TIDES TO STORMS

PREPARING FOR NEW HAMPSHIRE'S FUTURE COAST

Assessing Risk and Vulnerability of Coastal Communities to Sea Level Rise and Storm Surge

Seabrook - Hampton Falls – Hampton - North Hampton – Rye - New Castle - Portsmouth

TOWN OF NEW CASTLE, NEW HAMPSHIRE

Vulnerability Assessment

of projected sea-level rise and coastal storm surge flooding

Prepared by the
Rockingham Planning Commission

September 2015

Cover Photo Credits: Steve Miller and RPC

Use and Applicability of this Report and Results:

The purpose of this vulnerability assessment report is to provide a broad overview of the potential risk and vulnerability of state, municipal and public assets as a result of projected changes in sea-levels and coastal storm surge. This report should be used for preliminary and general planning purposes only, not for parcel level or site specific analyses. The vulnerability assessment performed was limited by several factors including the vertical accuracy of elevation data (derived from LiDAR) and the static analysis applied to map coastal areas subject to future flooding which does not consider wave action and other coastal dynamics. Also, the estimated flood impacts to buildings and infrastructure are based upon the elevations of the land surrounding them, not the elevation of any structure itself.

PLANNING TO REDUCE RISK AND VULNERABILITY

New Hampshire coastal municipalities are confronted by land use and hazard management concerns that include extreme weather events, storm surges, flooding and erosion. These issues are only intensified by recent increases in the frequency and intensity of extreme storm events and increases in sea level.

New Hampshire's economy and quality of life have historically been linked to its shores, its vast expanses of productive saltmarshes and sandy beaches. Increased flooding has the potential to place coastal populations at risk, threaten infrastructure, intensify coastal hazards and ultimately impact homes, businesses, public infrastructure, recreation areas, and natural resources. Accounting for changes in sea level and coastal storms will help lead to informed decisions for public and private investments by minimizing risk and vulnerability.

What is a Vulnerability Assessment?

A vulnerability assessment identifies and measures impacts of flooding from sea level rise and storm surge on built structures, human populations and natural environments. Factors that influence vulnerability include development patterns, natural features and topography. The assessment evaluates existing and future conditions such as:

- inland extent and depth of flooding
- impacts to natural and human systems
- changes in impacts between different flood levels

How can the vulnerability assessment be used?

Information from a vulnerability assessment can help guide common sense solutions, strategies and recommendations for local governments, businesses, and citizens to enable them to adopt programs, policies, business practices and make informed decisions.

Planning for the long-term effects of sea level rise may also help communities better prepare in the short-term for periodic flooding from severe coastal storms.

How will the vulnerability assessment benefit the community?

The Tides to Storms assessment is intended to assist coastal NH communities to take actions to prepare for increase flood risk, including:

- Enhance preparedness and raise community awareness of future flood risks.
- Identify cost-effective measures to protect and adapt to changing conditions.
- Improve resiliency of infrastructure, buildings and investments.
- Protect life, property and local economies
- Protect services that natural systems provide
- Preserve unique community character

Results from a vulnerability assessment can be incorporated into various municipal planning, regulatory and management documents such as:

Master Plan	Capital Improvement Plan	Land Conservation Plan
Zoning Ordinance	Site Plan Review Regulations	Subdivision Regulations
Roadway Management Plan	Stormwater Management Plan	Facilities Management Plan

TABLE OF CONTENTS

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This project is funded by New Hampshire Homeland Security and Emergency Management (HSEM) through a Pre-Disaster Mitigation Grant from the Federal Emergency Management Agency (FEMA).

Additional funding for this project provided by the NH Department of Transportation through Federal Highways Administration.

MAPPING AND ASSESSMENT

1. VULNERABILITY ASSESSMENT: SEA LEVEL RISE AND STORM SURGE SCENARIOS

The *Tides to Storms* coastal vulnerability assessment project produced maps and statistical data about the potential impacts to New Hampshire's seven coastal municipalities from sea-level rise and storm surge to infrastructure, critical facilities transportation systems, and natural resources. Three sea-level scenarios were evaluated accounting for a range from the intermediate-low to the highest projected sea-levels at the year 2100.

Figure 1. Sea-Level Rise and Storm Surge Scenarios

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Sea Level Rise	1.7 feet	4.0 feet	6.3 feet	--	--	--
Sea-level Rise + Storm Surge	--	--	--	1.7 feet + Storm Surge	4.0 feet + Storm Surge	6.3 feet + Storm Surge

Note: Storm surge is the area flooded by the 100-year/1% chance storm event.

Baseline: Flooding from the sea-level rise scenarios and sea-level rise plus storm surge scenarios evaluated in this study were mapped from Mean Higher High Water (MHHW) which is 4.4 feet in the coastal region of NH. ***Mean Higher High Water is the average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. The National Tidal Datum Epoch (NTDE) refers to the specific 19-year period adopted by the National Ocean Service as the official time segment over which tide observations are taken. The present NTDE is 1983 through 2001 and is considered for revision every 20-25 years (the next revision would be in the 2020-2025 timeframe).***[1]

Storm Surge: ***Storm surge is the rise of water level accompanying intense coastal storm events such a tropical storm, hurricane or Nor'easter, whose height is the difference between the observed level of the sea surface and the level that would have occurred in the absence of the storm event.***[2] Storm surge is mapped using the 100-year/1% chance flood events from the Preliminary Flood Insurance Rate Maps (FIRMs) released by FEMA in 2014. The preliminary FIRM's account for the limit of moderate wave action in coastal areas, however this assessment does not take into account additional flooding and impacts related to more severe wave action, wind action, erosion and other dynamic coastal processes.

