State of Rhode Island State Hazard Mitigation Plan Update Draft

October 2018

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Executive Summary

Plan Purpose

The purpose of the Rhode Island State Hazard Mitigation Plan (SHMP) is to provide comprehensive guidance for hazard mitigation in the State of Rhode Island. Rhode Island has experienced its share of natural disasters in the past, with one presidential disaster declaration since 2014. This Plan serves the people of Rhode Island by providing the impetus for making homes, businesses and communities more resilient to the impacts of hurricanes, floods, tornadoes, earthquakes, winter storms, wildfires and other natural hazards as well as cybersecurity and civil disturbance incidents, dam and infrastructure failures, terrorism, and other human- and technologically-caused hazards. In response to these threats, hazard mitigation actions are designed and implemented to reduce or eliminate long-term risk from hazards and their effects. The Plan also provides the people of the State with information regarding the overall capabilities of the state and local governments to reduce or eliminate threats and vulnerabilities.

Hazard Mitigation Planning in Rhode Island

Rhode Island completed its initial Plan in April 2005, followed by updates in 2008, 2011, and 2014. This Plan update was guided by the Rhode Island Emergency Management Agency (RIEMA) and representatives from the State Interagency Hazard Mitigation Committee (SIHMC). Future iterations of this Plan will seek to attract additional stakeholders in order to increase participation in hazard mitigation efforts statewide.

Plan Format

The State Hazard Mitigation Plan is divided up into seven sections followed by Appendices.

Table 1 Plan Format and Sections

Section	Section Title	Content
1	Introduction	Introduces the plan.
2	Planning Process	Provides an overview of the planning process, including stakeholders who participated in the process and key planning steps.
3	Hazard Identification and Risk Assessment	Presents the hazard identification and risk assessment that includes hazard descriptions, an assessment of the geographic extent of hazards, and hazard specific loss estimates for State facilities.
4	Capability Assessment	Summarizes the capability assessment of the state, including resources and assistance that can be used for mitigation activities.
5	Local Coordination	Offers information on local mitigation plans, and local programs to implement mitigation projects.

Section	Section Title	Content
6	Mitigation Strategy	Highlights the hazard mitigation goals, objectives and recommended actions and initiatives for state government that will reduce injury and damage from natural hazards.
7	Plan Maintenance	Outlines the implementation of the Plan and processes for updating the Plan.

Scope of the Plan

The Plan addresses all hazards that pose significant risks to Rhode Island. Each hazard has been assessed using the same methodology and information including vulnerability, exposure and potential losses, and historical significance, as available. The following types of hazards are analyzed and discussed in the Plan:

- Biological incidents
- Chemical incidents
- Civil Disturbance
- Cybersecurity
- Dam Failure
- Drought
- Earthquake
- Extreme Cold
- Extreme Heat
- Fire
- Flood
- High Winds
- Infectious Disease
- Infrastructure Failure
- Radiological Incident
- Sea Level Rise
- Severe Winter Weather
- Terrorism
- Thunderstorms
- Tornadoes
- Tropical and Extratropical Storms

Additional information about these hazards and potential impacts to the state and critical facilities can be found in Section 3. Hazards identified in specific communities, including local municipalities and Counties can be found in Section 5.

The following vision statement drives the State's Mitigation Strategy: ***Rhode Island is resilient to natural, technological, and human caused hazards and climate change.*** The following goals developed by the SIHMC support the achievement of this vision:

Table 2 Mitigation Strategy Goals

Rhode Island Hazard Mitigation Goals	Description
Goal 1	Rhode Island has the capacity to promote and implement projects, programs, plans, policies, and legislative actions to reduce vulnerability and repetitive loss to natural, technological, and human-caused hazards, under current and future conditions.

Rhode Island Hazard Mitigation Goals	Description
Goal 2	Statewide coordination of hazard mitigation with organizations, agencies, and stakeholders.
Goal 3	Local communities address natural, technological, and human-caused hazards and long-term risk reduction in local decision making and planning for current and future conditions.
Goal 4	The public understands, supports, and acknowledges the need for hazard mitigation.
Goal 5	The built environment, infrastructure, people, natural environment, and economy are resilient to the impacts of natural, technological, and human-caused hazards under current and future conditions (including repetitive loss [RL] and severe repetitive loss[SRL]).

Mitigation Actions

The Mitigation Strategy includes a matrix of mitigation actions and activities that will be implemented by the State of Rhode Island and its communities to mitigate the impacts of all hazards. The implementation timelines for these activities are divided into short-, medium- and long-term time periods. These different time periods provide an estimated implementation timeline for the State to develop priorities and organize projects, activities and funding for mitigation.

Section 1: Introduction

The purpose of the Rhode Island State Hazard Mitigation Plan (SHMP) is to provide comprehensive guidance for hazard mitigation in the State of Rhode Island. This Plan has been developed to serve the people of Rhode Island by making homes, businesses and communities more resilient to the impacts of hurricanes, floods, tornadoes, earthquakes, winter storms, wildfires and other natural hazards as well as cybersecurity and civil disturbance incidents, dam and infrastructure failures, terrorism, and other human- and technologically-caused hazards. It contains a wealth of geographic and demographic information, along with a thorough assessment of the natural, human-, and technologically-caused hazards faced throughout the state. It also evaluates the overall capability of state and local governments to reduce or eliminate the vulnerability of our communities to these natural hazards.

This Plan identifies an overall hazard mitigation vision, goals, objectives and recommended actions and initiatives for state government that will reduce injury and damage from natural hazards. Most importantly, the Plan outlines a coordinated Mitigation Strategy developed by the Rhode Island State Interagency Hazard Mitigation Committee (SIHMC), which includes goals, objectives and specific, measurable actions. Therefore, this Plan is designed to be informative, strategic and functional in nature. Through routine monitoring and updating, this Plan will remain the guide for the SIHMC to follow in accomplishing its vision of a safe and sustainable future for Rhode Island.

Mitigation actions help safeguard personal and public safety. Retrofitting bridges, for example, can help keep them from being washed out, which means they will be available to fire trucks and ambulances in the event of a storm. Installing hurricane clips and fasteners can reduce personal and real property losses for individuals and reduce the need for public assistance in the event of a hurricane. Increasing coastal setbacks reduce the risk of deaths and property losses from tsunamis and storm surge. Increased setbacks also reduce the risk of property losses from coastal erosion. Another important benefit of hazard mitigation is that money spent today on preventative measures has been shown to significantly reduce the impact of disasters in the future, including the cost of emergency response and post-disaster cleanup.

Funding for this Plan was provided to the Rhode Island Emergency Management Agency (RIEMA) through the Federal Emergency Management Agency's (FEMA) Pre-Disaster Mitigation (PDM) program. The areas of focus for the updated 2019 Plan include:

- Update the existing Plan to the standards contained within Section 322 of Disaster Mitigation Act of 2000 (DMA 2000) for a standard state mitigation plan;
- Expand and modify the Hazard Identification and Risk Assessment (HIRA), including the addition of analysis using state owned and critical facility data and updated vulnerability methodology;
- Expand the capabilities assessment to include state agencies and additional stakeholders involved with hazard mitigation and the addition of numerous new initiatives;
- Expand the discussion in hazard-specific sections about the potential impacts of climate change on future hazard occurrences and natural hazard mitigation;
- Inclusion of updated information within all chapters of the Plan and reformatting of the Plan;
- Reassessment of the goals, objectives, and activities presented in the 2014 Plan; and
- Increase state agency and other stakeholder participation.

1.1 Federal Authorities

In October 2000, the United State Congress recognized that the nation as a whole was ill-prepared to handle the risks and damages associated with natural hazards by adopting DMA 2000 Public Law (PL) 106-390. The law amended the existing 1988 Robert T. Stafford Disaster Relief and Emergency Assistance Act, defining language for 44 Code of Federal Regulations (CFR) Section 201.4. DMA 2000 reinforced the importance of mitigation planning, emphasizing planning before disasters occur. It set an initial standard for a SHMP. The standard was further defined by FEMA in 2002 with modifications made via FEMA's Final Rule, published in October 2009.

Mitigation planning is specifically addressed at the state and local levels in Rhode Island under the Stafford Act Section 322 (42 United States Code [USC] 5165). Adherence to the requirements and criteria set forth in Section 322 of the act qualifies Rhode Island to utilize disaster-related assistance, including categories C through G of the Public Assistance (PA) Program, an essential component of disaster recovery. In addition, the State will remain eligible for Hazard Mitigation Assistance (HMA) program funds including Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) and PDM grants. The state also participates in the Community Assistance Program-State Support Services Element (CAP-SSSE) program and the Cooperating Technical Partners (CTP) program.

Since 2005, Rhode Island has been eligible to receive non-emergency Stafford Act assistance and federal mitigation pre-disaster assistance by maintaining an approved standard SHMP compliant with 44 CFR §201.4 and related FEMA mitigation planning guidance. The 2019 Rhode Island SHMP Update is a standard plan meeting the requirements for a SHMP detailed in Interim Rule 44 CFR 201.4.

1.2 Current Conditions in Rhode Island

Understanding the current condition of the population, economy, infrastructure, and natural environment in Rhode Island supports the determination of areas and communities that are more vulnerable than others to natural, human-, and technologically-caused hazards. This section outlines the current conditions across these sectors and highlights areas of potential or inherent vulnerability.

1.2.1 Demographics

1.2.1.1 Population

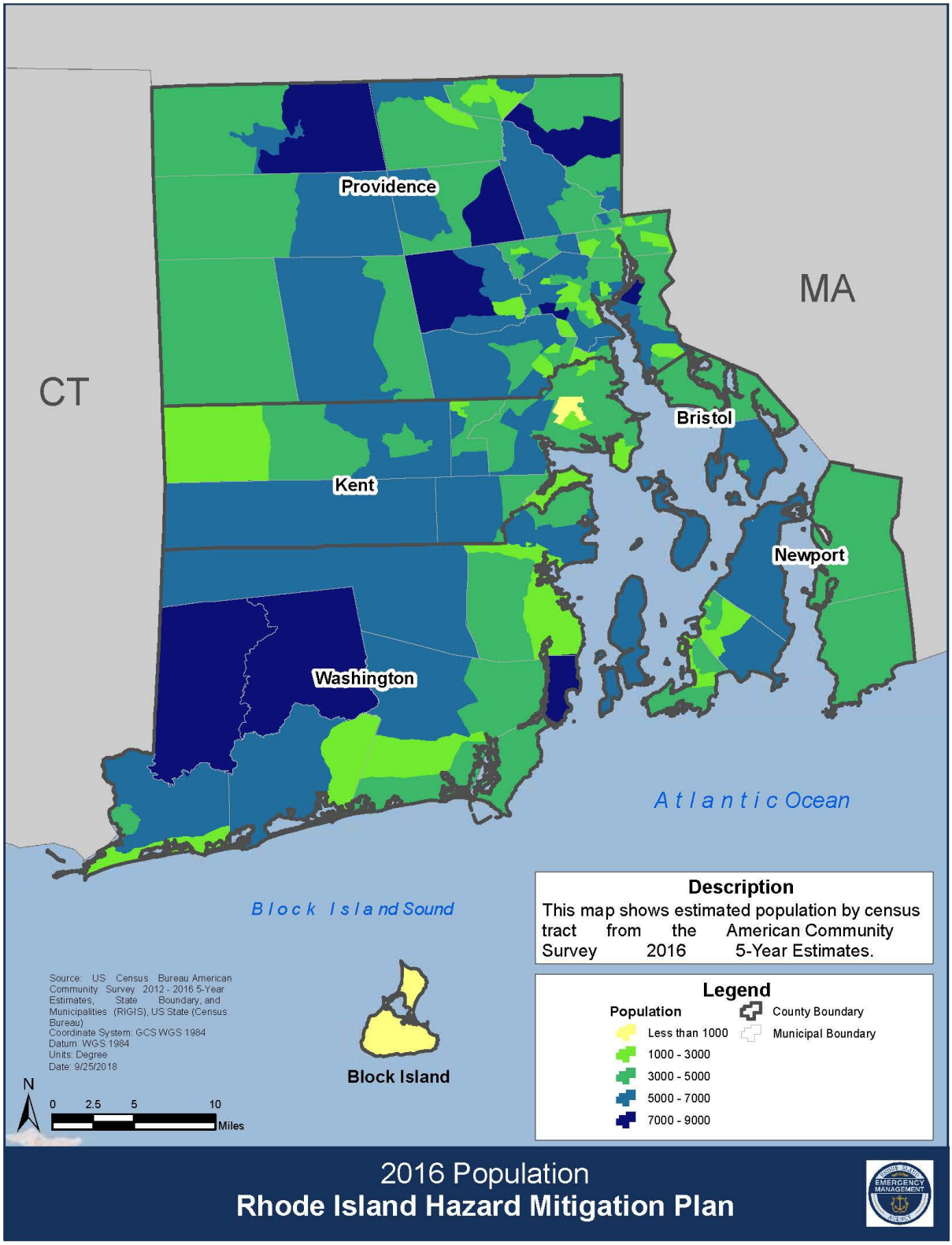
Rhode Island's estimated total population in 2017 was 1,059,639 people, making it the 7th smallest state in the United States in terms of total population.[1,2] Given the population size and geography, the average population density of the state is 1,025 people per square mile, which is amongst the highest in the nation.[3] A map displaying population per county, according to 2016 five year American Community Survey (ACS) data, can be seen below.

[1] U.S. Department of Commerce, Bureau of Economic Analysis 2017. Rhode Island. Retrieved from https://www.bea.gov/regional/bearfacts/pdf.cfm?fips=44000&areatype=STATE&geotype=3

[2] DataUSA, 2016: Rhode Island. Retrieved at https://datausa.io/profile/geo/rhode-island/

[3] Densities were calculated by dividing the area of dry land per county by population estimates.

Figure 1-1 2016 Population



Population demographics are important to consider in overall planning efforts, both for understanding population density and for estimating and planning for populations that may face higher levels of vulnerability than others. One of the factors that may increase vulnerability is age. Older adults are often less mobile and are more likely to have chronic diseases that make them particularly sensitive to disruptions of their living situations. Overall, 16.8% of Rhode Islanders are ages 65 or older, which is slightly higher than the national average of 15.6%.

Similarly, young children often cannot care for themselves and may not be able to communicate their needs during a hazard or disaster event. The number of individuals ages five (5) or younger in Rhode Island accounts for roughly five (5) percent of the overall population, which is slightly less than the national average of approximately six (6) percent of the total population.[4] Special considerations must be made for those populations on both ends of the age spectrum.

1.2.1.2 Ethnic Composition and Language

Characteristics of the state population can assist in gaining a comprehensive understanding of life in Rhode Island and can also help identify existing vulnerabilities. Diversity is an important characteristic in understanding the vulnerabilities introduced by hazards and how to mitigate those vulnerabilities. Understanding diversity is critical because unique community needs can impact the identification of vulnerabilities and implementation of actions to reduce risk. Major factors embedded within the common understanding of diversity include racial and ethnic composition, percentages of urban and rural populations, mobility identifiers, and income.

In Rhode Island, the racial and ethnic composition is 84.1% White (not Hispanic), 8.2% Black (not Hispanic), 3.7% Asian (not Hispanic), 15.5% Hispanic, 1.0% American Indian, 0.2% Native Hawaiian and other Pacific Islander, and 2.8% identifying as two or more races.[5] The American Indian population is inclusive of the one federally recognized tribal government in Rhode Island, the Narragansett Indian Tribe, based in Charlestown on the southern edge of the state.

Rhode Island has a lower percentage of Black population (by approximately five percent) and a lower percentage Hispanic population (by approximately three percent) than national averages.[6] Providence County is considered the most diverse county in Rhode Island, where 17.54% of the county's population is Hispanic and 9.42% is Black.[7] This information is important to consider when describing vulnerability and developing community outreach material.

Language is another important diversity factor. In 2013, one in five (5) Rhode Islanders spoke a language other than English at home.[8] Top languages spoken in Rhode Island other than English include Spanish and Spanish Creole, Portuguese and Portuguese Creole, French and French Creole, Chinese, and Mon-Khmer/Cambodian. Of all Rhode Islanders, 11% of the population – roughly 117,000 people – speak Spanish at home.[9] Many of those who speak a language other than English at home also speak English very well but are more comfortable speaking in their native language. This should be considered in State and local planning efforts, particularly when developing community outreach materials and deploying educational campaigns.

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[4] U.S. Census Bureau, 2010. United States Quick Facts. Retrieved at https://www.census.gov/quickfacts/fact/table/US#viewtop
[5] U.S. Census Bureau, 2016. Rhode Island Quick Facts: Population Estimates 2017. Retrieved at https://www.census.gov/quickfacts/ri
[6] U.S. Census Bureau, 2016. United States Quick Facts. Retrieved at https://www.census.gov/quickfacts/fact/table/US#viewtop
[7] Statistical Atlas, 2015. Rhode Island Race and Ethnicity. Retrieved at https://statisticalatlas.com/state/Rhode-Island/Race-and-Ethnicity
[8] Rhode Island Data Center, 2013. Census Data Bulletin. Retrieved at http://www.planning.ri.gov/documents/census/bulletin/bulletin_sept2013.pdf
[9] Statistical Atlas, 2015. Rhode Island Languages. Retrieved at https://statisticalatlas.com/state/Rhode-Island/Languages

Another language consideration in Rhode Island is the number of children who speak both English and another language. In 2013, an estimated 26,377 children ages five to seventeen spoke Spanish or Spanish Creole at home. It can be surmised that most of these children speak English outside of the home; outreach and education to this population may serve the dual purpose of also filtering information to parents and guardians at home who may or may not have English proficiency.

1.2.1.3 Housing

According to the U.S. Census Bureau, there are a total of 410,240 households and 468,251 housing units in the State of Rhode Island.[10] An estimated two (2) percent of these housing units are vacant, while the apartment market vacancy rate is 2.3%.[11] The 2016 *Projecting Future Housing Needs Report*, commissioned by Rhode Island Housing, anticipates the need for 34,000 new homes over the next ten years, 27,000 of those to be multifamily and specifically cater to low-income residents.[12]

1.2.1.4 Mobility and Income

An important consideration for understanding the population of Rhode Island is the divide between urban and rural populations. Nationwide, communities are becoming more urban. In Rhode Island, 90.7% of the population is urban compared to 80.7% of the United States.[13] Some considerations for addressing risks in both urban and rural areas include mobility and access to transportation and income fluctuations between urban and rural populations.

The urban-rural divide can contribute to differences in mobility. Mobility is an important population characteristic to consider for hazard mitigation planning as it can affect community members' resources and ability to adequately prepare for and recover from disasters. Lack of mobility can also present challenges in educating the public on the hazards facing the community. One measure of population mobility is prevalence of home ownership, as homeowners tend to be less likely to move than renters. In Rhode Island, an average of 59.7% of housing units are occupied by the owner, compared to 63.6% nationwide, implying that residents in Rhode Island are slightly more mobile than the rest of the country.[14]

Income is another important factor to consider during the planning process. Rhode Island has a median household income of $58,387, which is slightly higher than the national median income of $55,322.[15] Rhode Island income by county varies considerably, with Providence County's median income the lowest in the State as demonstrated in Table 1-1.

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[10] U.S. Census Bureau, 2016. Rhode Island Quick Facts. Retrieved at https://www.census.gov/quickfacts/fact/table/ri/LFE041216
[11] U.S. Department of Housing and Urban Development, 2016. Housing Market Profiles: Rhode Island. Retrieved at https://www.huduser.gov/portal/periodicals/USHMC/reg//RhodeIsland-HMP-Dec16.pdf
[12] HousingWorksRI, 2017. 2017 Housing Fact Book. Retrieved at https://www.housingworksri.org/Portals/0/Uploads/Documents/2017_Housing%20Fact%20Book.pdf
[13] U.S. Census Bureau, 2010. Rhode Island 2010 Population and Housing Unit Counts. Retrieved at https://www.census.gov/prod/cen2010/cph-2-41.pdf
[14] U.S. Census Bureau, 2016. Owner-occupied housing unit rate, 2012-2016. Retrieved at https://www.census.gov/quickfacts/fact/table/US/HSG445216#viewtop
[15] U.S. Census Bureau, 2016. Income in the Past 12 Months (in 2016 Inflation-Adjusted Dollars) 2012-2016 American Community Survey 5-Year Estimates. Retrieved at: https://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_16_5YR_S1901&prodType=table.

Table 1-1 Rhode Island Median Income by County[16]

County	Median Income
Providence County	$49,297
Kent County	$62,279
Bristol County	$71,238
Newport County	$71,713
Washington County	$72,138

A critical consideration during the planning process is planning for Access Functional Needs (AFN) populations. AFN populations may require special planning considerations before, during and after a disaster, especially if they have mobility issues or require regular medical treatment. The AFN population in Rhode Island is 9.3%, which is slightly higher than the national average of 8.6%.[17]

1.2.2 Economy

Rhode Island's 2017 Gross Domestic Product (GDP) was ranked 44th in the United States at $59.5 billion.[18] The state's real GDP grew 1.6% in 2017, compared with a national growth rate of 2.1%.[19] Rhode Island has an estimated 870,136 individuals aged 16 and older, which are considered "potential workers".[20]

In early 2018, Rhode Island's economy was ranked as the ninth best in the United States by Business Insider. This ranking indicates the success of a strategic approach to economic development as shown by the fact that in 2014, the State had the highest unemployment rate in the nation. This rate has been substantially lowered and stands at 4.4% as of May 2018.[21,22] This rate is slightly above the national average of 4.0% and leaves 38,286 of Rhode Island's "potential workers" population without a source of steady income.[23]

The largest industry in Rhode Island in 2017 was finance, insurance, real estate, rental, and leasing. This industry accounted for 26.1% of the state's GDP, while the second largest industry, government and government enterprises, accounted for 13.2% of the total.[24]

The State's largest employing sectors include healthcare and social assistance (80,023 workers), accommodation and food service (48,204 workers), retail trade (48,190), and manufacturing (40,421 workers).[25]

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[16] Statistical Atlas, 2015. Rhode Island Household Income. Retrieved at https://statisticalatlas.com/state/Rhode-Island/Household-Income
[17] U.S. Census Bureau, 2016. Rhode Island Quick Facts. Retrieved at https://www.census.gov/quickfacts/fact/table/US#viewtop
[18] Bureau of Economic Analysis, 2018. Rhode Island. Retrieved at https://www.bea.gov/regional/bearfacts/pdf.cfm?fips=44000&areatype=STATE&geotype=3
[19] Ibid.
[20] Ibid.
[21] Rhode Island Department of Labor and Training 2018. Labor Market Information. Retrieved at http://www.dlt.ri.gov/lmi/laus/state/histadj.htm
[22] Ahlquist, Steve. 2018. Rhode Island rated 9th best economy in the United States. Retrieved at https://upriseri.com/news/economics/2018-03-15-state-business-ranking/
[23] National Conference of State Legislatures. National Unemployment Rates 2008-2018. Retrieved at http://www.ncsl.org/research/labor-and-employment/national-employment-monthly-update.aspx
[24] Ibid.
[25] Ibid.

1.2.2.1 Business Environment

The Small Business Association's (SBA) 2017 Small Business Profile for the State of Rhode Island shows that the 98,134 small businesses counted account for 98.9% of total businesses in the state.[26] These small businesses employ 53.5% of all Rhode Island employees. Firms with fewer than 100 employees have the largest share of small business employment. This is important to consider when performing hazard mitigation planning; not only are small businesses more vulnerable to the impacts of hazards than large companies with access to additional resources, but the employees of those businesses are similarly vulnerable to job and income loss if their employer is affected by a hazard event and has difficulty recovering from an incident.

While the majority of the State's businesses fall under the category of "small", four (4) Rhode Island companies landed on the 2017 Fortune 500 list: CVS Health, Textron, United Natural Foods, and Citizens Financial Group.[27]

1.2.3 Natural Environment

1.2.3.1 Geography

The State of Rhode Island is nestled between Connecticut and Massachusetts along the New England coast. It is the smallest state in the Union with most of its eastern half dominated by the Narragansett Bay and no point more than 30 miles from sea water, lending Rhode Island its nickname of "the Ocean State".[28] There are 39 cities and towns within Rhode Island, each with their own governing body.

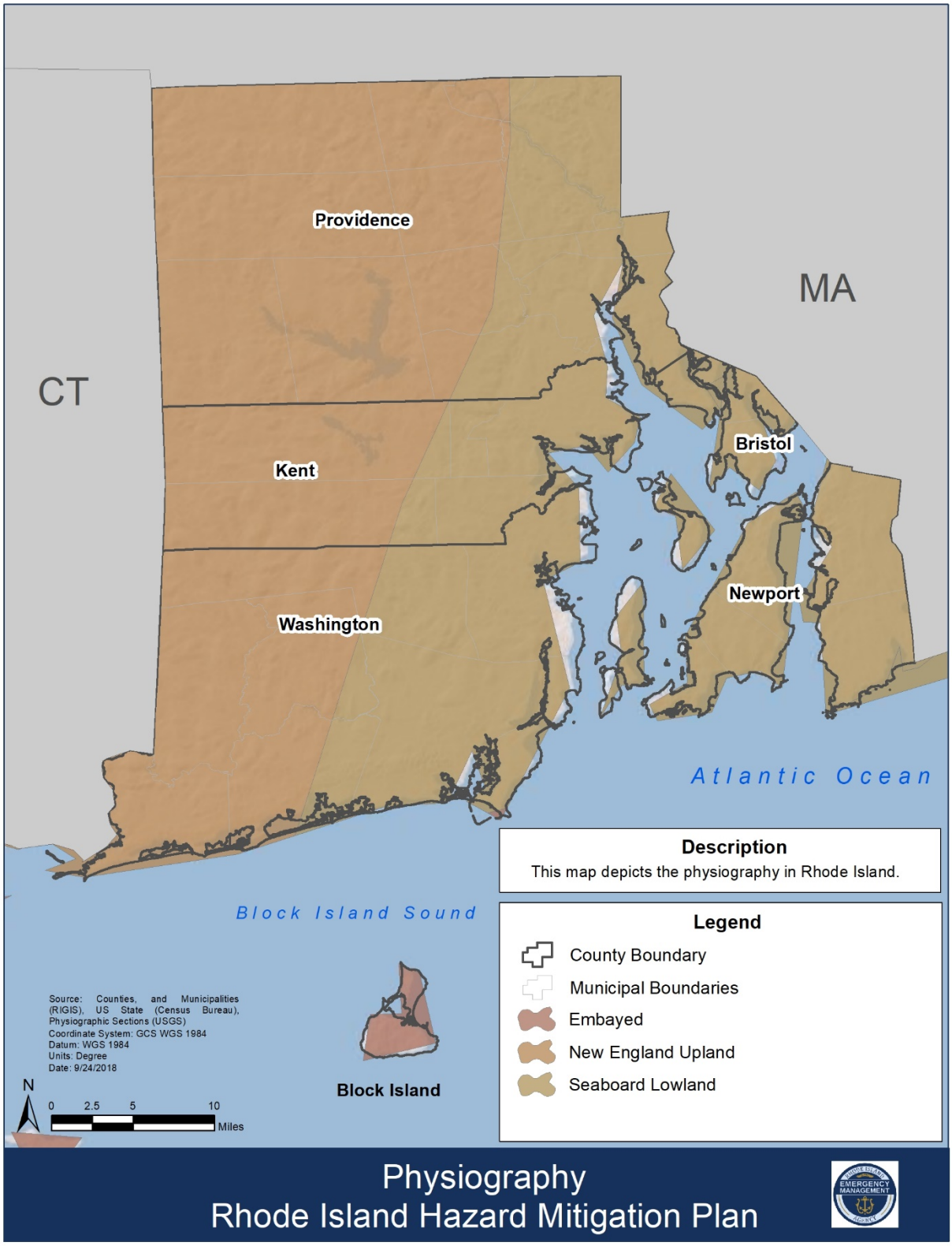
Twenty-one of these 39 cities and towns have exposed coastal areas that are vulnerable to a hurricane's storm surge, particularly the associated wave action and wind hazards. With nearly 400 miles of coastline, hurricanes and related coastal flooding affect Rhode Island on a recurring basis. Much of the coastline on the Atlantic Ocean consists of barrier beaches that are open to the full force of destructive hurricane waves. Other damages associated with hurricanes include inland flooding, coastal erosion and tornadoes.

1.2.3.2 Geology

Generally, Rhode Island's topography can be described as flat and coastal. The highest point in the State is Jerimoth Hill in Foster at 812 feet above sea level; the lowest point is at sea level along the Atlantic coast. The figure on the follow page displays the physical geography of the State.

[26] U.S. Small Business Administration, 2017. Small Business Profile: Rhode Island. Retrieved at https://www.sba.gov/sites/default/files/advocacy/Rhode_Island_1.pdf
[27] Nesi, T. 2017. 4 RI companies land on Fortune 500 list; CVS ranks 7th. WPRI Eyewitness News. Retrieved at https://www.wpri.com/news/4-ri-companies-land-on-fortune-500-list-cvs-ranks-7th/1044263284
[28] State Master 2018. The Northeast – Rhode Island. Retrieved at http://www.statemaster.com/state/RI-rhode-island

Figure 1-2 Physiography of Rhode Island



1.2.3.3 Rivers and Watersheds

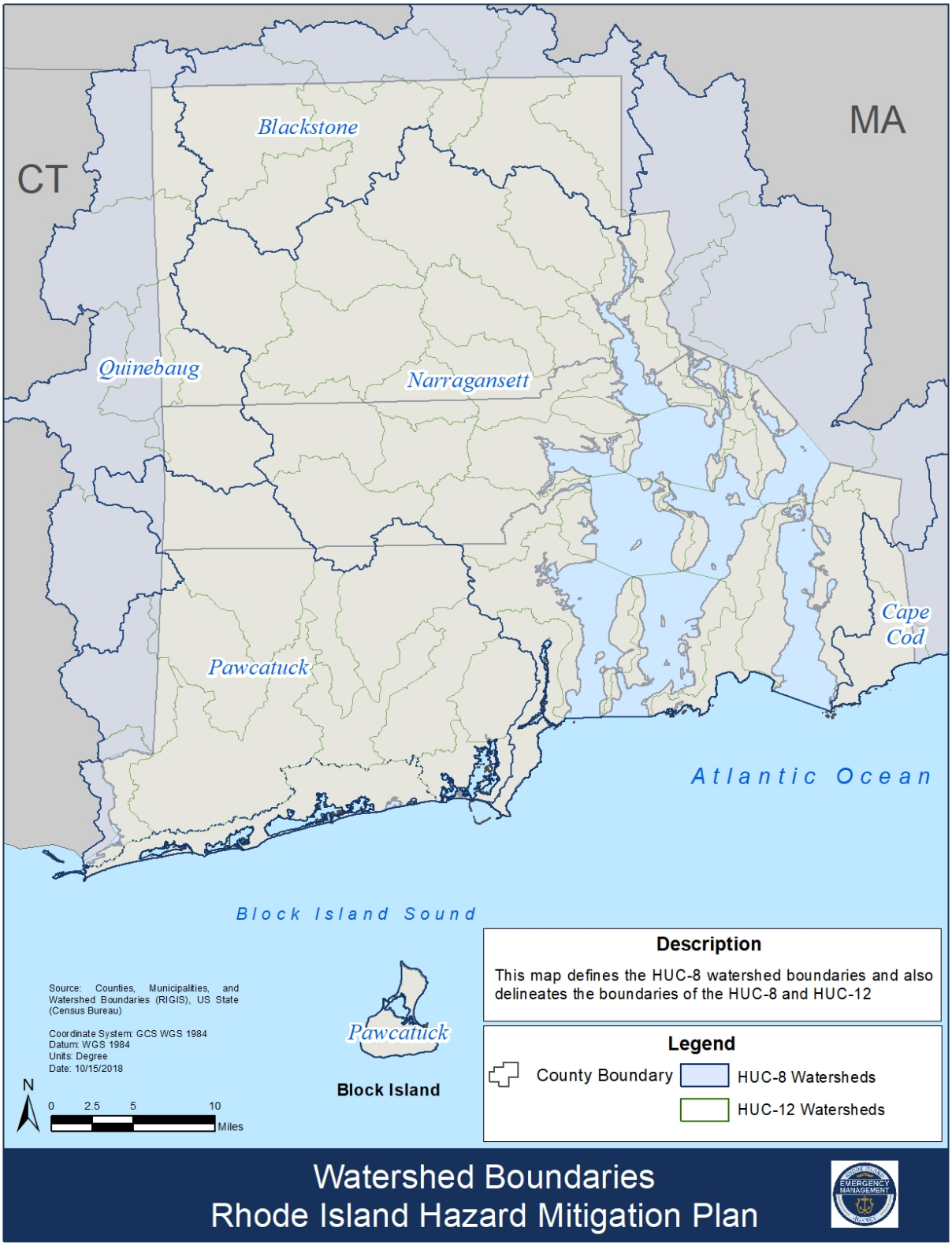
Water is a critical component to the natural environment of Rhode Island. The State's coastal waters consist of 159 square miles of estuarine and marine shoreline waters. Estuaries constitute transition zones from freshwater to salt water and are considered highly productive ecosystems that provide nursery habitat for important commercial and recreational fisheries. More than 70% of Rhode Island's recreationally and commercially important finfish species depend on estuaries for a portion of their life cycle.

Narragansett Bay lies in the center of Rhode Island. The Bay is a temperate, well-mixed estuary covering 147 square miles. This vital natural resource supports a diversity of recreational activities and is integral to the economy including commercial fisheries, tourism, transportation and industry. The major tributary rivers discharging to the Bay include the Blackstone and Pawtuxet Rivers as well as the Taunton River in Massachusetts. Rhode Island's coastal waters also include Little Narragansett Bay and a number of coastal ponds.[29]

These rivers, bays, and other bodies of water are separated by watersheds. The figure on the following page displays watershed boundaries in Rhode Island.

[29] Department of Environmental Management, 2018. Bay and Coastal Waters. Retrieved at http://www.dem.ri.gov/programs/water/bay/

Figure 1-3 Rhode Island Watersheds



1.2.3.4 Coastline

Rhode Island's coastline extends for nearly 400 miles along the Atlantic Coast. The geography of this area has been determined by unique coastal geology processes where sea level fluctuations and wind have eroded and built up sand along the coastline. Additionally, human influence has impacted the geography of the coastline through use and development.

1.2.3.5 Ecosystems

Rhode Island ecosystems are particularly vulnerable due to the state's small size and advanced stage of urbanization. Fresh and salt water systems and wetlands have been degraded by industrial pollution, bacterial contamination, and excess nutrients. About 23% of the 1,300 known native plant species in Rhode Island are becoming rare or are threatened or endangered. Similarly, 28% of the state's native vertebrate species, including mammals, fish, and birds, are rare or endangered. Eelgrass beds, valuable nursery and feeding grounds for commercial and recreational fish species, have been reduced to about one hundred acres. Approximately 4,000 acres of Narragansett Bay have been filled over the past 300 years. Restoring critical habitats, including wetlands, is vital to restoring native plant and wildlife species.[30]

1.2.3.6 Climate

Rhode Island has a humid continental climate with hot summers and cold winters. The City of Providence's average temperatures range from a low of 20.3°F in January to a high of 82.6°F in July.[31]

1.3 Future Conditions in Rhode Island

The changing conditions in Rhode Island have an impact on the future vulnerability of population, property, and the environment from natural hazards. This section identifies the changes in population and land use in Rhode Island. Each hazard profile, in Section 3 of this Plan, identifies the impact of the changing land use on the risk from each hazard.

1.3.1 Population Trends

The table below (Table 1-2) summarizes the April 2013 report by the Rhode Island Statewide Planning Program titled *Rhode Island Population Projections 2010-2040*. This report projected that the state would see population decline between 2010 and 2015, growth through 2035, and subsequently population decline thereafter.

[30] Department of Environmental Management, 2018. Environmental Results. Retrieved at http://www.dem.ri.gov/pubs/ar/demrep99/eco.htm

[31] RSS Weather, 2013. Average temperatures, Rhode Island. Retrieved from http://www.rssweather.com/climate/Rhode%20Island/Providence/

Table 1-2 Rhode Island Population Projections[32]

	2010	2015	2020	2025	2030	2035	2040
Population	1,052,567	1,046,327	1,049,177	1,061,796	1,070,677	1,073,799	1,070,104
Births over previous five years	60,436	57,825	56,470	56,015	55,848	54,751	52,518
Deaths over previous five years	48,100	50,722	49,464	50,191	53,592	58,492	63,053
Net migration over previous five years	-24,088	-13,346	-4,156	6,795	6,904	6,864	6,840

As the state's population shifts, planning will need to be done to ensure adequate understanding of demographics and expected population changes.

1.3.2 Land Use Trends

In Rhode Island, land use and development decisions are made at the local level. Rhode Island's Land Use Polices and Plan provides the vision for how Rhode Island will grow through the year 2025. Land Use 2025 describes a vision for the state as "a unique and special place, retaining its distinctive landscape, history, traditions, and natural beauty, while growing to meets its residents' needs for a thriving economy and vibrant place to live".[33] The main theme of Land Use 2025 is to target growth within areas already serviced by public services and facilities, indicated by an Urban Services Boundary, and in smaller, more rural growth centers. This plan will use seven percent of the state's land area with an emphasis on new housing at higher densities and greater use of public transit. The plan limits impacts on natural resources, especially in the western portion of the state.

[32] Rhode Island Statewide Planning Program, 2013. Rhode Island Population Projections 2010-2040. Retrieved at http://www.planning.ri.gov/documents/census/tp162.pdf
[33] Rhode Island Division of Planning. 2006. Land Use 2025: Rhode Island State Land Use Policies and Plan.

Section 2: Planning Process

This section details the planning process used for the 2019 State Hazard Mitigation Plan (SHMP) update. The process spanned a little less than a year prior to plan adoption. It included meetings between representatives of various Federal, State, and local agencies, and organizations. The update process included the review of existing programs, plans, policies, statutes, and historical hazard data. The planning team reviewed this information in the early stages of plan development and remained supportive throughout the planning process to better inform decisions on potential mitigation actions.

To facilitate statewide collaboration, the update process engaged the State Interagency Hazard Mitigation Committee (SIHMC), which was established in 2003 for the initial SHMP development. The SIHMC includes representatives from a wide array of State agencies, departments, and offices, whose participation is an important part of the planning process. Contributions from the SIHMC not only ensures that a wide variety of perspectives and interests are represented in the plan, but also allows for mitigation actions to be developed, adopted, and enacted by agencies with a wide variety of skill sets and resources. This engagement process ensures that the many resources available throughout Rhode Island are fully used. Appendix B contains a full listing of the SIHMC members for the 2019 SHMP update.

2.1 2019 Plan Update

The Federal Emergency Management Agency (FEMA) provided funding assistance for the preparation of this plan through a Hazard Mitigation Assistance grant. The plan was completed with planning assistance and support by the hazard mitigation and floodplain management program staff at the Rhode Island Emergency Management Agency (RIEMA), and Hagerty Consulting. FEMA Region I offered additional technical assistance throughout the plan development and plan review process, including a preliminary review of Section 3 of the plan.

Each section of the plan outlines the changes that were made during this plan update process. The overall organization of this plan did not change from the 2014 SHMP update. Section 3 changed the most due to an effort to integrate the Hazard Identification and Risk Assessment (HIRA) completed in 2017 with this SHMP update. Many of the planning activities were completed concurrently throughout the summer and fall of 2018.

2.1.1 Coordination Among Agencies

State, federal, and non-profit agencies participated actively in the 2019 SHMP update process highlighting coordination amongst stakeholders and provided critical input to each step in the plan update process. Representatives from each of these agencies reviewed the 2014 plan and contributed reflective changes in programs and policies since 2014. They also shared crucial data and resources, and valuable input. The primary group responsible for oversight of the plan is RIEMA and the SIHMC. RIEMA oversees the SIHMC, which was established to identify current hazard mitigation needs, to review project applications and set priorities, and to update previous recommendations.

RIEMA and consultant Hagerty Consulting were primarily responsible for providing input and data, plan writing, assessment, review, and planning coordination. The SIHMC provided guidance and assisted with development and subsequent updates of the SHMP, including review of previous hazard

mitigation planning initiatives and development of the Mitigation Strategy and Action Plan. The advantage of this group is that it provides a cross-disciplinary forum in which to discuss the myriad of statewide hazard mitigation issues.

The SIHMC also provides expertise and perspective to the planning process, including State and local emergency management initiatives throughout Rhode Island; natural hazards; land-use planning; building codes; transportation; State owned and operated facilities; critical facilities; utilities; State agency capability assessment analyses, and public and private infrastructure. From 2016 through 2017 the committee met regularly during the 2017 HIRA development process. Throughout the planning process, the SIHMC was asked to validate and add to the stakeholders involved in the planning process and SIHMC as necessary. One of the mitigation actions in the 2019 SHMP includes expanding the SIHMC membership and establishing a standing committee meeting to ensure implementation of the Mitigation Action Plan.

This effort to engage a broad spectrum of stakeholders will be key in the continued implementation of this plan. Appendix B includes a complete listing of the participants in the 2019 SHMP update. RIEMA has discussed strategies to engage additional partners in the SIHMC. The information in this section has been reviewed and revised by the SIHMC as well as subject matter experts and the general public. The SIHMC has approved the information presented in this section and feel it represents the planning process completed for the 2019 Plan update.

2.1.1.1 Capabilities Assessment

Section 4 of the 2019 SHMP was updated to capture new and ongoing capabilities in Rhode Island. Individual agency profiles were updated using 2014 SHMP information as a base. The completed profiles were shared with SIHMC members and agency contacts for review and modification. Updates to agency profiles were completed by the agency representative and characterized their agency's role in mitigation planning. Additional agencies were added to the 2019 SHMP update. Each agency had the opportunity to provide information via worksheets during the 2019 SHMP plan development process. Information was provided, and then reviewed by each agency during the plan development process. Any gaps in the profiles represent information that the agency did not have available to provide during the planning process.

2.1.2 Plan Update Meeting Schedule

The 2019 SHMP update included three (3) in-person meetings from June to October 2018:

1. Project Kick-off meeting: June 14, 2018
2. Risk Assessment and Mitigation Opportunities meeting: September 5, 2018
3. Plan Review meeting: October 31, 2018

The full SIHMC participated in the Risk Assessment and Mitigation Opportunities meeting and the Plan Review Meeting. Thirty (30) people attended the Risk Assessment and Mitigation Opportunities meeting, and [PLACEHOLDER] stakeholders attending the Plan Review Meeting. Appendix B captures all related documentation from these meetings, including: invitations, agendas, presentations, handouts, meeting notes, and attendance. The following sections summarize the outcomes of each of the planning process meetings.

2.1.2.1 Project Kick-off Meeting

RIEMA met with Hagerty Consulting on June 14, 2018 for the 2019 Plan Update Internal Kick-off Meeting. This meeting served as the beginning of the 2019 SHMP update. Hagerty presented an overview of the project management plan, engagement strategies, plan development, as well as discussed initial information needs, and next steps.

2.1.2.2 Risk Assessment Review and Mitigation Strategy Workshop Meeting

RIEMA hosted the Risk Assessment and Mitigation Strategy meeting for SIHMC members on September 5, 2018. Hagerty Consulting presented an overview of the risk assessment methodology and results. Additionally, the presentation included an overview of 2014 SHMP mitigation goals and objectives, proposed 2019 mitigation goals and objectives, and ongoing and new mitigation actions. The meeting included discussions where several SIHMC subject matter experts provided critical input into the HIRA as well as the mitigation strategy. The meeting also included two (2) interactive exercises. Participants were given dots to place over hazard maps to indicate the location of risk assessment revisions and mitigation strategy recommendations. Comments from this meeting have been incorporated into Sections 3 and 6 of this plan.

2.1.2.3 Plan Review Meeting

On October 31, 2018, RIEMA hosted the Plan Review Meeting for the SIHMC. During the meeting, Hagerty presented the draft SHMP, provided guidance on how to review the plan, and gave disposition to comments received prior to submittal to FEMA Region I for review. Comments on the draft plan were received from the SIHMC and incorporated into the plan. These comments can be found in Appendix B.

2.2 Public Outreach

Public participation in the update of this Plan occurred through participation in reviewing the posted Draft 2019 SHMP update on RIEMA's webpage. RIEMA posted the Draft 2019 SHMP update in October 2018, where the public was able to review the Draft SHMP and provide comments, and suggested revisions. These comments were incorporated into the Final 2019 SHMP update. More information related to outreach during the 2019 SHMP update can be found in the Outreach Strategy in Appendix B.

2.3 Local Hazard Mitigation Plan Integration

To ensure complimentary planning efforts that are in compliance with the Interim Final Rule, this update of the SHMP includes the integration of all available data from Rhode Island's local hazard mitigation plans (HMPs). RIEMA provided all local plans (approved, under review, and expired) and some supplemental local comprehensive plans for inclusion in the plan update.

Specifically, the following components of the local HMPs were surveyed:

- Hazard identification terminology;
- Vulnerability and risk assessment methodologies;
- Capabilities in planning, development programs and policies, and staffing and technical assistance;

- Mitigation goals;
- Types of mitigation actions; and
- Mitigation actions completed since the 2014 Plan update.

This information was collected, catalogued, and incorporated throughout this SHMP. Section 5 includes a complete summary of the local plan review. Where data limitations exist or inconsistencies in methodologies were observed, those were noted. For example, as noted in Section 3, attempts to utilize the local HMP vulnerability and loss estimates were limited for this SHMP update due to variability in the level of detail and results of the vulnerability assessments in the local HMP. The 2019 Mitigation Strategy identifies actions that can help to improve local plan incorporation and consistency in future plan updates. The tabular data collected during this survey can be found in Appendix E.

Section 3: Hazard Identification and Risk Assessment

This 2019 Hazard Identification and Risk Assessment (HIRA) updates content from the State of Rhode Island HIRA finalized in 2017. Significant changes to the HIRA include:

- Update of all maps and data to encompass changes since the 2017 HIRA; and
- Update of all exposure and Hazus analysis.

The information in this section has been reviewed and revised by the State Interagency Hazard Mitigation Committee (SIHMC), as well as subject-matter experts. The SIHMC has validated that the information contained within this section adequately represents the risk and vulnerability in Rhode Island.

3.1 Purpose

The purpose of this document is to provide a statewide overview of how various natural, human-caused, and technological hazards impact the State of Rhode Island. This HIRA undertakes an all-hazards identification, classification, and vulnerability indexing process to ensure hazard analysis is comprehensive and all-encompassing.

For the purposes of this HIRA, a natural hazard is defined as an event or physical condition that has the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. In addition, a human-caused hazard includes any disastrous event caused directly by one or more identifiable deliberate or negligent human actions, while a technological hazard is a hazard originating from technological or industrial conditions, including accidents, dangerous procedures, or failures.[1]

These hazards can be exacerbated by societal behavior and practices like building in a floodplain or along a sea cliff. All of these hazards may cause loss of life, injury, illness or other health impacts, property damage, loss of livelihoods and services, social and economic disruption, or environmental damage depending on the extent, magnitude, and impact of an incident. While it is impossible to prevent and mitigate all hazards, the impacts of hazards can, at a minimum, be mitigated or, in some instances, prevented entirely.

Rhode Island is not immune to these hazards. Hurricanes and related coastal flooding, winter storms, and riverine flooding affect Rhode Island on a recurring basis. Rhode Island's vulnerability to hurricanes and tropical storms is rated as high. There are 21 coastal area communities in the state that are vulnerable to wave actions and wind hazards, such as hurricane storm surge. Much of the coastline on the Atlantic Ocean consists of barrier island beaches that are open to the full force of destructive hurricane waves. Other damages associated with hurricanes and tropical storms include inland flooding, sea level rise (SLR), and tornadoes. The most serious inland flood threats occur when the eye of a hurricane passes just to the west of Rhode Island at a time of high tide. Flooding can pose additional health risk as it involves the overflow of storm-sewer systems and is usually caused by inadequate drainage following heavy rain, rapid snow melt, or an extreme storm surge up Narragansett Bay. In addition, Rhode Island is home to numerous pieces of critical infrastructure that

[1] Federal Emergency Management Agency, 2018. "Threat and Hazard Identification and Risk Assessment Guide." Retrieved at: https://www.fema.gov/media-library-data/1527613746699-fa31d9ade55988da1293192f1b18f4e3/CPG201Final20180525_508c.pdf

are vulnerable to both human-caused hazards, such as a cybersecurity incident or terrorism, and technological hazards, such as infrastructure failure or a transportation accident.

Identifying the risk and vulnerability for a community is critical when determining how to allocate finite resources to carry out feasible and appropriate mitigation actions. Hazard analysis involves identifying the hazards that potentially threaten Rhode Island and analyzing them individually to determine the degree of threat posed by each hazard. Addressing risk and vulnerability through hazard mitigation measures will reduce societal, economic, and environmental exposure to the impacts of hazards.

For multi-hazard identification, hazards that are likely to impact the state should be identified, as well as cascading impacts that could be triggered by an emergency incident—situations when one hazard triggers another sequentially. For example, severe flooding that damages buildings that store hazardous, water-reactive chemicals, could result in critical contamination problems that would dramatically escalate the type and magnitude of events. Dam failures may occur as a result of high precipitation, creating a dangerous flash flooding scenario for communities located in dam inundation areas.

3.2 Hazard Identification

In order to fulfill the planning guidelines outlined in the 2000 Disaster Mitigation Act and the Emergency Management Accreditation Program (EMAP), this HIRA addresses natural, human-caused, and technological hazards. The 2014 Rhode Island State Hazard Mitigation Plan (SHMP) update focused on natural hazards and the 2017 HIRA development expanded this to include all hazards. For the purposes of this 2019 Plan update, hazards have been organized alphabetically. Table 3-1 includes the hazard categories and corresponding hazards, which are listed from most frequent to least frequent. The following table outlines the identified hazards and groupings as well as the process involved in hazard identification, with Table 3-2 displaying natural hazards and Table 3-3 displaying human-caused and technological hazards.

Table 3-1 Hazard Identification and Hazard Groupings

<table>
<tr><th>Natural Hazards</th><th>Human-Caused Hazards</th><th>Technological Hazards</th></tr>
<tr><td>Severe Winter Weather
-Ice Storm
-Snow</td><td>Cybersecurity Incident</td><td rowspan="6">Infrastructure Failure
-Communications
-Emergency Services
-Energy
-Information Technology
-Transportation Systems
-Water and Wastewater Systems</td></tr>
<tr><td>Flood
-Riverine
-Coastal
-Flash
-Urban</td><td>Chemical Incident</td></tr>
<tr><td>High Wind</td><td>Terrorism
-Foreign and Domestic</td></tr>
<tr><td>Extreme Heat</td><td>Biological Incident</td></tr>
<tr><td>Hurricane and Tropical Storms
-Nor’easter
-Storm Surge</td><td>Radiological Incident</td></tr>
<tr><td>Extreme Cold</td><td>Civil Disturbance</td></tr>
</table>

Natural Hazards	Human-Caused Hazards	Technological Hazards
Thunderstorm -Hail -Lightning		
Dam Failure		
Fire -Urban -Wild		
Sea Level Rise		
Infectious Disease		
Drought		
Earthquake		
Tornado		

Table 3-2 Natural Hazard Identification Process

Hazard of Concern	How and Why Hazard was Identified
Severe Winter Weather Ice Storm Snowstorm	• Review historical disaster declarations and the National Oceanic and Atmospheric Administration (NOAA)'s National Centers for Environmental Information (NCEI) Storm Events Database. • National Weather Service (NWS) weather station data average annual snowfall. • Eight (8) out of 22 declared disaster events in Rhode Island were winter weather-related events.
Flood Riverine Coastal Flash Urban	• Review of historical disaster declarations and NOAA NCEI Storm Events Database. • Review of Flood Insurance Rate Maps (FIRMs), National Flood Insurance Program (NFIP) policies and claims, and repetitive loss (RL) and severe repetitive loss (SRL) properties. • Flooding impacts Rhode Island nearly every year and results in the majority of the damages associated with hazard events. • The National Hurricane Center (NHC) and the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model. • Nine (9) out of 22 declared disaster events in Rhode Island were flood events.
High Wind	• Review of historical disaster declarations and NOAA NCEI Storm Events Database. • American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures. • Four (4) out of 22 declared disaster events in Rhode Island were high wind events.
Extreme Heat	• Review of historical disaster declarations and NOAA NCEI Storm Events Database.

Hazard of Concern	How and Why Hazard was Identified
Hurricane and Tropical Storms Nor'easter Storm Surge	• Review of historical disaster declarations and NOAA NCEI Storm Events Database. • NWS hurricane data. • ASCE Minimum Design Loads for Buildings and Other structures. • Seven (7) out of 22 declared disaster events in Rhode Island were hurricane, tropical storm, or coastal events.
Extreme Cold	• Review of historical disaster declarations and NOAA NCEI Storm Events Database.
Thunderstorm Hail Lightning High Wind	• Review of historical disaster declarations and NOAA NCEI Storm Events Database. • Four (4) out of 22 declared disaster events in Rhode Island were high wind events.
Dam Failure	• Review of historical disaster declarations. • U.S. Army Corps of Engineers (USACE) National Inventory of Dams data. • There are 667 dams in Rhode Island; 96 high hazard and 81 significant hazard rating (Department of Environmental Management [DEM] 2017 Annual Report to the Governor).
Fire Urban Wild	• Review of historical disaster declarations, NOAA NCEI Storm Events Database, Rhode Island Division of Forest Environment data. • SIHMC input. • SILVIS Lab Wildland-Urban Interface (WUI) data.
Sea Level Rise	• Input from SIHMC, Rhode Island Sea Level Rise Committee, Rhode Island Sea Grant College Program data. • Coastal communities have the potential to be affected by SLR. • The Atlantic Ocean makes up the southern border of Rhode Island.
Infectious Disease	• Numerous bodies of water located in the state that assist with the breeding of mosquitos and other waterborne pathogens.
Drought	• Review of historical disaster declarations, NOAA NCEI Storm Events Database, U.S. Drought Monitor and Drought Impact Reporter. • The entire State of Rhode Island is subject to the effects of drought.
Earthquake	• Review of historical data from United States Geological Survey (USGS) and Weston Observatory. • Earthquakes have impacted Rhode Island in the past. Between 1568 and 2014, there have been over 34 felt earthquake events with epicenters in or near Rhode Island. • Peak ground acceleration (PGA) data.
Tornado	• Review of historical disaster declarations and NOAA NCEI Storm Events Database.

Table 3-3 Human-Caused and Technological Hazard Identification Process

Hazard of Concern	How Hazard was Identified
Cybersecurity Incident	• Most of Rhode Island's critical infrastructure is linked to some technology-based platform, which is a key vector of attack in a cybersecurity incident.
Chemical Incident	• There are 724 Tier III facilities in Rhode Island. • Since 1989, eight (8) major chemical incidents have occurred in Rhode Island.
Terrorism Foreign and Domestic	• Terrorist attacks can occur anywhere; Rhode Island is an attractive target due to its proximity to major urban areas.
Biological Incident	• Intentional biological incidents can cause serious public health risks and have the potential to overwhelm health care facilities/professionals as well as first responder resources.
Radiological Incident	• Rhode Island is within the 50-mile Ingestion Exposure Pathway for two (2) nuclear power plants.
Civil Disturbance	• Seven (7) large-scale (15,000 to 100,000 people), state-supported events occur within Rhode Island each year.
Infrastructure Failure	• Rhode Island is home to numerous pieces of critical infrastructure across all six (6) identified sectors.

As part of the 2017 HIRA development, infectious disease (formally referred to as "epidemic") was added as a natural hazard, in order to align with its inclusion in the Threat and Hazard Identification and Risk Assessment (THIRA). In addition, human-caused hazards and technological hazards were added to the overall vulnerability assessment to align with the THIRA and address EMAP accreditation. Climate change is included in the discussion of the identified hazards in this HIRA as an "amplifier" and is not profiled as an independent hazard. It is important to note that the results of the HIRA are used to inform the THIRA's threat and hazard development. By applying the identified priority hazards from the HIRA into the THIRA, Rhode Island can better identify and allocate its resources to the specific hazards of concern.

It should be noted that the above hazards are not a complete listing of all hazards that may occur in Rhode Island. The SIHMC agreed that this listing accurately represents the hazards that impact Rhode Island most frequently and have the potential to cause fatalities, injuries, property and infrastructure damage, agricultural loss, damage to the environment, interruption of business, or other types of harm or loss. The following hazards are not addressed in the HIRA:

- Avalanche
- Expansive soils
- Land subsidence
- Landslides
- Volcanoes
- Tsunamis

The hazards listed above were considered and discussed during several SIHMC meetings during the 2017 HIRA development as well as the 2019 SHMP update process, but it was decided that these hazards would not be included in the HIRA due to their low probability of occurrence and the lack of resources to devote to further researching the likelihood of occurrence or impact.

3.3 Disaster History

Historically, hurricanes and winter weather-related events have caused the most damage to the state and its citizens. Recent disasters have shifted the attention of Rhode Island's citizens and government officials to the resultant human, economic, and environmental impacts. The State of Rhode Island has had 10 emergency declarations and 12 major disaster declarations since 1954. The most recent federal disaster declaration occurred in April 2015, due to a Severe Winter Storm and Snowstorm. Table 3-4 summarizes the disaster declarations in Rhode Island from 1954 to August 2018.

These disasters have had significant impacts on Rhode Island, and its residents have had to bear the majority of the costs of clean up and restoration of services. Disasters impact the state through death and injury; loss of residences, property, and possessions; lost wages, tax revenue, and business revenue; and the immeasurable psychological and sociological costs to disaster victims and their families. In considering the economic costs of disasters, it is important to recognize that small- to medium-sized businesses, which provide the majority of jobs in an average community, are at a high risk for failure following a disaster.

3.3.1 Major Disaster Declarations

Local and state government share the responsibility for protecting Rhode Island citizens and for helping them recover when a disaster strikes. In some cases, a disaster is beyond the response capabilities of state and local government. In 1988, the Stafford Act was enacted to support state and local governments and their citizens when disasters overwhelm them and exhaust their resources. This law, as amended, established a process for requesting and obtaining a Presidential Disaster Declaration, which defines the type and scope of assistance available from the Federal Government and sets the conditions for obtaining that assistance.[2] The most recent declared Disaster Recovery (DR) projects in the state are summarized below. Table 3-4 that follows displays all disaster and emergency declarations in Rhode Island from 1954 to 2018.

- **DR-4212:**[3] A major disaster declaration (DR-4212) was declared on April 3, 2015, for Bristol, Kent, Newport, Providence, and Washington counties affected by a severe winter storm and snowstorm during the period of January 26, 2015, to January 28, 2015. The total Public Assistance (PA) Program cost estimate for the entire State of Rhode Island was $8,423,228. The governor requested PA in response to this severe winter weather event—publicly known as Winter Storm Juno—and funds were made available to state and eligible local governments, and certain private non-profit organizations on a cost-sharing basis. The assistance covered emergency work and the repair or replacement of damaged facilities. In addition, the disaster declaration authorized snow assistance for a period of 48 hours in affected counties.
- **DR-4107:**[4] A major disaster declaration (DR-4107) was declared on March 22, 2013, for Bristol, Kent, Newport, Providence, and Washington counties affected by a severe winter storm and snow during the period of February 8, 2013 to February 9, 2013. The storm, named Winter Storm Nemo by the Weather Channel, produced hurricane-force winds and extreme snowfall accumulations across much of the northeast. In West Glocester, 25.7 inches of snow

[2] FEMA. March 4, 2008. *A Guide to the Disaster Declaration Process and Federal Disaster Assistance*. Retrieved at https://www.fema.gov/media-library-data/20130726-1536-20490-8240/dec_proc.pdf
[3] FEMA, n.d. Rhode Island Severe Winter Storm and Snowstorm (DR-4212). Retrieved at: http://www.fema.gov/disaster/4212
[4] FEMA, n.d. Rhode Island Severe Winter Storm and Snowstorm (DR-4107). Retrieved at https://www.fema.gov/disaster/4107

were reported.[5] The total PA cost estimate for the entire State of Rhode Island was $7,929,498.13.

- **DR-4089:**[6] A major disaster declaration (DR-4089) was declared on November 3, 2012, for Bristol, Kent, Newport, and Washington counties affected by Hurricane Sandy during the period of October 26, 2012, to October 31, 2012. The hurricane made landfall in northern New Jersey with winds of 80 miles per hour (mph) and made its way along the east coast, affecting much of the northeast, including Rhode Island. Total damages were estimated at nearly $70 billion.[7] The PA cost estimate for the entire state of Rhode Island was $8,627,926.84. Total Individual and Households Program cost estimates for the state were $421,340.81.
- **DR-4027:**[8] A major disaster declaration (DR-4027) was declared on September 3, 2011, for Bristol, Kent, Newport, Providence, and Washington counties affected by Tropical Storm Irene during the period of August 27, 2011, to August 29, 2011. Hurricane Irene was a powerful storm that left extensive flood and wind damage along the east coast. In Rhode Island, power loss affected over half of National Grid's Rhode Island customers, as well as traffic signals and other aspects of the transportation system.[9] Mandatory evacuations were ordered for low-lying communities. The total PA cost estimate for the entire State of Rhode Island was $8,341,293.11.
- **DR-1894**:[10] A major disaster declaration (DR-1894), commonly known as the 2010 floods, was declared on March 29, 2010, for Bristol, Kent, Newport, Providence, and Washington counties affected by severe storms and flooding during the period of March 12, 2010 to April 12, 2010. Record rains caused flooding that destroyed homes, businesses, and infrastructure. The impacts were most severe along the Pawtuxet, Wood, and Pawcatuck rivers and their tributaries, where bridges and dams washed out, including the Blue Pond, Geneva Pond, and Usquepaugh dams.[11] The total PA cost estimate for the entire State of Rhode Island was $25,063,551.58. This funding was made available to state and eligible local governments for emergency work and the repair or replacement of facilities damaged by the flooding.

[5] NASA Earth Observatory, 2013. February Blizzard Strikes U.S. Northeast. Retrieved at https://earthobservatory.nasa.gov/images/80412/february-blizzard-strikes-us-northeast
[6] FEMA, n.d. Rhode Island Hurricane Sandy (DR-4089). Retrieved at https://www.fema.gov/disaster/4089
[7] NASA, 2013. Hurricane Sandy (Atlantic Ocean). Retrieved at https://www.nasa.gov/mission_pages/hurricanes/archives/2012/h2012_Sandy.html
[8] FEMA, n.d. Rhode Island Tropical Storm Irene (DR-4027). Retrieved at https://www.fema.gov/disaster/4027
[9] CBS News, August 28, 2011. Impacts from Irene, state by state. Retrieved at https://www.cbsnews.com/news/impacts-from-irene-state-by-state/
[10] FEMA, n.d. Rhode Island Severe Storms and Flooding (DR-1894). Retrieved at: http://www.fema.gov/disaster/1894
[11] Fisher, David, June 7, 2010. "What Made the Flood of 2010 So Devastating?" ecoRI News. Retrieved at: http://www.ecori.org/smart-growth/2010/6/7/what-made-the-flood-of-2010-so-devastating.html

Table 3-4 Disaster and Emergency Declarations in Rhode Island, 1954 – 2018

Disaster Number	Declaration Type	Declaration Date	Description	Individual Assistance Total	Public Assistance Total	Hazard Mitigation Grant Program Total
4212	DR	4/3/2015	Severe Winter Storm and Snowstorm	N/A	$8,423,229	$1,327,144
4107	DR	3/22/2013	Severe Winter Storm and Snowstorm	N/A	$7,057,671	$1,070,561
4089	DR	11/3/2012	Hurricane Sandy	$421,341	$6,519,140	$1,525,853
4027	DR	9/3/2011	Tropical Storm Irene / Hurricane Irene	N/A	$9,260,898	$1,608,921
3334	EM	8/27/2011	Hurricane Irene	N/A	N/A	N/A
3311	EM	3/30/2010	Severe Storms and Flooding	N/A	N/A	N/A
1894	DR	3/29/2010	Severe Storms and Flooding	$37,033,311	$17,043,832	$11,033,039
1704	DR	5/25/2007	Severe Storms and Island/Coastal Flooding	N/A	$605,080	$86,280
3255	EM	9/19/2005	Hurricane Katrina Evacuation	N/A	$1,110,010	N/A
3203	EM	2/17/2005	Record Snow	N/A	$6,273,609	N/A
3182	EM	3/27/2003	Snowstorm	N/A	$2,002,984	N/A
3123	EM	11/19/1996	Major water main break	N/A	N/A	N/A
1091	DR	1/24/1996	Blizzard	N/A	N/A	N/A
3102	EM	3/16/1993	Blizzards, High Winds, and Record Snowfall	N/A	N/A	N/A
3094	EM	9/16/1992	Water Contamination	N/A	N/A	N/A
913	DR	8/26/1991	Hurricane Bob	N/A	N/A	N/A
748	DR	10/15/1985	Hurricane Gloria	N/A	N/A	N/A
548	DR	2/16/1978	Snow, Ice	N/A	N/A	N/A

Disaster Number	Declaration Type	Declaration Date	Description	Individual Assistance Total	Public Assistance Total	Hazard Mitigation Grant Program Total
3058	DR	2/7/1978	Blizzards and Snowstorms	N/A	N/A	N/A
39	DR	8/20/1955	Hurricane, Flood	N/A	N/A	N/A
23	DR	9/2/1954	Hurricanes	N/A	N/A	N/A

Note: Total assistance values are not inflated.
DR = Major Disaster Declaration
EM = Emergency Disaster Declaration
N/A = Information Not Available

3.3.2 National Centers for Environmental Information

The HIRA used NOAA's NCEI Storm Events Database as a primary source for previous occurrences of storm events. This database contains information on previous storms and weather phenomena that have caused loss of life, injuries, significant property damage, and/or disruption to commerce. Efforts are made to collect the best available information, but because of time and resource constraints, information may not be verified, and the accuracy or validity of the information will not be guaranteed by the NWS.

Most of the events from NCEI are not associated with a federal emergency or disaster. If the event occurred at the same time as an event that was later determined to be a federal emergency or disaster, it is included with the NCEI data even if it occurred in a county not included in the federal declaration. High wind events make up more than approximately 28.4% of the reported events in Rhode Island, followed by thunderstorms (27.3%), winter storms (27.2%), and flooding (11.9%) (Table 3-5). These event totals represent reports from each jurisdiction within each county. Therefore, an event that happens on one (1) day could include more than one (1) event report if multiple jurisdictions are impacted.

Table 3-6 and Table 3-7 show the total damages and annualized damages summarized by jurisdiction and hazard type. These estimates are believed to be an underrepresentation of the actual losses experienced from events that go unreported or that are difficult to quantify and are not likely to appear in the NCEI database.[12] This is especially true with hurricanes.

[12] NOAA, n.d. Storm Data FAQ Page. Retrieved at: https://www.ncdc.noaa.gov/stormevents/faq.jsp

Table 3-5 NCEI Total Number of Events

County Name	Flood	Hurricane	Wind	Tornado	Winter Storm	Drought	Extreme Cold	Extreme Heat	Thunderstorm
Years of Record	*1996-2018*	*1996-2018*	*1955-2018*	*1950-2018*	*1996-2018*	*1996-2018*	*1996-2018*	*1996-2018*	*1955-2018*
Bristol	25	1	66	2	58	4	0	0	48
Kent	49	2	136	2	153	8	5	21	121
Newport	20	1	90	0	56	5	2	2	56
Providence	99	3	142	6	185	9	4	8	223
Washington*	36	4	113	2	72	8	0	3	78

*Includes Block Island

Table 3-6 NCEI Total Property Damages

County Name	Flood	Hurricane	Wind	Tornado	Winter Storm	Thunderstorm	Total
Years of Record	*1996-2018*	*1996-2018*	*1955-2018*	*1950-2018*	*1996-2018*	*1955-2018*	
Bristol	$6,234,000.00	$10,000.00	$110,500.00	$45,000	$135,000.00	$315,000.00	$6,849,500.00
Kent	$27,872,000.00	$65,000.00	$692,800.00	$250,000	$497,000.00	$873,500.00	$30,250,300.00
Newport	$6,635,000.00	$20,000.00	$497,100.00	$0	$291,000.00	$104,000.00	$7,547,100.00
Providence	$32,580,000.00	$93,000.00	1,004,400.00	$3,250,000	10,955,000.00	$2,249,000.00	$50,131,400.00
Washington*	$33,427,000.00	$75,000.00	$554,900.00	$50,000	$220,000.00	$941,750.00	$35,268,650.00
Statewide	$106,748,000.00	263,000.00	$2,859,700.00	$3,595,000	12,098,000.00	$4,483,250.00	$130,046,950.00

*Includes Block Island

Table 3-7 NCEI Annualized Total Property Damages (1950-2018)

County Name	Flood	Hurricane	Wind	Tornado	Winter Storm	Thunderstorm	Total
Years of Record	*1996-2018*	*1996-2018*	*1955-2018*	*1950-2018*	*1996-2018*	*1955-2018*	
Bristol	$271,043.48	$434.78	$1,726.56	$652.17	$5,869.57	$4,921.88	$284,648.44
Kent	$1,211,826.09	$2,826.09	$10,825.00	$3,623.19	$21,608.70	$13,648.44	$1,264,357.51
Newport	$288,478.26	$869.57	$7,767.19	$0	$12,652.17	$1,625.00	$311,392.19
Providence	$1,416,521.74	$4,043.48	$15,693.75	$47,101.45	$476,304.35	$35,140.63	$1,994,805.40
Washington*	$1,453,347.83	$3,260.87	$8,670.31	$724.64	$9,565.22	$14,714.84	$1,490,283.71
Statewide	$4,641,217.39	$11,434.78	$44,682.81	$52,101.45	$526,000.00	$70,050.78	$5,345,487.21

*Includes Block Island

3.4 Hazard Ranking Methodology

In this section, the methodology of scoring vulnerability for the profiled hazards will be explained as it relates to each hazard. The discussion of the methodology is critical to understanding how and why hazards are prioritized differently in Rhode Island. Many of the hazards assessed in this HIRA did not have quantifiable probability or impact data, thus a semi-quantitative ranking system was used to compare all of the hazards of interest instead.

A standardized methodology, which allows for greater flexibility and room for subject matter expertise, was developed to compare different hazards' risk on a county basis. This method prioritizes hazard risk based on a blend of quantitative factors extracted from NCEI and other available data sources. These factors include:

- Likelihood of occurrence (expected frequency) (Table 3-8);
- Likely range of impact (predictable size and location of impact) (Table 3-9); and
- Probable level of impact (estimated strength, magnitude, onset, duration, and damage potential) (Table 3-10).

Three (3) ranking components were used to identify county-based hazard rankings. Likely range of impact and probable hazard magnitude parameters were rated on a scale of one (1) through three (3), with those rated at one (1) considered as low risk and those rated at three (3) considered as high risk. Likelihood of hazard occurrence was rated on a scale of one (1) through four (4), in which the probability of future occurrence ranged from less than 1% annual probability (score of one [1]) to greater than 90% annual probability (score of four [4]).

Five (5) criteria were evaluated to assign a probable magnitude for each hazard: injuries and deaths, infrastructure shutdown, structure damage, environment, and state operations. Each criterion was evaluated independently, and the probable hazard magnitude was determined based on the maximum score of the five (5) criteria (Table 3-10). For example, if a hazard was determined to have no injuries and deaths, but would result in significant structure damages, the probable hazard magnitude assigned would be a three (3).

The scores for each of the factors (likelihood of hazard occurrence, likely range of impact, and probable hazard magnitude) were summed at a county level for each hazard separately, allowing for easy comparison between counties for each hazard type. A summation of the scores for all hazards in each county provides an overall, all-hazards composite hazard index.

The NWS does not guarantee the accuracy or validity of the information used for weather-related hazards. Although the historical records in the database often vary widely in their level of detail, the NWS does have a set of guidelines for use in the preparation of event descriptions; these were followed in researching this hazard analysis.[13]

[13] Gall, Melanie; Kevin A. Borden; and Susan L. Cutter, 2009. *When Do Losses County? Six (6) Fallacies of Natural Hazards Loss Data*. Retrieved at: http://www.spc.noaa.gov/wcm/data/2008bams.pdf

Table 3-8 Likelihood of Hazard Occurrence

Likelihood	Score	Frequency of Occurrence
Highly Likely	4	Greater than 90% annual probability
Likely	3	Between 50-89.9% annual probability
Potential	2	Between 1-49.9% annual probability
Unlikely	1	Less than 1% annual probability

Table 3-9 Likely Range of Impact

Size of Area	Score	Jurisdictional Coverage
Large	3	40-100% of the total jurisdictional boundaries
Medium	2	10-40% of the total jurisdictional boundaries
Small	1	10% or less of the total jurisdictional boundaries

Table 3-10 Probable Hazard Magnitude

Intensity and Impacted Area	Score	Magnitude
Significant	3	• Multiple deaths and severe injuries • Medium shutdown of some critical infrastructure and facilities • Twenty percent (20%) to 50% of residential and 10-25% of commercial structures are severely damaged • Impacted greater than 20% of natural resources • Large impacts to state operations for long amounts of time
Limited	2	• Some injuries • Short shutdown of some critical infrastructure and facilities • Fewer than 10% of residential and commercial structures damaged • Impacted fewer than 20% of natural resources • Small amount of state operations impacted for short amounts of time
Negligible	1	• Minor injuries • No shutdown of critical infrastructure and facilities • Scattered incidental residential and commercial structure damages • Impacted fewer than 5% of natural resources • Few or no operations impacted for short amounts of time

3.5 Vulnerability Assessment

Vulnerability includes all populations and assets (environmental, economic, and critical facilities) that may be at risk from natural, human-caused, and technological hazards. The vulnerability analysis performed in this HIRA measures the level of exposure of assets, populations, or resources within a

given region, city, or town to different hazards. The vulnerability is a function of the built environment, local economy, demographics, and environmental uses of a given region.

3.5.1 Building Data

The 2019 SHMP update analyzed the vulnerability of state-owned facilities, infrastructure, critical facilities, and residential and commercial buildings to the different hazards that pose a risk in Rhode Island. Not all critical facilities are state- or locally-owned. For example, many privately-owned buildings and structures such as hospitals, power plants, and certain industrial facilities are critical to societal function, especially during emergencies and disasters. Thus, critical facility data collection extended to a broader array of facilities than would be available by using only state-owned facilities.

Most of the critical facility data was obtained through the Rhode Island Geographic Information System (RIGIS) distribution website. This data included infrastructure related to first responders, healthcare, education, transportation, dams, and government operations. Emergency 911 contact points were also provided by RIGIS. Additional facility data provided through Homeland Infrastructure Foundation-Level Datasets (HIFLD) included financial institutions, shipping and receiving facilities, power generation infrastructure, poultry slaughterhouses and food processing, and solid waste facilities. Military Critical Facilities were provided by RIDCAMM.

Table 3-11 summarizes the different types of buildings and infrastructure analyzed and the corresponding data sources. This data represents the best available at the time of this plan update; however, it is not a complete representation of all possible facilities in the state. For the most part, the data used only contained the structure's location information. Detailed attribute information like building value was generally unavailable.

Table 3-11 Rhode Island Buildings and Infrastructure

Type	Publication Date	Source	Total Structures/Facilities
Cellular Towers	Unavailable	Hazus	39
EMS	September 2008	RIGIS	111
EOC/Response Center	Unavailable	Hazus	17
Fire Stations	February 2017	RIGIS	160
Police Stations	September 2014	RIGIS	70
Electrical Generation Facilities	Unavailable	Hazus	14
Power Plants	March 2016	HIFLD	13
Oil and Natural Gas Distribution Pipelines and Facilities	Unavailable	Hazus	2
Airports	October 2013	RIGIS	48
Marinas	December 1995	RIGIS	78
Port	September 2010	RIGIS	22
Rail Systems and Mass Transit	September 2016	RIGIS	5014
Water/wastewater facilities	Unavailable	Hazus	21

Type	Publication Date	Source	Total Structures/Facilities
Public Water Reservoirs	October 2015	RIGIS	50
Hazardous Material Facilities	Unavailable	Hazus	330
Public Assembly	March 2013	RIGIS	39
Postal and Shipping	June and July 2017	HIFLD	327
Dams	December 2011	RIGIS	669
Credit Unions and Banks	November 2014 and June 2015	HIFLD	358
Poultry Slaughtering and Processing Facilities	July 2009	HIFLD	18
City and Town Halls	March 2013	RIGIS	39
Libraries	March 2014	RIGIS	113
Military Bases	Unavailable	RIDCAMM	83
Schools	April 2008	RIGIS	677
Colleges and Universities	October 2007	RIGIS	20
Hospitals	April 2013	RIGIS	20
Nursing Homes	September 2018*	HIFLD	153
Urgent Care	July 2009	HIFLD	21
Active Solid Waste Facility Sites	April 2015	RIGIS	61
E911 • Residential (R1, R2, and R3) • Commercial (C1, and C9)	July 2017	RIGIS	371,184

*Publication date of data has been updated since exposure analysis was conducted

3.5.2 Exposure Analysis

ArcGIS was used to perform the exposure analysis. The analysis determined which critical facilities were located within the boundaries of identified hazards. Hazard data used for exposure analysis was obtained from a variety of federal sources. Flood hazard data was collected from the Federal Emergency Management Agency (FEMA)'s National Flood Hazard Layer (NFHL). The 2010 WUI dataset was obtained from SILVIS labs which produces the national WUI dataset. Storm surge and SLR data was collected from NOAA.

The exposure analysis to earthquake ground motion, hurricane peak winds, and flood depth was developed through the hazard loss estimation program called Hazus. Hazus is an extension of ArcGIS administered by FEMA that uses default federal data to project losses from hurricanes, earthquakes, floods, and tsunamis.

To analyze the exposure of Rhode Island's buildings and infrastructure to different hazard areas, the points were converted to polygons by adding a 30-foot buffer around each point. By converting the points to polygons, the data could more closely resemble an average building footprint. One limitation of this method is that it does not capture the full spatial extent of larger facilities.

Table 3-12 summarizes the hazard data used to conduct the exposure analysis, as well as additional state and federal hazard data sources consulted for the hazard profiles and the rest of the 2019 Plan. For example, average snowfall, tornado tracks, and wind and hail incident data were obtained from NOAA and their Storm Prediction Center. Earthquake epicenter data was collected from the USGS Earthquake Catalog, and high and significant hazard dam information was obtained from the Rhode Island Emergency Management Agency (RIEMA).

The corresponding hazard profiles summarize and interpret the results of this exposure analysis. The full results are also summarized at the end of the HIRA in Section 3.27.2.

Table 3-12 Hazard-Specific Datasets

Hazard/Map	Data	Publication Date	Source
Fire	WUI	2010	SILVIS Lab
Hurricane	SLOSH data	2015	NOAA
Sea Level Rise	NOAA SLR inundation predictions	2014	RIGIS/NOAA
Flood	FEMA Flood Hazard Areas	2015	RIGIS/FEMA
Hurricane	Hurricane Carol (peak wind gusts) Hazus	Unknown	Hazus
Earthquake	PGA Hazus	Unknown	Hazus
Snowfall	Average Snowfall	2018	NOAA Storm Prediction Center
Thunderstorm	Wind and Hail Incidents	2018	NOAA Storm Prediction Center
Tornado	Tornado Tracks	2018	NOAA Storm Prediction Center
Population Density	American Community Survey (ACS) 5-year Estimates	2016	U.S. Census Bureau
Watersheds	Watershed boundaries	2007	RIGIS
Physiography	Physiographic Sections	2018	USGS

3.5.3 Hazus

An additional loss assessment was run using Hazus. Hazus is a program administered by the FEMA and is used to model losses from floods, hurricanes, earthquakes, and tsunamis. The program is an extension of ArcGIS, the primary program used to perform risk assessment analysis. Risk assessments for earthquake, flood, and hurricane hazards use Hazus analysis to estimate losses and projected impacts from historical and annualized hazard events. Hazus default data was used in the analysis. The default data includes the 2010 Census and other State and Federal government facility databases.

Level I analyses were run in Hazus for flood, hurricane, and earthquake, meaning the default population, building stock, and critical infrastructure data within the program was used to calculate losses and damages. Hazus results can become more robust when additional data—including but not limited to facility construction materials, year built, number of stories, and content costs—are imported into the program. Hazus default data can provide a general estimate of the location and magnitude of hazard related damages and losses.

Multiple hazard scenarios were run to estimate losses for the identified hazards. For the earthquake and hurricane hazards, historic event scenarios (such as the Cape Anne earthquake and Hurricane Carol) and probabilistic scenarios were run. A probabilistic hazard scenario estimates the average annual loss expected. Flood losses were analyzed using the full suite of return periods (10, 50, 100, and 500 years) as well as a probabilistic scenario.

In addition to loss estimation, the projected hazard conditions from some of the Hazus generated scenarios were used to conduct additional exposure analysis on the critical facility stock compiled for this plan. Earthquake exposure was analyzed using PGA (%g) and hurricane exposure was analyzed using peak wind gusts (in mph). Depth grids generated by Hazus were used to determine the depth of flooding that critical facilities may be exposed to as a result of different flood return periods.

3.6 Biological Incident

3.6.1 Description

A biological incident includes the accidental or intentional release of naturally occurring biological diseases (communicable and non-communicable). Biological agents are organisms or toxins that can kill or incapacitate people, livestock, and crops. There are several types of biological agents:

- **Bacteria** are single-cell organisms that are the causative agents of anthrax, brucellosis, tularemia, plague, and numerous other diseases. They vary considerably in infectivity and lethality.
- **Rickettsiae** are microorganisms that resemble bacteria in form and structure but differ in that they are intracellular parasites that can reproduce inside animal cells. Examples of rickettsial diseases that could be employed as biological agents include Typhus, Rocky Mountain spotted fever, and Q fever.
- **Viruses** are intracellular parasites that are about 100 times smaller than bacteria. They can infect humans, crops, and domestic animals. An example of a virus that could be employed as a biological agent is VEE. VEE virus causes a highly infectious disease, but rarely kills. A virus's strength can be altered to increase its efficiency. A particularly powerful strain of an endemic pathogen could simply be blamed on a chance natural mutation.
- Some **Fungi** can cause severe disease in humans, such as coccidiodmycosis (valley fever) and histoplasmosis. Examples of plant fungal pathogens include rice blast, cereal rust, and potato blight.
- **Toxins** are a poisonous substance made by a living system, or a synthetic analogue of a naturally occurring poison. A wide variety of toxins are produced by bacteria, fungi, marine organisms, plants, insects, spiders, and other animals.[14] Examples of biological toxins include ricin and botulinum toxin.

Incidents can result from both intentional and un-intentional acts. A biological attack is the deliberate release of germs or other biological substances that can make a person sick, including biological agents found in the environment or diagnosed in animals, which have the potential for transmission to humans (zoonosis). Accidental exposure to some biological substances can also kill or incapacitate people and animals. Examples of un-intentional biological incidents include exposure to anthrax on animal hides or deaths and illnesses resulting from improperly stored or maintained food products.

3.6.2 Location

The entire State of Rhode Island is vulnerable to biological incidents. However, areas of higher human movement and urban areas are at greater risk. The transmission of disease may be more efficient in cities due to housing and population density; poor housing conditions and antiquated sewage and water systems can also contribute to the spread of disease.

Cities and urban areas often have high concentrations of rat (*Rattus*) populations, and close encounters between rats and humans can lead to transmission of zoonotic infectious diseases. Rats can carry pathogens such as *Yersinia pestis*, *Leptospira* spp., *Rickettsia typhi*, *Streptobacillus*

[14] Adopted from the Federation of American Scientists. https://fas.org/irp/cia/product/go_appendixc_032796.html. Retrieved 7 August 2018.

moniliformis, *Bartonella* spp., Seoul hantavirus, and *Angiostrogylus cantonensis.*[15] Studies have shown that encounters between rats and humans have been linked to proximity to open public spaces and subway lines and the presence of vacant housing units.

3.6.3 Extent

The three (3) basic groups of biological agents that would likely be used as weapons are bacteria, viruses, and toxins. Many biological agents are difficult to grow and maintain. Many become non-viable when exposed to sunlight and other environmental factors, while others, such as anthrax spores, are very long lived, even under adverse environmental conditions. Biological agents can be dispersed by aerosolizing them into the air, by infecting animals that subsequently spread the disease to humans, and by contaminating food and water. While biological agents can be deadly in and of themselves, it is the method and accuracy of their delivery that determines the severity of the damage. The ultimate effectiveness of these agents is determined by the following factors, regardless of the circumstances of their use:

- Agent delivery;
- Doses on target;
- Downwind dispersal;
- Doses inhaled or absorbed; and
- Symptoms.

Routes of exposure and means of delivery are particularly important for predicting and understanding the potential severity of a biological incident. Routes of exposure or delivery include:

- **Inhalation:** This method requires that a biological agent be aerosolized in a particle size that could be inhaled by an individual. Scenarios include airborne dissemination, for instance, via crop dusting aircraft, or dispersal through a building air handling system.
- **Injection:** This method involves the introduction of an agent into an individual by penetrating the skin barrier. Scenarios include targeted attacks with an injection device such as a syringe.
- **Ingestion:** This method would involve an individual swallowing the agent or toxin. Scenarios include the introduction of an agent into a food or water source.
- **Absorption:** This method would involve absorption of an agent by an individual's body, most readily through the mucous membranes. Scenarios include aerosolized liquid dispersal via a backpack sprayer.
- **Person-to-person:** The spread of infectious agents from person-to-person is also possible. The delivery of an agent via person-to-person transmission would involve infecting an individual through a variety of means (including those listed above), with the hope that that individual will subsequently infect those with whom he or she comes into contact. Conceivably, someone could also intentionally infect him or herself, and then proceed to expose other individuals through intentional contact.

Diseases that cause widespread human deaths can have an impact on the environment in relation to the handling and disposal of human remains and the handling of biohazardous waste. Similarly,

[15] Neiderud, C.-J. (2015). How urbanization affects the epidemiology of emerging infectious diseases. *Infection Ecology & Epidemiology*, *5*, 10.3402/iee.v5.27060. Retrieved at http://doi.org/10.3402/iee.v5.27060

diseases that cause the widespread death of animals, both captive and wild, would also affect the environment during the disposal of animal carcasses.

During a biological incident, federal, state, tribal, territorial, and local officials require a highly coordinated response to public health and medical emergencies. A biological incident, either deliberate or unintentional, is often first detected by medical providers when patients present at a hospital or other medical facility. There are other methods of early detection, including environmental surveillance technologies and medical and syndromic surveillance systems. Early detection of biological incidents offers an opportunity to take proactive measures to mitigate both the spread and consequences of a disease outbreak.

3.6.4 Previous Occurrences

There has not been a significant example of a human-caused biological incident in the State of Rhode Island. Globally, however, biological agents, such as *Bacillus anthracis* or *Salmonella*, have been used as a means of attack. Although the probability of a biological incident in Rhode Island is less likely based on past occurrences in the state, the consequences of such an incident could potentially be very high (see Probability of Future Events below).

A number of incidents involving "white powder" have occurred in Rhode Island since the 2001 anthrax (*Amerithrax*) attacks. None of these incidents were confirmed to contain live biological agents. While they did not cause the morbidity and mortality that an actual biological incident might bring, they nonetheless placed a strain on resources dedicated to ensuring biosecurity in Rhode Island. Such incidents continue to occur, with the most recent in August 2018.

For more information on naturally occurring infectious diseases, see the Infectious Disease section.

3.6.5 Probability of Future Events

Although no major biological incident has occurred within Rhode Island, the ease of foreign travel and other factors increase the risk of a biological incident at any time. There is an unlikely probability of an incident occurring within the next one (1) to three (3) years based on the hazard analysis conducted (Table 3-13).

The Rhode Island State Health Laboratories (RISHL) Center for Biological Sciences, within RIDOH, provides an extensive array of testing to quickly identify biological agents of public health concern, including potential agents of bioterrorism, in human and animal clinical specimens as well as in food. Serving as a reference laboratory within the Centers for Disease Control and Prevention (CDC) Laboratory Response Network (LRN), RISHL also performs testing on unknown powders and other suspicious environmental substances to rule out or confirm the presence of biothreat agents. The RISHL Bioterrorism Preparedness & Response Program continues to instruct clinical microbiology laboratories throughout the state on how to perform rule-out testing and refer potential agents of bioterrorism to RISHL, as well as how to prepare their laboratories to respond rapidly to a large infectious disease outbreak.

The Environmental Microbiology Laboratory within the RISHL Center for Environmental Sciences routinely tests water from a variety of sources throughout the state for indicators of bacterial contamination that could affect the public's health.

3.6.6 Vulnerability and Risk Assessment

3.6.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined biological incidents to be a low priority hazard in Rhode Island. As described in the profile above, biological incidents within the state are unlikely to occur within the next one (1) to three (3) years. Biological incidents have the potential to impact large areas if transmitted through air or drinking water sources; however, in general this hazard is expected to have a smaller range of impact of between 1% and 10% of the state. Probable magnitude of a biological incident ranges from negligible to limited magnitude, including some injuries, shutdown of critical infrastructure and facilities, and scattered incidental residential and commercial structures damaged from the events. The overall impact on the environment is expected to be limited, with less than 20% of land and natural resources impacted by this hazard. Impacts on state operations are believed to be limited. Table 3-13 outlines the hazard rankings for each of the hazard priority criteria related to a biological incident.

Table 3-13 Biological Incident Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Unlikely** *Less than 1% probability within next 12-60 months*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**

3.6.6.2 Risk and Vulnerability to People and Property

The entire State of Rhode Island's population is vulnerable to the effects of a biological incident, which can be measured in terms of number of fatalities and injuries. A biological attack can cause illness and death. Biological incidents can cause cascading economic impacts via loss of productivity due to incapacitated populations, shutdown of work locations due to contaminants, and loss of economic revenue. These effects may be further exacerbated by the perception of risk and a decrease in activities that expose populations to that perceived risk (e.g., less socializing, fewer community events).

Risk and Vulnerability to People (Injuries and Death)

Depending on the means of dissemination and the agent deployed, large numbers of people could become ill or die from a biological incident. Without knowing the specifics of a future event, it is difficult to predict how a biological incident will impact residents. Certain populations, including the very young and the elderly, are considered to be more vulnerable to future incidents.

Areas with high population density such as Providence, Warwick, and Cranston are most vulnerable to a biological incident and the subsequent spread of the disease. Areas that experience high rates of seasonal tourism, such as Newport County, may also be susceptible. Other parts of the state with lower population densities, such as West Greenwich, Richmond, Scituate, and Warren, are not as susceptible to a biological outbreak. However, viruses can still spread in schools, workplaces, and other crowded places. While most biological agents are difficult to create and maintain, the more stable agents, including anthrax, ricin, smallpox, and mad cow disease, pose a more considerable risk to populations.

Risk and Vulnerability to Property (Structures and Facilities)

The direct risk or vulnerability to property and facilities from a biological incident is generally limited. Impacts include restricting access to a facility due to an existing or potential communicable biological disease. Direct risk and vulnerability to actual structures is very limited due to the characteristics of a biological incident.

While unlikely, biological agents could possibly be released through a facility's ventilation system. An incident like this would not pose a direct risk to the structure's integrity; however, considerable contamination of the facility may occur, requiring hazardous materials response and potential loss of access to the building for a considerable length of time. Quarantine of infected or at-risk populations may also be necessary. If employees are unable to work either due to illness or due to access restrictions on the facilities, substantial long-term impacts may be felt.

Risk and Vulnerability to Critical Infrastructure

Due to the characteristics of biological agents and how they are spread, the most susceptible critical infrastructure are water treatment facilities, food production and processing facilities, and transportation facilities. The contamination of facilities that store food and water could immediately affect surrounding populations and their access to critical resources. Without access to clean water and food, citizens would likely become highly dependent on the State to provide necessary resources. Contamination of water and food sources does not always require a nefarious act to occur. Bacteria and illness-causing viruses exist naturally in the environment and can contaminate both food and water if necessary precautions are not taken and regular testing does not occur. Through this testing,

most biological incidents which have the potential to cause large-scale contamination of water and food sources are identified and mitigated. This occurs through partnerships with local, state, and federal agencies who possess the necessary resources to ensure monitoring occurs.

Critical facilities and infrastructure generally will not suffer direct impacts from a biological incident. Employee absenteeism due to a large-scale biological incident could indirectly impact the ability for a critical facility to operate. Without necessary operators, critical infrastructure may be susceptible to indirect failure.

3.6.6.3 Risk and Vulnerability to the Environment

The type and scale of a biological incident will determine the severity of the effect on the environment. Diseases that cause widespread human deaths can impact the environment during the disposal of human remains and the handling of biohazardous waste. Similar impacts would be seen in the aftermath of a biological incident causing widespread deaths of animals. Whether the infected animals are buried, burned, or left in place, a large quantity and concentration of carcasses may have an impact on air, soil, and groundwater quality, if disposal is not planned and executed appropriately.

3.6.6.4 Risk and Vulnerability to State Operations

A biological incident could have direct impacts on state government operations if state facilities or personnel are targets of attack. Conceivably, there could also be impacts resulting from the psychological implications of a large-scale biological incident in the State. State personnel could refrain from reporting to work out of concern for personal well-being or concern for the well-being of family and loved ones. A pandemic outbreak could jeopardize essential functions by causing high levels of absenteeism in critical service areas.

A contagious biological attack can quickly infect large populations requiring significant—potentially burdensome—response from first responders. Bioterrorism can also cause mass panic and societal disruption which may directly impact the ability to maintain order and sustain critical state functions, directly affecting state operations. The economy could be significantly impacted from a biological incident and may result in economic impacts due to workforce absenteeism, decreased revenue from tourism, and potential trade losses. An increase in hospitalization and emergency room visits could occur, creating greater demand on critical facilities, staff, and resources.

3.7 Chemical Incident

3.7.1 Description

A chemical incident has been defined as an unexpected uncontrolled release of a chemical from its containment. Chemical incidents generally occur at fixed-site facilities that manufacture, store, process, or otherwise handle hazardous materials or along transportation routes like major highways, railways, navigable waterways, and pipelines. In the majority of cases, this is an acute release, where the exposure dose is rising or is likely to rise rapidly. When the release is chronic, the exposure and dose do not rise quickly and public health measures do not have to be taken so rapidly, though the public health concern may emerge suddenly and acutely.

Generally, routes of exposure include inhalation, ingestion, and physical contact, and may lead to respiratory distress, organ failure, burns, or death. The rate of absorption via these paths is different for unlike chemicals and is also affected by the concentration of the chemical in contact with the body (the concentration may change over time), the length of time the chemical is in contact with the body, the air temperature, humidity levels, and the person's age. The severity of a chemical incident depends on the type of material released, the amount of the release, the proximity to populations or sensitive areas like wetlands or waterways, and environmental factors such as wind velocity and direction and sunlight. The release of materials can lead to injuries or the evacuation of thousands of nearby residents.

Injuries vary depending on the chemicals involved. The National Institute for Occupational Safety and Health pocket guide, material safety data sheets, the most current Emergency Response Guidebook, Agency for Toxic Substances and Disease Registry publications, and emergency hotlines such as CHEMTREC offer chemical specific injury details and protective measures.

3.7.2 Location

The identification of hazardous sites in the local community is an important means of recognizing possible vulnerabilities to the population. Ideally, a local inventory should be collated and kept up to date because chemical use may change frequently. For example, chemicals such as fertilizers, swimming pool disinfectants, and fireworks are only transported and stored locally at certain times of the year.

Numerous facilities in Rhode Island store, use, dispose, or have the capacity and infrastructure to handle hazardous materials on a regular basis. Under Title III of the Emergency Planning and Community Right to Know Act, facilities that meet certain requirements must report to federal, state, and local authorities. These facilities are commonly referred to as "Tier I" or "Tier II" facilities. There are 724 Tier II facilities located in Rhode Island.

Rhode Island is also home to hundreds of miles of natural gas transmission lines. RIGIS natural gas transmission lines span the northern and eastern portions of the state, including Providence, Bristol, and Newport counties. The Algonquin Gas Transmission pipeline, operated by Spectra Energy, transports 2.74 billion cubic feet per day of natural gas through 1,129 miles of pipeline that connects to the Texas Eastern Transmission and Maritimes & Northeast pipelines. The Algonquin Gas Transmission pipeline spans New Jersey, Connecticut, Rhode Island, and Massachusetts. Tenneco Gas Transmission is present in Providence County. Algonquin and Tenneco transmission lines total approximately 33 miles each.

3.7.3 Extent

Counties with multiple chemical facilities, such as Providence, experience a greater risk of a chemical incident than other locations. However, almost every community in Rhode Island has at least one (1) facility that stores, produces, or utilizes a hazardous material. Propane installations are located across the state and their presence increases the risk of an incident. Hundreds of thousands of hazardous materials shipments move through Rhode Island annually. These shipments can occur at any time, day or night, and by means of road, rail, air and water, and often through areas with urbanized, high volume traffic routes.

3.7.4 Previous Occurrences

In the past fiscal year, DEM's Office of Emergency Response responded to 579 oil spills that resulted in the removal of 5,390 gallons of oil and 723 tons of oil spill debris from the environment. Residential oil spills accounted for 30%, or 173, of these responses.[16] In 2014, DEM reported 513 oil spills. The amount of oil products and oil spill debris remediated or removed from the environment during these response activities was estimated to be 3,678 gallons of oil and 1,053 tons of oil spill debris.[17]

Most recently, a tractor-trailer carrying 11,000 gallons of gasoline overturned on Route 95, spilling fuel into the Providence River.[18] Additional significant chemical incidents have occurred in Rhode Island in other years. These incidents have been deemed significant due to the number of people affected or injured by the incident:

- Prosys Finishing Technologies Fire and Hazardous Material Release, Cranston, 2018[19]
- Mercury Release at Lawn Terrace Apartment Complex, Pawtucket, 2004[20]
- Pascoag Water Supply Contamination, 1996 to 2002
- Tugboat Eastern Star Sinking, November 17, 2000
- Route 95 Fuel Spill, July 20, 2000
- Penn 460 Oil Spill, July 5, 2000
- North Cape Oil Spill, January 19, 1996[21]
- World Prodigy Oil Spill, June 23, 1989

3.7.5 Probability of Future Events

As with responses to all types of disasters, careful planning and thorough preparedness are prerequisites for an effective response to a chemical incident. Rhode Island's first line of defense in protecting public health, safety, and welfare in an environmental emergency is the DEM. Like police and fire fighters, DEM's emergency responders are prepared to handle incidents of great variety including everything from a spill of a few gallons to an entire tanker full of petroleum; from a single

[16] Rhode Island Department of Environmental Management, 2018. Press Releases. Retrieved at https://www.ri.gov/press/view/32593
[17] Rhode Island Department of Environmental Management, 2015. Oil Spill Prevention, Administration and Response (OSPAR) Fund. Retrieved at http://www.dem.ri.gov/programs/emergencyresponse/documents/osparfy15.pdf
[18] Kuffner, 2018. DEM hopes environmental impact from Providence gasoline spill will be limited. Retrieved at http://www.providencejournal.com/news/20181004/dem-hopes-environmental-impact-from-providence-gasoline-spill-will-be-limited--video
[19] Doiron, S. 2018. 20 Cranston firefighters sick from chemical exposure after fire, hazmat incident. WPRI Eyewitness News. Retrieved at https://www.wpri.com/news/local-news/cranston-still-monitoring-health-of-crews-who-responded-to-chemical-fire/1082493714
[20] Rhode Island Department of Environmental Management, 2005. Lawn Terrace Incident Report. Retrieved at http://www.dem.ri.gov/programs/director/emerresp/pdf/lawnterr.pdf
[21] New York Times Archives, 1996. Rhode Island spill is more serious than initially thought. Retrieved at https://www.nytimes.com/1996/01/22/us/rhode-island-oil-spill-is-more-serious-than-initially-thought.html

abandoned drum to biological and chemical weapons. Highly trained first responders are on-call 24-hours a day, seven (7) days a week.

Although major chemical incidents seem most threatening, it is the smaller, more routine accidents and spills that have a greater impact on humans, wildlife, economy, and environment. Based on previous occurrences available, there is a 10% likelihood that a chemical incident will occur in the next 12 to 60 months. Some of the most common spills involve tanker trucks and railroad tankers containing gasoline, chlorine, or other industrial chemicals.

3.7.6 Vulnerability and Risk Assessment

3.7.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined chemical incidents to be a moderate priority hazard in Rhode Island. As described in the profile above, chemical incidents within the state have the potential to occur within the next one (1) to three (3) years. Chemical incidents have a small range of impact, accounting for 10% or less of the jurisdictional boundaries. The probable magnitude of this hazard ranges from negligible to limited, including some injuries, short-term shutdown of critical facilities and infrastructure, and scattered and incidental residential and commercial structures damaged from the events. The overall impact on the environment is expected to be limited, with less than 20% of land and natural resources impacted by this hazard. The impact on state operations is also anticipated to be limited. Table 3-14 outlines the hazard rankings for each of the hazard priority criteria related to chemical incidents.

Table 3-14 Chemical Incident Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Potential** *1% to 10% probability within next 12-60 months*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**

3.7.6.2 Risk and Vulnerability to People and Property

Hazardous materials are widely used in public and private facilities and farms. Factors that affect vulnerability include the amount and quality of shelter, the access into and out of the site, and people's awareness of risks and response measures.

Risk and Vulnerability to People (Injuries and Death)

Rhode Island's densely populated cities can often force people to live in closer proximity to major travel routes and zoned chemical manufacturing sites where chemical incidents have a higher probability of occurrence. Generally, these incidents occur due to a transportation accident or a malfunction during the manufacturing of chemicals which results in an unintended release. The resulting effect on people, including injury and death, is contingent on the type, amount, and environment in which the incident occurred. Generally, the release of hazardous materials poses the greatest risk to those in the immediate vicinity, although runoff of hazardous materials into drinking water sources and supplies may create an indirect impact on the public outside of the immediately impacted area.

Generally, routes of exposure to chemical incidents include inhalation, ingestion, and physical contact, and may lead to respiratory distress, organ failure, burns, or death. The rate of absorption via these paths is different for unlike chemicals and is also affected by the concentration of the chemical in contact with the body, the length of time that the chemical is in contact with the body, the air temperature, humidity, and the person's age. The characteristics of incidents involving unintended chemical releases, and the associated protection and response capabilities to those releases should be specifically considered for the most vulnerable segments of the population. Infants and young children in day-care centers, children in schools, the elderly in residential facilities, and hospital patients are especially susceptible to the immediate and long-term effects of exposure to chemicals.

Risk and Vulnerability to Property (Structures and Facilities)

These facilities, and other facilities within a reasonable proximity, are vulnerable to the effects of an accidental or intentional chemical release. Chemicals can be corrosive or toxic, and they may react with the environment and exposure to other chemicals, often explosively. Depending on the type of chemical(s) responsible for the incident, the release of the chemical(s) would at minimum create an environment where access to the facility would be limited and potentially affect the structural integrity of the facility to a point where it may require demolition.

Risk and Vulnerability to Critical Infrastructure

The accidental or intentional release of chemicals into the environment may have a direct effect on critical infrastructure as well. Other fixed facilities include water and wastewater treatment facilities, pipelines, and related facilities. These are particularly vulnerable to chemical incidents both directly and indirectly.

Pipelines provide the necessary infrastructure to transport natural gas and other materials from non-coastal states to the processing facilities within and surrounding Rhode Island. Disruption of these pipelines and the potential hazardous materials release into the environment and congested urban areas would pose a considerable interruption of operations and provided services.

Every vehicle and rail car carrying hazardous materials is at risk of an accident that could release the materials on board. Rhode Island contains part of the railway infrastructure utilized to transport North Dakota-produced Bakken crude oil to processing facilities. This highly flammable material poses a considerable risk not only to the environment but also to the public if a release, and potentially a subsequent explosion, were to occur. The vehicles could also be used for malicious activity by their drivers or by hijackers.

3.7.6.3 Risk and Vulnerability to the Environment

Chemical accidents and spills can be devastating to humans, wildlife, and the environment. Chemical incidents may impact the environment directly by causing pollution, damaging sewer and wastewater treatment plants, adversely affecting nature preserves, and disturbing or killing wildlife. The agricultural industry is also extremely susceptible to the adverse effects of chemicals due to the potential of a spill or contamination of a large area of land and water sources.

The immediate and long-term effects that a chemical release may have on the environment are relatively obvious and visibly occurring. Chemically induced fires may release hazardous gases, liquid, or smoke that can impact the health of the environment. Some of the most devastating impacts on the environment result from petroleum spills at sea or in rivers or lakes. The toxicity of the water after a spill occurs often depends on the type of petroleum. In addition to the contamination of drinking water supplies, oil and petroleum spills can injury and kill a variety of mammals, birds, fish, and reptiles that live in or near impacted waterbodies. Clean up after a spill occurs is very expensive and can take several years to complete. The natural environment will continue to be vulnerable to future chemical incidents in Rhode Island, especially in areas along the many different transportation routes.

3.7.6.4 Risk and Vulnerability to State Operations

Chemical release incidents may primarily affect the delivery of critical services to the impacted communities. First responders and public service activities may be impeded due to the nature of the chemical incident. Response delays due to several factors, including potential confusion over how to respond to a chemical incident, lack of resources (proper personal protective equipment [PPE], for example) to ensure the safety of first responders, and desire to not compound the incident. This may delay initial response, which in turn may decrease the public's confidence in the state's ability to respond and govern. While first responder services may be the primary service impacted, other services and facilities could potentially be destroyed or damaged depending on the chemical and its direct impact.

State operations may be affected by employee absenteeism after a chemical release incident. The effect of absenteeism on state operations may occur due to the direct impact of the chemical incident on individual employees, misinformation received by employees about the impact of the incident, or simply fear incurred by employees regarding the chemical incident and how it could potentially impact them.

3.8 Civil Disturbance

3.8.1 Description

Sociologists who study collective behavior typically define a civil disturbance as "a disruption of the typical social order; it can involve a strike or protest, and it can be peaceful or violent".[22] Civil disturbances often occurs when a group strives to gain attention for something they feel is unjust. Although a civil disturbance is not always violent, assemblages that cause an immediate danger or result in damage or injury to the property or person of any other individual present the largest hazard.

Any variety of actions such as strikes, civil disobedience, demonstrations, riots, and rebellions can be considered forms of civil disturbance. These disturbances arise from often-spontaneous acts of civil disobedience involving an agitated group of people, generally caused by political grievances, social justice conflicts, or a decrease in the supply of essential goods and services. Instances of civil disturbance are often a form of protest, arising from highly emotional social and economic issues such as trade and ideas of personal rights and liberties.

3.8.2 Location

Because of their often-spontaneous nature, it is difficult to pinpoint a location for the occurrence of a civil disturbance. However, monitoring social trends and social media can often inform responders about where potential demonstrations may take place. In addition, information gathered in advance may warn officials and provide locations of sites of potential future disturbances. Oftentimes, demonstrations and large, crowded gatherings begin peacefully and escalate to instances of sometimes-violent civil disturbance.

Instances of civil disturbance may originate from a number of different public gatherings, including political rallies, university football games, and peaceful protests. Civil disturbance is typically seen in large urban areas; therefore, the City of Providence (in Providence County) is considered the area most likely for this hazard to occur. In addition, with Rhode Island's relative proximity to both Boston and New York City, areas of Rhode Island may experience civil disturbance "spillover".

3.8.3 Extent

The severity of a civil disturbance incident depends on the nature of the disturbance. Significant disturbances can result in mass arrests, civilian curfews, intensive response efforts, property damage, injuries, and deaths. In general, civil disturbance impacts can range from low to high depending on the severity of the incident.

Police dispatched to control traffic corridors or intrusion on private property is considered a low severity civil disturbance. Disruption of businesses and potential property damage are assessed as a moderate civil disturbance. In these cases, police intervention would be required to restore order without employing chemical agents or physical force. A severe civil disturbance incident would involve rioting, arson, looting, assault, and death, where aggressive police action (tear gas, curfews, and mass arrests) may be required.

[22] Sternheimer, K. 2012. Civil unrest, riots, and rebellions: what's the difference? Everyday Sociology Blog. Retrieved at http://www.everydaysociologyblog.com/2012/05/civil-unrest-riots-and-rebellions-whats-the-difference.html

Civil disturbances may take on different characteristics depending on the severity of an incident. Each level of severity—low, medium, or high—poses risk to property. A low severity rating may be given to a localized event that results in minimal to no property damage, minimal police action, and no physical harm to the participants, bystanders, or police. While low severity disturbances may simply disrupt usual business activity due to large crowds and inability to access businesses and possibly residences, they have the potential to become incidents of medium or even high severity due to the amount of people involved and the sometimes emotionally-charged atmosphere that can result. A localized event that results in damage to property, police action, and physical harm to people involved, such as police or protestors, may be considered moderately severe. A moderately severe event may cause some damage to businesses and residences but overall the damage is limited.

Civil disturbances involving emotionally-charged and highly contentious business, police, or political action, or unrest based on the outrage of a segment of the population, could be considered high severity. The results and extent of severe civil disturbances are expected to range from financially burdensome on businesses facing considerable damage and possibly looting to potential destruction of public and private property as well as fire and subsequent smoke damage.

3.8.4 Previous Occurrences

Rhode Island has experienced several local incidents related to civil disturbances in recent years. Demonstrations as part of the Occupy Wall Street and Black Lives Matter movements impacted local response efforts, and in late 2014, significant protests and demonstrations led to shutdowns on I-95 outside Providence as protesters flooded the roadway.

Outside of Rhode Island, significant civil disturbance incidents have occurred across the United States. Riots in Ferguson, Missouri in 2014, Baltimore, Maryland in 2015, and Dallas, Texas in 2016, are key examples of civil unrest that included instances of violence, looting, and property damage. Several political protests against President Donald Trump occurred after his election in 2016, with civil unrest breaking out in Oakland, California, causing fires and property damage, and, in Portland, Oregon, with protesters blocking a major interstate.[23,24]

In 2017, hundreds of white nationalists converged in Charlottesville, Virginia, to protest plans to remove a Confederate statue. The white nationalist rally clashed with counter-protesters, and at one point a vehicle drove through a downtown crowd, leaving one (1) dead and dozens injured.[25]

An extreme example of civil disturbance is the 1992 Los Angeles riots that unleashed seven (7) days of violence, $1 billion in property damage, and left 50 people dead. Such an example indicates the possible magnitude of destruction caused by civil disturbances.

3.8.5 Probability of Future Events

Civil disturbances will continue to occur in the future. These events are usually difficult to predict; however, hazard analysis using previous event occurrences indicates that there is between a 1% and 10% chance of a civil disturbance occurring in the next 12 to 60 months. Some forms of civil

[23] ABC 7 News. 2016. Fires erupt, vandalism reported at anti-Trump protest in Oakland. Retrieved at http://abc7news.com/news/fires-erupt-vandalism-reported-at-anti-trump-protest-in-oakland-/1599421/
[2424] Domonoske, C. 2016. Anti-Trump Protest In Portland, Ore., Turns Destructive, Declared A Riot. Retrieved at https://www.npr.org/sections/thetwo-way/2016/11/11/501685976/anti-trump-protest-in-portland-ore-turns-destructive-declared-a-riot
[25] Time Magazine. 2017. Unrest in Virginia. Retrieved at http://time.com/charlottesville-white-nationalist-rally-clashes/

disturbance can be anticipated with more accuracy than others. For example, it is reasonable to assume that a riot may occur after the verdict is read in a high-profile legal case. In many instances, there is some amount of reasonable warning available to help prepare for a civil disturbance.

3.8.6 Vulnerability and Risk Assessment

3.8.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined civil disturbance to be a low priority hazard in Rhode Island. As described in the profile above, civil disturbance within the state has the potential to occur within the next one (1) to three (3) years. Civil disturbance events have a small range of impact, accounting for 10% or less of the jurisdictional boundaries. The probable magnitude of this hazard is considered to be negligible, including minor injuries, no shutdown of critical facilities and infrastructure, and scattered incidental residential and commercial structures damaged from the events. The overall impact on the environment is expected to be negligible with less than 5% of land and natural resources being impacted by this hazard. The impact on state operations is believed to be limited. Table 3-15 outlines the hazard rankings for each of the hazard priority criteria related to civil disturbance.

Table 3-15 Civil Disturbance Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Potential** *1% to 10% probability within next 12-60 months*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**

3.8.6.2 Risk and Vulnerability to People and Property

The impact of civil disturbance can be directly measured in economic loss due to both destruction and loss of business, as well as fatalities and injuries due to potential violence attributed to the disturbance.

Risk and Vulnerability to People (Injuries and Death)

During incidents of civil disturbance, people, especially those within the most vulnerable groups of the population, are most at risk. Civil disturbances are often characterized by random acts of violence and property destruction. Individuals, particularly those vulnerable populations and those without access to private transportation, may be unable to evacuate from the area in which the disturbance is occurring, placing them in harm's way.

A civil disturbance is more likely to occur when large groups of people are congregated together at localized events. The following special events that take place in Rhode Island could be at risk for a civil disturbance incident or terrorist attack due to their ability to draw large crowds, including:

- Newport St Patrick's Day Parade – 50,000 people
- Rhode Island National Guard Open House Air Show – 50,000-100,000 people
- Bristol 4th of July Parade – 100,000 people
- Autumnfest Woonsocket – 15,000 people
- Scituate Art Festival – 35,000 people
- Newport Folk Festival – 35,000-40,000 people
- Newport Jazz Festival – 20,000-40,000 people
- WaterFire Providence – 40,000 – 100,000 people per evening

Risk and Vulnerability to Property (Structures and Facilities)

Civil disturbances can present significant risk to property, structures, and facilities. Depending on the severity of an incident, property and structures may receive minimal physical damage or may be entirely affected. The previously mentioned 1992 Los Angeles riots produced roughly $1 billion in damages; upwards of 3,000 buildings were burned or destroyed and 3,000 businesses were affected, leaving an estimated 20,000 to 40,000 people out of work.[26] Civil disturbance can involve vandalism, arson, and theft, all of which pose risks to property, structures, and facilities.

