Report on Coastal Resiliency
Falmouth Massachusetts

2030: Mitchell Bath House, 100-year-storm water level

Presented to the Select Board
June 2021

Falmouth Coastal Resiliency Action Committee
Acknowledgements

The members of Falmouth’s Coastal Resiliency Action Committee would like to acknowledge the many guest speakers and participants who have engaged with the group since its inception in May 2017. Numerous Town Department Heads, County Officials, local Scientists, Consultants, and interested residents have presented germane information and/or participated from the ‘gallery’. Hundreds attended the Committee’s Workshops and Public Information Sessions at the Public Library, the new Senior Center, and a private venue in town. Such broad participation makes this report more universal, than if it were merely drafted by the Committee, alone.

The Committee would also like to thank Elise Leduc and Melissa Jaffe of the Woods Hole Group for assisting us with editorial assistance: appendices, footnotes and other minutia would be a jumble without their help.

Lastly, we must thank Susan Cronin, our Recording Secretary, and Jennifer Lincoln, Conservation Director, for their dedicated service. We were not always the easiest group to understand, but they managed to ‘translate’ our activity and keep up focused – most of the time!

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Paul Dreyer, Planning Board representative
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June 2021
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Resilience is defined as the ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a potentially hazardous event in a timely and efficient manner, including through ensuring the preservation, restoration, or improvement of its essential basic structures and functions.

--Intergovernmental Panel on Climate Change, 2012

Resilience is a fundamental characteristic of Nature — the integrity of natural systems naturally support resilience, and in an age of increasing disruption of the integrity of ecological and human systems, resilience serves as an ethical and legal principle that should be mainstreamed into the governance frameworks of human societies in order to guide holistic and integrated sustainable development.

--Habitat Climate Working Group, December 15, 2018

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2 UNEP HLPF Habitat-Climate-Environment Working Group, https://hcewg.wordpress.com/category/international-law/
1.0 INTRODUCTION

Cape Cod is a geologically young landform, deposited during the final ice-age period of the Pleistocene Epoch/Wisconsin Phase. As this ice age ended, the ends of retreating ice sheets occasionally paused for hundreds to thousands of years. Even as the ice sheet edge stopped, the glacial ice continued to move, melting along the way. This flowing ice acted as a conveyor belt, moving rock and sediment from Canada and New England to the edge of the ice sheet, depositing sand, gravel, and boulders – forming Cape Cod. About twelve thousand years ago the world climate warmed, the ice sheets retreated, and the sea level rose to outline present-day Cape Cod.

The further extent of glaciation reached Martha’s Vineyard and Nantucket, forming end moraines on those islands. As the ice sheet continued to retreat, a recessional moraine, a high, hilly area that marks the pause of the ice sheet’s advance, runs from Woods Hole to West Falmouth, and into North Falmouth. Beyond the edge of the terminal moraine, meltwater streams carried large quantities of sand and gravel depositing them over a large area to the east of the moraine, creating an irregular sloping surface called the “outwash plain”; lakes and streams developed on this outwash plain. In some places, sand and gravel covered large blocks of the glacial ice, which subsequently melted and created kettle hole pond.
Coastal erosion and storms have and will increasingly occur along Falmouth’s coast. These forces significantly affect infrastructure, properties, and natural resources. With a changing climate, and an acerating rate of sea-level rise, natural forces will increase in severity and intensity, threatening public infrastructure, private development, vulnerable populations, beaches and natural landforms, wildlife habitats, and Falmouth’s groundwater. In order to thrive well into the future in the face of potentially drastic outcomes, Falmouth must adapt. That is: Falmouth must become Resilient.

In 2017, the Falmouth Select Board established the Coastal Resiliency Action Committee (“the Committee”) to prepare action plans to help the Board better understand and address the risks and hazards to coastal infrastructure and coastal properties that may be caused by coastal erosion, storms, and sea level rise. For the past four years, the Committee has been analyzing coastal risks and assembling data for the Town’s usage to increase Town resiliency in the face of these forces, and now presents its Final Report to the Board.

Falmouth has been actively involved in management of its shoreline for over twenty years. The Town understands the importance of healthy beaches, dunes, and coastal banks in creating a more resilient coastal community. It is this Committee’s wish that the Town continue and improve upon its record of preserving and enhancing Coastal Resources, while envisioning and implementing policies that will protect Falmouth and its Natural Resources for future generations. Attaining such goals requires building resilience.

This report serves as a synopsis of past activity and will highlight key information and data collected by the Committee. It is the intention of the Committee to inform the Select Board of threats to the Falmouth coastline, from now through the end of the 21st century and beyond, to present data that will inform resilient policy proposals from the Board, and to make recommendations leading to action by the Town. Data and recommendations consider near-, mid- and long-term actions using temporal benchmarks at 2030, 2050, and 2070. Policy suggestions focus solely upon building resilience against natural forces, such as persistent tidal flooding, coastal storms, and sea level rise in Town coastal areas. Federal, State and Local studies referenced in the report are included as appendices.

1.1 COASTAL RESILIENCY ACTION COMMITTEE’S PROCESS AND ACTIVITIES

Consisting of a committee of five residents, with support from an alternate member and the Conservation Department, the Committee usually met twice per month, inviting experts, officials, and the public to open meetings to inform about relevant programs, projects and natural threats. Early in the process, meetings focused upon gathering and reviewing past reports relevant to its task, then hosting speakers from an array of departments and agencies at

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7 From Falmouth Board of Selectmen’s May 2017 Charge to the Coastal Resiliency Action Committee.
8 Neither CRAC nor this paper approaches emergency management or climate change mitigation, although we suggest that the Town exercise with deference to both in all future planning and activity.
9 Charles McCaffrey, chair; Melissa C Freitag, vice-chair; Andrew Ashton; Jamie Mathews, Conservation Commission; Paul Dreyer, Planning Board; Edward Schmitt, alternate, Jennifer Lincoln, Conservation Director; Susan Cronin, recording secretary.
the local, regional, state and federal levels in order to bring members up to date on current science, data and programs. The Committee paid special attention to existing Town Reports, such as the 2003 and 2010 Coastal Resources Working Group (CRWG) reports, and the 2017 FEMA Multi-Hazard Mitigation Plan.

In 2017 the Committee applied for and received a $20,000 grant to undergo the Commonwealth’s Municipal Vulnerability Preparedness (MVP) training process. It then sponsored a day-long community workshop in March 2018; a comprehensive invitation list included all Board and Committee members, Town Meeting Members, and neighborhood groups. Several members of the Board and Town Department Heads participated. This workshop certified Falmouth as an MVP Community and compiled Town-wide concerns and recommendations regarding climate change. MVP Certification allows the Town to be eligible for Action Grants to help increase climate resiliency. To maintain Falmouth’s MVP status and grant eligibility, the Town, via the Committee, must submit Annual Activity Reports to the Commonwealth.

Through successful grant applications and Town Meeting appropriations, the Coastal Resiliency Action Committee has completed two significant studies: a Town-wide Vulnerability Assessment (VA) and the Surf Drive Study. The Vulnerability Assessment is a comprehensive survey and study that tabulates and analyzes all Town infrastructure and properties within the coastal zone. It provides Town planners and policy makers with significant data regarding Town assets and the level of threats to each due to sea-level-rise and storm-flooding predictions. With this site-specific data, Falmouth can prioritize planning and projects to increase resiliency in the face of rising and shifting waters. The VA built upon results from the earlier-funded FEMA Multi-Hazard Mitigation Plan. The Committee and the consultant presented VA findings to the Select Board in 2019 and introduced findings to the general public with a meeting at the Library.

In 2019, the Committee applied for and was awarded an MVP Action Grant based upon findings in the VA. The Surf Drive Study project correlates to an MVP Workshop conclusion that Falmouth must “develop a retreat plan for coastal roadways.” The VA demonstrated that the Surf Drive area is amongst the most at-risk, exposed areas in town. The Surf Drive area is home to significant Town-owned infrastructure and extensive natural resources, all threatened by the encroaching sea; Town Hall – a priority structure – is contiguous to this coastline, via Siders Pond. The Committee used the MVP grant to hire consultants to focus upon the area closely, and devise Adaptive Pathway Solutions for the area, not just for Town property, but also for the residential neighborhood and natural resources. The consultant began the project with a community meeting at the Senior Center to glean residential points of interest and concern and worked with an interdepartmental steering committee throughout the study. At the conclusion

10 CRAC hosted experts from USGS, Mass CZM, WHRC, CCC, BCCE, DPW, Harbormaster et al.
11 See Appendix A-5 for the Vulnerability Assessment (2019)
12 See Appendix A-6 for the Surf Drive Study (2020)
13 See Appendix A-2 for the FEMA Multi-Hazard Mitigation Plan (2017)
of the Study, the consultant presented data to the Committee and then the community via an open Zoom meeting. The Committee and the consultant presented Surf Drive Study findings to the Select Board in November 2020. The Committee anticipates that Falmouth will conduct similar studies of other vulnerable coastal neighborhoods in the near future.¹⁴

Through the Coastal Resiliency Action Committee, Falmouth is working through the process of becoming a Community Rating System (CRS) Community. The federal CRS program, as part of FEMAs National Flood Insurance Program, will help fund and facilitate flood basin management in Falmouth. This program will not only help reduce coastal flooding risk in town, but it will also result in discounted flood insurance premium rates for coastal properties. We anticipate acceptance into the program in late 2021.

Concurrent to the above studies and projects, the Committee has provided guidance and resources to the Town about ongoing issues, projects and proposals in Town. Through MVP eligibility, the Coonamessett River Restoration Project received a $700,000+ grant to complete the restoration of the River. The Wastewater Department has applied for grants through the Town’s MVP eligibility. The Committee presented Falmouth an opinion regarding the Menahaunt Beach Project, and has presented several formal updates to Town Meeting, the Select Board, the Planning Board, and the Conservation Commission.

As the Committee’s charge sunsets in June 2021, the Committee respectfully presents this report on current issues and potential paths toward resolution to the Select Board. Amongst other policy recommendations, the Coastal Resiliency Action Committee suggests that its charge be extended.

### 2.0 ISSUES AND ANALYSIS

Falmouth lies exposed to multiple climate-change-related hazards. Natural resources, human settlement, and commercial resources are all exposed to a variety of natural forces, including tidal flooding, erosion, coastal storms, and sea-level rise. It is incumbent upon the Town policy makers to both identify what is at risk, and decide how to mitigate those risks, or accept the loss of what is at risk and the consequences incumbent from their choices. Ideally, Falmouth’s future development will be designed and executed with a purpose towards resilience, so future sites and uses will not need to be undone.

All development brings some level of risk with it. As Falmouth develops into the future, the Town must be cognizant of the changes the evolution of risk at certain points at and near the coastline. To adapt to sea-level rise, erosion, and flooding, policy makers and planners should abide by best practices and up-to-date scientific knowledge and data; planning for change over time is key to longevity. Remember, too, that technologies and uses will evolve over time. Development in 2030, 2050, and 2070 must assume an enhanced embrace of climate resilience

¹⁴CRAC has divided Falmouth into 13 Coastal Transects. Each transect houses Town assets at risk to severe flooding damage in the near-future.
if this infrastructure is to survive for generations. It is the Falmouth of the future as much as the Falmouth of today that must be resilient.

2.1 NATURAL FORCES

This section describes the natural forces that impact Falmouth’s coastline both in their present condition and how they are expected to change over time.

2.1.1 Erosion

Coastal shorelines—especially beaches, dunes, and banks—change constantly in response to winds, waves, tides, and other factors including seasonal variations, sea-level rise, and human alterations to the shoreline system. Every day, winds, waves, and currents move sand, pebbles, and other materials along the shore, onshore, or out to sea. The dynamic and continuous process of sediment transport, causing erosion and accretion, shapes Falmouth’s shoreline. Beaches change seasonally, tending to accrete gradually during the summer months when sediments are moved onshore by relatively low-energy waves, and erode dramatically during the winter when high-energy storm waves and currents, such as those generated by nor’easters, move sediment offshore.