Sea-Level Rise Scenarios

The sea-level rise projections used in this study are based on an earlier study completed in 2011 by Wake et al but are similar to a more recent report issued by the NH Coastal Risks and Hazards Commission's Science and Technical Advisory Panel in 2014. As shown in the graphics below, while slightly different than the scenarios cited in the 2014 report, the sea level rise scenarios used in the Tides to Storms assessment

[1] NOAA website at http://tidesandcurrents.noaa.gov/datum_options.html
[2] EPA website at http://epa.gov/climatechange/glossary.html

yield coverage estimates of flooding that are within the mapping margin of error for the scenarios in both the 2011 and 2014 reports.

Figures 2 and 3 below document how the scenarios used in this report relate to 2011 by Wake et al but are similar to a more recent report issued by the NH Coastal Risks and Hazards Commission's Science and Technical Advisory Panel in 2014.

	Lower Emissions (B1)		Higher Emissions (A1fi)	
	2050	2100	2050	2100
Current Elevation of MHHW [a,b]	4.43	4.43	4.43	4.43
100-Year Flood Height	7.78	7.78	7.78	7.78
Subsidence	0.012	0.016	0.012	0.016
Eustatic SLR	1.0	2.5	1.7	6.3
Total Stillwater Elevation [a,c]	**13.2**	**14.7**	**13.9**	**18.5**

a - NAVD: North American Vertical Datum of 1988
b - MHHW: Mean Higher High Water at Fort Point, NH
c - Total Stillwater Elevation may not equal total of components due to rounding

Table 13. Preliminary estimates of future 100-year flood Stillwater elevations at the Fort Point Tide gauge under lower and higher emission scenarios (feet relative to NAVD[a]).

Figure 2. 2011 Sea-Level Rise Scenarios

Source: Wake CP, E Burakowski, E Kelsey, K Hayhoe, A Stoner, C Watson, E Douglas (2011) *Climate Change in the Piscataqua/Great Bay Region: Past, Present, and Future*. Carbon Solutions New England Report for the Great Bay (New Hampshire) Stewards.

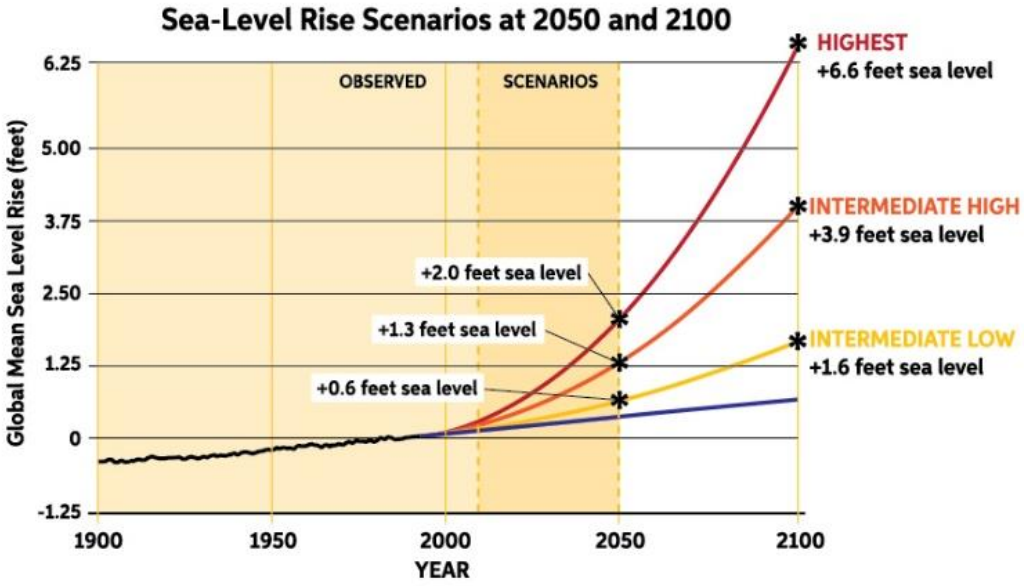


Figure 3. 2014 Sea-Level Rise Scenarios

Source: Wake CP, Kirshen P, Huber M, Knuuti K, and Stampone M (2014) *Sea-level Rise, Storm Surges, and Extreme Precipitation in Coastal New Hampshire: Analysis of Past and Projected Future Trends*, prepared by the Science and Technical Advisory Panel for the New Hampshire Coastal Risks and Hazards Commission.

2. ASSETS AND RESOURCES EVALUATED

List each asset/resource (see Part V) and data, reports, expert analyses or other information used to evaluate current and potential future impacts

TABLE 1. ASSETS AND RESOURCES EVALUATED FOR THE VULNERABILITY ASSESSMENT

CATEGORY	ASSETS AND RESOURCES
INFRASTRUCTURE AND CRITICAL FACILITIES	Municipal Critical Facilities (identified in Hazard Mitigation Plans) NHDOT Transportation Infrastructure State and Municipal Culverts Federal and State Historic Register Properties Other Assets: fire and police stations, graveyards, schools, dams, power stations and substations, public water supply wells, harbors, bridges NHDOT Ten-year and Long Range Plan Projects
ROADWAYS AND TRANSPORTATION ASSETS	State and Local Roadways Regional and Municipal Evacuation Routes Urban Compact Areas
NATURAL RESOURCES	Freshwater and Tidal Wetlands Aquifers and Wellhead Protection Areas Land Conservation Plan for NH's Coastal Watershed – Core Focus Areas Wildlife Action Plan – Tier 1 and Tier 2 habitats

3. MAP DESIGN AND ORGANIZATION

The Tides to Storms map set is comprised of two components: a map depicting the extent of projected flooding from the three sea-level rise scenarios in shades of green, and a map depicting the three sea-level rise plus storm surge scenarios in shades of pink. Each of the asset categorized evaluated are displayed on these two maps. Examples of the two scenario maps are shown on the following page.

