves greater than 50% of the value.

The change was approved smoothly, with unanimous consent of council members and only one resident speaking in dissent. Town planner Bob Hamblen was quoted as saying, "Coastal homeowners have been receptive of the policy...some really appreciate the city partnering with them in this" (Clean Air Cool Planet, n.d.). Mr. Hamblen attributed the idea and instigation of the ordinance as a result of the research done by the Saco Sea Level Rise Adaptation Working Group. He also said, "In a lot of ways, Saco was the perfect community to consider changes to the floodplain ordinance ... We've seen in very real terms what can happen to structure down at the beach" (Personal Communication, Oct. 15, 2012)

3.1.4. YORK, ME

Population Density	229/ sq. mi.
Form of Government	Town
Category	Seasonal Oceanfront
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
73907	39548	49.6	12529	-0.26	97.6	1%	3.1%	31.6

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	Other
Flood Hazard Development Permits Apply to Minor Projects	Implemented	No	Accommodation	Mandatory	Above Required	Zero	None
Freeboard Requirement - 2 or 3 Ft.	Implemented	No	Accommodation	Mandatory	Above Required	Zero	None
Transfer of Development Rights	Implemented	No	Prevention	Permissive	Unique	Zero	None

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POPULATION AND GEOGRAPHY

The town of York—although technically in the Portland census metropolitan statistical area—is located in extreme southern Maine, only 5 miles from the New Hampshire border. Its famous Gulf of Main shore is to the east, while the towns of Kittery and Eliot border its south. South Berwick is on the northwest, and Ogunquit to its north along the coast. It has a land area of nearly 55 square miles and a population density of 229 people per square mile.

York has been a summer resort for the well-off for more than 100 years. The resort area is famous for its beaches—York Beach, Long Sands, and Short Sands Beach—as well as the historic villages of York Harbor, York Village, York Beach, and Cape Neddick, which became popular destinations in the early 20th century. York reportedly has the highest real estate values in the state of Maine. Its median household income of $73,907 is likely skewed low because many owners of second homes are not counted in the census—over 31% of the housing stock is reported as seasonally occupied. York's population is over 97% white.

York's landscape is characterized as rugged. (York, Me. Comprehensive Plan, Natural Resources Chapter, p. 3) The town's 55 square miles are also geographically diverse, with elevations that range from sea level to the 692-foot-high Mount Agamenticus, which is only 5 miles from the beach. Much of the town's remaining open space has been preserved. Over 6,000 acres of contiguous land remains preserved in its natural state.

COASTAL ISSUES

The York coastline is characterized by sandy beaches of up to a mile long that terminate in headlands. The historic villages, particularly York Beach, are located in vulnerable locations; significant flooding recently occurred during the Mother's Day and Patriot's Day storms. About 10 repetitive loss flood properties are in town.

The comprehensive plan characterizes much of this development as having occurred in environmentally unsuitable areas, such as coastal dunes and former salt marsh behind the primary dune. In a rare acknowledgement that the existing historic community might have been a result of flawed planning in the past, the plan boldly states, "many of the current land use problems faced in York are a result of uninformed decisions over 100 years ago" (York, Me. Comprehensive Plan (2007), Natural Resources Chapter, Inventory and Analysis, p. 4)

The town also readily acknowledges in multiple documents the impact that sea level rise will have on the community. The existing plan is being updated to include a chapter to look at the issue in much more detail, though the current plan characterizes the issues that sea level rise will bring, including rising floodplains, the degradation of salt marshes into mud flats, worsening erosion and destabilizing shorelines, and threats to the coastal road network.

ADAPTATIONS

Sea Level Rise Incorporated into Comprehensive Plan

Sea level rise is addressed in parts of the current comprehensive plan, and the town is drafting an entire chapter on sea level rise for its upcoming plan update.

The current plan contains a sea level rise subsection of the Coastal Resources Inventory & Analysis section of the Natural Resources Chapter, and contains a specific goal to implement a variety of strategies to adapt to sea level rise. The plan considers sea level rise and the impact it will have on the exacerbation of coastal flooding, as well as shoreline stability as a specific risk to natural resources (p. 6) The plan also frames the goal of coastal sand dune protection as a bulwark against sea level rise. (p. 39) It states, "The buffering function will become more vital ... development of municipal policies regarding dunes must occur in conjunction with a response to the issues of sea level rise and beach erosion." (p. 40)

The section on Sea Level Rise cites the State of Maine marine geologist's prediction of a 2-foot sea level rise in a century. The plan acknowledges the lack of specific data, which is one reason the town is pursuing the current effort to expand the analysis. It nevertheless states that "it is clear that properties within the 100 year floodplain today will remain in the flood prone area and the floods will become deeper." It recommends the town should "pursue preventative policies such as requiring greater freeboard in new construction and renovations" (p. 44).

The impacts on salt marshes and erosion are detailed, and the section asks questions about policies of the town, such as "When large coastal storms hit, should the Town automatically pursue rebuilding roads ... and infrastructure where it exists today?" (p. 44) What role should the Town have in permitting homes to be replaced on site?" (p. 44) The section recommends these issues integrate with emergency planning.

Community Development Director Stephen Burns described the reason the town is choosing to address sea level rise in its comprehensive plan: "We felt it was important to address regardless of the cause, whether it is man-made or not, because the sea level is going up—the gauges prove it—we need to figure out what it means for us" (Personal Communication, Oct. 17, 2012). While aware that other towns, such as Ogunquit, have made code changes to respond to sea level rise, York felt it was important to address it in the comprehensive plan first.

The amendments the town is making to its comprehensive plan are:

1. Amend the "Sea Level Rise" and "Beach Erosion" subsections of the existing Coastal Resources Inventory & Analysis section of the Natural Resources Chapter.
2. Add a new Inventory & Analysis Chapter entitled: "Adaptation to Sea Level Rise;" and
3. Add new Town Goals and Town Actions Under State Goal 6, to Implement a Variety of Strategies to Adapt to Sea Level Rise

The last of these is particularly significant, since the last adopted plan, while it presented the threats, did not include any specific strategies to adapt. This is taken seriously, since Maine law requires town codes to be in compliance with Comprehensive Plans within 2 years of adoption.

Funding to draft the SLR chapter, in the amount of $7,000, came through the Southern Maine Regional Planning Commission, with a grant from the Maine Coastal Program, Maine Department of Agriculture, Conservation and Forestry. The town provided a match in staff time and soft costs.

Transfer of Development Rights Program

The town recently instituted a Transfer of Development Rights (TDR) program to discourage development in coastal wetlands in York Beach. The program was instituted after homeowners brought regulatory takings cases against the town, and the courts accepted the use of TDR as just compensation.

Owners of wetland property can now transfer the development rights to an area outside the wetlands. There is no credit bank, so the program only works if a seller can find a willing buyer. Unfortunately, the town has not yet seen any TDR transactions.

The program does not allow building in a wetland, but it allows landowners to recoup some of the loss of value from the development prohibitions.

2 or 3 Foot Freeboard Required

While the State of Maine requires a minimum of one foot freeboard, the town's floodplain management ordinance goes further and requires two feet of freeboard. The ordinance applies to all new construction or substantial improvement of any residence. Within the AE and A zones, the lowest floor must be elevated to two feet above base flood. (York, Me., Town Code, Floodplain Management Ordinance, Art. VI(F)) Zone AO requires "adequate drainage paths around structures on slopes, to guide floodwater away from the proposed structures," and elevation of the structure:

a. at least two feet higher than the depth specified in feet on the community's Flood Insurance Rate Map; or,
b. at least three feet if no depth number is specified. (Art. VI. F.3.)

Similar provisions also apply to manufactured homes. (Art VI. H.)

For Non-Residential structures, either two feet of freeboard is required or, alternately, structures can be floodproofed to two feet above the base flood elevation. Bridges in the AE, AO, A, and VE zones are also required to have the lowest horizontal member excluding pilots elevated to 2 feet above base flood. (Art. VI. M.)

Flood Hazard Development Permits Apply to Minor Projects

In York, as in many Maine communities, the municipality must issue a Flood Hazard Development Permit for any construction activity to take place in the floodplain.

There are three types of permits. Type I applies to elevated structures, and requires a two-part permit; Part I for the structure up to and including the first horizontal floor above the base flood. After this is completed, the applicant must then "provide the Code Enforcement Officer with a second Elevation Certificate completed by a Professional Land Surveyor or registered professional engineer based on the Part I permit construction, “as built”, for verifying

compliance with the elevation requirements of Article VI, paragraphs F, G, H, or P." Once this requirement is met, the applicant may apply for the second permit to complete the construction.

Figure 9 - The historic York Shoreline

Type II applies to non-residential structures that are not elevated, and requires they meet certain flood proofing standards.

Type III contains provisions for the issuance of a Flood Hazard Development Permit for construction in the floodplain that is less than 50% of the value of the structure. It applies to any "minor development," such as "repairs, maintenance, renovations or additions," or accessory structure. Minor development also includes land-altering activities such as dredging, excavation, paving, or drilling, as well as storage of equipment and non-structural projects such as fencing, pipelines, piers, and bridges. (Art. VI. F. 3)

This unique provision ensures compliance with flood regulations for all construction activity in the floodplain, whereas nearly all other ordinances in other states only apply once the 50% threshold is met.

3.2. NEW HAMPSHIRE

3.2.1. PORTSMOUTH, NH

Population Density	1340 / sq. mi.
Form of Government	City
Category	Riverfront Urban
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
52831	35386	47.0	20779	0	91.5	3%	10.2%	1.3

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Resiliency Initiative	In Progress	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	Other
Tidal Wetlands Buffer Protection - 100 Feet	Implemented	No	Protection	Mandatory	Unique	Low (< $10,000)	None

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POPULATION AND GEOGRAPHY

Historic Portsmouth, settled in 1623 and incorporated in 1848, is the largest city on the New Hampshire coast, with a population of 20,779. The city was once one of the busiest ports in the United States, and it continues that role today as an industrial and business center. Portsmouth is also a major tourist destination. Its historic downtown and its numerous cafes and restaurants attract many summer visitors, although the seasonal population of less than 2% of housing stock.

Figure 3.2.1:1 - Historic Downtown Portsmouth

Portsmouth's population is 91% white, and has a median per capita income of $35,380.

The city does not have a seacoast, but rather borders the tidal Piscataqua River, which separates it from the State of Maine. The towns of Rye and New Castle are to its east, and it borders the towns of Greenland and Newington on the west. Interstate 95 and US 1 cross the city and provide direct access. It has a land area of 15.6 square miles.

COASTAL ISSUES

The city's hazard mitigation plan identifies Portsmouth as vulnerable to a number of coastal hazards, including flooding, hurricanes, and coastal storms. Portsmouth has a low average elevation and its building stock is vulnerable due to its significant age. 33% of the land mass of Portsmouth is classified as wetlands, including the major wetland areas of Great Bog, Berry Brook, Sagamore Creek, and Packer Bog. (Portsmouth, N.H. Master Plan, 2005)

Total damage estimates for a 1-, 2-, and 4-foot flood were calculated for five potential flood hazard areas. The State and Middle flood hazard area was calculated at risk for the most widespread damage, with estimates of total structural and contents damage of $11 million, $15 million, and $21 million in a 1-, 2-, and 4-foot flood, respectively. The Sewall and Thaxer area was estimated to have up to $4.5 million in damages in a 4-foot flood, while the North Mill Pond area could experience $2.5 million in losses. Total damages for the Sagamore Creek area in a 4-foot flood were estimated at $928,000.

The total area subject to a 10-year flood is 70 acres; the area subject to a 100-year flood is 102 acres. In one sea level rise scenario calculated for the New Hampshire coast, the area in each

category in Portsmouth would double by 2100. Portsmouth's recently issued RFP for a coastal resiliency project also detailed a number of the risks of climate change. In particular, it stated, "Increased intensity and frequency of coastal storms and sea level rise has the potential to result in extensive property damage and costly repairs..." (Portsmouth, N.H. Coastal Resilience Initiative Request for Proposals "RFP" 2012) The RFP also highlights the concern about property losses in its historic district.

The RFP in particular highlighted the following key issues facing Portsmouth:
- Locational vulnerabilities of existing densely built neighborhoods and commercial areas
- Age and potential instability of existing buildings and infrastructure
- Economic hardship to prepare for and recover from storm damage
- Impacts on water quality
- Impacts on significant ecosystems
- Costs of hazard preparedness

ADAPTATIONS

Coastal Resilience Initiative

The City of Portsmouth received an NROC & GOMA Coastal Resilience Grant through the New England Municipal Coastal Resilience Grants Program. The funds will be used to assess and increase the city's resiliency to climate change and extreme weather events. The city posted a request for proposals for its coastal resilience initiative in April 2012. The consultant team is to "analyze the potential future impacts of climate change on the city of Portsmouth in order to integrate adaptation planning into the City's local planning and regulatory framework." (RFP, p. 1)

Figure 3.2.1:2 - The Portsmouth High School is located close to the downtown on this tidal pond. It is subject to flooding, but is an essential part of the historic and scenic character of the community, illustrating the place-based challenges of adaptation.

The scope of work includes a vulnerability assessment, development of risk scenarios and a risk management plan, and a public outreach component. The project will include the identification of climate change scenarios based on projections for the rate of sea level rise, change in storm frequency and intensity, potential change in storm surge, and temperature changes.

Three to six scenarios are to be developed to evaluate vulnerability and resilience. GIS mapping will be used to identify geographic areas of the city vulnerable to different climate

change impacts, including a list of impacts to city facilities, infrastructure, private homes, and businesses, as well as impacts to natural resources such as wetlands, saltmarsh, and other natural communities.

The risk management plan will use a set of potential strategies to address different climate change risks, including high- and low-cost and short- and long-term options.

The consultant is also expected to identify adaptation implementation strategies, including a report on additions and changes to the master plan and recommendations for incorporating best practices into the zoning and building ordinances, and is also expected to provide content for the StormSmart Coasts website, including a discussion of how the projects' outcomes can be shared and used by other coastal communities.

Tidal Wetlands Buffer Law - 100 Feet

Portsmouth requires a wetland buffer for any wetland or water body of 100 feet. (Portsmouth, N.H. Town Code, Sec. 10.1014.22). The buffer requirements apply to the tidal wetlands of Sagamore Creek, Little Harbour, North Mill Pond, and South Mill Pond; all vernal pools; and inland wetlands of great than 10,000 sq ft. (Sec. 10.1013)

The ordinance prohibits construction of buildings or any impervious surfaces as well as filling or dredging in the wetland or wetland buffer. Examples of permitted uses include forestry and tree farming, wildlife refuges, parks and recreational uses, conservation and nature trails, and open spaces. (Sec. 10.1016.10). The use of motor vehicle is also expressly prohibited.

There is an exception for the construction of an addition or extension to a house that existed prior to the effective date of the ordinance or was constructed subject to a conditional use permit, with specific limitations on the size of such addition.

3.2.2. HAMPTON, NH

Population Density	1050 / sq. mi.
Form of Government	Town
Category	Oceanfront Seasonal
CRS Rating	In Application Process

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
67461	40371	46.8	15430	0.33	96.1	2%	4.9%	22.4

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Adaptation Workgroup Participant	Implemented	Yes	Procedural	Recommendation	Unique	Zero	None
Comprehensive Plan - Incorporates SLR	Completed	Yes	Procedural	Recommendation	Unique	Medium (<$100,000)	None
Wetlands Conservation District Zoning	Implemented	No	Prevention	Mandatory	Above Required	Medium (<$100,000)	State

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POPULATION AND GEOGRAPHY

New Hampshire has the shortest coastline of any U.S. state(18 miles) and Hampton is one of only four New Hampshire towns having an Atlantic Ocean shoreline. Hampton consists of an area of 14.7 square miles. The town's shore is a well-known resort destination. Elevation ranges from sea level to 150 feet above sea level near the border with the town of Exeter. Hampton also borders the towns of Hampton Falls on the south and North Hampton to the north. I-95 and Route 1 traverse the town.

The town has a population of just over 15,000. There is also a significant summertime increase in population, as 22% of the housing stock is reported as seasonal. The population is 96% white and has a median per capita income of just over $40,000.

COASTAL ISSUES

The Town of Hampton has been subject to over 50 major floods from coastal storms and high tides since 1723. Flooding is particularly severe in the Hampton Beach area, where most of the town's NFIP floodplains exist. Flooding can occur any time of year, and even a single intense rainfall can cause minor to moderate flooding. Severe flooding occurs when two storms occur within a week or when coastal surge and heavy rain occur together.

The entirety of Hampton Beach is in the FEMA Special Flood Hazard Area. Hampton contains over 4,000 structures and 2,703 lots totaling 2,577 acres in flood zones. This includes over 2,200 in Zone AE, 260 in Zone AO, 5 in Zone VE, 1,277 in Zone X, and 188 in Zone X500. There are 935 NFIP policies in the town and $2.6 million has been paid in flood claims from 1978 to 2001.

The Master Plan for Hampton Beach states that increased development of the Hampton Beach area has increased impervious surfaces and increased the rate of runoff. However, the problem is particularly exacerbated when combined with coastal storms "and potential sea level rise due to climate change … [which will] make the Hampton Beach area highly vulnerable to destructive flooding and storm damage" (III-96).

The town experienced rapid development of its coastal dunes in the 1880s and the state constructed seawalls and breakwaters in the early 1900s, which have been maintained by the town, state, and U.S. Army Corps of Engineers.

ADAPTATIONS

Coastal Adaptation Workgroup/Piscataqua Region Estuaries Partnership/COAST Tool

The town of Hampton, along with other New Hampshire coastal towns Hampton Falls and Seabrook, joined with the Coastal Adaptation Workgroup (CAW) to participate in a sea level rise adaptation project.

The project was spearheaded by the Casco Bay Estuaries Partnership (CBEP) in Portland, Maine, the Piscataqua Region Estuaries Partnership (PREP) in coastal New Hampshire, and the New England Environmental Finance Center. The groups were awarded funding by the EPA Climate

Ready Estuaries program to develop and use a sea level rise simulation called COAST ("Coastal Adaptation to Sea level rise Tool").

The town identified vulnerable assets and adaptation actions to model using COAST. The Environmental Finance Center, under the direction of Sam Merrill, ran the simulations and made presentations of the results in Hampton. After numerous meetings with stakeholders, however, the town indicated it has actually done little with the information or taken any steps to actually implement adaptation activities. The one adaptation the town is undertaking is increasing setbacks of a firehouse that is being reconstructed due to necessary maintenance.

Incorporates Sea Level Rise into Master Plan

The Hampton Beach Master Plan, which was completed in 2001, discusses the impact of sea level rise and climate change on the town's vulnerability to coastal flooding. The plan states that recent analyses suggest sea level is rising 1/8 inch a year, and suggests a number of challenges it will cause, including "inundation of ocean water into low-lying areas ... storm surge and wave runoff [which] is likely to cause more of a problem than inundation since the built areas will be affected by storm waves" (Hampton Beach, N.H. Master Plan 2001) The plan cites inundation of ocean water into low-lying areas, erosion of beach cliffs, loss of low-lying land, loss of sediment along beachfronts, salt intrusion into aquifers and surface waters, and higher water tables.

The plan mentions challenges such as elevation standards being based on static floodplain designations without considering sea level rise, and suggests future adaptations, such as regulations to enhance flood controls, stricter building codes in flood areas, and similar actions that change the types of structures that are built near or in high-velocity wave areas.

Wetlands Conservation District Zoning

The town of Hampton has adopted a Wetlands Conservation District Zone to protect and preserve its tidal and inland wetlands and wetland buffers (Hampton, N.H., Town Code, Sec. 2.3.1).

The Wetlands Conservation District is intended to:

- Prevent the destruction and preserve the integrity and health of wetlands and areas of very poorly drained soils and poorly drained soils and their buffers, all of which provide flood protection, connection to the ground or surface water supply, filtration of water flowing into ponds and streams, and augmentation of stream flow during dry periods;

- Prevent the development of structures and land uses on wetlands, areas of very poorly drained soils and poorly drained soils, and their buffers, which would contribute to pollution of surface and ground water by sewage or other wastes or toxic materials;

- Prevent unnecessary or excessive expense to the Town for provision and maintenance of essential services and utilities;

- Protect wildlife habitat, maintain ecological balance and enhance ecological values;

- Preserve and enhance the aesthetic values associated with wetlands and areas of very poorly drained soils and poorly drained soils and their buffers in Hampton;

- Prevent construction or earth moving activities in wetlands and their buffers, which could impact adjacent property. (Town Code, Sec. 2.3.1)

The State of New Hampshire does not require minimum wetland buffers, but towns are permitted to adopt such stricter standards. Hampton requires a buffer of 50 feet out from 1) the wetland boundary line and/or 2) the boundary line of areas of very poorly drained soils and poorly drained soils. (Town Code, Sec. 2.3.2) In this area, no structures, impermeable surface, parking space, or building activity including dredging, filling, or regrading is permitted (Town Code, Sec. 2.3.4) A buffer of 75 feet is required for all septic systems and leach fields. Uses in the wetlands are highly restricted to low-impact activities such as wildlife refuges and certain types of agricultural activities, though use of fertilizers, pesticides, insecticides, and herbicides are prohibited in wetlands and buffers. The code permits seawalls, fences, footbridges, catwalks and wharves to be constructed on tidal wetlands but requires them to be constructed on posts and pilings to allow tide flow to preserve the natural vegetation and contour of the tidal wetlands. (Town Code, Sec. 2.3.2 (D))

NFIP Floodplain Activities

The town originally adopted a model flood ordinance that allowed it to participate in the National Flood Insurance Program in 1986. Required by FEMA, the town completed a Flood Mitigation Plan in 2000 which identified flood prone areas and proposed strategies to mitigate future losses. The plan identified a number of structural and non-structural mitigation tools, including

- A pilot program to provide incentives to owners of residential and commercial property
- Enhancements to the town's Floodplain Management regulations
- A conservation program to acquire land for flood storage purposes and prime undeveloped land in the floodplain area
- A grant or loan program for residential floodproofing
- Public information programs to educate homeowners in the floodplain
- Apply for a designation as a FEMA Project Impact Community
- Participate in the Community Rating System

The Town applied for and received designation as a FEMA Project Impact Community. This designation will provide incentives to incorporate the multi-hazard planning process into its ongoing comprehensive planning process and allow the Town to participate in the NFIP Community Rating System.

3.3. MASSACHUSETTS

3.3.1. BARNSTABLE, MA

Population Density	76.3/ sq. mi.
Form of Government	Town
Category	Seasonal Ocean and Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
58601	33838	54.5	45193	-0.58	89.3	3%	12.6%	22.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard	Costs	Funding Source
Adaptations	Status	Incorporates CC	Type	Impact	Standard	Costs	Funding Source
Climate Change Adaptation Project	In Progress	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	NGO/Foundation
Incorporates SLR into Coastal Resource Management Plan	Implemented	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	Other
Incorporates CC Into Comprehensive Plan	Implemented	Yes	Procedural	Recommendation	Above Required	Very Low (< $1,000)	None
Incorporates SLR into Hazard Mitigation Plan	Implemented	Yes	Procedural	Recommendation	Above Required	Very Low (< $1,000)	None
Zoning Law Explicitly Incorporates Sea Level Rise, Requires Freeboard and allows Height Limit Waiver	Implemented	Yes	Accommodation	Mandatory	Unique	Zero	None

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POPULATION AND GEOGRAPHY

Barnstable is the largest town, in area and population, on Cape Cod. It covers a large land area of 60 square miles, that extends from the Cape Cod Bay shore on the north to the Nantucket Sound on the south. It contains seven villages within its jurisdiction, including the large village of Hyannis, where the Barnstable town offices are located. It has land borders with the town of Sandwich and Mashpee on the west and Yarmouth on the east.

Figure 3.3.1:1 - Downtown Hyannis, part of the Town of Barnstable

The town contains a large variation in geography within its borders. In addition to the large village of Hyannis, the town has many beaches, from the dunes of Sandy Neck on the north to the popular summer communities along the south shore beaches. The town contains 170 miles of shoreline, 11 great ponds, over 3,800 acres of salt marsh, 264 acres of fresh marsh, and 932 acres of barrier beach/dunes (Barnstable, Mass., Hazard Mitigation Plan, p. 14).

Elevations range from sea level along the north and south shores to a high point of approximately 230 feet on the moraine, near the Sandwich town line. (Barnstable, Mass., Open Space and Recreation Plan (2010), p. 36). The northern part of town has extensively sloping terrain characterized by the knob and kettle landscape of the moraine, while the south is dominated by level outwash plain. The town is a hub of activity on the cape and contains the cape's largest airport; it is famous as the summer home of the Kennedys.

It has a relatively large share of permanent residents, numbering over 45,000. 22% of the housing is seasonal. The population is middle income and largely white. 54% of homes are owner-occupied. As described in the Coastal Resource Management Plan for the Three Bays and Centerville River Systems:

> The Town of Barnstable is home to abundant and varied coastal resources, including harbors, bays, estuaries, salt marshes and shoreline. The extensive coastal resources are a source of local pride and scenic beauty, and they provide important ecological functions such as aquatic and terrestrial habitat, storm damage prevention, pollution attenuation, and sediment replenishment. They also support recreational and commercial activities ranging from shellfishing, fin fishing, and aquaculture to birdwatching, boating and beachgoing. These activities provide important opportunities for residents and visitors of the Town to enjoy the

refreshing beauty of the coastline, which in turn nurtures environmental stewardship (Barnstable, Mass., Coastal Resource Management Plan, Three Rivers and Centerville River Systems, 1.1).

COASTAL ISSUES

As a large town on the Cape Cod peninsula, with two coastal exposures, Barnstable is highly susceptible to coastal hazards. The Hazard Mitigation Plan identified the risk of hurricanes and coastal storms, winter storms and nor'easters, shoreline change/coastal erosion, sea level rise, and dam failure. The hazard identification matrix—which includes measures on frequency, location, and extent—ranks floods, hurricanes, and wind as the most threatening risks.

The town has 7,475 acres in hurricane surge zones and 8,000 acres in flood zones, as well as 18 repetitive loss properties. The town has 24 critical facilities in the hurricane surge zone.

The town has over 1,000 residential units with an assessed value of over $425 million in the 100-year flood zone. Commercial property value in the flood area is over $38 million, excluding mixed-use categories. (Barnstable, Mass., Hazard Mitigation Plan, p. 18)

The town has a number of areas of special concern that are subject to coastal flooding and at risk from sea level rise. The Craigville Beach area and the Centerville Village Center are neighborhoods particularly at risk. The town has recognized this by designating them a District of Critical Planning Concern (DCPC). A number of roads are also subject to flooding. In particular, Route 6 in Barnstable (evacuation route), Mill Way in Barnstable, Commerce Road in Barnstable, and the West Bay (Oyster Harbors) Bridge are at risk.

ADAPTATIONS

Climate Change Adaptation Project

Barnstable (along with Dover, NH, Cranston, RI, and Wells, ME) recently signed on to participate in a Climate Change Adaptation Project led by the Consensus Building Institute, the Massachusetts Institute of Technology, and the National Estuarine Research Reserve System. The goal of the project "is to develop a better understanding of climate change risks, barriers to preparing for climate change impacts, and potential risk management strategies" (Barnstable, Mass., Press Release, Nov. 1, 2012) It will involve the community in role-play simulations as well as produce a comprehensive stakeholder assessment and mapping of various scenarios.

The town billed the project as "important and timely because climate change has the potential to impact coastal communities like Barnstable in a variety of ways, including increased flooding, shoreline erosion, saltwater intrusion into drinking water supplies, and possible damage to infrastructure and property...coastal communities can make investments and policy changes that will reduce their vulnerability...while protecting local environments and the communities that rely on them" (Barnstable, Mass., Press Release, Nov 1., 2012). Funding is being provided by the National Estuarine Research Reserve program administered by the University of New Hampshire.

Incorporates Sea Level Rise into Coastal Resource Management Plan: Three Bays and Centerville River Systems

In 2009, the town prepared and adopted a coastal resource management plan for the Three Bays and Centerville River systems, which are among the Town's south-facing coastal resource areas. The plan includes such matters as Marine Services and Facilities, Fisheries, Natural Resources, and Coastal Structures. The goals for the plan were to enhance natural resources, enhance public access, protect traditional water activities and uses, and enhance aesthetic quality.

The project incorporates Sea Level Rise as a concern throughout the document. (6.3.3.1) It recommends the town continue periodic monitoring of bathymetry and hydrodynamics in light of the concerns about sea level rise.

The plan states, "Recent publications suggest potential of approximately three feet of relative sea level rise by 2100. Possible effects include shoreline erosion, loss of wetlands and beach areas, damage to sensitive infrastructure, saltwater intrusion into wells, and elevated storm surge levels. Relative sea level rise is an impending threat to natural resources, public infrastructure and private property. Although the acceleration of sea level rise is beyond the scope of local control, the Town can adopt management practices to prepare and potentially mitigate damaging effects."

In the recommended actions, it suggests the town should "protect the integrity of coastal features that provide storm damage protection" by:

- Focusing on land acquisitions in FEMA A and V zones,
- Limiting development in FEMA V zones,
- Ensuring regulations allow for reasonable use of property,
- Adoption of a sewer neutral regulation,
- Adoption of a Flood Plain ordinance. (6.4.3)

Other recommendations include "assess potential threats posed by accelerated sea level rise" (6.4.3.2) by collecting data on shoreline elevations and land uses, and recommends the town "develop a local management plan for sea level rise. (6.4.3.3).

Incorporates Sea Level Rise and Climate Change into Comprehensive Plan

The Town Comprehensive Plan includes recommended actions to address flood hazards and sea level rise, including:

- Purchasing land in FEMA A and V zones and barrier beach areas
- Preparing a pre-disaster mitigation plan to meet FEMA standards
- Directing development outside of FEMA A and V zones
- Developing regulations to prevent movement of earth, development of erosion control structures, or mounding of septic systems from altering the flood preventing functions of coastal landforms
- Adopting a flood plain bylaw based on the Cape Cod Commission Model
- Designing stormwater infrastructure and septic systems within A and V zones to accommodate sea level rise (Comprehensive Plan, 2.2.2.1).

The plan promotes smart growth by encouraging compact development patterns and infill and redevelopment.

This approach is aimed at preserving the Town's sensitive environmental areas and natural resources. The plan designates areas as "designated for growth," "designated for infill and redevelopment," or "not designated for growth," and states that areas including FEMA flood zones and Hurricane Surge Inundation areas are "not designated for growth."

Zoning Law Explicitly Incorporates Sea Level Rise (Districts of Critical Planning Concern (DCPC), Requires Freeboard and Allows Height Limit Waiver

The town has recognized that the Craigville Beach area and the Centerville Village Center are at particular risk to coastal flooding. The town enacted a special zoning ordinance as part of the designation of the Craigville Beach area as a District of Critical Planning Concern. Districts of critical concern are permitted under the Cape Cod Commission legislation, and permit towns to supersede state law with respect to certain regulations, including requiring freeboard of structures above the state law.

Figure 3.3.1:2 - House in Craigville Beach District of Critical Planning Concern

The purpose and intent section of the town code states: "As the entire complex of coastal wetland resources moves landward due to relative relative sea level rise, the Craigville Beach area's coastal floodplains immediately landward of salt marshes, coastal beaches, barrier beaches, coastal dunes, and coastal banks require special protection" (Barnstable, Mass., Town Code Sec. 131.1) The law requires structures in the V zone and the A zone to be elevated to 2 feet and 1 foot above base flood elevation, respectively. (Sec 131.7)

§240-131.1 Purposes and Intent

A. The purposes and intent of this section is to guide development in the Craigville Beach District by promoting development and redevelopment that:

(1) Contributes to and respects the character and historic development patterns of the area; lessens development and redevelopment impacts to the historic and community character resources in this area;

(2) Protects and preserves scenic views and vistas and ways to the water;

(3) Protects and improves natural resources including but not limited to the barrier beach and groundwater and coastal water quality; lessens development and redevelopment impacts to the natural resources and ecosystems in this district;

(4) Protects human life and property from the hazards of periodic flooding,

(5) Preserves the natural flood control characteristics and the flood control function of the flood plain,

> (6) Preserves and maintains the ground water table and water recharge areas within the floodplain. As the entire complex of coastal wetland resources moves landward due to relative sea level rise, the Craigville Beach area's coastal floodplains immediately landward of salt marshes, coastal beaches, barrier beaches, coastal dunes, and coastal banks require special protection.

The special district, which was also concerned with preservation of views and community character, specifically allows for waiver of height limits when necessary to elevate a structure:

> Within the flood plain the maximum building height, when necessary to flood proof the structure, reconstruction or addition, may be increased to allow the required elevation above the BFE plus 2 feet (131.7).

Figure 3.3.1:3 - Craigville Beach

Incorporates Climate Change into Hazard Mitigation Plan

Sea level rise was addressed as separate hazard in the town's HMP. In addition to sea level rise, the hazard mitigation team determined that the town was at risk to hurricanes and coastal storms, winter storms and nor'easters, shoreline change/coastal erosion, earthquakes, drought/wildfire, and dam failure.

The plan considers two mitigation actions in relation to sea level rise specifically:

> *Mitigation Action #11* suggests "Buildings and infrastructure in areas of projected sea level rise should be designed for protection from flooding as well as to minimize risk to human health and safety. The priority level was rated low, however.
>
> *Mitigation Action #12* recommends the town "design stormwater management systems and new and replacement septic systems within FEMA A and V zones to accommodate a sea level rise." The priority level was also rated low for action 12.

Many of the other recommended actions would also be climate and sea level rise adaptive, including:

> Mitigation Action #4: Explore the adoption of regulations and incentives to restrict new development and redevelopment in A and V zones, on barrier beaches, or on coastal dunes where there is known to be danger of significant flood damage
>
> Mitigation Action #9, reduce impacts in FEMA A and V zones by amending the Zoning Ordinance to require floor area ratio requirements that allow development and redevelopment that does not create large impervious surface, is also climate adaptive, and

Mitigation Action #15, which is to identify, pursue, and fund actions, regulations or outreach efforts necessary to qualify for the National Flood Insurance Program's Community Rating System (CRS).

Incorporates Sea Level Rise and Flood Mitigation into land acquisition strategy/ uses restoration, "undevelopment" to improve Environmental quality

The Barnstable 2010 Open Space and Recreation Plan, which is a component of the Barnstable Comprehensive Plan, considers the town's open space needs and proposes a strategy for land acquisition.

As an overall open space plan, it considers all of the needs of the town including protection of public water supply, protection of fresh and marine surface water bodies, wildlife habitat, agriculture, and public access to the water. The plan considers the issue of sea level rise and its impact on open spaces at numerous points. The plan also includes as a priority action to "look for opportunities to protect open space adjacent to coastal resource areas for the purposes of public access and/or resource protection, through acquisition or alternative land protection tools. (Barnstable, Mass., Open Space Plan, p. 13)

One unique element of the plan is support for retreat strategies, or "Property Reclamation" or "undevelopment," which the town adopted as a land use strategy. The town uses reclamation for a variety of purposes, "including traffic mitigation, resource protection or property remediation, with the added benefit of creating open spaces in densely developed areas" (Barnstable, Mass. Open Space Plan, p.18) Six properties in Hyannis, Centerville, and Cotuit have been undeveloped. A former motel on Craigville Beach Road in Centerville was acquired and demolished, to preempt more intensive development in the vulnerable coastal location. The property is now used as the town's coastal plant nursery. In addition, a Gulf Station on Main Street in Hyannis was razed and now serves as a pocket park utilizing phytoremediation (p.19).

3.3.2. BREWSTER, MA

Population Density	427/ sq. mi.
Form of Government	Town
Category	Seasonal Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
59663	35547	45.4	9820	-0.28	96.7	2%	4.6%	39.6

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Hazard Mitigation Plan - Incorporates Sea Level Rise	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	None
Incorporates climate change into Water Resource Management Plan	Completed	Yes	Procedural	Recommendation	Unique	High (<$1,000,000)	None
Minimum Lot Size Restricts Development in Floodplain	Implemented	No	Prevention	Mandatory	Unique	Zero	None
Wetlands Buffers Includes Performance Standards and Sea Level Rise Considerations	Implemented	Yes	Prevention	Mandatory	Above Required	Medium (<$100,000)	None

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POPULATION AND GEOGRAPHY

Cape Cod is a 70-mile-long sandy peninsula that extends out 35 miles from mainland New England in the shape of a hook. Cape Cod has 586 miles of natural shoreline and is world famous as a summer resort destination. The town of Brewster is located on the northern half of the lower cape, about midway to Provincetown.

Brewster has a land area of 23 sq mi and an year-round population of just under 10,000 giving it a population density of 427 people per square mile, but that number is much higher in the summer. The median household income is just under $60,000 and the population is almost 97% white. The town has 8.3 miles of shoreline, which is characterized by extensive tidal flats. Brewster also contains the largest freshwater pond on Cape Cod. The town does not have a downtown area or commercial district of any appreciable size.

Its maritime boundary on the north is the Cape Cod Bay, and Brewster has land borders with the towns of Orleans on the east, Harwich to the south, and Dennis to the west. More than one-third of the town is protected in conservation or open space.

COASTAL ISSUES

Brewster had been integrating sea level rise and climate change into its administrative and planning processes. The town's hazard mitigation plan identifies hurricanes, flooding, and sea level rise as significant hazards. It states that coastal and inland flooding is one of the major risks faced by citizens and visitors and can result in damage to public and private property. The hazard plan ranks wind hazards as "highly likely" and flood hazards as "likely." (Brewster, Mass. (2011) Hazard Mitigation Plan.) Flood hazards are seen to only concern a small area and with less impact than wind related hazards.

Figure 3.3.2:1 - Brewster's shoreline

32% of the town's land is developed, 17% is protected uplands, and 15% protected wetlands. 4.4 square miles, or 19%, is in the FEMA A or V zone and 6% is located in the SLOSH zone. There are no repetitive loss properties in the town and, despite the relatively large percentage of land in the flood zones, the town only has 94 NFIP policies in force, and only 15 losses claimed under NFIP between 1978 and 2009. Coastal erosion is a significant problem, mostly occurring during

storms. Areas of coastal flooding include Cape Cod Bay beaches and beach parking lots. Infrastructure failure caused by coastal storms is considered a significant hazard.

A number of tidal restricted areas and one road and park are considered to have deficient infrastructure. This problem, unique to Brewster, is caused by physical restrictions in tidally influenced water bodies that cannot exchange water freely during tidal cycles. The plan states that removing these restrictions would provide many hazard reduction benefits, including increased flood mitigation potential and reduced risk of wildfire.

The town has recognized issues of sea level rise and climate change in a number of documents. The town's Water Resources Management Plan summarizes the issues expected to impact the town: "It is expected that the climate change effects for Brewster will focus on coastal areas and include inundation of low-lying areas, inland migration of flood zones, and higher groundwater levels near the ocean" (Brewster, Mass. Water Resources Management Plan, p. 90). Although specifics are not enumerated, the language further acknowledges awareness "that future infrastructure improvements will need to take flood zones into account and the potential for expansion of the flood zones due to climate change and rising sea levels ..." According to other documents, the town has made progress in addressing climate risks and setting in motion processes to adapt to those risks.

ADAPTATIONS

Wetlands Regulations Include Performance Standards and Sea Level Rise Considerations

The conservation commission of the town regulates coastal and inland wetlands. The commission raised standards recently to include a limitation on site disturbance and an undisturbed buffer zone of natural vegetation between wetlands resources. Sea level rise is explicitly discussed as rationale for these stricter regulations.

The town code states “The concern for continued efficacy…[of resources] in buffering, storing, or containing floodwaters has recently been elevated in [due to] predictions of sea level rise...only the relative rate of increase in sea level is being debated, not the tendency to sustained increase in the coming decades…The effect of an accelerated rate of rise in sea level will be an appreciable acceleration in coastal erosion processes and their notable manifestations: land erosion, storm damage, flooding and loss of coastal wetlands.” (Brewster, Mass. Town Code, Ch. 704, E(2))

The regulations require a 35-foot setback from wetlands and 50 feet from coastal areas. When the slope of an undisturbed setback exceeds 18%, or in any instance where the scope of the project is likely to require a greater spatial offset to wetland areas, the commission reserves the right to increase the setbacks.

The zoning code minimum required lot dimensions includes the following restriction: "No building, except a boathouse or building used for agricultural purposes, shall be within 50 feet of any water body, watercourse or wetland area or, if subject to flooding, within 50 feet beyond its flood line to the higher elevation." (Brewster, Mass. Town Code, Ch, 179)

Incorporates SLR into Hazard Mitigation Plan

Sea level rise is addressed in the hazard mitigation plan as one of the nine significant hazards facing the town.

Sea level rise is described in the plan as potentially causing shoreline change, long-term coastal erosion, and flooding. (Brewster, Mass. 2011 Hazard Mitigation Plan) Because it affects these other risks, which are analyzed as separate but interrelated threats, sea level rise is weaved throughout the plan and is discussed as an exacerbation of other risks.

In the natural hazards ranking, sea level rise is mentioned under flood hazards along with coastal storm surge, storm tides, wave action, and erosion. It is also mentioned under the heading of geologic hazards along with shoreline erosion, long-term shoreline change, storm-caused change, and landslides of coastal banks. Sea level rise is also predicted to have exacerbating impacts on the problem of shoreline erosion. Although not specified as a separate threat, the list of nine hazards is followed with the following language concerning climate change:

"In addition climate change can exacerbate these events, causing impacts such as increased frequency and intensity of heavy downpours. Rising sea levels are expected to continue while new impacts will likely emerge, such as increased intensity of hurricanes. This could result in an increase in storm surge"(p.9).

