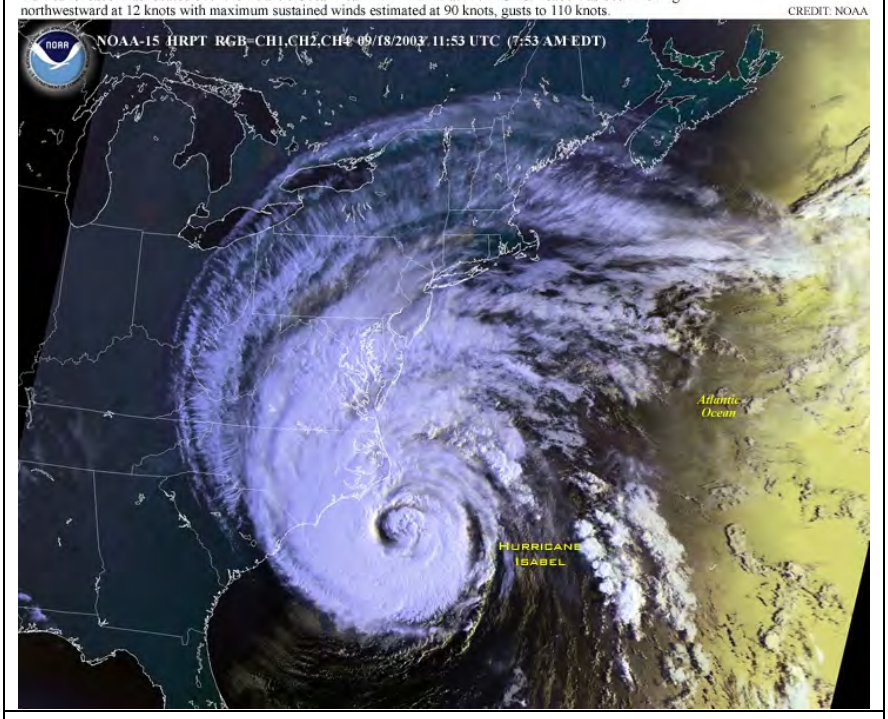
3.3.2. HAZARD MITIGATION

The Town of Nags Head is vulnerable to a wide range of natural and man-made hazards. These hazards threaten the life and safety of residents and visitors, and have the potential to damage or destroy both public and private property and disrupt the local economy and overall quality of life. Natural hazards are a part of the world in which we live. These include floods, hurricanes, tornadoes, winter storms, wildfires, and other hazardous events. Natural hazards are inevitable and there is little humans can do to control their force and intensity. However, how the natural and the built environments interact with hazards is quite different. The natural environment is amazingly recuperative from the forces of nature and can regenerate with resiliency, restoring habitat and ecosystems in time for the next generation of plant and animal life to begin. The built environment, however, is not as resilient. Natural disasters occur when human activities in the form of buildings, infrastructure, agriculture and other land uses are located in the path of the destructive forces of nature. Since the built environment is more susceptible to natural hazards and cannot recuperate like the natural environment, communities impacted by a natural hazard often recover only over a long period of time and at great social and economic cost.

In recent years, the frequency and impact of natural disasters has increased because more people are choosing to live and work in locations that put them and their property at risk. As a result, risk of disasters occurring in the wake of natural hazards has grown exponentially. Likewise, while floods have caused a greater loss of life and property and have disrupted more families and communities than all other natural hazards combined, the rate of development in flood-prone areas continues to escalate, putting more people and property in danger.



In addition to natural

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hazards, the town is vulnerable to man-made hazards. Man-made hazards can be categorized as technological hazards or terrorism. FEMA Guide 386-7 "Integrating Man-made Hazards into Mitigation Planning" provides the following definitions: Technological hazards refer to the origins of incidents that can arise from human activities such as the manufacturing, transportation, storage and use of hazardous materials. Terrorism refers to the use of Weapons of Mass Destruction (WMD), including biological, chemical, nuclear and radiological weapons; arson, incendiary, explosive and armed attacks; industrial sabotage and intentional hazardous materials releases; and "cyber-terrorism."

With the increase in man-made hazard events in recent years, the need to incorporate these new threats into mitigation planning is becoming more and more evident. Events such as the 1995 bombing of the Murrah Federal Building, the 1996 Olympic Park Bombing, the 2001 Anthrax attacks, the 2001 hazardous materials train derailment, the September 11th attacks on Washington and New York, the 2002 Beltway sniper attacks, the 2009 mass casualty shooting at Fort Hood, the 2012 Sandy Hook shootings, the 2013 Boston Marathon Bombing, and a multitude of smaller-scale incidents and accidents reinforce the need for communities to reduce their vulnerabilities to future terrorist acts and technological disasters.

While natural and man-made hazards cannot be prevented, local communities can use various means to reduce the vulnerability of people and property to damage. Communities can reduce exposure to future natural hazards by managing the location and characteristics of both the existing and future built environment. By utilizing location and construction techniques, a community can mitigate negative impacts and reduce future damage to both human lives and property.

Hazard mitigation is defined as "any action taken to eliminate or reduce the long-term risk to human life and property from natural and technological hazards." Mitigation activities are ongoing and overlap all phases of emergency management.

Local hazard mitigation planning is the process of organizing community resources, identifying and assessing hazard risks, and determining how to best minimize or manage those risks. This process results in a hazard mitigation plan that identifies specific mitigation actions, each designed to achieve short-term planning objectives as well as a long-term community vision.

The primary objective of the Town of Nags Head related to hazard mitigation is to reduce, to the extent possible, damage to life and property from hurricanes, severe coastal storms, and the other hazards identified in this plan. To support this objective, the following goals will serve to guide the development of mitigation strategies and policies:

Mitigation planning offers many benefits, including:

- Saving lives and property;
- Saving money;
- Speeding recovery following disasters;
- Reducing future vulnerability through wise development and post-disaster recovery and reconstruction;
- Expediting the receipt of pre-disaster and post-disaster grant funding; and
- Demonstrating a firm commitment to improving community health and safety.