Extent of Flooding from Sea-Level Rise and Storm Surge

The green and pink color schemes are arranged from lightest to darkest with increasing flood levels and extents.

Figure 4.
Sea–Level Rise Scenarios 1.7 feet, 4.0 feet and 6.3 feet

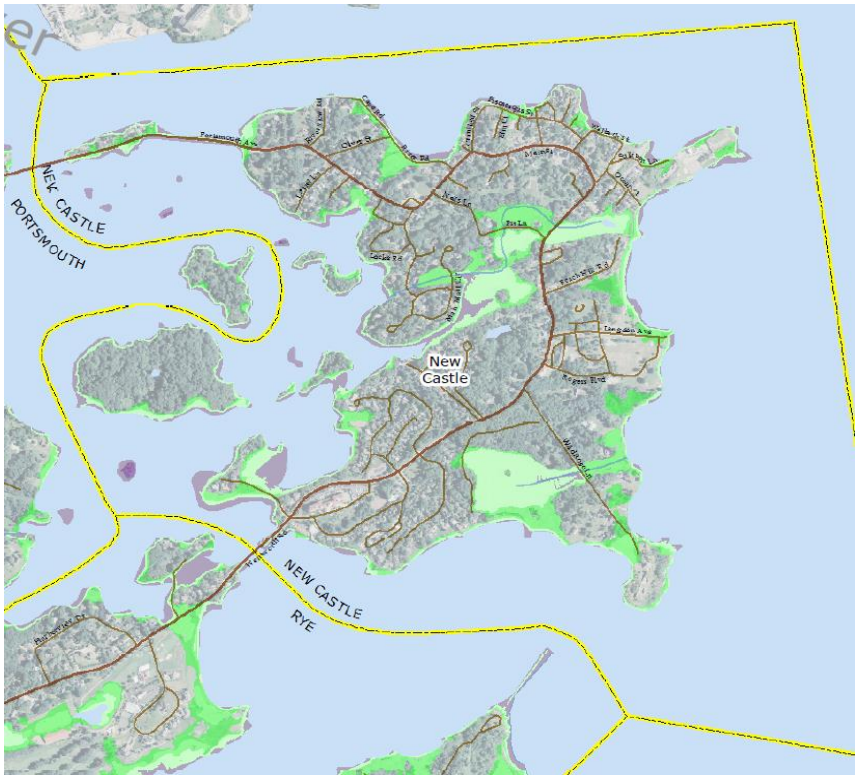
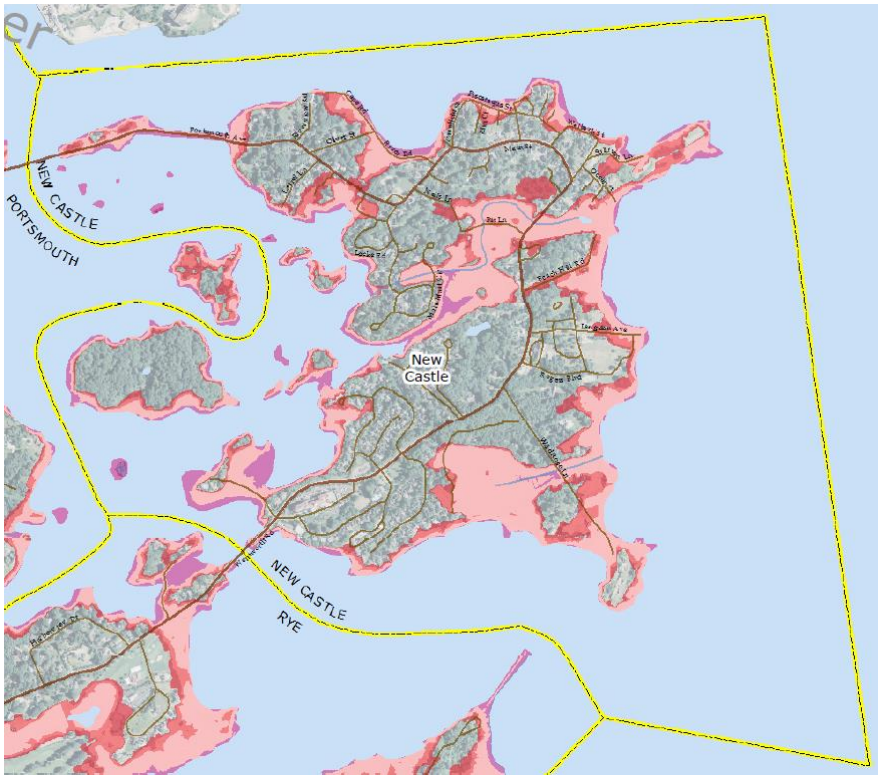
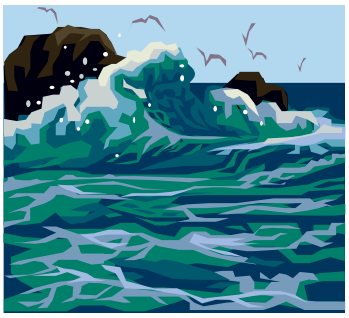


Figure 5.
Sea–Level Rise Scenarios 1.7 feet, 4.0 feet and 6.3 feet plus storm surge



Note: Storm surge is the area flooded by the 100-year/1% chance storm event.