During a severe civil disturbance incident, the following venues within the State of Rhode Island could be vulnerable to damage and destruction:

- Educational events at Rhode Island Convention Center, University of Rhode Island, Roger Williams University, Providence College, Rhode Island School of Design, and Brown University. These venues host large numbers of residents and visitors, increasing both the likelihood of a civil disturbance incident occurring in these locations, and the potential extent of damages due to amount of people involved in the incident and the value of the property or structures.
- Venues and performances at The Stadium Theater, Courthouse Center for the Arts, Blackstone River Theatre, Twin River Casino, Providence Performing Arts Center, Arctic Playhouse, Spring Community Center, Dunkin' Donuts Center, Jamestown Arts Center, and

[26] History Channel, n.d. Los Angeles Riots. Retrieved at https://www.history.com/topics/the-los-angeles-riots

McCoy Stadium. Like educational facilities, these venues host large numbers of people. Theatres and art centers also depend on the revenue generated from the physical space itself, so any damages to these facilities will be compounded by an extended lack of ability of the space to be utilized.

Risk and Vulnerability to Critical Infrastructure

Incidents involving civil disturbance can be small or large depending on the location of the incident and population demographics. These incidents do have the potential to disrupt or destroy critical infrastructure including critical facilities. A civil disturbance occurring at a facility or site providing a critical piece of infrastructure could result in service disruption or other cascading effects to these vital systems.

Disruption of critical transportation systems is a key vulnerability presented by civil disturbance. Protesters blocking a highway or bridge, the closure of public transit systems, and traffic or other obstacles impacting ingress and egress routes for first responders and critical public safety personnel are all potential cascading effects to emergency services and other sectors because of a civil disturbance incident.

3.8.6.3 Risk and Vulnerability to the Environment

The debris and other byproducts of civil disturbances can pollute the environment, damage sewage and wastewater infrastructure, and potentially destroy green spaces. Incidents of civil disturbance can include the use of fire to cause destruction; the resulting smoke creates immediate air pollution and can contribute to long-term environmental effects.

3.8.6.4 Risk and Vulnerability to State Operations

The City of Providence, given the concentration of state buildings, population density, and its designation as the state capital, is particularly vulnerable to civil disturbance. Facilities exposed to civil disturbance may include:

- Colleges and Universities
- Correctional Facilities
- State Facilities
- State House

Several factors may contribute to the disruption of state operations. Incidents large in scope or otherwise severe may contribute to first responders being placed in dangerous situations; unsafe working environments may reduce the number of employees available to perform critical state functions. Additionally, resources may become scarce during a civil disturbance incident, causing disruptions in the ability of the State to operate and a lack of confidence in the government.

3.9 Cybersecurity Incident

3.9.1 Description

A cybersecurity incident is an incident that threatens the confidentiality, integrity, or accessibility of an information system or the information systems processes, which constitutes a violation of security policies or standard security practices. A significant cybersecurity incident will require effective incident response to minimize the disruption of services and loss of critical information, while ensuring continuity of services and security throughout the state. While cyber threats happen daily, such as a performance shotgun phishing campaign to install adware, the sophistication of these threat actors vary considerably. Cybersecurity threat actors can be classified into three (3) distinct categories:

- **Hacktivists/Petty Criminals**: Constitute the vast majority of cyber-attacks on the Internet, typically conducted by single individuals or small unaffiliated groups. These unstructured attacks exploit unprotected targets with known vulnerabilities and can be completely automated, using little technical skill and sophistication.
- **Organized Crime/Cyber-terrorists**: Target a specific person or entity for financial gain, intellectual property, or blackmail. These structured attacks, for instance a DDoS or intellectual property theft, tend to be more organized and planned, and often rely on insider knowledge.
- **Sophisticated Nation States**: Although fewest in number, these adversaries conduct reconnaissance over long periods of time, with extreme preparation and organization. These highly structured attackers use multiple methods of reconnaissance and multiple attack techniques to achieve their goal that may combine a physical attack with a cyber incident (such as the Libya Air Defense Systems).

Additionally, cybersecurity incidents can occur as a result of natural hazard events—for example, long-term loss of power or extreme heat can impact or incapacitate information systems and processes. While cybersecurity threats and potential secondary impacts on cybersecurity systems due to natural hazards are distinct, they all possess the ability to impact Rhode Island's critical infrastructure and potentially the public health of its citizens, if and when an incident occurs. Examples of risks associated with cybersecurity incidents in Rhode Island include:

- **Internet of Things (IoT):** IoT presents unique security challenges due to the number of interconnected devices and systems present in the state. As this concept was not created with security in mind, many hackers will compromise these connections. Whether it be the healthcare industry or the energy sector, all infrastructure is vulnerable to these compromises, placing the data belonging to Rhode Island businesses and citizens at risk.
- **Cyber theft:** This is an increasingly lucrative business for cyber criminals. For instance, while the Target breach was not an isolated incident in Rhode Island, many Rhode Island citizens fell victim to this act of cyber theft. Cyber thieves hacked as many as 40 million accounts, stealing customer names, credit and debit card numbers, encrypted PIN data, and card expiration dates, which affected as many as 110 million people. This incident highlights the financial risks posed against citizens' personally identifiable information (PII) and the economy.
- **Advanced Persistent Threat (APT):** These threats are of significant concern as sophisticated threat actors are gaining unauthorized access to computer systems as a means of carrying out various disruptive actions to achieve political or social objectives. Deploying

a targeted, long-term pattern of complicated attacks, nation-states conduct malicious network activity and reconnaissance. While this activity would be a rarity in Rhode Island, if it were to happen the risk would be detrimentally crippling to the state.

3.9.2 Location

The entire state is vulnerable to a cybersecurity incident. As most day-to-day activities rely on the internet in one aspect or another, any person or infrastructure is susceptible to cybersecurity threats. For example, virtual systems, such as Supervisory control and data acquisition (SCADA) systems, are used to operate critical infrastructure across the state. These systems, which provide remote monitoring and control operating with coded signals over communication channels, place any number of critical facilities at risk if the appropriate informational security safeguards are not properly implemented.

3.9.3 Extent

As Rhode Island relies on cybersecurity networks and assets to provide security, public safety, and economic vitality, state operations depend on information systems that are maintained, protected, and secured from exploitation and attack. Although cybersecurity incidents originate in a virtual environment, the increased sophistication of attacks could have damaging impacts on physical components of critical infrastructure in the state. For example, if Rhode Island were to experience unscheduled power outages impacting a large number of customers, such as that of the cybersecurity attack against Ukrainian critical infrastructure, the state could be incapacitated and unable to provide essential services to citizens. Basic functions people rely upon would be inoperable if a significant cybersecurity attack were to impact Rhode Island.

3.9.4 Previous Occurrences

Rhode Island has experienced several occurrences of cybersecurity-related issues. In 2006, the Naval War College in Newport experienced computer and e-mail disruptions due to a suspect network intrusion.[27] Although not explicitly linked to nation-state activity, some indicators reveal that the Chinese may have been behind the attack. Because of the attack, the college experienced an extended outage and was forced to replace all impacted machinery following the attack.

Instances of cyberattacks have grown in recent years. The Rhode Island State Police Cyber-Crimes Unit says that police departments, town halls, law firms, accounting firms, and individuals have been hit across the state.[28] In 2016, a prominent Providence law firm was "held captive" for months by an unknown person or group who encrypted the firm's files and then demanded $25,000 in ransom paid in anonymous cyber currency to restore access. During the months-long incident, the firm's 10 lawyers were almost entirely unable to perform their work, amounting to $700,000 in lost revenue.[29]

More recently, devices at three (3) state agencies were infected with malicious software originating from a generic phishing email. The Department of Human Services and the Department of Behavioral Health, Developmental Disabilities and Hospitals all experienced technical issues in early 2018 after

[27]https://fcw.com/articles/2006/12/04/china-is-suspected-of-hacking-into-navy-site.aspx?sc_lang=en
[28] Ibid.
[29] Mulvaney, K. 2017. 'Ransomware' locks down prominent Providence law firm. Providence Journal. Retrieved at http://www.providencejournal.com/news/20170501/ransomware-locks-down-prominent-providence-law-firm

receiving and opening the malicious email.[30]

While the instances above were serious and caused economic damages, the state has not yet experienced a major catastrophic cybersecurity incident that has led to extended disruptions of critical infrastructure. However, this should not undermine the need to consider the potential for devastating impacts to Rhode Island's critical infrastructure. A cybersecurity incident could disable most of the critical infrastructure systems including the power grid, traffic control systems, water and wastewater services, and communications systems.

3.9.5 Probability of Future Events

The resilience and sophistication of adversaries indicate that the probability of future events is significant. Although the state has not experienced a large-scale cybersecurity incident, several large-scale attacks, including the 2017 WannaCry ransomware attack and the 2017 Equifax breach, have occurred worldwide in recent years, and that number is projected to increase as threat actors increasingly target critical infrastructure. By and large, due to the widespread use of electronic devices and the reliance on technology to support daily functions, the risks of cybersecurity incidents will continue to grow in significance in the future.

3.9.6 Vulnerability and Risk Assessment

3.9.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined a cybersecurity incident to be a moderate priority hazard in Rhode Island. Cybersecurity incidents within the state are likely to occur within the next one (1) to three (3) years, impacting less than 10% of the state's area. The magnitude of this hazard ranges from limited to significant, including the risk of some injuries, a short to medium shutdown time of critical infrastructure and facilities, and scattered incidents of damage to residential and commercial structures from the events. The overall impact on the environment is expected to be negligible, with less than 5% of land and natural resources being impacted by this hazard. The impact on state operations is believed to be limited, with some operations impacted for short amounts of time. Table 3-16 outlines the hazard rankings for each of the hazard priority criteria related to cybersecurity incidents. Of note is the high hazard risk in Newport; the 2006 network intrusion at the Naval War College in Newport serves as an example of the extent to which cybersecurity threats can affect operations and equipment.

[30] List, M. 2018. Malware breach at three (3) R.I. agencies. Providence Journal. Retrieved at http://www.providencejournal.com/news/20180603/malware-breach-at-3-ri-agencies

Table 3-16 Cyber Incident Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Likely** *10% to 100% probability within next 12-60 months*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Negligible** *Scattered incidental of residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
Kent County								
Newport County				**Significant** *Medium shutdown of some critical infrastructure and facilities*				**High**
Providence County				**Limited** *Short shutdown of some critical infrastructure and facilities*				**Moderate**
Washington County								

3.9.6.2 Risk and Vulnerability to People and Property

Significant cybersecurity incidents typically target traffic pipelines or powerful servers of an information technology (IT) system. Cyber adversaries may seek to compromise their target through service disruption or manipulation, while the attack itself could use destructive worms and viruses, denial of service exploits, or intrusions to disrupt the targeted networks. An adversary can infiltrate many institutions, including banking, medical, education, government, military, and business. Actors inside or outside the asset's organization could carry out acts of sabotage on attractive targets, such as government websites and high-value networks.

Information systems are only as strong as their weakest end user. To this day, it remains difficult to continuously monitor and manage the end user vulnerability. The entire population of Rhode Island is exposed to the effects of a cybersecurity incident.

Risk and Vulnerability to People (Injuries and Death)

The public is heavily reliant on technology for daily life, including cell phones, handheld devices such as tablets, and computers. Any disruption to these technologies caused by a cybersecurity incident could impair the ability for the public to conduct basic activities, such as communications and mobile banking. All populations who directly use a computer or those receiving services from automated systems are vulnerable to cybersecurity incidents.

Although mostly indirect, the impacts of cybersecurity incidents on the public health sector may include loss of access to important medical information, services, and personal information, and unwanted sharing or dissemination of that information to other parties. Disruption in attaining medical help or resources may delay receiving proper medical attention or care.

A cybersecurity incident related to power grid failure would impact individuals with medical needs requiring power. The time of year can also play a role in the number and types of vulnerable populations. If an incident were to occur in extreme temperatures, either heat or cold, susceptible populations (e.g., infants, young children, elderly, sick, and those with special needs) would be most vulnerable due to lack of climate control.

Risk and Vulnerability to Property (Structures and Facilities)

Property and facilities may become either uninhabitable or unusable as a result of a cybersecurity incident, particularly if their infrastructure is reliant on technology for sustainability. Some devices in the home that rely on the internet, such as computers, television, or lighting, may be disrupted in the event of a cyber incident. Impacts to private homes and businesses would be dependent upon the type of cyber-attack as well as the intentions of the individual carrying out the actions. Depending on the scale of the attack, power or communications networks may be disrupted, impacting homes and businesses across the state.

Homes and businesses may also be susceptible to attacks targeting specific infrastructure or systems in their homes (e.g., fixtures with remote control capabilities such as garage doors, lighting, speakers, or television). Attacks via components of the home may be conducted to disrupt individuals or cause damage to their homes or businesses (e.g., disabling safety features, playing loud music unexpectedly, turning on appliances remotely). Cybersecurity incidents may also compromise personal data such as login credentials or other sensitive information. These kinds of attacks likely would not directly impact facilities or buildings but would impact the ability to respond to cyber intrusions or fund the

repair of damages caused by intrusions.

Risk and Vulnerability to Critical Infrastructure

Most critical infrastructure systems are in some way tied to technology, oftentimes through virtual operations and SCADA systems. Therefore, a cybersecurity incident could disable the majority of systems which control these pieces of critical infrastructure, as well as traffic control, dispatch, utility, and response systems.

Targeted cybersecurity incidents can impact water or wastewater treatment facilities. By disrupting processing systems or disabling certain features of equipment, the availability of water resources may be disturbed or halted. Disruption of water utilities may also cause water pollution or contamination and subsequent environmental issues.

Intentional disruption of power or communications infrastructure could result in outages, which would impede government operations in addition to the provision of emergency medical services, public health services, or other basic functions. Communications disruptions specifically could have a direct impact on the state's ability to coordinate response and recovery operations. Attacks on communications infrastructure may also prevent people from contacting first responders, thereby impeding lifesaving activities.

By targeting traffic control infrastructure, access to certain areas of the state may be limited by very dense traffic or vehicle crashes/debris blocking the roads. Public transportation could be delayed or otherwise malfunction, causing crashes or delays.

3.9.6.3 Risk and Vulnerability to the Environment

A hazardous materials release that occurs because of the cascading effects of a cybersecurity attack or breach is an example of the risk posed to the environment by cybersecurity issues. Attacks on water utilities and pipelines may result in the contamination of drinking water or contamination of streams and rivers if the water is not properly treated before it is drained or distributed. Targeting infrastructure containing hazardous materials and releasing it into the environment can have detrimental effects to humans, plants and agricultural crops, as well as wildlife. These types of attacks may be carried out in a number of ways, but the impact to the environment would be significant, especially if water supplies, pipelines, or food sources are targeted or affected by secondary effects of a cybersecurity incident.

3.9.6.4 Risk and Vulnerability to State Operations

Cybersecurity incidents can interfere with emergency response communication and activities. Given that many first responders rely on technology both at operations centers and in the field, a cyber incident could drastically impair the ability to communicate. For example, many agencies rely on technology to notify and route responders to the scene of the emergency. More specifically, 911 dispatch centers rely on technology which makes them vulnerable to cyber exploits.

A cybersecurity incident could significantly disrupt the delivery of goods and services to the extent upon which businesses and entities rely on technology for the delivery of their materials.

A significant cybersecurity incident could produce major ramifications to the state economy. Society is heavily reliant on electronic-based commerce through mobile banking, automated teller machines,

and electronic trading. Any disruption to daily activities by a cyber incident, particularly those that halt the ability to conduct transactions electronically, can have disastrous impacts on the economy.

In the case of a cybersecurity incident in which significant amounts of data is stolen, the government's inability to protect confidential personal data could impact confidence in the state. Such an incident could also subsequently cause pause regarding the security of using electronic systems for government services.

3.10 Dam Failure

3.10.1 Description

Dam failure can occur as a result of natural events, human-induced events, or a combination of the two. Failures due to natural events, such as prolonged periods of rainfall and flooding, can result in overtopping, which is the most common cause of dam failure. Overtopping occurs when a dam's spillway capacity is exceeded and portions of the dam that are not designed to convey flow begin to pass water, erode, and ultimately fail. Other causes of dam failure include design flaws, foundation failure, internal soil erosion, inadequate maintenance, or mis-operation. Complete failure occurs if internal erosion or overtopping results in a complete structural breach, releasing a high-velocity wall of debris-laden water that rushes downstream, damaging or destroying everything in its path. An additional hazard concern is the cascading effect of one dam failure causing multiple dam failures downstream due to the sudden release of flowing water.

While dam failures that occur during flood events compound an already tenuous situation and are certainly problematic, dam failures that occur on dry days are the most dangerous. These "dry day" dam failures typically occur without warning, and downstream property owners and others in the vicinity are more vulnerable to being unexpectedly caught in life threatening situations than failures during predicted flood events.

Dams are classified by size and hazard ratings. The size classification provides a relative description of small, medium, or large, based on the storage capacity and height of the impounded water. The hazard classification relates to the probable consequences of failure or mis-operation of the dam; however, it does not relate to the current condition or the likelihood of failure of the dam. The hazard classifications are defined in the Rhode Island Dam Safety Regulations as follows:

- **Low Hazard:** Dams where, if failure occurred, it would result in no probable loss of human life and low economic/environmental losses.
- **High Hazard:** When dam failure or mis-operation will result in a probable loss of human life.
- **Significant Hazard:** When dam failure or mis-operation results in no probable loss of human life, but can cause major economic loss, disruption of lifeline facilities, or detrimental concern to the public's health, safety, or welfare.

There are 96 high hazard dams, 81 significant hazard dams, and 490 low hazard dams in Rhode Island, for a total inventory of 667 dams (Table 3-17). Of these, 14% have an Emergency Action Plan (EAP). According to the USACE, Rhode Island has 227 dams included in the National Inventory of Dams. In addition, one of the DEM's responsibilities in the Dam Safety Program is to inspect and identify unsafe dams and take appropriate action to return the dams to a safe condition. An unsafe dam is a high or significant hazard dam whose condition is such that an unreasonable risk of failure exists.

Table 3-17 Dams in Rhode Island

County	Municipality	High	Significant	Low	Total
Bristol	Barrington	0	0	2	2
	Bristol	0	1	2	3
	Warren	0	2	2	4

County	Municipality	High	Significant	Low	Total
Kent	Coventry	6	6	49	61
	East Greenwich	0	1	13	14
	East Greenwich/North Kingstown	0	0	1	1
	Warwick	2	1	15	18
	West Greenwich	0	0	27	27
	West Warwick	4	1	8	13
Newport	Jamestown	0	2	4	6
	Little Compton	1	2	8	11
	Middletown	3	0	3	6
	Newport/Middleton	1	0	0	1
	Portsmouth	3	1	4	8
	Tiverton	1	2	1	4
Providence	Burrillville	5	6	30	41
	Central Falls/Cumberland	0	0	1	1
	Central Falls/Pawtucket	0	0	1	1
	Cranston	5	1	17	23
	Cranston/Warwick	0	0	1	1
	Cumberland	3	3	11	17
	Cumberland/Lincoln	0	0	4	4
	East Providence	2	0	8	10
	Foster	2	1	23	26
	Foster/Scituate	0	0	1	1
	Glocester	8	10	32	50
	Glocester/Smithfield	1	0	0	1
	Johnston	5	5	10	20
	Johnston/North Providence	0	0	2	2
	Johnston/Providence	0	0	1	1
	Lincoln	9	0	10	19
	Lincoln/North Smithfield	1	0	0	1
	North Providence	2	0	4	6
	North Providence/Johnston	0	0	1	1
	North Smithfield	3	2	15	20
	North Smithfield/Smithfield	1	0	0	1
	Pawtucket	0	0	5	5
	Providence	0	2	7	9
	Scituate	1	8	18	27

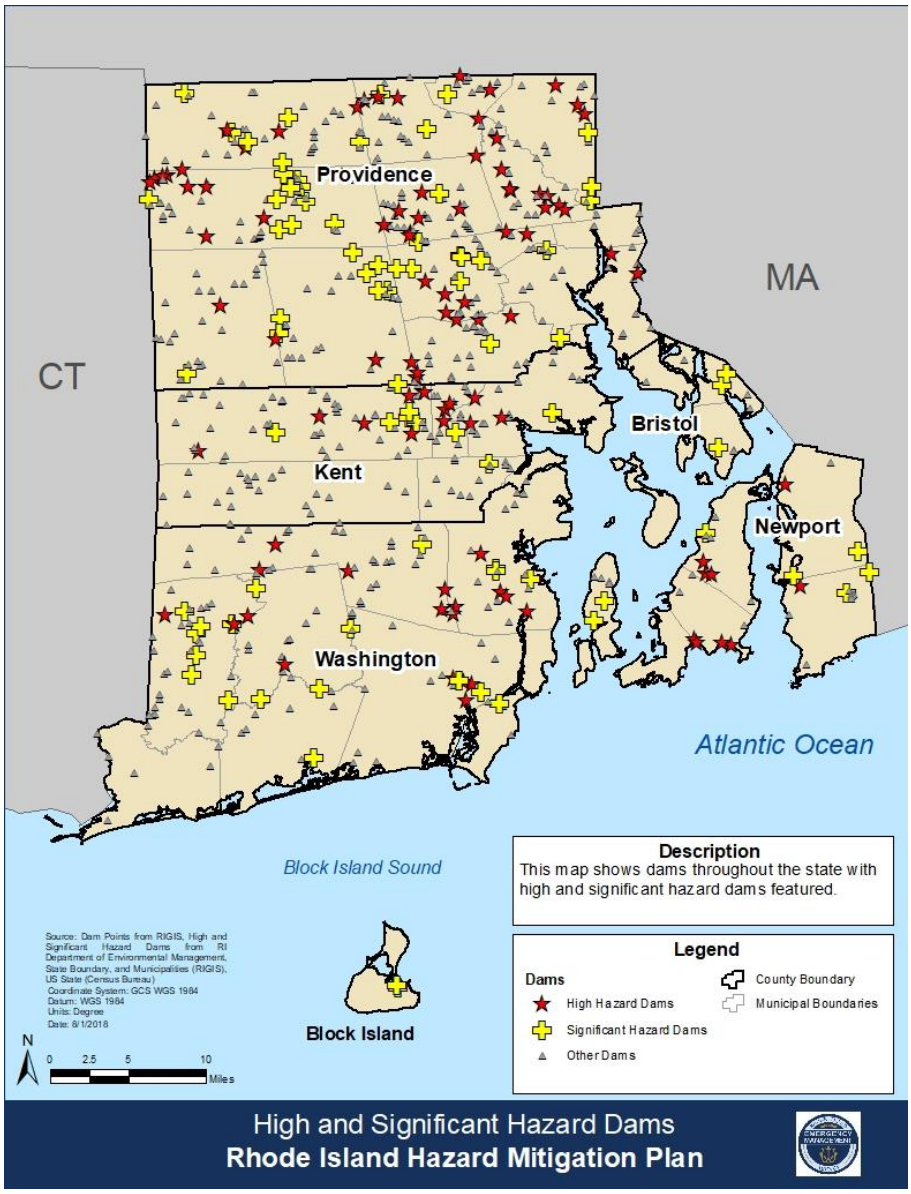
County	Municipality	High	Significant	Low	Total
	Smithfield	6	2	22	30
	Woonsocket	2	1	10	13
Washington	Charlestown	0	1	6	7
	Charlestown/Richmond	0	1	2	3
	Charlestown/Hopkinton	0	0	1	1
	Exeter	5	1	30	36
	Hopkinton	2	6	26	34
	Hopkinton/Richmond	1	2	2	5
	Hopkinton/Westerly	0	0	1	1
	Narragansett	0	1	4	5
	New Shoreham	0	2	0	2
	North Kingstown	6	3	13	22
	Richmond	1	1	10	12
	South Kingstown	4	3	17	24
	Westerly	0	0	4	4
	Westerly/CT	0	0	1	1

3.10.2 Extent

Dams have been an important part of Rhode Island's water infrastructure for centuries. In addition to the historic economic benefits provided by dams, they are used for flood control, water supply, power generation, recreation, and for mitigating the impact of increased runoff typically caused by land use changes associated with property development. Surrounding states also utilize dams, increasing the extent to which Rhode Island might be affected by a dam incident or failure. The USACE, as mentioned previously, maintains a national inventory of dams in Rhode Island and within proximity to the state. In addition to proximity, the level of failure and meteorological conditions during a dam failure will greatly contribute to the extent of an incident. A minor failure will have lesser impacts than a total dam failure. Weather conditions also impact extent, as a dam failure without rainy conditions will have lesser extent, but the population will likely receive less warning. Conversely, rainy conditions exacerbate impacts, but may allow for more warning due to expected failure.

According to the Federal Guidelines for Dam Safety, two (2) factors influence the severity of a dam failure: the amount of water impounded and the density, type, and value of development and infrastructure located downstream. Most dam failures are described by their potential point of inundation; the hazard potential levels of low, significant and high are further defined in the table below, while the figure on the following page provides a map of the locations of significant- and high-hazard dams. The magnitude and severity of dam failures may also be assessed in terms of damage, including loss of life and injury, damage to infrastructure, loss of services or utilities, debris, and economic damage. Figure 3-1 shows dams in the State and their levels of hazard.

Figure 3-1 High, Significant, and Low Hazard Dams in Rhode Island



3.10.3 Previous Occurrences

Rhode Island has experienced many dam failures, primarily resulting from major flood events. Historically, however, the consequences of dam failures have not been well-documented. Descriptions of previous dam failure events provided in this section are based on data available from the National Performance of Dams Program at Stanford University, the Association of State Dam Safety Officials, and NCEI.

Over 111 dam incidents have been recorded in Rhode Island, of which seven (7) resulted in dam failure. The most recent documented event was a series of dam failures affecting the Blue Pond, Geneva Pond, and Glen Rock dams in March of 2010.

Table 3-18 National Performance of Dams Program Rhode Island Reported Dam Incidents

Incident Date	Dam Name	Incident Type
8/25/1889	Spring Lake Dam	Piping
3/11/1901	Randall's Pond (Lower)	Inflow Flood - Hydrologic Event
1991	Burton Pond Dam	Concrete Deterioration
1991	Unnamed Dam (RIS00003)	Not Known
2/18/1998	Peace Dale Pond Dam	Inflow Flood - Hydrologic Event
8/6/2000	Mill Pond Dam	Embankment Erosion
5/8/2002	Sweet's Mill Dam	Biological Attack (e.g., bush, tree growth); Embankment Erosion
3/30/2010	Blue Pond Dam, Geneva Pond Dam, Glen Rock Dam	Embankment Erosion; Structural Deterioration; Inflow Flood- Hydrologic Event

3.10.4 Probability of Future Events

While generally considered an infrequent occurrence, the potential for dam failure in Rhode Island is a significant concern given the large number of dams across the state and the fact that there have been dam failure incidents in the past. The probability of future occurrence or annualized events shown in Table 3-19 illustrates a potential to likely probability of occurrence across the state, depending on the county. Specifically, Bristol and Newport Counties have a potential probability (between 1% and 49.9% annual probability) of having a dam failure within the next 12 to 60 months. The remaining Rhode Island counties (Washington, Kent, and Providence) have a likely probability (between 50% and 89.9% annual probability) of dam failure occurring within the next 12 to 60 months.

The probability of future dam failure events is not easily measured, but correlates to some extent with the probability of future major flood events coupled with preventative measures, including the routine inspection, maintenance, repair, and proper operation of dams by their owners, and as regulated by DEM's Dam Safety Section.

The Dam Safety Section through DEM is tasked with monitoring the routine inspection and maintenance of those dams that present the greatest risk or are in need of structural repair. State regulations in accordance with the State of Rhode Island General Laws require that the over 600 dams in Rhode Island be inspected annually, with priority placed on those dams which pose the greatest potential threat to downstream persons and properties. Other structures are inspected as time and funding permit, and upon notification of potentially significant deficiencies or emergency conditions. These laws also require that EAPs are prepared for each significant and high hazard dam. Dam owners are responsible for complying with maintenance and repair requirements and developing the EAPs that are required for significant and high hazard dams.

Dams that receive construction permits for repair and/or reconstruction are designed to pass at least the 1%-annual-chance rainfall event with one (1) foot of freeboard (a factor of safety against overtopping). The most critical and hazardous dams are required to meet a spillway design standard much higher than passing the runoff from a 1%-annual-chance rainfall event. Although not all the dams have been shown to withstand the 1%-annual-chance rainfall event, most of the dams meet this standard due to original design requirements or recent spillway upgrades. If smaller rainfall events,

such as 10-year and 25-year events, occur more frequently, there will be little impact on the ability of the dams to operate safely.

As more and more state- and privately-owned dams are repaired, the number of dams that do not meet the state minimum requirements for spillway design diminishes. Nonetheless, the average age of dams across Rhode Island continues to increase. Therefore, the state must remain vigilant in administering its dam safety regulations and related programs.

3.10.5 Vulnerability and Risk Assessment

3.10.5.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined dam failure to be a moderate priority hazard in Rhode Island. As described in the profile above, dam failure events within the state range from potential to likely within the next one (1) to three (3) years. Dam failure events have a small to large range of impact, accounting for less than 10% to 100% of the jurisdictional boundaries. Hazard magnitude varies and is considered to have negligible to limited magnitude including minor injuries, no shutdown of critical facilities and infrastructure, and less than 10% of residential and commercial structures damaged from the events. The overall impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-19 outlines the hazard rankings for each of the hazard priority criteria related to dam failure.

Table 3-19 Dam Failure Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
Kent County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*		**Limited** *Short shutdown of critical infrastructure and facilities*				**High**
Newport County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*		**Negligible** *No shutdown of critical infrastructure and facilities*				**Moderate**
Providence County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*				**High**
Washington County		**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*					

3.10.5.2 Risk and Vulnerability to People and Property

Dam failures may be caused by structural defects from poor design, construction materials, lack of maintenance, or gradual weakening of the dam. Factors attributing to dam failure include debris blocking the spillway, flooding, wrongdoers, or improper operation. Dam failures present a clear risk to both people and property downstream.

The DEM maintains dam inundation data and maps; however, this data is for state use only. As a result, dam inundation mapping with critical and state facilities was not possible for the 2019 SHMP update. The state may consider conducting internal analysis between dam inundation layers and critical and state facilities and reporting on the number of facilities within the dam inundation zone for future SHMP updates. No estimated losses from specific vulnerable structures could be estimated due to the lack of inundation mapping.

Dam inspections assist in ranking the hazard potential classification level, ranging from low to significant to high. Hazard probability levels are summarized again below:

- Low hazard potential represents those dams where, if failure occurred, it would result in no probable loss of human life and low economic/environmental losses.
- Significant hazard potential can be categorized by those failures that result in economic loss, environmental damage, or disruption of lifeline facilities, but not in loss of life.
- High hazards potential signifies those dams that will result in loss of life if they fail.[31]

Dam inspections may also reflect dam vulnerability. High hazard dam inspections are required to be performed every two (2) years, while significant hazard and low hazard dam inspections are required every five (5) years. A visual inspection is performed whenever DEM has cause to believe that an unsafe dam exists, or upon request by any person who has cause to believe that an unsafe dam exists. In 2017, 13 high hazard dams and six (6) significant hazard dams were inspected[32].

Summaries of the visual inspections are provided in the *Rhode Island 2017 Annual Report to the Governor,* prepared by the Office of Compliance and Inspection within DEM. Table 3-20 summarizes the unsafe dams in Rhode Island. A summary of each of these dams and the reason they were deemed unsafe can be found in the above referenced *Annual Report to the Governor* on the activities of the Dam Safety Program. During 2017, DEM addressed 61 unsafe dams and by the end of 2017, three (3) of the dams were returned to a safe condition. Of the unsafe dams, 37 are ranked as a high hazard and 23 are ranked as significant.

[31] FEMA, 2004. *Federal Guidelines for Dam Safety*. Retrieved at: http://www.fema.gov/media-library-data/20130726-1516-20490-7951/fema-333.pdf
[32] Rhode Island Department of Environmental Management Dam Safety Program, http://www.dem.ri.gov/programs/benviron/compinsp/pdf/damrpt17.pdf

Table 3-20 Rhode Island Unsafe Dams[33]

County	Municipality	Dam Number	Dam Name	Hazard Class	Unsafe Conditions
Bristol	Barrington	N/A			
	Bristol	N/A			
	Warren	480	Warren Upper	Significant	Vegetation prohibited inspection, spillway location unknown, low-level outlet operability unknown
Kent	Coventry	186	Upper	Significant	Seepage and sediment transport, embankment section low, spillway discharge flowed along base of dam
		498	Hopkins Farm	Significant	Raised spillway crest, auxiliary spillway partially filled
		645	Centre of New England #1	Significant	Vegetation prohibited inspection, spillway movement and debris impacting flow
	East Greenwich	N/A			
	Warwick	N/A			
	West Greenwich	N/A			
	West Warwick	455	Bouchar Farm	Significant	Vegetation prohibited inspection
Newport	Jamestown	575	Jamestown Lower	Significant	Vegetation prohibited inspection, low-level outlet could not be located
	Little Compton	485	Watson	High	Vegetation prohibited inspection, unknown operation of low-level outlet
	Middletown	582	Nelson	High	Vegetation prohibited inspection, deteriorated auxiliary spillway
	Middletown	583	Gardiner	High	Vegetation prohibited inspection, embankment erosion
	Middletown	584	Easton North	High	Vegetation prohibited inspection, deteriorated spillway, unknown operability of low-level outlet
	Newport/ Middletown	585	Easton South	High	Vegetation prohibited inspection
	Portsmouth	395	Lawton Valley	High	Vegetation prohibited inspection, vegetation may inhibit spillway flow
	Portsmouth	580	Sisson	High	Vegetation prohibited inspection, vegetation may inhibit spillway flow
	Portsmouth	581	St. Mary's	High	Vegetation prohibited inspection, vegetation may inhibit spillway flow

[33] Rhode Island Department of Environmental Management Dam Safety Program, http://www.dem.ri.gov/programs/benviron/compinsp/pdf/damrpt17.pdf

County	Municipality	Dam Number	Dam Name	Hazard Class	Unsafe Conditions
	Tiverton	396	Nonquit	Significant	Vegetation prohibited inspection, inoperable low-level outlet
	Tiverton	742	Creamer	High	Vegetation prohibited inspection
Providence	Burrillville	003	Wilson	High	Vegetation prohibited inspection, embankment movement
	Burrillville	016	Pascoag West Dike	High	Vegetation prohibited inspection, embankment movement
	Burrillville	027	Sucker	Significant	Vegetation prohibited inspection, plywood blocked spillway, low-level outlet inoperable, auxiliary spillway modified
	Burrillville	565	Ross	Significant	Vegetation prohibited inspection, low-level outlet inoperable
	Burrillville	572	Wilbur	High	Vegetation prohibited inspection, spillway headwall & seepage, low-level outlet operability
	Central Falls	N/A			
	Cranston	198	Curran Lower	High	Vegetation prohibited inspection, vegetation in spillway inhibited flow, low-level outlet inoperable
	Cranston	320	Stone	High	Vegetation prohibited inspection, vegetation inhibited spillway flow, embankment movement & seepage
	Cumberland	N/A			
	East Providence	N/A			
	Foster	163	Westconnaug	High	Vegetation prohibited inspection
	Foster	349	Spear	High	Vegetation prohibited inspection, low-level outlet inoperable, failed downstream wall, eroded spillway
	Glocester	018	Burlingame	High	Vegetation prohibited inspection, inadequate erosion protection
	Glocester	354	Coomer	Significant	Vegetation prohibited inspection, inoperable low-level outlet, severe embankment erosion
	Glocester	401	Lake Washington	High	Vegetation inhibited spillway flow
	Glocester	727	Bowdish Lower	High	Vegetation prohibited inspection, debris obstructing spillway, low-level outlet operability unknown
	Glocester/ Smithfield	111	Waterman	High	Vegetation/debris prohibited inspection, drainage trench clogged

County	Municipality	Dam Number	Dam Name	Hazard Class	Unsafe Conditions
	Johnston	127	Belknap	Significant	Vegetation prohibited inspection, embankment leakage, improper trash rack inhibiting flow, failed downstream wall
		169	Almy	High	Vegetation prohibited inspection, spillway not functioning properly, low-level outlet inoperable
		170	Simmons Upper	High	Vegetation prohibited inspection, low-level outlet inoperable
		171	Simmons Lower	High	Vegetation prohibited inspection, severe embankment erosion, spillway not functioning properly, low-level outlet inoperable
		313	Hughesdale Upper	High	Low section of embankment, low-level outlet inoperable
		346	Kimball	Significant	Vegetation prohibited inspection
	Lincoln	097	Butterfly	High	Low-level outlet inoperable
		104	Bleachery	High	Low-level outlet inoperable
	North Providence	084	Wenscott	High	Low-level outlet inoperable
	North Providence	046	Slatersville Middle	High	Vegetation prohibited inspection
	North Smithfield	067	Todd's	Significant	Vegetation prohibited inspection, low-level outlet inoperable
	Pawtucket	N/A			
	Providence	093	Canada Upper	Significant	Low-level outlet inoperable
	Scituate	161	Gainer	High	Vegetation prohibited inspection
	Scituate	345	Jordan	Significant	Inoperable low-level outlet, embankment deterioration, leakage at the primary & auxiliary spillways
	Scituate	351	Peeptoad	Significant	Embankment deterioration
	Scituate	361	Pine Swamp No. 1	Significant	Vegetation prohibited inspection, spillway deterioration
	Scituate	648	Shoestring Mill	Significant	Depressed areas of embankment, spillway deterioration
	Smithfield	108	Stillwater	High	Vegetation prohibited inspection, unknown operability of low-level outlet
		109	Stillwater	Significant	Vegetation prohibited inspection, vegetation inhibited spillway flow, low-level outlet inoperable

County	Municipality	Dam Number	Dam Name	Hazard Class	Unsafe Conditions
		121	Sprague Lower	High	Vegetation prohibited inspection, unknown operability of low-level outlet, unknown capability of low-level outlet discharge to flow away from dam
	Woonsocket	621	Holley Lane	High	Vegetation prohibited inspection, spillway flow diverted
Washington	Charlestown	N/A			
	Exeter	219	Boone	High	Vegetation prohibited inspection, debris in spillway affected flow, leakage with sediment transport
		221	Browning	High	Vegetation prohibited inspection, vegetation may be impacting flow
		238	Edward's	Significant	Vegetation prohibited inspection
	Hopkinton	440	Hoxie Farm	Significant	Vegetation prohibited inspection
		216	Wyoming Upper	High	Vegetation prohibited inspection, inoperable low-level outlet, embankment depressions, sinkholes, failing & rotating areas, spillway leakage
	Narragansett	N/A			
	New Shoreham (Block Island)	424	Rod & Gun Club	Significant	Vegetation prohibited inspection, auxiliary spillway not present
	North Kingstown	444	Silver Spring	High	Vegetation prohibited inspection, vegetation affected spillway flow
	Richmond	273	Wood River Junction	Significant	Vegetation prohibited inspection, unknown presence of low-level outlet
	South Kingstown	426	Peace Dale	High	Vegetation prohibited inspection
	Westerly	N/A			

Risk and Vulnerability to People (Injuries and Death)

Dam failures will almost certainly result in flooding. Significant flooding events can lead to the damage and loss of homes, property, and businesses, which can impact public safety and morale. Flash flooding following a dam failure may lead to dangerous conditions on roadways, as well as creating mudslides that may quickly place members of the public in dangerous situations. In the event of a dam failure, first responders may issue evacuation orders. Individuals who are on the roads or in low-lying areas will be at the highest risk for injury or death.

Closures of health and medical facilities is a major public health concern if flooding causes buildings to be uninhabitable. Water sources may also become contaminated with toxic material or human waste, and water or sewer systems may be completely disrupted. Vector-associated problems can increase the risk for some mosquito-borne infectious diseases.

Providence County has a higher risk of dam failure due to the number of dams in the county and previous events resulting in deaths and injuries.

Risk and Vulnerability to Property (Structures and Facilities)

Dam failure can significantly impact residential, business, and government property and infrastructure, potentially causing loss of life. Several factors affect the severity of the damage caused by a dam failure, including the amount and type of development located downstream, amount of water released, speed at which the failure occurred, and if the failure was partial or complete.

If a dam failure were to occur, it would result in the evacuation of downstream residences and businesses. Depending on the severity of the dam failure and flood levels, structures may be uninhabitable and there may be a need to rebuild or relocate. Businesses would have to do the same and may have to close their doors for good. If utilities and infrastructure are damaged, residents may have to rely on supplemental power. Roadways could become flooded, resulting in essential facilities becoming isolated or emergency services rerouted in response to calls. A catastrophic dam failure, without ample warning and evacuation, could cause a number of injuries and deaths.

Risk and Vulnerability to Critical Infrastructure

A dam failure in and of itself constitutes a failure of critical infrastructure. If utilities and infrastructure are damaged following a dam failure, residents may have to rely on supplemental power; flooding may prevent access to roadways and other essential ingress and egress routes. In addition, road infrastructure (e.g. bridges, culverts) may require replacement. Some of these structures will require extensive planning and design and may draw significantly on recovery resources.

A catastrophic dam failure can lead to injury and death due not only to the immediate effects of the dam failure itself, but also to the inability to provide immediate life-saving services within flooded hospitals and other health and medical facilities. Dam failures may also impact waste water treatment plants and community water facilities. Contamination of water production facilities would result in loss of access to clean water and potential exposure to chemicals and bacteria which can cause illness and death. For example, the Scituate Reservoir—which is held by the Gainer Dam—creates the largest inland body of water in the State of Rhode Island. The Scituate Reservoir supplies drinking water to more than 60% of the state's population, including Providence. Loss of the dam and subsequent draining of the reservoir would be catastrophic.

3.10.5.3 Risk and Vulnerability to the Environment

The environmental impact of dam failures depends on the circumstances of the failure. After a dam failure occurs, the resulting flooding and moving debris can affect wildlife and natural habitats. The spread of pollution and hazardous materials can have negative impacts on the environment. Ecosystems and natural habitats may be destroyed, causing the migration or death of local wildlife.

A dam failure that inadvertently triggers the flooding of a downstream waste water treatment plant would put the health of the environment at great risk. The sizeable release of chemicals and waste water would contaminate large bodies of water, impacting plant and wildlife health, and potentially affecting the availability of clean water sources for communities within Rhode Island.

3.10.5.4 Risk and Vulnerability to State Operations

Coordinating response to flooding events caused by dam failure can be a significant effort by first responders. Fire, police, and emergency responders are often called on to evacuate people from an area that is imminently at risk of flooding. First responders may face challenges with transportation and access to a location due to flooded or obstructed roadways. Immediately following an event, these first responders are also responsible for closing roads and directing traffic away from flooded areas, pumping out flooded basements, and attending to the injured.

Flooding due to dam failure has the potential to cause major disruptions to transportation systems. The ability to deliver goods and services efficiently will be impacted by the closure of roads, bridges, and railroads. These transportation disruptions will also impact state operations by preventing some state employees from getting to work.

Exposure to water may also damage or destroy physical goods such as food, clothing, and hygiene products. The loss of access to these goods could create an environment where the population becomes highly reliant on state operations to provide necessary resources. State operations could become quickly overwhelmed by the quantity of resources requested.

3.11 Drought

3.11.1 Description

Drought is characterized as a continuous period in which rainfall is significantly below the normal levels for a particular area. The American Meteorology Society defines drought as a period of abnormally dry weather sufficiently long enough to cause a serious hydrological imbalance. Drought differs from other natural hazards in that it is not something that occurs suddenly. Rather, a drought evolves over months or even years and, while causing very little structural damage, can have profound economic, environmental, and social impacts.

Four (4) methods are used to define the severity of drought: meteorological, hydrological, agricultural, and socioeconomic. Meteorological drought refers to a reduction in the normal rainfall for a given geographic area. This needs to be area-specific, as the average rainfall can vary greatly in different areas. Hydrological drought is based on the amount of surface and groundwater relative to normal levels. Agricultural drought is categorized by the amount of moisture in soils available for plants, and a socioeconomic drought measures the impact that any or all of the first three (3) have on people and businesses.

Drought levels are measured using several major hydrologic indices and the precipitation, groundwater, and surface water levels are evaluated in terms of departure from normal. Normal is defined as the statistical average of the data for the period of record. The time of year may influence the measurement process considerably. In the fall and winter months, the crop moisture index (CMI) and the Palmer drought index (PDI) may react slowly but decline rapidly once the spring "green-up" occurs. The lag between surface water levels and groundwater levels could similarly skew the relative importance and number of indicators that are critical to determining the level of drought. Groundwater and reservoir data particular to suppliers may also be used in conjunction with statewide data to determine drought levels. Definitions for terms related to drought are below:

- **PDI:** An index that reflects soil moisture and weather conditions, including temperature. It is compiled by NWS and NCEI.
- **CMI:** An index that reflects short-term soil moisture conditions, particularly as it pertains to agriculture. The agricultural sector is usually the first to be affected because of its heavy dependence on stored soil water, which can be rapidly depleted in extended dry periods.
- **Precipitation:** Data is collected by the NWS at eight (8) data points managed by NWS, and two (2) U.S. Climate Reference Network sites maintained by NOAA's Climate Reference Network. Additional rainfall data is also collected by the NWS via a suite of citizen weather rainfall sites, part of a network called CoCoRaHS (Community Collaborative Rain, Hail and Snow network). A drought phase determination is based on conditions relative to normal in 2-, 3-, 6-, and 12-month intervals.
- **Groundwater Levels:** These are monitored by the USGS from 38 observation wells. A drought phase determination is based on the number of months groundwater levels are below normal (lowest 25% of period of record). Local water suppliers also monitor public wells to make seasonal water availability comparisons.
- **Stream Flow:** Conditions are monitored by the USGS from 21 near-real-time stations with 30 or more years of record. A drought phase determination is based on the number of months that stream flow levels are below normal compared to historical trend data.

- **Surface Water Reservoir Levels:** Data is typically reported by water suppliers, relative to normal conditions or percent "full". A drought phase determination considers historic monthly averages of small, medium, and large index reservoirs.

The Rhode Island Drought Steering Committee assigns drought levels for the seven (7) designated drought regions in the state based on hydrological indices including precipitation, groundwater, stream flow, and the PDI, as well as local supply indices such as static groundwater levels and reservoir levels. Normal, Advisory, and Watch levels are issued statewide; Warning and Emergency levels are issued on a regional basis and consider local conditions, source of water supply, and water storage capacity issues. This information is organized in the table below.

Table 3-21 Drought Indices and Phases

Drought Level	PDI	CMI	Precipitation	Ground Water	Stream Flow	Surface Water Reservoirs
Normal	-1.0 to -1.99	0.0 to -1.0 Slightly dry	Slightly dry	1 month below normal	2 consecutive months below normal	Reservoir levels at or near normal for the time of year
Advisory	-2.0 to -2.99	-1.0 to -1.9 Abnormally dry	2 month cumulative below 65% of normal	At least 2 out of 3 months below normal	3 consecutive months below normal	Small index reservoir below normal
Watch	-3.0 to -3.99	-2.0 to -2.9 Excessively dry	1 of the following criteria met: 3 month cum. <65% or 6 months cum. <70% or 12 months cum. <70%	4-5 consecutive months below normal	At least 4 out of 5 consecutive months below normal	Medium index reservoir normal
Warning	-4.0 and below	>-2.9 Severely dry	2 of 3 of the above criteria met: 3 months cum. <65% **and** 6 months cum. <65% **and** 12 months cum. <65% Or 3 months cum. <65% **and** 12 months <65%	6-7 consecutive months below normal	At least 6 out of 7 consecutive months below normal	Large index reservoir below normal

Drought Level	PDI	CMI	Precipitation	Ground Water	Stream Flow	Surface Water Reservoirs
Emergency	-4.0 and below	>-2.9 Severely dry	Same criteria as Warning and previous month was a warning.	7 months below normal observation wells recording monthly record lows	>7 months below normal	Continuation of previous month's conditions

Notes: PDI and CMI are short-term indicators. Local triggers will also be considered in assessing drought, such as water storage capacity and other water supply system management considerations, particular1y in the later phases of drought.

3.11.1.2 Water Usage in Rhode Island

According to the DEM's Section 305(b) *State of the State's Waters Report (2006),* the primary use of water in Rhode Island by the general population is for domestic uses, sanitation, and drinking water. Domestic water use includes water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, and watering lawns and gardens. There are 647 public wells in Rhode Island according to the RIDOH's Center for Drinking Water Quality, with 170 of these wells being community wells serving residential populations of 25 persons or more. The remaining 477 wells are non-community wells that supply places such as schools and businesses. The Scituate Reservoir provides water to a large percent of the State population living in the Providence metropolitan region and its surrounding suburbs. It is estimated that there are an additional 127,000 people served by an on-site water supply source.

3.11.2 Location

Drought conditions that have occurred in Rhode Island in the past have typically affected the entire state to varying levels of severity. In 2016, the southern portion of the state was in a moderate drought, while the northern part of the state was in a severe drought.[34] These drought conditions continued until June 2017.

While different parts of the state have experienced varying levels of drought severity, the location of drought conditions in Rhode Island are more related to Rhode Island's position in the northeast U.S. and the effects of climate change on the region in general. Average temperatures in the northeast have risen by almost two (2) degrees Fahrenheit (one [1] degree Celsius) over the last century while precipitation has increased five (5) inches (12.7cm).[35] The northeast has experienced a greater recent increase in extreme precipitation than any other region in the United States, with a more than 70% increase in the amount of precipitation falling in very heavy events between 1958 and 2010.[36] Most precipitation prediction models indicate conditions will become even wetter in the future. Despite this predicted increase in overall precipitation, warming and less frequent precipitation events favor an increase in drought intensity. Therefore, increases in the frequency of short-term

[34] Naylor, D. 2016. Most of R.I. wrestles with drought conditions. Providence Journal. Retrieved at http://www.providencejournal.com/news/20160811/most-of-ri-wrestles-with-drought-conditions
[35] Northeast Climate Science Center Workshop. 2016. Ecological Drought in the Northeast United States. Retrieved at https://casc.usgs.gov/sites/default/files/files/Northeast_EcoDrought_Newsletter_Ian.pdf
[36] Ibid.

(one [1] to three [3] months) droughts are projected.[37]

Current drought conditions in Rhode Island and the nation are tracked by the U.S. Drought Monitor, a partnership between the University of Nebraska-Lincoln and various federal and state agencies and other experts. Graphic and text summaries of current and projected drought conditions are updated on a weekly basis and are available through the Drought Monitor website.[38]

3.11.3 Extent

An existing index, the PDI, also known as the Palmer Drought Severity Index, or PDSI,[39] uses temperature and precipitation levels to determine dryness, measuring a departure from the normal rainfall in a given area (Table 3-22). The advantage of the PDSI is that it is standardized to local climate, so it can be applied to any part of the country to demonstrate relative drought or rainfall conditions. A monthly PDSI value below -2.0 indicates moderate drought, and a value below -3.0 indicates severe drought.

Table 3-22 Palmer Drought Severity Index

Severity	Index Value
Extreme Drought	-4 or less
Severe Drought	-4 to -3
Moderate Drought	-3 to -2
Mild Drought	-2 to -1
Incipient Dry Spell	-1 to -0.5

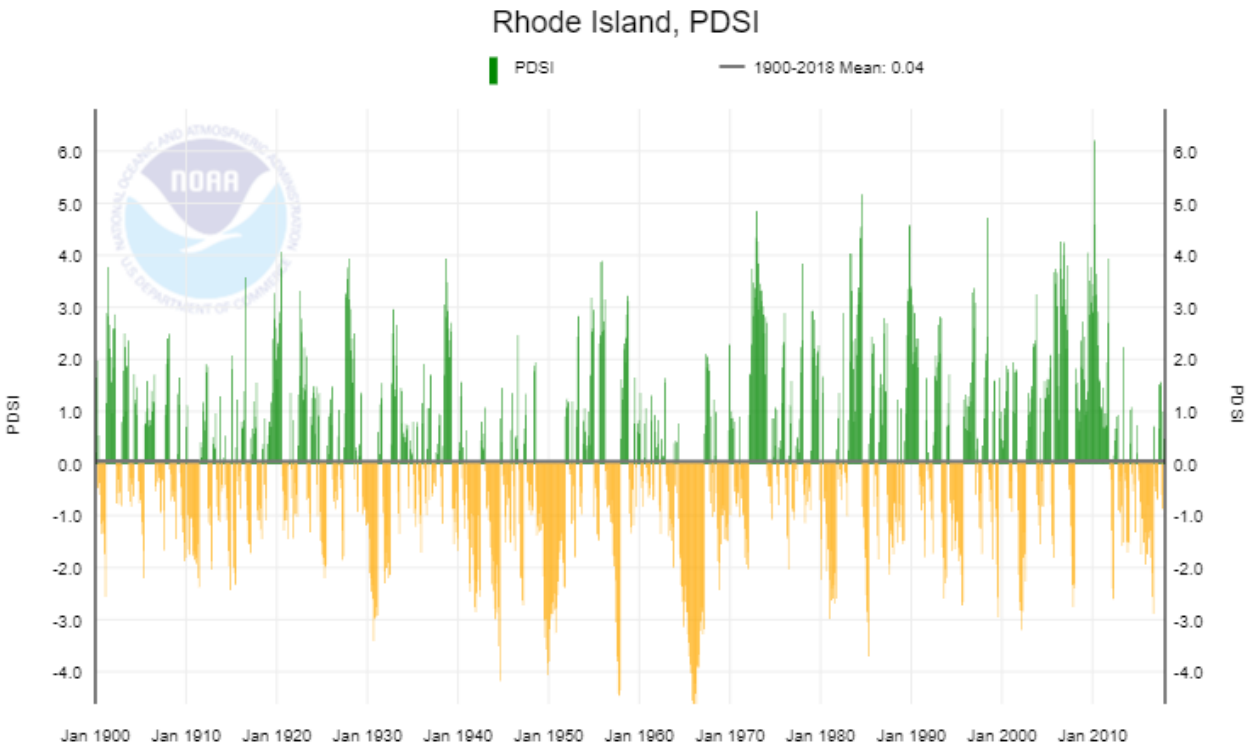
In addition, the Keetch-Byram Drought Index (KBDI)[40] was developed to assess fire risk and in concert with current drought conditions. This index is discussed in more detail in the fire hazard profile.

3.11.4 Previous Occurrences

Annual average PDSI values have been recorded for Rhode Island since 1895.[41] Historically, Rhode Island has ranged from near-normal moisture conditions to moderate and severe droughts throughout the past century (Figure 3-2). Periods of two (2) or more months of severe or extreme drought were documented in 1911, 1925, 1930, 1943 to 1944, 1947, 1949 to 1950, 1957, 1965 to 1967, 1985, and 1987 to 1988. The lowest PDSI of -4.60 was recorded in April 1966.[42] In 2016, the entire state experienced drought conditions to varying levels of severity.[43]

[37] Ibid.
[38] http://droughtmonitor.unl.edu
[39] https://www.drought.gov/drought/content/products-current-drought-and-monitoring-drought-indicators/palmer-drought-severity-index
[40] https://www.drought.gov/drought/content/products-current-drought-and-monitoring-wildfire/keetch-byram-drought-index
[41] NOAA NCDC, http://www.ncdc.noaa.gov/temp-and-precip/time-series/
[42] Source of historic data for droughts consisting of a two (2) or more-month period of severe or extreme drought is: http://www.nrcc.cornell.edu/drought/RI_drought_periods.html.
[43] Naylor, D. 2016. Most of R.I. wrestles with drought conditions. Providence Journal. Retrieved at http://www.providencejournal.com/news/20160811/most-of-ri-wrestles-with-drought-conditions

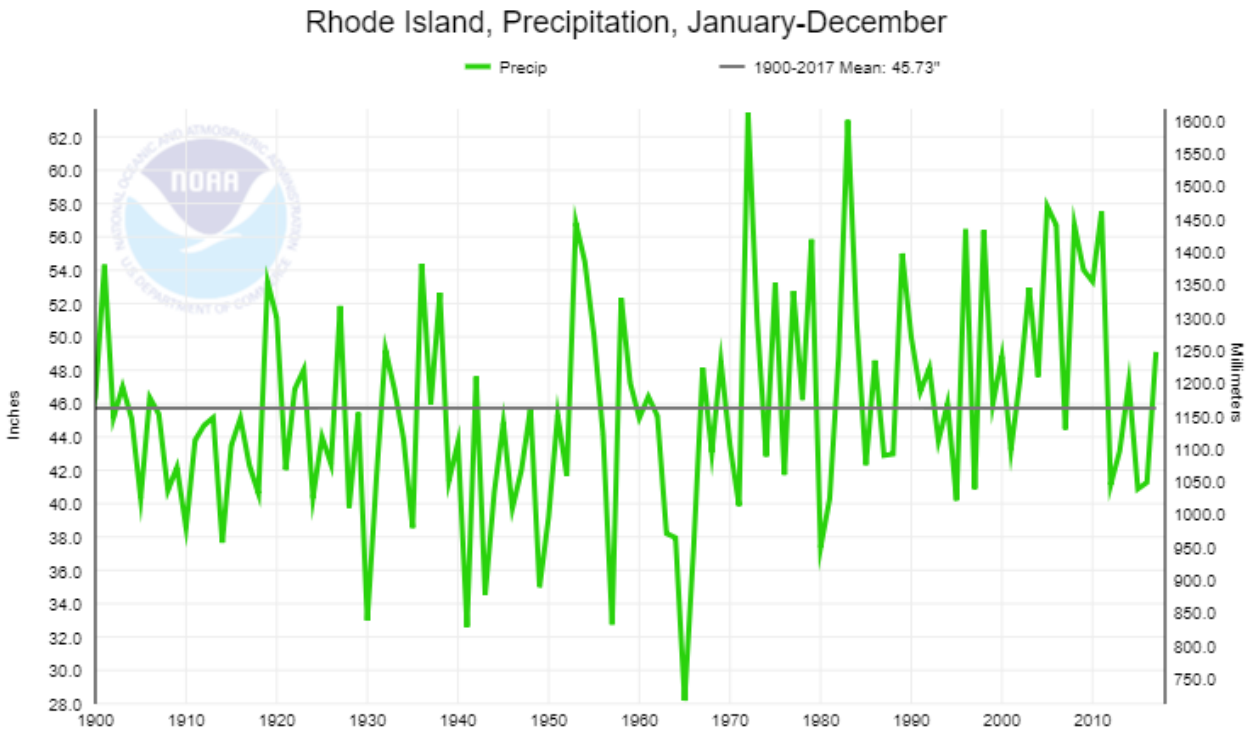
Figure 3-2 Palmer Drought Severity Index for Rhode Island (1900 – July 2018).[44]



A noticeable trend in the PDSI is the lowering frequency of moderate to severe droughts (PDSI at or below -1.0) since the late 1960s. This corresponds very closely to a similar trend in the annual rainfall in Providence, which shows the majority of dry years (experiencing less than 36 inches of rainfall) occurring prior to 1970. The majority of very wet years (experiencing greater than 54 inches of rainfall) have occurred since 1970. Figure 3-3 on the following page shows annual precipitation in Rhode Island from 1900 to 2018.

[44] NCEI, 2018 https://www.ncdc.noaa.gov/cag/

Figure 3-3 Annual Precipitation in Rhode Island (1900 – July 2018)[45]



For most major historical drought events, the NWS noted that the precipitation during the preceding fall and winter months was below normal (which is typically defined as between 90% and 75% less than levels through the spring) and led to the most severe drought episodes, including the 1965 to 1967 long-term drought. Historically, most droughts in Rhode Island have started with dry winters, rather than a dry summer. The 1965 to 1967 drought episode lasted for three (3) summers and included long periods of below normal precipitation through the winter, spring, and summer months. This drought period serves as the classic model of a long-term drought in Rhode Island. Though short-term droughts, such as the one that occurred in 1999, may not have a significant impact on the state's public water systems, no water system will be immune to periods of long-term drought. Extended droughts, though not common, require statewide monitoring of climatic conditions. Table 3-23 details historical droughts in Rhode Island.

Table 3-23 Rhode Island Historical Droughts and Locations of Impacts

Date	Area Affected	Remarks
1930 to 1931	Statewide	Estimated stream flow about 70% of normal
1941 to 1945	Statewide. Particularly severe in the Pawtuxet and Blackstone Rivers	Estimated stream flow about 70% of normal
1949 to 1950	Statewide	Estimated stream flow about 70% of normal
1963 to 1967	Statewide	Water restrictions and well replacements common

[45] NOAA National Centers for Environmental Information, 2018 https://www.ncdc.noaa.gov/cag/

Date	Area Affected	Remarks
1980 to 1981	Statewide. Groundwater deficient in eastern part of state	Considerable crop damage in 1980
1987 to 1988	Southern part of state	Crop damage of $25 million

In addition to the events above, three (3) drought events affecting each county in Rhode Island have been documented by NCEI since 1993, all in the spring and summer of 2012. A meteorological drought was documented by precipitation that had been approximately one-half (0.5) of normal levels from January 2012 through April 2012, and U.S. Drought Monitor declared a severe drought across Rhode Island. Rivers and streams were most affected, running at record low levels during the spring run-off season, and small pond levels were reduced. The main risk posed by this drought was periods of very high fire danger; while soil moisture was well below normal, this drought occurred prior to the beginning of the growing season, reducing agricultural effects.

In 2016, northeastern states, including Rhode Island, endured a severe drought beginning in the summer and extending into the fall which cost the United States billions of dollars in impacts and affected agricultural production.[46]

3.11.5 Probability of Future Events

Extended periods of dry weather with significant negative impacts on crops, livestock, and people have occurred in the past and should be expected to occur into the future. Since drought is highly unpredictable and may be localized, assessing probability of its occurrence is difficult. Calculation of annualized drought risk as a function of probability and impact has not been performed for this analysis. Quantifying drought in terms of historical frequency also proves to be a difficult task because of the variations in drought definition and the very limited and curtailed historical reports. However, as climatic conditions continue to change in the future, the probability of drought will likely increase.

According to the NCEI, annual precipitation in the state ranges from 28 inches to 63 inches, and average annual precipitation is approximately 46 inches (1900 to 2017).[47] In contrast, the average annual precipitation for the U.S. is 29.53 inches. Even though the state receives more precipitation annually than the average for the U.S., Rhode Island does experience extended periods of dry weather. Summer dry spells are fairly common in the state and typically occur during times when crops and lawns require increased irrigation due to higher daily temperatures.

Using the hazard ranking criteria, drought is deemed unlikely to occur in Rhode Island within the next 12 to 60 months.[48] Table 3-24 provides the annualized events qualitative ranking used for determining probability of future events.

Other factors may also contribute to the degree and probability of droughts and their impacts on Rhode Island. These include projections of humidity levels (decrease), hotter temperatures and increased heat wave occurrences, transpiration rates, and increased water demands by the general population and industry sectors. A review of the limited amount of data available suggests that a

[46] U.S. Drought Monitor, 2018
[47] National Centers for Environmental Information, 2018 https://www.ncdc.noaa.gov/cag/
[48] Although the data analysis here is accurate based on existing predictors, it should be noted that during the 2016 HIRA update most of RI was experiencing in a (D2) Severe Drought and the remaining portions of the state are in a (D1) Moderate Drought.

drought will occur about every 10 years in Rhode Island.

Recent climate change studies have indicated that although precipitation is projected to increase throughout this century, it will be in the form of short duration, intense, and less frequent events.[49] In addition, it is projected by the Northeast Climate Impacts Assessment Group and the New York City Panel on Climate Change that most of this increased precipitation may occur during colder times of the year, such as winter, in the form of snow or ice. Furthermore, it is projected that the frequency and intensity of both long-term and short-term droughts throughout the Northeast will increase throughout the century with the impacts beginning to occur with a greater degree of frequency beginning in the mid-century (2050s).

3.11.6 Vulnerability and Risk Assessment

3.11.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined drought to be a low priority hazard in Rhode Island. As described in the profile above, drought events within the state are unlikely within the next one (1) to three (3) years. Droughts have a medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries. Hazard magnitude for a drought event is considered to have negligible, including minor injuries, no shutdown of critical infrastructure and facilities, and scattered damage to residential and commercial structures. The impact on state operations is believed to be negligible. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-24 outlines the hazard rankings for each of the hazard priority criteria related to drought.

[49] Information derived from two (2) recent studies: *Confronting Climate Change in the Northeast*, by the Northeast Climate Impacts Assessment Group, July 2007, and *Climate Risk Information,* by the New York City Panel on Climate Change, 2/17/09.

Table 3-24 Drought Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Unlikely** *Less than 1% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Low**

3.11.6.2 Risk and Vulnerability to People and Property

The entire state of Rhode Island is vulnerable to a drought occurrence, although the severity of any impacts experienced because of a drought will vary depending on who or what is affected. Impacts may be costly in both social and economic terms. The direct impacts of a drought on the economy are due to a loss of agricultural commodities. Often as a result of a drought, farmers can lose livestock and crops or pay substantially more to produce a year's production. Water suppliers may lose income if they impose restrictions or face increased costs for developing alternate water supplies. Economic impacts to industries can include loss of production due to use restrictions or increased costs for alternate water supplies, such as cooling.

In addition, Rhode Island relies heavily on tourism. Restricting access to beaches, restricting water recreation activities such as fishing and boating, and restricting golf course water supply could reduce the state's appeal to visitors, causing reduced tourism revenue. The vulnerability of the state to drought is increasing as water use and land use change. The economic and social impacts from such an event could be significant for Rhode Island.

Risk and Vulnerability to People (Injuries and Death)

During a drought, restrictions may be placed on water usage, which will impact residents' habitual use of water. Water usage restrictions may have adverse effects on agricultural crops including reducing availability of fresh fruits and vegetables as well as a reduction in water-based recreational activities to stay cool during warm weather. Unless water was so scarce that residents were unable to hydrate properly, it is unlikely that drought would result in a high number of deaths or injuries.

If the drought coincides with warmer months, vulnerable populations of Rhode Island may face an increased risk of exposure to hot weather. Physical effects of heat can cause major health problems, which can be exacerbated by dehydration, and may lead to death. People begin to suffer heat-related illness when their bodies are unable to compensate for the heat by properly cooling the body. Heat stroke may increase body temperature to 106 degrees Fahrenheit or higher. Very high body temperatures may damage the brain and other vital organs.

Loss of water access, under extreme conditions, may increase the frequency or likelihood of disease outbreak. If individuals are desperate for water, they may be more inclined to consume water that is not safe to drink to alleviate thirst. Lower quantities of water may also increase the likelihood of contamination due to higher concentrations of bacteria.

During droughts, dry soils and frequent wildfires can increase the number of airborne particles like pollen and smoke. These particles can irritate airways and worsen chronic respiratory illnesses such as asthma. Poor air quality can also increase the risk of respiratory infections.

Risk and Vulnerability to Property (Structures and Facilities)

Even though there is minor variation throughout the state in terms of areas more prone to experience drought conditions, it is assumed that the drought hazard would impact buildings in a fairly uniform and negligible manner. However, the occurrence of a drought may increase risk of secondary impacts, such as structure fires, wildfires, mudslides, or landslides. Water shortages may decrease the functionality of household equipment such as heating or cooling infrastructure, resulting in increased payloads on equipment and/or eventual malfunction.

Under extreme drought conditions, where local water supplies are depleted, and water utilities are unable to supply adequate water pressure, health and medical functions could be impacted. Healthcare facilities, including hospitals, clinics, and nursing homes, rely on water for heating, cooling, and ventilation systems, as well as for equipment sterilization, sanitation, water-based patient treatments, fire suppression, and hazmat-decontamination.

Risk and Vulnerability to Critical Infrastructure

Drought conditions may threaten levels or quality of municipal public water supplies or impact small community or private potable water wells. During drought conditions, the availability of fresh water may be reduced, resulting in increased risk of contamination (bacterial or chemical) or the need to drill deeper wells. Residents may have inadequate access to fresh water.

According to the Rhode Island's Department of Administration's Division of Planning and the Rhode Island Water 2030 report, 92% of the state's resident population is served public water by 28 major water suppliers and 458 small public systems. The remaining population is served by private wells; the total number of persons on private wells varies by each region with the highest percent, nearly 30%, in the southern region. The quantities of water used by small systems and private wells are estimates as there is no reporting system to record this type of water use. Much of the public drinking water in the central and southern parts of the state comes from wells relying on groundwater aquifers, and it is this surface water that provides the majority of the water for the other regions in the state. Some of the surface water supplies in the north and east come from out of the state as well. A major drought has the potential to directly impact the availability of these surface water supplies and restrict the availability of drinking water to large portions of the state.

All sources of energy (including electricity) require water in their production processes, including extracting raw materials, cooling in thermal processes, cleaning processes, cultivating of crops for biofuels, and powering turbines. Because of the interdependency between the energy sector and the availability of water, drought greatly affects the resilience of energy systems.

Communications equipment and information technology data centers also use water for cooling. Data centers, for example, often use high-tonnage heating, ventilating, and air conditioning systems that require drinkable water to operate and keep their computer systems cool. A sustained loss of water to a communications facility, which could happen during a drought, can cause equipment shutdown or failure, resulting in a degradation of communication capabilities.

Persistent drought conditions have the potential to limit port and waterway transportation operations by reducing route available and limiting cargo carrying capacity, resulting in increased transportation costs.

3.11.6.3 Risk and Vulnerability to the Environment

The most immediate consequence of drought is a decrease in crop production due to inadequate and poorly distributed rainfall. The potential of drought-related impacts on corn and other crops will have significant impacts on supplies and prices for animal feed, livestock, meat and dairy products, and processed grain products, including ethanol. While there is little information on crop loss related to drought in Rhode Island, the 1987 to 1988 drought caused over $25 million in crop damage, while the 2016 west/northeast/southeast drought contributed to over $3.5 billion in damage across the

nation, of which primary losses in Rhode Island were related to stressed water supplies.[50] It can be reasonably assumed that future drought conditions may detrimentally impact crops in the state.

Drought conditions may also increase the potential of structure fires or wildfires, which have significant impacts on the environment. Drought is also associated with insect infestations, plant disease, and wind erosion of soil.

Rhode Island contains naturally occurring aquifers that bolster the public water supply. If groundwater is depleted more quickly than it is replenished, which may happen during a drought, aquifer levels can drop, making water unavailable for irrigation and consumption. In areas that rely on surface water, hot and dry weather exacerbates the situation by increasing the amount of water lost to evaporation.

3.11.6.4 Risk and Vulnerability to State Operations

Reduced freshwater availability would likely complicate firefighting efforts in urban and suburban areas where standard wildfire-fighting tactics, such as chemical retardants and controlled burns, are less suitable. Some fire suppression equipment requires a minimum level of water pressure to activate and work properly.

An immediate consideration in fighting structure fires is electric power and transmission line outages. Electricity may be required to maintain water pressure in municipal hydrants systems. If electric transmission lines are affected by wildfire and are unable to provide power to an urban area, there may be insufficient power to produce water pressure for the fire hydrants; consequently, fighting structure fires in settled areas may be difficult without the use of tanker fire trucks.

Droughts may also impact the delivery of goods and services if there are shortages of raw materials. Drought conditions will have a minimal impact on transportation infrastructure, except by water. Declining levels may impact the size of ships or boats that can access Rhode Island harbors.

State operations will likely experience minimal impacts from drought conditions, unless there are substantial power, communications, or water outages. Critical life-saving activities and fire suppression will be directly impacted by these outages. Continuity of operations will likely be hindered by these extreme outages as well.

[50] NOAA, 2018. U.S. Billion-Dollar Weather and Climate Disasters. National Centers for Environmental Information. Retrieved at https://www.ncdc.noaa.gov/billions/events.pdf

3.12 Earthquake

3.12.1 Description

An earthquake is caused by a sudden displacement within the earth. Strong and destructive earthquakes usually result from the rupturing or breaking of great masses of rocks far beneath the surface of the earth. All earthquakes produce both vertical and horizontal ground shaking. This ground movement begins at the focus or hypocenter, deep in the earth, and spreads in all directions. The motion felt is the result of several kinds of seismic vibrations. The primary waves (P waves) are compressional. The secondary waves (S waves) have a shear motion. These body waves radiate outward from the fault to the ground surfaces where they cause ground shaking.

The fast-moving P waves are the first waves to cause the vibrations of a building. The S waves arrive next and may cause a structure to vibrate from side to side. Rayleigh and Love waves (surface waves), which arrive last, cause low-frequency vibrations and are more likely than P and S waves to cause tall buildings to vibrate. Surface waves decline less rapidly than body waves. As the distance from the fault increases, tall buildings located at relatively great distances from the epicenter can be damaged. Damage can also occur because of liquefaction, which happens when loosely packed, water-logged sediment loses its strength in response to strong shaking.

Geologists have found that earthquakes tend to reoccur along faults, which reflect zones of weakness in the earth's crust. A fault is a fracture in the earth's crust along which two (2) blocks of the crust have slipped with respect to each other. Faults are divided into three (3) main groups, depending on how they move:

- **Normal faults:** occur in response to pulling or tension; the overlying block moves down the dip of the fault plane.
- **Thrust (reverse) faults:** occur in response to squeezing or compression; the overlying block moves up the dip of the fault plane.
- **Strike-slip (lateral) faults:** occur in response to either type of stress; the blocks move horizontally past one another.

Most faulting along spreading zones is normal, along subduction zones is thrust, and along transform faults is strike-slip. Even if a fault zone has recently experienced an earthquake, there is no guarantee that all the stress has been relieved.

The focal depth of an earthquake is the depth from the earth's surface to the region where an earthquake's energy originates (the focus*).* Earthquakes with focal depths from the surface to about 70 kilometers (43.5 miles) are classified as shallow. Earthquakes with focal depths from 70 to 300 kilometers (43.5 to 186 miles) are classified as intermediate. The focus of deep earthquakes may reach depths of more than 700 kilometers (435 miles). The focuses of most earthquakes are concentrated in the crust and upper mantle. The depth to the center of the earth's core is about 6,370 kilometers (3,960 miles), so even the deepest earthquakes originate in relatively shallow parts of the earth's interior. The epicenter of an earthquake is the point on the earth's surface directly above the focus. The location of an earthquake is commonly described by the geographic position of its epicenter and by its focal depth.

Earthquakes beneath the ocean floor sometimes generate immense sea waves or tsunamis. These waves travel across the ocean at speeds as great as 597 mph (960 kilometers) and may be 49 feet (15 meters) high or more by the time they reach the shore.

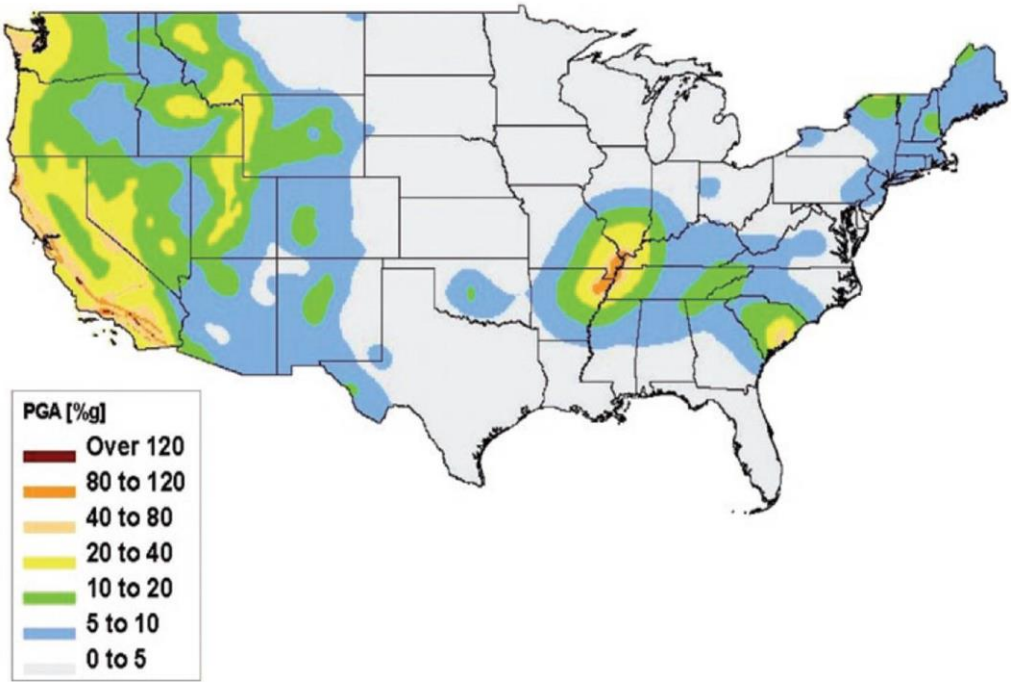
3.12.2 Location

Rhode Island is on the North Atlantic tectonic plate and is in a region of historically low seismicity. Because of this low seismic level there is a general perception that the state has very little risk of sustaining any earthquake-induced damage. However, areas geographically close to Rhode Island have had moderate seismic activity historically. For example, the area off Cape Ann, Massachusetts, has had several Modified Mercalli Intensity (MMI) VIII or greater events within the past 300 years. An earthquake of that location and intensity has the possibility to cause damage to structures in Rhode Island not designed to withstand seismic loadings.

In addition, an examination of the regional geology of Rhode Island yielded the potential for amplification of ground motions in significant areas in the state. Most of the region is generally characterized by till plains. Till is generally composed of unsorted rocks of varying sizes and is considered a stable geological formation not susceptible to amplification. However, the area around Narragansett Bay is characterized by outwash deposits. These deposits are typically sorted sand and gravel under dynamic loading; they tend to amplify the intensity of the bedrock motion so that the surface intensity is greater than that of the bedrock. This phenomenon has been known to cause extensive damage to structures. The City of Providence (in Providence County) is located at the head of Narragansett Bay, within the outwash region and zone of potential amplification. In this region of outwash deposits, the bedrock intensity will be increased by one intensity level to account for the possibility of amplification. The region identified as Charlestown and New Shoreham Moraine within Washington County will be increased by a 0.5 intensity level.

Probabilistic ground motion maps are typically used to assess the magnitude and frequency of seismic events. These maps measure the probability of exceeding a certain ground motion, expressed as %PGA over a specified period of years. The severity of earthquakes is site-specific and is influenced by proximity to the earthquake epicenter and soil type, among other factors. Average PGA, for the 1000-year return period, has been used in the hazard ranking as the geographic extent parameter (Figure 3-4). The average PGA values for the state would result in no felt shaking or potential damage.

Figure 3-4 USGS Seismic Hazard Map - 1,000-year Return Period[51]



3.12.3 Extent

The severity of an earthquake can be expressed in terms of both intensity and magnitude. Intensity is based on the observed effects of ground shaking on people, buildings, and natural features. It varies from place to place within the disturbed region, depending on the location of the observer with respect to the earthquake epicenter. Although numerous intensity scales have been developed over the last several hundred years to evaluate the effects of earthquakes, the one currently used in the United States is the MMI Scale. This scale, composed of 12 increasing levels of intensity that range from imperceptible shaking to catastrophic destruction, is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

Magnitude is related to the amount of seismic energy released at the hypocenter of the earthquake. It is based on the amplitude of the earthquake waves recorded on instruments that have a common calibration. The magnitude of an earthquake is thus represented by a single, instrumentally determined value. The magnitudes of seismic waves are recorded on instruments called seismographs, using the Moment Magnitude System (MMS). Previously, seismologists used the Richter Scale to measure the magnitude of seismic events, but the MMS is now used as it is more exact and sensitive. Like the Richter scale, MMS is not used to express damage. An earthquake in a densely populated area that results in many deaths and considerable damage may have the same magnitude as a shock in a remote area that does nothing more than frighten the wildlife. Large magnitude earthquakes that occur beneath the oceans may not even be felt by humans.

Due to the geological makeup of New England's base rock, seismic energy is conducted on a greater scale (four [4] to 10 times that of an equivalent magnitude earthquake in California). Many coastal regions of New England are made up of soft soils. These soils can magnify an earthquake as much as

[51] FEMA and USGS

two (2) times.

Table 3-25 Richter Magnitude Scale and MMI Scale Comparison

Richter Magnitude Scale	Modified Mercalli Intensity Scale
1.0 to 3.0	I
3.0 to 3.9	II to III
4.0 to 4.9	IV to V
5.0 to 5.9	VI to VII
6.0 to 6.9	VII to IX
7.0 and Higher	VIII or Higher

Table 3-26 MMI Scale

Defined Modified Mercalli Intensity Scale Rating	
I	Not felt except by a very few under especially favorable conditions
II	Felt only by a few persons at rest, especially on upper floors of buildings
III	Felt quite noticeably by persons indoors, especially on upper floors of buildings. Many people do not recognize it as an earthquake. Standing motor cars may rock slightly. Vibrations similar to the passing of a truck
IV	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors, disturbed; walls make cracking sound. Sensation like heavy truck striking building. Standing motor cars rocked noticeably
V	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop
VI	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight
VII	Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable damage in poorly built or badly designed structures; some chimneys broken
VIII	Damage slight in specially designed structures; considerable damage in ordinary substantial buildings with partial collapse. Damage great in poorly built structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned
IX	Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb. Damage great in substantial buildings, with partial collapse. Buildings shifted off foundations
X	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent
XI	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly
XII	Total damage. Lines of sight and level are distorted. Objects thrown into the air

3.12.4 Previous Occurrences

The USGS National Earthquake Information Center maintains a national database of significant earthquake epicenters from 1568 to present.[52] USGS defines significant earthquakes as those that

[52] http://earthquake.usgs.gov/earthquakes/eqinthenews/

caused deaths, property damage, or geological effects, or that were experienced by populations in the epicentral area.

Only a few earthquakes have had a measured intensity of V (Moderate) or greater on the MMI and been centered in Rhode Island. One past occurrence of note is the 1951 South Kingstown earthquake that had a magnitude of 4.7 on the MMI scale. Other past earthquakes were centered in Narragansett Bay, which most significantly impacted Newport, Bristol, and Providence counties.

The Weston Observatory maintains the history of earthquakes in the northeast. Earthquakes that occur most frequently in the northeastern U.S. have a Richter magnitude of <3.0.[53] Previous earthquakes that occurred in and near Rhode Island are presented in Table 3-27, compiled from several northeast earthquake catalog files. Rhode Island has experienced 34 felt earthquakes between 1766 and 2016, while the New England region as a whole has experienced 2,030 felt earthquakes between 1678 and 2016.[54]

Table 3-27 Rhode Island Historic Earthquakes.[55]

Year	Month	Richter Magnitude	Epicenter Location
1766	August	Unknown	Newport (Near Middletown)
1849	February	Unknown	Rhode Island
1849	March	Unknown	Newport
1876	September	Unknown	Newport
1883	February	Unknown	Newport
1888	January	Unknown	Fall River, MA
1925	November	Unknown	Fall River, MA
1925	December	Unknown	Wareham/Taunton, MA
1926	January	Unknown	Voluntown, CT
1940	January	Unknown	Block Island
1948	May	Unknown	Westerly
1949	April	Unknown	N Kingstown
1951	June	4.6	Kingstown, RI
1956	September	Unknown	Swansea, MA
1962	August	Unknown	East Greenwich
1965	December	2.6	Warwick
1967	February	3	Narragansett Bay
1974	October	2.5	West Warwick
1976	March	1.8	Portsmouth
1976	March	2.9	Portsmouth

[53] Kafka, A.L. *Why Does the Earth Quake in New England*? Retrieved at Boston College's Weston Observatory website
[54] Northeast States Emergency Consortium, http://nesec.org/rhode-island-earthquakes/.
[55] USGS and Weston Observatory

Year	Month	Richter Magnitude	Epicenter Location
1976	March	2.7	New Bedford, MA
1978	September	2.8	Rhode Island Sound
1978	April	1.7	Block Island Sound
1978	October	1.9	South of Dartmouth, MA
1981	April	2.7	Portsmouth
1982	November	1.8	West of Providence
1983	February	2.2	NW of Newport
1983	February	1.8	SW of New Bedford, MA
1989	May	Unknown	Island Park
2000	June	Unknown	East Greenwich
2005	November	Unknown	Newport
2003	November	Unknown	Near North and South Kingstown
2007	November	Unknown	West of Warwick, RI
2011	August	0.9	Near South Kingstown, RI
2012	December	1.0	Near Exeter, RI
2013	April	1.8	2km WSW of Hope Valley, Rhode Island
2014	September	1.5	2.0km N of Melville
2015	February	1.1	7.0km NE of Narragansett Pier
2015	February	2.0	7km SE of Newport, Rhode Island
2015	July	2.4	5.0km S of Providence
2016	February	1.0	3.0km NNW of Providence
2016	February	0.9	2.0km SW of Newport
2017	January	1.6	1km SE of West Warwick, Rhode Island
2018	April	0.9	6.0km ESE of Warwick
2018	June	1.3	12km ESE of Newport, Rhode Island
2018	July	1.3	5km W of Coventry, Rhode Island

New England has a history of earthquakes, including those recorded by the first settlers, and by the Plymouth Pilgrims in 1630. Several significant earthquake events in Rhode Island are highlighted below:

- A February 27, 1883, earthquake that was centered in Rhode Island was felt from New London, Connecticut, to Fall River, Massachusetts. Within Rhode Island, it was felt (MMI V) from Bristol to Block Island.
- A large area, estimated at over 5,000,000 square kilometers of eastern Canada and the U.S. (south to Virginia and west to the Mississippi River) was affected by a magnitude 7.0 shock on February 28, 1925. The epicenter was in the St. Lawrence River region; minor damage was confined to a narrow belt on both sides of the river. Intensity effects were felt on Block Island

and at Providence; intensity MMI IV was felt at Charlestown.

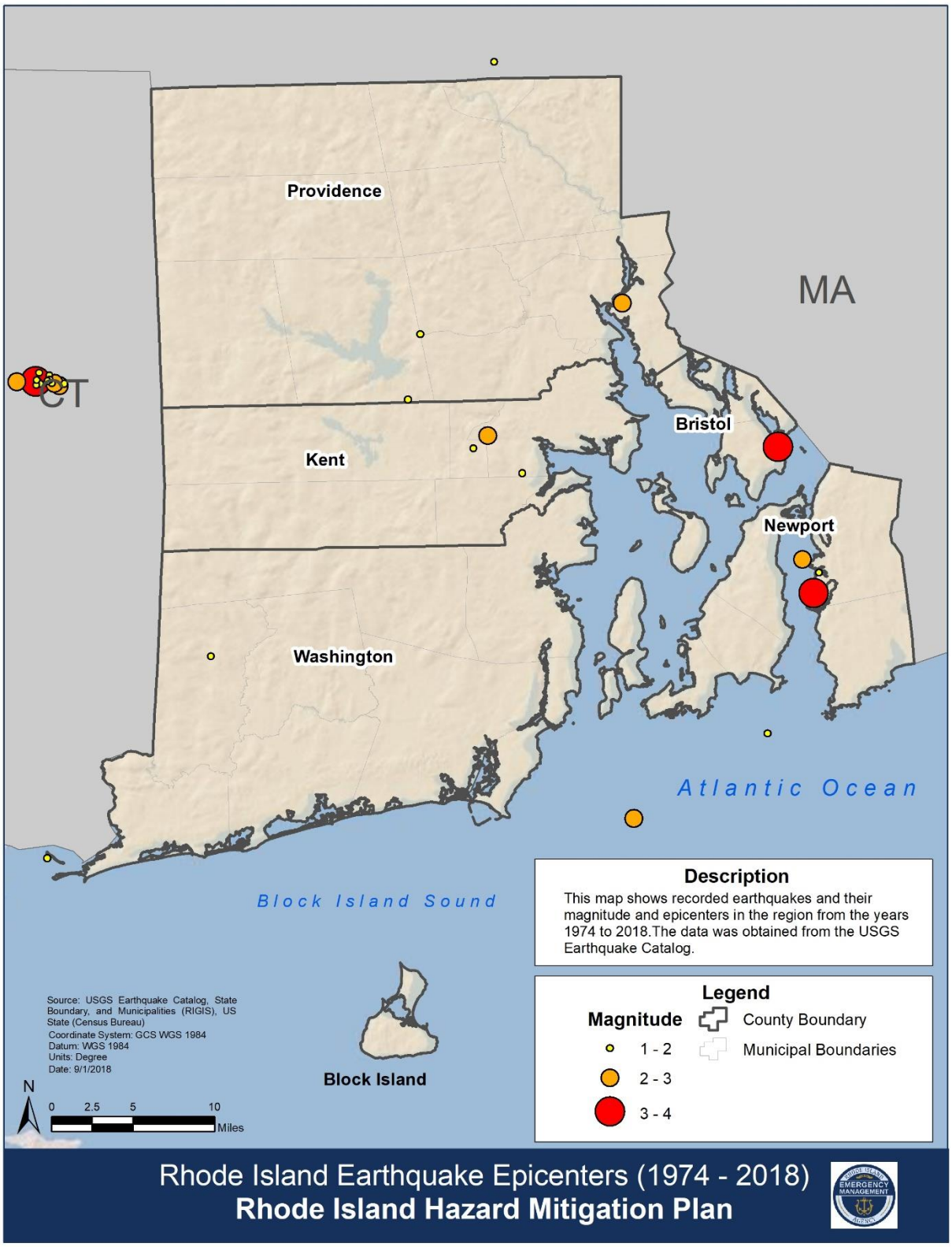
- The major submarine earthquake (magnitude 7.2) near the Grand Banks of Newfoundland on November 18, 1929, was felt throughout the New England states. Moderate vibrations were felt on Block Island and at Chepachet, Newport, Providence, and Westerly.
- Another widely felt earthquake occurred on November 1, 1935, near Timiskaming, Quebec, Canada. Measured at magnitude 6.25, the shock was felt (MMI IV) on Block Island and at Providence and Woonsocket. The total area affected was about 2,500,000 square kilometers of Canada and the United States.
- The strong earthquakes centered near Lake Ossipee, New Hampshire, on December 20 and 24, 1940, caused some damage in the epicenter area and effects were felt in Newport, Rhode Island. Additional reports included intensity MMI IV effects in Central Falls, Pascoag, Providence, and Woonsocket, and intensity MMI I through III effects in Kingston, New Shoreham, and Wakefield.
- Minor intensities were also reported from a September 4, 1944, shock in the Massena, New York, and Cornwall, Ontario, area. Kingston, Lonsdale, Providence, Wakefield, and Woonsocket reported intensity I through III. In addition, a magnitude 4.5 earthquake on October 16, 1963, near the coast of Massachusetts caused some cracked plaster (MMI V) at Chepachet, Rhode Island.
- A small earthquake was felt in the Narragansett Bay region on December 7, 1965, with a MMI V. Both windows and doors were reported to be shaking slightly. Moreover, some 14 months later, another small earthquake (MMI V) was felt in the lower bay area.
- A magnitude 5.2 earthquake in western Maine on June 14, 1973, caused some damage in the epicenter region and was reportedly felt over an area of 250,000 square kilometers of New England and Quebec. The intensities in Rhode Island were MMI IV at Charlestown and MMI I through III at Bristol, East Providence, Harmony, and Providence.
- The last earthquake in Rhode Island with a magnitude of 4.0 or greater was near North Kingstown on June 10, 1951, with a magnitude of 4.6.

Earthquake events do occur in the state, though with much less intensity than elsewhere in the region or on the west coast. Additionally, earthquake events are more likely to be felt as a result of an earthquake that occurs in the surrounding region rather than originating within Rhode Island.

3.12.5 Probability of Future Events

Seismologists and geologists agree that earthquakes are impossible to predict with any degree of accuracy. Rhode Island is in an area of moderate seismicity and low risk. Figure 3-5 shows earthquake epicenters near Rhode Island. Seismic risk is a function of the seismic hazard, location demographics, and regional economics to the vulnerabilities of the structure or lifeline on the site. Using the hazard ranking criteria, probability of future occurrence has been related to an unlikely probability in Bristol, Providence, and Washington, and a potential (between 1% and 49.9% annual probability) probability in Kent and Newport County within the next 12 to 60 months.

Figure 3-5 Earthquake Epicenters near Rhode Island (1974 – 2018)



3.12.6 Vulnerability and Risk Assessment

3.12.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined earthquakes to be a low priority hazard in Rhode Island. As described in the profile above, earthquake events within the state range from potential to unlikely occurrence within the next one (1) to three (3) years. Earthquake events have a small range of impact, accounting for 10% or less of the jurisdictional boundaries. The probable magnitude for earthquakes ranges from negligible to limited magnitude, including minor injuries, no shutdown of critical infrastructure and facilities, and a range of scattered incidental damage to less than 10% of residential and commercial structures damaged from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-28 outlines the hazard rankings for each of the hazard priority criteria related to earthquakes.

Table 3-28 Earthquake Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Unlikely** *Less than 1% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damage*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
Kent County	**Potential** *Between 1% and 49.9% annual probability*				**Limited** *Less than 10% of residential and commercial structures damaged*			
Newport County								
Providence County	**Unlikely** *Less than 1% annual probability*				**Negligible** *Scattered incidental residential and commercial structure damage*			
Washington County								

3.12.6.2 Risk and Vulnerability to People and Property

Earthquakes are low probability, high-consequence events. Although earthquakes may occur infrequently, they can have devastating impacts. Deaths, injuries, and extensive property damage are possible impacts of earthquakes. Shaking can lead to the collapse of buildings and bridges and the disruption of gas and electric lines, phone service, and other critical utilities. Deaths, injuries, and extensive property damage may result from earthquakes. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure.

Risk and Vulnerability to People (Injuries and Death)

Impacts from earthquakes can be severe and cause significant damage. Ground shaking can lead to the collapse of buildings and bridges as well as disrupt gas and electric lines, phone service, and other critical utilities. Some secondary hazards caused by earthquakes may include fire, hazardous material release, landslides, flash flooding, avalanches, tsunamis, and dam failure. Most injuries or deaths resulting from earthquakes are not caused by the ground shaking itself, rather from the damage to property and infrastructure that can collapse or malfunction and injure individuals.

Risk and Vulnerability to Property (Structures and Facilities)

If a moderate to large earthquakes occurred in Rhode Island the buildings in the state would be extremely vulnerable as they are seldom designed to deal with an earthquake threat. The New England region, being one of the first settled areas of the United States, has an abundance of older, unreinforced masonry structures that are inherently brittle and very vulnerable to seismic forces.

Certain areas, buildings, and infrastructure are at increased risk due to soil type and the manner of construction. When completing an earthquake risk assessment, it is challenging to monetize the potential damage accurately. The Northeast States Emergency Consortium estimated that the northeast area could incur annual damages of $170 million dollars due to earthquakes.[56] Currently, the Rhode Island Building Code follows the Building Official and Code Administrators International code, which has very basic earthquake provisions. Thus, even a moderate earthquake could cause severe damage to aged structures and unreinforced masonry buildings. In addition, these codes are only for new structures and do not take into account older structures that were built before the codes were enacted. New England has a high seismic vulnerability because of the built environment, despite being considered to have moderate to low seismic risk.

FEMA's Hazus earthquake model software was utilized to estimate damage and losses to buildings, lifelines, and essential facilities from deterministic (scenario based) and probabilistic earthquakes. Estimates of annualized losses as well as estimates based on two (2) historical scenarios were developed and will be discussed below. Recent earthquakes worldwide depict a pattern of steadily increasing damage and losses that are due to significant growth in earthquake-prone urban areas and vulnerability of older building stock, including buildings constructed within the past 20 years. In April 2008, FEMA released an update to the 2000 report that conducted a nationwide evaluation of earthquake losses in the U.S.: Hazus Estimated Annualized Earthquake Losses for the United States. FEMA's evaluation ranked Rhode Island 42nd in the Nation for Annualized Earthquake Loss Ratio (AELR) ($2.7 million) and 34th for Annualized Earthquake Losses (AEL) ($36/million $). As of the 2018 plan update, this study is still valid though the age of this study should be considered when

[56] Northeast States Emergency Consortium, http://nesec.org/earthquakes-hazards/.

utilizing these losses for planning purposes.

The evaluation considers two (2) measures of losses:

- AEL in any single year, and
- AELR, which is a measure of seismic risk in relation to the value of the building inventory. The ratio is considered a more accurate picture of seismic risk and makes it easier to compare between regions.

In addition to the AELR and AEL studies, several default scenarios were completed in July 2018. These scenarios included the 1755 Cape Ann earthquake with a magnitude 6.5 (Richter) and the 1951 North Kingstown earthquake with a magnitude 5.0 (Richter). The North Kingstown earthquake was not available in the historic earthquake database. To replicate the historic earthquake a similar earthquake scenario was run with an epicenter in North Kingstown and a magnitude of 5.0, the minimum value available in custom Hazus scenarios. The Hazus scenario global summary reports are available in Appendix C. A summary of these events is also included in Table 3-29. As shown in the table, the 1951 earthquake in North Kingstown would result in over $3.3 trillion of damages if the event happened today. It is expected that all facilities would maintain functionality during and following this earthquake, based on Hazus historic simulations.

Table 3-29 Hazus Historic Earthquake Scenario Results

Hazus Damage Category	1755 Cape Ann (6.5 magnitude)	1951 North Kingstown (5.1 magnitude)
Buildings Moderately Damaged	6,173	10,943
Buildings Damaged Beyond Repair	73	414
Tons of Debris	309,000 (62% brick & wood)	645,000 (47% brick & wood)
Total Economic Loss	$1,242.02 million	$3,369.99 million
Utility Systems Loss	$0.72 million	$13.60 million

A probabilistic earthquake scenario was also completed to estimate the annualized losses expected from an earthquake in Rhode Island (Table 3-30). Though the projected economic impacts resulting from these simulations may appear low, the results indicate that some attention should be paid to planning for this hazard in the future to avoid losses. In any given year, Providence, Kent, and Washington counties are projected to experience the greatest losses from an earthquake, likely due to the higher building stock values and populations found in these areas. Figure 3-6 displays the annualized losses from an earthquake by census tract. The list below summarizes the municipalities within each county with greater than $25,000 in annualized earthquake losses by census tract:

- Bristol (East Providence)
- Kent (Warwick)
- Newport (Middletown)
- Providence (Cranston, Johnston, Lincoln, East Providence, Providence, Smithfield)
- Washington (North Kingstown, South Kingstown)

Table 3-30 Hazus Earthquake Annualized Losses for Buildings

County	Annualized Economic Loss for Buildings
Bristol	$155,000
Kent	$531,000
Newport	$277,000
Providence	$2,195,000
Washington	$420,000
Total	$3,578,000.00

Figure 3-6 Annualized Losses from Earthquake

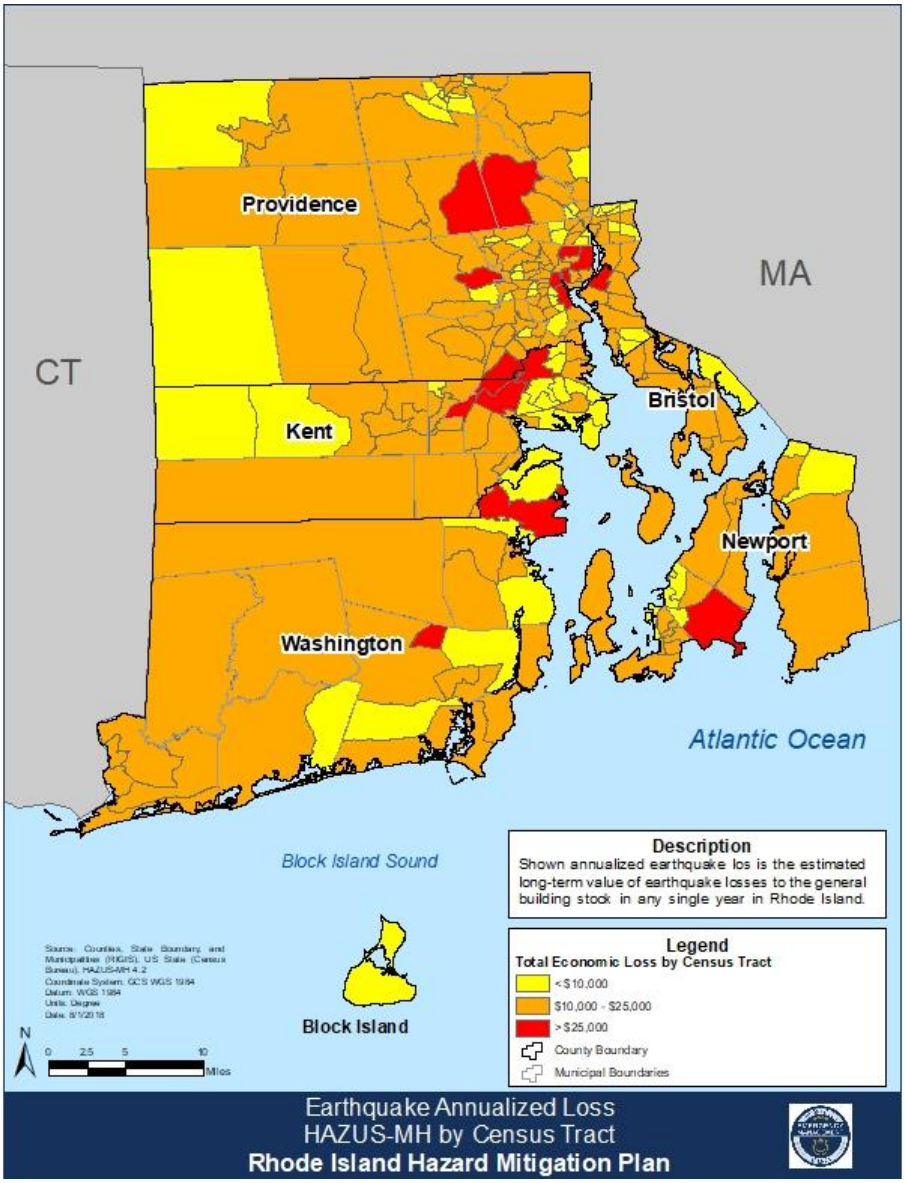
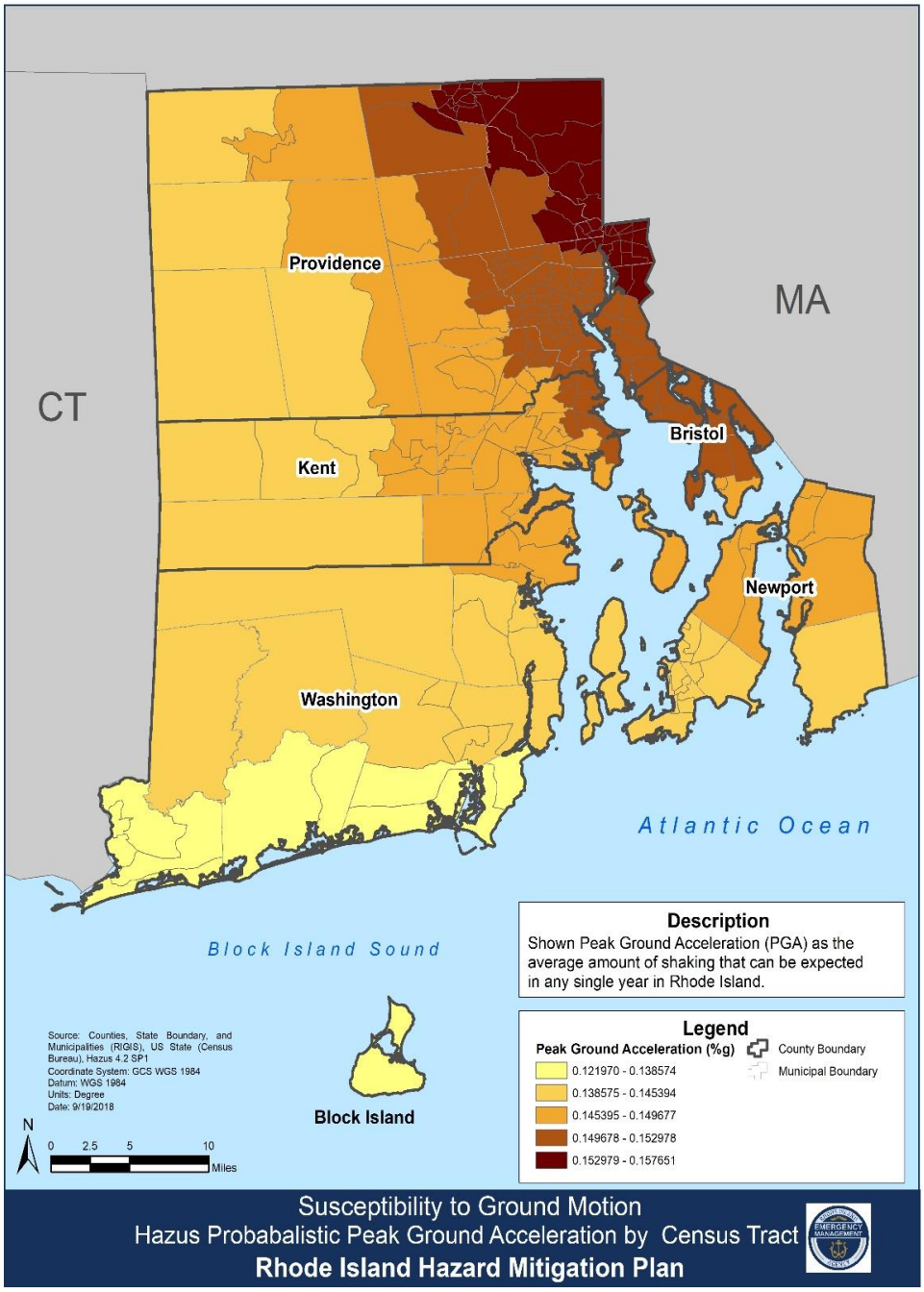


Figure 3-7 Susceptibility to ground motion



Based on the probabilistic earthquake scenario run in Hazus, the northern part of Providence County and most of Bristol County were found to be the areas most susceptible to ground motion (Figure 3-7). This data was then used to run an exposure analysis of critical facilities and structures to different areas of ground motion susceptibility. Section 3.27.2 summarizes the buildings that are vulnerable to ground shaking above 0.15 (%g).

In addition to the physical characteristics of the soil and built environment, one of the most critical

factors of vulnerability is low public awareness. In Rhode Island, there is little public recognition of earthquake threat, and no established system of educating or informing the public of the threat or how to prepare for or respond during an earthquake. Therefore, higher losses may occur than in other regions of the country.

Although Rhode Island has not suffered a major earthquake in modern times, if an earthquake were to occur in the northeast region now, Rhode Island would bear some of the impacts. Inherent risks to life and property include the increase in population since the Cape Ann earthquake of 1755, buildings which were built prior to seismic building code regulation, aging infrastructure vulnerable to any ground shaking, and any construction in "filled areas" which could be victim to liquefaction.

Risk and Vulnerability to Critical Infrastructure

All critical facilities in the planning areas are exposed to the earthquake hazard. Certain critical facilities store chemicals and other hazardous material that is at risk of spilling and being released due to facility damage from an earthquake. Transportation corridors and pipelines can be disrupted during an earthquake, leading to the release of materials to the surrounding environment, and disrupting services well beyond the primary area of impact.

Ground shaking can lead to the collapse of buildings, bridges, roads, and disrupt gas, life lines, power, and communications infrastructure. Critical supply lines for utilities will likely be damaged as a result of the earthquake, disrupting power, water, communications, and gas. Residents may experience difficulty heating or cooling their homes, which may cause additional public health concerns depending on weather conditions. Within a few days without power, residential food supplies may spoil and people likely will not have access to water.

Roads and other transportation infrastruture will likely be damaged during the earthquake or deemed unsafe to use until the structural integrity can be verified. Roads, bridges, and railways will need to be inspected before they can be used to transport supplies, equipment, or other items to support response. Even if roads appear undamaged by ground shaking, the collapse of buildings may cause debris to obstruct roadways, limiting access to critical facilties, residents, or equipment.

3.12.6.3 Risk and Vulnerability to the Environment

Earthquakes have the potential to trigger secondary hazards such as fire, flash flooding, hazardous materials release, slope failure, dam failures, and tsunamis, all of which are potentially devastating to the environment. Toxins released during fires, hazardous materials incidents, and tsunamis may have detrimental effects on the environment, not only to animals and livestock, but to rivers, streams, and agricultural crops. Flooding, slope failure, and dam failure may cause hazardous materials to be spread by land or water movement. These hazardous materials can completely wipe out habitats and environments, cause significant injury to animals or livestock, or contaminate certain components of the environment (e.g., rivers and streams).

3.12.6.4 Risk and Vulnerability to State Operations

The extent of the damage caused by a earthquake can greatly impact first responders' ability to access or transport victims. Equipment, facilities, or other assets may be damaged as the result of an earthquake and inhibit first responders' capacity to respond to calls for assistance. Disruptions to service lines due to ground shaking may also reduce the speed and efficiency of response.

Damage to communications infrastructure may also impact first responders' ability to respond to calls for assistance and communicate with relevant partners (e.g., hospitals, coroner) to direct the flow of residents to appropriate locations if or when they are retrieved. Lack of access to clean water may decrease health professionals' abilities to perform job tasks, the ability to suppress fires caused by collapsed or damaged infrastructure, and to stay hydrated throughout response and recovery operations.

Additionally, some state-owned equipment and facilities may be damaged as a result of the earthquake, further impeding the state's ability to perform key response and recovery operations. State continuity of operations may be impacted by damage to critical infrastructure resulting in power, water, or communication outages, access to roadways or public transportation, or damage to facilities or infrastructure.

3.13 Extreme Cold

3.13.1 Description

Extreme cold typically indicates temperatures are well below zero (0°F) for an extended period of time. Specifically, extreme cold can be characterized by temperatures falling to -22°F (or -30°C) or less. Excessive cold may accompany winter storms, be left in their wake, or can occur without storm activity; however, these temperatures are rarely reached in Rhode Island.

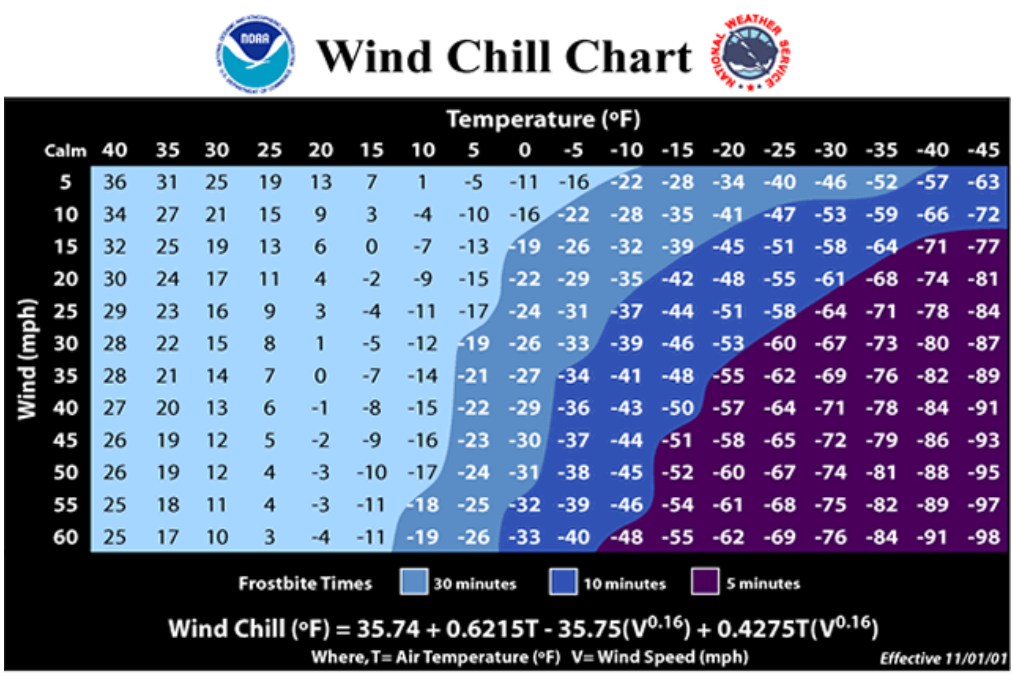
3.13.2 Location

Rhode Island's location in the northeastern U.S. makes it susceptible to extreme cold. In addition, coastal counties, specifically Kent, Newport, and Washington counties, have stronger winds coming off the Atlantic Ocean and are more likely to have higher wind chills, which can significantly lower the overall temperature.

3.13.3 Extent

In relation to extreme cold, the wind chill index attempts to quantify the cooling effect of wind with the actual outside air temperature to determine a wind chill temperature that represents how cold people and animals feel, based on the rate of heat loss from exposed skin. The NWS uses a Wind Chill Temperature Index to measure the current wind chill in the atmosphere and the speed at which frostbite will set in. A wind chill index of -5°F indicates that the effects of wind and temperature on exposed flesh are the same as if the air temperature alone were five (5) degrees below zero (0), even though the actual temperature may be much higher. The NWS issues a wind chill advisory when wind chill temperatures are potentially hazardous and a wind chill warning when the situation can be life-threatening. Figure 3-8 shows NOAA's calculation chart for wind chill.

Figure 3-8 NOAA Wind Chill Chart

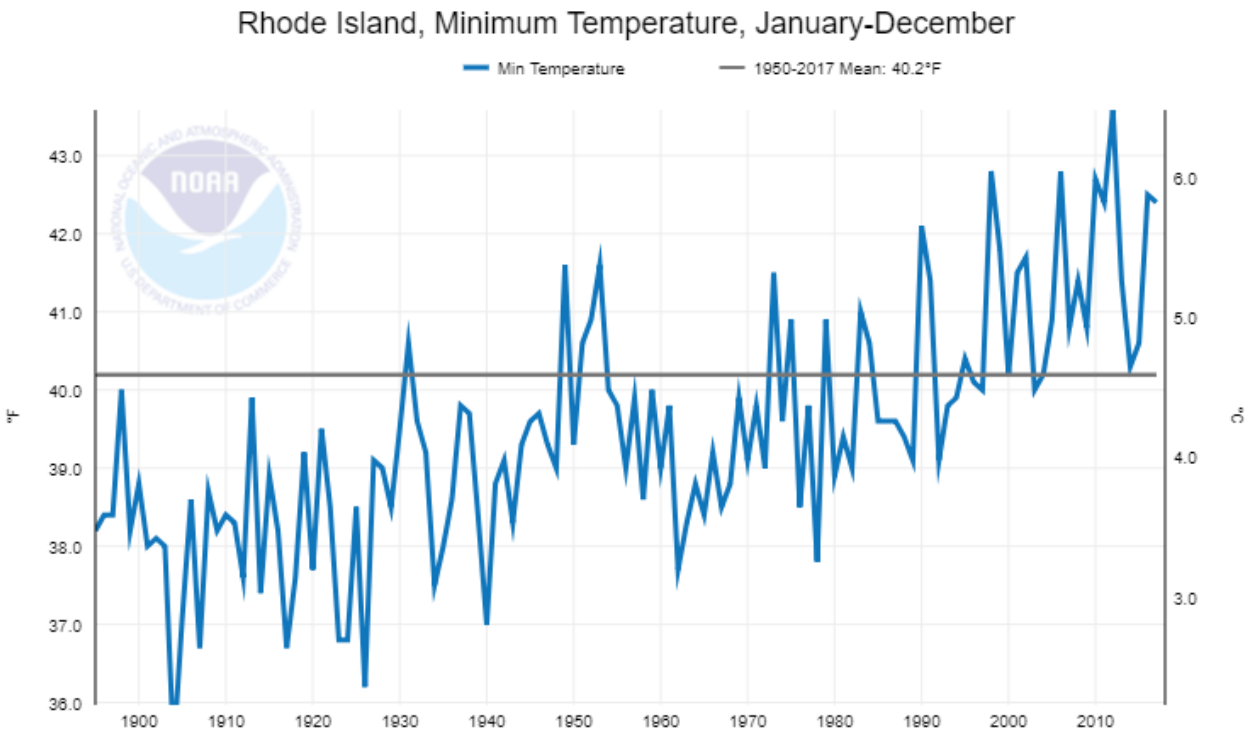


The impacts of extreme cold weather are also affected by their onset and duration. Early onset cold spells can have negative impacts, especially on crop growth.