Typically, mitigation planning is described as having the potential to produce long term and recurring benefits by breaking the repetitive cycle of disaster loss. A core assumption of hazard mitigation is that pre-disaster investments will significantly reduce the demand for post-disaster assistance by lessening the need for emergency response, repair, recovery, and reconstruction. Furthermore, mitigation practices will enable local residents, businesses, and industries to re-establish themselves in the wake of a disaster, getting the community economy back on track more quickly and with less interruption.

The benefits of mitigation planning go beyond solely reducing hazard vulnerability. Measures such as the acquisition or regulation of land in known hazard areas can help achieve multiple community goals, such as preserving open space, maintaining environmental health, and enhancing recreational opportunities. Thus, it is vitally important that any local mitigation planning process be integrated with other concurrent planning efforts, and any proposed mitigation strategies must take into account other existing community goals or initiatives that will help complement or hinder their future implementation.

A. Hazards

Nags Head is vulnerable to a wide range of natural and manmade hazards that threaten life and property. A rating system that evaluates the potential for occurrence for each identified threat is provided below. The hazards identified in Table 3.3.2.A were determined to be of concern for the town, even if only a low probability of occurrence.

Table 3.3.2.A: Hazards Affecting Nags Head

Natural Hazards		Manmade Hazards
Hurricanes	Erosion	Transportation/Infrastructure Impacts
Tropical Storms	Drought/Heat Wave	Active Shooter/Mass Casualties
Nor'easters	Earthquakes	Cyber Attacks

Table 3.3.2.A: Hazards Affecting Nags Head		
Natural Hazards		**Manmade Hazards**
Floods	Landslides/Sinkholes	Pandemic Events
Tornadoes	Tsunami	Public Health Events
Winter Storms	Dam/Levee Failure	Terrorism
Sea Level Rise	Rip Currents	

Table 3.3.2.A.1 ranks the hazards that could affect the town according to several measures:

- Likelihood of Occurrence estimates the likelihood of each type of hazard occurring in the Albemarle Region.
  - Highly likely = near 100% probably in the next year.
  - Likely = between 10 and 100% probability in the next 100 years.
  - Possible = between 1 and 10% probability in the next year, or at least one chance in the next 100 years.
  - Unlikely = Less than 1% probability in the next year, or at least one chance in the next 100 years.
- Intensity Rating- varying levels of potential intensity using relative terms high, moderate, and low.
- Impacts describe a combination of the severity of the event, its magnitude, and the density of human activity in the affected areas.
  - Catastrophic= >50% magnitude, multiple deaths, complete shutdown of critical facilities for >30 days, >50% of property is severely damaged.
  - Critical= 25% to 50% magnitude, multiple severe injuries, complete shutdown of critical facilities for >13 days, >25% of property is severely damaged.
  - Limited= 10% to 25% magnitude, some injuries, complete shutdown of critical facilities for >7 days, >10 % of property is severely damaged.
  - Negligible= <10% magnitude, minor injuries, shutdown of critical facilities for <24 hours, <10% of property is severely damaged.

Table 3.3.2.A.1: Hazards Ranking				
Hazard Type	**Likelihood of Occurrence [1]**	**Intensity Rating [2]**	**Impacts [3]**	**Conclusion Rank**
Earthquake	Unlikely	Low	Negligible	2
Floods	Highly Likely	High	Critical	5
Hurricanes	Highly Likely	High	Catastrophic	5
Land Slides	Unlikely	Low	Negligible	1
Nor'easters	Highly Likely	High	Critical	4
Thunderstorms	Highly Likely	Moderate	Negligible	2
Tornadoes	Possible	Moderate	Limited	3
Wildfires	Likely	Moderate	Limited	4
Winter Storms	Likely	Moderate	Limited	3
Dam/Levee Failure	Unlikely	Moderate	Limited	2
Tsunami	Unlikely	High	Critical	1
Erosion	Highly Likely	Moderate	Critical	5
Rip Currents	Highly Likely	High	Limited	3
Drought	Unlikely	Low	Negligible	1
Bridge Collapse	Possible	Moderate	Critical	3
Transportation Infrastructure Impacts	Possible	Moderate	Critical	3
Terrorism Event	Unlikely	Low	Negligible	1
Active Shooter/Mass Casualties	Possible	Moderate	Critical	3
Cyber Security Attacks	Likely	High	Critical	4
Pandemic Event	Unlikely	Moderate	Critical	1
Public Health Event	Possible	Moderate	Critical	2

NOTES:
[1] Highly Likely, Likely, Possible, Unlikely
[2] Relative terms
[3] Catastrophic, Critical, Limited, Negligible

B. Vulnerability

Vulnerability is defined as the extent to which people experience harm and property damage from a hazard. This section provides an overview of vulnerability by discussing the physical layout, existing development, and hazardous locations.

The following provides an overview of development vulnerability with respect to non-specific hazards throughout the Albemarle Region:

1) Dare County Existing Vulnerability

Table 3.3.2.B: Dare County Vulnerability						
Location	Developed			Undeveloped		
	# of Parcels	Acreage	Total Value	# of Parcels	Acreage	Total Value
Dare County (Unincorporated)	10,968	28,175	$ 4,134,129,900	5,917	191,658	$ 972,636,700
Duck	2,226	1,063	$ 1,413,368,100	455	232	$ 76,731,100
Kill Devil Hills	5,775	1,974	$ 1,752,751,900	1,177	1,140	$ 162,041,100
Kitty Hawk	2,502	1,792	$ 920,425,300	991	2,865	$ 91,706,900
Manteo	746	440	$ 414,007,600	284	611	$ 32,398,300
Nags Head	4,484	2,636	$ 2,098,215,800	1,013	6,082	$ 266,585,500
Southern Shores	2,411	1,671	$ 1,178,210,700	619	544	$ 122,646,700

2) Dare County Future Vulnerability

Currently, Dare County does not have the future land use information required to perform a detailed analysis of potential future conditions in relation to the non-specific hazard area. The County will continue to work on improving its GIS capabilities and aim to incorporate this element into future updates of this plan.