New Castle - Portsmouth

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TOWN OF NEW CASTLE, NEW HAMPSHIRE

OVERVIEW

The Town of New Castle is located along the north coastal area of New Hampshire. The town is the smallest and most eastern town in the state, and the only one located entirely on islands. With a population of 968 (2010), New Castle is the least populated of the seven coastal municipalities. The town is characterized by densely populated single family homes, a large hotel and conference facility, and recreational marinas and boating facilities.

Vulnerability Assessment Results

Key findings for the Town of New Castle are reported in the table below based on evaluation of the 1.7 feet intermediate-low, 4.0 feet intermediate, and 6.3 feet highest sea-level rise projections at the year 2100 and these sea-level rise projections with the 100-year storm surge.

TABLE 2. SUMMARY OF ASSESSMENT DATA

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Infrastructure (# of sites)	5	11	17	17	17	21
Critical Facilities (# of sites)	1	3	4	4	4	5
Roadways (miles)	0.0	0.7	1.3	1.3	2.6	3.3
Upland (acres)	33.6	64.5	96.4	94.7	126.0	159.7
Freshwater Wetlands (acres)	15.7	20.8	23.8	24.1	25.4	26.6
Tidal Wetlands (acres)	14.5	21.5	24.0	24.7	25.2	25.4
Conserved and Public Lands (acres)	12.2	17.9	25.4	26.1	31.9	38.5
100-year floodplain (acres)	36.7	36.7	36.7	36.7	36.7	36.7
500-year floodplain (acres)	68.0	68.0	68.0	68.0	68.0	68.0

Notes: Storm surge is the area flooded by the 100-year/1% chance storm event. Upland refers to land above mean higher high water (highest tidal extent) and excluding wetlands. 500-year floodplain impacts were calculated based on flooding beyond the extent of the 100-year floodplain impacts.

The assessment shows that the greatest flood impacts will be to upland areas, conserved lands and freshwater and tidal wetlands. Flooding from both the sea-level rise and storm surge scenarios will impact neighborhoods along New Castle's entire coastline.

The complete assessment information is provided beginning on page 3 of this report.

SUMMARY OF VULNERABILITY ASSESSMENT RESULTS BY ASSET TYPE

INFRASTRUCTURE AND CRITICAL FACILITIES

Maps 3 and 4 Critical Facilities and Infrastructure shows state and municipal infrastructure types affected by sea-level rise and coastal storm surge flooding. Table 3 reports when specific infrastructure types are affected by each sea-level rise and coastal storm surge scenario.

State and municipal culverts and bridges are the infrastructure types most affected by projected sea-level rise and coastal storm surge flooding. Projects included in the state's Ten Year Plan and Long Range Plan are affected by projected by sea-level rise and coastal storm surge flooding, however no analysis has been done to determine to what degree they might be impacted.

TABLE 3. INFRASTRUCTURE

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
State And Municipal Infrastructure (# of facilities)						
Culverts	1	5	11	11	11	13
Transportation Infrastructure (# of facilities)						
Bridges	2	2	2	2	2	2
Harbor/Marina	0	1	1	1	1	1
Signs, Lights, Signals, Beacons, and Other	1	1	1	1	1	3
Ten Year and Long Range Plan Projects	1	2	2	2	2	2
Total	**5**	**11**	**17**	**17**	**17**	**21**

Definition of a Bridge. Per RSA 234:2, a bridge defines a bridge as a structure, having a clear span of 10 feet or more measured along the center line of the roadway at the elevation of the bridge seats, spanning a watercourse or other opening or obstruction, on a public highway to carry the traffic across, including the substructure, superstructure and approaches to the bridge. This definition includes a combination of culverts constructed to provide drainage for a public highway with an overall combined span of 10 feet or more and a distance between culverts of half the diameter or less of the smallest culvert.

Bridges Evaluated. Bridges identified as "impacted" by sea-level rise and/or storm surge scenarios indicates that the bridge and its infrastructure are located within the extent of the scenario. There has been no analysis to determine if the bridge, or any part of its structure is impacted.

Municipal Critical Facilities

Maps 3 and 4 Critical Facilities and Infrastructure shows the municipal critical facilities affected by sea-level rise and coastal storm surge flooding. Table 4 reports when specific municipal critical facilities are affected by each sea-level rise and coastal storm surge scenario.

Municipal critical facilities most susceptible to projected sea-level rise and coastal storm surge flooding are Great Island Common, the Coast Guard/Marine Patrol facility and Portsmouth Yacht Club. Only one wastewater pump station is impacted by sea-level rise flooding.

TABLE 4. MUNICIPAL CRITICAL FACILITIES (# of facilities)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
UNH/NOAA Research Facility	0	0	0	0	0	Flood
Pump Stations	0	1	1	1	1	2
Great Island Common	0	0	Flood	Flood	Flood	Flood
Coast Guard/Marine Patrol	0	Flood	Flood	Flood	Flood	Flood
Portsmouth Yacht Club	Flood	Flood	Flood	Flood	Flood	Flood
Total	**1**	**3**	**4**	**4**	**4**	**5**

Note: Municipal Critical Facilities as identified in the Town's Natural Hazards Mitigation Plan.