The hazard plan suggests specific mitigation actions. Action #17, which suggests the town "continue to participate in marsh restoration projects to remediate tidally restrictive infrastructure which affects the retention time of floodwaters or impound stormwater," contemplates mitigating the threats of sea level rise, erosion, fires, and floods.

The plan also projects Action #20—to "conduct an educational workshop for coastal and riverfront landowners and contractors on hazard mitigation"—will mitigate sea level rise as well as floods, wind, and erosion.

Water Resource Management Plan Incorporates Climate Change

The Town of Brewster developed a Water Resource Management Plan, which assesses surface and groundwater issues and prioritizes issues and needs to protect water resources through the year 2030. Of particular concern is nitrogen and phosphorous loads in the town's drinking and surface waters. The town was required to draft a plan by state law to meet water pollution regulations.

Minimum Developable Lot Requires 60,000 sq ft of Uplands

The town of Brewster set a town-wide minimum lot size of 60,000 sq ft of buildable uplands for any lots subdivided after the date of effectiveness of the bylaw. This bylaw has effectively limited further subdividing of land and reduced development in the town. The code also prohibits new temporary housing and bans all mobile homes not in trailer parks or camps. This has implications for affordability, but is also a significant coastal resilience measure, since such structures are much more vulnerable to the effects of wind and floods.

The language of the code is as follows:

A. No premises in the Town of Brewster shall be used for the following purposes: residing in (i.e., occupying) any tents, trailers, mobile units, except in commercial trailer parks or camps.

B. No lot in the Town of Brewster shall be used for residential building purposes unless there is at least 60,000 square feet of contiguous buildable uplands as defined in the Zoning Bylaw or unless the lot existed as a lot on May 1, 1986, and satisfied the May 1, 1986, requirements for a buildable lot. June 30, 1987, shall be set as the effective date for all aspects of this subsection (Brewster, Mass. Town Code, Sec. 179-13).

3.3.3. HULL, MA

Population Density	3676/ sq. mi.
Form of Government	Town
Category	Bayfront Suburban
CRS Rating	8
Land Area In Municipality	2.8 sq. mi.

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
60742	34892	55.3	10293	-0.71	95.2	2%	5.7%	13.8

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Beach Management Plan Incorporates Climate Change	Completed	Yes	Plan	Procedural	Planning	Recommendation	Unique
Capital Investment in Culverts and Tidegates	Implemented	No	Capital Investment	Protection	Infrastructure (Gray)	NA	Unique
Hazard Mitigation Plan Incorporates Climate Change	Completed	Yes	Plan	Procedural	Planning	Recommendation	Unique
Freeboard Incentive Program	Implemented	No	Administrative	Accommodation	Building	Incentive	Unique
Zoning Law Explicitly Incorporates CC and SLR	Implemented	Yes	Law	Accomodation	Planning	Mandatory	Unique
Height Limit Waivers for Freeboard	Implemented	Yes	Law	Accommodation	Building	Incentive	Unique
Code Requires Planning Board to Consider Flooding and SLR in Decisions on Applications	Implemented	Yes	Law	Prevention	Planning	Mandatory	Unique

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POPULATION AND GEOGRAPHY

The town of Hull is located entirely on the narrow Nantasket peninsula that sits at the entrance of the Massachusetts Bay, across from Boston. At 2.8 square miles, the town is the fourth smallest in land area in the Commonwealth of Massachusetts. Its population is quite dense, however, with 10,293 people, giving it a population density of 3,676 per square mile. Hull has 33 miles of densely developed shoreline, and is surrounded by water on its north, east, and west. It is connected by land to the town of Cohasset and by two bridges to Hingham on the south. The town's diverse shoreline environment includes bays, estuaries, rocky promontories, beaches, and bluffs and the bayside is comprised of sandy coves, inlets, marshes, and a tidal pond. Its southern border is flanked by the Protected Weir River estuary, which contains 600 acres of undeveloped land. Hull's jurisdiction also contains some of the islands in the Boston Harbor Islands State Park.

The town has a long history of attracting seaside tourism as an economic engine, but in recent decades has morphed into more of a bedroom community. As described in the Hazard Mitigation Plan ("HMP") Update (Hull, Mass. 2012, p.9):

> In 1825, a new industry was launched in Hull when Paul Warrick built the Sportsman Hotel on Nantasket Avenue, the very first hotel in the town. The magnificent beaches of the town, easy access to Boston, and sea air brought hordes of visitors and by 1840 steamers were making three trips a day between Boston and Hull. Boardinghouses and elaborate hotels catered to visitors while Hull fishermen and farmers still pulled nets and farmed in its rural acreage. When the amusement park closed in 1985, an era ended for the town and the millions of visitors. But another era began as Hull acquired a suburban character with a growing number of professionals moving into town, and today there are over 11,050 year round residents.

This new reality is reflected in its current demographic and housing profile. Seasonal housing currently only represents 13.8% of the residential stock, and the minority population is under 6%. The 2010 Census recorded the median per-capita income as $34,892 and the median household income as $60,742.

COASTAL ISSUES

The Town of Hull is located in an extremely vulnerable location. According to the Hull Hazard Mitigation Plan, coastal flooding caused by hurricanes, nor'easters, and other oceanic storms poses the most significant threat to the community. (Hull, Mass. 2012 Hazard Mitigation Plan Update) The plan highlights sea level rise associated with global warming as a threat and addresses how it impacts other hazards in the town.

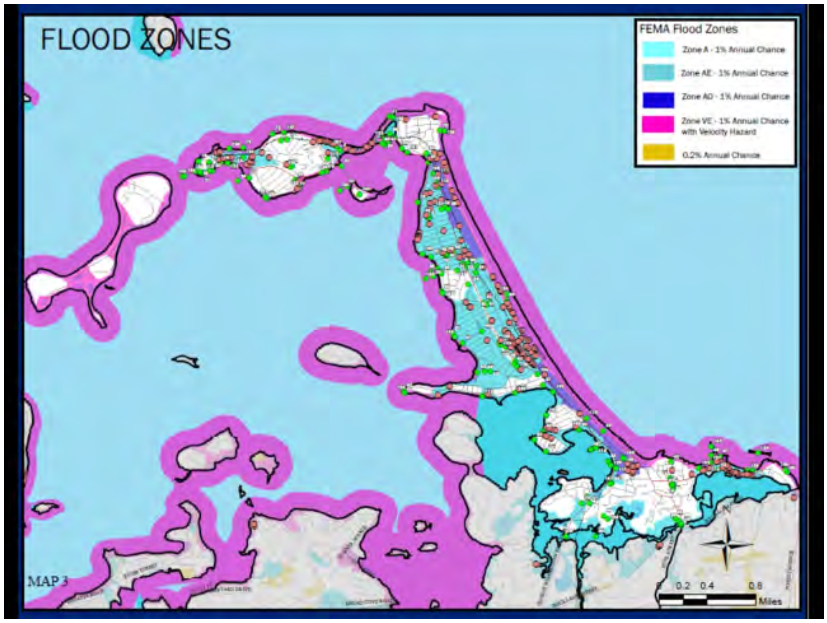

Figure 3.3.3:1 - Hull Flood Zone Maps

Low-lying parts of town directly on the shore are particularly vulnerable, since storm-driven waves can top the sea wall and dunes. The Hazard Mitigation Planning Committee identified 931 buildings in the town in that high-risk zone. The town has experienced a number of significant historical flood events, including March 1968, the blizzard of 1978, January 1979, April 1987, October 1991 ("The Perfect Storm"), October 1996, June 1998, March 2001, April 2004, May 2006, April 2007, March 2010, and December 2010.

In Hull, flooding occurs most frequently along the open ocean shoreline, which is subject to wind-driven waves, and "where even a relatively small storm can lead to very high tides and overwash of seawalls and dunes, and in a number of low-lying neighborhoods throughout the town" (Hull, Mass. 2012 Hazard Mitigation Plan Update, p. 21). A significant majority of the town is in a FEMA-designated floodplain. There are 235 repetitive loss structures in Hull and 2,102 NFIP policies in force.

ADAPTATIONS

Beach Management Plan Incorporates Climate Change

The North Nantasket Beach is comprises the northernmost two miles of the 3.5-mile barrier beach. The plan provides best management practices to enhance natural resource functions and values and stewardship of the beach. The plan includes mention of sea level rise in the following manner:

> Sea level rise and an increasing frequency and intensity of coastal storms are among the projected impacts of a warming global climate. In the Boston area, seas are currently rising at the rate of nearly one foot per century. While future rates of sea level rise are uncertain, projections are in the range of 2 to 4 feet, or higher, by the end of the century. The dunes serve as critical protection

> against flooding and storm damage during winter northeasters. The impacts of climate change will make it more challenging to maintain and protect our dune system – and all the more critical that we do so in order to protect lives, property, and town infrastructure. (Hull, Mass., North Nantasket Beach Management Plan, p. 6)

Intriguingly, and unique among our sample communities, the Beach Management Plan has the force of law. The plan contains legal language explaining its enforcement and provides criminal and civil penalties for violation:

> Whoever violates any of the provisions of this Plan shall be deemed to have violated the provisions of the Code of the Town of Hull authorizing this Plan. Violators shall be subject to a fine of up to $300.00, or such maximum fines as may be otherwise provided by law, whichever is greater. A violation of this Plan may also be penalized by a non-criminal disposition as provided for in M.G.L. C. 40, section 21 D and as provided for under Chapter 1 of the Code of the Town of Hull. Each day's violations shall constitute a separate violation.
>
> If any person or entity violates the provisions of this Plan, or causes damage to the dune or beach, including but not limited to physically damaging or destroying the access control structures, signs, and beach grass, or lowering the elevation of the dune, the Town may initiate civil action against such person or entity to protect the dune and beach system, and to restore the same. Nothing contained herein shall however, operate to limit civil actions or criminal prosecutions which the Town may take under this Plan, or any other applicable law, rule, regulation or right. (Sec. 7.14; p. 22).

The plan's regulations include:
- Prohibition on trespassing on the primary dunes (7.3)
- Removing natural vegetation except for construction or maintenance (7.5)
- Removing sand from the beach or dune (7.6)
- Requiring sand transported by wind, tides, or storms to be restored to the beach (7.7)

Hazard Mitigation Plan Incorporates Climate Change

Hull incorporated climate change into its Hazard Mitigation Plan. It states:

> Global climate change, erosion of beaches, and a variety of other factors impact the Town's vulnerability, and local officials will need to work together across municipal lines and with state and federal agencies in order to understand and address these changes. (HMP, p. 2)

The following goals of the HMP reference climate change:

- Encourage future development that addresses hazard mitigation including measures that reflect mitigation and adaptation to climate change and the risk of sea level rise
- Educate the public about natural hazards and mitigation measures including the potential impacts of climate change

Hull's HMP evidences its efforts to seriously implement many of the mitigation measures suggested. Successfully implemented projects since the previous iteration of the HMP include:

1) Public education for residents in flood hazard zones
2) Repairing and protecting dunes along Nantasket Beach
3) Repairing the Nantasket sea wall
4) Upgrading the Straits Pond at Nantasket Avenue Culvert
5) Atlantic Avenue bridge and tidegate repairs
6) Reinforcing and protecting electric transmission lines from weather and tree damage
7) Examining the need to elevate generator and mechanical systems at the Memorial School, which serves as the Town's emergency shelter
8) Structure elevation incentive program

Freeboard Incentive Program

In 2009, Hull began an incentive program enabling the Buildings Department to offer a $500 credit toward building permit fees for builders and owners of existing and new residential and commercial structures that are built two feet above the highest state flood zone minimum height elevation requirement. For residential and commercial building elevation, or new construction projects, building department permit fees are reduced by $500 if an elevation certificate is provided to verify the building is elevated a minimum of 2 feet above the highest federal or state requirement for the flood zone.

Since the program began in 2009, 20 of 24 building permits issued for construction have incorporated more than two feet of freeboard – an 83% participation rate. Of the total number of permits issued, 17 were for new construction and 7 for elevation of an existing structure. Costs of constructing with freeboard include a 0.25% to 1.5% increase of total construction costs, which over time may be outweighed by savings from reduced flood insurance premiums, sometimes at more than 50% annually (Mass. CZM, n.d.).

Explicit Incorporation of Climate Change and Sea Level Rise into Zoning Bylaw

The town passed the Nantasket Beach Overlay District zoning on May 7, 2013. (Hull Town Code, Art. X)

The stated purpose of the district "is to stimulate mixed use redevelopment...appropriate for an historic beachfront community...to revitalize the economy...while protecting people, property and resources." The purpose section includes climate mitigation objectives - to encourage mixed uses and a pedestrian and bicycle-friendly community, less sprawl explicitly stated to reduce GHG emissions; and 1.6) to protect barrier beaches and dunes in providing storm and flood protection and wildlife habitat, and 1.7) to incentivize development that can withstand increased flooding "and frequency and intensity of storms caused by climate change, and thereby; protect persons and property from the hazards that may result from unsuitable development in areas subject to flooding, extreme high tides, and rising sea level" (1.7).

The zoning provides for section entitled S. 12. *Adaptive and Resilient Building* and *Open Space.* Town Planner Robert Fultz indicated that the NBOD district will guide large projects to clusters with usable open space. The stated purpose of the section is "to encourage construction that will

withstand increased flood elevations and frequency and intensity of storm events for new (and substantially improved) buildings." (S. 12)

Section 12.2. lays out the incentives the town provides to encourage resilient buildings, including including the $500 freeboard rebate (12.2.1), and the savings on insurance from NFIP (12.2.2); and provides that the planning board may allow building heights up to 40 feet above a non-habitable lowest floor; provided the space be a "market hall." The section allows up to 6 feet of freeboard. (12.2.3)

In order to receive the incentives, the projects must meet certain requirements, including that they not allow any habitable space on the ground floor. Instead, it requires a "market hall," which is defined as a traditional-open market, for temporary commercial uses, that contribute to the economic and social activity of the district. (12.3.2.) Suggested uses include farmers markets, art exhibition or performance spaces and outdoor cafes. Parking is allowed provided it does not occupy more than 50 percent of the space.
The section also prohibits mechanical, HVAC equipment, and generators on the lowest floor and requires them be elevated on the roof or upper stories.

The code also provides the following unique requirements:
12.3.6. Requires underground utility lines and submersible HVAC equipment
12.3.8. Requires incorporation of green building standards (to the greatest extent possible)
12.3.9. Requires incorporation of landscape features to provide storm and flood protection (to the greatest extent possible)

The new zoning was developed through an extensive public participation process with over 23 meetings. As a result of the extensive public involvement process, the town was able to balance community values, market viability and concern about climate change and sea level rise.

Section 43 of the code also has a cluster provision which provides for a density bonus of 25% for subdivisions of a minimum of ten acres and potentially could be used to prevent development of floodplains and wetlands. Hull has few parcels of this size, however, so the provisions have not been yet utilized.

Zoning Bylaw Allows Height Limit Waivers for Freeboard

The Town of Hull has furthered its goal of encouraging voluntary freeboard, by taking the additional step of amending its code to allow property owners to request a special permit to exceed the permissible height limit. The language allows owners to exceed the height limit by the amount of freeboard incorporated into the design of the structure, up to a maximum possible four feet. Rooftop mechanicals must be below the total allowed height, however. (Hull Town Code, 7.2.2)

Amended Code to Require Planning Board to Consider Sea Level Rise in Applicaions

Hull also amended its code (Hull Town Code, Art IV., Sec. 40) to require the planning board to consider Sea Level Rise in its site plan reviews. Site plan review applies to subdivisions three lots or greater, multi family buildings of three units or more, and changes to buildings larger than 5000 square feet. According to the town, the purpose of these amendments was to ensure that

applicants provide information about flood zones and consider the current and future potential for flooding, and have the Planning Board review the adequacy of plans to prevent flood damage.

The town added a new flooding provision to Section 40-4 A of the code, which provides for considerations the Planning Board should use when rendering a decision on an application, including:

1. Preservation of Landscape
2. Community Impacts
3. Relation of Proposed Buildings and Structures to Environment
4. Drives, Parking and Circulation
5. Surface Water Drainage
6. Utility Service
7. Advertising Features
8. Special Features
9. Other Environmental Impacts
10. Outdoor Lighting
11. Vistas and View Corridors
12. Flooding: Special attention shall be given to maintaining the natural capacity of the land to prevent or reduce flooding. Structures, including fill, shall be designed with special attention to minimizing the potential for property damage from flooding and the re direction of flood waters to other locations.

The code also requires applicants provide a narrative description of the proposed project. The amendment added flooding and the impact of sea level rise to a list of items required including "site planning, architectural, landscaping and engineering solutions...to handle the problems of traffic, parking, internal pedestrian circulation, provision of utilities, drainage, wastewater and solid waste disposal, lighting and signage, environmental protection and aesthetic considerations such as views and design compatibility with surrounding development." (Hull Town Code, Art IV., Sec. 40).

In addition, the town added "Protection against flood damage on site and protection against flood impacts to adjoining properties, taking into consideration current conditions and the potential for future sea level rise" (Sec. 40-4) to the code, which sets out the design guidelines the Planning Board may consider in making its decision.

3.3.4. MARSHFIELD, MA

Population Density	881/ sq. mi.
Form of Government	Town
Category	Bayfront Suburban
CRS Rating	10

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
85503	39538	70.8	25132	0.33	96.8	1%	4.0%	9.9

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Advisory Committee	In Progress	Yes	Procedural	Recommendation	Unique	Low (Staff)	Town
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Unique	Low (Staff)	Town; UMass
South Shore Coastal Hazards Adaptation Plan	Completed	Yes	Procedural	Recommendation	Unique	$15,000	SRPEDD - DLTA

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GEOGRAPHY AND COASTAL ISSUES

The Town of Marshfield is located 30 miles south of Boston in the South Shore region (NOAA, n.d.). The town has about 12 miles of shoreline directly exposed to the ocean, with 3.9 miles of with coastal structures (e.g., bulkheads and jetties) (MAPC, 2011). Marshfield is currently exposed to coastal flooding and storm surge hazards associated with hurricanes and nor'easters. Nor'easter impacts are more frequently significant as Cape Cod usually protects the town from the full force of hurricanes (MAPC, 2011). The population is just over 25,000, and is largely a year-round community. The town does have a small seasonal population, as the census statistics report almost 10% of the housing stock as seasonal. The median per capita income is just under $40,000 and the population is almost 97% white.

ADAPTATIONS

The Town of Marshfield has implemented several ongoing low-cost adaptation activities. The town is currently most active in planning for potential change in coastal flood risk. Recent planning-related projects include a vulnerability assessment, student participation in writing the town master plan, and a proposed coastal advisory committee specifically charged to address climate adaptation. The table provides adaptation information, followed by brief project summaries.

Regional Coastal Adaptation Study

Marshfield has coordinated with the neighboring towns of Duxbury and Scituate to submit a successful joint proposal for funding to study coastal flood vulnerability and adaptation options. The study was produced by the Metropolitan Area Planning Council (MAPC), and was completed in late 2011 (see MAPC, 2011). This multi-town study is cost-effective in at least three ways: 1) it pools resources between towns, making study participation comparatively less costly than if towns act alone; 2. regional bottom-up actions attract funding and other support involving higher political levels (e.g. SFRCCC, 2011) as it did for this study (pers. comm. Barry Keppard, MAPC, July 20, 2012); and 3)regionally consistent vulnerability assessments involving, for example, a single set of sea level rise scenarios have been viewed as a critical need to develop effective regional adaptation strategies at the local level (SFRCCC, 2011). This best practice is documented here for Marshfield, but credit also extends to the towns of Duxbury and Scituate as collaborators.

While the towns' collaboration to attract adaptation study resources is cited here as a local-level best practice, the plan itself developed by the MAPC with support from the state CZM office contains best practice guidance that may be transferable to other locations. For example, other towns or regions may consider adopting a similar cost-effective study design. With $15,000, the MAPC identified current and future potential coastal hazard risks including the condition of current coping structures, presented detailed adaptation strategies, documented funding and adaptation support resources, and held public workshops to communicate study findings.

The MAPC report (2011) includes extensive information that may be useful not only for managers in the study area, but also for other U.S. coastal towns. In particular, the funding and adaptation resources section is extensive and written with the local manager's perspective in

mind with examples of how towns have used the resources. While some resources are specific to Massachusetts towns, most apply to any U.S. town. Additionally, the report provides recommendations for cost-effective adaptation planning, including specific actions towns can take to make use of the available resources.

Student Participatory Town Master Plan

Students in the Student Participatory Town Master Plan – UMass-Amherst Regional Planning Studio wrote the climate adaptation chapter for Marshfield's new town master plan. This project was in progress at the time of this writing, but initial plans indicate potential cost-effectiveness. Customized climate projections were prepared for the town, which can be used for policy decision-making by all town departments, such as public works and the harbor master. A multi-hazard planning approach is used, which economizes on efforts that could meet multiple adaptation objectives instead of duplicating efforts with a piecemeal approach. Alternatives to expensive and costly repairs to the sea wall are proposed, including elevating homes, improving on-site stormwater management, and installing living shoreline treatments. Multi-hazard plan components will provide a base reference for inserting climate change concerns into official town management decisions, increasing the likelihood of adaptive actions.

Coastal Advisory Committee

Marshfield is assembling an interdisciplinary town committee with an explicit goal to foster a more comprehensive approach to coastal planning to address the challenges of climate adaptation (Marshfield, Mass. 2012). Like many towns in the U.S. Northeast, hazard mitigation plans and long-term planning efforts are developed and administered separately, a consequence of financial constraints, sometimes involving town departmental "turf wars" as town staff compete for responsibility to secure funding. As a result, many hazard mitigation plans do not adequately account for long-term hazard risk change. A specific motivation for forming the advisory committee was to help integrate the hazard mitigation and long-term plans by dissolving this administrative divide (Pers. Comm. Paul Halkiotis, Town of Marshfield, July 19, 2012). The specific charges of the proposed advisory committee are as follows (see Marshfield, Mass. 2012):

- Proactively promote a research-based approach to making local decisions about various seal level rise adaptation strategies that include but are not limited to: flood-proofing, beach nourishment, armoring sea walls, tactical retreat, and land acquisition.

- Develop policies that will help to minimize the town's exposure to coastal storms in an effort to protect public safety, infrastructure, natural resources, and private property.

- Develop various benchmark indicators to measure sea level rise and coastal storm frequency and intensity.

- Evaluate the costs and benefits of various adaptation measures.

- Work with Planning, Conservation and DPW staff on long-range planning for the coastal zone in an effort to obtain projections on sea level rise, to determine what areas in the coastal zone will be subject to inundation of flood waters.

- Identify federal, state, and privately funded grant opportunities to study and plan for adaptation to sea level rise.

- Work with neighboring South Shore communities on regional solutions for coastal infrastructure management.

- Work with state legislators to support new legislation that will: (a) provide funding sources for coastal infrastructure management and (b) provide flexibility in spending money for repairs/replacements, when needed, such as a revolving fund.

- Educate citizens on sea level rise predictions, adaptation strategies, impacts to natural resources, and the potential costs associated with taking no action. This should include establishing and maintaining a website and organizing seminars and presentations by outside experts.

- Promote communication and collaboration among various town boards, committees, and departments on coastal management issues.

- Perform a cost-benefit analysis on the cost of new seawalls with revetments versus flood proofing structures.

- Advise the Capital Budget Committee and Advisory Board on coastal infrastructure management expenditures recommended by the Board of Public Works.

3.4. RHODE ISLAND

3.4.1. NORTH KINGSTOWN, RI

Population Density	607.4/ sq. mi.
Form of Government	Town
Category	Bayfront Suburban
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
77478	35613	69.1	26486	0.06	94.7	2%	6.9%	3.3

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Assessment of Coastal Wetland Vulnerability	Completed	Yes	Procedural	Recommendation	Unique	Medium (<100,000)	NOAA Sea Grant
Climate Change Vulnerability Analysis	Completed	Yes	Procedural	Recommendation	Unique	NA	NA
Sea Level Rise Pilot Study and Plan	Completed	Yes	Procedural	Recommendation	Unique	Medium (<100,000)	NOAA Sea Grant

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POPULATION AND GEOGRAPHY

North Kingstown is a coastal community located in Washington County, Rhode Island, boarding Narragansett Bay, 23 miles southeast of the state capital of Providence (USGS, 2008; NOAA, n.d.). The town is highly susceptible to flooding effects from hurricanes in the late summer months and nor'easters in the winter. Since 1900, Rhode Island has been impacted by 33 hurricanes (USACE, 1995). Narragansett Bay exacerbates storm surges due to a funneling effect

during coastal low pressure events, leaving adjacent towns like North Kingstown at increased risk (Freas et al., 2002). According to the state's hazard mitigation plan (State of RI, 2008),[2] just under 7,000 people with permanent residence and just over 300 people with seasonal occupancy live in the hurricane evacuation zone. Of the town's 45 square miles of land area, 9 square miles (or about 20%) are exposed to flood hazard, including about 850 homes and other structures in FEMA-designated flood hazard areas (Rhode Island, State Hazard Mitigation Plan 2008).

ADAPTATIONS

The Town of North Kingstown has implemented several ongoing low-cost adaptation efforts. The town is currently most active in assessing coastal vulnerability to sea level rise. Recent vulnerability assessment projects include: a sea level rise pilot study and plan, a coastal wetland vulnerability assessment, and a transportation network vulnerability study. The table below provides adaptation information, followed by brief project summaries.

Sea Level Rise Pilot Study and Plan

Following the state-wide flood mapping noted above, North Kingstown was selected as the site for a pilot study to identify critical assets vulnerable to sea level rise. The pilot study included the development of a map set that illustrates asset value at risk (North Kingstown, R.I. 2011). The study also identified opportunities to incorporate climate risks into the town hazards mitigation and comprehensive plans (North Kingstown, R.I. 2011). The pilot project cost less than $30,000, which is the total cost for the state-wide collection of LiDAR (Light Detection And Ranging) data and the North Kingstown pilot study. The working group included North Kingstown town staff in addition to those involved with the state-wide assessment (see above).

The University of Rhode Island's Coastal Resources Center recently was awarded the Statewide 2012 Planning Grant Challenge Grant to incorporate climate change components into North Kingstown's Town Comprehensive Plan, building on results from the NOAA pilot study (RI CCC, 2012). This project will include workshops to help other communities incorporate sea level rise into their comprehensive plans.

Assessment of Coastal Wetland Vulnerability

With LiDAR data and a sea level rise model in-hand, North Kingstown and collaborators from the sea level rise pilot study applied the Sea Level Affecting Marshes Model (SLAMM) to project migration of marshes in the town in response to various sea level rise scenarios (see Ruddock, 2011). Much of marsh habitats that line North Kingstown's coast have been lost to development and those that remain will be stressed by rising sea levels. If unimpeded, the marshes could migrate inland as seas rise. The SLAMM assessment helps decision-makers identify marsh areas most at risk, and locations where landward migration should be made possible. With good elevation data and a sea level rise flood extent model provided by the state-wide elevation project and the pilot study, developing the SLAMM model comprises the cost for the wetland vulnerability assessment.

[2] Based on 1990 U.S. Census data when the total permanent population for North Kingstown was 23,790 and seasonal population was 630.

Unique Considerations for Rhode Island

Rhode Island is in the unique position of being the smallest state in the union, which has implications for sea level rise and climate change planning.

Most importantly, the State passed an amendment to its comprehensive planning law in 2011 requiring all municipalities to consider natural hazards including flooding and sea level rise in their mandatory plans by 2016.

The best practices for North Kingstown involved pilot projects to do detailed sea level rise vulnerability assessments that were extensions of state-wide programs. Due to Rhode Island's small size, detailed analyses can often be scaled up and transferred to other locations or state-wide (see Pamela Rubinoff of NOAA Sea Grant citation in NOAA, 2009). With methods developed in North Kingstown, the state has plans to apply the pilot assessments state-wide (see RI CCC, 2012).

State-wide vulnerability assessments and a coastal wetlands migration study are underway, which draw from methods developed in North Kingstown pilot studies (RI CCC, 2012). Additionally, an erosion and inundation special area management plan (SAMP) is being implemented for all coastal areas in the state.

In RI, state level activities are significantly driving local adaptation, with local best practices largely taking the form of receptiveness and engagement with state adaptation efforts. Initiatives that are directly influencing North Kingstown's adaptation to coastal flooding hazards are outlined below:

- RI legislation enacted in 2011 (H 5380, S 0021) requires towns to map areas vulnerable to the effects of sea level rise and storm surge as well as other climate hazards. The legislation also requires towns to develop goals, policies, and adaptation techniques to reduce anticipated impacts.

- In 2010, the RI Climate Risk Reduction Act (RIGL 23-84) established the twenty-eight member RI Climate Change Commission. The Commission is charged with studying projected climate impacts, developing methods for adapting to expected impacts, and identifying mechanisms to mainstream adaptation into existing state and municipal programs such as infrastructure design and maintenance (see RI CCC, 2012). The Commission released its first report in November 2012 (RI CCC, 2012), which outlines key climate vulnerabilities, recommendations to begin adapting, and documents current adaptation initiatives taking place throughout the state.

- In 2008, the RI Coastal Resources Management Program (CRMP) adopted climate change policy to plan – Section 145 - for a 3 to 5 foot rise in sea level by 2100 in siting, design, and implementation of private and public coastal development projects (RI CRMP, 2008).

- A joint effort between the University of Rhode Island, RI Coastal Resources Management Council, Statewide Planning, The Nature Conservancy, and the RI

Emergency Management Agency mapped flood extents for 1', 3', and 5' sea level rise scenarios and the 1938 hurricane surge using a "bathtub" model for the entire state.

- The state's Department of Transportation was conducting a state-wide vulnerability assessment to identify vulnerable roads and bridges.

A recent and more comprehensive list of federal, state, and local adaptation initiatives in RI can be found in RI CCC (2012)

The cost-effectiveness of the North Kingstown pilot projects is in large part owed to how readily what is learned at the community level can be scaled up to a state-wide program. State-wide vulnerability assessments and a coastal wetlands migration study are underway, which draw from methods developed in North Kingstown pilot studies (RI CCC, 2012). Additionally, an erosion and inundation special area management plan (SAMP) is being implemented for all coastal areas in the state. Funds for the new SAMP are initially being provided by RI Bays, Rivers, and Waterways Coordination Team, NOAA, and the RI Coastal resources Management Council (RI CCC, 2012). The SAMP project budget is currently estimated at $497,112 (RI CRMC, 2012).

3.5. CONNECTICUT

3.5.1. GREENWICH, CT

Population Density	1285/ sq. mi.
Form of Government	Town
Category	Suburban Soundfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
125266	60076	60.0	61171	0.01	86.7	10%	20.2%	3.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	Town
Freeboard - 1 Ft in A/AE 2 Ft in VZ	Implemented	No	Accommodation	Mandatory	Unique	None	NA
Green Area Ordinance	Implemented	No	Prevention	Mandatory	Unique	Low (< $10,000)	NA
Evacuation Mapping	Implemented	Yes	Procedural	NA	Unique	Mixed High initial cost for GIS capacity. Minimal staff time with GIS skill.	Town
Flood Zone Home Elevation Database	Implemented	Yes	Procedural	Recommendation	Unique	Town staff time/$7,700 NOAA Coastal Resilience Grant	Town, NOAA
Cumulative Substantial Improvement Ordinance	Implemented	No	Procedural	Mandatory	Above Required	None	NA
Green Area Ordinance	Implemented	No	Prevention	Mandatory	Unique	None	NA

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POPULATION AND GEOGRAPHY

Evidence of human activity in Greenwich dates back 12,000 years, but the town was formally settled and organized in 1640. It has a current population of 61,171 as of the 2010 Census. It includes areas also known as Cos Cob, Riverside, Byram, Old Greenwich, and Glenville. The town is well-known as an extremely wealthy suburb of New York City; peak-hour express trains take only 38 minutes to reach Grand Central Terminal in Manhattan.

The State of Connecticut has the highest median and per-capita income in the country. In Greenwich, the median household income is $125,266 and the median home price, according to data cited in the comprehensive plan, is $1,770,000 (2008).

Like most of New England, the town operates on the town meeting system, although Greenwich uses a "representative" town meeting system with 230 elected representatives. Demographically, the town is 86.7% white, 2.15% African American, 6.6% Asian, and 1.19% Latino.

Greenwich is located in the extreme southwestern corner of the state, bordered on two sides by Westchester County in New York State, the Long Island Sound on its south, and Stamford on the east. It consists of 67.2 square miles—47.8 sq. mi. is land and 19.4 is water. Its southern third is the most heavily developed and contains the major east–west transportation corridor of I-95, U.S. Route 1, the Merritt Parkway, Amtrak, and the Metro-North commuter rail. Its historic downtown and smaller historic commercial areas are also located in the southern part of town. The town has seven National Historic Register Districts, including downtown Greenwich. The northern half of the town, also known as the back-country, is a heavily wooded, lower density area that does not have sewer or municipal water infrastructure. Zoning in much of this area mandates a minimum lot size of four acres. The entirety of the town is located in the New York-Northern NJ-Long Island, NY-NJ-CT-PA consolidated metropolitan statistical area and serves as a commuter suburb to New York City metropolitan center activity centers, including White Plains/Westchester County, Stamford/Hartford, and Manhattan. Commuter rail service runs through the town and provides direct trains to Grand Central Terminal from four separate stations in the town. The town also has a number of major employers itself, including Nestlé Waters North America, United Rentals, Inc., Blythe, Inc., and a number of private equity firms.

COASTAL ISSUES

Greenwich recognizes that its economic vitality is tied to the quality of its environment. The Plan of Conservation and Development highlights that "Among the things that make Greenwich so attractive are its numerous open spaces and unspoiled natural features—public parks, beaches, wooded areas, massive rocks, lakes, rivers, fields, and scenic views" (Greenwich, Conn. Plan of Conservation and Development (Plan), p.1)

According to the plan, flooding has been an increasing challenge in town because of both development in the flood plain and increased impervious surfaces. "Floods have caused major damage to residential properties and structures. The Town is very concerned about flooding and drainage and is developing stormwater master plans to address this problem in various areas and watersheds of Town in a cost-effective manner" (p.2)

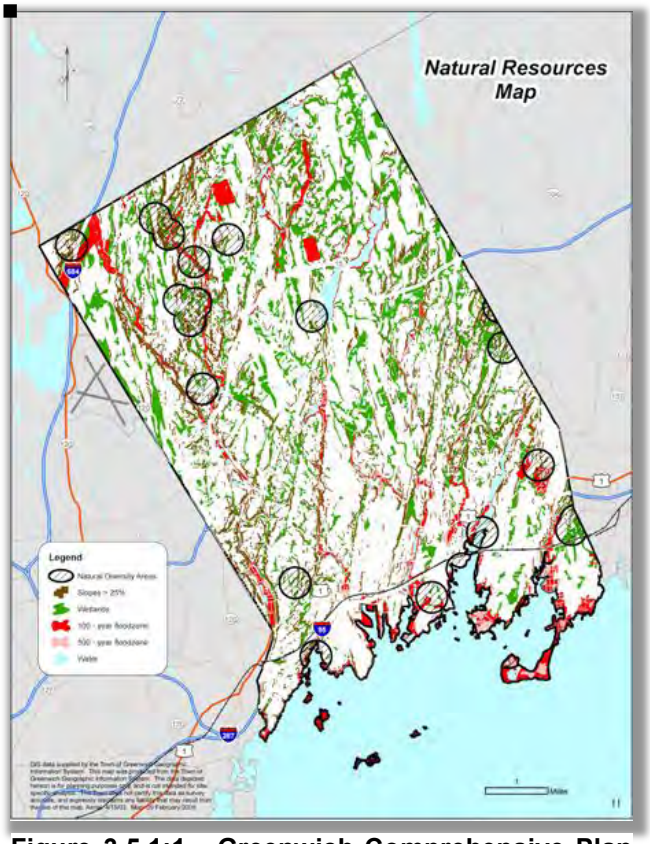

Figure 3.5.1:1 - Greenwich Comprehensive Plan Natural Resource Map, Showing 100- and 500-Year Floodplains

Sea level rise is seen as a component of this challenge that Denise Savageau, Conservation Director, says is understood by local residents. "...there are more and more people getting that sea level is rising ... but that said, [we are] just letting them know that even in existing conditions how bad it can be..." (Personal Communication, Jul. 9, 2012)

Ms. Savageau identified the challenge of the lack of institutional memory created by a large influx of new residents and a long period without a significant storm. The last major hurricane was in 1965 and a significant amount of construction has taken place since then. "We've had little minor storm events such as in 2007 ... but we don't have a history of people understanding where it is going to flood ... they don't know the elevation of their houses and they have never been in the 100-year storm event," Ms. Savageau said.

Another challenge, however, is that a large percentage of buildings in town are historic structures that were built before provisions for runoff mitigation were enacted. Equally challenging is the multitude of agencies that complicate flood hazard mitigation in Connecticut. The plan states "There are many departments with autonomous authorities and regulatory powers that are involved with stormwater management, drainage and flooding issues ... includ[ing] the Flood and Erosion Control Board (FECB), Inland Wetlands and Watercourses Agency, Department of

Public Works, Planning and Zoning Commission, Board of Appeals and the Conservation Commission" (Plan, p.2)

ADAPTATIONS

Comprehensive Plan

The most recent Greenwich Comprehensive Plan of Conservation and Development, required by state law, was adopted in 2009. To achieve the plan's goals, it includes the following action strategies:

The town's comprehensive plan mentions the need to address climate change. Specifically, it states "Coastal flooding is also an increasingly important issue, as concerns about global warming and sea level rise draw additional attention to this topic. Areas within the Old Greenwich coastal zone are particularly affected" (Plan, p.2)

To deal with these concerns, the plan recommended that Greenwich update the Building Zone Regulations and the Engineering Drainage Manual, which is currently being completed. The plan also recommended that Greenwich require that post-development hydrology of a site use low-impact and best management practices, which was implemented through the Green Area Ordinance.

Floodplain Initiatives

Greenwich recently adopted a new drainage manual that further elaborates the town's commitment to low-impact development, which the town believes helps it prepare for climate change. In March 2012, the town also passed an innovative green area ordinance, which regulates the percentage of a lot that must remain vegetated, and helps reduce stormwater runoff.

The town's flood ordinance was updated in 2010. The town maintains a freeboard requirement of 1 foot in excess of FEMA base flood elevations in the A and AE zones that applies to residential and commercial buildings (Greenwich, Conn. Town Code, Sec. 6-139.1 (11a)).[3] No basements are allowed in the 100-year floodplain.

In the VE zone (Coastal High Hazard Area—areas with special flood hazards associated with high velocity waters, including hurricane wave wash), Greenwich allows two feet of fill. All mechanical equipment, electrical, plumbing, and other utility connections must be elevated 1 foot above Base Flood Elevation (Greenwich, Conn. Town Code, Sec. 6-139.1 (12.b).

One square inch of flood venting is required for every square foot of enclosed area, which exceeds FEMA requirements. Homeowners can voluntarily elevate their homes above these levels, and the town has recently seen applications for 2 feet and higher above BFE. The town

[3] Greenwich, Conn. Town Code, Sec. 6-139.1 (11.a) "No new or substantial improvement of any residential structure shall have the lowest floor, including basement, elevated to at least 1 foot above the base flood elevation." Sec. 6-139.1 (11.c) permits non residential structures to be flood-proofed in lieu of freeboard if all utilities and sanitary facilities below required elevation are watertight and use structural components capable of resisting hydrostatic and hydrodynamic loads and the effects of buoyancy.

has been encouraging the use of fill instead of structural elevation of homes. The town is also working to educate homeowners about the risks and options for increasing their resilience.

The town also has a cumulative substantial improvement ordinance. Substantial improvement is defined as "any combination of repairs, reconstruction, alteration, or improvements to a structure taking place during the life of a structure." The ordinance defines "substantial improvement" "to occur when the first alteration (after 8/19/86) of any wall, ceiling, floor or other structural part of the building commences ... the term does not ... include any improvement project required to comply with existing health, sanitary or safety code specifications ... necessary to assure safe living conditions..." (Town Code, Sec. 6-139.1(c)(40))

Evacuation and First Responder Mapping Using GIS

Greenwich also has several ongoing low-cost adaptation activities involving effective use of Geographic Information Systems (GIS) to plan for extreme coastal flooding. These actions are low-cost for communities equipped with strong GIS capacity, particularly with respect to handling elevation data. However, with increased LiDAR provision throughout the region, the mapping work and methods developed by Greenwich could be scaled up with state and federal support, and extended to towns with inadequate GIS capacity.