3.13.4 Previous Occurrences

Rhode Island's location on the coast makes the state susceptible to weather systems that harbor cold weather. Figure 3-9 shows Rhode Island's average minimum temperature of 40.2°F for the months of January through December from 1950 to 2017. Additionally, in the same time period, there were 112 days with a wind chill between 20°F and 0°F, and 68 days when the wind chill was below 0°F. The wind chill was estimated using the minimum temperature and the average wind speed and temperature.

Figure 3-9 Mean Minimum Temperature



3.13.5 Probability of Future Events

Extreme cold in Rhode Island is projected to continue as extreme weather events experience an upswing due to climate change. The specific likelihood of extreme cold is unpredictable, as days of frigid, arctic air and below freezing temperatures may be followed by days of mild temperatures in the 40s or 50s. Based on history and climatic conditions, there is a likely probability that extreme cold will continue to occur and impact Rhode Island. Within the next one (1) to five (5) years there is between a 50% and 89.9% annual probability of extreme cold affecting Rhode Island. Extremely cold temperatures that occur for a short period of time are more likely to occur in the next one (1) to five (5) years, with cold temperatures that extend for long periods of time not being as likely during that same period of time.

3.13.6 Vulnerability and Risk Assessment

3.13.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined extreme cold to be a high priority hazard in Rhode Island. As described in the profile above, extreme cold events within the state are likely within the next year to five (5) years. Extreme cold events have a large range of impact, accounting for 40% to 100% of the jurisdictional boundaries. Hazard magnitude for extreme cold is considered to have negligible magnitude including minor injuries, no shutdown of critical facilities and infrastructure, and scattered incidental residential and commercial structure damage from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-31 outlines the hazard rankings for each of the hazard priority criteria related to extreme cold.

Table 3-31 Extreme Cold Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**

3.13.6.2 Risk and Vulnerability to People and Property

Extreme cold poses a fiscal impact on local and state governments, even though some costs can be recouped through federal grant reimbursements in the event of a disaster declaration related to extremely cold temperatures. Local, county, and state resources may be drained by preparing for, responding to, or recovering from extreme cold events. For example, the State can stand up warming centers for those without adequate heating during forecasted extreme cold events, and may also issue "code blue" warnings, which open up a broader range of housing services to vulnerable populations. These efforts require jurisdictional funding and resources to stand up and maintain.

Risk and Vulnerability to People (Injuries and Death)

Extreme cold presents health risks to individuals caused by prolonged exposure to cold, resulting in hypothermia or frostbite. Infants, elderly residents, homeless individuals, low income residents, non-English speaking residents, and people with life-threatening illnesses are the most susceptible to the risks posed by extreme cold. Additionally, medical conditions or the consumption of certain medications or alcohol can increase individuals' susceptibility to the effects of exposure to extreme cold. Cold temperatures also lead to a decrease in immune system function, causing the body to become more susceptible to illness and disease.

During periods of extreme cold weather, incidents of house fires and carbon monoxide (CO) poisoning may also increase as residents seek out supplemental sources of heat. These alternative sources of heat such as heaters, fireplaces, and generators, can cause a production of CO due to combustion fumes.[57] The buildup of CO in small spaces can poison and kill those who breathe it. The second leading cause of all reported house fires and of deaths caused by house fires are attributed to heating equipment usage, according to the National Fire Protection Association. Improper use of heating equipment is generally attributed to failure to adequately clean heating equipment (30% of heating equipment related fires) or placing it too close to flammable items (56% of heating equipment related fires).

In addition to health risks and injuries caused by improper use of secondary heating sources, the public may also face increased risk from extreme cold temperatures from exposure during power failures, inability to contact assistance if needed communication disruption, or dangerous driving conditions.

Risk and Vulnerability to Property (Structures and Facilities)

Extremely cold temperatures may lead to property damage as well as loss of heat and power and lack of shelter from the elements. Heating systems in homes may not be adequate for the weather and can lead to the use of space heaters and fireplaces, increasing the risk of household fires and CO poisoning. Pipes in homes may freeze and burst, causing disruption of water service, as well as flooding.

Businesses or households may be faced with an increased financial burden due to unexpected repairs, such as pipes bursting and higher utility bills, and business interruption due to power failure.

[57] Centers for Disease Control and Prevention, 2018. Preventing Carbon Monoxide Poisoning after an Emergency. Retrieved from: https://www.cdc.gov/disasters/cofacts.html; Mehta, S., Das, S., & Singh, S. (2007). Carbon Monoxide Poisoning. Medical Journal, Armed Forces India, 63(4), 362–365. http://doi.org/10.1016/S0377-1237(07)80017-7

Risk and Vulnerability to Critical Infrastructure

The cascading effects of extreme cold can bring critical infrastructure to a halt. Critical facilities may be shut down or disrupted due to unsafe travel conditions for workers (should the extreme cold occur in conjunction with severe winter weather), the risk of serious health problems, or the failure of processes, materials, and machinery. Extreme cold events can lead to power interruption or failure. Increased demand for utilities, such as electricity and natural gas, may result in shortages and higher costs for these resources.

Delivery of services may be impacted by icy and dangerous transportation conditions, causing food, water, and resource systems to be delayed or halted, as well as personal transportation by the public. Waterways can freeze, stopping barge and ship traffic. Extremely cold temperatures may also damage or destroy goods if exposed for longer periods of time.

Energy consumption is extremely high during extremely cold conditions due to heating homes and critical facilities, which creates a strain on energy supply.

3.13.6.3 Risk and Vulnerability to the Environment

Extreme cold can freeze crops and food sources, as well as disrupt ecosystems. Critical infrastructure such as pipes or equipment may freeze and break, causing hazardous and dangerous chemicals and materials to spread into human and animal-populated areas, as well as water systems and the food supply. Extreme cold may also contribute to ground freezing problems, which can impact the availability of water, sanitation, and agriculture.

Extremely cold temperatures may injure or kill wildlife or livestock. Wildlife or livestock may experience physical stress as the result of extreme cold weather, in which their body metabolizes food at a higher rate to maintain body temperature. Transportation of livestock during extreme cold may also cause injury or death if proper precautions are not taken. Domesticated animals lacking the metabolic or physical traits of wildlife and livestock are more prone to death or injury as the result of extreme cold. These animals may require shelter or heat to survive extreme cold.

3.13.6.4 Risk and Vulnerability to State Operations

All state buildings, critical facilities, and infrastructure are vulnerable to extreme cold. Additional sources of heating may be required to protect employees from the cold weather, secondary effects of extreme cold (e.g., ice, snow) may cause power outages or limit access to certain facilities or equipment, or the cold temperatures may negatively affect equipment functionality.

First responders may face extremely icy and dangerous road conditions, as well as risk personal injury due to working in an extremely cold environment. Ice on roads may lead to vehicular crashes and prolonged response times. First responders will also respond to more cold-related injuries such as hypothermia. Additionally, first responders themselves may be at increased risk for cold-related injuries such as hypothermia or frostbite if they are exposed to the cold weather for prolonged periods.

Extreme cold is a dangerous threat that can adversely affect the public, first responders, infrastructure, agriculture, economy, and overall state operations. Direct, effective, and timely response to restore critical infrastructure or provide emergency medical services by all levels of government is required for public confidence in the state's governance.

3.14 Extreme Heat

3.14.1 Description

Extreme heat conditions are defined by summertime weather that is substantially hotter and/or more humid than average for a location at that time of year. In Rhode Island, when the outside temperature goes above 90 degrees for three (3) or more days, it is a heat wave. A heat advisory is issued when there are daytime heat indices of 95°F to 99°F for 2 or more hours over 2 consecutive days, or 100°F to 104°F for 2 or more hours over 1 day. An excessive heat warning is issued when there are daytime heat indices of ≥ 105°F for two (2) or more hours. Hot temperatures and extreme heat can occur and last for any amount of time, which can vary from one (1) day to several weeks. This definition for extreme heat may be refined to read: summertime temperatures that hover 10 degrees or more above the average high temperature for the region for any amount of time. The Heat Index (HI) or the "Apparent Temperature" is an accurate measure of how hot it really feels when the Relative Humidity (RH) is added to the actual air temperature. The HI may be used to help determine when an extreme heat event is occurring. Heat alert procedures from the NWS are based mainly on HI values.

3.14.2 Location

Extreme heat impacts the entire State of Rhode Island. Metropolitan areas, the interior north, and other areas in Rhode Island not on the coast experience higher temperatures since the temperature moderating effect of the ocean is reduced.[58] For this reason, residents who live away from the coast in Kent, Providence, and Washington counties are at greater risk for extreme heat.

Within these counties specifically, locations of high concentrations of the following at-risk populations are particularly sensitive to extreme heat. This is due to their health, inability to regulate body temperature, difficulty adjusting to sudden changes, living and working conditions, mobility, as well as financial resources, which make them more susceptible to heat-induced illnesses and the impacts of extreme heat events:[59]

- Infants and young children
- The elderly
- People with chronic conditions
- People who are obese
- Athletes
- Outdoor workers
- People of low socio-economic status
- Homeless
- Persons with disabilities
- People under the influence of drugs or alcohol
- People living in urban areas

In the State of Rhode Island, trends indicate that deaths and emergency department visits are

[58] NOAA. Climate of Rhode Island. Retrieved at: https://www.ncdc.noaa.gov/climatenormals/clim60/states/Clim_RI_01.pdf.
[59] Centers for Disease Control and Prevention, 2018. Protecting Vulnerable Groups from Extreme Heat. Retrieved at: https://www.cdc.gov/disasters/extremeheat/specificgroups.html; Freeman, J., 2015. *Protecting People from Sweltering Summers*. Retrieved at: https://www.climate.gov/news-features/climate-case-studies/protecting-people-sweltering-city-summers.

significantly higher on days with hot weather, even on days with a HI below the current advisory threshold. For example, between 2005 and 2012, an increase in maximum daily temperature from 75°F to 85°F was associated with 23.9% higher rates of heat related Emergency Department visits in Rhode Island. The corresponding effect estimate for all-cause mortality from 1999 through 2011 was 4.0%.

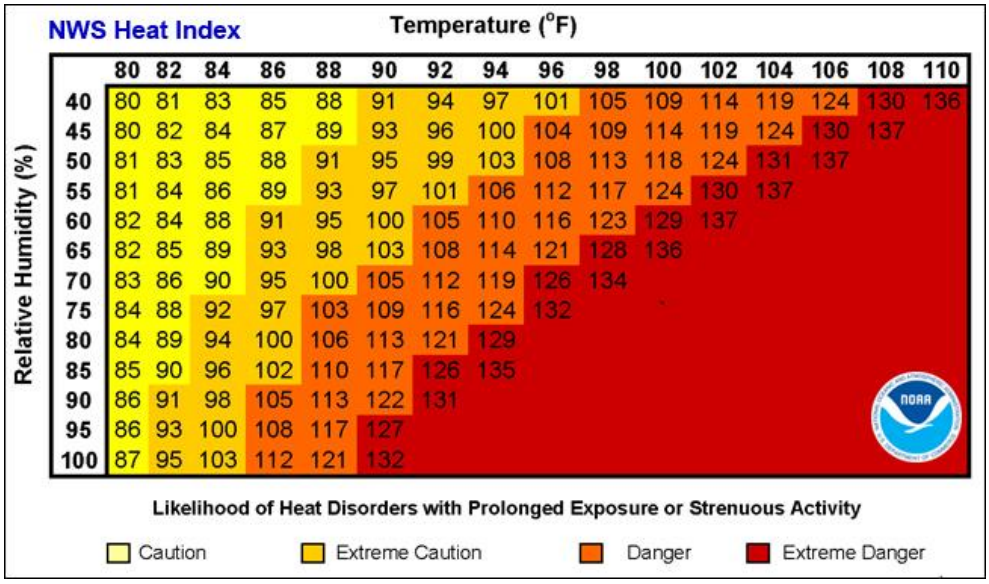
3.14.3 Extent

Heat waves and extreme heat can cause dust storms or droughts. For individuals, heat waves and extreme heat can cause heat-related illnesses, including:

- **Heat cramps:** Muscle pains and spasms caused by heat and heavy exertion.
- **Heat exhaustion:** Occurs during work or exercise in a hot, humid place and the body is dehydrated as a result of sweating.
- **Hyperthermia:** Fever and Heat stroke: Life-threatening medical emergency in which the body can no longer stay cool and the body temperature rises.

Most recently, the Rhode Island Department of Health established the Northeast Regional Heat Collaborative. The Collaborative examined the relationship between heat and morbidity and mortality in the northeast and, based on research findings from New England and in collaboration with key partners across the region, the NWS Regional and local offices in the region are planning to modify the heat advisory threshold for the northeast. Specifically, under the updated criteria, heat advisories in New England will be issued when either the HI is forecast to be 95 to 99°F for two (2) or more consecutive days or the HI is forecast to be 100 to 104°F for any length of time.[60] Figure 3-10 shows how the NWS calculates the HI.

Figure 3-10 NWS Heat Index Chart



Overall, the number of heat related deaths in the state is declining. This indicates that the population has become better adapted to heat waves and extreme heat. This adaptation is most likely a result of

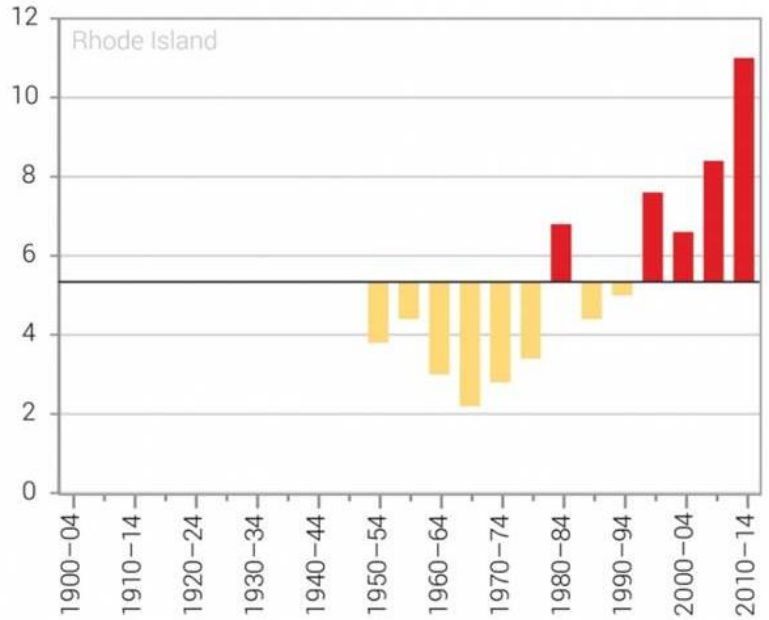
[60] Rhode Island Department of Health Heat Advisory Letter

improvements in the following: medical technology; access to air-conditioned homes, cars, and offices; public awareness of potentially dangerous weather situations; and proactive responses of municipalities during extreme weather events. However, regardless of these adaptations, longer duration and earlier onset of extreme heat events are likely to cause more heat related impacts.

3.14.4 Previous Occurrences

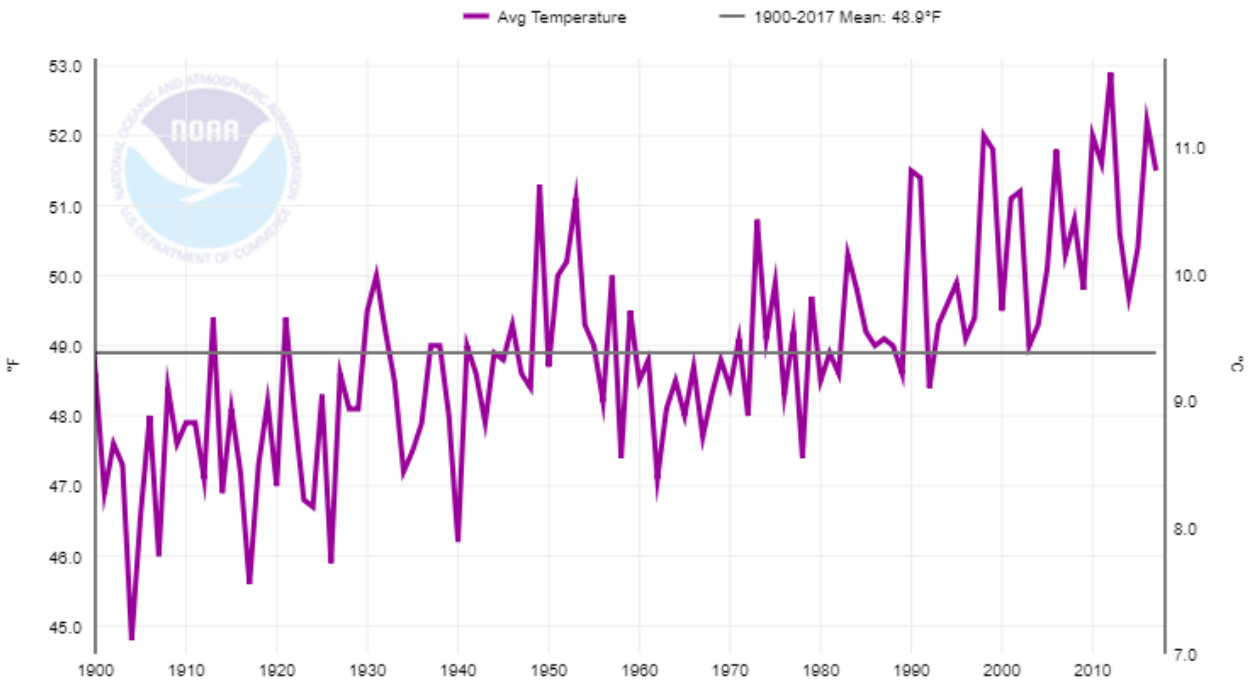
Heat has caused more deaths in the United States than any other type of extreme weather event, including tornadoes, hurricanes, floods, earthquakes, and lightning.[61] Ninety-four (94) heat related deaths were reported in the United States in 2016, with a 30-year (1987 to 2016) average of 131 heat related deaths per year.[62] Climate change has made extreme heat events and temperature increases more common and likely.[63] Extreme heat and hot weather have already increased in frequency and magnitude. Temperatures in Rhode Island have increased by more than 3°F since the beginning of the 20th century (Figure 3-12). The number of hot days (maximum temperature above 90°F) in Rhode Island has been above the long-term average since the mid-1990s with the largest number occurring during the most recent five(5)-year period of 2010 to 2015. The number of warm nights (minimum temperature above 70°F) was also largest during the most recent period and very cold nights (minimum temperature below 0°F) have been below average since the mid-1990s. Figure 3-11 displays the number of hot days recorded over time while Figure 3-12 displays the average annual temperature from 1900 to 2018 in the State of Rhode Island.

Figure 3-11 Observed Number of Hot Days in Rhode Island[64]



[61] CDC, n.d. Climate Change and Extreme Heat Events. Retrieved at: https://www.cdc.gov/climateandhealth/pubs/ClimateChangeandExtremeHeatEvents.pdf.
[62] NOAA, 2017. Summer Weather Safety. Retrieved at: https://www.weather.gov/media/lsx/wcm/Heat/SummerWeatherSafetySummary2017.pdf
[63] United States Environmental Protection Agency, 2016. Climate Change and Extreme Heat: What You Can Do to Prepare. Retrieved from https://www.epa.gov/sites/production/files/2016-10/documents/extreme-heat-guidebook.pdf.
[64] NOAA State Climate Summaries, 2017. Retrieved at: https://statesummaries.ncics.org/ri

Figure 3-12 Annual Average Temperature from 1900-2018 in Rhode Island[65]



3.14.5 Probability of Future Events

Rhode Island as a whole is highly likely (greater than 90% annual probability) to experience extreme heat events within the next 12 to 60 months. Kent, Providence, and Washington counties specifically are also highly likely to experience an extreme heat event within the next 12 to 60 months.

Regardless of any trends indicating heat related deaths are declining, extreme heat events remain a danger. Specific high-risk groups of the population typically experience a disproportionate number of health impacts from extreme heat conditions. In addition, the number of days over 90°F is projected to continue to grow. Climate change studies estimate that by 2070, Rhode Island could have up to 50 days over 90°F per year.

3.14.6 Vulnerability and Risk Assessment

3.14.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined extreme heat to be a high priority hazard in Rhode Island. As described in the profile above, extreme heat events within the state are highly likely within the next year to five (5) years. Extreme heat events have a large range of impact, accounting for 40% to 100% of the jurisdictional boundaries. The hazard magnitude for extreme heat ranges and is considered to have negligible magnitude including minor injuries, no shutdown of critical infrastructure and facilities, and scattered incidental, residential, and commercial structure damage from the event. The impact on state operations is believed to be

[65] NOAA National Centers for Environmental Information

negligible. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-32 outlines the hazard rankings for each of the hazard priority criteria related to extreme heat.

Table 3-32 Extreme Heat Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Negligible** *No meaningful impact on operations*	**High**
Kent County	**Highly Likely** *Greater than 90% annual probability*							
Newport County	**Likely** *Between 50% and 89.9% annual probability*							
Providence County	**Highly Likely** *Greater than 90% annual probability*		**Limited** *Some injuries*					
Washington County			**Negligible** *Minor injuries*					

3.14.6.2 Risk and Vulnerability to People and Property

The main concern in periods of extreme heat is the potential public health impact, such as heat exhaustion or heat stroke. Extreme heat drains state, and local resources. Extreme heat may cause fiscal impacts on local businesses, governmental operations, or individual households.

Risk and Vulnerability to People (Injuries and Death)

Risks from exposure to extreme heat include sunburn, heat cramps, heat exhaustion, heat stroke, and death. Physical effects of heat can cause major health problems, dehydration, and may lead to death. People begin to suffer heat related illness when their bodies are unable to compensate and properly cool. Heat stroke may increase the body temperature to 106°F or higher. Very high body temperatures may damage the brain or other vital organs. The majority of injuries and deaths attributed to extreme heat are a result of heat exhaustion or improperly functioning air conditioning units.

The effect of extreme heat can have severe consequences on the well-being of those more vulnerable to severe conditions, such as the elderly and young children. Persons living in major urban areas of the state, which are more likely locations for extreme heat due to urban heat island effects, are vulnerable to this risk.

Risk and Vulnerability to Property (Structures and Facilities)

The entire state is susceptible and vulnerable to the occurrence of an extreme heat event. Similar to drought, the vulnerability of the state to extreme heat is increasing as water use and land use change. Even though there is some minor variation throughout the state in terms of areas potentially more prone to experience extreme heat conditions, it is assumed that the extreme heat hazard would impact buildings in a fairly uniform and negligible manner.

Loss of electricity may impact air conditioning and cooling mechanisms, leading to increased indoor temperatures, making some buildings unsafe to use until temperatures are reduced.

Risk and Vulnerability to Critical Infrastructure

Facility integrity is at risk with regards to power cables and stations becoming overheated. This overheating could lead to brownouts in urban areas where power lines are damaged by the heat or overtaxed by use. Power outages may cause air conditioning systems to be inoperable, increasing risk to the public. While unlikely, it is possible that prolonged power outages may result in civil unrests, as the case was in New York City following the citywide power outage in 1977. Power outages may also impact the availability of water and fresh food if the infrastructure is not restored quickly.

Risk and Vulnerability to the Environment

Extreme heat can cause significant damage to the local environment by dehydrating vegetation and wildlife, which may result in cascading effects to the surrounding environment, such as drought, wildfires, mudslides, or landslides. Extreme temperatures may severely decrease the yield of Rhode Island's agricultural sector. The yield of cash crops may be reduced, livestock may be adversely impacted by extreme heat, or grazing losses may be incurred by farmers or ranchers; potentially

resulting in decreased food security. In the event of significant agricultural losses caused by extreme heat or drought, some assistance may be available to impacted farms or ranches.

Risk and Vulnerability to State Operations

Because it is assumed that extreme heat would impact buildings in a fairly uniform manner, it is expected that state-owned and critical facility buildings would sustain very minor, if any, direct physical damage from exposure to extreme heat. However, depending on the extent of the event, it is likely for state operations to be impacted due to extreme heat. Loss of power, communication lines, and water availability could be expected if electricity and water demands increase.[66]

Without proper mitigation efforts to heat, drinking water and proper rest, responders can become hampered in their efforts from extreme heat. Emergency responders will be susceptible to heat stroke and severe dehydration as a result of extreme heat waves. Extreme heat may also lead to spontaneous fires, which can complicate response operations, as well as soften asphalt and damage highways and roadways. Extreme heat may also damage instruments or equipment necessary for response activities.

Extreme heat waves can impact efficient delivery or inability of goods or services to be delivered. This results from a cascading effect related to workers being negatively affected by the extreme heat, which in turn drives productivity down significantly. Equipment and vehicles may be damaged due to high temperatures and sun exposure. Extreme heat may also damage goods if exposed to high temperatures for longer periods of time.

[66] United States Environmental Protection Agency, 2015. Incident Action Checklist – Extreme Heat. Retrieved from https://www.epa.gov/sites/production/files/2015-06/documents/extreme_heat.pdf

3.15 Fire

3.15.1 Description

Fire is a combustion or burning, in which substances combine chemically with oxygen from the air and typically give out bright light, heat, and smoke. For the purposes of the 2019 SHMP update, fire is distinguished into two primary categories: urban fire and wildfire.

3.15.1.1 Urban Fire

Urban fires in cities or towns involve buildings with the potential for spreading to adjoining structures. Although the overall 10-year fire death rate trend in the United States decreased 21.6% from 2006 to 2015, the U.S. rate remains much higher than the yearly reported fire death and damage rates for other developed areas of the world, such as Western Europe.[67]

The urban fire hazard in Rhode Island involves areas where single family homes, multi-family occupancies, and/or business facilities are clustered close together, increasing the possibility of a rapid spread to another structure. Other areas, particularly downtown regions, are characterized by adjoining buildings, similarly increasing the possibility of a fire spreading quickly from one structure to another. The cause of fires in urban areas usually includes one of the following:

- Criminal acts (arson, illegal explosive devices, acts of terrorism);
- Residential accidents (improper use of electrical appliances, faulty connections, grease fires, smoking, heating appliances, or improper disposal of wood ashes);
- Industrial accidents (hazardous material incidents, explosions, transportation accidents); and
- Acts of nature (lightning strikes, earthquake byproduct).

3.15.1.2 Wildfire

Wildfires are fueled by natural cover, including native and non-native species of trees, brush and grasses, and crops, along with weather conditions and topography. Fuel quality is determined by several factors, including fuel density, chemistry, and arrangement. The density of vegetation, or how close plants are to one another, can impact the ability of a wildfire to spread. Because dead plants burn very easily, the presence of dead vegetation increases the likelihood of a more intense and faster spreading wildfire, although live, green, and wet plant life can also act as fuel.[68] Gypsy moth populations in Rhode Island have recently defoliated sections of the State's forests, causing an increase in dead trees, a factor which increases the likelihood of wildfires, especially in South County.

3.15.2 Location

Urban fires can occur in any building, facility, or infrastructure across the state. Small urban fires occur routinely and are resolved expediently by first responders with minimal incident. Similarly, small wildfires are common throughout the state. Wildfires are commonly perceived as hazards in the western part of the country; however, wildfires are a growing problem in the wildland/urban

[67] U.S. Fire Administration. 2015. U.S. fire deaths, fire death rates, and risk of dying in a fire. Retrieved at https://www.usfa.fema.gov/data/statistics/fire_death_rates.html
[68] FEMA Independent Study. IS-320: Wildfire Mitigation Basics for Mitigation Staff. Retrieved at https://emilms.fema.gov/IS320/WM0102030text.htm

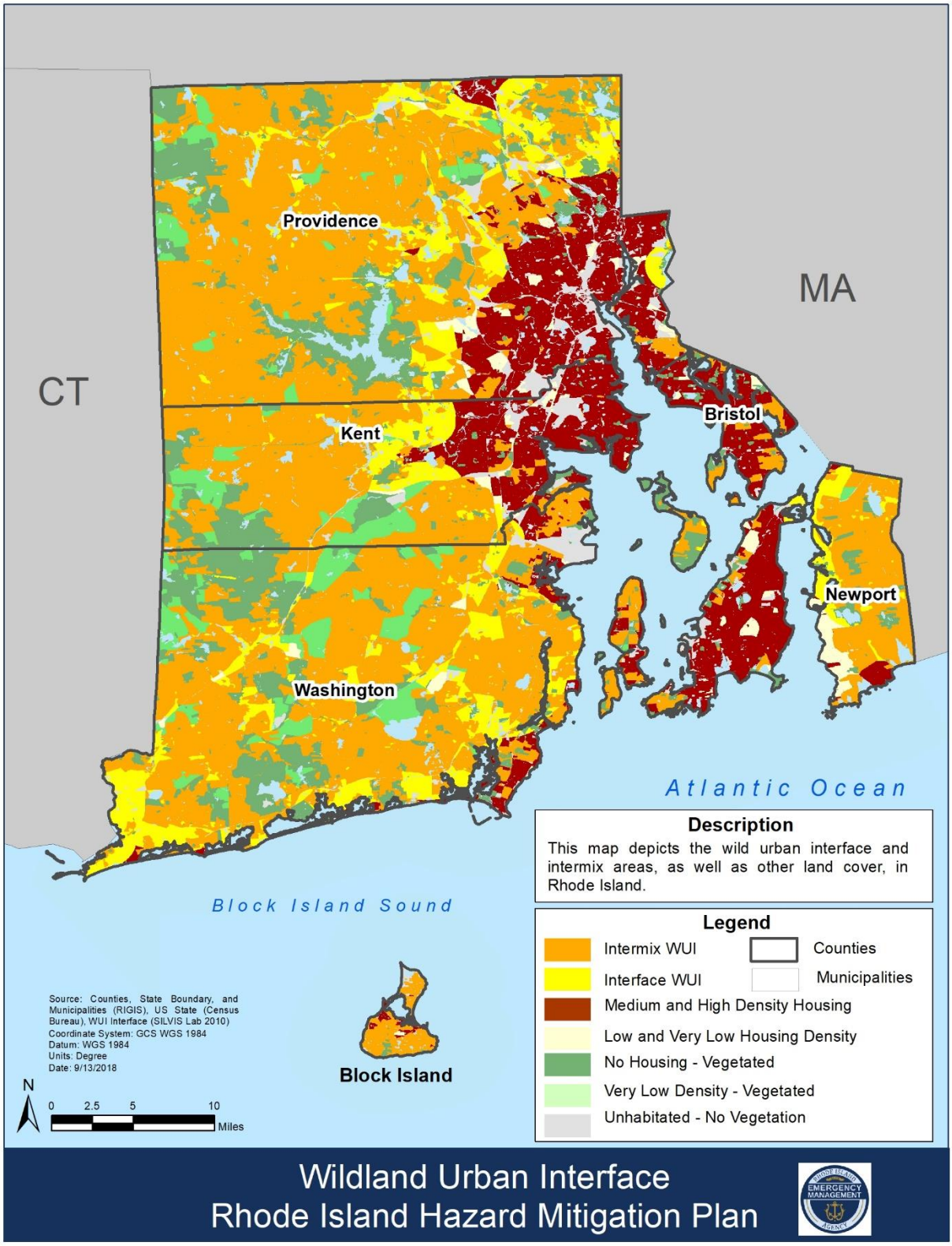
interface of the eastern United States, including Rhode Island. Forests cover more than half of Rhode Island's land area and the state's woodlands are increasingly being developed. Development in wooded areas creates an area of particular risk for Rhode Island. The WUI is the area where structures and human development meet and intermingle with undeveloped wildland. WUI areas create an environment in which fire can move readily between structural and vegetative fuels. Providence and Washington Counties have a large combined WUI area, which could lead to great devastation should a wildfire occur. Intermix WUI are areas where housing and vegetation intermingle (48% of Rhode Island land area), whereas interface WUI are areas with housing in the vicinity of contiguous wildland vegetation (9% of Rhode Island land area).[69] Table 3-33 identifies the WUI and wildland intermix area in square mile per county in Rhode Island. Figure 3-13 presents a map of WUI and wildland intermix areas in the State, identifying the specific geographic areas of higher wildfire risk.

Table 3-33 Wildland Urban Interface Area by County and Zone

County	Intermix Area (Square Mile)	Interface Area (Square Mile)	Total Area (Square Mile)
Bristol	2.85	0	24.72
Kent	78.85	8.49	173.96
Newport	41.02	8.27	107.49
Providence	213.48	34.57	429.95
Washington	185.77	41.13	341.86
Total	521.97	92.46	1077.98

[69] Radeloff, V. C., R. B. Hammer, S. I Stewart, J. S. Fried, S. S. Holcomb, and J. F. McKeefry. 2005. The Wildland Urban Interface in the United States. Ecological Applications 15:799-805.

Figure 3-13 Wildland Urban Interface Zones



3.15.3 Extent

According to the NWS, the elements that make up the criteria of a "Red Flag Warning" for New England are a combination of current meteorological conditions (winds, RH), longer term dryness (rainfall amounts, KBDI) and the vegetation status. When drought or near-drought conditions persist, the potential for wildfire spreading is real. KBDI is an index used to determine forest fire potential. The drought index is based on a daily water balance, where a drought factor is balanced with precipitation and soil moisture (assumed to have a maximum storage capacity of eight [8] inches) and is expressed in hundredths of an inch of soil moisture depletion. The drought index ranges from 0 to 800, where a drought index of 0 represents no moisture depletion, and an index of 800 represents absolutely dry conditions.

"Alarm" systems are also commonly used to describe the severity and level of difficulty to contain a fire, especially among fire departments and news agencies. This scale defines fires as being in a category of 1-alarm, 2-alarm, or 3-alarm. The level of alarm typically designates the amount of response units that have been deployed to contain a fire. The term "multiple-alarm fire" is often used to describe a fire that is severe and difficult to contain. Fires may also be measured in terms of acres burned. Acreage measurements may be estimations in the early stages of response, but are also more accurately measured through infrared scanning, aerial GPS readings, and on-the-ground measurements of the fire perimeter to determine the size and speed of spread of a fire.

The accurate prediction of the potential risk of a fire and the forewarning of dangerous wildfire conditions can help reduce the incidence and seriousness of wildland fires. It can also provide firefighters the critical time needed for important preparation and readiness for wildfire suppression, as well as assist decision makers in the appropriate uses and activities for the public at large during times of extreme fire danger to aid in the prevention efforts.

Climatic and meteorological conditions that influence wildfires include solar insulation, atmospheric humidity, and precipitation, all of which determine the moisture content of wood and leaf litter. Dry spells, heat, low humidity, and wind increase the susceptibility of vegetation to fire. In Rhode Island, common factors leading to large fires include short-term drought, humidity below 20%, and fuel type.

3.15.4 Previous Occurrences

The largest wildfire in Rhode Island was the Coventry Fire, occurring from April 30, 1942, to May 2, 1942, in which 18,000 acres were burned. The most intense fire was the Wood River Fire on May 2, 1951, in which 7,400 acres burned. The worst year for fires was 1930, when 37,400 acres burned.

The most significant urban fire event was the nightclub fire at The Station in West Warwick, Rhode Island on February 20, 2003. The conditions produced by the fire and lack of sufficient exits in the club resulted in 100 deaths and several injuries. This incident prompted a major overhaul in the NFPA policies and standards regarding occupying spaces.[70]

Table 3-34 highlights the number of yearly wildfires and acreage burned in the State since 2010.

[70] National Fire Protection Association, n.d. The Station Nightclub Fire. Retrieved at: http://www.nfpa.org/public-education/by-topic/property-type-and-vehicles/nightclubs-assembly-occupancies/the-station-nightclub-fire

Table 3-34 Yearly Number of Wildfires and Acres Burned in Rhode Island (2017).[71]

Year	Number of Fires	Number of Acres Burned
2010	30	23
2011	30	27
2012	Data not available	Data not available
2013	7	27
2014	1	0
2015	86	132
2016	79	57
2017	31	30

3.15.5 Probability of Future Events

Bristol, Kent, and Providence Counties have a potential probability (between 1% and 49.9% annual probability) of experiencing a fire within the next 12 to 60 months. The remaining Rhode Island counties (Newport and Washington) have a likely probability (between 50% and 89.9% annual probability) of a fire occurring within the next 12 to 60 months.

Drought conditions and other natural disasters increase the probability of wildfires by producing fuel in both urban and rural settings. It can be estimated that Rhode Island will experience one wildland type or natural vegetation fire event every 10 years, or a 10% occurrence annually, which is consistent with a low probability of occurrence.

3.15.6 Vulnerability and Risk Assessment

3.15.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined fire to be a moderate priority hazard in Rhode Island. As described in the profile above, fire events within the state range from potential to likely within the next year to five (5) years. Fire events have a medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries, which translates to approximately 105,937 to 423,748 people in Rhode Island at risk. Hazard magnitude is considered to have limited magnitude including some injuries, short shutdown of critical facilities and infrastructure, and less than 10% of residential and commercial structures damaged from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-35 outlines the hazard rankings for each of the hazard priority criteria related to fire.

[71] National Interagency Fire Center, 2017. *Wildfires by State.* Retrieved from: https://www.iii.org/table-archive/23284

Table 3-35 Fire Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
Kent County								
Newport County	**Likely** *Between 50% and 89.9% annual probability*							**High**
Providence County	**Potential** *Between 1% and 49.9% annual probability*							**Moderate**
Washington County	**Likely** *Between 50% and 89.9% annual probability*							**High**

3.15.6.2 Risk and Vulnerability to People and Property

The effect of fire can extend beyond the initial impact caused by fire damage. Wildfires can affect any type of asset and may threaten major population centers when they break out on the rural-urban fringe. Fires drain state and local resources. There is a fiscal impact on the local government even if costs can be recouped by federal grants.

Rhode Island's agriculture, tourism, and aquaculture are a major component of the local, county, and state economy. Major fires can cause significant impact to those sectors, further draining state resources. Fire-related costs may be attributed to loss of state parks or forests, damage to factories, businesses or agricultural crops, loss or damage to rented homes or apartments, costs associated with fire suppression, and restoration of sensitive habitats and environments. Additionally, fires affecting factories and other structures critical to local industry may have long-lasting economic impacts on the local community, affecting production and revenue as well as available jobs.

Risk and Vulnerability to People (Injuries and Death)

Deaths from fires and burns are the fifth most common cause of unintentional injury deaths in the United States. From 2007 to 2011, home structure fires killed an estimated average of 2,570 people and caused an average of 13,210 reported civilian injuries per year, according to the National Fire Protection Agency. House fires disproportionately injure or kill elderly residents, young children, African Americans, and men, when compared to the rest of the population.[72] People located in an area in the immediate vicinity of a fire face the risk of relocation for unknown periods of time, especially if there is complete destruction of the area.

Injuries or deaths among first responders can also occur. First responders may have to deal with the psychological reactions of the public during an extreme event, such as trauma and shock. Firefighters are at a higher risk of smoke inhalation, burns, and health problems due to working in close proximity to fires and the subsequent smoke.

Fires have also, in the past, injured and killed people in public venues. However, the creation of standard fire codes and evaluation processes for public spaces have significantly reduced the risk of death or injury to the public in the event of a major fire at a public venue.

Beyond the risks presented by fire itself, both urban and wildfires can release toxic components that can cause adverse health effects in people as well as animals. The respiratory and cardiovascular systems are most affected by fire and smoke inhalation, and psychological and psychiatric problems may arise as well due to exposure to the traumatic event. In 2010, Rhode Island was identified as having one of the highest population densities at approximately 1,018 people per square mile.[73] In 2017, Rhode Island's density increased to approximately 1,025 per square mile, posing a greater risk to a fire event.

Risk and Vulnerability to Property (Structures and Facilities)

According to the National Fire Protection Agency, businesses, homes, and other structures are at the greatest risk of fires caused by cooking, heating source or equipment, electrical equipment, lightning,

[72] Ahrens, M., 2014. *Characteristics of Home Fire Victims*. Retrieved at: https://www.nfpa.org/-/media/Files/News-and-Research/Fire-statistics/Victim-Patterns/oshomevictims.ashx?la=en.
[73] United States Census Bureau, 2010. 2010 Census: Population Density Data. Retrieved at: https://www.census.gov/data/tables/2010/dec/density-data-text.html

and wildfires. Buildings without fire suppression (i.e., sprinkler systems) are more vulnerable to fires than those with a fire suppression system. Fires may cause major damage to buildings, farmland, equipment, or other assets. Newport County and Washington County have a higher hazard priority compared to Bristol, Kent, and Providence counties due to the number of facilities located within WUI areas.

Intermix WUI are areas where development and vegetation intermingle, whereas interface WUI are areas with development in the vicinity of contiguous wildland vegetation. An exposure analysis was completed to identify the critical facilities, state-owned assets, and buildings located in the WUI intermix and interface zones. There are a total of 129,234 critical facilities and infrastructure in areas at risk to wildfire (both intermix and interface). Facilities located in both intermix and interface are roughly equal, with interface having slightly more. The transportation sector is heavily impacted, specifically Rhode Island Public Transit Authority (RIPTA), with 843 bus stops at risk. Dams, schools, and emergency services are also significantly impacted. Providence County and Washington County have the most critical facilities and infrastructure in areas at risk, with approximately 52,877 exposed in Providence County and 46,705 exposed in Washington County. The full results of this analysis can be found in Section 3.27.2.

Risk and Vulnerability to Critical Infrastructure

Fire can damage or completely destroy property and critical facilities, as well as lead to interruption of the power, communications, water, and transportation systems. Power infrastructure may be destroyed, causing long-term power outages. Without electricity to fuel pumps, the water supply may also be disrupted. Wildfires may cause trees to collapse and down power lines, causing a disruption even if the powerlines are not directly damaged by the fire.

Similarly, fires may cause damage to communications infrastructure and cause outages until damaged components can be repaired or restored. Communications may also be caused by power outages. Wildfires can also have serious and lasting negative consequences for a water systems' ability to provide clean drinking water to its customers. Ash carrying toxins may contaminate water treatment facilities, in addition to nearby streams and rivers. Additionally, if there are limited quantities available, these systems may need to be preserved to support fire suppression efforts.

Large fires may also interrupt transportation systems such as trains, buses, subways, and cars and bus lines, creating a challenge for public transit, especially during evacuation. Fires may cause damage to roadways, bridges, or other means of transportation. While transportation infrastructure may appear to be intact after a fire, access will still need to be restricted until structural integrity is assessed and confirmed. In the event of a wildfire, forest damage from fires may block interior access roads and fire breaks.

3.15.6.3 Risk and Vulnerability to the Environment

Fires can cause significant impact to the environment by spreading pollution, creating health problems, carrying ash and smoke, damaging agricultural crops, and disturbing the wildlife and natural areas. Fires can destroy wildlife habitats and timber and release CO, a key greenhouse gas, into the atmosphere. The effect of fire on the environment may be long-lasting depending on the pre-disaster mitigation efforts.

Water and soil pollution caused by fire can cause longer term threats to human and ecosystem health. Ash carrying toxins from burnt materials, equipment, or other items will be left behind by the fire

and eventually carried by rain into rivers, streams, and manmade drainage systems. Fire damage may also affect soil formation, nutrient cycling, and carbon sequestration and storage. An important component of recovery also includes restoring sensitive habitats and environments that were damaged. Fire changes the ability of the environment to absorb water and increases both the amount and speed of run-off. The lower absorption rate can increase flash flood potential and stream bed degradation or aggregation. Additionally, if a fire impacts a sensitive habitat or environment, additional costs may be associated with the restoration of that habitat.

3.15.6.4 Risk and Vulnerability to State Operations

Disruptions to power, communications, or water services, as well as access to transportation infrastructure, will likely impede state operations in responding to and recovering from fires. Forest damage from fires may block interior access roads and fire breaks, pull down overhead power lines, or damage pavement and underground utilities, thereby creating heavy fire load and making suppression and response more difficult.

Fire, police, and emergency responders are called on to evacuate people from the fire area, close roads, create fire breaks, attend to the injured, and direct traffic away from the area. Injuries or deaths to responders can impact the ability of the state to respond to an incident, as well as affect responder agencies' abilities to conduct daily operations in the future. As noted, firefighters are at a higher risk of smoke inhalation, burns, and health problems because of exposure to fire. They may also witness psychological trauma or suffer from it themselves due to a fire event. This can have long-term impacts on fire departments and state operations.

Damages to communications infrastructure may impede fire suppression, as communications are a critical component of response operations. There may also be an increased demand on health services due to the challenge of access to healthcare facilities by patients with chronic healthcare conditions. This is largely because of traffic congestion caused by people evacuating, or because of the fire itself, which restricts access routes to hospitals and other healthcare facilities.[74]

Fires can cause disruption of services in the event of an urban or wildfire in the impacted area. If a fire does occur, the ability to deliver goods and services efficiently will be impacted locally, regionally, or statewide depending on the magnitude of the event and level of service disruptions. Normal operations would be affected and could lead to a reduced level of service provision or inability to provide certain services. Goods and facilities may also be damaged or destroyed by fire, smoke, or extremely high temperatures.

[74] Finlay, S. E., Moffat, A., Gazzard, R., Baker, D., & Murray, V. (2012). Health Impacts of Wildfires. PLoS Currents, 4, e4f959951cce2c. http://doi.org/10.1371/4f959951cce2c

3.16 Flood

3.16.1 Description

A flood is defined by the NFIP as:

- A general and temporary condition of partial or complete inundation of two (2) or more acres of normally dry land area or of two (2) or more properties from: overflow of inland or tidal waters; unusual and rapid accumulation or runoff of surface waters from any source; or a mudflow; or
- The collapse or subsidence of land along the shore of a lake or similar body of water as a result of erosion or undermining caused by waves or currents of water exceeding anticipated cyclical levels that result in a flood as defined above.

Floodplains, by their very nature, are the low, flat, periodically flooded lands adjacent to rivers, lakes, and oceans, and are subject to geomorphic (land-shaping) and hydrologic (water flow) processes. It is only during and after major flood events that the connections between a river and its floodplain become more apparent. These areas form a complex physical and biological system that not only supports a variety of natural resources, but also provides natural flood and erosion control. In addition, the floodplain represents a natural filtering system, with water percolating back into the ground and replenishing groundwater. When a river is divorced from its floodplain with levees and other flood control structures, the natural benefits are either lost, altered, or significantly reduced.

Floods are measured by the crest height of the water, how many feet over the flood stage it has reached, and the recurrence interval. High tide flooding, also known as "nuisance" flooding, leads to public inconveniences such as road closures. Nuisance flooding has significantly increased along the northeast coast of the United States as sea level continues to rise. More intense rainfall, as a result of climate change, is likely to increase the magnitude of flash flooding, particularly in urban environments.

3.16.1.1 Riverine Flooding

Riverine flooding is a function of precipitation levels (both rain and snow) and water runoff volumes within the stream or river. Riverine flooding is defined as the periodic occurrence of overbank flows of rivers or streams resulting in partial or complete inundation of the adjacent floodplain. The recurrence interval of a flood is defined as the average time interval, in years, expected to take place between the occurrences of a flood of a particular magnitude and an equal or larger flood, or more accurately by the annual chance of the occurrence of that magnitude of flood. Floods with a higher magnitude typically are referenced by their statistical recurrence interval. Flooding at the 1%-annual-chance (100-year) level is higher than at the 4%-annual-chance (25-year) level for the referenced location. When land next to or within the floodplain is developed, these cyclical floods can become costly and hazardous events.

3.16.1.2 Flash Flooding

A flash flood is the fastest-moving type of flood. It happens when heavy rain collects in a stream or gully, turning the normally calm area into an instant rushing current. Any flood involves water rising and overflowing its normal path. A flash flood is a specific type of flood that appears and moves quickly across the land, with little warning, making it very dangerous.

Flash floods are the result of heavy rainfall concentrated over one area. Most flash flooding is caused by slow-moving thunderstorms, thunderstorms that repeatedly move over the same area, or heavy rains from hurricanes and tropical storms. Dam failures can create the most damaging flash flood events. A dam failure occurs when a dam or levee breaks, suddenly releasing a large quantity of water downstream. The force of this water release can destroy structures in its immediate path and cause flash flooding in surrounding areas. The best response to any signs of flash flooding is to move immediately and quickly to higher ground.

3.16.1.3 Urban Flooding

Urban flooding occurs when water flows into an urban area faster than it can be absorbed into the soil or stored in a lake or reservoir. Flash flooding, coastal flooding, river floods, and rapid snow melt can all cause urban flooding. Increased development in the floodplain can increase the frequency of urban flooding because of the increase in pavement and therefore decrease in soil area for water to absorb into.

In Rhode Island, flooding in urban areas occurs frequently in cities adjacent to waterbodies. A lot of the state's cities were established during times when waterways were used for transportation. Sites adjacent to rivers and coastal inlets provided convenient places to ship and receive commodities. Floodways and wetlands, which are the natural storage basins for flood waters, were filled to accommodate development. Urbanization can decrease the permeable area in a city. As a result, stormwater has less places to go and can overwhelm insufficient drainage systems, leading to urban flooding. Often, when heavy rains occur, Rhode Island's aging sewer systems are overrun, resulting in raw sewage flowing into Narragansett Bay, often creating bay closures to shell fishing and swimming.

3.16.1.4 Coastal Flooding

Coastal flooding is typically a result of storm surge and wind-driven waves that erode the coastline. These conditions are produced by hurricanes or tropical storms during the summer and fall, and Nor'easters and other large coastal storms or extra-tropical storms during the fall, winter, and spring. Storm surges may overrun barrier islands and push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff. Thousands of acres of crops and forest lands may be inundated by both saltwater and freshwater. Escape routes, particularly from barrier islands, may be cut off quickly, stranding residents in flooded areas and hampering rescue efforts.

High tides also cause "nuisance" coastal flooding. When severe flooding events occur along coastal areas during times of high tides, this can greatly increase the amount of flooding. Moreover, as SLR occurs, this can make high tide flooding more frequent and destructive.[75]

3.16.1.5 FEMA Risk Mapping, Assessment, and Planning

According to FEMA, a floodplain is any land area susceptible to being inundated by floodwaters, from any source. Through their Risk Mapping, Assessment, and Planning (Risk MAP) program, FEMA works with state and community partners to assess these flood risks and create maps and data products that display the flood risk in any given area. This flood hazard mapping is a key part of the

[75] NOAA, n.d. What is high tide flooding? Retrieved at: https://oceanservice.noaa.gov/facts/high-tide-flooding.html.

NFIP because these maps, called FIRMs, serve as the basis for the NFIP regulations and flood insurance purchase requirements.

To establish floodplains, FEMA adopted the Base Flood Elevation (BFE), which is the computed elevation to which floodwater is anticipated to rise during a base flood, which has a 1% chance of occurring in any given year. The BFE establishes the regulatory requirement for the elevation or floodproofing of structures, and the relationship between the BFE and a given structure's elevation determines the flood insurance premium through the NFIP.

The area inundated by the base flood is commonly referred to as the Special Flood Hazard Area (SFHA), the 1%-annual-chance flood, or the 100-year flood. The FIRM depicts the SFHA, including the 1%-annual-chance flood. These areas are labeled on the map as Zone A, Zone AE, Zone AH, Zone AO, and Zone VE. Areas protected by a levee are displayed in red. The table below summarizes these different flood zones (as well as zone designations not found in Rhode Island) and describes the type of flooding that causes each.

Table 3-36 FEMA Flood Zone Designations[76]

Zone	Description
C and X	Area of minimal flood hazard usually depicted on FIRMs as above the 0.2%-annual-chance flood level. Zone C may have ponding and local drainage problems that don't warrant a detailed study or designation as base floodplain. Zone X is the area determined to be outside the 0.2%-annual-chance flood and protected by levee from 1%-annual-chance flood.
B and X	Area of moderate flood hazard, usually the area between the limits of the 1%- and 0.2% annual-chance floods. B Zones are also used to designate base floodplains of lesser hazards, such as areas protected by levees from the 1%-annual-chance flood, or shallow flooding areas with average depths of less than one (1) foot or drainage areas less than one (1) square mile.
A	The 1%-annual-chance or base floodplain. There are six (6) types of A Zones.
AE	The base floodplain where base flood elevations are provided.
AH	Shallow flooding base floodplain. BFEs are provided.
AO	The base floodplain with sheet flow, ponding, or shallow flooding. Base flood depths (feet above ground) are provided.
AR	The base floodplain that results from the decertification of a previously accredited flood protection system that is in the process of being restored to provide a 1%-annual-chance or greater level of flood protection.
A99	Area to be protected from base flood by levees or Federal Flood Protection Systems under construction. BFEs are not determined.
V	The coastal area subject to a velocity hazard (wave action) where BFEs are not determined on the FIRM.
VE	The coastal area subject to a velocity hazard (wave action) where BFEs are provided on the FIRM.
D	Area of undetermined but possible flood hazards.

[76] FEMA, n.d. Managing Floodplain Development Through the NFIP. Retrieved at: https://www.fema.gov/flood-zones.

3.16.2 Location

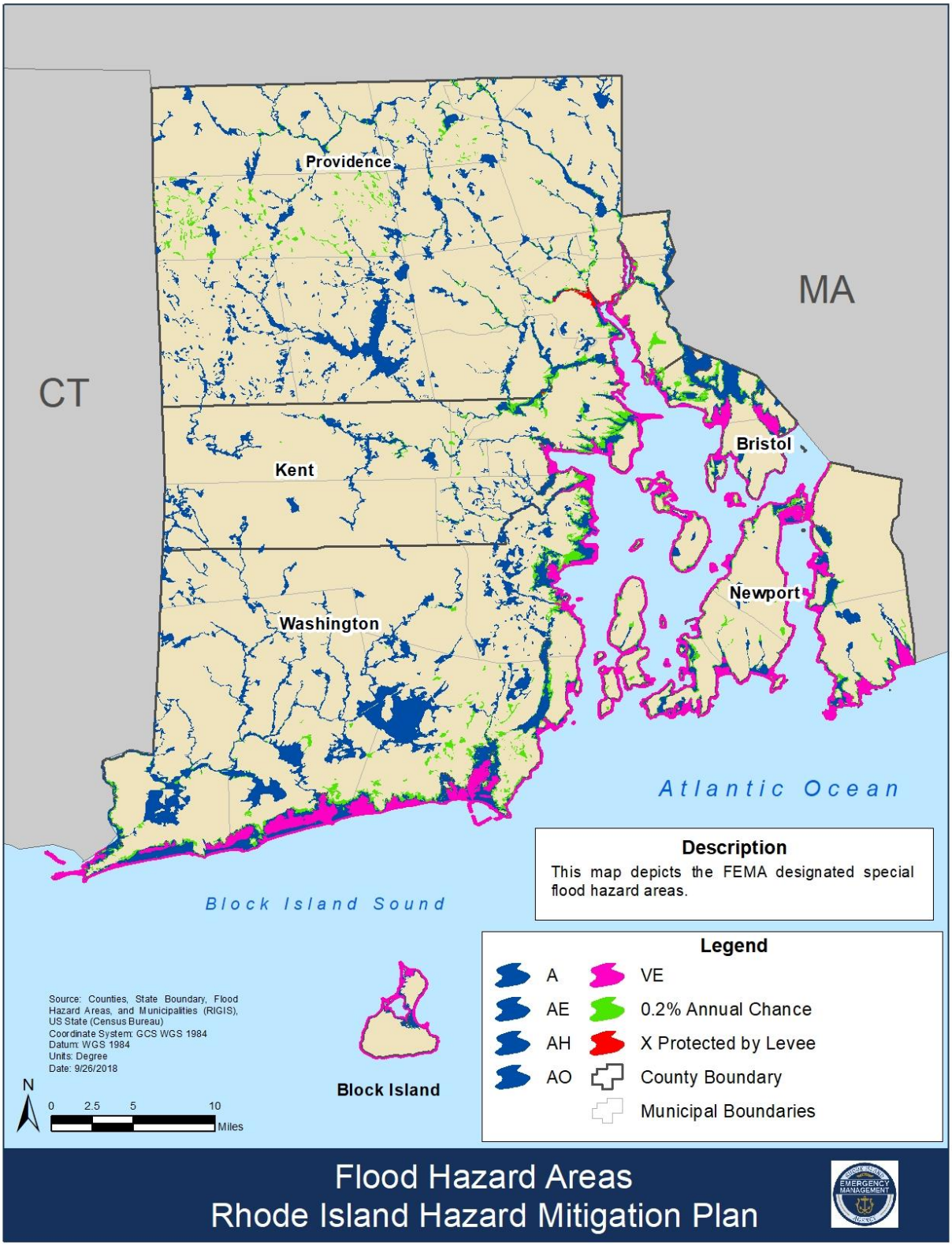
In general, the location of flood events varies by type of flooding. Coastal areas are most at risk from flooding caused by hurricanes, tropical storms, and nor'easters. Low-lying coastal areas in close proximity to the shore, sounds, or estuaries are exposed to the threat of flooding from storm surge and wind-driven waves, as well as from intense rainfall. Areas bordering rivers may also be affected by large discharges caused by heavy rainfall over upstream areas. Urbanized and inland areas with poor drainage capabilities are most at risk from flash flooding caused by intense rainfall over short periods of time. Stream flow tends to increase rapidly. Large amounts of impervious surfaces in urban areas increase runoff amounts and decrease the lag time between the onset of rainfall and stream flooding. Human-caused channels may also constrict stream flow and increase flow velocities.

All Rhode Island communities are subject to some type of flooding. Table 3-37 summarizes the total area within each type of flood hazard area while Figure 3-14 shows the flood hazard areas within the state. Washington County contains over 40% of the state's floodplains, followed by Providence County with 31%.

Table 3-37 FEMA SFHA within Jurisdictions by Flood Zone

County Name	Zone A (sq. mi)	Zone AE (sq. mi)	Zone AO (sq. mi)	Zone AH (sq. mi)	Zone VE (sq. mi)	Zone X 0.2%-annual-chance area (sq. mi)	Zone X Levee (sq. mi)
Bristol	0.080	7.614	0.002	0.000	3.872	3.205	0.000
Kent	6.520	8.255	0.007	0.000	4.066	3.161	0.024
Newport	1.817	5.827	0.000	0.000	23.525	4.289	0.000
Providence	24.853	13.300	0.000	0.008	2.525	5.985	0.652
Washington	30.463	20.673	0.000	0.000	21.205	10.002	0.000

Figure 3-14 FEMA SFHA in Rhode Island by Flood Zone



Riverine flooding in Rhode Island may be associated with hurricanes, the aftermath of winter storms, spring snow melts combined with heavy rains, or may take place independently of major storm activity. The Blackstone River Basin and the Pawtuxet River watershed of Narragansett Bay Drainage Basin have had long histories of flooding, with records dating as far back as 1818.

Specific areas prone to riverine and urban flooding include:

- **Pawtuxet River:** The Pawtuxet River runs through the communities of Coventry, Warwick, West Warwick, and Cranston. Frequent flooding occurs, due to the river's shallow depths from sediment buildup, increased development, lack of pervious surface, and other localized drainage issues. The Pawtuxet River experienced the most significant flooding in recorded history during the March 2010 floods. Flood levels hit historic levels, with a record of 20.79 feet observed at the Cranston USGS river gage on March 31, 2010.
- **Pawcatuck River:** The Pawcatuck River and tributaries run west to east through the southern reaches of the state, including portions of Westerly, Richmond, and North Kingstown. There is limited development in these areas; however, during significant flood events, flooding damages do occur. The Pawcatuck River experienced the most significant flooding in recorded history during the March 2010 floods. Flood levels hit historic levels, with a record of 15.38 feet observed at the Westerly and 11.16 feet observed at the Wood River Junction USGS river gages on March 31, 2010, as well as 13.72 feet observed at the Wood River at Hope Valley USGS river gage on March 30, 2010. Sewer plants in West Warwick and Warwick sustained $23 million in damages collectively, business and homes were flooded, and I-95 was shut down in addition to many other local roads in the state.[77]
- **Woonasquatucket River:** The Woonasquatucket River runs from Smithfield to Providence. The areas surrounding this river are densely populated and developed with a combination of mixed-use lots, including residential and commercial properties.
- **Blackstone River:**[78] The Blackstone River forms in Worcester, Massachusetts and then follows a southeast course through Woonsocket, Cumberland, Lincoln, Central Falls, and Pawtucket, where the river reaches Pawtucket Falls before becoming tidal and turning into the Seekonk River. During late March through early April 2010, pre-existing elevated river levels and saturated soil conditions combined with heavy rainfall caused significant flooding along the river in northern Rhode Island. The flooding of 2010 caused flooding on many roads, as well as in business and residential areas in the Cumberland, Lincoln, and Pawtucket areas.
- **Natick Area:** Natick is an area located within the Town of West Warwick. This area is relatively flat and has a combination of mixed-use structures, including commercial, industrial, and residential. Natick was hit incredibly hard during the March 2010 floods. NFIP staff assisted with building inspections, technical support, and site visits after the flood receded.
- **East Providence:** There are several low-lying areas in East Providence that routinely get flooded, including Riverside and Marsh Street off Waterman Avenue. Marsh Street and the surrounding area are adjacent to freshwater wetlands, which fill up and create a "bathtub" effect during significant rain events.

Beavertail Road at Mackerel Cove, Matunuck Beach Road, and Arnolds Neck Road are examples of coastal flood prone coastal access routes. Areas vulnerable to coastal flooding include Nausauket,

[77] Johnston, Stephanie. (March 27, 2017). Remembering the historic floods of 2010. WPRI. Retrieved at: https://www.wpri.com/community/green-team/remembering-the-historic-floods-of-2010_20180314123702244/1044139385
[78] USACE, 2012. Blackstone River Flood Risk Management Feasibility Study. Retrieved at: http://www.nae.usace.army.mil/Missions/Projects-Topics/Blackstone-River-Flood-Risk-Management/

Oakland Beach, Buttonwoods, and Conimicut in Warwick, the Port of Providence area, the Newport Harbor area, Narragansett Bay, the Bristol Harbor, and New Shoreham.

3.16.3 Extent

Even though there is no universally accepted scale for flooding, given previous occurrences in Rhode Island, the magnitude of a future hazard event could be as severe as the water height measured and inundation experienced during the 2010 floods. The Pawtuxet River at Cranston rose to 20.79 feet, breaking several records during the series of rain events during the month of March. Inland areas are most at risk from flash flooding caused by intense rainfall over short periods of time. Cranston, Warwick, West Warwick, Westerly, and Coventry experienced the most severe flash flooding in 2010. Portions of the state also experienced flooding equivalent to the 0.2%-annual-chance and the 1%-annual-chance event.

Populations and property are extremely vulnerable to flooding. Homes, businesses and industry may suffer damage and be susceptible to collapse due to heavy flooding. Floodwaters can carry chemicals, sewage, and toxins from roads, factories, and farms; therefore, any property affected by the flood may be contaminated with hazardous materials.[79] Debris from vegetation and man-made structures may also be hazardous following a flood. In addition, floods may threaten water supplies and quality, and initiate power outages.

In the future, climate change will cause more intense rainfall which is likely to increase flood crest elevations and frequency of flooding, particularly in urban environments. It is estimated that rainfall could increase by roughly 18% to 20% between 2018 and 2099.[80] Similarly, Rhode Island is likely to experience more extreme precipitation events per year (one [1] inch in 24 hours or two [2] inches in 48 hours).[81]

3.16.4 Previous Occurrences

Flooding is the most prevalent and frequent natural hazard that impacts the state. Though there is no distinct flood season in Rhode Island and major river flooding can occur in any month of the year, studies have identified three (3) prevalent times throughout the year that are more prone to flood activity:

- Late winter/spring
- Late summer/early fall
- Early winter

According to FEMA's disaster declaration database, Rhode Island has experienced 22 disaster or emergency declarations, with 12 of them related to severe flooding and hurricanes.[82] Flood events

[79] For more information on management of flood and wastewater, please consult the Rhode Island DEM Wastewater Study (http://cels.uri.edu/rinemo/publications/WW.CreativeDesignAndManagement.pdf)
[80] Rhode Island Executive Climate Change Coordinating Council, 2017. *RIEC⁴ Annual Report*. http://climatechange.ri.gov/documents/ec4ar17.pdf
[81] Rhode Island Executive Climate Change Coordinating Council, 2017. *RIEC⁴ Annual Report*. http://climatechange.ri.gov/documents/ec4ar17.pdf
[82] FEMA, n.d. Disasters. Retrieved at: https://www.fema.gov/disasters?field_state_tid_selective=34&field_disaster_type_term_tid=All&field_disaster_declaration_type_value=All&items_per_page=60#

have caused significant damage and impact to Rhode Island. Several historic events are described below:

- In August 1955, record flooding along the main rivers in the Blackstone River Basin in Rhode Island and Massachusetts, as well as the Thames River Basin (predominantly in Connecticut), occurred, resulting from torrential rainfall accompanying Hurricane Diane. Damages from the 1955 flood were estimated at approximately $28 million for Rhode Island, with the Woonsocket area hardest hit in the state. Except for a small local protection project in Blackstone, Massachusetts, there were no federal flood control projects in operation at the time of the flood. Subsequently, two (2) projects in Rhode Island, for Upper and Lower Woonsocket, and two (2) projects in Massachusetts were constructed for Blackstone River Basin flood protection. The USACE estimates that these projects prevented about $8 million in damages during the March 1968 flood.
- Prior to the 2010 floods, the March 1968 flood constituted as the record flood in the state. The March 1968 flood resulted from heavy rainfall that followed a period of sustained snowmelt, which had caused stream flows to be significantly above normal.
- In January 1979, flooding in the Belmont Park area, a residential section built in and adjacent to a flood hazard area in Warwick, occurred when a combination of above-normal temperatures and rainfall caused the Pawtuxet River to overflow its banks, inundating about 30 acres of land in Belmont Park. Flooding had worsened with increased upstream development. To prevent repeated flooding, some 60 homes were purchased and demolished. Currently, frequent flooding of the Pawtuxet River in the Natick Flats section between Warwick and West Warwick have been investigated for potential flood control measures by the USACE.
- In March 2010, Rhode Island encountered the worst flooding in its recorded history on a number of the state's largest rivers including, but not limited to, the Pawtuxet, Pawcatuck, and Woonasquatucket. The sizable amount of precipitation in February and March 2010, along with saturated soils, high water tables, lack of leaf cover, and limited pervious surfaces all contributed to the disastrous March floods. The hardest hit areas in the state included Warwick, West Warwick, Coventry, and Cranston, which are located around the Pawtuxet River, and Westerly, which is located along the Main Stem Pawcatuck River. The USGS river gage at the Pawtuxet River in Cranston hit Record Flood Stage at 14.98 feet on March 15, 2010. This record was quickly superseded by another Record Flood Stage of 20.79 feet on March 31, 2010. Prior to these two (2) back-to-back Record Flood Stages, the highest recorded level of the Pawtuxet River at Cranston was 14.5 feet on June 7, 1982.
- On August 27, 2011, Tropical Storm Irene, DR-4027 (EM- 3334), hit Rhode Island. A major disaster was declared on September 3, 2011. A preliminary damage assessment report from FEMA brought the total PA cost to $9,260,898. Reports estimated that up to half of Rhode Island residents were left without power after Irene knocked down trees and power lines. The majority of damage was caused by wind, with reported wind gusts up to 71 mph, as well as storm surge causing coastal damage in Narragansett Bay. More than $8.3 million in PA grants were approved, $7.8 million of which was for emergency work.[83]
- In October 2012, Hurricane Sandy, DR-4089 (EM- 3355), hit Rhode Island. A major disaster was declared on November 3, 2012. Hurricane Sandy provides an example of a storm that caused a major flooding event due to coastal flooding.[84] Beaches along Westerly, including

[83] FEMA, 2011. Rhode Island Tropical Storm Irene. Retrieved at: https://www.fema.gov/disaster/4027.
[84] Salt Pond Coalition, n.d. Examining the Impacts of Hurricane Sandy on Southeast New England. Retrieved at: http://www.saltpondscoalition.org/OtherDocs/Vallee_SPC_StormsRI.pdf.

Misquamicut, were devastated and almost unrecognizable.[85] More than 122,000 people lost power.[86]More than $8.6 million in PA grants were approved for state and local agencies and some private nonprofits.[87]In addition, 105 Individual Assistance applications were approved and over $421,000 in grants paid directly to eligible individuals and families to meet basic needs for housing and cover other essential disaster-related expenses.[88]

Flooding is often a result of the occurrence of other natural hazards, such as hurricanes and tropical storms, winter and coastal storms, ice jams, dam failures, and severe precipitation events. Rhode Island has historically experienced all these natural hazards at one time or another and can expect to experience them in the future. According to NCEI records, there have been 229 flood events in Rhode Island since January 1993 (Table 3-38). These events resulted in a total of $106.7 million in estimated property damages.

Rhode Island can expect between an estimated zero (0) to five (5) flood events per year, which can be related to a highly likely probability of occurrence. Providence County has experienced the most flood events in the state and is predicted to continue to experience upward of three (3) events per year. Table 3-38 also summarizes the annualized events, which was used as a quantitative ranking for determining probability of future events.

Table 3-38 NCEI Flood Events (1996 – 2018)[89]

Jurisdiction	Number of Events	Annualized Events	Property Damages	Annualized Damages
Bristol	25	1.09	$6,234,000.00	$271,043.48
Kent	49	2.13	$27,872,000.00	$1,211,826.09
Newport	20	0.87	$6,635,000.00	$288,478.26
Providence	99	4.3	$32,580,000.00	$1,416,521.74
Washington	36	1.57	$33,427,000.00	$1,453,347.83

3.16.5 Probability of Future Events

Based on historical occurrences and an understanding of floodplains, Rhode Island will continue to experience flood events on an annual basis. FEMA's FIRMs do not take into consideration climate change or SLR, therefore they only provide a baseline understanding of the location of future flood events that have 1%-annual-chance and 0.2%-annual-chance of occurring. Nevertheless, these maps should be consulted for development and planning to understand the areas that have a future chance of flooding. Figure 3-14 summarizes the location of these flood zones in Rhode Island.

[85] MassLive, 2012. Hurricane Sandy leaves beaches along Westerly, R.I. shore, including Misquamicut, devastated and nearly unrecognizable. Retrieved at: http://www.masslive.com/news/index.ssf/2012/10/hurricane_sandy_leaves_beaches.html
[86] CBS News, 2012. A state-by-state look at superstorm's effects. Retrieved at: http://www.cbsnews.com/8301-201_162-57544801/a-state-by-state-look-at-superstorms-effects/.
[87] FEMA, 2012. Rhode Island Hurricane Sandy. Retrieved at: https://www.fema.gov/node/325389.
[88] FEMA, 2012. Rhode Island Hurricane Sandy. Retrieved at: https://www.fema.gov/node/325389 .
[89] NCEI, n.d. Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=44%2CRHODE+ISLAND.

3.16.6 Vulnerability and Risk Assessment

3.16.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined flooding to be a high priority hazard in Rhode Island. As described in the profile above, flood events within the state are highly likely within a given year. Flood events have a medium range of impact, accounting for 10% to 40% of jurisdictional boundaries. Hazard magnitude for flood ranges is considered to have limited magnitude, including minor to some injuries, short duration of shutdown for some critical infrastructure and facilities, and less than 10% of residential and commercial structures damaged from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-39 outlines the hazard rankings for each of the hazard priority criteria related to flooding.

Table 3-39 Flood Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
Kent County			**Limited** *Some injuries*					
Newport County								
Providence County								
Washington County								

3.16.6.2 Risk and Vulnerability to People and Property

All areas of Rhode Island continue to be vulnerable to flooding and the impacts associated with this natural hazard. Rhode Island is a water-rich state, in that it has many rivers, streams, and brooks flowing within and between its boundaries and other states. Past land use patterns and the continued use of structures within areas vulnerable to flooding will continue to promote future risk and vulnerability of flood impacts to structures and people. Local land use regulations and ordinances have done much to curb unregulated development within flood hazard areas. However, Rhode Island is one of the older states in the nation, with limited land resources. This places a high value on all property within the state. The limitation of land availability and high property values will continue to encourage the reuse of land and structures in areas vulnerable to flooding.

Risk and Vulnerability to People (Injuries and Death)

Flooding directly impacts members of the public in a low-lying area or floodplain, typically near a river, lake, or coastal area. Significant flooding events can lead to the damage and loss of homes, property, and businesses, which can impact public morale and safety. Flash flooding and excessive rainfall may lead to dangerous conditions on roadways, as well as create mudslides that may quickly place members of public in dangerous situations.

Closures of primary-care physician offices is a major public health concern if flooding causes the buildings to be uninhabitable. Water sources may also become contaminated with toxic material or human waste, and water or sewer systems may be completely disrupted. Vector-associated problems can increase the risk for some mosquito- borne infectious diseases.

Risk and Vulnerability to Property (Structures and Facilities)

Many factors contribute to the relative vulnerabilities of areas within the floodplain. Population and property in floodplains or areas prone to flooding is a critical factor in determining vulnerability to flooding. Additional factors that contribute to flood vulnerability range from specific characteristics of the floodplain to characteristics of the structures located within the floodplain. Flooding has the potential to cause significant damage and destruction; flood water can transport large objects, structure foundations, or hazmat chemicals downstream.

Extensive flooding may result in road closures and event evacuation of residences and businesses. Depending on the severity of the flood, this could result in structures being uninhabitable, leading to the need to rebuild or relocate. In some cases, businesses may have to close their doors for good. If utilities and infrastructure are damaged, residents and critical facilities would have to look for supplemental power (generators) or water supplies. Roadways would become flooded, possibly resulting in essential facilities becoming isolated or emergency services rerouted in response to calls. A catastrophic flood could lead to injury or death.

Based on NCEI historical data (1996 through 2018), Rhode Island is highly likely to experience between approximately one (1) and five (5) flood events per year accounting for annualized damages between $271,043.48 in Bristol County and $1,416,521.74 in Providence County. Specific areas prone to riverine and urban flooding are summarized in the hazard description section of the flood profile.

FEMA's Hazus flood model software was utilized to estimate damage and losses to buildings, lifelines,

and essential facilities from deterministic (scenario based) and probabilistic flood events. Loss was based on riverine and coastal inundation. The estimated total economic loss by county for a 1%-annual-chance and 0.2%-annual-chance flood event is included in the table below. Due to unforeseen technical difficulties with the Hazus flood module, results could not be produced for Providence County and the results for Washington County were split out by riverine and coastal flooding.

Table 3-40 Total Estimated Economic Loss for 1%- and 0.2%-annual-chance Flood Events

County		Total Economic Loss (Values in Millions of Dollars)	
		1%-annual-chance Flood Hazard	0.2%-annual-chance Flood Hazard
Bristol		$1,255.82	$2,432.97
Kent		$1,086.74	$2,311.18
Newport		$460.89	$927.49
Washington	Riverine Loss	$335.75	$460.66
	Coastal Loss	$10.73	$1,324.51

Based on the analysis, Bristol County is projected to experience the greatest economic loss from a 1%-annual-chance and 0.2%-annual-chance flooding event. Figure 3-16 and 3-17 summarize the estimated losses by block group for both flooding events. Based on the scenarios run, Bristol and Kent county will experience the greatest losses at the block level, while Newport county will experience the most widespread losses.

Figure 3-15 1%-Annual-Chance Flood Estimated Loss by Census Block Group

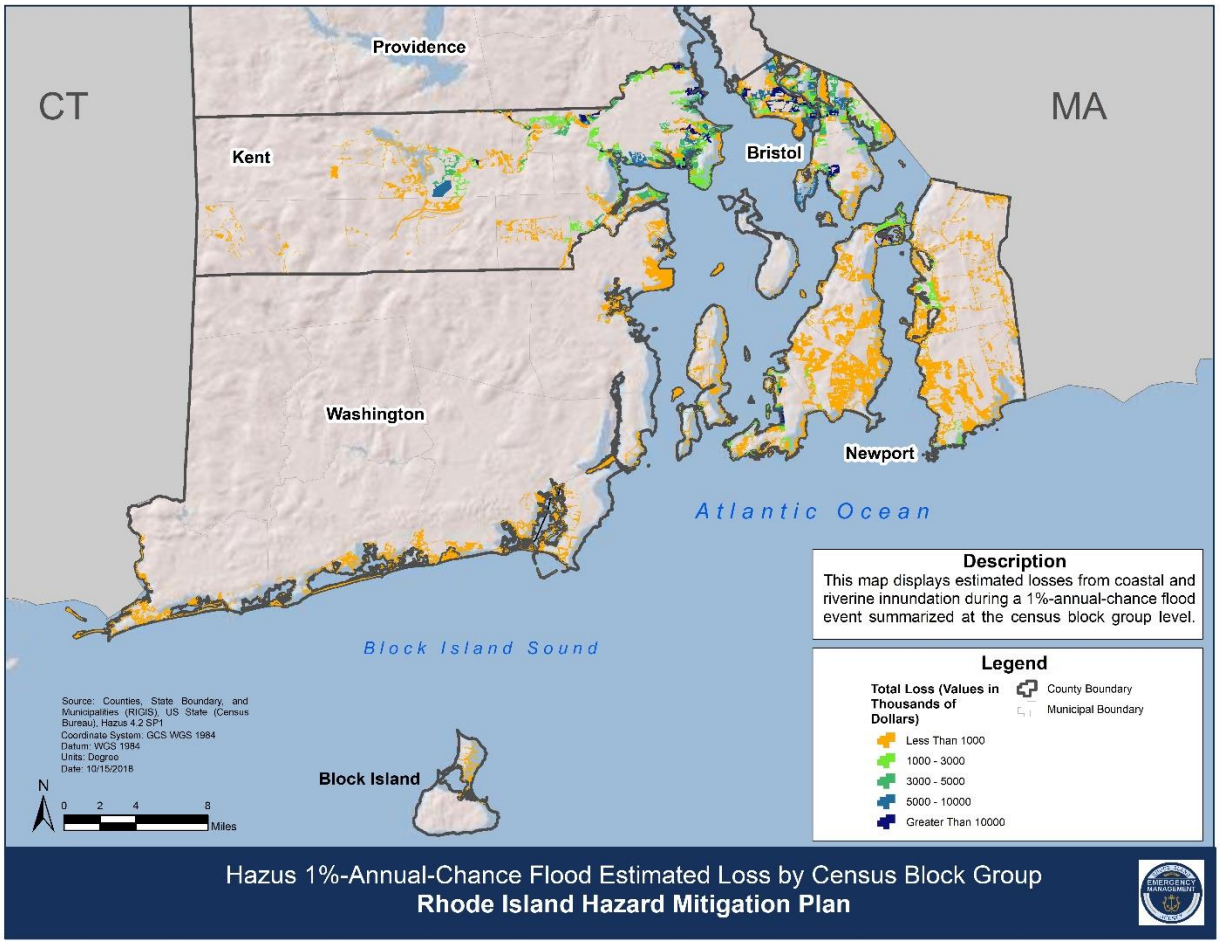
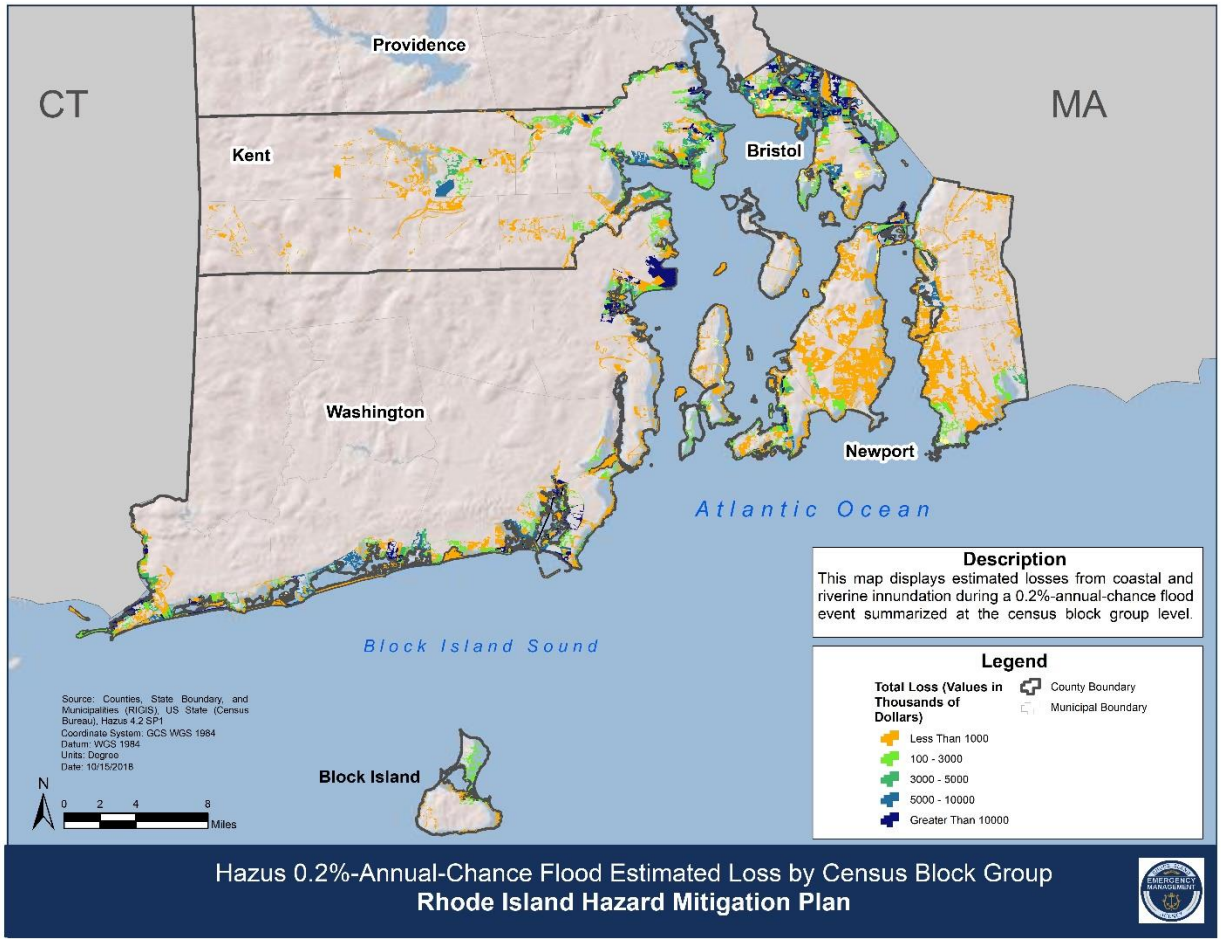


Figure 3-16 0.2%-Annual-Chance Flood Estimated Loss by Census Block Group



In order to determine the number of facilities and structures within the different FEMA's flood zones, the facility and structure points were assigned a 30-foot buffer to resemble the general footprint of a building. Then, the resulting polygon layer was intersected with the NFHL. The results of this exposure analysis are summarized in Section 3.27.2. In total, 30,783 structures and facilities are located in a medium or high-risk flood zone in Rhode Island. Where some facility and structure polygons were located within multiple flood zones, the more conservative zone was assigned. Over 45% of the structures analyzed are located within the 1%-annual-chance flood zone. There are also over 2,300 residential structures that are in a VE zone and are exposed to the 1%-annual-chance flood event with additional hazards due to storm-induced velocity wave action.

In addition to the FEMA SFHA mapping, the Rhode Island Coastal Resources Management Council (CRMC) provides shoreline change maps that show the shoreline rates of change that are applied to the council's regulatory programs to address issues, including setbacks of activities from coastal features. CRMC is also in the process of developing the Coastal Environmental Risk Index (CERI). CERI is a tool that utilizes modeling, combined with shoreline change maps and damage functions, to provide an objective and quantitative assessment of risk.[90]

[90] CRMC, n.d. STORMTOOLS: CERI. Retrieved at: http://www.beachsamp.org/stormtools/stormtools-coastal-environmental-risk-index-ceri/

3.16.6.2..2 National Flood Insurance Program

The NFIP was established in 1968, with the passage of the National Flood Insurance Act, to reduce the loss of life and property associated with flooding while offering property owners an opportunity to financially protect themselves. Participation in the NFIP is based on an agreement between the municipality and the federal government. If a municipality agrees to adopt and enforce a floodplain ordinance designed to reduce future flood risks, all citizens in the participating municipality can purchase flood insurance. Floodplain management begins at the community level with operation of a community program of corrective and preventative measures for reducing flood damage. These measures take a variety of forms; for inclusion in the NFIP, communities adopt their flood hazard maps and the community Flood Insurance Study (FIS), as well as a FEMA-compliant floodplain management ordinance that regulates activity in the floodplain.

Rhode Island has 39 incorporated municipalities, 5 counties, and 1 tribal nation (Narragansett Indian Tribe) that have elected to participate in the NFIP to make federally-subsidized flood insurance available to their residents. Data on active NFIP policies was obtained from FEMA's BureauNet database and is summarized below. Table 3-41 shows the NFIP flood policy and claim information by each participating municipality. There are 13,592 active policies for Rhode Island NFIP communities as of May 2018. Rhode Islanders pay $18.8 million annually in premiums for $3.5 billion in coverage. Since January 1, 1978, there have been 6,508 total losses of more than $121 million. Four (4) municipalities have more than 1,000 insurance policies in force. The average claim payment on active policies is $18,647. The Town of Narragansett in Washington County accounts for nearly 10.8% of the policies in force and 11.4% of the total coverage, followed by the City of Warwick in Kent County that accounts for 10.6% of the policies in force and 8.9% of the total coverage. It should be noted that the information presented here does not consider any of the uninsured losses caused by flooding.

Table 3-41 NFIP Policies and Claims Paid in Rhode Island as of May 31, 2018[91,92]

County	Municipality	Number of Policies In-Force	Coverage Total $	Annual Premium	Number of Claims	Claim Total Value	Average Claim Value $
Bristol	Barrington	1,120	$335,639,900.00	$1,235,823.00	444	$1,686,459.57	$3,798.33
	Bristol	51	$126,985,400.00	$763,865.00	199	$1,440,528.95	$7,238.84
	Warren	418	$85,613,300.00	$585,432.00	137	$1,225,074.18	$8,942.15
Kent	Coventry	190	$52,118,300.00	$139,324.00	74	$1,283,599.98	$17,345.95
	East Greenwich	156	$44,938,500.00	$234,290.00	88	$497,713.24	$5,655.83
	Warwick	1,443	$320,850,000.00	$1,793,643.00	862	$10,893,700.06	$12,637.70
	West Greenwich	13	$3,612,000.00	$5,173.00	2	$10,427.18	$5,213.59
	West Warwick	153	$31,126,500.00	$208,448.00	163	$6,045,254.40	$37,087.45
Newport	Jamestown	230	$67,839,300.00	$203,468.00	59	$242,333.52	$4,107.35
	Little Compton	147	$41,254,700.00	$214,935.00	33	$318,972.48	$9,665.83
	Middletown	115	$39,103,300.00	$171,398.00	51	$269,167.83	$5,277.80
	Newport	1,092	$269,365,800.00	$1,921,548.00	291	$7,068,896.45	$24,291.74
	Portsmouth	622	$149,248,300.00	$1,150,713.00	204	$747,672.27	$3,665.06
	Tiverton	161	$39,847,100.00	$247,227.00	90	$497,552.45	$5,528.36
Providence	Burrillville	53	$14,227,700.00	$37,939.00	18	$117,975.40	$6,554.19
	Central Falls	56	$9,998,800.00	$48,658.00	28	$438,404.47	$15,657.30
	Cranston	431	$122,633,000.00	$556,249.00	495	$14,582,767.21	$29,460.14
	Cumberland	58	$18,139,500.00	$69,930.00	47	$2,642,954.21	$56,233.07
	East Providence	246	$70,899,000.00	$246,973.00	117	$985,326.44	$8,421.59
	Foster	8	$2,432,000.00	$6,391.00	3	$35,025.35	$11,675.12

[91] FEMA, 2018. Policy Statistics. Retrieved at: https://bsa.nfipstat.fema.gov/reports/1011.htm#RIT.
[92] FEMA, 2018. Loss Statistics. Retrieved at: https://bsa.nfipstat.fema.gov/reports/1040.htm#44.

County	Municipality	Number of Policies In-Force	Coverage Total $	Annual Premium	Number of Claims	Claim Total Value	Average Claim Value $
	Glocester	30	$7,640,500.00	$27,301.00	9	$28,913.55	$3,212.62
	Johnston	69	$20,339,400.00	$58,159.00	79	$3,793,866.12	$48,023.62
	Lincoln	233	$60,230,200.00	$84,061.00	60	$1,830,081.28	$30,501.35
	North Providence	62	$17,983,000.00	$42,753.00	129	$1,150,315.09	$8,917.17
	North Smithfield	34	$10,339,400.00	$36,440.00	13	$267,144.67	$20,549.59
	Pawtucket	90	$23,431,100.00	$49,396.00	37	$1,622,558.35	$43,852.93
	Providence	587	$161,164,600.00	$553,898.00	334	$10,478,385.56	$31,372.41
	Scituate	33	$8,103,900.00	$19,144.00	30	$593,410.50	$19,780.35
	Smithfield	153	$29,642,900.00	$81,098.00	30	$321,776.42	$10,725.88
	Woonsocket	166	$38,289,300.00	$114,124.00	7	$67,360.55	$9,622.94
Washington	Charlestown	701	$196,417,500.00	$1,095,902.00	249	$2,962,120.45	$11,896.07
	Exeter	21	$5,706,900.00	$10,590.00	8	$45,407.57	$5,675.95
	Hopkinton	27	$6,273,500.00	$21,189.00	15	$152,241.62	$10,149.44
	Narragansett Indian Tribe	1	$100,000.00	$948.00	0	$0	$0.00
	Narragansett	1,470	$411,426,300.00	$1,736,558.00	479	$8,169,750.50	$17,055.85
	New Shoreham	78	$23,658,200.00	$155,445.00	17	$346,760.24	$20,397.66
	North Kingstown	769	$218,073,000.00	$1,158,835.00	284	$1,664,037.26	$5,859.29
	Richmond	30	$9,469,000.00	$36,350.00	31	$1,689,263.14	$54,492.36
	South Kingstown	850	$223,818,500.00	$1,408,788.00	424	$7,241,272.07	$17,078.47
	Westerly	963	$259,636,900.00	$2,223,025.00	868	$27,905,865.43	$32,149.61
Total		13,592	$3,578,245,800.00	$18,758,943.00	6,508	$121,360,336.04	$18,647.87

To mitigate structures in flood prone areas, FEMA established the Hazard Mitigation Assistance Flood Mitigation Assistance Grant Program to provide funds for local governments to address the most egregious flood-prone properties with the most flood insurance claims.[93] The program features a reduced non-federal match (from 25% to 10%) with an approved mitigation plan that specifies the state's strategy to reduce the number of RL and SRL properties. The amendment authorizes scheduled increases in flood insurance premium rates to actuarial rates for SRL property owners who refuse a formal and complete mitigation grant offer through the SRL grant program to mitigate an SRL structure.

Many flood-insured properties have had more than one (1) claim. A property that is currently insured for which two (2) or more NFIP losses (occurring more than 10 days apart) of at least $1,000 each have been paid within any 10-year period since 1978 is defined as a "repetitive loss property" by the NFIP program.

A SRL property is a single family property (consisting of one [1] to four [4] residences) that is covered under flood insurance by the NFIP and has incurred flood-related damage on four (4) or more separate occasions with the amount of each claim exceeding $5,000 and the cumulative amount of the total claims paid exceeding $20,000; or cumulative amount of the claims exceeds the value of the property, when at least two (2) separate claim payments have been made. In either case, at least two (2) losses must have occurred within a 10-year time span and claims must be more than 10 days apart.

As of July 2018, there were 440 repetitive loss and 10 severe repetitive loss properties in Rhode Island. As of June 2016, here were 1,266 losses involving repetitive loss properties with payouts of $56,619,333.28. The severe repetitive loss properties experienced 52 losses totaling $1,431,774.10 in paid claims.

Table 3-42 includes the number of non-mitigated RL and SRL structures. The City of Cranston in Providence County accounts for approximately 9% of the non-mitigated RL properties, followed by the Town of Westerly in Washington County, and the City of Warwick in Kent County. The City of Warwick has the greatest number of SRL properties.

Table 3-42 Non-Mitigated RL and SRL Properties as of July 31, 2018

County Name	Community Name	Total RL Properties	Total SRL Properties
Bristol County	Barrington	12	0
	Bristol	12	0
	Warren	9	0
Kent County	Coventry	6	0
	East Greenwich	7	0
	Warwick	46	4
	West Warwick	20	0
Newport County	Jamestown	1	0
	Middletown	3	0

[93] FEMA, 2018. Flood Mitigation Assistance Grant Program. Retrieved at: https://www.fema.gov/flood-mitigation-assistance-grant-program.

County Name	Community Name	Total RL Properties	Total SRL Properties
	Newport	20	0
	Portsmouth	7	0
	Tiverton	3	0
Providence County	Burrillville	2	0
	Central Falls	5	0
	Cranston	79	1
	Cumberland	4	0
	East Providence	15	0
	Johnston	13	1
	Lincoln	6	0
	North Providence	19	0
	North Smithfield	2	0
	Pawtucket	4	1
	Providence	26	0
	Scituate	3	0
	Smithfield	1	0
	Woonsocket	1	0
Washington County	Charlestown	10	1
	Narragansett	19	1
	North Kingstown	10	0
	Richmond	1	0
	South Kingstown	25	0
	Westerly	49	1
Total	N/A	440	10

The Community Rating System (CRS) is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. The CRS program emphasizes three (3) goals: the reduction of flood losses, facilitating accurate insurance rating, and promoting the awareness of flood insurance. By participating in the CRS program, communities can earn a 5% to 45% discount for flood insurance premiums based on the activities that reduce the risk of flooding within the community. A point system is used to rate communities based on the level of safety provided with the enforced floodplain management activities. A Class 9 community receives the lowest flood insurance premium discount of 5% while a Class 1 receives a discount of as much as 45%. Currently, eight (8) communities participate in the CRS and receive flood insurance premium discounts. These communities are shown in Table 3-43

Table 3-43 CRS Eligible Community Status as of October 2017[94]

County	Municipality	CRS Entry Date	Current Effective Date	Current Class	% Discount for SFHA	% Discount for Non-SFHA
Bristol	Town of Bristol	5/1/13	5/1/13	8	10	5
Kent	City of Warwick	10/1/15	10/1/15	9	5	5
Newport	Town of Middletown	10/1/91	4/1/00	8	10	5
Newport	City of Newport	10/1/17	10/1/17	7	15	5
Providence	City of East Providence	5/1/14	10/1/17	9	5	5
Providence	City of Pawtucket	10/1/14	10/1/14	8	10	5
Washington	Town of Narragansett	10/1/92	10/1/17	7	15	5
Washington	Town of North Kingstown	10/1/93	10/1/93	9	5	5
Washington	Town of Westerly	5/1/13	5/1/13	8	10	5
Washington	Town of Charlestown	5/1/15	5/1/15	7	15	5

Risk and Vulnerability to Critical Infrastructure

Floods can impact schools, hospitals, and other public infrastructure which impacts the public's ability to use these services. Road infrastructure can be impaired or compromised based on the size and scale of flooding, which can also disrupt transportation infrastructure. Water sources can become contaminated with toxic chemicals, dangerous chemicals, or fecal matter. Because water and sewer systems may be disrupted, solid-waste collection and disposal may also be impacted, causing dangerous public health risks.

Extensive flooding may result in direct damage to critical infrastructure. Road closures and event evacuation of residences and businesses. Depending on the severity of the flood, utilities and infrastructure may be damaged. Flooding may force critical facilities to look for supplemental power (generators) or water supplies. Roadways would become flooded, possibly resulting in essential facilities becoming isolated or emergency services rerouted in response to calls. A catastrophic flood could lead to injury or death.

The devastating floods of 2010 within the state of Rhode Island provide a stark example of how impactful flooding can become. Between February and April of 2010, Rhode Island was soaked by a total of 20.15 inches of rain in just 38 days. This event caused millions of dollars in damage throughout the state, including those caused by failures at wastewater treatment facilities.

[94] FEMA, 2017. Community Rating System. Retrieved at: https://www.fema.gov/media-library-data/1503240360683-30b35cc754f462fe2c15d857519a71ec/20_crs_508_oct2017.pdf.

3.16.6.3 Risk and Vulnerability to the Environment

Rising waters from flooding impact the environment by spreading pollution, inundating water and wastewater treatment plants, carrying debris, and disrupting wildlife and reserve areas. Floods can cause soil erosion along riverbanks and unanticipated pollution, both of which negatively impact the environment in the long and short term. The flooding of farmland can result in the runoff of chemicals and hazardous pesticides into the river causing contamination of rivers and streams. Changes in habitat and food availability due to flooding and subsequent contamination can heavily impact the health of animals, as well as cause death. In addition, the standing water following a flooding event can facilitate the spread of vector-associated issues such as mosquitos, disease, and public health.

3.16.6.4 Risk and Vulnerability to State Operations

Coordinating response to flooding events can be a significant effort by first responders. Fire, police, and emergency responders are often called on to evacuate people from a flood area if flooding is imminent, as well as close roads, pump out flooded basements, attend to the injured, and direct traffic away from the flooded area and roads. First responders may face challenges with transportation and access to a location due to flooded or obstructed roadways. Flash floods and mudslides due to heavy rainfall can delay response operations and put first responders at risk that are performing swift water rescues.

Flooding has the propensity to cause road and bridge closures, as well as disrupt transit service. If any of these shutdowns occur, the ability to deliver goods and services efficiently will be impacted. Exposure to water may also damage or destroy physical goods such as food, clothing, and hygiene products.

Significant and repeated flooding can lower property value throughout the state, which can have a deleterious effect on the tax base. Furthermore, flooding drains response resources, which can be costly during a large flooding event for disaster reimbursement.

3.17 High Winds

3.17.1 Description

Wind is the motion of air past a given point caused by a difference in pressure from one place to another. Severe wind poses a threat to Rhode Island in many forms, including that produced by severe thunderstorms and tropical weather systems. The effects can include blowing debris, interruptions in elevated power and communications utilities, and intensified effects of winter weather. Harm to people and animals, as well as damage to property and infrastructure, may be the result. Two (2) basic types of damaging wind events, other than tropical systems, affect Rhode Island: synoptic-scale winds and thunderstorm winds. Synoptic-scale winds are high winds that typically occur with cold frontal passages or Nor'easters. When thunderstorm winds exceed 58 mph, the thunderstorm is considered severe and a warning is issued.

Straight-line winds from thunderstorms are another type of high wind risk. Unlike tornadoes, straight-line winds move in a straight line, without rotation. Downburst winds, a type of straight-line wind, result from the sudden descent of cool or cold air toward the ground. As the air hits the ground, it spreads outward, creating high winds like those in a thunderstorm. Microburst and macroburst are two (2) other types of straight-line winds. According to the National Severe Storms Laboratory (NSSL), microbursts refers to small, concentrated downbursts that produce strong winds at or near the surface. They typically do not last longer than 10 minutes, are smaller than 4 km in diameter, and have wind speeds up to 100 mph.[95] A macroburst, in comparison, is defined as "an outward burst of strong winds at or near the surface with horizontal dimensions larger than 4 km (2.5 mi) and occurs when a strong downdraft reaches the surface."[96]

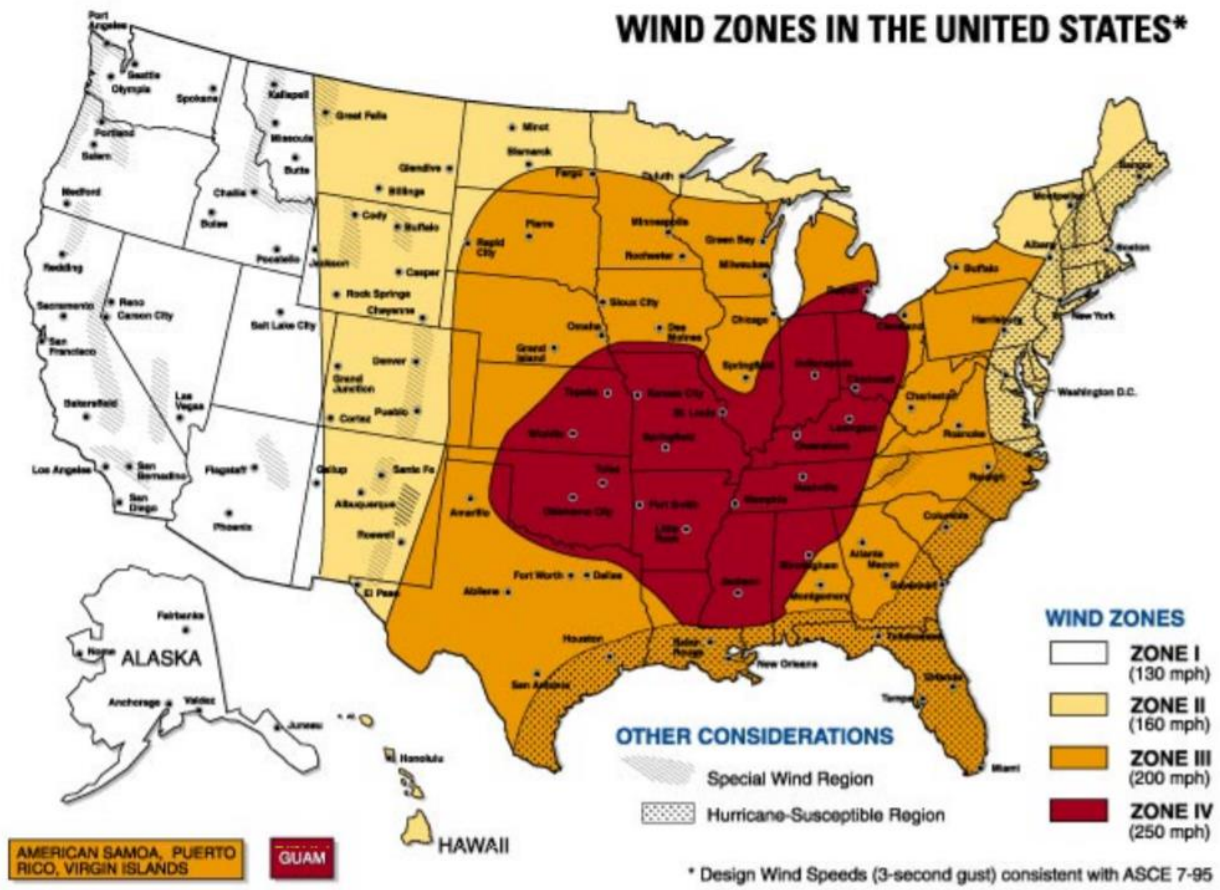
Rhode Island wind events can produce damage often associated with thunderstorms or tornadoes. In some instances, these events have been associated with weakening tropical weather systems, including downgraded tropical and sub-tropical storm systems. This section examines the risks associated with damaging wind events with emphasis on hurricanes, tornadoes, and thunderstorms.

3.17.2 Location

While all areas of Rhode Island are at risk from high speed winds, Washington and Newport counties, near the Narragansett Bay, are within highest wind speed area due to the direct proximity to the coast. Figure 3-17 below outlines the wind zones for the United States, indicating that Rhode Island falls into Zone II (160 mph) in addition to Rhode Island being located in a Hurricane-Susceptible region. Figure 3-18 outlines Rhode Island wind speed zones. The areas with the greatest risk for highest wind speeds (greater than 120 mph), are located within Washington County.

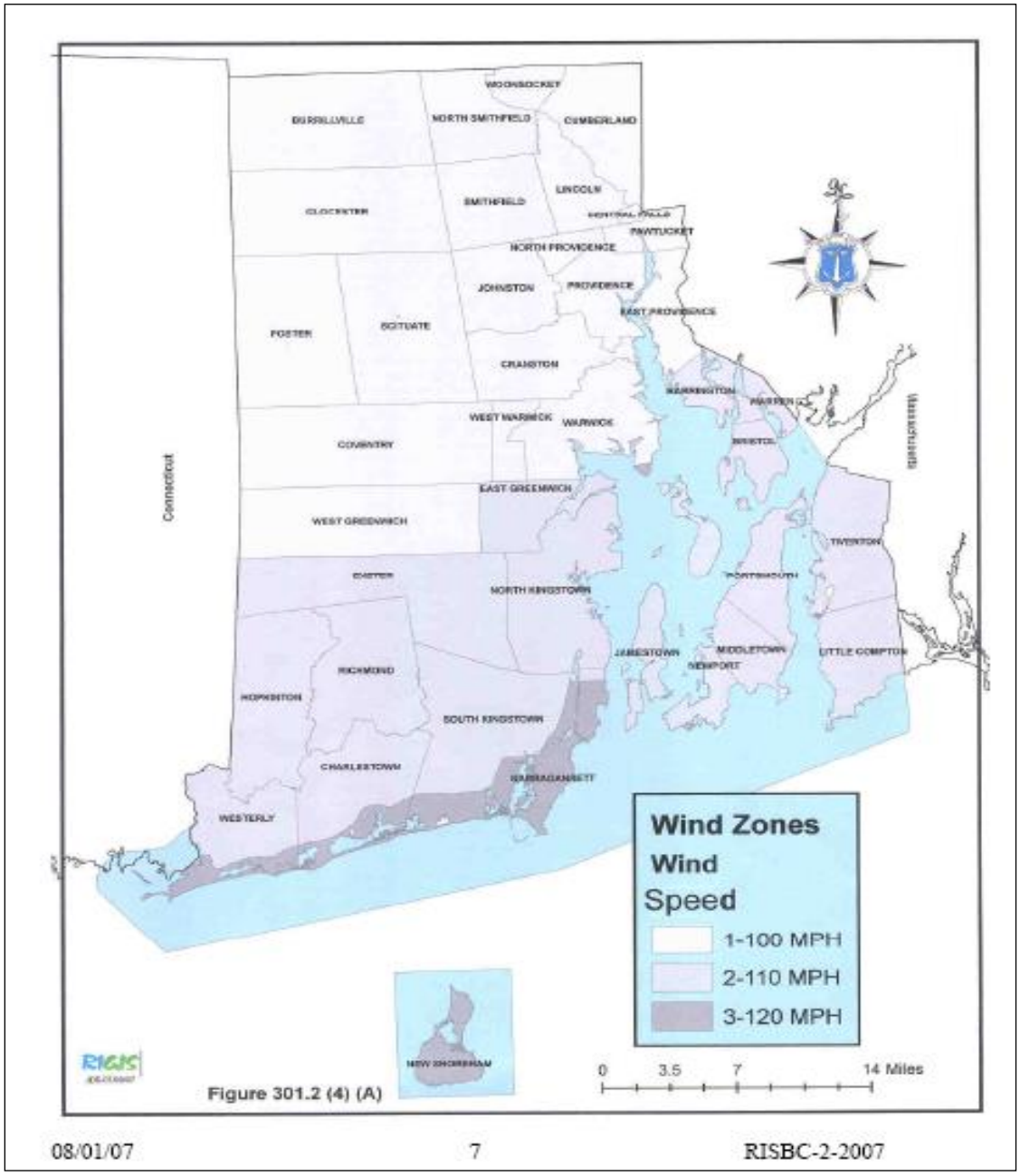
[95] The National Severe Storms Laboratory, Date Unknown. Wind Types. Retrieved at https://www.nssl.noaa.gov/education/svrwx101/wind/types/
[96] The National Severe Storms Laboratory, Date Unknown. Wind Types. Retrieved at https://www.nssl.noaa.gov/education/svrwx101/wind/types/

Figure 3-17 Wind Zones in the United States[97]



[97] FEMA, Date Unknown. "Section 1: Understanding the Hazards." Retrieved at: https://www.fema.gov/pdf/library/ism2_s1.pdf

Figure 3-18 Rhode Island Wind Speed Zones[98]



3.17.3 Extent

The Beaufort Wind Scale, outlined in Table 3-44, measures wind force based on the wind value in knots, the World Meteorological Organization (WMO) classification, and the appearance of wind

[98] RI Secretary of State, 2007. State Building Code. Retrieved at: https://sos.ri.gov/assets/downloads/documents/SBC9-enforcement-and-implementation-procedure-for-projects-under-jurisdiction-of-state-of-RI.pdf

effects. Based on the data presented, the Washington County area is at greater risk for higher force winds. NOAA's NSSL defines damaging winds as those exceeding 50 to 60 mph.[99]

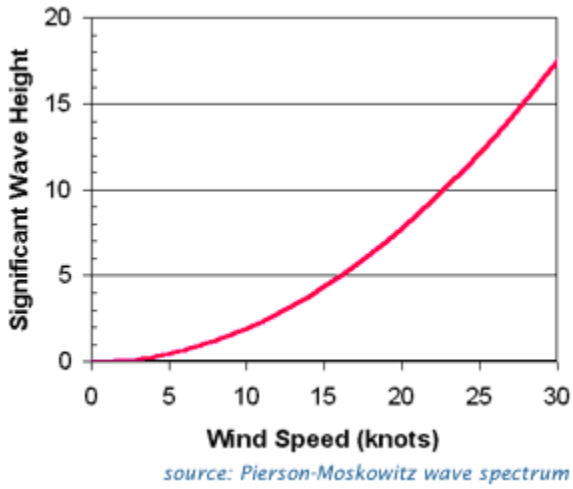
Table 3-44 Beaufort Wind Scale

Force	Wind (Knots)	WMO Classification	Appearance of Wind Effects	
			On the Water	On Land
0	Less than 1	Calm	Sea surface smooth and mirror-like	Calm, smoke rises vertically
1	1-3	Light Air	Scaly ripples, no foam crests	Smoke drift indicates wind direction, still wind vanes
2	4-6	Light Breeze	Small wavelets, crests glassy, no breaking	Wind felt on face, leaves rustle, vanes begin to move
3	7-10	Gentle Breeze	Large wavelets, crests begin to break, scattered whitecaps	Leaves and small twigs constantly moving, light flags extended
4	11-16	Moderate Breeze	Small waves (1-4 feet) becoming longer, numerous whitecaps	Dust, leaves, and loose paper lifted, small tree branches move
5	17-21	Fresh Breeze	Moderate waves (4-8 feet) taking longer form, many whitecaps, some spray	Small trees in leaf begin to sway
6	22-27	Strong Breeze	Larger waves (8-13 feet), whitecaps common, more spray	Larger tree branches moving, whistling in wires
7	28-33	Near Gale	Sea heaps up, waves 13-19 feet, white foam streaks off breakers	Whole trees moving, resistance felt walking against wind
8	34-40	Gale	Moderately high (18-25 feet) waves of greater length, edges of crests begin to break into spindrift, foam blown in streaks	Twigs breaking off trees, generally impedes progress
9	41-47	Strong Gale	High waves (23-32 feet), sea begins to roll, dense streaks of foam, spray may reduce visibility	Slight structural damage occurs; slate blows off roofs
10	48-55	Storm	Very high waves (29-41 feet) with overhanging crests, sea white with densely blown foam, heavy rolling, lowered visibility	Seldom experienced on land, trees broken or uprooted, "considerable structural damage"
11	56-63	Violent Storm	Exceptionally high (37-52 feet) waves, foam patches cover sea, visibility more reduced	Information unavailable
12	64+	Hurricane	Air filled with foam, waves over 45 feet, sea completely white with driving spray, visibility greatly reduced	Information unavailable

[99] The National Severe Storms Laboratory, Date Unknown. Damaging Wind Types. Retrieved at https://www.nssl.noaa.gov/education/svrwx101/wind/

In addition, wind speed can impact wave height (as demonstrated in Figure 3-19). This affects coastal areas where the risk for increased wave height could lead to other cascading effects such as flooding.

Figure 3-19 Pierson-Moskowitz Wave Spectrum



3.17.4 Previous Occurrences

Rhode Island has observed a number of very destructive wind events over the years. The NCEI has recorded 547 high wind events (including high wind, marine high wind, marine strong wind, and strong wind); these events have caused more than $2.8 million in total damages. Some of the most significant high wind events in the state's history are listed in Table 3-45.

Table 3-45 NCEI High Wind Events (1955-2018)

Jurisdiction	Number of Events	Annualized Events	Property Damages	Annualized Damages
Bristol	66	1.03	$110,500.00	$1,726.56
Kent	136	2.13	$692,800.00	$10,825.00
Newport	90	1.41	$497,100.00	$7,767.19
Providence	142	2.22	1,004,400.00	$15,693.75
Washington	113	1.77	$554,900.00	$8,670.31

3.17.5 Probability of Future Events

Historically, wind events have occurred throughout the state, with Providence and Kent counties experiencing the greatest number of events. Based on hazard analysis, Rhode Island is highly likely to experience severe high winds, or those exceeding 50 to 60 mph, with an annual probability of greater than 90%.

Based on historical frequency of occurrence using NCEI data, a reasonable determination of probability of future high wind events can be made. An examination of NCEI data suggests that on an annual basis, approximately one (1) to two (2) wind events occur in any particular county in Rhode Island.

3.17.6 Vulnerability and Risk Assessment

3.17.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined high wind to be a high priority hazard in Rhode Island. As described in the profile above, high wind events within the state are highly likely, meaning that there is a greater than 90% annual probability of a high wind event. High wind events have a medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries. Hazard magnitude for high wind varies and is considered to have limited magnitude, including some injuries, short duration shutdown of critical facilities and infrastructure, and scattered incidental, residential, and commercial structure damages from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be negligible with less than 5% of land and natural resources being impacted by this hazard. Table 3-46 outlines the hazard rankings for each of the hazard priority criteria related to high wind.