C. Flooding & Storm Surge

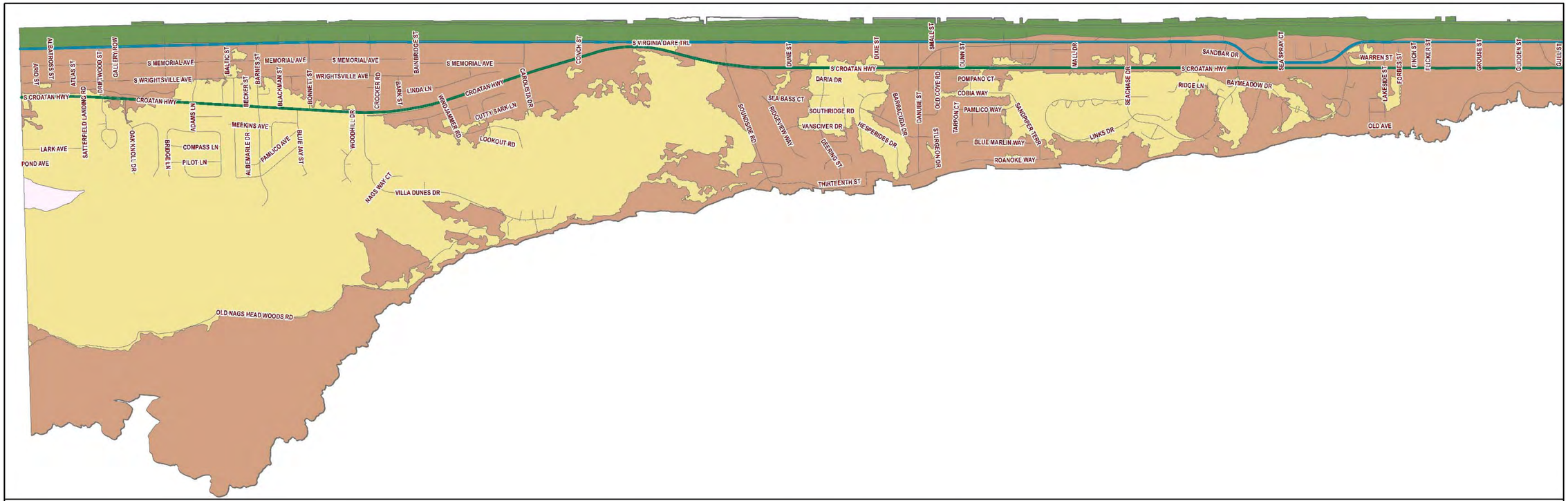
The Town of Nags Head is vulnerable to flooding from heavy rain events, hurricanes, tropical storms, and nor'easters. Flooding during hurricanes, tropical storms, and nor'easters impacts the ocean and estuarine shorelines, as well as adjacent development, which are vulnerable to the impacts of storm surge. Maps included in the Appendix, Section 5.3, graphically depict the Sea, Lake and Overland Surge from Hurricanes (SLOSH) model runs for both slow moving and fast moving Hurricanes. SLOSH is a computerized model run by the National Weather Service to estimate storm surge heights resulting from hypothetical hurricanes by taking into account the maximum of various category hurricanes as determined by pressure, size, forward speed and sustained winds. Storms are categorized into three groups - Category 1&2, Category 3 and Category 4&5- for both fast and slow approaches. The SLOSH model should be seen as defining the "worst case scenario" of potential maximum surge for particular locations as opposed to the regional impact of one singular storm surge event.

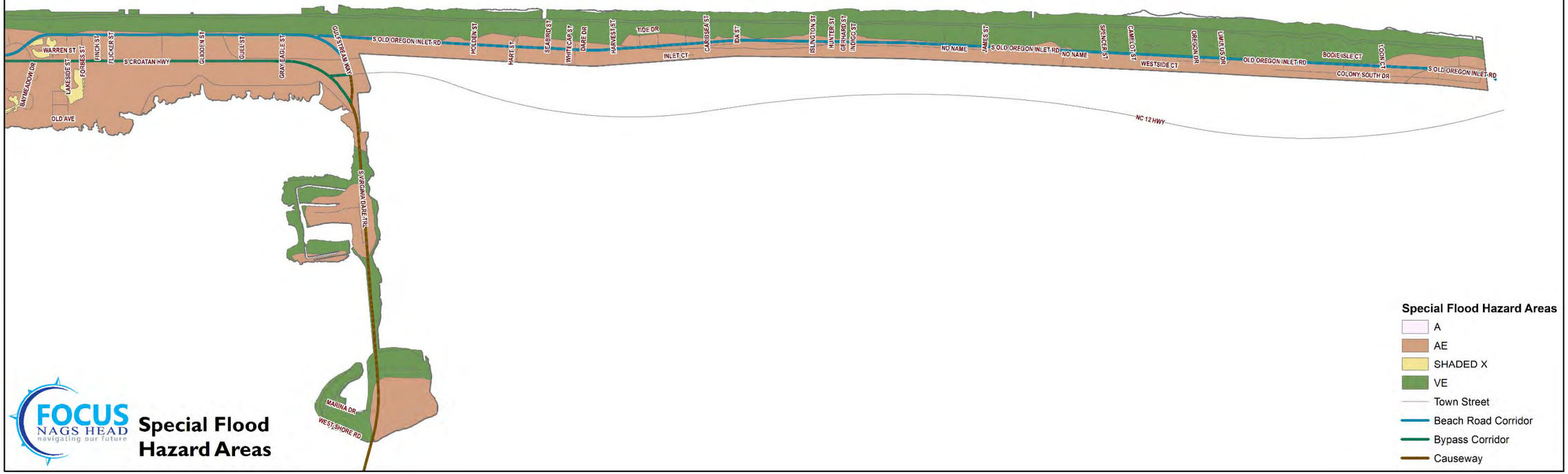
The following Table 3.3.2.C provides an overview of existing conditions for portions of Dare County that are impacted by potential storm surge generated by both slow and fast approaching storms.