Historical Resources and Assets

The vulnerability assessment identified one National Historic Register properties that are affected by the sea-level rise and coastal storm surge scenarios evaluated. The Portsmouth Harbor Light House is affected at the highest sea-level rise scenario of 6.3 feet and the three coastal storm surge scenarios.

TABLE 5. NATIONAL HSITORIC REGISTER PROPERTIES

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Portsmouth Harbor Light	0	0	1	1	1	1
Total - Sites	**0**	**0**	**1**	**1**	**1**	**1**

TRANSPORTATION

Municipal and state roadways are impacted by rising sea-levels and storm surge. Collectively, these roadway impacts will isolate certain neighborhoods and evacuation routes during a 100-year storm event. Roadways impacted include NH Route 1B, Wild Rose Lane, Campbell's Lane, Duck's Head, Walbach Street, Piscastaqua Street, Atkinson Street, Elm Court, Neal's Lane, Neal's Pit Lane, River Road, Davidson Street, Grist Mill Lane, Cape Road, Laurel Lane, and Quarter Deck Lane.

Maps 5 and 6 Road and Transportation Assets show the state and municipal roadways affected by sea-level rise and coastal storm surge flooding. Table 6 reports the miles of state and local roadways affected by each flood scenario.

TABLE 6. STATE AND MUNICIPAL ROADWAYS AND INFRASTRUCTURE (miles)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Roadway Type						

Local	0.0	0.5	0.9	0.8	1.3	1.8
State	0.0	0.2	0.4	0.4	1.2	1.5
Total Road Miles	**0.0**	**0.7**	**1.3**	**1.3**	**2.6**	**3.3**
Guardrail	0.0	0.1	0.1	0.1	0.1	0.2
Bike Routes	0.0	0.2	0.5	0.5	1.1	1.4
Evacuation Routes	0.0	0.0	0.0	0.0	0.4	0.5

NATURAL RESOURCES

Maps 7 and 8 Conservation Areas and ***Map 9 and 10 Wetlands, Aquifers, Wellhead Protection Areas*** show natural resources affected by sea-level rise and coastal storm surge flooding. Table 6 reports the number of acres for each natural resource affected by each sea-level rise and coastal storm surge scenario.

TABLE 7. NATURAL RESOURCES (acres)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Resource Type						
Surface Water	0.2	0.2	0.9	0.9	0.9	1.0
Aquifers	0.0	0.0	0.0	0.0	0.0	0.0
Freshwater Wetlands	15.7	20.8	23.8	24.1	25.4	26.6
Tidal Wetlands	14.5	21.5	24.0	24.7	25.2	25.4
Wildlife Action Plan – Tier 1 and Tier 2 habitat	118.4	193.1	264.7	261.0	325.4	393.7
Coastal Conservation Plan Focus Areas	0.0	0.0	0.0	0.0	0.0	0.0
Conserved and Public Lands	12.2	17.9	25.4	26.1	31.9	38.5
Agriculture Soils (All Types)	4.7	8.7	12.0	11.6	13.7	15.2

Freshwater wetlands, tidal wetlands and conserved lands will be most impacted by flooding from sea-level rise and storm surge. There is potential for conversion of freshwater wetlands to tidal marshes and for tidal marshes to migrate into upland areas as sea-levels rise. Freshwater wetlands and salt marshes provide natural protection against flooding from sea-level rise and storm surge. Although freshwater wetland to tidal marsh conversion and tidal marsh migration will help retain some flood storage capacity in coastal areas, there is also potential for loss of flood storage by conversion of mud flats and low/high marsh to open water permanently.

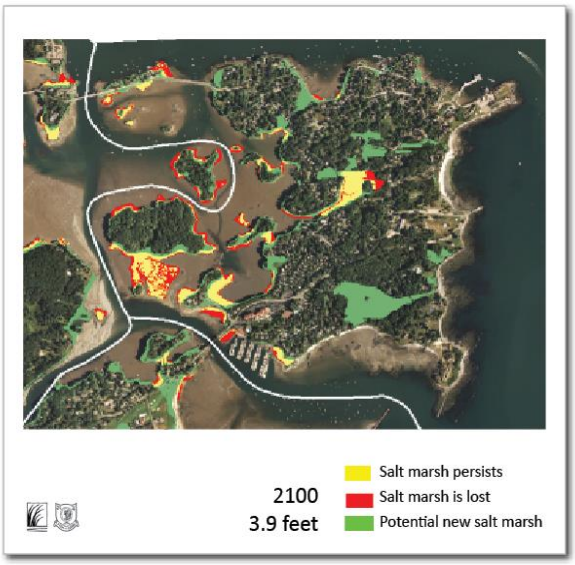
New Castle and conservation organizations have conserved 21% of the land in the community. Retaining these lands in a natural undeveloped state helps to reduce the town's risk and vulnerability to projected

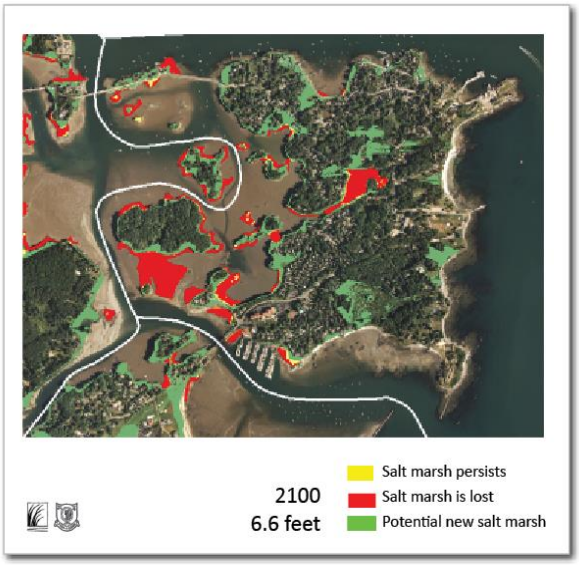
sea-level rise and coastal flooding. The Town may consider aligning its land protection strategies by incorporating criteria in its selection process that takes into account the value and benefits to both humans and ecosystems of increasing land protection efforts in areas projected to have high flood risk in the future.