Table 3-46 High Wind Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**

3.17.6.2 Risk and Vulnerability to People and Property

The impacts of strong winds on Rhode Island communities can be measured in financial terms, as well as fatalities and injuries. Factors such as location, condition, and maintenance of trees also play a significant role in determining vulnerability.

Risk and Vulnerability to People (Injuries and Death)

Human vulnerability is largely determined by the availability and reception of early warnings for the approach of meteorological events that cause high winds, and by the availability of nearby shelters. Individuals who immediately seek shelter in a sturdy building or metal-roofed vehicle are much safer than those who remain outdoors. Early warnings of high winds are also vital for aircraft flying through the affected area.

An examination of NCEI data shows that wind hazard events contributed to at least 20 injuries in Rhode Island since 1950. Individuals within structures which are not built to standards to protect them against high wind incidents are susceptible to injury and death. Those who are not able to find proper shelter increase that risk and vulnerability considerably. Danger posed by high winds to residents of Rhode Island include flying debris, falling trees, or failure of structures which may collapse causing injury or death to the inhabitants. Windows within structures pose significant risk to inhabitants and should be avoided during high wind events.

Risk and Vulnerability to Property (Structures and Facilities)

Using historical records, it can be estimated that Rhode Island will experience between one (1) and two (2) high wind events in any given year. As presented in the NCEI data, property damage from high wind events can be very costly. Annualized damages range from $1,726.56 in Bristol County to $15,693.75 in Providence County from 1955 to 2018. Within Providence County, Scituate and Pawtucket have experienced multiple wind events of increased size and magnitude, followed by Cranston and Providence. Richmond in Washington County has experienced significant damages due to wind-related events. As previously described, the NCEI loss estimates are only available at the county level and are believed to be an underrepresentation of the actual losses experienced due to hazards, as losses from events that go unreported or that are difficult to quantify are not likely to appear in the NCEI database. This is especially true with crop damages.

All facilities within Rhode Island are considered vulnerable to severe wind. The damages resulting from high winds are impacted by the condition of the exposed structures, their design and construction, and the quality of the building materials. The location and construction of a facility plays a role in how it will be affected by severe wind events. If a tall structure is located on a hilltop, has other tall structures around it, or has large exposed windows, it may be damaged during a wind storm. Communications and power supplies may be compromised during wind events, and some critical facilities might not be equipped with a backup power source. As the facilities data sets are expanded to include construction and value information, analysis to thunderstorms should be reconsidered.

There are 4,028 structures in the RIGIS E911 data categorized as mobile homes, which is the building stock considered most vulnerable. Of these structures, 1,342 are located within Kent County, 946 in Providence County, 927 in Washington County, and 811 in Newport County. The largest concentration of mobile homes is in Coventry, with a total of 1,074 mobile home structures. Table 3-47 summarizes the number of mobile homes by municipality and road names. Mobile homes are

susceptible to high winds because they lack concrete footings and the necessary framework to ensure structural integrity.

Table 3-47 Mobile Home Structures in Rhode Island (E911 Site Type R3)

County	Municipality	Number of Mobile Homes
Bristol	Barrington	0
	Bristol	0
	Warren	0
Kent	Coventry	1,074
	East Greenwich	75
	Warwick	105
	West Greenwich	88
	West Warwick	0
Newport	Jamestown	0
	Little Compton	30
	Middletown	209
	Newport	0
	Portsmouth	279
	Tiverton	293
Providence	Burrillville	206
	Central Falls	0
	Cranston	23
	Cumberland	21
	East Providence	71
	Foster	10
	Glocester	193
	Johnston	18
	Lincoln	62
	North Providence	0
	North Smithfield	0
	Pawtucket	331
	Providence	1
	Scituate	5
	Smithfield	0
	Woonsocket	5
Washington	Charlestown	136
	Exeter	204
	Hopkinton	59
	Narragansett	1
	New Shoreham (Block Island)	0
	North Kingstown	245
	Richmond	118
	South Kingstown	162
	Westerly	2
Total		4,028

Risk and Vulnerability to Critical Infrastructure

High winds can cause minor to extreme damage to property including critical infrastructure, ranging from peeling off surfaces and roofs to total destruction of foundations and steel-reinforced concrete structures. Excessive winds can uproot and topple trees, lift cars, break windows, and knock out powerlines, leading to power outages to critical facilities. Transportation pathways may become obstructed by hazardous and non-hazardous debris, slowing down response and recovery activities. Water systems and reservoirs may become full of debris, leading to an impact on the water supply system. The ability to disrupt the power supply causes a cascading effect in other critical infrastructure, where electricity utilization is critical.

Utility lines, communication towers, and transportation networks can be impacted by high winds or flying debris. While the power of high winds has also been harnessed for renewable energy with the use of turbines, that infrastructure is also susceptible to damage. While these turbines utilize wind, excessive winds may have the ability to damage or destroy the turbines.

3.17.6.3 Risk and Vulnerability to the Environment

High winds can lead to the possibility of hazardous and dangerous chemical release due to high winds dislodging, uprooting, or rupturing pipelines, tanks, and sewage disposal systems which can affect foliage, trees, animals, cars, and structures.[100] These materials are then introduced to the environment and affect waterways, agriculture, public and private spaces, and can affect fragile ecosystems.

Soil loss, particularly in agricultural areas, can also be directly attributable to sustained high winds. The effects of high winds include beach erosion, as well as soil loss and erosion which can damage vegetation and ecosystems reliant on that top soil. The winds can also generate large amounts of dust within the air which is deposited in streams and other areas which may cause an adverse reaction to the environment.

3.17.6.4 Risk and Vulnerability to State Operations

High winds and the direct effect they may have on critical infrastructure and property will have a direct impact on state operations. The ability of first responders to conduct their duties may be hindered by high winds, especially if trees, powerlines, and/or debris have impacted roadways and transit. High winds may also destroy property and resources of first responders. High winds may create power outages that can hinder critical communications, access, or usability of resources. Injuries to first responders and equipment may be caused by flying debris, further challenging response operations.

The delivery of goods and services will be impacted locally, regionally, or statewide if high winds cause powerlines, debris, and woody debris to fall into roadways or other structures, obstructing passage and access. High winds can also damage suspension bridges, as well as cause damage to transport vehicles, loading docks, and goods being transported.

[100] Young, Stacy; Balluz, Lina; and Malilay, Josephine, 2004. "Natural and Technologic Hazardous Material Releases During and After Natural Disasters: A Review" Public Health Resources. 90. Retrieved at http://digitalcommons.unl.edu/publichealthresources/90

3.18 Infrastructure Failure

3.18.1 Description

Infrastructure failure refers to any significant disruption to critical infrastructure that could have cascading effects that negatively impact Rhode Island's security, public health and safety, and economic vitality every day. Rhode Islanders know infrastructure as the power they use in their homes, the water they drink, the transportation that moves them, the stores they shop in, the bridges that connect them, and the communication systems they rely on to stay in touch with friends and family. More broadly, critical infrastructure refers to the assets, systems, and networks, whether physical or virtual, so vital that their incapacitation or destruction would have a debilitating effect on Rhode Island's way of life.

Critical infrastructure is increasingly at risk from a variety of factors—including climate change and extreme weather, aging and failing infrastructure components, cybersecurity threats, pandemics, and acts of terrorism. These threats have evolved over the years, presenting ever-changing challenges. In particular, physical and cyber infrastructure have grown inextricably linked, requiring the implementation of cyber and physical measures to guard against the full array of threats. Furthermore, growing interdependencies between infrastructure sectors and the lifeline functions Rhode Island relies upon increases the possibility of cascading effects if a single sector is disrupted or compromised. Understanding and mitigating these risks is a key element of the state's security, resilience, and economic prosperity.

Though there are 16 infrastructure sectors whose resources and assets are extremely important to the safety, security, and economic well-being of Rhode Island, there are six (6) sectors that Rhode Island designates as "lifeline" sectors.[101]Lifeline sectors are essentially those sectors that are key foundational elements of Rhode Island's infrastructure that provide the ability to remain resilient to the myriad of threats and hazards that could potentially impact the state each year. In line with the National Infrastructure Advisory Council's recommendations to the President, Rhode Island considers the Transportation, Communications, Water/Wastewater, and Energy Sectors as lifelines to resilience. In addition, Rhode Island has adopted the Information Technology Sector and the Emergency Services Sector as two (2) additional lifeline sectors. Ensuring the survivability of these sectors enables Rhode Island to resist or quickly recover from the impacts of catastrophic events. These lifeline sectors impact almost every aspect of daily lives, not to mention the interdependencies they have on all other sectors. Identifying our potential threats, clearly understanding their potential impacts and cascading effects, and working to mitigate those consequences is key prescription toward ensuring Rhode Island's wellbeing. The lifeline sectors Rhode Island has identified as essential are outlined in detail in Table 3-48 below.

[101] Department of Homeland Security, 2013. *Presidential Policy Directive 21.* Retrieved from: https://obamawhitehouse.archives.gov/the-press-office/2013/02/12/presidential-policy-directive-critical-infrastructure-security-and-resil

Table 3-48 Lifeline Sectors Impacted by Infrastructure Failure

Lifeline	Description
Communications	The communications sector includes any services that enable both routine and emergency communications, such as cell towers, phone lines, dispatch systems, radio infrastructure, and satellite communications.
Emergency Services	The emergency services, which include police, fire, emergency management, public works, and emergency medical services life line sectors, provide support to the public during daily response operations. The emergency services sector represents the first line of defense in the prevention and mitigation of risk from hazards such as terrorist attacks, human-caused incidents, and natural disasters. In addition, the emergency services sector has a myriad of specialized capabilities such as hazardous materials response, search and rescue, and tactical teams.
Energy	The energy sector provides power to the community, public and private sectors, government, and first responders. The energy sector is divided into three (3) interrelated segments: electricity, oil, and natural gas.
Information Technology	The information technology sector includes all system networks, hardware, software, information technology systems and services, and the internet.
Transportation Systems	Transportation systems include roadways (federal, state, and local managed), railway (passenger and freight), airports, and marine ports (passenger and freight). Transportation incidents include a large-scale crash, collision, or incident involving the disruption of an air, land (road), rail, or marine mode of transportation. The State of Rhode Island is home to major highways, airports, railroads and marine ports.
Water and Wastewater Systems	Water and wastewater systems ensure the provision of clean water and the treatment of all water and wastewater. Safe drinking water is a prerequisite for protecting public health and all human activity and properly treated wastewater is vital for preventing disease and protecting the environment.

3.18.1.2 Roads, Highways, and Bridges

The quality of roads and bridges can have a significant contribution to the aftermath of a disaster. Poor quality roads and bridges may exacerbate the effects of a disaster or reduce ability to evacuate an area if necessary. Rhode Island has 6,046 miles of public roads and 68 miles of interstate highways, including I-84, I-95, and I-895. Fifty-four percent (54%) of the State's public roads are in poor condition, implying that they have ruts, cracks, and potholes that require maintenance. For major highways and other busy roadways, commercial trucking traffic has caused a majority of existing road damage.

Rhode Island bridges are another piece of critical infrastructure. The state ranks last in the nation in terms of bridge conditions. Of the 1,162 total bridges in Rhode Island, about 22% (256 bridges) are rated as structurally deficient. This accounts for state- and federal-owned as well as privately-owned bridges. The following table summarizes by county the condition of Rhode Island's bridges, excluding those that are privately owned.

Table 3-49 Bridge Conditions by County 201732

County	Bridge Counts				
	All	Good	Fair	Poor	Structurally Deficient
Bristol	8	3	4	1	1
Kent	115	27	67	21	21
Providence	38	8	27	3	3
Newport	473	66	281	126	126
Washington	142	27	85	30	30
TOTALS	776	131	464	181	181

In 2013, Rhode Island spent $93,870,443 on bridge capital projects. The Rhode Island Department of Education (RIDOT) has started or completed reconstruction of 32 structurally deficient bridges and has acted on 77 more to prevent them from becoming structurally deficient since the 2016 passing of the sweeping, $4.9 billion piece of legislation called RhodeWorks, focused on infrastructure management and maintenance.

3.18.1.3 Other Transportation Infrastructure

Rhode Island has six (6) public use airports. The aviation system in the state is owned by RIDOT and managed by the Rhode Island Airport Corporation (RIAC), a quasi-public corporation of the State of Rhode Island. RIAC is responsible for all aviation management, operations, and airport improvement planning.

Rhode Island plays an important role in the overall aviation system of New England. The region is compact, congested, and residents have an "unusually high reliance on air transportation" according to the State of Rhode Island Airport System Plan. The Airport Plan notes that T.F. Green Airport in Warwick, Rhode Island is particularly important in the six (6)-state New England area and plays a substantial role in regional aviation.

In addition to its importance in regional air travel, Rhode Island's Port of Providence is one of the busiest deep-water ports in the northeast. It is one (1) of only two (2) deep water ports in New England and is located at the convergence of Narragansett Bay and the Providence River. The facility offers 4,200 feet of berthing space, 130,000 square feet of covered storage, and provides both domestic and international bulk, break bulk and project cargo clients. Primary imports include petroleum, asphalt, cement, liquefied petroleum gas, coal, aluminum oxide, project cargoes, and road salt.

Despite its large presence in the aviation and shipping industries, due to Rhode Island's small geographic size, it has only 19 miles of freight railroad across the state, ranking it 50th in the nation for total rail miles.

RIPTA provides public transportation via fixed route, flex service, beach bus service, and the paratransit program. RIPTA operates statewide intra- and intercity bus transport from its hubs at Kennedy Plaza in Providence, Pawtucket, and Newport. RIPTA currently operates 58 routes, including daytime trolley service in Providence and Newport. Additionally, the Massachusetts Bay Transportation Authority (MBTA)'s Commuter Rail Providence/Stoughton line links Providence and T.F. Green Airport in Warwick to the City of Boston.

In addition to services provided by RIPTA and the MBTA, Rhode Island is served by Amtrak's *Northeast Regional* and *Acela Express* train lines, which stop at three (3) stations in the state. In 2016, Amtrak estimated the number of local riders at 455,871, and noted that 100% of Rhode Island residents live within 30 miles of an Amtrak station.

Given Rhode Island's coastal geography, ferry transit is popular with residents and visitors alike. Popular ferry services between Providence and Newport resumed in 2016 after a six (6)-year hiatus. Privately run water transit companies including Block Island Ferry, Martha's Vineyard Fast Ferry, and Seastreak Ferries offer daytrips and transit between Rhode Island and locations along the coast.

3.18.1.4 Energy

Rhode Island has high renewable energy potential, particularly from winds along its extensive shoreline and offshore. Like the rest of New England, Rhode Island does not have any fossil fuel energy resources and does not produce crude oil. Rhode Island's electrical grid is part of the larger regional New England power grid, which includes more than 350 generating resources such as natural gas, coal, and oil-fired power plants; hydroelectric dams; nuclear stations; biomass plants; and renewable energy units. The regional grid is composed of 8,000 miles of transmission lines and 6.5 million households and businesses. Three (3) distribution companies operate in the State, the largest being National Grid, which distributes electricity to 99% of the state, serving approximately 486,000 customers with more than 6,000 miles of distribution lines. The other two (2) companies, Block Island Power Company and the Pascoag Utility District, distribute to Block Island and western Burrillville[102].

Rhode Island had the lowest per capita energy consumption among all states in 2016 and utilized natural gas to fuel 92% of Rhode Island's net electricity generation in 2017. The State has 12 electric power plants (2 petroleum-powered, 7 natural-gas powered, 2 hydroelectric, and 1 other renewable power plant), but with nearly all of its net electricity generation coming from natural gas rather than coal, Rhode Island is among the nation's lowest carbon emitters.

In Rhode Island, limited hydropower resources exist due to the state's flat, coastal terrain and small number of large rivers. Therefore, the principal opportunity to develop hydropower generation in Rhode Island lies in co-locating new projects on existing dams. Most studies estimate total state hydropower potential at approximately 10 to 20 megawatts (MW). Seven (7) permitted hydroelectric facilities exist in Rhode Island, with a combined authorized capacity of 6.7 MW.

Rhode Island is committed to developing sustainable energy policy and consumption; the Rhode Island Office of Energy Resources is the State's lead state agency on energy policy and programs with a mission of leading Rhode Island to a secure, cost-effective, and sustainable energy future. To this end, the State is a member of Regional Greenhouse Gas Initiative, a market-based effort to reduce carbon emissions from electricity production in the northeastern United States.

3.18.1.5 Drinking Water, Stormwater, and Wastewater

The Rhode Island Department of Health monitors drinking water through its Center for Drinking Water Quality Drinking water and its Public Drinking Water Program. Through these programs, all public water systems are required to take water samples and have them analyzed at certified laboratories. The State also maintains a Private Well Program that provides training and education

[102] Office of Energy Resources, 2018. *Rhode Island State Profile and Energy Estimates*. Retrieved from: https://www.eia.gov/state/?sid=RI

for the public and licensing for well inspectors. In 2017, RIDOH invested $4,182,548 of State and federal funds in Rhode Island's public water systems.

Rhode Island residents primarily utilize public water systems for drinking water. The following table identifies water system customers by system type:

Table 3-50 Rhode Island Water System Customers by System Type, 2017

System Type	Number of Customers
Public Water System	1,126,470
Surface Water Systems	886,957
Groundwater Systems	239,513
Public Water Systems	481
Community Systems	89
Non-Transient, Non-Community Systems	82
Transient, Non-Community Systems	308
Active Non-Operational Systems	2
Systems using surface water	32
Systems using groundwater	447

As the majority of Rhode Island residents utilize public water systems, it is critical to understand and remedy the contamination of public drinking public water. A Tap Water Database report provided to RIDOH by the Environmental Working Group tested 91 public water utilities in Rhode Island serving 1,004,000 customers and found 75 contaminants. Rhode Island's old housing stock, lead pipes, and antiquated plumbing contribute to the problem of contamination. Providence Water's drinking water system is one of the largest in the country to routinely exceed federal acceptable lead level (57% of the time) during the past decade.

Less people utilize private water systems than public water systems in Rhode Island, with an estimated 120,000 people relying on these systems for drinking water. As of December 31, 2017, there were 18 licensed water quality analysis interpreters in the State and 47 licensed water samplers. In 2017, the Private Well Program responded to 1,641 inquiries regarding well-water quality in the State.

There are approximately 19 utility networks operating wastewater treatment plants in the state. Like the drinking water systems, much of the wastewater system has outdated its intended lifetime. Damage to pipes can adversely affect the environment, as sanitary sewer overflows are a common occurrence during storm events.

3.18.2 Location

Critical infrastructure in each sector is located throughout the state. Rhode Island is home to communications infrastructure for multiple phone and telecommunications companies, energy facilities, major highways, airports, and water and wastewater facilities. Predicting the precise location of the next infrastructure failure is often difficult and generally dependent on the quality, upkeep, and maintenance of each piece of infrastructure as well as any protective actions that can mitigate or prevent acts of terrorism or cyber-attacks.

3.18.3 Extent

The failure of any one of these infrastructure systems could have potentially devastating impacts, including significant disruption to essential life, economic and financial impacts, and physical damage to infrastructure. The reliance of virtually all industries on electric power and fuels from the energy sector is of key importance. A significant event could have cascading effects on other infrastructure sectors' ability to operate.

In addition, the information technology sector's complex and dynamic environment makes identifying threats and assessing vulnerabilities difficult and requires that these tasks be addressed in a collaborative and creative fashion. Although information technology infrastructure has a certain level of inherent resilience, its interdependent and interconnected architecture presents vulnerabilities as well as opportunities for coordinating public and private sector preparedness and protection activities.

While not a direct measure of infrastructure failure, the National Infrastructure Report Card by the ASCE can help to indicate the adequacy of infrastructure within the State of Rhode Island. Generally, States are given an overall grade for their infrastructure and individual infrastructure sectors are analyzed including: aviation, bridges, dams, drinking water, energy, hazardous waste, inland waterways, levees, ports, public parks, rail, roads, schools, transit, wastewater. This rating system includes infrastructure which, if it failed, would have both immediate and long-term effects. The state has yet to receive a grade for its infrastructure, but gaps were identified in the areas of road and bridge infrastructure, drinking and wastewater needs, high-hazard dams, and schools. The national overall grade was a D+ for 2017.[103]

3.18.4 Previous Occurrences

Oftentimes, smaller scale infrastructure failures occur as a secondary impact from a natural disaster, such as a temporary power outage due to a thunderstorm or a communications outage from downed lines following a hurricane. Rhode Island experiences these minor disruptions routinely and manages them through coordination across agencies and with the private sector. Specifically, when utility and/or infrastructure failure does occur, utility providers generally respond quickly to restore service. However, depending on the cause of the utility disruption, events of prolonged outages do occur. The National Grid is one utility provider in Rhode Island. The National Grid's Storm Fund Report represents the cumulative non-capital deficit in paying for all weather hazard damages in Rhode Island. At the end of 2017, this fund was at a deficit of $91.8 million.[104] This deficit reflects the costs of National Grid's incremental costs in repairing storm damage and excludes capital expenses, which are recovered elsewhere in rates.

3.18.5 Probability of Future Events

In general, the state has not experienced any direct, prolonged catastrophic infrastructure failures. However, a significant failure of any of these life line sectors could result in severe disruptions to public life and overall response efforts. In addition, there are strong indications that the potential threat of a large-scale infrastructure failure is becoming more probable due to the extent of sector interdependencies. In addition, cyber-attacks against critical infrastructure sectors have increased

[103] American Society of Civil Engineers, 2017. *Rhode Island Infrastructure Overview.* Retrieved from: https://www.infrastructurereportcard.org/state-item/rhode-island/
[104] National Grid, 2018. *Annual Storm Report for 2017*.

significantly and could cause major disruptions. Overall, the State of Rhode Island is vulnerable to infrastructure failure, and it has the potential (between 1% and 49.9% annual probability) of occurring within the next 12 to 60 months.

3.18.6 Vulnerability and Risk Assessment

3.18.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined infrastructure failure to be a moderate priority hazard in Rhode Island. As described in the profile above, infrastructure failure within the state has the potential of occurring within the next year to five (5) years. Infrastructure failure has a medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries. Probable hazard magnitude ranges from negligible to limited magnitude to include minor injuries, short shutdown of critical infrastructure and facilities, and scattered incidental residential and commercial structures damaged from the events. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. The impact on state operations is believed to be limited. Table 3-51 outlines the hazard rankings for each of the hazard priority criteria related to infrastructure failure.

Table 3-51 Infrastructure Failure Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Potential** *Between 1% and 49.9% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**

3.18.6.2 Risk and Vulnerability to People and Property

Infrastructure failures are a form of lifeline system failure. A failure could involve potable water system, power system, natural gas system, wastewater system, communication system, or transportation system and will have a direct impact on both people and property.

Risk and Vulnerability to People (Injuries and Death)

Risk from critical infrastructure failures is considered limited based on the number of possible injuries and no deaths anticipated, although infrastructure failures can impact large populations in the State at a time. Damaged or destroyed utility lines and facilities—including electricity, computer and satellite links, gas, sewer, and water services—can cripple a region after a disaster. Power lines are often badly damaged or destroyed, resulting in the loss of power for days, weeks, or even months. This is particularly significant considering modern societies' dependence on electricity. A loss of electricity can lead to the loss of household utilities and appliances, transportation, and communication networks.

Often, infrastructure failures are a secondary impact of another event. For example, it is possible that a dam failure would pose a direct threat to water and waste water treatment plants by flooding the plant and causing service disruptions and damage to treatment systems. Flooding-related risks to water treatment plants include pipe breaks resulting in sewage spills or low water pressure, changes in water quality, or debris blockages.[105] An infrastructure failure of either a water facility or a waste water treatment plant would have a direct effect on the health of the population. Without access to clean water, residents would be at risk of exposing themselves to bacteria and infection, which could lead to sickness and even death. Furthermore, without access to clean water, people would quickly become reliant on state resources to provide those resources.

The failure of energy infrastructure including gas, electricity and other energy sources would create an immediate strain on the population. Particularly in the winter, Rhode Island residents would be susceptible to freezing temperatures (for more information on Extreme Cold hazard events see Section 3.12). Without gas and the ability to heat their homes, residents (especially the vulnerable populations) would be vulnerable to injury and death. Additionally, house fires and CO poisoning increase during these freezing temperatures. Coupled with an event where failure of sewer or clean water services occurred, without the option to boil water, this infrastructure failure would pose an immediate risk to the health and wellbeing of the residents of Rhode Island.

As the population of Rhode Island grows and traffic congestion worsens, the number of automobile accidents is likely to increase, along with automobile-related fatalities. More car accidents lead to traffic delays, resulting in economic losses to commuters and employers. Depending on the size and duration of an incident, major or minor traffic flow disruptions can cause delays for commuters. Structurally deficient bridges throughout Rhode Island, and their potential failure, pose a significant risk to the population, the state economy and ability for residents to evacuate if it were required.

Risk and Vulnerability to Property (Structures and Facilities)

Damaged or destroyed utility lines and facilities, including electricity, computer and satellite links, gas, sewer, and water services, can cripple a region after a disaster. Power lines are often badly damaged or destroyed, resulting in the loss of power for days, weeks or even months. This is particularly critical considering modern societies' dependence on electricity. Without electricity,

[105] Environmental Protection Agency, 2015. *Incident Action Checklist- Flooding*. Retrieved from: https://www.epa.gov/sites/production/files/2015-06/documents/flooding.pdf

basic modern household appliances will not operate; public water supplies, water treatment and sewage facilities will not operate.

The disruption of natural gas in Rhode Island, supplied by Algonquin Gas Transmission and Tenneco Gas Transmission, would have an immediate impact on facilities reliant on natural gas. If natural gas lines to these facilities were to fail or be compromised for even a relatively short amount of time, the resulting service disruption, particularly in winter, would have an immediate impact on facilities. The result could be frozen and subsequently burst pipes within structures and facilities resulting in flooding and structural damage. A rupture in the Tennessee Gas Pipeline, which runs through the State, would also have secondary impacts including a loss of income from the pipeline, and the health and environmental impacts associated with a hazardous materials spill.

Risk and Vulnerability to Critical Infrastructure

Infrastructure failures can be the consequence of any of the other hazards identified or as a primary hazard, without an outside trigger. A failure could involve potable water system, power system, natural gas system, wastewater system, communication system, or transportation system and will have a direct impact on both people and property. Damaged or destroyed utility lines can result in a compromised water delivery system. Elevated water tanks may be damaged during a disaster event resulting in compromised safe drinking water. During disasters, citizens may be advised to boil water to eliminate waterborne pathogens introduced to the supply in breached areas.

The components of critical infrastructure in Rhode Island have been identified and would pose the following risk and vulnerability:

Table 3-52 Lifeline Sectors Impacted by Infrastructure Failure

Lifeline	Vulnerability
Communications	The communications sector is an integral component of the underlying operations of all businesses, public safety organizations, and government. Communications (e.g., phone, cable, internet) infrastructure can also be affected through loss of power to system components or direct physical damage to system components caused by natural disaster or intentional acts. Failure of communications infrastructure would impact all facets of public and private life within Rhode Island.
Emergency Services	Disruption of emergency services, which include police, fire, emergency management, public works, and emergency medical services, could inhibit response, which could have cascading impacts to include serious injury or death to those who do not receive emergency services.

Lifeline	Vulnerability
Energy	This lifeline sector is uniquely critical because it provides and enables the functionality of all infrastructure sectors. For example, the energy sector supplies fuels to the transportation industry, electricity to households and businesses, and other sources of energy that are integral to growth and production across the nation. Failure of this component would have direct and sizeable cascading impacts on the community, public and private sectors, government, and first responders. Power outage, the most common type of failure, can result in negative sequential patterning to the environment and lifestyle: it can cause an overabundance of CO due to the use of generators, grills, and similar items during an outage; spoiling of food; compromised water purification systems resulting in water that may be unsafe to drink; loss of heating/air conditioning, resulting in vulnerability to extreme heat and cold; electric shock resulting from damaged power lines and power surges when electricity is restored. Power outages can also result from other natural and man-made disasters, including earthquakes, transportation accidents, and major structural collapses. Power outages can be particularly dangerous for critical facilities, such as hospitals. Many vaccines must be refrigerated, and a power outage could severely deplete the supply of certain vaccines in the affected area. Depending on the scale of the power outage, power may not be restored for some time. If a power outage occurs during extreme cold, water heaters, plumbing systems, and heating and cooling systems may be susceptible to damage due to freezing. If a power outage occurs during flooding such that electrical equipment and appliances are submerged, electric shock may occur.
Information Technology	This sector is central to security, economy, and public health and safety as businesses, governments, academia, and private citizens. As Rhode Island becomes increasingly dependent upon technological functions for communications and operations, failure off this system would be catastrophic.
Transportation Systems	Transportation incidents become critical when they negatively impact or affect critical infrastructure dependent on transportation systems for operations. Transportation incidents which would have a direct and sizeable impact on Rhode Island would include those that affect: transportation and energy systems, defense installations, banking and financial assets, water supplies, chemical plants, food and agricultural resources, police and fire departments, hospitals and public health systems, and government offices.
Water and Wastewater Systems	The water and wastewater sector ensure the provision of clean water and the treatment of all water and wastewater for the state. Water distribution can be affected in three (3) ways: the amount of water available; the quality of the water; and the viability of the physical components of the distribution systems. Contamination of the water supply can occur naturally, as a result of human error, or intentionally. Occasionally, the release of agricultural run-off, manure or other farming byproducts can contaminate water. Accidents resulting in hazardous material spills can also adversely affect groundwater. Disruption to the distribution system can occur because of loss of power to pumping and treatment stations; it can also be caused by direct physical damage to pump and treatment stations caused either by natural disaster or intentional acts. Lack of access to safe drinking water would pose a direct public health incident.

Overall, the failure of critical infrastructure would severely impact and affect nearly all aspects of life, business, and operations within Rhode Island.

3.18.6.3 Risk and Vulnerability to the Environment

The impacts on the environment would vary based on the type of critical infrastructure failure and the situation of the failure:

- Communications infrastructure failure would have a limited impact on the environment.
- Failure of emergency services may not directly impact the environment, but swift action taken to recover after emergency events can have cascading impacts on the environment.
- Failure of power and other energy systems will likely not have an immediate effect on the environment.
- Failure of information technology infrastructure again may not have a direct effect on the environment, but again can have cascading effects which depending on the situation could affect the environment.
- The major impacts of transportation system failure would not impact the environment, however in the situation where there is a transportation accident—there could be debris or a hazardous spill which would impact the environment.
- Failure of critical infrastructure including waste water plants would have a direct and immediate impact on the environment. Following failure of waste water plant, it is possible that a large release of waste water would occur into the stream and surrounding environment. This would have a direct impact on the ecosystem and result in contamination of large bodies of water.

3.18.6.4 Risk and Vulnerability to State Operations

Delivery of services provided by the state will be disrupted following a critical infrastructure failure. Depending on the critical infrastructure that fails, and the potential cascading effects of that failure, the effects would range from minor and quickly overcome to severe, long-lasting, and considerably problematic for state operations. As state operations are inextricably linked to critical infrastructure, the failure would be seen as a failure of state operations in and of itself.

Provision of emergency services, energy, and water and wastewater systems are critical components of state operations, so failure of the state to provide these infrastructures would pose an immediate and impactful risk to the public health of the citizens of Rhode Island. Additionally, failure of communications, information technology, and transportation systems (while not posing an immediate threat to public health) would make all state operations more challenging and limit the ability of the state to operate as usual.

3.19 Infectious Disease

3.19.1 Description

An infectious disease is an illness due to a specific infectious agent or its toxic products that arises through transmission of that agent or its products from an infected person, animal, or inanimate source to a susceptible host; either directly or indirectly through an intermediate plant or animal host, through a vector, or through contact with the inanimate environment. Diseases such as influenza, pertussis, tuberculosis, and meningitis are examples of infectious diseases that can pose a threat to a community's population. Global, federal, state, and local agencies for human and animal health closely monitor for diseases with the potential to cause outbreaks or that could cross species, and work to develop strategies to contain their spread and to provide medical countermeasures such as antibiotics and antiviral medications to prevent or treat infection.

To gauge the potential impact of disease on Rhode Island's human population, it is helpful to classify disease occurrence in the following fashion:

- **Isolated case of a high-consequence disease:** One or more cases of a particularly serious disease (e.g., botulism), whose further spread is unlikely, but place significant strain on the resources required to isolate and provide treatment for the infected.
- **Institutional outbreak:** Two (2) or more cases of similar illness with a common exposure at an institution (e.g., a school, nursing home, correctional facility).
- **Epidemic:** An increase, often sudden, in the number of cases of a disease above what is normally expected in that population in that area.
- **Pandemic:** An epidemic that has spread over several countries or continents, usually affecting a large number of people.

3.19.2 Location

Rhode Island's geographic and demographic characteristics make it vulnerable to importation and spread of infectious diseases. An abundance of waterbodies and forested land throughout the State provide rich environments for vectors like mosquitos, ticks, and wild animals, all of which can carry infectious diseases, to breed and flourish. Although the entire state is susceptible to the spread of infectious diseases, factors like high population density, for instance in crowded urban centers where people are in routine, close contact with one another, can further aid transmission. For example, Central Falls, which is the smallest and most densely populated city in Rhode Island, may experience more rapid spreading of disease, not only because of its density, but also because its residents are among the lowest income groups in the State, they have great ethnic diversity, and a high number of its residents are foreign-born and frequently travel outside of the country. In addition, Providence, the capital of Rhode Island, is home to a number of colleges and universities, bringing together students from a wide range of socioeconomic, ethnic, and cultural backgrounds, factors which increase Providence's risk.

3.19.3 Extent

The extent of an infectious disease's impact depends on a variety of factors, including, though certainly not limited to:

- The disease's virulence, transmissibility, and pathogenesis;
- Environmental conditions, including temperature and rainfall;

- Modes of transmission;
- Individuals' vulnerability factors, such as underlying medical conditions, malnutrition, behavior, and pregnancy;
- Quality and availability of healthcare services;
- Immunization prevalence; and
- Availability and accessibility of medical countermeasures that protect against and treat the disease.

3.19.4 Previous Occurrences

A number of incidents resulting from infectious diseases have occurred in Rhode Island in recent history. The following is a list of disease outbreaks investigated by RIDOH in 2017, gathered from data provided by RIDOH's Center for Acute Infectious Disease Epidemiology. Table 3-53 below shows disease outbreak data for 2017.

Table 3-53 Infectious Disease Outbreaks in Rhode Island, 2017

Category		Total Number of Outbreaks Identified
Enteric [1]	Waterborne	0
	Enteric Foodborne	6
	Enteric Person-to-Person	53
	Enteric Animal Contact-associated Disease	3
	Enteric Environmental Exposure-associated Outbreaks	0
	Other enteric outbreaks of Unknown Transmission	6
Respiratory	Influenza	121
	Other Respiratory	7 (pneumonia/unknown)
Mosquito borne		0
Tickborne (excluding Lyme)		0
Select Vaccine-preventable Diseases [2]		16
Select Healthcare Associated Infections [3]		1
Other (Please Specify)		3 (Coxsackie, Scabies, and Herpes Simplex Virus)
Total		216

1. Outbreaks of all pathogens that result in gastroenteritis with the exception of those specifically named further down in the table
2. Diphtheria, Haemophilus influenza Type B (Hib), Measles, Meningitis, Mumps, Pertussis, Rubella, and Varicella
3. Healthcare-acquired methicillin-resistant Staphylococcus aureus, Clostridium difficile, and Carbapenem-resistant Enterobacteriaceae, Also, CLABSI, CAUTI, SSI

Recent history has shown that seasonal influenza has the potential to significantly affect the operations of the Healthcare and Public Health Sector. In Rhode Island, and in the U.S., the 2017 to 2018 influenza season was a high severity season, with high levels of influenza and influenza-like illnesses, hospitalizations, respiratory outbreaks, and deaths. All Rhode Island surveillance sources revealed a season with an early increase in activity, and an unusually high peak. The Outpatient Influenza-like Illness Surveillance Network, or ILINet, reached the highest level since the 2009 H1N1 pandemic. At its peak, Rhode Island ILINet providers reported that 7.82% of all health care visits to their practices were due to influenza-like illness. Influenza A (H3N2) was predominant across all influenza surveillance systems, both in Rhode Island and nationally. Influenza A (H3N2) is known to be associated with severe illness, mortality, and increased hospitalization, particularly among older adults and those with compromised immune systems.

From 2017 to 2018, 6,577 specimens tested positive for influenza at hospitals in Rhode Island. This represents 2,500 more positive tests than in the 2016 to 2017 influenza season. Of the individuals who tested positive for influenza at hospitals, 1,390 were admitted to the hospital as inpatients (21.1%). Adults aged 65 years or older accounted for 65.8% of influenza hospitalizations. RIDOH responded to and monitored 141 respiratory outbreaks in congregate living settings including long-term care facilities, assisted living facilities, and hospitals. There were 60 influenza-associated deaths reported to RIDOH during the 2017 to 2018 influenza season, 90% of which occurred in adults aged 65 years or older. Of the 60 individuals who died, 66.7% had received the seasonal influenza vaccination. High rates of hospitalizations and mortality in older adults are consistent with the circulating influenza A (H3N2) viruses. All data in Rhode Island and throughout the country showed a severe influenza season that started early and lasted for many weeks.

It may go without saying, but it is important to note that diseases do not recognize borders or boundaries. In today's era of globalization, it is easier than ever before for diseases that were once isolated to a particular region of the world to be transported to entirely new locations.

An example in recent history is the 2014 to 2015 Ebola outbreak in West Africa, during which the world witnessed cases of Ebola carried from the African continent to the U.S., the United Kingdom, Italy, and Spain. While the number of cases in the United States was relatively limited (a total of four [4]), and only one instance of transmission between persons was documented, a tremendous effort was made to prepare the nation to respond effectively to the prospect of more cases and further transmission. Similar effort was made in the State of Rhode Island to develop a response plan, monitor travelers arriving from West African nations, and prepare hospitals and other healthcare facilities to isolate and treat patients with suspected Ebola. Efforts have continued since, leading to the development of a tiered system of hospitals, both in the State and nationally. To date, Rhode Island has eight (8) frontline hospitals, whose mission is to identify, isolate, and notify RIDOH of patients suspected to have Ebola or another high-consequence disease, and two assessment hospitals, whose mission is to receive and isolate a patient with suspected infection from a frontline facility until confirmatory testing can be completed. If confirmed, the patient is then transferred to a treatment center. Rhode Island has established agreements with Massachusetts for use of their treatment centers in such a situation. This system has been tested in two tabletop exercises, each conducted annually since 2017.

Another example can be found in the 2015 to 2016 Zika virus epidemic. Prior to this event, incidence of local Zika infection in the U.S. was non-existent. Changes in climate, however, had begun to make certain regions of the country, especially the south, more hospitable to the species of mosquito that are known to carry the virus. There was grave concern about the virus' ability to cause severe birth defects, including microcephaly, in situations where pregnant women were infected. RIDOH led the State's efforts in developing and implementing a large-scale public information campaign to inform

vulnerable populations (especially pregnant women and women trying to get pregnant) of infection risks and mitigative measures. There were 98 cases of Zika in Rhode Island from 2015 to 2017 resulting from infections that occurred during travel (no local mosquito transmission was documented in the State). Systems were developed and implemented to monitor these cases and provide support to pregnant women who were infected.

3.19.5 Probability of Future Events

Responding to and mitigating the effects of infectious disease is a national priority, as articulated by the 2018 National Security Strategy, which encourages strengthening capabilities to detect and contain biothreats at their source, support biomedical innovation, and improve emergency response.

The probability of incidents that result from infectious disease occurring in Rhode Island over the next 12 to 60 months is likely (between 50% and 89.9% probability). Indeed, such incidents occur every year; the probability of an infectious disease incident over the next 12 to 60 months has a significant probability. The probability of an infectious disease progressing to the epidemic stage within the same timeframe is less clear, as is the probability of a pandemic. Generally speaking, pandemics are predicted to occur once every 100 years; the most recent pandemic was in 2009, which suggests that the probability of a pandemic within the next 12 to 60 months is relatively low. However, the incidence of infectious disease outbreaks is increasing. In 2007, the WHO reported that over 40 infectious diseases had been discovered since 1970; nearly one new infectious disease has emerged each year over the last 50 years.

At present, there are a number of diseases circulating internationally that cause concern for public health and medical professionals. Since the 2014 to 2015 West African Ebola outbreak, Ebola has re-emerged twice in large-scale outbreaks on the African continent. MERS-CoV continues to infect individuals in the Middle East and Asia since first identified in 2012. In the United States, there is currently an ongoing epidemic of Hepatitis-A among people experiencing homelessness and intravenous drug users. Any one of these diseases bears the potential of significant impact to Rhode Island in the event infections occur in the State.

3.19.6 Vulnerability and Risk Assessment

3.19.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 HMP update determined infectious disease to be a moderate priority hazard in Rhode Island. As described in the profile above, while incidents resulting from infectious diseases are very likely within the next one (1) to three (3) years, more severe infectious disease incidents, such as a pandemic, are less likely. The probable magnitude of an infectious disease incident from negligible to moderate, with moderate impacts experienced by people as a result of illness and negligible impacts to critical infrastructure, residential, and commercial structures. The impact on state operations and the regional economy is believed to be limited. The overall impact on the environment is expected to be negligible, with less than 5% of land and natural resources being affected by this hazard. Table 3-54 outlines the hazard rankings for each of the hazard priority criteria related to epidemic.

Table 3-54 Infectious Disease Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Likely** *Between 50% and 89.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Moderate**

3.19.6.2 Risk and Vulnerability to People and Property

Depending on its nature and scope, an infectious disease incident could impact the State of Rhode Island significantly. If residents and workers become infected, employee absenteeism could increase, and the length of time necessary to recoup and regain lost time and money could be six (6) months or longer.

Risk and Vulnerability to People (Injuries and Death)

Depending on the scale of incident and type of disease, residents of the State of Rhode Island may be at risk of illness or death if they are exposed to the disease. Different diseases will have different impacts on the population. General scenarios for various infectious disease incidents are detailed below:

Isolated Case of a High-Consequence Disease

The impact of isolated cases of high-consequence disease, while limited in their immediate scope, can be particularly burdensome on the Healthcare and Public Health Sector. If the disease is such that treatment and infection control are resource intensive, then a single facility caring for such a patient may have to extend beyond its own walls – and perhaps beyond even its local community – for support.

Institutional Outbreak

The impact of an institutional outbreak within a facility or organization can be extensive. Much will depend on the type of institution experiencing the outbreak; the type of population (based on age), health condition of the population, and other factors may make institutional occupants more vulnerable to certain types of disease, and therefore may experience particularly high rates of morbidity and mortality.

Epidemic

An epidemic in Rhode Island would have significant impacts on its Healthcare and Public Health Sector. It is entirely possible that all of Rhode Island would be affected by such an event. Exact impacts are difficult to assess without knowing the disease in question; however, by definition, an epidemic bears the potential to cause morbidity and mortality in a large percentage of Rhode Island's, if not the region's, population.

Pandemic

While it can be challenging to predict and evaluate the exact impacts of a disease prior to its spread, the worst-case scenario – a pandemic – has been assessed by the CDC to have the potential to infect as much as 25% to 30% of the U.S. population. Such an event could cause a number of cascading impacts, including widespread employee absenteeism, leading to reduced function of critical infrastructure and services in a community. The healthcare system would be placed under considerable strain, potentially impeding its ability to provide routine, non-disease-related care to the general public. High rates of mortality are also possible.

Population density can play a role in the spread of disease. Areas with high population density such as Providence, Warwick, and Cranston are most vulnerable to the spread of certain diseases, such as an influenza virus. Other areas, such as Newport County, that experience high rates of seasonal tourism may also be at heightened vulnerability, depending on the time of year of the incident. Other parts of the State with lower population densities, such as West Greenwich, Richmond, Scituate, and Warren, may be less vulnerable to the spread of certain diseases; however, viruses can still spread with relative ease in schools, workplaces, and other crowded settings.

The greatest number of cases of infectious disease managed by RIDOH on a daily basis are sexually transmitted diseases, but, due to their nature, they are unlikely to cause an epidemic, unless a novel strain or new mode of transmission is identified. Measles has typically had a low probability of occurrence; however numerous outbreaks nationwide have occurred recently because vaccine immunity is waning and fewer parents are choosing to vaccinate their children. It should be noted that flu, which is not tracked on a case-by-case basis since it is so prevalent, and novel or emerging infectious diseases (diseases whose incidence in humans has increased in the past two [2] decades or threatens to increase in the near future) are considered the highest threats. Using the 2017 estimated population in Rhode Island of 1,059,639, it has been estimated that a medium-level pandemic, using the CDC scenario estimates of a 30% attack rate of infection, a 0.8% hospitalization rate among the infected, and a 0.2% mortality rate among the infected would produce the following numbers of people affected:

Table 3-55 Rhode Island CDC Scenario Estimates

CDC Rate	Population Affected
30% Attack Rate (number of those infected)	317,892
0.8% Hospitalization Rate of those infected	2,543
0.2% Mortality Rate of those infected	636

To help residents minimize their risk of infection, RIDOH provides detailed information and protocols for citizens to protect themselves on the agency's website. RIDOH also provides services to help minimize vulnerability to disease outbreaks. The RIDOH website notes that disease prevention, specifically related to infectious diseases, includes vaccinating and using medicines properly; proper hand washing and awareness of food preparation; being aware of surroundings and avoiding areas with disease threats (ticks, mosquitoes); avoiding others when sick; safer sex practices; abstaining from intravenous drug use and not sharing needles and syringes.

RIDOH maintains a number of programs that could be engaged in response to large-scale disease outbreaks, including, though not limited to, the Medical Emergency Distribution System (MEDS). MEDS is an initiative that has been implemented throughout Rhode Island's 39 municipalities to rapidly dispense or administer medical countermeasures as mass prophylaxis for disease outbreaks or bioterrorism incidents. Since the early 2000s, each municipality has been engaged with RIDOH to develop and maintain plans, processes, and capabilities to perform this function.

In addition to the physical effects that infection can bring, the psychological toll of a large-scale infectious disease incident can be particularly burdensome. The strain placed on family members and friends of those who fall ill or succumb to disease can be enormous. The psychological toll can put significant demands on the Healthcare and Public Health Sector, whose resources will already be taxed by the incident.

Risk and Vulnerability to Property (Structures and Facilities)

It is unlikely that an epidemic would have direct (physical) effects on structures and facilities. However, when considering absenteeism as a result of infection, it is possible that operation and maintenance of some structures and facilities could be affected. Such a situation could be further compounded by absenteeism within those partner agencies that affected structures and facilities might ordinarily call upon for support.

Risk and Vulnerability to Critical Infrastructure

Considerable impacts to critical infrastructure, particularly infrastructure within the Healthcare and Public Health and the Emergency Services Sectors, should be expected in the event of a large-scale infectious disease incident, such as an epidemic or pandemic. If there are high rates of infection within the general public, and the nature of infection is such that it causes significant morbidity and mortality, then infrastructure within those two sectors in particular will be strained to maintain operations in the face of tremendous demand for service. All sectors of critical infrastructure in Rhode Island should consider the impacts of absenteeism as a result of an infectious disease incident.

3.19.6.3 Risk and Vulnerability to the Environment

Certain diseases that have the ability to cross between animals and humans (known as zoonoses) have been known to cause disease outbreaks. These diseases can have an impact on animal health in addition to human health. Public health, animal health, and environmental protection agencies will need to coordinate closely to limit impacts to human and animal populations.

In an event wherein an infectious disease causes mass fatalities, and the nature of the disease is such that cremation of decedent remains is not indicated, then it is possible that environmental considerations will need to be taken into account when determining burial solutions. Land-use and zoning implications might have to be similarly considered.

Ensuring proper disposal of medical waste generated during a response to an infectious disease incident can reduce the risk of potential environmental impacts.

3.19.6.4 Risk and Vulnerability to State Operations

Infectious disease incidents can pose unique risks to the public. Similarly, operations of state government are not immune to the risk or impacts of infectious disease. Even a relatively small-scale infectious disease incident can affect the ability of the State to perform its normal operations, especially if state personnel become infected. As the scale of an infectious disease increases, so too does the risk of infection for individuals, including state personnel. State agencies must therefore consider the risks posed by absenteeism to the continuation of routine operations.

3.20 Radiological Incident

3.20.1 Description

A radiological incident can be defined as the uncontrolled release of radioactive material that can harm people or damage the environment. Radiological incidents typically involve nuclear assemblies, research, production, or power reactors and chemical operators. Although these sites do not exist within Rhode Island boundaries, sites within neighboring states, including the Millstone Nuclear Power Station in Connecticut and the Pilgrim Nuclear Power Station in Massachusetts, place the population of Rhode Island potentially in harm's way following an incident.

Radiological incidents may also include the use of Radiological Dispersal Devices (RDDs), such as "dirty bombs", which cause the purposeful dissemination of radioactive material without a nuclear detonation. Other radioactive materials, such as radioactive medical devices, or radioactive recyclable metals, may also become a hazard.

3.20.2 Location

Although Rhode Island does not have any commercial nuclear power plants within its borders, it does fall within the 50-mile Ingestion Exposure Pathway for two (2) nuclear power plants: Millstone Power Station in Waterford, Connecticut, and Pilgrim Nuclear Power Station in Plymouth, Massachusetts. Table 3-56 shows specific municipality proximity to each of these plants.

RDDs may disseminate radioactive materials at any location, but the range of dispersal varies based on the design of the device, type and quantity of radioactive material, and pattern of dispersion.

3.20.3 Extent

A wide-range of possible events that can occur during reactor operations have been analyzed. The impacts on the off-site public range from benign to severe. A nuclear power plant accident can be expected, in the worst-case analysis, to result in a large release of radioactive isotopes into the environment and this release will have a significant impact.

Rhode Island farmers, livestock owners, fruit and vegetable growers, food processors, sod producers, fisherman, or food distributors that are within 50 miles of a Connecticut or Massachusetts nuclear power plant, may be required to protect the food or water supplies in the event of radioactive contamination.

Table 3-56 below identifies municipalities in Rhode Island that are within 50 miles of neighboring state nuclear power plants:

Table 3-56 Rhode Island Municipalities Nuclear Power Plant Range

Town	Millstone (CT)	Pilgrim (MA)	Town	Millstone (CT)	Pilgrim (MA)
Barrington	-	X	Newport	X	X
Bristol	-	X	New Shoreham	X	-

Town	Millstone (CT)	Pilgrim (MA)	Town	Millstone (CT)	Pilgrim (MA)
Burrillville	X	-	N. Kingstown	X	X
Central Falls	-	X	N. Providence	-	X
Charlestown	X	-	N. Smithfield	-	X
Coventry	X	-	Pawtucket	-	X
Cranston	X	X	Portsmouth	X	X
Cumberland		X	Providence	X	X
E. Greenwich	X	X	Richmond	X	-
E. Providence	-	X	Scituate	X	-
Exeter	X	-	Smithfield	X	X
Foster	X	-	S. Kingstown	X	-
Glocester	X	-	Tiverton	-	X
Hopkinton	X	-	Warren	-	X
Jamestown	X	X	Warwick	X	X
Johnston	X	X	Westerly	X	-
Lincoln	-	X	W. Greenwich	X	-
Little Compton	-	X	W. Warwick	X	-
Middletown	X	X	Woonsocket	-	X
Narragansett	X	-		-	-

X indicates which towns are within the 50-mile Ingestion Pathway Zone for each plant, a (-) signifies that the town is not within 50-mile Ingestion Pathway Zone for that plant.

RIEMA outlines the Nuclear Regulatory Commission (NRC)'s emergency classification system indicating the risk of radiological incident to the public. This system includes four (4) types of alerts (Table 3-57).

Table 3-57 NRC Emergency Classification System[106]

Name of Notification	Description
NOUE	Under this category, events are in process or have occurred which indicate potential degradation in the level of safety of the plant. No release of radioactive material requiring offsite response or monitoring is expected unless further degradation of the safety systems occur.
Alert	If an alert is declared, events are in process or have occurred which involve an actual or potential substantial degradation in the level of safety of the plant. Any releases of radioactive material from the plant are expected to be limited to a small fraction of the EPA PAG exposure levels.

[106] RIEMA, n.d. NRC Emergency Classification System. Retrieved at: http://www.riema.ri.gov/resources/emergencymanager/prepare/radiological/index.php.

Name of Notification	Description
SAE	A site area emergency involves events in process or which have occurred that result in actual or likely major failures of plant functions needed for protection of the public. Any releases of radioactive material not expected to exceed the EPA PAG exposure levels except near the site boundary.
General Emergency	Events are in process or have occurred which involve actual or imminent substantial core degradation or melting with potential loss of containment integrity. Releases can reasonably be expected to exceed the EPA PAG exposure levels offsite for more than the immediate site area.

3.20.4 Previous Occurrences

Previous incidents have long-term effects that require years, even decades, of cleanup efforts. Depending on the severity of the incident, areas affected could take decades or even centuries to fully recover. Some affected areas may be irreparably altered by the incidents. No previous high impact incidents have been reported at either the Pilgrim or the Millstone locations. Millstone Power Station has had periodic shutdown of its Unit 2 and Unit 3 reactors, with its Unit 1 reactor permanently shut down in 1998.

3.20.5 Probability of Future Events

The reactor design at Millstone Power Station is a pressurized water reactor with inherent risks of degradation cascading into a potential melt-down event. This would be a high-impact event, as a melt-down could potentially cause significant immediate and long-term damage to the environment and surrounding area. This has an unlikely probability (less than 1% annual probability) of occurrence, as Millstone has only had minor malfunctions that have led to shutdowns for extended periods.

Pilgrim has a Mark 1 G.E. Boiling Water reactor that has been in use for several decades. This design was the same as that of Fukushima, which melted down in 2011 causing massive environmental, human, and economic damage in Japan. Should a similar geological event such as Fukushima occur at Pilgrim Nuclear Power Station, it is likely that a high-impact radiological event could occur. Risk for earthquakes impacting Pilgrim is considered low, but past occurrences have demonstrated the possibility of earthquakes impacting this area.[107] While an earthquake affecting Pilgrim would be a high-impact event, the probability of occurrence is lowered, as recent reports have confirmed that Pilgrim will be shutting down permanently in 2019, thus significantly reducing the risk. However, the risk may not be eliminated as there are hazards related to the decommissioning process and wet or dry cask storage poses risks if storage is done on-site or within the State of Rhode Island. Though the risk remains, based on analysis, there is an unlikely probability of an incident occurring within the next one (1) to five (5) years.

[107] Nuclear Regulatory Commission, 2014. *Seismic Hazard and Screening Report for Pilgrim Nuclear Power Station.* Retrieved from: https://www.nrc.gov/docs/ML1409/ML14092A023.pdf

3.20.6 Vulnerability and Risk Assessment

3.20.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined radiological incidents to be a low priority hazard in Rhode Island. As described in the profile above, radiological incidents within the state are unlikely within the next one (1) to three (3) years. Radiological incidents have a small range of impact, accounting for less than 10% of the jurisdictional boundaries. The probable magnitude of this hazard ranges from negligible to limited magnitude including minor injuries, short shutdown of critical infrastructure and facilities, and scattered incidental residential and commercial structures damaged from the events. The overall impact on the environment is expected to be negligible with less than 5% of land and natural resources being impacted by this hazard. The impact on state operations is believed to be limited. Table 3-58 outlines the hazard rankings for each of the hazard priority criteria related to radiological incidents.

Table 3-58 Radiological Incident Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Unlikely** *Less than 1% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
Kent County								
Newport County								
Providence County								
Washington County								

3.20.6.2 Risk and Vulnerability to People and Property

Communities can be at risk if radiological materials are used unsafely or released in harmful amounts into the environment. Contamination could affect areas up to 50 miles from the accident site. Although construction and operation of nuclear power plants is closely monitored and regulated by the NRC, an accident, though unlikely, is possible.

Risk and Vulnerability to People (Injuries and Death)

The NRC defines two (2) emergency planning zones around nuclear power plants: a plume exposure pathway zone with a radius of 10 miles (16 km), concerned primarily with exposure to, and inhalation of, airborne radioactive contamination, and a post-plume/ingestion pathway zone of about 50 miles (80 km), concerned primarily with ingestion of food and liquid contaminated by radioactivity. As described above, Rhode Island is within the 50-mile post-plume/ingestion pathway of two (2) nuclear power plants: Millstone Power Station in Waterford, Connecticut, and Pilgrim Nuclear Power Station in Plymouth, Massachusetts. Table 3-56 provides a summary of the municipalities located with the ingestion pathway for each plant. Eleven (11) municipalities are located within both of the 50-mile post-plume/ingestion pathways.

Hazardous materials can cause death, serious injury, long-lasting health effects, and damage to buildings, the environment, homes, and other property. The potential danger from an accident at a nuclear power plant is exposure to radiation. This exposure could come from the release of radioactive material from the plant into the environment, usually characterized by a plume (cloud-like) formation. The size of the area affected is determined by the amount of radioactive material released from the plant, wind direction and speed, and weather conditions, which would quickly drive the radioactive material to the ground, causing increased deposition of radionuclides.

Similar risks are posed in the event of an RDD or other accidental release of radioactive materials. However, in most cases, the damage to people is mainly due to direct contact with the explosion itself, and not due to radiation. People in the impacted area will likely have to be decontaminated but will usually not require medical treatment for radiation.

Risk and Vulnerability to Property (Structures and Facilities)

The release of a hazardous material to the environment could cause a multitude of problems. Although these incidents can happen almost anywhere, certain areas of the state are at higher risk, such as roadways that are frequently used for transporting hazardous materials and locations with industrial facilities that use, store, or dispose of such materials. Areas crossed by railways, waterways, airways, and pipelines also have increased potential for accidents involving radiological material. Hazards can occur during production, storage, transportation, use, or disposal.

While the immediate risk of a radiological incident is to the public, buildings are vulnerable to prolonged and intense exposure to radiation. Radiation can have harmful effects on solid materials as it can degrade their properties so that they are no longer mechanically sound. As a result of continued exposure to radiation, the effects on metals and concrete are particular areas of concern and potential failure. This poses particularly dangerous consequences for tall buildings with considerable metal construction. While concrete serves as a strong barrier from dangerous radiation, prolonged exposure will change the overall properties of the concrete and, over time, affect its ability to block radiation.

Risk and Vulnerability to Critical Infrastructure

While natural gas fueled almost 96% of Rhode Island's net electricity generation in 2016, the Millstone Power Station is operated by Dominion Nuclear Connecticut, Inc near the Rhode Island state border. The facilities are pressurized water reactors with Combustion Engineering reactor vendor/type. Pilgrim Nuclear Power Station, located in Massachusetts, is operated by Entergy Nuclear Operations Inc. The facilities are boiling water reactors with G.E. Type 3 reactor vendor/type. These facilities present a risk to critical infrastructure within Rhode Island during an incident involving the release of radiation, creating a direct impact to services provided by critical infrastructure, especially in the 11 municipalities located within both 50-mile ingestion pathways, such as radiation contaminating food and water supplies, affecting hospital operations, and effecting first responders.

3.20.6.3 Risk and Vulnerability to the Environment

The effects of a radiological incident may cause damage to the environment. Several factors affect the severity of hazardous materials events including the quantity of the materials released, toxicity of the materials released, and the weather during a release, such as wind and rain, which may readily transport the hazardous material. Hazardous materials may have one of more of the following properties including: corrosive, oxidizing, explosive, radioactive, infectious, flammable, reactive, or poisonous (including carcinogens). Based on these properties, a hazardous material release can have significant impacts on the environment, including water quality issues, wildlife casualties, and ground contamination.

3.20.6.4 Risk and Vulnerability to State Operations

Radiological incidents may primarily affect the delivery of critical services, specifically first response and public service activities may be impeded due to the concern and ability to safely and properly respond to a radiological incident. Response delays and long preventative care procedures may delay or lengthen response times and decrease the public's confidence in the state's ability to respond and govern. The public may also develop concerns about the health effects of being exposed to radiological incidents. To prevent a loss of confidence in government, response across local, state, regional, and federal bodies should be as effective and efficient as possible to prevent injury or death.

3.21 Sea Level Rise

3.21.1 Description

Sea level is the level of the sea's surface relative to the land. Sea level changes can be caused by absolute changes of the sea level and/or by absolute movements of the land either through post glacial isostatic re-adjustment of the lithosphere, the rigid upper layers of the earth, or by extraction of water or other resources that cause the land to sink. SLR presents a coastal hazard that should be considered in long-term land use, development, and critical infrastructure planning. Rhode Island has large exposure to the potential impacts of SLR, with approximately 400 miles of shoreline, 21 coastal communities, and significant areas of low elevation.[108] Climate change, including the continued increase in global temperature, is projected to result in an acceleration of observed rates of SLR. Projections of increases in SLR in Rhode Island by 2100 range from less than one (1) foot to over 11 feet as determined by the USACE's online sea level change calculator for the Newport tide gauge station (See Figure 3-21).[109]

Although current SLR is a gradual process, impacts may be experienced in the short term, including increased frequency of nuisance flooding, exacerbated flood elevations during storm events, increased rates of coastal erosion, septic system failure, and increased saltwater intrusion into groundwater.

As part of the Rhode Island CRMC Shoreline Change Special Area Management Plan (SAMP), also known as the Beach SAMP, the University of Rhode Island Ocean Engineering program developed STORMTOOLS, which is an online high-resolution Rhode Island-specific model based on the most recent updated state digital elevation data that allows users to view the combined impacts from SLR and storm surge for selected areas within the state's 21 coastal communities. The online tool and more details are available through the Beach SAMP website.[110]

The state has completed several other SLR vulnerability assessment projects through the Statewide Planning Program including a study titled "Vulnerability of Transportation Assets to Sea Level Rise."[111] An assessment of SLR and storm surge vulnerability based on the state E911 point data set for all 21 Rhode Island coastal communities has also been completed and is posted on the CRMC Beach SAMP website.[112] The CRMC Beach SAMP Plan was adopted on July 12, 2018, and also posted on the CRMC Beach SAMP website.[113]

The Sentinel Monitoring for Climate Change in Long Island Sound Program is a multidisciplinary scientific approach to provide early warning of SLR impacts to Long Island Sound ecosystems, species, and processes to facilitate appropriate and timely management decisions and adaptation responses.[114] It has been such a successful collaborative project that Sentinel Monitoring is being scaled up for the entire northeast and Gulf of Maine region through the joint Ecosystem Heath Committee of NROC and NERACOOS. With a scaled-up Sentinel Monitoring program, Rhode Island and regional efforts intends be leveraged to support key monitoring for discernible climate signals

[108] NOAA, 2013. Office of Science and Technology webpage: New England summary of communities.
[109] USACE, n.d. Sea Level Change Curve Calculator. Retrieved at: http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html
[110] Beach SAMP, n.d. RI Shoreline Change Special Area Management Plan. Retrieved at: http://www.beachsamp.org/stormtools/.
[111] State of Rhode Island Department of Administration Division of Statewide Planning, n.d. Sea Level Rise Analysis at the Statewide Planning Program. Retrieved at: http://www.planning.ri.gov/geodeminfo/data/slr.php.
[112] Beach SAMP, n.d. RI Shoreline Change Special Area Management Plan. Retrieved at: http://www.beachsamp.org/.
[113] Beach SAMP, n.d. RI Shoreline Change Special Area Management Plan. Retrieved at: http://www.beachsamp.org/.
[114] Bi-State Sentinel Monitoring Work Group, n.d. Sentinel Monitoring for Climate Change in Long Island Sound Program. Retrieved at: http://longislandsoundstudy.net/research-monitoring/sentinel-monitoring/

and impacts, as well as inform adaptation strategies to keep our ocean and coastal resources as healthy as possible. Data from this effort will be available on their data clearinghouse and will contain SLR data and trends.

Heat waves, coastal flooding due to SLR and storm surge, coastal erosion, and river flooding due to more extreme precipitation events will pose a growing challenge to Rhode Island. This will increase the vulnerability of the region's residents, especially those already disadvantaged. While several municipalities have already begun to incorporate the risk of SLR into their planning efforts, implementation of adaption measures is still in its early stages.[115] Since Rhode Island is a "home rule" state and nearly all land use decisions are made at the municipal level, planning and implementation of actions to reduce the impacts of SLR will likely happen at the local level.

3.21.2 Location

In the northeastern U.S., signs of the planet's changing climate have become increasingly evident. Over the past 30 years, average winter temperatures in the region have risen 3.8°F, and the largest increase in extreme precipitation events in the country occur in the northeast.[116] New England has experienced a 61% increase in storm events over the past 59 years, while Rhode Island in particular has witnessed an 88% rise over the same period.[117]

Since the initial pilot study, STORMTOOLS, a Rhode Island specific coastal mapping software which has both a basic (aimed at homeowners) and advanced interfaces, have been developed and are available on an ArcGIS online platform. STORMTOOLS map the extent and water depths for 1, 2, 3, 5, 7, 10, and 12-foot SLR scenarios as well as several recurrence interval storm parameters with and without SLR. Mapping products include interactive maps for beginners and advanced user groups, and a series of map journals comparing historic storm surges, current nuisance flooding and tutorials.

USACE and NOAA have developed a SLR calculator that incorporated various models that project accelerated rates of SLR.[118] The CRMC has adopted the most recent NOAA SLR data to address both short and long-term planning horizons and design life for public and private infrastructure. The NOAA high SLR scenarios, currently 1.48 feet by 2030, 3.02 feet by 2050, and 8.99 feet by 2100 for Rhode Island. Figure 3-20 shows the differences in planning horizons using the NOAA high scenarios.

[115] Horton, R., G. Yohe, W. Easterling, R. Kates, M. Ruth, E. Sussman, A. Whelchel, D. Wolfe, and F. Lipschultz, 2014: Ch. 16: Northeast. Climate Change Impacts in the United States: The Third National Climate Assessment, J. M. Melillo, Terese (T.C.) Richmond, and G. W. Yohe, Eds., U.S. Global Change Research Program, 371-395. doi:10.7930/J0SF2T3P.
[116] Union of Concerned Scientists, 2006. *The Changing Northeast Climate: Our Choices, Our Legacy.* Retrieved at: https://www.ucsusa.org/sites/default/files/legacy/assets/documents/global_warming/The-Changing-Northeast-Climate.pdf
[117] Madsen, T. and Figdor, E., 2007. Heavy Precipitation Processes in a Warmer Climate. Geophysical Research Letters, 25, 1431-1434. Retrieved at: http://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1837178
[118] USACE, n.d. Climate Preparedness and Resilience. Retrieved at: https://www.usace.army.mil/corpsclimate/.

Figure 3-20 SLR Curves for the Newport Tide Station[119]

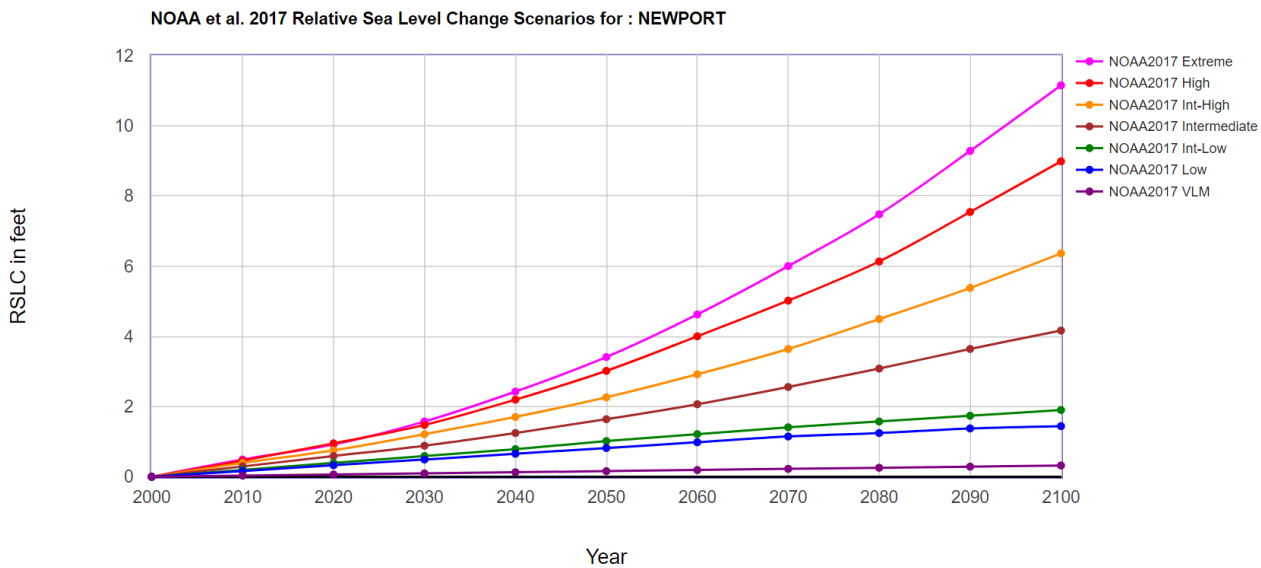


Figure 3-21 Sea Level Change Chart

Sea Level Change Curve
Scenarios for NEWPORT
NOAA2017 VLM: 0.00322 feet/yr
All values are expressed in feet

Year	NOAA2017 VLM	NOAA2017 Low	NOAA2017 Int-Low	NOAA2017 Intermediate	NOAA2017 Int-High	NOAA2017 High	NOAA2017 Extreme
2000	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2010	0.03	0.16	0.20	0.30	0.39	0.46	0.49
2020	0.06	0.33	0.39	0.59	0.75	0.95	0.92
2030	0.10	0.49	0.59	0.89	1.21	1.48	1.57
2040	0.13	0.66	0.79	1.25	1.71	2.20	2.43
2050	0.16	0.82	1.02	1.64	2.26	3.02	3.41
2060	0.19	0.98	1.21	2.07	2.92	4.00	4.63
2070	0.23	1.15	1.41	2.56	3.64	5.02	6.00
2080	0.26	1.25	1.57	3.08	4.49	6.14	7.48
2090	0.29	1.38	1.74	3.64	5.38	7.55	9.28
2100	0.32	1.44	1.90	4.17	6.36	8.99	11.15

3.21.3 Extent

SLR will result in wide scale systematic changes in the terrestrial and marine environments. Future increases in relative sea level will displace coastal populations, threaten infrastructure, intensify

[119] USACE, n.d. Sea Level Change Curve Calculator. Retrieved at: http://corpsmapu.usace.army.mil/rccinfo/slc/slcc_calc.html

coastal flooding and ultimately lead to the loss of recreation areas, public space, and coastal wetlands. Coastal infrastructure will become increasingly susceptible to complications from rising sea levels, as the upward trend continues. Residential and commercial structures, roads, and bridges will be more prone to flooding.

SLR will also reduce the effectiveness and integrity of existing seawalls and revetments, designed for historically lower water levels. Higher sea levels will result in changes in surface water and groundwater characteristics. Salt intrusion into aquifers will contaminate drinking water supplies and higher water tables will compromise onsite wastewater treatment systems in the coastal zone.

The most recent findings of the Intergovernmental Panel on Climate Change (IPCC) reports that global air and ocean temperatures are rising due to climate change. As global temperatures continue to increase, thermal expansion of seawater and accelerated melting of glacial ice leads to an increase in the total volume of global ocean waters. Over the last 100 years, sea levels have risen 6.7 inches globally. By 2100, greenhouse gas concentrations are predicted to reach levels greater than or equal to those observed during the last interglacial period when sea levels were between 13.1 feet and 19.7 feet higher than present levels.[120] Moreover, it has been reported that the occurrence of severe storm events is increasing almost everywhere in the contiguous United States.[121] Climate change may increase both the frequency and the severity of these events. Due to the timescales associated with climate processes and feedbacks, anthropogenic warming and SLR will continue for centuries, regardless of steps taken to curb greenhouse gas emissions.[122]

Future increase in relative sea level will increase the extent of flood damage over time. Lower elevations will become increasingly susceptible to flooding as storm surge reaches further inland due to SLR in concert with a probable increase in the frequency and intensity of predicted storms. As a result, more coastal lands will be susceptible to erosion. Barriers, if unimpeded by development, will tend to over wash which causes the barriers to increase in elevation and move landward. Increased frontal erosion and retreat of the barriers will cause Rhode Island's south shore barriers to migrate continuously landward with rising sea levels. The headland areas also erode in response to storm surge and high wave energy. Extent of erosion is dependent on the shoreline geology, with unconsolidated sediment eroding much more rapidly than bedrock areas. Low lying headland areas are susceptible to flooding in place.

3.21.4 Previous Occurrences

Sea level in Rhode Island has increased by an average of almost one (1) inch per decade since 1930. Over the past half century, sea levels in the Northeast have been increasing 3-4 times faster than the global average rate, resulting in a 6-inch rise since 1970.

Data from the Newport tide gauge show a relative rate of SLR of 2.72mm/year which equates to 9.10 inches of SLR in Rhode Island during the period of 1930-2015.[123] However, more recent data shows that the annual rate of SLR for Newport is 2.75mm/year (1930 to 2017) as determined by the

[120] Overpeck, Jonathan T.; Otto-Bliesner, Bette L.; Miller, Gifford H.; Muhs, Daniel R.; Alley, Richard B.; and Kiehl, Jeffrey T., 2006. "Paleoclimatic Evidence for Future Ice-Sheet Instability and Rapid Sea-Level Rise". USGS Staff -- Published Research. 189. https://digitalcommons.unl.edu/usgsstaffpub/189

[121] Madsen, T. and Figdor, E. (2007) Heavy Precipitation Processes in a Warmer Climate. Geophysical Research Letters, 25, 1431-1434. Retrieved at: http://www.scirp.org/(S(351jmbntvnsjt1aadkposzje))/reference/ReferencesPapers.aspx?ReferenceID=1837178

[122] IPCC, 2013. *Climate Change: The Physical Science Basis.* Retrieved at: http://www.ipcc.ch/report/ar5/wg1/

[123] NOAA, n.d. Tides and Currents. Retrieved at: https://tidesandcurrents.noaa.gov/sltrends/sltrends_station.shtml?stnid=8452660.

Permanent Service for Mean Sea Level.[124]

Data shows that tide levels can vary by more than a foot above or below average conditions due to gravitational forces from the alignment of the earth, the moon, and the sun. In addition, water levels at high tide become increasingly higher travelling north through Narragansett Bay. Mean Higher High Water (MHHW) at the Providence tide gauge is about seven (7) inches higher than at the Newport tide gauge. Five (5) SLR inundation scenarios for Rhode Island were used in this pioneering study; MHHW (the average height of the highest tide of the day over a 19 year National Tidal Data Epoch, currently 1983 to 2001), MHHW plus 1 foot, MHHW plus 4 feet (equivalent to a storm surge associated with a typical extra-tropical storm with 1 foot of SLR), MHHW plus 5 feet, and the 1938 Hurricane surge height. Data in Table 3-59 is derived from this study.

3.21.5 Probability of Future Events

Climate planning is being completed in an adaptive approach to allow for best available science to be continually updated. Based on Table 3-59 there is a highly likely probability of occurrence within the next year. The issue with creating more quantitative probabilities is that no widely accepted method is currently available for probabilistic projections at the regional or local level. However, there are various projected scenarios of SLR to the year 2100. Multiple scenarios allow for experts and decision makers to consider future conditions and develop responses based on the information that may reduce future impacts and vulnerabilities.[125]

Rhode Island has large exposure to the potential impacts of SLR, with over 400 miles of shoreline and significant areas of low elevation. Climate change, including the continued increase in global temperature, is projected to result in an acceleration of observed rates of SLR.

The scenarios shown in Table 3-59 are four (4) estimates based on NOAA's 2017 analysis of SLR scenarios 2030 through 2100. The information in Table 3-59 shows values based on the "high" curve and is estimated at the 83% confidence interval. These scenarios provide a set of plausible trajectories of global mean SLR for use in assessing vulnerability, impacts, and adaptation strategies. None of the scenarios should be used in isolation, and experts and coastal managers should factor in locally and regionally specific information on climatic, physical, ecological, and biological processes and on the culture and economy of coastal communities.[126]

Table 3-59 Rhode Island SLR Scenarios[127]

Year	SLR (in feet)
2030	1.67
2050	3.25
2080	6.69
2100	9.6

[124] NOAA, n.d. Sea Level Trends. Retrieved at: https://tidesandcurrents.noaa.gov/sltrends/sltrends.html
[125] Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1. 37 pp.
[126] Parris, A., P. Bromirski, V. Burkett, D. Cayan, M. Culver, J. Hall, R. Horton, K. Knuuti, R. Moss, J. Obeysekera, A. Sallenger, and J. Weiss. 2012. Global Sea Level Rise Scenarios for the US National Climate Assessment. NOAA Tech Memo OAR CPO-1. 37 pp.
[127] Rhode Island Coastal Resources Management Council, 2018. Chapter 2: Trends and Status: Current and Future Impacts of Coastal Hazards in Rhode Island. Retrieved at: http://www.beachsamp.org/wp-content/uploads/2018/07/BeachSAMP_Ch2_Trends_061218_CRMCApproval.pdf

CRMC and its partners developed Sea Level Affecting Marshes Model maps for the 21 Rhode Island coastal communities. These maps show how the coastline will change with SLR, illustrating 1 foot, 3 feet, and 5 feet scenarios. These maps are meant to support local communities in preparing for SLR and can be found online.[128]

3.21.6 Vulnerability and Risk Assessment

3.21.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined SLR to be a low priority hazard in Rhode Island. As described in the profile above, SLR within the state has a highly likely probability of occurrence within the next year (greater than 90% annual probability). SLR has a small to medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries. Hazard magnitude is considered to be negligible, including minor injuries, no shutdown of critical facilities and infrastructure, and scattered incidental residential and commercial structures damaged from the events. The impact on state operations is believed to be negligible. The overall impact on the environment is negligible and will be limited to less than 5% of land and natural resources being impacted by this hazard. Table 3-60 outlines the hazard rankings for each of the hazard priority criteria related to SLR. It is important to note this is an assessment for the five (5) years of this plan update. Vulnerability and risk described below is outlined for beyond the scope of this plan.

[128] CRMC, 2015. Sea Level Affecting Marshes Model. Retrieved at: http://www.crmc.ri.gov/maps/maps_slamm.html

Table 3-60 Sea Level Rise Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Moderate**
Kent County		**Small** *10% or less of the total jurisdictional boundaries*						
Newport County		**Medium** *10% to 40% of the total jurisdictional boundaries*						
Providence County		**Small** *10% or less of the total jurisdictional boundaries*						
Washington County		**Medium** *10% to 40% of the total jurisdictional boundaries*						

3.21.6.2 Risk and Vulnerability to People and Property

SLR presents a hazard that should be considered in long-term land use, development, and critical infrastructure planning. SLR vulnerability is restricted to the coastal communities and shoreline in Rhode Island. Washington County has the largest projected inundation area with potential vulnerability and losses in North Kingstown, Narragansett, South Kingstown, Charlestown, and Westerly. All municipalities within Newport County are vulnerable to inundation and losses; these include Jamestown, Newport, Middletown, Portsmouth, Tiverton, and Little Compton. Barrington, Warren, and Bristol within Bristol County are also vulnerable, with the entire extent of Barrington and Warren at eminent risk due to the elevation of the community in relation to the potential inundation.

Rhode Island Statewide Planning Program, in collaboration with CRMC, Rhode Island Office of Housing and Community Development–Disaster Recovery, DEM, Sea Grant (Coastal Resources Center) recently completed a two (2)-phase project to determine the socioeconomics of SLR. Phase I identified the vulnerability of transportation assets to SLR using infrastructure and SLR projections. Phase II identified the socioeconomics of SLR by identifying populations located within the inundation scenario areas. The key goal of the project was to identify the socioeconomic and demographic makeup of the estimated population residing in each coastal inundation zone, based on the number of occupied residential units located within each inundation zone. Critical steps in the project included:

- Utilizing the SLR inundation zones developed by CRMC in GIS;
- Overlaying the RIGIS "Sites – E-911" data with the SLR inundation zones to identify the number and types of residential units within each inundation zone; and
- Applying Census data to calculate an estimated number of occupied residential units, and develop estimates for social, economic, demographic and housing variables.

Identifying the number of residential units in each inundation zone served as a foundation for the socioeconomics of SLR project. The project also estimated population at risk and socioeconomic trends of at-risk population using census tract occupancy and variable rates of the 21 coastal communities.[129]

Risk and Vulnerability to People (Injuries and Death)

Rhode Island has large exposure to the potential impacts of SLR, with over 400 miles of shoreline and significant areas of low elevation. SLR may pose risks to human life by causing more frequent or severe instances of flooding, storm surge, or coastal erosion. Individuals living in areas where sea level is expected to rise, as well as those positioned in the immediate surrounding areas are more susceptible to the impacts of SLR.

While flooding currently occurs within Rhode Island following severe storms, particularly hurricanes and tropical storms, SLR will increase the severity of the flooding in coastal and low-lying areas. Higher sea levels will mean that coastal flood zones will be higher and move inland, encroaching on areas that currently are not in high risk flood zones.[130] Flooding directly impacts members of the public in a low-lying area or floodplain. Significant flooding events can lead to the damage and loss of homes, property, and businesses, which can impact public morale and safety. Flash flooding, which

[129] State of Rhode Island Department of Administration Division of Statewide Planning, n.d. *Socioeconomics of Sea Level Rise*. Retrieved at: http://www.planning.ri.gov/planning-areas/climate-change/sea-level-rise/socioeconomics-slr.php.
[130] CRMC Metro Bay SAMP, 2009

will become more likely with furthering SLR, may lead to dangerous conditions on roadways, as well as create mudslides that may quickly place members of public in dangerous situations.

Closures of hospitals and clinics is a major public health concern if flooding caused by SLR limits access to residents. Water sources may also become contaminated with toxic material or human waste, and water or sewer systems may be completely disrupted.

Risk and Vulnerability to Property (Structures and Facilities)

As the SLR inundation zone height increases, the number of residential units identified within each inundation zone increases as well. An exposure analysis was conducted using inundation zone data from 2011, created by NOAA using the "modified bathtub" model. Four (4) inundation zones were analyzed: MHHW, 1 foot, 3 feet, and 5 feet. Table 3-75 shows the critical facilities, infrastructure, residences, and commercial structures with a 30' buffer in each inundation zone, without calculations for the percent occupied or vacant applied.

As the SLR scenarios increase in height above mean high tide, the number of critical facilities and infrastructure exposed within each inundation zone increases as well. For the first increment, which assumes SLR will be one (1) foot higher than current measurements, approximately 518 facilities, residences, and commercial structures will be inundated. The highest scenario of SLR, five (5) feet, shows approximately 4,490 critical facilities, infrastructure, residences, and commercial structures will be inundated and approximately 115 RIPTA bus stops (categorized as rail systems and mass transit) will be inundated with five (5) feet of SLR. Approximately one-half (0.5) of all marinas will be inundated due to their proximity along the coast.

For the first increment, which assumes one (1) foot of SLR, the greatest impact is to Washington County, where 197 critical facilities, residences and commercial structures would be impacted. A one (1) foot increase would impact a total of 451 residences and commercial areas statewide. If sea levels increase by three (3) feet, Washington County would again face the most significant impacts, followed by Newport County, with impacts to a total of 863 critical facilities, residences and commercial structures statewide. Five (5) feet of SRL would have the greatest impact on Washington, Newport, and Bristol Counties. The number of homes and commercial structures impacted at five (5) feet of SLR would total 4,272 statewide.

Depending on the structures impacted, the economy could be dramatically increased. Coastal communities rely on businesses and beaches to attract tourists to come to their communities. SLR can make beaches and businesses unusable, dramatically impacting the Rhode Island coastal communities.

Risk and Vulnerability to Critical Infrastructure

Flooding caused by SLR can impact schools, hospitals, and other public infrastructure which impacts the public's ability to use these services. Road infrastructure can be impaired or compromised based on the size and scale of flooding, which can also disrupt transportation infrastructure. This can lead to impacts on access to critical services as well, as certain road closures prohibit or restrict access to healthcare. Water sources can become contaminated with toxic chemicals, dangerous chemicals, or fecal matter. Because water and sewer systems may be disrupted, solid-waste collection and disposal may also be impacted, causing dangerous public health risks.

Extensive and consistent flooding caused by SLR may result in direct damage to critical infrastructure as well as road closures and event evacuation of residences and businesses. Depending on the severity of the flood, utilities and infrastructure may be damaged. Flooding may force critical facilities to look for supplemental power (generators) or water supplies. Inundation of drinking water/stormwater systems can degrade the infrastructure or require or intense treatment. Roadways would become flooded, resulting in essential facilities becoming isolated or emergency services rerouted in response to calls.

Risk to State-owned and critical facilities were evaluated for each SLR risk class by facility category. Exposed State-owned and critical facilities were tabulated by county. Facilities data did not have building contents or exposure value and, as a result, this analysis does not include total exposure or monetary loss estimates. Welfare state facility in Newport County and Block Island state facility in Washington County intersected with the MHHW. The following is a list of notable critical facilities that will be affected by SLR, and Table 3-75 and Table 3-76 discuss the exposure analysis for all critical facilities:

- Striper Marina (Bristol County)
- Angel's Marina (Kent County)
- Pawtuxet Reservoir Lower Dam (Kent County)
- Christie's Restaurant (Newport County)
- Newport Yacht Club, Harbor Court (Newport County)
- Newport Fire Department Station 1 (Newport County)
- Old Harbor Marina (Providence County)
- Rhode Island Yacht Club (Providence County)
- Avondale Boatyard Inc. (Washington County)
- Kenport Marina. (Washington County)
- Wickford Yacht Club (Washington County)

These facilities may be at increased threat of flooding or permanent inundation due to SLR. If these facilities are damaged as a result of SLR, the provision of state services may be disrupted. As sea level gradually increases, access to facilities located in low-lying areas or near the coast may be restricted if roads become flooded. Alternatively, equipment or facilities in low-lying areas may gradually be inundated, resulting in damage to equipment, structural integrity of facilities, or even injury to state employees.

While not considered in the analysis of critical facilities, state-owned beaches are a critical attraction for tourism of the state. SLR will dramatically impact the State's ability to attract tourist to the area and cost the state to reconstruct beaches.

3.21.6.3 Risk and Vulnerability to the Environment

There may be increased risk of damage to the environment caused by factors of SLR. SLR will cause more frequent and severe instances of flooding, storm surge, and coastal erosion. Inundation caused by SLR may cause contamination of food or water resources (e.g., water treatment facilities, agricultural crops) with toxic material or human waste, and water or sewer systems may be completely disrupted. Storm surge may also cause flooding (and subsequent contamination of resources).

When coastal areas flood, there is a chance that some of the land will be washed away with the water, resulting in coastal erosion. This could be detrimental to environments or habitats located directly

on shorelines.

3.21.6.4 Risk and Vulnerability to State Operations

Unless steps are taken to implement mitigation projects, state facilities may be at increased risk of damage caused by SLR, which could result in increased expenses to repair or maintain facilities or disruption of state provided services given the secondary effects of SLR (e.g., flooding, storm surge). If facilities are flooded or otherwise impacted by incremental SLR, the state will need to fund the removal/reconstruction of those facilities to a safer location within the state.

Extensive and consistent flooding caused by SLR may result in direct damage to critical infrastructure, impact schools, hospitals, and other public infrastructure which impacts the public's ability to use these services. As detailed in the Risk and Vulnerability to Critical Infrastructure section, the impacts from flooding can cause dangerous public health risks and significantly impede the ability of first responders to perform critical job functions.

Roadways can become flooded more frequently due to the effects of SLR, resulting in essential facilities becoming isolated or emergency services rerouted in response to calls. A catastrophic flood could lead to injury or death. Flooding may result in significant delays in responding to emergency calls for assistance and death. Depending on the extent of the flooding, first responders may face increased risk of injury themselves.

3.22 Severe Winter Weather

3.22.1 Description

Severe winter weather includes heavy snow and ice storms that can affect the entire state. A heavy snow is generally defined as having more than nine (9) inches of accumulation in less than 24 hours (Winter Storm Warning for Heavy Snow).[131] Heavy snow can bring a community to a standstill by inhibiting transportation, knocking down trees and utility lines, and causing structural collapse in buildings, and infrastructure not designed to withstand the weight of the snow. Repair and snow removal costs can be significant and surpass annual municipal salt and snow removal budgets, often before the end of the season. A winter storm warning is issued when there is an expected winter weather event within the 12 to 36 hours with more than one (1) predominant hazard (i.e., heavy snow and blowing snow [below blizzard conditions], snow and ice, snow and sleet, sleet and ice, or snow, sleet and ice) meeting or exceeding warning criteria for at least one (1) of the precipitation elements. It may also be issued when there are over eight (8) inches of sleet, snow, or ocean effect snow expected averaged over a forecast zone in a 24-hour period.

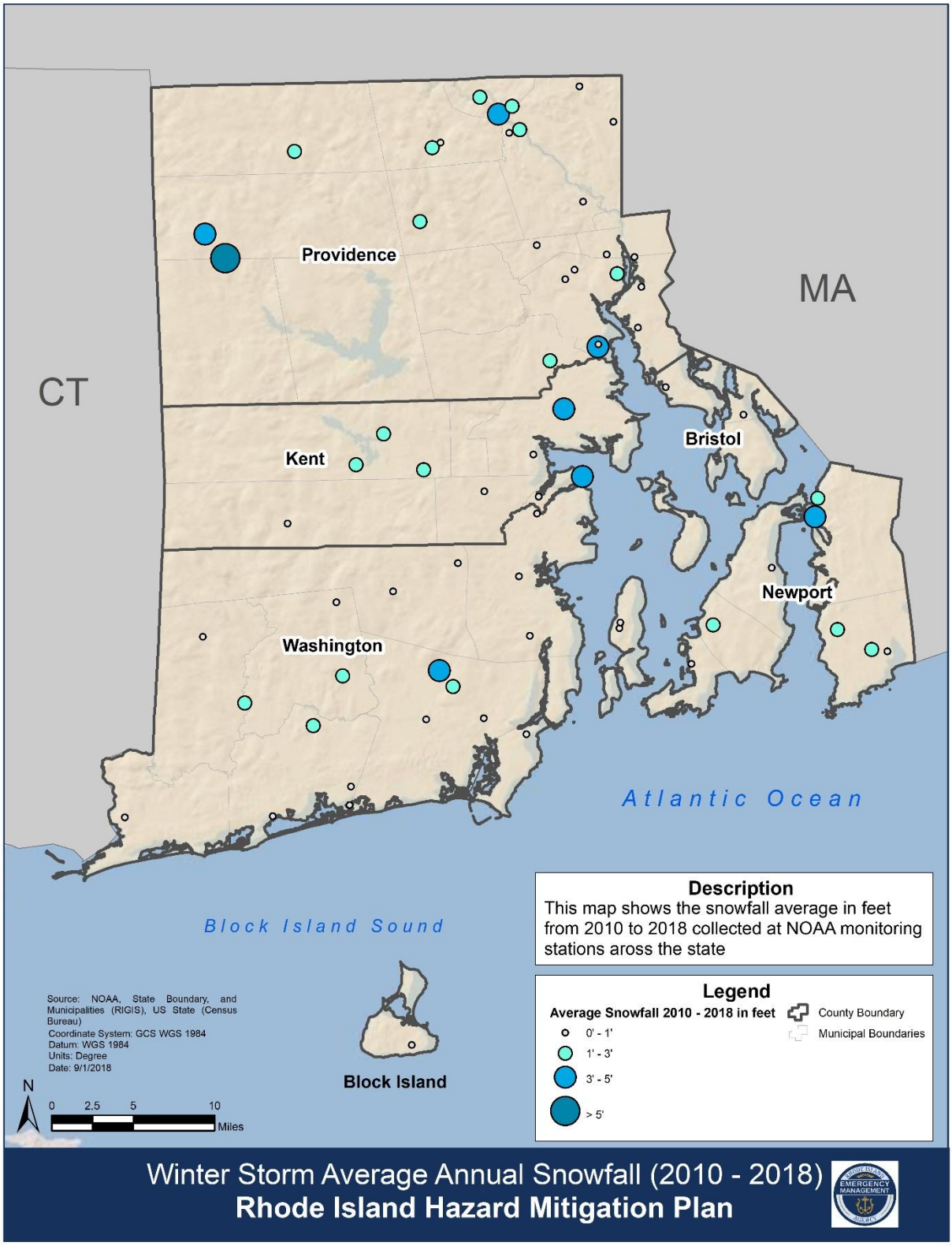
The term ice storm is used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Ice storm warnings are issued in the event of one-half (0.5) an inch or greater accretion of freezing rain. Freezing rain most commonly occurs in a narrow band within a winter storm that is also producing heavy amounts of snow and sleet in other locations.

3.22.2 Location

Average annual snowfall based on extrapolation of weather station snow climatology data is shown in the figure below. Although somewhat more variable in terms of distribution, northwest portions of Providence and Kent counties see these heavy snowfall events with greater frequency (roughly five (5) or six (6) events per year) compared to Bristol, Newport, and Washington counties that tend to have less than two (2) significant events per year. Providence County will likely see annual snowfall totals over 57 inches, with the greatest impacts and vulnerability in western Glocester and northern Foster communities. Burrillville and Scituate also have an elevated risk and associated damages. The majority of the estimated annualized damage for Providence County will be located within these four (4) municipalities. Heavy snow can affect the entire State of Rhode Island, but the highest amounts occur in the northern areas of the state and some coastal communities as shown in the figure (Figure 3-22) below. This figure is based on best available data from NOAA's Global Historical Climate Network Daily dataset. This dataset summarizes daily snowfall totals reported by stations in Rhode Island. The total snowfall from 2010 to 2018 was summarized by station and averaged for the reporting time period.

[131] NWS, n.d. National Weather Service Expanded Winter Weather Terminology. Retrieved at: https://www.weather.gov/bgm/WinterTerms.

Figure 3-22 Rhode Island Average Annual Snowfall Reported (2010-2018)



3.22.3 Extent

Based on the data collected from 1981 to 2010, the average annual snowfall for Rhode Island is 33.8 inches, which exceeds the national average of 22.4 inches.[132] The known record snowfall occurred from February 5 to February 7, 1978, during the Blizzard of 1978. The storm produced hurricane-force winds and resulted in over 27 inches of snow accumulation in Providence and up to 38 inches of snow accumulation in other parts of the state. This event serves as the storm of record for Rhode Island.

Even though there is no universally accepted scale to measure a snowstorm, the Northeast Snowfall Impact Scale (NESIS), developed by Paul Kocin and Louis Uccellini of the NWS, characterizes and ranks high-impact Northeast snowstorms. These storms have large areas of 10-inch snowfall accumulations and greater.[133] The five (5) categories of NESIS are: Extreme, Crippling, Major, Significant, and Notable shown in Table 3-61. The index differs from other meteorological indices in that it uses population information, considering how many people live in the path of the storm, in addition to meteorological measurements.[134] Thus, NESIS gives an indication of a storm's societal impacts. The Blizzard of 1978 scored a 6.25 on the scale and was classified as Crippling based on its widespread impact and extreme conditions.

Table 3-61 NESIS Values

Category	NESIS Value	Description
1	1—2.499	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10.0+	Extreme

Ice storms can be the most devastating winter weather phenomena and are often the cause of automobile accidents, power and communication system outages, personal injury, and death. Moreover, they can hinder the delivery of emergency services needed in response to these catastrophes and endanger the responders. Ice storms accompanied by wind gusts cause the most damage.

The Sperry-Piltz Ice Accumulation (SPIA) Index is a scale for rating ice storm intensity, based on the expected storm size, ice accumulation, and damage on structures, especially exposed overhead utility systems. Sid Sperry of the Oklahoma Association of Electric Cooperatives and Steven Piltz from the NWS office in Tulsa, Oklahoma, developed the index together. The SPIA Index uses forecast information to rate an upcoming ice storm's impact from zero (0) (little impact) to five (5) (catastrophic damage to exposed utility systems), as shown below in Figure 3-23.

[132] NOAA NCEI, n.d. 1981-2010 U.S. Climate Normals. Retrieved at: https://www.ncdc.noaa.gov/data-access/land-based-station-data/land-based-datasets/climate-normals/1981-2010-normals-data.
[133] NOAA NCEI, n.d. Regional Snowfall Index (RSI). Retrieved at: https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis.
[134] NOAA NCEI, n.d. Regional Snowfall Index (RSI). Retrieved at: https://www.ncdc.noaa.gov/snow-and-ice/rsi/nesis.

Figure 3-23 SPIA Index

The Sperry-Piltz Ice Accumulation Index, or "SPIA Index" – Copyright, February, 2009

ICE DAMAGE INDEX	* AVERAGE NWS ICE AMOUNT (in inches) *Revised-October, 2011	WIND (mph)	DAMAGE AND IMPACT DESCRIPTIONS
0	< 0.25	< 15	Minimal risk of damage to exposed utility systems; no alerts or advisories needed for crews, few outages.
1	0.10 – 0.25	15 - 25	Some isolated or localized utility interruptions are possible, typically lasting only a few hours. Roads and bridges may become slick and hazardous.
	0.25 – 0.50	> 15	
2	0.10 – 0.25	25 - 35	Scattered utility interruptions expected, typically lasting 12 to 24 hours. Roads and travel conditions may be extremely hazardous due to ice accumulation.
	0.25 – 0.50	15 - 25	
	0.50 – 0.75	< 15	
3	0.10 – 0.25	> = 35	Numerous utility interruptions with some damage to main feeder lines and equipment expected. Tree limb damage is excessive. Outages lasting 1 – 5 days.
	0.25 – 0.50	25 - 35	
	0.50 – 0.75	15 - 25	
	0.75 – 1.00	< 15	
4	0.25 – 0.50	> = 35	Prolonged & widespread utility interruptions with extensive damage to main distribution feeder lines & some high voltage transmission lines/structures. Outages lasting 5 – 10 days.
	0.50 – 0.75	25 - 35	
	0.75 – 1.00	15 - 25	
	1.00 – 1.50	< 15	
5	0.50 – 0.75	> = 35	Catastrophic damage to entire exposed utility systems, including both distribution and transmission networks. Outages could last several weeks in some areas. Shelters needed.
	0.75 – 1.00	> = 25	
	1.00 – 1.50	> = 15	
	> 1.50	Any	

(Categories of damage are based upon combinations of precipitation totals, temperatures and wind speeds/directions.)

3.22.4 Previous Occurrences

In Rhode Island, there is no single database or repository of consistent, detailed descriptions of the types of ongoing "normal" winter hazards that occur. The NCEI Storm Event Database tracks reported Winter Storm Events defined as: "A winter weather event that has more than one (1) significant hazard (i.e., heavy snow and blowing snow; snow and ice; snow and sleet; sleet and ice; or snow, sleet and ice) and meets or exceeds locally/regionally defined 12- and/or 24-hour warning criteria for at least one (1) of the precipitation elements."[135] This definition may not encompass all severe winter weather events; however, it represents some of the most severe events. The information reported has been compiled into Table 3-62.

Major disaster declaration DR-4212, or Winter Storm Juno, was declared on April 3, 2015 for Bristol, Kent, Newport, Providence and Washington counties. This Severe Winter Storm and Snowstorm occurred during the period of January 26, 2015, to January 28, 2015. The Governor requested that federal assistance funds be available to the state and eligible local governments and private nonprofit organizations on a cost-sharing basis for emergency work and the repair or replacement of damaged facilities in Bristol, Kent, Newport, Providence, and Washington counties. In addition, the disaster declaration authorized snow assistance for a period of 48 hours for Bristol, Kent, Newport, Providence, and Washington counties.

Another major disaster declaration DR-4107 was declared on March 22, 2013, due to a severe winter storm and snowstorm in Bristol, Kent, Newport, Providence, and Washington counties. Reports

[135] NWS, 2016. Storm Data Instruction. Retrieved at: http://www.nws.noaa.gov/directives/sym/pd01016005curr.pdf.

indicated that this storm stretched from New Jersey to Maine and into Canada. More than two (2) feet of snow fell in Rhode Island overnight. National Grid estimated more than 180,000 customers lost power.

Table 3-62 Winter Weather Storm Events (1996 – 2018)[136]

County Name	Number of Events	Annualized Events	Total Reported Damages	Annualized Damages
Bristol	58	2.52	$135,000.00	$5,869.57
Kent	153	6.65	$497,000.00	$21,608.70
Newport	56	2.43	$291,000.00	$12,652.17
Providence	185	8.04	10,955,000.00	$476,304.35
Washington	72	3.13	$220,000.00	$9,565.22
			Total	$625,520.34

3.22.5 Probability of Future Events

The probability of winter weather events in Rhode Island is difficult to accurately determine. Days of frigid, arctic air and below freezing temperatures may be followed by days of mild temperatures in the 40s or 50s. While snowfall and rainfall amounts can vary from year to year, Rhode Island residents can expect to experience about one (1) Nor'easter per winter. A Nor'easter storm can bring high wave action that causes coastal erosion in addition to blizzard conditions or heavy rainstorms dependent on the temperature. Additional information related to Nor'easter events in Rhode Island can be found in Section 3.26.

Winter storms have had significant impacts on Rhode Island in the past and are likely to impact the state in the future. An examination of NCEI data suggests that on an annual basis, approximately two (2) to seven (7) winter weather events of some significance will occur in any particular county (Table 3-62). This can be related to a highly likely probability of occurrence (greater than 90% annual probability). Table 3-62 provides the annualized events qualitative ranking used for determining probability of future events.

3.22.6 Vulnerability and Risk Assessment

3.22.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined severe winter storms to be a high priority hazard in Rhode Island. As described in the profile above, severe winter weather events within the state are highly likely to occur with an annual probability of greater than 90%. Severe winter weather events have a large range of impact, affecting 40% to 100% of the jurisdictions in the state. The probable magnitude for severe winter weather ranges from negligible magnitude, with no shutdown of critical infrastructure and facilities, to limited magnitude, including some injuries and less than 10% of residential and commercial structures damaged from the events. The

[136] NOAA NCEI, n.d. Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/.; Period was analysis was chosen based on available data from the NCEI Storm Events Database under the "Winter Storm" event type.

impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-63 outlines the hazard rankings for each of the hazard priority criteria related to severe winter storms.

Table 3-63 Severe Winter Weather Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
Kent County								
Newport County								
Providence County								
Washington County								

3.22.6.2 Risk and Vulnerability to People and Property

Impacts of severe winter weather are primarily quantified by the financial costs associated with preparing for, responding to, and recovering from severe winter weather. In general, the northwestern areas of Rhode Island experience winter weather of significance with greater frequency than the rest of the state.

Risk and Vulnerability to People (Injuries and Death)

Injuries and deaths related to heavy snow usually occur due to vehicle accidents and hypothermia. Casualties also occur due to overexertion while shoveling snow and hypothermia caused by overexposure to the cold weather. Cold temperatures also lead to a decrease in immune system function, causing the body to become more susceptible to illness and disease.

Winter-related events can adversely affect people, but infants, persons 65 years or older, and the homeless population are especially vulnerable. General observations by NOAA indicate that of injuries related to winter storms, 50% are experienced by those over 60 years old, with males incurring approximately 75% of overall injuries. Approximately 70% of injuries occur in automobiles and 20% of injuries occur in or around the home.[137] The majority of injuries related to winter storms are attributed to males over 40 years old (e.g., from heart attacks while shoveling snow).

Human vulnerability is impacted by the availability, reception, understanding of advanced warnings of impending significant winter weather events (e.g., Winter Storm Watches and Warnings issued by the NWS), and heeding the advice of local officials. In some cases, despite having access to technology (e.g., computers, radio, television) and resources (e.g. shelters, warming stations for homeless) that enable the reception of a watch or warning, language barriers may prevent individuals from understanding and responding appropriately. Socially vulnerable populations and rural communities are especially at risk during winter storms. Outdoor animals are also susceptible to exposure to extreme cold, which may lead to illness or death.

Risk and Vulnerability to Property (Structures and Facilities)

Damage to homes, vehicles, structures, and resources may adversely affect response activities. Downed powerlines can lead to a loss of electricity and heat in homes and businesses. Extended power outages would require residents to identify supplemental heat sources and increase the risk for injury or death caused by house fires or CO poisoning. The second leading cause of all reported house fires and deaths caused by house fires are attributed to heating equipment usage, according to the National Fire Protection Association. Improper use of heating equipment is generally attributed to failure to adequately clean heating equipment (30% of heating equipment related fires) or placing it too close to flammable items (56% of heating equipment related fires). The CDC estimate that at least 430 people die annually from CO poisoning.

Rhode Island state building codes were first implemented in 1981 and have been updated periodically (an approximate average of every two (2) to three (3) years) since their implementation. The state building codes account for the unique features and hazards of building in Rhode Island, to

[137] NOAA, n.d. Severe Weather 101: Winter Weather Basics. Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/winter/.

include severe weather events. It is estimated that approximately 79% of residential homes are facing a higher risk of damage than homes built after 1981.[138]

Additionally, U.S. Census Data indicates that 69.9% of residents rely on electricity or utility gas to heat their homes. While gas may still be available during a power outage, equipment required to convert the gas to heat (i.e., furnaces) may not function if they have electric components. Attempts to re-ignite furnaces without adequate knowledge, proper ventilation, or failure to notice the smell of gas may cause injury to the individual by igniting gas and causing burns or fires.

Risk and Vulnerability to Critical Infrastructure

Electrical utilities and communications infrastructure, as well as transportation systems, are vulnerable to damage from winter storms. These damages may cause disruptions in service for residents, businesses, and critical facilities. Reduced functionality or loss of critical infrastructure may have devastating impacts on the economy. Without power, communications, or transportation, commerce will slow or completely halt until the infrastructure is restored. Employees will be unable to commute to work, unable to conduct operations without power, or unable to purchase goods or services with bank cards or credit cards. The cost of snow removal, repairing damage, and the loss of business caused by power outages can have severe economic impacts on Rhode Island cities and towns.

Roads and bridges may be heavily impacted by severe winter weather which can cause detours and, delays. Roads and bridges can be completely obstructed by downed trees, powerlines, and snow accumulation. Snow and ice can impact access to homes and critical facilities such as hospitals, schools, and supermarkets. Power loss can lead to disruption of critical infrastructure and technology. Additional information related to infrastructure failure can be found in Section 3.18.

To address the vulnerability of infrastructure to the impacts of ice storms, it is important to complete an inventory of utility lines as they are susceptible to breakage, resulting in power failure. This can be caused by over-hanging ice or tree limbs above the lines. Rhode Island has GIS data for its electric transmission lines found online in their RIGIS system.[139]

3.22.6.3 Risk and Vulnerability to the Environment

Heavy snow and ice accumulation can weigh down and damage vegetation and tree limbs in addition to utility lines. Flooding may also occur after the rapid melting of a heavy snowfall, or ice jams, causing bodies of water to flood, damaging the surrounding areas. Secondary effects of rapid snow or ice melt also include mudslides or landslides.

Damage to materials and facilities may allow dangerous chemicals and agents to leak into natural environments and water reservoirs, causing contamination or additional damage. Agricultural crops may be susceptible to permanent damage due to cold temperatures or become contaminated by hazardous materials in the event of damage to nearby facilities or equipment.

[138] U.S. Census data only provides estimates by decade; therefore, buildings built in 1980 are included in the estimate despite the fact that the Rhode Island state building code had yet to be implemented.
[139] RIGIS, n.d. Rhode Island Geographic Information System. Retrieved at: http://www.rigis.org/datasets?t=UTILITY.

3.22.6.4 Risk and Vulnerability to State Operations

State and critical facilities often do not have redundant power sources and are not wired to accept a generator for auxiliary heat. Therefore, power disruptions could have adverse impacts on state operations by causing disruptions to the usability of facilities or infrastructure.

Dangerous road conditions create a transportation challenge for first responders. First responders may have to manage the evacuation of people from snow impacted areas, as well as direct traffic, close roads, operate shelters, and take care of the injured and sick. First responders must control their own exposure to the elements for prolonged periods of time and may need to continuously seek heat and shelter to stay warm. Equipment may also be damaged or destroyed due to cold temperatures, heavy wind, ice, and heavy snow fall, which may lead to a decrease in response capabilities.

Snow and ice can cause disruptions in transportation lines and utilities resulting in emergency response delays. Increased need for emergency services to respond to injuries, deaths, or fires may tax the first response system. Deteriorated road conditions may delay the timeliness with which these services are provided. First responders will need to exercise caution when performing job duties to prevent injury to themselves or others.

The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

3.23 Terrorism

3.23.1 Description

The Federal Bureau of Investigation defines terrorism incidents as the "unlawful use of force or violence against persons or property to intimidate, or coerce a government, civilian population, or any segment thereof in the furtherance of political and social objectives."[140] Acts of terrorism are typically perpetrated by violent extremists, with threats coming from a range of groups and individuals, including domestic terrorists and homegrown violent extremists in the United States, as well as international terrorist groups like al-Qaeda and the Islamic State of Iraq and the Levant (ISIL). The use of the internet and social media to recruit and radicalize individuals to violence means that conventional approaches are unlikely to identify and disrupt all terrorist plots. Lone offenders or small groups may be radicalized to commit violence at home or attempt to travel overseas to become foreign fighters.

One (1) of the trends in the terrorist threat is the use of improvised explosive devices (IEDs). IEDs make a lethal impact, while requiring a relatively low level of technical skill to produce them. Major high-profile acts of terrorism using IEDs included the first World Trade Center attack in 1993 and for the Oklahoma City bombing in 1995. This threat has expanded to include both vehicle-borne IEDs and small arms attacks. These bombs have an enormous potential to create an atmosphere of fear and uncertainty, thereby influencing public perception. For example, a car bomb exploding in the middle of a busy urban setting quickly undermines emergency response efforts to protect the public. A significant trend in acts of terrorism is the execution of complex coordinated terror attacks (CCTAs) by terrorist groups. CCTAs often involve multiple attacks in different locations perpetrated by multiple individuals with IEDs and high capacity weapons.

In recent events, terrorist activity has been conducted by an active shooter. Active shooters are defined as an individual or group of individuals actively engaging in killing or attempting to kill people in a confined and populated area using a firearm. An active shooter may be a disgruntled student or group of students, an employee, or an anti-government/anti-political/extremist citizen or group. Other types of terrorism, including chemical, nuclear, and biological weapons has occurred less than a handful of times in the last 50 years.

3.23.2 Location

The entire State of Rhode Island is vulnerable to terrorism, particularly in densely populated urban areas or crowded venues. Specifically, the Cities of Providence (Providence County) and Newport (Newport County) may be key targets for terrorist activity due to their large tourist populations. However, it is nearly impossible to pinpoint the exact location of the next terrorist attack so all five (5) counties in Rhode Island are vulnerable. Through information and intelligence sharing, public safety personnel at the local, state, and federal level help identify potential targets for terrorist activity. Although it is impossible to predict for certain where the next terrorist attack will take place, terrorists generally target large, crowded places, such as malls, parks, and other large public or social gatherings, in order to maximize damage. In addition, some acts of terror are conducted against critical infrastructure in an effort to weaken or cripple services on which American daily life depends, such as transportation, communications, and electricity.

[140] Federal Bureau of Investigation, 2005. Terrorism 2002 – 2005. Retrieved at: https://www.fbi.gov/stats-services/publications/terrorism-2002-2005.

Although events such as the World Trade Center bombing and destruction (in 1993 and 2001) and Oklahoma City bombing (in 1995) did not occur in Rhode Island, the threat, real or implied, to employ terrorism in this state remains. Threats often involve the employment of weapons of mass destruction (WMD), to include bombs, pathogens, or IEDs, and can be directed at targets in both rural and urban-industrial settings.

3.23.3 Extent

In the United States, acts perpetrated by violent extremists have far-reaching consequences, including structural and infrastructure damage, mass casualty and fatality incidents, environmental harm, decreased national morale, heightened perceived risk and fear by the public, and economic impacts. Large-scale terrorist attacks, such as those committed during the September 11, 2001 terrorist attacks in New York City, demonstrate the significant catastrophic extent, including 2,977 deaths and approximately $38.1 billion dollars in compensation (including federal funding, insurance, and charitable donations), of a terrorist attack.[141]

Terrorism threat extent is determined using the National Terrorism Advisory System. This system provides three (3) levels of alert, including: elevated, intermediate, or imminent. This system provides a summary of the terrorism threat, additional details regarding the threat, a duration for the threat, and information for how the public can help and be prepared.[142]

3.23.4 Previous Occurrences

Although there has not been a terrorist attack in the State of Rhode Island, this does not reduce the significance of the threat, nor does it undermine the examples of terrorism that have occurred on United States soil. In addition to the World Trade Center attacks in 1993 and 2001 and the Oklahoma City bombing, which have already been discussed, recent terrorist attacks have occurred in large, populated areas, though the venues, times, and locations of the attacks differ. These events demonstrate the realistic and terrifying consequences of terrorist attacks. Examples of these events include:

- Boston Marathon Bombing (2013)
- Paris Bombing (2015)
- San Bernardino Mass Shooting (2015)
- Orlando Shooting (2016)
- New York City Truck Attack (2017)

There have been two (2) federal disaster declarations directly referred to as terrorist attacks in the past, including the terrorist attacks of September 11th (DR-1391 [New York] and DR-1392 [Virginia]). The response to the efforts outlined above required extensive coordination and communication on behalf of the responders, to include extensive logistics and resource support, as well as financial ramifications.

[141] RAND, 2004. Compensation for the Losses from the 9/11 Attacks. Retrieved at: https://www.rand.org/content/dam/rand/pubs/monographs/2004/RAND_MG264.pdf.
[142] Department of Homeland Security, 2018. National Terrorism Advisory System (NTAS). Retrieved at: https://www.dhs.gov/national-terrorism-advisory-system.

3.23.5 Probability of Future Events

Although it is difficult to predict when and where the next terrorist attack will occur, the intelligence community across the local, state, and federal levels is continually gathering information to prevent future events from occurring. Heightened tensions in the Middle East and increased traction by ISIL have increased the risk of additional terrorist attacks from occurring. Therefore, countering violent extremism has become a key focus of the work of the Department of Homeland Security in securing the homeland. Countering violent extremism efforts aims to address the root causes of violent extremism by providing resources to communities to build and sustain local prevention efforts and promote the use of counter-narratives to confront violent extremist messaging online. Building relationships based on trust with communities is essential to this effort. Based on past hazard data, the likelihood of a terrorism incident occurring in the next one (1) to five (5) years is potential, with a 1% to 49.9% likelihood.