Table 3.3.2.C: Vulnerability to Storm Surge						
Developed Land						
	Hurricane Storm Surge Category					
	Cat 1-2 Slow	**Cat 3 Slow**	**Cat 4-5 Slow**	**Cat 1-2 Fast**	**Cat 3 Fast**	**Cat 4-5 Fast**
# of Parcels	13,962	4,292	8,188	12,248	9,390	4,016
Acreage	20,841	5,414	10,482	31,215	3,630	1,724
Building Value ($)	$2,633,947,500	$786,698,900	$1,974,548,600	$2,846,411,600	$1,649,638,000	$777,027,200
Total Assessed Value ($)	$4,675,451,800	$1,752,163,000	$4,619,689,400	$6,322,145,900	$3,144,768,200	$1,394,292,000
Undeveloped Land						
	Hurricane Storm Surge Category					
	Cat 1-2 Slow	**Cat 3 Slow**	**Cat 4-5 Slow**	**Cat 1-2 Fast**	**Cat 3 Fast**	**Cat 4-5 Fast**
# of Parcels	6,002	1,305	2,353	5,953	2,300	1,203
Acreage	101,270	38,285	8,388	199,858	2,088	1,231
Total Assessed Value	$566,287,500	$560,970,900	$508,811,700	$1,252,873,700	$270,208,100	$117,207,400

Flooding also impacts many areas of the town with low ground elevations and/or high groundwater tables. The town has experienced significant ponding, as much as 3 feet in some areas of town, during heavy rainfall events due to limited drainage features, flat topography, and high groundwater elevations. A high groundwater table prevents infiltration of rainfall and stormwater. Flooding not only causes public safety hazards due to flooded roadways but a public health hazard if septic tanks and drainfields become covered. Stormwater is discussed in greater detail in Section 3.8.5 Stormwater Management. Additionally, high groundwater tables and water quality issues are discussed in more depth in Section 3.3.5, Water Quality.

The State of North Carolina, through the Federal Emergency Management Agency's (FEMA's) Cooperating Technical Partnership, has assumed primary ownership and responsibility of the Flood Insurance Rate Maps (FIRMs) for all North Carolina communities. The FIRM maps depict the 1% annual chance of flooding (i.e. there is a 1% chance in any given year that the town will experience a 100-year flood event) in the Town of Nags Head. These are called Special Flood Hazard Areas. There are two types of Special Flood Hazard Areas in the town; the VE zone and the AE zone. The AE zone includes areas subject to flooding from the 100-year storm event. The VE zone includes areas subject to flooding from the 100-year storm event as well as wave action of three feet or more.





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Special Flood Hazard Areas

Special Flood Hazard Areas

- A
- AE
- SHADED X
- VE
- Town Street
- Beach Road Corridor
- Bypass Corridor
- Causeway

The town also includes areas vulnerable to flooding beyond the Special Flood Hazard Areas depicted on the maps. Properties in the X zone are considered to be outside the Special Flood Hazard Area and are not required to have flood insurance nor do they need to meet minimum construction standards. These properties are considered low or moderate risk and have .2% annual chance of flooding. While these areas have a reduced risk, nearly 25% of all flood claims come from properties in an X flood zone.

Areas that are inundated by flooding include:

- Areas along or adjacent to NC 12 including:
  - the Old Post Office site
  - Kitty Hawk Kites/Sports (Casino Outfall)
  - the Ocean Rescue Station at Jockey's Ridge
  - Small Street
  - Eastern portions of the Municipal Complex site
  - E. Gray Eagle Street
- Areas between Highway 158 and NC12
  - Properties between Baltic Street, north to the town line at 8th Street on Wrightsville Ave., Memorial Ave., and NC 12.
  - Bonnett Street
  - Engagement Hill Loop, Seven Sisters Subdivision- frequent road flooding
  - Sandbar Drive and Bluewater Dr. -Dolphin Run Subdivision
  - Portions of Old Nags Head Place Subdivision along S. Memorial Ave.
- Areas adjacent to the Sound including:
  - W. Lakeside Street
  - Areas off S. Old Road, Forrest Street, and King Fisher Street
  - Outer Banks Event Site
  - W. Danube Street
  - Properties adjacent to the sound
  - Old Nags Head Cove sound access
  - Soundside Road

- Old Nags Head Cove Subdivision along Roanoke Way, S. Blue Marlin Way, and S. Pamlico Way

- Neighborhoods west of US 158
  - Vista Colony subdivision (northern portion)
  - North Ridge
  - Properties along Lookout Road and Cutty Shark Lane
  - Southridge
  - Deering Street (western portion)
  - Nags Head Acres (southeastern portion)
- South Nags Head
  - Juncos Street vicinity
  - Tides Drive vicinity
  - Areas adjacent to S. Nags Head drainage ditch
  - Outer Banks Pier vicinity
- Nags Head/Manteo Causeway (South Virginia Dare Trail/US RT 64/264)
  - Flooding across the road near the estuarine accesses site
  - The east bound and west bound approaches of the "Little Bridge"
  - Areas near Sugar Creek Restaurant
  - Pond Island

The following provides an overview of existing conditions for portions of Nags Head located within a defined flood hazard area. (Zones A, AE and VE):

Table 3.3.2.C.1: Dare County Vulnerability to Flooding

Location	Developed				Undeveloped		
	# of Parcels	Acreage	Building Value	Total Value	# of Parcels	Acreage	Total Value
Dare County (Unincorporated)	9,799	27,412	$1,849,483,000	$3,873,104,100	5,344	191,060	$937,944,100
Duck	1,216	733	$372,637,600	$932,482,700	271	166	$51,863,200
Kill Devil Hills	4,309	1,646	$734,155,700	$1,462,959,600	805	963	$131,322,600
Kitty Hawk	1,785	1,469	$336,956,800	$654,080,600	746	2,836	$67,823,100
Manteo	746	440	$250,295,600	$414,007,600	283	611	$32,326,100
Nags Head	3,620	2,361	$838,142,400	$1,831,212,400	821	5,992	$249,968,100
Southern Shores	1,428	1,156	$375,004,800	$813,983,000	373	377	$87,662,300
Source: Based on Flood Insurance Rate Maps (FIRMs) adopted on September 20, 2006							