SEA LEVEL AFFECTING MARSHES MODEL (SLAMM): TOWN OF NEW CASTLE

From: A Natural Choice: Conservation and Restoration Options to Enhance Coastal Resiliency in New Hampshire (NH Fish & Game, DRAFT September 2015)

Currently, 43 acres of salt marsh lie within New Castle. At the 3.9 feet sea level rise by 2100 scenario there is potential for 49 acres of new marsh to form and at the 6.6 feet scenario there is potential for 51 acres.





Protecting land where salt marsh can potentially migrate is a good strategy to enhance coastal resiliency. Of the opportunities available, the areas circled below are some of the priority areas for conservation as they are some of the largest in town, currently mainly undeveloped, and are robust as they remain under the highest sea level rise scenario modeled.

There are several opportunites to remove or modify barriers to tidal flow, although not all will be logistically feasible. Potential opportunites are show in blue on the map below.

LAND USE

Maps 1 and 2 Extent of Flooding show upland affected by sea-level rise and coastal storm surge flooding above mean higher high water. Table 8 reports the number of acres of upland affected by each flood scenario.

New Castle is particularly vulnerable to sea-level rise and storm surge due because the town is a series of islands connected by a single roadway, NH Route 1B. As the maps illustrate, flooding of roadways and neighborhoods will come as a result of rising waters in the tidal Piscataqua River and the Atlantic Ocean, as well as interconnected tidal creeks that bisect the town.

TABLE 8. UPLAND (acres)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Acres	33.6	64.5	96.4	94.7	126.0	159.7
% Upland	6.4	12.2	18.3	17.9	23.9	30.2

Total Upland in New Castle = 528.1 acres. Upland refers to land above mean higher high water (highest tidal extent) excluding wetlands.

Land Use/Land Cover

Map 14 Regional Land Use shows land use/land cover types affected by sea-level rise and coastal storm surge flooding. Table 9 reports the number of acres for each land use/land cover type affected by each flood scenario.

Developed land uses most impacted by sea-level rise and storm surge flooding are residential, recreation and transportation. Undeveloped land uses most impacted by sea-level rise and storm surge flooding are forest, other/idle, water and wetlands.

TABLE 9. LAND USE/LAND COVER (acres)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Land Use						
Active Agricultural	0.0	0.0	0.0	0.0	0.0	0.0
Aux. Transportation	0.0	0.0	0.0	0.0	0.0	0.0
Farmsteads	0.0	0.0	0.0	0.0	0.0	0.0
Forested	3.1	9.8	16.4	15.1	22.4	30.9
Industrial/Commercial	0.5	2.1	4.9	5.4	8.5	11.4
Mixed Urban	0.1	0.1	0.3	0.3	0.5	0.7
Other/Idle	4.3	11.1	15.9	16.9	19.0	20.4
Playing fields / Recreation	0.1	0.7	1.8	2.1	3.2	5.0
Railroad	0.0	0.0	0.0	0.0	0.0	0.0
Residential	3.1	10.0	20.8	19.1	34.5	51.4
Transportation	0.0	1.2	3.1	2.9	4.2	5.8
Utilities	0.0	1.2	3.1	2.9	4.2	5.8
Water and Wetlands	25.6	34.2	38.5	38.3	39.4	40.0

Note: Auxiliary Transportation refers to small pieces of land adjacent to transportation assets.

Zoning

Map 13 Regional Zoning shows local zoning districts affected by sea-level rise and coastal storm surge flooding. Table 10 reports the acres within each zoning district affected by each flood scenario. Zoning districts are superimposed over land use and land cover.

Zoning districts most impacted by sea-level rise and storm surge flooding are low and medium density residential neighborhoods.

TABLE 10. ZONING DISTRICTS (acres)

Sea-Level Rise (SLR) Scenarios	SLR 1.7 feet	SLR 4.0 feet	SLR 6.3 feet	SLR 1.7 feet + storm surge	SLR 4.0 feet + storm surge	SLR 6.3 feet + storm surge
Zoning / Land Use						
Residential – High Density	4.4	8.9	13.2	12.4	17.0	21.1
Residential – Medium Density	12.3	25.8	38.4	36.5	51.3	69.9
Residential – Low Density	15.5	25.5	37.7	38.4	48.9	58.7

Parcels and Assessed Value

Table 11 reports the number of parcels affected by for each of the six scenarios evaluated and the aggregated assessed value of these parcels. The degree to which the parcel and any development on the parcel is affected by sea-level rise or storm related flooding was not analyzed. Affected parcels were

identified based on their location either partially or fully within the extent of the scenarios evaluated. The data may include a number of high value parcels under state and municipal ownership.