The Town of Greenwich Conservation Commission has created detailed flood inundation maps for several extreme coastal flood scenarios using a bathtub model. Using 2-foot elevation contours, the maps show individual homes that would likely be inundated by extreme flood extents. These maps are different from other commonly available inundation maps (e.g., SLOSH) by providing needed detail to plan for individual homes and infrastructure made possible by high-resolution elevation data and a creative GIS application. Next, Greenwich will use 1-foot contours for greater precision. The maps are used for the following:

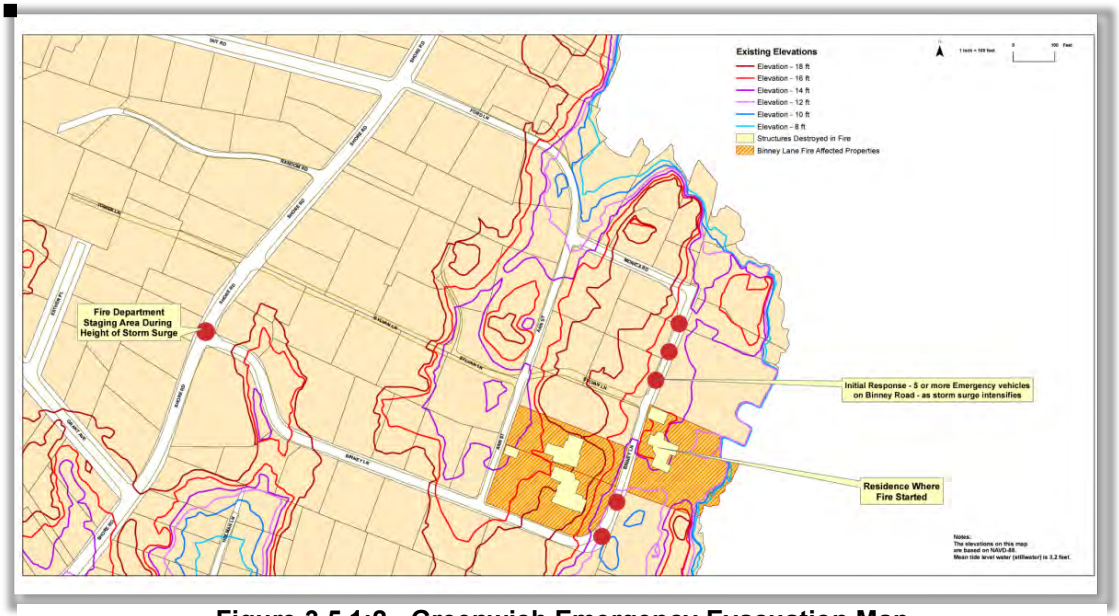

Figure 3.5.1:2 - Greenwich Emergency Evacuation Map

Education – Since extreme coastal floods are relatively rare, they are often not in the memory of residents located in the flood zone and, increasingly, they are out of the memory of those who manage the zone. Maps that show possible extreme flood inundation extents help communicate flood risk to provide an experience substitute to increase awareness for events that have not recently occurred.

Evacuation maps – Homes exposed to each flood scenario are identified to provide accurate evacuation zones and affected assets.

TESTING THE GIS SYSTEM IN SANDY

Greenwich used this system for emergency response during Hurricane Sandy. At 6:06 P.M. on the night of the storm, the Greenwich Fire Department received a call about a fire that broke out in a coastal property. According to Ms. Savageau, they "used the detailed elevation map to guide the fire department in terms of staging during the worst part of the storm"* to look at surge predictions in the area. While low tide was at 6 P.M., the fire department arrived on the scene and "found themselves in 2 ft of water...the storm surge was already creating water levels above flood stage."

With the severity of the wind that night, the fire was spreading and engulfed two other homes and two garages. "Winds were gusting to 80 mph and there were trees and electric lines down on some of the roads. We didn't want our fire crew to get trapped without a way out during the surge," according to Ms. Savageau. In addition, 33 residents had to be evacuated from the combined fire and surge risk.

Using the 2 ft. contour elevation maps and corroborating with the Army Corps of Engineers Stamford Hurricane Barrier Gauge, the town was able to determine the best evacuation route and the location for the optimal staging area, so they could locate fire equipment and personnel as close to the fire as possible but out of the risk of the incoming storm surge.

Using the data from the GIS and observations in the field, the Emergency Operations Center Staff were able to safely direct the fire options and determine when it was safe for fire and EMS personnel to move onto the scene, based on incoming storm surge data correlated to street elevations.

Following the storm, town staff used a GIS unit to document the wrack line and compare it to their topographical lines in the GIS. They determined that the surge was at 10 ft NAVD88 (a 50 year storm event - 100 year is 10.5').

The town is planning to further verify the state's SLOSH maps with data collected during the storm, "so that we can have better evacuation maps...so as not to appear to "cry wolf" with evacuating folks that do not need to be evacuated.

Emergency response – Each home is assigned a number indicating under what flood scenarios they would likely be inundated. Emergency responders can use this information to guide first response during a known flood height.

Home Elevation GIS Database

Greenwich is inventorying the elevation of all homes in the coastal flood zone to be added to their GIS database. In addition to increasing the accuracy of the evacuation maps noted above, this GIS layer will help the town assess whether their ongoing practice to use fill dirt to provide freeboard in the AE flood zone is more detrimental than beneficial during extreme floods. The result of this assessment will determine whether this is a best practice.

Not all homes in the flood zone have elevation certificates on town record. While elevation certificates are available for new homes or those that have recently been renovated, other homes are not required to provide an elevation certificate. As part of a $7,700 NOAA Costal Resiliency Grant, Greenwich is obtaining elevation information for homes without elevation certificates from other sources, such as mortgage companies, that have this information on record. With accurate elevation information for every home in the flood zone, the emergency response maps with extreme flood exposure designations (see above) will also be more accurate.

Greenwich is also using the home elevation information to study the costs verses the benefits of using fill to raise homes in the AE flood zone. Height limitation variances are usually granted for homes raised by fill, and many homes are built above the FEMA minimum elevation requirement.[4] While this low-cost method for raising homes decreases property exposure to floods, it has the unintended collective effect of creating little islands, which may increase flood vulnerability in other ways. Each dirt mound diverts flood waters adding to a water pooling effect that may worsen floods by preventing water from draining back into the ocean. Some potential consequences of the pooling effect include increased flood exposure of property not raised by fill (e.g., cars and utility infrastructure), increased risk of people being trapped in their homes by flood waters, and decreased accessibility for emergency responders during extreme events. The results of the fill effect study will be used to determine whether Greenwich should change their regulations and not allow fill to be used in the AE flood zone.

Green Area Ordinance

The town enacted a new green area ordinance in March 2012 to achieve the goal of the Comprehensive Plan "to remain a well-maintained residential community who protects and enhances water and land natural resources, pervious surfaces, open space, parklands, recreational facilities and areas in an environmentally sensitive manner" (Town Code, Sec. 6-5 (a)(35)).

The purpose of the law "is to maintain open areas and green spaces," that has the related benefit of "helping with drainage, flooding and water quality problems" (Greenwich, Conn., Planning and Zoning Commission). The law impacts all residentially zoned property except one multi-family zone.

Officially, the law amended Section 6-5 (a)(35) of the Town Code, specifically prescribing "the required percentage of a residentially-zoned property that is naturally occurring, such as rock outcroppings, wooded, grassed, manicured or landscaped areas."

[4] Note: height limitations are also not an issue in the VE flood zone where Greenwich. However, fill is not allowed in the VE zone, so number of story restrictions tends to limit height in these areas.

The law was not entirely new, since many towns regulate impervious coverage. However, the law expanded Greenwich's previous regulations, which only covered commercial areas to all zones in the town. The new law reverses the typical manner of regulating impervious coverage by instead requiring a certain percentage of green space on the lot.

The law was intended to encourage retention of natural features and existing vegetation instead of relying on engineering solutions to stormwater management such as impervious pavers. The minimum green area coverage varies from up to 84% of the lot in the RA-4 zone to 35% in the R6 zone.

The town requires any landowner making improvements of greater than 500 sq. ft. of impervious surface to complete a drainage analysis. The town engineering department is also conducting an extensive town-wide master drainage study, but this cannot be considered a low-cost adaptation solution.

3.5.2. GROTON, CT

Population Density	1297/ sq. mi.
Form of Government	Town
Category	Suburban Soundfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
54944	30952	45.5	40115	0.03	78.8	9%	26.1%	3.8

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Climate Change Project	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	Other
Incorporated Climate Change into Public Works/Infrastructure Decision Guidance	Completed	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	None

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POPULATION AND GEOGRAPHY

The town of Groton has a population of 40,115 as of the 2010 Census. 79% of residents are white, 7% are black or African American, just over 6% are Asian, and about 10% are Hispanic. The population growth rate is 1%. The median per capita income is $61,709 and the median house value is $245,740. Groton does not have a significant seasonal home market.

Groton is a town government in the New England manner and thus it covers a large geographic area of 31 square miles. It is located on Long Island Sound in southeastern Connecticut, 10 miles west of the Rhode Island border.

Groton is known as the “American submarine capital” for good reason. It is home to the U.S. Naval Submarine Base and the government contractor Electric Boat, Inc. 49% of jobs in town

are in the government sector. Pfizer also has a large plant in Groton and is the third largest employer in town.

Figure 3.5.2:1 - Historic Downtown Mystic in the Town of Groton

The municipal geography in Groton can be confusing. Groton's borders are formed by the Thames River on the west (which separates it from New London), the Mystic River on the east, and Long Island Sound on the south. It is bordered by the town of Ledyard on the north. Within the town of Groton are two independent municipalities—Groton Long Point and the City of Groton—and the unincorporated village of Noank. The well-known and historic seaport of Mystic is partly in eastern Groton and partly in neighboring Stonington, but is not a recognized municipality in itself. The Mystic Aquarium & Institute for Exploration is located on the Stonington bank, but the Groton bank is known as the more historic quarter.

COASTAL ISSUES

Groton is facing a number of increasing threats from coastal processes due to climate change. Its coastline has been receding and was determined to be 100 feet inland from the 1888 level. In addition, analysis of local sea level trends at the New London tide gauge indicate a doubling since 1980 to approximately 4 mm/yr. (Stults and Pagach 2011, p.6)

Inundation from sea level rise has already been impacting the community. Flooding has become more frequent and intense in vulnerable locations such as the Navy Base, the Groton-New London Airport, downtown Mystic, and Bluff Point State Park.

ADAPTATIONS

Coastal Climate Change Project: Preparing for Climate Change in Groton, Connecticut: A Model Process for Communities in the Northeast

Groton has long been involved on the leading edge of climate change policy. It most notably participated in the Preparing for Climate Change Model Process, which was funded by the EPA's Climate Ready Estuaries program and the Long Island Sound Study. The project was acollaboration between ICLEI-Local Governments for Sustainability USA (ICLEI), the Connecticut Department of Environmental Protection (CT DEP), and the town of Groton.

The partners conducted an analysis of a local-level climate resilience collaboration between federal, state, and local stakeholders. The project involved the organization of three workshops that were attended by over 100 individuals from all three major institutional sectors, as well as local citizens.

The project's main aims were to: (p.4)

- Understand how to prioritize vulnerabilities so that lawmakers have a framework to utilize when selecting projects that are competing for limited financial resources;
- Determine if and how existing laws and regulations need to consider future rates of sea level rise and erosion in order to protect the priority vulnerable areas that sustain the local, state, and regional economies;
- Identify synergies and begin fostering collaboration between all levels of government in order to increase local resilience towards climate related vulnerabilities; and
- Share lessons learned through the process with other communities in the region

Figure 3.5.2:2 - Evacuation route sign with flood measurements located in Groton

The workshops used the new COAST climate change modeling and visualization tool developed by the New England Environmental Finance Center (EFC) and the Battelle Memorial Institute. The tool aids in adaptation assessment by displaying location-specific avoided costs. It uses GIS to estimate potential economic damage from sea level rise scenarios by incorporating data such as property and infrastructure values; NOAA's Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model; and U.S. Army Corps of Engineers Depth-Damage functions. The participants identified specific locations vulnerable to climate impacts, looking at transportation, infrastructure, ecological resources, and emergency services.

Incorporated Climate Change into Public Works Decision Guidance

Building on the awareness of climate change impacts generated by the model process, the Town of Groton adopted a public works decision guidance document that incorporates climate impacts.

POTENTIAL ACTIONS IDENTIFIED TO BUILD PREPAREDNESS TO CLIMATE CHANGE IN GROTON:

- Relocate/Elevate vulnerable roads and infrastructure – ensure emergency access and preservation of public safety during extreme events;
- Develop Memorandums of Understanding with state personnel regarding funding of local police costs incurred to vulnerable protect safety along state owned road infrastructure during and after storm events, so that police can also monitor other hazardous areas;
- Stormwater runoff reduction program designed to control peak discharges and to require post-development rates of runoff to be no greater than pre-development conditions in most circumstances;
- Flood-proofing of existing buildings;
- Conversion of land upriver to wetlands in order to accommodate increased sea level rise;
- Creation of incentives for retreat zoning and/or zoning and redevelopment restrictions and building code changes or enforcement to prevent building in the most vulnerable locations;
- Educational programs that alert residents about climate change and vulnerable areas of the Town;
- Purchase of vulnerable land or land that will act as a buffer by Groton;
- More stringent building and engineering design standards that anticipate future climate conditions, as opposed to just existing conditions;
- Beach nourishment;
- Installation of flood/tide gates at locations such as Groton Long Point and Mumford Cove; Creation of a comprehensive watershed management plan for debris and culverts, in partnership with Amtrak and CTDOT;
- Improved road condition reports during extreme events, in order to help the school district and other agencies to identify the safest transportation routes;
- Identification of Town, State, and Federal funding available to make the improvements to infrastructure that is deemed highly vulnerable;
- Integrate climate preparedness into the Capital Planning process, Master Plan of Conservation and Development update process, the zoning regulations revision, and streetscape project; and
- Investigate the logistical challenges of incorporating climate change, adaptation, and preparedness into school curriculum

POTENTIAL FUTURE IMPACTS FROM CLIMATE CHANGE IN GROTON, CT*

- More frequent river and coastal flooding;
- Increased occurrence of sewer overflows;
- Loss of coastal habitats and resources (wetlands);
- Increased coastal erosion;
- Reduced drinking water quality and supply caused by salt water intrusion as well as increased precipitation, flooding, drought, and erosion;
- More frequent flooding that could prevent access to and reduce function of Groton-New London Airport;
- Access to state parks such as Bluff Point and Haley Farm could be hampered by flooding;
- Access to UCONN-Avery Point campus may be impaired during storm events;
- Docks and marina facilities could be damaged by flooding and sea level rise;
- Increased economic impacts related to infrastructure replacements, loss of employment hours, additional emergency service personnel,
- Sections of Amtrak railroad could flood under certain sea level rise and storm flooding scenarios;
- Mystic River bridge may experience additional openings for smaller boats as bridge clearance diminishes with sea level rise;
- Shellfishing and fish spawning could be drastically reduced and/or collapse; and
- Overall quality of life, aesthetics, and enjoyment of citizens may be reduced

*A component of the *Preparing for Climate Change Project* was an analysis of future impacts.

3.5.3. GUILFORD, CT

Population Density	450 /sq. mi.
Form of Government	Town
Category	Suburban Soundfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
97134	47745	77.1	22375	0.45	94.7	3%	7.8%	5.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Climate Change Project	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	Other
Incorporated Climate Change into Public Works/Infrastructure Decision Guidance	Completed	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	None
Community Coastal Resiliency Plan	Completed	Yes	Procedural	Recommendation	Unique	Medium (<$100,000)	NOAA
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	Other
Formal resolution recognizing climate change	Completed	Yes	Procedural	Recommendation	Unique	Zero	None
Hazard Mitigation Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	FEMA

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POPULATION AND GEOGRAPHY

The town of Guilford is located in central coastal Connecticut along the Long Island Sound shore, about 15 miles east of New Haven and due south of Hartford. The town is 47 square miles with approximately 15 miles of shoreline.

Guilford is bordered by the towns of Madison to the east, Durham to the north, and Branford and North Branford to the west. Its population is just over 22,000. It is a wealthy community, with a median household income of $97,000 as it is primarily a commuter suburb of New Haven and Fairfield County. The population is almost 95% white and 77% of residents own their homes. The town is a permanent resident community, with only 5% seasonal occupancy.

COMMUNITY COASTAL RESILIENCE PLAN
SEA LEVEL RISE RISKS

1. A continued increase in the rate of rising sea levels will inundate low areas, increase erosion of beaches and tidal marshes, increase the incidence of flooding from storm surges, and enable saltwater to advance upstream and intrude further into estuaries and aquifers.
2. Future sea level rise could result in the disappearance of a large percentage of Guilford's tidal wetlands unless they can advance as quickly as the rising level. Saltwater advancing upstream along estuaries can alter the point at which sedimentation leads to the creation of shoals and other features.
3. FEMA's coastal base flood elevations will progressively rise along with sea level. This means that the 100-year and 500-year flood levels will affect lands and structures that are currently at unaffected elevations.
4. As sea level rises, storm surges from hurricanes and nor'easters will reach further inland as they are starting from a higher base level

Most of Guilford's shore is developed. There are many single family homes ranging from multimillion-dollar mansions to small cottages. Many were summer cottages winterized and converted to year-round use. According to George Kral, Town Planner, many are vulnerable to coastal storms (Personal Communication, Jul. 18, 2012).

COASTAL ISSUES

Guilford is at risk from coastal hazards that will increase as sea level rises. "More frequent coastal storms, storm surges, and flooding can cause a wide range of outcomes, from minor property damage to injury and loss of life. Even the indirect outcomes of increased flooding can cause a range of problems, from the slight inconvenience of waiting for low tide to traverse a key intersection, to being unable to mobilize an ambulance to the home of a person in need of medical attention." (Guilford, Conn., Community Coastal Resilience Plan (CCRP), p. 24)

Figure 3.5.3:1 - Waterways and wetlands intersperse the town of Guilford. This photo was taken from the Amtrak Corridor train

Guilford has 4,363 acres located within the 100-year floodplain, and 354 acres in the VE flood zone. In addition, nuisance flooding occurs near streams and rivers throughout the town as a result of poorly functioning drainage; low-lying roads; bridges and culverts with insufficient capacity; and other factors.

The hazard mitigation plan identified a number of critical roads that are subject to nuisance flooding because of poor drainage, low elevation, and bridges and culverts without sufficient capacity. The town also has 11 repetitive loss properties and many coastal structures vulnerable to flooding. One unique challenge in Guilford is that some neighborhoods—including Old Quarry, Sachem's Head, Little Harbor, Leetes Island, Vineyard Point, Indian Cove, Mulberry Point, and Tuttles Point—are subject to isolation when flooding cuts these areas off from the rest of town. (Guilford, Conn., Natural Hazard Mitigation Plan (NHMP), p. 2-61) All of the tidal marshes are vulnerable to sea level rise. The town has a number of neighborhoods at significant risk from encroachment of seawater in a number of the scenarios generated by the coastal resilience plan. The plan reports that "developed areas of Guilford that are most vulnerable to sea level rise include those at low elevations and those characterized by a lack of near-surface

competent bedrock ... these include at-grade roads, certain neighborhoods, and larger areas adjacent to marshes." (NHMP p. 4-19)

Commercial properties were also shown to be at risk. In particular, 13 businesses along the Soundview Road corridor are presently in hurricane surge zones, and the plan states that risks will increase over time. In addition, some hazardous materials are stored at these businesses, which the plan states causes vulnerability to surrounding properties. (CCRP p. 28)

ADAPTATIONS

Formal Resolution Recognizing Climate Change

The Guilford Board of Selectmen passed a resolution in 2007 recognizing climate change. It directed town departments, boards, and commissions to "formally consider impacts of this phenomenon on planning, management, procurement and budgetary decisions, and regulations relating to the objective of reducing greenhouse gas emissions, and mitigating negative effects projected to evolve from climate change" (Guilford, Conn. Resolution of the Board of Selectmen Feb. 5, 2007). Unfortunately, the resolution was not followed with any specific policies and was reported by George Kral as fairly ineffectual (Personal Communication, July 18, 2012).

Coastal Community Resiliency Plan

The town is in the process of drafting a Coastal Community Resiliency Plan, which is to be incorporated into the town's comprehensive plan. The plan was supported by a grant from NOAA and supported by Yale University and The Nature Conservancy. Broad goals of the project include raising awareness of coastal vulnerability, assessing risks, examining options to address those risks, and creating an action plan.

COASTAL RESILIENCE PLAN KEY STRATEGIES

1. Generating public awareness and understanding of coastal resilience issues and increasing support for town action to address it;
2. Assuring public safety;
3. Identifying plans to compatibly protect, rehabilitate or relocate critical infrastructure;
4. Amending Town coastal development policy to assure greater resilience of structures and natural resources;
5. Adopting post-storm redevelopment which respects property rights and provides for greater coastal resilience, and sustains coastal habitats such as tidal marsh and barrier beaches through protection of adjoining upland areas and provision for the migration of these habitats

The Nature Conservancy used their Coastal Resilience Tool to study storm and sea level rise predictions to determine how climate change will affect the tax base, residential and commercial development, public and private properties, natural habitats, and infrastructure (such as septic systems).

The four basic steps of the Coastal Resilience Program are:

1. Generate awareness of coastal risk (already underway and largely complete)
2. Assess coastal risks and opportunities (the current effort)
3. Identify options or choices for addressing priority risks and vulnerabilities (future effort)
4. Develop and implement an action plan to put selected options or choices into

place (future effort)

The town followed a deliberate participatory planning process to engage neighbors and town agencies. Mr. Kral emphasized the importance of this engagement. "The process is the most important thing—not just the document—to get the key people who have to implement it on board ... so they have sense of ownership in what it says," he said (Personal Communication, July 18, 2012).

The Risk and Vulnerability Assessment portion of the report was released in September 2012. The report discusses the relationship between risk, vulnerability, and resilience and reviews the history and relationship to previous planning efforts as well as to other towns and regional planning. It also looks at existing capabilities and strengths, current municipal regulations, and boards and commissions that deal with coastal vulnerability concerns. It addresses vulnerabilities to social, economic, utility, emergency services, and natural systems and then concerns itself with specific vulnerability assessments for neighborhoods along Guilford's coastline.

The town already has a number of initiatives, mostly focused on land preservation, that have enhanced its resiliency. The town actively encouraged cluster development and fees in lieu for open space preservation. The town maintains an active land acquisition fund, largely funded from rent from telecommunications towers, and recently issued $18 million in bonds.

The costs of the project to the town are nebulous. Mr. Kral said that it was hard to figure out what the costs are, since two of the major players—The Nature Conservancy and Yale University—are providing services for free. He also said it would be difficult to account for staff time and even more difficult to measure volunteers' time. They paid $25,000 to consulting firms for parts of the work (Personal Communication, July 18, 2012).

Comprehensive Plan Incorporates Climate Change

Guilford has a long and rich history of planning. Its first Plan of Development was adopted in 1959, and in 1966 the first Comprehensive Plan of Development and Conservation was approved. In 1978 and 2002 the town adopted an updated plan. The town first adopted a plan unique to coastal issues in 1982. The Municipal Coastal Program created plans and procedures for protecting coastal resources and promoting public access that were incorporated into Guilford's Zoning Regulations. Guilford is currently working on the fifth update to the plan of conservation and development. A consultant has been contracted to write the report, and they are currently working on the risk and vulnerability section. The second phase will focus on implementation strategies. The coastal community resiliency plan will be incorporated into the updated comprehensive plan.

Coastal Area Overlay District

The town of Guilford adopted amendments to Section 273-91 of the Zoning Code, the Coastal Site Plan Review, and the Coastal Area Overlay District on December 16, 2009.

The Coastal Area Overlay District is coincident with the Coastal Area Management Boundary. As the vulnerability analysis states, "one of the objectives of revising the section of the

regulations was to strengthen resiliency from coastal hazards." (Guilford, Conn. Town Code, Sec. 273-91)

The code requires certain uses, such as multi-family dwellings and certain commercial uses, to apply for a special permit. Certain uses are prohibited in the Coastal Area Overlay District because they pose too great a risk to costal resources: foundries, painting shops (except when accessory to boat repair), waste transfer operations, motor vehicle washing establishments, and oil and propane filling stations, except as accessory to a water-dependent principal use.

Hazard Mitigation Plan Incorporates Climate Change

Guilford is one of a few towns in our study to have funded and drafted its own Hazard Mitigation Plan and incorporated climate change and sea level rise. The plan was approved by FEMA in spring 2012 and adopted in June 2012.

The Nature Conservancy's Coastal Resilience Tool was used in the plan and included 27 separate maps. The coastal resilience tool was used to map potential flood scenarios for the decades of the 2020s, 2050s, and 2080s under three sets of conditions: no storm (in other words, only the impacts of sea level rise), Category 2 hurricane, and Category 3 hurricane (NHMP p. 4-24). The plan explains the challenge to the town:

> Increases in the rate of sea level rise will increase the incidence, severity, and adverse effects of erosion and shoreline change as well as flooding. Sea levels are currently rising along the Atlantic coast. Many believe that this is a result of climate change, which may be attributable to greenhouse gases or may be at least partly related to natural warming and cooling cycles that the Earth experiences. Regardless, a continued increase in the rate of rising sea levels will inundate low areas, increase erosion of beaches and tidal marshes, increase the incidence of flooding from storm surges, and enable saltwater to advance upstream and intrude further into estuaries and aquifers. (NHMP p. 4-5)

However in the Existing Programs, Policies, and Mitigation Measures section, the plan notes:

> Like many communities, the Town lacks existing policies and mitigation measures that are specifically designed to address sea level rise. Although Guilford does not currently have a comprehensive plan to address sea level rise, important pieces are in place in the form of the codes and regulations cited in Section 2.9 that have been enacted to minimize storm, erosion, and flood damage. (NHMP p. 4-13)

The plan suggests a number of mitigation measures to specifically address sea level rise. Among them, the plan suggests:

- Adopt V-zone standards in A-zones
- Adopt Freeboard standards in the building code
- Reform of Evacuation Procedures and/or Establishment of Satellite Shelters

3.6. NEW YORK

3.6.1. EAST HAMPTON, NY

Population Density	289.96/ sq. mi.
Form of Government	Town
Category	Seasonal Ocean and Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
68570	38532	29.8	21457	0.85	84.8	26%	32.1%	54.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Overlay District	Implemented	Yes	Prevention	Mandatory	Above Required	Zero	None
Community Preservation Fund (2% Real Estate Transfer Tax) for land conservation	Implemented	No	Prevention	Recommendation	Unique	Zero	None
Harbor Protection Overlay Zone	Implemented	No	Planning	Mandatory	Unique	Zero	None
Local Waterfront Revitalization Plan - Incorporates Climate Change and Policy of Strategic Retreat	Implemented	No	Procedural	Mandatory	Unique	Medium (<$100,000)	State
Setbacks from Bluffs and Wetlands	Implemented	No	Prevention	Mandatory	Above Required	Zero	None
Vegetation Preservation Ordinance	Implemented	No	Prevention	Mandatory	Unique	Zero	None

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POPULATION AND GEOGRAPHY

The town of East Hampton is located at the eastern tip of Long Island's South Fork, 100 miles east of Manhattan. It is a peninsula in itself, surrounded by ocean shores on its south, the rocky headlands of Montauk at its far east, and the bays and inlets of its north shore.

The town is known as the summer playground of the rich and famous, but its year-round population of 22,000 people have a median per-capita income of about $38,500. Perhaps also belying its reputation, the town's census reported population is 26% Hispanic and 32% Minority. However, the housing stock is 54% seasonal, reflecting percentages of the permanent population.

Its only land border is by town of Southampton on its west; otherwise it is completely surrounded by water. The Atlantic Ocean is on its south, the Block Island Sound on the northeast, and on the north side of the peninsula are the Gardiners, Napeague, and Fort Pond Bays. The town contains the villages of East Hampton and Sag Harbor, as well as the census-designated places of Amagansett, Montauk, Napeague, Springs, and Wainscott.

The entire land surface area of the town is 74.7 square miles. It contains 23.7 miles of ocean shoreline, 38.9 miles of north bayfront shoreline, and 53.3 miles of harbors and creeks. There are a number of significant state parks within the town including the Montauk Point State Park. It is served by the Long Island Rail Road with stops in downtown East Hampton and the hamlets of Amagansett and Montauk. One state road—Route 27, a two-lane highway that winds its way to the tip of the peninsula—provides the only way in, out, or through the town.

The town has taken care to preserve the many unique natural environments it comprises. From its natively vegetated coastal neighborhoods to its woodlands and bays, the variety and beauty of its landscapes are a prominent and meaningful part of its identity. The importance of preserving this beauty has driven the strict legislation the town has had on its books for 30 years and has made the town an exemplary community in coastal adaptation policy.

As part of the comprehensive planning process, the town conducted statistically significant surveys on scenic and aesthetic preferences. Water and water views were found to be the most important, but residents also indicated their appreciation of other ecological features such as woods, fields, and historic downtowns. Town planners indicated the prominence that preservation of the environment has played in the town's identity and its economic value.

As the town planning staff explained, the strict regulatory system that prevented development of its beaches was enacted after a building boom during a pro-growth Republican administration in the early 1980s. Brian Frank, Chief Environmental Analyst relayed the story that residents extirpated the pro-development administration out of fear they would "turn into the Jersey Shore" (Personal Communication, Jul. 6, 2012). A democratic town board was subsequently elected on a landslide vote to preserve the natural and historic character of the town, which instituted the strict setbacks and land preservation schemes the town is known for. Its unspoiled beaches and scenic vistas now provide economic value. The town does have a significant, if declining, commercial fishing industry, but clearly its largest economic driver is tourism. However, instead of the hotel- and motel-based transient tourism of resorts father south, East Hampton has more second homes, largely occupied by wealthy Manhattanites.

Town Planner Brian Frank also thought that the location at the island's terminus gave the towns a chance to see what happened in other towns and decide that direction was not right for East Hampton. Residents said, "Maybe we don't want a sewer district and an urban hub the way there is in western towns ... and the only way to protect that is to have zoning and regulations and guidelines to shape the community in a direction that we find appropriate" (Personal Communication, Jul. 6, 2012).

COASTAL ISSUES

As described in the LWRP, East Hampton is "an island promontory surrounded by water," and therefore "is singularly exposed to forces of the sea and weather." It continues:

> The Town's 110 miles of shoreline are protected by fragile beaches, dunes and bluffs, and while these are the same scenic and recreational attributes that lure tourists and second homeowners to a resort community, they are also vulnerable to winter nor'easters and catastrophic hurricanes. The awesome natural forces of storm events can quickly transform scenic views and real estate assets into disaster areas and insurance liabilities. Coastal flooding and erosion planning and policy in East Hampton have largely evolved in response to storms and other impacts of natural forces on development. Historically there has been less concern about episodic flooding and erosion in undeveloped areas where private property or public infrastructure were not at risk. This emphasis on protecting developed areas has masked the importance of maintaining unspoiled natural coastal features, both to sustain the Town's resort economy and because of their vital protective role in buffering the coast from flooding and erosion. (East Hampton, NY LWRP, Sec. V, p. 268)

The town contains an enormous diversity of human and natural landscapes within its 74 square miles of land and 70 miles of coastline. The area of the peninsula is as wide as 6 miles and as narrow as less than 1 mile in parts.

Long Island's geomorphology is the result of sediment deposits from the advance and retreat of glaciers during the last ice age. These glacial deposits and lands built up from eroded sediments

create the two dominant landforms. Here are cliffs of over 100 feet on the town's northern shore in some locations.

At its narrowest isthmus in Napeague, the land is very low and thin, and there is the significant potential for the entire eastern 20 miles of the town to be severed from the rest of Long Island, as occurred during the severe flooding from the hurricane of 1938 and Hurricane Carol. The 1938 hurricane caused such extensive flooding on Fort Pond in the existing hamlet of Montauk that a decision was made to relocate the downtown 3 miles south. However, the town also contains areas of very high ground and beaches with escarpments and bluffs both on the north shore and the eastern headlands that pose a different erosion risk from gently sloping beaches of the south shore. A unique feature of this part of eastern Long Island is the lack of barrier beaches. East Hampton's miles and miles of beach is connected to the mainland, which prevents the threat of overwash.

Though the severe weather it is exposed to is no less compelling than in other communities, compared to many other locations on the east coast, East Hampton is actually far less vulnerable because of its strict land use policies. The only hamlet located directly on the shore is in Montauk, and even there height limits and the setbacks strictly limit new development. The other historic downtowns are located miles inland from the coast, along with the critical road and rail infrastructure. Single family homes on large lots dominate in most neighborhoods adjacent to the coast, and they too must comply with strict setback requirements. These policies are not sacrosanct, however, and debate about the town's decision to embrace soft and natural infrastructure instead of harder approaches has been reignited, especially in the wake of Superstorm Sandy.

Emergency planning and evacuation is administered through the police department, and there is town-wide training for FEMA disaster training. The town partners with all of Suffolk County to identify critical infrastructure, temporary evacuation locations, identification of vulnerable populations, and people with chronic medical needs, to find out where they are and those who will be most severely affected.

ADAPTATIONS

Coastal Erosion Overlay Zone

The Town of East Hampton has been on the forefront of planning for climate change. The town has its own Coastal Erosion Overlay Zone that controls placement of shoreline hardening structures.

The findings and objectives of the law explicitly mention climate change, stating, "Changes in climate (global warming and the "greenhouse effect") may exert an influence on future storm activity and also cause sea-level to rise, with profound effects on the Town's coast. Such changes would render these natural protective features all the more important. In any case, while future sea level rise and increased storm activity may be uncertain, it is well established that present sea level is rising and statistically certain that storms will be an ever-present threat to the Town's coastal zone." (East Hampton, N.Y. Town Code § 255-3-80)

The Coastal Overlay District establishes four zones adopted from the town's use district map and incorporated into its zoning code. Construction of erosion control structures is banned in three of the four zones and severely restricted in the fourth. Erosion control structures are prohibited along the entirety of the ocean shoreline and most of the inner harbors. However, as with all zoning regulations, landowners may bring a variance case to the board of standards and appeals, and many such exemptions are issued.

The boundary of the town's coastal erosion overlay district includes all areas located up to 200 feet landward from the mean high water line and 1,000 feet seaward from the mean low water line. The erosion zones are a component of the town's zoning code and designated as specific use districts. Zone 1 is the ocean coastal zone, which is predominantly free of erosion control structures; zone 2 is the bay coastal zone, free of erosion control structures; zone 3 is the bay zone, which contains erosion control structures that are isolated and discontinuous; and zone 4 is the bay coastal zone, with numerous erosion control structures and whose natural defenses have been substantially compromised. The loss of natural features, "and features such as bluffs, dunes, and beaches means that in many cases erosion control structures provide the only remaining protection against flooding and erosion" (Town Code §255-3-80). In this latter zone, new erosion control structures may be permitted by special permit.

There are a number of notable features of the law. The lot area definition in the zoning code excludes areas seaward of the dune line or bluff crest as well as tidal and freshwater wetlands. The town does its own surveying for the wetlands and bluff lines.

Community Preservation Fund (2% Real Estate Transfer Tax) for land conservation

In 1998, New York State passed the Peconic Bay Region Community Preservation Act, which authorized the Town of East Hampton, along with the towns of Southold and Southampton, to establish a fund to preserve sensitive lands financed by a special 2% real estate transfer tax on sales of certain property within each town.

The cumulative total revenue since 2001 from 2% transfer tax receipts, interest, co-op sales, donations, and rental agreements amounts to $205,295,221. As of the report date, the town had acquired interests or rights in 205 parcels totaling 1,658 acres (East Hampton, N.Y., Community Preservation Fund 2012).

The six main categories of acquisition include Parks and Recreation, Wetlands, and Beaches and Shoreline among others such as farmland and historic sites. The Beaches and Shoreline category includes dune lands, bluffs, and bayfront, oceanfront, and lakefront property. 345 acres in this category were identified in the plan as eligible for acquisition, including a 122-acre beachfront parcel acquired with the county, the state, and a federal grant; another 150 acres jointly acquired with the state and county; and smaller parcels acquired by the town alone.

Harbor Protection Overlay District

The town's Harbor Protection Overlay District (Sec. 255-3-70) provides clearing restrictions and setbacks for sanitary systems from surface waters and wetlands. The code protects wetlands, ponds, and coastal areas from water pollution and excessive runoff that may exacerbate flooding. Any new or upgraded septic system must be set back 150 feet, or the maximum practicable

distance from the upland boundary of tidal wetlands and surface waters. (Town Code, Sec. 255-3-70C(2)B). The Harbor Protection Overlay District also regulates clearing of indigenous vegetation, restricting the permitted clearing to the following:

In Residence Districts:

Lot Size	Clearing Permitted
Up to 39,999 sq ft	10,000 sq. ft. or 35% of lot area, whichever is greater
40,000 to 280,000 sq. ft	10,000 sq. ft. Plus (lot area x 12.5%)
280,000 sq. ft. and larger	45,000 sq. ft.

In Commercial Districts:
10,000 sq ft or 50% of lot area, whichever is greater. (Town Code Sec. 255-3-70.D.)

LWRP Incorporates Climate Change and Sea Level Rise

New York State law authorizes local communities to prepare a comprehensive plan for waterfront issues called the Local Waterfront Revitalization Plan. The Town of East Hampton has one of the most extensive plans completed by a locality under the CZMA.

The town completed its most recent LWRP in 1999 and it was finally approved by the state in 2007. The 882-page plan, along with Southold's LWRP, is the most thorough coastal planning document of any we came across in this project. Analysis is completed in land use and development patterns; public access and recreation; natural, historic, scenic, and archaeological resources; and development constraints (which include detailed flood risk analysis, and assessment of coastal landforms and processes).

In East Hampton and in New York State, the LWRP is not just a set of recommendations. It is an enforceable set of policies. The Waterfront Consistency Review process, required under state law of any town with an adopted LWRP, reviews actions in the coastal area for consistency with the LWRP and coordinates review with the New York Department of State regarding federal and state actions. All projects must undergo Waterfront Consistency Review, except for specifically designated exempt actions.

The town designated agency (similar to the responsible agency under NEPA) makes the determination of consistency based on the submitted form and the LWRP coordinator's recommendation. If the action is inconsistent, the applicant may need to modify their project or the project might be denied entirely. Chapter 6 of the town's plan addresses Climate Change and Sea Level Rise. It focuses mostly on the science of climate change and concludes "these climate factors point to an increasing risk of flooding and erosion in coming years, and a need for planning procedures better adapted to receding shorelines and more frequent catastrophic storms. However, whatever risks future climate change and consequent sea level rise may pose, present storm activity and existing sea level rise already constitute great risks and problems for development in the coastal zone, and should be given more consideration in management

decisions. Wherever possible, decision makers should embrace options that are adaptable to future sea level rise" (LWRP p. V-17)

The section also makes reference to two products recommended by the LWRP for the town to follow up on—the Town Coastal Erosion Monitoring Program and a Hurricane Damage Mitigation Plan.

The LWRP specifically addresses sea level rise and in Flooding and Erosion Policies #11-17, Sec. 3, which asks: What can the Town do to assess, plan for, and mitigate the effects of sea level rise, both present and future? In this section the policy of strategic retreat is mentioned as a potential policy response:

> In the face of recurrent storm damage and shoreline recession, when future sea-level rise may accelerate due to global warming, a priority goal is to maintain the dynamic equilibrium of natural protective features, beaches, bluffs, dunes, wetlands and native vegetation. In practice, this approach to flooding and erosion problems leads to an emphasis on non-structural and soft solutions which will not disrupt coastal processes or damage natural protective features. In some instances, in order to both maintain natural features and protect homes and other shorefront development, a strategic retreat of development from receding shorelines is the preferred approach for flooding and erosion protection. (LWRP p V-4)

Although not explicitly adopted, the inclusion of strategic retreat as a policy goal has not gone unnoticed. In an article in the local newspaper *The East Hampton Star* entitled "Need Seen For Post-Storm Recovery Plan," a town councilwoman was quoted as saying, "We have a code, and the code actually mandates retreat ... Our current code doesn't have the ability to protect the structures. You can dump sand, but the sand just washes away in the storm. Is that appropriate? I don't think that's appropriate" (Pilgrim 2012). This interpretation by an elected official demonstrates that East Hampton's codes and politicians are pushing the outer boundaries of progressive climate adaptation policy as far as any community in the Northeast.

The town's comprehensive plan incorporated the LWRP as its coastal management component, and the LWRP policies and objectives were summarized in Appendix C (Coastal Management Component). The LWRP is also consistent with the vision and goals of the comprehensive plan. The Town Board also adopted a revised zoning map to implement the comprehensive plan, incorporating the need to protect natural features called for in the LWRP, which served as the basis for the new zoning classifications. (LWRP p. 11)

Vegetation Preservation Ordinance

The vegetation preservation ordinance was passed in 2004 and applies to residential property in a number of specific zones. It limits clearing of native vegetation to specific percentages of the parcel based on its size. 100% of property may be cleared for lots less than 11,000 sq. ft. For lots up to 20,000 sq. ft., 75% may be cleared. For lots larger than 20,000 up to 280,000 sq. ft., 10,000 sq. ft. plus the lot area multiplied by 25% may be cleared, and for lots larger than 280,000 sq. ft. 80,000 sq. ft. may be cleared. (Town Code, Sec. 255-2-60).

The removal of any vegetation other than listed non-native species and dangerous deadwood is considered to be a clearing. The law allows for the removal of some native species that are a nuisance, such as poison ivy, only after review and approval of plans by the Town Natural Resources Department.

The town code also prohibits the "clearing, removing, uprooting, burying or otherwise damaging any beach vegetation, or replacing the same with lawn, sod, or turf" in the VE flood hazard zones within the Flood Hazard Overlay District.

Setbacks from Bluffs and Wetlands and Dune Protection

East Hampton protects its dunes from destruction. Within 100 feet of the dune crest (and 150 feet in some specific geographical areas) the town prohibits clearing land; digging, dredging, or excavating; and building, enlarging, reconstructing, "altering, or placing any structure or other improvement whatsoever in or upon land" (Town Code, Sec. 255-4-20). Any other dune is also prohibited from clearing, grading, filling, cutting, removing, or otherwise being altered. (Town Code, Sec. 255-4-20 (D).