The Falmouth shoreline has been engineered, often in piecemeal steps, in a manner that has significantly impaired the ability of the coast to evolve in response to natural processes, resulting in an overall reduction in coastal resiliency. The natural processes that would normally build and maintain beaches have largely been halted or altered by the presence of jetties, groins, and, in particular, construction of seawalls and other coastal armoring. Although groins and jetties trap sand on their upstream sides, downstream beaches become sediment starved because their continued erosion is no longer offset by replenishment of sediment from an upstream supply. The coastline’s sand supply is further impaired by armoring with seawalls and revetments, as the material previously eroded from coastal banks no longer enters the littoral system, accelerating erosion of downcoast beaches.

The two Coastal Resources Working Group reports on the Buzzards Bay and the South Shore coastlines provide a detailed discussion of the underlying geology, the ongoing coastal processes and sediment transport directions, and a summary of recommendations for coastal management. In addition, the Multi-Hazard Mitigation Plan presents the long-term and short-term town-wide shoreline change results derived from the Massachusetts Office of Coastal Zone Management’s statewide Shoreline Change Project. These data indicate the highest rates of recent (1975 to 2009) erosion in the following areas:

- Along Chapoquoit Beach south to the Great Sippewisset Marsh
- From the tip of Nobska point east to Oyster Pond Road
- From Bristol Beach to Menauhant Beach
- The southern shoreline of Washburn Island

Policy makers should remember that – except for harbor and port-related uses – people did not develop or settle near the coastline until the early 20th century. Current coastal development is a relatively new phenomenon.
2.1.2 Nor’easters
A nor’easter is a particular kind of cyclonic winter storm that moves along the east coast of North America, from south to north; once these storms reach New England, they often intensify. It is called a nor’easter because the winds associated with the storm affecting coastal regions typically blow from a northeasterly direction. Sustained wind speeds of 20 to 40 mph are common during a nor’easter, with gusting often reaching 50 to 60 mph. In some cases, the wind speed may meet or exceed hurricane force. Although the entire town is impacted by the heavy precipitation, which can take the form of rain and/or snow, and high winds that accompany these storm events, the low-lying coastal areas are particularly vulnerable to damage resulting from the significant storm surge and flooding that also come with the storm. Nor’easters have the potential to inflict more damage than many hurricanes because the high storm surge and high winds can last anywhere from 12 hours to 3 days, while local impacts from hurricanes usually last only for hours as the storms barrel through our community.

2.3 Hurricanes and Tropical Storms
Hurricanes are typically fast-moving storms (typically lasting 6 to 12 hours) with high winds (maximum sustained winds of 74 mph or higher) and torrential rains averaging 6 to 8 inches, but possibly dropping as much as 15 to 20 inches of rainfall during a single event. Similar to nor’easters, they can produce significant storm surges and result in widespread flooding (Figure 1). Storm surge happens when water is pushed towards shore by the force of storm-generated winds. An advancing storm surge combines with the water elevation of the normal tides to create a hurricane storm tide, which can increase water levels in Falmouth by as much as 10 ft. In addition, wind-generated waves are superimposed on the storm surge. This rise in water level can cause severe flooding in coastal areas, especially when a storm surge coincides with a high tide. However, due to the general short duration of hurricanes, the actual impact of flooding is highly depended on the level of the tide; if a hurricane passes at low tide, impacts from storm surge flooding can be greatly reduced.

The hurricane season for the Atlantic Ocean extends from June 1st to November 30th, with the peak from mid-August to late-October. However, deadly hurricanes can occur anytime during the hurricane season. Although tropical storms have impacted New England in the last few decades, a hurricane has not made landfall in the Falmouth area in the last 30 years (i.e., Hurricane Bob in 1991) although landfalling hurricanes were more common mid-century (Table 1). Smaller tropical storms and depressions have affected the area, generally inflicting minor damage such as some downed tree limbs, power outages, and limited damage to boating-related infrastructure.

Figure 1. Falmouth hurricane risk flooding scenarios from NOAA’s Sea, Lake and Overland Surges from Hurricanes (SLOSH)
Table 1. Major New England hurricanes.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 19, 1991</td>
<td>Hurricane Bob</td>
<td>Category 1</td>
</tr>
<tr>
<td>September 27, 1985</td>
<td>Hurricane Gloria</td>
<td>Category 2</td>
</tr>
<tr>
<td>September 12, 1969</td>
<td>Hurricane Donna</td>
<td>Category 2</td>
</tr>
<tr>
<td>September 11, 1954</td>
<td>Hurricane Edna</td>
<td>Category 3</td>
</tr>
<tr>
<td>August 31, 1954</td>
<td>Hurricane Carol</td>
<td>Category 3</td>
</tr>
<tr>
<td>September 15, 1944</td>
<td>Unnamed</td>
<td>Category 3</td>
</tr>
<tr>
<td>September 21, 1938</td>
<td>Unnamed</td>
<td>Category 3</td>
</tr>
</tbody>
</table>

2.1.4 Flooding

Two major types of flooding occur in Falmouth: coastal flooding and precipitation-induced flooding, often caused or exacerbated by blocked or undersized drainage during a heavy rainfall event. The most dangerous type of flooding occurs from coastal storm surges, which occur when water is pushed onshore during powerful storms, such as hurricanes and nor’easters (see above). Storm surges are easily capable of inundating low-lying areas, and waves associated with coastal storms can be highly destructive as they move inland, battering buildings, structures, and infrastructure in their path. However, the magnitude of flooding is strongly influenced by the tides; storm surge that occurs during a high tide will inundate a larger area than if the same surge occurs at low tide. A storm surge coinciding with a high tide event can devastate coastal structures such as piers, floats, docks, and boats. The 2014 FEMA Flood Insurance Rate Map (FIRM) for Falmouth, indicates areas mapped by FEMA as being in an AE zone (areas with a 1% annual chance to flood, colloquially referred to as the 100-year floodplain) or a VE zone (areas corresponding to the 100-year floodplain but with the potential for significant wave impacts), as well as areas within the 0.2% annual chance flood area (the area expected to be inundated during the “500-year” storm event). The effective FEMA flood map is included within the Multi-Hazard Mitigation Plan\textsuperscript{16}.

The second type of flooding, from blocked drainage, occurs in flat or depressional areas where runoff or rain collects and cannot drain out. Drainage systems are made up of ditches, storm drains, retention ponds, and other infrastructure designed to transport storm water away from roadways and parking lots, to receiving streams, ponds, or the ocean. When most of these systems were built, they were designed to withstand a 10-year storm event. Larger storms - that are expected to increase in both severity and frequency - can overwhelm these systems, and blocked or clogged drainage ditches and storm drains can stop the flow of water, resulting in backups and ponding. Water will remain in an area until it infiltrates into the soil, evaporates, the blockage is cleared, or the water is actively pumped out.

\textsuperscript{16} See Appendix A-2 for Multi-Hazard Mitigation Plan.
2.1.5 Sea-Level Rise

Sea-level rise refers to the increase in mean sea level (MSL) over time. Global MSL has been rising since the end of the last ice age approximately 11,000 years ago. The rate of rise has been relatively slow (~2mm/yr) over the past 6,000 years, however, sea-level rise (SLR) rates have accelerated since the late 19th century. Rising sea level results in two changes: higher daily high tides, which will convert current upland areas into intertidal areas, and an elevation of the storm surge baseline, which will allow coastal storm surge to extend farther inland. With the higher sea levels predicted as we move through the 21st century, areas much farther inland will be at risk of inundation. Furthermore, higher sea levels expose beaches to more frequent wave action, and raising of the wave-worked coastal profile leads to shoreline retreat as sediment is reworked offshore.

Falmouth has evaluated the potential reach of both of these impacts through the Falmouth Climate Change Vulnerability Assessment and Adaptation Planning report (VA), which looked at the probability of storm surge inundation today, as well as in 2030 and 2070 given a high sea level rise scenario, as well as the follow-up Neighborhood-Level Assessment, which considered not only the potential for storm surge inundation, but the potential future location of the mean high water (MHW) line, given a high SLR scenario (Figure 2). These detailed assessments indicate some of the most vulnerable areas to sea level rise are:

- **North Falmouth:** 157 structures vulnerable to inundation at high tide in 2070.
- **Woods Hole:** 26 structures vulnerable to inundation at high tide in 2030; 118 structures vulnerable to inundation at high tide in 2070.
- **Surf Dr/Main St:** 4 structures vulnerable to inundation at high tide in 2030; 174 structures vulnerable to inundation at high tide in 2070.
- **Central:** 3 structures vulnerable to inundation at high tide in 2030; 48 structures vulnerable to inundation at high tide in 2070.
Figure 2. Woods Hole's risk of daily tidal inundation. MHW = mean high water. VA, p.88: WHG, 2020.
2.2 **RESOURCES AND USES AT RISK**

Climate change poses risks to societal and natural resources along Falmouth’s extensive coastline. Planning for future development, corresponding infrastructure, and societal needs requires deference to the strengthening future forces of nature. However, plans, economic and societal trends, along with technological changes can dictate a very different nature of development in 2050/2070. Development that exists in the future will not necessarily resemble today’s development. Energy transmission or personal transportation may assume a very different mien by late century, and not require present-day infrastructure. Climatic activity or market shifts might alter the attractiveness of coastal dwelling. Alongside present development, it is this future development that must be made resilient in regard to sea-level rise and coastal storms.

With over 90 miles of coastline, Falmouth must approach this complex problem with solutions that match the complexity. Devising overarching responses for all parts of coastal Falmouth, it may be easier to approach the challenge piecemeal. For manageability or discussion’s sake, the Coastal Resilience Action Committee has divided the Town’s coastline into thirteen (13) distinct sections (Figure 3), coastal regions that all share certain geological or community characteristics.17

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17 These thirteen sections, or transects, include: 1) North Falmouth, including Megansett Harbor, Nyes Neck, and Wild Harbor/Silver Beach; 2) Old Silver Beach; 3) West Falmouth, including Little Island, West Falmouth Harbor, Chapoquoit, and Sippewisset; 4) Quissett; 5) Woods Hole, including Nobska to Trunk River; 6) Surf Drive/Main Street, including Oyster Pond, Salt Pond, Siders Pond, Main Street to Falmouth Harbor; 7) Falmouth Heights; 8) Maravista, including Bristol Beach; 9) Acapesket; 10) Davisville; 11) Central Avenue; 12) Seacoast Shores; and Waquoit, including Washburn Island.
Vulnerable Infrastructure includes buildings, bridges, roads, water mains and sewer lines, amongst other objects.

Figure 3. Falmouth's coastline was divided into thirteen sections, or transects.

2.2.1 Public Infrastructure and Facilities

Falmouth owns seventy-five miles (75) of coastal roadway and tens of million dollars of infrastructure\(^{18}\) situated in threatened areas along the coastline. The Town must decide for each of these assets if it wants to reinforce, move, or abandon them. One of the Coastal Resiliency Action Committee's early actions was to contract the Woods Hole Group to conduct a Vulnerability Assessment (VA) of Town resources. This study developed a detailed inventory of all Town resources vulnerable to flooding, and then created a weighted, ranked system to help department heads and policy makers prioritize actions.\(^{19}\)

\(^{18}\) Vulnerable Infrastructure includes buildings, bridges, roads, water mains and sewer lines, amongst other objects.
The ranking system devised by the Consultant and conclusions met suggest that several coastal assets, including roads, parking lots, docks, and piers around Town already stand at great risk of flooding today, and will suffer twice-daily inundation before other major buildings and structures around town do. Several Town assets in Woods Hole, such as the Park Road Sewer Lift Station and Taft Park experience flooding today.