For New Castle, there is a 27 percent increase in the number of affected parcels and nearly a $44 million increase in assessed value from the 1.7 feet to the 4.0 feet sea-level rise scenarios. There is a 17 percent increase in the number of affected parcels and approximately a $39 million increase in assessed value from the 4.0 feet to the 6.3 feet sea-level rise scenarios

TABLE 11. PARCELS AND ASSESSED VALUE BY SCENARIO

Sea-Level Rise (SLR) Scenarios	Number of Parcels Affected by scenario	Aggregate Value of Affected Parcels
1.7 feet SLR	171	$334,852,224
4.0 feet SLR	217	$378,907,024
6.3 feet SLR	253	$418,426,724
1.7 feet SLR + storm surge	250	$417,128,124
4.0 feet SLR + storm surge	280	$445,871,524
6.3 feet SLR + storm surge	307	$468,415,824

FEMA Flood Hazard Areas

Maps 23 and 24 Preliminary FEMA Flood Hazard Areas show areas within the 100-year and 500-year floodplain affected by sea-level rise and coastal storm surge flooding. Table 12 reports the acreage within the current 100-year and 500-year floodplains affected by each flood scenario.

Table 12 below reports the acreage within the current 100-year and 500-year floodplains affected by projected sea-level rise and coastal storm surge flooding. The majority of land affected by projected sea-level rise and coastal storm surge flooding is located within the current 100-year floodplain with minor extension of flooding into the 500-year floodplain.

The occurrence of the three sea-level rise scenarios within the 100-year floodplain provides the rationale to implement climate adaptation strategies within the current 100-year floodplain that will create resiliency to protect against long term impacts from projected sea level rise at 2050 and 2100.

TABLE 12. FEMA FLOOD HAZARD AREAS (acres)

Sea-Level Rise (SLR) Scenarios	S1 1.7 feet	S2 4.0 feet	S3 6.3 feet	S1F 1.7 feet + storm surge	S2F 4.0 feet + storm surge	S3F 6.3 feet + storm surge
100-year floodplain	**927.3**	**1,017.8**	**1,023.1**	**1,022.8**	**1,023.9**	**1,023.8**
Total Coastal Region Impacted	8,179.5	9,631.1	9,593.2	9,639.0	9,765.8	9,818.0
500-year floodplain (values in parenthesis = acres beyond 100-year floodplain)	**927.3 (+0.0)**	**1,017.9 (+0.1)**	**1,028.8 (+5.7)**	**1,028.0 (+5.2)**	**1,030.8 (+6.9)**	**1,031.3 (+7.4)**
Total Coastal Region Impacted	1.1	7.3	244.4	240.8	249.5	251.5

Floodplain assessment based on Preliminary Flood Insurance Rate Maps (FIRMs) released by FEMA in 2014.

ISSUES AND CONSIDERATIONS

New Castle is made up entirely of islands and is only connected to the mainland by bridges. Encompassing only 504 acres, or 0.8 square miles, but with 7.5 miles of coastline along the Atlantic Ocean and Piscataqua River, New Castle presents a unique set of circumstances when facing sea-level rise and storm surge. Due to its small size and access to municipal water and sewer systems, New Castle has a high population density.

The vulnerability assessment highlights how a storm surge could divide the main island into two parts at the intersection of NH Route 1B and Neal's Pit Lane during a flood event. Twenty one percent of land in the community, 105 acres, is conserved from development. While this level of conservation is to be commended, the risks to human life and infrastructure posed by sea-level rise and storm surge cannot be underestimated.

RECOMMENDATIONS

The following recommendations are short-term climate adaptation actions that can be included in the town's Natural Hazards Mitigation Plans, Master Plan and other planning and policy documents. These actions are focused on strengthening land use development standards, resource protection, municipal policy and plans, and public support to create more resilient development, infrastructure and natural systems. *Refer to Appendix B for an expanded list of climate adaptation strategies.*

REGULATORY

R1 - Elevate Structures 2 feet Above Base Flood Elevation. Adopt standards in floodplain zoning and/or Site Plan Review and Subdivision Regulations that require all new development and redevelopment to be elevated 2 feet above the base flood elevation. Two feet of additional elevation will ensure that structures are protected from flooding based on the highest sea-level rise projection of 2 feet by 2050.

R2 - Coastal Flood Hazard Overlay District. Adopt in the town's zoning ordinance a Coastal Flood Hazard Overlay District that includes performance based standards that protect against flood impacts from sea-level rise and coastal storm surge. Establish the overlay district boundaries based on current flood hazard areas on FEMA Flood Insurance Rate Maps and projected future high risk flood areas mapped by the Tides to Storms Vulnerability Assessment. (Also see similar recommendation in the Community Outreach and Engagement section below.)

R3 - Coastal Buffers and Tidal Marshes. Adopt buffers and setbacks that adequately separate development and infrastructure from tidal wetlands, freshwater wetlands and surface waters to sustain flood storage capacity, and allow for inland migration of tidal marsh systems and conversion of freshwater systems to tidal systems to accommodate projected changes in sea-levels. Incentives to further protect wetlands may include applying increased buffers and setbacks as mitigation for wetlands impacts from development

PLANNING AND NON-REGULATORY

P1 - Natural Hazards Mitigation Plan. Incorporate the vulnerability assessment information and recommendations from the Tides to Storms profile report in the Town's next Natural Hazards Mitigation Plan update. Continue revising and updating the assessment information and climate adaptation recommendations in future updates of the Plan.