D. Incipient Inlets

An incipient inlet is an ocean-to-sound inlet which has the potential form as a result of a severe storm event. Historically, three incipient inlets have been identified in Nags Head. These include:

- Whalebone Junction Incipient Inlet
- Marlin Waterway Incipient Inlet
- South Jockey's Ridge Incipient Inlet

Figure 8. Incipient Inlet Potential

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E. Vulnerability to Sea Level Rise

The impacts of a changing climate, which includes sea level rise, present potentially enormous future challenges to municipalities across the world, especially those with a close connection to the ocean like Nags Head. The Town of Nags Head wants to improve its resilience to preserve the core values and quality of life despite current and future hazards. A resilient Nags Head means our community will be better able to withstand, respond to, and recover rapidly from disruptions due to hazards without long-term damage to our economy or environment. It means the town will ideally require less government and/or private funding to recover, rebuild, and redevelop after a hazard occurs. Sustaining natural systems improves resilience by providing ecosystem services that directly or indirectly support our community's survival and quality of life. As stressors like accelerating sea level rise alter the damage we see from future hazards, it may not be enough to repeat actions the town has used in the past to recover. Therefore, we must identify, study, and implement adaptations – the actions the town, its residents, and business owners need to take to maintain and improve our resilience.

While sea level rise is often thought of as a rise in the ocean height, it has many more impacts on the land than simple inundation (flooding). Sea level is a component of the rates of erosion and can also interact with coastal aquifers, influencing both water table height and salinity. These types of impacts can affect Nags Head long before dry land is permanently flooded. Further, soundside marshes will struggle to migrate eastward and keep pace with the rising sea level and, in places where marsh migration is impeded by development, marsh acreage may be lost.

Sea level rise also adds to storm surge on both ocean and sound sides, not only changing the rate of erosion but also increasing the potential hazards from overwash. In addition, it is possible that a change in sea level may alter the potential risk of an inlet opening during exceptionally severe storm surges.

Higher water tables especially coupled with these type events where sea level increases on top of storm surge, could keep ocean outfalls inundated longer and may slow drainage leading to prolonged flooding in low lying areas. Additionally, chronically higher and saltier water tables may impact septic system function. It is not yet known how severe such impairments would need to be to affect surface water quality.

Resiliency, sea level rise, and adaptation are discussed in greater detail in Section 3.3.4, Coastal Resiliency and Sea Level Rise.

F. Critical Facilities

After a hazard event, it is important to be aware of those facilities that are essential to the health, safety, and viability of the community and general public. The damage or destruction of publicly-owned facilities could disrupt the everyday lives of citizens throughout the town. Critical facilities are defined as those facilities that are essential to the preservation of life and property during a disaster, those that are critical to the continuity of government, those necessary to ensure timely recovery, and those that provide shelter to individuals needing that service. The following is a list of identified critical facilities in the Town of Nags Head:

Table 3.3.2.F: Critical Facilities

Facility	Physical Address
Nags Head Municipal Complex & Police Station	5401 S. Croatan Highway
Fire Station #16	5314 South Croatan Hwy
Fire Station #20/Ocean Rescue Station	3719 South Croatan Hwy
Fire Station #21	8806 South Old Oregon Inlet Road
Nags Head Public Works Facilities	2200 Lark Ave
Nags Head Elementary	3100 S Wrightsville Avenue
Nags Head Water Processing Facility/Eighth Street Pump Station	2100 Pond Ave.
Gull Street Pump Station and Water Tank	104 East Gull
Water Tower - S. Nags Head	South Old Oregon Inlet Road
Water Tower - 8th Street	8th Street
Power Transmission Facility	West Lakeside Drive
Outer Banks Hospital	4800 South Croatan Hwy
Outer Banks Medical Center	4917 South Croatan Highway
Peak Resources Nursing Facility	430 Health Center Drive
Village at Nags Head Sewage System	Croatan Highway
Villas Package Plant & Central Sewage System	Villa Dunes Drive
State Roads/Stormwater Outfalls- North Carolina Department of Transportation	Town wide
Dare County Water- Water Main	Parallel to US 158

G. Repetitive Loss Properties

Repetitive loss structures are those that have suffered damage from repeated hazard events. A Repetitive Loss (RL) property is technically defined as any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A repetitive loss property may or may not be currently insured by the NFIP. The only reliable source of information on repetitive loss structures is flood insurance claims data available through the NFIP.

3.3.3. MITIGATION STRATEGIES

These focus areas define the various aspects of mitigation, and provide guidance toward the development of a truly comprehensive solution to mitigation planning.

1. Prevention includes regulatory methods such as planning and zoning, building regulations, open space planning, land development regulations, and stormwater management.
2. Property protection actions diminish the risk of structural damage through acquisition of land, relocation of buildings, modifying high-risk structures, and floodproofing high-risk structures.
3. Natural resource protection can soften hazard impacts through mechanisms such as erosion and sediment control or wetlands protection.
4. Emergency services measures include warning and response capabilities, town critical infrastructure protection, and health and safety maintenance.
5. Structural mitigation controls natural hazards through projects such as reservoirs, levees, diversions, channel modifications and storm sewers.
6. Public education includes providing hazard maps and information, outreach programs, real estate disclosures, technical assistance and education.

The following goals will provide the basis for the policies and actions that will be included in this section, some of which are already being administered and implemented:

1. Reduce the risk of loss of life and personal injury from natural hazards.
2. Reduce the risk and impact of future natural disasters by regulating development in known high hazard areas.
3. Maintain critical facilities in functional order.
4. Protect infrastructure from damage.
5. Ensure that hazard mitigation is considered when redevelopment occurs after a natural disaster.
6. Provide education to citizens that empowers them to protect themselves and their families from natural hazards.
7. Fulfill federal and state requirements for receipt of future disaster recovery and hazard mitigation assistance.
8. Improve inter-jurisdictional cooperation and coordination, especially regarding the reduction of natural hazard impacts.

POLICIES & ACTIONS

NR-10 Protect the public health and safety of the town from natural and manmade hazards through proactive planning and mitigation efforts.