According to the VA, the most at-risk assets of the Town, ranked by their composite risk scores include

1. Water Street (Luscombe Ave to Drawbridge)
2. Chapoquoit Road (Little Neck Bars Road to causeway)
3. Clinton Ave (Swing Lane to Scranton Ave)
4. Menauhant Road (at Bristol Beach/Little Pond)
5. Scranton Ave (Lowry Rd to Clinton Ave)
6. Waquoit Hwy (Waquoit Landing Rd to Childs River)
7. Surf Drive (Mill Rd to Bywater Ct)
8. Trunk River Sewer Main
9. Clinton Ave (Swing Ln to Sheridan Ave)
10. Surf Drive (Elm Rd to Mill Rd)
11. Nashawena St (Lummis Ln to Pine Island Circle)
12. Falmouth Harbor Dock (6)
13. Nashawena St (Cordwood Landing Rd to Swift St)
14. Old Dock Rd (Bowline Rd to Chapoquoit Rd)
15. Mill Rd (Hedge Ln to Seagull Ln)
16. Falmouth Harbor Clinton Ave Wharf
17. Falmouth Harbor Docks 1,2, 3 and 4

Most of the above-listed assets are Town Roads and Harbor Facilities. Many Town buildings and structures exist along and below these routes. Such assets, like sewers, culverts, water and gas lines will need to be secured or modified as coastal waters encroach.

The Vulnerability Assessment identifies these Town buildings and major structures as amongst the most vulnerable to flooding:

1. Park Road Sewer Lift Station
2. Woods Hole Drawbridge Hut
3. Old Dock Road Pier Shed and Upwellers
4. Town Hall
5. Mitchell Bathhouse

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19 See Appendix A-5 for the complete Vulnerability Assessment.
20 See VA Table 3-11, p.32, for complete data including probability of flooding in present day, 2030, 2050 and 2070.
21 See VA Table 3-5, p.26 for a comprehensive list including present day, 2030, 2050 and 2070 risks.
The Vulnerability Assessment shines light onto Town-owned assets that will experience inundation both today and in the near future. Officials must remember, however, that residential communities surround these roads and assets. These communities will experience flooded properties in concert with Town infrastructure.

### 2.2.2 Private Development

The Committee-sponsored Vulnerability Assessment (VA), described below, inventories the vast majority of Town infrastructure and property at risk. Based on the same model used for the Vulnerability Assessment the Committee also obtained data on the flooding risk for parcels with private structures, primarily residential structures (Figure 4), and the areas of Town directly affected by future sea level rise.

![Figure 4](#)

**Figure 4.** Properties at risk by neighborhood: The total number of properties exposed to different inundation risks for present and future sea level scenarios. Data from WHG Vulnerability Assessment addendum.

While the frequency and extent of flooding that is experienced now will increase over the next 50 years, the landward movement of the high tide line due to sea level rise creates a new and
significant risk to some existing development. By 2070, 849 structures will be within or seaward of the intertidal zone, meaning they will be permanently underwater or flooded twice-daily by high tide (Table 2). Silver Beach in North Falmouth is one of the areas in Town most affected by the landward movement of the high tide line due to sea level rise.

Table 2. Number of residential structures at risk from daily flooding.

<table>
<thead>
<tr>
<th>Neighborhood Name</th>
<th>Total Structures in Neighborhood</th>
<th>Number and Percent of Developed Residential Structures at Risk of Inundation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Present Day</td>
</tr>
<tr>
<td></td>
<td></td>
<td>At Risk of Inundation</td>
</tr>
<tr>
<td></td>
<td>#</td>
<td># %</td>
</tr>
<tr>
<td>Acapesket</td>
<td>1844</td>
<td>1844 100.0</td>
</tr>
<tr>
<td>Central</td>
<td>670</td>
<td>670 100.0</td>
</tr>
<tr>
<td>Davisville</td>
<td>1836</td>
<td>1,836 100.0</td>
</tr>
<tr>
<td>Falmouth Heights</td>
<td>1179</td>
<td>1,179 100.0</td>
</tr>
<tr>
<td>Maravista</td>
<td>1792</td>
<td>1,792 100.0</td>
</tr>
<tr>
<td>North Falmouth</td>
<td>2012</td>
<td>2,012 100.0</td>
</tr>
<tr>
<td>Old Silver</td>
<td>700</td>
<td>700 100.0</td>
</tr>
<tr>
<td>Quissett</td>
<td>791</td>
<td>791 100.0</td>
</tr>
<tr>
<td>Seacoast Shores</td>
<td>1525</td>
<td>1,524 99.9</td>
</tr>
<tr>
<td>Surf Drive/Main Street</td>
<td>2817</td>
<td>2,817 100.0</td>
</tr>
<tr>
<td>Waquoit</td>
<td>1154</td>
<td>1,153 99.9</td>
</tr>
<tr>
<td>West Falmouth</td>
<td>2177</td>
<td>2,174 99.9</td>
</tr>
<tr>
<td>Woods Hole</td>
<td>1085</td>
<td>1,077 99.3</td>
</tr>
<tr>
<td>All Combined</td>
<td>19572</td>
<td>19,558 99.9</td>
</tr>
</tbody>
</table>

Figure 5, below, shows the extensively developed Silver Beach residential and wetland area that will be directly at risk of inundation from sea level rise. This situation is repeated along low-lying areas of the Falmouth shoreline. While some actions could be conceived that might mitigate this projected inundation, the costs and negative effects of those actions on natural resources would likely make them unfeasible. Therefore, over time, most of this development may need to be abandoned or relocated. Mechanisms will need to be created to facilitate the transition of affected low-lying areas to a natural shoreline. A variety of tools, such as transfer of development rights, acquisition, and amortization of development, are available to induce relocation of development from unsustainable locations, such as, areas of future daily inundation and velocity zones, to nearby areas with low flooding risk. In some areas, resilience projects may alter the flood risk and consequently the need for relocation or abandonment.

For structures and infrastructure in areas of Falmouth at high enough elevations to avoid impacts from daily tidal flooding (i.e., sunny day conditions), but that will become increasing vulnerable to flooding due to storm surge, resiliency adaptations can be incorporated. They can be made more resilient through a variety of means, such as elevation or flood proofing.
The extensive data from the Committee’s studies can help the Town make the decisions where and how areas, structures and infrastructure can feasibly be made resilient by modification, relocation or abandonment.

Figure 5. Extent of future mean high water in the Silver Beach neighborhood (based on a high sea level rise scenario).

2.2.3 Vulnerable Populations

It is incumbent upon Town leaders to remember that people, including vulnerable populations, reside near and amongst the Town assets at risk. Tenets of Environmental Justice require the effective policy maker afford all residents meaningful opportunities in the decision-making process when creating and implementing environment and sustainability policies. These policy decisions affect residents, regardless of race, national origin or income. Environmental Justice accommodations are encouraged and protected by the US Environmental Protection Agency, the Civil Rights Act of 1964, and other federal and state institutions.

Certain human populations in Falmouth will find themselves at greater risk than others to climate change and sea level rise. Falmouth has many elderly residents, many of whom survive on fixed incomes and struggle with mobility and transportation. The Town must remain mindful of them while planning emergency and evacuation scenarios. Some residents will face
great challenges as roads and sidewalks become impassable. Many affordable-housing residents will not have the means to relocate or evacuate when conditions dictate such action. Furthermore, the Commonwealth has identified a neighborhood near the Town Harbor as one that must be regarded with an eye towards Environmental Justice.

Already, coastal communities elsewhere in the US are experiencing a decline in the value of real estate along the coastline. In 2020, Miami Beach reported a 15% decline in value of coastal properties, alongside a 19% surge in value for inland, once-affordably Little Haiti neighborhood properties. These value shifts ultimately force relocation of and resettlement of already at-risk populations. Meanwhile, some banks are re-assessing underwriting policies (“Underwaterwriting”) regarding long term/30-year loans for threatened coastal properties. Higher seas are also compelling insurers to reconsider insurance policies for potentially threatened coastal properties. Economists expect such trends to continue.

Market and lending fluctuations will indeed affect the Falmouth market and Town finances. Future property value inversions will exacerbate the availability of housing for lower- to moderate-income, local residents and risk the exaggeration of Climate Gentrification. Without pro-active planning for Affordable Housing, low- to moderate- income residents will be disproportionately disrupted by climate change. Meanwhile, the Town risks losing property tax revenue from devalued waterfront properties.

By combining Climate Change Adaptation initiatives with Community Development programs, Falmouth will better insulate itself and the community from the effects of coastal climate change hazards. The more Falmouth does to uphold environmental justice and repel climate gentrification will enable the Town to retain the benefits of its character and community.

2.2.4 Groundwater

Higher sea levels will raise coastal water tables, increasing the frequency of inland nuisance flooding in regions that were previously dry. Furthermore, rising seas force a wedge of saline groundwater inland, meaning that portions of Falmouth’s groundwater table is at risk to permanent salt-water contamination. According to a recent USGS study, Cape Cod’s freshwater lenses will become inundated by ocean water as the sea level continues to rise. At

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24 For more on Climate Gentrification, see Harvard Graduate School of Arts and Sciences, https://sitn.hms.harvard.edu/flash/2019/climate-newest-gentrifying-force-effects-already-re-shaping-cities/


the November 2019 Town Meeting, Falmouth’s Water Superintendent mentioned – in passing –
that one of Falmouth’s wells already has a “saline intrusion.”

2.2.5 Wetlands and other Aquatic Resources

There are a variety of wetlands and aquatic resource areas within the Town of Falmouth
including salt marshes, salt ponds, freshwater ponds and other freshwater vegetated wetlands.
Salt marshes are coastal tidal wetlands composed of salt-tolerant grasses and sedges
established on organic and mineral soils. Vegetation is typically dominated by smooth cordgrass
(Spartina alterniflora), salt meadow cordgrass (Spartina patens), and saltmarsh rush (Juncus
gerardii). Phragmites (Phragmites australis), an invasive species, has begun to encroach around
the higher elevation portions of many salt marshes. Salt marshes provide habitat for birds,
crabs, shellfish, fish, and numerous other species. Major salt marshes within Falmouth include
Great Sippewissett Marsh, Little Sippewissett Marsh, and Waquoit Bay National Estuarine
Research Reserve. Salt ponds within Falmouth also support wetland ecosystems.

Salt ponds are relatively shallow and contain brackish waters that tend to be fresher inland at
the inland edges. Periodically, a breach from the ocean to the pond can form, allowing ocean
water into the pond, maintaining a brackish environment. Some of the salt ponds in Falmouth
are managed to have permanent openings to maintain water quality and boat access. Salt
ponds support a range of salt tolerant and freshwater vegetation along the shoreline, as well as
eelgrass in the subtidal areas of the ponds. Salt ponds provide important habitat areas for
benthic invertebrates, shellfish, fish, and birds. Salt ponds in Falmouth include Oyster Pond, Salt
Pond, Little Pond, Great Pond, Green Pond, Bourne’s Pond, and Eel Pond. The town also
contains freshwater ponds such as Coonamessett Pond, Grews Pond, Ashumet Pond, Jenkins
Pond, and Long Pond. Similar to salt ponds, freshwater ponds support algae, benthic
invertebrates, fish, and birds.

Wetland resource areas provide many benefits for the Town of Falmouth. For instance, salt
marshes maintain water quality, mitigate erosion, attenuate floodwaters, provide nursery
habitat for recreationally and commercially fished species, and support recreational activities.
In addition, both saltwater and freshwater ponds create a buffer between upland terrestrial
ecosystems and marine environments, filtering out pollutants before they are introduced to the
ocean. Similar to salt marshes, the ponds also provide a sink for excess floodwaters.