3.23.6 Vulnerability and Risk Assessment

3.23.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined terrorism to be a moderate priority hazard in Rhode Island. As described in the profile above, terrorist events within the state have the potential to occur with annual probability ranging between 1% and 49.9%. Terrorist events have a small range of impact, accounting for 10% or less of the jurisdictional boundaries. The magnitude of an act of terrorism is considered to be limited, including some injuries, short shutdown of critical facilities and infrastructure, and less than 10% of residential and commercial structures damaged from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-64 outlines the hazard rankings for each of the hazard priority criteria related to terrorism.

Table 3-64 Terrorism Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Potential** *1 to 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Severe** *Multiple deaths and severe injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**

3.23.6.2 Risk and Vulnerability to People and Property

Rhode Island is vulnerable both to attacks on the jurisdictions within the state and to the residual effects of an attack on surrounding states and metropolitan areas. In general, areas with higher population and development density are more vulnerable to adverse effects of terrorism events.

Risk and Vulnerability to People (Injuries and Death)

Terrorist activities such as bombings, kidnappings, shootings, and hijackings pose a direct threat to people, causing considerable injury and death. A WMD attack could kill and injure hundreds to thousands of people, which could overwhelm hospitals in the five (5) counties and the surrounding areas.

In addition to the direct effects of terrorism activities to people, there are also indirect effects of terrorism. Depending on the type of attack, infrastructure may be impacted, making transportation extremely challenging and limiting access to facilities like hospitals, or limiting utility services. Terrorism can also impact the state economy, as people may stay home until they feel safe and not travel for tourism as much as they would have. The terrorism event may limit access to goods and services, and general day-to-day activities will change, thus impacting quality of life of the public.

Risk and Vulnerability to Property (Structures and Facilities)

Terrorists utilize multiple methods to carry out attacks. Methods include explosive devices, shootings and close quarter attacks, kidnappings, and attacks involving chemicals and biological and radiological agents. Additionally, some instances of cyberattack may be considered terrorism. Methods and weapons of terrorism continue to evolve. Explosives prove a particularly impactful measure utilized during acts of terrorism due to their ability to cause severe damage to property. As the bombing in Oklahoma City displayed, materials and opportunities to obtain, manufacture, and detonate the explosives are relatively easy for civilians to access, while not always are immediately identified by authorities.

Because they are so difficult to anticipate and detect, nearly every type of structure is vulnerable to a conventional bomb. Some structures are more likely to be targets of IEDs than others, such as buildings with great political or economic importance. Even if the structures surrounding the incident or explosion were not the direct target, they are likely to sustain damage. This damage may require construction to return the structure to its original state. Investigations of the act of terrorism may also deem certain facilities inaccessible for a considerable amount of time. Both the reconstruction effort and the investigation create timelines which will directly affect the facilities operations.

There could be cascading impacts on the economy when certain structures or facilities are affected. If large warehouses are destroyed, the ability of goods and services to be provided to community is reduced, and if small businesses are destroyed, the local economy is impacted.

Risk and Vulnerability to Critical Infrastructure

The potential impact posed to critical infrastructure through the use of explosives is significant. Communication and power supply infrastructure are highly susceptible to this type of attack, which results in adverse impacts to businesses, residences, and critical facilities.

Due to its continued online interconnectivity, critical infrastructure has become more and more susceptible to acts of cyber terrorism. While cyber terrorism would not necessarily destroy the physical presence of critical infrastructure, it has the potential to shut down operations, which could in turn destroy physical structures if cyber terrorists were able to compromise internal systems and programs which provide service delivery.

3.23.6.3 Risk and Vulnerability to the Environment

Terrorist attacks involving bombings and arson pose considerable negative impacts to the environment in the form of smoke and destruction of vegetation. A terrorist attacks utilizing chemical, nuclear, and biological weapons pose a significantly higher risk to the environment based on the direct effect of those weapons. If a terrorist attack were to utilize chemical, nuclear, or biological weapons the impact would cause immediate and potentially long-lasting contamination of the area. The use of chemical, nuclear, or biological weapons in an act of terrorism would certainly impact natural preserves (both directly and indirectly) and possibly affect food sources throughout the food-chain.

3.23.6.4 Risk and Vulnerability to State Operations

Common types of terrorism (explosions, fires, vandalism, and shootings) are the same kind of critical incidents first responders handle on a daily basis. While the initial response will follow standard operating procedures for response, once an incident has been determined to be an act of terrorism, federal operations will take over the investigation. This will require state operations to maintain a close working relationship with federal operations.

Targets of an armed attack vary; however, in recent history, schools, office buildings, federal and state-owned buildings, religious institutions, military installations, and large public areas have all been subject to armed attacks. Large-scale bombings can also pose a significant threat to state operations and decrease the public's confidence in the state's ability to respond and govern. To prevent the loss of confidence in government, response across local, state, regional, and federal bodies must be as effective and efficient as possible to prevent injury and death.

3.24 Thunderstorms

3.24.1 Description

Thunderstorms are formed when atmospheric conditions combine to provide moisture, lift, and warm and unstable air that can rise rapidly. Thunderstorms occur any time of the day and in all months of the year, but are most common during summer afternoons and evenings, and in conjunction with frontal boundaries. The NWS classifies a thunderstorm as severe if it produces hail at least one (1) inch in diameter, winds of 58 mph or greater, or a tornado. About 10% of the estimated 100,000 annual thunderstorms that occur nationwide are considered severe. [143] Thunderstorm events affect a smaller area compared with winter storms or hurricanes, but they are still dangerous and destructive. Storms can form in less than 30 minutes, giving very little warning; they have the potential to produce lightning, hail, tornadoes, powerful straight-line winds, and heavy rains that produce flash flooding.

Lightening

All thunderstorms produce lightning, and therefore all thunderstorms are dangerous. Lightning often strikes outside of areas were it is raining and may occur as far as 10 miles away from rainfall. Lightning can strike from any part of the storm and may even strike after the storm has passed. Hundreds of people across the nation are injured annually by lightning, most commonly when they are moving to a safe place but have waited too long to seek shelter.[144] Lightning strike victims often suffer long-term effects such as memory loss, sleep disorders, weakness and fatigue, chronic pain, depression, and muscle spasms. Lightning also has the potential to start both urban fires and wildfires. Lightning causes an average of 55 to 60 fatalities, 400 injuries, and over $1 billion in insured losses annually nationwide.

Hail

Hail is formed in towering cumulonimbus clouds (thunderheads) when strong updrafts carry water droplets to a height at which they freeze. Eventually, these ice particles become too heavy for the updraft to hold up, and they fall to the ground at speeds of up to 120 mph. Hail falls along paths called swaths, which can vary from a few square acres to up to 10 miles wide and 100 miles long.[145] Hail larger than three-quarters (0.75)-inch in diameter can do great damage to both property and crops, and some storms produce hail over two (2) inches in diameter. Hail causes about $1 billion in damage annually in the U.S.

3.24.2 Location

All counties in Rhode Island are vulnerable to risks and hazards associated with thunderstorms. Based on NCEI Storm Events Database, Providence County has experienced the most thunderstorm events, accounting for 42.4% of the thunderstorm events between 1955 and 2018. The specific number and location of events according to NCEI Storm Events Database is outlined in Table 3-65.

[143] National Severe Storms Laboratory, n.d. Severe Weather 101: Hail Basics. Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/hail/
[144] NWS, n.d. Lightning Myths and Facts. Retrieved at: https://www.weather.gov/safety/lightning-myths.
[145] Ibid

3.24.3 Extent

NOAA classifies types of thunderstorms as any of the following: single-cell, multi-cell, squall line, supercell, bow echo, mesoscale convective system, mesoscale convective complex, mesoscale convective vortex, and derecho, which are defined below:[146]

- **Single-cell thunderstorms** are small, brief, weak storms that grow and die within an hour or so. They are typically driven by heating on a summer afternoon. Single-cell storms may produce brief heavy rain and lightning.
- **A multi-cell storm** is a common, garden-variety thunderstorm in which new updrafts form along the leading edge of rain-cooled air (the gust front). Individual cells usually last 30 to 60 minutes, while the system as a whole may last for many hours. Multi-cell storms may produce hail, strong winds, brief tornadoes, and/or flooding.
- **A squall line** is a group of storms arranged in a line, often accompanied by "squalls" of high wind and heavy rain. Squall lines tend to pass quickly and are less prone to produce tornadoes than are supercells. They can be hundreds of miles long but are typically only 10 or 20 miles wide.
- **A supercell** is a long-lived (greater than one [1] hour) and highly organized storm feeding off an updraft (a rising current of air) that is tilted and rotating. This rotating updraft—as large as 10 miles in diameter and up to 50,000 feet tall—can be present as long as 20 to 60 minutes before a tornado forms. Scientists call this rotation a mesocyclone when it is detected by Doppler radar. The tornado is a very small extension of this larger rotation. Most large and violent tornadoes come from supercells.
- **A bow echo** is a radar signature of a squall line that "bows out" as winds fall behind the line and circulations develop on either end. A strongly bowed echo may indicate high winds in the middle of the line, where the storms are moving forward most quickly. Brief tornadoes may occur on the leading edge of a bow echo. Often the north side of a bow echo becomes dominant over time, gradually evolving into a comma-shaped storm complex.
- **A Mesoscale Convective System (MCS)** is a collection of thunderstorms that act as a system. An MCS can spread across an entire state and last more than 12 hours. On radar one (1) of these storms might appear as a solid line, a broken line, or a cluster of cells. This all-encompassing term can include any of the following storm types:
    - **A Mesoscale Convective Complex (MCC)** is a large, circular, long-lived cluster of showers and thunderstorms identified by satellite. It often emerges out of other storm types during the late-night and early-morning hours. MCCs can cover an entire state.
    - **A Mesoscale Convective Vortex (MCV)** is a low-pressure center within an MCS that pulls winds into a circling pattern, or vortex. With a core only 30 to 60 miles wide and one (1) to three (3) miles deep, an MCV is often overlooked in standard weather analyses. But an MCV can take on a life of its own, persisting for up to 12 hours after its parent MCS has dissipated. This orphaned MCV will sometimes then become the seed of the next thunderstorm outbreak. An MCV that moves into tropical waters, such as the Gulf of Mexico, can serve as the nucleus for a tropical storm or hurricane.
    - **A derecho** is a widespread, long-lived wind storm that is associated with a band of rapidly moving showers or thunderstorms. Although a derecho can produce destruction similar to that of tornadoes, the damage typically is in one direction along a straight swath. As a result, the term "straight-line wind damage" sometimes is used to describe derecho damage. By definition, if the wind damage swath extends more

[146] http://www.nssl.noaa.gov/education/svrwx101/thunderstorms/types/

than 240 miles (about 400 kilometers) and includes wind gusts of at least 58 mph (93 km/h) or greater along most of its length, the event may be classified as a derecho.

Tornado hazards are not profiled extensively in this section; more information on tornado hazards can be found in Section 3.25.

Any one of the types of thunderstorms described above can be severe, which is defined by wind speeds of 58 mph or greater and/or hail one (1) inches or greater in diameter.[147] Thunderstorms also carry the risk of lightning that is categorized as cloud-to-ground flashes, that is, differences in charges between the cloud and ground which creates a major electrical discharge. In 2014, Rhode Island experienced 311 flashes, with an average of 2.3 flashes per square mile.[148]

When lightning is produced by the storm, extent of the lightning hazard event is typically measured in lightning flash density.[149] Higher lightning flash density indicates a more severe lightning hazard event.

When hail is produced by the storm, the initial criterion to determine severity is based on the diameter produced by the storm. The Tornado and Storm Research Organization (TORRO) hail intensity scale (Table 3-65) is a scale used to indicate the severity of a hail event.

Table 3-65 TORRO Hailstorm Intensity Scale[150]

	Intensity Category	Typical Hail Diameter (mm)	Typical Damage Impacts
H0	Hard Hail	5	No damage
H1	Potentially Damaging	5-15	Slight general damage to plants, crops
H2	Significant	10-20	Significant damage to fruit, crops, vegetation
H3	Severe	20-30	Severe damage to fruit and crops, damage to glass and plastic structures, paint and wood scored
H4	Severe	25-40	Widespread glass damage, vehicle body work damage
H5	Destructive	30-50	Wholesale destruction of glass, damage to tiled roofs, significant risk of injuries
H6	Destructive	40-60	Bodywork of grounded aircraft dented, brick walls pitted
H7	Destructive	50-75	Severe roof damage, risk of serious injuries
H8	Destructive	60-90	Severe damage to aircraft bodywork
H9	Super Hailstorms	75-100	Extensive structural damage. Risk of severe or even fatal injuries to persons caught in the open
H10	Super Hailstorms	> 100	Extensive structural damage. Risk of severe or event fatal injuries to persons caught in the open

[147] NWS, n.d. Severe Weather Definitions. Retrieved at: https://www.weather.gov/bgm/severedefinitions.
[148] http://www.lightningsafety.noaa.gov/stats/05-14_Flash_Density_State.pdf
[149] NOAA, n.d. Lightning Products and Services. Retrieved at: https://www.ncdc.noaa.gov/data-access/severe-weather/lightning-products-and-services.
[150] TORRO, n.d. Hail Scale. Retrieved at: http://www.torro.org.uk/hscale.php.

3.24.4 Previous Occurrences

Rhode Island experiences the severe thunderstorms less frequently than the Midwest and Southeast, but the state has observed a number of very destructive hail and lightning events. The NCEI has recorded 528 significant (those causing injury, fatalities, and/or damage) thunderstorm events from 1955 to 2018 in Rhode Island, which includes thunderstorm wind, marine thunderstorm wind, heavy rain, lightning, and hail events. Two (2) deaths as a result of a lightning are recorded, one (1) on August 11, 2004 in Washington County and one (1) on June 24, 2008 in Bristol County. Nineteen (19) additional injuries have been recorded since 1955 due to a thunderstorm event. Some of the most significant thunderstorm events in the state's history are listed in Table 3-66. From this data, it is notable that Providence County is most affected by thunderstorm hazards. Hail and wind events are shown in Figure 3-24.

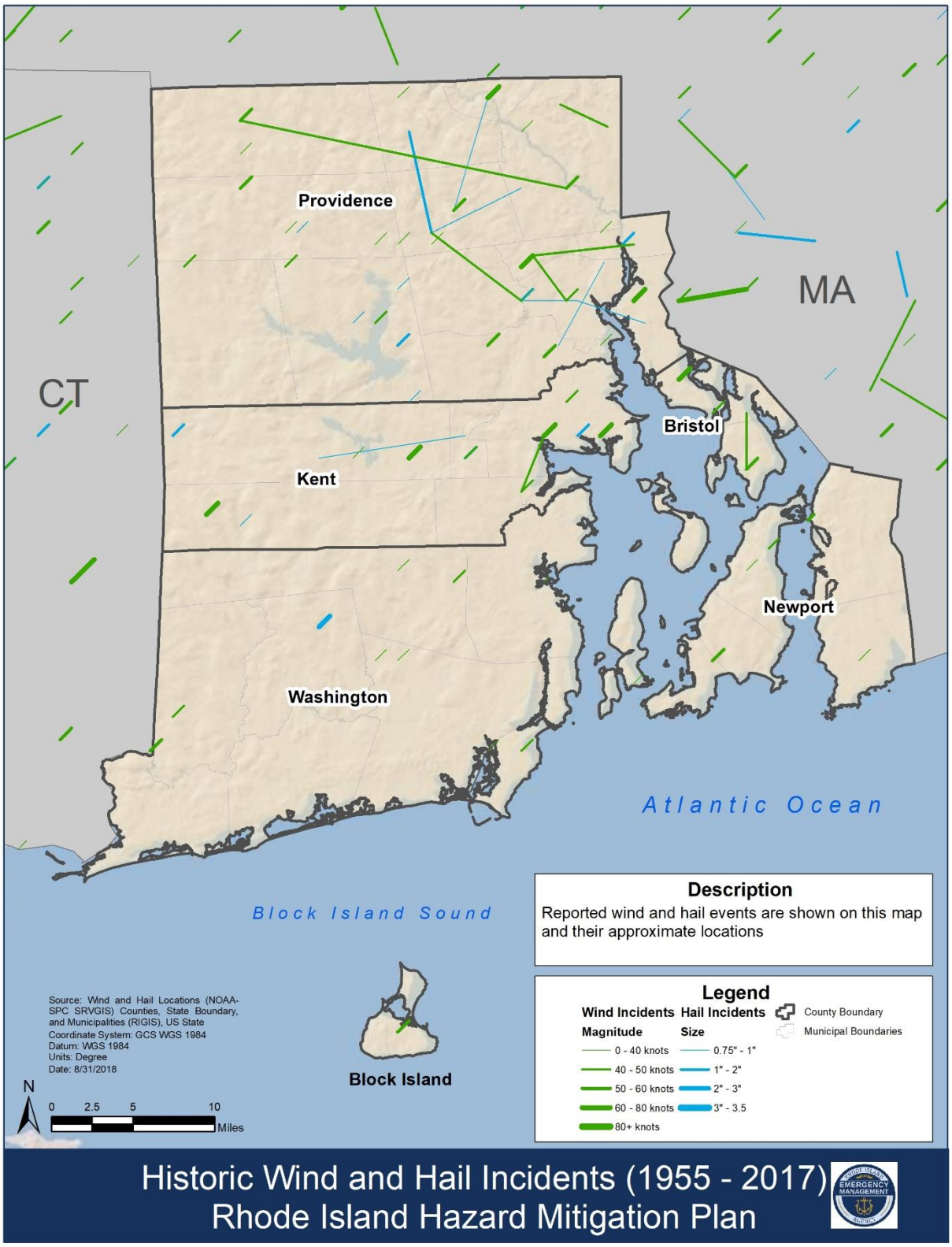
Table 3-66 Reported Thunderstorm Hazard Events in Rhode Island (1955 – 2018)[151, 152]

County Name	Number of Events	Annualized Events	Total Reported Damages	Total Annualized Reported Damages
Bristol County	48	0.75	$315,000.00	$4,921.88
Kent County	121	1.89	$873,500.00	$13,648.44
Newport County	56	0.88	$104,000.00	$1,625.00
Providence County	223	3.48	$2,249,000.00	$35,140.63
Washington County	78	1.22	$941,750.00	$14,714.84

[151] NOAA NCEI, 2018. Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=44%2CRHODE+ISLAND

[152] Period of analysis was selected for continuity amongst the three (3) Storm Event Types selected in the chart including: "Thunderstorm Wind," "Hail," and "Lightning."

Figure 3-24 Rhode Island Historic Wind and Hail Incidents



3.24.5 Probability of Future Events

NCEI historical frequency of occurrence data indicates that Rhode Island is highly likely to experience between zero (0) and five (5) thunderstorm wind events in a given year, between zero (0) and three (3) hail events in a given year, and between zero (0) and two (2) lightning events in a given year.

Thunderstorm events are highly likely to occur within the next one (1) to five (5) years in Rhode Island. These events have a small range of impact, affecting 10% or less of the jurisdictional boundaries when they occur. The hazard ranking shown in Table 3-67 includes the probability of future events by county.

There are uncertainties regarding changes in thunderstorm activity as a result of climate change. The localized nature of these storms is difficult for climate scientists to model; however, it is likely that frequency of thunderstorm events may increase with time as a result of climate change.[153]

3.24.6 Vulnerability and Risk Assessment

3.24.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined thunderstorm events to be a high priority hazard in Rhode Island. As described in the profile above, thunderstorm events within the state are highly likely within the next year to five (5) years. Thunderstorm events have a small range of impact, accounting for 10% or less of the jurisdictional boundaries. The magnitude of thunderstorm events can range from negligible to limited magnitude, including some injuries, no shutdown of critical facilities and infrastructure, and scattered incidental damage to residential and commercial structures. The impact on state operations is believed to be negligible. The overall impact on the environment is expected to be negligible with less than 5% of land and natural resources being impacted by this hazard. Table 3-67 outlines the hazard rankings for each of the hazard priority criteria related to thunderstorms.

[153] NASA, 2013. Severe Thunderstorms and Climate Change. Retrieved at: https://climate.nasa.gov/news/897/severe-thunderstorms-and-climate-change/

Table 3-67 Thunderstorm Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County Kent County Newport County Providence County Washington County	**Highly Likely** *Near 100% probability in next 12-60 months and 1 incident during the next 10 years*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damage*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**High**

3.24.6.2 Risk and Vulnerability to People and Property

The impact of thunderstorms (including lightning and hail) is measured in financial terms, as well as fatalities and injuries. This hazard is a particular priority for Rhode Island to address, because as discussed in 3.24.1**,** thunderstorms are more frequent in the summer, when tourism is more common in the state.

Risk and Vulnerability to People (Injuries and Death)

An examination of the NCEI data shows that thunderstorm events contributed to at least 19 injuries in the state of Rhode Island from 1955 to 2018. During a thunderstorm, individuals are susceptible to injury or death caused by high winds, rain, hail, flooding, and excessive lightning.

The primary injuries resulting from lightning strikes include loss of life, business interruption due to temporary power loss, fire, and minor structural damage. A false sense of security often leads people to believe that they are safe from a lightning strike because it may not appear to strike near their location.[154] However, lightning can strike in locations up to 10 miles away from a rain column, meaning that people within the 10-mile radius are at risk of injury, even if they are experiencing clear weather conditions.

Risk and vulnerability to people from thunderstorm hazards is of critical concern to the State of Rhode Island. To reduce the risk of injury during a hail storm, individuals must seek overhead cover to the fullest extent possible (e.g., sheltering indoors). Individuals must also subscribe to local and state emergency alert systems, such as CodeRED in the City of Providence, which help to inform residents of storm hazard risk and inform them of when they should take shelter inside.

Risk and Vulnerability to Property (Structures and Facilities)

All facilities within Rhode Island are considered equally vulnerable to thunderstorms with negligible impacts to facilities, infrastructure, and residential and commercial properties. The location, construction, and proximity to tall trees or buildings have significant impacts on the vulnerability of a facility or structure. For example, if a tall structure is located on a hilltop, near other tall structures, or has large exposed windows, it is at a higher risk of being damaged during a thunderstorm. Depending on the building(s) damaged, property damage may affect the local economy.

A rough estimate of a structure's likelihood of being struck by lightning can be calculated using the structure's ground surface area, height, and striking distance between the downward-moving tip of the stepped leader (negatively charged channel jumping from cloud to earth) and the object.[155] In general, buildings are more likely to be struck by lightning if they are located on high ground or if they have tall protrusions, such as steeples or poles.

Structural vulnerability to hail is determined by construction and exposure. Metal siding and roofing is better able to stand up to the damage of a hailstorm than other materials, such as glass. Additionally, this damage can also impact personal vehicles, causing an economic impact.

The vulnerability of infrastructural damage caused by wind is based in largely on building construction and standards. Other factors, such as location, condition, and maintenance of trees also

[154] NWS, n.d. Lightning Myths and Facts. Retrieved at: https://www.weather.gov/safety/lightning-myths.
[155] Hasbrouck, P.E. *Determining the Probability of Lightning Striking a Facility*, National Lightning Safety Institute, http://lightningsafety.com/nlsi_lhm/prbshort.html (April 2004).

play a significant role in determining vulnerability.

Annualized damage per county from NCEI data can indicate vulnerabilities within the counties to thunderstorm hazards. Annualized losses from thunderstorms range from $4,921.88 in Bristol County to $35,140.63 in Providence County.

Risk and Vulnerability to Critical Infrastructure

Communications and power supply infrastructure may be compromised during thunderstorms, resulting in service disruptions. Additionally, some critical facilities may not be equipped with a sufficient backup power source. As the facilities datasets are expanded to include details of construction and approximate value, analysis of damage caused by thunderstorms will be reconsidered.

Communications and power supply infrastructure are also susceptible to service disruptions caused by direct lightning strikes, which may result in adverse impacts to businesses, residences, and critical facilities.

3.24.6.3 Risk and Vulnerability to the Environment

Agricultural crops and structures are extremely susceptible to hailstorm damage, as even the smallest hail stones can rip apart unsheltered vegetation. High winds, hail, lightning, and debris may cause injury or death to livestock, as well as wildlife.

Flooding and excessive winds resulting from a thunderstorm cause foundational and structural damage to businesses, residences, or public facilities; potentially causing the spread of hazardous waste among populated areas, waterways, or food sources. Waste or debris from structural damage can also lead to the contamination of sources of water, food, and threaten public health or safety.

Debris or byproducts of thunderstorms impact the environment by causing pollution; damaging sewer and wastewater treatment plants; or disturbing wildlife or nature preserves. Lightning strikes may ignite wooded areas or fields, leading to destruction of agricultural crops, critical ecosystems, or natural habitats.

3.24.6.4 Risk and Vulnerability to State Operations

All state assets are vulnerable to adverse impacts from thunderstorm hazards. The effects of thunderstorms primarily affect the delivery of critical services, specifically, first response and public service activities. Debris from storms and hail can cause damage to response vehicles, impeding response services.

Road conditions become hazardous due to detritus deposited by the storm. Extreme caution must be exercised in the event that visibility or driving conditions are negatively impacted by heavy rains or hail, impeding emergency services delivery related to transport and response times. Additionally, first responders may be unable to access roadways due to flooding, trees, or debris. Exposure to lightning, flooding, and high winds may cause injuries to first responders, vehicles, or resources, leading to reduced capacities for response.

The provision of public services, such as medical treatment or wastewater management will be impaired if equipment, vehicles, or other resources are damaged during a thunderstorm.

Ineffective thunderstorm response decreases the public's confidence in the state's ability to respond and govern. The state and local jurisdictions must balance this against protecting the safety of their responders; because of this, some jurisdictions across the nation restrict response activities in sustained wind conditions exceeding 40 mph. To prevent a loss of confidence in government, response across local, state, regional, and federal bodies must be as effective and efficient as possible to prevent injury or death.

3.25 Tornado

3.25.1 Description

A tornado is a violently rotating column of air in contact with and extending between a cloud and the surface of the earth. Winds in most tornadoes are 100 mph or less, but in the most violent and less frequent tornadoes, wind speeds can exceed 250 mph. Tornadoes typically track along the ground for a few miles or less and are less than 100 yards wide, though some can remain in contact with the earth for well over 50 miles and exceed one (1) mile in width.

Several conditions are required for the development of tornadoes and the thunderstorm clouds with which most tornadoes are associated. Abundant low-level moisture is necessary to contribute to the development of a thunderstorm, and a "trigger" (perhaps a cold front or other low-level zone of converging winds) is needed to lift the moist air. Once the air begins to rise and becomes saturated, it will continue rising to great heights and produce a thunderstorm cloud if the atmosphere is unstable. An unstable atmosphere is one where the temperature decreases rapidly with height. Finally, tornadoes usually form in areas where winds at all levels of the atmosphere are not only strong, but also turning with height in a clockwise, or veering, direction. More information on Thunderstorm hazard events is discussed in Section 3.24.

Tornadoes can appear as a traditional funnel shape, or in a slender rope-like form. Some have a churning, smoky look to them, while others contain "multiple vortices"—small, individual tornadoes rotating around a common center. Others may be nearly invisible, with swirling dust or debris at ground level as the only indication of the tornado's presence.

A tornado begins in a severe thunderstorm called a supercell. A supercell can last longer than an hour, greater than a regular thunderstorm which typically lasts under an hour.[156] The wind coming into the storm starts to swirl and forms a funnel. The air in the funnel spins faster and faster and creates a very low-pressure area which sucks more air (and often debris) into it. The severe thunderstorms that produce tornadoes form where cold dry polar air meets warm moist tropical air.

The NWS Storm Prediction Center issues tornado watches. A tornado watch defines an area shaped like a parallelogram, where tornadoes and other kinds of severe weather are possible in the next several hours. A tornado watch does not indicate an imminent tornado; rather, a tornado watch is an advisory for citizens to be alert and prepared to go to safe shelter if tornadoes do develop or if a tornado warning is issued.

Local NWS offices are responsible for issuing tornado warnings. Tornado warnings indicate that a tornado has been spotted, or that Doppler radar detects a thunderstorm circulation capable of spawning a tornado. However, it is also possible that a tornado is not identified through radar. In some of these cases, there are citizen volunteer spotters that can identify a tornado and alert local communities.[157]

[156] National Severe Storms Laboratory, 2018. Severe Weather 101: Thunderstorm Types. Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/thunderstorms/types/
[157] National Severe Storms Laboratory, 2018. Severe Weather 101: Frequently Asked Questions about Tornados. Retrieved at: https://www.nssl.noaa.gov/education/svrwx101/tornadoes/faq/

3.25.2 Location

The highest concentrations of tornadoes in the U.S. have been in the central part of the country (in an area referred to as "Tornado Alley" composed of South Dakota, Nebraska, Kansas, Oklahoma, and Texas) and portions of the Gulf Coast states. While Rhode Island is far from Tornado Alley, tornadoes do occur in the state, and though not frequent, they may occur anytime and anywhere throughout New England.

New England has its own "Tornado Alley", where there are higher incidences (although certainly lower than the Tornado Alley of the great plains region) of tornado action. Rhode Island is outside this area but is at risk for tornado incidence from the tornado alley to the States north and west. All areas of Rhode Island face nearly uniform susceptibility to tornadoes, but based on past events displayed below, it appears that the areas at greatest risk for touchdowns run from northwestern to northeastern Rhode Island.

Nationally, the tornado season lasts from March to August, with peak tornado activity normally occurring in April, May, and June. Tornadoes in Rhode Island have occurred July through October with August representing the month that has the most recorded incidents since 1950.

3.25.3 Extent

The Fujita (F) scale, introduced in 1971 by Dr. Ted Fujita, provided a way to characterize tornadoes based on the damage they produced and relating that damage to the fastest quarter-mile wind at the height of a damaged structure. An Enhanced Fujita (EF) scale became operational in 2007 and improves upon the original scale by including more damage indicators, considering construction quality and variability, and providing a more definitive correlation between damage and wind speed (Table 3-68).

Table 3-68 Fujita Scale and Enhanced Fujita Scale

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest 1/4-mile (mph)	3-Second Gust (mph)	EF Number	3-Second Gust (mph)
0	40-72	45-78	0	65-85
1	73-112	79-117	1	86-110
2	113-157	118-161	2	111-135
3	158-207	162-209	3	136-165
4	208-260	210-261	4	166-200
5	261-318	262-317	5	Over 200

3.25.4 Previous Occurrences

Twenty (20) tornadoes have touched down in Rhode Island since 1950, with almost half impacting Providence County. Based on previous occurrence, Providence County has a slightly higher probability compared to the other counties in Rhode Island and has over $3 million in annualized

damages due to past events. Bristol County and Kent County have experienced tornado events and approximately $45,000 and $250,000 in damages are vulnerable to them in the future.

Table 3-69, shown below, was derived from the NOAA NCEI Storm Events Data that has collected storm data since 1950. Rhode Island has had 12 instances of tornadic activity (including waterspouts) recorded in the database with property damage amounting to approximately over $3.5 million. The most significant tornado event, both in terms of the F-Scale (or EF-Scale) and the property damage, was from an F-2 tornado in Providence County in 1986 causing $3 million in damage. There were 23 reported injuries due to tornadoes, with no fatalities. Figure 3-25, shows the historic locations of tornadoes in and around Rhode Island.

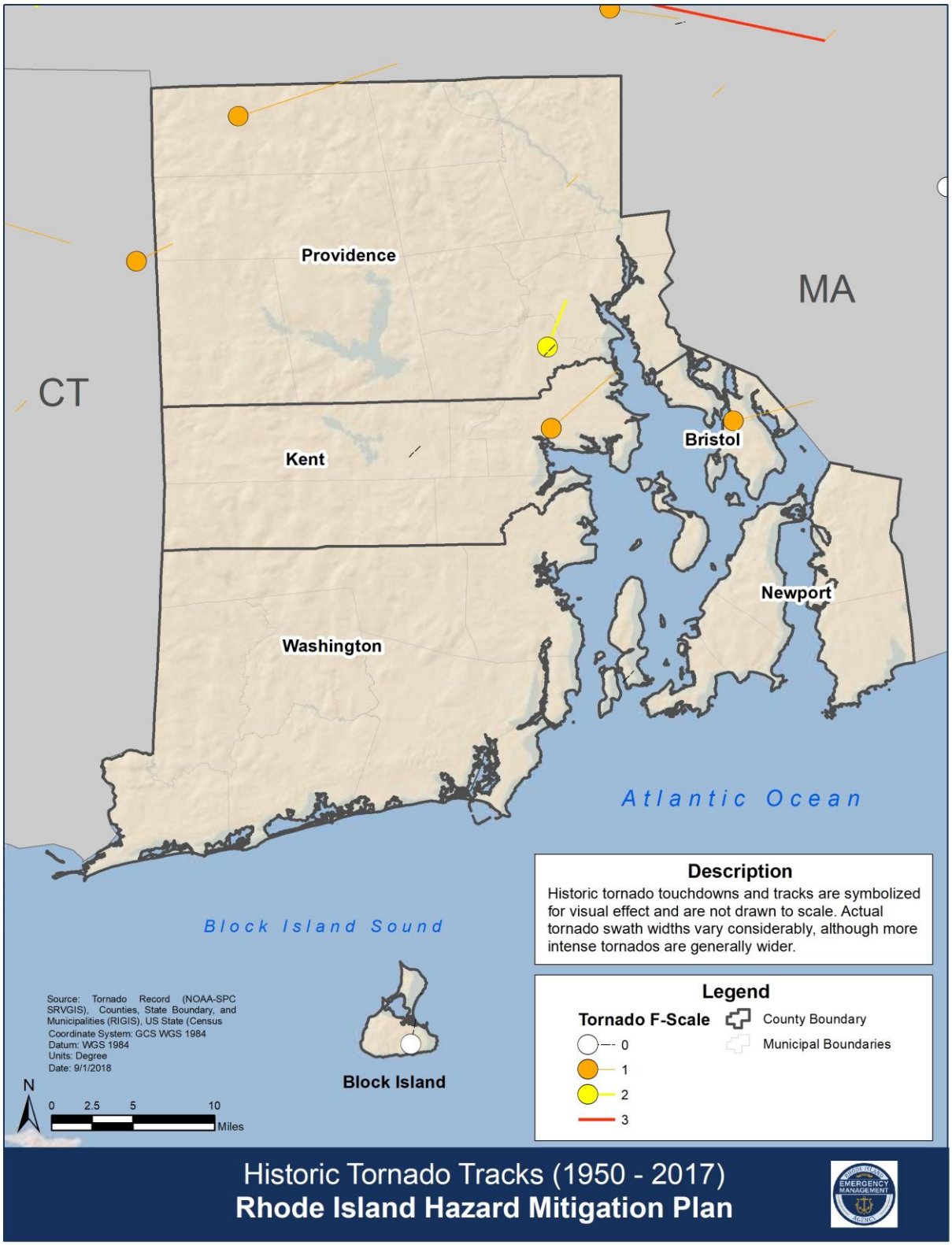
Table 3-69 Tornadoes in Rhode Island (1950-2018)[158]

Date	County	Length (Miles)	Width (yards)	Scale	Fatalities	Injuries	Property Damages
9/14/1972	Bristol County	2.00	33	F0	0	0	$0
8/26/1985	Providence County	1.00	100	F1	0	0	$0
8/7/1986	Providence County	0.50	100	F1	0	0	$574,792
8/7/1986	Providence County	4.00	1000	F2	0	20	$5,747,924
8/8/1986	Providence County	6.00	1000	F1	0	0	$574,792
9/23/1989	Providence County	0.20	40	F0	0	3	$508,042
10/18/1990	Kent County	4.50	73	F1	0	0	$481,999
8/13/1994	Kent County	0.50	50	F0	0	0	$0
7/13/1996	Washington County	*	*	*	*	*	*
8/16/2000	Providence County	0.20	15	F0	0	0	$0
7/23/2008	Bristol County	2.97	40	EF1	0	0	$56,164
8/10/2012	Washington County	3.83	20	EF0	0	0	$54,877

*Information unavailable

[158] NOAA NCEI, 2018. Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=44%2CRHODE+ISLAND.

Figure 3-25 Tornado Touchdowns and Tracks (1950-2017)[159]



Tornado tracks have also occurred in neighboring states near the Rhode Island state border, particularly in Massachusetts where 58 tornado events have been recorded in the three (3) counties bordering Rhode Island since 1950.

3.25.5 Probability of Future Events

Based on historical frequency of occurrence using NCEI data, a reasonable determination of probability of future tornado events can be made. Although relatively infrequent, tornadoes have had significant impacts on property and infrastructure in Rhode Island in the past and are likely to impact the state in the future. An examination of NCEI data suggests that on an annual basis, approximately 0.00 to 0.07 tornadoes occur in any particular Rhode Island county. Considering the historical occurrence of the entire state, the NCEI data suggests that on an annual basis approximately 0.16 tornadoes occur in Rhode Island. All previous tornados have been rated less than F2, therefore future tornados will likely be of similar magnitude. The hazard ranking shown in Table 3-70 includes the probability of future events by county. As a whole, Rhode Island has less than 1% probability of a tornado incident occurring in a given year.

3.25.6 Vulnerability and Risk Assessment

3.25.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined a tornado to be a low priority hazard in Rhode Island. As described in the profile above, tornado events within the state are unlikely with less than 1% annual probability. Tornado events have a small to medium range of impact, accounting for 10% to 40% of the jurisdictional boundaries. Probable hazard magnitude is limited magnitude to include minor injuries, short shutdown of critical infrastructure and facilities, and less than 10% of residential and commercial structures damaged from the events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-70 outlines the hazard rankings for each of the hazard priority criteria related to tornadoes.

[159] NOAA NCEI, 2018. Storm Events Database. Retrieved at: https://www.ncdc.noaa.gov/stormevents/choosedates.jsp?statefips=44%2CRHODE+ISLAND

Table 3-70 Tornado Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Unlikely** *Less than 1% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
Kent County		**Small** *10% or less of the total jurisdictional boundaries*						
Newport County								
Providence County								
Washington County								

3.25.6.2 Risk and Vulnerability to People and Property

Tornadoes are high-impact, low-probability hazards for Rhode Island whose effect is dependent on its intensity and the vulnerability of development in its path. This situation may be more dangerous because Rhode Island residents do not expect severe tornadoes and are ill-prepared to respond to a tornado strike. Tornadoes pose a fiscal impact on the local and state governments through property destruction and life-saving and sustaining missions after a tornado.

Risk and Vulnerability to People (Injuries and Death)

The damage from tornadoes comes from the strong winds they contain. It is generally believed that tornadic wind speeds can be as high as 300 mph in the most violent tornadoes. Wind speeds that high can cause automobiles to become airborne, destroy homes, and turn broken glass and other debris into projectiles. The biggest threats to people caused by tornadoes result from flying debris and from being tossed about in the wind, which may cause injury or death. Table 3-69 gives a breakdown of injuries and fatalities by county that are the result of tornadoes since 1950.

Injury to people caused by tornadoes may include deep cuts, concussions, unconsciousness, or broken bones. Individuals most susceptible to injury to death caused by tornadoes includes those living in mobile homes; of advanced age (60+ years); with no physical protection (e.g., not having been covered with a blanket or other object); having been struck by broken window glass or other falling objects; or whose home lifted off its foundation, collapsed ceiling or floor, or walls blown away.

Secondary injuries or deaths caused by tornadoes typically result from smoke and CO asphyxiation, cardiovascular events, lack of care due to medical equipment failure during power outages, medical complications secondary to tornado injuries, or motor vehicle crashes. Residents supporting search and rescue operations or debris removal after a tornado may be susceptible to injury if in contact with exposed utilities or other hazardous materials.

The entire state population in Rhode Island is considered uniformly vulnerable to tornadoes due to their destructive and unpredictable nature. The factors that result in tornadoes are not more or less likely to result in a tornado in any part of the state, and the vulnerability to tornadoes is generally the same for each level of severity.

Human vulnerability is based on the availability, reception, and understanding of early warnings of tornadoes, such as a Tornado Warning issued by the NWS, and access to shelter. With improved forecasting and early warning systems the national death toll from tornadoes has dropped significantly over the years, despite increasing populations in tornado-prone areas.[160] In some cases, despite having access to technology (computer, radio, television, or outdoor sirens) that allows for the reception of a warning, language differences are sometimes a barrier to full understanding of the risk. More awareness of the tornado risk before it strikes and better adherence to tornado protection guidelines could reduce injuries and deaths. Once warned of an impending tornado hazard, seeking shelter indoors on the lowest floor of a building away from windows is recommended as the best protection against bodily harm.

Risk and Vulnerability to Property (Structures and Facilities)

Tornado vulnerability is based on building construction and standards, the availability of shelters or

[160] NOAA NCEI, n.d. Deadliest Tornadoes. Retrieved at: https://www.ncdc.noaa.gov/climate-information/extreme-events/us-tornado-climatology/deadliest

safe rooms, and advanced warning capabilities. Even well-constructed buildings are vulnerable to the effects of a stronger (generally EF-2 or higher) tornado.

Vulnerability to tornadoes is dependent on the geographic extent and magnitude of the event. Damages from lower intensity tornadoes (EF-0) can range from chimney damage to uprooted shallow trees. A significant tornado (EF-2) would cause considerable damage to roofs on frame houses, complete destruction of mobile homes, and large trees and utility lines snapping. Though it hasn't historically occurred, a devastating tornado (EF-4) would result in well-constructed houses being leveled, weak foundations blown away some distance, and cars thrown. Mobile homes within the state are especially vulnerable.

The type and age of construction plays a role in the vulnerability of facilities to tornadoes. In general, concrete, brick, and steel-framed structures tend to fare better in tornadoes than older, wood-framed structures or mobile homes. Heavy building materials that are connected to building infrastructure, enclosed buildings, short spans on the roof, and interior partitions are some of the building elements that comprise of a protected building.[161] Other factors, such as location, condition, and maintenance of trees play a significant role in determining vulnerability.

As evidenced by property loss figures obtained from NCEI, tornadoes have the potential to be very destructive. The NCEI estimates are believed to be an underrepresentation of the actual losses experienced due to hazards, as losses from events that go unreported or that are considered difficult to quantify, or are not reported, will not appear in the NCEI database.

Risk and Vulnerability to Critical Infrastructure

Tornadoes have the potential to cause extensive damage to critical infrastructure if it reaches a certain magnitude. EF1 classified tornadoes can peel off roofs and overturn mobile homes.[162] Communications or power infrastructure may be damaged or destroyed as a result of high winds, resulting in service disruptions. Power infrastructure may be destroyed or toppled as the result of high winds or flying debris, causing widespread outages. Downed wires and lightning strikes have been known to spark fires. In addition to lost revenues, downed power lines present a threat to personal safety. Without power, water and food supplies may also be disrupted. See Section 3.18 for more information on impacts to critical infrastructure.

Access to infrastructure may be blocked by debris, delaying responsible parties for making necessary repairs and causing extended outages. Tornadoes may also disrupt transportation services. Some tornadoes have stripped asphalt pavement, but it is more likely that access to roadways will be reduced by debris carried by the tornado.

3.25.6.3 Risk and Vulnerability to the Environment

Tornadoes may cause significant damage to the environment by exposing hazardous materials, causing contamination of water or food sources, or uprooting vegetation. Animals may be injured by flying debris or being lifted by the tornado. Tornadoes may carry toxic debris with high winds and deposit it in a natural environment or habitat, causing contamination. High winds may also uproot trees or other vegetation, causing significant damage to wildlife. The costs associated with restoring

[161] FEMA, 2009. *Tornado Protection: Selecting Refuge Areas in Buildings*. Retrieved at: https://www.fema.gov/media-library-data/20130726-1456-20490-4099/fema_p_431.pdf
[162] FEMA, 2011. Mitigation Assessment Team Report: Tornado Outbreak of 2011. Retrieved at: https://www.fema.gov/media-library-data/20130726-1827-25045-7585/tornado_mat_app_e_508.pdf

natural habitats or environments may be steep depending on the extent of damage.

Agricultural crops may be lost due to contamination from flying debris or being uprooted by high winds. Livestock and other animals may be injured by flying debris or carried off by high winds, causing injury or death.

3.25.6.4 Risk and Vulnerability to State Operations

Tornadoes may cause significant disruptions to state operations by destroying key assets, equipment, or facilities (e.g., ambulances). Damage or destruction to critical infrastructure during the tornado may cause long-term power or communications outages, impacting the state's ability to perform critical operations such as search and rescue operations. Power outages will impact public health capabilities and the performance of basic government functions. Without power, water may not be readily available, which may complicate performance of public safety tasks.

First responders may be injured as the tornado passes, resulting in employee absenteeism that impacts the overall capacity to respond to the event. In addition, the deposit of debris on major roadways, the location of the event, damage to equipment or facilities may increase the amount of time required for first responders to complete rescue operations. Exposed wires or hazardous materials may cause injury to first responders in the process of conducting search and rescue operations.

3.26 Tropical and Extratropical Storms

3.26.1 Description

Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that form over the tropics. These storms are referred to as "cyclones" due to their rotation. Tropical cyclones are among the most powerful and destructive meteorological systems on earth. Their destructive effects include high winds, heavy rain, lightning, tornadoes, and storm surge. As tropical cyclones move inland, they cause severe flooding, downed trees and power lines, and structural damage. Once a tropical cyclone no longer has tropical characteristics, it is then classified as a post tropical cyclone.

There are three (3) categories of tropical cyclones:

- Tropical Depression: maximum sustained surface wind speed is less than 39 mph
- Tropical Storm: maximum sustained surface wind speed from 39–73 mph
- Hurricane: maximum sustained surface wind speed exceeds 73mph

Most Atlantic tropical cyclones begin as atmospheric easterly waves that propagate off the coast of Africa and cross the tropical North Atlantic Ocean and Caribbean Sea. When a storm starts to move toward the north, it leaves the area where the easterly trade winds prevail and enters the temperate latitudes where the westerly winds dominate. This produces the eastward curving pattern of most tropical cyclones that pass through the Mid-Atlantic region. When the westerly steering winds are strong, it is easier to predict where a hurricane will go. When the steering winds become weak, the storm follows an erratic path that makes forecasting very difficult.

3.26.1.1 Nor'easter

An extratropical cyclone, known as a Nor'easter, is typically a large, counter-clockwise wind circulation around a low-pressure center. The storm radius is often as large as 1,000 miles, and the horizontal storm speed is about 25 mph, traveling up the eastern United States coast. Short-term wind speeds gusting up to 70 mph are common for a Nor'easter. Unlike hurricanes and tropical storms, Nor'easters can sit offshore, causing damage for days. Nor'easters are a common winter occurrence in New England as the polar jet stream meets the warm air from the Gulf to form a storm.[163] They result in flooding, various degrees of wave and erosion-induced damage to structures, and erosion of natural resources, such as beaches, dunes, and coastal bluffs. The erosion of coastal features results in greater potential for damage to shoreline development from future storms.

Nor'easters can produce wind gusts to near hurricane force, significant storm surge, flooding rain, and crippling snowfall. These storms also produce varying amounts of coastal erosion depending on the intensity and the duration of the storm; the tidal phase at the time of the storm (neap or spring tide); the path of the storm; and the time interval between storms. Back-to-back storms do not allow time for the beaches and dunes to recover sand that has been transported offshore.

[163] National Weather Service. What is a Nor'easter? Retrieved from https://www.weather.gov/safety/winter-noreaster

Nor'easters' effects can cause significant damage, often due to undermining the structures that were previously behind the dunes or on the top of coastal bluffs.[164]

3.26.1.2 Storm Surge

Storm surge is the abnormal rise in water level caused by the wind and pressure forces of a tropical storm, hurricane or Nor'easter.[165] Nationally, storm surge flooding has caused billions of dollars in damage and hundreds of deaths.[166] As population density in coastal communities increases, the need for information about the potential for flooding from storm surge becomes even more important. The breaking wave height is related to water depth so that as water depth over a given surface increases with storm surge, larger waves can be generated. Sea level rise caused by storm surge during a hurricane, or even during coastal flooding unrelated to a hurricane event, can increase the severity of impact.

The fundamental forcing mechanism of storm surge is wind and the resultant frictional stress it imposes on the water surface. Winds blowing over a water surface generate horizontal surface currents flowing in the general direction of the wind. These surface currents in turn create subsurface currents which, depending on the intensity and forward speed of the hurricane or Nor'easter, may extend from one (1) to several hundred feet below the surface. If these currents are in the onshore direction, water begins to pile up as it is impeded by the shoaling (shallow) continental shelf causing the water surface to rise. This dome of water will increase shoreward until it reaches a maximum height at the shoreline or at some distance inland. Storm surge heights in Rhode Island can reach more than 10 feet during hurricanes. The continental shelf slope also determines the scale of storm surges; wide, gently sloping shelves create larger storm surges.

The magnitude of storm surge during a hurricane or tropical storm within a coastal basin is governed by both the meteorological parameters of the hurricane and the physical characteristics of the basin. The meteorological aspects include:

- Hurricane size, measured by the radius of maximum winds. (Measured from the center of the hurricane to the location of the highest wind speeds within the storm. This radius may vary from as little as four (4) miles to as much as 50 miles.)
- Hurricane intensity, measured by sea level pressure and maximum surface wind speeds at the storm center.
- Hurricane path, or forward track of the storm.
- Hurricane forward speed.

The counterclockwise rotation of the hurricane's wind field in combination with the forward motion of the hurricane causes the highest surge levels to occur to the right of the hurricane's forward track. This phenomenon has been observed in regions where the shoreline is typically straight and not fragmented by large inlets and bays, and when a hurricane travels generally perpendicular to the shore. In Rhode Island, the increased wind stress from the rotational wind field has a large effect on the level of surge. The contribution to surge generation from the forward motion of the storm can be greater than the contribution made by an increase in hurricane intensity.

[164] NOAA National Centers for Environmental Information, 2018. Billion-Dollar Weather and Climate Disasters: Table of Events. Retrieved from: https://www.ncdc.noaa.gov/billions/events/RI/1980-2018
[165] NOAA, n.d. *Introduction to Storm Surge*. Retrieved at: https://www.nhc.noaa.gov/surge/surge_intro.pdf
[166] NOAA, 2017. Storm Surge. Retrieved at: https://toolkit.climate.gov/topics/coastal/storm-surge.

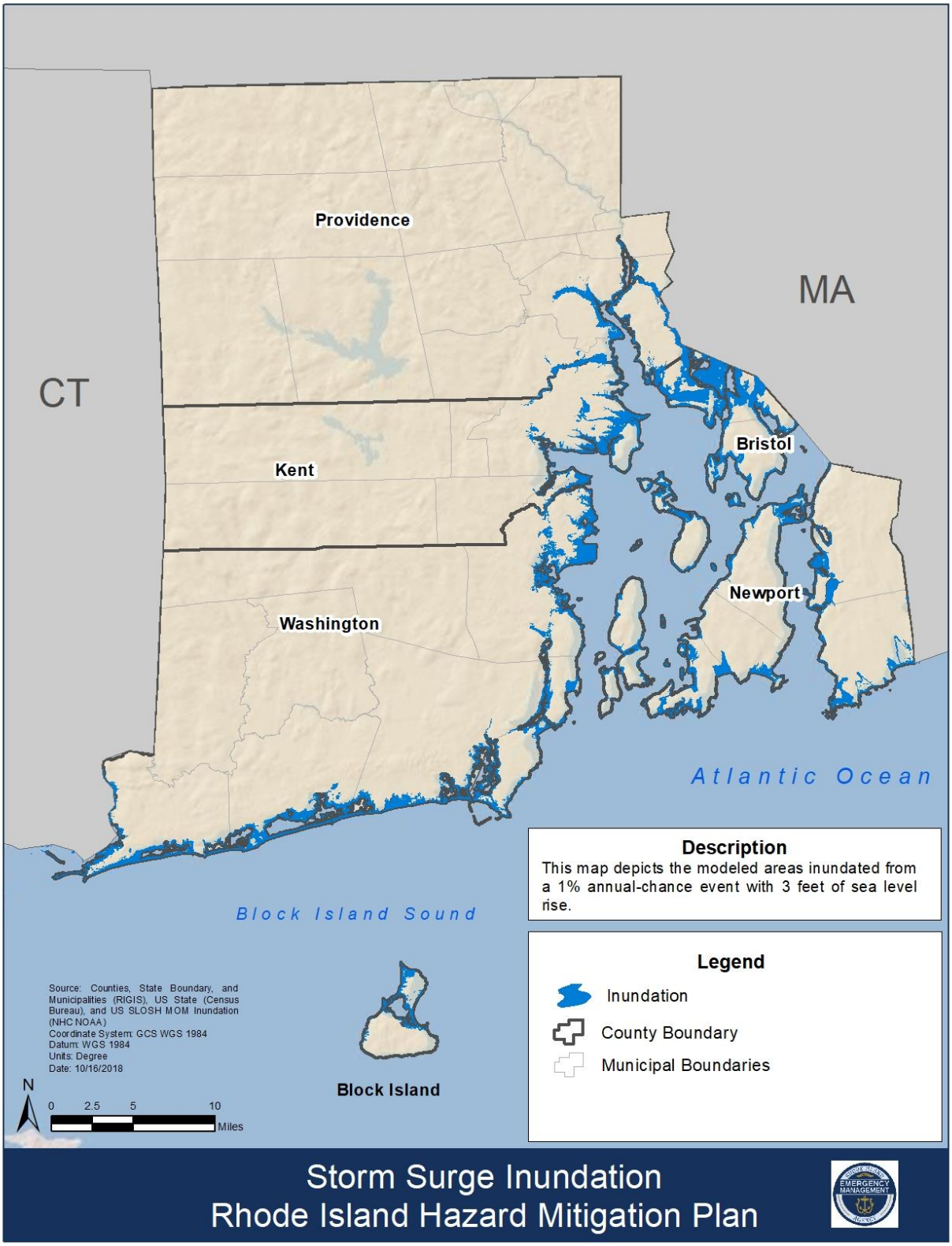
Most of the Rhode Island contiguous shoreline faces south, resulting in storms passing to the west raising the highest storm surges for Rhode Island. Narragansett Bay funnels the surge northward where decreasing surface area amplifies the surge height. The 1938 hurricane made landfall west of Rhode Island as a Category 3 hurricane with a forward speed in excess of 50 mph. Because the center of the 1938 hurricane made landfall in Connecticut to the southwest of the State, the Rhode Island shoreline experienced the highest storm surge levels.

The reduction of atmospheric pressure within the storm system results in another surge-producing phenomenon known as the inverted barometer effect. Within a region of low pressure, the water level rises at the approximate rate of 13.2 inches per inch of mercury drop. This can account for a water level rise of one (1) to two (2) feet near the center of the hurricane. This effect is a more important factor in the open ocean where there are no depth-related restrictions to water flow.

3.26.2 Location

The entire State is vulnerable to impacts from the wind associated with hurricanes, tropical, and extratropical storms. The storm surge associated with these high wind events can cause significant flooding in low lying coastal areas. The Rhode Island STORMTOOLS data was used to map the inundation area from a 1%-annual-chance storm event with an additional three (3) feet of SLR (Figure 3-26). As shown in the figure, Rhode Island's coastline is vulnerable to storm surge from this kind of event, particularly the more densely populated areas of Bristol and Washington counties.

Figure 3-26 Inundation from 1%-annual-chance event with 3 feet of SLR



3.26.3 Extent

Hurricanes are categorized according to the Saffir-Simpson hurricane wind scale, which was developed in 1971 by Herbert Saffir and Robert Simpson. The scale rates the intensity and effects of hurricanes based on wind speed and barometric pressure measurements as shown in Table 3-71. Hurricane categories range from one (1) through five (5), with Category 5 being the strongest (winds greater than 157 mph). It gives an indication of the potential flooding and wind damage associated with each hurricane category. The scale is designed to give public officials and the general public usable information on the magnitude of a storm. A hurricane watch is issued when hurricane conditions could occur within the next 48 hours. A hurricane warning indicates that sustained winds of at least 74 mph are expected within 36 hours or less. Storm surge watches, storm surge warnings, and extreme wind warnings also indicate hazardous conditions related to hurricanes.

Table 3-71 Saffir-Simpson Hurricane Wind Scale[167]

Wind Speed	Typical Effects
Category 1 Hurricane – Weak	
74-95 mph (64-82 kt)	Minimal Damage: Damage is primarily to shrubbery, trees, foliage, and unanchored mobile homes. No real damage occurs in building structures. Some damage is done to poorly constructed signs.
Category 2 Hurricane – Moderate	
96-110 mph (83-95 kt)	Moderate Damage: Considerable damage is done to shrubbery and tree foliage; some trees typically are blown down. Major structural damage occurs to exposed mobile homes. Extensive damage occurs to poorly constructed signs. Some damage is done to roofing materials, windows, and doors; no major damage occurs to the building integrity of structures.
Category 3 Hurricane – Strong	
111-129 mph (96-112 kt)	Extensive Damage: Foliage torn from trees and shrubbery; large trees blown down. Practically all poorly constructed signs are blown down. Some damage to roofing materials of buildings occurs, with some window and door damage. Some structural damage occurs to small buildings, residences, and utility buildings. Mobile homes are destroyed. There is a minor amount of failure of curtain walls (in framed buildings).
Category 4 Hurricane – Very Strong	
130-156 mph (113-136 kt)	Extreme Damage: Shrubs and trees are blown down; all signs are down. Extensive roofing material and window and door damage occurs. Complete failure of roofs on many small residences occurs, and there is complete destruction of mobile homes. Some curtain walls experience failure.

[167] NOAA NHC, 2012. Minor Modification to Saffir-Simpson Hurricane Wind Scale for the 2012 Hurricane Season. Retrieved at: https://www.nhc.noaa.gov/pdf/sshws_2012rev.pdf.

Wind Speed	Typical Effects
Category 5 Hurricane – Devastating	
Greater than 157 mph (137 kt)	Catastrophic Damage: Shrubs and trees are blown down; all signs are down. Considerable damage to roofs of buildings. Very severe and extensive window and door damage occurs. Complete failure of roof structures occurs on many residences and industrial buildings, and extensive shattering of glass in windows and doors occurs. Some complete buildings fail. Small buildings are overturned or blown away. Complete destruction of mobile homes occurs.

3.26.4 Previous Occurrences

Rhode Island has experienced tropical depressions, tropical storms, and hurricanes ranging from Category 1 to Category 3. Hurricanes can have potentially devastating effects on Rhode Island. Hurricane wind damage can be costly, but storm surge is by far the most destructive force acting on the Rhode Island coast. The highest storm surges recorded at the Newport tide gauge were 9.45 feet and 6.76 feet above MHHW during the Great September Hurricane of 1938 and Hurricane Carol, in August 1954, respectively. By comparison, the Providence gauge recorded surges of 12.66 feet and 9.96 feet above MHHW respectively during those events.

The duration of high surge and winds in a hurricane is six (6) to 12 hours, while a Nor'easter's duration can be from 12 hours to three (3) days. The amount of damage resulting from a strong hurricane is often more severe than a Nor'easter, but Rhode Island has historically suffered more damage from Nor'easters because of the greater frequency with which they occur.

Damages from Hurricane Carol in Westerly are pictured in Figure 3-27. Table 3-72 highlights hurricanes that have resulted in significant damage, injuries, and deaths in Rhode Island.

Figure 3-27 Hurricane Carol damages in Westerly[168]

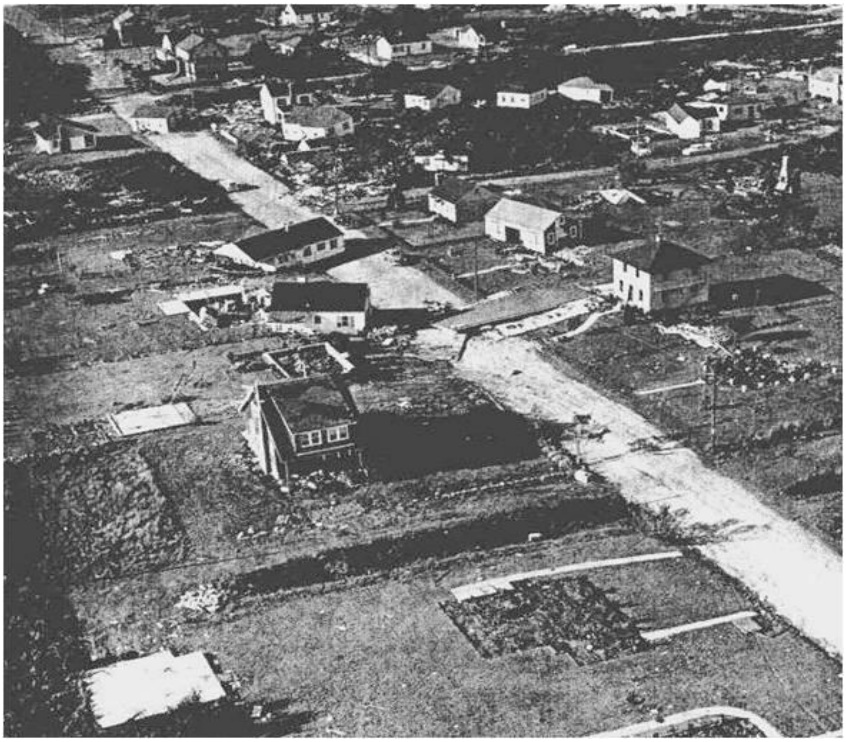


Table 3-72 Rhode Island Historic Hurricanes

Hurricane	Date	Description
Great New England Hurricane - 1938	September 21, 1938	The hurricane of September 21, 1938, brought major devastation to the state, with 262 persons losing their lives and damage estimated at $100 million. The Rhode Island coastline experienced widespread damage. The maximum storm surge with this hurricane arrived at high tide during the highest astronomical tide of the year. Sustained winds of 95 mph recorded; tide 15 feet above mean sea level (at USGS gage in Westerly). Virtually all of the state was without power. Ten percent (10%) of electric customers still without power 12 days after hurricane.
Great Atlantic Hurricane - 1944	September 14, 1944	Affected Rhode Island and southeastern Massachusetts; $2 million in property damage; no loss of life.
Carol	August 31, 1954	On August 31, 1954, Hurricane Carol swept into Rhode Island with little warning. The result was 19 deaths and

[168] Rhode Island National Guard, 1954. Damage from Hurricane Carol. Retrieved at: https://web.archive.org/web/20091025123903/http://geocities.com/hurricanene/hurricanecarol.htm.

Hurricane	Date	Description
		$200 million in property damage. The storm center passed to the west of Providence and came at high tide. The central area of Providence was flooded to a depth of 13 feet, and 3,500 cars were inundated in the downtown areas. Hurricane Edna occurred 12 days after Carol, with heavy rain and major river flooding. There were 19 fatalities in New England, $200 million in property damage, and 13 feet of flooding. In Providence, wind speeds of 90 mph, with 115 mph gusts; nearly 3,800 homes destroyed. Tide 12.2 feet above mean sea level (at USGS gage in Westerly). Most of state was left without power. Four (4) days after storm approximately 50% had power restored; 90% after seven (7) days.
Edna	September 11, 1954	Heavy rain and major flooding in the Blackstone River Valley.
Diane	August 17–20, 1955	In 1955, remnants of the August Hurricane Diane swept over Rhode Island, but its wind velocities were far below hurricane force because of its long inland trip over North Carolina, Virginia, and Pennsylvania. Damage to power lines was high, and at one point 82% of Rhode Island's homes were without electricity. Ample warning permitted people to return home from school and work early, and as a result, only two (2) lives were lost. Property damage amounted to $170 million, most resulting from torrential rains, which caused serious river flooding. Blackstone River crests 15 feet above normal; $170 million in property damage. Heavy rain and six (6)-foot tidal surge; $5 million in property damage; 82% of electric customers lost power.
Donna	September 12, 1960	Heavy rain and major flooding in the Blackstone River Valley.
Esther	September 21, 1961	Heavy shore damage at Sakonnet Point in Little Compton and Misquamicut in Westerly.
Gloria	September 27, 1985	Two (2) fatalities in New England; property damage estimated at $19.8 million; 8,596 of electric customers lose power; an estimated 23,700 people evacuated.

Hurricane	Date	Description
Bob	August 18, 1991	Southern New England damage at $1.5 billion; 60% of residents across Southeastern New England lost power; 6- to 10- foot storm surge in Narragansett Bay; two (2) unconfirmed tornadoes in Rhode Island. There were 18 fatalities in Southern New England, although none in Rhode Island.
Irene	August 27, 2011	Preliminary damage assessment report from FEMA brings the total PA cost to $9,260,898. Irene knocked down trees and power lines, leaving up to half of Rhode Island residents without power. Gusts of wind up to 71 mph were reported, and storm surge in Narragansett Bay caused some coastal damage. However, the majority of damage was caused by wind. The storm surge experienced along the coast was generally in the two (2)- to four (4)-foot range with a high of 4.78 feet at Fox Point in Providence, Rhode Island. The highest sustained wind speed was 54 knots (62 mph) at the Physical Oceanographic Real Time System station at Conimicut Light in Narragansett Bay, Rhode Island.
Sandy	October 29, 2012	Hurricane Sandy swept through the region in October 2012 leaving significant damage all along the coast. Beaches along Westerly, including Misquamicut, were devastated and almost unrecognizable. More than 122,000 people lost power. It is estimated that more than $39.4 million in support from four (4) federal disaster relief programs is helping Rhode Island recover from this disaster, the majority of which is from the NFIP ($31.1 million).

3.26.5 Probability of Future Events

Based on historical frequency of occurrence, Rhode Island is likely, with between 50% and 89.9% annual probability, to experience a hurricane in next 12 to 60 months. High magnitude events, such as Category 4 or Category 5 hurricanes, are less likely to occur in the next 12 to 60 months. Nor'easters, while typically less severe, have a high probability of occurring in the next 12 to 60 months, with an average annual frequency of one (1) to two (2) events and storm surges greater than two (2) feet. Nuisance flooding and heavy rain events are more common and likely to occur in the

next five (5) years. Table 3-73 provides the annualized events qualitative ranking used for determining probability of future events. The hazard ranking includes the probability of future events by county. Long-term global climate models under IPCC warming scenarios indicate that it is possible that hurricanes will become more intense, with stronger winds and heavier precipitation throughout the twenty-first century.

3.26.6 Vulnerability and Risk Assessment

3.26.6.1 Hazard Ranking

The priority hazard ranking process for the 2019 SHMP update determined tropical and extratropical storms to be a high priority hazard in Rhode Island. As described in the profile above, tropical and extratropical storm events within the State are likely within the next year to five (5) years. These events have a medium to large range of impact, accounting for 10% to 40% (medium impact) and 40% to 100% (large impact) of the jurisdictional boundaries. Hazard magnitude ranges and is considered to have negligible to limited magnitude, including some injuries and short duration shutdown of critical facilities and infrastructure. There is a range of scattered incidental to less than 10% of residential and commercial structure damage from these events. The impact on state operations is believed to be limited. The overall impact on the environment is expected to be limited with less than 20% of land and natural resources being impacted by this hazard. Table 3-73 outlines the hazard rankings for each of the hazard priority criteria related to tropical and extratropical storms.

Table 3-73 Tropical and Extratropical Storms Hazard Priority

Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Appendix C)	Probable Hazard Magnitude					Composite Hazard Index
			People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible**[169] *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
Kent County								
Newport County		**Large** *40% to 100% of the total jurisdictional boundaries*			**Limited** *Less than 10% of residential and commercial structure damages*			
Providence County		**Medium** *10% to 40% of the total jurisdictional boundaries*						
Washington County		**Large** *40% to 100% of the total jurisdictional boundaries*						

[169] RI Shoreline Change Special Area Management Plan, n.d. StormTools. Retrieved at: http://www.beachsamp.org/stormtools/)

3.26.6.2 Risk and Vulnerability to People and Property

Rhode Island, as with other New England states, is particularly vulnerable to hurricanes, tropical storms, and Nor'easters. One reason is that the geography of Southern New England in relation to the Atlantic seaboard: historically, most hurricanes that have struck the New England region re-curved northward on tracks, which paralleled the eastern seaboard, maintaining a slight north-northeast track direction. The fact that the states of Connecticut, Rhode Island, and Massachusetts geographically project easterly into the Atlantic and have southern exposed shorelines places them in direct line of any storm that tracks in this manner. Therefore, even though New England is a relatively far distance from the tropics, its susceptibility to hurricane strikes can be statistically greater than states closer to the tropics.

There are three (3) components of statewide vulnerability to the impact of a hurricane: storm surge (coastal flooding); ability to evacuate in a timely manner; and shelter capacity. Storm surge has the potential to create implications related to evacuating Rhode Island coastal communities because, in most cases, water may rise to extremely high levels and cover roads and bridges.

The vulnerability of Rhode Island to hurricane surges is further increased by the presence of Narragansett Bay. The Bay's configuration can cause a funneling of tidal surges as they flood the East and West Passages and the Sakonnet River. Ocean waters entering these inlets become more restricted, causing higher flood levels with continued movement into the upper reaches of the Bay. The funneled ocean waters along the shores of the Bay's northernmost points tend to result in higher storm surge elevations, causing a greater amount of coastal and tidal riverine flooding. The northern reaches of Narragansett Bay are the most urbanized and densely developed areas in the State.

Further evidence of New England's unique vulnerability to hurricanes is the tendency of hurricanes that eventually strike the region to undergo significant increases in forward speed. Historically, hurricanes tend to lose their strength and accelerate in a forward motion after passing the outer banks of Cape Hatteras, North Carolina. The increase in forward speed that usually occurs as the hurricane weakens with further northward movement can often compensate for any diminishment in hurricane intensity. Surge flooding, wave effects, and wind speeds accompanying a faster moving, weaker hurricane may exceed conditions and impacts caused by faster-moving, more intense hurricanes.

Risk and Vulnerability to People (Injuries and Death)

Among other considerations, human vulnerability is influenced by the availability, reception, and understanding of early warnings of coastal hazard events (e.g., Hurricane Watches and Warnings issued by the NWS), as well as access to appropriate shelter and a means and desire to evacuate if necessary. In some cases, despite having access to technology (such as computer, radio, television, and outdoor sirens) that allows for the reception of a warning, individuals may not understand the warning and its implications. Once warned of a significant impending coastal hazard event, sheltering in an indoor structure that is wind-resistant and outside of storm surge zones is recommended as the best protection against bodily harm.

Due to the natural geography of Rhode Island, hurricanes and tropical storms often bring substantial overland flooding. Flooding directly impacts members of the public in a low-lying area or floodplain, typically near a river, lake, or coastal area. Significant flooding events can lead to the damage and loss of homes, property, and businesses, which can impact public morale and safety. Flash flooding and

excessive rainfall may lead to dangerous conditions on roadways, as well as create mudslides that may quickly place members of public in dangerous situations.

Interruption of healthcare service delivery (e.g., closure of doctors' offices, infrastructure damage to hospitals) can have serious public health impacts. Water sources may also become contaminated by floodwaters, and water or sewer systems may be damaged or completely disrupted. Post-storm, increases in vector-borne diseases, food safety, access to healthcare services, and risk of exposure to hazardous materials are all public health considerations (among many others) that will require planning, response, and strong public communication efforts to remediate.

Risk and Vulnerability to Property (Structures and Facilities)

Hurricanes and tropical storms, depending on their magnitude and impact, can cause widespread destruction to property, facilities, and infrastructure. Residential and commercial properties that are damaged or destroyed by a coastal event can require significant recovery efforts. Hurricanes and tropical storms can also impact roads, bridges, schools, and healthcare facilities in the evacuation zone through water damage from storm surge, debris, power, and utility loss, as well as drifting sand from storm winds.

Every year, Rhode Island has a 22.8% chance of experiencing a hurricane. NCEI annualized damages range from negligible amounts up to an estimated $11,434.78 statewide. These estimates are believed to underrepresent actual losses experienced due to hazards as there are losses from events that go unreported or that are difficult to quantify.

Risk and Vulnerability to Critical Infrastructure

Electrical utilities, communications, and transportation infrastructure are vulnerable to significant coastal events. Damage to power lines or communication towers has the potential to cause power and communication outages for residents, businesses, and critical facilities. In addition to lost revenues, downed power lines present a threat to personal safety, as the lines remain live, even when downed. Downed power lines have also been known to spark fires.

A structure's vulnerability to significant coastal event hazards is based primarily on building construction and standards, and its location in relation to potential storm surge inundation zones. Mobile homes and wood-framed structures are more vulnerable to damage from wind during significant coastal events than steel framed structures. Other factors, such as location and condition and maintenance of trees also play a significant role in determining vulnerability.

Table 3-77 summarizes the exposed critical facilities, infrastructure, and structures with a 30' buffer that are vulnerable to storm surge categories one (1) through four (4). Storm surge was mapped with 2016 NOAA National Hurricane Center SLOSH data, which uses a computerized model to estimate storm surge. With a Category 4 storm, there are approximately 41,152 vulnerable critical facilities and infrastructure. The analysis shows that the Transportation Sector will experience high levels of inundation, with marinas and ports being severely impacted due to their adjacency along the coast. Rhode Island Public Transit Authority bus stops, identified as rail systems and mass transit, may also experience severe impacts with approximately 874 inundated under Category 4. Additionally, Washington County is expected to be most vulnerable, with approximately 12,150 critical facilities and infrastructure at risk with a Category 4 storm.

Hazus was used to generate peak wind gust speeds in miles per hour (mph) for a 1%-annual-chance storm event such as Hurricane Carol in 1954. Severe winds equivalent to a category two (2) hurricane (96 to 110 mph) would affect most of Washington County, the eastern portion of Kent County and southeastern Providence County. Figure 3-28 shows the location and magnitude of the peak wind gusts associated with this particular storm event in Rhode Island. Table 3-83 shows the exposed critical facilities, infrastructure, and structures that are vulnerable to Category 2 force winds from Hurricane Carol. This exposure is expected for storms with a similar track to Carol.

Hazus was also used to estimate the annualized losses and damages that could occur as a result of the wind associated with tropical storm and hurricanes (Figure 3-30 and Table 3-74). Total damages (adjusted for inflation) on an annualized basis could exceed $102 million statewide. Providence County is estimated to experience $41.9 million in hurricane-related damage, with damage estimates distributed evenly among its municipalities. Kent County also has a relatively uniform distribution of vulnerability and loss among municipalities, with Warwick experiencing the highest risk and loss in the County. Bristol County municipalities are all likely to experience $500,000 to $1 million in losses, by census block. The central portion of Bristol County is estimated to experience at least $1 million in losses. As show in Figure 3-30 shoreline communities such as Narragansett in Washington County and Middletown and Jamestown in Newport County are extremely vulnerable to hurricanes and could experience losses of over $1.5 million per census block. Appendix C provides background information regarding Hazus runs and includes additional loss results. RIEMA continues to pursue funding to develop parcel datasets as well as assessment values for critical facilities to allow for more comprehensive loss estimates by municipality for hazards with known geographic extents.

Table 3-74 Hazus Simulated Losses for Various Hurricane Scenarios (using 2018 Dollars and 2010 Census Data)

County	1938 Unnamed Hurricane	Hurricane Carol (1954)	Hurricane Donna (1960)	Hurricane Irene (2011)	Annualized Loss
Bristol	$2,576 Million	$1,682 Million	$2,164 million	$3,981,000	$7,271,000
Kent				$11,282,000	$16,652,000
Newport				$3,166,000	$16,704,000
Providence				$30,746,000	$41,918,000
Washington				$8,869,000	$12,584,000
Total				$58,043,000	$102,129,000

Figure 3-28 Peak wind gust for simulated 1%-annual-chance storm event

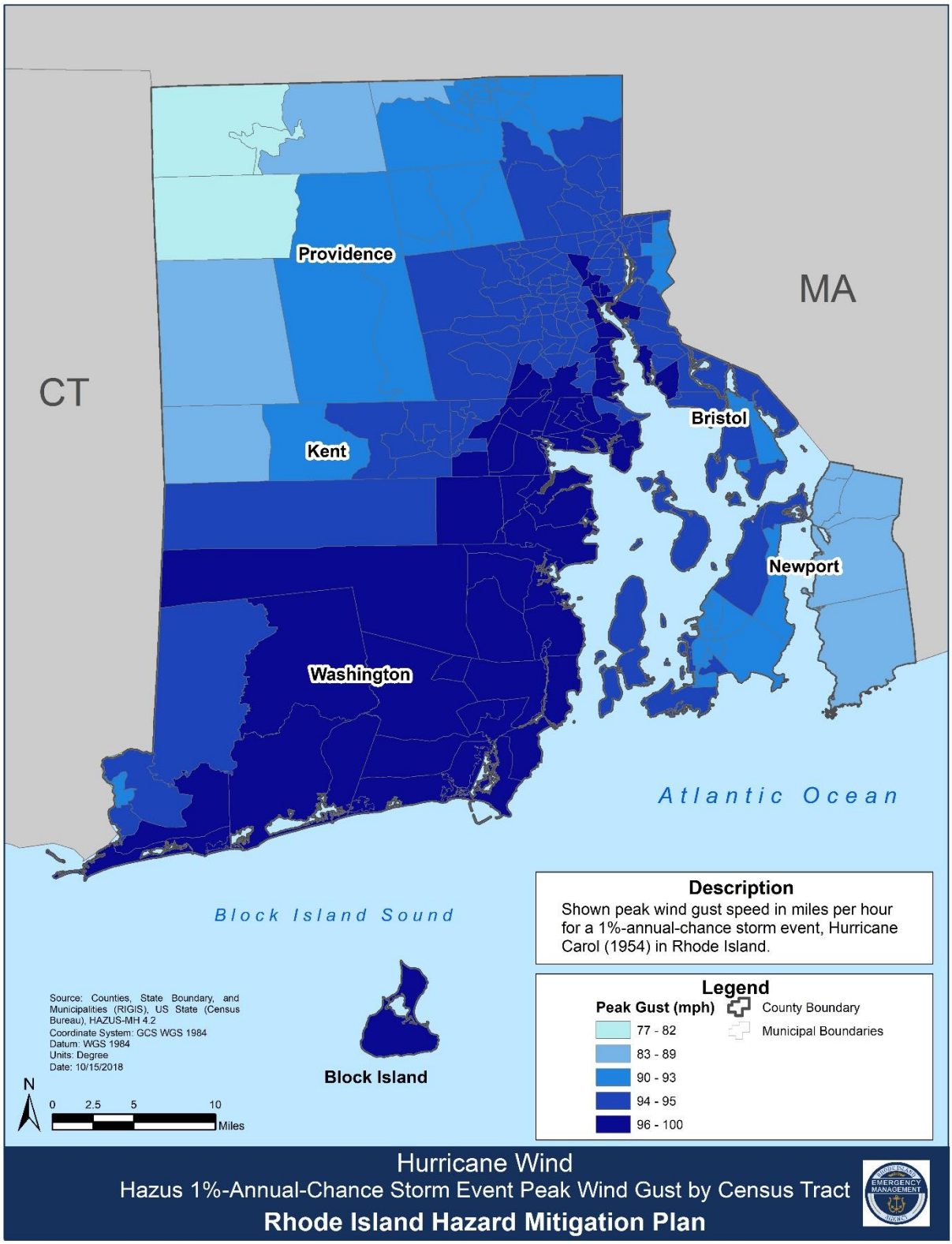


Figure 3-29 Hurricane Irene simulated losses

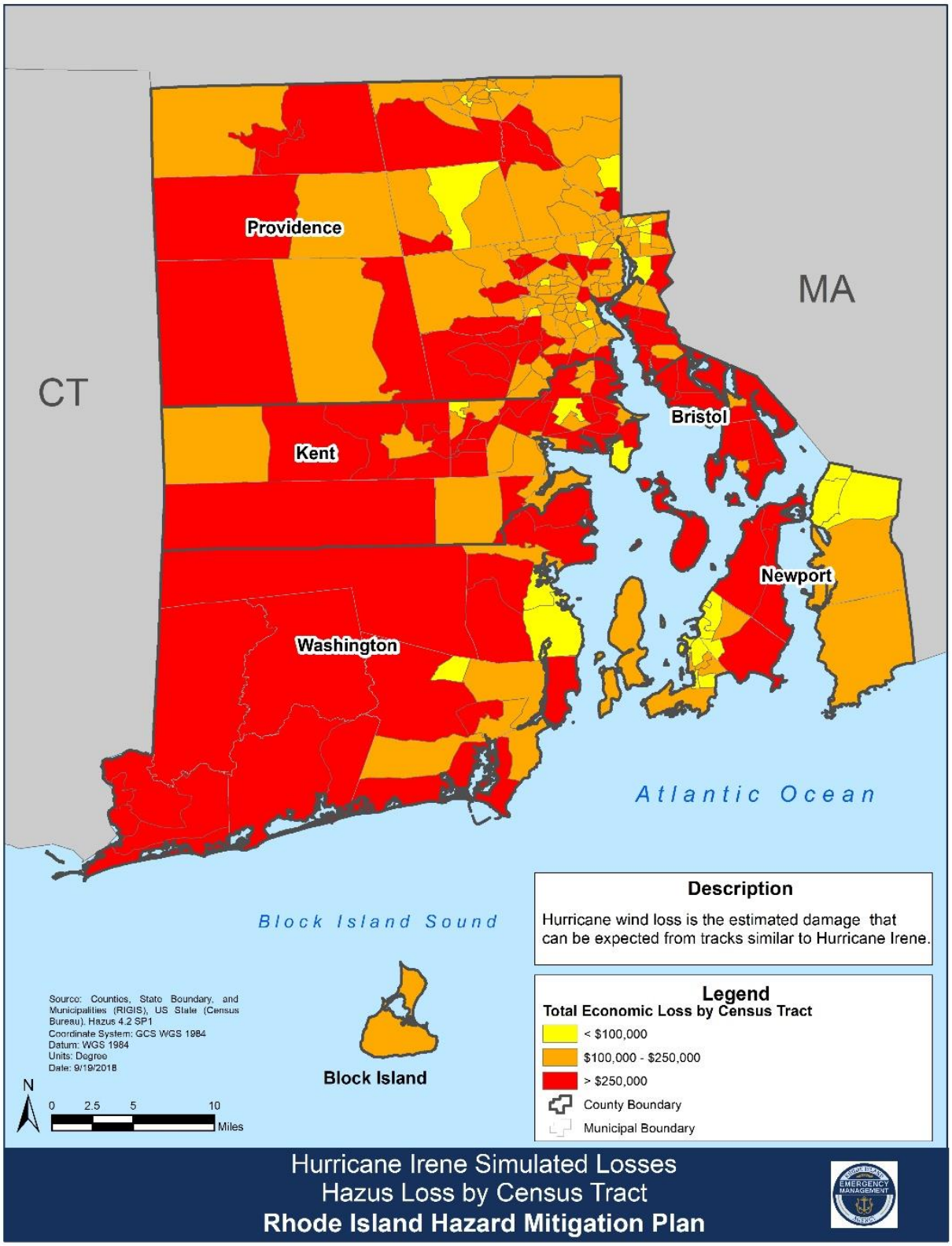
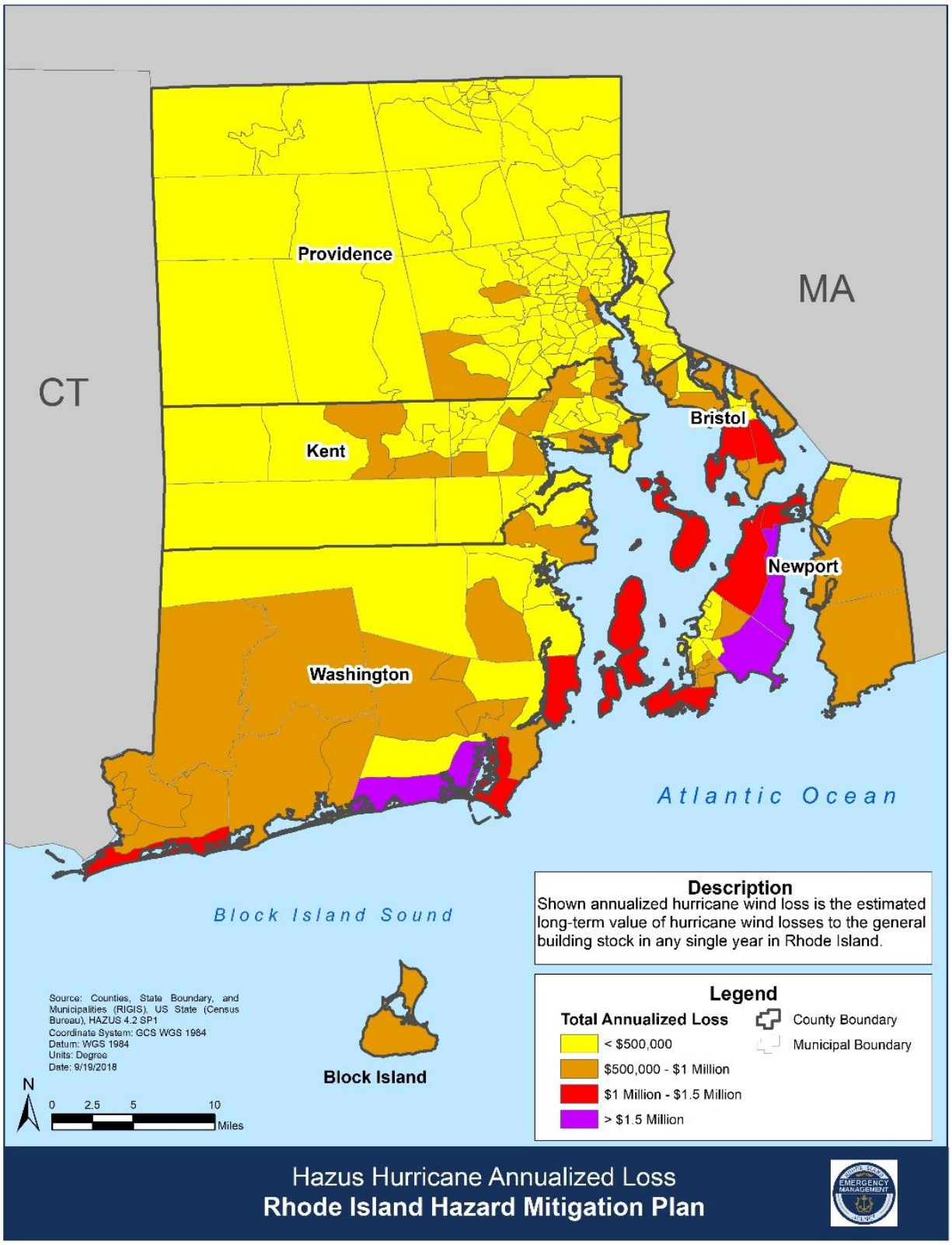


Figure 3-30 Annualized loss from Hurricane Wind



3.26.6.3 Risk and Vulnerability to the Environment

Hurricanes and tropical storms cause beach erosion and unanticipated pollution, both of which negatively impact the environment in the long and short term. Strong winds are generated that completely defoliate forest canopies and cause structural changes in wooded ecosystems. Changes in habitat and food availability due to flooding, winds, and storm surge heavily impact the health of animals, as well as cause death.

Rising waters from flooding associated with hurricanes and tropical storms impact the environment by spreading pollution, inundating water and wastewater treatment plants, carrying debris, and disrupting wildlife and reserve areas. Storm produced flooding causes soil erosion along riverbanks and unanticipated pollution, both of which negatively impact the environment in the long and short term. The flooding of farmland results in the runoff of chemicals and hazardous pesticides into the river causing contamination of rivers and streams. In addition, the standing water following a flooding event facilitates the spread of vector-associated issues such as mosquito-borne disease.

3.26.6.4 Risk and Vulnerability to State Operations

Coordinating an evacuation in advance of a significant hurricane or tropical storm event requires enhanced planning and response coordination and places a substantial strain on resources. First responders also face the hazards that flooding, high winds, and storm surge bring, which may lead to personal injury, disease, or death. Critical roadways and response facilities may flood, lose power, or become damaged or destroyed. Response equipment and vehicles may become inoperable or inaccessible, further complicating response and recovery operations.

Similar to the impacts of flooding, hurricanes and tropical storms can cause road and bridge closures and transit disruptions to ensure public safety in the wake of the storm. The ability to deliver goods and services efficiently will be impacted. Goods and delivery vehicles may become damaged, destroyed, or inoperable under the conditions, depending on the magnitude of the storm.

3.27 Overall Hazard Results and Summary

The preceding hazard sections discussed the probability, impacts, vulnerabilities, and risk for each of the natural, human-caused, and technological hazards that have been determined to have a significant impact on the population, facilities, and infrastructure in the State of Rhode Island. This final sub-section to the HIRA provides an overall assessment and summary of the individual hazard analyses.

3.27.1 Composite Hazard Priorities

As described in the ranking methodology, the composite hazard index characterizes vulnerability in general terms of low, medium, or high hazard propensity. To determine overall risk, the scores for each of the parameters were added together for each hazard to estimate the total county risk due to that hazard. The maximum score from deaths and injuries, infrastructure, structures, environment, and state operations was used to assign the probability hazard magnitude factor. The overall or total hazard score for the state was determined by calculating the average hazard risk for each of the counties. The tables in Section 3.4 summarize the parameters used to prioritize the identified hazards in Rhode Island.[170]

The significance of the priority scores is relative in nature. A given score does not correspond to a dollar loss level or other direct measure of risk. Instead, the risk scores are intended to provide a framework for understanding the aggregate distribution of hazard and vulnerability combinations across the state. Appendix C contains the culmination of the hazard scores broken down by hazard. It should be noted that the results are relative to Rhode Island and should not be used to compare risk and vulnerability of the state to other geographic locations.

3.27.2 Vulnerability Assessment Results

The tables in the section below display the full results of the critical facility exposure analysis. Sources for the data used can be found in Section 3.5.2.

[170] It should be noted that injury and death probable hazard magnitude values for extreme temperature (cold and heat) were derived from existing Department of Health data.

Table 3-75 Exposure of Critical Facilities and Structures to Flooding (per FEMA Flood Zones) by Sector

Sector	Facility Type	Flood Zone							
		VE	A	AE	AH	AO	0.2% Annual Chance	Zone X Protected by Levees	Grand Total
Communications Sector	Cellular Tower	1	0	7	0	0	3	0	11
Emergency Services Sector	EMS	0	1	4	0	0	4	0	9
Emergency Services Sector	EOC/Response Center	0	0	0	0	0	0	0	0
Emergency Services Sector	Fire Stations	0	0	4	0	0	7	0	11
Emergency Services Sector	Law Enforcement*	0	0	0	0	0	3	1	4
Energy Sector	Electric	0	0	1	0	0	0	2	3
Energy Sector	Power Plants	0	0	1	0	0	0	2	3
Energy Sector	Natural Gas Distribution Pipes and Facilities	0	0	0	0	0	0	0	0
Transportation Sector	Airports	3	0	2	0	0	0	0	5
Transportation Sector	Marinas	35	0	27	0	0	10	1	73
Transportation Sector	Port	9	0	11	0	0	0	1	21
Transportation Sector	Rail and Mass Transit (RIPTA Bus Stops)	21	9	229		5	251	218	733
Water/Wastewater Sector	Wastewater Facilities	2	0	3	0	0	6	0	11
Water/Wastewater Sector	Public Water Reservoirs	5	1	2	0	0	0	0	8

Sector	Facility Type	Flood Zone							
		VE	A	AE	AH	AO	0.2% Annual Chance	Zone X Protected by Levees	Grand Total
Chemical Sector	Hazardous Material Facilities	17	6	27	0	0	12	2	64
Commercial Facilities Sector	Postal and Shipping	1	2	14	0	0	25	17	59
Dams Sector	Dams	6	158	150	0	0	41	0	355
Financial Services Sector	Credit Unions and Banks	2	0	13	0	0	14	13	42
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	0	0	3	0	0	2	0	5
Government Facilities Sector	City and Town Halls**	0	0	0	0	0	2	1	3
Government Facilities Sector	Libraries	0	0	0	0	0	3	4	7
Government Facilities Sector	Military Bases	4	0	17	0	0	9	1	31
Government Facilities Sector	Schools	0	0	13	1	0	18	2	34
Government Facilities Sector	Colleges and Universities	0	0	0	0	0	0	1	1
Healthcare and Public Health Sector	Hospitals	0	0	0	0	0	1	0	1
Healthcare and Public Health Sector	Nursing Homes	1	0	3	0	0	7	0	11
Healthcare and Public Health Sector	Urgent Care Facilities	0	0	1	0	0	1	0	2

Sector	Facility Type	Flood Zone							
		VE	A	AE	AH	AO	0.2% Annual Chance	Zone X Protected by Levees	Grand Total
Waste Sector	Active Solid Waste Facility Sites	1	0	2	0	0	6	0	9
E911 Sites	Residential***	2,362	610	9,190	26	12	13,644	96	25,940
E911 Sites	Commercial***	284	53	1,210	5	2	1,320	453	3,327
Grand Total		**2,754**	**840**	**10,934**	**32**	**19**	**15,389**	**815**	**30,783**

*Law enforcement includes police, safety programs, and response teams at colleges and universities
**City and town hall data is also public assembly locations
***Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-76 Exposure of Critical Facilities and Structures to Flooding (per FEMA Flood Zones) by County

County	Flood Zone							
	VE	A	AE	AH	AO	0.2% Annual Chance	Zone X Protected by Levees	Grand Total
Bristol	363	0	1603	0	0	2,050	0	4,016
Kent	304	177	1,463	0	15	3,674	0	5,633
Newport	878	25	1,763	0	0	2,166	0	4,832
Providence	117	332	1,948	32	4	2,487	815	5,735
Washington	1,092	306	4,157	0	0	5,012	0	10,567
Grand Total	**2,754**	**840**	**10,934**	**32**	**19**	**15,389**	**815**	**30,783**

Table 3-77 Exposure of Critical Facilities and Structures to Hurricane Storm Surge by Sector

Sector	Facility Type	Hurricane Category*			
		Cat 1	Cat 2	Cat 3	Cat 4
Communications Sector	Cellular Towers	2	6	7	7
Emergency Services Sector	EMS	2	5	9	12
Emergency Services Sector	EOC/Response Center	0	0	0	0
Emergency Services Sector	Fire Stations	3	6	13	19
Emergency Services Sector	Law Enforcement**	0	2	6	8
Energy Sector	Electrical Generation Facilities	1	3	3	3
Energy Sector	Power Plants	1	3	3	4
Energy Sector	Natural Gas Distribution Pipes and Facilities	0	0	0	0
Transportation Sector	Airports	7	7	7	9
Transportation Sector	Marinas	46	57	62	65
Transportation Sector	Port	15	16	17	18
Transportation Sector	Rail Systems and Mass Transit (RIPTA Bus Stops)	156	545	706	874
Water/Wastewater Sector	Wastewater Facilities	2	4	4	9
Water/Wastewater Sector	Public Water Reservoirs	10	11	13	13
Chemical Sector	Hazardous Material Facilities	20	31	34	44
Commercial Facilities Sector	Postal and Shipping	8	42	50	67
Dams Sector	Dams	18	27	37	49
Financial Services Sector	Credit Unions and Banks	4	29	39	53
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	0	1	3	3
Government Facilities Sector	City and Town Halls***	0	2	2	4
Government Facilities Sector	Libraries	0	5	8	15
Government Facilities Sector	Military Bases	15	25	25	31
Government Facilities Sector	Schools	7	13	28	51
Government Facilities Sector	Colleges and Universities	0	1	3	3

Sector	Facility Type	Hurricane Category*			
		Cat 1	Cat 2	Cat 3	Cat 4
Healthcare and Public Health Sector	Hospitals	0	0	1	1
Healthcare and Public Health Sector	Nursing Homes	4	7	9	10
Healthcare and Public Health Sector	Urgent Care	0	0	0	0
Waste Sector	Active Solid Waste Facility Sites	2	3	4	6
E911 Sites	Residential****	9,868	18,173	27,000	36,066
E911 Sites	Commercial****	986	2,220	2,978	3,708
Grand Total		**11,177**	**21,244**	**31,071**	**41,152**

*Hurricane categories used in exposure analysis only include categories one (1) through four (4) due to data availability.
**Law enforcement includes police, safety programs, and response teams at colleges and universities.
***City and town hall data is also public assembly locations.
****Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-78 Exposure of Critical Facilities and Structures to Hurricane Storm Surge by County

Counties	Hurricane Category*			
	Category 1	Category 2	Category 3	Category 4
Bristol	2,701	5,010	7,090	8,317
Kent	1,466	3,546	5,647	8,154
Newport	1,930	3,242	4,290	5,356
Providence	266	2,076	4,084	7,175
Washington	4,811	7,370	9,960	12,150
Grand Total	**11,174**	**21,244**	**31,071**	**41,152**

*Hurricane categories used in exposure analysis only include categories one (1) through four (4) due to data availability

Table 3-79 Exposure of Critical Facilities and Structures to Wildfire (per WUI Zones) by Sector

Sector	Facility Type	WUI Zones		
		Interface	Intermix	Total
Communications Sector	Cellular Tower	2	22	24
Emergency Services Sector	EMS	25	21	46
Emergency Services Sector	EOC	4	7	11
Emergency Services Sector	Fire Stations	45	29	74
Emergency Services Sector	Law Enforcement*	10	11	21
Energy Sector	Electrical Generation Facilities	3	1	4
Energy Sector	Power Plants	1	6	7
Energy Sector	Natural Gas Distribution Pipes and Facilities	0	1	1
Transportation Sector	Airports	8	7	15
Transportation Sector	Marinas	11	6	17
Transportation Sector	Port	0	0	0
Transportation Sector	Rail Systems and Mass Transit (RIPTA Bus Stops)	395	448	843
Water/Wastewater Sector	Wastewater Facilities	3	2	5
Water/Wastewater Sector	Public Water Reservoirs	2	21	23
Chemical Sector	Hazardous Material Facilities	34	10	44
Commercial Facilities Sector	Postal and Shipping	52	22	74
Dams Sector	Dams	67	316	383
Financial Services Sector	Credit Unions and Banks	67	33	100
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	3	2	5
Government Facilities Sector	City and Town Halls**	13	3	16
Government Facilities Sector	Libraries	18	13	31
Government Facilities Sector	Military Bases	0	83	83
Government Facilities Sector	Schools	100	83	183
Government Facilities Sector	Colleges and Universities	1	2	3

Sector	Facility Type	WUI Zones		
		Interface	Intermix	Total
Healthcare and Public Health Sector	Hospitals	3	2	5
Healthcare and Public Health Sector	Nursing Homes	33	23	56
Healthcare and Public Health Sector	Urgent Care Facilities	6	2	8
Waste Sector	Active Solid Waste Facility Sites	4	25	29
E911 Sites	Residential***	63,023	59,445	122,468
E911 Sites	Commercial***	2,967	1,688	4,655
Grand Total		**66,900**	**62,334**	**129,234**

*Law enforcement includes police, safety programs, and response teams at colleges and universities
**City and town hall data is also public assembly locations
***Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-80 Exposure of Critical Facilities and Structures to Wildfire (per WUI Zones) by County

County	WUI Zones		
	Interface	Intermix	Total
Bristol	0	954	954
Kent	9,379	8,263	17,642
Newport	5,140	5,916	11,056
Providence	28,956	23,921	52,877
Washington	23,425	23,280	46,705
Grand Total	**66,900**	**62,334**	**129,234**

Table 3-81 Exposure of Critical Facilities and Structures to Projected Sea Level Rise by Sector

Sector	Facility Type	Sea Level Rise Scenario			
		MHHW	+1 Foot	+3 Feet	+5 Feet
Communications Sector	Cellular Tower	0	1	2	2
Emergency Services Sector	EMS	0	0	0	1
Emergency Services Sector	EOC/Response Center	0	0	0	0
Emergency Services Sector	Fire Stations	0	0	0	1
Emergency Services Sector	Law Enforcement*	0	0	0	0
Energy Sector	Electrical Generation Facilities	0	0	0	1
Energy Sector	Power Plants	0	0	0	1
Energy Sector	Natural Gas Distribution Pipes and Facilities	0	0	0	0
Transportation Sector	Airports	1	1	3	4
Transportation Sector	Marinas	14	17	31	39
Transportation Sector	Port	2	2	2	6
Transportation Sector	Rail Systems and Mass Transit (RIPTA Bus Stops)	19	25	50	115
Water/Wastewater Sector	Wastewater Facilities	0	0	0	2
Water/Wastewater Sector	Public Water Reservoirs	5	5	5	6
Chemical Sector	Hazardous Material Facilities	2	2	11	11
Commercial Facilities Sector	Postal and Shipping	2	5	5	8
Dams Sector	Dams	6	6	10	12
Financial Services Sector	Credit Unions and Banks	0	0	0	0
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	0	0	0	0
Government Facilities Sector	City and Town Halls**	0	0	0	0
Government Facilities Sector	Libraries	0	0	0	0
Government Facilities Sector	Military Bases	1	1	2	3
Government Facilities Sector	Schools	0	1	1	2
Government Facilities Sector	Colleges and Universities	0	0	0	0

Sector	Facility Type	Sea Level Rise Scenario			
		MHHW	+1 Foot	+3 Feet	+5 Feet
Healthcare and Public Health Sector	Hospitals	0	0	0	0
Healthcare and Public Health Sector	Nursing Homes	0	0	0	0
Healthcare and Public Health Sector	Urgent Care Facilities	0	0	0	0
Waste Sector	Active Solid Waste Facility Sites	0	0	2	2
E911 Sites	Residential***	147	315	1360	3678
E911 Sites	Commercial***	107	136	283	594
Grand Total		**306**	**518**	**1,768**	**4,490**

*Law enforcement includes police, safety programs, and response teams at colleges and universities
**City and town hall data is also public assembly locations
***Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-82 Exposure of Critical Facilities and Structures to Projected Sea Level Rise by County

Counties	Sea Level Rise Scenario			
	MHHW	+1 Foot	+3 Feet	+5 Feet
Bristol	39	62	287	805
Kent	36	54	148	489
Newport	87	135	374	949
Providence	58	70	97	165
Washington	86	197	863	2,082
Grand Total	**306**	**518**	**1,769**	**4,490**

Table 3-83 Exposure of Critical Facilities and Structures to Hurricane Carol Peak Wind Gust (mph)

Sector	Facility Type	Peak Wind Gust 96 mph and Above
Communications Sector	Cellular Tower	8
Emergency Services Sector	EMS	30
Emergency Services Sector	EOC/Response Center	2
Emergency Services Sector	Fire Stations	48
Emergency Services Sector	Law Enforcement*	24
Energy Sector	Electrical Generation Facilities	5
Energy Sector	Power Plants	5
Energy Sector	Natural Gas Distribution Pipes and Facilities	0
Transportation Sector	Airports	40
Transportation Sector	Marinas	48
Transportation Sector	Port	19
Transportation Sector	Rail Systems and Mass Transit (RIPTA Bus Stops)	1451
Water/Wastewater Sector	Wastewater Facilities	7
Water/Wastewater Sector	Public Water Reservoirs	2
Chemical Sector	Hazardous Material Facilities	110
Commercial Facilities Sector	Postal and Shipping	126
Dams Sector	Dams	164
Financial Services Sector	Credit Unions and Banks	100
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	4
Government Facilities Sector	City and Town Halls**	9
Government Facilities Sector	Libraries	38
Government Facilities Sector	Military Bases	40
Government Facilities Sector	Schools	199

Sector	Facility Type	Peak Wind Gust 96 mph and Above
Government Facilities Sector	Colleges and Universities	8
Healthcare and Public Health Sector	Hospitals	5
Healthcare and Public Health Sector	Nursing Homes	34
Healthcare and Public Health Sector	Urgent Care Facilities	4
Waste Sector	Active Solid Waste Facility Sites	17
E911 Sites	Residential***	96,261
E911 Sites	Commercial***	5,538
Grand Total		**104,346**

*Law enforcement includes police, safety programs, and response teams at colleges and universities
**City and town hall data is also public assembly locations
***Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-84 Exposure of Critical Facilities and Structures to Hurricane Carol Peak Wind Gust by County

Counties	Peak Wind Gust 96 mph and Above
Bristol	1,815
Kent	35,011
Newport	0
Providence	17,676
Washington	49,844
Grand Total	**104,346**

Table 3-85 Exposure of Critical Facilities and Structures to Earthquake PGA (mph)

Sector	Facility Type	Events with PGA of .15 and above
Communications Sector	Cellular Tower	15
Emergency Services Sector	EMS	41
Emergency Services Sector	EOC/Response Center	5
Emergency Services Sector	Fire Stations	63
Emergency Services Sector	Law Enforcement*	30
Energy Sector	Electrical Generation Facilities	8
Energy Sector	Power Plants	5
Energy Sector	Natural Gas Distribution Pipes and Facilities	0
Transportation Sector	Airports	4
Transportation Sector	Marinas	16
Transportation Sector	Port	13
Transportation Sector	Rail Systems and Mass Transit (RIPTA Bus Stops)	3,005
Water/Wastewater Sector	Wastewater Facilities	7
Water/Wastewater Sector	Public Water Reservoirs	18
Chemical Sector	Hazardous Material Facilities	222
Commercial Facilities Sector	Postal and Shipping	168
Dams Sector	Dams	134
Financial Services Sector	Credit Unions and Banks	182
Food and Agriculture Sector	Poultry Slaughtering and Processing Facilities	13
Government Facilities Sector	City and Town Halls**	13
Government Facilities Sector	Libraries	53
Government Facilities Sector	Military Bases	22
Government Facilities Sector	Schools	337
Government Facilities Sector	Colleges and Universities	12
Healthcare and Public Health Sector	Hospitals	13

Sector	Facility Type	Events with PGA of .15 and above
Healthcare and Public Health Sector	Nursing Homes	81
Healthcare and Public Health Sector	Urgent Care Facilities	12
Waste Sector	Active Solid Waste Facility Sites	21
E911 Sites	Residential***	160,951
E911 Sites	Commercial***	11,545
Grand Total		**177,009**

*Law enforcement includes police, safety programs, and response teams at colleges and universities
**City and town hall data is also public assembly locations
***Residential includes R1, R2, and R3 designated structures. Commercial includes C1 and C9 designated structures.

Table 3-86 Exposure of Critical Facilities and Structures to Earthquake PGA (mph) by County

Counties	Events with PGA of .15 and above
Bristol	15,859
Kent	7,979
Newport	0
Providence	153,171
Washington	0
Grand Total	**177,009**

Section 4: State Capability Assessment

44 Code of Federal Regulations (CFR) Requirement
State Capability Assessment **Requirement §201.4(c)(3)(ii):** [The State mitigation strategy shall include a] discussion of the State's pre-and post-disaster hazard management policies, programs, and capabilities to mitigate the hazards in the area, including: an evaluation of State laws, regulations, policies, and programs related to hazard mitigation as well as to development in hazard-prone areas [and] a discussion of State funding capabilities for hazard mitigation projects.

Several different Rhode Island State agencies and offices have incorporated hazard mitigation objectives into their organizational missions. Descriptions of each agency's hazard mitigation-related functions, including their enabling legislation, and examples of the agency's current hazard mitigation measures are summarized in this section.

4.1 2019 Plan Update

The State Capability Assessment section is organized into three (3) main sections: an overview of the 2019 State agency capabilities, a capabilities summary matrix, and agency specific profiles. The overview of State agency capabilities documents programs, policies, and funding for each State agency. The summary matrix details the programs, policies, and funding opportunities each State agency is implementing to reduce risk, and assigns each agency a score on hazard mitigation capabilities. The agency specific profiles provide further detail on these programs, policies, and funding opportunities by summarizing pre- and post- disaster capabilities as well as funding, staffing, and technical assistance capabilities. In addition, each profile documents if that agency regulates development in hazard areas.

Statewide hazard mitigation capabilities documented in the 2019 Plan update were reviewed for relevance. Programs, policies, and funding capabilities that are no longer applicable to hazard mitigation or are outdated and have been removed from the Plan. Prior to the Risk Assessment and Mitigation Opportunities meeting held on September 5, 2018, the capability assessment and pre-populated agency profiles were sent to individual agencies for review and update. New profiles have been created for agencies newly involved in the State Interagency Hazard Mitigation Committee (SIHMC) as part of the 2019 Plan update. Comments have been incorporated into each agency's profile and completed to the best of each agency's ability.

Noteworthy Statewide capabilities that have changed or been added since 2014 include:

- STORMTOOLS and Rapid Property Assessment and Coastal Exposure (Rapid PACE) Mapping Programs
- Resilient Rhode Island Act (2014)
    - Executive Climate Change Coordinating Council (EC4) (2014)
- Resilient Rhody Strategy (2017)
- State LiDAR data
- Rhode Island Shoreline Change Special Area Management Plan (Beach SAMP)
- National Grid Gas and Electric Infrastructure Safety and Reliability plans

The following section further details the capabilities of agencies with programs and policies related to hazard mitigation. Each agency specific profile includes new capabilities since the 2014 plan. The information in this section has been reviewed and revised by the SIHMC and members of the highlighted agencies and offices. The SIHMC has approved the information presented in this section and feel it represents the hazard mitigation capabilities of Rhode Island. SIMHC members and agency contacts who provided additional data and information are listed in Appendix B along with their role in the plan update.

4.2 Pre- and Post-Disaster Management Policies, Programs, and Capabilities

This section presents a summary of the State's hazard mitigation capability including a description and analysis of State laws, regulations, policies, and programs organized by the agency responsible. A general description and analysis of the effectiveness of local mitigation policies and programs can be found in Section 5.

Table 4-1 lists the plans, programs, policies, and funding opportunities that support risk reduction activities, encourage mitigation measures, and increase community resiliency at the state level. This matrix includes current State laws, Executive Orders, regulations, policies and programs as well as related federal programs that currently support hazard mitigation throughout the State. These items are discussed in more detail under the agency descriptions in the sections below.

Each agency's hazard mitigation effectiveness, which includes accomplishments such as funding of mitigation projects, risk reduction activities, public education/outreach, and other ways the agency has contributed to increasing state-wide resiliency, is documented in the agency descriptions. New State policies, programs, and funding resources available within or to the agency and changes to hazard management capabilities since 2014 are also included.