The law also prohibits "clearing, removing, uprooting, burying, or otherwise damaging any beach vegetation, or replacing the same with lawn, sod, or turf." (Town Code, Sec. 255-4-20) As described by Mr. Frank, "Climate change is associated with our wetlands and coastal setbacks." The town has longstanding local laws that prohibit development in the coastal zone and wetlands. The law predates New York State's coastal erosion hazard area law and is almost 30 years old.

Restrictions prohibit grading, dredging, or building within 100 feet of the inland boundary of any beach and within 100 or 150 feet of the bluff line along the Atlantic Ocean, depending on location (Town Code, Sec. 255-4-20 (B) and (C)). In addition, within 200 feet of the inland boundary of any beach, constructing a cesspool or septic tank or any tank for fuel is similarly prohibited (Town Code, Sec. 255-40 (B)(2)). Setbacks apply to the primary dune on the south shore as well as north shore bays and lots. Setbacks along bays vary from 50 feet to 150 feet depending upon lot size and exposure along inner harbor or outer bay shorelines (Town Code, Sec. 255-5-40 (D) and (E).

As Mr. Frank explained about the setback laws, "they recognize that these areas are dynamic, unstable to begin with and are subject to rapid and severe changes due to weather events. It keeps human activity and construction out of most volatile area and part of that volatility includes rate of sea level rise." The setbacks vary depending on geomorphology and severity of erosion. Both erosion areas and wetlands are delineated by town staff. For instance, east of downtown Montauk the setback is 150 feet from the bluffs since erosion is particularly significant in that area. Setbacks can vary with the size of the lot, but property owners are not prohibited from applying to the town for a variance to allow a shallower setback if their land erodes.

Although many of these regulations regarding and preservation of land were not enacted explicitly for the purpose of coastal resilience, they have had that effect. A significant portion of

the land east of Amagansett is state park, and some of these sites were proposed for large-scale development at one time.

3.6.2. SOUTHOLD, NY

Population Density	409/ sq. mi.
Form of Government	Town
Category	Seasonal Soundfront
CRS Rating	Not Participants

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
64260	37127	46.9	21968	0.65	90.0	11%	15.2%	35.7

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Community Preservation Fund (2% Real Estate Transfer Tax) for land conservation	Implemented	No	Prevention	Mandatory	Unique	High (< $1,000,000)	None
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	Other
Freeboard - 2 Ft.	Implemented	No - Symptoms	Planning, Building	Mandatory	Unique	Medium (< $100,000)	None
Local Waterfront Revitalization Plan	Implemented	No	Procedural	Mandatory	Unique	High (< $1,000,000)	State
NOAA Coastal Services Center Roadmap Project	In Progress	No	Procedural	Recommendation	Unique	Low (< $10,000)	Other
Transfer of Development Rights	Implemented	No - Symptoms	Planning	Permissive	Unique	Very Low (< $1,000)	None

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POPULATION AND GEOGRAPHY

Settled in 1640, the town of Southold is located on Long Island's north fork, which is a peninsula at the far eastern tip of the island. Comprising 163 linear miles of coastline, it is surrounded by water on three sides—the Long Island Sound on the north, the Peconic Bay on the south, and the Atlantic Ocean off its eastern flank; the town has no exposed oceanic shore. The only land border is on its west, the town of Riverhead. The town is long and narrow, only 3 miles in width on average and is 21 miles in length.

The topography is generally gently sloping, but the Long Island Sound shoreline is comprised of many steep bluffs and wooded hills. Significant interior portions of the peninsula are in agricultural production, particularly in viniculture. A number of historic towns dot the peninsula, surrounded by farms, extensive waterfronts and estuaries. Approximately 35% of the housing stock is estimated to be second homes. The town's economy is based in agriculture, maritime industries, and tourism and recreation. The Town of Southold contains 22% of Suffolk County's remaining agricultural acreage. As part of its aggressive land preservation efforts, the town has purchased development rights to support agriculture as well as its natural landscape, and has purchased over 1,360 acres of farmland alone.

Served mainly by one two-lane state highway and the Long Island Railroad, no controlled access highways exist in the town. As in New England, the town governance form does not describe an incorporated municipality, but rather a large area of incorporated and unincorporated territory. Within the town are nine unincorporated hamlets—Cutchogue, East Marion, Fishers Island, Laurel, Mattituck, New Suffolk, Orient, Peconic, and Southold—and the Village of Greenport.

The census reported a population of 21,968, which is predicted to increase 30% by 2050 (Suffolk County Comprehensive Plan 2035, p 2). In the height of the summer season, the population is estimated to double. 36% of housing was reported as seasonal. (Southold, N.Y., Local Waterfront Revitalization Plan (LWRP), Sec. IA-13 (p.44))

Figure 3.6.2:1 - The Village of Greenport in the Town of Southold

COASTAL ISSUES

Although Southold sits surrounded by water at the tip of an island, it is in an enviable position compared to many other North Atlantic towns. The fact that Long Island is a terminal moraine is a distinct

advantage in allowing it sufficient acreage free from flooding risk, particularly for sound-facing shores, because of the high bluffs along much of its shore.

Nevertheless Southold is facing increasing vulnerability to coastal storms. The FEMA V-zone area in the Town of Southold extends along the entire coastline with the exception of a 7-mile stretch between Cedar Beach Point and Pipes Cove, as well as Cutchogue Harbor.

The A-zone includes all creeks, ponds, and wetlands extending between 200 and 1,000 feet inland from the edge of these areas. Many single-family homes are located in the flood zones. "Most of the Southold's flood-prone areas are located along the Peconic Estuary shoreline and its numerous creeks and inlets, although there are several areas of the Town's Long Island Sound shoreline that are susceptible to flooding" (LWRP. p.235).

Long Island is affected by both nor'easters and tropical storms. Most of the storms with significant impacts in Southold are non-tropical in nature, in particular because the town has no south-facing ocean shoreline. The town's most exposed face is northward, and is most affected by prolonged north-northwest winds that tend to follow the passage of low-pressure systems that produce large waves and wind setup along the north shore.

Geologically, the north shore is highly subject to irreparable erosive processes. Recovery is fairly slow along the Long Island Sound shoreline because there are few long period swells to move sand from deeper water onto the beach. For the same reason, erosion of bluffs, which were created by glacial deposit, are essentially irreversible. Structural solutions to counter erosion are ultimately of little value, and options such as beach replenishment are of little help and have generally not been used extensively.

However, like the south fork of Long Island, Southold's long history of strict land use controls and sophisticated land purchase scheme have combined to significantly limit development, and potential damage, on its shores. There are no high-rise buildings and strict setback laws prohibit extensive new development. This allows the town to maintain large areas of ecological function and to rely on maintaining wetland and dune buffers as significant protection from climate-induced hazards. Town Planner Mark Terry critiqued FEMA regulations as actually increasing vulnerability since they allow construction in flood zones as long as the building meets engineering and architectural

Figure 3.6.2:2 - Natural landscapes dominate the shores of Southold

design standards, whereas the town could afford greater resilience by requiring buildings to be out of the hazard zone through setbacks and site design. Planning, rather than engineering, is the dominant resiliency technique here.

ADAPTATIONS

Local Waterfront Revitalization Plan

The Local Waterfront Revitalization Planning process (LWRP) is New York State's implementation of the Federal Coastal Zone Management Act of 1972. It is worth profiling in the case of New York State and particularly in the Town of Southold for the extensiveness and uniqueness of its plan.

New York's law is codified in the Waterfront Revitalization of Coastal Areas and Inland Waterways Act (Art. 42 Executive Law). It authorizes local communities to prepare a comprehensive plan for waterfront issues. The Town of Southold has one of the most extensive plans completed by a locality under the CZMA and takes the process to another level by having a full-time staff member as the LWRP coordinator. The town completed its most recent LWRP in 2005. The 874-page plan, the most thorough coastal planning document of any we came across in this project, includes analysis comprising detailed geological, historical, economic, planning, and legal inventory. Analysis is completed in land use and development patterns; public access and recreation; natural, historic, scenic, and archaeological resources; and development constraints including detailed flood risk analysis, assessment of coastal landforms, and processes. Furthermore, a specific detailed analysis in all of the above subfields is completed for each of 10 "reaches"—a stretch of shoreline between two easily distinguishable landmarks.

In Southold and in New York State, the LWRP is not just a set of recommendations. It is an enforceable set of policies implemented through Chapter 95 of the town code. The Waterfront Consistency Review process, required under state law of any town with an adopted LWRP, reviews actions in the coastal area for consistency with the LWRP and coordinates review with the New York Department of State regarding federal and state actions. All projects must undergo Waterfront Consistency Review, except for specifically designated exempt actions.

Project applicants must submit a Coastal Assessment Form similar to an Environmental Assessment form in Environmental Review under the federal National Environmental Policy Act or New York's similar State Environmental Quality Review Act. The town-designated agency (similar to the responsible agency under NEPA) makes the determination of consistency based on the submitted form and the LWRP coordinator's recommendation. If the action is inconsistent, the applicant may need to modify their project or the project might be denied entirely.

Southold's exemplary implementation of the LWRP process has a long history. Salkin (2005) highlighted the town's 1985 plan, which, she reports, allowed the town to "use the LWRP as a means of enacting a new comprehensive plan." Moreover, the plan does not just regulate local activities. Because LWRPs become amendments to the state's program, they by law must be followed by the local, state, and federal government.

Although the LWRP was completed in 2005—and is therefore unlikely to concern itself with the specific issues of sea level rise and climate change—it was used by Southold to positively effect coastal policy, protect its shoreline, and preserve its natural environment, making its program an example of a first-line coastal climate adaptation.

SOUTHOLD - LOCAL WATERFRONT REVITALIZATION PLAN
WATERFRONT CONSISTENCY REVIEW
EVALUATION POLICIES

Policy 1 - Foster a pattern of development in the town of Southold that enhances community character, preserves open space, makes efficient use of infrastructure, makes beneficial use of a coastal location, and minimizes adverse effects of development.

Policy 2 - Preserve historic resources of the Town of Southold

Policy 3 - Enhance visual quality and protect scenic resources throughout the Town of Southold

Policy 4 - Minimize the loss of life, structures and natural resources from flooding and erosion

Policy 5 - Protect and improve water quality and supply in the Town of Southold

Policy 6 - Protect and restore the quality and function of the Town of Southold ecosystem

Policy 7 - Protect and improve air quality in the Town of Southold

Policy 8 - Minimize environmental degradation in the Town of Southold and hazardous substances and wastes

Policy 9 - Provide for public access to and recreational use of coastal waters, public lands, and public resources of the Town of Southold

Policy 10 - Protect the Town's water dependent uses and promote siting of new water-dependent uses in suitable locations

Policy 11 - Promote sustainable use of living marine resources

Policy 12 - Protect agricultural lands

Policy 13 - Promote appropriate use and development of energy and mineral resources

Comprehensive Plan/Coastal Resilience Tool

The town of Southold is now in the process of updating its comprehensive plan and expects to complete it by mid-2013. The Nature Conservancy has partnered with the town to participate in the plan and to incorporate information generated from its Coastal Resilience tool (www.coastalresilience.org). "The Coastal Resilience Tool allows decision-makers in coastal Long Island (and Connecticut) to explore different sea level rise and storm surge scenarios; analyze the potential impacts on communities and critical infrastructure like roads and schools; and develop solutions to address these realities" (The Nature Conservancy 2011). The tool,

which is available online and covers all of Long Island, will allow Southold to explore different flooding scenarios from sea level rise and storm surge, analyze the impacts, and incorporate the data into the comprehensive plan update.

Other partners have been involved in Southold's planning for climate risks. Besides The Nature Conservancy, the Association of State Floodplain Managers and NOAA Coastal Services Center held a workshop to introduce data and information available through the Digital Coast as well as a participatory process for assessing and planning for hazards and coastal resilience.

Community Preservation Fund (2% transfer tax)

In 1998, New York State passed the the Peconic Bay Region Community Preservation Act, which authorized the Town of Southold, along with the four other towns in the Peconic Bay region, to establish a fund to preserve sensitive lands financed by a special 2% real estate transfer tax on sales of certain property within each town. Use of the funds was limited to objectives in the Community Preservation Project Plan that furthered the preservation of:

- Open space and agricultural lands
- Parks, nature preserves, and recreation areas
- Lands of exceptional scenic value
- Freshwater and saltwater marshes and wetlands
- Aquifer recharge areas
- Undeveloped beach lands or shorelines
- Wildlife refuges with significant biological diversity
- Unique or threatened ecological areas
- Natural free-flowing rivers or river areas
- Historic places and properties whether listed on the NewYork State Register of Historic Places or protected by municipal law
- Any of the aforementioned types in the furtherance of a greenbelt

The plan sets the list of eligible priorities, describes mechanisms for protection, and determines which properties should be given highest priority. The unique source of monies has been used to "preserve and protect privately owned real estate assets in a way that benefits the community as well as the owner" (Southold, N.Y., 2008 Community Preservation Project Plan). Of ecologically sensitive lands, farmlands, wetlands, and vulnerable coastal properties. Different tools are available to the town to accommodate the unique circumstances of each property. Conservation easements and purchase of development rights are commonly used, as well as tax-exempt installment sales, bargain sales, like kind exchanges, charitable remainder trusts, and land donation. The direct cost to the town is minimal; by August 2008, the most recent published data available, the fund had raised $54 million and had protected 1,480 acres in 87 individual acquisitions.

Transfer of Development Rights Program

Initially passed into law in 2005, the Town of Southold fully implemented a town-wide TDR program in April 2008.

The intent of the law as stated in Ch. 117 of the town code was established as follows:

> The Town's goals include the preservation of open space, agricultural lands and recreational landscapes; preservation of the rural, cultural and historic character of the hamlets and surrounding countryside; preservation of the natural environment and prevention of further deterioration of resources; preservation and promotion of a broad range of housing and business opportunities to support a socioeconomically diverse community; and increased transportation efficiency... (Southold, N.Y. Town Code, Ch. 117)

TDR is designed to meet multiple supportive goals leading to a more sustainable community, one significant component of which is greater coastal resilience, and to do so at very low cost to the public. TDR "provide(s) a means to expand programs which provide for land preservation ... and to leverage funds through alternative preservation tools that do not require public expenditures" (Southold, N.Y., n.d., TDR Program Planning Report, p 16).

Unique among TDR programs, in Southold the entire town is either a sending or receiving district. Any zone not a receiving district is a sending district, and receiving districts are designated only in or adjacent to historic hamlets and villages, (called "hamlet locus districts" HALOs in the code), many of which are near a transit stop. This both mitigates carbon emissions and increases resiliency by transferring development rights to less vulnerable locations. By law, the town board considers whether the project in the receiving district is compatible with existing and planned development and does not cause significant environmental damage.

The town considers factors such as:

- Infrastructure such as roads, utilities, and water supply currently exist.
- Residential density proximate to the hamlets strengthens the business environment.
- Residential density in the HALOs provides opportunity for alternative transportation such as walking and bicycle travel.
- Use of TDRs in the HALOs may promote beneficial investment and redevelopment.
- Use of TDRs in the HALOs will provide alternative forms of housing to single-family detached development, thus increasing housing stock providing potentially more affordable housing of various types (p.4)

The town uses TDR as one component of an overall strategy to develop in a sustainable, resilient manner. It also continues to use purchase of land, purchase of development rights, and conservation subdivision design to achieve these goals.

As of September 2009 the Town had severed flow credits from four or five open space parcels purchased by the Town. About 30 flow credits were deposited in the town's TDR bank as result. Unfortunately, in the three years since the program was adopted, no multi-family housing units have been permitted, indicating that the density levels promised in the HALOs have yet to be realized.

Flood Hazard Law

In conformance with FEMA regulations, the town adopted Chapter 148 of the town code— the Flood Damage Prevention Law. The law follows FEMA model ordinances and includes a requirement for buildings to be elevated to at least 2 feet above the base flood elevation.

3.6.3. NEW YORK, NY

Population Density	24,012.5/ sq. mi.
Form of Government	City
Category	Urban Oceanfront, Bayfront, Soundfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
51,270	31,417	32.6	8175133	2.1%	44	28.6%	67%	1.2%

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
NYC Panel on Climate Change and Report	On-going	Yes	Procedural	Recommendation	Unique	High (<1 Million)	Non-profit/foundation
PlaNYC	On-going	Yes	Procedural	Recommendation	Unique	High (<1 Million)	None
Coastal Climate Resilience/Urban Waterfront Adaptive Strategies Project	On-going	Yes	Procedural	Recommendation	Unique	NA	Federal Government/Non-Profit
Zone Green - Provisions to allow relocation of utilities to rooftops	Implemented	Yes	Accommodation	Permissive	Unique	High (<1 Million)	None
Local Waterfront Revitalization Plan Incorporates Climate Change and Extends Jurisdictional Boundary	Completed	Yes	Procedural	Mandatory	Above Required	High (<1 Million)	NA
Emergency Preparedness Pilot Program (Housing Authoirty)	On-going	Yes	Procedural	NA	Unique	NA	NA

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
High performance guidelines (Department of Parks and Recreation)	Completed	Yes	Procedural	Recommendation	Unique	NA	NA

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POPULATION AND GEOGRAPHY

Figure 3.6.3:1 - NYC Hurricane Evacuation Zone Map

New York City is an archipelago at a river delta, though it is understandably difficult to imagine that while standing in Times Square or even traversing the boroughs in the subway tunnels. New York is more than just a coastal city; within its boundaries are many unique coastal geographic features, consisting of islands, tidal straits, barrier islands, open ocean shore, sounds, and tidal wetlands.

New York has 578 miles of shoreline within the five boroughs. The most populous boroughs are Brooklyn and Queens, located on the glacial moraine of Long Island. These two boroughs are highly vulnerable to coastal flooding, with their southern shores exposed to the Atlantic Ocean. The boroughs contain two barrier islands, the Rockaway Peninsula in Queens and Coney Island in Brooklyn. Other Brooklyn neighborhoods are also vulnerable, located on low-lying land along the New York harbor and East River. Queens

contains New York's two airports, both located in the 100-year floodplain. LaGuardia's runways, built on fill, are extended out into the Long Island Sound on pilings, and sit just a few feet above sea level. Kennedy airport also sits on former tidal marsh on the Jamaica Bay and is in the floodplain. It is separated from the open Atlantic by the Rockaway barrier island peninsula.

The New York Harbor separates Brooklyn from Staten Island, the most remote and lowest-density borough. Staten Island has varied topography and actually contains the highest point in the city, but its south shore is particularly at risk from coastal floods and was hard hit by Sandy.

Manhattan itself is also an island, surrounded by the New York harbor on its south, the East River (actually a tidal strait) on the east, and the Bronx River on the north, and is separated from New Jersey by the Hudson River to the west. Lower Manhattan was built largely on fill and its intensive development and infrastructure is vulnerable to coastal surges. The Bronx, the only borough on the mainland of the United States, has low-lying tidal wetlands and vulnerable development along its Long Island Sound shore.

New York's growth is clearly tied to its maritime history and especially its excellent natural harbor. The significance of water-dependent industry has declined markedly over the past 100 years, and the city has shifted the focus of its waterfronts toward recreation and ecological restoration.

COASTAL ISSUES

This city of over 8 million people has an immense number of people, buildings, and infrastructure in harm's way. In the five boroughs, there are 215,000 people that live in 24,114 single- and two-family homes and 3,079 walk-up multi-family buildings in the FEMA Special Flood Hazard Area (100-year flood zone).

There are 475,000 residents and 290,000 jobs in the 500-year floodplain. In terms of floor area, multi-family elevator apartment buildings are the most exposed building type. In New York, contrary to the pattern most often seen in coastal communities, a disproportionate number of low-income residents tend to reside in the low-lying coastal zone. 40% of residents of New York City Housing Authority properties, the city's low-income public housing agency, are in the 100-year floodplain. New York has been taking these threats seriously and the state and city leaders have been taking a global leadership position on climate change.

Superstorm Sandy hit the city on October 29, 2012, with storm surge flooding that broke all historical records in New York. 43 people in New York City lost their lives in the storm, mostly in Queens and on Staten Island. The largest concentration of fatalities were along the south shore of Staten Island and on the Rockaway Peninsula in Queens. (Mapping Hurricane Sandy’s Death Toll, New York Times, Nov. 17, 2012).

Governor Cuomo said that the storm cost New York State over $42 billion—$33 billion to repair housing and infrastructure, and $9 billion to help protect transit systems, the power grid, and sewage treatment facilities from future storms. It will cost $3.1 billion to replace or repair damaged homes alone in New York City. In New York alone, Sandy inflicted more damage than Hurricane Katrina.

The storm has renewed calls by leaders to heed warnings about climate change. As Governor Cuomo said after the storm: "Anyone who says there is not a dramatic change in weather patterns I think is denying reality" (Eagan 2012). This was followed by New York Mayor Michael Bloomberg's own prognostication: "While the increase in extreme weather we have experienced in New York City may or may not be the result of climate change, the risk that it might be—given this week's devastation—should compel all elected leaders to take immediate action" (Revkin, 2012).

New York's leaders are clearly echoing a change in political will that signals a shift in the seriousness with which climate change is being taken.

ADAPTATIONS

NYC Panel on Climate Change/Report and Passed legislation institutionalizing the regular convening of the New York City Panel on Climate Change

In 2008, Mayor Bloomberg convened the New York City Panel on Climate Change. The panel was comprised of climate scientists and with legal, insurance, and risk management experts and tasked with drafting a climate change adaptation report and a set of tools to deal with projected impacts. It built on experience in other cities, such as London and Chicago and in King County, Washington, and previous reports.

The key findings of the report were:

- NYC should begin to adapt to climate change today as it already faces a number of climate risks without climate change as a factor
- Temperature increases and sea level rise are already occurring, and along with other climate changes, will continue to occur and accelerate in the future
- There is potential for tipping points in the climate system, such as rapid melting of ice sheets, which could have great magnitude of consequence in the city
- Current risk management, legal and insurance structures can be built upon to address climate adaptation

New York City
Panel on Climate Change Action Recommendations

- Involve multiple partners, including scientific experts in the process, with high-level proactive leadership and bottom-up involvement
- Create a standard of regional climate scenarios
- Adapt a risk-based approach to develop Flexible Adaptation Pathways
- Focus on strategies for incremental changes as well as long-term low-probability, high impact events
- Pay attention to early win-win strategies
- Work with the legal, engineering and insurance industries
- Conduct a review of standards and codes

In August 2012, the New York City Council passed a law permanently institutionalizing the science panel as well as a task force of government agencies and partners from the energy, telecommunications, and other private sectors. Participation is voluntary and unpaid. James F. Gennaro, chair of the City Council's Committee on Environmental Protection, said the legislation creates "an institutional government mechanism to assess the latest climate change science, plan for climate change impacts and implement adaptive strategies" (Navarro, 2012). The legislation also explicitly called for the panels to create an inventory of potential risks to vulnerable populations such as the elderly and low-income residents of industrial areas where flooding also raises the risk of toxic spills. The law also requires that they meet to review the latest science and to update projections every three years.

PlaNYC

In 2007, Mayor Bloomberg launched a long-term sustainability planning process, called PlaNYC, with the stated objectives to combat climate change, strengthen the economy, and enhance the quality of life. Ten areas of interest were set: housing and neighborhoods, parks and public space, brownfields, waterways, water supply, transportation, energy, air quality, solid waste, and climate change.

These areas were to be addressed with more than 125 individual initiatives.

Figure 3.6.3:2 - PlaNYC Report

PlaNYC Goals:

- Reduce and track greenhouse gas emissions
- Assess vulnerabilities and risks from climate change
- Increase the resilience of the city's built and natural environments
- Protect public health from the effects of climate change
- Increase the city's preparedness for extreme climate events
- Create resilient communities though public information and outreach

Many of these actions are well underway as the city moves to implement the plan, although Sandy may have provided a glimpse into the magnitude and speed of necessary interventions to adjust to its ongoing planning work.

NEW YORK CITY
PLANYC MILESTONES TO BE COMPLETED BY DEC. 2013

Regularly assess climate change projections
- Institutionalize New York City Panel on Climate Change (NPCC) and establish process to regularly update its climate projections

Partner with the Federal Emergency Management Agency (FEMA) to update Flood Insurance Rate Maps
- Release draft updated Digital Flood Insurance Rate Maps (DFIRMS) for public comment

Develop tools to measure the city's current and future climate exposure
- Develop a climate risk assessment tool
- Develop an updated digital elevation model using LiDAR data to promote more accurate sea level rise modeling
- Launch effort to develop publicly available projected flood maps that incorporate sea level rise projections for planning purposes

Update regulations to increase the resilience of buildings
- Conduct study of the urban design implications of enhanced flood protection for buildings
- Pursue amendments to freeboard requirements to require freeboard for wider range of buildings to account for climate change projections
- Incorporate consideration of climate change within the policies of the City's Waterfront Revitalization Program (WRP)
- Launch study of effects of rising water tables, inland flooding, wind, and extreme heat events on buildings

Work with the insurance industry to develop strategies to encourage the use of flood protections in buildings
- Explore measures to promote flood protection in areas that may be subject to flooding based on climate forecasts

Protect New York City's critical infrastructure
- Complete Climate Change Adaptation Task Force assessment and report and begin to implement its recommendations
- Maintain the Climate Change Adaptation Task Force with an expanded focus on public health and safety services
- Assess the opportunities for the incorporation of climate change projections into design specifications and standards for critical infrastructure

Identify and evaluate citywide coastal protective measures
- Develop an inventory of best practices for enhancing climate resilience in coastal areas
- Coordinate with academic institutions, scientists, engineers, and designers to develop pilot projects to test potential strategies and evaluate their costs and benefits

Vision 2020 and the Local Waterfront Revitalization Plan Incorporates Climate Change

The Local Waterfront Revitalization Planning process (LWRP) is New York State's implementation of the Federal Coastal Zone Management Act of 1972. New York's law is codified in the Waterfront Revitalization of Coastal Areas and Inland Waterways Act (Art. 42 Executive Law). As in other municipalities in the state, the City of New York can elect to prepare a LWRP and companion legislation that fully implements the CZMA.

New York's Local Waterfront Plan, called Vision 2020, considers the impact of climate change and identifies strategies for addressing rising sea levels and more frequent and severe storms. Proposed changes to the city's LWRP "will solidify New York City's leadership in the area of sustainability and climate resilience planning as one of the first major cities in the U.S. to incorporate climate change considerations into its coastal zone management plan" (New York, N.Y., Dept. of City Planning, Press Release 2012)

The plan states in unequivocal terms: "Climate change and rising sea level clearly have important ramifications for New York. Climate change raises important considerations for all five functional categories of the waterfront identified in Vision 2020" (New York, N.Y., Dept. of City Planning, Vision 2020, Ch. 3, Goal 8).

For example, the principals for designing waterfront sites explicitly address climate change or issues relevant to it:

Environment:

- Promote the greening of the waterfront with a variety of plant material, including shrubs and groundcover, for aesthetic and ecological benefit.
- Use water- and salt-tolerant plantings in areas subject to flooding and salt spray. Maximize water-absorption functions of planted areas.
- Preserve and enhance natural shoreline edges.
- Design shoreline edges that foster a rich marine habitat.
- Design sites that anticipate the effects of climate change, such as sea level rise and storm surges

Figure 3.6.3:3 - Vision 2020 Report

Current law establishes the boundary of the coastal zone at the 100-year floodplain, and the new LWRP proposes to expand its jurisdiction to include the 500-year floodplain. Expansion of the WRP jurisdiction means that the LWRP and its consistency review requirements will apply in the expanded zone.

This change effectively mandates the more stringent review within the area projected to become the 100-year floodplain in the next century. The WRP itself requires assessment of climate change impacts in projects proposed in the WRP zone, meaning that all projects will need to assess their vulnerability to sea level rise, coastal flooding, and storm surge, and incorporate measures to reduce those risks to the maximum extent practicable.

Coastal Strategies for Climate Protection/Urban Waterfront Adaptive Strategies Project

While New York already has some basic coastal protection measures in place (such as a 40-foot setback from coastlines) and has used climate information to design new shoreline facilities, a new project being undertaken by the Department of City Planning proposes to develop highly detailed resilience strategies for all 578 miles of shoreline.

Funds for the study were provided by a federal NY-CT Sustainable Communities Initiative grant, a partnership of the Environmental Protection Agency, U.S. Department of Housing and Urban Development, and U.S. Department of Transportation. The study fulfills the mission of the grant, as the issue intersects climate adaptation and mitigation concerns. For example, ground-floor uses enliven the pedestrian experience and contribute to walkable neighborhoods, these requirements may interfere with freeboard mandates.

The study states that it "will outline a framework for decision making to address coastal risks from climate change at the scale of the site, neighborhood, and reach" (New York, N.Y., Department of City Planning, Sept. 14, 2012).

As a component of the study, the Department of City Planning is also conducting an urban-design-based study of freeboard strategies for urban building types. The city ascertained that current guidance was insufficient to permit developers and building owners to adequately address foundation elevation in multi-family and multi-story building types, which are a significant component of the building stock in New York City. In addition, it was concerned about the impact of vacant ground-floor space on the vitality and street life in its coastal neighborhoods. New York currently requires freeboard for some buildings—1 or 2 feet of freeboard is required for different types of buildings and critical facilities in the A and V zones.

In fact, the incompatible aesthetics of elevated ground floors was raised as a significant issue in many communities, especially communities with a historic built environment. NYC will also be studying alternative flood-proofing and resilience strategies for building types, such as brick row houses, that are difficult to retrofit and are also prevalent in many historic northeastern communities. The city expressed its hope that the study will be of use to neighboring communities with similar issues.

The project defines climate resilience as "the ability to prepare for, withstand, and recover from extreme events and environmental changes." It proposes to draft a guide to identifying and evaluating potential strategies for increasing the resilience of waterfront areas.

This will involve a four step process:

1) Understand the vulnerabilities by creating Coastal Area Typologies that are representative of the range of uses, densities, and conditions of the coastal zone.
2) Identify specific adaptive strategies at different scales (site, neighborhood, and reach)
3) Develop resilient approaches, which may include a combination of strategies
4) Set up a framework on how to evaluate the overall costs and benefits of strategies for different kinds of neighborhoods

Site strategies include building and site-scale measures such as elevating structures, using sandbags, temporary flood gates, armoring or dry floodproofing. Neighborhood strategies include such measures as elevating streets, floodwater retention, multi-use levees, living shorelines, breakwaters, and strategic retreat. Reach strategies include measures such as surge barriers, constructing wetlands, bathymetry modifications, and constructing barrier islands. The study will also explore a range of best practices to climate adaptation that are applicable to New York City and the surrounding region.

"Zone Green"

In April 2012, New York completed "Zone Green" code revisions to its zoning and building code to more readily encourage green building strategies to reduce energy consumption and cut greenhouse gases. However, at least one initiative will also benefit voluntary adaptation. The code revisions now allow certain mechanical equipment, such as boilers, to be placed on the rooftop of buildings, as a permitted obstruction. Previously, a building owner might have encountered restrictions such as height limits that would discourage such a retrofit. Permitting mechanicals on roofs allows equipment to be out of potential flood risk areas in basements or ground floors and has the added carbon mitigative bonus of operational efficiency compared to a basement-installed boiler.

NYCHA Emergency Preparedness Pilot Program

The New York City Housing Authority, the public housing agency in NYC, has 45% of its properties located in the FEMA 100-year floodplain. In recognition of this and other risks, the agency launched an emergency preparedness pilot program, which was part of its green agenda. Meetings were held at all six housing projects in the Rockaways—Ocean Bay Bayside, Ocean Bay Oceanside, Beach 41st Street, and Carlton Manor—and over 700 residents attended. As Margarita Lopez said to the group in the Rockaways, a low-income community located on located on a barrier island, "Climate change affects you more than anybody else in the NYC housing authority" (Negron 2011)

Department of Parks & Recreation (DPR) High Performance Landscape Guidelines

The NYC Department of Parks and Recreation recently released new high-performance guidelines describing best practices for planning, design, construction, and maintenance of city parks (Adams et al. 2011). These new guidelines, created to comply with PlaNYC, promote design for the 21st century, seeking not only to meet the recreational needs of the more than 9 million people who are expected to live in New York City by the year 2030, but also increase climate resilience and environmental benefits. The manual incorporates climate change impacts in its more than 100 best practices, including retaining stormwater in parks and increasing the resiliency of vegetation by considering climate change.

Part D.7 specifically addresses the plan's mitigation and adaptation to climate change. It highlights the role that creating parks can have in addressing flood control, sequestering carbon dioxide, and reducing energy use. As part of its next steps, the department intends to identify parks that are specifically vulnerable to sea level rise, saltwater intrusion, and temperature impacts. It also intends to use park design to educate the public about future flooding potential,

design sites to minimize potential impacts from flooding and other storm-related damage, and enhance recovery planning.

3.6.4. SOUTHAMPTON, NY

Population Density	190/ sq. mi.
Form of Government	Town
Category	Ocean and Bayfront Resort
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
71193	37338	36.8	56790	0.37	84.2	20%	27.5%	41.7

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Erosion Districts	Implemented	No	Protection	Permissive	Unique	NA	NA
Coastal Erosion Hazard Law	Implemented	No	Prevention/ Retreat	Mandatory	Above Required	NA	NA
Community Preservation Fund (2% Real Estate Transfer Tax) for land conservation	Implemented	No	Prevention	Recommendation	Unique	NA	NA
Comprehensive Plan - Goal to adopt policy of strategic retreat	Completed	Yes	Procedural	Recommendation	Unique	NA	NA
Transfer of Development Rights Program	Implemented	No	Prevention	Permissive	Unique	NA	NA
Vegetation Preservation Ordinance	Implemented	Yes	Prevention	Mandatory	Unique	NA	NA

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POPULATION AND GEOGRAPHY

The Town of Southampton is located just west of East Hampton on Long Island's South Fork. The town is surrounded by the Gardiner's Bay on the north, the town of Brookhaven on the west, and the Atlantic Ocean on its south. Renowned for its miles of white sand beaches and as the tony resort area for wealthy New Yorkers, it is not surprising that a large percentage of its housing stock is seasonal (41%).

The town is known as the summer playground of the rich and famous, many of whom own second homes in the town. The summer population is nearly three times the year-round population, with the second-home population comprising the largest component of Southampton's summer tourism. (Southampton, N.Y., 1999, Comprehensive Plan). Its year-round population of 22,000 people have a modest median per-capita income of about $37,338. The town also has a number of neighborhoods dominated by Latino immigrants, with 20% of its year-round population identifying as Hispanic.

As the community Preservation Plan describes,

> Southampton is endowed with many natural blessings; a countrified area with abundant forests, wetlands, farmlands and historic hamlets bordered by beautiful sandy beaches, a magnificent ocean and sparkling bays. The Town also enjoys clean air, clean water, plentiful fisheries and a wealth of open space. These, in addition to its rich maritime, native American and colonial heritage, as well as its warm and entrepreneurial people, place Southampton as one of the top places to live and visit in the world. (Southampton, N.Y., 2010, Community Preservation Project Plan Report, p.44)

With nearly 658 miles of coastal shoreline, the town's identity and economy is dominated by the waters that surround it. Although Southampton developed historically as an agricultural community, that has largely been supplanted by residential uses. Today, agricultural land embodies only 8 percent of the total acreage in town and represents less than 2 percent of individually owned properties within the town. Maritime-based industries, including commercial and sport fishing, have declined in economic importance, but still contribute enormously to the sense of place and has multiplier effects in the tourist economy.

Long Island's South Fork retains much of the landscape character the glaciers left behind when they retreated. More than in the rest of the south shore of Long Island, which is largely dominated by outwash plain, the forks are dominated by the character of the moraine ridges. This creates some significant variation in elevation and a diversity of biotic zones. One of the most significant natural features of the town is the domination of the pine barrens on its western half. The area has been the subject of years of preservation policies and is the site of the first and most successful Transfer of Development Rights program in New York State.

A large majority of the town's immediate ocean coastline is dominated by a natural dune line. About half of the town's shoreline is in public ownership. (Southampton, N.Y., 2001, DGEIS) The Westhampton shore of the town is the most heavily developed and has experienced the most significant alteration of the coastal environment. This necessitated installation of a groin field and beach nourishment projects. In the majority of the town, however, structures rarely crowd the primary dune and the town's setback laws ensure no new development occurs close to the dune. As of a 2001 report, its 14 miles of oceanfront had about 270 private parcels, the majority in residential use, along the Atlantic shoreline. Although the town sees this fragmentation as a liability, it is minor compared to most of its East Coast peers.

COASTAL ISSUES

Southampton is exposed to numerous coastal hazards, which motivated an extensive regulatory scheme along its 658 miles of coastline and 14 miles of Atlantic Ocean shorefront comprising barrier islands, headlands, sandspits, and inlets. As is the case on the rest of the northeast coast, tropical storms and extratropical nor'easters, which occur about every two or three years, can have a major impact on the town. Particular locations in town, including the Bridgehampton area and parts of Hampton Bays, have recently been subject to appreciable impacts from erosion.

As the comprehensive plan explains: "In the early 1990s, severe storm activity combined with natural coastal geologic processes to cause extensive flooding and erosion of Southampton's south coast. This caused significant damage to oceanfront property, municipal infrastructure, commercial fishing docks, and recreational beaches" (Comprehensive Plan, p.31). The preamble to the town's Tidal Floodplain Overlay district also explains the hazard mitigation rationale behind that law: "[T]he recorded history of Atlantic coastal storms and hurricanes establishes the fact that flooding of the ocean beach and uplands along the bays can be anticipated with consequent danger to life and health as well as property damage and other related hazards ..." (Southampton, N.Y., Town Code § 330-42)

In many of its laws, plans, and reports the town repeatedly emphasizes its multifaceted goals to protect its shoreline. Southampton's concern is not only about erosion and flooding hazards, but also about protection of natural and scenic resources. These concerns jointly have motivated the town to pass and enforce a comprehensive regulatory program to ensure its resiliency, environmental quality, and aesthetic beauty.

ADAPTATIONS

Coastal Erosion Hazard Law (Town Code, §138-2) and Coastal Erosion Hazard Adjacent Areas (§330-42)

Under New York State law, towns may adopt an ordinance to implement the state's Coastal Erosion Hazard Area program. The law vests power in the State DEC, and therefore ensures uniformity of statewide law, but also allows for flexibility if a local government, such as Southampton, is a willing partner. The law sets a minimum standard but also allows for local implementation.

Southampton used its authority under the law to adopt regulations banning shoreline armoring measures. *The New York Times* called it a "nearly total prohibition on shoreline armoring, a landmark step that would formally change longstanding policies of coastal management and property rights..." (Clavin 2003) *The Times* billed the ordinance as "part of a larger scheme for a measured and orderly retreat from the coast..." Steve Kenny, the councilman who introduced the law, was quoted as saying: "[W]e are going to get homes as far back from the dunes and oceanfront as possible."

Art. 1, Sec. 138-2 of the town code is known as the "Town of Southampton Coastal Erosion Hazard Area Law" (Southampton, N.Y. Town Code) The enumerated purposes of the law include establishing standards for minimizing and preventing damage to structures from coastal flooding and erosion, to protect native vegetation; to "regulate land use and development activities so as to minimize or prevent damage or destruction to man-made property; to preserve access and use of the beaches," protect human life, regulate new construction to ensure buildings are safe from the impact of coastal storms; to ensure natural resources and natural processes are maintained; to restrict public investment in "facilities or activities which are likely to encourage new permanent development in erosion hazard areas;" (Town Code, §138-3(D)) and to eliminate the construction and the replacement of existing erosion protection structures." (Town Code, §138-3(E)). Existing armoring is allowed to remain as a non-conforming use but, if destroyed in a storm or other event, cannot be rebuilt.

The town's enforcement of these laws has led to disputes, but ultimately homeowners who have been denied the right to construct shoreline armoring have taken other measures. For instance, one area of town that has experienced significant erosion saw a large number of permit applications for bulkheads or similar shoreline protection structures. The town consistently required evaluation of alternatives and denied structure permits. As a result, some homeowners moved their homes back and elevated them out of the flood zone. (Southampton, N.Y., DGEIS 2001 p. S-3)

The Town Board recently passed amendments to Chapter 330 of the town code, called the Coastal Erosion Hazard Adjacent Areas. The resolution passed by the Town Board includes the following language: "Indeed, the Town Board remains committed to establishing, regulating, and implementing standards and procedures for minimizing and preventing damage to man-made property and structures from coastal flooding and, of equal importance, preserving public access and the use of the beaches, as well as protecting natural protective features and other natural resources."

The Adjacent Areas legislation is intended to establish standards for minimizing and preventing damage from coastal flooding and erosion as well as to protect natural features and native vegetation. In addition, it is intended to "restrict public investment in services, facilities or activities which are likely to encourage new permanent development" in such zones, as well as to "eliminate the construction of new and the replacement of existing erosion protection structures in coastal adjacent areas..." (Town Code § 330-42 (E))

Figure 3.6.4:1 - Beachfront in Southampton evidencing coastal setbacks and natural dune preservation

The section generally applies to lands immediately adjacent to the ocean coastline up to one street inland from the ocean, which expands the definition of the coastal erosion hazard area that is provided under state law. "Coastal erosion hazard adjacent" permits are required for any construction within the area, and permits shall only issue upon a determination by the Administrator that the action is reasonable and necessary, considering alternatives and the extent to which the activity (A) requires a shoreline location, (B) does not cause an increase in erosion, and (C) "prevents or minimizes adverse effects on natural protective features and their functions and protective values...natural resources...[and] significant fish and wildlife habitats" (Town Code, §330-46(A)).