Falmouth’s wetland resources, particularly its salt marshes, are threatened by future sea level
rise. Based on the results of the town-wide Vulnerability Assessment (WHG, 2020), which
utilized the SLAMM results developed for the Massachusetts Office of Coastal Zone
Management (CZM) to model the effects of sea-level rise on coastal wetlands and natural
resources, future sea level rise will result in an overall loss of salt marsh area. There are
currently 466 acres of salt marsh in town, but by 2070 salt marsh habitat in Falmouth is
expected to cover only 155 acres. These data indicate a lack of long-term resilience in
Falmouth’s salt marsh systems and an inability to keep pace with sea level rise; this is the case
for many communities throughout Massachusetts where trends are a general conversion from
high marsh to low marsh by 2030 and to tidal flats or open water by 2070. Additionally, the
Coastal Resiliency Action Committee

The topography in Falmouth is such that there is very little low-lying land around the periphery of existing salt marshes, affecting their ability to migrate inland with the rising tide. Salt marshes provide a natural sponge to buffer inland areas from storm surge, and act as a natural break, absorbing wave energy. Conversion of low marsh areas to tidal flats and open water would result in a reduced capacity for Falmouth’s salt marsh systems to protect inland areas.

2.2.6 Beaches, Barrier Beach, Dunes and Bluffs

As a coastal community, Falmouth contains a significant amount of coastline, much consisting of sandy coastal beaches although large stretches of armored shoreline now remain beachless. The main beaches in Falmouth are Bristol Beach, Chapoquoit Beach, Falmouth Heights Beach, Megansett Beach, Menauhant Beach, Old Silver Beach, Surf Drive Beach, and Wood Neck Beach. Along Falmouth’s southern shoreline are a number of barrier beaches, bordered to the north by salt ponds. Due to a disrupted sediment supply resulting from a series of groins, jetties and other coastal engineering structures, as well as from dense development (e.g., houses and roads) immediately north of these beaches, the coastal dunes along these beaches are currently relatively small and low in elevation, providing only minimal storm protection for inland resource areas and infrastructure. In contrast, some of the more natural (i.e., less developed/armored) beaches along the Buzzards Bay shoreline contain a more substantial dune system offering increased storm damage protection (e.g., Wood Neck Beach, Black Beach).

The topography is relatively flat along much of Falmouth’s shoreline, but there are a few notable locations where a substantial bluff or headland borders the coastline. Two examples of this are the area around Nobska Lighthouse and Falmouth Heights. In these locations, the landform rises steeply from the shoreline.

These coastal resource areas provide invaluable ecosystem services. Coastal beaches and dunes dissipate wave energy and buffer inland areas during extreme weather/storm events, as well as provide a sediment supply to downdrift shorelines. Barrier beaches also provide storm and wave protection for the wetlands and waterways behind them, as well as the surrounding development. Coastal beaches, dunes, and bluffs also provide habitat for important coastal wildlife and form the foundation for a healthy coastal ecosystem. Species that rely on coastal beaches and dunes for habitat include threatened and endangered species, such as the Piping Plover. Vegetation such as beach grass established along the coastal dune also sequesters carbon and helps combat erosion by promoting sand trapping and dune building.

Coastal resource areas also provide economic benefits to towns. Falmouth is a premier tourist destination on Cape Cod visited by large numbers of people each year. One of the great draws of Falmouth is the coastal character and access to many beaches for recreation and scenic beauty. Once in Falmouth, tourists support the local economy by renting houses, staying in hotels, eating in restaurants, shopping, and supporting other local businesses. Furthermore, coastal resource areas also provide essential shellfish and fish habitat, which enhances the recreational and commercial fishing and shellfishing industries. Finally, Falmouth’s beaches are quintessential to the character of the Town and are an essential component of the Town’s identity that residents take pride in.
2.3 CURRENT PROGRAMS AND LAWS

The Town of Falmouth Zoning Bylaw Recodification has been under a comprehensive and reorganization review over the last four years by the Planning Board and consultants. However, at this time, neither the Select Board nor Town Meeting has approved the Recodification; approval is anticipated in 2021. Unfortunately, the adverse impacts of climate change and sea level on the coastal areas of Town was not considered when Chapter 40 of the Falmouth General Code was last revised in 2011; however, these issues will have to be addressed by the Planning Board in the next revision.

2.3.1 Coastal Resources Working Group

In 2000, the Board of Selectmen formed the Coastal Resources Working Group (CRWG) to “explore reasons for the current condition of the coastal zone and provide future scenarios for the coastal zone based on an understanding of physical processes and management approaches.” Two studies were completed:

- *The Future of Falmouth’s South Shore* in May 2003
- *The Future of Falmouth’s Buzzards Bay Shore* in October 2010

The Executive Summary of these reports summarizes the comprehensive analysis of the Falmouth shorelines, and emphasizes encouraging the restoration of the natural sediment processes. Some of the recommendations included are as follows:

- Acquire coastal land for open space to increase public access, reduce property and infrastructure damage, and improve the functioning of coastal processes.
- Move or change vulnerable public infrastructure to reduce damage and maintenance costs.
- Conduct beach nourishment at key “source” locations to restore the natural sand transport system and provide recreation and storm protection.
- Remove unnecessary, hazardous, or damaging coastal armoring structures.
- Create sand management systems that will keep sand from being transported offshore into deep water by jetties.
- Develop improved regulations to protect coastal systems and beaches.
- Develop a comprehensive coastal management plan that addresses long-term planning and provides for timely responses to short-term issues.”

Past Boards of Selectmen have been remiss in implementing the CRWG recommendations. The most effective action taken by a Board was the establishment of this Committee. The Coastal Resiliency Action Committee strongly suggests that the Select Board implement recommendations of the Coastal Resources Working Group.

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27 See Appendix A-4 for the CRWG 2003 study, *The Future of Falmouth’s South Shore*
28 See Appendix A-3 for the CRWG 2010 study, *The Future of Falmouth’s Buzzards Bay Shore*
29 See Appendices A-3 and A-4 for the Executive Summary of each of these reports
2.3.2 Local Comprehensive Plan
The Falmouth Planning Board Local Comprehensive Plan\textsuperscript{30}, approved by Town Meeting in November 2014, includes some actions under the Coastal Resiliency element, as follows:

Community Goals and Public Policy:

- Policy #1: Falmouth shall preserve, restore, and enhance coastal ecosystems to better absorb impacts.
- Policy #2: Falmouth shall protect the operational capacity of vulnerable infrastructure systems.
- Policy #3: Falmouth shall create the tools to foster the dynamic natural system’s own resiliency.
- Policy #4: Falmouth shall encourage community-wide institutional adaptability.

Action items:

- Create a wetland restoration plan and begin reconstruction of the most vulnerable areas.
- Contract with an independent environmental risk analysis firm to evaluate the Town of Falmouth’s vulnerability to flooding, wind damage, and other coastal storm hazards with specific recommendations based on actual data and best practices.
- Integrate municipal adaptation projects into the town’s operating and capital budgets.
- Thoroughly review all local codes and by-laws to increase the resiliency of construction projects, and lobby for changes in the state building code.

Through CRAC, Falmouth has initiated some analyses regarding climate change risk. This Committee understands that addressing climate change is a complex and expensive prospect but emphasizes that sitting silent will not alleviate matters. Budgeting solutions will pose challenges, especially in the long term. The Town must begin integrating climate change adaptation or mitigation projects into the operating and capital budgets now, in order to be able to fund such projects in the future. The Select Board should develop a policy to require each department to consider the impacts of climate change on their respective operations in developing their future operating budgets.

2.3.3 Falmouth Select Board Strategic Plan
The Falmouth Select Board Strategic Plan is dated July 1, 2019 (FY 2020 to FY 2024), is included in Appendix A-7\textsuperscript{31}, and states that the resiliency of our coast and our infrastructure is a driver of our Strategic Plan and community decision making process. Some of the action steps proposed are:

\textsuperscript{30} See Appendix B-1 for the Local Comprehensive Plan Coastal Resiliency element
\textsuperscript{31} See Appendix A-7 for the Falmouth Select Board Strategic Plan
• Adopt Coastal Resiliency Action Plan recommendations of Coastal Resiliency Action Committee.
• Develop a policy to prioritize and protect public infrastructure.
• Explore alternatives to increase annual dredging and support regional efforts to improve dredging resources.
• Prioritize and plan for repairs for aging coastal structures, such as docks, ramps and retaining structures.
• Prioritize, plan and manage needs of non-waterways coastal structures, such as parking areas, bridges, bikeways, Trunk River sewer, etc. and other non-waterways retaining structures.

2.3.4 Zoning and Site Plan Review

Article XVIII of Chapter 240 of the Falmouth General Code addresses the dangers inherent upon coastal flooding at times of hurricanes or severe storms and as a means of protecting its citizens and their property established a series of Floodplain Overlay Districts and zoning regulations for construction of structures and for the use of the land within these districts as shown in Appendix B-432.

Article XXXIX of Chapter 240 of the Falmouth General Code refers to the Site Plan Review. This is a review of a potential significant addition to a developing or developed area od the Town. “The purpose of site plan review is to ensure the design and layout of certain developments permitted as a matter of right or by special permit will constitute suitable development and no result in a detriment to the neighborhood or the environment.” At this time, there is no consideration for addressing climate change or sea level rise although the transfer of development rights is being discussed.

2.3.5 Cape Cod Regional Policy Plan

The Cape Cod Regional Policy Plan prepared by the Cape Cod Commission dated February 2019 notes the following challenge:

Cape Cod faces threats due to climate change. The region’s 586 miles of vulnerable, tidal shoreline is already at risk due to flooding and erosion. Sea level rise and climate change will further exacerbate these challenges, as well as impact how Cape Cod’s ecosystems function, and recommends support and engagement of communities around coastal hazard mitigation and climate change adaptation planning.

32 See Appendix B-4 for Chapter 240 of the Falmouth General Code
2.3.6 Coastal Barrier Resources Act

The U.S. Fish and Wildlife Service’s website provides the following information on the Coastal Barrier Resources Act:

In the 1970s and 1980s, Congress recognized that certain actions and programs of the Federal Government have historically subsidized and encouraged development on coastal barriers, resulting in the loss of natural resources; threats to human life, health, and property; and the expenditure of millions of tax dollars each year. To remove the Federal incentive to develop these areas, the Coastal Barrier Resources Act (CBRA) of 1982 designated relatively undeveloped coastal barriers along the Atlantic and Gulf coasts as part of the John H. Chafee Coastal Barrier Resources System (CBRS), and made these areas ineligible for most new Federal expenditures and financial assistance.

The CBRA was reauthorized in 1990 under the Coastal Barrier Improvement Act (CBIA) and was expanded to include undeveloped coastal barriers along the Florida Keys, Great Lakes, Puerto Rico, and U.S. Virgin Islands; and added a new category of coastal barriers to the CBRS called "otherwise protected areas" (OPAs). OPAs are predominantly comprised of conservation and/or recreation areas such as national wildlife refuges, state and national parks, local conservation areas, and private conservation areas, though they may also contain private areas that are not held for conservation and/or recreation.

The law encourages the conservation of hurricane prone, biologically rich coastal barriers by restricting Federal expenditures that encourage development, such as Federal flood insurance. Areas within the CBRS can be developed provided that private developers or other non-Federal parties bear the full cost.

2.3.7 State and Town Wetlands Laws

The Wetlands Protection Act (WPA) MGL c. 131§ 40 protects wetlands and the public interests they serve, including flood control, prevention of pollution and storm damage, and protection of public and private water supplies, groundwater supply, fisheries, land containing shellfish, and wildlife habitat. These public interests are protected by requiring a careful review of proposed work that may alter wetlands. In addition to wetlands the law protects other resource areas, such as land subject to flooding (100-year floodplains), the riverfront area, and land under water bodies, waterways, salt ponds, fish runs, and the ocean. At the local level, the WPA is administered by the municipal Conservation Commissions and at the state level administered by the Department of Environmental Protection (DEP). DEP develops and WPA regulations and policy.