Table 4-1 Current Plans, Programs, Policies, and Funding Opportunities that Support Risk Reduction, Community Resiliency, and Mitigation Activities

Agency	Plan/Program		Policy	Funding
Federal Emergency Management Agency (FEMA)	See Rhode Island Emergency Management Agency (RIEMA) profile		See RIEMA profile	See RIEMA profile
National Grid	Electric Infrastructure, Safety, and Reliability Plan (includes status of flood mitigation projects) Enhanced Hazard Tree Mitigation Program Regular inspections and maintenance Storm warnings and safety/power notifications		N/A	N/A
National Weather Service (NWS)	HURREVAC/SLOSH training Severe Weather Spotter training StormReady	Flood event summaries and studies River and dam break modeling	N/A	Coastal Resilience Grants Coastal Zone Management Estuarine Research Reserves Coastal Zone Management Administration
Rhode Island Coastal Resources Management Council (RICRMC)	State Coastal Plan Sea Level Affecting Marshes Model (SLAMM) Special Area Management Plans (Ocean, Shoreline Change (Beach), MetroBay, Greenwich Bay, Aquidneck Island, Salt Pond, Narrow River, Pawcatuck River Estuary, Providence Harbor, and Little Narragansett Bay) Coastal Zone Buffer Program Stormwater Design and Installation Standards Manual Rhode Island Coastal and Estuarine Land Conservation Plan Coastal Resources Management Program Coastal Smart Growth Guide Rhode Island Coastal Wetland Restoration Strategy Coastal Landscapes Low Impact Development Planning and Design Guidance Manual Mapping Protocol for Eroding Bluffs		Wetland Preservation Dune Preservation Barrier Island and Spits Planning Policy Climate Change and Sea Level Rise (SLR)	Coastal and Estuary Habitat Restoration Program and Trust Fund

Agency	Plan/Program	Policy	Funding
Rhode Island Department of Environmental Management (RIDEM)	Governor's Task Force on Dam Safety and Maintenance Dam Safety Program Division of Forest Environment (tree warden, fire mitigation) Office of Water Resources (OWR) (wastewater and storm water management, drought monitoring) Emergency Response Planning (ERP) (hazardous materials/oil spills, hurricane, prescribed fire burn, droughts) Implications of Climate Change for Rhode Island Wastewater Collection & Treatment Infrastructure study	Dam Environmental Protection Agency (EPA) Regulation	N/A
Rhode Island Department of Health (RIDOH)	Center for Emergency Preparedness and Response (CEPR) SafeWater Rhode Island Long-term Care Mutual Aid Plan Climate Change and Health – Senior Resiliency Project	Safe Water Drinking Act	Public Health Emergency Preparedness (PHEP) grant Hospital Preparedness Program
Rhode Island Department of Transportation (RIDOT)	Hurricane Evacuation Routes Strategic Highway Safety Plan and Highway safety campaigns Stormwater management program Infrastructure vulnerability assessments	N/A	Funding through the Federal Highway Administration (FHWA) available for capital repairs along Federal Aid System of Highways
Rhode Island Department of Administration (RIDOA)	EC4	N/A	N/A

Agency	Plan/Program		Policy	Funding
Rhode Island Department of Administration (Division of Planning)	State Guide Plan Element 110: General Goals and Policies Element 121: Land Use 2025 Element 131: Cultural Heritage and Land Management Plan for the Blackstone River Valley National Heritage Corridor Element 140: State Historical Preservation Plan Element 152: Ocean State Outdoors: Rhode Island's Comprehensive Outdoor Recreation Plan Element 155: A Greener Path: Greenspace and Greenways for Rhode Island's Future Element 156: Urban and Community Forest Plan Element 161: Forest Resources Management Plan Element 421: State Housing Plan Element 423: Rhode Island Five Year Strategic Housing Plan Element 611: Transportation 2035 Element 640: State Airport System Plan Element 651: Waterborne Passenger Transportation Plan Element 661: State Rail Plan Element 721: Rhode Island Water 2030 Energy 2035, Rhode Island State Energy Plan Rhode Island Rising, Economic Development Solid Waste 2038 Water Quality 2035 Vulnerability of Transportation Assets to Sea Level Rise and Storm Surge Assessments Socioeconomics of Sea Level Rise Railway Vulnerability Plan		Comprehensive Planning Regulation and Land Use Act (RIGL 45-22.2) Rhode Island Zoning Enabling Act (45-24) Rhode Island Land Development and Subdivision Review Enabling Act (45-23) Social Equity Report	N/A
Rhode Island Emergency Management Agency	National Flood Insurance Program (NFIP) Community Rating System (CRS) FEMA Risk Mapping, Assessment and Planning (Risk MAP) Common Alerting Protocol (CAP) Rhode Island Flood Audit Task Force Debris Management Plan Technical Assistance Emergency Operations Plan (EOP)	Infrastructure Protection Program Protected Critical Infrastructure Information Program State Emergency Operations Center (SEOC) State Hazard Mitigation Program Threat and Hazard Identification and Risk Assessment (THIRA) Homeland Security Information Network	N/A	Hazard Mitigation Grant Program (HMGP) Pre-Disaster Mitigation (PDM) Flood Mitigation Assistance (FMA) Emergency Management Performance Grant (EMPG) Program State Homeland Security Program (SHSP)

Agency	Plan/Program	Policy	Funding
Rhode Island Historical Preservation and Heritage Commission (RIHPHC)	N/A	State Historic Preservation Office (SHPO)/RIEMA Disaster Recovery Memorandum of Understanding (MOU)	Not applicable
Rhode Island Infrastructure Bank (RIIB)	Resilient Rhody	N/A	Brownfields Revolving Loan Fund Clean Water State Revolving Fund Commercial Property Assessed Clean Energy (C-PACE) Community Septic System Loan Program (CSSLP) Drinking Water State Revolving Fund Efficient Buildings Fund Facility Plan Loan Fund Municipal Road and Bridge Revolving Fund Rhode Island Water Pollution Control Revolving Fund Sewer Tie-In Loan Fund
Rhode Island Office of Energy Resources (RIOER)	Energy Assurance Plan Energy 2035: Rhode Island State Energy Plan (also part of State Guide Plan)	N/A	N/A
Rhode Island Office of the Governor	Cybersecurity Commission	Resilient Rhode Island Act Executive Orders 15-17, 17-06, and 17-10	Office of the Governor Budget
Rhode Island Office of Housing and Community Development (Division of Planning)	Disaster Housing Task Force (DHTF) Housing Resources Commission Community Development Block Grant Disaster Recovery (CDBG-DR) Action plans	N/A	CDBG Program/Grants – including CDBG-DR funds
Rhode Island Public Utilities Commission and Division of Public Utilities and Carriers	Infrastructure, Safety, and Reliability dockets for National Grid Gas and Electric (include flood mitigation projects and vegetation management) Major storm event damage summaries	N/A	N/A
Rhode Island Rivers Council	Cultural Heritage and Land Management Plan for the Blackstone River Valley Rhode Island Rivers Policy and Classification Plan Establishment of Riparian and Shoreline Buffers and the Taxation of Property included in Buffers report	N/A	Grants for projects proposed by state designated local watershed councils

Agency	Plan/Program		Policy	Funding
Rhode Island Sea Grant College Program and University of Rhode Island (URI) Coastal Resources Center	Ongoing research/vulnerability assessments for coastal hazards and SLR Technical assistance to decision makers at the state and local level Climate change adaptation planning Rhode Island Ocean Special Area Management Plan (SAMP) Rhode Island Green Infrastructure Project Rapid PACE Mapping Providing Resilience Education for Planning Preparedness in Rhode Island (PREP-RI) STORMTOOLS Block Island Shoreline Change Maps		N/A	Research grants National Fish and Wildlife Foundation (NFWF)
Rhode Island State Police	Storm Preparedness Resources Rhode Island Joint Cyber Task Force (RIJCTF)		N/A	N/A
Rhode Island Water Resources Board (Division of Planning)	Strategic Plan Water Supply System Management Plan program Drought Management and Steering Committee		Water Use and Efficiency Act	Water Quality Protection Surcharge Corporate Water Quality Protection Surcharge
Scientific Support for Environmental Emergency Response	Environmental disaster response and recovery		N/A	N/A
State Building Code Commission	Building Code Standards Committee Rebuilding After a Storm		State Building Code	N/A
United States Army Corp of Engineers (USACE)	Dam breach failure analysis SLR analysis Flood Control Projects Habitat Restoration Floodplain Management Services	Planning Assistance to States Wetland Identification and Restoration Estuary Protection Inspections of infrastructure Rhode Island Silver Jackets Team	N/A	Floodplain Management Services Planning Assistance to States
United States Department of Agriculture Natural Resources Conservation Service (NRCS)	Emergency Watershed Protection (EWP) Program Watershed and Flood Prevention Program		N/A	EWP Program Federal Watershed Operations funding assistance
United States Geological Survey (USGS)	Real-time river flood stage monitoring and warning systems Stream gauges Coastal storm tide data collection Post-storm/flood data analysis		N/A	N/A
University of Rhode Island Environmental Data Center (EDC)	Geographical Information Systems (GIS)/Mapping services 2014 LiDAR Statewide Digital Elevation Model (DEM) Data	Technical support	N/A	N/A

Table 4-2 summarizes the capabilities captured in each agency Capability Checklist presented in the subsections below. This table highlights the capabilities of the State as it pertains to hazard mitigation and helps identify gaps where risk reduction capabilities can be improved upon in the future. To sufficiently evaluate the capabilities of each stakeholder's agency or organization, a weighting system was implemented to determine their relative rank for how effective the capability of the agency is at achieving the goals and implementing mitigation. Each of the basic capabilities were reviewed and given a numerical value to demonstrate the ability of each activity to support mitigation efforts.

Capabilities with the greatest mitigation related benefit were ranked the highest. These include pre and post-disaster capabilities and received a weighting of two (2). Other important but lesser valued capabilities included the 1) funding and 2) technical assistance resources available and were weighted with a value of one and a half (1.5). An agency or organization's ability to regulate development in hazard prone areas and staffing resources were weighted with a value of one (1).

Once assessments were completed, agencies with an overall capability of nine (9), having all capabilities to complete hazard mitigation activities, were given a high capability ranking. Assessment totals between seven (7) and eight (8) were given a medium capability ranking. Neutral capabilities were given for agencies with total ranking scores between five (5) and six (6).

As the planning process continues to evolve, the SIHMC will review the current agencies and expand upon capabilities, as they are presented, that help mitigate hazards identified in the risk assessment.

Table 4-2 Rhode Island mitigation capabilities matrix

Agency	Pre-Disaster Capabilities	Post-Disaster Capabilities	Regulates Development in Hazard Prone Areas	Funding Capabilities	Staffing Resources	Technical Assistance	Overall Capacity Score	Capability Ranking
Weighting	***2***	***2***	***1***	***1.5***	***1***	***1.5***		
Federal Emergency Management Agency	2	2	1	1.5	1	1.5	9	High
Rhode Island Department of Health	2	2	1	1.5	1	1.5	9	High
Rhode Island Department of Transportation	2	2	1	1.5	1	1.5	9	High
Rhode Island Emergency Management Agency	2	2	1	1.5	1	1.5	9	High
Rhode Island Infrastructure Bank	2	2	0	1.5	1	1.5	8	Medium
Rhode Island Rivers Council	2	2	0	1.5	1	1.5	8	Medium
Rhode Island Water Resources Board	2	2	1	1.5	0	1.5	8	Medium
United States Department of Agriculture Natural Resources Conservation Service	2	2	1	1.5	0	1.5	8	Medium
National Weather Service	2	2	0	1.5	1	1.5	8	Medium
Rhode Island Coastal Resources Management Council	2	2	1	0	1	1.5	7.5	Medium
Rhode Island Department of Administration	2	2	1	0	1	1.5	7.5	Medium
Rhode Island Division of Planning	2	2	1	0	1	1.5	7.5	Medium
Rhode Island Office of Energy Resources	2	2	1	0	1	1.5	7.5	Medium

Agency	Pre-Disaster Capabilities	Post-Disaster Capabilities	Regulates Development in Hazard Prone Areas	Funding Capabilities	Staffing Resources	Technical Assistance	Overall Capacity Score	Capability Ranking
Weighting	***2***	***2***	***1***	***1.5***	***1***	***1.5***		
Rhode Island Office of Housing and Community Development	2	2	0	1.5	0	1.5	7	Medium
Rhode Island Sea Grant College Program and URI Coastal Resources Center	2	0	1	1.5	1	1.5	7	Medium
United States Army Corp of Engineers	2	2	0	1.5	0	1.5	7	Medium
National Grid	2	2	0	0	1	1.5	6.5	Neutral
Rhode Island Department of Environmental Management	2	2	1	0	0	1.5	6.5	Neutral
Rhode Island Office of the Governor	2	2	0	1.5	1	0	6.5	Neutral
Rhode Island State Police	2	2	0	0	1	1.5	6.5	Neutral
Scientific Support for Environmental Emergency Response	2	2	0	0	1	1.5	6.5	Neutral
United States Geological Survey	2	2	0	0	1	1.5	6.5	Neutral
University of Rhode Island Environmental Data Center	2	2	0	0	1	1.5	6.5	Neutral
Rhode Island Historical Preservation and Heritage Commission	2	2	0	0	0	1.5	5.5	Neutral

Agency	Pre-Disaster Capabilities	Post-Disaster Capabilities	Regulates Development in Hazard Prone Areas	Funding Capabilities	Staffing Resources	Technical Assistance	Overall Capacity Score	Capability Ranking
Weighting	***2***	***2***	***1***	***1.5***	***1***	***1.5***		
Rhode Island Public Utilities Commission and Division of Public Utilities and Carriers	2	2	0	0	1	0	5	Neutral
State Building Code Commission	2	2	1	0	0	0	5	Neutral

4.2.2 Agency Specific Profiles

The following section includes each of the Agency profile capability assessments completed for the 2019 Plan update. To update the profile, each contributing agency received a pre-populated profile, based on information presented in the 2014 State Hazard Mitigation Plan (SHMP) to review and edit, as well as the template shown in Figure 4-1. For agencies newly engaged as part of the 2019 SHMP Update, a blank worksheet was provided to complete in addition to an example profile for guidance. Agency profile contacts are shown in Appendix D; all of the contacts are also members of the SIHMC.

Figure 4-1 Capability assessment agency profile worksheet.

Agency Name

Description of Agency

(Summary of agency mission and description of programs and policies that support risk reduction activities, including development in hazard prone areas)

Funding capabilities

(Summary of operating budget, grant programs available to complete structural projects or outreach activities, investments in risk reduction or mitigation activities)

Staffing resources

(Summary of total staff within agency; identification of available staff support risk reduction or mitigation activities)

Technical Assistance

(Description of Expertise with technical programs such as GIS, engineering models, etc. Any qualified/committed personnel for preparing project grant applications? Does the agency provide technical support to the public or other state agencies?)

Hazard Mitigation Effectiveness

(State accomplishments such as funding of mitigation projects, risk reduction activities, public education/outreach, etc. What has the agency contributed or achieved with regard to increasing state-wide resiliency? Does the agency have the authority to regulate impact to or development in hazard prone areas?)

New Capabilities since 2014

(State new policies, programs, and funding resources available within or to the agency since 2014)

4.2.2.2 Federal Emergency Management Agency

Description of agency

FEMA's mission is to help people before, during, and after disasters. FEMA works in partnership with State, Tribal, and local partners to develop comprehensive disaster preparedness plans, prepare for better intergovernmental coordination in the face of a disaster, encourage the use of insurance coverage, and provide federal assistance programs for losses due to a disaster. Many Federal mitigation funding opportunities, policies, and programs are administered by FEMA and carried out at the State level. Additionally, the Presidential Executive Order 12148 was implemented following the accident at Three Mile Island in Pennsylvania in 1979, which gave FEMA the responsibility of ensuring the ensuring the health and safety of residents living and working in the emergency planning zone outside the plant.

Funding capabilities

The Mitigation Division and the Grants Management Division at FEMA Region I provide support for the management of all disaster, non-disaster, and preparedness grants issued by FEMA. RIEMA's profile includes information on FEMA grants that RIEMA uses to fund mitigation projects, including HMA and Public Assistance (PA). Additional information regarding program descriptions can be found in Appendix 4.

Staffing resources

The Mitigation Division in FEMA Region I has staff available to support risk reduction and mitigation activities within Rhode Island, by providing staff to provide the technical assistance capabilities listed in this profile.

Technical assistance

FEMA Region I can provide expertise and technical advisory assistance to Rhode Island on matters pertaining to Floodplain Management and Insurance, Environmental and Historic Preservation, Hazard Mitigation Assistance (FMA, HMGP, and PDM), Risk MAP, and Hazard Mitigation Planning.

Hazard mitigation effectiveness

FEMA works with RIEMA to increase opportunities to minimize future damage to public and private property from natural hazard events. See the RIEMA profile for more information.

New capabilities since 2014

See RIEMA profile.

4.2.2.3 National Grid

Description of agency

National Grid strives to deliver safe and reliable energy to approximately 500,000 electric and 270,000 gas customers throughout Rhode Island.

Funding capabilities

National Grid is an international electricity and gas company and one of the largest investor-owned energy companies in the world. Funding is made available for pre- and post- disaster assistance.

Staffing resources

National Grid has a core staff of operations and support personnel staffed in Rhode Island on a normal full-time basis. This staff is capable of handling day to day operations and small-scale emergencies on a standalone basis. During emergency events, which require additional support, the company has the ability to surge operations and allocate and support resources from its Massachusetts and New York service territory. Additionally, the company maintains relationships with utilities and contractors from across the U.S. in order to obtain additional support and operations resources on an as needed basis. These relationships are facilitated by RMAGs, which manage voluntary mutual assistance agreements to support the restoration process.

Technical assistance

The company maintains lists of contact persons for emergency events, with names, titles, addresses, phone/cell numbers, emails and other pertinent data as appropriate for:

- Local elected, local appointed, state and local public safety officials and emergency management and response personnel.
- Contact persons for facilities that are jointly considered critical to both the community and the Company. These facilities are typically engaged in providing services essential to the health and safety of the community, and where the loss of electrical service would interrupt vital services to the public (e.g., hospitals, nursing homes, key municipal facilities, and sewage treatment plants).

On "Blue Sky" days, the company's Community & Customer Manager is the primary liaison between National Grid and each municipality. This position was established to develop relationships between the Company and municipal officials to better respond to the community needs during a restoration effort.

During major events and extended restoration efforts, additional employees who are trained Community Liaisons are deployed to supplement the Community & Customer Manager. The Community Liaison will contact the assigned Emergency Management Director, or local Incident Commander of the individual community, as the forecast becomes more certain. This role is in addition to the Community & Customer Manager and the Municipal Call Center. When directed, Community Liaisons will report to the municipality's Incident Commander and will provide assistance in the prioritization of work and communication of municipal priorities to ensure public safety. Additionally, this position may assist in facilitating the restoration of electric service to the assigned community. Each Community Liaison has access to feeder maps, which are maps outlining

municipal substations, distribution networks, and up-to-date customer outage information. In addition, the Liaison will have all the key contact, facility, and other municipal information to facilitate communications. The Community Liaison will utilize the maps and outage reports to respond to inquiries from state and local officials and relevant regulatory agencies. National Grid has provided feeder (circuit) maps and town specific power restoration information to local points of contact as well.

The company may elect to establish a Municipal Call Center with a dedicated telephone number(s) for responding to local governmental authority inquiries during major events. The telephone number will only be provided to authorized municipal officials, for their official use only, prior to activation of the dedicated line. If a municipality is concerned over the loss of electrical service to facilities that provide vital services to the public (e.g. key municipal facilities, sewage treatment plants), they are directed to communicate this concern to the company via this dedicated line or their Community Liaison. If the dedicated line or Community Liaison has not been activated, the municipality is directed to contact the company via their assigned Customer & Community Manager.

During an emergency event, the company provides a representative to the RIEMA Emergency Operation Center (EOC) to provide Emergency Support Function (ESF) 12 support as well as facilitate communications between the Company and other response agencies. The RIEMA liaison will:

- Liaise with the State EMA during the emergency
- Provide outage information on a regular basis
- Support ESF 12
- Assist with the coordination of additional of requests of other responding agencies as required

Hazard mitigation effectiveness

As described above, the company has extensive technical assistance capabilities, particularly with local and state coordination. Similarly, the Company sends text and email message notifications out to customers during major storms and provides safety tips. Storm recovery information on power restoration and steps customers can take to recover from an outage or from property damage are also provided.

National Grid reaches out to United Way's 2-1-1 system to craft messages for people looking for information and assistance. In addition, the company has a website that provides live electrical outage information and estimated restoration times on a 24-hour basis.

A list of print and broadcast media contact information is maintained and may uses various means to disseminate information to the press, including news releases, news conferences and teleconferences, interviews.

New capabilities since 2014

The company has upgraded its Outage Management System (OMS) to include new functionality and capabilities. Near real time outage reporting is available via a suite of configurable dashboards that interface with the OMS, providing information that can be communicated with municipal officials and communities during outage events.

National Grid has also implemented the First Responder smartphone and tablet application for community first responders in the company's service territory, to provide improved situational awareness. First responders are able to utilize the application to take pictures of damage to electric or gas facilities and submit these pictures to the Company, providing visual information to be used in advance of the Company's response.

4.2.2.4 National Weather Service

Description of agency

NWS provides life-saving forecast and warning services to the region as well as detailed event-driven decision support services.

NWS offers training on hydrologic services and tools, severe weather spotter training and all-weather hazards training. Monthly summaries of flood events (E-5 Reports) are available from the weather forecast office (WFO) in Norton while all hazardous weather event summaries are available through the Storm Data publications.

Rhode Island has many NWS-trained weather spotters feeding "ground truth" observations directly into NWS Norton as part of the NWS SkyWarn program. Such observations can trigger warnings to be issued by NWS.

Funding capabilities

The NWS does not currently offer funding opportunities for hazard mitigation. However, the National Oceanic and Atmospheric Association (NOAA), the organization, which oversees NWS, has several funding capabilities, such as the coastal resilience grant, coastal zone management estuarine research reserves grants, and coastal zone management administration grants.

Staffing resources

The NWS WFO in Norton leads local outreach and education efforts, including the Warning Coordination Meteorologist and Senior Service Hydrologist. The Northeast River Forecast Center provides river and dam break modeling expertise and conducts outreach with partners on a regional basis, led by the Service Coordination Hydrologist.

Technical assistance

NWS provides technical support in the form of Decision Support Services on an event-driven basis in support of ongoing hydrometeorological events.

Hazard mitigation effectiveness

The NWS has helped to raise situational awareness for a host of hydrometeorological hazards through training and public outreach and education programs, attendance at workshops and conferences, as well as conducting Spotter Training classes. One specific example is the use of HURREVAC, which allows local Emergency Medical Services (EMS) Directors and personnel to plan and forecast evacuations and to identify potential resource needs and areas at greatest risk.

New capabilities since 2014

There are no new capabilities added since 2014.

4.2.2.5 Rhode Island Coastal Resources Management Council

Description of agency

The CRMC plans for and manages the coastal resources of the State.

Within the State Coastal Plan, there are numerous policies and programs for the protection of coastal resources, including coastal wetlands and other shoreline features (e.g., beaches, and dunes). CRMC has statutory authority to restrict the alteration of coastal wetlands for preservation purposes, and to implement regulations requiring erosion setbacks, coastal buffer zones and to prohibit construction on beaches, in dunes, and on barrier spits that are identified as undeveloped or moderately-developed. The preservation of coastal wetlands, beaches and dunes from development and destruction will provide for the natural and beneficial use of coastal wetlands, beaches and dunes as related to flood retention and natural buffers from coastal storm surge and waves.

Funding capabilities

The CRMC receives federal and state funds for its annual operational costs, most of which supports its staff.

Staffing resources

CRMC currently employs 28 staff members including coastal policy analysts, a coastal geologist, and a marine resources specialist, who are assigned to analyze climate change and SLR issues, shoreline change, beneficial re-use of sediment, and wetlands restoration. In addition, The CRMC Executive Director spends a significant amount of time in the development of coastal hazard analysis tools and engagement with stakeholders.

Technical assistance

Technical support is provided to other state agencies and municipalities related to CRMC programs, including SAMP, stormwater design and installation, and coastal and estuarine land conservation.

Hazard mitigation effectiveness

CRMC has several ongoing partnerships to reduce risks from coastal hazards and for public education and outreach. Some specific projects include:

- Working with federal, state and local agencies for post-hurricane Sandy recovery initiatives.
- Partnering with statewide and local planners, URI, GIS coordinators, and Sea Grant to develop tools for determining vulnerability to present and future coastal flooding scenarios from storm surge and sea level rise. For example, STORMTOOLS, Coastal Environmental Risk Index (CERI) and Substantial Damage Estimation (SDE) Maps.
- Coordinating the Rhode Island Habitat Restoration Team, comprised of partners from Local, State, and Federal governments, as well as non-profit and educational organizations.

In addition, CRMC staff give numerous presentations to professional groups and the public on coastal hazards, climate change adaptation, coastal habitat restoration and other topics.

New capabilities since 2014

The CRMC recently adopted a new Shoreline Change (Beach) SAMP to assess flood inundation coupled with SLR and shoreline erosion, to better inform planning efforts and decision-making to enhance community resilience. It also includes a Coastal Hazard Application Process that will be implemented by regulatory amendments to the CRMC's Red Book to address the coastal hazard issues detailed in the Beach SAMP chapters. Applicants meeting project thresholds within CRMC jurisdiction will have to assess coastal hazard impacts to their proposed projects. In 2015, the CRMC also adopted and released SLAMM maps for the 21 coastal communities, which illustrate how coastal wetlands will change with different sea level rise scenarios. SDE Maps are now developed showing recommended alternative base flood elevations that incorporate SLR for consideration in coastal resilient construction. CERI maps are available for several communities (Charlestown, Warwick, Barrington, Bristol and Warren) that show high risk areas for coastal flood inundation. CRMC has also completed the mapping protocol for eroding bluffs as part of the Beach SAMP.

4.2.2.7 Rhode Island Department of Administration

Description of agency

RIDOA provides support services to ensure the coordination and implementation of statewide programs, as well as policy direction related to administrative services.[1] The Department of Administration's is comprised of the following divisions:

- Director
- Chief of Staff
- Public Information Officer
- Office of Management and Budget
- Budget Office
- Internal Audits
- Central Business Office
- Human Resources
- Information Technology
- Division of Purchases
- Internal Audits
- Legal Services
- Accounts & Control
- Capital Asset Management and Maintenance
- Division of Planning
- Office of Diversity, Equity and Opportunity

RIDOA oversees division(s) that have roles in hazard mitigation and risk reduction, such as the Division of Planning. RIDOA also manages the Rhode Island Climate Change website as well as other online resources that provide information regarding plans, programs, and policies related to resilience in Rhode Island.

Funding capabilities

There are no grants or financing opportunities specifically through RIDOA.

Staffing resources

There are currently 29 staff members as points of contact for the divisions listed above. Additional staffing resource information was not publicly available.

Technical assistance

Technical assistance is provided by the number of divisions that have hazard mitigation and risk reduction capabilities, such as the Office of Management and Budget, and the Division of Planning. This includes grant application management, grants tracking, technical planning, GIS, and community engagement.[2]

[1] Rhode Island Department of Administration, n.d. Mission. Retrieved at: http://www.admin.ri.gov/index.php
[2] Rhode Island Office of Management and Budget, n.d. Grants Management. Retrieved at: http://www.omb.ri.gov/grants/

Hazard mitigation effectiveness

RIDOA is a member agency of the EC4 formed in 2014. This council develops strategies to reduce greenhouse gas emissions and ensures State agencies are incorporating climate change impacts into actions and programs.[3]

New capabilities since 2014

Since 2014, RIDOA has joined the EC4. RIDOA has also managed various new capabilities department divisions, such as in the Division of Planning.

[3] Rhode Island Department of Administration, n.d. EC4 Summary. Retrieved at: http://climatechange.ri.gov/state-actions/ec4/

4.2.2.8 Rhode Island Department of Environmental Management

Description of agency

RIDEM is committed to preserving the quality of Rhode Island's environment, maintaining the health and safety of its residents, and protecting natural systems. The department enforces law to protect the environment. Specific program areas and plans pertain to risk reduction and hazard mitigation. RIDEM has an Emergency Response Plan that addresses hazardous material and oil spill response, securing state parks, beaches, forests, and closing Ports of Galilee and Newport in event of a hurricane, and includes a prescribed fire plan. There are several offices and departments within RIDEM that contribute to hazard mitigation efforts in Rhode Island.

Office of Compliance and Inspection – This office includes three (3) programs that are important to hazard mitigation.

- Hazardous Waste - This program investigates citizen complaints and referrals from RIDEM divisions and offices relating to facilities storing hazardous waste and performs compliance monitoring of hazardous waste generators. The program is critical in preventing chemical waste from being released into the environment.
- Underground Storage Tanks - This program investigates citizen complaints and referrals from RIDEM divisions and offices relating to underground storage tanks and performs compliance monitoring of underground storage tanks.
- Dam Safety Program - The Division's Dam Safety Section is the nucleus within the State for inspecting and evaluating the structural stability and maintenance of all dams and dikes, both privately and publicly owned. Dam owners are notified owners of any deficiencies and must seek corrective action as necessary. All dams and reservoirs are to be inspected at regular intervals. Regular inspection schedules are critical to assessing safety of dams, especially in the densely developed and populated areas in proximity to the spillway. Through a regular assessment and inspection program, an accurate inventory of unsafe/safe dams is created. This inventory provides a basis for prioritizing dam repair and maintenance. In addition, plans for construction or alteration of dams and reservoirs must be approved by RIDEM.

Division of Agriculture –The Division of Agriculture within RIDEM works to ensure long-term agricultural viability, and oversees six (6) primary program areas, including pesticides, animal health, plant industry, produce safety, mosquito abatement, and farmland information.[4]

Division of Forest Environment – This Division manages 40,000 acres of State-owned rural forestland. The division performs the following fire mitigation capabilities:

- Coordination of statewide forest fire protection plan
- Forest fire protection on State owned lands
- Assist rural volunteer fire departments
- Development of forest fire and wildlife management plans for private landowners
- Risk assessments of fires in wild land areas, State forests, parks, and rural areas
- Management of suppression resources and coordination with local, state, and federal entities

[4] Rhode Island Department of Emergency Management, n.d. Division of Agriculture Home. Retrieved at: http://www.dem.ri.gov/programs/agriculture/

The Division promotes public education and outreach on environmental conservation. The Tree Warden can be found within the Division of Forestry and is responsible for tree removal and pruning if constituting an immediate hazard to the public.

Office of Water Resources - OWR implements a variety of programs aimed at the protection of the quality of the State's surface waters, groundwater and wetlands. OWR's programs play a pivotal role in controlling wastewater discharges, promoting non-point source pollution abatement, setting standards for wastewater and stormwater management, and preventing alterations to wetlands. The OWR also holds state drought information.

Office of Emergency Response (OER)– OER is Rhode Island's first line of defense in protecting public health, safety, and welfare in an environmental emergency. Like police and fire fighters, RIDEM's emergency responders are prepared to handle incidents of great variety - everything from a spill of a few gallons to a whole tanker-full of petroleum, from a single abandoned drum to biological and chemical weapons. Highly trained first responders are on-call 24-hours a day, seven (7) days a week to secure the incident and to minimize the risk to the public and the environment. The office responds to around 700 complaints each year and the work load includes overseeing the Aboveground Storage Tank program that has requirements for all petroleum tanks greater than 500 gallons.

RIDEM is also a member of the 11-member council, EC4. Established by the Resilient Rhode Island Act in 2014, EC4 aims to create a more resilient Rhode Island by addressing climate change and its impacts.[5]

Funding capabilities

Detailed information on funding capabilities for mitigation activities is not publicly available.

Staffing resources

Detailed information on staffing resources for mitigation activities is not publicly available.

Technical assistance

Within the Division of Planning and Development, DEM uses GIS technology to create, manipulate and analyze spatial data that help achieve their mission of preserving the quality of Rhode Island's environment. This section works closely with other divisions of DEM to provide high quality GIS services necessary to forward the mission of the Department.

Hazard mitigation effectiveness

The OER provides outreach to local schools and universities to assist with the proper storage and disposal school chemicals.

The Division of Agriculture provides outreach and funding for the disposal of farm chemicals for Rhode Island farmers.

DEM has worked with local building officials to establish more resilient building codes and designs (e.g. septic systems, underground storage tanks and above ground storage tanks).

[5] State of Rhode Island, n.d. EC4 Summary. Retrieved at: http://climatechange.ri.gov/state-actions/ec4/

New capabilities since 2014

The EC4 council was established in 2014 and is led by the RIDEM Director.

4.2.2.9 Rhode Island Department of Health

Description of agency

The mission of RIDOH is to prevent disease and to protect and promote health and safety of the people of Rhode Island. Many of the programs administered by RIDOH routinely serve to prevent and mitigate the spread of morbidity and mortality within the State. RIDOH's current organizational structure, (as of August 2018), includes the following divisions, centers, and programs:

Division of Environmental Health - This division oversees the following programs:

- Center for Healthy Homes and Environment
  - Climate Change Program
  - Lead Program
  - Occupational Safety and Health Administration (OSHA) Consultation Program
- Center for Food Protection
- Center for Drinking Water Quality

Division of Community Health and Equity – This division works to ensure health equity and eliminate health disparities by engaging with the community and understanding social and environmental determinants of health.[6] Programs within this division include:

- Center for Chronic Care and Disease Management
- Center for Health Promotion
- Center for Perinatal and Early Childhood Health
- Center for Preventative Services

Division of State Health Laboratories and Medical Examiners – The mission of this division is to "provide quality analytical and technical laboratory information in support of state and national disease prevention and control, environmental health programs, and the criminal justice system."[7] Programs in this division include:

- Center for Environmental Sciences
  - Chemical Terrorism Laboratory
- Center for Forensic Sciences
- Center for Biological Sciences
  - Bioterrorism Laboratory
- Center for Laboratory Support Services
- Center for the Office of State Medical Examiners

[6] Rhode Island Department of Health, n.d. Division of Community Health and Equity. Retrieved at: http://health.ri.gov/programs/detail.php?pgm_id=1051
[7] Rhode Island Department of Health, n.d. Division of State Laboratories and Medical Examiners. Retrieved at: http://health.ri.gov/programs/detail.php?pgm_id=146

Division of Policy, Information, and Communications – This division oversees the following programs:

- Center for Public Health Communication
- Center for Health Data and Analysis and Public Health Informatics
- Center for Health Systems Policy and Regulation
- Center for Legislative and Regulatory Affairs

Division of Customer Services – This division oversees the following programs:

- Center for Professional Boards and Licensing
- Center for Vital Records
- Center for Health Facilities Regulation
    - Radiological Health Program

Division of Preparedness, Response, Infectious Diseases, and Emergency Medical Services – This division oversees the following programs:

- Center for Acute Infectious Disease Epidemiology
- Center for human immunodeficiency virus (HIV), Hepatitis, sexually transmitted diseases (STD), and tuberculosis (TB) Epidemiology
- Center for Emergency Preparedness and Response
    - Medical Emergency Distribution System Program
    - Healthcare Preparedness Program
    - Training Program
    - Exercise Program
    - Internal Planning Program
    - CHEMPACK Program
    - Community Initiatives Program
        - Rhode Island Special Needs Emergency Registry
- Center for Emergency Medical Services

RIDOH maintains the CEPR, whose mission centers on public health and healthcare emergency preparedness and response. During emergencies, CEPR is tasked with facilitating the Department's response and with the coordination between private, local, state, and federal partners to further the state's overall response. When not responding to emergencies, the Center is actively engaged with both internal and external partners in activities to prepare for and mitigate against threats to the public's health and the healthcare system.

RIDOH maintains an ongoing pursuit of public water supply resiliency within the State. The following bullets outline programs that support this pursuit:

- Implementation of the Drinking Water Incident Response Plan, that as of the date of this plan is awaiting final approval. Development of accompanying standard operating procedures is ongoing.
- Assessment of redundant emergency power present in drinking water systems to identify gaps and vulnerabilities that might be addressed through the installation of generators.
- Continued participation in the Rhode Island Water/Wastewater Agency Response Network (RIWARN), while also continuing to encourage participation on the part of all drinking water systems in Rhode Island.
- Continued exploration of options to leverage mass notification systems to share emergency information with drinking water systems and ways that drinking water systems can rapidly notify their customers.

Funding capabilities

Rhode Island was awarded approximately $5 million from the Center for Disease Control (CDC) PHEP grant for fiscal year 2019 and was also awarded $920,000 from the Department of Health and Human Services' Assistant Secretary for Preparedness and Response's Hospital Preparedness Program grant.

RIDOH is more than 80% federally funded. RIDOH preparedness grants are prepared with Division Liaisons who manage the fiscal and administrative requirements (annual grant cycle including application, budget development, progress and budget tracking, contracts, reporting, performance measures, carry forward/no-cost extension requests, and closeout). Program staff complete the project plans and their implementation internally and with external partners.

Staffing resources

The following information provides detail regarding RIDOH's staffing resources:

- Total staff within the agency: ~470 (August 2018)
- CEPR staff: 11 (August 2018)
- Total number of RIDOH staff trained in Incident Command System (ICS) (ICS 100, 200): ~385 (August 2018)

Technical assistance

RIDOH staff who are funded with preparedness dollars develop, test, and revise plans to respond to emergencies; train physicians, nurses, and frontline staff to watch for unusual disease presentations; develop plans and train laboratories to test for these agents/diseases; set up and maintain emergency communications networks; and teach the public what to expect during emergencies and what they can do to prepare for them.

CEPR maintains contracts with the Hospital Association of Rhode Island, the Rhode Island Health Center Association, and the Rhode Island Department of Behavioral Healthcare, Developmental Disabilities, and Hospitals to continue to improve preparedness and response capabilities in the public health and healthcare sectors. Because there are no local health departments in Rhode Island, RIDOH maintains contracts with all 39 municipalities to ensure the capability of each of the

municipalities to mass dispense and/or vaccinate all people within Rhode Island in an expedited timeframe during a public health emergency. RIDOH also maintains a contract with the Rhode Island Disaster Medical Assistance Team (DMAT)/Medical Reserve Corps (MRC) to continue to build and maintain a medical supply and equipment cache, which is intended to be used to establish a field hospital and/or other types of medical support in response to a large-scale disaster or planned event. A second contract with DMAT/MRC ensures the continued building and training of its pool of volunteer health professionals.

Hazard mitigation effectiveness

Through numerous emergency responses, RIDOH has supported the development, testing, and evaluation of mitigation actions for healthcare facilities, drinking water systems, food establishments, and other public and private sector partners, and has developed ongoing recommendations for additional mitigation actions. Some of these activities include improving systems that provide warning and emergency communications and providing additional training to first responders. Data collected about storm-related health impacts are driving projects related to climate change to mitigate the impacts of heat and cold weather on individuals who are most vulnerable to their effects.

The following ongoing quality improvement activities performed by RIDOH ensure that mitigation activities are constantly being improved:

- The Healthy Homes and Environment Team is responsible for conducting lead screening, surveillance, and monitoring; lead training for the building trades, and lead compliance and enforcement.
- The OSHA Consultation Program provides safety and health consultation services to promote the safety and health of Rhode Island's workers in small to medium size private businesses (less than 250 employees) by identifying hazards and ensuring their timely abatement. This program has increased the number of companies in its Safety and Health Achievement Recognition Program (SHARP) to 12 employers.
- The Climate Change Program supports Rhode Islanders to prepare for the health effects of climate change through policy change, public education, research and data collection, and developing tools that assist individuals, businesses, and communities to become more resilient.
- The Center for Food Protection certifies food managers, inspects food establishments, investigates illness complaints and disease outbreaks, and inspects, reviews plans for, and licenses food establishments including schools.
- The Center for Drinking Water Quality approves and inspects water sources and treatment, monitors public drinking water quality, conducts outreach and training, and certifies operators.
- The Beach Monitoring Program monitors water quality at beach and bathing areas.
- CEPR conducts training and exercises on a regular basis, as outlined in its Multi-Year Training and Exercise Plan. Findings from real-world responses and past exercises are frequently incorporated into new trainings and exercises, as part of a continuous quality improvement process of continually reviewing after-action reports and improvement plans. In 2017 alone, CEPR trained 1,133 individuals in 35 trainings, and conducted 21 exercises.

Since 2007, CEPR has partnered with multiple entities throughout the State to create a voluntary registry for individuals with disabilities, chronic conditions, and other special medical needs called the Rhode Island Special Needs Emergency Registry (RISNER). RISNER allows the state and local

responders to see not only where people who might need special assistance during an emergency reside through a GIS system, but also what their self-identified needs are. Enrollment in RISNER does not guarantee assistance, but allows first responders to better plan for, prepare for, and respond to the needs of the community. Outreach workers promote registration of citizens through community fairs/events, doctors' offices, public housing facilities, home healthcare agencies, and durable medical equipment suppliers. CEPR continually updates the data and coordinates outreach to municipal users, community organizations, and the public. Access is provided to local emergency managers, so that they can log in to RISNER before and/or during an event to access information about individuals within their respective municipalities who have registered, providing local emergency management and responders a greater degree of situational awareness. Some of the best practices employed by locals in the past several storms have been wellness visits to enrollees; swapping out of enrollees' oxygen containers; providing transportation assistance to shelters; and charging of their medical device batteries.

Municipal users of RISNER can import their RISNER data into the emergency notification system CodeRED to contact enrollees by phone, text, and email.

New capabilities since 2014

Rhode Island's emergency preparedness healthcare coalition has undergone a formalization process and is now referred to as the Healthcare Coalition of Rhode Island (HCRI). Prior to the relatively recent formalization, HCRI has been in operation since 1999 and has grown over time to meet changing needs and guidance. While the Coalition has undergone several name changes over the years, its mission has fundamentally remained the same: to serve as a forum for cooperation among organizations to develop a networked plan for interaction and collaboration in disaster-related planning, mitigation, response, and recover efforts that address Rhode Island's healthcare system. The recent formalization has served to further strengthen existing processes and relationships within the Healthcare and Public Health Sector, creating a more efficient environment in which partners can coordinate with one another to support preparedness, response, recovery, and mitigation activities.

Since 2014, and since the 2014-15 West African Ebola outbreak, RIDOH has worked to establish a tiered system among Rhode Island's hospitals to manage both patients who are suspected to have Ebola and patients who are suspected to be infected with other high-consequence diseases. This system mirrors other national level systems: hospitals are designated as either frontline hospitals, assessment hospitals, or (regional) Ebola and other special pathogen treatment centers. In its borders, Rhode Island has eight (8) frontline hospitals, whose mission is to identify, isolate, and notify RIDOH of patients suspected to have Ebola or another high-consequence disease, and two (2) assessment hospitals, whose mission is to receive and isolate a patient with suspected infection from a frontline facility until confirmatory testing can be completed. If confirmed, the patient is then transferred to a treatment center. Rhode Island has established agreements with Massachusetts for use of their treatment centers in such a situation. This system has been tested in two (2) tabletop exercises, each conducted annually since 2017, in addition to numerous facility-specific exercises.

In 2017, RIDOH began development of its own continuity of operations program, which will further support the ability of the Department to respond to the needs of the Healthcare and Public Health Sector during large-scale incidents that impact the Department itself. Work on this program is ongoing.

Also, in 2017, RIDOH led development of a plan template to support hospitals and nursing homes in their planning for point-of-dispensing operations within their respective facilities (Closed PODs). These plans will support the provision of medical countermeasures to staff and patients during a disease outbreak or other public health emergency requiring mass prophylaxis or vaccination. Establishing these processes in hospitals and nursing homes will allow them to more effectively serve the public and support the Healthcare and Public Health Sector during a large-scale public health emergency.

RIDOH and HCRI continue to support the Long-Term Care Mutual Aid Plan (LTC-MAP). LTC-MAP is an initiative that has been implemented to support nursing homes and assisted living communities in Rhode Island through the establishment of a mutual aid network that allows facilities to efficiently share resources with one another, support each other during facility evacuations, place evacuees in appropriate care settings, and so on. Since the implementation of LTC-MAP, coordination among nursing homes and assisted living communities has grown tremendously, especially in times of disaster, thereby reducing risk through their posture of individual and collective preparedness.

Through LTC-MAP and other mechanisms, RIDOH and HCRI maintain up-to-date information on healthcare facilities in the State, including the vendors that service them and the generators and other emergency sources of redundant power that are in place. This information is especially critical in identifying areas of potential conflict prior to a disaster and, either during or following the disaster, coordinating support to healthcare facilities whose operations have been disrupted. RIDOH and HCRI routinely request that healthcare facilities regularly review and update this information to ensure the validity of the common operating picture it supports.

4.2.2.10 Rhode Island Department of Transportation

Description of agency

The mission of RIDOT is to provide, maintain, and secure a safe intermodal transportation network that increases mobility opportunities for the movement of people and goods, with the goals of enabling economic development and improving quality of life. RIDOT provides several programs that are designed to protect residents, the environment, and increase economic growth. Examples include:

- Highway safety campaigns
- Storm Water Management Planning
- Economic Recovery Tools

Funding capabilities

In fiscal year 2019, RIDOT will receive approximately $518 million dollars: $292 million estimated from federal grants, $97 million estimated from Rhode Island Highway Maintenance funds, $77 million estimated net from the State Gas Tax, $37 million in RICAP funds and approximately $15 million in Toll Revenue. The Division of Highway & Bridge Maintenance receives approximately $40 million for Operations, $18 million for Winter Operations and $10 million for Fleet from the State Gas Tax and Rhode Island Highway Maintenance Funds.

In response and recovery to federally declared disasters, capital repairs along the Federal Aid System of Highways are eligible for funding through the FHWA's emergency relief program.

Staffing resources

In fiscal year 2019, the Department is allotted 755 full time employees (FTEs), comprising four (4) major divisions: Highway & Bridge Maintenance, Transportation Development, Planning & Finance, and Administrative Services. The Division of Maintenance serves as the main operations group and has approximately 250 FTEs within seven (7) maintenance districts and the headquarters in Warwick.

Technical assistance

RIDOT has the following technical programs available to provide expertise and assistance:

- Engineering – bridge/structural inspections and assessments, hydraulics, geotechnical, transportation, electrical, etc.
- GIS/Mapping
- Equipment – certified mechanics/technicians/operators
- Environment
- Historic preservation

Hazard mitigation effectiveness

RIDOT conducted the first ever collaboration among cities and towns and the State to develop a comprehensive approach to creating statewide evacuation routes. RIEMA provided the RIDOT with local evacuation routes for hurricanes. The RIDOT digitized these routes, uploading them to the

RIEMA website. This benefits communities in knowing where their evacuation routes are and where abutting communities are directing evacuees to help reduce risk of causalities and injuries during a hazard event. Critical resource needs were also inventoried through collaboration with towns, State Police, and the RIDOT.

All roads in the State except rural minor collectors and local roads and streets are eligible for federal highway aid and must adhere to federal design regulations. These include standards for the location and hydraulic design of roads and bridges that encroach on floodplains. It is the stated policy of the FHWA to "prevent uneconomic, hazardous or incompatible use and development" of floodplains. RIDOT conducts hydraulic analyses for all new and rebuilt roadways over water bodies, including emergency construction when feasible. While there is no set rule, it is RIDOT policy to build bridges to the 100-year flood standard wherever appropriate from an engineering standpoint.

New capabilities since 2014

There are no new capabilities added since 2014.

4.2.2.11 Rhode Island Division of Planning

Description of agency

The Rhode Island Statewide Planning Program is tasked with preparing, adopting, and amending strategic plans for the physical, economic, and social development of the state (RIGL 42-11-10 (b) (1)), also known as the State Guide Plan. The Statewide Planning Program also oversees the local comprehensive planning process, which is governed by the Rhode Island Comprehensive Planning and Land Use Act (RIGL 45-22.2). Local comprehensive plans are used to direct community land use decisions and capital improvement funding strategies. The Rhode Island Statewide Planning Program offers both staffing and planning capabilities that can be used to implement hazard mitigation strategies.

The State Guide Plan is Rhode Island's centralized and integrated long-range planning document. The State Guide Plan is a collection of plans that have been adopted over many years, comprising of many separately published elements covering a range of topics. The Rhode Island Statewide Planning Program develops the State Guide Plan in conjunction with other state agencies and has four (4) main functions: it sets long-range policy (generally 20 years), provides a means to evaluate and coordinate projects or proposals of state importance, sets standards for local comprehensive plans, and serves as a general background information source on various topics. Many of the goals, objectives, policies and strategies set forth in the State Guide Plan recommend that the state and municipalities prepare for and respond to natural hazards and climate change impacts. The specific elements of the State Guide Plan that have the most relevance to hazard mitigation are described in more detail below.

In 2011, amendments to the Rhode Island Comprehensive Planning Regulation and Land Use Act were enacted that require municipalities to include goals, policies, and actions related to natural hazards within their comprehensive plans by June 1, 2016. Incorporating natural hazards and climate change impacts into the framework of the local comprehensive plan requires communities to consider the impacts of these items relative to land use, transportation, infrastructure and other important community decisions. Additionally, the Rhode Island Statewide Planning Program has developed guidance for municipalities on how best to incorporate natural hazards and climate change into municipal comprehensive plans, including recommendations on how to assess impacts and determine appropriate strategies.

<u>State Guide Plan Element 121: Land Use 2025</u> **-** The purpose of this plan element is to guide future land use, conservation, and development. One major concept defined in this element is sustaining the urban-rural distinction within the state through the identification of an Urban Services Boundary and municipally-designated growth centers, based upon land capability and suitability analysis, which demonstrates the capacity of the area to accommodate future growth. Element 121 directs the State and communities to concentrate growth inside the Urban Services Boundary and within locally-designated growth centers in rural areas. Areas of Special Concern, which include areas under high development pressure, are also discussed in this element. Understanding land use trends and knowing the locations of areas with high development pressures are crucial to hazard mitigation since the impacts from natural hazards are more severe in areas with greater development densities.

In addition, Element 121 recognizes and protects open space and mandates that urban and community development should be undertaken in such a way as to upgrade or maintain open space in the state. Statewide guidelines concerning the protection of wetlands, floodways, and coastal areas help preserve the natural and beneficial uses of floodplains for storm water retention and buffers from coastal storm events. Specifically, Land Use Policy 10 of Land Use 2025 calls for the state to

"Guide development in a manner that will prevent encroachment on floodways, dunes, barrier beaches, coastal and freshwater wetlands, and other natural features that provide protection from storms, flooding, and sea-level rise." (Note: other elements of the Plan protect open space, which is beneficial for natural hazard mitigation techniques. These elements include: 152, 155, and 162).

State Guide Plan Element 423: Rhode Island Five Year Strategic Housing Plan **-** The Strategic Housing Plan element describes recent development trends and housing and population projections within the State. It designates that communities should avoid locating affordable housing on sites that have poor topography or are located in critical environmental areas, such as floodplains. Element 423 also suggests that while increased density may be suitable in some areas of the state, communities should ensure that increasing density will not create other serious impacts such as increased run-off, flooding, and water quality degradation.

State Guide Plan Element 611: Transportation 2040 - Adopted in 2017, this plan addresses Rhode Island's transportation needs over the next twenty plus years. The plan addresses how transportation projects can be conducted in relation to, among other aspects, water quality, flooding, and SLR. To ensure water quality and reduce flooding, RIDOT conducts drainage improvement projects on roadways, encourages runoff prevention from transportation construction through education, inspection, and maintenance, and has concentrated on using "best management" practices for erosion, sediment, and runoff control planning. In an effort to understand the effects of SLR on transportation infrastructure, the plan encourages the identification of infrastructure lying within SLR inundation zones and categorized as to their future status as a means of creating future adaptation strategies. In addition, the transportation element documents significant and high hazard dams that are within 1,000 feet of a roadway to assess roadways vulnerable to dam failure. The plan states that future analysis should screen the condition of the dam as well as the importance of the roadway and should identify diversionary routes given a dam failure event.

One goal of the plan is to "Develop transportation and communication systems that serve Rhode Islanders and the region in the event of natural disasters, accidents, and acts of terrorism in a manner that minimizes injury, loss of life, and disruption to the economy; facilitates evacuation of people; and allows emergency response and recovery activities to occur." Objectives and policies that support this goal in addition to ways to measure performance of these objectives and policies to reach the goal are found in this plan element.

State Guide Plan Element 721: Rhode Island Water 2030 **-** The Rhode Island Water 2030 State Guide Element consolidates five (5) previous State Guide Plan Elements that examined issues that directly affect the availability of, demand for, and management and protection of drinking water, as well as the operation and maintenance of water systems to meet or exceed public health and safety standards, sustain growth and development, and improve the overall quality of life in Rhode Island. The consolidated plan identifies the previously adopted goals, policies, and recommended actions that are based on strategies deemed essential to maintaining existing and protecting future water supplies. In conjunction with Land Use 2025, this element of the state plan is intended to advance the effectiveness of public and private stewardship of the state's water supply resources.

In addition to including information on Drought Mitigation and Response, the plan includes a table listing natural and human-caused hazards and their potential water related consequences, such as service disruption, system contamination, damage to infrastructure, and loss of revenue.

State Guide Plan Water Quality 2035: Rhode Island Water Quality Management Plan - This plan was recently adopted in October 2016 and sets forth a plan to protect and restore the water quality (both

fresh water and salt water) as well as aquatic habitats in the state. This plan includes the Rhode Island Groundwater Protection Strategy, and Rhode Island Wellhead Protection Program. This plan currently serves as the state's nonpoint source management program, which is required by the EPA and NOAA.

State Guide Plan Energy 2035: Rhode Island State Energy Plan **-** The State Planning Council recently adopted Energy 2035 in 2015. This plan identifies actions to address future energy use in Rhode Island, with considerations regarding the state's economic development, transportation, land use, and current energy needs and usage. Energy 2035 provides a vision to ensure a secure, cost-effective, and sustainable supply of energy in the future by setting forth an "all-of-the-above" strategy to meet future energy needs.

Solid Waste 2038 - Solid Waste 2038 is an update of the State Guide Plan Element 171 adopted in 2007. It is intended to guide the activities of the Division of Planning, the Rhode Island Resource Recovery Corporation and the Department of Environmental Management. It also serves to meet the need for a solid waste management plan as required by the Federal Resource Conservation and Recovery act of 1976, as amended and the Statewide Resource Recovery System Development Plan. This plan describes existing practices, programs, and activities in all major solid waste management areas and develops recommendations specific to each. It is intended to advance the effectiveness of public and private stewardship of the State's disposal of solid waste.[8]

The Division of Planning is also currently leading the Small Business Resilience Study to be completed in 2019.

Funding capabilities

Currently, the Rhode Island Statewide Planning Program has no direct funds available to assist in hazard mitigation activities, but the comprehensive planning and technical assistance provided by this program is available to greatly improve development of integrated mitigation strategies across the state.

Staffing resources

The Rhode Island Statewide Planning Program currently includes a staff of 18, split into four (4) units: Transportation Operations, Strategic Planning, Planning Information and Technical Assistance, and Support Staff. Staff from each unit is available to provide technical assistance related to planning for natural hazards and climate change.

Technical resources

The Rhode Island Statewide Planning Program provides technical planning, GIS, and community engagement assistance to municipalities, state agencies, and non-governmental organizations as requested. The Division of Planning has also been instrumental in assisting communities in meeting the requirements of a new provision of RIGL §45-22-7, which requires that each member of a planning board or commission must participate in training and education classes concerning the effect of development in a flood plain and the effects of sea-level rise once every two (2) years.

[8] See Part two pg. 2-8 Natural Disaster Debris Management

Hazard mitigation effectiveness

The Rhode Island Statewide Planning Program has completed several studies related to sea level rise and storm surge, including vulnerability assessments of municipal and statewide transportation, as well as a report on the socioeconomics of sea level rise. The Division of Planning also plays a large role through the State Guide Plan and land use strategies to guide development. The Division of Planning also participated in the development of "Resilient Rhody," an actionable vision for addressing the impacts of climate change in Rhode Island.

New capabilities since 2014

The Rhode Island Division of Planning has added three (3) elements to the State Guide Plan: Water Quality 2035, Energy 2035, and Solid Waste Management Plan. Water Quality 2035 and Energy 2035 are described in more detail above.

4.2.2.12 Rhode Island Emergency Management Agency

Description of agency

The mission of RIEMA is to protect life and property in the event of a disaster or crisis situation through an emergency management program of mitigation, preparedness, response, and recovery. Numerous hazard mitigation and disaster preparedness and recovery programs and policies are administered by RIEMA.

Critical Facilities and Infrastructure Management

The RIEMA Infrastructure Protection Program enhances critical infrastructure protection on a state-wide basis across the mission areas of prevention, protection, response, recovery, and mitigation. The program, developed in December of 2010, supports the intent of Homeland Security Presidential Directive 8 "National Preparedness Goal" as well as the recent Presidential Preparedness Directive 21 "Critical Infrastructure Security and Resiliency". The program may be extremely useful in supporting agency goals and objectives when deciding where to invest resources and grant allocations to enhance asset protection and resiliency.

To support the program, RIEMA is an accredited Department of Homeland Security (DHS) agency for the Protected Critical Infrastructure Information program. The Protected Critical Infrastructure Program (PCII) Program is an information-protection program that enhances voluntary information sharing between infrastructure owners and operators and the government. PCII protections mean that homeland security partners can be confident that sharing their sensitive security information with the government will not expose sensitive or proprietary data. The DHS and other federal, state, tribal, and local analysts use PCII to:

- Analyze and secure critical infrastructure and protected systems,
- Identify vulnerabilities and develop risk assessments, and
- Enhance recovery preparedness measures.

In addition, RIEMA maintains access to the DHS Automated Critical Asset Management System Decommission (ACAMS) to provide a secure, online database as a management and analysis platform that allows for the collection and management of critical infrastructure asset data.

State Emergency Operations Center

RIEMA's SEOC provides a central location from which all state government at any level can provide interagency coordination and executive decision-making in support of any regional incident or local response. This is done by: Information Collection and Evaluation, Executive Decision-Making, Priority Setting, Management, Coordination and Tracking of Resources, and Interoperable Communication Facilitation to support any overall response efforts. RIEMA's SEOC operates under the guidance of the National Response Framework (NRF) and National Incident Management System (NIMS). This is done by using the ICS and 18 predetermined ESFs.

Rhode Island State Communications Network

The Rhode Island State Communications Network (RISCON) system serves public safety agencies at the local, state, military, and federal levels. There are approximately 11,000 radios in the system, some of which are used heavily during incidents and planned events to coordinate agencies from

across the state and country. There are 27 radio sites spread throughout Rhode Island, linked by microwave. All sites have a combination of diesel and propane generators. RISP, RIDEM, RIDOT and the City of Providence are the largest users of the system, while numerous other state and local agencies use the system as well.

National Flood Insurance Program

Each of Rhode Island's 39 municipalities and one (1) Tribal nation are members of the NFIP. The program participants maintain and enforce floodplain regulations conforming to NFIP requirements as part of their zoning ordinance or as a standalone ordinance. These regulations can involve regulation of development within a designated floodway area, restrictions on activities that involve alteration of watercourses or sand dunes, and criteria for the location of mobile homes. In addition, some communities also impose special zoning regulations governing accessory structures, storage of buoyant or hazardous materials, and set-backs for new/substantially improved and/or damaged structures within flood hazard zones. The NFIP affords homeowners, renters or business owners the opportunity to purchase flood insurance if their community agrees to enact and enforce regulations that meet or exceed FEMA's floodplain requirements.

Risk MAP

Map Modernization for Rhode Island was completed in 2010 and is now included in a new FEMA initiative called Risk MAP. FIRMs and the accompanying FIS data are used in the administration of the minimum requirements of NFIP. Rhode Island cities and towns are dependent upon the flood hazard information contained in the FIRMs and FISs for review of proposed development. As part of the NFIP, the federal government provides FIRMs to communities that agree to regulate development in high risk flood areas. The maps identifying the flood prone areas would then form the basis for the federally backed flood insurance rates. Risk MAP is designed to help increase the purchase of flood insurance and increase the public's awareness of flood prone structures and potential mitigation measures.

Community Rating System

The CRS is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. The CRS program emphasizes three (3) goals: the reduction of flood losses, facilitating accurate insurance rating and promoting the awareness of flood insurance. By participating in the CRS program, communities can earn a 5-45% discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community.

The State of Rhode Island currently has ten communities participating in CRS.[9] As of July May 1, 2018, 71 communities within Region I participate in CRS.[10] The participating Rhode Island communities and the premium reduction they receive can be found in Table 3-43.

[9] FEMA, 2018. *NFIP Flood Insurance Manual, 20 CRS Section*. Retrieved at: https://www.fema.gov/media-library-data/1523648898907-09056f549d51efc72fe60bf4999e904a/20_crs_508_apr2018.pdf

[10] FEMA, 2018. *National Flood Insurance Program (NFIP), Community Rating System (CRS) FEMA Region I (Map).* Retrieved at: https://crsresources.org/files/100/maps/region_and_nation/crs_region_i_may_2018.pdf

Funding capabilities

RIEMA administers the following grant programs supporting risk reduction and mitigation activities for state and local agencies:

Pre-Disaster:

- PDM
- FMA
- EMPG
- SHSP
- HMGP

Post-Disaster:

- Section 404 - HMGP
- Section 406 - Public Assistance Program

Grant awards are described below. Additional information regarding grant programs can be found in Section 4.3, as well as in Appendix D.

Staffing resources

The agency staff is currently 32 employees across all sections and departments. The State currently employs a State Floodplain Coordinator, SHMO, Risk MAP Coordinator, HMA Program Coordinator, and a Community Rating System Coordinator. These positions are all federally funded through FEMA and are housed at RIEMA.

Technical assistance

RIEMA technical assistance related to hazard mitigation is provide through:

- GIS technical assistance (local and state levels)
- Floodplain Management assistance
- Local Hazard Mitigation Planning assistance (More information related to local hazard mitigation planning assistance can be found in Appendix E)
- Mitigation project oversight and assistance

The SEOC can assist the Local EOCs or Local Incident Commanders by:

- Creating a Common Operating Picture from Informative Collection;
- Evaluating information for Executive Policy Decision Making;
- Creating static plans and priority setting;
- Managing, coordinating and tracking resources;
- Provide Interoperable Communications Support; and
- Manage Public Information.

Most of the above goals can be accomplished using the system WebEOC. WebEOC is the original web-enabled crisis information management system that provides secure real-time information sharing to help managers make sound decisions quickly. WebEOC allows for up-to-date situational

awareness throughout the state and 18 ESFs, as well as various state agencies that may not be physically present in the SEOC.

Hazard mitigation effectiveness

FEMA's HMA grant programs for the State of Rhode Island are administered by RIEMA. The programs are designed to provide funding for eligible mitigation activities that protect life, property and the environment from future disaster damages. Mitigation supports actions that are long-term, cost-effective and environmentally sound. HMA funding opportunities enable eligible sub-applicants to implement mitigation actions pre and post-disaster. FEMA's PA program provides supplemental Federal disaster grant assistance funding to support communities in recovery following a disaster. Through Section 406 of the PA program, mitigation measures can be funded in conjunction with the repair of disaster-damaged facilities.

The following tables summarize the mitigation grants RIEMA has been awarded and is currently coordinating:

Table 4-3 Public Assistance Program Awards

Award Year	Period of Performance (End Date)	Number of Sub-Grantees	Activity Types	Total Federal Award Share (To Date)	Status
DR-1894	March Floods 2010	143	Emergency Protective Measures (EPM), Roads & Bridges, Wastewater Treatment Facilities	$24,263,849.38	Open
DR-4089	SS Sandy 2012	71	Debris Removal, EPM, Public Buildings, Recreational Facilities	$8,627,926.84	Open
DR-4107	Snow 2013	130	Snow/Debris Removal, EPM	$7,929,498.13	Open
DR-4212	Snow 2015	119	Snow Removal, EPM	$8,894,054.75	Open

Table 4-4 PDM Grant Awards

Award Year	Period of Performance (End Date)	Number of Sub-Grantees	Activity Types	Total Federal Award Share (To Date)	Status
PDM 2015	October 31, 2018	5	Hazard Mitigation Plans	$199,755.35	Open
PDM 2016	August 30, 2019	3	Hazard Mitigation Plans	$182,187.50	Open
PDM 2018	PLACEHOLDER	PLACEHOLDER	PLACEHOLDER	PLACEHOLDER	PLACEHOLDER

Table 4-5 HMGP Awards

Declared Disaster	Event	Number of Sub-Grantees	Activity Types	Total Federal Share (To Date)	Status
HMGP DR -1894	March 2010 Floods	13	• Acquisitions • Backflow valves • Drainage • Outreach initiative • Structure Relocation	$2,962,408.00	Open
HMGP DR- 4027	Tropical Storm Irene	13	• Backflow valves • Hazard Mitigation Plans • Residential Elevations	$1,119,240.00	Open
HMGP DR – 4089	Superstorm Sandy	6	• Generator Installations • Hazard Mitigation Plans • Residential Elevations	$857,580.00	Open
HMGP DR – 4107	Severe Winter Storm 2013	5	• Generator Installations • Hazard Mitigation Plans • Residential Elevations	$299,643.00	Open
HMGP DR - 4212	Severe Winter Storm 2015	7	• Acquisitions • Generator Installations • Hazard Mitigation Plans • Residential Elevations	Unavailable	Open

Table 4-6 EMPG Awards

Award Year	Period of Performance	Number of Sub-Grantees	Activity Type	Total Federal Award	Status
FY 2014[11]	October 1, 2013 – March 30, 2018	29	Planning Organization Equipment Training Exercise	$3,314,806	Closed
FY 2015[12]	October 1, 2014 – December 31, 2017	17	Organization Equipment Training	$3,311,501	Closed
FY 2016[13]	October 1, 2015 – September 30, 2019	15	Organization Equipment	$3,306,975	Open
FY 2017	October 1, 2016 – September 30, 2018	24	Planning Organization Equipment Training Exercise	Information Unavailable	Open
FY 2018[14]	October 1, 2017 – September 30, 2019	17	Information not available at this time	$3,300,473	Open

[11] FEMA, n.d. Fiscal Year 2014 Emergency Management Performance Grant Program Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1406301164934-dc25444d26520013bbd504904dca9936/EMPG_Fact_Sheet_Final.pdf
[12] FEMA, n.d. Fiscal Year 2015 Emergency Management Performance Grant Program Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1438020444107-4db58a4f1c24b3bd0962b8327652df5b/FY_2015_EMPG_Fact_Sheet_Allocations.pdf
[13] FEMA, n.d. Fiscal Year 2016 Emergency Management Performance Grant Program Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1467832646176-42bb5896c89053a7f7aa3f5100684c6c/FY_2016_EMPG_Fact_Sheet_Final.pdf
[14] Cicilline, David, 2018. RI Delegation Announces $7.4 Million in Homeland Security Grants for RI [Media Release]. Retrieved at: https://cicilline.house.gov/press-release/ri-delegation-announces-74-million-homeland-security-grants-ri

Table 4-7 SHSP Awards

Award Year	Period of Performance	Number of Sub-Grantees	Activity Type	Total Federal Award	Status
FY 2014[15]	September 1, 2014 – August 31, 2016	38	Planning Organization Equipment Training Exercise	$3,733,000	Closed
FY 2015[16]	September 1, 2015 – August 31, 2018	52	Planning Organization Equipment Training Exercise	$3,734,500	Closed
FY 2016[17]	September 1, 2016 – December 31, 2019	35	Planning Organization Equipment Training Exercise	$3,734,500	Open
FY 2017	September 1, 2017 – August 31, 2020	29	Planning Organization Equipment Training Exercise	Information not available	Information not available
FY 2018[18]	September 1, 2018 – August 31, 2021	26	Information not available at this time	$3,980,000	Open

New capabilities since 2014

There are no new capabilities added since 2014.

[15] FEMA, n.d. FY 2014 Homeland Security Grant Program (HSGP) Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1406300389096-4a90f0348040a8210de9854d8f597edf/HSGP_Fact_Sheet_Final.pdf
[16] FEMA, n.d. Fiscal Year 2015 Homeland Security Grant Program Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1438021101390-ce3bbdde8b84b174b8212fcfd7aaa5c3/FY_2015_HSGP_Fact_Sheet_Allocations.pdf
[17] FEMA, n.d. Fiscal Year 2016 Homeland Security Grant Program Fact Sheet. Retrieved at: https://www.fema.gov/media-library-data/1467836973305-76b1650140531d2fab3f08e67f755572/FY_2016_HSGP_Fact_Sheet.pdf
[18] Cicilline, David, 2018. RI Delegation Announces $7.4 Million in Homeland Security Grants for RI [Media Release]. Retrieved at: https://cicilline.house.gov/press-release/ri-delegation-announces-74-million-homeland-security-grants-ri

4.2.2.13 Rhode Island Historical Preservation and Heritage Commission

Description of agency

The Commission identifies and protects historic sites, buildings, structures, and districts and prehistoric sites throughout the State. Rhode Island's historic properties are an important resource and are major attractions for the State's billion-dollar tourism industry. The Commission carries out its mission by nominating significant properties to the NHRP and the State Register; administering grants, loans, and tax credits for rehabilitation of historic buildings; reviewing federal and state projects that affect cultural resources; and regulating archaeological exploration on state land and under state territorial waters. The Commission also develops and carries out programs to document, support, and celebrate the ethnic and cultural heritage of Rhode Island's people.

In the event of destruction and damage resulting from a natural disaster, a MOU is established where RIEMA would defer to the SHPO when repairing historic structures and other structures. The MOU provides a mechanism whereby damaged buildings will be repaired utilizing mitigation measures while also following state and federal historic preservation regulations.

Funding capabilities

Detailed information on funding capabilities for mitigation activities is not publicly available.

Staffing resources

The RIHPHC has a staff of 15.6 FTEs, including administrative staff, grants managers, historical architects, architectural historians, historians, and archaeologists. Staff who are involved with reviewing risk reduction or mitigation activities may (depending on the project) include some combination of two (2) historical architects, five (5) architectural historians, one (1) historian, and two (2) archaeologists.

Technical assistance

The SHPO reviews and provides technical assistance for projects at federal, state, and municipal properties and reviews approximately 1,200 projects annually that are funded or permitted by the state or federal government to identify and avoid harmful effects to historic resources. These include the review of and provision of technical assistance for repair and mitigation at historic structures following a disaster.

Hazard mitigation effectiveness

The MOU was tested during the March 2010 floods, where numerous historic structures were affected. The MOU allows structures to be retrofitted utilizing disaster mitigation measures while also preserving the historical integrity of these unique resources.

New capabilities since 2014

There are new capabilities since 2014.

4.2.2.14 Rhode Island Infrastructure Bank

Description of Agency

RIIB mission is to actively support and finance investments in the State's infrastructure. The Infrastructure Bank does so through a variety of means, including the issuance of bonds, originating loans and making grants, and the engagement with and mobilization of sources of public and private capital. Through its activities, the Bank fosters infrastructure improvements that create jobs, promote economic development and enhance the environment.

Funding capabilities

Over nearly three (3) decades, the Infrastructure Bank has invested nearly $2 billion in infrastructure projects across the Rhode Island. Broken down by sector, the investments during 2017 totaled $43 million in clean water, $19 million in drinking water, $8 million in road and bridge and $17 million in clean energy. Rhode Island Infrastructure Bank has the following financing programs available:

- Brownfields Revolving Loan Fund
- Clean Water State Revolving Fund
- C-PACE
- CSSLP
- Drinking Water State Revolving Fund
- Efficient Buildings Fund
- Facility Plan Loan Fund
- Municipal Road and Bridge Revolving Fund
- Rhode Island Water Pollution Control Revolving Fund
- Sewer Tie-In Loan Fund

Staffing Resources

RIIB has 12 FTEs comprised of two (2) main divisions, Operations and Finance and Business Development. The Bank employs a Director of Stormwater and Resiliency and that position also has the additional duties of Chief Resilience Officer for the State of Rhode Island.

Technical Assistance

The Chief Resilience Officer is located within the RIIB and provides technical expertise and leads efforts related to resilience in Rhode Island.

Hazard Mitigation Effectiveness

RIIB has been actively engaging with Rhode Island's municipal officials about their infrastructure needs and identifying opportunities to build climate resilience across the state.

Project Examples:

- The Statewide Climate Resilience Action Strategy — released on July 2, 2018 — responds to changing weather and environmental conditions in Rhode Island caused by climate change and outlines aggressive and actionable strategies to better prepare the state for these impacts. Rhode Island Infrastructure Bank led the development of Resilient Rhody with a

diverse group of state agencies and statewide stakeholders to increase collaboration and enable shared goal setting.

- The City of Warwick's wastewater treatment facility was flooded during the 2010 floods causing $13 million in damages. The City of Warwick worked with the FEMA and the Bank to bring both federal funding and local financing to implement a berm protecting the treatment facility from future flooding. The berm provides an additional five and a half (5.5) feet of protection.
- The Bank provided financing to a beach infrastructure project in the Town of Bristol that enhances water quality at the beach through green infrastructure investments. The financing was for installation of a permeable pavement parking lot with vegetated bioswales and rain gardens. As a result, the town reduced the number of beach closure days due to stormwater runoff while increasing local revenue attributable to beach activities.
- The Town of Warren financed a $20 million upgrade to the Town's wastewater treatment facility through the Clean Water State Revolving Fund managed by Rhode Island Infrastructure Bank. The project will modernize the wastewater treatment facility by reducing nitrogen discharges into the Warren River, increasing energy efficiency, replacing obsolete equipment, improving safety for workers, and increasing the resiliency of the facility to storms, flooding, and the effects of climate change. The resilience components of the project make it the first wastewater treatment facility in Rhode Island to incorporate flood protection measures identified in the Rhode Island Department of Environmental Management's 2017 climate change vulnerability assessment. Specific measures include relocating electrical equipment and motor drives above projected flood elevation and replacing pumps and mixers with submersible motors where raising pumps above flood level is not feasible. Green elements of the project also allowed Warren to receive approximately $450,000 of principal forgiveness that reduces the overall cost of the project.
- Through two (2) of Rhode Island Infrastructure Bank programs the Bank helped the City of Newport increase the resiliency of their wastewater treatment facility from impacts of extreme weather events. The Bank provided $42 million in financing to Newport to increase the wastewater treatment plant's capacity to manage increase wet weather flows while hardening pump stations throughout the city. The City of Newport used the Bank's Efficient Buildings Fund to make a solar investment at the facility, becoming the first wastewater treatment plant in Rhode Island to have onsite solar, increasing the resiliency of the plant from power outages due to extreme weather events.

New Capabilities since 2014

RIIB is Rhode Island's central hub for financing infrastructure improvements for municipalities, businesses, and homeowners. The bank leverages limited capital in a revolving fund to offer innovative financing for an array of infrastructure-based projects including water and wastewater, road and bridge, energy efficiency and renewable energy, and brownfield remediation. These quality of life projects improve the State's infrastructure, create jobs, promote economic development and enhance the environment.

In 2018, Resilient Rhody, the state's first climate preparedness plan, was finalized and released. Rhode Island Infrastructure Bank, specifically the Chief Resilience Officer, led the effort to develop this plan and will be providing the leadership and expertise to implement the plan's recommended projects.

Established by the Rhode Island General Assembly in 1989 as the Clean Water Finance Agency, the Infrastructure Bank's charter was significantly expanded in 2015 to include energy and brownfield

remediation initiatives. The Infrastructure Bank's expanded mandate has significantly enhanced its ability to provide competitive financing to a broad variety of infrastructure-based projects. In conjunction with the expansion of its charter, the Infrastructure Bank was rebranded to better reflect its mission and service capabilities.

4.2.2.15 Rhode Island Office of Energy Resources

Description of agency

The mission of the Rhode Island Office of Energy Resources (OER) is to help Rhode Island achieve a reliable, cost-effective, and sustainable energy future. They work closely with private and public stakeholders to increase the security of the State's energy supply, reduce energy costs, and improve environmental quality. The OER recommends and implements smart energy policies to help reduce RI's dependency on out-of-state fuels.

The OER maintains an Energy Assurance Plan and Rhode Island State Energy Plan, each are discussed in further detail below.

Funding capabilities

The OER operating budget is secured through federal funding from the Department of Energy; the Regional Greenhouse Gas Initiative Program; and by Rhode Island gas and electric ratepayers through a System Benefit Charge Program. The OER operating budget is used for staffing and activities associated with planning, management and evaluation of energy efficiency programs, renewable energy programs, system reliability, and least-cost procurement. The OER also manages regulatory proceedings, contested cases, and other actions pertaining to the purposes, powers and duties of the Office as laid out in legislation.

Staffing resources

The OER has 14 staff members. Staff include the Commissioner, Deputy Commissioner, Communications Manager, Financial Management Administrator, and Chief Implementation Aide. Four (4) staff members are responsible for energy efficiency, one (1) is responsible for transportation-related projects, two (2) staff members are responsible for renewable energy projects. One (1) staff member serves as the primary contact during storm or emergency related events, while another is designated as the secondary point of contact.

Technical assistance

The OER provides support to the distillate fuel terminals in Providence and Tiverton during emergency related events. The OER communicates and assists the fuel terminals in getting any matters resolved with the electric distribution company. The OER also works in coordination and provides necessary support to other state agencies, including the Department of Public Utilities Commission (DPUC) and the RIEMA.

Hazard mitigation effectiveness

Adopted in June 2012, the Energy Assurance Plan provides the State with guidance to prepare for, monitor, and mitigate energy deficiencies and disruptions. It focuses on electricity, natural gas, and petroleum. The information in this plan expedites the State's response process by laying out key information that is necessary to address the safety, health, and economic viability of its constituents. Critical infrastructure is outlined in this plan and there is a complete vulnerability and risk assessment section, which incorporates information from the SHMP. The Energy 2035 Plan works in conjunction with the Energy Assurance Plan.

New capabilities since 2014

The OER completed the update of the Rhode Island State Energy Plan, now titled Energy 2035: Rhode Island State Energy Plan in collaboration with the Division of Planning. The plan sets forth a comprehensive vision for providing secure, cost-effective and sustainable energy services across all sectors including residential, municipal, and industrial.

4.2.2.16 Rhode Island Office of Housing and Community Development

Description of agency

The Rhode Island Office of Housing and Community Development (OHCD) coordinates housing functions and selected community development activities of State agencies. The primary purpose of the office is to promote decent, safe, and affordable housing opportunities; create a suitable living environment; and expand economic opportunities, principally for low-and moderate-income Rhode Islanders. This Office provides financial and operational support for all housing programs administered by the Housing Resources Commission. The Office works with communities to achieve their affordable housing goals. They assist the Planning staff in review of Local Comprehensive Plan Updates for consistency with State Affordable Housing Elements. They have partnered with RIEMA to create the DHTF to address housing issues following a disaster.

Funding capabilities

CDBG-DR funds may be used to restore public facilities and infrastructure, rehabilitate or replace housing, acquire property, promote economic revitalization, and support hazard mitigation planning. CDBG-DR funds are intended to support long-term recovery from a specific natural disaster and may not be applied to recovery activities associated with other disasters.

Annual CDBG Program funds may also be used for certain eligible hazard mitigation and disaster recovery activities.

Staffing resources

OHCD staff support the Housing Resources Commission and administer housing, homelessness, emergency shelter, lead safe housing, and community development funds. In fiscal year 2019, 0.6 FTEs are assigned to disaster recovery and addresses hazard mitigation issues in the context of disaster recovery. In fiscal year 2020, designated disaster recovery resources will terminate.

Technical assistance

OHCD prepares CDBG-DR Action Plans after funds are allocated to the State by the U.S. Department of Housing and Urban Development (HUD). Staff provides technical assistance to municipalities on federal regulations and the CDBG program.

Hazard mitigation effectiveness

Specific activities were funded through CDBG-DR for the Hurricane Sandy grant using a competitive grant application process. Funded programs included:

- Post Disaster Housing Stabilization Program
- Public Facilities and Infrastructure
- Economic Recovery
- Recovery Planning
- Administration

New capabilities since 2014

The State received an allocation of $19,911,000 in CDBG-DR funds to address the impacts of Hurricane Sandy, Hurricane Irene and Winter Storm Nemo. Previously, the State of Rhode Island received $8,935,237 in federal CDBG-DR funding to address the impacts of the March 2010 floods. Eighty percent of the Hurricane Sandy CDBG-DR allocation is reserved for Washington County, designated a "most impacted and distressed county." As of publication, the CDBG-DR grants are fully obligated to recovery activities and most such activities are complete.

4.2.2.17 Rhode Island Office of the Governor

Description of agency

The Rhode Island Office of the Governor manages several initiatives related to hazard mitigation and risk reduction. This office helped to develop and currently oversees the Rhode Island Cybersecurity Commission and EC4. The Rhode Island Cybersecurity Commission is tasked with creating a strategic plan to develop the cybersecurity industry in Rhode Island. The commission was also tasked with bolstering cybersecurity initiatives to protect against cyberattack in the public and private sector. The Office of the Governor also can implement executive orders that play a direct role in hazard mitigation and risk reduction in the state.

Funding capabilities

Resilient Rhody strategizes different funding and financial opportunities that the State can capitalize on to implement resilience measures. The Office of the Governor's budget also provides funding for public safety, natural resources, and transportation. This funding includes budgetary resources for RIEMA, RIDEM, RIDOT, Department of Public Safety (DPS), and CRMC, that all have roles in risk reduction and hazard mitigation.

Staffing resources

Staffing information was not publicly available.

Technical assistance

There is no technical assistance available.

Hazard mitigation effectiveness

The Office of the Governor has signed executive orders that reinforce Rhode Island's goal to become more resilient, such as Executive Order 17-06 (Reaffirming Rhode Island's Commitment to the Principles of the Paris Climate Agreement), and Executive Order 15-17 (State Agencies to Lead by Example in Energy Efficiency and Clean Energy). These efforts have culminated in an online website that provides resources for agencies and partnering organizations, successfully completed projects, as well as an overview of the mission and goals of climate action in Rhode Island.[19] The completion of the Resilient Rhody in 2018 (plan described further below), as well as the ongoing efforts of the Rhode Island Cybersecurity Commission, showcase the important role of the Office of the Governor in implementing resilience actions in the state.

New capabilities since 2014

In 2014, the Resilient Rhode Island Act established the EC4, a council that sought to reduce greenhouse gas emissions and design strategies to ensure Rhode Island's is prepared and resilient to climate change. Member agencies of this organization include CRMC, RIDOA, RIDEM, RIDOH, RIDOT, Rhode Island Division of Planning, RIEMA, RIIB, RIOER, DPUC, and the Rhode Island Commerce Corporation (Commerce RI). More recently, Resilient Rhody, the state's first comprehensive climate preparedness strategy, was submitted to the Governor on July 1, 2018. This plan was derived from Executive Order 17-10 that appointed a Chief Resilience Officer to begin implementing statewide

[19] State of Rhode Island, n.d. State of Rhode Island Climate Change. Retrieved at: http://climatechange.ri.gov/

resilience efforts. Resilient Rhody outlines policies, programs, and funding opportunities that the state can utilize to protect against the effects of climate change. Additionally, since 2014, Executive Orders 15-17, 17-06, and 17-10, and the Rhode Island Cybersecurity Commission have been established.

4.2.2.18 Rhode Island Public Utilities Commission and Division of Public Utilities and Carriers

Description of agency

The Commission and Division execute laws relating to public utilities and carriers that govern the conduct and rates of public utilities. The commission maintains statutorily mandated annual gas and electric infrastructure, safety, and reliability (ISR) dockets for National Grid Gas and Electric. Projects, like flood mitigation work at substations, are taken up in those proceedings. The status of flood mitigation projects undertaken and planned by National Grid are detailed in the company's 2014 Electric Infrastructure, Safety, and Reliability Plan. The Electric ISR also includes provisions for vegetation management and inspection and maintenance programs. The Gas ISR provides for ongoing leak prone pipe replacement as well as other reliability such as the extension of high-pressure service, which is less prone to flood water incursion.

Summaries from major storm events, such as the 2010 flooding event (March 30-April 1), Hurricanes Sandy, and Irene, provide a description of the storm along with a summary of the extent of damage to National Grid's system, including the number and length of outages. Supplemental reports detailing restoration costs caused by the storm are also available.

Funding capabilities

The Commission and Division review and annually approve National Grid's ISR plans, which are funded by ratepayers.

Staffing resources

The three-member Commission has a staff of nine (9). The Division has a staff of 35.

Division staff review the annual ISR filings. This review includes Division Engineering staff (three) and the Division's Gas Engineer (one). Additionally, accounting and legal staff review this annual filing.

The Commission is the final authority for approving the ISR plan and its funding through utility rates.

Technical assistance

The Commission and Division do not currently offer technical assistance to the public or other state agencies regarding hazard mitigation.

Hazard mitigation effectiveness

For electric service:

- National Grid is engaged in a flood mitigation program at several substation locations.
- The Company is engaged in an Enhanced Hazard Tree Mitigation Program in addition to its cycle pruning programs.
- Inspection and maintenance program methodologies have been incorporated into annual ISR filings.

For gas service:

- From 2007 to 2012, 8.4% of the state's leak-prone gas mains have been replaced, with projections for 50 to 60 additional miles a year of pipe replacement from 2013 onward. As of May 2018, there is a petition from Narragansett Electric Company for declaratory order regarding the replacement of 1,600 linear feet of existing gas pipeline and improvements to the existing pipeline manifold.
- The company is relocating 8,500 indoor high-pressure service meters to outdoor location, a process completed in 2014.
- As part of a 15-year program, 80,000 low pressure gas service lines are being replaced.

The Rhode Island Public Utilities Commission and DPUC are also involved in the coordination of energy security issues as part of Energy Assurance Planning.[20]

New capabilities since 2014

The National Grid Gas and Electric ISR Plans became effective in April 2011 and have been submitted and adopted annually.

[20] Rhode Island Office of Energy Resources, n.d. Energy Assurance Planning. Retrieved at: http://www.energy.ri.gov/energyassurance/index.php

4.2.2.19 Rhode Island Rivers Council

Description of agency

The Rhode Island General Assembly created the Rhode Island Rivers Council in 1991 to coordinate efforts to improve the quality of the state's rivers and their watersheds. The Rhode Island Rivers Council authorizes local watershed councils with state designation for five-year terms. This authority provides local watershed councils legal standing to represent water bodies in their watersheds before state and local government agencies. These local watershed councils are also eligible for an annual grant from the Rivers Council. State designated local watershed councils/associations include:

- Blackstone River Watershed Council / Friends of the Blackstone
- Buckeye Brook Coalition
- Friends of the Moshassuck
- Kickemuit River Council
- Narrow River Preservation Association
- Pawtuxet River Authority & Watershed Council
- Salt Ponds Coalition
- Ten Mile River Watershed Council
- Wood-Pawcatuck Watershed Association
- Woonasquatucket River Watershed Council

The Rhode Island Rivers Council also advocates that Congress establish the Blackstone River National Historical Park as a permanent unit within the National Park System and that Congress designate the Wood-Pawcatuck river system to be part of the National Wild and Scenic Rivers System.

Funding capabilities

The Rhode Island Rivers Council receives an annual legislative grant from the Rhode Island General Assembly. This money is used to conduct an annual grant round for projects proposed by state designated local watershed councils. As of 2018, ten local watershed councils are state designated.

Staffing resources

The Rhode Island Rivers Council is an "associated function" of the Rhode Island Water Resources Board, which provides staff assistance to the Rivers Council. Also, two (2) state agencies, the RIDOA and the RIDEM, have voting member representatives on the Rivers Council. These representatives provide staff assistance in addition to Rhode Island Water Resources Board staff.

Technical assistance

The Rhode Island Rivers Council is author of the Rhode Island Rivers Policy and Classification Plan, as amended May 2004, and is charged with its implementation. The plan utilizes US Hydrologic Unit Code (HUC) Levels 10 and 12 mapping. In 2005, the Rhode Island Rivers Council provided the Rhode Island General Assembly a report entitled *Establishment of Riparian and Shoreline Buffers and the Taxation of Property Included in Buffers.* The Rhode Island Rivers Council pays attention to Rhode Island Dam Inventory assessments of State's 670 dams conducted by the RIDEM.

Hazard mitigation effectiveness

The Rhode Island Rivers Council has worked to strengthen the capacity and capability of local watershed councils and associations. The Rhode Island Rivers Council has been supportive of efforts by the state designated Pawtuxet River Authority and Watershed Council in mitigation efforts resulting from the Rhode Island Flood of March/April 2010. The Rhode Island Rivers Council also participated on the intergovernmental agency review team for the Theodore Francis (TF) Green Airport Improvements Program Environmental Impact Statement effort from approximately 2007 to 2011. The Rhode Island Rivers Council has also assisted with the identification, development, and completion of stormwater related projects in fiscal years 2015 and 2016. Project categories included on the ground implementation, water quality assessment, and education and outreach.

New capabilities since 2014

The Rhode Island Rivers Council has recently participated in the Rhode Island Renewable Energy Siting Partnership regarding the hydropower element of the state energy plan. The Rhode Island Rivers Council considers the merits of dam removal projects, hydropower projects and the like on a case by case basis. The Rhode Island Rivers Council established the riparian and shoreline buffers, including reduced taxation for buffered properties. The Rhode Island Rivers Council has also participated in the TF Green Airport Improvements Environmental Impact Statement as part of the Intergovernmental Review Team (part of the TF Green Airport Improvement Program). [21]

[21] Rhode Island Rivers Council, n.d. RI Rivers Council Policy & Programs. Retrieved at: http://www.ririvers.org/programs.htm

4.2.2.20 Rhode Island State Police

Description of agency

Rhode Island State Police (RISP) is a "full-service, statewide law enforcement agency whose mission is to fulfill the law enforcement needs of the people with the highest degree of fairness, professionalism and integrity, and protect the inherent rights of the people to live in freedom and safety."[22] This agency includes three (3) bureaus and units: administrative, detective, and patrol. RISP is critical in response during and immediately following an emergency incident, whether natural or human-caused. In collaboration with RIEMA and Rhode Island Department of Education (RIDE), RISP develops emergency procedure toolkits for schools. RISP also provides preparedness resources online to ensure that the public is safe and educated prior to a hurricane, tropical storm, or winter storm.

Agency risk reduction programs also include the Rhode Island Joint Cyber Task Force, which is part of the Detective Bureau. Members of this task force include the Rhode Island State Police Computer Crimes Unit, and individuals representing other critical facilities, infrastructure, and community needs (such as hospitals and utilities). The mission of this task force is to bolster resources and preparedness to respond to and protect against cyberattack and disturbances to critical infrastructure. The Fusion Center is part of the Detective Bureau as well and is the point for information sharing between state, local, territorial, federal, and private sector partners to enhance homeland security.

Funding capabilities

Funding capabilities are not publicly available.

Staffing resources

The agency is comprised of the following:

- Superintendent (and Director, Rhode Island Department of Public Safety)
- Deputy Superintendent/Chief of Field Operations
- Chief Investigative/Administrative Officer
- Executive Officer Operations/Department of Public Safety
- Detective Commander
- Executive Administrative Officer
- Executive Officer, Department of Public Safety
- Opioid Enforcement & Prevention Coordinator
- Cyber Crimes Unit and Fusion Center Commander
- Professional Standards Officer
- Assistant Detective Commander
- Director of Training
- District "B" Commander

Staffing resources beyond this level are not publicly available.

[22] Rhode Island State Police, n.d. Mission Statement and Organization Chart. Retrieved at: http://risp.ri.gov/about/mission.php

Technical assistance

RISP provides pre- and post-disaster assistance in the form of first response, as well as safety and education, and other preparedness measures.

Hazard mitigation effectiveness

RISP worked jointly with RIEMA, Rhode Island National Guard, and other utility providers to develop the State Cyber Disruption Annex to the State Emergency Operations Plan.

New capabilities since 2014

There are no new capabilities added since 2014.

4.2.2.21 Rhode Island Sea Grant College Program and University of Rhode Island Coastal Resources Center

Description of agency

The Rhode Island Sea Grant College Program and University of Rhode Island Coastal Resources Center (RISG/CRC) conducts research, training, and public outreach on priority issues of importance to coastal communities and the marine environment with the goal of providing the best available information to decision makers and the public. The program is a partnership between RISG, a NOAA funded program, and CRC, a center within the University of Rhode Island (URI) with links to a network of 30 Sea Grant university programs nationwide. The program supports research on issues such as resilient coastal development, healthy coastal ecosystems, and safe and sustainable seafood. The program has done extensive research on SLR and coastal hazards in Rhode Island. They are part of several interagency work groups and have a history of working with communities and businesses to minimize impacts of coastal and riverine flooding. RISG/CRC works closely with various state agencies, including the CRMC, with a specific focus on the development of coastal policy and SAMPs.

Funding capabilities

RISG/CRC receives core funding from NOAA to conduct outreach activities, all other funding for the organization is supported through federal, state, or private foundation grants. RISG competitively awards research grants on a biannual basis to support priority themes.

Staffing resources

RISG/CRC has a combined total of 45 team members working on projects within Rhode Island. A portion of this team works primarily on hazard mitigation planning, SLR and climate change related issues.

Technical assistance

RISG/CRC helps decision makers at the state and local levels to better understand the science and policy implications of SLR and climate change. Information and tools developed by this organization assist stakeholders in identifying vulnerabilities and developing actions to reduce risk. Staff regularly partner with university researchers, faculty, and students to advance development of knowledge in natural and social sciences.

Hazard mitigation effectiveness

RISG/CRC worked with RIEMA in the 1990s to develop the first pilot community hazard mitigation plans. Today RISG/CRC is working with communities to pilot climate adaptation planning and incorporate this information into hazard mitigation plans and local comprehensive plans. Linking planning and policy, the team has facilitated the development of SAMP with CRMC, which integrates coastal hazards into state policy and permitting. These efforts include the Metro Bay SAMP and Shoreline Change (BEACH) SAMP. RISG funded research over the years has provided a foundation for policy development (CRMC SLR policy) and is a means to understand coastal processes (erosion mapping). In addition, maps depicting SLR have been developed for communities. RISG/CRC has a series of fact sheets and summary reports for stakeholders and decision makers on the science, issues, and actions related to flooding, SLR and other climate related risks.

New capabilities since 2014

RISG/CRC has been involved with several SLR, climate change, and resilience-based projects in Rhode Island. They are currently part of the Coastal Green and Resilient Infrastructure Project and have worked to develop the STORMTOOLS and Rapid PACE Mapping tools. In conjunction with CRCM, RISG/CRC completed the Block Island Shoreline change maps as a part of the Beach SAMP.

4.2.2.22 Rhode Island Water Resources Board

Description of agency

The Rhode Island Water Resources Board (WRB) regulates the proper development, protection, conservation, and use of the state's water resources[23] and manages the withdrawals and use of the waters of the state[24], while providing for economic development and protection of the environment. The WRB implements capital projects that result from their plans and studies, including the 2012 Strategic Plan[25], managing the Water Supply System Management Plans (WSSMP)[26]. These programs help strengthen water resources and supply in the state and prepare the state for emergency drought conditions, the ongoing effects of climate change, and the future water supply needs based on growth and water availability. Statewide strategic planning and risk evaluation assist in identifying risk, capacity, and mitigation and response strategies. Allocation research supports mitigation efforts and future allocation programs will consider the potential impacts of climate and hydrologic variability. They also administer the Drought Steering Committee, which assigns drought stages, engages in public communication, and coordinates with suppliers. One policy that the WRB oversees is the Water Use and Efficiency Act, which was passed to ensure reasonable, needed, and adequate water supplies through managing demand, reinvesting in water supply infrastructure and water supply resources, and protecting and preserving the health and ecological function of the water resources in the state.

Funding capabilities

The WRB administers the Water Quality Protection Surcharge ($4.2 million/year)[27], and the Water Quality Protection Surcharge program along with the Rhode Island Infrastructure Bank ($1 million/year)[28]. These surcharges are collected by major water suppliers and deposited by the WRB to support water resource and water supply programs and administrative expenses.

Staffing resources

The WRB staff includes one (1) full-time staff member. The board is comprised of the following as stated in Statue (46-15.1-2):[29]

- Director, Department of Health,
- Associate Director, Division of Planning within the Department of Administration,
- Director, Rhode Island Economic Development Corporation,
- Director, Department of Environmental Management,
- Members of the public,
- Representative of a water user that withdraws more than 100,000 gallons per day,

[23] Legislative declaration, RI. Stat. §46-15-1 (1990 and Supp. 2004). Retrieved at: http://webserver.rilin.state.ri.us/Statutes/TITLE46/46-15/46-15-1.HTM
[24] Legislative findings and declaration, RI. Stat. §46-15.7-1 (1998 and Supp. 2000). Retrieved at: http://webserver.rilin.state.ri.us/Statutes/TITLE46/46-15.7/46-15.7-1.HTM
[25] Rhode Island Water Resources Board, 2012. *Strategic Plan*. Retrieved at: http://www.wrb.ri.gov/policy_statutes_planning/WRB_StrategicPlan_031612.pdf
[26] Water supply systems management plans, RI. Stat. §46-15.3-5.1 (1990 and Supp. 2009). Retrieved at: http://webserver.rilin.state.ri.us/Statutes/TITLE46/46-15.3/46-15.3-5.1.HTM
[27] Water quality protection funds, RI. Stat. §46-15.3-10 (1987 and Supp. 2002). Retrieved at: http://webserver.rilin.state.ri.us/Statutes/TITLE46/46-15.3/46-15.3-10.HTM
[28] Collection of charges, RI. Stat. §46-15.3-9 (1987 and Supp. 2007). Retrieved at: http://webserver.rilin.state.ri.us/Statutes/TITLE46/46-15.3/46-15.3-9.HTM
[29] Rhode Island Water Board, n.d. "About Us." Retrieved at: http://www.wrb.ri.gov/aboutus_board.html

- Representative of a public water system that withdraws more than 100,000 gallons per day, primarily from ground water supply,
- Representative of a public water system that withdraws more than 100,000 gallons per day, primarily from a surface water supply,
- A professional with expertise in land and/or watershed management,
- A professional with expertise in financial planning and/or investment,
- A professional with expertise in engineering and relevance to water supply,
- A professional with expertise in geology, and/or hydrology,
- A representative of conservation organization, with respect to which appointment the governor shall give due consideration to the recommendation of the environmental council of Rhode Island, and
- A person who is actively engaged in agricultural business, preferably an owner and/or operator of an agricultural business, with respect to which appointment the governor shall give due consideration to the recommendation of the Rhode Island Agricultural Council established pursuant to the provisions of chapter three (3) of title two.

Technical resources

The Board provides technical guidance for municipalities and water suppliers to align land management programs with water resource programs.

Hazard mitigation effectiveness

WRB has assessed [30] and invested in interconnections (25% and 50% grants) to improve the ability of water systems to respond to emergencies.

Early warning of drought conditions allows for reductions in water use and preserving storage and groundwater levels. A thorough understanding of the hydrology, water use, and projected demand is a necessary first step to assessing risk and mitigating impacts of drought emergencies. Several models are publicly available and could assist in developing planning scenarios and identifying solutions.

The WRB regulates development in hazard prone areas through the WSSMP and Statewide Planning Program's Community Comprehensive Plan (CCP), in coordination with the Division of Planning. Both documents reference each other and must be integrated in regard to water availability. WSSMPs also contain emergency plans that are updated every five (5) years to provide continuous assessment of hazards, risks and responses.

New capabilities since 2014

There are no new capabilities added since 2014.

[30] Maguire Group, 2008. *Report: Statewide Supplemental Water Supplies Feasibility Assessment.* Retrieved at: http://www.wrb.ri.gov/data_supplementalwaterstudies/SSWS_Feasibility_Phase2.pdf

4.2.2.23 Scientific Support for Environmental Emergency Response

Description of agency

An MOU was established between the URI Coastal Institute and the Rhode Island Department of Environmental Management to sustain an administrative process for Scientific Support for Environmental Emergency Response (SSEER). The process enables state agencies to deploy university resources to assess, reduce, and remediate threats to public health and safety and the environment of Rhode Island. The agreement helps the state be ready to engage rapid, incident-specific support from university staff and facilities.

Funding capabilities

SSEER does not currently have direct funding to support hazard mitigation.

Staffing resources

Staffing resources within SSEER include professors in hydrology and biology, fisheries, oceanography, watershed experts, and GIS professionals across multiple organizations. These organizations include, but are not limited to:

- Rhode Island Space Grant (RISG)
- URI
- RIDEM
- RICRMC
- EPA
- University of Massachusetts at Dartmouth
- Roger Williams University
- URI Coastal Resources Center (CRC)
- Providence Emergency Management Agency
- URI Watershed Watch
- National Sea Grant Advisory Board
- McLaughlin Research Corporation
- URI Environmental Data Center
- URI/Inner Space Center
- Brown University
- URI Coastal Institute
- Eastern Connecticut State University
- Narragansett Bay National Estuarine Research Reserve
- Napatree Point Conservation Area
- CY Communications

A full list of staffing support can be found online. [31]

[31] Scientific Support for Environmental Emergency Response (SSEER), 2018. Roster. Retrieved at: https://ci.uri.edu/files/SSEER_Roster_PDFNoContact_6.21.181.pdf

Technical assistance

SSEER staff include GIS professionals with mapping, analysis, and GPS skills.

Hazard mitigation effectiveness

SSEER accomplishments in hazard mitigation and emergency preparedness include:

- Development of standard procedures for the Natural Resource Damage Assessment and Restoration Program following an oil spill, and
- Conducting annual exercises and training opportunities.

New capabilities since 2014

There are no new policies, programs, or funding resources available from SSEER. The MOU is effective from June 2015 to June 2020, with the possibility of being extended in the future.

4.2.2.24 State Building Code Commission

Description of agency

The Building Code Commission, currently within the Department of Business Regulation, administers the State Building Code. The Building Code is implemented statewide and enforced through the building official in each municipality. The Code consists of uniform regulations to control construction, reconstruction, repair, removal, demolition, and inspection of all buildings. The NFIP standards, wind, and snow loads are all an integral part of the State Building Code, ensuring that all new construction and substantial improvements meet national flood resistant standards through consistent statewide application of the NFIP minimum criteria. Communities have enacted stricter standards under their local floodplain ordinances. Seismic design standards are advisory and not required for building or structures.

Funding capabilities

Detailed information on funding capabilities for mitigation activities is not publicly available.

Staffing resources

The State Building Code Commission is comprised of 12 staff members.

Technical assistance

The Building Commission distributes a brochure entitled Rebuilding After a Storm. This brochure, sponsored by the Rhode Island Flood Awareness and Climate Change Taskforce, includes a checklist of the types of items residents should have available in their homes to prepare for hurricanes and nor'easters. It also outlines the process property owners should take if their homes have been damaged after a storm event and special procedures if their home is located in a CRMC or if they have a septic system. New structures or those that are being rebuilt and are within a CRMC jurisdiction require a CRMC permit. Existing structures that have been physically destroyed 50% or more by coastal storms must meet all current regulations when being rebuilt. In some cases, these structures may not be permitted to be rebuilt if located on undeveloped or moderately developed barriers. New or substantially improved residential or commercial buildings located within the SFHAs are also required to conform to state and local requirements.

Hazard mitigation effectiveness

The effective date of the original implementation of the Rhode Island State Building Code was July 1, 1977, following adoption of the concept of uniform regulations to control construction, reconstruction, repair, removal, demolition, and inspection of all buildings in the State. The Rhode Island Building Code incorporates provisions of ICC, the basic national building code, with changes and additions as adopted by the State of Rhode Island Building Code Standards Committee. ICC consists of model building regulations for the protection of public health, safety and welfare. The chief executive of each city and town is required to appoint a Building Official to administer the building code; two (2) or more communities may join in the appointment of a building official. The Code stipulates that the building official review all permits for construction in flood hazard areas to ascertain that all required federal, State, and local permits have been obtained.

The Building code has been effective in addressing structural issues as they relate to potential damage and safety issues in regard to natural disasters. The Building Commission has also been very proactive in minimizing the granting of variances to the NFIP criteria.

New capabilities since 2014

There are no new capabilities added since 2014.

4.2.2.25 United States Army Corps of Engineers

Description of agency

In the past USACE has assisted the State and its communities by conducting investigations related to dam breach failure analysis, public awareness and outreach related to potential flooding, wetland restoration opportunities, and the effects of SLR.

Flood Control Projects, built by the USACE, such as dams, levees, groins, breakwaters, hurricane barriers and seawalls, protect many municipalities in Rhode Island from riverine and tidal flooding.

Habitat restoration projects such as Town Pond in Portsmouth or the Galilee Salt Marsh in Narragansett help to repair the original condition of the natural area that, in the case of a coastal wetland, restores it back to its natural and beneficial use and helps to control flooding and acts as a natural buffer prior to the onset of coastal storms.

Funding capabilities

Flood Plain Management Services (FPMS) funding is requested annually and can be used to investigate flooding or floodplain related issues. Studies are 100% federally funded.

Planning Assistance to States (PAS) studies can address any water resource related problem and are cost shared on a 50/50 basis.

Larger investigations such as the Pawcatuck River Watershed Coastal Storm Risk Management investigation requires specific Congressional authorization and appropriation for both the study and design/construction phases.

Staffing resources

Detailed information on staffing resources for mitigation activities is not available; however, the USACE is broadly staffed with scientists and engineers in order to meet the needs of stakeholders when it comes to coastal and riverine flood risk.

Technical assistance

USACE can provide technical assistance to the state and communities on flooding through its FPMS program and any water resource related problem through its PAS program. USACE assists the state and local governments in conducting annual inspections of flood protection infrastructure that was constructed by the USACE.

Technical assistance is also provided by the USACE's Silver Jackets Team program. Silver Jackets teams in states across the United States bring together multiple state, federal, and sometimes tribal and local agencies to learn from one another in reducing flood risk and other natural disasters. The charter for the Rhode Island Silver Jackets was finalized in August 2016. This team has various FPMS projects in the works, such as a Flood Inundation Mapping (FIM) project, Rhode Island Floodplain Managers handbook and a Vulnerability Assessment of the Historic Structures in the Floodplain. The Silver Jackets program continues to grow in Rhode Island with more State agencies and Congressional staff attendance. Current state and federal partners include:

- FEMA
- NOAA/NWS
- USACE
- USGS
- RIEMA
- RICRMC
- RIDEM

Hazard mitigation effectiveness

Flood Control Projects constructed by the USACE have prevented flood damages in major Rhode Island urban areas estimated at saving millions of dollars.

The Habitat Restoration Program has been very beneficial to Rhode Island. The USACE and the CRMC have been working together on one of the largest habitat restoration programs in the south county coastal lagoons to repair decades of damage to this environmentally fragile area. The negative result of using hard structures is that they require continual maintenance, which is a challenge to state and local governments.

New capabilities since 2014

Two new feasibility studies were conducted in the areas impacted by Hurricane Sandy. The Pawcatuck River Flood Risk Management feasibility was completed in July 2017 and recommended that further action (elevation and floodproofing) be taken on scattered properties throughout the watershed. The Pawcatuck River Coastal Storm Risk Management feasibility completed in 2017 and similarly recommended elevating 247 residential structures and floodproofing another 21 mainly commercial structures. [32]

[32] USACE, 2018. Update for Rhode Island. Retrieved at: http://www.nae.usace.army.mil/Portals/74/docs/Media/State%20Updates/RI_Apr_2018.pdf?ver=2018-05-16-091714-260; USACE, 2017. Update for Rhode Island. Retrieved at: http://www.nae.usace.army.mil/portals/74/docs/Media/State%20Updates/RI_Oct2017.pdf

4.2.2.26 United States Department of Agriculture - Natural Resource Conservation Service

Description of agency

The NRCS is a federal agency that works with the people of Rhode Island to improve and protect their soil, water, and other natural resources. Private landowners have worked with NRCS specialists to prevent soils erosion, improve water quality, and promote sustainable agriculture. NRCS employees include soil conservationists and scientists, engineers, geologists, and resource planners. These experts help develop conservation plans, create and restore wetlands and other natural ecosystems as well as provide advice on stormwater remediation and watershed planning.

The objective of the Emergency Watershed Protection (EWP) program, managed by NRCS, is to undertake emergency measures, including the purchase of floodplain easements for runoff retardation and soil erosion prevention, to safeguard lives and property from floods, drought, and erosion within watersheds when fire, flood, or any other natural occurrence is causing or has caused a sudden impairment of the watershed. This allows for immediate action to be taken to stabilize storm damages in watersheds following a federal declared natural disaster.

Through the Watershed and Flood Prevention Operations Program, another program managed by NRCS, the agency provides technical and financial assistance to States, local governments and Tribes to plan and implement watershed project plans for:

- Watershed protection
- Flood mitigation
- Water quality improvement
- Soil erosion reduction
- Rural, municipal and industrial water supply
- Irrigation
- Water management
- Sediment control
- Fish and wildlife enhancement
- Wetlands and wetland function creation and restoration
- Groundwater recharge
- Wetland and floodplain conservation easements

Project sponsors help in installing land treatment measures when watershed project plans are approved.

Funding capabilities

NRCS may bear up to 75% of the construction cost of emergency measures under the EWP. The remaining 25% must come from local sources and can be in the form of cash or in-kind services. Funding is subject to congressional approval.

Sponsoring local organizations can request that watershed project plans be authorized for Federal Watershed Operations funding assistance. Plans involving Federal contributions in excess of $5,000,000 for contribution, or construction of any single structure having a capacity in excess of

2,500 acres, require congressional approval. Some plans may be authorized for Federal funding by the Chief of NRCS. Funds that may be available for watershed projects are subject to the following:

- Annual congressional appropriations
- State and national resource priorities
- Acquisition of land and water right permits
- Local funding established for specific project measures
- Completion of structural, agronomic, and vegetative designs for project measures
- NRCS and the project sponsor approval of an Operation and Maintenance Agreement involving the measures to be installed

Staffing resources

Detailed information on staffing resources for mitigation activities was not provided at this time.

Technical assistance

NRCS experts help develop local conservation plans, create and restore wetlands and other natural ecosystems as well as provide advice on stormwater remediation and watershed planning.

Hazard mitigation effectiveness

The EWP program has been extremely effective in working with communities that have stormwater/urban flooding problems. The program offers best practices in developing watershed management programs and ideas on how to redevelop watershed hydrology and hydraulics, enabling these communities to have new FIRMs developed.

New capabilities since 2014

There are no new capabilities added related to hazard mitigation since 2014.

4.2.2.27 United States Geological Survey

Description of agency

The USGS provides science about the natural hazards that threaten lives and livelihoods, the water, energy, minerals, and other natural resources we rely on, the health of our ecosystems and environment, and the impacts of climate and land-use change. The scientists at USGS develop new methods and tools to supply timely, relevant, and useful information about the Earth and its processes.

Funding capabilities

The USGS does not supply funds to other agencies. The USGS can provide up to 50% matching dollars, if available, to a hydrologic study done in cooperation with another Federal, State, or local government agency.

Staffing resources

USGS staff are available to work on funded water-resources data collection activities and studies.

Technical assistance

USGS maintains and operates real-time stream gages, lake and reservoir gages, tidal gages, groundwater monitoring wells, and water-quality stations in cooperation with other Federal, State, and local government agencies. The USGS also works on other water-resources studies in cooperation with other Federal, State, and local government agencies. These activities must be funded work.

Hazard mitigation effectiveness

<u>Flood</u>

Real-time streamflow and stage monitoring are critical for the operation of flood response plans, and to provide additional lead time to downriver communities for response purposes.[33] The USGS stream gage program is critical for Rhode Island to address riverine flooding. The State continues to partner with USGS and is seeking ways to develop a statewide system of real-time river flood warning and monitoring systems. An example of this is the USGS Flood-Inundation Mapping Science Program, which is providing real-time flood-inundation maps for the mainstem Pawtuxet River and the lower Pawcatuck River in Rhode Island.[34]

In addition, the USGS conducts studies and other documentation of the riverine high-water mark elevations and extent of major flood events, and the annual exceedance probabilities of these flood events. These results are displayed on USGS flood-event viewer and in online publications.[35]

[33] USGS, n.d. WaterWatch. Retrieved at: https://waterwatch.usgs.gov/new/index.php?r=ri&m=real
[34] USGS, n.d. Flood Inundation Mapper. Retrieved at: https://wimcloud.usgs.gov/apps/FIM/FloodInundationMapper.html
[35] USGS, n.d. Flood Event Viewer. Retrieved at: https://stn.wim.usgs.gov/FEV/

Hurricanes and Tropical Storms

The USGS also provides data collection on coastal storm-tide and high-water marks elevations from tropical storms, hurricanes, nor'easters, or another major coastal event. These results are displayed on USGS flood-event viewer and in online publications.[36]

Drought

Real-time streamflow and groundwater level monitoring is critical for the State's Drought Management Plan.[37] It provides streamflow and groundwater level data used to determine the drought levels for the drought regions within the State.

Earthquakes

The Earthquake Hazards Program provides real-time information is provide on the location, time, and magnitude earthquakes globally.[38]

New capabilities since 2014

The newest USGS programs include the Flood-Inundation Mapping Program, and the USGS Flood Event Viewer: Providing Hurricane and Flood Response Data. The USGS does not have new policies or funding resources available for hazard mitigation since 2014.[39]

[36] USGS, n.d. Flood Event Viewer. Retrieved at: https://stn.wim.usgs.gov/FEV/
[37] USGS, n.d. New England Drought Information. Retrieved at: https://newengland.water.usgs.gov/drought/index.html
[38] USGS, n.d. Earthquake Hazards Program. Retrieved at: https://earthquake.usgs.gov/
[39] USGS, n.d. Flood Inundation Mapping Program. Retrieved at: https://water.usgs.gov/osw/flood_inundation/; USGS, n.d. USGS Flood Event Viewer: Providing Hurricane and Flood Response Data. Retrieved at: https://water.usgs.gov/floods/FEV/

4.2.2.28 University of Rhode Island Environmental Data Center

Description of agency

The URI Environmental Data Center (EDC) offers a wide range of professional geospatial technology services that are available on a contractual basis to partners, including Rhode Island state and municipal governments. Services include production of risk and vulnerability maps for Rhode Island municipalities that highlight local hazard and critical facility locations. Such information educates communities on vulnerable areas and helps inform how and where to allocate and prioritize the resources necessary to minimize the damages from natural hazards. The URI EDC is available to provide mapping capabilities for the SHMP and is also available to work with RIEMA on other geospatial data development and analyses that support hazard mitigation vulnerability assessment initiatives.

Funding capabilities

The URI EDC is a professional services provider and does not have direct funds for mitigation activities at this time.

Staffing resources

The URI EDC is staffed by 11 full-time grant-funded professionals, as well as hosts a dynamic group of graduate and undergraduate student research assistants.

Technical assistance

All aspects of geospatial technology support for the analysis and mapping of risks and vulnerabilities in Rhode Island. The URI EDC has a very successful record of grant applications and is potentially available to support the preparation of mutual grant applications with partners.

Technical support is provided on a contractual basis to a wide range of partners representing the federal, state, municipal, and non-profit sectors.

Hazard mitigation effectiveness

In its role as the public distributor for data by the RIGIS consortium, the URI EDC maintains the primary source for geospatial data in Rhode Island for supporting local hazard and mitigation efforts, including mapping. Hazard and risk mapping provide a critical spatial component to hazard mitigation and is critical to improving the effectiveness of mitigation programs and the broader understanding of Rhode Island risks and vulnerabilities.

New capabilities since 2014

The URI EDC has continued to enhance the most robust platform for online web mapping application development currently available in Rhode Island. The vast majority of the underlying server-based map, image, locator, and geoprocessing services developed and hosted by the URI EDC are available for use by the general public. The URI EDC produced the 2014 LiDAR DEM Mapping data.

4.2.3 State Higher Education Mitigation Capabilities

Higher education institutions in Rhode Island are themselves communities in many ways, and they can draw on important lessons from the efforts of counties and municipalities to reduce disaster risks. Higher education institutions are engaged in and skilled at planning exercises for a wide range of issues. The addition or improvement of campus-based hazard mitigation planning will yield substantial benefits. Moreover, steps taken to become more disaster-resistant can complement the long-term sustainability of the campus and improve the overall quality of life.

The State of Rhode Island has three (3) public institutions of higher education as shown in Table 4-8. These institutions include:

- The University of Rhode Island,
- Rhode Island College, and
- The Community College of Rhode Island.

The Rhode Island Board of Governors for Higher Education administers all of these institutions of higher education. The largest, URI, has approximately 15,000 residents and commuting students spread over four (4) campus locations. Rhode Island College has an approximate enrollment of 9,000 commuting and resident students located in Providence. The Community College of Rhode Island has roughly 18,000 commuting students at six (6) locations across the State. [40]

Table 4-8 University and College Locations

School	Campus Location
University of Rhode Island	Kingston Campus, Route 138 Kingston, RI 02881
	W. Alton Jones Campus, 401 Victory Highway, West Greenwich, RI
	Narragansett Bay Campus 215 South Ferry Road Narragansett, RI 02882
	URI Providence Campus 80 Washington Street Providence, RI 02903
	Rhode Island Nursing Education Center, 350 Eddy St., Providence, RI 02903
Rhode Island College	600 Mount Pleasant Avenue, Providence, RI 02908-1991
Community College of Rhode Island	Knight Campus 400 East Avenue Warwick, RI 02886-1807
	Flanagan Campus 1762 Old Louisquisset Pike Lincoln, RI 02865-4585
	Liston Campus One Hilton Street Providence, RI 02905
	Newport County Campus One John H. Chafee Blvd. Newport, RI,02840
	Satellite Campus, Westerly Education Center, 23 Friendship Street Westerly, RI 02891

[40] The Community College of Rhode Island, n.d. General Information. Retrieved at: https://www.ccri.edu/about/general.html

4.3 Funding Capabilities and Funding Programs

44 CFR Requirement
Funding Sources: §201.4(c)(3)(iv) **Requirement §201.4(c)(3)(iv):** [The State mitigation strategy shall include an] identification of current and potential sources of Federal, State, local, or private funding to implement mitigation activities.

As highlighted in the agency profiles and Table 4-1, half of the agencies have funding capabilities related to hazard mitigation. This is a current gap identified in the SHMP. RIEMA and SIHMC will further investigate this gap and identify additional sources that can be used to implement mitigation activities; this investigation will take place during the second and fourth quarter meetings of the SIHMC (See Section 7). Resilient Rhody, Rhode Island's Resilient Strategy, contributes to this effort by identifying funding opportunities to bolster the state's resilience.

4.3.1 Federal Funding Sources

The federal government has been the primary source of funding to support risk reduction through a range of grant programs. The availability of federal funding depends upon Congress' ongoing appropriations process. The United States Department of Health and Human Services (HHS) is a managing partner of a comprehensive website that tracks available funding from all federal agencies.[41]

Table 4-9 provides a description of programs that are the primary sources of federal funding for hazard mitigation projects and activities in Rhode Island (though it is not a comprehensive list of all federal funding available). These sources have been referenced in the previous section agency profiles and additional details provided in this section for the most frequently used sources. Appendix D includes detailed program descriptions and includes the *FEMA Funding Sources* guide.

Table 4-9 Federal Funding Programs.