Within the "adjacent area," buildings are required to be set back as far from the ocean as possible, and no less than 125 feet inland from the crest of ocean dunes. The justification for this is explicated in the law, and reads "Siting a building farther landward than required by the minimum setbacks, and designing a building so it can be easily relocated, minimizes the risk of storm damage, as it allows for the natural episodic cycle of dune building and storm erosion to occur without jeopardizing the building itself. Siting a building as far landward as possible also provides for greater protection for natural protective features, including beaches, bluffs, and dunes" (Town Code, §330-46.2(B)(1)).

The code provides for a reduction in the required front yard setback up to 30 feet to allow structures to be placed further from the primary dune. The code also provides for a type of Transfer of Development Rights often referred to as a "zoning lot merger." It allows for a doubling of maximum coverage on an existing non-conforming single family residence when the owner of an oceanfront lot purchases and permanently prohibits, through conservation easement or transfer to the town, all development on an adjacent vacant lot. (Town Code, §330-46.2(D) Construction of new erosion protection structures and reconstruction of pre-existing structures is allowed in the adjacent area. (Town Code, §330-46.4)

Coastal Erosion Districts

The Town of Southampton has taken the unique initiative to establish beach erosion control districts—separate taxing authorities established to fund beach and dune restoration in specific neighborhoods. Two years ago it established one such district in Sagaponack, called the Sagaponack Beach Erosion Control District. (Toy 2012). Since then, the Town Board and a consultant have prepared baseline surveys, evaluated shoreline erosion along the beach, developed alternate plans for beach restoration, and commenced the permitting process for a beach restoration project that will add more than 1 million cubic yards of sand.

The project includes the development of a comprehensive dune preservation and restoration plan as well as $11 million in projected capital improvements. The project is billed to improve recreation by widening the beach as well as to preserve the community by preserving the existing dune line and reduce flooding risk. The project will cost over $12 million and will be financed by town-issued bonds. The annual tax for properties that fall within 120 feet of the waterfront will be $1,536. While not low-cost to the taxpayers, costs to the town itself are minimal. The town also maintains a second Erosion Control District in Bridgehampton, and the Tiana Beach Erosion Control District in Hampton Bays. (Scro 2010)

Community Preservation Fund (2% transfer tax)

In 1998, New York State passed the the Peconic Bay Region Community Preservation Act, which authorized the five towns on the east end to establish a fund to preserve sensitive lands financed by a special 2% real estate transfer tax on sales of certain property within each town. The tax is charged on developed properties costing over $250,000 and vacant land over $100,000. The first $250,000 and $150,000 respectively are exempt from the transfer tax.

Since the inception of the program, it has generated over $384 million and has protected over 3,000 acres of land. The second project update, adopted in 2005, consisted of eight target areas for acquisition. The Pine Barrens represent the largest acreage targeted for acquisition, as well as agricultural land and land for aquifer recharge. Coastal and freshwater wetlands were also targeted in significant amount for acquisition. Many areas targeted for acquisition are related to coastal resilience, such as the high-priority Bullhead Bay—an area of tidal marshes, oak-hickory

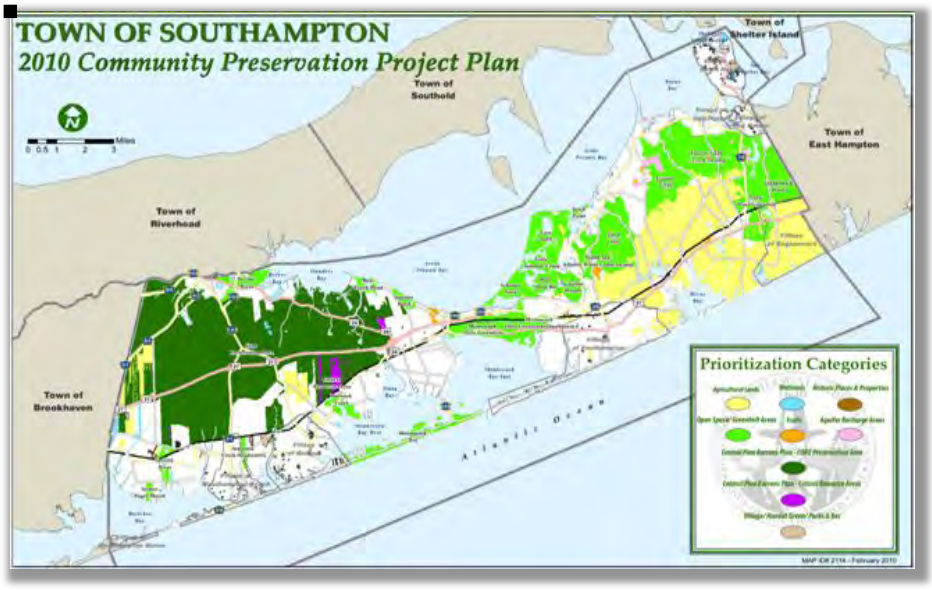

Figure 3.6.4:2 - Community Preservation Project Plan map depicting prioritization categories for land acquisition

forests, and spring-fed maple and tupelo swamps. The town's strict wetlands law also complements the land acquisition strategy, which includes more than 1,000 wetland parcels that meet consideration for acquisition.

Comprehensive Plan - Policy of Strategic Retreat

The town's 1999 comprehensive plan recommends the town adopt a policy of "strategic retreat in the ocean-fronting areas," defined by the plan as a mechanism for the elevation and relocation of a structure further from the Coastal Erosion Hazard line, or public acquisition of subject properties.

Transfer of Development Rights

Southampton's Transfer of Development Rights program is one of the oldest in the nation, and dates from the early 1980s. The TDR program is codified in Chapter 330, Section 330-7 of the town code. The TDR program has multiple objectives that improve the overall planning and environmental quality of the town, including farmland preservation and affordable housing goals. It is designed to support the regulatory programs of the town and especially the protection of the Pine Barrens. However, the code provides that land from which development rights are transferred must have one of a number of specific objectives, including the following:

> Wetlands, as defined in the Town Code, and their immediate upland environments...be retained for their ecological benefits and held in permanent open space use, and lands found in an area designated by the Comprehensive Plan for a greenbelt park system or for an individual park, beach or public recreation area, which will be retained for such open space use. (Town Code, § 330-7 (A))

Furthermore, the code prohibits the transfer of credits into any of the environmentally sensitive zones, including the Tidal Wetlands and Ocean Beach Overlay District, unless specifically authorized by the town board under special circumstances. (Town Code, § 330-7 (D)4)). These provisions support the transfer of development rights out of flood-prone, ecologically sensitive coastal locations and only toward upland parts of town where infrastructure and existing development support growth.

Vegetation Preservation Ordinance

Native vegetation in the immediate coastal zone is protected within the Coastal Erosion Hazard Area and adjacent areas. The section describes the purpose for the law as follows:

> "Native vegetation is unique and extremely important to preservation of the coastline. Beach grass and other native plants protect and stabilize beaches and dunes. These maritime dune communities are sheltered on the back side by a mosaic of maritime shrubland and wetland communities, which together provide essential shelter, nesting habitat, and a rich food resource for resident and migratory wildlife, including rare, threatened or endangered species. Maintenance and enhancement of the continued ecological integrity of the beach, dune, shrubland, heathland and wetland vegetation is essential to the preservation of the essential character and natural and scenic values of the coastline" (Town Code, § 330-46.3).

The law restricts disturbance of native vegetation or natural grades by the size of the lot as well. For lots up to 15,000 sq. ft., 50% may be cleared; for lots of 15,001 to 30,000 sq. ft., 40% of the lot may be cleared; for lots of 30,001 sq. ft. to 60,000 sq. ft., 35% may be cleared; 60,001 to 90,000, 25% may be cleared; 90,001 to 140,000, 20% may be cleared; 140,001 to 200,000, 15% may be cleared, and for lots of over 200,000 sq. ft., only 10% may be cleared. (Town Code, § 330-46.3(A))

Section (E) limits site clearance to 50% for nonresidential lots. (Town Code, § 330-46.3(E)) Applications for building permits in the coastal erosion hazard or adjacent area must include revegetation and restoration measures as set forth in (G). (Town Code, § 330-46.3(G)). The code requires that applicants prepare a revegetation and restoration plan to restore native vegetation to areas temporarily cleared beyond the limits during construction.

3.7. NEW JERSEY

3.7.1. LITTLE SILVER, NJ

Population Density	2226/ sq. mi.
Form of Government	Borough
Category	Suburban Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
115836	53891	88.6	5950	-0.36	96.4	3%	6.3%	2.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Community Vulnerability Assessment Tool	Completed	Yes	Procedural	Recommendation	Unique	NA	NA
Flood gauge warning system	Implemented	No	Procedural	NA	Unique	Low (< $10,000)	State Police, FEMA, Other Towns
Coastal Wetlands Ordinance	Implemented	No	Infrastructure (Green)	Mandatory	Above Required	NA	NA
Open Space Levy, Approved Open Space Plan and Wetlands Mitigation Bank	Implemented	No	Infrastructure (Green)	Mandatory	Unique	NA	NA

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POPULATION AND GEOGRAPHY

Little Silver is located in eastern Monmouth County, New Jersey. The Borough is 2.76 square miles and its jurisdiction includes .60 sq. mi. of submerged lands. It is located on tidal marshes about 2 miles from the Atlantic coastline.

The borough is a peninsula surrounded by waterways—the Shrewsbury River, Little Silver Creek, Parker's Creek, and Town Neck Creek all can cause flooding in town. 8% of the homes in Little Silver abut the Shrewsbury River. Some parts of town are more vulnerable due to some variation in topography, as the average elevation is 30 feet and the highest point is 80 feet.

Little Silver is a wealthy commuter suburb of New York City and northern New Jersey. It is a year-round community with only 2% seasonal homes. Its population as of 2010 is 5,950. The population density is 2,226 people per sq. mi. The community is 96% white, .31% African American, and 1.51% Asian. Median per capita income is $53,831.

COASTAL ISSUES

Little Silver is a largely built-out community with little room for development. It consists mostly of single-family homes and has a small commercial district. A New Jersey Transit train station provides service to New York and Northern New Jersey. The town was hit hard in the 1992 nor'easter, and it takes the threat of coastal flooding seriously.

NFIP data shows that more than over $3.2 million in flood losses were paid to 156 properties under the National Flood Insurance Program.[5] The Coastal Communities Resilience Demonstration Project report also pointed out that the entirety of the Borough is at risk from inundation in a Category 1 or 2 hurricane.

Figure 3.7.1:1 Sandy's wrath on Little Silver Point Road in Little Silver, NJ

Since 1850, nine tropical storms have passed over the Borough, but nothing in recent memory prepared it for the onslaught from Post-Tropical Superstorm Sandy. One-and-a-half weeks after the storm, one-third of homeowners remained without power. In addition to downed power lines, damage to the substations was also significant.

Little Silver escaped without injury to emergency workers and residents, but experienced significant property damage from falling trees and flooding. A few residences were severely

[5] FEMA, NFIP Report Data, Cited in Ida Leigh Wood, Jenny Tirrito and Mariana Leckner.

damaged or destroyed, and some residents were displaced for a lengthy period of rebuilding. (Little Silver Storm Recovery Update 2012)

The tales of destruction and devastation were widespread via electronic media in the days following the storm. The most badly damaged area was reported to be a section of town called Silvermere at the end of Point Road. The niece of a resident whose Shrewsbury riverfront home was badly damaged was quoted saying, "I knew it was bad, I just didn't think it would be like this" (Byrnes 2012). Alvin Terrace was another street that sustained serious impacts from the surge. One resident of that street reported that her house of five years was destroyed by winds, high water, and a fallen tree. Another neighbor reported that his entire neighborhood was under 3 feet of water during the height of the storm.

ADAPTATIONS

New Jersey Coastal Community Resilience Demonstration Project

The Borough of Little Silver was a participant in the New Jersey Coastal Community Resilience Demonstration Project, which consisted of the Coastal Community Vulnerability Assessment Tool (VAT) as well as the "Getting to Resilience" (GTR) questionnaire.

The VAT and the GTR were pilot projects spearheaded by the National Sea Grant Coastal Communities Climate Adaptation Initiative (CCCAI) and the New Jersey Sea Grant Consortium (NJSGC), in partnership with the New Jersey Department of Environmental protection (NJDEP), Monmouth University Urban Coast Institute (UCI), and Stevens Institute of Technology. The community-based climate adaptation demonstration projects were conducted in partnership with the communities of Oceanport, Little Silver, and Cape May Point.

The objective was to provide communities with a vulnerability assessment so they could improve their resilience to coastal hazards and sea level rise. The project used mapping to illustrate inundation scenarios (the Coastal Community Vulnerability Assessment Protocol, "CCVAP") as well as developed the GTR questionnaire. The CCVAP was used to identify critical infrastructure, natural resources, and special need populations subject to inundation from coastal floodwater.

The goal of the questionnaire was to help local officials identify planning, mitigation, and adaptation opportunities to reduce vulnerability to coastal storms and sea level rise and to highlight the importance of local plan coordination, as well as integration with hazard mitigation and town planning and building codes.

The questionnaire was developed with input from government agencies, planning practitioners and academic experts, and focused on land use planning, hazard mitigation and coastal issues. It was comprised of five sections—Risk and Vulnerability Assessment, Planning Integration, Public Engagement, Emergency Preparedness and Recovery, and Hazard Mitigation and Implementation. The questionnaire was administered to Oceanport as well as Little Silver and Cape May.

Coastal Wetlands Ordinance

The Borough has an innovative Coastal Wetlands Ordinance, originally adopted in 1973 and updated since (Little Silver, N.J., Revised General Ordinances, Ch. XIX). The farsighted law prevented development of vulnerable coastal wetlands that act as protective barriers for storm surge flooding for the existing community. The preamble states that the borough council found "the spread of development and increasing demands upon natural resources are encroaching upon, polluting, or eliminating many of the borough's natural coastal water resources, coastal wetlands, tidal marshes and other natural resources in the coastal flood zone...which, if preserved and maintained in an undisturbed and natural condition, constitute important physical, social, aesthetic, recreational and economic assets to existing and future residents and the public in general" (19-1).

The ordinance allows only three activities as-of-right in the coastal flood zone, and only "provided that there is no significant adverse impact on the coastal flood zone" (§ 19-5)

These include:
a. Conservation of soil, vegetation, water, fish, shellfish, and wildlife.
b. Outdoor low-intensity recreation including nature study, hiking, swimming, etc.
c. Boat anchorage or mooring.

Regulated acts are permitted by special permit issued by the Planning Board only after a permit application is made to the Environmental Commission and the project is also approved under county, state, and federal rules and regulations. Aside from the Environmental Commission, applicants must also forward a copy to the Borough Engineer and Shade Tree Commission, both of whom have 30 days to respond in writing with a recommendation. (§ 19-7.2)

Regulated activities include the erection of structures, driving pilings, changing tidal ebb and flow, temporary storage of materials, construction of dams or water control structures, construction driveways and roads where they pass over tidal wetlands or marshes, deposit of materials or wastes, and the removal, digging, or dredging of any material. (§ 19-6)

In order to obtain a permit, the applicant must provide the names and addresses of all owners within 500 feet; a description of the purpose of the project, and an environmental assessment statement. A description of the "manner in which material will be removed or deposited, structure installed or use carried out" is also required. Topographical maps, a map showing soil types, filing fees, and proof of approvals and permits issued by county, state and federal agencies, "including, but not limited to Freehold Soil Conservation District, Department of Environmental Protection of the State of New Jersey and the United States Army Corps of Engineers" (§19-7.1) The ordinance requires posting of any permit issued and makes clear that the Borough may inspect the project at any time. An environmental bond may also be required for any environmental damage the project may cause.

Shrewsbury River Flood Warning System

Little Silver partnered with the Monmouth County Office of Emergency Management and nine other municipalities to install five automated flood gauges at key locations along the Shrewsbury and Navesink rivers to provide real-time information about tidal flooding, wave heights, and weather during coastal storms. The data is received and decoded by Monmouth University and the Stevens Institute of Technology, who were also partners in the project. The gauges are installed on the Gooseneck Bridge, Rumson-Sea Bright Bridge, Oceanic Avenue Bridge, Highlands-Sea Bright Bridge, and Patten Avenue Bridge. The project was funded by a $90,000 FEMA Emergency Management Performance Grant to the New Jersey State Police, with a required contributing match of $1,500 in maintenance funds annually from each of the municipalities.

Figure 3.7.1:2 - Shrewsbury River Flood Gauge and Weather Station

Open Space Levy, Approved Open Space Plan and Wetlands Mitigation Bank

The Borough passed an annual levy for open space and approved an open space plan in 2003. The plan identifies floodplain management as a priority. It also maintains a wetlands mitigation bank on Town Neck Creek, which restores degraded tidal wetlands and acts as a protective buffer. Unfortunately, the opportunities to acquire land are few as most of the Borough is built out according to current regulations.

3.7.2. OCEANPORT, NJ

Population Density	1802 / sq. mi.
Form of Government	Borough
Category	Suburban Bayfront
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
88562	42893	78.3	5832	-0.26	93.4	4%	9.5%	1.7

Adaptations	Status	Incorporates CC	Type	Applies To	Standard	Costs	Funding Source
Coastal Community Vulnerability Assessment Tool	Completed	Yes	Procedural	Planning	Unique	Low (<$10,000)	State Police, FEMA, Other Towns
Freeboarrd – 2 Ft.	Implemented	No	Accommodation	Building	Above Required	Very Low (<$1,000)	None

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POPULATION AND GEOGRAPHY

Oceanport, New Jersey, is a town of 3.9 square miles located in the northern portion of Monmouth County, less than a mile from the Atlantic Ocean shore and, according to officials we interviewed, “80 percent of the borough is surrounded by water.” These bodies of water include Parkers Creek, Oceanport Creek, Blackberry Creek, Branchport Creek, and the Shrewsbury River (which is a tidal strait). The borough borders Little Silver, Long Branch, Eatontown, and West Long Branch and has a maritime boundary with Monmouth Beach. Average elevation of

the community is 20 feet. The town is a wealthy year-round (1.7% seasonal homes) commuter suburb of New York City and Northern New Jersey. It has a relatively high (78%) owner-occupancy, and much of the town consists of single-family homes on large lots.

The population as of the 2010 Census is 5,832 and the population density is 1,802 people per sq. mi. There are 2,114 housing units with a density of 656 per sq. mi. The population is 95.7% white, 1.96% African American, and less than 1% other. Median household income is $71,458 and median per capita income is $42,893, which is sixth highest of our study communities. 2.7% of the population live below the poverty line.

COASTAL ISSUES

Superstorm Sandy was an unprecedented late-breaking event in Oceanport. Many roads and bridges were impassible during the storm, and flooding was severe. A local paper quoted resident Margaret Murray as saying "I've lived here my whole life and I've never seen (the water) up so high."

Despite this outsized event, the town is not a stranger to coastal flooding. In particular, the town suffered extensive damage during a 1992 nor'easter. Oceanport has been proactive about the issues facing the community. Kimberly Jungfer, Borough Administrator/Clerk, said, “In all aspects of the town...we are very conscious about flooding...anything that we do...we are always conscious about how it will affect flooding...and anything that we can do to lessen it...” (Personal Communication, Jun. 18, 2012).

When asked “If there is one thing that the state or federal government can do to improve your ability to respond to flooding and climate change,” borough OEM coordinator Buzzy Baldanza responded that there was not much they could do to help the town. “Unless someone wants to build the equivalent of the Thames River floodgate...I don’t see it happening soon...there’s no way we can stop that water from coming in...there’s no way you can put a bulkhead around Oceanport...so it’s just going to keep coming in...” (Personal Communication, Jun. 18, 2012). Oceanport clearly believes that adapting to these constraints is the way it will survive the future.

Because it is largely built out, Oceanport is limited in its ability to affect the development pattern. However, a major development project for the town is in the works. Fort Monmouth is a large army base on the north side of town that was decommissioned in 2010. The decommissioning expanded the town’s total land area by one-third.

ADAPTATIONS

Coastal Community Vulnerability Assessment Tool

Oceanport was a participant in the “Coastal Community Vulnerability Assessment Tool” (VAT) as well as the “Getting to Resilience” (GTR) questionnaire, as explained and referenced in the summary for Little Silver.

Mr. Baldanza explained that the town first became involved with the coastal resilience project as a partner in the installation of tide gauges on the Shewesbury River. A professor working with Monmouth University, who was the project manager for the tide gauge project, contacted Oceanport and asked if they would be willing to participate in the GTR project as well.

The information from the tide gauges is being used by Stevens Institute of Technology to develop modeling to predict future inundation, with information from the gauges and an app they developed which allows emergency management teams to report the levels of flooding on the streets. The funding was provided through the state, but each participating town contributes $1,500 per year for maintenance of the gauges.

Mr. Baldanza noted that the report generated from the vulnerability assessment enhanced their awareness of the risk of flooding in some of the town's critical and public facilities, but he waxed futile about what they could do about it. He indicated they could not qualify for federal or state funds to relocate any of these facilities since they had not been inundated severely enough at that point. But he noted that future development at Fort Monmouth might provide an opportunity to relocate the facilities at risk.

Regarding future plans to incorporate the information into planning and decision making, Mr. Baldanza said he made a presentation to the planning department, and that he hoped they used the information.

Building Code/Freeboard Requirement

The Borough's building code requires a 2-foot freeboard, which effectively means an 11-1/2 foot elevation for all new or substantially renovated structures (over 50% of the assessed value of the structure, not the total assessed value.) Oceanport's elevation requirement is 9-1/2 feet above the minimum FEMA requirements. They believed that their regulatory requirements for flood elevation were most effective and could serve as a model for other towns. They adopted this strict regulation when the risk to homes became evident in the flooding caused by the 1992 nor'easter in the region. They indicated that many homeowners elected to raise their homes after that storm.

Shrewsbury River Flood Warning System

Oceanport participates in this multi-jurisdictional partnership described in detail in the Little Silver summary.

3.7.3. GREENWICH, NJ

Population Density	42.1/ sq. mi.
Form of Government	Township
Category	Rural Bayshore
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
55456	28237	75.4	804	-0.52	91.4	3%	10.1%	3.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Community Vulnerability Assessment Tool	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	State, NOAA
Conservation Zone - Restrictive Zoning and Environmental Impact Statement Requirement	Implemented	No	Prevention	Mandatory	Unique	Low (< $10,000)	None

CONTACTS

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POPULATION AND GEOGRAPHY

Greenwich Township is the smallest community in our survey. The Township, including the Village of Greenwich, has a population of 804 people. Its population, which is 91% white, has exhibited a slow but steady decline in recent decades. Greenwich is located on the Delaware Bay, on the Cohansey River in western Cumberland County, about an hour south of Philadelphia. The town's 19 square miles is largely wetlands and farmland with a few small settlements. The town was settled in the mid-1600s and has a significant historic district designated as a state and federal historic district. It is protected by agricultural levees that are hundreds of years old and in declining condition.

Greenwich is a riverine community that is predominantly agricultural. Its maritime history—as a colonial port-of-entry and as a major 18th and 19th century ship-building, oystering, and fishing center—is well documented. It is primarily a year-round community with only 3% of the housing stock reported as seasonal.

COASTAL ISSUES

Greenwich Township is a low-lying community surrounded by coastal wetlands and the Delaware Bay. As the Coastal Community Vulnerability report stated, "While the township has made great progress towards preserving its historic and natural landscape, coastal hazards threaten agriculture, historic properties, tidal wetlands, and the safety of township's residents. Greenwich Township is already experiencing coastal erosion along the Delaware Bay, saltwater intrusion into freshwater resources, habitat transition from freshwater to salt marshes, and shallow coastal flooding in low-lying areas" (NJDEP 2011).

The mapping exercise revealed that, although Greenwich currently experiences shallow coastal flooding in low-lying areas during spring tides, storm surge from a Category 1 hurricane would be rebuffed by tidal wetlands that protect the majority of the community.

Indeed, Superstorm Sandy had a relatively minor impact on the community. However, the report concluded that a storm having a magnitude greater than Category 1 would inundate a large expanse of developed land (p.9) and stated "the destruction of a hurricane or major nor'easter could have an immense impact on historic resources in the township and result in short-term disruption of agricultural production" (p.13)

The Mayor agreed that "flooding is a big issue" in the township. (Personal Communication, Jul. 26, 2012). Two primary earthen levees dating to colonial times have become highly vulnerable and a third agricultural levee was breached in the late 1980s. That levee was repaired in 1994. The town then worked for two years with DEP and the Corps of Engineers but the last active repair project was abandoned in 1996. "The levees help retain our fresh irrigation water since we don't have a very deep aquifer. We are very concerned with fresh water resources that are protected by these three dikes," Mayor Kiefer explained. One of the biggest challenges in Greenwich is not just its physical vulnerability, but its lack of resources. "Greenwich has few financial resources and our local government functions are primarily served on a volunteer basis," Mayor Kiefer explained.

Township interviewees explained that the Township lacks the infrastructure, technical resources, and financial resources of larger communities. For example, flapper gates need to be replaced at one of the dikes, but the cost is estimated at a minimum of $100,000. Without working tide gates, the dike is compromised and Greenwich-Bridgeton Road, a major county road and coastal evacuation route, is at high risk of flooding. At this time, the Township is working with Cumberland County officials to make emergency repairs to the physical structure of the dike adjacent to this road, to be followed by critical tide gate repairs to protect the community while further solutions are identified.

Township interviewees indicated that Greenwich Township has been experiencing the effects of water rise in multiple ways. Planning/Zoning Board member Michael Henry said, "One thing we are concerned about is the fact that in recent periods of heavy rainfall we have noted an increase in the shallow aquifer level. In addition to flooding, some homes are experiencing groundwater rise in their basements. In some instances, groundwater flooding has occurred in houses where homeowners have not seen water in basements in 50 years. There is a sense that increased tide levels are putting pressure on the shallow aquifer and putting back pressure on the aquifer. The implications are increased insurance claims, and insurance redlining which would affect mortgage values..." (Personal Communication, July 26, 2013).

At the end of December 2010, a heavy snowstorm was followed by rapid temperature rise and snow melt that caused extensive flooding, especially in basements of properties along the Township's historic Ye Greate Street. In August 2011, a major storm followed by Tropical Storm Irene resulted in flooding. Other storms and storm surges have threatened several historic homes nearest the Cohansey River that were directly protected by the breached levee, and historic and contemporary properties in the Township have experienced repeated basement flooding and other damage.

A detailed study of elevations was conducted as part of the Vulnerability Assessment Tool, one of the adaptations profiled in Greenwich. The study's final report states that, "In a worst case scenario, almost everyone in the town would be affected." Xx

As of July 2012, sandbags that were used to protect the Market Street levee from Tropical Storm Irene remained, although this is far from a permanent solution. Trudy Hansen, a member of the Sustainable Greenwich advisory committee, said that, "coastal vulnerability is a very serious issue... it affects both the built and natural environment and impacts the lives of all residents" (Personal Communication, July 26, 2013).

ADAPTATIONS

Coastal Community Vulnerability Assessment Tool and Getting to Resilience Survey

The community was very grateful to have been selected to participate in the project. The Mayor said, "The Coastal Community Vulnerabilities Assessment Tool project was one of the best things that has come our way" (Personal Communication, July 26, 2013).

Greenwich Township is using the data generated from the project in recent communications with Verizon Wireless, who contacted the town wishing to site a badly needed cell tower. Using the new storm surge projections, the Township wants the utility to site the critical telecommunications facility outside the areas projected to be inundated by the most extreme storm surges. The Township has also formed a special Dikes Committee that is working with state and county officials to find appropriate solutions and alternatives to the continuing threats of flooding, storm surge, and water rise.

Greenwich Township also drew some distinctions between itself and the majority of New Jersey communities in the way they could use the information in the report. Interviewees said that common responses, including regulating building code, are not as relevant in a slow-growing rural historic township such as Greenwich. They are concerned with protecting their historic district, open space, farms, and an agricultural way of life. As Mayor Kiefer explained, "We are concerned with protecting what we have rather than regulating new development. We could change all of the codes on the books and it wouldn't make a difference..."

One of the direct outcomes of the vulnerability study was a community visioning study that the Township conducted with the aid of a University of Pennsylvania School of Design/Historic Preservation Planning studio. The Township has also reached out to the Civil and Environmental Engineering department at Rowan University and is hoping to obtain assistance in gathering data that will help the Township develop proactive measures for challenges including water supply and septic system options.

In general, the interviewees felt that they had limited resources to implement the solutions necessary to become more resilient. They thought our report might help because, as Ms. Hansen explained, "It would be valuable to have more access to information about how other communities... especially those with similar challenges...are meeting water-related challenges. We have several different types of water rise, flood, and storm surge impacts, but we often feel like we are in the dark...we don't know where to access that information or look at how other communities have implemented protective measures."

Conservation District Zoning and Environmental Impact Statement Requirements

Although growth pressure has been minimal, the Township attempts to protect its agricultural way of life and low-impact human activities through a number of regulations. Over one-third of the Township, the majority of which is coastal wetlands, is protected by a conservation easement. The town's Conservation District (CD) zoning category includes the majority of tidal marshes, floodplains, and wetlands in the Township.

The zoning code describes the zone as "established to recognize and conserve environmentally sensitive areas from inappropriate development or uses" (Greenwich, N.J., Town Code Art. XIV, §700) Conservation Areas are established to recognize and conserve environmentally sensitive areas from inappropriate development or uses. It prescribes that land in the CD district can only be used for compatible activities such as farming, nurseries, recreation, forestry, game farms, fisheries, wildlife sanctuaries, and arboretums. Parking, dumping, sewage treatment, and the application of pesticides is prohibited without approval.

For any activity in the CD district, the township requires:

1. A detailed environmental impact statement establishing the exact limits of environmentally sensitive areas.
2. Buffer requirements in accordance with the requirements under the State of New Jersey.
3. Any landowner with development adjacent to a conservation overlay area must submit an environmental impact statement (EIS).

The EIS requirement is unique among our study communities. Although some states, such as New York, require EIS, Greenwich is the only town we know of that has instituted such a requirement on its own. Although procedures are not detailed, an EIS could significantly help to disclose hydrologic and ecologic impacts of any development activity and ensure the town opportunity has an to consider mitigation measures. The Township also requires 1 foot of freeboard described in its flood hazard ordinance. (Greenwich, N.J., Town Code, Art V. §388)

In the Conservation Zone, development is greatly limited and the law requires any proposed development prepare an EIS; 1 foot freeboard is required. (Ch 388, Art V.)

3.7.4. SEA ISLE CITY, NJ

Population Density	845 /sq. mi.
Form of Government	City
Category	Seasonal Barrier Island
CRS Rating	6

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
58472	40651	12.1	2114	-2.89	98.6	2%	3.3%	79.4

Adaptations	Status	Incorporates CC	Type	Impact	Standard	Costs	Funding Source
Comprehensive Plan - Incorporates SLR	Completed	Yes	Procedural	Recommendation	Above Required	Medium (<$100,000)	NA
Cumulative substantial improvement ordinance with no expiration date	Implemented	No	Procedural	Mandatory	Unique	Low (< $10,000)	NA
Strict Enforcement of Flood Ordinance	Implemented	No	Accommodation	Mandatory	Unique	Medium (<100,000)	NA

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POPULATION AND GEOGRAPHY

Sea Isle City's reported 2010 population is 2,114, but summertime population estimates are closer to 40,000. The year-round population is 98.6% white. Hispanics make up 2.4% of the year-round population. Median income as of 2010 was $40,651. Sea Isle City has the highest percentage of seasonal homes of any community in our project inventory, with 5% more seasonal homes than Ocean City, Maryland, and 25% more seasonal homes than the third-most-seasonal community, East Hampton, N.Y.

Sea Isle City, located in Cape May County, lies entirely upon Ludlam Island, a barrier island it shares with Dennis Township. It is located north of Avalon, which is across Corson Inlet, and

south of Ocean City, NJ. It constitutes an area of 2.5 sq. miles. The Ludlam Bay and Townsend Sound separate it from Ocean View on mainland New Jersey.

COASTAL ISSUES

Sea Isle City had the distinction of being the landfall location for Hurricane Sandy on October 29, 2012, according to a number of reports. The fact that Sea Isle City is located entirely on a barrier island makes it extraordinarily vulnerable to coastal storms. Tropical Storm Ida and a nor'easter affected the Jersey Shore in November 2009. Winter storms and coastal flooding caused $225,000 of damage in Cape May County in 2006. Hurricane Floyd hit in 1999 causing $492,000 in damage; and storms in January and February of 1998 each caused about $4 million in damage in Cape May County. The damage from Superstorm Sandy is likely to be much higher. Coastal storms, flooding, and coastal erosion were ranked as the most significant hazards in a neighboring township's natural hazard risk/vulnerability risk ranking, and they will likely be similar in Sea Isle City. (Cape May County N.J., Hazard Mitigation Plan, Oct 2010, Sec. 9.7)

ADAPTATIONS

Comprehensive Plan Incorporates Sea Level Rise

Sea level rise appears a number of times in the city's master plan update of 2007. The plan explains that "an analysis of the impact of rising sea levels on the coast of Sea Isle City" should be undertaken regarding the erosion control plan for the city's north end, for which the city is continuing to seek funding and regulatory approval to implement. (Sea Isle City, N.J., Master Plan Re-Examination Report 2007, p.3)

The plan references the recent study *Future Sea Level Rise and the New Jersey Coast,* funded by the Policy Research Institute for the Region (PRIOR) and the Science, Technology and Environmental Policy Program at the Woodrow Wilson School of Public and International Affairs of Princeton University, which, the plan notes, classifies the vulnerability of Sea Isle City as severe. The plan also references the need to preserve vulnerable land as a sea level rise strategy. It states the following goal:

> "Continue to pursue the acquisition of privately owned land parcels located in flood prone areas and within the City's sand dune system. The City remains committed to the preservation and acquisition of open space as necessary. The City should continue to work with the New Jersey Department of Environmental Protection (NJDEP) to secure any available funding for the acquisition of these important environmental lands. With the recent passage of the State's referendum, additional State funds will likely be made available to the Green Acres and Blue Acres (e.g. wetlands, coastal protection areas, etc.) programs"(p.6).

Cumulative Substantial Improvement Rules

CRS also encouraged the city to modify its cumulative substantial improvement rules. As described by the NFIP CRS program, the purpose of such a law is to ensure that "property owners [don't] 'beat the system' by applying for a 40% improvement project one year and applying for another 40% project the next year" (NFIP CRS 2006, p 20). NFIP regulations "do

not require that smaller individual improvements made over a period of years and that add up to 50% be considered a substantial improvement," but CRS grants 45 points for rules that count improvements of 10 years or more. Sea Isle City goes beyond the CRS by having no limit on the years it counts, although, according to Mr. Byrne, practically speaking they count back to 1993 when permits were digitized.

Strict Enforcement of Flood Prevention Regulations

Sea Isle City recently adopted a spate of regulations that have catapulted its CRS rating from non-participating to a category 6, resulting in a 20% discount on flood insurance. The efforts date back to 1993, when the Mayor first was elected. At that time, the city was nearly on probation with FEMA and had been removed from eligibility to participate in CRS.

The Mayor reportedly said, “This project was nearly 20 years in the making. We simply kept moving forward toward the goal of receiving a discounted rate. To achieve that goal, we worked together as a community, we took numerous trips to FEMA headquarters in New York City, we involved Congressman Frank LoBiondo’s office, and we wrote new ordinances that have taken us from being last in the state to one of only seven Class 6 Communities in New Jersey” (Cape May County Herald July 2012)

The city eliminated bonus rooms on the ground floor of homes and passed an ordinance that “called for a non-conversion agreement between the city and all property owners prior to the sale of a home or approval of construction,” which ensures regulations are complied with. Its efforts to achieve one of the highest scores in the state have culminated in a controversial decision to issue summons to about 200 homeowners who were in noncompliance with FEMA flood standards. 6,193 homeowners were issued summonses regarding FEMA’s standards.

The violations at issue most often relate to widening or unblocking vents that allow floodwater to flow in without endangering the structural integrity of the house. Many homeowners were caught by surprise because the regulations for flood venting have become stricter over time. The average retrofit, according to a contractor cited in a news article, costs $1,500 to come into compliance (Miller, Aug. 7, 2011).

The purpose of the summonses, as Mr. Bryne explains in the article, is not to fine violators. “Sea Isle does not want to drag anyone into court. We don't want to fine anyone. We want to bring people into compliance so we can enter the Community Rating System” (Miller, Aug. 7, 2011).

In terms of the politics of such aggressive action, the Mayor expressed empathy for homeowners who needed to pay for the retrofits, but stated, “the city has to consider the welfare of the entire island, and the benefits everyone stands to gain from insurance discounts.” With only 193 violations out of 7,250 residential units in the city, the political cost-benefit analysis was clear. He said, “We're working on this as a community. All we're asking is for cooperation" (Miller, Aug. 7, 2011).

Road Elevation Project

Cape May County is in the process of bidding a project to reconstruct the main causeway, JFK Boulevard, that extends from Sea Isle City to mainland New Jersey. The road floods often. The

county is planning to elevate the two-mile-long road five feet "to ensure it is passable during coastal storms and back-bay flooding, which is expected to grow worse with rising sea levels" (Cape May County Hazard Mitigation Plan). Cape May County Engineer Dale Foster noted, "The issue here is sea levels are rising...and we are seeing a good majority of high tides pushing the limits" (Miller July 2, 2011) The county is planning to address six other at-risk causeways and has recently completed two projects to elevate roads out of the 100-year floodplain.

3.8. DELAWARE

3.8.1. BOWERS BEACH, DE

Population Density	1063/ sq. mi.
Form of Government	City
Category	Seasonal Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
38519	22956	43.8	335	-0.52	94.0	3%	7.5%	29.0

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Resiliency Action Plan	Completed	Yes	Procedural	Recommendation	Unique	Medium (<100,000)	State
Buyout of Repetitive Loss Property and Conversion to Park	Implemented	Yes	Retreat	Recommendation	Above Required	Low (< $10,000)	FEMA
Rezoning to Relocate Downtown to Less Vulnerable Area	Proposed	No	Retreat	Mandatory	Unique	Low (< $10,000)	None
Renovation of Parking Lot and Replacement with Pervious Natural Surface	Proposed	No	Accommodation	Recommendation	Unique	Low (< $10,000)	State

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POPULATION AND GEOGRAPHY

The town of Bowers Beach is a small community of 335 year-round residents perched at the edge of the Delaware Bay, between the St. Jones and Murderkill Rivers in Kent County, Delaware. It is surrounded by unincorporated Kent County. The town also has a significant summer resident population, with 29% of the housing reported as seasonal. The town is in the Dover Metropolitan Statistical Area. The town has a total area of 0.3 square miles of which 3.33% is water. The year-round population is largely white and middle income. The town is a fishing center —it has a small commercial fishing fleet and is popular with recreational boaters.

COASTAL ISSUES

The Mayor explained that the town knows how to live with flooding: "If we get a hurricane we will have three feet of water down main street...it comes in and it goes out" (Personal Communication, Aug. 9, 2012). The area is subject to minor flooding during a full-moon high tide. One interviewee explained that there will be a foot of water on Hubbard Avenue even without a storm. "Just a high tide and a little bit of wind and it will flood..."

Hurricane Ernesto and the storm of 1962 were two of the most powerful to hit Bowers Beach. Hurricane Ernesto resulted in the loss of about 14 feet of beach dune. Residents recalled complete flooding of the town in those events with no evacuation possible after flooding became severe. Homes were destroyed and severe erosion impacted natural defenses.

Nor'easters have removed as much as 35 feet of beach in the past. Rapid flooding during past storms have stranded residents, flooded cars and homes, caused electricity outages, and closed businesses for 3 to 4 weeks. The town also has a deteriorated dune system that has been destroyed by recent storms. Although homeowners relinquished property rights in exchange for the state agreeing to maintain the dunes in the 1970s, the state has not done so recently. The Mayor said that the state plans to repair the dunes in 2013.

A sea wall on Hubbard Avenue protecting a portion of town is totally deteriorated and puts a number of homes at risk. One official interviewed described the dire situation: There is a house not far from there that has holes drilled in the kitchen floor so that when it floods water can drain out..." (Personal Communication, Aug. 9, 2012).

ADAPTATIONS

The Bowers Beach administration is bent on being proactive and working toward coastal resiliency. The Mayor explained that they understand that water will come in during storms, but that they want to make smart decisions to reduce the damage and clean-up after a storm (Personal Communication, Aug. 9, 2012). The town has taken a number of unique actions to reduce its risk, including relocating its commercial district to a less vulnerable location, buying

out and converting repetitive loss properties to a public park, and replacing a large parking lot with vegetated, pervious material.

Coastal Resilience Action Plan for Bowers Beach

As part of the statewide Sea Level Rise Adaptation Initiative, the Delaware Coastal Programs Office of the Division of Soil and Water Conservation in the Delaware Department of Natural Resources and Environmental Control (DNREC) is helping the Town of Bowers Beach conduct a vulnerability assessment and develop a coastal resiliency action plan to prepare for and adapt to sea level rise and other projected climate change impacts. This pilot implementation project will examine the coastal hazards risks to the Town of Bowers Beach, identify issues of concern, collect relevant information, and develop adaptation strategies.