NR-10a: Partner with the county, state, and local agencies to develop a special needs registry list.

NR-10b: Coordinate with the Outer Banks Hospital, the Peak Resources nursing care facility, and other special needs populations to develop a policy and procedure for evacuation procedures. Ensure that yearly contact is made, prior to an event, to verify the town's role.

NR-10c: Explore the feasibility of developing a Local Emergency Preparedness Committee (LEPC) to assist in planning, preparedness, response, and mitigation for potential hazards that could affect the town.

NR-11 Ensure that the town is a disaster resilient community that can survive, recover from, and thrive after a natural or man-made disaster event.

NR-11a: Engage the community in the update of the town's Emergency Operations Plan.

NR-11b: Ensure that an emergency transportation route, parallel to US 158, is maintained to provide an alternate route to NC 12 and US 158.

NR-11c: Obtain pre-storm authorization from the NC Department of Transportation (NCDOT) to clear NCDOT maintained roads after storm events.

NR-11d: Enter into an agreement prior to storm events to secure the use of the helipad at the hospital for pre- and post-disaster event needs.

NR-11e: Maintain mutual aid agreements and reevaluate as necessary to continue post-storm assistance with building inspections, damage assessment, utilities repair, public facilities maintenance, and additional public safety personnel. This includes continued participation in the Statewide Mutual Aid Compact.

NR-11f: Obtain debris removal and monitoring agreements on a yearly basis and seek pre-approved temporary disaster-debris management sites with the North Carolina Department of Environment and Natural Resources (NCDENR).

NR-11g: Continue to exercise inter-local agreements with Dare County and other municipalities for debris management and monitoring.

POLICIES & ACTIONS

NR-11h: Identify and implement methods to streamline the damage assessment process to provide information to Dare County, the state, and any other agencies assisting the town with recovery efforts. This includes methods to expedite the availability of damage and condemnation information to town staff and the public.

NR-11i: Explore resilient construction techniques and higher regulatory standards to protect existing and future development from frequent localized flooding events.

NR-11j: Monitor areas of frequent flooding during regular and major storm events. Maintain and utilize this information to ensure accurate floodplain mapping, educational efforts, and the application of higher regulatory standards (if needed).

NR-12 Support mitigation projects that reduce the potential damaging effects of hazards on the town.

NR-12a: Update and maintain a map of properties that are considered repetitive loss.

NR-12b: Assist home and businesses owners in mitigating hazards to their structures through grant funding opportunities, educational efforts, or one-on-one opportunities as they seek permits to complete work.

NR-12c: Develop a program to identify businesses and material storage areas where significant amounts of toxic or hazardous products are stored which would be subject to flooding.

NR-13 Support the town's continued participation in the National Flood Insurance Program (NFIP) and Community Rating System (CRS). Participation in the NFIP is key in making federally backed flood insurance available within the town and to improve the town's CRS rating.

NR-14 Promote public awareness of risks from natural and manmade hazards through public education programs.

NR-14a: Partner with Dare County's Joint Information Section and other neighboring municipalities to develop a process and protocol for informing visitors, residents, and special needs populations of potential hazard events prior, during, and after events. This includes storm-related information as well as evacuation and re-entry. The policy should explore alternative non-traditional methods of information dissemination.

POLICIES & ACTIONS

NR-14b: Enhance and expand the internal processes for providing public information pre, during, and post storm. This includes automated voice messaging system and other means of social media with storm damage and re-entry information, a Mayor's radio broadcast, email broadcasts, improved real-time website information with relevant local contact information, available information at traffic stops, and designation of a post-storm public information officer.

NR-14c: Develop a comprehensive educational outreach program to inform the public and increase awareness on hazards, how to develop and retrofit their properties against hazards, and individual tasks that can help them better prepare and respond to hazards. This should also include targeted educational strategies for repetitive loss properties. Staff should explore alternative options to traditional on-site meetings This may include increased use of social media, the public access channel, and short videos or handouts.

3.3.4. COASTAL RESILIENCY AND SEA LEVEL RISE

Nags Head's coastal location and environment ensure an abundance of natural resources that make it a highly desirable place to live, work, and visit. While the town's coastal location and environment enhance the quality of life and are key to the economic vitality of the community, it also makes the town vulnerable to a range of hazards including climate change and sea level rise. Vulnerability is the quality or state of having little resistance to some outside agent or the state of being left without shelter or protection against something harmful. Section 3.3.2 Hazard Mitigation, outlines a full list of hazard vulnerabilities in Nags Head.

The impacts of a changing climate, which includes sea level rise, present potentially enormous future challenges to municipalities across the world, especially those with a close connection to the ocean like Nags Head. The town recognizes the need to prepare for future hazards today.

A. Science of Sea Level Rise

1) Potential Impacts of Sea Level Rise

While sea level rise is often thought of as a rise in the ocean height, it has many more impacts on the land than simple inundation (flooding). Sea level is a component of the rates of erosion and can also interact with coastal aquifers, influencing both water table height and salinity. These types of impacts can affect Nags Head long before dry land is permanently flooded. Further, soundside marshes will struggle to migrate eastward and keep pace with the rising sea level and, in places where marsh migration is impeded by development, marsh acreage may be lost.

Sea level rise also adds to storm surge on both ocean and sound sides, not only changing the rate of erosion but also increasing the potential hazards from overwash. In addition, it is possible that a change in sea level may alter the potential risk of an inlet opening during exceptionally severe storm surges.

Higher water tables, especially coupled with these type events where sea level increases on top of storm surge, could keep ocean outfalls inundated longer and may slow drainage leading to prolonged flooding in low lying areas. Additionally, chronically higher and saltier water tables may impact septic system function. It is not yet known how severe such impairments would need to be to affect surface water quality.

2) Measuring the Change in Sea Level

While the ability to predict the exact sea level in 30 years is far from precise, the best available science suggests that sea level rise presents a risk of potentially serious impacts.

There are two scales on which sea level change is discussed: global sea level and relative (local) sea level.