Program	Type of Assistance	Availability	Funding Sources
NFIP	Flood Insurance	Any time (pre- and post-disaster)	NFIP
FMA	Cost share grants for pre-disaster planning and projects	Annual pre-disaster grant program	Federal share (up to 100%), non-federal share (local government or other organization)
HMGP	Post-disaster cost share grants	Post disaster grant program	75% federal share, 25% non-federal share (local government or other organization)
PDM	National, competitive grant program for multiple hazard mitigation projects and "all hazards" plans	Annual pre-disaster grant program	75% federal share, 25% non-federal share (local government or other organization)

[41] www.grants.gov

Program	Type of Assistance	Availability	Funding Sources
PA Program (Section 406 Mitigation)	Post-disaster aid to state, tribal and local governments	Post-disaster	Federal share (minimum of 75%, up to 100%), non-federal share (local government or other organization)
EMPG	National, competitive grant program for implementation of State Homeland Security Strategies	Pre-Disaster grant program	50% federal Share, 50% non-federal share (local government or other organization)
SHSP	National, competitive grant program for all-hazard mitigation preparedness	Pre-Disaster grant program	Federal government
CDBG-DR	Post-disaster aid to state, tribal and local governments	Post-disaster	US Department of Housing and Urban Development
Volunteer Fire Assistance (VFA)	Pre-disaster Grants	Pre-disaster	US Forest Service
Assistance to Firefighters Grants Program – Fire Prevention & Safety Grants (FP&S)	Pre-disaster Grants	Pre-disaster	FEMA

4.3.2 State Funding Sources

The Office of the Governor allocates part of their annual budget towards agencies that oversee hazard mitigation projects related to public safety, natural resources, and transportation. The Rhode Island Rivers Council has allocated funding from the state to distribute to selected watershed projects around the state. Additionally, RIIB has several funds in place to finance infrastructure projects. For most federally funded projects, all non-federal cost sharing requirements (usually 25% of the total project costs) are the responsibility of the jurisdiction applying for funding. The State does, however, provide resources in terms of staffing and in-kind match to federal dollars intended for mitigation planning and projects within RIEMA and other state agencies, as described in Section 4.2.2.

4.4 Summary of Current Programs Supporting Hazard Mitigation

Table 4-2 in Section 4.2 summarizes the capabilities captured in each agency's Capability Checklist. This table highlights the capabilities of the state as it pertains to hazard mitigation and helps identify gaps where risk reduction capabilities can be improved upon in the future. Future updates to this plan should review the current agencies and expand upon capabilities, as they are presented, that help mitigate the hazards identified in the risk assessment.

4.4.1 Program Integration - Incorporation of Research and Plans

44 CFR Requirement
Program Integration **Requirement §201.4(b):** [The State mitigation planning process should] be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.

Table 4-10 summarizes the plans, studies, and data that were provided by state agencies and organizations and were used to inform the 2019 Plan update.

Table 4-10 Provided Resources for the 2019 SHMP update.

Plan/Study/Data Title	Agency/Agencies
Rhode Island State Energy Plan	OER, Rhode Island Division of Planning
Resilient Rhody Strategy	Rhode Island Office of the Governor
Shoreline Change (Beach) SAMP	CRMC
STORMTOOLS Data	CRMC/CRC
Storm Report 2017	DPUC
State Guide Plan Element 121: Land Use 2025, State Guide Plan Element 611: Transportation 2040, State Guide Plan Element 423: Rhode Island Five Year Strategic Housing Plan, State Guide Plan Element 721: Rhode Island Water 2030, State Guide Plan Water Quality 2035: Rhode Island Water Quality Management Plan	RI Division of Planning
CDBG-DR Grant Information	OHCD
Rhode Island Rivers Policy and Classification Plan	Rhode Island Rivers Council
LiDAR DEM Mapping	URI EDC
Flood Inundation Mapper/Flood Event Viewer	USGS
PDM, HMGP, EMPG, and SHSP Grant Information	RIEMA
Water Resources Board Strategic Plan	WRB

4.4.2 "Ongoing" Mitigation Actions converted to State Capabilities

The 2019 update of Rhode Island's SHMP recognizes that some strategies and actions from prior editions of the plan may have been continued several times and denoted as "ongoing". These actions are conducted on a regular basis and should be considered state capabilities. Table 4-11 summarizes the ongoing and continued actions from the 2014 mitigation plan that are capabilities for Rhode Island. RIEMA is the responsible agency for the majority of the mitigation actions identified in the 2014 SHMP.

Table 4-11 Ongoing State Capabilities

2014 Action #	Action
2014.34	**Rhode Island Shoreline Change Special Area Management Plan** - The Rhode Island Coastal Resources Management Council's Shoreline Change (Beach) SAMP is a collaborative effort with the URI and the Rhode Island Sea Grant Program. The goal is to prepare a state management plan that provides the best available science on the projected impacts of coastal erosion, storm flooding and SLR and develop best practices, as well as regulatory policies to address both the short- and long-term changes to Rhode Island's shoreline. Attention will be paid to how erosion, flooding and SLR will impact the built environment along the coast including public and private infrastructure, roads, ports, and public safety issues. In addition to developing the management plan, an extensive public outreach and educational campaign will be conducted to inform stakeholders of their risk, as well as present a range of options to local officials and property owners on actions they can take to increase their preparedness or hazard resilience.
2014.2	**Stormwater and Floodplain Management Coordination** - Improve coordination with State agencies in addressing storm water management and other riverine and floodplain management-related issues.
2014.26	**SLR Policies.** Based on SLR modeling, develop and propose policies to reduce risks for new development, including consideration towards relocating structures or reducing existing hazards within inundation areas with increasing risk. Policies should also address appropriate use of federal and state mitigation monies.
2014.14	**Natural Hazard and Climate Change Vulnerability Database.** Work with the National Weather Service and local communities to develop a statewide database of how natural hazards impact communities throughout Rhode Island. Includes documenting frequency and intensity of past hazards and future probabilities. Assessment of hazard events to include vulnerability to climate change. Hazard-prone or environmentally sensitive lands will be made available to local communities to ensure integration with local risk assessments and mitigation activities.
2014.31	**Enhance coordination between Fed, State and local partners regarding evacuation routes, zones and planning.** Identify flood prone evacuation routes and simulated inundation surfaces for SLR. Develop viable mitigation actions to reduce the risk associated with flooding. Use the Rhode Island Simulated Inundation Surfaces tool to aid in the development of evacuation routes for tropical and extra-tropical storms. Pilot projects in North Kingstown and Newport to look at vulnerabilities to SLR flooding. The goal is for all coastal communities to look at SLR vulnerability for transportation and other critical infrastructure. This tool would determine what sections of evacuation routes will flood first, potentially cutting off the access. Develop evacuation protocol training and disseminate to local communities.

Several agencies are currently working on, or have plans to begin, initiatives that support hazard mitigation activities. These initiatives, shown in Table 4-12, should be reviewed during the SIHMC 2nd Quarter meeting(s) on Mitigation Strategy Progress & Research Initiatives. The meetings should include discussions about how information from these initiatives will be incorporated into this plan. update.

Table 4-12 Plans and studies in progress

Plan/Study Title	Agency/Agencies
URI Scituate Reservoir Study available January 2018	URI
Small Business Resilience Study 2018-2019	Rhode Island Division of Planning

Section 5: Local Hazard Mitigation Plan Coordination

44 Code of Federal Regulations (CFR) Requirement
Local Plan Integration §201.4(c)(4)(ii) **Requirement §201.4(c)(4)(ii):** [The section on the Coordination of Local Mitigation Planning must include a] description of the State process and timeframe by which the local plans will be reviewed, coordinated, and linked to the State Mitigation Plan.

The Rhode Island Emergency Management Agency (RIEMA) continually works to foster the development of the state and local hazard mitigation plans (HMPs). The development of these plans will ensure that hazard mitigation principles become incorporated into the routine activities and day-to-day decision-making of local governments, ultimately decreasing the current and future vulnerability of communities to all hazards. The initial phase of this initiative began following Hurricane Bob in 1991 with the award of Hazard Mitigation Grant Program (HMGP) funds. Under a partnership with the University of Rhode Island's Coastal Resources Center, a hazard mitigation program was conceived in addition to an outreach program to Rhode Island's communities with the objective of reducing losses from natural disasters.

Much of the work in hazard mitigation and sustainable development must be carried out at the local level. It is at the local level where land use decisions are made, growth and development take place, and where the impacts of natural hazards are most direct. RIEMA has always supported local self-sufficiency and reliance, providing assistance to communities where it is needed, but allowing local initiative to take the lead. As noted within this State Hazard Mitigation Plan (SHMP), a major goal of RIEMA is to build and support such local capacity and commitment to mitigation planning.

5.1 2019 Plan Update

As local HMPs are completed they are typically reviewed by RIEMA within 90 days of being submitted by local jurisdictions. In addition to the Federal Emergency Management Agency (FEMA) review tool, RIEMA will document local areas of hazard risks and vulnerability, mitigation actions, programs, policies and projects for inclusion in SHMP updates. As part of the 2019 Plan update, these results were collected and compiled into Appendix E.

Section 7 details the process in which local plans will be monitored and included in the SHMP update. As part of SHMP implementation, local plan status will be discussed during the State Interagency Hazard Mitigation Committee (SIHMC) 3rd Quarter meeting. At this Quarterly meeting, the SIHMC will discuss holding workshops with the local communities and stakeholders to solicit input to ensure that the local interests and issues have been accurately represented in the SHMP. SIHMC members will assist RIEMA in the organization and facilitation of the meetings. The SIHMC will identify tentative workshop locations and dates, as well as meeting leads at the 3rd Quarter meeting.

The information in this section has been reviewed and revised by the SIHMC, as well as the public during the period of plan review. Section 2 gives an overview of SIHMC and public review process. The SIHMC has approved the information presented in this section and feels it represents the information presented in the local HMPs.

5.2 Status of Local Hazard Mitigation Plans

The following provides information regarding the status of local HMPs that inform this SHMP.

5.2.1 Local Hazard Mitigation Plan Incorporation into 2019 SHMP

During the 2019 Plan update, the planning team reviewed 39 local jurisdictions to determine their HMP status and identify current information to integrate into the SHMP. Of the 39 total municipalities in the state, 27 municipalities have approved or approved-pending-adoption plans, 11 municipalities have an expired plan, and 1 locality has no plan. Approved, up to date plans were used where available to complete the analysis of local HMPs. Nine (9) draft plans were used in this assessment, and seven (7) of these plans were approved by FEMA as of September 2018. RIEMA is currently working with municipalities to update the local HMPs that have expired or do not have a plan in place.

The municipalities, their HMP status, and relevant data to inform the SHMP are identified in Appendix E. For Smithfield, a comprehensive plan was used to complete an analysis, since they did not have an HMP. Main categories of this review include:

- **Catalog of Local HMPs:** Municipality, plan date, FEMA approval date, expiration date, and relevant notes.
- **Hazard Identification:** Identifies the hazards discussed in plan, how the hazards were rated, their location in the HMP, and the location of loss estimation.
- **Capabilities:** Identifies the capability of the locality via programs, plans, and policies noted in the plan.
- **Development Trends:** Summarizes the areas within the community that are experiencing growth and development.
- **Goals:** Identifies the types of goals identified by the locality.
- **Mitigation Actions:** Summarizes the identified and completed actions in each of the municipalities.
- **Funding sources:** Identifies the types of funding that municipalities have utilized for completed projects and sources for their current actions.
- **Losses:** Provides the estimates for losses by hazard type.

5.2.2 Local Hazard Identification and Risk Assessment

As part of a program of improving the integration of local HMPs into the State's Plan, local Hazard Identification and Risk Assessment (HIRA) information has been incorporated into the 2019 Plan update.

Table 5-1 provides a statewide average summary of the hazards identified in local plans and prioritized by the state. It should be noted that this table is a combination of all the individual hazards identified in local HMPs and combined based on the state hazard identification naming convention. For example, several local plans made the distinction between ice storm and snow storm, while others categorized Winter Storm as including winter storm, severe winter storm, snow, ice, and ice storms. RIEMA is currently working with municipalities to standardize the hazard identification naming convention used in plan updates.

Table 5-1 Statewide summary range of local plan hazard ranking

Hazard	Rank Range
Storm Surge	High
Winter Storms	Medium-High
Flood and Heavy Rains	Medium-High
Nor'easter	Medium - High
Dam Failure	Medium
Hurricanes	Medium-High
Windstorm / Wind Related Events	Low - High
Earthquake / Geologic	Low - High
Wildfires / Conflagration	Low - High
Tornadoes	Low - High
Dam Failure	Low - High
Severe Thunderstorms	Low - High
Drought	Low - Medium
Extreme Temperature	Low - Medium

Some hazards that are not addressed in this SHMP may be addressed in local HMPs. For example, approximately half of the local plans addressed hail/hailstorms as a potential hazard, however most plans ranked this hazard as low, in the SHMP hail/hailstorms has been combined into the Thunderstorm profile.

Appendix E includes the hazards, prioritizations, and how they were rated, if applicable, in the local HMPs. The system used to rank the hazard is shown in the table, such as High, Medium, and Low. If the plan did not assign a rank but included the plan in the risk assessment, this is denoted with an "X" in the table.

All the prevalent hazards identified in the local HMPs are addressed in the SHMP, either using the same hazard terminology or using comparable hazard terminology. Some hazards identified in local HMPs are not directly addressed in the Plan update. Generally, these hazards appear in a small number of local HMPs. There are three (3) reasons why the 2019 SHMP update does not directly address mitigation for these hazards.

- These hazards may have profiles that lead to similar mitigation measures as hazards that are addressed directly by the SHMP;
- These hazards may be sufficiently addressed by another State or Federal agency or local entity; or
- These hazards may have been deemed by the SIHMC to not be among the most serious threats to the State.

5.3 Local Capability Assessment

44 CFR Requirement
Local Capability Assessment: §201.4(c)(3)(ii) **Requirement §201.4(c)(3)(ii):** [The State mitigation strategy shall include] a general description and analysis of the effectiveness of local mitigation policies, programs, and capabilities.

A local emergency management agency (EMA), headed by a director, exists in each city and town in the state. The emergency management director (EMD) is primarily responsible for local response and recovery, in addition to overseeing updates and implementation of the local hazard mitigation strategy. The powers and duties of these agencies within their respective jurisdictions are similar to those of RIEMA. Local agencies may act jointly with other such agencies. The chief executive officer of each city and town has powers and duties with respect to disaster preparedness within their city or town similar to those of the governor on the state level. During a local or state disaster, the head of the local government or the director of the local EMA activates their local emergency operation center (EOC), with direct communication link to the State EOC. Each Rhode Island municipality has an Evacuation Annex as part of its local emergency operations plan (EOP). The Evacuation Annex includes a map of coastal areas (if any) threatened by a hurricane storm surge and wave action flooding. The map shows areas to be evacuated, routes of travel, and shelters.

Local municipalities have primary authority over land use and development in Rhode Island. With regard to hazard mitigation, local government has the primary role in developing policy, making all land use decisions, establishing annual capital budgets, and implementing hazard mitigation and floodplain management activities. Appendix E includes an overview of the local departments and/or organizations that have a responsibility in overseeing and/or implementing the local hazard mitigation projects, programs, and policies within each community.

Each community has unique programs, policies, and organizations relating to hazard mitigation. The local HMPs have been reviewed for the 2019 SHMP update and Appendix E provides an overview of those capabilities identified in the local HMPs. As shown, many communities have a comprehensive plan, which can be utilized to implement hazard mitigation actions. In addition, every Rhode Island community participates in the National Flood Insurance Program (NFIP), which means that communities adopt and enforce ordinances that meet or exceed FEMA requirements to reduce the risk of flooding.

It should be noted that the capabilities shown in Appendix E are solely based on the information in the local HMPs and may not be a complete representation of all capabilities at the local level related to mitigation. RIEMA is currently working with communities undergoing updates to ensure local capabilities are captured. An example of the range of capabilities presented can be seen in the documentation of local, State, and International Building Codes, where all municipalities with a HMP including information on capabilities indicated building code standards within their jurisdiction.

Local plans list many response activities as capabilities. Appendix E includes a complete listing of the capabilities catalogued for each local HMP in Rhode Island.

5.3.1.1 Local Plan Mitigation Strategy

The results of the HIRA and capability assessment portions of the HMPs were used by local planning committees to formulate and determine mitigation goals and strategies that would address vulnerabilities faced by local communities in Rhode Island.

The analysis of the types of mitigation goals and activities provides a baseline assessment of local hazard mitigation priorities. It also demonstrates the recognition among local communities that an effective mitigation strategy is comprised of a wide array of activities and actions and provides areas of opportunity to strengthen local mitigation strategies.

All mitigation measures described in the local HMPs were reviewed and analyzed to identify trends and issues related to these proposed hazard mitigation measures. Dependent on future funding, RIEMA will provide the participating communities with technical assistance as needed for the identification and implementation of cost effective hazard mitigation measures.

During the review of local HMPs, it is apparent that certain plans areas are not consistent. For example, weather terminology and descriptions in plans vary significantly. To create consistent terminology and other descriptive issues within the local plans, RIEMA created a format and terminology of the SHMP to serve as an example for local HMPs to follow and utilize when updating their plan (see Appendix E for the Local Hazard Mitigation template).

Mitigation Goals

Mitigation goals in the local HMPs are focused on protecting people, property, and infrastructure. Five (5) main goal concepts have been summarized from the local plans:

1. Protect and reduce loss to present and future structures or property from all hazards (29 local plans).
2. Protect the public and reduce injury and protect lives from all hazards (25 local plans).
3. Protect critical infrastructure (includes dams, roads, utilities, and essential services) (24 local plans).
4. Provide public education and increase public understanding and support for hazard mitigation (15 local plans).
5. Protect cultural, historical, natural, and economical environments (23 local plans).

Mitigation Actions

A large majority of local plans include similar mitigation actions and categories of actions. The most popular mitigation actions are indicated below:

- Infrastructure improvements (bypass sewer main, bridges, water, and other utilities) (37 local plans).
- Provide public outreach/education/incentives (30 local plans).
- Acquire lands/repetitive loss structures in hazard prone areas of the community (26 local plans).
- Implement/continue tree trimming program (23 local plans).

- Building/code/zoning improvements or enforcement (20 local plans).
- Assess dams/address dam safety issues (18 local plans).

RIEMA and the SIHMC strongly believe that mitigation is most successfully achieved when implemented at the local level. As part of the SHMP update process, RIEMA conducted a survey of local communities, to determine what mitigation actions had been completed since the last SHMP update in 2014, and how those completed actions further the established goals of the SHMP and hazard mitigation programs. Appendix E provides information on those actions that have been implemented since 2014.

Appendix E also includes the jurisdictions that have not reported any completed actions since the 2014 SHMP. In many cases, the plans for these communities are in the process of being updated. It is likely that mitigation actions have in fact been implemented and relevant information will be included in the local plan updates and future updates of the SHMP.

Compliance with the NFIP

All of Rhode Island's 39 cities and towns and 1 Tribal nation participate and are compliant with the NFIP. The NFIP minimum building and construction criteria and floodplain ordinances are implemented through the local NFIP Coordinators. Each local planning board's responsibilities for NFIP enforcement are part of its larger duty to review and regulate the subdivision of land in the community.

The NFIP criteria pertaining to subdivisions require that they be reasonably safe from flooding and that subdivision developers furnish flood data for subdivision proposals above a certain size. Under the State Building Code and local zoning ordinances, applicants who are denied permits for floodplain development can generally apply to the Local Building or Zoning Appeals Board for variances to the floodplains management criteria. The Appeals Board may grant variances on a case-by-case basis provided they comply with the variance guidelines established by the NFIP. *The National Flood Insurance Program Handbook for Rhode Island Communities,* produced by the Office of State Planning, cautions:

> "In granting variances, however, the Appeals Boards must be aware that they are reducing the effectiveness of the NFIP's floodplain management requirements and likely exposing floodplain development to greater flood risks. Beyond the specific land use regulations required for participation in the NFIP, communities have broad discretion to guide development in a manner that will protect the health and safety of their residents and reduce the dangers of floods."

5.4 Local Hazard Mitigation Plan Funding and Assistance

44 CFR Requirement
Local Funding and Technical Assistance §201.4(c)(4)(i) **Requirement §201.4(c)(4)(i):** [The section on the Coordination of Local Mitigation Planning must include a] description of the State process to support, through funding and technical assistance, the development of local mitigation plans. **Prioritizing Local Assistance §201.4(c)(4)(iii)** **Requirement §201.4(c)(4)(iii):** [The section on the Coordination of Local Mitigation Planning must include] criteria for prioritizing communities and local jurisdictions that would receive planning and project grants under available funding programs, which should include consideration for communities with the highest risks, repetitive loss properties, and most intense development pressures. Further, that for non-planning grants, a principal criterion for prioritizing grants shall be the extent to which benefits are maximized according to a cost benefit review of proposed projects and their associated costs.

As part of Rhode Island's statewide planning strategy to meet the multiple hazard mitigation planning goal of the Disaster Mitigation Act of 2000, over 19 communities have received funding through the Pre-Disaster Mitigation Grant Program to complete local HMPs since 2010. Additionally, 14 communities have received funding from HMGP from past disasters:

- DR-4027 HMGP: 8 municipalities
- DR-4089 HMGP: 3 municipalities
- DR-4107 HMGP: 1 municipality
- DR-4212 HMGP: 2 municipalities

These plans identified specific local hazard mitigation strategies and specific mitigation measures, such as non-structural measures and projects that addressed natural hazard risks within their community.

Appendix E provides a detailed description of the process by which RIEMA prioritizes local assistance, project eligibility, technical assistance, and how local HMPs are tracked and monitored.

Section 6: State Hazard Mitigation Strategy

44 Code of Federal Regulations (CFR) Requirement
Mitigation Strategy **Requirement §201.4(c)(3):** [To be effective the plan must include a] Mitigation Strategy that provides the State's blueprint for reducing the losses identified in the risk assessment.

Rhode Island continues to aggressively implement a widely-recognized and comprehensive strategy that goes beyond that of solely reducing hazard vulnerability, but also incorporates complementary goals that can address multiple state and local needs. This is intended to lead to safer, more sustainable communities. This mitigation strategy directly addresses the prioritized hazards from the risk assessment.

Rather than focus on short-term solutions to inevitably long-term problems, the following mitigation strategy emphasizes the need to ensure communities become better able to withstand hazards while at the same time improving their residents' overall quality of life. By avoiding unnecessary exposure to known hazard risks, communities will save lives, reduce property damage and minimize the social, economic and environmental disruptions that follow hazard events. This State Hazard Mitigation Plan (SHMP) addresses the needs of current residents and also considers the needs of future generations. The focus on an integrated, future-oriented approach will result in communities that are less vulnerable and more sustainable. Therefore, the principles and spirit of community sustainability have been carefully and deliberately integrated throughout this SHMP.

6.1 2019 Plan Update

The Rhode Island SHMP's mitigation strategy has been modified since the 2014 Plan update. During the 2019 planning process, the State Interagency Hazard Mitigation Committee (SIHMC) convened twice in-person (September 5, 2018 and October 31, 2018). The Planning Process section of this plan further details these meetings. Prior to the September 5, 2018, the SIHMC determined that the 2014 Mitigation Strategy required some modifications to incorporate new progressive objectives and account for the addition of human-caused and technological hazards in the Hazard Identification and Risk Assessment (HIRA).

The 2019 SHMP update includes one new objective and 30 new actions that were developed as a blueprint for risk reduction, following strategic planning ideals. Concepts from the 2014 mitigation strategy were integrated into the update. For example, mitigation actions contained within the 2014 Plan were reviewed and duplicate actions were consolidated or deleted. Furthermore, ongoing actions were migrated directly to the 2019 Action Plan. The mitigation goals outline the overall desired outcomes, while the mitigation actions detail specific projects to be executed. Accomplishing the goals depends on successful implementation of supporting actions.

The following terms were utilized when developing the 2019 mitigation strategy:

Vision: Long-term view for the Rhode Island

Goal: The desired outcome that provides direction and purpose

Objective: Supports the achievement of a defined goal; should be Specific, Measurable, Achievable, Realistic, and Time-Oriented (SMART)

Action: Specific approaches or projects to achieve the objectives and attain the goals; includes identified responsible parties, timeframes, and potential funding sources

Section 6.5 includes the 2019 Mitigation Action Plan and Appendix F includes a full status update on the 2014 mitigation actions as provided by participating hazard mitigation committee members.

A number of different Rhode Island state agencies and offices have incorporated hazard mitigation objectives into their organizational missions. Descriptions of each agency's hazard mitigation-related functions, including their enabling legislation, and examples of the agency's current hazard mitigation measures can be found as individual agency profiles in Section 4.

The information in this section has been reviewed, revised and prioritized by the SIHMC. Ongoing mitigation actions were removed from the mitigation strategy and integrated within the capability assessment for the various agencies and programs. Rhode Island SIMHC members and subject-matter experts who provided additional data and information are listed in Appendix B along with their role in the plan update.

6.2 Local Hazard Mitigation Plan Integration

Section 5 discusses local hazard mitigation plan coordination. The full review of the local plan review can be found in Appendix E. Local plans were analyzed for their status and expiration date. Additionally, local capabilities were analyzed, indicating local abilities to implement mitigation actions discussed in the Local Hazard Mitigation Plan (LHMP). Mitigation goals and actions featured in LHMPs are analyzed and can be seen to coordinate with the motivations of the SHMP.

Much of the work in hazard mitigation and sustainable development must be carried out at the local level. At the local level is where land use decisions are made, growth and development take place, and the impacts of natural, adversarial, and human-caused hazards are most direct. The Rhode Island Emergency Management Agency (RIEMA) has always supported local sufficiency and reliance, providing assistance to communities where it is needed, but allowing local initiative to take the lead. As noted within this SHMP, a major goal of this plan is to support local capacity and commitment to hazard mitigation practices.

6.3 2019 Rhode Island Vision, Goals, and Objectives

44 CFR Requirement
Hazard Mitigation Goals: §201.4(c)(3)(i) **Requirement §201.4(c)(3)(i):** [The State mitigation strategy shall include a] description of State goals to guide the selection of activities to mitigate and reduce potential losses. **Requirement §201.4(d):** Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.

The State of Rhode Island's overall mitigation strategy is to minimize the loss of life, property, and cultural and environmental resources from disasters. Additionally, a component of the overall strategy is to focus on developing better programs to educate the public in issues related to hazard mitigation, as well as strengthening communication within RIEMA and with other state agencies, local officials, and other appropriate and potential partners in mitigation.

The following subsection details the 2019 Vision, Goals, and Objectives that reflect the State's commitment to enhancing resilience to disasters by minimizing potential impact to the state. The vision, goals, and objectives were agreed upon by the entire committee. Mitigation actions have been developed using the HIRA, the 2019 Vision, Goals, and Objectives, and input from SIHMC members. All of the mitigation actions in Section 6.5 support the vision for the state and multiple goals and objectives.

6.3.1 Vision Statement

Rhode Island is resilient to natural, technological, and human caused hazards and climate change.

6.3.2 Goals and Objectives

Goal 1: Rhode Island has the capacity to promote and implement projects, programs, plans, policies, and legislative actions to reduce vulnerability and repetitive loss to natural, technological, and human-caused hazards, under current and future conditions.

> *Objective 1.1:* Maintain and implement a SHMP that fosters innovation, advances public support, and gains long-term commitments to action from all stakeholders.
>
> *Objective 1.2:* Increase the capacity of and diversify representation on the SIHMC.
>
> *Objective 1.3:* Increase the capability of Rhode Islanders to address natural, technological, and human-caused hazards in their daily lives and work.

Goal 2: Statewide coordination of hazard mitigation with organizations, agencies, and stakeholders.

Objective 2.1: Leverage resources and expertise and capitalize on opportunities that will further hazard mitigation efforts.

Objective 2.2: Institutionalize hazard mitigation into the activities of all stakeholders.

Objective 2.3: Increase communications and streamline policies, procedures, and operations to eliminate conflicts and duplication of effort.

Goal 3: Local communities address natural, technological, and human-caused hazards and long-term risk reduction in local decision making and planning for current and future conditions.

Objective 3.1: Aid in the development and implementation of LHMPs.

Objective 3.2: Improve the quality of comprehensive plans in addressing natural, technological, and human-caused hazards.

Objective 3.3: Increase the capabilities of local decision makers in hazard mitigation.

Goal 4: The public understands, supports, and acknowledges the need for hazard mitigation.

Objective 4.1: Identify and implement opportunities to educate the public about hazard specific issues.

Objective 4.2: Engage the private sector in hazard mitigation initiatives.

Objective 4.3: Increase stakeholder, public sector, and private sector coordination.

Objective 4.4: Implement and maintain an extensive planning outreach strategy in order to gain feedback from all stakeholders and the public throughout the hazard mitigation planning process.

Goal 5: The built environment, infrastructure, people, natural environment, and economy are resilient to the impacts of natural, technological, and human-caused hazards under current and future conditions (including repetitive loss [RL] and severe repetitive loss [SRL]).

Objective 5.1: Implement measurable actions to reduce vulnerability, before and after disasters and during recovery.

Objective 5.2: Increase and measure losses avoided as a result of mitigation actions through regular monitoring and evaluation.

6.4 Development of 2019 Mitigation Action Plan

44 CFR Requirement
Mitigation Actions: §201.4(c)(3)(iii) **Requirement §201.4(c)(3)(iii):** [State plans shall include an] identification, evaluation, and prioritization of cost-effective, environmentally sound, and technically feasible mitigation actions and activities the State is considering and an explanation of how each activity contributes to the overall mitigation strategy. This section should be linked to local plans, where specific local actions and projects are identified. **Requirement §201.4(d):** Plan must be reviewed and revised to reflect changes in development, progress in statewide mitigation efforts, and changes in priorities.

As discussed in Section 2, the SIHMC members met in-person on September 5, 2018, to review and update the SHMP mitigation strategy. At this meeting, the SIHMC discussed revisions to the goals and objectives for the 2019 Plan, mitigation action development, prioritization criteria and options for action prioritization. In preparation for the September in-person meeting, the 2014 mitigation strategy was reviewed, and new mitigation actions were developed. The SIHMC members received a copy of the 2014 Mitigation Action Plan and were asked to provide a status update for all relevant actions (Section 6.5.2).

SIHMC members also coordinated via email to identify new mitigation actions to achieve the new 2019 mitigation goals and objectives. The committee used Mitigation Activity Worksheets to capture details and implementation approaches for each of the new actions. Another major resource for the 2019 SHMP mitigation strategy was "Resilient Rhody: An Actionable Vision for Addressing the Impacts of Climate Change in Rhode Island." The SIHMC decided to integrate actions from the "Resilient Rhody" strategy into this update of the SHMP. Actions suggested on the worksheets and from the Rhody strategy directly correlate to new actions in the 2019 Mitigation Action Plan.

The 2019 Mitigation Action Plan includes 56 actions; 22 actions from the 2014 plan were carried forward to develop this comprehensive strategy. The complete list of the 2019 actions is available in Table 6-3. The SIHMC will use the tracker in Appendix F to track their progress on mitigation actions at the quarterly SIHMC meetings. A complete review of the mitigation actions will take place as a committee at least twice a year.

6.4.1 Mitigation Action Prioritization

Mitigation actions were evaluated using the Social, Technical, Administrative, Political, Legal, Economic, and Environmental (STAPLEE) criterion suggested in the Federal Emergency Management Agency (FEMA)'s Hazard Mitigation Planning How-to-Guide Series (Table 6-1). The STAPLEE criteria addresses feasibility, cost-effectiveness, and environmental considerations, among other factors. An initial STAPLEE analysis was completed and sent to the SIHMC for review with the draft plan. The process for prioritization varied from both the 2014 and the 2011 Plan updates. During the 2014 Plan update process, the SIHMC completed a survey for the STAPLEE analysis of the

mitigation actions. For the 2011 Plan update, each action was scored based on RIEMA staffing levels, financial resources, cost-effectiveness, environmental soundness, technical feasibility, and timeline.

Table 6-1 STAPLEE Review and Selection Criteria

Category	Criteria
Social	• Is the proposed action socially acceptable to the community(s)? • Are there equity issues involved that would mean that one (1) segment of a community is treated unfairly? • Will the action cause social disruption?
Technical	• Will the proposed action work? • Will it create more problems than it solves? • Does it solve a problem or only a symptom? • Is it the most useful action in light of other community(s) goals?
Administrative	• Can the community(s) implement the action? • Is there someone to coordinate and lead the effort? • Is there sufficient funding, staff, and technical support available? • Are there ongoing administrative requirements that need to be met?
Political	• Is the action politically acceptable? • Is there public support both to implement and to maintain the project?
Legal	• Is the community(s) authorized to implement the proposed action? Is there a clear legal basis or precedent for this activity? • Are there legal side effects? Could the activity be construed as a taking? • Is the proposed action allowed by a comprehensive plan, or must a comprehensive plan be amended to allow the proposed action? • Will the community(s) be liable for action or lack of action? • Will the activity be challenged?
Environmental	• How will the action affect the environment? • Will the action need environmental regulatory approvals? • Will it meet local and state regulatory requirements? • Are endangered or threatened species likely to be affected?

Category	Criteria
Economic	• What are the costs and benefit of this action? • Do the benefits exceed the costs? • Are initial, maintenance, and administrative costs taken into account? • Has funding been secured for the proposed action? If not, what are the potential funding sources (public, non-profit, and private)? • How will this action affect the fiscal capability of the community(s)? • What burden will this action place on the tax base of local economy? • What are the budget and revenue effects of this activity? • Does the action contribute to other community goals, such as capital improvements or economic development? • What benefits will the action provide?

For the 2019 Plan update, each action was ranked as high, medium, or low, based on the results of the STAPLEE analysis. Table 6-2 summarizes the priority level of each hazard mitigation action. This is a subset of the available information for each action. Appendix F contains a complete description of the actions and the full prioritization.

Table 6-2 Mitigation Action Prioritization

Prioritization	Mitigation Action
High	2019-6: Stormwater and Floodplain Management Coordination 2019-7: Update the HEALTH/Drinking Water Quality Emergency Operations Plan 2019-15: Rhode Island Mitigation Resources and Technical Assistance 2019-19: Newport Climate Change Outreach for Vibrant Waterfront 2019-23: Urban Tree Inventory & Urban Forest Master Plan 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-31: Cyber Education 2019-35: Dam Remediation Prioritization 2019-36: Green Stormwater Infrastructure 2019-37: Stormwater infrastructure flood mitigation 2019-38: Repetitive Loss Property Mitigation 2019-39: Infrastructure, Safety, and Reliability (ISR) program for National Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Power Outage Reduction

Prioritization	Mitigation Action
Medium	2019-1: Threat and Hazard Identification and Risk Assessment (THIRA) & Hazard Mitigation Plan (HMP) Integration 2019-2: Flood modeling/mapping 2019-3: Partnerships with High Education 2019-4: State Interagency Hazard Mitigation Committee 2019-8: Small Public Water System Emergency Preparedness Planning 2019-9: Extreme Heat Action Plan 2019-10: Rhode Island Public Transit Authority (RIPTA) Continuity of Operations 2019-16: Emergency Planning for Patient Care Centers 2019-21: Comprehensive Planning Guidance Integration 2019-22: Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown 2019-25: State and Local Professional Development 2019-26: Facility-level impacts storm predictions 2019-29: Increase participation in National Flood Insurance Program (NFIP) and Community Rating System (CRS) 2019-30: Disaster Evacuation Route and Shelter Location Outreach 2019-33: Coordination Between Utilities and State Agencies 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-45: Evacuation Route Reassessment
Low	2019-5: Facilities database and vulnerability 2019-11: Expand Rhode Island Water/Wastewater Agency Response Network (RIWARN) membership 2019-12: Medical Emergency Distribution System (MEDS) full-scale exercise 2019-13: Local Water Supplier Emergency Interconnection Programs 2019-14: Develop a Petroleum Set-Aside Program 2019-17: Spillway Management and Coordination 2019-18: Agency and Municipality Data Consistency 2019-20: Technological and human-caused Vulnerability Database 2019-27: Resilient Coastal Communities 2019-28: Water Conservation 2019-32: Partnerships with Private and Non-Profits 2019-34: Hazard Mitigation Training 2019-46: Wildfire Fuels Management 2019-47: State-owned property retreat 2019-48: Beach Ecosystem Preservation 2019-49: Integrate climate resilience into the school construction process 2019-50: Coastal Wetland Habitat Preservation 2019-51: Establish dedicated funding sources for beach replenishment projects and/or property buyouts in high hazard areas 2019-52: Coastal Drinking Water Reservoir Assessment

6.5 Implementing Mitigation Actions

Shortsighted development patterns, along with a misunderstanding of how the natural environment functions to provide protection from threats and hazards, have contributed to community vulnerability to natural, adversarial, and human-caused hazards. The consideration and need to mitigate adversarial and technological threats has grown in recent years, and this 2019 Plan update considers these hazards for the first time. Implementing the precepts and practices of hazard mitigation can help ensure that such communities do not increase their vulnerability by continuing

inappropriate land use practices, and by encouraging the acquisition, relocation or retrofitting of existing vulnerable structures, along with the protection of valuable natural resources.

Through experience, communities can develop strategies to face the significant challenges that accompany post-disaster redevelopment and learn to balance the driving need for rapid recovery with implementing long-term hazard mitigation. In the immediate aftermath of a disaster, the necessity to meet basic needs and resettle displaced populations often overshadows the more abstract, longer-term sustainability considerations. Once full-scale reconstruction is initiated, it is difficult to modify projects in progress to meet sustainability objectives. This phenomenon highlights the need for pre-disaster mitigation planning that incorporates principles of sustainable development within the context of reconstruction. If a disaster should strike, this plan will guide communities to rebuild stronger than before, incorporating the tenets of hazard mitigation.

Much of the work in hazard mitigation and sustainable development must be carried out at the local level. As noted above, the local level is where land use decisions are made, growth and development take place, and the impacts of hazards are most direct. RIEMA aims to support local sufficiency and reliance while allowing local initiative to take the lead.

All of the mitigation activities listed in Table 6-3 have been deemed feasible with respect to their implementation or performance on a state or local level. Each of the actions can be implemented independently of other proposed activities. In addition, each activity will support the improvement of an increasingly effective and comprehensive plan. However, the implementation of any of the proposed activities listed is completely dependent upon availability of resources, both monetary and other (e.g., staff, technical, supplies). This dependence on available resources will be a significant factor regarding the implementation of activities and performance over the next five years.

A listing of potential funding sources for mitigation projects is included in Section 5. Additional details on the mitigation actions are included in Appendix F. Further feasibility analysis of individual activities will be performed prior to the implementation and performance of any activity. Similarly, the implementation of any proposed activity is contingent on confirmation that it satisfies the STAPLEE evaluation criteria at the time of the proposed performance or implementation. This ensures the activity still has the necessary social, technical, administrative, political, legal, economic, and environmental support required, even if conditions have changed since plan adoption.

Table 6-3 2019 Mitigation Action Plan

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-1	THIRA & HMP Integration	1	1.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA; SIHMC		Medium
2019-2	Flood modeling/mapping	1	1.1	Hazard Mitigation Grant Program (HMGP)/Pre-disaster Mitigation Program (PDM)/Flood Mitigation Assistance (FMA)	No	Medium-Term (6-24 months)	Rhode Island Department of Environmental Management (RIDEM); Executive Climate Change Coordinating Council (EC4)	University of Rhode Island (URI)	Medium
2019-3	Partnerships with High Education	1	1.2	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-4	State Interagency Hazard Mitigation Committee	1	1.2	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA; SIHMC		Medium
2019-5	Facilities database and vulnerability	1	1.3	Agency fiscal budget	No	Medium-Term (6-24 months)	Rhode Island Division of Public Utilities (DPU); RIEMA; SIHMC		Low
2019-6	Stormwater and Floodplain Management Coordination	2	2.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIDEM; Rhode Island Department of Transportation (RIDOT); RIEMA		High

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-7	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	2	2.1	Rhode Island Department of Health (RIDOH) Center for Drinking Water Quality (DWQ) Budget	No	Short-Term (0-6 months)	RIDOH		High
2019-8	Small Public Water System Emergency Preparedness Planning	2	2.1	RIDOH DWQ Budget	No	Medium-Term (6-24 months)	RIDOH		Medium
2019-9	Extreme Heat Action Plan	2	2.1	FEMA Hazard Mitigation Assistance (HMA) Grant	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-10	RIPTA Continuity of Operations	2	2.1	Agency fiscal budget	No	Medium-Term (6-24 months)	Rhode Island Public Transit Authority (RIPTA)	Rhode Island Infrastructure Bank (RIIB)	Medium
2019-11	Expand RIWARN membership	2	2.1	RIDOH DWQ Budget; FEMA HMA Grant	No	Medium-Term (6-24 months)	RIDOH		Low
2019-12	MEDS full-scale exercise	2	2.1	RIDOH MEDS Budget; FEMA HMA Grant; Emergency Management Performance Grant (EMPG)	No	Long-Term (>24 months)	RIDOH		Low

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-13	Local Water Supplier Emergency Interconnection Programs	2	2.1	Drinking water state revolving fund	No	Long-Term (>24 months)	RIDOH	Water suppliers, Water Resources Board (WRB)	Low
2019-14	Develop a Petroleum Set-Aside Program	2	2.1	Agency fiscal budget	No	Medium-Term (6-24 months)	Office of Energy Resources (OER)		Low
2019-15	Rhode Island Mitigation Resources and Technical Assistance	2	2.2	Agency fiscal budget	No	Short-Term (0-6 months)	DPU; National Grid; RIEMA; SIHMC		High
2019-16	Emergency Planning for Patient Care Centers	2	2.2	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA	American Red Cross, local Emergency Management Departments (EMDs)	Medium
2019-17	Spillway Management and Coordination	2	2.3	Drinking water state revolving fund	No	Short-Term (0-6 months)	RIDOH/WRB	WRB; URI; Rhode Island Public Utilities Commission (RIPUC); RIIB; Pawtucket Water Supply Board (PWSB)	Low

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-18	Agency and Municipality Data Consistency	2	2.3	Agency fiscal budget	No	Short-Term (0-6 months)	EC4	EC4, URI Environmental Data Center (EDC), Rhode Island Geographic Information System (RIGIS), Division of Information Technology (DOIT), Coastal Resources Management Council (CRMC), RIDOT, Statewide Planning	Low
2019-19	Newport Climate Change Outreach for Vibrant Waterfronts	3	3.1	Private Foundation	No	Short-Term (0-6 months)	URI Coastal Resources Center (CRC); City of Newport		High
2019-20	Technological and human-caused Vulnerability Database	1	1.3	Agency fiscal budget	No	Medium-Term (6-24 months)			Low
2019-21	Comprehensive Planning Guidance Integration	3	3.2	Agency fiscal budget	No	Short-Term (0-6 months)	Statewide Planning		Medium

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-22	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown	3	3.2	Statewide Planning Challenge Grant	No	Short-Term (0-6 months)	North Kingstown Planning Department; Statewide Planning; URI CRC		Medium
2019-23	Urban Tree Inventory & Urban Forest Master Plan	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDEM		High
2019-24	Municipal disaster preparedness and resilience building activities incentives	3	3.3	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA		High
2019-25	State and Local Professional Development	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-26	Facility-level impacts storm predictions	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-27	Resilient Coastal Communities	3	3.3	Private Foundation and National Oceanic and Atmospheric Association (NOAA) Sea Grant	No	Long-Term (>24 months)	URI CRC; RI Sea Grant		Low
2019-28	Water Conservation	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDOH		Low

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-29	Increase participation in the National Flood Insurance Program (NFIP) and the Community Rating System (CRS)	4	4.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-30	Disaster Evacuation Route and Shelter Location Outreach	4	4.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA	American Red Cross, local EMDs	Medium
2019-31	Cyber Education	4	4.2	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		High
2019-32	Partnerships with Private and Non-Profits	4	4.2	Agency fiscal budget	No	Long-Term (>24 months)	RIEMA		Low
2019-33	Coordination Between Utilities and State Agencies	4	4.3	Agency fiscal budget	No	Long-Term (>24 months)	DPU; National Grid; RIEMA		Medium
2019-34	Hazard Mitigation Training	4	4.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Low
2019-35	Dam Remediation Prioritization	5	5.1	PDM	No	Short-Term (0-6 months)	RIDEM	Newport; Bristol County Water Authority (BCWA); Barrington; Warren; Bristol; Save the Bay; Burrilville	High

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-36	Green Stormwater Infrastructure	5	5.1	PDM	No	Long-Term (>24 months)	RIDOT; RIDEM	RIIB, Middletown, Portsmouth, Aquidneck Island Planning Commission (AIPC), Farm Fresh RI, Pawtucket, NBC, Providence	High
2019-37	Stormwater infrastructure flood mitigation	5	5.1	PDM/ HMGP	No	Long-Term (>24 months)	RIDEM	Newport, Bristol, West Warwick, Office of Housing and Community Development (OHCD), CRMC, RIDOT, local DPWs, NBC, Central Falls, Providence, Bonne Shores Fire District and Beach Club, Warren	High
2019-38	Repetitive Loss Property Mitigation	5	5.1	Agency fiscal budget	Yes	Medium-Term (6-24 months)	RIEMA		High
2019-39	ISR program for National Grid Gas	5	5.1	Annual funding is generated by ratepayers as approved by the Commission.	Yes	Long-Term (>24 months)	DPU		High

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-40	Assessment of facility generator needs	5	5.1	Agency fiscal budget	Yes	Long-Term (>24 months)	DPU		High
2019-41	Acquire generators for drinking water systems	5	5.1	RIDOH DWQ Budget; FEMA HMA Grants	Yes	Medium-Term (6-24 months)	RIDOH		High
2019-42	Power Outage Reduction	5	5.1	Bonds	No	Long-Term (>24 months)	RIPUC		High
2019-43	Treatment System and Pumping Station Hardening Projects	5	5.1	PDM	No	Long-Term (>24 months)	RIDEM	Westerly; Smithfield; Newport; Narragansett; South Kingstown	Medium
2019-44	Fuel Terminal Hardening and Resilience Measures	5	5.1	PDM	No	Short-Term (0-6 months)	OER		Medium
2019-45	Evacuation Route Reassessment	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium
2019-46	Wildfire Fuels Management	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDEM		Low
2019-47	State-owned property retreat	5	5.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIDEM; CRMC	Westerly, Save the Bay, Warwick, Municipalities, Providence Parks, Warren	Low

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-48	Beach Ecosystem Preservation	5	5.1	HMGP/PDM/FMA	No	Ongoing	CRMC	Barrington, Save the Bay, University of New Hampshire (UNH) Stormwater Center, Westerly, Cranston, Edgewood Waterfront Protection Association, Providence, Newport	Low
2019-49	Integrate climate resilience into the school construction process.	5	5.1	Efficient Buildings Fund	No	Medium-Term (6-24 months)	RIIB	Rhode Island Department of Education (RIDE)	Low
2019-50	Coastal Wetland Habitat Preservation	5	5.1	Agency fiscal budget	No	Ongoing	CRMC; RIDEM	Save the Bay, URI Coastal Institute, Warwick, The Nature Conservancy (TNC), US Fish and Wildlife (US F&W), Bristol, Warren, EDC	Low

2019 Activity Number	Title	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority
2019-51	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas	5	5.1	Agency fiscal budget	No	Long-Term (>24 months)	CRMC; RI Sea Grant		Low
2019-52	Coastal Drinking Water Reservoir Assessment	5	5.2	Drinking water state revolving fund	No	Short-Term (0-6 months)	RIDOH; CRMC		Low

Table 6-4 shows a summary the types of hazards mitigated as an indication that the state has developed strategies to address each hazard profiled in this plan's risk assessment. Several actions can reduce losses for more than one hazard. Appendix F shows the complete analysis for each hazard per each mitigation action.

Table 6-4 Hazard Addressed per Mitigation Action Analysis Summary

Type of Hazard	Mitigation Action
Biological Incident	2019-11: Expand RIWARN membership 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-20: Technological and human-caused Vulnerability Database
Chemical Incident	2019-11: Expand RIWARN membership 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-20: Technological and human-caused Vulnerability Database
Civil Unrest	2019-14: Develop a Petroleum Set-Aside Program 2019-20: Technological and human-caused Vulnerability Database 2019-42: Power Outage Reduction
Cyber Security	2019-11: Expand RIWARN membership 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-14: Develop a Petroleum Set-Aside Program 2019-20: Technological and human-caused Vulnerability Database 2019-31: Cyber Education 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction
Dam Failure	2019-13: Local Water Supplies Emergency Interconnection Programs 2019-17: Spillway Management and Coordination 2019-20: Technological and human-caused Vulnerability Database 2019-35: Dam Remediation Prioritization 2019-41: Acquire generators for drinking water systems
Drought	2019-11: Expand RIWARN membership 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-28: Water Conservation 2019-42: Power Outage Reduction
Earthquake	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-41: Acquire generators for drinking water systems
Infectious Disease	2019-12: MEDS full-scale exercise
Extreme Cold	2019-11: Expand RIWARN membership 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction

Type of Hazard	Mitigation Action
Extreme Heat	2019-9: Extreme Heat Action Plan 2019-11: Expand RIWARN membership 2019-23: Urban Tree Inventory & Urban Forest Master Plan 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-28: Water Conservation 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction
Fire	2019-10: RIPTA Continuity of Operations 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-28: Water Conservation 2019-42: Power Outage Reduction 2019-46: Wildfire Fuels Management
Flood	2019-2: Flood modeling/mapping 2019-6: Stormwater and Floodplain Management Coordination 2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-17: Spillway Management and Coordination 2019-19: Newport Climate Change Outreach for Vibrant Waterfronts 2019-22: Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-27: Resilient Coastal Communities 2019-29: Increase participation in NFIP and CRS 2019-30: Disaster Evacuation Route and Shelter Location Outreach 2019-36: Green Stormwater Infrastructure 2019-37: Stormwater infrastructure flood mitigation 2019-38: Repetitive Loss Property Mitigation 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-45: Evacuation Route Reassessment 2019- 48: Beach Ecosystem Preservation 2019-49: Integrate climate resilience into the school construction process 2019-51: Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas

Type of Hazard	Mitigation Action
High Winds	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-49: Integrate climate resilience into the school construction process 2019-52: Coastal Drinking Water Reservoir Assessment
Tropical and Extratropical Storms	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-27: Resilient Coastal Communities 2019-29: Increase participation in NFIP and CRS 2019-30: Disaster Evacuation Route and Shelter Location Outreach 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-45: Evacuation Route Reassessment 2019-49: Integrate climate resilience into the school construction process 2019-50: Coastal Wetland Habitat Preservation 2019-51: Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas
Infrastructure Failure	2019-11: Expand RIWARN membership 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-14: Develop a Petroleum Set-Aside Program 2019-17: Spillway Management and Coordination 2019-20: Technological and human-caused Vulnerability Database 2019-36: Green Stormwater Infrastructure 2019-37: Stormwater infrastructure flood mitigation 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-52: Coastal Drinking Water Reservoir Assessment

Type of Hazard	Mitigation Action
Sea Level Rise	2019-6: Stormwater and Floodplain Management Coordination 2019-11: Expand RIWARN membership 2019-19: Newport Climate Change Outreach for Vibrant Waterfronts 2019-22: Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-27: Resilient Coastal Communities 2019-29: Increase participation in NFIP and CRS 2019-30: Disaster Evacuation Route and Shelter Location Outreach 2019-36: Green Stormwater Infrastructure 2019-37: Stormwater infrastructure flood mitigation 2019-38: Repetitive Loss Property Mitigation 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-45: Evacuation Route Reassessment 2019-47: State-owned property retreat 2019-48: Beach Ecosystem Preservation 2019-50: Coastal Wetland Habitat Preservation 2019-51: Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas 2019-52: Coastal Drinking Water Reservoir Assessment
Severe Winter Weather	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-49: Integrate climate resilience into the school construction process
Thunderstorms	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-49: Integrate climate resilience into the school construction process

Type of Hazard	Mitigation Action
Tornado	2019-10: RIPTA Continuity of Operations 2019-11: Expand RIWARN membership 2019-14: Develop a Petroleum Set-Aside Program 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-49: Integrate climate resilience into the school construction process
All Hazards	2019-1: THIRA & HMP Integration 2019-3: Partnerships with High Education 2019-4: State Interagency Hazard Mitigation Committee 2019-5: Facilities database and vulnerability 2019-7: Update the HEALTH/Drinking Water Quality Emergency Operations Plan 2019-8: Small Public Water System Emergency Preparedness Planning 2019-15: Rhode Island Mitigation Resources and Technical Assistance 2019-16: Emergency Planning for Patient Care Centers 2019-18: Agency and Municipality Data Consistency 2019-21: Comprehensive Planning Guidance Integration 2019-25: State and Local Professional Development 2019-32: Partnerships with Private and Non-Profits 2019-33: Coordination Between Utilities and State Agencies 2019-34: Hazard Mitigation Training

Table 6-5 shows a summary the types of mitigation actions as an indication that the state has developed strategies to address each type of mitigation action. Appendix F shows the complete analysis for each type of mitigation action per each mitigation action.

Table 6-5 Type of Mitigation Action Analysis Summary

Type of Hazard	Mitigation Action
Local Plans and Regulations	2019-7: Update the HEALTH/Drinking Water Quality Emergency Operations Plan 2019-8: Small Public Water System Emergency Preparedness Planning 2019-16: Emergency Planning for Patient Care Centers 2019-21: Comprehensive Planning Guidance Integration 2019-22: Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown 2019-23: Urban Tree Inventory & Urban Forest Master Plan 2019-28: Water Conservation

Type of Hazard	Mitigation Action
Structural Projects	2019-10: RIPTA Continuity of Operations 2019-35: Dam Remediation Prioritization 2019-37: Stormwater infrastructure flood mitigation 2019-41: Acquire generators for drinking water systems 2019-42: Power Outage Reduction 2019-43: Treatment System and Pumping Station Hardening Projects 2019-44: Fuel Terminal Hardening and Resilience Measures 2019-47: State-owned property retreat 2019-49: Integrate climate resilience into the school construction process
Natural Systems Protection	2019-36: Green Stormwater Infrastructure 2019-37: Stormwater infrastructure flood mitigation 2019-46: Wildfire Fuels Management 2019- 48: Beach Ecosystem Preservation
Education Programs	2019-25: State and Local Professional Development 2019-27: Resilient Coastal Communities 2019-29: Increase participation in NFIP and CRS 2019-31: Cyber Education
Preparedness and Response Actions	2019-1: THIRA & HMP Integration 2019-2: Flood modeling/mapping 2019-3: Partnerships with High Education 2019-4: State Interagency Hazard Mitigation Committee 2019-5: Facilities database and vulnerability 2019-6: Stormwater and Floodplain Management Coordination 2019-9: Extreme Heat Action Plan 2019-11: Expand RIWARN membership 2019-12: MEDS full-scale exercise 2019-13: Local Water Supplies Emergency Interconnection Programs 2019-14: Develop a Petroleum Set-Aside Program 2019-15: Rhode Island Mitigation Resources and Technical Assistance 2019-17: Spillway Management and Coordination 2019-18: Agency and Municipality Data Consistency 2019-19: Newport Climate Change Outreach for Vibrant Waterfronts 2019-20: Technological and human-caused Vulnerability Database 2019-24: Municipal disaster preparedness and resilience building activities incentives 2019-26: Facility-level impacts storm predictions 2019-27: Resilient Coastal Communities 2019-30: Disaster Evacuation Route and Shelter Location Outreach 2019-32: Partnerships with Private and Non-Profits 2019-33: Coordination Between Utilities and State Agencies 2019-34: Hazard Mitigation Training 2019-38: Repetitive Loss Property Mitigation 2019-39: ISR program for national Grid Gas 2019-40: Assessment of facility generator needs 2019-42: Power Outage Reduction 2019-45: Evacuation Route Reassessment 2019-50: Coastal Wetland Habitat Preservation 2019-51: Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas 2019-52: Coastal Drinking Water Reservoir Assessment

Climate change and adaptation techniques are an area of continued concern for which hazard mitigation strategies and activities must be linked. This will be accomplished through future coordination and plan integration across multiple state agencies, as deemed appropriate. This plan's mitigation strategy has incorporated several mitigation actions from "Resilient Rhody" that consider the future impacts of climate change in the State of Rhode Island.

6.5.2 Mitigation Action Progress (2014 -2019)

Mitigation actions from the 2014 SHMP were reviewed and an assessment of progress made in implementing each action has been completed. Several tables in Appendix F have been created based on the status of each item relative to this 2014 update of the plan. Progress has been tracked using the following definitions:

- **Completed** – indicates that the action was discrete and completed during the period from 2014 to 2019. These actions are not included in the 2019 Mitigation Strategy. As appropriate, actions have been integrated into Section 4.
- **Not Started and Ongoing** – includes actions that are to be continued in the plan update; the 2019 updated action number is provided.
- **Cancelled** – action has been removed from consideration due to lack of resources or not contributing to the 2019 Mitigation Strategy.
- **Ongoing** – indicates that progress was made in implementing this action and/or that the action represents an on-going continuing activity by RIEMA and/or other state agencies and partners in the implementation of the plan. Activities that are considered ongoing have been moved to Section 4. A listing of ongoing actions is shown in Appendix F and integrated into the Capabilities Assessment.

The 2014 Plan included 34 actions. As of September 2018, three of these actions were completed, eight were considered ongoing and have been added to capabilities for Rhode Island (see Section 4), and two were combined, so that 22 actions were rolled into the 2019 Mitigation Action Plan.

6.6 Repetitive and Severe Repetitive Loss Mitigation Strategies

44 CFR Requirement
Repetitive Loss Mitigation Strategy **Requirement §201.4(c)(3)(v):** A State may request the reduced cost share authorized under §79.4(c)(2) of this chapter for the FMA and SRL programs, if it has an approved State Mitigation Plan … that also identifies specific actions the State has taken to reduce the number of RL properties (which must include SRL properties), and specifies how the State intends to reduce the number of such RL properties. **Coordination with Repetitive Loss Jurisdictions** **Requirement §201.4(c)(3(v):** In addition, the plan must describe the strategy the State has to ensure that local jurisdictions with SRL properties take actions to reduce the number of these properties, including the development of local mitigation plans.

Mitigating the State's 440 RL and 10 SRL structures will require the combined efforts of agencies and organizations beyond the hazard mitigation program staff housed at RIEMA. Rhode Island's approach to targeting mitigation of RL and SRL properties is multi-tiered. Some activities must be coordinated and directed at the state level, while others require the support of the local governments that serve as HMA project sponsors. RIEMA will continue to seek assistance to implement this strategy through close cooperation with its public and private sector partners.

In acknowledgement of the importance of mitigating RL and SRL structures, the following mitigation actions will continue in the 2019 Mitigation Action Plan:

- Annually perform data synthesis and update of BureauNet databases in coordination with FEMA Region I; provide RL and SRL datasets to local governments for use in their RL and SRL targeting efforts.
- Initiate contact with each local government with listed SRL property through a letter and follow-up communication to promote HMA grant programs to mitigate listed SRL and RL properties.
- Encourage communities to notify each listed SRL property owner with a letter promoting mitigation at no cost to the property owner through HMA grant programs.
- Prioritize mitigation activities for HMA funds to RL and SRL properties for acquisition and demolition projects in targeted communities.

A number of mitigation projects targeting RL and SRL are currently underway and the State will continue to advocate to target these types of properties moving forward. RIEMA staff will continue to manage the datasets with the tools created for the 2014 Plan update in the following manner:

- Maintain access to the BureauNet NFIP database of RL and SRL properties.
- Align RL property data and SRL property data with validated FEMA NFIP RL and SRL property data, annually.
- Use Greatest Savings to the Fund data and amplified Benefit Cost Analysis (BCA) module environmental benefits to inventory to further demonstrate the cost effectiveness of mitigation projects.
- Review potential acquisition projects to determine if new BCA module accelerated environmental benefits will enable these structures to be eligible for HMA grants.
- Continue to complete FEMA Form AW-501 for each mitigated property and provide it to FEMA through the current FEMA database or submittal to Region I upon project close-out.
- Ensure that the latitude and longitude of each property is gathered during project close-out as well as during the sponsoring community's three-year mitigation compliance inspection for completed properties.

Creating a competitive FEMA HMA grant application can be challenging for local officials. Local government-to-local government mentoring can be highly effective; RIEMA and FEMA will help to facilitate this process and match experienced grant participants with those that have not participated in HMA programs. In addition to mentoring local governments, the data analysis performed for the

Risk Assessment in the 2019 SHMP update will be provided to localities to assist in targeting future mitigation opportunities. This will be done by:

- Providing State direction that each jurisdictional plan must include the targeting and mitigation of RL and SRL structures in the mitigation strategies section of every local §322 plan with RL and SRL properties.
- Examining the FEMA RL and SRL data sets to seek candidate properties that could potentially be mitigated through the FEMA HMA funding programs or any other available funding sources on an annual basis, or more frequently as required by disaster experience or available staffing resources. Include targeting of RL and SRL structures for mitigation in the mitigation strategies section of every §322 plan with RL and SRL properties.
- Developing and conducting education efforts that increase residential and business owners' knowledge and awareness of mitigation grants by conducting various outreach activities, especially to SRL property owners.
- After the distribution of a RL and SRL letter, RIEMA staff will meet with municipalities if requested for follow up.

For the purposes of this plan, "mitigation of high-hazard structures" is an alteration of a flood prone property or its immediate surroundings (such as a minor drainage project) that reduces or eliminates the risk from flooding. FEMA's HMA grant programs – HMGP, PDM and FMA – continue a focus on mitigating RL and SRL buildings, as do some U.S. Department of Housing and Urban Development (HUD) Community Development Block Grant – Disaster Recovery (CDBG-DR) grants and other state, local, and privately funded efforts. RIEMA will use all available programs to fund projects that mitigation RL and SRL properties.

6.7 Monitoring the Mitigation Strategy

44 CFR Requirement
Monitoring Progress of Mitigation Activities **Requirement §201.4(c)(5)(ii):** [The Standard State Plan Maintenance Process must include a] system for monitoring implementation of mitigation measures and project closeouts. Requirement §201.4(c)(5)(iii): [The Standard State Plan Maintenance Process must include a] system for reviewing progress on achieving goals as well as activities and projects in the Mitigation Strategy.

The RIEMA mitigation staff, with assistance from the SIHMC during the second and fourth quarterly meetings, will maintain a Mitigation Strategy spreadsheet that has been developed in accordance with this plan. The major tasks that are anticipated during the five-year cycle following plan approval will include:

- Continued development of protocol for local data input;
- Inclusion of local §322 plan databases from local HIRAs, capability assessments, and local priority mitigation strategies;
- Expansion of state hazard historical data;
- Refinement of facility inventories; and,

- Continued expansion of databases to target critical facilities to enhance Continuity of Operations Plans (COOPs) and human-caused vulnerability assessment.

RIEMA has developed, in cooperation with FEMA and local mitigation planners, a local hazard mitigation plan template that includes standardized terms and methodology. The template can be accessed through RIEMA's website. As local plans are updated, their HIRA information will be uploaded into the local plan tracker tool at the time the local plan is reviewed so that local vulnerability as characterized in local plans is continually updated. This iterative process of updating the local plan data base to reflect annual accomplishment of mitigation actions and plan update HIRA data will facilitate a much easier local plan upload process for the next update of the SHMP.

6.7.1 Progress of Goals and Mitigation Actions/Projects since 2014

The 2019 Rhode Island SMHP update provides guidance for hazard mitigation within Rhode Island. Its vision is supported by five goals, 15 supporting objectives and 56 targeted mitigation actions that will reduce or prevent injury from natural, adversarial, and technological hazards to citizens, reduce damage to property, and maintain operation of critical state and local facilities. Rhode Island's state agencies, colleges and universities, federal agency cooperators and related non-governmental organizations contributed these actions to create a well-rounded mitigation strategy.

As SHMPs must be revised five years after FEMA approval, Rhode Island agencies that initiated an action were asked to report on the progress and accomplishments of each action during the summer of 2018. They were also asked to evaluate the relevance of goals, objectives, and action that were not accomplished due to inadequate funding or other barriers.

As previously described, many of the actions that were identified in previous versions of the Rhode Island plan were completed. However, due to funding constraints, additional actions have not yet been initiated or completed. The 2019 mitigation strategies were informed by the vastly improved vulnerability analysis and renewed priorities of the state. The continued relevance of current goals, objectives, and actions will be evaluated during the development of the next plan revision. Agencies will continue to integrate mitigation activities with their planning efforts.

Detailed descriptions of project closeout, program closeout, and reporting are included in Appendix F.

Section 7: Plan Maintenance

7.1 Method for Monitoring, Evaluating, and Updating the Plan

The State Hazard Mitigation Plan (SHMP) is a living document which will be reviewed, updated and adopted by State officials and submitted to the Federal Emergency Management Agency (FEMA) for approval every five years. The plan will be revised more frequently as local plans are completed and if conditions under which the plan was developed change, such as a major disaster or a new or revised State policy. Also, many state planning documents were being revised or written during the time that this plan was being updated. The information in these planning documents will be reviewed and incorporated into the next plan update as necessary.

This section describes the process through which this plan will be monitored, evaluated, and updated. Federal hazard mitigation planning regulations (44 CFR 201.4) require the State plan to be reviewed, revised and submitted for approval to the Regional Administrator of FEMA every five years. The regulations require a plan maintenance process that includes:

- An established method and schedule for monitoring, evaluating and updating the plan;
- A system for monitoring implementation of mitigation measures and project closeouts; and
- A system for reviewing progress on achieving goals as well as activities and projects identified in the Mitigation Strategy.

7.1.1 Plan Monitoring

The plan will be monitored by the Rhode Island Emergency Management Agency (RIEMA). At a minimum, the plan is reviewed annually and after each disaster. Each time the State Interagency Hazard Mitigation Committee (SIHMC) convenes, the team will review progress toward mitigation goals and completion of mitigation activities. The project status is reported on and any new project ideas are discussed. Each agency maintains its own list of projects completed, and the details of these projects (completed mitigation goals, for example) are added to the plan during the state plan update process. As part of the monitoring process, RIEMA and/or the team will:

- Review hazard mitigation projects and initiatives to ensure that there are no potential conflicts with ongoing agency initiatives;
- Review hazard mitigation projects and initiatives to ensure that they complement the statewide mitigation strategy; and
- Review existing state/federal programs to ensure that the state takes full advantage of possible funding sources in implementing the state hazard mitigation program.

7.1.2 2019 Plan Update

The SIHMC, first convened in 2005, mainly included representatives from state and federal agencies. The committee was expanded for the 2019 Plan update to include additional state and federal agencies as well as public and private utilities and nongovernmental agencies, such as the climate change subgroup that was established in September 2013.

The 2019 Plan update presents a new and obtainable plan maintenance process that actively engages the SIHMC and local stakeholders. A well-defined schedule and process provides the foundation for successful mitigation practices and the 2024 SHMP update.

7.1.3 2014 Plan Evaluation

Prior to initiation of the plan update process, little evaluation of the plan was conducted and no SIHMC meetings were held on a scheduled basis. Although the 2014 Plan identified a schedule for plan maintenance, monitoring and updating, it lacked a process for regular evaluation, particularly criteria for measuring progress and success and for identifying corrective measures for filling gaps in plan implementation success. The SIHMC agreed that resources were limited during the last plan update and its implementation and made adjustments for that gap by applying for a grant and hiring professional consulting assistance for the update. The 2019 Plan update outlines a specific schedule and evaluation criteria that will assist in making this a living document for Rhode Island.

7.1.4 Plan Updates

As disasters occur, projects are completed, and hazard information is improved, the Rhode Island Hazard Mitigation Plan will need to be updated. The plan will be updated and re-submitted to FEMA for re-approval every five years, as required by law. Updates will be based on the latest available FEMA guidance and incorporate new technologies and methods so that the plan is kept current and relevant. The mitigation action plan is updated annually and/or post-disaster, while all other sections of the plan are updated every five years.

The plan may also be subject to interim updates if any of the following conditions apply:

1. At the request of the Governor;
2. When significant new risks or vulnerabilities are identified; or
3. If the findings of the annual / post-disaster review and evaluation warrant.

7.1.5 Parties Responsible for Plan Monitoring and Maintenance

RIEMA is responsible for developing and maintaining the SHMP. Additional participants in the plan maintenance process include representatives of local jurisdictions whose hazard mitigation plans were used in the development of the multi-jurisdictional plans, or who developed a “stand alone” local plan and representatives from the SIHMC.

The SIHMC will facilitate the review and revision of the SHMP every five years. The review and revision will be an ongoing process. This process will incorporate all of the revisions made during the annual plan review, especially new data obtained from the local hazard mitigation plans. As these plans are completed, new information relative to hazards and threats will be incorporated into the formal five-year update.

Rhode Island will seek to expand participation in the mitigation planning process through expansion of the committee to represent municipal planners, other State agencies and nongovernmental organizations (see Section 6). This expansion will focus on implementation of this plan update as well as to inform the next plan update.

The SIHMC will meet quarterly to share information and to review implementation of the mitigation actions identified in this plan.

7.1.6 Plan Implementation, Monitoring, Evaluating, and Updating

The SHMP was significantly expanded and enhanced to support development of the plan in consideration of the changes in disaster related activity throughout the state, local mitigation plan development and statewide capabilities. The RIEMA mitigation program staff and SIHMC, in consultation with key state agencies, federal partners and organizations will direct implementation of the plan. RIEMA serves as the lead coordinating agency for emergency management in Rhode Island, including plan maintenance. The RIEMA will track projects identified this SHMP and local plans through the mitigation trackers developed for the 2014 Plan update.

7.1.7 Plan Monitoring Procedures, Schedule, and Evaluation for 2019 – 2024

The planning process timeline will be revised continually in the coming years to ensure that the 2024 plan revision can be prepared and submitted to FEMA within the required five-year time period. Special attention will continue to be focused on ensuring that businesses and special interest groups are included and have an input into the plan revision.

Plan updates will continue to emphasize the expanded vulnerability assessment of the database of local and state facilities and the redevelopment of strategies for the intended purpose of continued proactive assistance to the most vulnerable citizens and assets of Rhode Island. State or federal legislative, regulatory or rule changes or additions that occur during the period following approval of the 2019 Plan will be integrated into the 2024 update. Should a specific plan element or section require revision or amendment prior to the subsequent plan revision due to State or Federal legislation or policy change, RIEMA staff will meet with all appropriate stakeholders and propose the change or addendum to FEMA as quickly as is practicable.

The monitoring, maintenance, and implementation approach outlined above will be conducted in accordance with the schedule in Table 7-1. The quarterly schedule will allow the RIEMA and SIHMC time to collect data from ongoing research and local hazard mitigation plans, review information, and include relevant information as necessary.

The plan maintenance schedule will act as the framework to ensure progress towards completing mitigation actions as well as to ensure that the 2024 Plan revision can be prepared and submitted to FEMA within the established time period. Funding sources for the update process will be investigated and secured six months prior to the schedule start of the process to allow for ample data collection and interagency coordination. As highlighted above and in the table, the SIHMC will meet quarterly to discuss plan implementation, changes in the plan, and progress on strategies and projects. The SIHMC meeting will also be used as a forum to discuss changes to the update process, committee members, what works well, what should be changed, and to assess the system used to evaluate the plan.

7.1.7.1 Quarterly Progress Meetings

The subsections below provide additional information on the plan monitoring procedures. The purpose of the quarterly progress meetings is to reconvene the SIHMC and to discuss status of proposed projects, current studies or conditions that may affect hazard mitigation planning and implementation in Rhode Island without overwhelming the members of the committee and allowing ample time for members to reach out to their agencies and organizations for information and feedback.

Attention will continue to be focused on ensuring that businesses and special interest groups are included and have an input into the plan revision. This will include inviting the Blackstone River Watershed Council, Partners of the Kickemuit River Council, Narragansett Bay Watershed Council to participate in the planning process and plan updates. RIEMA will also reach out to and coordinate with neighboring states to ensure integration and collaboration on mitigation related projects and programs impacting the shared geographic area. Should a specific plan element or section require revision or amendment prior to the subsequent plan revision due to state or federal legislation or policy change, RIEMA staff will meet with all appropriate stakeholders and propose the change or addendum to FEMA as quickly as is practicable.

RIEMA will be the main point of contact for the quarterly meetings and will maintain attendance, meeting minutes, and will update the mitigation tracker and local plan tools to truly make this a living document. Evaluation criteria have been summarized in Table 7-1. The SIHMC will use the State Hazard Mitigation cross-walk as the main evaluation tool to update the plan and guide the quarterly meetings. The plan maintenance cycle is displayed in the figure below.

Figure 7-1 Plan Maintenance Schedule

1st Quarter Meeting: Annual Progress Evaluation

The first quarter meeting will be used to set the stage for the remaining quarterly meetings for the year, review overall progress and chances to the plan and establish agenda items for the second, third, and fourth quarter meetings. This meeting will also be used to refine the Planning Process and timeline for upcoming year and 2024 Plan update.

The SHMP will be reviewed annually to reflect significant policy changes that took place during the preceding year and to report on the progress made on funded and implemented hazard mitigation projects statewide. The first quarterly meeting will be used to discuss FEMA cross-walk comments from the 2019 Plan, and how/if the comments should be addressed throughout the year and in the 2024 SHMP update.

Overall implementation will be monitored to identify any problems or obstacles (financial, technical, political and legal), and develop recommendations to overcome them. In addition, the SIHMC roster will be reviewed the council will identify additional people who should be included in the SIHMC and recommend ways to increase participation by State agencies and local jurisdictions in the hazard mitigation planning process.

2nd Quarter Meeting: Mitigation Strategy and Research Initiatives

The purpose of the Mitigation Strategy and Research Initiatives meeting is to gauge the progress of mitigation activities and evaluate any changed conditions or priorities that may affect hazard mitigation planning and implementation in Rhode Island. A status of each of the mitigation actions will be presented, discussed, and documented in the Mitigation Action Tracker tool (Appendix 6).

The second portion of this meeting will be focused on discussing current research and program/policy initiatives that should be included, or updated, in the SHMP. The policies, programs, and plans in the Capability Assessment (Section 4) will be used to launch discussion. The tables at the end of Section 4 will be updated and maintained in an effort not to lose sight of initiatives discussed.

3rd Quarter Meeting: Vulnerability Assessment Updates

The Vulnerability Assessment meeting will review the Risk Assessment (Section 3) and will discuss hazards and analysis that should be updated or revised. The information obtained during the second quarterly meeting will assist and help to focus the areas that should be discussed. Facilities data will need to be a priority.

The SIHMC will decide how this review will be handled. Council members may want to tackle only specific hazards. It will be important to engage subject-matter experts in this meeting.

4th Quarter Meeting: Mitigation Strategy, Capabilities, and Local Plan Status

The main focus of the fourth quarter meeting will be to review the mitigation strategies (full discussion during the third quarter meeting) and refine or develop additional actions that reflect the Vulnerability Assessment (third quarter meeting) findings.

Each represented stakeholder will use this time to comment on the agency profiles. SIHMC will recommend any necessary revisions to reflect changes in federal and State policies, priorities, programs and funding, and incorporating new information following major disaster events. As plan

reviews are completed, RIEMA will populate the Local Plan tracker. During this meeting, a summary of the local plans hazards, capabilities, and actions these plans will be presented.

SIHMC will be involved with the monitoring of effectiveness of funded, local mitigation projects. The 4th quarter meeting may include multiple agenda items depending on how many local plans have been approved during the previous year.

Post Disaster Review

After each Presidential disaster declaration and in coordination with FEMA, the SIHMC will assist in documenting the effects of the disaster. Meetings will be scheduled by RIEMA to share disaster related data and to determine the areas in need of mitigation to reduce future risk. This will allow for the development of hazard mitigation recommendations to FEMA during the disaster operation as well as to update the Mitigation Strategy as needed. The post-disaster review may coincide with the already established SIHMC quarterly meetings and the agenda items can be altered to reflect recent events.

This has been successful practice in the past. Following the March 2010 floods (DR-1894), the SIHMC was convened, and a workshop planning team was created to identify the direct actions and preparatory actions the State of Rhode Island and the 39 municipalities within the five declared counties (Kent, Washington, Providence, Newport and Bristol) took to mitigate and respond to the effects of the March flooding. Topics discussed included:

- Planning
- Communications
- Emergency Operations Center Management
- Critical Resource Distribution
- Volunteer and Donations Management
- Environmental Health
- Citizen Evacuation
- Urban Search and Rescue
- Mass Care
- Restoration of Lifelines
- Economic and Community Recovery

Some of the major strengths identified during the Workshop included the coordination and cooperation among federal, state and local agencies, the use of internet and media outlets to provide information, and the State's expedited process to declare a State of Emergency. As a result of the State's capabilities, the federal disaster declaration was quickly received, and FEMA was able to coordinate the response in a timely manner. A number of primary areas for improvement were also identified including increasing statewide training in Incident Command System (ICS), National Incident Management System (NIMS), National Response Framework (NRF), and WebEOC will aid the State in preparing for future incidents.

7.1.1.2 Plan Maintenance Tools

The tables on the following page outline the schedule for plan maintenance and revision for the 2024 Plan update, as well as a task list for plan updates.

Table 7-1 Schedule for Plan Maintenance and Revision (January 2020 - October 2023)

Quarterly Meeting	Task	Evaluation Criteria	Responsibility	Timeframe
1: Annual Progress Evaluation	• Refine planning process and timeline for upcoming year and 2024 Plan update. • Assess SIHMC members and involvement and discuss expanding and increase participation. • Review entire SHMP: identify problems/obstacles (financial, technical, political, and legal) and develop recommendations. • Review current regulatory requirements for plan revision. • Review progress from FEMA on 2019 SHMP comments.	• Review Code of Federal Regulations (CFR) and State Crosswalk. • Email SIHMC list and expand based on agency feedback. • Review 2019 SHMP FEMA crosswalk.	SIHMC (RIEMA lead)	January 2020 January 2021 January 2022 January 2023
2: Mitigation Strategy and Research Initiatives	• Evaluate progress on strategies and projects. • Review 2019 mitigation goals, actions and objectives and update as appropriate. • Discuss research initiatives or special project group findings. • Progress from FEMA on 2024 SHMP Approval.	• Distribute mitigation actions and progress tracking Excel spreadsheet to SIHMC a week prior to 2nd quarterly meeting. • Report on progress of high mitigation actions and obstacles preventing projects from starting. • Evaluate effectiveness against current goals and objectives. Does the goal help achieve the purpose of the plan?	• RIEMA Mitigation Staff • Project sponsors • SIMHC	April 2020 April 2021 April 2022 April 2023

Quarterly Meeting	Task	Evaluation Criteria	Responsibility	Timeframe
3: Vulnerability Assessment Update	• Initiate review and revision of HIRA and Vulnerability Analysis. • Update facilities information. • Use available tools and resources to apply vulnerability analysis to manmade hazard mitigation where cross-program relationships exist. • Draft Review (July 2023).	• Evaluate facilities included in 2014 analysis. • Review hazard data and analysis completed. Is the analysis representative of current risk? • Consider impacts and losses reduced through mitigation. • Review local risk assessments. Have local plans been completed? • Evaluate changes in development. Have there been significant population changes, planned development, new building codes?	• RIEMA Mitigation Staff	July 2020 July 2021 July 2022 July 2023
4: Mitigation Strategy, Capabilities, and Local Plan Status	• Evaluate progress on strategies and projects. • Evaluate Agency Profiles for Capabilities Assessment. • Review Local Plan Updates. • Review and expand, based on HIRA, mitigation actions. • Submit new Revised All-Hazard Mitigation Plan to FEMA (October 2023).	• Review current vision, goals and objectives. Are goals consistent with risk assessment findings? • Have modifications been made to the system to track the initiation, status and completion of actions? • Report on actions and changes to funding. • Review assigned responsibility for monitoring and evaluating actions and project closeout. • Have Rhode Island pre and post disaster policies, programs, and regulations changed? • SIHMC review each agency profile • Have local jurisdiction funding programs changed?	• RIEMA Mitigation Staff • Project sponsors • SIMHC • State Emergency Coordinator • RIEMA Mitigation Staff	October 2020 October 2021 October 2022 October 2023
Post-Disaster	• Review of SHMP to address areas where the plan should be refocused due to the impact of the disaster(s).	• Evaluate mitigation actions and strategy to reassess vulnerability and priorities.	• SIHMC	As needed

Table 7-2 Plan Update Task List

Step/Task
1. Begin tracking communications associated with the plan update.
2. Review existing plan and completed crosswalks and identify needed updates.
3. Identify who will be responsible for updating the plan (i.e. agency personnel, contractors, etc.) and the timeframe for completing the update.
4. Secure any necessary funding sources.
5. If necessary, develop a request for hazard mitigation project proposals, evaluate proposals, and award contract(s).
6. Begin tracking significant plan changes.
7. Evaluate and update the planning process.
8. Review the stakeholder contact list, make necessary changes, and identify new stakeholders.
9. Initiate plan outreach and discussion, including a stakeholder meeting.
10. Consider the addition, removal, or modification of hazards identified in the plan.
11. Update and revise membership of the mitigation planning committees.
12. Evaluate risk assessment methodologies and data sources.
13. Evaluate and update state inventory information.
14. Evaluate and update the hazard profiles, including interaction with the mitigation planning committees.
15. Evaluate and update the risk assessment summary.
16. Evaluate and update the mitigation strategy, including interaction with the mitigation planning committees.
17. Evaluate and update the mitigation implementation system, including interaction with relevant state agencies.
18. Evaluate and update the plan maintenance.
19. Develop the necessary annual mitigation reports.
20. Integrate new and updated local and tribal mitigation plans.
21. Integrate new and updated related state plans.
22. Evaluate and update other plans sections (i.e. table of contents, adoption documentation, introduction, appendices, etc.).
23. Identify and add any additional sections or information needed.
24. Review updated plan in its entirety.
25. Conduct updated plan outreach, including public information, comment period, and stakeholder meeting.
26. Integrate additional comments received.
27. Finalize plan document.
28. Complete crosswalk and submit final plan to FEMA for review and approval.
29. If necessary, make additional modifications as required.
30. Obtain signed letter from the Governor adopting the plan.

Appendix A: Acronyms and Terminology

A.1 Acronyms

Table A-1 Acronyms

Acronym	Definition
ACAMS	Automated Critical Asset Management System
ACS	American Community Survey
AED	Automated External Defibrillator
AELR	Annualized Earthquake Loss Ratio
AFG	Assistance to Firefighters Grants
APA	Approved Pending Adoption
APTs	Advanced Persistent Threats
ARC	American Red Cross
ASCE	American Society of Civil Engineers
ASFPM	Association of State Floodplain Managers
ATSDR	Agency for Toxic Substances and Disease Registry
BFE	Base Flood Elevation
BMP	Best Management Practices
BW-12	Biggert-Waters Flood Insurance Reform Act Of 2012
CCP	Comprehensive Planning Program
CCTAs	Complex Coordinated Attacks
CDBG	Community Development Block Grant
CDBG-DR	Community Development Block Grant - Disaster Recovery
CDC	Centers for Disease Control and Prevention
CEM	Certified Emergency Manager
CEPR	Center for Emergency Preparedness and Response
CERI	Coastal Environmental Risk Index
CERT	Community Emergency Response Team
CFFA	Cooperative Forestry Assistance Act
CFM	Certified Floodplain Manager

Acronym	Definition
CFP	Cooperative Fire Protection
CFR	Code of Federal Regulations
CHEMTREC	Chemical Transportation Emergency Center
CIP	Capital Improvement Program
CMI	Crop Moisture Index
CO	Carbon Monoxide
COOP	Continuity of Operations Plan
C-PACE	Commercial Property Assessed Clean Energy
CPD	Office of Community Planning and Development
CRC	University Of Rhode Island Coastal Resources Center
CRMC	Coastal Resources Management Council
CRS	Community Rating System
CSO	Combined Sewer Overflow
CSSLP	Community Septic System Loan Program
DDoS	Distributed Denial of Service
DEM	Digital Elevation Model
DHS	Department of Homeland Security
DHTF	Disaster Housing Task Force
DHTK	Disaster Housing Task Force
DMA	Disaster Mitigation Act
DMAT/MRC	Disaster Medical Assistance Team/Medical Reserve Corps
DOS	Department of State
DPS	Department of Public Safety
DPUC	Rhode Island Division of Public Utilities Commission
DR	Disaster Recovery
DWQ	Drinking Water Quality
EAP	Emergency Action Plan
EC4	Executive Climate Change Coordinating Council
EDC	Environmental Data Center
EMA	Emergency Management Agency

Acronym	Definition
EMAP	Emergency Management Accreditation Program
EMD	Emergency Management Director
EMPG	Emergency Management Performance Grant
EMS	Emergency Medical Services
EOC	Emergency Operation Centers
EOP	Emergency Operation Plan
EPA	United States Environmental Protection Agency
ERG	Emergency Response Guidebooks
ERP	Emergency Response Plan
ESF	Emergency Support Function(S)
EWG	Environmental Working Group
EWP	Emergency Watershed Protection Program
FBI	Federal Bureau of Investigation
FEMA	Federal Emergency Management Agency
FHA	Federal Highway Act
FHWA	Federal Highway Administration
FIM	Flood Inundation Mapping
FIRM	Flood Insurance Rate Map
FIS	Flood Insurance Study
FMA	Flood Mitigation Assistance Grant Program
FP&S	Fire Prevention and Safety Grants
FPMS	Floodplain Management Services
FTE	Full-Time Equivalent (Employees)
GE	General Electric
GIS	Geographical Information System
HAZUS	Hazards US
HCRI	Healthcare Coalition Of Rhode Island
HHS	United States Department of Health and Human Services
HI	Heat Index
HIFLD	Homeland Infrastructure Foundation-Level Data

Acronym	Definition
HIRA	Hazard Identification and Risk Assessment
HMA	Hazard Mitigation Assistance
HMGP	Hazard Mitigation Grant Program
HMPs	Hazard Mitigation Plan
HUD	United States Housing and Urban Development
HURREVAC	Hurricane Evacuation
IA	Individual Assistance
IBC	International Building Codes
ICC	International Code Council, Inc
ICF	Incident Command System
IEDs	Improvised Explosive Devices
IHR	International Health Regulations
IoT	Internet of Things
IPCC	Intergovernmental Panel on Climate Change
ISC	Inner Space Center
ISDS	Individual Sewage Disposal System
ISIL	Islamic State of Iraq And the Levant
ISR	Infrastructure, Safety, And Reliability
IT	Information Technology
KBDI	Keetch-Byram Drought Index
LHMC	Local Hazard Mitigation Committee
LHMP	Local Hazard Mitigation Plan
LTC-MAP	Rhode Island Long-Term Care Mutual Aid Plan
MBTA	Massachusetts Bay Transportation Authority
MCC	Mesoscale Convective Complex
MCS	Mesoscale Convective System
MCV	Mesoscale Convective Vortex
MEDS	Medical Emergency Distribution System
MERS-CoV	Middle East Respiratory Syndrome Coronavirus
MHHW	Mean Higher High Water

Acronym	Definition
MMS	Moment Magnitude System
MOU	Memorandum of Understanding
MPH	Miles Per Hour
MSDS	Material Safety Data Sheets
MW	Megawatts
NCEI	National Centers for Environmental Information (formerly the National Climatic Data Center)
NERACOOS	Northeast Regional Association of Coastal and Ocean Observing Systems
NESIS	Northeast Snowfall Impact Scale
NFHL	National Flood Hazard Layer
NFIP	National Flood Insurance Program
NFWF	National Fish and Wildlife Foundation
NHC	National Hurricane Center
NHRP	National Register of Historic Places
NIAC	National Infrastructure Advisory Council
NIMS	National Incident Management System
NIOSH	National Institute for Occupational Safety and Health
NOAA	National Oceanic and Atmospheric Administration
NOUE	Notification of Unusual Event
NPR	National Preparedness Report
NRC	Nuclear Regulatory Commission
NRCS	National Resources Conservation Service
NRDA	Natural Resource Damage Assessment
NRF	National Response Framework
NROC	Northeast Regional Ocean Council
NSSL	National Severe Storms Laboratory
NWS	National Weather Service
OER	Office of Energy Resources
OHCD	Office of Housing and Community Development
OHCD-DR	Office of Housing and Community Development - Disaster Recovery
OMS	Outage Management System

Acronym	Definition
OSHA	Occupational Safety and Health Administration
OWR	Office of Water Resources
PA	Public Assistance
PAC	Public Assistance Coordinator
PACE	Property Assessment and Coastal Exposure
PAG	Protective Action Guideline
PAS	Planning Assistance to States
PCII	Protected Critical Infrastructure Information
PDA	Preliminary Damage Assessments
PDM	Pre-Disaster Mitigation Grant Program
PDSI	Palmer Drought Severity Index
PGA	Peak Ground Acceleration
PHEP	Public Health Emergency Preparedness
PII	Personally Identifiable Information
PIN	Personal Identification Number
PODs	Points of Dispensing
PPE	Personal Protective Equipment
ProvPlan	The Providence Plan
PSMSL	Permanent Service for Mean Sea Level
PWS	Public Water System
RDD	Radiological Dispersal Devices
RGGI	Regional Greenhouse Gas Initiative
RH	Relative Humidity
RIAC	Rhode Island Airport Corporation
RICAP	Rhode Island Capital Plan
RIDCAMM	Rhode Island Division of Asset Management and Maintenance
RIDE	Rhode Island Department of Education
RIDEM	Rhode Island Department of Environmental Management
RIDOH	Rhode Island Department of Health
RIDOT	Rhode Island Department of Transportation

Acronym	Definition
RIDPW	Rhode Island Department of Public Works
RIEMA	Rhode Island Emergency Management Agency
RIGIS	Rhode Island Geographic Information System
RIHPHC	Rhode Island Historical Preservation and Heritage Commission
RIIB	Rhode Island Infrastructure Bank
RIJCTF	Rhode Island Joint Cyber Task Force
RIPTA	Rhode Island Public Transit Authority
RISCON	Rhode Island Statewide Communications Network
RISG	Rhode Island Sea Grant College Program
RISNER	Rhode Island Special Needs Emergency Registry
RIWARN	Rhode Island Water/Wastewater Agency Response Network
RL	Repetitive Loss
RMAGs	Regional Mutual Assistance Groups
SAE	Site Area Emergency
SAMP	Special Area Management Plan
SBA	Small Business Administration
SCADA	Supervisory Control and Data Acquisition
SDE	Stormtools Design Elevation
SEOC	State Emergency Operations Center
SFHA	Special Flood Hazard Areas
SHARP	Safety and Health Achievement Recognition Program
SHMO	State Hazard Mitigation Officer(S)
SHMP	State Hazard Mitigation Plan
SHPO	State Historic Preservation Officer
SHSP	State Homeland Security Program
SIHMC	State Interagency Hazard Mitigation Committee
SJ	Silver Jackets
SLAMM	Sea Level Affecting Marshes Model
SLOSH	The Sea, Lake, And Overland Surges from Hurricanes
SLR	Sea Level Rise

Acronym	Definition
SPIA	Sperry–Piltz Ice Accumulation
SPR	Stakeholder Preparedness Review
SRL	Severe Repetitive Loss
SSEER	Scientific Support for Environmental Emergency Response
STD	Sexually Transmitted Diseases
THIRA	Threat and Hazard Identification and Risk Assessment
TIP	Transportation Improvement Program
TORRO	Tornado and Storm Research Organization
URI	University Of Rhode Island
USACE	U.S. Army Corps of Engineers
USDA	United States Department of Agriculture
USGS	United States Geological Survey
VBIEDs	Vehicle-Borne Improvised Explosive Devices
VEE	Venezuelan Equine Encephalitis
VFA	Volunteer Fire Assistance Grants
WFO	Weather Forecast Office
WHO	World Health Organization
WMD	Weapons of Mass Destruction
WMO	World Meteorological Organization
WRB	Water Resources Board
WSSMP	Water Supply System Management Plan Program
WUI	Wildland Urban Interface

A.2 Commonly Used Terminology

1%-annual-chance flood (100-year flood) – A flood that has a 1% chance of being equaled or exceeded in any given year. This flood event is also referred to as the base flood. The term "100-year flood" can be misleading; it is not the flood that will occur once every 100 years. Rather, it is the flood elevation that has a 1% chance of being equaled or exceeded each year. Therefore, the 100-year flood could occur more than once in a relatively short period of time. The 100-year flood, which is the standard used by most federal and state agencies, is used by the NFIP as the standard for floodplain management to determine the need for flood insurance.

0.2%-annual-chance flood (500-year flood) – A flood that has a 0.2% chance of being equaled or exceeded in any one year.

Aggregate Data – Data gathered together across an area or region (for example, census tract or census block data).

Annualized Loss – The estimated long-term value of losses from potential future hazard occurrences of a particular type in any given single year in a specified geographic area. In other words, the average annual loss that is likely to be incurred each year based on frequency of occurrence and loss estimates. Note that the loss in any given year can be substantially higher or lower than the estimated annualized loss.

Annualized Loss Ratio – Represents the annualized loss estimate as a fraction of the replacement value of the local building inventory. This ratio is calculated using the following formula: Annualized Loss Ratio = Annualized Losses / Exposure at Risk. The annualized loss ratio gauges the relationship between average annualized loss and building value at risk. This ratio can be used as a measure of relative risk between hazards as well as across different geographic units.

Asset – Any man-made or natural feature that has value, including but not limited to people, buildings, infrastructure (such as bridges, roads, and sewer and water systems), and lifelines (such as electricity and communication resources or environmental, cultural, or recreational features like parks, dunes, wetlands, or landmarks).

At-Risk – Exposure values that include the entire building inventory value in census blocks that lie within or border the inundation areas or any area potentially exposed to a hazard based on location.

Base Flood – Flood that has a 1% probability of being equaled or exceeded in any given year. It is also known as the 100-year flood.

Base Flood Elevation (BFE) – Elevation of the base flood in relation to a specified datum, such as the National Geodetic Vertical Datum of 1929. The BFE is used as the standard for the NFIP.

Benefit – Net project outcomes, usually defined in monetary terms. Benefits may include direct and indirect effects. For the purposes of conducting a benefit-cost analysis of proposed mitigation measures, benefits are limited to specific, measurable, risk reduction factors, including a reduction in expected property losses (building, content, and function) and protection of human life.

Benefit-cost analysis (BCA) – Benefit-cost analysis is a systematic, quantitative method of comparing the projected benefits to projected costs of a project or policy. It is used as a measure of cost effectiveness.

Blizzard – Characterized by low temperatures, wind gusts of 35 mph or more and falling and/or blowing snow that reduces visibility to 0.25 miles or less for an extended period of time (three or more hours).

Building – A structure that is walled and roofed, principally aboveground and permanently fixed to a site. The term includes a manufactured home on a permanent foundation on which the wheels and axles carry no weight.

Building Codes – Regulations that set forth standards and requirements for construction, maintenance, operation, occupancy, use, or appearance of buildings, premises, and dwelling units. Building codes can include standards for structures to withstand natural disasters.

Capability Assessment – An assessment that provides a description and analysis of a community or state's current capacity to address the threats associated with hazards. The capability assessment attempts to identify and evaluate existing policies, regulations, programs, and practices that positively or negatively affect the community or state's vulnerability to hazards or specific threats.

Climate – The meteorological elements, including temperature, precipitation, and wind, which characterizes the general conditions of the atmosphere over a period of time (typically 30 years) for a particular region.

Community Rating System (CRS) – CRS is a program that provides incentives for NFIP communities to complete activities that reduce flood hazard risk. When the community completes specific activities, the insurance premiums of these policyholders in communities are reduced.

Comprehensive Plan – A document, also known as a "general plan", covering the entire geographic area of a community and expressing community goals and objectives. The plan lays out the vision, policies, and strategies for the future of the community, including all of the physical elements that will determine the community's future development. This plan can discuss the community's desired physical development, desired rate and quantity of growth, community character, transportation services, location of growth, and siting of public facilities and transportation. In most states, the comprehensive plan has no authority in and of itself but serves as a guide for community decision-making.

Critical Facility – Facilities that are critical to the health and welfare of the population and that are especially important following a hazard. Critical facilities include essential facilities, transportation systems, lifeline utility systems, high-potential loss facilities, and hazardous material facilities.

Debris – The scattered remains of assets broken or destroyed during the occurrence of a hazard. Debris caused by a wind or water hazard event can cause additional damage to other assets.

Digital Elevation Model (DEM) – USGS data files that are digital representations of cartographic information in a raster form. DEMs include a sampled array of elevations for a number of ground positions at regularly spaced intervals. These digital cartographic/geographic data files are produced by USGS as part of the National Mapping Program.

Digital Flood Insurance Rate Maps (DFIRMs) – These maps are used to calculate the cost insurance premiums, establish flood risk zones and base flood elevations to mitigate against potential future flood damages to properties.

Displacement Time – After a hazard occurs, the average time (in days) that a building's occupants must operate from a temporary location while repairs are made to the original building due to damages resulting from the hazard.

Disaster Mitigation Act of 2000 (DMA 2000) – Law that requires and rewards local and state pre-disaster planning, promotes sustainability as a strategy for disaster resistance, and is intended to integrate state and local planning with the aim of strengthening state-wide mitigation planning.

Duration – The length of time a hazard occurs.

Earthquake – A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of earth's tectonic plates.

Essential Facility – A facility that is important to ensure a full recovery of a community or state following the occurrence of a hazard. These facilities can include: government facilities, major employers, banks, schools, and certain commercial establishments (such as grocery stores, hardware stores, and gas stations).

Exposure – The number and dollar value of assets that are considered to be at risk during the occurrence of a specific hazard.

Extent – The size of an area affected by a hazard or the occurrence of a hazard.

Federal Emergency Management Agency (FEMA) – Independent agency (now part of the Department of Homeland Security) created in 1978 to provide a single point of accountability for all federal activities related to disaster mitigation and emergency preparedness, response, and recovery.

Flash Flood – A flood occurring with little or no warning where water levels rise at an extremely fast rate.

Flood – A general and temporary condition of partial or complete inundation of normally dry land areas resulting from (1) the overflow of inland or tidal waters, (2) the unusual and rapid accumulation or runoff of surface waters from any source, or (3) mudflows or the sudden collapse of shoreline land.

Flood Depth – Height of the flood water surface above the ground surface.

Flood Elevation – Height of the water surface above an established datum (for example, the National Geodetic Vertical Datum of 1929, North American Vertical Datum of 1988, or mean sea level).

Flood Hazard Area – Area shown to be inundated by a flood of a given magnitude on a map.

Flood Information Tool (FIT) – Hazard U.S. Multi-Hazard (HAZUS-MH) - related tool designed to process and convert locally available flood information to data that can be used by the HAZUS-MH Flood Module. The FIT is a system of instructions, tutorials and GIS analysis scripts. When provided with user-supplied inputs (such as ground elevations, flood elevations, and floodplain boundary information), the FIT calculates flood depth and elevation for river and coastal flood hazards.

Flood Insurance Rate Map (FIRM) – Map of a community, prepared by the FEMA that shows both the special flood hazard areas and the risk premium zones applicable to the community.

Flood Insurance Study (FIS) – A study that provides an examination, evaluation, and determination of flood hazards and, if appropriate, corresponding water surface elevations in a community or communities.

Flood Mitigation Assistance (FMA) Program – A program created as a part of the National Flood Insurance Report Act of 1994. FMA provides funding to assist communities and states in implementing actions that reduce or eliminate the long-term risk of flood damage to buildings, manufactured homes, and other NFIP insurance structures, with a focus on repetitive loss properties.

Floodplain – Any land area, including a watercourse, susceptible to partial or complete inundation by water from any source.

Flood Polygon – A geographic information system vector file outlining the area exposed to the flood hazard. HAZUS-MH generates this polygon at the end of the flood computations in order to analyze the inventory at risk.

Freezing Rain – Rain that falls as a liquid but freezes into glaze upon contact with the ground.

Frequency – A measure of how often events of a particular magnitude are expected to occur. Frequency describes how often a hazard of a specific magnitude, duration, and/or extent typically occurs, on average. Statistically, a hazard with a 100-year recurrence interval is expected to occur once every 100 years on average and would have a 1% chance of happening in any given year. The reliability of this information varies depending on the kind of hazard being considered.

Fujita Scale of Tornado Intensity – Rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 (wind speed less than 73 mph) indicates minimal damage such as broken tree limbs or signs, while an F5 (wind speeds of 261 to 318 mph) indicated severe damage sustained.

Geology – The scientific study of the earth, including its composition, structure, physical properties, and history.

Goals – General guidelines that explain what you want to achieve. They are usually broad policy-type statements, long term in nature, and represent global visions.

Geographic Information Systems (GIS) – A computer software application that relates data regarding physical and other features on the earth to a database to be used for mapping and analysis.

GIS Shape Files – A type of GIS vector file developed by ESRI for their ArcView software. This type of file contains a table and a graphic. The records in the table are linked to corresponding objects in the graphic.

Hailstorm – Storm associated with spherical balls of ice. Hail is a product of thunderstorms or intense showers. It is generally white and translucent, consisting of liquid or snow particles encased with layers of ice. Hail is formed within the higher reaches of a well-developed thunderstorm. When hailstones become too heavy to be caught in an updraft back into the clouds of the thunderstorm (hailstones can be caught in numerous updrafts adding a coating of ice to the original frozen droplet of rain each time), they fall as hail and a hailstorm ensues.

Hazard – A source of potential danger or an adverse condition that can cause harm to people or cause property damage. For this risk assessment, priority hazards were identified and selected for the pilot project effort. A natural hazard is a hazard that occurs naturally (such as flood, wind, and earthquake). A man-made hazard is one that is caused by humans (for example, a terrorist act or a hazardous material spill). Hazards are of concern if they have the potential to harm people or property.

Hazards of Interest – A comprehensive listing of hazards that may affect an area.

Hazards of Concern – Those hazards that have been analytically determined to pose significant risk in an area, and thus the focus of the particular mitigation plan for that area (a subset of the Hazards of Interest).

Hazard Identification – The process of identifying hazards that threaten an area.

Hazardous Material Facilities – Facilities housing industrial and hazardous materials, such as corrosives, explosives, flammable materials, radioactive materials, and toxins.

Hazard Mitigation – Sustained actions taken to reduce or eliminate the long-term risk and effects that can result from the occurrence of a specific hazard. For example, building a retaining wall can protect an area from flooding.

Hazard Mitigation Grant Program (HMGP) – Authorized under Section 404 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act, HMGP is administered by the FEMA and provides grants to states, tribes, and local governments to implement hazard mitigation actions after a major disaster declaration. The purpose of the program is to reduce the loss of life and property due to disasters and to enable mitigation activities to be implemented as a community recovers from a disaster.

Hazard Mitigation Plan – A collaborative document in which hazards affecting the community are identified, vulnerability to hazards assessed, and consensus reached on how to minimize or eliminate the effects of these hazards.

Hazard Profile – A description of the physical characteristics of a hazard, including a determination of various descriptors including magnitude, duration, frequency, probability, and extent. In most cases, a community can most easily use these descriptors when they are recorded and displayed as maps.

Hazards U.S. (HAZUS) – A GIS-based nationally standardized earthquake loss estimation tool developed by FEMA. HAZUS was replaced by HAZUS-MH (see below) in 2003.

Hazards U.S. – Multi-Hazard (HAZUS-MH) – A GIS-based nationally standardized earthquake, flood, and wind loss estimation tool developed by FEMA. The purpose of this pilot project is to demonstrate and implement the use of HAZUS-MH to support risk assessments.

HAZUS-MH Risk Assessment Methodology – This analysis uses the HAZUS-MH modules (earthquake, wind--hurricane and flood) to analyze potential damages and losses. For this pilot project risk assessment, the flood and hurricane hazards were evaluated using this methodology.

HAZUS-MH-Driven Risk Assessment Methodology – This analysis involves using inventory data in HAZUS-MH combined with knowledge such as (1) information about potentially exposed areas, (2) expected impacts, and (3) data regarding likelihood of occurrence for hazards.

Heavy Snow – Snowfall accumulating to 4 inches or more in depth in 12 hours or less; or snowfall accumulating to 6 inches or more in depth in 24 hours or less.

High Potential Loss Facilities – Facilities that would have a high loss associated with them, such as nuclear power plants, dams, and military installations.

Hydrology – The science of dealing with the waters of the earth (for example, a flood discharge estimate is developed through conduct of a hydrologic study).

Infrastructure – The public services of a community that have a direct impact on the quality of life. Infrastructure includes communication technology such as phone lines or Internet access, vital services such as public water supplies and sewer treatment facilities, transportation system (such as airports, heliports; highways, bridges, tunnels, roadbeds, overpasses, railways, bridges, rail yards, depots; and waterways).

Ice Jam – An accumulation of ice in a river that acts as a natural dam and can flood low-lying areas upstream. They occur when warm temperatures and heavy rains cause rapid snow melt.

Ice Storm – Term used to describe occasions when damaging accumulations of ice are expected during freezing rain situations. Significant accumulations of ice pull down trees and utility lines resulting in loss of power and communication.

Intensity – A measure of the effects of a hazard occurring at a particular place.

Inventory – The assets identified in a study region. It includes assets that can be lost when a disaster occurs and community resources are at risk. Assets include people, buildings, transportation, and other valued community resources.

Level 1 Analysis – A HAZUS-MH analysis that yields a rough estimate or preliminary analysis based on the nationwide default database included in HAZUS-MH. A Level 1 analysis is a great way to begin the risk assessment process and prioritize high-risk communities without collecting or using local data.

Level 2 Analysis – A HAZUS-MH analysis that requires the input of additional or refined data and hazard maps that will produce more accurate risk and loss estimates. Assistance from local emergency management personnel, city planners, GIS professionals, and others may be necessary for this level of analysis.

Level 3 Analysis – A HAZUS-MH analysis that yields the most accurate estimate of loss and typically requires the involvement of technical experts such as structural and geotechnical engineers who can modify loss parameters based on the specific conditions of a community. This level analysis will allow users to supply their own techniques to study special conditions such as dam breaks and tsunamis. Engineering and other expertise is needed at this level.

Lifelines – Critical facilities that include utility systems (potable water, wastewater, oil, natural gas, electric power facilities and communication systems) and transportation systems (airways, bridges, roads, tunnels and waterways).

Lightning – A visible electrical discharge produced by a thunderstorm. The discharge may occur within or between clouds or between a rain cloud and the ground.

Loss Estimation – The process of assigning hazard-related damage and loss estimates to inventory, infrastructure, lifelines, and population data. HAZUS-MH can estimate the economic and social loss for specific hazard occurrences. Loss estimation is essential to decision making at all levels of government and provides a basis for developing mitigation plans and policies. It also supports planning for emergency preparedness, response, and recovery.

Lowest Floor – Under the NFIP, the lowest floor of the lowest enclosed area (including basement) of a structure. For the HAZUS-MH flood model, this information can be used to assist in assessing the damage to buildings.

Magnitude – A measure of the strength of a hazard occurrence. The magnitude (also referred to as severity) of a given hazard occurrence is usually determined using technical measures specific to the hazard. For example, ranges of wind speeds are used to categorize tornados.

Major Disaster Declarations – Post-disaster status requested by a state's governor when local and state resources are not sufficient to meet disaster needs. It is based on the damage assessment, and an agreement to commit state funds and resources to the long-term recovery. The event must be clearly more than the state or local government can handle alone.

Mean Return Period (MRP) – The average period of time, in years, between occurrences of a particular hazard (equal to the inverse of the annual frequency of exceedance).

Mitigation Actions – Specific actions that help you achieve your goals and objectives.

Mitigation Goals – General guidelines that explain what you want to achieve. They are usually broad policy type statements, long term, and represent global visions.

Mitigation Objectives – Strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

Mitigation Plan – A plan that documents the process used for a systematic evaluation of the nature and extent of vulnerability to the effects of natural hazards typically present in a state or community. The plan includes a description of actions to minimize future vulnerability to hazards. This plan should be developed with local experts and significant community involvement.

National Flood Insurance Program (NFIP) – Federal program created by Congress in 1968 that makes flood insurance available in communities that enact minimum floodplain management regulations in 44 Code of Federal Regulations (CFR) §60.3.

Objectives – Objectives define strategies or implementation steps to attain the identified goals. Unlike goals, objectives are specific and measurable.

Occupancy Classes – Categories of buildings used by HAZUS-MH (for example, commercial, residential, industrial, government, and "other").

Ordinance – A term for a law or regulation adopted by local government.

Outflow – Associated with coastal hazards and follows water inundation creating strong currents that rip at structures and pound them with debris, eroding beaches and coastal structures.

Parametric Model – A model relating to or including the evaluation of parameters. For example, HAZUSMH uses parametric models that address different parameters for hazards such as earthquake, flood and wind (hurricane). For example, parameters considered for the earthquake hazard include soil type, peak ground acceleration, building construction type and other parameters.

Planimetric – Maps that indicate only man-made features like buildings.

Planning – The act or process of making or carrying out plans; the establishment of goals, policies and procedures for a social or economic unit.

Post-disaster mitigation – Mitigation actions taken after a disaster has occurred, usually during recovery and reconstruction.

Presidential Disaster Declaration – A post-disaster status that puts into motion long-term federal recovery programs, some of which are matched by state programs, and designed to help disaster victims, businesses, and public entities in the areas of human services, public assistance (infrastructure support), and hazard mitigation. If declared, funding comes from the President's Disaster Relief Fund and disaster aid programs of other participating federal agencies.

Preparedness – Actions that strengthen the capability of government, citizens, and communities to respond to disasters.

Priority Hazards – Hazards considered most likely to impact a community based on frequency, severity, or other factors such as public perception. These are identified using available data and local knowledge.

Provided Data – The databases included in the HAZUS-MH software that allow users to run a preliminary analysis without collecting or using local data.

Probability – A statistical measure of the likelihood that a hazard event will occur.

Public Education and Outreach Programs – Any campaign to make the public more aware of hazard mitigation and mitigation programs, including hazard information centers, mailings, public meetings, etc.

Q3 Flood Zone Data – FEMA flood data that delineate the 100- and 500-year flood boundaries. The Q3 Flood Data are digital representations of certain features of FEMA's product, intended for use with desktop mapping and GIS technology.

Recovery – The actions taken by an individual or community after a catastrophic event to restore order and lifelines in the community.

Regulation – Most states have granted local jurisdictions broad regulatory powers to enable the enactment and enforcement of ordinances that deal with public health, safety, and welfare. These include building codes, building inspections, zoning, floodplain and subdivision ordinances, and growth management initiatives.

Recurrence Interval – The average time between the occurrences of hazardous events of similar size in a given location. This interval is based on the probability that the given event will be equaled or exceeded in any given year.

Repetitive Loss Property – A property that is currently insured for which two or more NFIP losses (occurring more than ten days apart) of at least $1,000 each have been paid within any 10-year period since 1978.

Replacement Value – The cost of rebuilding a structure. This cost is usually expressed in terms of cost per square foot and reflects the present-day cost of labor and materials to construct a building of a particular size, type and quality.

Resolutions – Expressions of a governing body's opinion, will, or intention that can be executive or administrative in nature. Most planning documents must undergo a council resolution, which must be supported in an official vote by a majority of representatives to be adopted. Other methods of making a statement or announcement about a particular issue or topic include proclamations or declarations.

Resources – Resources include the people, materials, technologies, money, etc., required to implement strategies or processes. The costs of these resources are often included in a budget.

Risk – The estimated impact that a hazard would have on people, services, facilities, and structures in a community; the likelihood of a hazard occurring and resulting in an adverse condition that causes injury or damage. Risk is often expressed in relative terms such as a high, moderate or low likelihood of sustaining damage above a particular threshold due to occurrence of a specific type of hazard. Risk also can be expressed in terms of potential monetary losses associated with the intensity of the hazard.

Risk Assessment – A methodology used to assess potential exposure and estimated losses associated with priority hazards. The risk assessment process includes four steps: (1) identifying hazards, (2) profiling hazards, (3) conducting an inventory of assets, and (4) estimating losses. This pilot project report documents this process for selected hazards addressed as part of the pilot project.

Risk Factors – Characteristics of a hazard that contribute to the severity of potential losses in the study area.

Riverine – Of or produced by a river (for example, a riverine flood is one that is caused by a river overflowing its banks).

Scale – A proportion used in determining a dimensional relationship; the ratio of the distance between two points on a map and the actual distance between the two points on the earth's surface.

Scour – Removal of soil or fill material by the flow of floodwaters. This term is frequently used to describe storm-induced, localized, conical erosion around pilings and other foundation supports where the obstruction of flow increases turbulence.

Special Flood Hazard Area (SFHA) – An area within a floodplain having a 1% or greater chance of flood occurrence in any given year (that is, the 100-year or base flood zone); represented on FIRMS as darkly shaded areas with zone designations that include the letter "A" or "V."

Stafford Act – The Robert T. Stafford Disaster Relief and Emergency Assistance Act, Public Law 100-107 was signed into law on November 23, 1988. This law amended the Disaster Relief Act of 1974, PL 93-288. The Stafford Act is the statutory authority for most Federal disaster response activities, especially as they pertain to FEMA and its programs.

Stakeholder – Stakeholders are individuals or groups, including businesses, private organizations, and citizens, that will be affected in any way by an action or policy.

State Hazard Mitigation Officer (SHMO) – The representative of state government who is the primary point of contact with FEMA, other state and Federal agencies, and local units of government in the planning and implementation of pre- and post-disaster mitigation activities.

Structure – Something constructed (for example, a residential or commercial building).

Study Area – The geographic unit for which data are collected and analyzed. A study area can be any combination of states, counties, cities, census tracts, or census blocks. The study area definition depends on the purpose of the loss study and in many cases will follow political boundaries or jurisdictions such as city limits.

Substantial Damage – Damage of any origin sustained by a structure in a SFHA, for which the cost of restoring the structure to its pre-hazard event condition would equal or exceed 50% of its pre-hazard event market value.

Thunderstorm – A local storm produced by a cumulonimbus cloud and accompanied by lightning and thunder. It forms from a combination of moisture, rapidly rising warm air and a force capable of lifting air such a warm and cold front, a sea breeze, or a mountain.

Topographic – Map that shows natural features and indicate the physical shape of the land using contour lines based on land elevation. These maps also can include man-made features (such as buildings and roads).

Tornado – A violently rotating column of air extending from a thunderstorm to the ground.

Transportation Systems – One of the lifeline system categories. This category includes: airways (airports, heliports, highways), bridges, tunnels, roadbeds, overpasses, transfer centers; railways (tracks, tunnels, bridges, rail yards, depots), and waterways.