DCP staff worked with the town planning committee to conduct public workshops to identify issues and measure their severity. There were four phases to the project: Data Collection and Synthesis, Vulnerability Assessment, Strategy Development, and Implementation. Concerns were raised that flooding could prevent evacuations, and the loss of infrastructure such as saltwater intrusion into wells and the loss of the pump station. The lack of protection by beach and dunes systems is also a concern.

The workshop report concluded, "the town of Bowers Beach is greatly vulnerable to the impacts of coastal hazards of all degrees" (DNREC 2009). Although the project excited the public and drew one-fifth of residents to meetings, the Mayor and residents were not pleased that the state decided to make Bowers the "poster child" for the sea level rise project. They identified the graphics in the report as a problem, since they sensationalized the long-range predictions without much explanation.

He told the story of a citizen who had commented to him, "We were thinking of moving to Bowers and we realized it was going to be under water in 50 years" (Personal Communication, Aug. 9, 2012). Town officials commented that this kind of marketing is not good for real estate sales and that such a prediction was in conflict with goals of the town and state to become an eco-tourism destination. Indicating his displeasure with the economic prospects the report predicted, one interviewee stated, "People need to eat...and sleep...and have a place to get a cup of coffee...it's a whole package."

Buyout of Repetitive Loss Property and Conversion to a Park

Bowers Beach is one of the only towns in our survey to have implemented actual retreat from a vulnerable coastal area. It purchased two homes that had experienced repetitive flooding and converted them into a public park on Main Street.

Bowers Beach worked with FEMA's repetitive loss program and the Delaware Department of Parks and Recreation to obtain funding to buy out two properties. Funding from FEMA was provided in a 75/25 split and from the Department of Parks and Recreation in a 50/50 split, which made the project feasible in this very small town.

The Mayor explained that, when the idea surfaced, the community became really excited about the idea of creating a bocce ball court. "It has really brought the community together," he said.

Figure 3.8.1:1 – Bowers converted a repetitive-loss property (left) into a community asset (right)

Rezoning to Relocate Downtown to Less Vulnerable Area

Unique among the communities we surveyed in the North Atlantic, Bowers Beach is planning to use a retreat strategy to relocate its downtown commercial district to make it less vulnerable to coastal flooding.

The business district is currently on Hubbard Avenue and at significant risk due to the deteriorated condition of the town's seawall. The Mayor explained the situation clearly: "Because the seawall is deteriorated we are faced with a choice—do we get the seawall fixed or do we run for the hills and let everything go?" (Personal Communication, Aug. 9, 2012)

He explained that the town is "deciding to try to get the seawall fixed...understanding that that will mitigate the problem...but it won't solve the problem for the future." To ensure the town has a viable business district, he said they plan to move the downtown to a location less impacted by flooding, and "to look at what kind of construction we can require so that it will last half a generation" (Personal Communication, Aug. 9, 2012)

The Mayor explained they are planning on rezoning the current commercial district to residential, and rezoning a part of town that is currently zoned residential (R2 zone) on higher ground to commercial. Although the plan would not move the commercial distinct overnight, it would do so as non-conforming uses are phased out over time.

Figure 3.8.1:2 - Parking lot that will be replaced with a natural surface

Renovation of Parking Lot and Replacement with Pervious Natural Surface

The town has a large parking lot for recreational fishing that is in severe disrepair. The town plans to remove the lot and replace it with stabilized turf, a pervious surface that can

provide for overflow parking and possibly for recreation or public gatherings, but that allows for better drainage and reduces flooding risk by serving as a flood retention area to reduce risk to the residential areas. Bowers Beach is working with the Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife, to find funding for the project.

3.8.2. NEW CASTLE COUNTY, DE

Population Density	1246 per sq. mi.
Form of Government	City
Category	Suburban Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
62050	31439	64.1	538479	0.74	65.5	9%	38.4%	0.3

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
FEMA Cooperative Mapping Project	Completed	No	Procedural	Mandatory	Unique	Very Low (< $1,000)	FEMA
Freeboard - 1.5 Ft	Implemented	No	Accommodation	Mandatory	Unique	Very Low (< $1,000)	NA
Hazardous Materials Prohibited in Floodplain	Implemented	No	Prevention	Mandatory	Unique	Low (< $10,000)	NA
Floodplain Setbacks / Prohibits new subdivisions in floodplain	Implemented	No	Prevention	Mandatory	Above Required	Very Low (< $1,000)	NA

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POPULATION AND GEOGRAPHY

New Castle County, called the first county in the first state, encompasses the northern third of the State of Delaware. Its northern reaches include the cities of Wilmington and New Castle, and the southern half is largely rural and sparsely settled. Although the county is the smallest of the three Deleware counties, it has the highest population. The county is considered a part of the 6-million-person Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metropolitan Statistical Area and the Philadelphia-Camden-Vineland, PA-NJ-DE-MD Combined Statistical Area. I-95 and Amtrak's northeast corridor pass through the county. Delaware is known for its favorable corporate taxes and corporation laws, particularly in the banking sector. Many of these industries are clustered in Newark and Wilmington. The largest employer is home-town chemical company DuPont, followed by MBNA Bank. Hospitals and the University of Delaware are also large employers. Taxes and cost of living are generally low.

The northern boundary of New Castle County is the State of Pennsylvania. To the west, the county borders Maryland and to the south, the County of Kent. The Delaware River and the Delaware Bay separate the county from New Jersey to the east.

The county has a total area of 493.51 square miles of which 426.27 square miles is land and 67.24 square miles is water. Unlike all of its northern neighbors, the state of Delaware does not have all of its land divided into municipalities. As such, the county is an important governing body and has primary control over the use of a significant amount of unincorporated land. The county has its own extensive planning staff, comprehensive plan, and land use controls.

New Castle County has a population of just under 540,000 and is growing rapidly, with a growth rate of 7.23% from 2000 to 2010. Its diverse population is 38.4% minority. Median per capita income is just over $31,000 and median household income is $62,050. The county is a year-round community with very little seasonal housing and a mixed housing stock of rentals and owner-occupied residences.

COASTAL ISSUES

Coastal risks in New Castle are similar to those in the rest of the Northeast and include tropical and nor'easter coastal storms, inland flooding, wind, and shoreline erosion.

New Castle County has many types of land uses and various coastal hazard risks. Flooding is a significant problem in the county, with losses in the tens of millions of dollars annually. (New Castle County, Del., 2012, Comprehensive Plan) New Castle County's Comprehensive Plan focuses extensively on inland stormwater flooding, which the county has made significant strides in addressing through technology and regulatory tools. Much of New Castle's Delaware Bay shoreline is developed. The northern reaches, in particular, have extensive heavy industry along the immediate banks. This presents unique challenges to coastal adaptation. The County has considered this and modified requirements for the redevelopment of brownfields in floodplains. The City of New Castle, addressed separately in this report, has unique vulnerabilities as it is protected by a series of 300-year-old dykes that are in disrepair.

ADAPTATIONS

FEMA Cooperative Mapping

New Castle County sought and received a FEMA grant (passed through State of Delaware) to update the floodplain maps for the Red Clay, White Clay, and Mill Creeks. The FEMA floodplain maps for the entire County were updated on January 17, 2007.

Floodplain Setbacks

The county adopted the groundbreaking Unified Development Code in 1997 to establish zoning setback and use regulations. The county describes the code as providing "100% protection of floodplains, wetlands, riparian buffers and Class A wellhead water resource protection areas, as well as protection of various other natural resources which indirectly affect the quality of our water" (New Castle County, Del., Stormwater System). The code was further amended in 2003 by the Environment First Ordinance to further protect natural resources and allow flexibility in subdivision design to promote more environmentally sensitive development. The goal was to not allow degradation of water quality, to encourage open space linkages, and to improve maintenance requirements for homeowners associations.

The code prohibits development in any floodplain with few exceptions that include site design standards to minimize debris trapping and 18 inches of freeboard. It only permits field crops, orchards, pastures, ball fields, fishing areas, natural areas, and trails. Uses that are allowed pursuant to an Art. 10 permit include horticultural nurseries, golf courses, day camps, playgrounds, pools, and playing courts.

The code also defines Riparian Buffer Areas (RBA) as 100 feet on either side of perennial or intermittent streams, lakes, and tidal wetlands. Revegetation is required when development occurs in and around riparian buffer areas.

These provisions apply to new construction only. Reconstruction or repair of non-conforming structures is permitted, pursuant to specific standards specified in the code, including elevation of the structure 18 inches above base flood. (New Castle County, Del., Code, Sec. 40.10.313, 316, 317). The code also provides an exception for brownfield sites to encourage redevelopment of contaminated land.

Environment First is a series of requirements added to the UDC in 2003 that requires low-impact development; 50% open space required. With the addition of these new requirements, the county has a comprehensive stormwater management system.

Hazardous Materials Prohibited in Floodplain

The county has strong language in its flood law prohibiting the storage of hazardous materials in the floodplain.

> "The storage or processing of materials within the floodplain that are in time of flooding buoyant, flammable, explosive, or could be injurious to human, animal, or plant life, is prohibited. Storage of other material or equipment may be allowed

> if not subject to major damage by floods, if firmly anchored to prevent flotation, or if readily removable from the area within the time available after a flood warning" (Sec. 40.10. 311 (C))

It also prohibits the "maintenance, use, or sale of substances listed in 40 CFR 116..." in "floodplains, floodways, wellhead class A, B or C, the Cockeysville Formation, drainageways, recharge areas, steep slopes, critical natural areas, wetlands, riparian buffers and sinkholes, unless such substances are used in the process of public water supply and treatment and sewer treatment facilities" (Sec. 40.10.600 (B)) The prohibition includes all petroleum products. The only exception is for replacement of existing storage facilities, which are further restricted to only those upgrades required by law.

3.8.3. NEW CASTLE CITY, DE

Population Density	3.1/ sq. mi.
Form of Government	City
Category	Suburban Bayfront
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
56143	30553	62.3	5285	0.53	67.3	5%	35.3%	0.3

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Delaware Coastal Resiliency Action Plan	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	None
1 Ft. Freeboard	Implemented	No	Accommodation	Mandatory	Unique	Very Low (< $1,000)	None

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POPULATION AND GEOGRAPHY

New Castle is located on the Delaware River, about 10 miles south of Wilmington and 35 miles downriver from Philadelphia. The town was settled by Dutch colonists in 1651 with the construction of Fort Casmir by Peter Stuyvesant to gain control of the mouth of the river. After the English capture and renaming of the town in 1664, William Penn made New Castle the colonial capital and later the first state capital of Delaware. New Castle remained an important port and government center throughout this period, and the city grew extensively in the late 1700s. This Dutch colonial history foretells its current conundrum because the Dutch, being master hydrological engineers, settled a coastal site and built earthen levees to drain the marshes and establish a site to construct the city.

The city of New Castle has a population of 5,285 as of the 2010 census. Although its boundaries have been fixed and it has very little land left for development, it had experienced a slow growth rate of 0.53%. The city is 63% white and 35% minority. New Castle's median per capita income

is $30,553 and household income is $56,143. The homeownership rate is 62.3%. As the comprehensiv e plan describes, the city "should be rightfully proud of the historic downtown—a pedestrian-oriented precinct of unmatched physical beauty and architectural distinction."

COASTAL ISSUES

New Castle was built directly on the Delaware River shore, and a significant portion of the town was built in the floodplain, including portions of Buttonwood, Penn Valley, Van Dyke Village, and the downtown.

The historic downtown and neighborhoods are protected by three earthen levees built by the Dutch and Swedish settlers over 300 years ago. These dikes—the Buttonwood, Gambacorta Marsh Dike, and Broad Dike—are all in various states of

Figure 3.8.3:2 - Historic New Castle

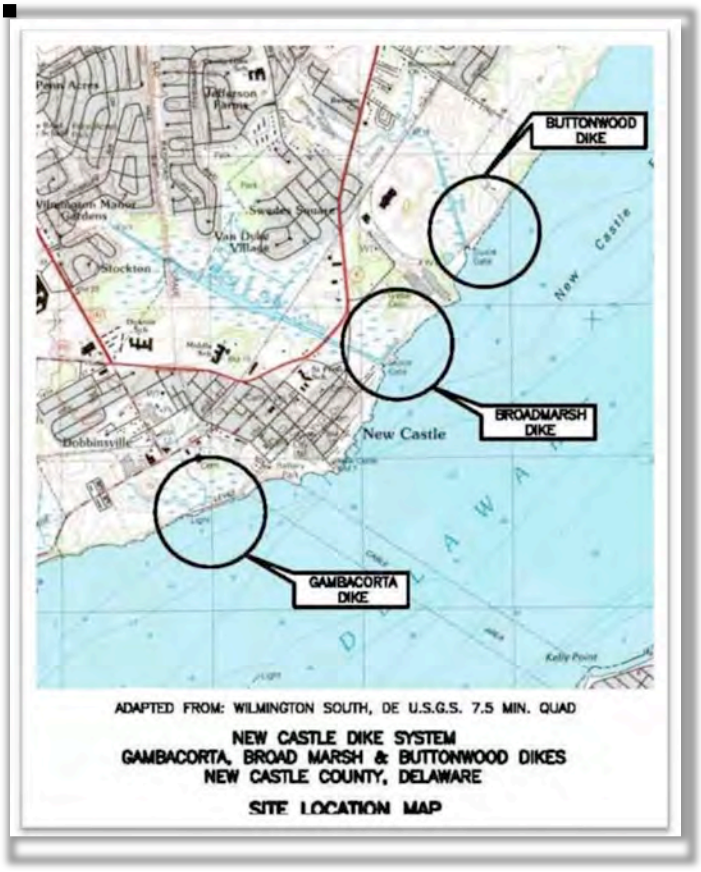

Figure 3.8.3:1 - Map depicting New Castle's Dike System

disrepair. The dikes are being compromised by trees and other vegetation growing on them, erosion, excavations, settlement, seepage, and other forms of instability, as well as by animals that have burrowed in to make homes.

The city is at risk from potential inundation from coastal flooding from waves, tides, and storm surge. The specter of dike failure is tangible, and made much more significant with the added risk of climate change and sea level rise. The tidal river has already overtopped the dikes 18 times in the past five years (Hurdle 2011). A particularly severe nor'easter in 2008 topped the Gambacorta Dike, although only a marsh behind the dike flooded, resulting in minimal property damage. Many residential and commercial structures are threatened by potential inundation as well as infrastructure such as Delmarva electric transmission lines, railroads, high-

pressure gas lines, and fiber optic cables. Rising sea levels will likely also impact pipes and storm drain channels as well as waste water pump stations, as in many coastal towns.

The city's dikes provide essential protection to the city from storms. According to the engineers who drafted the study, "Without these dikes, or in the event of dike failure, approximately 25 percent of the land in the City of New Castle boundaries would flood during high-intensity rainfall events, affecting homes, other commercial and industrial structures and properties" (Hurdle 2011).

The report highlights the fact that overtopping of the dikes would affect the city more severely than natural flooding because it happens with little or no warning and can be extremely damaging. In a 100-year flood, almost 200 structures are at risk, and a 500-year flood puts over 400 structures at risk.

Figure 3.8.3:3 - Broad Dike in New Castle, one of the four earthen dikes that protect the historic city

ADAPTATIONS

Coastal Resilience Action Plan

The State of Delaware Coastal Programs Section (DCP) of the Delaware Department of Natural Resources and Environmental Control is leading a multi-year Sea Level Rise Initiative to reduce its vulnerability. It is doing so by providing scientific and technical support for decision-making, educating the public, improving existing policies, and implementing on the ground projects in partnership with stakeholders, such as the city of New Castle's Coastal Resilience Plan.

The first step the city took in cooperation with DCP was to conduct a vulnerability study including a dike evaluation and assessment project. This led to the drafting of the Dike Management and Emergency Planning report in January 2011.

The study, funded by a Delaware Coastal Management implementation g rant from NOAA, presents a summary of findings of a physical assessment of the four dikes that protect the city, a summary of the risks of dike failure, emergency action plans and operation and maintenance plans for the dikes, and concept-level improvement recommendations. The concept-level planning to identify improvements to enhance flood protection includes a decision matrix for

each dike that compares order of magnitude costs for different levels of protection and the consequences of failure for each dike system.

A cost-benefit analysis was conducted to evaluate the feasibility of elevating the dikes to protect against a 100-year storm event. The analysis concluded that the damage reduction realized would significantly outweigh the cost to improve the dikes.

The study suggested a number of improvements be made to the dikes to ensure their effectiveness, including:

- Raise Dikes to Elevation 8.5 Feet
- Enlarge Dike in Portions (Raising and Broadening)
- Supplement/Replace Flood Side Rip Rap
- Remove Trees and Woody Vegetation
- Construct Filters on Seepage Areas
- Extend Dikes to Tie-Out as Required

The costs to implement the improvements were estimated to be about $1.5 million for each dike, and a number of permits would be required, including U.S. Army Corps of Engineers Section 10 and Section 404 permits, DNREC Wetlands and Sub-Aqueous Lands permits, NPDES Stormwater Discharge Associated with Construction Activity permits, and New Castle County Floodplain permits and site plan review, all of which may present regulatory challenges.

The city is moving toward implementation of the recommendations. It secured $3 million in state funds to spend on the repairs in 2013. It is in the process of deciding which specific aspects of the recommendations to implement. It will likely focus on removing trees and shoring up the structures. The city is also proposing installing new floodgates at existing road or rail culverts between the dikes and most buildings in the areas that would be flooded, treating the culverts as additional dikes.

The city would like to go beyond repairing the existing dikes and elevate them to protect against expected sea level rise. The report estimated that the cost of raising the Broad Dike to 100-year flood elevation is $0.8 million, although the cost-benefit analysis concluded that the economic benefits of improvements to the dike would be $72.6 million.

3.8.4. LEWES, DE

Population Density	742/ sq. mi.
Form of Government	City
Category	Suburban Bayfront
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
57225	37328	37.5	2747	0.05	89.8	2%	11.3%	40.8

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Climate Change and Hazard Mitigation Plan	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	Other
Establishment of Mitigation Planning Team	In Progress	Yes	Procedural	Recommendation	Unique	Low (< $10,000)	Other
Floodplain Ordinance - Hazardous Materials Prohibited and Dune Protection	Implemented	No	Accommodation	Mandatory	Above Required	Zero	Other
Higher Height Limits in Flood Zone	Implemented	No	Accommodation	Permissive	Unique	Zero	Other

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Figure 3.8.4:1 - Historic Downtown Lewes

Figure 3.8.4:2 - Lewes' Zwaandael Museum was constructed in 1931 and modeled on the town hall in Hoorn, Netherlands, to honor its Dutch heritage

POPULATION AND GEOGRAPHY

The City of Lewes, founded by the Dutch in 1631 and incorporated in 1818, is called "the first town in the first state" because it was the site of the first European settlement in Delaware. Lewes comprises an area of 4.3 sq. mi., 0.6 sq. mi of which is water.

Lewes was laid out at the strategic location of Cape Henlopen, where the Delaware Bay joins the Atlantic Ocean. The city is bordered by tidal wetlands, tidal creeks and tributaries, and has a 5-mile-long bayfront sandy beach. The topography ranges from sea level to 20 feet in some locations.

The town remains one of exquisite historic character, with a vibrant downtown and many historic buildings. The historic district, established in 1977 and expanded in 1992, comprises 629 buildings and sites. The number of historic buildings is a testament to the town's resiliency. Lewes hosts the oldest standing building in Delaware, the Ryves Holt House, which was built in 1655. In meetings conducted for the comprehensive plan process, residents identified core values that include its "special and historic relationship with the sea," "its humane town scale and sense of face to face intimacy that is characteristic of its quality of life," and "its unique historical

origins" which it strives to protect through building design and architectural preservation (Lewes, Del. 2005 Comprehensive Plan, p. 14).

The Chamber of Commerce bills Lewes as a year-round city, tough the town has a 40% seasonal housing stock. The answer to the question "What kind of community is Lewes?" was not completely clear. Some suggested answers during the comprehensive planning outreach include: an investment community, retirement community, working community, and bedroom community. Economic data suggest that the town is primarily a summer tourism destination with a high percentage of seasonal employment in the sales, lodging, and hospitality sectors (p.69).

However, only 48% of residents participate in the labor force, depicting Lewes' high percentage of retirees. The Comprehensive Plan depicts residents as "wealthier, more highly educated, less likely to be in the workforce, less likely to be disabled, and more likely to be self-employed than the general population" (p.70). What is clear is that Lewes residents care about their community. Civic engagement abounds on the many commissions, boards, and non-profit and civic groups in the city. Thirteen standing ad-hoc committees advise the city, including the Architectural Review Commission, Parks and Recreation Commission, Street Improvement Committee, Greenways and Trails Committee, Canalfront Advisory Committee, and Flood Mitigation Planning Team (p.21).

Lewes' year round population is 2,747 according to the 2010 census, with a density of 742 people per square mile. According to the Comprehensive Plan, summer weekends cause the population to grow 300 to 400%. Based on 2003 data, the City of Lewes had 11 inns and 12 bed-and-breakfasts with a total of about 384 rooms (p.68). The population is 89% white and has a median per capita income of $36,585. The median private home value is just over $700,000.

COASTAL ISSUES

As the City's Hazard Mitigation and Climate Change Adaptation Action Plan (2011) Climate describes, "The City Lewes has been and will continue to be directly impacted by natural hazards including storms, flooding/inundation and high winds" (p.6). As Wendy Carey of Delaware Sea Grant explained, "It seems that every year there is a new hazard that moves from the back of our minds to the front...there are a lot of hazards that occur here...such as the tornado associated with Irene that touched down right outside the city...we need to be proactive in addressing them" (Personal Communication)

Like elsewhere on the east coast, nor'easters and hurricanes can affect the mid-Delaware coast. Seventy-three tropical storms passed within 100 nautical miles of Lewes between 1842 and 2008. The most significant damage occurred in 1933, 1944, and 1956.

Yet the plan identifies nor'easters as the type of storm that has historically caused the most destruction. In Lewes, high tides and storm surge cause water levels to rise in Delaware Bay and the Lewes/Rehoboth Canal, which results in flooding of low-lying areas. The nor'easter of 1962 (also called the Ash Wednesday storm) caused the most damage of any historical storm in Lewes, when it stalled off the Delaware coast, pounding the city with wind and waves for five high-tide cycles. The Lewes/Rehoboth canal overflowed, which caused flooding in Lewes

Beach, and the tide at the Lewes Breakwater Harbor tide gauge registered a record 9.5 feet during the storm.

Two nor'easters in 1998 were also severe, when hurricane-force winds were recorded, the canal overflowed, and the gauge registered 9 feet. Damage was estimated at $1.3 million and $1.7 million for the two 1998 storms. Concerns in Lewes include coastal erosion along the Delaware Bay shore, as well as along some marshes and the edges of the Lewes/Rehoboth Canal. (p. 23)

898 out of 2,210 structures in Lewes are within the 100-year floodplain. The most severely impacted are homes along Lewes Beach, the Lewes/Rehoboth Canal, and Roosevelt Inlet. Also at risk is Cedar Avenue from Iowa Avenue to Illinois Avenue and the Market Street vicinity, which are in the city's AE zone. The city's wastewater treatment plant is located in this zone, as well as parts of the University of Delaware campus and the Coast Guard station. Some new post-FIRM construction has been in the AE zone, and the city has elevated eight structures with help from the FEMA hazard mitigation grant program.

ADAPTATIONS

Lewes Hazard Mitigation and Climate Change Adaptation Action Plan

Lewes has long taken an active role in planning for coastal hazards and it continued that tradition by drafting a proactive plan that addresses the impacts that climate change will play in exacerbating these risks in the future.

The project was a partnership between the City of Lewes, Delaware Sea Grant, and ICLEI-Local Governments for Sustainability. The project was funded by Delaware Sea Grant with funds from the NOAA Office of Sea Grant and the University of Delaware Sustainable Coastal Communities Program. The project, which integrates climate change adaptation information into hazard mitigation planning, is unique in that it explicitly recognizes "the threat climate change poses to hazard mitigation efforts."[6]

By engaging with local citizens, officials, and regional and state partners, it "helped the City of Lewes enhance local understanding of climate change and natural hazards impacts and begin devising strategies to build resilience towards these impacts" (p. ii).

The plan states "climate change will impact Lewes directly through continuous sea-level rise, increased coastal erosion, changes to wet/dry seasons that can cause both severe drought and higher volume precipitation and associated floods that impact both natural systems and the built environment" (p.13)

The specific goals of the project were to:

- Increase overall awareness of the threats from natural hazards and climate change and create outreach materials for City officials to keep citizens and others informed,

[6] Climate Change Plan, Preface

- Design a methodology that integrates climate change adaptation into hazard mitigation planning which will enable the City, in the future, to engage in a combined hazard mitigation and climate adaptation planning effort,

- Enhance the understanding of Lewes' vulnerability to climate change and natural hazards and identify data gaps related to natural hazards, climate change and associated threats,

- Utilize a prioritization system to select two to four climate adaptation/hazard mitigation initiatives from national best adaptation/preparedness strategies for coastal communities,

- Create a final action plan that the City can use to implement the chosen initiatives.

All potential actions were prioritized and ranked as detailed in the box below. The plan details specific implementation steps to effect each recommended action. The plan further stated, "It is important to note that many of these actions could help create a foundation towards other actions that were highly regarded by participants but that did not make the top of the list..." (p.49). Evaluating the vulnerability of infrastructure to flooding was given as an example, explaining that it could "help the city to incorporate climate change and natural hazard impacts into design, construction, operations and maintenance of these facilities" (p.53). The plan emphasized the reinforcing nature of many of these actions and the nature of each initiative to build on others.

LEWES CLIMATE CHANGE AND HAZARD MITIGATION PLAN
Potential Hazard Mitigation and Climate Change Adaptation Strategies

1. Planning Tools
- Integrate climate change and natural hazards into Local Comprehensive Plans
- Consider water resources in all planning efforts

2. Information Gathering Tools
- Survey of vulnerable homes based upon home heights
- Increase understanding of aquifer dynamics and amount of influence of recharge zones

3. Regulatory Tools
- Zoning and floodplain overlays
- Setbacks
- Water conservation requirements

4. Spending Tools
- Capital improvements
- Acquisitions of vulnerable lands

5. Tax and Market-Based Tools
- Additional financial incentives for building above the building code
- Stormwater utilities
- Beach nourishment tax district

6. Community Engagement Tools
- Improve outreach and education focused on successful behavior changes related to home building and retrofits
- Create water monitoring or storm monitoring programs that utilize citizens while also providing useful data to the City

7. Ecosystem-Based Tools
- Create buffer zones for inland migration of natural resources
- Restore the health of natural water purification systems

LEWES CLIMATE CHANGE AND HAZARD MITIGATION PLAN
Top Recommended Actions

Actions are listed in order of the scores that they received

1. Incorporate climate change concerns into the comprehensive plan and into future review of the building and zoning codes.

2. Improve outreach and education particularly focused on successful behavior changes related to home building and retrofits.

3. Ensure that aquifer information is integrated into all planning efforts. .

4. Use elevation data to determine road levels and evacuation risk.

5. Evaluate the City and the Board of Public Works (BPW) infrastructure's flood vulnerability from direct flood impacts as well as from indirect flood impacts to access routes.

6. Improve the City's level of participation in the community rating system (CRS).

In terms or taking steps to implement the plan, Paul Eckrich, the City Manager, said the city "picked the low hanging fruit" to begin. He said they reached out to community groups and conducted educational talks about climate change (Personal Communication, Aug. 29, 2012). In addition, the city is sending information about flood insurance to all rental homeowners. Outreach and participation has been a strength of Lewes and is a cornerstone of the implementation plan.

Establishment of Mitigation Planning Team

The Lewes Mitigation Planning Team was formed in 2002 by a former mayor and council members. Its mission was to maintain the disaster mitigation activities that began with the city's involvement with FEMA Project Impact. The team meets regularly to dialog and implement actions to reduce the city's vulnerability, and has had significant success in implementing projects throughout its history. It coordinates meetings with staff and other organizations.

Wendy Carey expressed the salience of the group and its role in continuing to keep Lewes among the leaders in adaptation planning. Having such a group, she said, is clearly a low-cost action that creates a space and place to get together, discuss, and make decisions on a regular basis. Interviewees thought one key to its success was having the mayor serve as chairperson, which demonstrates the city's commitment to the issue. The team will play an instrumental role in ensuring long-term implementation; it plans to track success of the projects and is considered the keeper of the action plan going forward (Personal Communication, Aug. 29, 2012).

Higher Height Limits in Flood Zone

Lewes does not have a mandatory freeboard requirement, but it does have a unique height limit exemption for properties within its coastal high hazard area flood zone. The height limit for residential structures in its R-2 and R-2(H) zones, formerly the LB - Lewes Beach District, and

the Coastal Flood Plain area on the northeast side of Lewes and Rehoboth Canal is permitted to 34 feet, 3 feet higher than in the city's other zones. The purpose of this exemption is to allow homeowners a buffer so they can elevate their homes to FEMA base flood elevations without running afoul of regulated height limits. (Lewes, Del., City Code §197-55)

C. Flood-prone areas:
(1) Applicability:
(a) R-2 and R-2(H) Zones (formerly LB-Lewes Beach District) located within the coastal high hazard area.
(b) Coastal Flood Plain Area and situate on the northeast side of the Lewes and Rehoboth Canal.
(2) Measurement. The vertical distance of a building measured from a point where the center line of the building to be erected intersects with the center line of the street on which the building will face to the highest point of the highest roof shall not exceed 34 feet for all lots created prior to and after September 14, 1987; provided, however, that any roof in the R-2 and R-2(H) Zone (formerly LB-Lewes Beach District) northeast of the Lewes and Rehoboth Canal shall have a minimum pitch of five inches of vertical rise for each 12 inches of horizontal run to the ridge of the greatest height of the roof.

Floodplain Ordinance – Prohibits Hazardous Materials and Protects Dunes

Lewes' floodplain ordinance prohibits the following in its high hazard area; many of these provisions also apply to the coastal floodplain area. (§197-73)

(1) Prohibited activities:
(a) Erection of any building or structure other than those specifically permitted or regulated.
(b) Placing, depositing or dumping of any solid waste.
(c) Any activity which involves the manufacturing, dumping, disposal or storage, except as authorized under the National Pollutant Discharge Elimination System, of pesticides, domestic and industrial waste, radioactive materials, petroleum products, except household storage, or other hazardous materials which, if flooded, would pollute coastal waters.
(d) The storage of materials or equipment which, if flooded, could be swept onto other properties.
(e) Any activity that will reduce the capacity of dunes existing at the time of legal adoption of this chapter to protect landward properties from storm-velocity waters.
(f) Building upon land within the reach of mean (average) high tide, except that piers, docks, wharves and harbor works shall be allowed as regulated uses.
(g) Fill for structural support.
(h) Mobile homes, except in an existing mobile home park or mobile home subdivision.

Lewes also protects its dunes with the following language:
[1] No part of an existing dune shall be removed or displaced to an extent that impairs its flood-hazard-protection qualities.

Dune disturbance is also prohibited by language in the high hazard zone prohibitions above.

3.9. MARYLAND

3.9.1. OCEAN CITY, MD

Population Density	1543/ sq. mi.
Form of Government	Town
Category	Seasonal Barrier Island
CRS Rating	7

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
55823	45317	8.5	7102	-0.1	92.2	6%	11.2%	74.2

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Beach Replenishment and Protection	Implemented	Yes	Protection	NA	Unique	NA	Other
Building Code and Foundation Requirements	Implemented	Yes	Accommodation	Mandatory	Above Required	NA	Other
Freeboard - 5 Ft	Implemented	No	Accommodation	Mandatory	Above Required	NA	Other
Hazard Mitigation Plan Incorporates SLR	Implemented	No	Accommodation	Mandatory	Unique	NA	None
Transfer of Development Rights Program	Implemented	No	Retreat	Mandatory	Unique	NA	Other

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POPULATION AND GEOGRAPHY

Ocean City's 2010 population was 7,102, but its summertime population is estimated between 320,000 and 340,000 on peak weekends. For the permanent resident population, median per capita income is $40,703 and median household income is $49,000. The homeownership rate among the year-round population is 79.6%.

Ocean City has a long history of development. The first lots were surveyed in the 1860s. A 400-room hotel opened in 1875, and a railroad was completed in 1878 across the Sinepuxent Bay. Since then the town has welcomed visitors, many of whom own condos and timeshares, largely from the Baltimore, Washington, Wilmington, and Philadelphia metropolitan regions. Over 8 million tourists visit Ocean City annually, which generates nearly $3 billion in revenue.

Ocean Cityis Maryland's only oceanfront municipality, and the only portion of the Maryland coast that is developed. It is described as "a flat, narrow strip of sand preserved by dunes, beach replenishment, and jetties" (Ocean City, Md., Hazard Mitigation Plan 2012, p. 21)

Its land area is a mere 4.6 square miles. The town is entirely located on a barrier island, Fenwick Island. Its northern border is the State of Delaware; otherwise it is completely surrounded by the Atlantic Ocean to its east and the Sinepuxent Bay to its west; on the south is the Ocean City inlet that separates it from Assateague Island.

COASTAL ISSUES

Ocean City is no stranger to storms and the risk from building on the coast. The All-Hazard Mitigation Plan focuses on coastal and tropical storms as the most cognizant threat, and states "nearly any part of town is equally vulnerable...oceanfront structures will endure high wind and waves...bayfront structures will see flooding and debris damage..." (p.21). SLOSH Modeling shows that a Category 1 hurricane would inundate 69% of the city, a Category 2 storm would inundate 79%, and a Category 3 or greater storm would inundate 100% of the city (p.36).

The Maryland Statewide Hazard Assessment calculates the annual risk of a tropical storm affecting ocean city at 0.368 events per year. The mean damage expected is $5.6 million. (p.36). Yet, in 127 years of record-keeping, Ocean City has never experienced a direct landfall of a hurricane. (p.38)

Major storms in the city's lore include the 1933 hurricane and 1962 nor'easter as well as Bob, Gloria, and Danielle in 1992. Floyd in 1999 caused a lot of rain and Isabel in 2003 caused significant flooding (p.39). A major boom in development occurred throughout the 1970s and 1980s, creating the significant high-rise skyline that characterizes the city today. However, in recent years Ocean City has taken significant steps to scale back development, create and preserve dunes, and establish strict building standards to enhance its resiliency and sustainability. All of Ocean City is in the V, A, or AO flood zone. Ocean City contains 49% of the flood policies in the State of Maryland. 27,476 individual properties are insured, and the total coverage of flood insurance is more than $4.5 billion.

Town Engineer Terry McGean explains that the issue of sea level rise is of definite concern, but he said "even before SLR became a big issue...we were dealing with storm protection and erosion..." (Personal Communication, Aug. 23, 2012). A major hurricane hit in 1933, which created the inlet that now separates Ocean City from Assateague Island (Ocean City, Md. 2012, Hazard Mitigation Plan p.38).

ADAPTATIONS

Beach Replenishment and Protection

Because Ocean City's entire eastern flank is exposed Atlantic shore, beach replenishment program is considered the city's primary storm protection. In 1992, the Atlantic Coast of Maryland Shoreline Protection Project was completed at a total cost of $45 million, which was shared by the federal government, the State of Maryland, Worcester County, and the Town of Ocean City. Although this could not be called a low-cost climate change adaptation, the incorporation of sea level rise into the design of the beach replenishment program is was not an expensive proposition. Town Engineer Terry McGean said that cost estimates for maintenance of the beach were set up to consider sea level rise in the calculations.

Figure 3.9.1:1 - This image clearly depicts Ocean City's build-to line and reconstructed dune enabled by the TDR program and beach replenishment project

The project, initiated in 1993, also had other climate-adaptive regulatory components. It included a new sheetpile seawall of a section of the beach which has a boardwalk; construction of a 220 ft. wide beach, and restoration of a 25 foot wide vegetated dune.

The town had established a strictly enforced build-to line in the early 1970s, which was

generally located at the historic extent of eastward development. Some buildings became non-conforming and many lots became unbuildable. That line is fixed in perpetuity, regardless of how much sand was pumped and how wide the beach became due to replenishment.

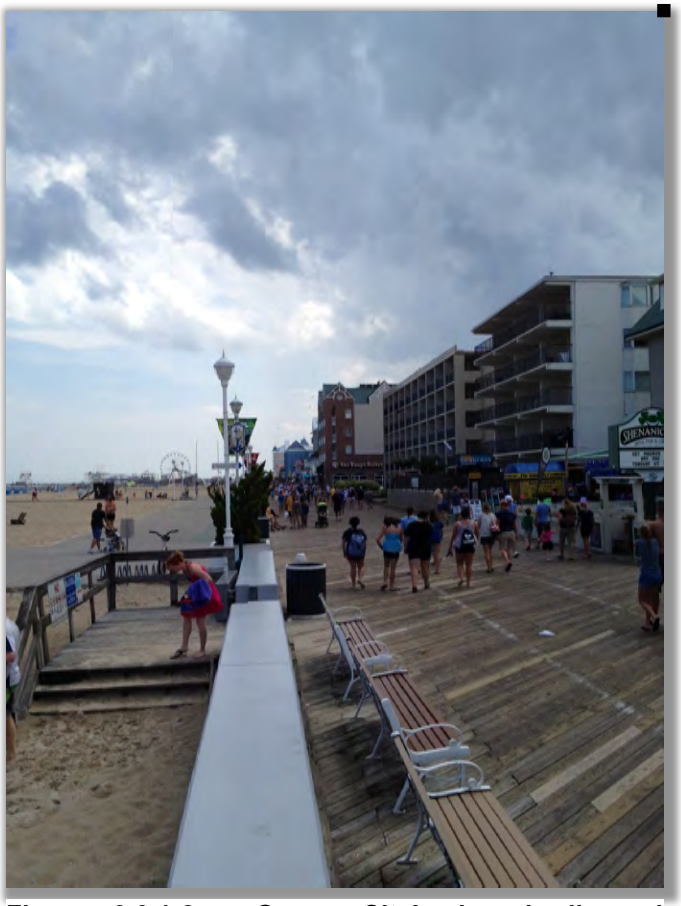

Figure 3.9.1:2 - Ocean City's boardwalk and recontructed seawall

Building Code, Freeboard and Foundation Requirements

The town joined NFIP in 1971 and, of the 6,300 structures in town, 4,733 were built after that date and meet elevation and construction standards. Town Engineer Terry McGean explained that the city's other regulations, including freeboard and special foundation regulations, help protect the city from the expected impacts of climate change. "So while the two feet of freeboard and the other things we require are storm based, they help us deal with sea level rise," he said. (Personal Communication, Aug. 23, 2012)

Ocean City also requires heavier and deeper foundations for buildings in the V zone. Wood pilings are prohibited and buildings are required to be supported by reinforced concrete piers or concrete foundations that are constructed to 8.5 feet below sea level. Ocean City also maintains stricter freeboard requirements than required by FEMA. Construction in the V zone is required to meet an elevation standard of 16.5 feet above mean sea level. Most other structures in the flood hazard zones are required to be elevated two or three feet above BFE.

Although the city is now taking aggressive measures to protect itself in the face of an uncertain future and circumstances created by decisions made in the past, perhaps the most prescient law was passed in 1972. At that time, the city established a build-to line, which was a city law and was later codified as state law. It has been strictly enforced since then, even though beach replenishment has widened the dry sand area. However, it was the 1993 beach replenishment project that formally extinguished landowners' rights east of the building line and allows the city to reconstruct a protective dune in front of the building line.

McGean's greatest concern was with the bayfront. The city has over 500 storm drain outfalls, he explained, and no pumping facilities. He said bayside flooding is just a nuisance now, but he is concerned with what might happen with sea level rise. "The only thing you can do is raise the bulkhead and build pumping stations...and you wind up like New Orleans," he said. He was

interested in what other towns in similar circumstances with concerns about their bayfront were doing to handle the issue.

Hazard Mitigation Plan Incorporates Sea Level Rise

The Ocean City All Hazards Mitigation Plan was updated in 2011. The plan also serves as the town's FEMA required floodplain management plan. The Hazard Mitigation Plan acknowledges the impact of climate change: "The effects of global warming, sea level rise and land subsidence will potentially exacerbate the severity of coastal storms and flooding." The plan reports that sea level has risen a foot since the beginning of the 20th century and is predicted to rise an average of two or more feet in the next century.

The plan describes the following effects of sea level rise: "Increased coastal flooding, submerging of coastal wetlands, increased shoreline erosion, and structural damage to unprotected structures...Coastal storm surge could become higher and more intense rainfall could raise the potential of flooding.." (Ocean City, Md. Hazard Mitigation Plan, p.22). Specific measures listed to decrease losses include elevating streets, improving bulkheads, and constructing buildings at higher elevation.

Transfer of Development Rights Program

Blaine Smith explained that there was intent to acquire the property at the time the town established the line, but the city did not have the money to proceed with condemnation actions. The federal government forced the issue upon the town, because acquisition of easements was a precondition to the receipt of funds for beach replenishment in 1993.

Facing the potential for enormous bills to compensate landowners for the acquisition of the easements, the town created an innovative Transfer of Development Rights program to compensate owners for private property taken to construct the dunes in areas north of the city's boardwalk and seawall.

The program allowed landowners to sell development rights to developers or owners in a receiving district. The town used the comprehensive plan to determine where to establish the receiving zones, which was created using an overlay district in the highest density zones. To encourage a market for the credits, a 25% density bonus was permitted for any project that used TDRs. One development right was awarded for every 500 square feet of land area in the sending district.