P2 - Master Plan Coastal Hazards Chapter. Adopt a Coastal Hazards Chapter in the town's Master Plan that incorporates information and recommendations from the Tides to Storms Vulnerability Assessment Profile for New Castle.

P3 - FEMA Community Rating System. Incentives to reduce flood insurance rate costs could be modeled after climate adaptation actions recommended by FEMA's Community Rating System (CRS) program. Climate adaptation implementation includes planning and policy, regulatory, non-regulatory, and community outreach and engagement activities.

P4 - Capital Infrastructure and Investments. Incorporate consideration of impacts from sea-level rise and coastal storm surge flooding in current and future capital infrastructure projects. Incorporate the Tides to Storms vulnerability assessment information into infrastructure management plans and capital improvement plans.

P5 – Retreat Through Land Conservation. Land conservation offers the greatest opportunities to provide for adaptation to the effects of sea-level rise and coastal storm flooding and climate change impacts.

- Identify lands in high risk areas to purchase for the purpose of removing development and infrastructure and restoring the land to a natural condition. This is a way to gradually retreat from areas highly susceptible to coastal flooding.
- Adopt a targeted scoring framework or incorporate new scoring criteria into existing land conservation prioritization efforts that consider climate adaptation benefits when evaluating land for purchase.

P6 - Wetlands Mitigation Site Inventory. Identify and inventory lands where protection of tidal and freshwater wetlands would provide tangible benefits to protect against flooding, and restoration opportunities to remove barriers to tidal function and marsh and migration. This inventory will allow the town to pre-identify and prioritize sites that can be permanently preserved as a mitigation strategy for wetland impacts from development in high risk coastal areas.

P7 - Evacuation Planning. Prepare evacuation plans and coordinate these plans with towns in the coastal region to implement timely and comprehensive planning and notification for coastal storm events.

COMMUNITY OUTREACH AND ENGAGEMENT

O1 – NH Coastal Adaptation Workgroup. The NH Coastal Adaptation Workgroup (CAW) is a voluntary collaborative advocacy group consisting of members from federal and state agencies, regional and non-profit organizations, municipalities, academia, and private businesses. The group's focus is to: 1) pursue activities that improve the resilience of natural systems, infrastructure and development to the impacts of climate change; and 2) facilitate communication and cooperation among stakeholders throughout the

coastal watershed, especially in regard to research, programs and other efforts designed to help preserve, protect, and strengthen the Great Bay and Hampton-Seabrook Estuary. CAW can assist the town with outreach, planning and regulatory activities involving climate adaptation implementation.

O2 - Implement FEMA's High Water Mark Initiative. Communities implement the High Water Mark Initiative by providing information on past floods, such as documenting high water marks in public places, and posting maps and photographs of past floods on their websites.

O3 - Coastal Flood Hazard Overlay Map. Use the Coastal Flood Hazard Overlay District as a tool to inform property owners of existing and future risks and hazards based on projected sea-level rise and coastal storm surge flooding.

O4 - Living Shorelines and Landscaping. Maintaining natural shorelines is an effective way to preserve the functions of shoreline systems (marshes, dunes, estuaries) in providing valuable services including flood storage, recreational areas, and commercial harvesting of fish and shellfish.

- Provide information to property owners about living shorelines and the importance of retaining the functions of natural shorelines, and implementing landscaping best practices.
- Implement living shorelines projects on town lands to demonstrate best practices, and the benefits and effectiveness of living shorelines approaches.

O5 – Historical and Cultural Resources Inventory. Inventorying historical and cultural resources is the first step toward developing strategies to protect and preserve them.

Refer to New Castle's Natural Hazards Mitigation Plan for additional recommendations for outreach and engagement activities.

APPENDIX A – MAP SET

Map 1 Extent of Projected Tidal Flooding - SLR 1.7', 4.0' and 6.3'
Map 2 Extent of Projected Tidal Flooding - SLR + Storm Surge
Map 3 Critical Facilities and Infrastructure - SLR 1.7', 4.0' and 6.3'
Map 4 Critical Facilities and Infrastructure - SLR + Storm Surge
Map 5 Roads and Transportation Assets - SLR 1.7', 4.0' and 6.3'
Map 6 Roads and Transportation Assets - SLR + Storm Surge
Map 7 Existing and Recommended Conservation Areas - SLR 1.7', 4.0' and 6.3'
Map 8 Existing and Recommended Conservation Areas - SLR + Storm Surge
Map 9 Wetlands, Aquifers, Wellhead Protection Area - SLR 1.7', 4.0' and 6.3'
Map 10 Wetlands, Aquifers, Wellhead Protection Area - SLR + Storm Surge
Break in map numbering.
Map 13 Zoning Districts - SLR 1.7', 4.0' and 6.3'
Map 14 Land Use/Land Cover - SLR 1.7', 4.0' and 6.3'
Break in map numbering.
Map 17 Depth of Flooding - Sea-Level Rise 1.7'
Map 18 Depth of Flooding – Sea-Level Rise 4.0'
Map 19 Depth of Flooding – Sea-Level Rise 6.3'
Map 20 Depth of Flooding – Sea-Level Rise 1.7' + Storm Surge
Map 21 Depth of Flooding - Sea-Level Rise 4.0' + Storm Surge
Map 22 Depth of Flooding – Sea-Level Rise 6.3' + Storm Surge
Map 23 Preliminary FEMA Flood Hazard Areas - SLR 1.7', 4.0' and 6.3'
Map 224 Preliminary FEMA Flood Hazard Areas - SLR + Storm Surge