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33 USFWS. Coastal Barrier Resources System – Coastal Barrier Resources Act. https://www.fws.gov/cbra/act.html#:~:text=The%20Coastal%20Barrier%20Resources%20Act%20(CBRA)%20of%201982%20and%20its%20conservation%20of%20natural%20resources
Similar to the WPA the Falmouth Wetlands Bylaw Chapter 235, and its implementing regulations protect wetland and coastal resources and the public interest they serve. The local bylaw exceeds the minimum requirements of the WPA to address the particular needs and concerns of the community. A major difference in the between the Falmouth Wetland Regulations and the state regulation is the performance standards and criteria for developing properties in Land Subject to Coastal Storm Flowage (LSCSF). LSCSF is defined as land subject to any inundation, caused by coastal storms up to and including that caused by the 1% annual chance (100-year) storm, surge of record, or flood of record, whichever is greater.

2.3.8 Massachusetts Coastal Zone Management Program

The Massachusetts Office of Coastal Zone Management (CZM) is the lead policy, planning, and technical assistance agency for issues related to the coast and ocean. The agency falls within the stat’s Executive Office of Energy and Environmental Affairs (EEA) and implements the state’s coastal program under the federal Coastal Zone Management Act (CZMA). To ensure consistency with the federal CZMA, CZM implements the federal consistency review process in Massachusetts using a set of consistency policies. The Massachusetts Coastal Program Policies fall into nine (9) categories:

1. Coastal Hazards
2. Energy
3. Growth Management
4. Habitat
5. Ocean Resources
6. Ports and Harbors
7. Protected Areas
8. Public Access
9. Water Quality

In addition to their policy and review role, CZM has also administered the Coastal Resilience Grant program since 2014. This program provides financial assistance to the 78 municipalities within the Massachusetts coastal zone, as well as to certified 501(c)(3) nonprofit organizations that own vulnerable coastal property. To be eligible, projects must fall into one or more of the following categories:

1. Detailed Vulnerability and Risk Assessment
2. Public Education and Communication
3. Proactive Planning
4. Redesigns and Retrofits
5. Shoreline Restoration

In 2016, the Town of Falmouth received a $81,767 Coastal Resilience Grant for the Design and Permitting for Restoration at Chapoquoit Beach through Beneficial Reuse of Dredging Materials. This grant allowed the Town to design a beach restoration project for a critically eroded section of Chapoquoit Beach and initiated coordination with the U.S. Army Corps of Engineers to
receive sand dredged from the Cape Cod Canal for future beach restoration projects. In 2018, Falmouth received a second grant for $124,695 for an Assessment of Shoreline Stabilization Alternatives for Menauhant Beach. With this financial assistance, Falmouth evaluated engineering alternatives to increase protection of Menauhant Beach and the associated roadway infrastructure located west of the Bournes Pond Inlet to address flooding, erosion, and sea level rise concerns.

2.3.9 Massachusetts Municipal Vulnerability Preparedness Program

The Municipal Vulnerability Preparedness (MVP) grant program was created in 2017 as part of Governor Baker’s Executive Order 569 and provides support for municipalities in Massachusetts to identify climate hazards, assess vulnerabilities, and develop action plans to improve resilience to climate change. Falmouth was one of the first municipalities to take advantage of the MVP Planning Grant to plan and facilitate a Community Resilience Building Workshop. Falmouth convened a Workshop in March 2018 and completed the initial planning phase, which led to the Town becoming certified as an MVP Community. Certification qualifies Falmouth for further MVP Grant eligibility, as long as the Town maintains MVP Certification by providing annual progress reports.

Falmouth was one of the first municipalities to take advantage of the MVP Planning Grant to plan and facilitate a Community Resilience Building Workshop. Falmouth convened a Workshop in March 2018 and completed the initial planning phase, which led to the Town becoming certified as an MVP Community.

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2.3.10 FEMA Programs and Opportunities

- **National Flood Insurance Program (NFIP)**
- **Community Rating System (CRS)**
- **Multi-Hazard Mitigation Plan**
- **Building Resilient Infrastructure and Communities (BRIC) Program**
The National Flood Insurance Program (NFIP), administered by the Federal Emergency Management Agency (FEMA), provides flood insurance for residential and business property owners and renters in participating municipalities. In order to participate, a municipality must adopt certain regulations for development that reduce the effects of flooding on buildings. Falmouth is a participating municipality and has adopted standards for building in the flood-prone areas mapped by FEMA. These NFIP-standard regulations do not, for the most part, limit development in flood-prone areas. Rather they set construction standards for development. Falmouth’s Town Building Code\(^{34}\) outlines these standards.

To further reduce risks to development, FEMA operates the Community Rating System (CRS). Under CRS, if the Town documents efforts that go beyond the requirements of the NFIP to reduce the risk of loss to flooding, the premiums charged to property owner could be reduced 5%-to-45% annually. The percentage reduction depends on the nature and extent of what the Town does and documents in order to reduce the risk of flood damage. The Town is working with FEMA to obtain the benefits of the Community Rating System.

FEMA also works with municipalities to develop plans to mitigate the impacts of flooding and storms. Falmouth completed -- and FEMA approved-- the Town’s Multi-Hazards Mitigation Plan in 2017. The CRAC endorses that Plan and views it as complementary to this Report.\(^{35}\) The Town’s FEMA Multi-Hazards Mitigation Plan is due for revision; the Town must complete this update in 2022, in order to remain eligible for State and Federal grant monies and assistance.

Furthermore, FEMA is providing grants to assist municipalities through its Building Resilient Infrastructure and Communities Program and through its Hazard Mitigation Assistance. With these programs, FEMA can provide funding for the acquisition and relocation of buildings subject to flood damage. It is not unreasonable to expect that more funding will be available for this purpose in the future.

3.0 STUDIES COMPLETED

3.1 MA MUNICIPAL VULNERABILITY AND PREPAREDNESS (MVP)

Working with a consultant trained in the MA MVP Regulations, the Coastal Resiliency Action Committee invited over seventy community members, including department heads, committee chairs, scientists, and Town Meeting Precinct Captains, to participate in the initial qualifying workshop.

At the all-day workshop on March 24, 2018, participants worked in groups and brainstormed concerns. The participants recognized several weaknesses and potential steps the Town can take to ameliorate damages by coastal storms and climate change. The participants identified coastal flooding, sea-level rise, coastal erosion, and nor’easters and other winter storms as the

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\(^{34}\) Chapter 95, [https://ecode360.com/9073570](https://ecode360.com/9073570)

\(^{35}\) See Appendix A-2 for Falmouth’s Multi-Hazard Mitigation Plan
top hazards for the Town of Falmouth. Workshop participants also identified several key concerns and challenges for the Town with respect to these hazards, including:

- Vulnerability of the coastal road network given the increasing hazards presented by flooding, sea-level rise and coastal erosion;
- Vulnerability of the Town’s utility distribution systems (e.g., electricity and water);
- Coastal flooding (standing flood waters, storm surge, resulting erosion) presents a major threat to the Town’s infrastructure, facilities, neighborhoods, and individual homes and property; and
- Ongoing erosion along Falmouth’s coastline.

To address these (and other) concerns raised during the workshop, participants developed a suite of recommended actions to improve resilience. A total of 28 recommended actions were developed. The top five actions included in the final Summary and Findings Report are:

1. Develop a retreat plan for coastal roadways;
2. Develop a sediment management regime for Falmouth’s coastline;
3. Replace, maintain, or relocate vital water and sewer infrastructure as necessary;
4. Relocate critical Town facilities out of the floodplain; and
5. Coordinate with utility companies to increase preparedness and hazard response.

The Coastal Resiliency Action Committee recommends that the Select Board accept and act upon all of the twenty-eight (28) recommended actions included in the Falmouth MA MVP Summary and Findings Report.36

3.2 FALMOUTH CLIMATE CHANGE VULNERABILITY ASSESSMENT AND ADAPTATION PLANNING REPORT (VULNERABILITY ASSESSMENT) (VA)

With funds appropriated by Town Meeting in 2017, the Coastal Resiliency Action Committee posted an RFP to engage a consultant to conduct a comprehensive Vulnerability Assessment of coastal areas in Falmouth. The resultant Falmouth Climate Change Vulnerability Assessment and Adaptation Planning Report (VA), completed in 2020, presents a comprehensive analysis of expectant changes to sea level over the next seventy years, and the impact that encroaching waters will have upon Town infrastructure. The report uses the IPCCs “High Level Scenario” in its model, as that is the figure utilized by the Commonwealth. The Woods Hole Group conducted the study.37

Dividing Falmouth’s coastline into thirteen transects, the VA supplies the Town with the data necessary to plan resiliency into future projects. It identifies and lists all current Town infrastructure that will be encumbered by rising or stormy seas over the next fifty years. Presenting data at the 2030, 2050 and 2070 year-mark, the VA weighs, then ranks Town

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36 See Appendix A-7 for the MVP Summary and Findings Report.
37 See Appendix A-5 for the complete Vulnerability Assessment.
infrastructure according to the apparent need to protect or remove now or in the near future. The VA presents a series of Recommended Actions to the Town, to help increase coastal resiliency. It also made clear the need for further study into the Town’s coastal neighborhoods - - and the need to examine each transect at a more-detailed level in the near future – to help make Falmouth truly resilient.

Two landmarks that are currently threatened by Vineyard Sound are Falmouth’s Town Hall and Main Street. The VA’s data indicates that, ultimately, Town Hall should be relocated. However, the VA presents a near-term solution, as well: a flood protection berm-like landscaping feature that can be constructed around the south side of Town Hall to reduce the risk of flooding.

Vulnerability Assessment data predicts that the lower level of the Town Hall building has a 5% probability of flooding in present day, a 20% probability of flooding in 2030, and a 100% probability of flooding at least once per year in 2070, based on a high sea level rise scenario. These results indicate an increasing vulnerability and likelihood of damage to the lower-level areas of Town Hall over time. However, because the next few decades will have a relatively low probability of inundation, and there is still ample service life left in the building at its current location, it is worth retrofitting the Town Hall property in the short-term to protect it.

The VA recommends that the Town construct an earthen berm approximately 1,000 feet long that would extend from the higher elevation area behind St. Barnabas Church, around the Ryan Family Amusement building, Town Hall, and the rear Town Hall parking lot, to a higher elevation point at the southeast corner of the main Town Hall parking lot.

![Figure 6. Proposed Berm to protect Town Hall and part of Main Street (green line).]
A berm constructed with a crest elevation of 10 feet\textsuperscript{38} would protect against a 1% annual chance occurrence flood event in 2030 and up to a 25% annual chance occurrence event in 2070. The area just south of the existing lower parking lot\textsuperscript{39} would require a 4-foot-high berm. As the berm moves closer to higher elevation areas, the height of the berm above existing ground will decrease. The Town should begin discussions with neighboring landowners to build support for this Flood-Risk-Reduction Solution, as this feature would need to be constructed across multiple properties; this structure would provide added protection for those buildings, as well. The Committee recommends that the Berm proposal be broadened to reflect an objective of protecting Main Street to King Street and the commercial areas to the south from storm surge flooding up at a 1% annual change event.

The Coastal Resiliency Action Committee recommends that the Select Board accept and implement the vast majority of Recommendations made in the 2020 Falmouth Climate Change Vulnerability and Assessment and Adaptation Planning Report.\textsuperscript{40}

3.3 **COASTAL RESILIENCY PLANNING FOR THE SURF DRIVE AREA (THE SURF DRIVE STUDY)**

In 2019, the Coastal Resiliency Action Committee applied for and received an MVP Action Grant to further study one of the top-five Action Items identified in Falmouth’s 2018 MVP Workshop. The Commonwealth awarded Falmouth a $74,787 MVP Action Grant for Coastal Resiliency Planning for the Surf Drive Area. The impetus for the study came from the results of both the MVP workshop and the Vulnerability Assessment: the MVP top recommendation suggested Falmouth “develop a retreat plan for coastal roadways”; the VA highlighted the Surf Drive area as one of the most at-risk-areas in Town, in consideration of the value of public infrastructure in the area. As Town Hall is contiguous to the Surf Drive Area, via Siders Pond, the Committee was able to address Town Hall resiliency issues and solutions through this study.