The program was a success. It was extensively used by property owners and more than 400 rights were transferred; about 70 rights remain. The value of the development rights has varied with the market, proving that the credits truly represented value. Some property owners received up to $2.5 million for their credits and the city succeeded in taking control of the beach beyond the build-to line, which allowed it to construct the wider beach and dunes.

The program was low-cost in that it saved the city millions of dollars in land acquisition costs and cost the city nothing but a small amount of staff time to administer the project. Mr. Smith said, "Other than some administrative costs, it almost cost the city nothing" (Personal Communication, Aug. 23, 2013)

Although many municipalities fear the complexity of a TDR system, Ocean City proves that it does not need to be complicated. "We tried to keep it as simple as we could...we just issued pieces of paper that we made on our computer...we don't get involved with the money and transactions...it gets assigned with the deed." TDR programs also have challenges when the value of the credits is uncertain or if the market is weak. That was not a problem in Ocean City and in most coastal areas, as property values tend to be high.

The Beach Transfer Program is essentially a TDR established to enforce a retreat strategy. Many communities now facing sea level rise and looking to retreat from the shore should look to Ocean City's low-cost regulatory system to extinguish rights to property landward of the mean high water line." It should be considered a model for communities considering retreat strategies under the threat of climate change today."

3.9.2. SOMERSET COUNTY AND CRISFIELD, MD

SOMERSET COUNTY, MD

Population Density	82.8/ sq. mi.
Form of Government	County
Category	Rural Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Minority	% Seasonal Housing
41420	17599	66.6	26470	-0.5	54.7	48.8	7.8

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Maryland Coast Smart Rising Sea Level Guidance Study	Completed	Yes	Procedural	Recommendation	Unique	Medium (<$100,000)	NOAA, State

CRISFIELD, MD

Population Density	1078.8/ sq. mi.
Form of Government	City
Category	Rural Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Minority	% Seasonal Housing
26988	20514	34.3	2726	-0.33	59	42.9	10.2

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Freeboard - 2 Ft	Implemented	No	Accommodation	Mandatory	Unique	Zero	None
Maryland Coast Smart Rising Sea Level Guidance Study	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	NOAA, State
Comprehensive Plan Incorporates SLR	Completed	Yes	Procedural	Recommendation	Unique	Zeronumbers	None

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POPULATION AND GEOGRAPHY

Somerset County has a population of 26,470 as of 2010 and a population density of 81 people per sq. mi. The population is 54.7% white and 42.5% black. The Asian population is less than 1% and the Hispanic population is 3.3%. Median per capita income is $16,191 and median family income is $42,443. The homeownership rate is 67%. The City of Crisfield has a population of 2,726. It has a homeownership rate of 43%. Its population is 59% white and 36% black and 3.7% Hispanic of any race. Median per capita income was $39,046.

Somerset County is located in the southwestern part of Maryland's Eastern Shore. It comprises an area of 611 sq. mi.—327 sq. mi. of land and 283 sq. mi. of water. It is bordered by Accomack County, Virginia, to the south, Wicomico County to the north, and Worcester County to the east. It is located to the southwest of Salisbury, MD. The county seat is Princess Anne. It is a largely agricultural county with concentrations in the poultry and seafood sectors. Sysco Food Services is one of the largest employers, with more than 750 workers. The University of Maryland Eastern Shore is also located in the county.

The City of Crisfield is one of two incorporated municipalities in the county. It is the southernmost municipality in the State of Maryland. Its legendary seafood and fishing industry has declined somewhat due to pollution and overfishing, while tourism has replaced some of the resource-based economy. It has an area of 3.0 square miles—1.6 sq. mi. is land and 1.4 sq. mi. is water. The city is located on the Tangier Sound, coterminous with the Chesapeake Bay. It is also bordered by the Pokomoke River and has an important commercial fishing industry, long been referred to as "The Crab Capital of the World."

Figure 3.9.2:1 - Crisfield's website depicts its status as the crab capital of the world.

COASTAL ISSUES

Somerset County contains 619 miles of shoreline and 30,000 acres of tidal wetlands. A number of rivers, such as the Pocomoke and Wicomico, are completely tidal, and almost all of the waterways in the county are tidal for several miles. Historical development occurred on these tidal reaches, making the county's population vulnerable to coastal flooding and the expected impacts of climate change and sea level rise. 58% of the county is in the 100-year floodplain. A three-part special cover series documenting the issue of sea level rise ran in *The Daily Times,* the local newspaper based in Salisbury, MD, the week of our visit. One article specifically addressed Somerset.

"Mayor Percy 'P.Jay' Purnell said the effects of rising sea level are obvious. 'I can see it because of the level of flooding...the water is higher, quicker and it stays longer." He went on to further state "while flooding from the waters of the Tangier Sound was always common during hurricanes and nor'easters, it has become a regular occurrence during unusually high tides." of particular concern are the decimation of offshore islands in the Chesapeake Bay. The article said at Janes Island and Old Island are "washing away." The Mayor said "we are only a year or two away from a wash-through at Old Island" (Holland, 2012).

Mr. Marshall said that the coverage in the local paper has raised awareness in the county, but not among the general public. "I go to a coffee club, and ever since that article came up in the paper, I just been hearing people laughing...a lot of people do not believe SLR will happen" (Personal Communication, Aug. 24, 2012).

Despite the skeptics, the knowledge that land is being lost to the sea appears widespread in these parts. Another article in *The Daily Times* series details the concern about loss of marshland. "Sea level rise is a reoccurring nightmare for the people, environment, and species of Wicomico, Dorchester and Somerset counties...At the 28,000 acre Blackwater National Wildlife Refuge, scientists estimate...an acre of marsh is lost every day... 3,000 acres a year in recent years, and 8,000 acres since 1938" (Montgomery and Murray 2012).

The article details the reason Cheseapeake Bay is particularly at risk: a relatively shallow tide of about 2 feet limits flushing, causing the marshes to be more subject to strain during times of drought. McCall was quoted as saying, "It's the first line of defense for our communities...any time a storm comes through, the marshes that stand between the water and the community play a vital role in helping the community adapt...without the buffer...the community becomes more vulnerable" (Montgomery and Murray 2012).

ADAPTATIONS

Maryland Coast-Smart Communities Rising Sea Level Guidance Study

Somerset County received a grant through Maryland's Coast-Smart Communities Initiative program to assess the county's vulnerability to climate change and develop a plan of action to prepare for those impacts. The county reviewed existing plans, development codes, regulations, and laws to ensure the necessary policies and codes were prepared for the reality of the county's climate future, specifically addressing sea level rise and coastal storms. The county developed

Somerset County, Maryland: Rising Sea Level Guidance, which included a vulnerability assessment as well as recommendations on how to adapt the county's management and codes to best prepare for climate change.

In 2009, Maryland launched the Coast-Smart Communities Initiative to provide a support center for local governments dealing with the impacts of climate change. The Coast-Smart Initiative undertook three initial projects in Somerset, Worchester, and Dorchester counties, some of Maryland's most at-risk coastline areas. The Coast-Smart program provided financial support for the county's adaptation planning processes through the Coastal Communities Initiative (CCI) grant program, as well as much-needed technical support.

The county conducted a vulnerability assessment to consider how sea level rise, coastal storms, and flooding will likely impact the county's population, housing, infrastructure, and critical facilities. Based on the analysis, the county proposed a number of changes to existing planning and regulatory policies, including the Zoning Ordinances, Floodplain Management Ordinance/Building Code, Subdivision Regulations, Comprehensive Plan, and Hazard Mitigation Plan.

However, county planner Bob Callander expressed some reservations about the project. He was disappointed that they only modeled one foot of sea level rise based on historical data and said that none of the recommendations had been adopted. The report was presented to the county commission and the planning commission, but very little happened. Shortly thereafter staff went to the county commission to propose a county freeboard requirement of 3 feet, and it was denied.

Mr. Cadwallader said that the project has raised awareness in the planning department but had little impact on the general public. Other ad-hoc actions were taken, such as elevating the generators above 10 feet at the local hospital and putting in place evacuation plans to move patients to other regional facilities. Many of these evacuation plans were put in place successfully during Hurricane Irene in 2011.

The county also has a Critical Area Law in its zoning ordinance, which is the implementation of the Maryland state law.

Crisfield – 2 Foot Freeboard and Zoning Ordinance

The City of Crisfield has a 2-foot freeboard requirement. Crisfield's zoning also attempts to incorporate flood mitigation and resource protection in significantly limiting development in sensitive areas. Although these regulations represent Crisfield's implementation of Maryland's Critical Areas Law, Crisfield's zoning is an exemplar of regulations designed to prevent further degradation of the natural environment and decreases risk from future sea level rise.

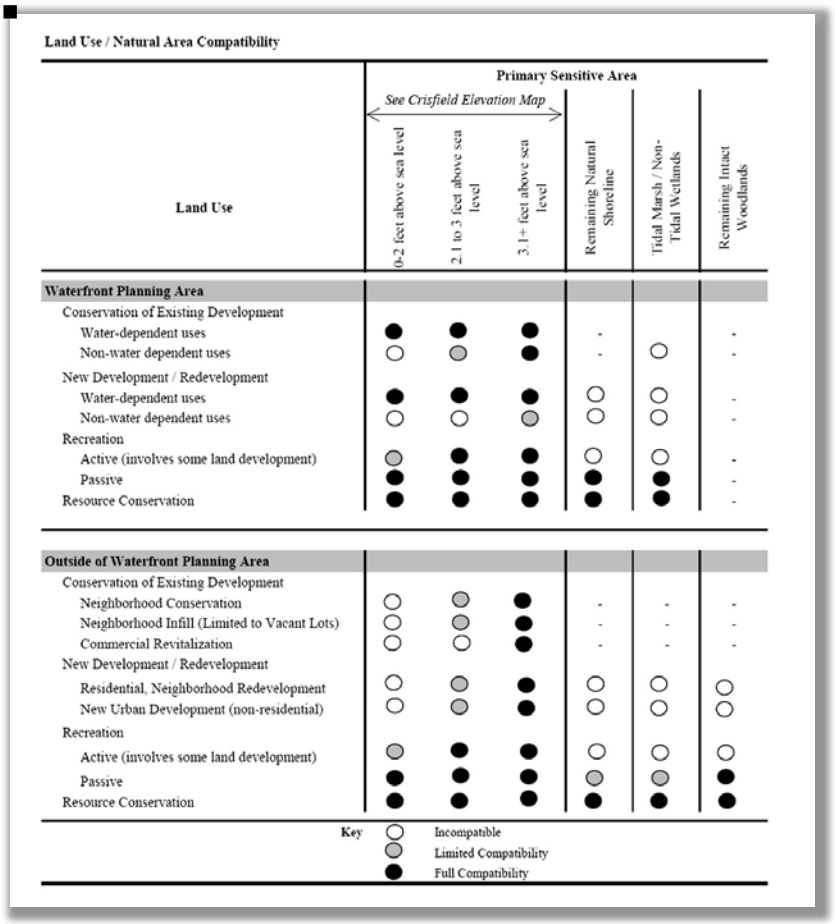
One interviewee pointed out the challenges to implementing new regulations, indicating the short time-horizon of elected officials is a challenge. The Somerset County and Crisfield staff thought that new laws are more likely to be effective if mandated by the state but implemented with a local component and extensive education and outreach efforts. The key to effective implementation of regulations, they indicated, is partnership and not mandates.

Crisfield – Comprehensive Plan Incorporates Sea Level Rise

Sea level rise was incorporated into Crisfield's recently adopted comprehensive plan: (Crisfield, Md. Comprehensive Plan 2010)

> "Sea level rise is a significant factor to consider with regard to the region's vulnerability to coastal flooding. Tide gauge records for the last 100 years show that the historical rate of sea level rise in Maryland has been between 3-4 mm per year or about one foot per century; a rate nearly twice the global average. Current scientific research, however, indicates that sea level rise rates are accelerating and may result in as much as two to three feet of rise along Maryland's shores by the year 2100. Sea level rise can influence and exacerbate coastal flood events. As sea level rises even in very small increments, storm surges heighten and extend further inland. In low-lying coastal areas, like Crisfield, a one-foot rise in sea level could translate into a one foot rise in flood level, intensifying the impact of flooding and storm surge to homes, businesses, institutions, and roadways."

Crisfield's comprehensive plan land use categories, which comply with Maryland's Critical Areas Law, were developed in consideration of existing shoreline conditions, potential exposure to flooding risks, and elevation to determine what development is permitted.



Land Use / Natural Area Compatibility

Land Use	Primary Sensitive Area (See Crisfield Elevation Map): 0-2 feet above sea level	2.1 to 3 feet above sea level	3.1+ feet above sea level	Remaining Natural Shoreline	Tidal Marsh / Non-Tidal Wetlands	Remaining Intact Woodlands
Waterfront Planning Area						
Conservation of Existing Development						
Water-dependent uses	●	●	●	-		-
Non-water dependent uses	○	◉	●	-	○	-
New Development / Redevelopment						
Water-dependent uses	●	●	●	○	○	-
Non-water dependent uses	○	○	◉	○	○	-
Recreation						
Active (involves some land development)	◉	●	●	○	○	-
Passive	●	●	●	●	●	-
Resource Conservation	●	●	●	●	●	-
Outside of Waterfront Planning Area						
Conservation of Existing Development						
Neighborhood Conservation	○	◉	●	-	-	-
Neighborhood Infill (Limited to Vacant Lots)	○	◉	●	-	-	-
Commercial Revitalization	○	○	●	-	-	-
New Development / Redevelopment						
Residential, Neighborhood Redevelopment	○	◉	●	○	○	○
New Urban Development (non-residential)	○	◉	●	○	○	○
Recreation						
Active (involves some land development)	◉	●	●	○	○	○
Passive	●	●	●	◉	◉	●
Resource Conservation	●	●	●	●	●	●

Key: ○ Incompatible; ◉ Limited Compatibility; ● Full Compatibility

Figure 3.9.2:2 - Crisfield's Comprehensive Plan Land Use Categories

3.9.3. WORCESTER COUNTY, MD

Population Density	109 / sq. mi.
Form of Government	County
Category	Seasonal Ocean and Bayfront
CRS Rating	Not Participating

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
55769	32936	29.5	51454	1.01	82.0	3%	19.7%	49.5

Adaptations	**Status**	**Incorporates CC**	**Type**	**Impact**	**Standard Costs**		**Funding Source**
Comprehensive Plan - Incorporates Climate Change	Completed	Yes	Procedural	Recommendation	Above Required	NA	State, Other
Freeboard - 2 Ft.	Implemented	No	Accommodation	Mandatory	Unique	Zero	None
Hazard Mitigation Plan - Incorporates Sea Level Rise	Completed	Yes	Procedural	Recommendation	Above Required	NA	Other
Preservation of Assateague Island	Implemented	No	Retreat	NA	Unique	NA	Other
Worcester County Sea Level Rise Response Strategy	Completed	Yes	Procedural	Recommendation	Unique	Very Low (< $1,000)	None

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POPULATION AND GEOGRAPHY

Worcester County, Maryland, stretches the length of Maryland's Atlantic Ocean shore, from Ocean City to Assateague Island National Seashore. The county borders the Atlantic Ocean on its east, Somerset County on its west, Wicomico County to the northwest, the state of Virginia on its south, and Delaware on its north.

As with the rest of the Delmarva Peninsula, the county is mostly level terrain. It ranges from sea level to 49 feet at its highest point. The population of the county was 51,454 as of 2010, comprising an area of 695 square miles (229 sq. mi. of which is under water). There are 109.9 people per square mile. The population is 83% white, 13.9% black, and 3.3% Latino of any race. Median per capita income was $31,520, household income was $55,487, and 121 building permits were issued in 2011.

Worcester's comprehensive plan describes the county in this way:

> [I]t would be difficult to find a similar seaside county with a premier family resort, compact communities served by near-by shops and stores all of which are bounded on the west by rich working farms and woodlands and on the southeast by wild barrier island parks. Blessed with such richness and diversity, Worcester County faces a challenge to continue its high quality of life (Worcester County, Md., Comprehensive Plan p.1).

Worcester's barrier island environment evidences perhaps the most dramatic contrast between development and preservation anywhere on the East Coast. The northern portion, consisting of Ocean City, is an entirely built-out environment complete with miles of high-rise hotels, all-you-can-eat seafood buffets, and miniature golf courses. This concentration of tourist facilities represents the largest component of the county's economy, employing over 60 percent of the county's labor force (p.2).

The southern portion—Assateague Island National Seashore— is nearly entirely undeveloped. The mainland part of the county remains largely sparsely settled and agricultural. This dramatic contrast is also evidence of the shifting "planning philosophy [which] evolved from a development emphasis to a priority on resource conservation and protecting its rural and coastal character" described in Worcester's Comprehensive Plan (p.2). Planning for the future in Worcester focuses on preserving its assets and minimizing development in sensitive and vulnerable locations.

COASTAL ISSUES

The meteorological history of Worcester County had a major influence on its land use trajectory. In 1933, a major hurricane battered the coast and cut an inlet near the southern boundary of Ocean City. The inlet was prevented from filling in by the natural littoral drift through the construction of jetties and dredging. That storm also seriously damaged Ocean City.

It was the 1962 nor'easter, however, that changed the trajectory of land use on Assateague. The storm caused extensive damage to much of the housing stock on the island and set in motion the eventual establishment of the National Seashore.

Worcester County's numerous tidal rivers, creeks, and bays are highly vulnerable to inundation and will become more so according to sea level rise projections. The Comprehensive Plan describes the direct impacts of sea level rise in Worcester County to include inundation of wetlands and lowlands; accelerated coastal erosion; increased flooding; raised water tables; and increased salinity of bays, rivers, and aquifers. The Maryland Department of Natural Resources determined that the storm surge from Hurricane Isabel in 2003 was one foot higher than the 1933 storm because of the higher sea level.

The *Worcester County Sea Level Rise Response Strategy* details which areas of the county are most vulnerable to flooding and erosion and will be the most significantly impacted. Ocean City is clearly at risk, and their adaptations are dealt with separately in this report. Worcester County's Snug Harbor neighborhood experiences repetitive flood losses, and is predicted to be "permanently inundated without protection measures" according to the sea level rise guidance document" (Worcester County Sea Level Rise Response Strategy (2008), p.18). The neighborhood of Ocean Pines, with 15,000 residents, was built on filled wetlands and is also at serious risk.

The county has 44 repetitive loss properties, representing 12% of all the repetitive loss properties in Maryland. Other areas that flood frequently include Western Berlin, Pocomoke River floodplains in Snow Hill and Pocomoke, Porter Crossing Road Bridge, and Whiton Crossing Bridge. Worcester has a history of planning leadership and its planned adaptations demonstrate it is taking these threats seriously.

Assateague Island National Seashore

Although not a recently implemented adaptation—and one that is certainly not low-cost and therefore quite distinct from the other types of projects profiled in this report—the preservation of Assateague Island merits attention here. Assateague Island, now populated only by its famous ponies, was once settled and platted for intense development.

Notions of preserving Assateague circulated in Congress as early is 1920, but pressure from developers did not subside after World War II. Leon Ackerman led a group of Baltimore and Washington investors in acquiring and subdividing 15 acres just north of the Virginia line, which he named Ocean Beach. Full-page ads coaxed 3,200 investors across the newly opened Chesapeake Bay Bridge to purchase almost 6,000 lots, and 30 homes were constructed. But a devastating nor'easter hit on March 6, 1962. Dunes were destroyed and the wind and water razed all but 16 cottages in the most protected bayside locations. The protective dunes were severed in many places, high winds and water destroyed all but the sturdiest structures, and the road was washed out and buried.

According to Barry Macintosh, "The storm, which had undone much of the development for which Assateague had been discounted in the 1955 National Park Service survey report and which augured ill for future private investment, galvanized Secretary of the Interior Stewart L. Udall to revive the prospect of Federal acquisition" (Macintosh 1982). The federal government subsequently recommended establishing a national seashore and purchasing the privately held land from lot owners.

At the time, Worcester County officials and most property owners were opposed to the concept of a federal government–owned seashore. Instead they had a vision for a residentially developed island. A document prepared by the county testified to its stance: "Worcester County does not believe that it is necessary or that it is warranted that the Federal Government condemn Assateague Island for a Federal recreation project, and does not believe that it would become anything but a barren wilderness useful only to bird watchers..." Today, it seems impossible to imagine this pristine stretch of barrier island as anything else. It deserves mention as a farsighted, critically important adaptation to climate change for Worcester County.

Worcester County Sea Level Rise Response Strategy

Research on the impact of sea level rise on Maryland's shore has significant historical precedent. In 2003, the Maryland Department of Natural Resources (DNR) developed a sea level rise inundation model using methods originally derived by the U.S. Geological Survey for the Blackwater Wildlife Refuge in Dorchester County, MD. Worcester County was chosen as the pilot county because LIDAR data had been completed in 2003 as well as numerous policy objectives that specifically targeted the area, such as the Coastal Bays Hazard Initiative.

A sea level rise inundation model and report was drafted by the Maryland Department of Natural Resources and the U.S. Geological Survey in November 2006. The report was partly funded by the Coastal Zone Management Act. Beatley (2009) also interviewed and documented Worcester County's extensive efforts to work toward coastal resilience.

The Worcester Sea Level Rise Response Strategy was completed in 2008, supported by a grant from DNR. The report modeled sea level rise for the years 2025, 2059, and 2100 and used three scenarios: steady state, average accelerated, and worst case. These scenarios allowed the county to understand projected impacts from extrapolated existing conditions to the most drastic potential. The report includes a vulnerability analysis, potential response options, and a chapter on priorities for sea level rise response, including setting criteria for prioritization and a ranking

matrix. It addresses adaptation options for existing development, future development, infrastructure, and natural systems.

The report makes specific suggestions for application of the adaptation principles to Worcester County and describes methods for integration with existing codes and plans. The Comprhensive Plan supports the sea level rise plan by designated large tracts of sensitive coastal land as conservation. Worcester's sophisticated planning limits sprawl by maintaining compact communities surrounded by agricultural and natural lands. This strategy comports well with projected sea level scenarios, since the plan reports that 30% of the property parcels projected to be 100% inundated by the worst case scenario in 2100 do not currently house any structures. (Worcester County Sea Level Rise Response Strategy (2008) p. 24). Growth for 18,000 new residents will be located in designated growth areas by infilling existing communities.

The plan also lays out a sophisticated set of criteria for prioritizing responses, which demonstrates sensitivity to the complex land use, political, and economic environment for adaptation strategies. The criteria include legal authority; institutional feasibility, consistency with community vision, political feasibility, expected benefits and costs, minimizing opportunity costs, urgency considerations, impact on environmental quality, equity impacts, demonstrated effectiveness, and potential resource availability. The plan overall positions Worcester with extensive knowledge on the potential use of different tools and their likely effectiveness given the unique circumstances, existing conditions, and regulatory systems already in place in the county.

SEA LEVEL RISE RESPONSE STRATEGY ACTION RECOMMENDATIONS
Adaptation for Existing Development

Protection Options
Structural Protection
Non structural protection

Accommodation Options
Rolling Easements
Elevation and Floodproofing Retrofits
Restrictions on Septic Tank and Hazardous Materials Storage

Retreat Options
Property Acquisition and Relocation
Redevelopment Restrictions
Setbacks and Buffers
Downzoning and TDR
Property and Easement Acquisition
Restrictions on Public Facilities and Infrastructure

Adaptation for Future Development
Protection
Accommodation
Temporary or Movable Structures
Elevation and Floodprooding Requirements
Subdivision Control

Comprehensive Plan – Incorporates Climate Change

The Comprehensive Plan for Worcester County, adopted by the County Commissioners on March 7, 2006, focuses development on smart-growth locations in existing towns and cities and away from coastal hazards and floodplains. Although historical precedent has placed a large portion of development in hazardous areas, existing development is highly concentrated in Ocean City, adjacent areas of the mainland called West Ocean City, and in the historic towns of Berlin and Snow Hill. The plan states that one of its "fundamental purposes is to continue the county's concentrated development pattern" (Worcester County, Md. Comprehensive Plan 2006 p.3)

The plan's goal statement is as follows:

> This plan's goal is to maintain and improve the county's rural and coastal character, protect its natural resources and ecological functions, accommodate a planned amount of growth served by adequate public facilities, improve development's compatibility and aesthetics, continue the county's prosperous economy, and provide for residents' safety and health (p.7).

The county's objectives for floodplain protection are:

- Limit development in floodplains.
- Reduce imperviousness of existing and future floodplain development where possible.
- Preserve and protect the biological values and environmental quality of tidal and non-tidal floodplains, where reasonable and possible to do so.

FLOODPLAIN MANAGEMENT RECOMMENDATIONS

1. Work with federal and state federal agencies to update the county floodplain maps, with first priority being areas that are mapped as 100-year floodplain without base flood elevation established.
2. Limit new development and construction in the floodplain. 33 Ibid.
3. For new development, encourage the dedication of 100-year floodplains (not including wetlands) to open space.
4. Promote uses, such as golf courses, open space easements, natural areas, and recreational open space to reduce impervious surfaces in floodplains.
5. Work to acquire properties in the 100-year floodplain, and return them to a natural state.
6. Reevaluate the effectiveness of the current floodplain protection regulations.
7. Discourage the location of new homes and roadways in the "V" or wave velocity zone and the 100-year floodplain.
8. Complete and implement a hazard mitigation plan for flooding, wildfire, and other natural hazards.
9. Develop and implement a post disaster recovery and reconstruction plan to facilitate recovery and to reduce exposure to future disasters.
10. Consider participating in the Community Rating System Program, to receive flood insurance premium credits. To participate, the flood program must address public information, mapping, regulation; flood damage reduction; and flood preparedness.
11. Consider code changes that will limit impervious surfaces.
12. Develop a sea level rise response strategy (include a two foot free board requirement for properties exposed to flooding) and discourage shoreline hardening.

The plan specifically addresses sea level rise by calling for the development of a sea level rise response strategy, and includes a 2-foot freeboard requirement for properties exposed to flooding and to discourage shoreline hardening. The county also plans on using the updated models and data generated in the Sea Level Rise Response Strategy in the next iteration of the comprehensive plan.

The plan designates growth suitability areas according to the following criteria:

1. To limit environmental damage
2. To reduce land consumption outside existing communities
3. To minimize negative impacts on natural, economic, and social resources
4. To efficiently provide adequate public facilities and services
5. To minimize adverse impacts on existing communities and to foster a cooperative approach to land use planning and development

By classifying all land into 10 categories, the county effectively encourages development only in areas well-suited for growth. The designated growth areas met certain express criteria, including that they include limited wetlands, hydric soils, floodplains and contiguous forest, and be located proximate to existing development, employment, transportation, and stormwater and sanitary infrastructure. Coastal and flood hazards were expressly considered and excluded from growth areas.

The plan was implemented through the zoning ordinance. It subsequently eliminated large lot zoning in the majority of the county, essentially banning scattered growth in greenfield areas. The county's implementation of Maryland's Atlantic Coastal Bays and Pocomoke River critical area regulations also support these land use designations by largely prohibiting new development in sensitive locations. Prescribed buffers, habitat protections, and review procedures are mandated by the state law and enforced by the county. Taken together, the county has prescribed a robust, enforceable set of laws and plans to ensure its economic, social, and climate sustainability for the future.

Hazard Mitigation Plan – Incorporates Climate Change

Worcester County's hazard mitigation plan incorporates long-term sea level rise and climate change. Regulations adopted to further these goals include the Worcester County Atlantic Coastal Bays Critical Area Program and the Buffer Management Area regulations, a 2-foot freeboard in FEMA V-zones, and impervious surface regulations in the Resource Conservation Area and Limited Development Areas.

3.10. VIRGINIA

3.10.1. POQUOSON, VA

Population Density	745/ sq. mi.
Form of Government	City
Category	Suburban Bayfront
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
76796	35510	78.5	12150	0.49	95.1	2%	6.2%	0.5

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Elevation standards of 4.5 ft for new roads	Completed	No	Protection	Recommendation	Unique	NA	None
Floodplain Management Overlay Ordinance	Implemented	No	Accommodation	Mandatory	Above Required	Low (< $10,000)	None
Freeboard - 1 Ft	Implemented	No	Accommodation	Mandatory	Unique	Low (< $10,000)	None
Hazard Mitigation Plan - Incorporates Sea Level Rise	Completed	Yes	Procedural	Recommendation	Above Required	Low (< $10,000)	None
Pump Station Improvements	Implemented	Yes	Accommodation	Recommendation	Unique	NA	None
Incorporated HMP into Comprehensive Plan	Completed	Yes	Procedural	Recommendation	Above Required	Zero	None

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POPULATION AND GEOGRAPHY

The City of Poquoson derives its name from a Native American word for flat land or great marsh. It is a suburban community of 12,150 people in the Hampton Roads metropolitan area. It was chartered as a city in 1975, when most of its construction took place. Approximately 10% of its land remains undeveloped and buildable.

Poquoson is located on Virginia's Lower Peninsula and bordered by the city of Hampton on the south and York County to the west. It is surrounded by water—the Poquoson River on the north, the back River and Wythe Creek on the north, and the Chesapeake Bay to its east.

The terrain is flat, with marshes, inlets, and creeks surrounding the city, giving a total shoreline of 118 miles. The developed portion of the city has elevations ranging from sea level to 15 feet, with average elevations between 4 and 7 feet.

A large portion of the land in the city is a federally owned and maintained wildlife refuge called Plum Tree Island. This impacts the calculation of area within the floodplain, because the refuge is included in the data. Although the Hazard Mitigation Plan statistics show that 90% of the land is in the 100-year floodplain, this is likely due to inclusion of Plum Tree Island. City staff report that less than 80% of the developable parcels in Poquoson are located within a floodplain.

Poquoson has a population of 12,150 people, 95% of whom are white and 1% black. Asians comprise 2.2% and Latinos 1.9% of the population. Median income is $36,840 and median household income is $84,315, making it the wealthiest community in our sample of cities in the Tidewater region. The population has been growing slowly in the past few decades. Poquoson is a middle-class residential community, part of the Norfolk-Virginia Beach metropolitan area. Immediately adjacent to the city is the NASA Langley Research Center and the Langley Air Force Base, providing a significant job base.

Poquoson also has a significant historic population of lower-income watermen, traditional tidewater residents who earn their living from the sea. These people, who have lived in town for generations before the suburbanization of Poquoson, are especially vulnerable to sea level rise as they live in low-lying parts of town.

COASTAL ISSUES

Like the other communities profiled in the Hampton Roads region, Poquoson is highly vulnerable to coastal hazards. The committee preparing the hazard mitigation plan determined floods and wind events to be the most likely hazards to impact the community.

Tidal flooding is the most significant threat in Poquoson, which occurs with tropical systems and nor'easters. Historically and according to the FEMA Flood Insurance Study, severe flooding was experienced in 1933, 1936, and in 2003 when Hurricane Isabel produced a storm tide of 8 to 9 feet above mean low water. Poquoson was one of the hardest hit areas in the Hampton Roads area during Hurrican Isabel. Strong east or northeast winds push the Chesapeake Bay into the mouth of the York and James Rivers, causing flooding in Poquoson. The most severe nor'easters to impact Poquoson occurred in 1956 and 1962.

As the Hazard Mitigation Plan ("HMP") explains, "Combined structure and content value losses in the community total nearly $400 million. The loss ratio represents the percent of the total building exposure that could be damaged. According to this model, damage associated with a 100-year event would be as high as 25-percent of the total value of all single family residential structures and their contents, or more than $365 million" (Poquoson, Va. HMP p. 44).

Poquoson's infrastructure and evacuation routes are also highly vulnerable. Only one road leading out of the city, Victory Boulevard, is not shown in the 100-year floodplain. (HMP p.49) The HMP reports that 48 of the city's 59 identified critical facilities are located in the 100-year floodplain (HMP p. 43).

ADAPTATIONS

Incorporation of climate change and SLR into hazard mitigation plan

A component of the hazard mitigation planning process is to conduct a hazard identification study to determine the most significant threats to the jurisdiction. For the 2009 update, the committee reviewed and validated a list that includes sea level rise as a critical hazard, one of five enumerated in the plan (HMP p.15). The plan cited and incorporated NOAA sea level records at Sewells Point and Gloucester Point. The HMP states that most of Poquoson's land lies below 7 feet mean sea level, and therefore increases in se alevel will have a significant impact on its 14-square miles of 100 and 500 year floodplains.

The hazards identified that will be exacerbated by sea level rise include:

Increased Shoreline Erosion – the plan references increasing vulnerability to erosion from chronic and episodic storm-caused erosion and secondary effects including increased water depth and sediment loads, which can inundate seagrass and reduce critical shoreline habitat.

Inundation of Normally Dry Lands - the plan addresses the risk of drowning wetlands when they cannot migrate upland. It specifically notes that the Poquoson Wetlands Board has observed an influx of requests for bulkhead repair as a result of more frequent inundation behind failing bulkheads.

It discusses the economic and cultural losses to watermen as a result of the reduction in spawning habitat for fish and crabs as a result. The plan also references potential flooding of barrier wetlands such as Plum Tree, Black Walnut Ridge, and Cow Island, which could increase flood vulnerability inland.

Coastal Flooding - the plan highlights the potential increase in coastal severity and frequency of coastal storms that could exacerbate coastal flooding as well.

Salt Water Intrusion - the plan also references the risk that saltwater may intrude into groundwater aquifers.

Given that so much of the territory of the city is in the 100-year floodplain, it is nearly unavoidable that many of the critical facilities are at risk of a flood. Except for the City Hall and one fire station, all of Poquoson's critical facilities are in the 100-year flood area. The plan mentions the city's commitment to construct all future critical facilities and infrastructure "to avoid the flood-prone areas of the City if possible, and to minimize impacts otherwise" (HMP p.43). Poquoson's 2009 Comprehensive Plan includes the most current Multi-Hazard Mitigation Plan by reference. The Multi-Hazard Mitigation Plan and the City's Comprehensive Plan are now complementary and they reinforce the importance of integrating the two.

Elevation standards for all new roads

The hazard mitigation plan explains that most flooding occurs on roads at or below 4.5 feet mean sea level, and as a result Poquoson development standards require all new roads to be built at least 4.5 above mean sea level.

Pump Stations

All of Poquoson's new pump stations are constructed above the 100-year flood elevation. The city also installed a system that allows the pump stations to notify the city when any of 16 events occur, such as when the water level rises, power is interrupted, or the pump fails. The city has also installed permanent generators or has mobile generators available to supply all 29 pumping stations. The city also mandates that all new utilities built below the 100-year flood elevation have watertight manhole lids.

Floodplain Management Overlay Regulations

Municipalities in Virginia cannot adopt standards for buildings that diverge from state code. Local officials are responsible for enforcing Virginia's Uniform Statewide Building Code, which is based on the International Construction Code. The Virginia code specified building standards to protect against hazards such as wind, flood, and fire.

Poquoson does go beyond state requirements with regard to wind zones. Poquoson is divided into two zones, but Poquoson requires the entire city to be built to the stricter standards. Buildings must be constructed to withstand winds of110 miles per hour with 3-second gusts and a ½-inch ice load, and mandates that all footings include rebar and that roof attachments use extra brackets at the ends.

The City of Poquoson Municipal Code, Appendix A, Zoning, includes the Floodplain Management Overlay District which regulates development in the Special Flood Hazard Area (SFHA).

The ordinance requires 1-foot freeboard for all new and substantially improved structures. In addition to the standards in the ordinance, some permitting procedures help Poquoson building officials protect new construction from flood damage. Replacement manufactured homes must be placed with the lowest horizontal structural element above the base flood elevation. Engineering details are required to indicate that replacement manufactured homes are anchored to resist flood and wind uplift forces. Permit applicants must sign a statement acknowledging that FEMA Elevation Certificates are required to be submitted at two stages of construction: one during construction (prior to the Floor Joist Inspection) and another before final inspection. The elevation data are maintained in a computer database. The Building Official affixes a sticker explaining the hydrostatic venting requirement to each of the three sets of plans for structures in the SFHA. The Building Official then requires that the permit applicant sign and date the sticker to indicate recognition of the requirement. (HMP p. 67)

3.10.2. NORFOLK, VA

Population Density	4571 people/ sq. mi.
Form of Government	City
Category	Urban Bayfront
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
37546	23471	39.6	242803	0.35	47.1	7%	55.7%	0.5

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Coastal Flood Study	Completed	Yes	Procedural	Recommendation	Unique	High (<$1,000,000)	Other
Comprehensive Plan - Incorporates SLR	Completed	Yes	Procedural	Recommendation	Unique	High (<$1,000,000)	Other
Flood Protection Ordinance	Implemented	No	Accommodation	Mandatory	Above Required	Zero	None
Freeboard - 1 Ft	Implemented	No	Accommodation	Mandatory	Unique	Zero	None
Stormwater Upgrades	Implemented	No	Accommodation	NA	Unique	Very High ($>1,000,001)	None

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POPULATION AND GEOGRAPHY

Norfolk is the largest city in the Hampton Roads/Tidewater metropolitan area, which is the northernmost ice-free seaport on the eastern seaboard. As of 2010 Norfolk had a population of 242,303, a 3.6% increase over 2000. Whites comprise 47.1% and 43.1% identify as black. Asians represent 3.3% and Hispanics of any race 6.6% of the population. The median per capita income was $41,613 and median family income was $50,992. Norfolk is a central city in a metropolitan area. The military is a significant presence and economic engine. More than 80,000 active duty Navy personnel, 50,000 military workers, and about 19,000 federal civilian employees are in Norfolk. Military and government represent just over 38% of employment. Norfolk encompasses 65.98 square miles of land and 13 square miles of water. The average elevation is 13 feet. Residential land use represents 41.4%, followed by military (15.6%), open space and recreation uses (10.7%), and utility and transportation uses (8.1%). Single-family homes represent 54% of the housing stock and the median value of owner-occupied units was $216,000. In 2011, the city issued 600 building permits for new housing units. Almost all of this is infill, as the Comprehensive Plan describes Norfolk as a mature, developed city. Of Norfolk's nearly 28,000 acres of land, only 3.1% is vacant. Military and maritime industries form the core of the city's economy. It houses the world's largest naval base, the Port of Virginia, which handled 56,325 metric tons of cargo valued at nearly $55 million in 2011 (Port of Virginia 2011). It is the sixth busiest U.S. port and second busiest on the East Coast, just barely behind the Port of Newark in volume handled.

COASTAL ISSUES

Norfolk is the largest city in the Hampton Roads metro area, and its vulnerability to climate change, sea level rise, and coastal flooding has been at the center of national media attention. The *New York Times* described the region as the "front line" of sea level rise and climate change (Kaufman 2010), and the issue was also recently covered by the Washington Post, CBS News, PBS Need to Know, and the Atlantic Monthly. According to the Organization for Economic Cooperation and Development, the Norfolk–Virginia Beach metropolitan area ranks 10th in the world in the value of assets exposed to increased flooding from sea level rise.

Norfolk's 118 miles of shoreline are subsiding at an alarming rate as the sea is rising. Boon et al., (2010) in their report for the U.S. Army Corps of Engineers, detailed the combined effect of sinking land and rising sea level in the Chesapeake Bay. They analyzed long-term data and determined relative sea level trends are consistently positive (rising) while land movement is negative (subsiding).

Their future outlook concluded:

> Subsidence will clearly remain a problem as it will continue to add to high relative sea level rise rates locally and heighten the risk of flooding from storm tides in the lower Chesapeake Bay as time goes on. Low-lying areas in

> communities such as Norfolk, Virginia Beach, Portsmouth, Chesapeake, Hampton and Poquoson are comprised of a patchwork of local areas that are not only vulnerable to storm tides but are experiencing varying rates of subsidence, meaning that some areas within these communities may be facing greater risk than others from global sea level rise going forward (Boon et al. p.26).

The mean sea level, as measured by a tide gauge at Sewell's Point, has risen 14.5 inches since 1930, and the rate of rise has been increasing (NOAA 2010).

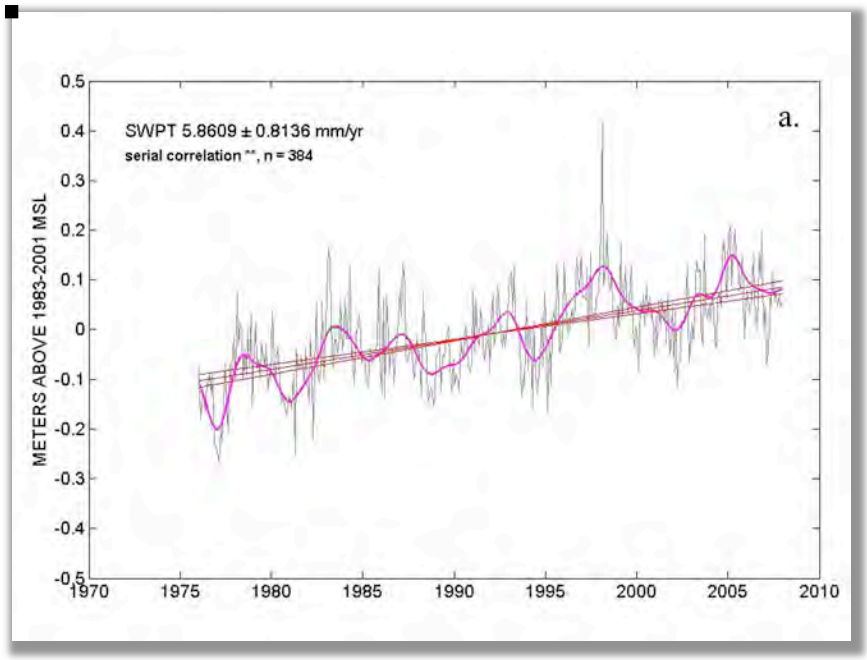

Figure 3.10.2:1 - Historical sea level rise trend in Norfolk from 1975 to 2010

Although these phenomena are being documented by scientific evidence, policy is being advanced by experience. According to city planning staff interviewed for this project, "people who have lived in Norfolk for 40 years and never saw water in their homes now have water in their homes. They don't know what is causing it, but they want us to do something about it" (Personal Communication, Aug. 27, 2012)

While on tour for this project, fellow Judd Schechtman experienced this first-hand when he was caught in a severe thunderstorm in Norfolk. He witnessed three citizen rescues performed in a flooded underpass. To experience this first hand provided an irreplaceable insight into the gravity of the situation. Planning staff indicated that an unfamiliar motorist could be stuck in downtown Norfolk even during dry high tides, and that "you have to know the tide cycles" to plan your commute. Norfolk has experienced the highest relative increase in sea level on the East Coast (Kaufman 2010).