Globally, ocean heat (thermal expansion with warmer water and contraction with cooler water) and the melting of land based ice are the main contributors to sea level. However, of greater concern to Nags Head is relative sea level change, or the difference in elevation between the surface of the ocean and the local land, averaged over time to eliminate the influence of tide and season. This relative sea level change is also influenced by vertical land motion and ocean dynamics in the region. The North Carolina Coastal Resources Commission (CRC) Science Panel 2015 NC Sea Level Rise Assessment Report gives an overview of the scientific causes of the tectonic structural deformation and glacial isostatic adjustment contributing to land subsidence measured in the Albemarle Embayment, the region in which Nags Head lies.

Tide gauges allow the measurement of sea level change over time in a place relative to a datum (a fixed point). The National Oceanic and Atmospheric Administration (NOAA) has two tide gauges near Nags Head for which sea level trends are computed: at the Duck pier on the ocean side, and at the Oregon Inlet Marina on the sound side. Of the two, the data record at the Duck pier is longer and uninterrupted, allowing a trend to be computed more precisely. While the Duck gauge is known to be extremely accurate it still has only been recording data since the 1970's. To understand relative sea level changes further back in history, samples of cores taken from marshes have also allowed scientists to reconstruct proxy data for the last 1,000-2,000 years that correlate with local tide gauge records and support that sea level in coastal North Carolina has been rising.

3) Research

In 2015, the North Carolina Coastal Resources Commission (NC CRC) Science Panel provided projections through 2045 of relative sea level at the Duck and Oregon Inlet tide gauges using linear interpretation of past trends and two greenhouse gas emissions scenarios, the lowest emissions scenario (RCP 2.6) and the highest emissions scenario (RCP 8/5). Greenhouse gas emissions scenarios are necessary to consider potential thermal expansion of water and melt rates of land-based ice due to scenarios of increased global temperature. These projections included vertical land motion, but did not attempt to include localized oceanographic effects that currently have an accelerating effect north of Cape Hatteras (Sallenger et al 2012 etc) because of disagreement in the literature on whether such effects are cyclical or will persist until 2045. The CRC Science Panel did not assign a likelihood to any of these scenarios, however, Kopp et al 2014 conducted a bottom-up analysis of all factors contributing to sea level rise and found that regardless of emissions scenarios it is very likely (probability of 90%) that by 2050 sea levels will rise at Duck between 9.4 and 23.2 inches above 2000 levels, with a median rise (half of scenarios less than, and half of scenarios greater than) of 16 inches. (tables here of mean, low, and

high for each) Kopp et al. 2015 note that these represent average trends over time, and because annual mean relative sea level varies to be higher or lower depending on conditions, sea level may be higher in isolated years even when a long term trend is absent. Such anomalously high sea level years may have shorter term impacts on infrastructure even if those trends do not persist, as in the 2009 anomaly.

Several studies have been produced since the NC CRC science panel report suggesting higher rates of global sea level rise (e.g. Mengel et al 2016). However, differing methodologies to estimate the contributions of land-based ice sheet behavior continue to produce different magnitudes of potential sea level contributions.

B. Adaptation

Coastal hazards like hurricanes, nor'easters and erosion currently affect the Town of Nags Head, and the town is taking actions to reduce the negative impacts of these hazards on town property owners. Over the past 10 years, the State of North Carolina also has begun to study how sea level rise and climate change may impact our coast in the future.

To begin identifying how proactive actions could increase resilience, the town has partnered with North Carolina Sea Grant to conduct a project that explores how sea level rise might impact the town, its infrastructure, economy, and ability to provide services. In order to consider a broad range of possible options, this process focuses on local community knowledge and perspectives on adaptations to potential hazards- including sea level rise.

Adaptations are actions that help the community and ecosystems prepare for and adjust to new conditions brought on by future sea level rise and climate change. Adaptation can be protective (i.e., reduce harm from the negative impacts of hazards) or opportunistic (i.e., take advantage of any beneficial effects of climate change).

Adaptation is an important step in order to become resilient. A resilient Nags Head means the town and its residents:

- Withstand, respond to, and recover rapidly from disruptions without long-term damage to the economy or environment;
- Require less government funding to recover, rebuild and redevelop its communities; and
- Sustain the way that natural systems provide ecosystem services that directly or indirectly support human survival and quality of life.

C. Sea Grant Partnership

In 2015, the Board of Commissioners supported entering into a partnership with NC Sea Grant to conduct an extension project to provide Nags Head with the data, legal, and

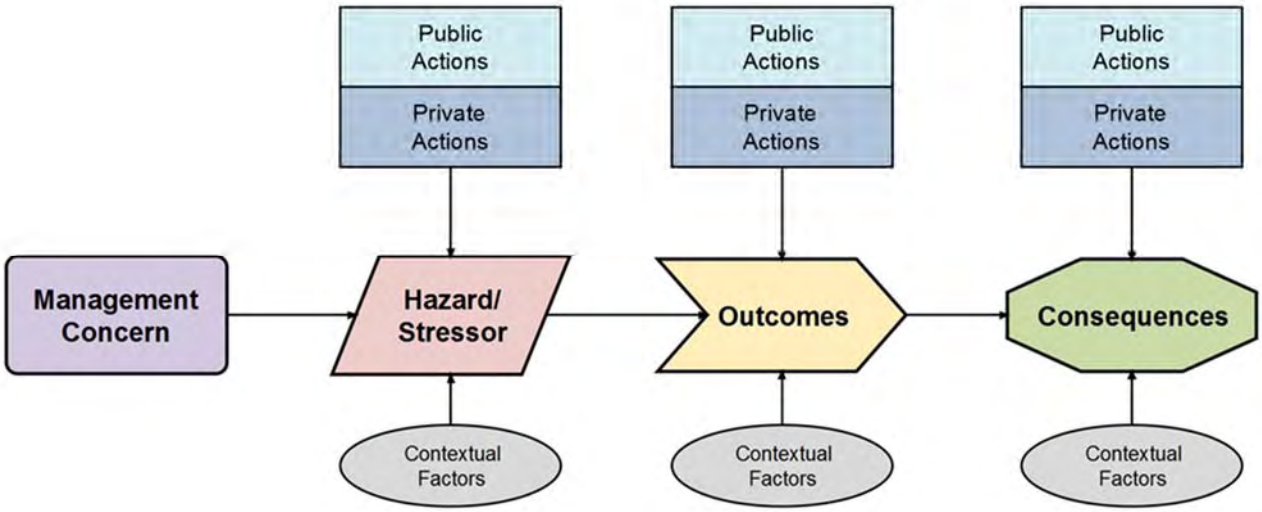
policy analysis it needs to understand its vulnerabilities and more effectively plan for the future. This project is rooted in a public process that involves generating community feedback to increase the publics' understanding of sea level rise. In a 2015 Board of Commissioners retreat, town staff developed several sea level rise adaptation goals, which this project will help Nags Head begin to address:

1. Determine the factors that make Nags Head vulnerable;
2. Explore adaptation and mitigation practices that may be used to offset negative impacts of sea level rise at a local scale;
3. Obtain scientific information to enable effective decision making to address threats posed by sea level rise;
4. Identify areas vulnerable to sea level rise;
5. Develop progress toward improving resiliency; and
6. Adopt a risk-based approach in planning policies.

In order to assist in meeting these goals, this project also will help the town to understand the legal and policy implications of adaptation alternatives, including issues of environmental justice. As part of the initial phase of this extension project, North Carolina Sea Grant utilized the Vulnerability Consequences and Adaptation Planning Scenario (VCAPS) process in the summer of 2015. The VCAPS process is intended to help communities become more resilient to hazards including climate change and sea level rise.

In the fall of 2015, Sea Grant staff conducted stakeholder interviews with key members of community, the Board of Commissioners, and staff. On December 7-8, 2015, approximately 60 people participated in a two-day community workshop. This workshop engaged those that participated in the initial stakeholder interviews as well as an open invitation to the community to participate. Participants at the workshop were broken into groups and asked to share how the town and its residents can reduce negative impacts to potential hazards. Through the VCAPS diagramming process, participants were able to communicate what they felt were hazards stressors, outcomes of the hazard stressors, and potential consequences of both of these. In addition, this process further engaged participants in thinking about potential public and private actions to adapt to or mitigate the issues identified. At the end of the two-day workshop, each group had produced a diagram that represents the potential hazards, outcomes, consequences, and public/private actions they felt could impact Nags Head. Following the meetings, interested participants signed up to participate in future planning activities.

Figure 9. VCAPS Diagram



In April 2016, a Climate Adaptation and Sea Level Rise Committee was formed. Later in June, the committee held its first meeting where they reviewed a draft report from the December workshop to ensure the report and diagrams were inclusive and captured the discussion of each of the three groups prior to moving a draft document forward to the Board of Commissioners. The Committee met again in August to review the public and private actions that are part of the draft report and diagrams. The committee worked to consolidate the actions and also engaged in a prioritization exercise. The adaptation actions identified can be generally broken into five main categories: ocean management, estuarine shoreline management, stormwater management, water (ground/surface) management, and an "all issues" category in which the actions were identified by all three groups at the December 2015 meetings.

Based on the prioritization exercise, key next steps for the town include: maintain and expand the Septic Health Initiative, on-going monitoring of erosion rates, development of a comprehensive education and outreach program on resiliency and sea level rise, development of an estuarine shoreline management plan, and development of a plan for adaptation that includes a suite of sea level rise scenarios.

Table 3.3.4.C: Sea Grant Implementation	
Date	**Task**
Early 2015	Board Approval
Summer 2015	- Research & Preparation - Stakeholder Interviews
Winter 2015	Vulnerability, Consequences, Adaptation, Planning Scenarios (VCAPS) Workshop
Spring 2016	- Drafting of Findings & Report - Formation of Coastal Resiliency & Sea Level Rise Committee
Summer 2016	Follow Up Meetings June 2016 – Review of Draft Plan August 2016 – Prioritization
Fall 2016- Current	- Finalize Report - Incorporate actions and policies into Comprehensive Plan
Spring/Summer 2017	- Final Committee Meeting - Presentation to BOC & Adoption

At this time, a detailed draft report has been completed and released. The action steps identified through this process will establish the foundation for the town's adaptation strategy. The Climate Adaptation and Sea Level Rise Committee will meet again to review the draft report. Following this meeting, the report will be presented to the Board of Commissioners for acceptance and adoption.

POLICIES & ACTIONS

NR-15 Foster partnerships with universities and non-profits to assist the town in identifying risks and making sound scientific based decisions that increase the town's resiliency.

NR-15a: Continue to partner with NC Sea Grant to finalize the VCAPS process and study on Sea Level Rise and Climate Adaptation.

NR-15b: Seek additional partners to assist the town in carrying out the actions of the VCAPS study including the scenario based vulnerability analysis.

NR-16 Minimize impacts of future sea level rise.

NR-16a: Conduct a vulnerability analysis to determine the town's risk to hazards including sea level rise. This analysis should include future sea level rise scenarios.

NR-16b: Research and map estuarine marsh migration along Roanoke Sound.

NR-16c: Develop a plan for adaptation that includes a suite of SLR scenario/probability distributions (more up-to-date than CRC).

NR-16d: Develop a comprehensive education and outreach program for K-12 and residents/property owners that includes the follow topics: SLR, storms, sound side & oceanfront erosion, beach nourishment, and CRS.

NR-16e: Maintain and expand the Septic Health Initiative by providing government assistance for septic retrofits, assisting homeowners in maintaining their septic systems, conducting more groundwater sampling, securing additional wells for sampling, developing partnerships to assist with the peer review of existing data, transitioning to a mandatory septic inspection program with incentives, and mapping of groundwater.

NR-16f: Develop an estuarine shoreline management plan that establishes policies, procedures, and an overall management strategy for the town's estuarine shoreline. This plan will work to develop projects and strategies to prevent estuarine flooding in the future. The plan should research, identify and map marsh loss, "soft" stabilization methods that are appropriate for Nags Head's estuarine shoreline, potential opportunities for land acquisition, and potentially restorable wetlands. Additionally, it should develop incentives that can be utilized for the protection of natural shorelines.