\textsuperscript{38} NAVD88

\textsuperscript{39} Where the ground elevation is approximately 6 feet (NAVD88).

\textsuperscript{40} See Appendix A-5 for the complete Vulnerability Assessment; specific recommendations for adaptation strategies are detailed in Chapter 4 of the Assessment.
Surf Drive and the adjacent shoreline and neighborhoods already experience significant challenges with today’s climactic conditions and will witness increased vulnerability in the near future. The area hosts significant public infrastructure, including local electricity lines, water mains, the Woods Hole sewer main and lift station, the Shining Sea Bikeway, and the Martha’s Vineyard electric substation. Furthermore, the area is home to several neighborhoods, including one classified by the Commonwealth as qualifying for “Environmental Justice” consideration. The increasing severity and frequency of storms will increase vulnerability and eventually threaten the neighborhoods and sever the services, if no adaptations or adjustments are made.

The Committee asked the Consultant to conduct a study that identifies multiple options that Falmouth could take to improve Town resiliency in the Area while supporting a healthy coastline and marine ecosystem. Goals included allowing the barrier beach’s natural ecosystem and geologic shifts to occur, while balancing human use of and access to Surf Drive. Preservation and restoration of natural processes will protect the operational capacity of infrastructure in the short term, and enhance the greater ecosystem in the long term.

As anticipated, the Surf Drive Study confirmed that the Area will indeed experience extensive Mean High Water flooding in the near future (Figure 8). By 2050, approximately 1200 feet of Surf Drive will be underwater twice daily, as will nearly 1000 feet of Mill Road and much of the Fresh River Lane and Bywater Court area. The lower level of Town Hall will see flooding today during a “25-year Storm” event, with water arriving from both the west and the south. Climate change events will dramatically impact the whole Surf Drive Study area by later this century.
Ultimately, this study developed a set of recommendations for a Phased Management Approach to address vulnerabilities to natural and built infrastructure from flooding, sea level rise and climate change within the Surf Drive area. The Consultants presented four themed pathways, including Natural Resources, Protection, Connection, and Managed Retreat. The road map suggests instituting near-term solutions that can protect assets and support or enhance natural ecosystem functions. Some notable suggestions include targeting beach and dune nourishment to protect Surf Drive in the short-term (while planning to abandon the road along the barrier beach by 2050), raising and ‘decking’ parts of the Shining Sea Bikeway, and elevating or relocating the Sewer substation by 2030. Extensive public outreach and education will prove to be a vital component to increasing resiliency here, as well as in other coastal neighborhoods.

The Coastal Resiliency Action Committee recommends that the Select Board accept and act within the Natural Resources and Managed Retreat Pathways, as presented in the Coastal Resiliency Planning for the Surf Drive Area study. These Pathways will allow natural processes to strengthen, enhance, and protect Falmouth’s coastline, with a more responsible fiscal outlay.
4.0 ADDITIONAL COASTAL RESILIENCY RECOMMENDATIONS

One of the most important issues facing the implementation of coastal resiliency recommendations is the development of a Town Resiliency Policy by the Select Board and approval by Town Meeting. Furthermore, the Committee suggests that Falmouth engage in four areas of action: additional public engagement and education; regulatory actions; administrative actions; and Commonwealth Policy adoption. Falmouth should implement the below suggestions, take action according to Town-sponsored study data and results, and monitor results for future use and reference. It is vital that the Town gathers and utilizes valid data in its Coastal Resiliency adaptation measures.

4.1 EDUCATION

Enhanced community knowledge and involvement in Town planning, decision making, and action will increase the likelihood that difficult decisions will meet community support.

1. Increase Neighborhood Outreach

Utilizing the VA and the WHG studies as a guide, Falmouth should continue neighborhood outreach programs to encourage neighborhood participation in the protection of their own ‘backyards’. By creating neighborhood working-groups, residents engage as a part of the solution first by allowing them to focus on their own neighborhoods. The groups would convene, compare notes and collectively participate in a solution process.

With comprehensive engagement, the Town as a whole will better understand the risks and what is needed to affect change. Where change is elusive, engaged people would better understand why certain assets may need to be abandoned and why relocation may be the best option. Engaging these same community groups for input in the public asset portion of targeted study will help gain the public’s trust, and supply much-needed support for Town Meeting proposals.

2. Student Engagement

Importantly, Falmouth needs to engage the Town’s youth, as climactic challenges exist in their future. The Town should create an elective program within the school system to encourage the town’s youth to participate and provide input. This would pay off in dividends, as students will establish and maintain some agency in their own future. They need to know and understand challenges coming and why, how it will affect them and what roles they can assume today in creating and implementing solutions. Provide the education and tools necessary for students to have some say in what they will see (or not) in their future and encourage them to participate in change!

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41 Utilizing transferrable development rights.
3. Targeted Community Signage and Virtual Imagery

Educational signs posted at areas most threatened by coastal hazards will alert “inland” residents and guests to community challenges. Presenting graphic representations of future scenarios – both positive and negative – will generate discussion and allow more agency from the community-at-large, and not just amongst residents of threatened neighborhoods.

4.2 Regulatory Action

Falmouth should adopt an official projection for use in all relevant regulatory and capital projects with regard to Sea Level Rise. The Committee suggests that the Town adopt the Commonwealth’s “High Sea Level Rise Scenario,” as outlined in the Vulnerability Assessment, and currently being used by the Commonwealth’s Department of Transportation for future resiliency planning initiatives. Falmouth should review and/or update the projections periodically.

1. Restrict new development/redevelopment in the Velocity Zone; existing development may be upgraded to meet current floodplain standards.

Category 3 hurricanes will have devastating effects on existing shoreline development. Falmouth should amend the zoning law to create an overlay zone coterminous with the FEMA-designated Velocity Zones that prohibits all development, except water-dependent development where such use is permitted in the underlying zone. Furthermore, existing development may be reconstructed to current standards if it is damaged to less than 50% by other than a coastal storm-related event. Building elevation would not except a structure from Velocity Zone categorization.

2. Phase out development in areas projected to be permanently inundated by sea level rise through a rolling amortization of existing and new development.

The VA and earlier studies have identified land areas seaward of current mean high water (MHW) that are expected to be permanently inundated or subject to daily high tide by 2070 or sooner.

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42 Category 3 hurricanes hit Falmouth in 1954 and 1938. Hurricane Bob was merely a Category 1; Hurricane Sandy missed Falmouth by 250 miles. With climate change, hurricane activity will increase; 2020 witnessed over 30 named storms. With warmer North Atlantic waters, science suggests that hurricane prevalence in New England waters will also increase.

43 Value of the structure.

44 If a building is destroyed by storm or SLR, the new prohibitions apply.

45 This recommendation complements the recommendation to remove roads and other infrastructure that will be subject to similar inundation and daily high tides, and are not able to be otherwise protected prior to such inundations, as well as the recommended incentives/disincentives to relocate development away from such hazardous areas (such as: acquisition; transfer of development rights; and removal of infrastructure).
Falmouth should amend the Zoning Law and/or Building Code to require that all non-water dependent uses in such areas shall cease five years prior to their projected inundation or daily high tide, based on the Commonwealth’s official sea level rise projections and adopted Town maps.

Falmouth should phase out development projected to experience permanent inundation due to SLR several years prior to the projected flooding. The Town could utilize a rolling amortization of existing and new development and require the posting of a bond to cover removal costs for new development. CRAC anticipates that the period of amortization will be updated regularly to reflect to changes in official State SLR projections, and actual coastal/climate events, and the effects of any proactive/protective measures implemented by a public agency.

3. Utilize Transfer of Development Rights (TDR) to facilitate the phase out of development in areas projected to experience daily tidal inundation or frequent flooding.

Transfer of Development Rights (TDR) is a common form of land use regulation that can be used to severely restrict development in one area by allowing property owners in the restricted development area to undertake greater than would otherwise be allowed development in another area. One use of TDRs to facilitate the reduction of development (existing and new) in areas subject to severe storms and sea level rise (particularly the Velocity zone and areas subject to future daily high tide flooding) would be to allow transfer of the density of development to undeveloped areas not subject to such risks, particularly within or adjacent to the same community. It can take different forms. Such as create a bank/or market does it.

Using the transfer of development rights to help phase out development in areas projected to be impacted by frequent flooding will ameliorate the pain of the coastal neighborhood communities.

Many properties in Town that are subject to high risk from severe storms and sea level rise are developed at a density as high as 8 units per acre while most undeveloped land in Town is zoned for 1 unit per acre. Through transferring development rights, a ten-acre undeveloped parcel near a vulnerable, densely developed area of bungalows and small capes or ranches could be allowed to accommodate 80 homes, rather than 10, and the area where the 80 homes had been would be abandoned or acquired by the Town at its reduced value, then converted to naturally valuable wetland, or open water. There are complicated logistics with this approach, but many options are feasible.

4. Thoroughly review all local codes and by-laws to increase the resiliency of projects. Falmouth needs to codify standards in land-use regulations that reflect resiliency.

These changes would primarily involve modifying dimensional standards in the various regulations to consider such factors as depth of flooding on a site and future high and
low tide lines. For example, fixed setbacks could be modified to site development on the least vulnerable part of a site and to adjust setbacks to accommodate future sea level rise.

5. Revise Article XVIII, Floodplain Zone, and Article XXXIX, Site Plan Review, of the Falmouth General Code to reflect the impacts of sea level rise and coastal resiliency.

The Town Zoning Bylaw flood plan zones have been static for about twenty years. Article XXXIX, Site Plan Review, refers to the comprehensive review of the Planning Board, but does not address flooding issues; it needs to be revised.

An example of revision includes allowing “transfer of development rights”, currently under consideration by the Planning Board. With “Transfer of Development Rights” Falmouth can preserve open space while supporting the potential for more development in other areas around Town.

6. Amend Town Wetlands Bylaw Regulations

The Town should enact regulations for areas predicted to be problematic the next 20 to 30 years, thereby restricting development in places threatened by inundation sooner, rather than once too late.

7. Add review criteria, through rules and regulations, to the Select Board’s Wetland Permit to assure that negative impacts to natural coastal processes are avoided and, in the case of projects necessary for public navigation, be mitigated.

Section 240-77 to 79 of the Zoning Code generally requires a special permit from the Select Board for all physical actions in or along waterbodies and wetlands in Town. The purpose of the section is to protect the aquatic resources of the Town. These resources are and will be significantly affected both by coastal processes and by the changes that the actions subject to a special permit may have on those coastal processes.

Currently, there are no guidelines for these decisions. Rules and regulations should be adopted by the Select Board to provide adequate decision guidelines that will assure that actions will not be approved that will interfere with natural coastal processes along the shore, particularly beyond the immediate area of the proposed action. Proposed public actions that interfere with natural coastal process but are necessary for navigational infrastructure should mitigate their effects on coastal processes.

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46 In that time much has changed in both climate conditions and mapping abilities, as have the predictive model studies conducted for the Town.
47 See full text of the Zoning Code in Appendix B-4.
48 Such as downstream, upstream, or in nearby estuaries.
Maintaining natural coastal processes and the landforms they create plays an important role in reducing the adverse effects on development from coastal storms and sea level rise.

8. Incorporate consideration of sea level rise into review criteria of land use regulations, such as site plan, subdivision, special permit, building permit, and others.

4.3 Administrative Actions

Some basic, introductory Administrative Actions will facilitate anticipating and dealing with sea level rise and other climate change hazards. Anticipation, response, and reaction will be easier if the Town has systems and resources in place before situations deteriorate.