The Times quotes residents of the Larchmont neighborhood, who identify the frequency and severity of the increasing tidal flooding. A resident who lived in the neighborhood for 40 years described the flooding as having gone from an occasional nuisance to severe in one month, when "there were eight or nine days the tide was so doggone high it was difficult to drive" (Kaufman 2010)

The article referenced residents' lobbying efforts that resulted in the city raising a street by 18 inches and adjusting the angle of a storm drain to reduce backups. The t otal cost of that project, not a low-cost adaptation, was $1.25 million. The severity of the situation has spurred elected officials to make some bold statements. The article also cited Mayor Fraim's acknowledgement that the city might need to create retreat zones (Kaufman 2010).

Figure 3.10.2:2 - Flooded streets in Norfolk captured by fellow J Schechtman during a severe thunderstorm

ADAPTATIONS

Norfolk is taking these increasing threats seriously, and is making a significant effort to assess the situation and implement flood mitigation measures.

Figure 3.10.2:3 - J Schechtman witnesses a citizen rescue of a motorist in a flooded vehicle

City-Wide Coastal Flood Study

One of the most significant efforts being undertaken is a City-wide Coastal Flooding Study contracted out to a Dutch engineering firm, FURGO Atlantic, by the Department of Public Works. The study, "intended to look at wind-driven rain, tidal departures, extraordinary precipitation events, and storm surges," will "allow the City to better identify risks and options to address nuisance and storm flooding along the 180 miles of shoreline surrounding the City" (Smith/FURGO Atlantic 2012). The FURGO study will install and monitor new long-term tide gauges, develop a GIS platform for a flood model, conduct coastal engineering evaluations to define flood exposure and prioritize projects and develop an interactive predictive flood-impact model.

The study focused on four areas: Mason Creek, Pretty Lake, The Hague, and Ohio Creek. Ohio Creek is also known as Spartan Village, one neighborhood most at risk from repetitive flooding. The area represents 1% of the size of the city but includes 584 structures, 523 of which are residential. The low-income neighborhood of 1970s-era townhomes was hit by extensive flood damage two years ago. Council members have advocated buying out and razing the neighborhood. Vice Mayor Anthony Burfoot was quoted as saying, "It's a very pricey

proposition and a very sensitive proposition...but the reality of it is that it's going to have to happen" (Hoyer 2009). Mayor Paul Fraim is also on the record with significant concern but uncertain as to what to do. He said "The next big rain that comes in there - I don't know how we're going to help them...we really ought to try to put together a plan" (Hoyer 2009).

The FURGO study recommended a three-phase approach for at-risk neighborhood. Phase 1 includes the buyout of the most vulnerable properties, Phase 2 includes installing a pump station to reduce rainfall impact during tidal surge; and Phase 3 includes installing a box culvert to improve the drainage system.

Two of the other neighborhoods in the study, The Hague and Pretty Lake, do not have tide surge control and contain just over 8,000 structures. The study recommended a capital project to protect Pretty Lake against coastal flooding and runoff, including construction of a tidal barrier to protect against surge; a tide gate to preserve navigation; a pump station to remove rainfall when the gate is closed, and the raising of roads where the land surface is low around the watershed perimeter. The capital cost for the project is estimated from $50 to $100 million and the benefit-cost ratio was determined to be 2:1.

The study includes project cost estimates, including potential pump stations and long-term operation and maintenance. Benefit-cost analysis will be used and recommendations made based on that analysis.

One direct result of the FURGO study has been the creation of a city-wide flood executive committee that has been meeting for several months on a weekly basis. Although at this point action has been mostly information exchange, there is evidence that the dialogue in Norfolk is serious. For instance, Frank Duke indicated that although the city currently has a city-wide freeboard requirement of 1 foot, they are looking at increasing it.

Norfolk 2030 Plan

The City of Norfolk was the earliest jurisdiction in our study to reference the issue of sea level rise. The issue appeared for the first time in the 1992 comprehensive plan. The city is currently in the late stages of drafting its updated plan—PlanNorfolk2030 (Norfolk, Va. 2013). The plan specifically continues to addresses sea level rise.

Action LU1.2.8 states, "Evaluate the impact of potential sea level rise when reviewing development proposals and future changes to development regulations."

Action LU1.2.7. states that Norfolk will "ensure that all new development in designated flood-prone areas complies with the city's flood protection regulations."

In addition, L. E.S.2.1.6 specifies the city will continue to implement wetland design changes, such as the use of living shorelines that allow for the landward migration of wetlands, for resilience to sea level rise.

Storm Water System Upgrades and Capital Improvement Investments

All new infrastructure and new construction are required to meet a 10-year standard. Storm water flooding projects are added yearly to the CIP program. The city is taking on a number of projects that will increase its resilience, including creating a living shoreline along Haven Creek and making drainage improvements.

In addition, the city is replacing and elevating a bulkhead 1.5 to 2 feet above the existing bulkhead at a cost of $440,000 as well as installing a mobile pump to deal with tidal flooding at Lea View and 15th St.

3.10.3. PORTSMOUTH, VA

Population Density	2839/sq. mi.
Form of Government	City
Category	Urban Bayfront
CRS Rating	9

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
40203	21850	51.8	95535	-0.51	41.6	3%	59.7%	0.3

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Cumulative Substantial Improvement Ordinance	Implemented	No	Procedural	Mandatory	Above Required	Low (< $10,000)	None
Elevated bulkhead as part of park reconstruction	Implemented	No	Protection	NA	Unique	NA	NA
Flood Protection Ordinance - Prohibits hazardous materials	Implemented	No	Accommodation	Mandatory	Above Required	Low (< $10,000)	Other
Floodplain Management and Repetitive Loss Plan	Completed	No	Procedural	Mandatory	Above Required	Low (< $10,000)	Other
Freeboard - 1.5 Ft	Implemented	No	Accommodation	Mandatory	Unique	Low (< $10,000)	None
Outreach and Coordination	In Progress	No	Procedural	NA	Unique	Low (< $10,000)	Other
Floodproofing Utility Equipment	Implemented	No	Accommodation	NA	Unique	NA	NA

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POPULATION AND GEOGRAPHY

Settled in 1752, the City of Portsmouth is one of the most historic communities in the Hampton Roads area and contains one of the world's greatest natural harbors. It has grown to a land area of 30 sq. mi. via annexations over time. The city has a rich maritime history and its location is clearly tied to its economic growth. Portsmouth is host to the largest port by volume on the East Coast, the Port of Hampton Roads, which handles more than 12 million tons of cargo annually. The city is also home of the Portsmouth Naval Hospital and is adjacent to the Norfolk Naval Shipyard. 56% of the land within the City of Portsmouth's boundaries is nontaxable property because of ownership by federal and state agencies and by non-profit organizations and tidal wetlands that cannot be built upon. Portsmouth is highly subject to flooding and the risks of climate change and sea level rise due to the relatively low elevations of land and the presence of a number of tidal rivers and creeks throughout the city.

The city has a population of 95,684 people and a population density of 2,839 people per sq. mi. The population is 41.6% white, 53.3% black, 1.1% Asian, and 3.1% Hispanic or Latino. It has a median per capita income of $22,302. It is bordered by the cities of Chesapeake and Suffolk to the south and west, and is separated from Norfolk by the James River on the north and the Elizabeth River on the east.

COASTAL ISSUES

Portsmouth, as the other Hampton Roads communities, is extremely vulnerable to repeated and frequent flooding. As its floodplain and repetitive loss plan describes, "Flooding events in the first ten years of the twenty first century have continued to affect Portsmouth. Nine events form January 1, 2000 to August 1, 2008 have caused over 400 claims to be filed by residents and businesses for flood damages. Of these nine events one event, Hurricane Isabel was responsible for over 320 claims for flood looses being filed. These flood losses had a total value of approximately 3.4 million dollars" (Portsmouth, Va. 2010 Floodplain Management Plan, p.19).

Although a general trend toward more frequent and severe flooding has been detected, Portsmouth has experienced flooding throughout its recorded history. The most destructive storm occurred in 1933, which registered the highest recorded tides in history at 8.9 feet above mean sea level in the harbor. Hurricane Isabel, by comparison, recorded a 7.89 foot high tide at the Sewell's Point Station. The 1933 storm occurred during an astronomical high tide, and recorded the record high tide with only an inch and a half of rainfall. Downtown Portsmouth and other low-lying areas were under water and severe wind and flood damage occurred to many wharves and docks (p.19).

Portsmouth has about 3,600 properties in the 100-year floodplain and about 225 repetitive loss properties. These repetitive loss structures nationwide account for approximately 2% of the insured properties but have received over 40% of the claims paid. In Portsmouth there were 181 claims from repetitive loss properties, while .8% of the city parcels in flood hazard districts account for 35% of the flood damages.

As in other Virginia Tidewater communities, sea level rise is a present and serious concern. According to its Floodplain Plan, a 1.46-foot rise in sea level has been documented during the past 100 years.

ADAPTATIONS

Floodplain Management Plan and Repetitive Loss Plan incorporates Sea Level Rise

The City of Portsmouth recently drafted and adopted a Floodplain Management Plan and Repetitive Loss Plan. The plan, required by the NFIP because the city has more than 10 repetitive loss properties, also earns Portsmouth CRS points. The plan is described as a "key component" in the assessment process under CRS and is an update of the city's 2005 floodplain management plan. Although required by FEMA, Portsmouth goes far beyond the requirements of NFIP in its programs and outreach.

Perhaps the most important way the city goes beyond requirements is by monitoring the implementation of the recommendations in the plan. The city prepares an annual status update on the action items with progress in the past year and expected dates for progress for items to be addressed in the future.

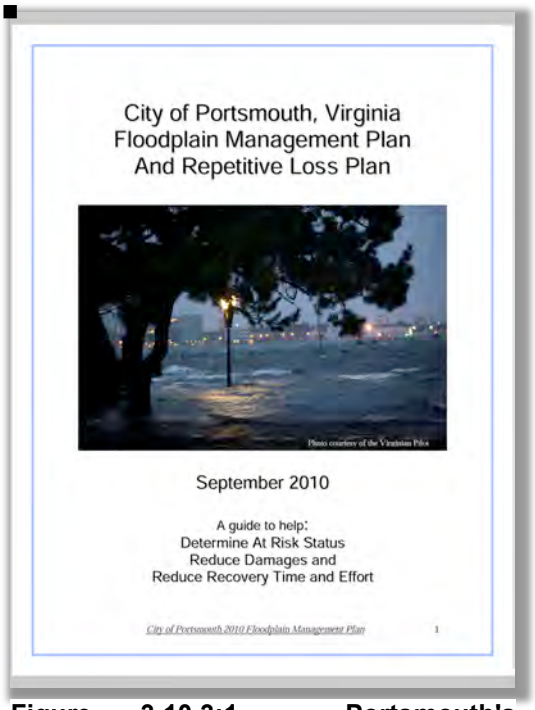

Figure 3.10.3:1 - Portsmouth's Floodplain Management and Repetive Loss Plan

Climate change and sea level rise are explicitly mentioned in Portsmouth's plan. As the plan describes:

> A parallel issue that will compound the problem of flooding is the rise in sea level. Sea level is rising along most of the U.S. coast, and around the world. In Portsmouth a 1.46 foot rise in sea level has been documented during the past 100 years. Higher temperatures are expected to further raise sea level by expanding ocean water, melting mountain glaciers and small ice caps, and causing portions of Greenland and the Antarctic ice sheets to melt…This rise in sea level would result in a loss of between .042 and 2.58 square miles of land in the City of Portsmouth. This rise in sea level will become an increasingly important component of the City's Floodplain Management program (Floodplain Management Plan p.2).

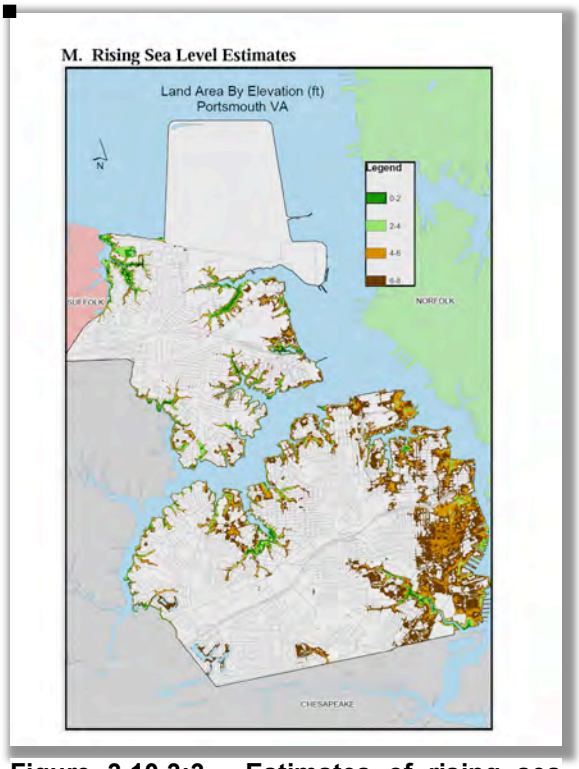

Figure 3.10.3:3 - Estimates of rising sea level in the plan

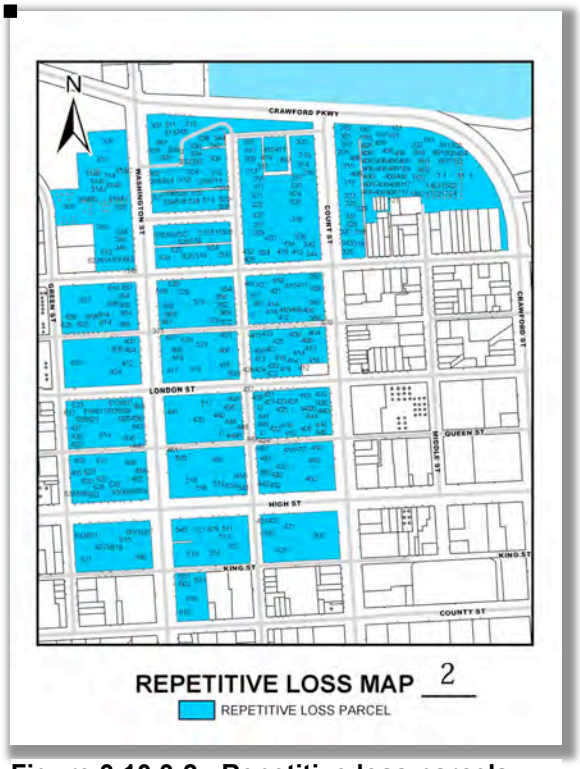

Figure 3.10.3:2 - Repetitive loss parcels

The plan details all of the repetitive loss areas (example shown above) as well as severely repetitive loss areas. The plan discusses Portsmouth's history, sets goals, and analyzes linkages with housing, economic development, and environmental quality. It discusses coordination with the private sector, the military, maritime industries, the school system, power generation, water systems, and transportation. It also presents a plan for implementation and continuing action, suggesting, for example, that the city determine which public fairs and festivals should be targeted for staff participation and information distribution and review plans for all new construction to ensure they meet or exceed the requirements of state federal and local regulations.

The plan also identifies actions the city should take in short term, some of which have already been implemented—such as raising the water and sewer utility system from damage. Other items are in progress, such as preparing infrastructure plans utilizing sea level rise as a determining and budget factor, and preparing evacuation policies for disabled individuals.

Long-term actions specified by the plan include some expensive items such as providing protection from surge flooding for the downtown, Olde Towne, Westhaven, and Cradock sections of the city, as well as low-cost actions such as prepare and adopt an overlay zoning district that addresses concerns of sea level rise.

Flood Awareness Outreach Program

Mr. Fred Brusso, Planning Administrator for the City of Portsmouth, described the city's extensive outreach program. The city took spots on local cable TV, rented billboards, and sent out postcards to disseminate information. He said they "tried to figure out ways to make

information available 24-hours, to let [citizens] know that information is available...we scan and put the letters of map amendment on file and make them available for the public to look at" (Personal Communication, Aug. 28, 2012). The city also prepared and posted an interactive floodplain map on its website, and has developed strategies and identified funding sources to help property owners looking to flood-proof their buildings. Portsmouth also has made a specific effort to reach out to renters. Approximately 60% of Portsmouth residents rent, a segment of the population that Mr. Brusso said is often ignored. The city leaves brochures about flood hazards in tenants' apartments when inspectors visit the buildings.

Mr. Brusso also spoke of the effectiveness of using postcards instead of letters to homeowners. He explained that letters are often thrown out without being opened but postcards are more difficult to ignore. After switching to postcards meeting attendance increased significantly.

Figure 3.10.3:4 - Postcard used to advertise public hearings on the Portsmouth's Floodplain Management Plan

Every year the city sends a specific letter to each repetitive loss property and to all of the properties in the repetitive loss areas. Mr. Brusso explained that FEMA programs miss about 60% of at-risk homes because only homeowners with a mortgage are required to hold flood insurance policies. The city uses GIS to assess which homes without policies might be at risk. "We were not getting a picture of the complete damage...so the idea was to create an area around the known repetitive loss structures...that are similar in location and elevation...the fact that they don't have a claim doesn't mean they haven't had damage," as Mr. Brusso explained. They are approaching these homeowners and educating them about available insurance and potential improvements to reduce flood risk.

Portsmouth currently is a Class 9 (5% discount) in CRS. But with the new regulations, outreach, and enforcement, Portsmouth has made significant progress on reducing its flood risk and they are confident this will be recognized by CRS. "We cut 18 severely repetitive structures down to 11, and it hasn't cost the city anything other than my time," Mr. Brusso said. "The reason we are doing this is...under CRS you have to show you are successful...so we are trying to build that starting point to show we are making progress."

Cumulative Substantial Damage Provision

Portsmouth recently passed a cumulative substantial damage provision in its flood ordinance, which counts all improvements in the past 10 years to determine whether a property must meet new code requirements. The 10-year period began in 2009. Substantial damage is defined as:

> [D]amage of any origin sustained by a structure when the cost of restoring the structure to its pre-damage condition would equal or exceed 50 percent of the market value of the structure before the damage occurred. A structure that has been damaged 2 or more times during any consecutive 10 year period with a cumulative building loss equal to or exceeding 50 percent of the assessed building value shall also be considered a substantial damaged structure.

The law also applies to voluntary improvements made to properties:

> In order to obtain a permit for additions or repairs to an existing building where the value of materials and labor for all alterations/repairs/additions combined over the ten year period is 50% or more of the assessed value of the building; the project will be treated as a new building. (Portsmouth, Va. City Code, Sec. 14-5)

When asked whether the new provisions have resulted in homeowners avoiding doing major construction projects, Mr. Brusso said, "I'm seeing a reverse of what we expected to happen. Citizens in Norfolk and Chesapeake are asking their cities to adopt a cumulative ordinance too..." He explained that FEMA ICCC grants are specifically available for homeowners if codes in their city require higher standards.

Figure 3.10.3:5 - An elevated home in Portsmouth

Floodplain Ordinance / 1.5 Ft. Freeboard and Prohibition of Hazardous Materials

Portsmouth's floodplain ordinance requires 1.5 feet of freeboard and in addition contains the following provisions:

The Ordinance (Sec. 14-11) prohibits the following use in the A, AE and V districts:

- Sanitary landfills
- Junkyards
- Outdoor storage of inoperable vehicles
- Manufactured homes
- Surface mines
- Industrial wastes
- Outdoor storage of buoyant, flammable, or explosive equipment or materials.

The code also prohibits the manufacture, bulk storage, or distribution of petroleum, chemical, asphalt, or any hazardous materials, as defined in the Superfund Amendment and Reauthorization Act of 1986 or the Identification and Listing of Hazardous Wastes in 40 CFR sec. 261 (1987), specifically including radioactive materials, biologically accumulative poisons, and substances highly lethal to mammalian or actuator life. (Sec. 14-11 (1d.2))

The city is also making a special effort to enforce the new law through the business license process. As Mr. Brusso explained, "We are working with the fire department...they gave us a list of properties that had hazardous materials...when they come in to get their business license they are asked if they are storing hazardous materials, and turned down if they say yes" (Personal Communication, Aug. 28, 2012)

Elevation of Bulkhead

Portsmouth also elevated a significant bulkhead to protect a major thoroughfare and historic downtown neighborhood. At the same time, it installed a bicycle path along the renovated bulkhead. The area is used extensively for recreation, especially for viewing fireworks displays across the bay.

Flood Proofing Utility Equipment

Portsmouth has either installed generators above Base Flood Elevation (BFE) on all pumping stations or placed switching gears above BFE so portable generators can be connected so these facilities continue to operate without power.

Figure 3.10.3:6 - Portsmouth's newly elevated bulkhead and bicycle/pedestrian path

Taken together Portsmouth's plans, implemented regulations, and concerted outreach demonstrate that Portsmouth is taking flooding, sea level rise, and securing its future very seriously. Communities that are just starting on the path toward increasing their resilience should look to it and the other proactive Hampton Roads communities as models.

3.10.4. HAMPTON, VA

Population Density	2673 /sq. mi.
Form of Government	City
Category	Urban Bayfront
CRS Rating	8

Median Household Income	Median Per Capita Income	% Owner Occ	Population	2000-2010 Pop Growth Rate	% White	% Hispanic	% Minority	% Seasonal Housing
67461	40371	46.8	15430	0.33	96.1	2%	4.9%	22.4

Adaptations	Status	Incorporates CC	Type	Impact	Standard Costs		Funding Source
Appointing Waterways Grants Manager	Implemented	No	Procedural	NA	Unique	Medium (<$100,000)	None
City Flood Protection Law	Implemented	No	Accommodation	Mandatory	Above Required	Very Low (< $1,000)	None
Comprehensive Waterways Management Plan	Completed	Yes	Procedural	Recommendation	Unique	Medium (<$100,000)	None
Freeboard - 1 Ft	Implemented	No	Accommodation	Mandatory	Unique	Very Low (< $1,000)	None
Hampton Beachfront and Storm Protection Management Plan	Implemented	No	Protection	Recommendation	Unique	Medium (<$100,000)	None
Tidal Floodplain Study and Protection Plan	Completed	Yes	Protection	Recommendation	Unique	Medium (<$100,000)	None

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POPULATION AND GEOGRAPHY

The City of Hampton has a population (as of Census 2010) of 137,436, making it the sixth most populous city in Virginia. The city is very diverse—42.7% of the population is white, 49.6% black, 2.2% Asian or Pacific Islander, and 4.5% are Hispanic or Latino of any race. The median income of the city is $39,532 while median household income is $46,110.

Hampton is a city of 163 sq. mi., 84 sq. mi. of which is water. Hampton is located on a peninsula and shares land borders with Newport News, Poquoson, and York County. The James River is to its west and the Chesapeake Bay is on the east. It is part of the Hampton Roads metropolitan area. The entire city is coastal plain, with an average elevation of 10 feet. Staff describe Hampton as a "built out" city, with little room to retreat. (Personal Communication, Aug. 28, 2012). They indicated that adaptations should focus on making the existing community more resilient, since historic communities are unlikely to relocate buildings or infrastructure.

COASTAL ISSUES

The City of Hampton is already dealing with the consequences of subsidence and sea level rise, and residents are taking these threats seriously. As described by Keith Cannady, Manager of Planning and Zoning Division, "On a personal level, people are seeing that water is in their garages every year for the last 5 years and this never used to happen...People know this is out there...they are looking for...tangible explanations as to why," he explained. (Personal Communication, Aug. 28, 2012) "People have lived in certain places for a long time and all of a sudden they are seeing water where they had not seen it before...and they want local government to do something about it."

Hampton has recognized the significance of the waterways as essential to the identity and economy of the city, as well as the challenges this presents. As stated in the Comprehensive Waterways Management Plan, "Hampton is facing short and long term stormwater and waterway related issues which will impact public and private infrastructure, development patterns, tax base, delivery of public services and the quality of life" (Hampton, Va., Waterways Plan, p. 1).

Due to the proximity of water bodies and its low elevation, Hampton is not a stranger to tidal and stormwater flooding. Historically, flooding is worst during hurricanes and nor'easters, though seasonal high tides also cause some flooding concerns. As the Tidal Flooding Subcommittee reported "... tidal events have [had] other significant and negative impacts on Hampton citizens' quality of life, primarily due to the rise of tidal waters along Hampton's extensive Chesapeake Bay coastline and tidally influenced rivers and creeks" (Hampton, Va., Waterways Plan, p. 7). Major storms have caused significant losses in the city, such as in 2003, when Hurricane Isabel devastated the Hampton shoreline causing significant flooding, beach erosion, and wind damage throughout the municipality. The tide gauge at Sewell's Point registered a peak water level of

7.89 ft. MLLW, the second highest on record. The majority of the older homes in the Grandview neighborhood were condemned, while significant flooding occurred in Buckroe, Phoebus, Fort Monroe, and other tidal areas throughout Hampton.

The recent apparent worsening of the frequency and severity of floods has raised the profile of the issue. The result has been a grassroots pressure put on city councils and the mayor. 11,500 structures (30% of land in city) are in the special flood hazard area.

ADAPTATIONS

Comprehensive Waterways Management Plan

Efforts to tackle the problem were launched in November 2010 when the city set about drafting the Comprehensive Waterways Management Plan. The Hampton City Council established a steering committee charged with overseeing the development of the plan through citizen guidance. The charge of the committee was to "[develop] a comprehensive set of goals, strategies and criteria to guide future City policies and investments regarding waterways management" (Hampton, Va., Waterways Plan, p.1). The committee homed on four areas of concern: tidal flooding, stormwater management, shoreline protection, and waterway maintenance and management.

The plan also recognized the significance of sea level rise in exacerbating the city's challenges: "...long term projected sea level rise has the potential to increase the frequency, magnitude and duration of flooding throughout Hampton and to inundate portions of the existing stormwater infrastructure as well as increase shoreline erosion. Increases in sea level will also affect floodplain determinations which will affect Hampton citizens and the pattern of development" (p.2).

The specific responsibilities of the Hampton Waterway Steering Committee were to develop an understanding of the challenges of protecting Hampton's shorelines from erosion and storm damage to waterfront properties and tidal flooding, including the effect of projected sea level rise; current and future stormwater quality and discharge regulations; management and maintenance of tidal waterways; form and charge subcommittees to investigate and make recommendations for short- and long-term strategies for dealing with each of these issues; work with city staff to develop methods for soliciting public input on these issues; educate the public about the importance of having a comprehensive plan, and draft recommendations for short- and long-term strategies. Once vision statements, goals, and strategies were established, the steering committee developed estimated costs for implementing the strategies, organized the strategies into a time-phased series of actions, and measured preferences for funding mechanisms. An implementation plan was developed that includes projected costs.

COMPREHENSIVE WATERWAYS MANAGEMENT PLAN
Major Action Recommendations

Tidal Flooding Committee
Near Term
- Commission LIDAR study
- Undertake comprehensive study to determine - Hampton's flooding vulnerability
- Expand tidal flooding public education effort
- Review building code options to reduce potential flood damage costs

Longer Term
- Begin planning modifications to city structures
- Develop home elevation incentive program
- Create purchase program for homes susceptible to significant repetitive flooding damage

Shoreline Protection Committee
- Adopt Wetlands Plan
- Appoint a waterways grant manager
- Implement a grassroots lobbying group
- Approve adoption of Sand Dune Resolution
- Adopt Shoreline Maintenance and Protection Plan

Waterway Management and Maintenance Subcommittee
- Develop and implement a comprehensive waterway management and maintenance function
- Recognize and minimize the storm water system's contribution to waterway degradation
- Take the necessary action to correct the historical degradation of Hampton's waterways
- Make Hampton the preferred waterway destination for the Chesapeake Bay

The plan was accompanied by an extensive public process under the banner "Hampton Engages." The city set up a website (www.hamptonengages.org) to raise awareness and obtain public input. Meeting announcements, documents, and videoed technical briefings were uploaded to the site.

Hampton is actively implementing the recommendations made in the Comprehensive Waterways Management Plan. According to Gail Hicks—Hampton's acting water resources engineer, floodplain manager, and CRS coordinator—all of the projects in the Capital Improvement Plan for FY 2013 and 2014 were recommended by the Waterways Management Plan. Funded projects include efforts at shoreline protection, waterways maintenance, stormwater quality and quantity, and tidal flooding.

Hampton has had a flood district in their zoning ordinance since the mid-1970s. They adopted a new flood zone ordinance in 2011 and it is a part of the zoning ordinance. Staff reported that the amendments were largely made to comply with CRS.

Appointing a Waterways Grants Manager
The city also implemented the recommendation to appoint a waterways grants manager. This staff person will be responsible to searching out and applying for funding specifically to implement the recommendations of the waterways plan and other related projects.

The city is also implementing the recommendation in the plan to improve data collection. It is receiving updated LIDAR from the state and is using its own funds to use mobile LIDAR to obtain finished floor elevations of structures.

Tidal Floodplain Study and Protection Plan

Hampton has written a number of other related plans. It recently funded and engaged a consultant to begin work on a Tidal Floodplain Study and Protection Plan. The plan will cover impacts and solutions ranging from individual basements to major infrastructure. The plan, a response to worsening tidal flooding, determines the extent of the flooding problem, assesses the impacts, and determines solutions to mitigate or prevent property damage from future tidal flooding events. Detailed neighborhood-level mapping will be made available so that residents will be able to better understand flooding projections in their neighborhoods. The project also includes a significant outreach component.

Hampton Beachfront and Storm Protection Management Plan

Additionally, in 2011 the city completed the Hampton Beachfront and Storm Protection Management Plan. This plan is mainly concerned with maintaining the continuous erosion challenges along Hampton's 8.3-mile sandy shoreline along the Chesapeake Bay from Fort Monroe to Factory Point. It assesses various engineering solutions to protect and restore the city's exposed shoreline. The plan considers sea level rise and subsidence in its assessments. Hampton recently implemented part of the plan when it installed three new breakwaters on a public beach. Smaller near-shore breakwaters are costing $500,000 to $600,000 each and are entirely city-funded. The beach has also been renourished, and they hope the breakwaters will minimize the need for maintenance. The city is paying to collect annual data, which it forwards to the U.S. Army Corps of Engineers for analysis to determine whether the beach needs to be renourished. Hampton also reported that they have a "great working relationship" with the Corps on this project and others. Ms. Hicks said that "the Corps is really committed, through their activities with the Virginia Silver Jackets, to providing assistance to communities related to floodplain management" (Personal Communication, Aug. 28, 2012). Hampton has also been actively engaged in partnerships with neighboring communities. It began a partnership with the city of Newport News to complete a study on Newmarket Creek,

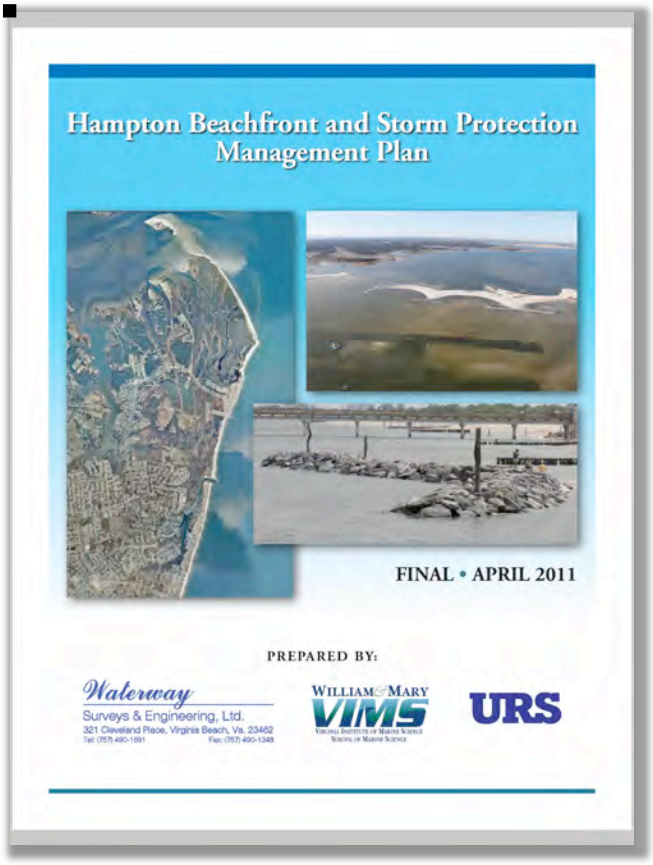

Figure 3.10.4:1 - The Hampton Beachfront and Storm Protection Management Plan

which straddles the border. The Corps obtained a grant for the two cities and they have been sharing data on a study regarding the creek. Partnerships are clearly important to Hampton. Ms. Hicks said that "every community should be looking for ways to partner with other communities...regionally and statewide" (Personal Communication, Aug 28, 2012).

4. CONCLUSIONS

Local governments are on the forefront of responding to and preparing for coastal threats, and they are more than willing and able to take on the task. Localities recognize the interdependent nature of managing coastal risks from climate change, and that partnership is necessary for successful planning to work. Without a doubt, localities face challenges with making decisions on a long time horizon, while budgets need to be balanced and election cycles are short. Therefore, they have found it imperative to justify actions on the basis of short-term risk mitigation that has long-term benefits as well.

Although many municipalities have been responding to these threats both on their own and in concert with others, many towns expressed keen interest in the opportunity to learn from each other and share best practices.

Of specific practices we found most helpful, town staff emphasized the importance of using existing processes and plans to respond to coastal hazards at low or no additional cost. Incorporating climate change information into comprehensive and hazard mitigation plans was considered an essential predicate step in nearly all communities to ensure such risks are considered now and into the future. The budgets to prepare such plans are already in place, as most towns must, or choose to, prepare such plans. Simple measures to incorporate climate change are nearly cost-free, when led by town staff or citizen volunteers, but more sophisticated planning requires funding, technical assistance, and partnerships with other levels of government and NGOs.

For example, New York City's efforts to generate data are widely lauded, but some much smaller places, such as Guilford, Connecticut, also have impressive studies. The key to these towns' successes were willing partnerships with other organizations, such as The Nature Conservancy, which developed a GIS-based sea level rise visualization tool for the Long Island Sound and then reached out to towns such as Guilford to lead a successful adaptation planning process. Data generated from these projects could easily be shared with neighboring communities. Incentives or encouragement to do so should be an award criteria for state and federal grants.

NOAA and state coastal management departments are also essential partners. The City of Lewes received funding from NOAA’s National Sea Grant climate change initiative to engage in a participatory process to develop a hazard mitigation and climate change plan in one document. This has created a model for such planning for the future, since hazard mitigation planning is already commonly done as required by federal law. However, one caveat to note is that we did not find a strong correlation between planning activities and implementation in codes and law as a result of that planning. We believe this is the case because it is early in the process for many towns, though follow-up research could investigate this relationship more thoroughly. Often, however, once we interviewed the towns, we found adaptations that had been implemented for other related reasons, such as flood hazard protection.

Much of the action needed for adaptation to climate change is not groundbreaking, but rather incremental shifting in the way that policy and planning is approached, as in Lewes, which

incorporated climate change adaptation into its hazard mitigation plan. Lewes felt that doing this was a cost-efficient strategy. It explained that it paid for it to do this since, "[A] major reason to begin enhancing Lewes' hazard mitigation efforts with climate change adaptation is that proactive planning is often more effective and less costly than reactive planning, and can provide immediate benefits" (Lewes, Del. Climate Change Action Plan, p.9). Towns are recognizing that not responding to climate change will be more costly than responding.

Many municipalities, such as Portsmouth, Virginia, emphasized the equal importance and value of community outreach and engagement, and has an especially notable program to engage citizens. The educational process is essential, both to build support for enforcing new regulations and stricter codes and to build capacity for and awareness of private measures residents can take to reduce their climate-related risks.

Many implementation actions taken by towns were considered no-cost or very low cost. Examples include laws and planning tools that enforce setbacks or freeboard requirements or unique land use management tools, such as cluster ordinances. Strict coastal setbacks are the hallmark of East Hampton's unparalleled protection of its coast, as its maintenance of a natural ocean-fronting shoreline is especially notable in the highly developed New York metropolitan area. The town also greatly restricts shoreline protective structures. The east end of Long Island also has an exceptional land protection program which includes a 2% tax on all real estate transfers in each town. Funds from the tax are spent exclusively on land purchase and other resource protection projects.

Ocean City, Maryland's seemingly complex transfer of development rights system was described by town staff as very low cost, and ultimately allowed the town to proceed with its beach replenishment program at a fraction of the expense of purchasing purchase land outright. TDR is a powerful tool to allow localities to use retreat/restoration strategies, since it can provide compensation to landowners.

While codes and laws are essential adaptation tools, and nearly always low-cost, they are prospective, and do not always completely answer the adaptation question in many communities. While towns with established, historic built environments may be especially heavily reliant on hard infrastructure to ensure their survival, nearly all have challenges with infrastructure at risk. Some communities, such as Norfolk, Virginia, are heavily investing in some especially flood-prone areas, while Hampton, Virginia, has enhanced their already robust program by hiring a full-time waterways grants manager to seek external funding for such projects. Incremental adjustment in standards is a popular way of enhancing infrastructure resiliency. Portsmouth, Virginia, increased the elevation of a new bulkhead constructed as part of a park renovation project by two feet, and Groton, Connecticut, incorporated sea level rise into their public works infrastructure decision guidance.

Although some adaptations do not require extensive modeled data, many towns are constrained by a lack of climate information. Information based in science would help communities to enforce stricter setbacks and mitigation requirements. Many would agree with the report issued recently by the Congressional GAO, which recommended that the federal government provide more and better data to assist with long-term planning strategies.

All communities need accurate flood maps provided by FEMA. If this data were enhanced with climate information, towns could incorporate that information into their plans and codes. FEMA could incentivize adopting regulations that responded to such information by granting CRS credits.

FEMA should be open to partnering with all towns to improve flood mitigation outcomes. Many towns expressed frustration at the delays in the current roll-out of LIDAR-based data. Towns with the capacity to do so should be allowed to proceed with adopting new maps on their own. For example, Greenwich, Connecticut, has already produced their own LIDAR maps, and are verifying the remote data with on-the-ground surveys. Just as with towns' own plans, greater openness to community engagement and incorporation of local knowledge, if administered through a verified program, could go a long way toward gaining local support for new flood maps.

Coordination among state and federal law was also a significant thread. Some communities, such as towns on the east end of Long Island, have been acting on their own to protect their resources. But nearly all towns would like more support from states for their own initiatives, including coordination with state coastal managers and more funding for planning and implementation assistance. We also found a growing trend toward coordinating hazard mitigation plans and comprehensive plans, and incorporating climate information in both—but such action is still rare.

For many communities, requirements and incentives matter. Many have floodplain codes that simply meet minimum standards, emphasizing the need for FEMA regulations to keep pace with increasing threats from climate change. For some towns, FEMA's Community Rating System is the adaptation toolkit, and it has great support among elected officials in places such as Sea Isle City, New Jersey, where the mayor made obtaining a high score his singular priority. While they achieved a 6 from a 10 in a few short years, the new codes passed and strict enforcement by the town building department no doubt reduced damage during Sandy compared to neighboring communities. CRS may have motivated the town, but on its own the town took the unprecedented step to enforce its building code by summonsing homeowners who had not complied with new flood venting requirements.

One significant limitation to our study was that our case study communities were explicitly selected on the basis of their taking a leadership role in the area of coastal climate adaptation planning. As a consequence, we may have a somewhat distorted and optimistic view of how extensive such activities are. Follow-up work should investigate the status of adaptation planning in a broader range of towns and cities.

Because of the geographic, political, and socioeconomic differences across locales, the range of adaptive strategies is wide and divergent. While this can be considered a strength—because it allows localities to respond to unique local circumstances—the ad-hoc nature of the programs is also a liability.

In addition, climate adaptation planning is nearly always a voluntary endeavor, which leave many municipalities without any effective adaptations. The NFIP model of setting a floor and

incentivizing higher standards is a good one, but both the floor and standards need to be enhanced. In addition, many towns need support to achieve their goals, in terms of both funding and technical assistance.

Communities have within their reach the tools to adapt. Local innovations, from expanding public participation to using transfer of development rights, cluster and subdivision ordinances to set-back development from the shoreline, are within the capacity and grasp of almost all North Atlantic local governments. Wider adoption of these local initiatives, with support from higher levels of government, are our best bet for a more resilient and sustainable future.

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6. APPENDICES

APPENDIX A. Adaptations Sorted by Practice Type