1. Continue the Coastal Resilience Action Committee as the Coastal Resiliency Advisory Committee

In addition to the original mission, a standing Coastal Resiliency Advisory Committee should be tasked to help plan and prioritize the recommendations made by the Original Committee in conjunction with the VA, Surf Drive Study, and future studies. Furthermore, the new iteration should implement some of the actionable items outlined in this Report. The new Committee should work closely with various Town departments and community working groups to strategize the planning, prioritizing and implementation of projects within the thirteen (13) vulnerable coastal transects.

The Coastal Resiliency Advisory Committee should expand membership from five to seven (7) members: A DPW liaison should sit on the committee in the same capacity as the current Conservation Commission and Planning Board members; the new Committee would benefit from a fourth (4) at-large community member, as well.

Furthermore, the Committee 2.0 would benefit greatly from dedicated resource staff.

2. Add dedicated staff to support the Conservation and Planning Departments: Coastal Resiliency Coordinator

A Coastal Resiliency Coordinator will bring untold benefits to the resiliency of Falmouth. The position can be shared between Planning and Conservation Departments, and work with other Town departments as needed. The Coordinator would also assist the Conservation Commission, Planning Board and the new Committee, as well as other committees as needed. The Coordinator can act as support for the Coastal Resiliency Advisory Committee and assist the Town in finding and applying for State and Federal funds. The Coordinator will also keep Town departments apprised of coastal FEMA (and related) code and/or regulatory changes.

3. Acquire coastal land for open space to increase public access, reduce property and infrastructure damage, and improve the functioning of coastal processes.
Falmouth should create a fund to acquire properties based on inundation predictions for the next 20-to-30 years. These properties will allow Town to remove structures or create infrastructure to help mitigate potential adverse effects of SLR, and to continue providing public access to the coastline. Creative funding could come from Real Estate transfer fees, or other fee- or tax-based structure.

4. Require that all Town agencies evaluate the effect of their actions on achieving adopted coastal resiliency policies.

Without constant, cross-agency consideration of SLR, Falmouth runs the risk of contradicting itself. With the recent passage of the Charter amendments the Select Board is required to adopt procedures to assure that Town agency actions are evaluated for their consistency with the Comprehensive Plan and Strategic Plan of the Select Board. These plans address resiliency now and are expected to adopt policy recommendations as a result of this report. In adopting the required procedures, the Select Board should include guidelines for assessing the effects of Town actions on coastal resiliency policies, particularly maintaining and expanding a natural shoreline for its storm protection, recreational, economic, and natural resource benefits.

5. Begin to develop future projects budget placeholder future municipal adaptation projects into the town’s Omnibus/Operating and Capital Budgets.

Placeholders for potential Surf Drive Study recommendations should be earmarked in the capital budget, if not just to actually begin planning for the solutions, but to allow taxpayers to begin discussing policy choices, and to indicate to the Board the Town’s tolerance level to new, complex projects. By placing large, future budget items into the Capital Plan now (e.g., Town Hall berm funding), taxpayers will begin to comprehend the magnitude of creative solutions needed to gain coastal resiliency. To assist with grant/funding alternatives, Town should incorporate funding for a Coastal Resiliency Coordinator (CRC) position in the Omnibus Budget.

6. Prioritize moving or changing vulnerable public infrastructure – including roads -- to reduce damage and maintenance costs.

The Vulnerability Assessment identified the flooding risks of all segments of Town roads. Many miles of road will need to be raised, otherwise protected or abandoned. Roads that are subject to frequent, let alone daily, flooding cannot be maintained, and the Town cannot afford to protect all. With the data provided by the Vulnerability Assessment, the DPW should begin to systematically identify roads that may not be maintained at some point in the future, and which roads will require improvements to remain viable. The DPW should also create a standard to determine when, roads will need to be improved or removed, either per SLR projections or the occurrence of destructive storms.

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49 Actions could include direct actions, funding actions, and permit actions.
It will be important to convey as early as possible to homeowners if they are on a road that cannot be maintained in the future. This is important for Town capital planning, particularly in areas that will be subject to future daily high tide flooding, because the infrastructure cannot be allowed to remain in these areas that will become future wetlands, beaches or boating facilities.

7. **Conduct beach nourishment at key “source” locations to restore the natural sand transport system and provide recreation and storm protection.**

Falmouth’s beaches have been eroding naturally for millennia, and as this erosion reaches permanent infrastructure along the coast, our beaches have shrunk and there is no longer room for protective dunes. As mentioned before, in many cases this erosion has been exacerbated by structures that block the flow of sand or prevent sand the was previously sourced from sand banks to enter the beach system. One common practice used to create larger beaches is so-called “beach nourishment,” the emplacement of compatible sandy fill along the shore to create a beach and dune system. Although a common practice in many communities, this approach has not seen widespread use in Falmouth.

We recommend, as suggested also in the Surf Drive study, that the town pursue (i.e., not include sediment-trapping structures) feasibility studies for nourishment projects along its most threatened shorelines. One hurdle for this approach is the large swaths of privately-owned beaches along these same shorelines. As outlined in the Surf Drive study, it is unlikely in the long run that the Town will be able to financially justify nourishing the beaches in perpetuity, particularly as sea level rise becomes more significant, but short-term nourishment could provide a temporary measure as the town increases its overall resiliency.

We recommend that any nourishment project be part of a Town-wide plan and not be performed piecemeal without the consideration of the costs of preserving beaches across our many neighborhoods. Most importantly, any pilot nourishment project should be closely monitored to assess the viability and sustainability of this practice for our beaches. Another important aspect of planning nourishment is the restoration of natural sediment pathways, and caution against plans that include impoundment of natural flowing sands by structures. We also note that other structural approaches, such as construction of offshore reefs, were not considered to be financially justifiable as part of potential solutions in the Surf Drive Study.

8. **Remove unnecessary, hazardous, or damaging coastal armoring structures; prohibit new structures.**

The Coastal Resources Working Group recommended in both 2003 and 2010 as an “immediate term” recommendation that Falmouth “actively “soften” existing groins and jetties where feasible in order to improve sand transport along shore, by loosening or
making such structures more porous.”\textsuperscript{50} The CWRG also recommended that Falmouth prohibit both construction of new-engineered coastal structures, and reconstruction or “substantive repair” of existing coastal engineering structures. Likewise, the Town should eliminate the 1989 and 1978 “grandfathering” of armoring eroding coastal banks.\textsuperscript{51}

Massachusetts Department of Coastal Zone Management has completed an “Inventory of Seawalls and Other Coastal Structures”.\textsuperscript{52} This study lists the types of structures as well as ownership of each. The Engineering Department/DPW has a hard copy of the Falmouth Inventory.

9. Create sand management systems that will keep sand from being transported offshore into deep water by jetties.

Falmouth contains many jettied inlets connecting ponds with the ocean for navigational purposes. In many cases, plumes of sand can be seen far offshore of these jetties, suggesting that these confined flows are transporting littoral sediment far offshore. We recommend that the town survey offshore to see if sand is indeed being deposited in these locations. We also recommend that any future jetties be designed to reduce offshore sediment transport.

10. Establish a fund to systematically acquire damaged property post storm to be combined with available federal and state funding.

11. Work with the 300 Committee and other non-profit landholders on coastal land acquisition.

12. Continue to support an annual appropriation for coastal resilience for use as match for state and federal funds and Town studies.

An annual appropriation of funding through Town Meeting can match Federal and State grants; and continue the engagement of local consultants to maintain sea level data currency; and support a local coordinator position, amongst other benefits.

13. Maximize access to State and federal funds through an aggressive grant application effort.

Utilize a dedicated support staff member – proposed Coastal Resiliency Coordinator – to keep track of available grants/funding available to the Town, providing Departments, CRAC II, and other committees with all available options.

\textsuperscript{50} See Appendix A-3 (page 16).
\textsuperscript{51} Eliminate the 1989 “grandfathering” of lots that currently allows coastal armoring of eroding coastal banks on lots that were developed prior to 1989 (the date of adoption of the Town’s Wetland Bylaw). Also eliminate the analogous 1978 “grandfathering” of lots that were developed prior to 1978 (the date of adoption of the Wetlands Protection Act coastal bank regulations) by adopting a provision under the Falmouth Wetlands Bylaw that prohibits armoring of eroding Coastal Banks or coastal dunes whether or not the lots were developed prior to 1978. (CRWG 2010 p 16; see Appendix A-3)
\textsuperscript{52} \url{www.mass.gov/service-details/inventories-of-seawalls-and-other-coastal-structures}
Figure 9. Woods Hole 2030 inundation risk, from the Falmouth Vulnerability Assessment (WHG, 2019).

4.4 Policies

Both the Massachusetts Coastal Zone Management Program (CZM) and Falmouth’s Local Comprehensive Plan drive most of the coastal policy planning for Falmouth. The Select Board should ensure that it follows already established policies and be mindful of implementing those policies.

The Massachusetts Coastal Zone Management Program establishes the policies of the Commonwealth for the management of the state’s coastal area, which includes all of Cape Cod. State and federal agencies are required to act consistently with these policies.

The Committee recommends that the Town adopt the Commonwealth’s coastal policies that pertain to the management of coastal hazards and require town agencies to act in a manner consistent with these policies, just as Commonwealth and federal agencies are required to do. The intent and wording of these policies is not inconsistent with the Policies of the Falmouth Local Comprehensive Plan as adopted at Town Meeting. Using the same policy wording as the Commonwealth can facilitate coordinated decision making and avoid conflicting interpretation of public policy at critical decision points. The state and federal governments through their direct actions, funding programs, and permit approvals are major participants in the management of the Town’s coastal area and are required to act consistent with the state’s policies.
The Massachusetts Office of Coastal Zone Management Policy Guide states that:

It is CZM’s intent to: (1) prevent, eliminate, or significantly reduce threats to public safety, property, and environmental resources resulting from hazards such as erosion, flooding, and storm damage; (2) allow natural physical coastal processes to continue while allowing appropriately sited coastal development and economic growth and promote the use of non-structural alternatives for shore protection where appropriate and to the extent feasible; (3) limit, prohibit, or condition public expenditures in coastal high hazard areas to ensure that increased exposure to coastal hazards is not encouraged; and (4) prioritize public expenditures for acquisition and relocation of structures out of hazardous coastal areas. Hazardous coastal areas are defined as areas susceptible to storm surge and waves, flooding, erosion, and relative sea level rise. CZM has developed the following four policies to achieve these objectives.53

Policy 1: Preserve, protect, restore, and enhance the beneficial functions of storm damage prevention and flood control provided by natural coastal landforms, such as dunes, beaches, barrier beaches, coastal banks, land subject to coastal storm flowage, salt marshes, and land under the ocean.

Policy 2: Ensure that construction in water bodies and contiguous land areas will minimize interference with water circulation and sediment transport. Flood or erosion control projects must demonstrate no significant adverse effects on the project site or adjacent or downcoast areas.

Policy 3: Ensure that state and federally (substitute “Town”) funded public works projects proposed for location within the coastal zone will:

- Not exacerbate existing hazards or damage natural buffers or other natural resources.
- Be reasonably safe from flood and erosion-related damage.
- Not promote growth and development in hazard-prone or buffer areas, especially in velocity zones and Areas of Critical Environmental Concern.
- Not be used on Coastal Barrier Resource Units for new or substantial reconstruction of structures in a manner inconsistent with the Coastal Barrier Resource/Improvement Acts.

Policy 4: Prioritize acquisition of hazardous coastal areas that have high conservation and/or recreation values and relocation of structures out of coastal high-hazard areas, giving due consideration to the effects of coastal hazards at the location to the use and manageability of the area.

53 See Appendix C-1 for the Massachusetts Office of Coastal Zone Management Policy Guide.
Figure 10. Conceptual illustrations of adaptation options (from NCCCARF, 2019\textsuperscript{54}).

The Commonwealth Coastal Management Policy Guide includes substantial guidance for interpreting and applying these policies.\textsuperscript{55} The Town can edit the state’s guidance to make it relevant to the Town’s circumstances and its application of the policies. Remember: these policies were adopted prior to the current understanding of the extent to which projected sea level rise will create substantial risks. The Town should edit the Policies to specifically reference risks associated with Sea Level Rise. The Select Board would issue rules and regulations to assure the consistency of Town agency actions with the adopted Town Hazards Policies.

4.5 Future Projects: Planning and Research

The studies conducted by the Committee, as well as earlier Town-sponsored reports, suggest a wide variety of projects that will enhance the Town’s natural vibrancy, protect vital Town infrastructure, and promote Coastal Resiliency. Some important policy and project suggestions include continued Planning, as well as further research focused upon specific Town transects and neighborhoods. Adaptation options will be necessary, and might change as situations evolve. It will be vital for the Town to establish a protocol for damaged or abandoned coastal properties.

4.5.1 Planning

Through the continued Coastal Resiliency Action Committee (CRAC 2.0), Falmouth should:

1. Develop a plan to protect or to phase out public infrastructure (roads, parking, parks, water and sewer lines, electric and gas service) to be implemented at least several years (3 to 5 years) prior to those services being permanently inundated by sea level rise. If infrastructure is not protected, its removal is necessary to assure the beneficial use of the resultant newly created near-shore areas for ecological, recreational, navigational and/or other public purposes can be effectively implemented or facilitated.

This activity needs to be coordinated with incentives for the removal or relocation of private development that is serviced by such infrastructure. Public projects that are designed to restrict the advance of sea level on infrastructure would eliminate or delay the phase out of affected infrastructure. Frequent flooding or a severe storm may also require or accelerate the decision to protect or remove infrastructure.

2. Work with the various town departments (specifically the Highway dept.) to create a schedule of priorities for what roads, bridges and related infrastructure are in the queue for


\textsuperscript{55} See Appendix C-1 for the Massachusetts Office of Coastal Zone Management Policy Guide.
reparis and upgrades. Integrate the VA into said plans to assess the practicality of repairs, modification or abandonment of certain Town assets. Note that in some instances the encouragement of natural expansion and/or restoration of existing wetlands, including marshes and barrier beaches, could prove beneficial.

4.5.2 Projects
Advance the project recommendations (near-, mid-, and long-term) from the Vulnerability Assessment of Town Assets, the Surf Drive Study, and from the summary Neighborhood Vulnerability Assessments, as well as any obvious neighborhood or generic-project related conclusions.

VA project recommendations include:

- Park Road Sewer Lift Station
- Old Dock Road Pier
- Woods Hole Drawbridge Hut
- Town Hall
- Beach Parking Lots
- Taft Park
- Shining Sea Bike Path, Chapoquoit Rd to Saconesset Rd
- Falmouth Inner Harbor Docks
- Green Pond Docks
- Various Jetties, Groins, and Revetments, assessed for removal or modification if necessary
- Chapoquoit Road
- Clinton and Scranton Avenues
- Menauhant Rd at Little Pond
- Washburn Island
- Great Sippewisset Marsh
- Chapoquoit Rd Wetlands
- Davis Straits Plan Resilience modifications at Falmouth Harbor and Little Pond
- Woods Hole, Building and Road elevation, new harbor entrance.

Falmouth should begin to undertake feasibility studies for several of the above-mentioned projects. Many potential projects will require near-term action. Beginning the planning process now would allow future projects to gain early acceptance from Town Meeting and residents, and allow beneficial adjustments to be included. For example, the Town Hall/Main Street Berm Project could include recreational potential, such as a walking path or picnic area, and/or potential expansion of the central business district. The Planning Board should coordinate a Re-

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56 FEMA recently announced upcoming grant opportunities allowing for multi-year planning/implementation that may benefit some of these tasks.
57 See Appendix A-5 for the Townwide Vulnerability Assessment
58 See Appendix A-6 for the Surf Drive Study Recommendations
59 To be conducted in the future
Development Study of the area (similar to the Davis Straits Study) that would be protected by a Berm. Community participation in the planning process will likely increase community acceptance.

VA Neighborhood reaches to be considered, for further planning and study, include:

- North Falmouth, including Megansett Harbor, Nyes Neck, Wild Harbor/Silver Beach
- Old Silver Beach, bluffs
- Little Island, West Falmouth Harbor, Chapaquoit, Sippewisset
- Quissett
- Woods Hole, Nobska to Trunk River
- Surf Drive/Oyster Pond, Salt Pond, Siders Pond, Falmouth Main St, Falmouth Harbor
- Falmouth Heights, Little Pond
- Maravista, Great Pond, Bristol Beach
- Acapesket Green Pond
- Davisville
- Menauhant, Bourne’s Pond
- Seacoast Shores, Eel Pond
- Washburn Island, Waquoit
4.5.3 Further Research and Planning Needed

1. **Sediment budgets for the various reaches of the Town’s shoreline**

   Projecting the future of Falmouth’s beaches requires and understanding of the sediment pathways along our coast. Such pathways remain poorly known as Falmouth has a complex coastline, facing two different water bodies, Vineyard Sounds and Buzzards Bay that have different wave climatology. Furthermore, the impact of existing structures on sediment transport and erosion pathways remains poorly quantified. We recommend that the town, through CZM funding, pursue as sediment pathway study, particularly along the Buzzards Bay shoreline. Such a study will require modeling wave generation and transformation with the bay by storms. Properly quantifying sediment transport rates and pathways is a first step to better understanding the causes of local erosion “hotspots,” the true effect of coastal structures, and planning future projects along the coast.

2. **Assess how natural features will respond to SLR and major storms.**

   The Falmouth Vulnerability Assessment shows a stark future for our town in terms of flooding of the current coastal configuration with raised sea levels. This study also looked at the potential changes of many of the marshes landwards of our beaches, suggesting that large marsh areas will be converted to open water, with limited space for marshes to migrate inland due to steep slopes and development. The Vulnerability Assessment, however, does not address changes to the coastline and increased erosion due to sea level rise. Erosion and loss of protective beaches will only make flooding scenarios worse in the future. Following up on the assessment of sediment budgets (above), we recommend the Town also study how our shorelines and coastal features (barriers, spits) may be expected to change their shape, or geomorphology, in response to higher seas and more frequent storms. Although the physics of sediment transport is more complicated than the hydrodynamic approach used in the Vulnerability Study such that detailed modeling such as that used in the Vulnerability Study is not likely to be an effective tool for understanding decadal coastal change, the USGS is developing data-driven approaches to projecting shoreline change, and we recommend that the town discuss their efforts with USGS scientists.

3. **Replicate the Surf Drive Study to study other reaches of the Town’s shoreline.**

   The Surf Drive Study is a model approach to a detailed analysis of Falmouth’s coastal transects that identifies an adaptable approach to strategic options for addressing resilience. Such studies should be conducted for all thirteen transects of Town (Figure?). Priority for conducting these studies should be set based on the area’s degree of vulnerability. In addition to the scope of work that was done by the Woods Hole Group for the Surf Drive area other factors essential for determining future management options need to be included in the analysis of each of the Towns coastal neighborhoods.
This additional scope of work would determine how the natural shoreline characteristics of the area would change over time as the shoreline experiences the effects of sea level rise and coastal storms (other than the elevation of flood waters) and what shoreline characteristics are required to achieve the planned uses of the shoreline, that is, for example, how would the Town maintain a wide sandy beach as a public recreational resource as the daily high tide moves inland. The recommendation regarding sediment budgets above should occur simultaneous to, or prior to, the initiation of the study for a given segment of shoreline.

4. Identify recommendations and action plans for the protection, modification, or removal of Town assets identified as vulnerable in 2020 VA Study.

Falmouth should develop plans for assets that have been compromised -- and are predicted to be repeatedly compromised -- to better protect assets from future damage or loss. Priority shall be given to the identification of road elevations, realignments, or abandonment, new or extended bridges, and causeways.

5. Reevaluate flood risk based on a planned systemwide modification of vulnerable road segments.

The Select Board should require the DPW and other appropriate Town Departments to plan for the eventual inundation and loss of certain roads and Town assets. Pre-planning, design, and permitting (where allowed by Code) should be put in place to re-locate, elevate or abandon certain Town roads and assets to prevent recurrence of compromise from future inundation or loss.

6. Sponsor Planning studies to identify future land use patterns and developments that are inherently resilient.

At this time there are no major planning studies underway on land use patterns, but there are elements of Coastal Resiliency being considered on several projects such as Davis Straits and Town Hall.

7. Continually survey national and regional studies on trends in waterfront property values and the evolving practices of financial institutions relative to development in vulnerable areas.

Coastal metropolitan areas are beginning to witness movement in the market value of coastal and inland properties. Coastal property values are predicted to decline substantially, while inland, protected areas will increase in value. Lending practices will adjust to the new reality. Falmouth will not escape these trends. Pro-active planning of Affordable Housing will increase resilience vis-à-vis climate change for Falmouth’s low- to moderate- income residents. Remaining apprised of coastal situations elsewhere will
allow Falmouth to better plan for redevelopment that is more inherently resilient and relocation of vulnerable portions of Town neighborhoods.

8. **Assess the legal implications of SLR and the permanent inundation of property on title, applicability of the Public Trust Document, and Chapter 91.**

There are several areas of law that will significantly affect the Town’s approach to future flooding, storm surge, and sea level rise. Important questions arise regarding the Public Trust Doctrine; Town requirements to maintain public infrastructure; and special project revenue appropriations.

The Public Trust Doctrine provides that, on account of the nature of lands underwater, the state owns these lands in trust for the benefit of the public, and generally may not alienate the public’s interests in these lands. The Public Trust Doctrine applies in the intertidal zones as well for the public’s rights for fishing, fowling, and navigation. Therefore, as sea levels rise and upland becomes underwater land, ownership may pass to the state. Currently in Massachusetts, waterfront property owners have property interests to the low water mark, and their deeds may set the property line at the low water mark.

Municipalities need to understand what the effects on the state and private property interest are as the high or low water marks move landward and private land and structures become underwater lands, and hence subject to the Public Trust Doctrine? Structures so located might also be considered “hazards to navigation” and removed as such.

Municipalities generally have an obligation to maintain infrastructure. Maintenance of infrastructure that will be subjected to sea level rise and frequent flooding might be too costly and cause too much environmental damage for maintenance to be justified. What are the possible defensible legal arguments and strategies for abandoning and removing infrastructure that serves existing development when that infrastructure will be overwhelmed by sea level rise and storms, and the economic and environmental costs of maintenance are high? A documented justification developed well in advance of the date of abandonment may be the most defensible approach, but state legislation may also be needed.

Furthermore, Can the Town establish special taxing districts to fund shoreline management projects that exclusively or primarily benefit a discrete geographic area? For example, can Falmouth establish a district to fund a beach nourishment project that benefits one neighborhood?
APPENDICES

Appendices are posted online with the electronic version of the report on the Coastal Resilience Action Committee website: https://www.falmouthma.gov/776/Coastal-Resiliency-Action-Committee

APPENDIX A: STUDIES

A-1: Municipal Vulnerability Preparedness (MVP) Summary and Findings Report
A-2: Falmouth Multi-Hazard Mitigation Plan
A-3: Coastal Resources Working Group: The Future of Falmouth’s Buzzards Bay Shore
A-4: Coastal Resources Working Group: The Future of Falmouth’s South Shore
A-5: Falmouth Climate Change Vulnerability Assessment and Adaptation Planning
   A-5.1: Vulnerability Assessment Addendum: Neighborhoods Assessment
A-6: Coastal Resiliency Planning for the Surf Drive Area
A-7: Board of Selectmen Strategic Plan (FY2020 – FY2024)

APPENDIX B: TOWN REGULATIONS

B-1: Local Comprehensive Plan - Coastal Section
B-2: Chapter 240 – Wetlands Regulations
B-3: Chapter 235 – Wetlands Protection
B-4: Chapter 240 – Zoning

APPENDIX C: OTHER REFERENCES

C-1: Massachusetts CZM Policy Guide