Utility Systems – One of the lifeline systems categories. This category includes potable water, wastewater, oil, natural gas, electric power facilities and communication systems.

Vulnerability – Description of how exposed or susceptible an asset is to damage. This value depends on an asset's construction, contents, and the economic value of its functions. Like indirect damages, the vulnerability of one element of the community is often related to the vulnerability of another. For example, many businesses depend on uninterrupted electrical power. If an electric substation is flooded, it will affect not only the substation itself, but a number of businesses as well. Often, indirect effects can be much more widespread and damaging than direct affects.

Vulnerability Assessment – Evaluation of the extent of injury and damage that may result from a hazard event of a given intensity in a given area. The vulnerability assessment should address impacts of hazard occurrences on the existing and future built environment.

Watershed – Area of land that drains down gradient (from areas of higher land to areas of lower land) to the lowest point; a common drainage basin. The water moves through a network of drainage pathways, both underground and on the surface. Generally, these pathways converge into streams and rivers, which become progressively larger as the water moves downstream, eventually reaching an estuary, lake, or ocean.

Zone – A geographical area shown on a National FIRM that reflects the severity or type of flooding in the area.

Zoning Ordinance – Designation of allowable land use and intensities for a local jurisdiction. Zoning ordinances consist of two components: a zoning text and a zoning map.

Appendix B: Planning Process

This appendix includes the materials, records of attendance, and notes from the meetings held during the planning process.

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B.2 SIHMC Members

Table B-1 SIHMC Members

First Name	Last Name	Affiliation
Chris	Albert	Senator Reed's Office
Nicole	Alexander-Scott	Rhode Island Department of Health (RIDOH)
Ernie	Allen	Rhode Island State Police (RISP)
Peter	Alviti	Rhode Island Department of Transportation (RIDOT)
Dave	Aucoin	Narragansett Bay Commission
Scott	Avedisian	Rhode Island Public Transit Authority (RIPTA)
Jim	Ball	Rhode Island Department of Environmental Management (DEM)
Brian	Balukonis	United States Army Corp of Engineers (USACE)
Susan	Barker	Greenways Alliance
Wayne	Barnes	East Providence
Nicole	Belk	National Weather Service (NWS)
Mark	Bennett	Rhode Island Emergency Management Agency (RIEMA)
Gardner	Bent	United States Geologic Survey (USGS)
Benny	Bergantino	Rhode Island Division of Statewide Planning
Ellen	Berggren	United States Army Corp of Engineers (USACE)
Veronica	Berounsky	Rhode Island Rivers Council
Kerry	Bogdan	Federal Emergency Management Agency (FEMA)
Greg	Bonynge	University of Rhode Island Environmental Data Center
Jim	Boyd	Rhode Island Coastal Resources Management Council (CRMC)
Laura	Bozzi	Rhode Island Department of Health (RIDOH)
Karen	Bradbury	Senator Whitehouse's Office
Joseph	Bucci	Rhode Island Department of Transportation (RIDOT)

First Name	Last Name	Affiliation
Edward	Capone	National Weather Service (NWS) / Northeast River Forecast Center (NERFC)
Steven	Cascione	Rhode Island Department of Transportation (RIDOT)
Michael	Casey	Rhode Island State Police (RISP)
Janet	Coit	Rhode Island Department of Environmental Management (DEM)
Bob	Cooper	Governor's Commission on Disabilities
Kathy	Crawley	Rhode Island Water Resources Board
Teresa	Crean	University Of Rhode Island Coastal Resources Center
Ryan	Curtis	Congressman Langevin's Office
Brian	Daniels	Rhode Island League of Cities and Towns
Michael	DiBiase	Rhode Island Department of Administration (DOA)
Warren	Ducharme	Rhode Island Building Code Commission
Sue	Earley	Rhode Island Department of Behavioral Healthcare, Developmental Disabilities and Hospitals (BHDDH)
Jeffrey	Emidy	Rhode Island Historic Preservation & Heritage Commission
Chris	Fox	Wood-Pawcatuck Watershed Association
Edward	Fratto	Northeast States Emergency Consortium (NESEC)
Janet	Freedman	Rhode Island Coastal Resources Management Council (CRMC)
Grover	Fugate	Rhode Island Coastal Resources Management Council (CRMC)
Randall	Galpin	Natural Resources Conservation Services (NRCS)
Peter	Gaynor	Rhode Island Emergency Management Agency (RIEMA)
Alan	Gillespie	Natural Resources Conservation Services (NRCS)
Peter	Ginaitt	Warwick Sewer Authority
Russ	Godin	Rhode Island Interlocal Risk Management Trust
Alicia	Good	Rhode Island Department of Environmental Management (DEM)

First Name	Last Name	Affiliation
Carol	Grant	Rhode Island Office of Energy Resources (OER)
Terry	Gray	Rhode Island Department of Environmental Management (DEM)
Caitlin	Greeley	Rhode Island Department of Administration (DOA) - Division of Planning
Chris	Hatfield	United States Army Corp of Engineers (USACE)
Peter	Healey	Rhode Island Department of Transportation (RIDOT)
Melinda	Hopkins	Rhode Island Emergency Management Agency (RIEMA)
Christopher	Kearns	Rhode Island Office of Energy Resources (OER)
John	Kennedy	National Grid
John	Kennelly	United States Army Corp of Engineers (USACE)
Stephen	King	Quonset Development Corporation
Anne	Kirori	ANA - Kenya
Seth	Klaiman	Congressman Langevin's Office
Thomas	Kogut	Rhode Island Department of Public Utilities Commission and Division of Public Utilities and Carriers
Nicholas	Larmore	Rhode Island Department of Health (RIDOH)
Gary	Lataille	National Grid
Peter	LePage	Providence Water
Dawn	Lewis	Hospital Association of Rhode Island
John	Leyden	Rhode Island Department of Administration (DOA) & Rhode Island Building Code Commission
Lawrence	Macedo	Rhode Island EMA
Raymond	Marshall	Narragansett Bay Commission
Mike	McCallan	National Grid
Tracy	McCormick	National Weather Service (NWS)
Ernest	McKenney	Rhode Island State Police (RISP)
Timothy	McLaughlin	Rhode Island Division of State Fire Marshal

First Name	Last Name	Affiliation
Alysia	Mihalakos	Rhode Island Department of Health (RIDOH)
Kara	Morris	National Grid
Erin	Norris	Rhode Island Emergency Management Agency (RIEMA)
Shaun	Orourke	Rhode Island Infrastructure Bank
Paula	Pallozzi	Department of Business Regulations (DBR)
Bill	Patenaude	Rhode Island Department of Environmental Management (DEM)
Spencer	Peck	Rhode Island EMA
Jamie	Pereira	Rhode Island Public Transit Authority (RIPTA)
Daniel	Porter	Rhode Island Airport Corporation
Denise	Poyer	Wood-Pawcatuck Watershed Association
Christine	Quigley	Narragansett Chamber of Commerce Chamber
Samantha	Richer	Rhode Island Emergency Management Agency (RIEMA)
Susan	Roberts	Red Cross
Christopher	Rolleston	Federal Emergency Management Agency (FEMA)
Pam	Rubinoff	University of Rhode Island Coastal Resources Center
Shannon	Ruff	Rhode Island Interlocal Risk Management Trust
Peder	Schaefer	Rhode Island League of Cities and Towns
John	Shea	Aquidneck Island Planning Commission
Philip	Sheridan	Rhode Island Department of Health (RIDOH)
Anthony	Silva	Lt. Governor's Office
Brett	Smiley	Governor's Office
Stephen	Soito	Providence Water
Dinalyn	Spears	Narragansett Indian Tribe
Monica	Staaf	Rhode Island Association of Realtors (RIAR)
Greg	Stewart	United States Geologic Survey (USGS)
Jonathan	Stone	Save the Bay

First Name	Last Name	Affiliation
Laura	Sullivan	Rhode Island Department of Administration (DOA)- Office of Housing and Community Development
Melissa	Surette	Federal Emergency Management Agency (FEMA)
Brian	Tardiff	Rhode Island Division of Information Technology (DOIT)
Erica	Tefft	University of Rhode Island Environmental Data Center
Michael	Tondra	Rhode Island Department of Administration (DOA)- Office of Housing and Community Development
Erik	Ulmen	U.S. Department of Homeland Security
Dave	Vallee	National Weather Service (NWS)
Phou	Vongkhamdy	Natural Resources Conservation Services (NRCS)
Henry	Walker	Environmental Protection Agency (EPA) - Rhode Island
Michael	Walker	Rhode Island Department of Commerce
Matt	Walsh	United States Army Corp of Engineers (USACE)
Jen	West	Narragansett Bay Estuary Research Reserve

B.3 Outreach Strategy

B.3.1 Strategy

State of Rhode Island Hazard Mitigation Plan Update: Outreach Strategy

July 2018

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Background

In June 2018, the State of Rhode Island initiated the 2019 Standard State Hazard Mitigation Plan (HMP) Update process, in collaboration with Hagerty Consulting, Inc. (Hagerty) and the State Interagency Hazard Mitigation Committee (SIHMC). In line with federal regulations for the plan update process, the state will engage in public engagement and outreach to inform the plan. Code of Federal Regulations, 44 CFR §201.4(b), identifies outreach requirements for Standard State Hazard Mitigation Plans in the following way:

> *The mitigation planning process should include coordination with other State agencies, appropriate Federal agencies, interested groups, and be integrated to the extent possible with other ongoing State planning efforts as well as other FEMA mitigation programs and initiatives.*[1]

Rhode Island may choose several paths to meet the intent of this regulation, however successful outreach has been defined as those that have the following characteristics[2]:

- Informs and educates about hazards and risks
- Invites interested parties to contribute their views and ideas for mitigation
- Identifies conflicts and incorporates different perspectives and priorities early in the process
- Provides data and information that improves overall quality and accuracy of the plan
- Ensures transparency and builds trust
- Maximizes opportunities for implementation through greater consensus and acceptance

The following pages identify a communication strategy with specific goals and tactics identified that meet both the intent of the regulation, and the vision for successful outreach.

1 Standard State Mitigation Plans, 44 CFR §201.4(b) (2015)
2 Center for Sustainable Community Design within the Institute for the Environment at the University of North Carolina
at Chapel Hill and the Institute for Sustainable Coastal Communities at Texas A&M University

Outreach Strategy

Outreach Goals

The Outreach Strategy will be achieved by four general goals and six specific tactics during the planning process for the HMP Update. The four general goals for the outreach strategy include:

1. **Organizational Identification:** Building from the established SIHMC, this goal is geared toward enhancing the participation in the planning process.
2. **Direct Engagement:** In person stakeholder meetings will be conducted between August 2, 2018 and October 10, 2018.
3. **Indirect Engagement:** To allow for more comprehensive awareness and involvement in the planning process, indirect engagement will be achieved through technological solutions.
4. **Outreach Documentation:** All planning outreach efforts will be documented and captured within the Hazard Mitigation Plan, and an ongoing outreach strategy will be included in the Plan Maintenance portion of the Hazard Mitigation Plan.

Outreach Stakeholders

The following players have key responsibilities to accomplish the goals and tactics identified within this strategy:

- **Hagerty Consulting (Hagerty)** – Contracted vendor to assist Rhode Island achieve its Hazard Mitigation Plan Update
- **State Hazard Mitigation Officer (SHMO)** – Assigned Point of Contact within the State of Rhode Island for this Hazard Mitigation Plan Update
- **State Interagency Hazard Mitigation Committee (SIHMC)** – FEMA defines a stakeholder as a representative of an agency, organization, jurisdiction, or other entity that has a role in natural hazard mitigation. These stakeholders, or an identified sub-set, form the State Interagency Hazard Mitigation Committee for the planning process.[3] The participation of the SIHMC in the planning process ultimately improves the quality of the plan. This core group of experts is responsible for developing and reviewing drafts of the plan, creating the mitigation strategy, and submitting the final plan for adoption

Outreach Tactics

To support these general goals, six specific tactics and associated assigned responsibilities are outlined in detail below and align in the following way with the overall goals of this strategy.

[3] State Mitigation Planning Key Topics Bulletins: Planning Process, July 2016, https://www.fema.gov/media-library-data/1468867403587-36535211c7c892fb7b1956e961d05a49/PlanningProcess_KeyTopics_Bulletin_508.pdf

Outreach Tactics	Outreach Goals			
	Organizational Identification	Direct Engagement	Indirect Engagement	Outreach Documentation
Identify Critical Partners	✓			
Leverage Groups	✓	✓	✓	
Brand HMP		✓	✓	
Meeting Material Accessibility		✓	✓	
Generate Awareness		✓	✓	
Document Activities				✓

Tactic 1: Identify critical partners

- FEMA encourages engagement with the following sectors during the planning process[4]: emergency management, economic development, land use and development, housing, health and social services, infrastructure, and natural and cultural resources. It is acknowledged that Rhode Island has a robust SIHMC that is actively involved in the planning process. However, there are potential non-traditional stakeholders that may provide added benefit to the planning process that aim to enhance the state's resilience through their commitment to creating resilient mitigation strategies during the State Hazard Mitigation Plan update process. Hagerty will work with the SHMO and SIHMC throughout the planning process to review and provide suggestions for additional stakeholders to invite to the planning process.

4 State Mitigation Planning Key Topics Bulletins: Planning Process, July 2016, https://www.fema.gov/media-library-data/1468867403587-36535211c7c892fb7b1956e961d05a49/PlanningProcess_KeyTopics_Bulletin_508.pdf

Actions -	
Hagerty:	Review SIHMC list, provide suggestions for additions throughout planning process
SHMO:	Provide SIHMC list to Hagerty for review
SIHMC:	Review and identify additional partners from other planning or response partnerships; draft list of potential partners; Approve finalized list

*This tactic supports **Goal 1: Organizational Identification** of this Outreach Strategy.*

Tactic 2: Leverage existing groups and stakeholder/public engagement activities

Other related, but distinctive, planning and public outreach campaigns may be ongoing concurrently to the Hazard Mitigation Planning process. To best leverage the varied engagements and stakeholder groups in a meaningful way for this planning process, Hagerty suggests the following:

- Identify groups to engage with that have aligned interests to that of the Hazard Mitigation Plan

Actions -	
Hagerty:	Identify potential stakeholder groups to supplement SHMO and SIHMC list
SHMO:	Identify stakeholder groups
SIHMC:	Identify stakeholder groups

- Identify potential catalogue of existing meetings to engage stakeholders in an efficient manner. These meetings could be two quarterly SIHMC meetings or two alternative meetings, to be determined at the discretion of the SIHMC.

Actions -	
SIHMC:	Identify existing meetings as potential opportunities for agency and public engagement coordination

- Develop a stakeholder meeting calendar to codify the in-person outreach strategy. In-person meetings will occur according to the calendar.

Actions -	
Hagerty:	Draft stakeholder meeting calendar
SIHMC:	Approve and advertise stakeholder meeting calendar

*This tactic supports **Goals 1: Organizational Identification** and **2: Direct Engagement** of this Outreach Strategy.*

Tactic 3: Develop distinctive and cohesive 2018 HMP Update "brand"

- Develop a style guide and templates distinctive to the HMP update planning process for all materials, including: PowerPoint decks, visual aids (handouts and posters), meeting materials (agendas, sign-in sheets, and meeting notes), maps, and the HMP.

- Develop 2018 HMP Update "Logo". An example of this can be viewed as the header of the example newsletter in Attachment B.

Actions -	
Hagerty:	Develop draft style templates; Develop three (3) draft logos
SHMO:	Approve brand templates, and one logo for use

This tactic supports Goal 2: Direct Engagement of this Outreach Strategy.

Tactic 4: Ensure meeting material and plan elements are available for stakeholder and public review

- Develop updates to the RIEMA Hazard Mitigation web page and provide visibility of that page. A draft of suggested updates can be found in Attachment A.

Actions -	
Hagerty:	Develop draft and final list of suggested RIEMA website updates
SHMO:	Coordinate with pertinent parties to update RIEMA website
SIHMC:	As possible, link to the updated Hazard Mitigation website from local agency sites

- Conduct in-person stakeholder meetings to gather information and validate findings for each of the elements being updated during the planning process, including: hazard analysis and risk assessment, mitigation strategy development, and draft plan review.

Actions -	
Hagerty:	Develop meeting materials; Attend and facilitate up to two (2) meetings
SHMO:	Attend and facilitate additional meetings
SIHMC:	Attend meetings; identify and leverage opportunities for hazard mitigation planning elements to be covered during relevant organizational meetings

- Draft public outreach materials to gather information and validate findings from the public for the planning process including: hazard analysis and risk assessment, mitigation strategy development, and draft plan review.

Actions -	
Hagerty:	Develop meeting materials; incorporate key findings in the plan
SHMO:	Host public meetings, provide notes and key findings from meetings to Hagerty for incorporation into the plan
SIHMC:	Include hazard mitigation plan agenda items in public meetings, provide notes and key findings from meetings to Hagerty for incorporation into the plan

This tactic supports Goal 3: Indirect Outreach and Goal 4: Outreach Documentation of this Outreach Strategy.

Tactic 5: Generate awareness and engagement

- Draft and deliver pre-scripted email messages to SIHMC and other stakeholder groups, as identified in Tactic 2.

Actions -	
Hagerty:	Draft messaging
SHMO:	Deliver messages to SIHMC

- Draft and deliver monthly SIHMC newsletters providing an update on the process and upcoming planning expectations. An example of this newsletter used for previous projects can be viewed in Attachment B.

Actions -	
Hagerty:	Draft newsletter, deliver upon approval from SHMO
SHM0:	Approve draft content

- Draft and deliver a survey (Attachment C) to gain public feedback on the hazard mitigation processes for the state.

Actions -	
Hagerty:	Draft public survey; Deliver public survey if determined course of action by SHMO
SHMO:	Review survey content; decide desired survey platform
SIHMC:	Review survey content; Notify public of survey through typical public outreach means

- Draft and deliver social media campaign (Attachment D) to promote awareness of the hazard mitigation process at the state and local level and open pathways to gain public feedback throughout the planning process.

Actions -	
Hagerty:	Draft social media strategy and template messaging
SHMO:	Approve strategy and draft content
SIHMC:	Deliver social media campaign

- Implement a State Preparedness Month Campaign that leverages the state's hazard mitigation plan update to educate and raise awareness of the hazards that can impact the state and encouraging mitigation action at the local level. Hagerty has developed an outline (Attachment E) of suggested activities that the SIHMC and RIEMA may choose to implement related to a State Preparedness Campaign.

Actions -	
SIHMC/RIEMA:	Implement a State Preparedness Month Campaign

- Draft presentation providing an update on the planning process and upcoming planning milestones for presentation at RiskMAP Meetings.

Actions -	
Hagerty:	Draft and finalize presentation
SIHMC:	Approve draft content; Deliver presentation

*This tactic supports **Goal 2: Direct Engagement and Goal 3: Indirect Engagement** of this Outreach Strategy.*

Tactic 6: Document outreach activities

- Record outreach activities and capture outreach materials for documentation in the HMP document.

Actions -	
Hagerty:	Develop outreach narrative and capture outreach activities within the HMP document according to federal guidance and requirements

- Develop ongoing outreach strategy for the Plan Maintenance portion of the HMP.

Actions -	
Hagerty:	Capture strategy and incorporate into the Plan Maintenance section of the plan
SIHMC:	Develop ongoing outreach strategy
SHMO:	Oversee ongoing outreach strategy

*This tactic supports **Goal 4: Outreach Documentation** of this Outreach Strategy.*

Attachments

A. Draft of Suggested Updates for RIEMA Website

- Provide a link to the draft plan and final adopted plan on the front page of the RIEMA website
- Provide contact information for where comments about the planning process or regarding the draft plan should be directed
- Make the State Hazard Mitigation Plan more accessible from the Hazard Mitigation tab of the Planning & Mitigation tab on the current website
- Update summary paragraph related to the State Hazard Mitigation Plan Page
- Consider directing residents to their local hazard mitigation plans on the Local Hazard Mitigation Plan Page.

B. Example Brand and Newsletter

Alabama MITIGATES

Communities Mitigating Disaster

Alabama State Hazard Mitigation Plan Monthly Newsletter

June 2018

Welcome to the latest issue of the ***Alabama State Hazard Mitigation Plan Monthly Newsletter***, an e-publication that curates news about the development of the plan, innovations in mitigation, and opportunities to get involved!

The Latest:
The Initial Draft is Complete!

On June 1, the State Hazard Mitigation Team (SHMT) distributed copies of the initial draft of the 2018 Plan Update to all state and county stakeholders. **Please check your inbox to make sure you received your copy, or access it online by visiting AEMA's web page.**

C. Draft Public Survey

The purpose of a Public Survey within the Outreach Strategy would be twofold: first, as a methodology to gain feedback from the general public on mitigation efforts and, second, to educate the public and encourage engagement. Below serves as a draft example of a survey, which can be revised to better fit specific interest groups or reflect the goals of the SIHMC overall.

Questions Related to Respondent Demographics

- Which region of Rhode Island is your permanent residence? (Provide multiple choice of regions of RI that we choose)
- What defines your role in your community?
  - Resident
  - Business Owner
- Do you rent or own your home?

Questions Related to Respondent's Knowledge of Hazard Mitigation

- Are you aware that Rhode Island has a 2013 Update to their State Hazard Mitigation Plan?
  - Yes
  - No
- Are you aware if your community has an up to date Hazard Mitigation Plan?
  - Yes
  - No
- Have you ever participated in the Hazard Mitigation Planning Process at the state or local level?
  - Yes, I have been a member of the SIHMC
  - Yes, I have been a member of a local hazard mitigation planning team
  - Yes, I attended a public meeting
  - Yes, I made comments on a draft state/local plan
  - No, I have never participated, but have been aware when either my local jurisdiction or the state is updating their plan
  - No, I have never heard of Hazard Mitigation Planning
- Has your awareness of natural hazards increased in recent years? If so, what would you attribute the increase of awareness to?
  - My awareness has not increased
  - (List relevant natural disasters)
  - Other/Additional comments:

Information about Effect of Hazards on Respondent

- Which of the following hazards poses a threat to your neighborhood: *[insert list of hazards]*
- Which of the following hazards is causing you most concern for the future: *[insert list of hazards]*
- Are there any specific areas of your community that are heavily/frequently impacted by disasters?

Public Input on Hazard Mitigation Planning

- What is the best way for you to receive information about making your property more resilient to hazards?
  - Newspaper
  - Radio
  - Television
  - Email
  - Direct Mail
  - Information in Utility Bills
  - Social Media (Facebook, Twitter, etc.)
  - Public Workshops/Meetings
  - Text Messages
  - Websites
  - Other: _____
- What are the most important things the State of Rhode Island, in your opinion, can do to reduce the impact hazards have on your life/community?

	Very Important	Important	Not Very Important	Not Important
Protecting private property				
Protecting Critical facilities and infrastructure				
Prevent development in hazard-prone areas				
Protect/enhance natural feature to aid in mitigation				
Protect historic and cultural landmarks				
Protect and reduce damage to utilities				
Strengthen emergency services				
Promote cooperation among public agencies, citizens, non-profit organizations, and businesses				

- What is your top priority for reducing hazard impacts?
- What are the most important things your community can do to reduce the impact hazards have on your life/community?
- Have you taken any action to reduce your personal risk to hazards? *(Identify personal preparedness measures to list here according to each hazard in the HIRA)*
  - Developed a disaster plan for my family, home, or business
  - Maintain a disaster supply kit for my family, home, or business
  - I have not taken any of these actions
  - Other
- Do you have any additional comments or questions for the State Interagency Hazard Mitigation Committee during this process?

- If you would like to receive responses to your comments/questions in the previous question or would like to receive updates on the hazard mitigation planning process, please provide your name and email address.

D. Draft Social Media Strategy

1. Conduct Social Media Gap Analysis

Determine RIEMA and SIHMC's current social media capacity, understanding:

- Which social media platforms do RIEMA and SIHMC stakeholders commonly use? And which platforms get the most engagement? (e.g. Facebook, Twitter, Instagram, Youtube, Periscope, Snapchat, YikYak)
- Does RIEMA or SIHMC members have a social media use policy?
    - How does RIEMA respond to engagement on social media (including direct comments and general public sentiment)?
    - Does RIEMA have a set posting schedule/response time?
    - Does RIEMA have a set policy for dealing with misinformation?

2. Establish Goals for Social Media Strategy

The goals of the Social Media Strategy should be established by the SHMO, SIHMC and promoted by RIEMA, sample goals to be discussed are outlined below.

- To promote the hazard mitigation planning process to relevant agencies and the public
- To provide awareness to the public of hazard mitigation throughout the hazard mitigation planning process
- To encourage participation of relevant agencies and the public in the hazard mitigation planning process

3. Develop Content of Social Media Strategy

- Develop process specific content for distribution during the planning process
- Develop hazard specific content for distribution during the planning process

E. State Preparedness Month Campaign

National Preparedness Month occurs every September and provides an opportunity to promote Rhode Island's update of their state hazard mitigation plan, education citizens about the hazards that their state is vulnerable to, and promote actions that individuals can take to mitigate their risk to these hazards. Hagerty suggests the following approach to the implementation of a State Preparedness Month campaign:

1. Collate a list of the currently planned or previous planned activities for FEMA Preparedness Month. Consider other related activities for FEMA Preparedness Month, including:
    a. Coordinate with hardware stores to add preparedness month displays, emphasizing personal preparedness
    b. Coordinate with hardware stores to conduct classes for completing personal mitigation measures
    c. Involve the media for promotion of these activities
    d. Integrate the activities of local emergency management agencies
    e. Conduct activities each day of preparedness month
2. Produce messaging to integrate goals of preparedness month with the goals of the hazard mitigation planning process:
    a. Develop process specific content for distribution during the planning process
    b. Develop hazard specific content for distribution during the planning process
3. Prepare materials to conduct campaign
4. Conduct the State Preparedness Month campaign

B.3.2 Newsletters

8.2.1.1 August 2018

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August 2018

Welcome to the first issue of the ***Rhode Island State Hazard Mitigation Plan Monthly Newsletter***, an e-publication that curates news about the development of the plan, innovations in mitigation, and opportunities to get involved!

The Latest: Plan Development is in Full Swing

We are moving ahead in developing the draft plan, focusing on developing the capability analysis and mitigation strategy sections. The hazard profiles are under review by you, the stakeholders, and should be reviewed prior to the Risk Assessment and Mitigation Opportunities Meeting on September 5.

Hazard in Focus: Hurricanes and Tropical Storms

Tropical Cyclones are a type of hazard that effects Rhode Island. Tropical cyclones are the general term for tropical depressions, tropical storms, and hurricanes. These storms are very intense low-pressure wind systems that form over tropical oceans, deriving their strength from the high temperature surface waters. They can cause severe flooding from storm surge, downed trees, and structural damage. The figure below, "Storm Surge Inundation" depicts the storm surge inundation categories for the Rhode Island coast and therefore represents potential damage from different hurricane strengths.

The primary difference between these three storms is their maximum sustained windspeed.

- Tropical Depression: maximum sustained surface wind speed is less than 39 mph.
- Tropical Storm: maximum sustained surface wind speed from 39-73 mph.
- Hurricane: maximum sustained surface wind speed exceeds 73 mph.

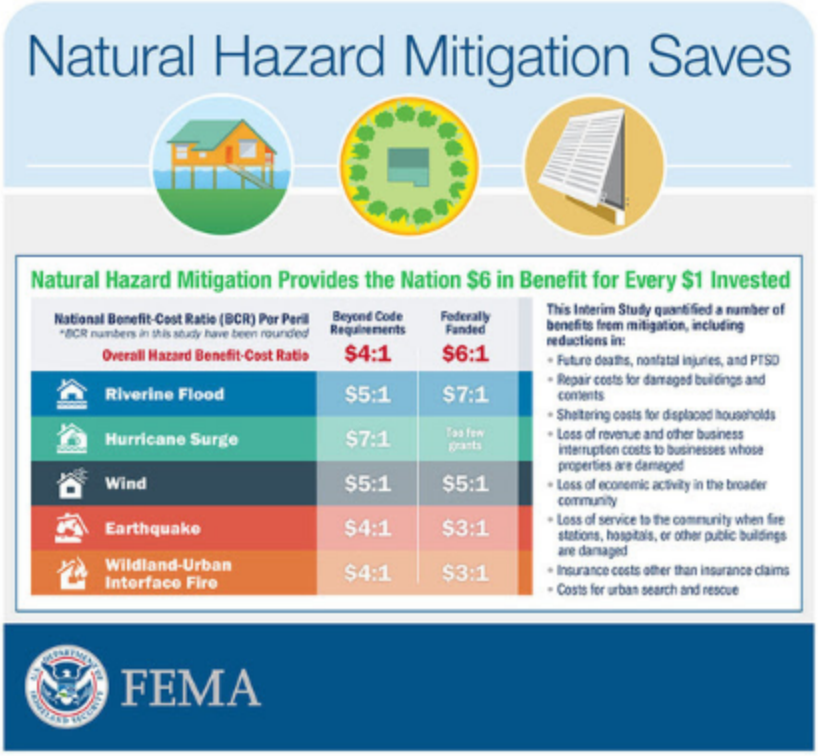
Once maximum sustained winds above 73 mph have been reached, the strength of the hurricane measured through the Saffir-Simpson Scale.
Tropical cyclones, including hurricanes and tropical storms, are likely to occur in the State of Rhode Island. Moreover, the whole state has been significantly impacted by past tropical cyclones and will continue to be vulnerable to the effects of future storms. Most recently, Rhode Island was effected by two hurricanes: Hurricane Sandy in 2012 and Hurricane Irene in 2011. Both storms caused notable damage throughout the coastline.

Coastal Damage After Hurricane Sandy (The Westerly Sun, 2016)

Hazard in Focus: Study Shows Mitigation Projects Save Money!

Recently, researchers with the National Institute of Building Sciences (NIBS), a non-profit group dedicated to the advancement of best practices in building construction, examined 23 years of data collected on federally funded mitigation grants. The **results of this study**, published in December 2017, demonstrate that federal mitigation funding **can actually save the country $6 in future disaster costs for every $1 invested in hazard mitigation!**

NIBS researchers also found that investing in hazard mitigation measures that exceed certain provisions of the 2015 International Building Code can **save the nation $4 in damages for every $1 spent, in addition to creating jobs, reducing injuries and deaths, and increasing consumption of domestically-produced construction materials.**



Rhode Island Mitigates: Newport Restoration Foundation leads in Preserving Historic Architecture in the context of a changing climate

The **Newport Restoration Foundation** (NRF) has paved the way for **strategic historic preservation** given the impact a changing climate will have on natural hazards, such as hurricanes. The NRF owns many homes in the Point Neighborhood of Newport, RI, which has one of the highest concentrations of colonial-era structures on the continent. In 2012, Hurricane Sandy caused flooding throughout the neighborhood.

Knowing this flooding would inevitably come to the neighborhood again, the NRF started their **Keep History Above Water Initiative** - which aims to bring together local, national, and international stakeholders working at the cross section of historic preservation and climate change for an annual conference. This initiative also is using one of the NRF properties in the Point Neighborhood, **74 Bridge Street**, as a case study for developing mitigation and resilience **strategies** for historic preservation.

74 Bridge Street, NRF's case study for resilient historic preservation (NRF, n.d.)

Looking Ahead: Upcoming Events

September

5

The Planning Team will host a **Risk Assessment and Mitigation Opportunities Meeting** on **Wednesday, September 5, 2018, from 9:30 am - 12:30 pm** at the Warwick Public Library (600 Sandy Lane; Warwick, RI). At this meeting, you will be invited to provide feedback on the risk assessment profiles and current/future mitigation actions for the Plan Update! You can register to attend this meeting **here** or by clicking on the link in the invite you received via email.

October

10

Save the date! The Planning Team will host a **Plan Review Meeting** on **Wednesday, October 10, 2018.** At this meeting, you will be able to provide feedback on the entire draft plan, for integration into the final plan that will be submitted to FEMA!

Get Involved

The Planning Team welcomes your input! If you would like more information on specific elements of the project, or if you believe that you may be able to supply critical information during the planning process, please reach out to our Planning Team leadership:

Melinda Hopkins
RIEMA, Mitigation Planning Supervisor & State Hazard Mitigation Officer
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8.2.1.2 September 2018

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September 2018

Welcome to the second issue of the ***Rhode Island State Hazard Mitigation Plan Monthly Newsletter***, an e-publication that curates news about the development of the plan, innovations in mitigation, and opportunities to get involved!

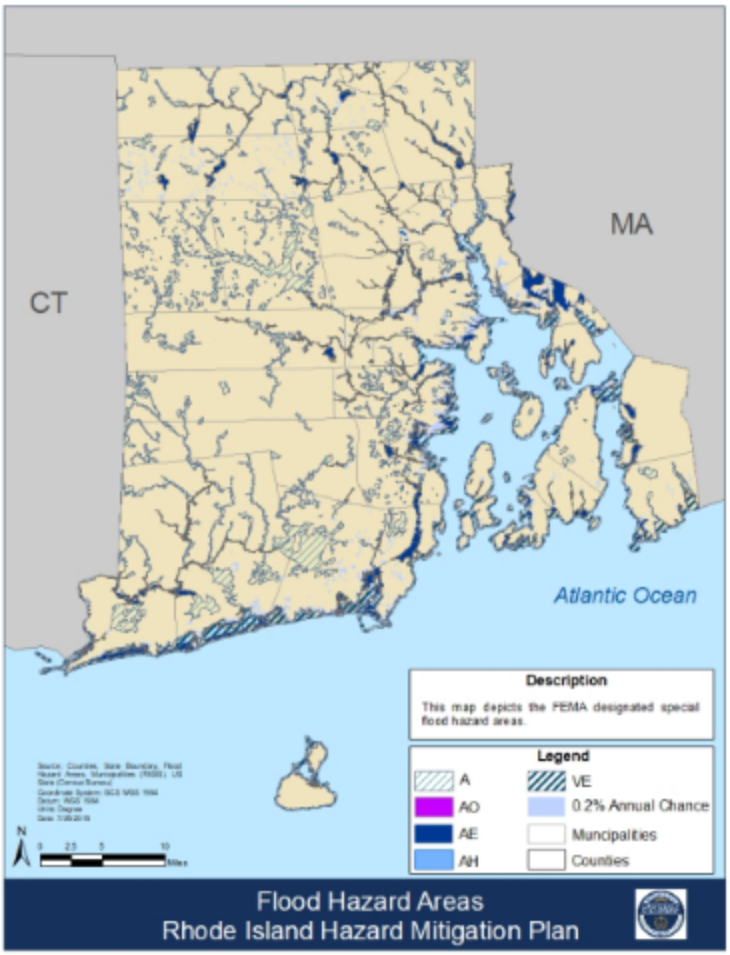
The Latest: Plan Development is in Full Swing

We are moving ahead in developing the draft plan, focusing on finalizing the the hazard identification and risk assessment (HIRA) and mitigation strategy sections. The team is reviewing your feedback on the HIRA profiles and mitigation strategy and integrating the information into the draft plan, which will be made available for stakeholder and public review on October 15, 2018.

Hazard in Focus: Flood

Flooding is the most prevalent and frequent natural hazard that impacts Rhode Island and therefore is a high priority hazard for the Hazard Mitigation Plan. The State has a long history of flooding, including riverine, flash, urban, and coastal flooding. Flooding can occur in a variety of different locations in Rhode Island, but the FEMA Flood Hazard Areas are outlined in the map below and specific areas prone to riverine and urban flooding include:

- Pawtuxet River;
- Pawcatuck River;
- Woonasquatucket River;
- Blackstone River;
- Natick Area; and
- East Providence.



Flooding is expected to occur annually due to heavy precipitation, hurricanes and tropical storms, winter and coastal storms, ice jams, and dam failures. According to historical data, Providence County has experienced the most flood events in the State.

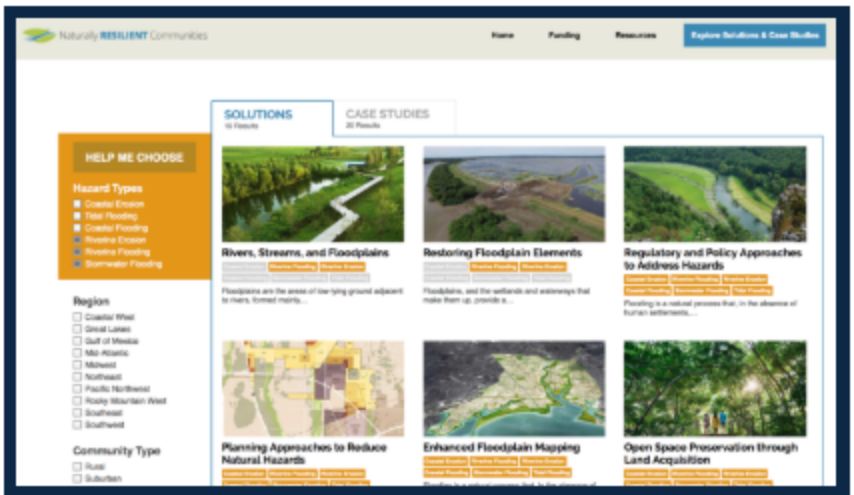
Record Flooding Along the Pawtuxet River (NWS, 2010)

Hazard in Focus: Study Shows Mitigation Projects Save Money!

Naturally Resilient Communities is **an interactive tool** featuring 30 case studies of places that rely on nature-based solutions to protect themselves against storm-related threats like flooding and coastal erosion.

The tool prompts users to select a hazard their city faces as well as their region, community type (urban, suburban, or rural), and desired scale and cost of a project. Then, a menu pops up listing relevant mitigation efforts around natural infrastructure, such as green streets that reduce the flow of stormwater and wetland habitats that combat flooding.

Naturally Resilient Communities also features **a webpage that outlines funding options** that cities can explore to support these innovative strategies!



Naturally Resilient Communities provides planners a tool to customize mitigation solutions to the needs of their own community.

Rhode Island Mitigates: Rhode Island Flood Mitigation Association

The **Rhode Island Flood Mitigation Association** (RIFMA) plays a large role in developing a culture of flood mitigation to increase resilience in the State. The goal of the association is to form a network of associates who could bring their ideas and experiences to a forum for people to share and learn from. Through this, the association looks forward to advance flood mitigation through professional development for city and county officials, consulting engineers and surveyors, state government agencies, watershed districts, federal government agencies, and insurance agents involved with floodplain management.

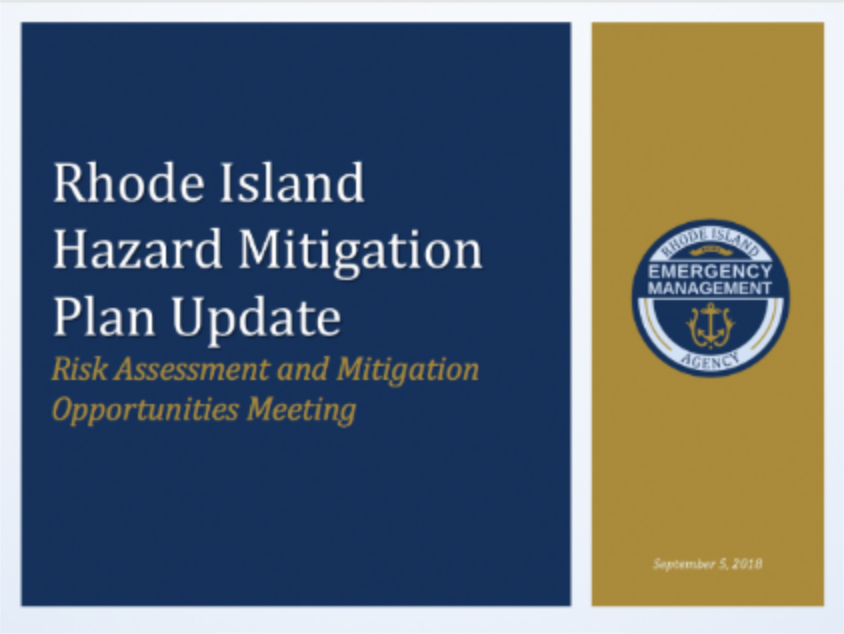
Specifically, RIFMA hosts a conference annually, holds exams for Certified Floodplain Management (CFM) certification, and provides information to members through the **newsletter** and **social media**.

RIFMA Homepage

Mitigation Planning Process: Risk Assessment and Mitigation Opportunities Meeting

On September 5, the State Interagency Hazard Mitigation Committe (SIHMC) attended the Risk Assessment and Mitigation Strategies meeting at the Warwick Public Library. A robust group of stakeholders participated in this meeting, including representatives agencies such as: Rhode Island Historic Preservation & Heritage Commission (RIHPHC), University of Rhode Island Coastal Resources Center (URI CRC), Rhode Island Department of Health (RIDOH), and the Rhode Island Public Transit Authority (RIPTA).

Hagerty Consulting presented an overview of the risk assessment methodology and results, as well as the proposed mitigation strategy goals and objectives. During this meeting, there were two breakout exercises where SIHMC members were encouraged to provide comments on the risk assessment and proposed mitigation strategy. These comments were collected at the end of the meeting to be incorporated into the plan.



Looking Ahead: Upcoming Events

October

31

Save the date! The Planning Team will host a **Plan Review Meeting** on October 31, 2018. At this meeting, you will be able to provide feedback on the entire draft plan for integration into the final plan that will be submitted to FEMA!

Get Involved

The Planning Team welcomes your input! If you would like more information on specific elements of the project, or if you believe that you may be able to supply critical information during the planning process, please reach out to our Planning Team leadership:

Melinda Hopkins
RIEMA, Mitigation Planning Supervisor & State Hazard Mitigation Officer
melinda.hopkins@ema.ri.gov
401-462-7141

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B.4 Internal Kick-off Meeting

B.4.1 Agenda

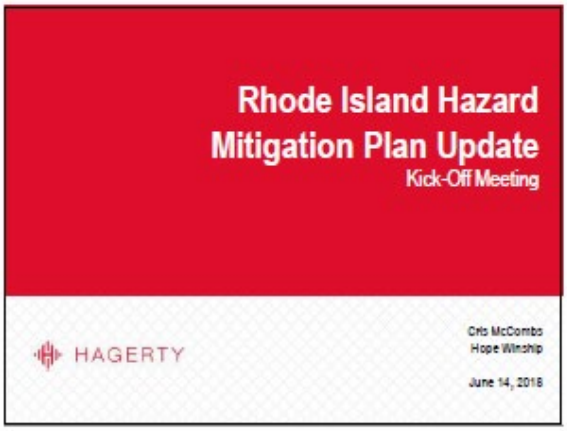
Rhode Island Emergency Management Agency
State Hazard Mitigation Plan Update
Kick-Off Meeting

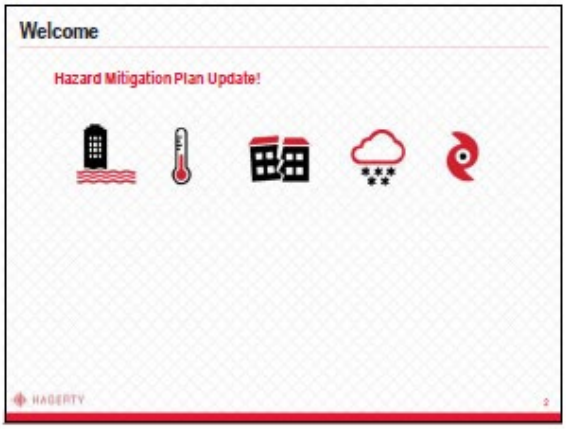
June 14, 2018
12:30 p.m. – 2:30 p.m.
645 New London Ave, Cranston, Rhode Island 02920

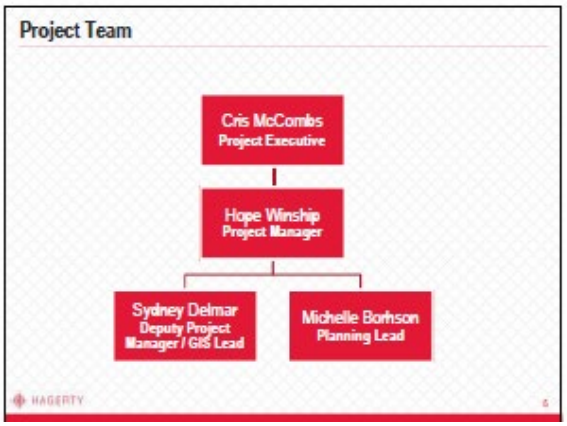
AGENDA

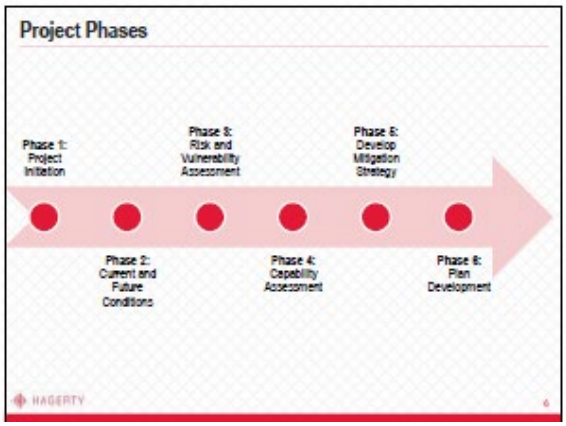
Topic	Time
Introductions and Agenda	12:30 – 12:40
Management ▪ Bi-Weekly Check-Ins ▪ Project Team	12:40 – 12:55
Schedule ▪ Initial Deliverables ▪ Meetings ▪ FEMA Review	12:55 – 1:15
Public Outreach and Stakeholder Engagement ▪ State Interagency Hazard Mitigation Committee Members ▪ Outreach Methods	1:15 – 1:35
Risk Assessment ▪ Integrating HIRA and Consequence Analysis ▪ GIS and Hazus Analysis	1:35 – 1:50
Initial Information Needs ▪ GIS Data ▪ Local Plans ▪ Mitigation Projects	1:50 – 2:10
Next Steps ▪ Templates ▪ Schedule Bi-Weekly Check-Ins ▪ Schedule Kick-Off Engagement ▪ Collect Data	2:10 – 2:30

B.4.2 Slide Deck









Project Management Tools

- Project Management Plan
- Bi-Weekly Check-Ins
- Outreach Strategy

Rhode Island Emergency Management Agency

Hazard Mitigation Plan Update

HAGERTY 7

Proposed Schedule: Initial Deliverables

- June 2018
  - Project Management Plan (Draft) – June 18
  - Project Management Plan (Final) – June 28
- July 2018
  - Outreach Strategy – July 18

HAGERTY 8

Proposed Schedule: Meetings

- Potential August 2018 Meetings
  - Risk and Capability Assessment Meeting
  - Mitigation Strategy Meeting
- October 2018
  - Plan Review Meeting
- Timeframe and Alignment with State Interagency Hazard Mitigation Committee (SIHMC) Quarterly Meetings
  - Support two Quarterly Meetings

HAGERTY 9

Proposed Schedule: Drafting and FEMA Review

- September 2018
  - Initial Draft (RIEMA Review) – September 17
- October 2018
  - Final Draft (SIHMC Review) – October 3
- November 2018
  - Final Draft – November 1
  - Submission to FEMA – November 6
- March 2019
  - Support Submission of Adoption for Approval – March 15

HAGERTY 10

Engagement: Stakeholder Involvement

- Target groups for SIHMC and planning involvement
  - Members of Recovery Planning Team
  - Local and regional community group stakeholders
  - Private sector
- Public outreach?
  - Social media
  - Survey

HAGERTY 11

Engagement: Initial Planning

- Validate identified hazards
- Identify additional information for risk and capability assessment

HAGERTY 12

Engagement: Stakeholder Outreach Methods

- Website
  - Planning materials
  - Comment forms
  - Public risk/mitigation information
- Newsletters
- Social media

HAGERTY 13

Risk Assessment

- Review Hazard Identification and Risk Assessment (HIRA) and Consequence Analysis
  - Validate hazards
  - Use best available information (from the last year)
- Update Vulnerability Assessment and GIS Analyses
  - Identify additional analyses to complete – Hazus

HAGERTY 14

Initial Information Needs

- Data
  - Defining state assets and critical infrastructure
  - Repetitive Loss and Severe Repetitive Loss
  - Property values?
- Plans
  - 2014 Word documents
  - Local Hazard Mitigation Plans
- Mitigation Successes
  - Mitigation funding and projects
  - "Successful" projects

HAGERTY 15

Next Steps

- Meeting Recap
- Schedule
  - Bi-Weekly Check-In
  - Initial SIHMC Engagement
- Collect Data
  - Research for plan updates
  - Risk analysis

HAGERTY 16

Contact

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B.5 Risk Assessment and Mitigation Opportunities Meeting

B.5.1 Invitation

B.5.2 Agenda

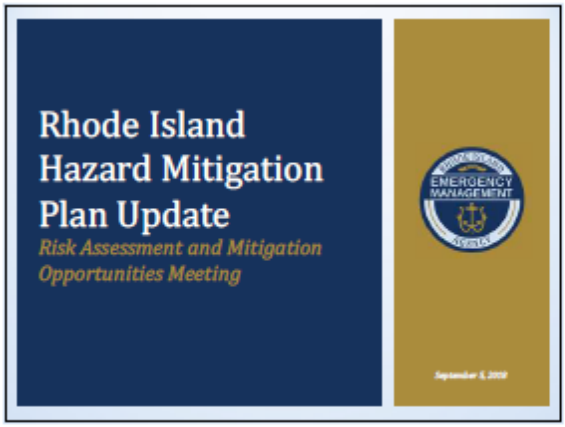
AGENDA

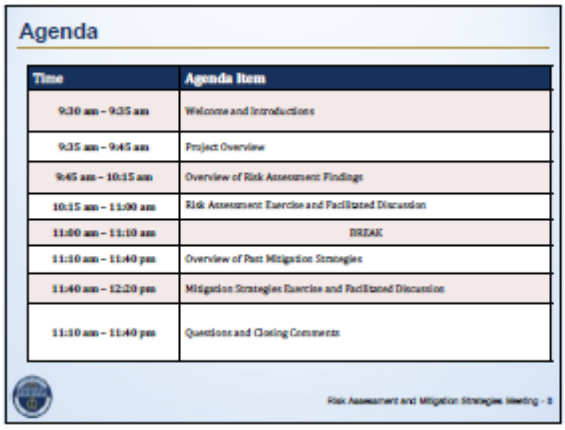
Risk Assessment and Mitigation Opportunities Meeting

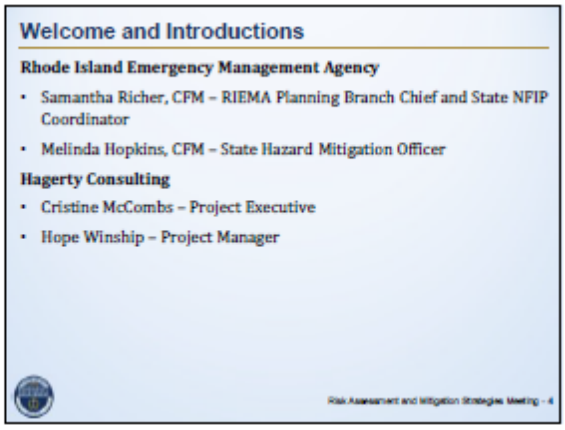
September 5, 2018, 9:30 am – 12:30 pm

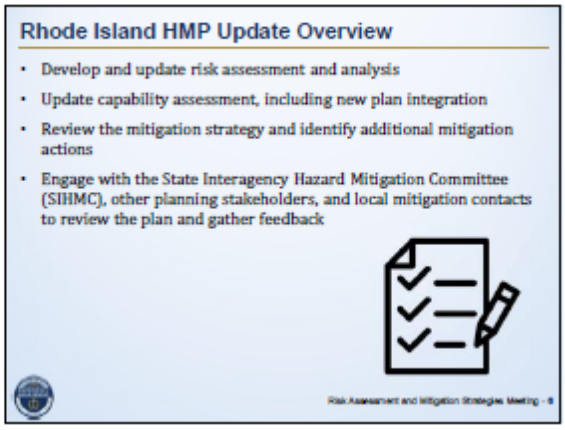
Time	Speaker	Activity
9:00 am		Registration and Check-in
9:30 am	Rhode Island EMA Cristine McCombs, Hagerty Consulting	Welcome and Introductions
9:35 am	Hope Winship, Hagerty Consulting	Project Overview
9:45 am	Hope Winship, Hagerty Consulting	Overview of Risk Assessment Findings • Risk assessment methodology • Hazard profile and risk assessment summary
10:15 am	Hope Winship, Hagerty Consulting	Risk Assessment Exercise and Facilitated Discussion
11:00 am	Break	
11:10 am	Hope Winship, Hagerty Consulting	Overview of Past Mitigation Strategies
11:40 am	Hope Winship, Hagerty Consulting	Mitigation Strategies Exercise and Facilitated Discussion
12:20 pm	Hope Winship, Hagerty Consulting Cristine McCombs, Hagerty Consulting	Questions and Closing Comments

B.5.3 Slide Deck









Risk Assessment

Risk Assessment Hazards

Natural Hazards
- Dam Failure
- Drought
- Earthquake
- Infectious Disease
- Extreme Cold
- Extreme Heat
- Fire
- Flood
- High Wind
- Hurricane and Tropical Storm
- Sea Level Rise
- Severe Winter Weather
- Thunderstorms
- Tornado

Technological Hazards
- Infrastructure Failure

Human-Caused Hazards
- Biological Incident
- Chemical Incident
- Civil Unrest
- Cybersecurity Incident
- Radiological Incident
- Terrorism

Exposure Analysis and Hazus Methodology

- **Exposure Analysis**
  - Compiled critical facility and hazard spatial data
  - Conducted spatial analysis to determine location and number of critical facilities currently exposed to hazards
- **Hazus Analysis**
  - Used FEMA's Hazus-MH version 4.2 software to estimate losses to people, property, and the economy due to different storm scenarios
    - Deaths and Injuries
    - Damage to critical facilities, infrastructure, and general building stock
    - Business interruption and economic loss
  - Ran scenarios for Earthquake, Wind (Hurricane), and Flood

Risk Assessment Methodology

The **Composite Hazard Index** characterizes vulnerability in terms of **low, medium, or high** hazards using the scores from each of these parameters

Risk Assessment Category	Levels and Score	Score
Likelihood of Hazard Occurrence	Highly Likely (4), Likely (3), Potential (2), Unlikely(1)	**Highly Likely** (Greater than 90% annual probability), **Likely** (Between 50% and 89.9% annual probability), **Potential** (Between 1% and 49.9% annual probability), and **Unlikely** (Less than 1% annual probability)
Likely Range of Impact	Large (3), Medium (2), Small (1)	**Large** (40% to 100%), **Medium** (10% to 40%), **Small** (10% or less) of total jurisdictional boundaries
Probable Hazard Magnitude (Injuries and deaths, infrastructure shutdown, structure damage, environment, and state operations)	Significant (3), Limited (2), Negligible (1)	**Significant** (Multiple injuries and death, high damage, destruction, and shutdown), **Limited** (Some injuries, moderate damage and shutdown), **Negligible** (Minor injuries, small if any damage and shutdown.)

Risk Assessment Findings

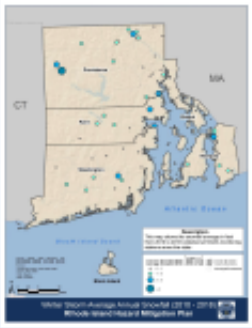
High Risk Hazards
- Severe Winter Weather
- Flood
- High Wind
- Extreme Heat
- Extreme Cold
- Hurricane and Tropical Storms
- Thunderstorms

Moderate Risk Hazards
- Dam Failure
- Fire
- Cybersecurity
- Chemical Incident
- Terrorism
- Infrastructure Failure
- Infectious Diseases

Low Risk Hazards
- Drought
- Earthquakes
- Tornado
- Biological Incident
- Radiological Incident
- Civil Unrest
- Sea Level Rise

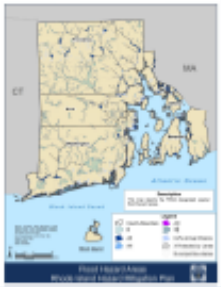
Severe Winter Weather

- High Risk Hazard
- Types:
  - Heavy snow and ice storms
- History in Rhode Island:
  - Two major disaster declarations due to winter storms in last 5 years
  - $22,500.00 in annualized damages across all counties since 1996
- Probability of Future Events:
  - Greater than 90% annual probability for all counties



Flood

- High Risk Hazard
- Types:
  - Riverine flooding, flash flooding, urban flooding, and coastal flooding
- History in Rhode Island:
  - Rhode Island has experienced 22 disaster or emergency declarations, (12 related to severe flooding and hurricanes)
  - More than $8.5 million in grants from PA due to Hurricane Sandy
- Probability of Future Events:
  - Greater than 90% annual probability in all counties



Risk Assessment and Mitigation Strategies Meeting - 13

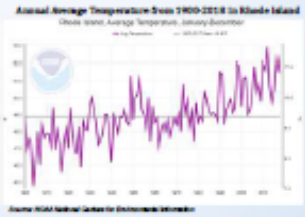
High Wind

- High Risk Hazard
- Types:
  - Synoptic-scale winds, thunderstorm winds, and tropical systems
- History in Rhode Island:
  - The NCEI has recorded 211 high wind events
  - Events have caused more than $2 million in total damages
- Probability of Future Events:
  - Greater than 90% annual probability in all counties
- Risk and Vulnerability:
  - 4,028 mobile homes in the state (most vulnerable building stock)

Risk Assessment and Mitigation Strategies Meeting - 14

Extreme Heat

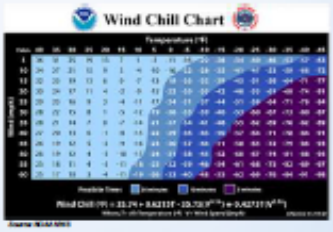
- High Risk Hazard
- History in Rhode Island:
  - In 1970, Providence had four (4) days with a maximum temperature over 90°F
  - Due to climate change, this number has risen to 22 days
- Probability of Future Events:
  - Greater than 90% annual probability in Kent, Providence, and Washington Counties
  - Between 50% and 89.9% annual probability in Bristol and Newport Counties



Risk Assessment and Mitigation Strategies Meeting - 15

Extreme Cold

- High Risk Hazard
- History in Rhode Island:
  - Between 2013 and 2018 there were **112 days** with a wind chill between 20°F and zero, and **68 days** when the wind chill was below zero
- Probability of Future Events:
  - Between 50% and 89.9% annual probability for all counties



Risk Assessment and Mitigation Strategies Meeting - 16

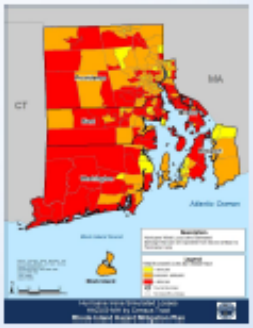
Hurricane and Tropical Storms

- High Risk Hazard
- Types of Tropical Cyclones:
  - Tropical depression
  - Tropical storm
  - Hurricane
  - Nor'easters
- History in Rhode Island:
  - Hurricane Sandy caused more than 122,000 people to lose power, and more than $39.4 million in support
- Probability of Future Events:
  - Between 50% and 89.9% annual probability in all counties

Risk Assessment and Mitigation Strategies Meeting - 17

Hurricane and Tropical Storms

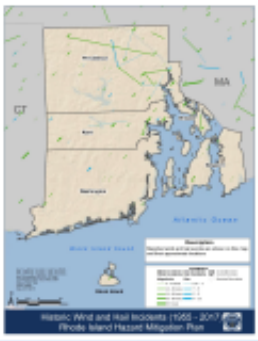
- Risk and Vulnerability:
  - Approximately **41,152** critical facilities, infrastructure, and commercial and residential properties are at risk from a Category 4 Hurricane
- Hazus-MH Annualized Hurricane Losses:
  - **$102,129,000** in annualized losses across all counties
  - Using a simulated Hurricane Irene storm, Providence experienced the highest annualized loss, with $30,746,000



Risk Assessment and Mitigation Opportunities Meeting - 18

Thunderstorms

- High Risk Hazard
- History in Rhode Island:
  - 40 significant (those causing injury, fatalities, and/or damage) lightning and hail events from 1996 to 2018
  - At least 20 injuries in the state of Rhode Island from 1996 to 2018
- Risk and Vulnerability:
  - Annualized losses range from $22,824 in Bristol County to $76,784 in Providence County
- Probability of Future Events:
  - Between 50% and 89.9% annual probability in all counties



Risk Assessment and Mitigation Strategies Meeting - 19

Dam Failure

- Moderate Risk Hazard
- History in Rhode Island:
  - Over 111 dam incidents have been recorded in Rhode Island, of which seven (7) resulted in dam failure
- Probability of Future Events:
  - Between 50% and 89.9% annual probability in Kent, Providence, and Washington Counties
  - Between 1% and 49.9% annual probability in Bristol and Newport Counties
  - Providence County has the highest risk of dam failure

Risk Assessment and Mitigation Strategies Meeting - 20

Fire

- Moderate Risk Hazard
- Types:
  - Urban fire and wildfire
- History in Rhode Island:
  - **Coventry Fire:** Largest wildfire in Rhode Island that burned 18,000 acres
  - **The Station Fire**: Urban fire that resulted in over 100 deaths and several injuries
- Probability of Future Events:
  - Greater than 90% annual probability for all counties

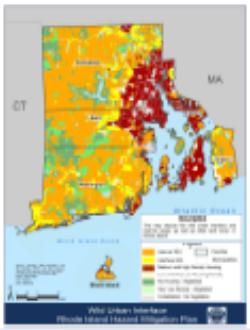
Prescribed Burn in South Kingstown, Rhode Island

Source: Rhode Island Division of Forest Environment, Wildland Fire Training, 2014

Risk Assessment and Mitigation Strategies Meeting - 21

Fire

- Risk and Vulnerability:
  - Fires can cause significant impact to the environment
  - Rhode Island's density increased to approximately 1,025 per square in 2017 from 1,018 in 2010, posing a greater risk to a fire event
  - Approximately **129,234** critical facilities, infrastructure, and commercial and residential properties are located in either the interface or intermix zones



Risk Assessment and Mitigation Opportunities Meeting - 22

Cybersecurity

- Moderate Risk Hazard
- History in Rhode Island:
  - One recent attack in 2016 lost a law firm up to $700,000 in revenue due to lack of access to files
  - The state has not yet experienced a major catastrophic cybersecurity incident that has led to extended disruptions of critical infrastructure
- Probability of Future Events:
  - Between 50% and 89.9% annual probability in all counties
- Risk and Vulnerability:
  - Property, critical infrastructure and facilities, businesses, and the public are all at risk

Source: [illegible]

Risk Assessment and Mitigation Strategies Meeting - 23

Chemical Incident

- Moderate Risk Hazard
- History in Rhode Island:
  - DEM has reported 579 oil spills during the last fiscal year
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in all counties
- Risk and Vulnerability:
  - Areas with high density in chemical manufacturing zones are **most vulnerable**

Source: Department of Environmental Management, 2011

Risk Assessment and Mitigation Strategies Meeting - 24

Terrorism

- Moderate Risk Hazard
- History in Rhode Island:
  - There has not been an attack reported in Rhode Island.
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in all counties
- Risk and Vulnerability:
  - Terrorists attacks pose a great threat to human life
  - Due to their unpredictability, all structures are vulnerable to an attack
  - Large-scale events, such as bombings, can pose significant threat to state operations

Risk Assessment and Mitigation Strategies Meeting - 26

Infrastructure Failure

- Moderate Risk Hazard
- History in Rhode Island:
  - The state has not experienced any direct, prolonged catastrophic infrastructure failures
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in all counties
- Risk and Vulnerability:
  - Lifeline sectors impacted from Infrastructure Failure:
    - Communications
    - Emergency Services
    - Energy
    - Information Technology
    - Transportation Systems
    - Water and Wastewater Systems

Risk Assessment and Mitigation Strategies Meeting - 26

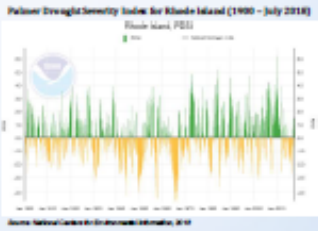
Infectious Diseases

- Moderate Risk Hazard
- History in Rhode Island:
  - There were 216 disease outbreaks in 2017
- Probability of Future Events:
  - Between 50% and 89.9% annual probability
- Risk and Vulnerability:
  - CDC Scenario 30% attack rate: 317,892
  - CDC Scenario 0.8% Hospitalization Rate: 2,543
  - CDC Scenario 0.2% Mortality Rate: 636

Risk Assessment and Mitigation Strategies Meeting - 27

Drought

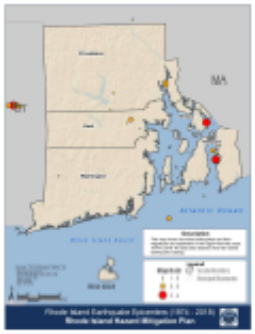
- Low Risk Hazard
- History in Rhode Island:
  - **Three drought events** affecting each county in the State have been documented by NCEI since 1993, all in the spring and summer of 2012
- Probability of Future Events:
  - Less than 1% annual probability for all counties
- Risk and Vulnerability:
  - **High impact** on the economy and environment



Risk Assessment and Mitigation Strategies Meeting - 28

Earthquakes

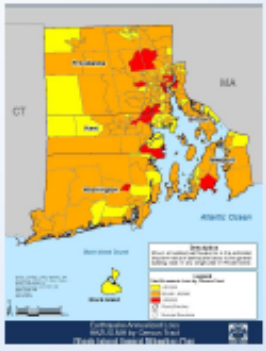
- Low Risk Hazard
- History in Rhode Island:
  - Rhode Island has experienced 34 felt earthquakes between 1766 and 2016
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in Kent and Newport Counties
  - Less than 1% annual probability in Bristol, Providence, and Washington Counties



Risk Assessment and Mitigation Strategies Meeting - 29

Earthquakes

- Risk and Vulnerability:
  - All critical facilities in the planning areas are exposed to the earthquake hazard which causes significant risk
- Hazus-MH Annualized Earthquake Losses:
  - $3,578,000.00 in annualized building losses across all counties
  - Providence would experience the highest annualized building losses, $2,195,000



Risk Assessment and Mitigation Opportunities Meeting - 30

Tornado

- Low Risk Hazard
- History in Rhode Island:
  - Rhode Island has had 11 tornadoes since 1950 with property damages amounting to approximately $8 million
- Probability of Future Events:
  - Less than 1% annual probability in all counties
- Risk and Vulnerability:
  - Potential to cause extensive damage to **critical infrastructure**
  - May cause significant damage by **exposing hazardous materials**

Risk Assessment and Mitigation Strategies Meeting - 31

Biological Incident

- Low Risk Hazard
- History in Rhode Island:
  - There has not been a significant example of a human-caused biological incident in the State of Rhode Island
- Probability of Future Events:
  - Less than 1% annual probability in all counties
- Risk and Vulnerability:
  - The entire State of Rhode Island's population is vulnerable to the effects of a biological attack
  - Large numbers of people could become ill or die

Risk Assessment and Mitigation Strategies Meeting - 32

Radiological Incident

- Low Risk Hazard
- History in Rhode Island:
  - No previous high impact incidents have been reported
  - Millstone Power Station has had periodic shutdown of its Unit 2 and Unit 3 reactors, with its Unit 1 reactor permanently shut down in 1998
- Probability of Future Events:
  - Less than 1% annual probability in all counties
- Risk and Vulnerability:
  - **Eleven municipalities** are located within both of the 50-mile ingestion pathways

Millstone Power Station

Source: NRC, 2017

Risk Assessment and Mitigation Strategies Meeting - 33

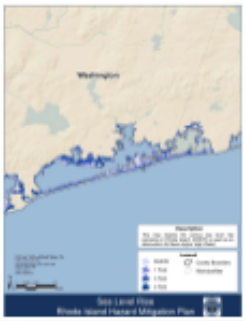
Civil Unrest

- Low Risk Hazard
- History in Rhode Island:
  - Two significant local incidents have occurred in recent years
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in all counties
- Risk and Vulnerability:
  - Civil unrest can present significant risk to **property, structures, and facilities**, potentially causing billions of dollars in **property damage**
  - People, especially those within the most vulnerable groups, are most at risk

Risk Assessment and Mitigation Strategies Meeting - 34

Sea Level Rise

- Low Risk Hazard
- Probability of Future Events:
  - Between 1% and 49.9% annual probability in all counties
  - NOAA model anticipates sea levels to be approximately 0.6 feet to 6.66 feet higher by 2100
- Risk and Vulnerability:
  - Approximately **4,490** critical infrastructure, facilities, commercial, and residential structures are at risk with 5 feet of sea level rise



Risk Assessment and Mitigation Strategies Meeting - 35

Interactive Exercise #1

Interactive Exercise #1 Instructions

- Place the yellow dots over hazards that require additional considerations
- We will discuss the results from the exercise as a group afterwards

Interactive Exercise #1 Considerations

- Is there anything in the hazard risk profile that should be changed, added, or removed? How would you prioritize each change: high, medium, or low priority?
- Is there a vulnerability identified in this hazard risk profile that is a top priority to address?
  - For example, one vulnerability for flooding is the "loss of property"

Interactive Exercise #1 Group Discussion

Discuss your key findings and takeaways from the interactive exercise.

- Were there any major changes needed for the risk assessment?

BREAK

We will reconvene in 10 minutes

Mitigation Strategies

Mitigation Strategy

What is a Mitigation Strategy?

- Long-term blueprint for reducing the potential losses identified in the risk assessment
- Describes how the state will accomplish the overall purpose, or mission, of the planning process – to reduce risk from the identified hazards
- Reflects the values and priorities of the community
- Addresses current and future threats

Mitigation Strategy Components

Defining Goals, Objectives, and Actions

- **Goals:** General guidelines that describe what the state would like to achieve
- **Objectives:** Define strategies that must be implemented to achieve the identified goal
- **Actions:** The specific activities the state will take to reduce or eliminate risks
  - There must be at least one mitigation action for each identified hazard
  - Mitigation actions should be realistic and sustainable

Mitigation Strategy Components

Defining Goals, Objectives, and Actions

Example:

- **Goal:** Minimize new development in hazard-prone areas
- **Objective:** Reduce the number of vulnerable structures in flood hazard areas
- **Action:** Develop a plan and prioritization for property acquisition

2014 State Hazard Mitigation Plan Goals

Goal 1: Rhode Island has the capacity to promote and implement projects, programs, plans, policies, and legislative actions to reduce vulnerability to natural hazards, in particular for properties with repetitive and SRLs due to flooding.

Goal 2: Statewide coordination with organizations, agencies, and stakeholders.

Goal 3: Local communities address natural hazards and long-term risk reduction in local decision making and planning.

Goal 4: The public understands, supports, and acknowledges the need for hazard mitigation.

Goal 5: The built environment and infrastructure are resilient to the impacts of natural hazards.

Proposed 2019 Mitigation Vision and Goals

Vision:

Rhode Island is resilient to natural, technological, and adversarial hazards and climate change.

Goals:

Goal 1: Rhode Island has the capacity to promote and implement projects, programs, plans, policies, and legislative actions to reduce vulnerability to natural, *technological, and adversarial hazards*, in particular for properties with RLs and SRLs due to flooding.

Goal 2: Statewide *coordination of hazard mitigation* with organizations, agencies, and stakeholders.

Goal 3: Local communities address natural, *technological, and adversarial hazards* and long-term risk reduction in local decision making and planning.

Goal 4: The public understands, supports, and acknowledges the need for hazard mitigation.

Goal 5: The built environment, infrastructure, *people, natural environment, and economy* are resilient to the impacts of *natural, technological, and adversarial hazards*.

2014 State Hazard Mitigation Plan Objectives

Goal 1: Rhode Island has the capacity to promote and implement projects, programs, plans, policies, and legislative actions to reduce vulnerability to natural, *technological, and adversarial hazards*, in particular for properties with RLs and SRLs due to flooding.

- Objective 1.1 Maintain and implement a SHMP that fosters innovation, advances public support, and gains long-term commitments for action from all stakeholders.
- Objective 1.2 Increase the capacity of, and diversify the representation of SIHMC.
- Objective 1.3 Increase the capability of Rhode Islanders to address natural hazards in their daily lives and work.

Discussion: Validate the goals and objectives for the 2019 Plan.

2014 State Hazard Mitigation Plan Objectives

Goal 2: Statewide *coordination of hazard mitigation* with organizations, agencies, and stakeholders.

- Objective 2.1 Leverage resources and expertise and capitalize on opportunities that will further hazard mitigation efforts.
- Objective 2.2 Institutionalize hazard mitigation into the activities of all stakeholders.
- Objective 2.3 Increase communications and stream line policies, procedures, and operations to eliminate conflicts and duplication of effort.

Discussion: Validate the goals and objectives for the 2019 Plan.

2014 State Hazard Mitigation Plan Objectives

Goal 3: Local communities address natural, ***technological, and adversarial hazards*** and long-term risk reduction in local decision making and planning.

- Objective 3.1 Aid in the development and implementation of LHMP.
- Objective 3.2 Improve the quality of Comprehensive Plans in addressing natural hazards.
- Objective 3.3 Increase the capabilities of local decision makers in hazard mitigation.

Discussion: Validate the goals and objectives for the 2019 Plan.

2014 State Hazard Mitigation Plan Objectives

Goal 4: The public understands, supports, and acknowledges the need for hazard mitigation.

- Objective 4.1 Identify and educate the public about hazard specific issues.
- Objective 4.2 Engage the private sector in hazard mitigation initiatives.
- Objective 4.3 Increase public and private sector coordination.

Discussion: Validate the goals and objectives for the 2019 Plan.

2014 State Hazard Mitigation Plan Objectives

Goal 5: The built environment, infrastructure, ***people, natural environment, and economy*** are resilient to the impacts of ***natural, technological, and adversarial hazards.***

- Objective 5.1 Implement measurable actions to reduce vulnerability.
- Objective 5.2 Increase and measure losses avoided as a result of mitigation actions.

Discussion: Validate the goals and objectives for the 2019 Plan.

Mitigation Opportunities

- Risk Assessment results will be used to develop mitigation actions
- **Mitigation Action:** specific action, project, activity, or process taken to reduce or eliminate long-term risk to people and property from hazards and their impacts
  - Local plans and regulations
  - Structural projects
  - Natural systems protection
  - Education programs
  - Preparedness and response actions

Ongoing Mitigation Actions

Discussion: What were the pros and cons of using this mitigation action tracker? What changes would you like to see made for the future?

Title	Activity Description	Vulnerabilities Addressed	Lead Agency	Priority	Current and Potential Funding Sources	Cost Benefit	Timeframe for Completion	Date if Known	2018 Status
Floodplain Management Education and Training	Work in coordination with other State, local municipalities and organizations to mitigate damage in hazard prone areas through acquisition, elevation or relocation. Conduct outreach and training to community leaders specifically focusing on the floodplain assessment program.	Properties at risk for flooding	ORM	High	Agency Fiscal budget	No Cost Benefit to be Complete d	Long Term (>3 years)		
Floodplain Management Education and Training	Work in coordination with other State, local municipalities and organizations to mitigate damage in hazard prone areas through acquisition, elevation or relocation. Conduct outreach and training to community leaders specifically focusing on the floodplain assessment program.	Properties at risk for flooding	ORGS	High	Agency Fiscal budget	No Cost Benefit to be Complete d	Long Term (>3 years)		

Ongoing Mitigation Actions

- SLR Policies:
  - Based on SLR modeling, develop and propose policies to reduce risks for new development, including consideration towards relocating structures or reducing existing hazards within inundation areas with increasing risk
    - Policies should also address appropriate use of federal and state mitigation monies
- Natural Hazard and Climate Change Vulnerability Database:
  - Work with the National Weather Service and local communities to develop a statewide database of how natural hazards impact communities throughout Rhode Island
    - Includes documenting frequency and intensity of past hazards and future probabilities. Assessment of hazard events to include vulnerability to climate change
    - Hazard Prone environmentally sensitive lands will be made available to local communities to ensure integration with local communities to ensure integration with local risk assessments and mitigation activities

New Mitigation Actions

- Natural Systems Protection:
  - Implement a wildfire fuels management program to reduce hazardous vegetative fuels threatening critical infrastructure and private homes/property
  - Protect and restore natural coastal buffers to mitigate risk of storm surge
  - Review coastal mapping and preserve high hazard areas as open space
- Non-Natural Hazards:
  - Technological and Adversarial Vulnerability Database: Develop a statewide database of how technological and adversarial threats and hazards impact communities throughout Rhode Island
  - Work to educate industry on ways to mitigate cyber threats affecting personal, private, and state security and other sensitive information

Risk Assessment and Mitigation Opportunities Meeting - 86

Interactive Exercise #2

Interactive Exercise #2 Instructions

- Place the green dots over hazards for which you have identified mitigation actions
- We will discuss the results from the exercise as a group afterwards

Risk Assessment and Mitigation Strategies Meeting - 87

Interactive Exercise #2 Considerations

- Think back to exercise #1, was there a vulnerability you identified in this hazard risk profile that is a top priority to address? If so, what are some actions that you think can be taken to mitigate these risks?
  - The example used in exercise #1 was loss of property due to flooding; some actions that can be taken to mitigate this could be elevating, floodproofing, or relocating the property
- What other actions can you think of that would be helpful in mitigating risk to this hazard?
  - An example of this includes an educational outreach, campaigns

Risk Assessment and Mitigation Strategies Meeting - 88

Interactive Exercise #2 Group Discussion

Discuss key findings and takeaways from the interactive exercise.

- What were the mitigation actions you brainstormed?
- Do you have any additional considerations for the 2019 State Hazard Mitigation Plan mitigation strategy?

Risk Assessment and Mitigation Strategies Meeting - 89

Questions & Conclusion

Upcoming Key Dates

- Draft Hazard Mitigation Plan delivered to RIEMA for review: **September 26**
- Draft Hazard Mitigation Plan delivered to State Interagency Hazard Mitigation Committee for review: **October 15**
- Plan Review Meeting in late October – location and date TBD

Risk Assessment and Mitigation Strategies Meeting - #1

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Risk Assessment and Mitigation Strategies Meeting - #2

B.5.4 Handout Materials and Exercises

Risk Assessment and Mitigation Opportunities Meeting

Exercise Comment Sheet

Directions: Please read the interactive exercise considerations and guiding questions on the screen. Once you have placed a dot on a map, please mark the number and your corresponding comment on the sheet.

- **Risk Assessment Exercise** (Exercise #1): Use the yellow dots to signify areas for additional risk assessment considerations.
- **Mitigation Strategies Exercise** (Exercise #2): Use the green dots to signify areas where new actions are needed to mitigate the risk to the identified hazards.

Dot Number	Comment

B.5.5 Meeting Notes

Meeting Notes

Risk Assessment and Mitigation Opportunities Meeting

September 5, 2018, 9:30 am – 12:30 pm

Summary of Meeting

Introductions and Project Overview

The purpose of this meeting was to review the Risk Assessment results as well as the proposed Mitigation Strategy for the 2019 State Hazard Mitigation Plan Update. Sam Richer (Planning Branch Manager, RIEMA) and Cristine McCombs (Project Executive, Hagerty) delivered introductory remarks to the SIHMC members in attendance. Hope Winship, Hagerty Project Manager, provided an overview of the presentation content and meeting objectives. She emphasized the importance of stakeholder engagement and the State Interagency Hazard Mitigation Committee's (SIHMC) roles and responsibilities in updating the state hazard mitigation plan.

Risk Assessment Review

Hagerty explained the methodology of the Risk Assessment, including the exposure analysis, Hazus-MH 4.2 hazard scenarios, and the Composite Hazard Index used to create the hazard ranking. Hagerty noted the change in definition of "likelihood of hazard occurrences", a departure from the HIRA completed in 2016.

Hagerty then reviewed each of the hazards profiled for the 2019 plan update, summarizing previous occurrences, probability of future impacts, vulnerability, and overall hazard ranking. In order of hazard ranking, the hazards discussed include:

- Severe Winter Weather
- Flood
- High Wind
- Extreme Heat
- Extreme Cold
- Hurricane and Tropical Storms
- Thunderstorms
- Dam Failure
- Fire
- Cybersecurity
- Chemical Incident
- Terrorism
- Infrastructure Failure
- Infectious Diseases
- Drought

- Earthquakes
- Tornado
- Biological Incident
- Radiological Incident
- Civil Unrest
- Sea Level Rise

Throughout the Risk Assessment Review portion of this meeting, members of the SIHMC made the following general comments:

- Several meeting participants requested to see the methodology used to rank hazards in the Composite Hazard Index. The group discussed the need to review the weight of different index factors, especially "past occurrences", to ensure that they are appropriately considered in the overall hazard ranking.
- Hagerty affirmed that both long-term and short-term impacts were considered in the risk assessment. In addition, each hazard profile considers both quantitative and qualitative impacts.

During the Risk Assessment Review, Hagerty responded to the following hazard-specific questions and comments from SIHMC members:

Sea Level Rise

- A SIHMC member asked the reasoning behind Sea Level Rise's "low" hazard ranking. Hagerty explained that it was not necessarily due to impacts, which are considered high, but to the low probability of occurrence throughout the state (only coastal areas will see impacts).
- A SIHMC noted that health impacts should also be considered as part of Sea Level Rise due to limited access to healthcare. There are maps that identify the location of frequently flooded roads that should be considered.

Drought

- A SIHMC member asked the reasoning behind Drought's "low" hazard ranking. Hagerty explained that it was due to probability as well as due to the varying degree of impacts to different community sectors.

Severe Winter Weather

- A SIHMC member asked how damages were calculated and whether insurance reports are included in this calculation. Hagerty responded that damages were calculated based on reported insurance damages, but not if insurance did not cover the damage. Additionally, Hagerty clarified that these damages were cumulative, not necessarily based on a singular event.
- Hagerty clarified that Nor'easters were addressed as part of Hurricanes and Tropical Storms hazard profile.

Flood

- Hagerty confirmed that Rhode Island has only received grants from FEMA for recovery and mitigation from flooding events.

- Hagerty clarified that all hazard profiles discuss how climate change and changes in land use and development will change the impacts of the hazard.

High Wind

- There was a comment to ensure that we incorporate an event-by-event breakdown of public infrastructure costs.
- Hagerty responded to a question about why high winds were ranked high. This ranking is primarily due to the high probability of future events. The ranking and methodology will be reviewed for the final draft plan.
- A threshold for a high wind event will be incorporated into the final draft of the high wind profile.

Hurricane and Tropical Storms

- The group discussed and decided to change the profile name to "Tropical and Extratropical Storms", especially since Nor'easters are included in this hazard profile.
- A SIHMC member commented that there is updated storm surge data available via STORMTOOLS. The profile map will be updated using 100-year scenario + 3' sea level rise.

Thunderstorms

- Hagerty will consider weighting the county size in the annual losses assessment for previous Thunderstorm events based on a SIHMC's members comment.

Tornado

- A SIHMC commented that services and mutual aid are provided when a tornado is close along the state border, but still in another state. This information should be included as part of the Tornado profile.

Civil Unrest

- A SIHMC commented that the civil unrest definition should align with the definition used in the THIRA. Additionally, the profile will be revised to ensure that disruption of service is included as part of the assessment.

Interactive Exercise #1: Risk Assessment

Following the review of the Risk Assessment results, meeting attendees participated in an interactive hazard mapping exercise. Meeting attendees placed numbered dots on maps hung around the room to identify the location of their comment(s) for a given hazard. All feedback was collected on comment cards and will be considered for incorporation into the Risk Assessment.

Mitigation Strategy

Hagerty reviewed the purpose of the plan's Mitigation Strategy and defined the role of mitigation goals, objectives, and actions in crafting this strategy. Hagerty reviewed the 2014 mitigation goals and objectives and then explained the proposed changes to these goals and objectives for the 2019

plan update. One main update to the 2019 goals and objectives included the addition of "adversarial and technological" threats to each of the goals.

Hagerty also presented on mitigation opportunities and actions. Mitigation opportunities are created based on the risk assessment results. Hagerty presented various types of mitigation opportunities, such as structural projects, educational programs, and natural systems protection, among others. Hagerty also posed a discussion regarding the action plan spreadsheet used to track updates to 2014 actions. Some of the comments from this discussion are summarized below. Lastly, Hagerty provided examples of ongoing mitigation actions from 2014 and proposed mitigation actions for the 2019 plan. SIHMC members identified and discussed several considerations and changes related to these 2019 mitigation goals, objectives, and actions. Overall comments and questions regarding the goals and objectives are included below:

- There was a discussion and consensus to change "adversarial" to "human-caused" hazards.
- A SIHMC commented that climate change is not mentioned in the goals and objectives and that the language should be changed to explicitly address "future conditions" in one or more of the goals.
- A SIHMC member noted that basic formatting and grammar should be reviewed (ex. RL and SRL should be spelled out completely).
- The mitigation strategy will be aligned with the Climate Resilience Action Strategy and incorporate information based on local plans in the local plan capability roll-up.
- Based on a comment from a SIHMC member, RIEMA explained the SIHMC is an invite only committee that includes agencies and organizations invited to participate in the hazard mitigation plan update.

Goal-specific feedback received from SIHMC members include:

Goal 1

- A SIHMC member noted that the language of Goal 1 should include broader language about repetitive loss to non-FEMA insured properties.
- A SIHCM member asked if Hagerty could be more specific with defining the terms of mitigation and preparedness in the plan (for example in Objective 1.3).
- Ensure that goals are broad enough. For example, there is no need to explicitly reference RL and SRL in goals since it can be inferred.

Goal 2

- A SIHMC noted that the CRCM developed new RI BFE maps "STORMTOOLS Design Elevation Maps" that are enhanced and provide voluntary flood elevations that people design and build to. Hagerty Consulting will incorporate this information as part of risk assessment updates.

Goal 3

- There were no comments and/or discussions regarding this goal.

Goal 4

- There was a discussion and consensus among the SIHMC that Goal 4's objectives are broad enough.

- A SIHMC member noted that the word "identity" should be reviewed and revised in Objective 4.1.
- A SIHMC member noted that the term "public" should be replaced with "stakeholders."
- A SIHMC member commented that it was necessary to review Objective 4.3 to include references to the public sector.

Goal 5

- A SIHMC member noted that Objective 5.1 should include a reference to reducing vulnerability after disasters during recovery.
- A SIHMC member noted that there is unusual wording in Objective 5.2. It was commented that the mitigation strategy should include actions that prepare us to build actions that line us up for grant money, and to change the word "vulnerability" to "risk."

Mitigation Actions

- Hagerty Consulting explained that the Capability Assessment will capture the ongoing actions from the 2014 mitigation action plan. The 2019 action plan will only include finite activities with timeframes. All actions should be realistic and achievable.
- A SIHMC requested to add a "supporting agency" column to the 2019 Action Plan.
- A SIHMC posed a question to RIEMA regarding writing actions about the State EOC's that are hazard specific, and about how to incorporate communication into this plan. RIEMA responded saying that the State Hazard Mitigation Plan is about writing actions to mitigate the impact of a hazard on people and property, and that it was difficult to write actions that mitigate communication. However, RIEMA and Hagerty Consulting recommended a separate meeting to discuss ways to incorporate communication into the strategy.
- RIEMA explained that they are striving to integrate the hazard mitigation planning process with other ongoing planning processes in RI to ensure there is no competition and funding is used as efficiently as possible.
- RIEMA will send out the matrix and actions from the Climate Action Plan to ensure they are incorporated into the State Hazard Mitigation Plan.

Interactive Exercise #2: Mitigation Strategies

Following the review of the Mitigation Strategies, meeting attendees participated in a second interactive hazard mapping exercise. Meeting attendees placed numbered dots on maps hung around the room to identify the location of their mitigation strategy comment(s) for a given hazard. All feedback was collected on comment cards and will be considered for incorporation into the Mitigation Strategy.

Next Steps, Questions, and Closing Comments

- All comments regarding the risk assessment and mitigation strategy must be submitted by ***September 12th.***
- The draft plan will be sent out for review on ***October 15th.***
- Plan Review Meeting will be on ***October 31st.***
- FEMA has 45 days to review plan once submitted.

- Hagerty Consulting noted that the comments collected will be reviewed, consolidated, and incorporated based on feasibility. These changes would be available for final review by agencies during the final draft plan review period.
- Hagerty and RIEMA emphasized that the State Hazard Mitigation Plan is an important document because it opens the availability of FEMA non-disaster grants.

Action Items

Hagerty Consulting

- Disseminate risk assessment methodology to stakeholders.
- Update risk assessment based on exercise and presentation comments.
- Update mitigation strategy based on exercise and presentation comments.
- Finalize draft plan for review by SIHMC.

SIHMC

- Review risk assessment profiles, mitigation strategy, and capability assessment profiles (where needed) and provide comments by **September 12.**

B.5.6 Attendance

Table B-2 Attendance for Risk Assessment and Mitigation Opportunities Meeting

First	Last	Affiliation	Email
Nicole	Belk	National Weather Service (NWS)	nicole.belk@noaa.gov
Gardner	Bent	United States Geologic Survey (USGS)	gbent@usgs.gov
Laura	Bozzi	Rhode Island Department of Health (RIDOH)	laura.bozzi@health.ri.gov
Teresa	Crean	University of Rhode Island Coastal Resources Center	tcrean@uri.edu
Ryan	Curtis	Congressman Langevin's Office	ryan.curtis@mail.house.gov
Jeffrey	Emidy	Rhode Island Historic Preservation & Heritage Commission	Jeffrey.Emidy@preservation.ri.gov
Russ	Godin	Rhode Island Interlocal Risk Management Trust	russgodin@ritrust.com
Caitlin	Greeley	Rhode Island Department of Administration (DOA) - Division of Planning	caitlin.greeley@doa.ri.gov
Melinda	Hopkins	Rhode Island Emergency Management Agency (RIEMA)	melinda.hopkins@ema.ri.gov

First	Last	Affiliation	Email
Thomas	Kogut	Rhode Island Department of Public Utilities Commission and Division of Public Utilities and Carriers	Thomas.Kogut@dpuc.ri.gov
Nicholas	Larmore	Rhode Island Department of Health (RIDOH)	nicholas.larmore@health.ri.gov
Dawn	Lewis	Hospital Association of Rhode Island	dawnl@hari.org
Alysia	Mihalakos	Rhode Island Department of Health (RIDOH)	alysia.mihalakos@health.ri.gov
Shaun	Orourke	Rhode Island Infrastructure Bank	sorourke@riib.org
Paula	Pallozzi	Department of Business Regulations (DBR)	paula.pallozzi@dbr.ri.gov
Jamie	Pereira	Rhode Island Public Transit Authority (RIPTA)	jpereira@ripta.com
Samantha	Richer	Rhode Island Emergency Management Agency (RIEMA)	samantha.richer@ema.ri.gov
Jonathan	Stone	Save the Bay	jstone@savebay.org
Melissa	Surette	Federal Emergency Management Agency (FEMA)	melissa.surette@fema.dhs.gov
Erik	Ulmen	U.S. Department of Homeland Security	erik.ulmen@hq.dhs.gov
Henry	Walker	Environmental Protection Agency (EPA) - Rhode Island	walker.henry@epa.gov
Jen	West	Narragansett Bay Estuary Research Reserve	jennifer@nbnerr.org
Benny	Bergantino	Rhode Island Division of Statewide Planning	benny.bergantino@doa.ri.gov
Steven	Cascione	Rhode Island Department of Transportation (RIDOT)	steven.cascione@dot.ri.gov
Spencer	Peck	Rhode Island EMA	spencer.peck@ema.ri.gov
Brian	Tardiff	Rhode Island Division of Information Technology (DOIT)	brian.tardiff@doit.ri.gov
Wayne	Barnes	East Providence	wbarnes@cityofeastprov.com
Philip	Sheridan	Rhode Island Department of Health (RIDOH)	philip.sheridan@health.ri.gov
Janet	Freedman	Rhode Island Coastal Resources Management Council (CRMC)	jfreedman@crmc.ri.gov
Lawrence	Macedo	Rhode Island Emergency Management Agency (RIEMA)	lawrence.macedo@ema.ri.gov

B.6 Plan Review Meeting

B.6.1 Invitation

[Placeholder]

B.6.2 Agenda

[Placeholder]

B.6.3 Slide Deck

[Placeholder]

B.6.4 Handout Materials

[Placeholder]

B.6.5 Meeting Notes

[Placeholder]

B.6.6 Attendance

[Placeholder]

Appendix C: Risk Assessment

C.1 Composite Hazard Priority Table

Table C-1 is the culmination of the hazard scores broken down by hazard. It should be noted that the results are relative to Rhode Island and should not be used to compare risk and vulnerability of the state to other geographic locations.

Table C-1 Composite Hazard Priority

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Severe Winter Weather	Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Flood	Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
	Kent County			**Limited** *Some injuries*					
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Extreme Heat	Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Negligible** *No meaningful impact on operations*	**High**
	Kent County	**Highly Likely** *Greater than 90% annual probability*							
	Newport County	**Likely** *Between 50% and 89.9% annual probability*							
	Providence County	**Highly Likely** *Greater than 90% annual probability*		**Limited** *Some injuries*					
	Washington County			**Negligible** *Minor injuries*					

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Tropical and Extratropical Storms	Bristol County	**Likely** *Between 50% and 89.9% annual probability.*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible**[1] *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
	Kent County					**Limited** *Less than 10% of residential and commercial structure damages*			
	Newport County		**Large** *40% to 100% of the total jurisdictional boundaries*						
	Providence County		**Medium** *10% to 40% of the total jurisdictional boundaries*						
	Washington County		**Large** *40% to 100% of the total jurisdictional boundaries*						

[1] Source: StormTools (http://www.beachsamp.org/stormtools/)

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Extreme Cold	Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**High**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Thunder-storms	Bristol County	**Highly Likely** *Greater than 90% annual probability.*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**High**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Dam Failure	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*		**Limited** *Short shutdown of critical infrastructure and facilities*				**High**
	Newport County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*		**Negligible** *No shutdown of critical infrastructure and facilities*				**Moderate**
	Providence County	**Likely** *Between 50% and 89.9% annual probability*	**Large** *40% to 100% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*				**High**
	Washington County		**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*					

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Fire	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County	**Likely** *Between 50% and 89.9% annual probability*							**High**
	Providence County	**Potential** *Between 1% and 49.9% annual probability*							**Moderate**
	Washington County	**Likely** *Between 50% and 89.9% annual probability*							**High**

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Cyber-security Incident	Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Negligible** *Scattered incidental of residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County				**Significant** *Medium shutdown of some critical infrastructure and facilities*				**High**
	Providence County				**Limited** *Short shutdown of some critical infrastructure and facilities*				**Moderate**
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
High Wind	Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of some critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Sea Level Rise	Bristol County	**Highly Likely** *Greater than 90% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Moderate**
	Kent County		**Small** *10% or less of the total jurisdictional boundaries*						
	Newport County		**Medium** *10% to 40% of the total jurisdictional boundaries*						
	Providence County		**Small** *10% or less of the total jurisdictional boundaries*						
	Washington County		**Medium** *10% to 40% of the total jurisdictional boundaries*						

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Terrorism	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Significant** *Multiple deaths and severe injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Infra-structure Failure	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Infectious Diseases	Bristol County	**Likely** *Between 50% and 89.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Chemical Incident	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Moderate**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Earthquake	Bristol County	**Unlikely** *Less than 1% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structure damages*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
	Kent County	**Potential** *Between 1% and 49.9% annual probability*				**Limited** *Less than 10% of residential and commercial structures damaged*			**Moderate**
	Newport County								
	Providence County	**Unlikely** *Less than 1% annual probability*				**Negligible** *Scattered incidental residential and commercial structure damages*			**Low**
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Drought	Bristol County	**Unlikely** *Less than 1% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Negligible** *Few operations impacted for small amounts of time*	**Low**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Tornado	Bristol County	**Unlikely** *Less than 1% annual probability*	**Medium** *10% to 40% of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Limited** *Less than 10% of residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
	Kent County		**Small** *10% or less of the total jurisdictional boundaries*						
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Biological Incident	Bristol County	**Unlikely** *Less than 1% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Limited** *Some injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Limited** *Less than 20% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Radiological Incident	Bristol County	**Unlikely** *Less than 1% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Limited** *Short shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

Hazard	Jurisdiction	Likelihood of Hazard Occurrence	Likely Range of Impact (Refer to Table C-2)	Probable Hazard Magnitude					Composite Hazard Index
				People (Injures & Death)	Critical Infrastructure	Property (Structures & Facilities)	Environment	State Operations	
Civil Disturbance	Bristol County	**Potential** *Between 1% and 49.9% annual probability*	**Small** *10% or less of the total jurisdictional boundaries*	**Negligible** *Minor injuries*	**Negligible** *No shutdown of critical infrastructure and facilities*	**Negligible** *Scattered incidental residential and commercial structures damaged*	**Negligible** *Less than 5% of land or natural resources impacted*	**Limited** *Some operations impacted for small amounts of time*	**Low**
	Kent County								
	Newport County								
	Providence County								
	Washington County								

C.2 Consequence Analysis

The CA investigates the impact of each identified natural and technological hazard on various elements of the community and state infrastructure of Rhode Island. The impact of each hazard is evaluated in terms of disruption of operations, recovery challenges, and overall wellbeing to all Rhode Island residents and first responder personnel. The CA supplements the hazard profile by analyzing specific impacts that the most probable hazards would have on the State of Rhode Island. The CA analyzes the impact on the following:

1. Public
2. Responders
3. Continuity of operations (including delivery of services)
4. Property, facilities, and infrastructure
5. Environment
6. Economic condition of the state
7. Public confidence in governance

Table C-2 below presents a CA for the hazards in the State of Rhode Island. The hazards are ordered from most to least impact.

Table C-2 Consequence Analysis

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Severe Winter Weather	Freezing temperatures coupled with heavy snow accumulation cause dangerous travel conditions. These conditions may lead to collisions and injury on roadways, individuals not being able to go to work, or accessing critical community facilities. Downed powerlines can lead to a loss of electricity and heat in homes and businesses. The young and the elderly are especially susceptible to a severe reduction in home heating over an extended period of time Pets are also affected by severe winter weather, especially those that are kept outdoors. **Public Health Impacts:** Extremely cold temperatures may lead to hypothermia once body temperature drops below 95 degrees Fahrenheit, which may ultimately lead to death. Cold temperatures also lead to a decrease in immune system function, causing the body to become more susceptible to illness and disease.	Dangerous road conditions create a transportation challenge for first responders. First responders may have to manage the evacuation of people from snow impacted areas, as well as direct traffic, close down roads, operate shelters, and take care of the injured and sick. First responders must control their own exposure to the elements for prolonged periods of time and may need to continuously seek heat and shelter to stay warm. Equipment may also be damaged or destroyed due to cold temperatures, heavy wind, ice, and heavy snow fall, which may lead to a decrease in response capabilities.	Rhode Island Emergency Management Agency maintains a COOP plan. In the event of severe winter weather that affects the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to implement their COOP Plan based on the hazards potential to cause power outages and transportation difficulties. If the activation of alternate facilities was required, travel may be difficult. Additionally, computer/network and other communication access may be impacted due to power outages caused by severe winter weather.	The ability to deliver services can be impacted locally, regionally, or statewide depending on the severity of the severe winter weather event. Dangerous road conditions may lead to roadway and bridge closures, as well as transit service disruptions. Slick and icy conditions may lead to an increase of vehicle accidents or vehicular damage to property. Businesses and places of commerce may completely shut down, which leads to the disruption of goods and services.	Transportation, governmental operations, and communications may be heavily disrupted during severe winter weather conditions. Roads and bridges may be heavily impacted by severe winter weather which can cause detours, delays. Roads and bridges can be completely obstructed by downed trees, powerlines, and snow accumulation. Snow and ice can impact access to homes and critical entities such as hospitals, schools, and supermarkets, as well as other critical facilities. Damage to homes, vehicles, structures, and resources may adversely affect response activities. Power loss can lead to disruption of critical infrastructure and technology.	Heavy snow and ice accumulation can weigh down and damage vegetation, tree limbs, and power lines. Flooding may also occur after the rapid melting of a heavy snowfall, causing bodies of water to flood, damaging the surrounding areas. Outdoor animals are susceptible to exposure to extreme cold, which may lead to illness or death. The damage to materials and facilities may allow dangerous chemicals and agents to leak into natural environments and water reservoirs, causing further damage.	Severe winter weather poses a fiscal impact on the local and state governments, even if some of those costs can be recouped through federal grant reimbursements. Local, county, and state resources may be drained by a severe winter weather event.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Flood	Flooding directly impacts members of the public in a low-lying area or floodplain, typically near a river, lake, or coastal area. Significant flooding events can lead to the damage and loss of homes, property, and businesses, which can impact public morale and safety. Flash flooding and excessive rainfall may lead to dangerous conditions on roadways, as well as create mudslides that may damage property. **Public Health Impacts:** Closures of primary-care physician offices is a major public health concern if flooding causes the buildings to be uninhabitable. Water sources may also become contaminated with toxic material or human waste, and water or sewer systems may be completely disrupted. Vector-associated problems can increase the risk for some mosquito-borne infectious diseases.	Coordinating response to flooding events can be a significant effort by first responders. Fire, police, and emergency responders are often called on to evacuate people from a flood area if flooding is imminent, as well as close roads, pump out flooded basements, attend to the injured, and direct traffic away from the flooded area and roads. First responders may face challenges with transportation and access to a location due to flooded or obstructed roadways. Flash floods and mudslides due to heavy rainfall can also injure first responders, as well as delay response operations.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a flood that affects the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. Floods which create power outages, debris damage, and road closures are not uncommon in Rhode Island. This threat may impact RIEMA's ability to maintain continuity of operations based on the incidents impact on power, communications and the potential to damage equipment and records within primary and alternate facilities.	Flooding has the propensity to cause road and bridge closures, as well as disrupt transit service. If any of these shutdowns occur, the ability to deliver goods and services efficiently will be impacted. Exposure to water may also damage or destroy physical goods such as food, clothing, and hygiene products.	Flooding can cause significant property destruction, including water damage to houses and businesses. This in turn impacts the market value of flooded property. In addition, floods can impact schools, hospitals, and other public infrastructure which impacts the public's ability to use these services. Road infrastructure can be impaired or compromised based on the size and scale of flooding, which can also disrupt transportation infrastructure. Water sources can become contaminated with toxic chemicals, dangerous chemicals, or fecal matter. Because water and sewer systems may be disrupted, solid-waste collection and disposal may also be impacted, causing dangerous public health risks.	Rising waters from flooding impact the environment by spreading pollution, inundating water and wastewater treatment plants, carrying debris, and disrupting wildlife and reserve areas. In addition, the standing water following a flooding event can facilitate the spread of vector-associated issues such as mosquitos, disease, and other public health risks.	Significant and repeated flooding can lower property value throughout the state, which can have a deleterious effect on the tax base. Furthermore, flooding drains response resources, which can be costly during a large flooding event for disaster reimbursement.	Ineffective flooding response can decrease the public's confidence in the state's ability to respond and govern. Multi-level government response requires direct actions that must be immediate and effective to maintain public confidence. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
High Winds	High winds can lead to damage of private and public property, vehicles, food sources, trees, and powerlines, as well as cause bodily injury from flying debris. Power outages can lead to disruption of employment, businesses, commerce, communication, and food resources. High winds may also cause buildings and structures to collapse, which may cause injury or death. **Public Health Impacts:** The damage of high winds may cause chemical and hazardous materials to spread to sources of food, water, and areas utilized by the public as well as animals.	The ability of first responders to conduct their duties may be hindered by high winds, especially if trees, powerlines, and/or debris have impacted roadways and transit. High winds may also destroy property and resources of first responders. High winds may create power outages that can hinder critical communications, access, or usability of resources. Injuries to first responders and equipment may be caused by flying debris, further challenging response operations.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a high wind incident that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. High wind incidents which create power outages and debris damage are not uncommon in Rhode Island. This threat may impact RIEMA's ability to maintain continuity of operations based on the incident's impact on power, communications, and transportation.	The delivery of goods and services will be impacted locally, regionally, or statewide if high winds cause powerlines, debris, and woody debris to fall into roadways or other structures, obstructing passage and access. Excessive winds can also damage suspension bridges, as well as cause damage to transport vehicles, loading docks, and goods being transported.	High winds can cause minor to extreme damage to property, ranging from peeling off surfaces and roofs, to total destruction of foundations and steel-reinforced concrete structures. Excessive winds can uproot and topple trees, lift cars, break windows, and knock out powerlines, leading to power outages to critical facilities. Transportation pathways may become obstructed by hazardous and non-hazardous debris, slowing down response and recovery activities. Water systems and reservoirs may become full of debris, leading to an impact on the water supply system. The ability to disrupt the power supply causes a cascading effect in other critical infrastructure, where electricity utilization is critical.	The impact of high winds on the environment affects foliage, trees, animals, cars, and structures, leading to the chance of hazardous and dangerous chemicals and materials being introduced into local waterways, agriculture, public and private spaces, and can affect fragile ecosystems. The power of high winds has also been harnessed for renewable energy, where wind turbines rotate with the force of the wind, creating electricity.	State and local resources may be costly for recovery from high wind damage. While federal grant reimbursements help cover the costs of damage, there is still a fiscal impact on the local government.	Immediate, effective, and direct actions are necessary to build and foster public confidence in state governance. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Extreme Heat	The effect of extreme heat can have severe consequences on the well-being of those more vulnerable to severe conditions, such as the elderly and young children. Loss of electricity may impact air conditioning and cooling mechanisms in homes, leading to increased indoor temperatures. **Public Health Impacts:** Physical effects of heat can cause major health problems, dehydration, and may lead to death. People begin to suffer heat-related illness when their bodies are unable to compensate and properly cool. Heat stroke may increase the body temperature to 106 degrees Fahrenheit or higher. Very high body temperatures may damage the brain or other vital organs.	Without proper mitigation efforts to heat, drinking water and proper rest, responders can become hampered in their efforts from extreme heat. Emergency responders will be susceptible to heat stroke and severe dehydration as a result of extreme heat waves. Extreme heat may also damage instruments or equipment necessary for response activities.	Rhode Island Emergency Management Agency maintains a COOP plan. In the event of extreme heat, In the event of extreme heat that affects the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is very minimal, this threat may impact RIEMA's ability to implement COOP based on the hazard's potential to cause power outages. If the activation of alternate facilities was required, continuity of operations may be difficult due to lack of computer/network access during power outages.	Major urban areas of the state are much more likely locations for extreme heat. These extreme heat waves can impact efficient delivery or inability of goods or services to be delivered. This results from a cascading effect related to workers being negatively affected by the extreme heat, which in turn drives productivity down significantly. Equipment and vehicles may be damaged due to high temperatures and sun exposure. Extreme heat may also damage goods if exposed to high temperatures for longer periods of time.	Major urban areas of the state, which are more likely locations for extreme heat, are vulnerable to this risk. Facility integrity is at risk with regards to power cables and stations becoming overheated. This overheating could lead to brownouts in urban areas where power lines are damaged by the heat, air conditioning systems being inoperable, increasing risk to the public. Extreme heat may also lead to spontaneous fires, which can further complicate response operations, as well as soften asphalt and damage highways and roadways.	Extreme heat can cause significant damage to the local environment by dehydrating vegetation and wildlife, which would create a cascading effect to the surrounding environment. Extreme temperatures may severely decrease the yield of Rhode Island's cash crops. Extreme heat can be associated with drought and violent weather conditions. Livestock are adversely affected by extreme heat and may suffer medical problems or death.	Extreme heat drains state, and local resources. Under the most severe heat conditions, some of the costs can be recouped through federal grant reimbursements, but there is a fiscal impact on the local government.	Governmental response, on all levels, requires direct actions that must be immediate and effective to maintain public confidence.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Hurricane and Tropical Storm	Rhode Island is home to several tourist and vacation destinations. The overlap between hurricane and tourist seasons could seriously impact both tourist populations and residents of coastal areas. Immediate damage to homes, businesses, infrastructure, government facilities, and roadways causes major disruptions in response operations for the entire state, which heavily impacts the public. Longer-term impacts can include population loss and economic destruction. High winds, flooding, and flying debris may injure the public or cause death. **Public Health Impacts:** Extreme flooding, storm surge, and high winds may cause death or injury for humans and animals. Hazardous waste and material may be introduced into flooding waters, contaminating water supplies as well as standing water. Toxic materials, carcasses, and waste can lead to the spread of disease. Disease vectors such as mosquitos may increasingly spread due to standing water, and may infect humans as well as other animals.	Coordinating an evacuation in advance of a significant hurricane or tropical storm event requires enhanced response coordination and causes a substantial strain on resources. First responders also face the hazards flooding, high winds, and storm surge bring, which may lead to personal injury, disease, or death. Critical roadways and response facilities may flood, lose power, or become damaged or destroyed. Response equipment and vehicles may become inoperable or inaccessible, further complicating response and recovery operations.	Rhode Island Emergency Management Agency maintains a COOP plan. In the event of a hurricane or tropical storm, the agency will utilize the plan. COOP plans ensure that state and local agencies are able to continue performance of essential functions in the wake of a hurricane or tropical storm. Storm produced flooding and high winds may impact a government building or agency directly through damage or destruction. Continuity of operations could be impacted due to this damage and the agency would need to relocate to their alternate facility as outlined in the COOP plan. Damage or destruction to primary and alternate facilities could also affect RIEMAs ability to perform COOP.	Similar to the impacts of flooding, hurricanes and tropical storms can cause road and bridge closures and transit disruptions to ensure public safety in the wake of the storm. In addition, many businesses in the hurricane evacuation zone shut down to prepare safely for the storm. As such, the ability to deliver goods and services efficiently will be impacted depending on the magnitude of the storm. Goods and delivery vehicles may become damaged, destroyed, or inoperable under the current conditions.	Hurricanes and tropical storms, depending on the magnitude and impact, can cause widespread destruction to property, facilities, and infrastructure. Residential and commercial properties that are damaged or destroyed by a coastal event can face significant recovery efforts. In addition, hurricanes and tropical storms can impact roads, bridges, schools, and hospitals in the evacuation zone through water damage from storm surge, as well as drifting sand from storm winds. Large coastal storms can also cause power outages and disrupt transportation and communications infrastructure, such as roads, bridges, telecommunications towers, and Internet connectivity.	Hurricanes and tropical storms can cause beach erosion and sea level rise, both of which negatively impact the environment in the long and short term. Strong winds may be generated that completely defoliate forest canopies and cause structural changes in wooded ecosystems. Changes in habitat and food availability due to flooding, winds, and storm surge can heavily impact the health of animals, as well as cause death.	Rhode Island has a significant tourist industry that furnishes the state economy. A major hurricane or tropical storm could cause damage to beaches, historical sites, and other areas that tourist frequent. In addition, the costs associated with response and recovery, although reimbursable during a federal declaration, are significant and can have cascading impacts on the state economy at large.	Ineffective response both before and after a hurricane or tropical storm can decrease the public's confidence in the state's ability to respond and govern. Governmental response across local, state, regional, and federal levels requires direct actions that must be immediate and effective to maintain public confidence.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Extreme Cold	Due to extreme cold, the public may have to face power failures, communication disruption, dangerous driving conditions, and even serious health problems. Extremely cold temperatures, heavy snowfall, and heavy icing of surfaces may lead to property damage, as well as power loss, heat loss, and lack of shelter from the elements. Pipes in homes may freeze and burst, causing disruption of water service, as well as flooding. The use of space heaters and fireplaces to sustain warmth increases the risk of household fires and carbon monoxide poisoning. Animals can also be heavily affected, especially if kept outdoors or without shelter. **Public Health Impacts:** Homes can quickly decrease in temperature due to a power outage, and individuals without shelter who face prolonged exposure may face cold-related health problems such as frostbite, hypothermia and death. Infants and older adults are particularly at risk.	First responders may face extremely icy and dangerous road conditions, as well as risk personal injury due to working in an extremely cold environment. Ice on roads may lead to vehicular crashes and prolonged response times. First responders will also respond to more cold-related injuries such as hypothermia.,	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of extreme cold that affects the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state or local governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to COOP based on the hazards potential to impact facility heating systems or reducing functionality of equipment. If the activation of alternate facilities was required, travel may be difficult due to icy or snowy road conditions.	Delivery of services may be impacted by icy and dangerous transportation conditions, causing food, water, and resource systems to be delayed or halted, as well as personal transportation by the public. Waterways can freeze, stopping barge and ship traffic. Extremely cold temperatures may also damage or destroy goods if exposed for longer periods of time.	The cascading effects of extreme cold can bring critical infrastructure to a halt. Critical facilities may be shut down or disrupted due to unsafe travel conditions for workers, the risk of serious health problems, or the failure of processes, materials, and machinery. Energy consumption is extremely high during extremely cold conditions due to heating homes, which creates a strain on energy supply. Communities may also face ground freezing problems, which affects the water supply, sanitation, and agriculture.	Extreme cold can freeze crops and food sources, as well as disrupt ecosystems. Pipe ways and critical facility equipment may freeze and break, causing hazardous and dangerous chemicals and materials to spread into human and animal-populated areas, as well as water systems and the food supply. Extremely cold temperatures may injure or kill wildlife, as well as cause decreased or destroyed food and water resources.	Local and state agencies, as well as businesses and general commerce, may face a sharp decline in revenue as individuals stay home due to being unable to get to work. Resources from all levels will be utilized and the local government will face fiscal consequences. Energy consumption greatly increases during extremely cold weather due to the increase heating of homes, businesses, and critical facilities for prolonged periods of time. The increase in generating heat energy comes at a high cost for local and state agencies, as well as homeowners.	Extreme cold is a very dangerous threat that can adversely affect the public, first responders, infrastructure, agriculture, economy, and overall state operations. Direct, effective, and timely response by all levels of government is required for public confidence in the state's governance.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Thunderstorms	Thunderstorms can have high winds, rain, hail, flooding, and excessive lightning, all of which can cause heavy damage, destruction, and injury to the public. Thunderstorms can cause destruction of property, power failures, hazardous materials spills, and even injury or death. A bolt of lightning can reach temperatures near 50,000 degrees Fahrenheit. Additionally, thunderstorms present some risk to those who are exposed to the elements during such events. Those most at-risk are low-income and homeless individuals without proper shelter from the elements during major thunderstorms. **Public Health Impacts:** Potential health concerns include lightning fatalities and long-term physical and mental effects for survivors.	First responders may be unable to access roadways due to flooding, trees, or debris. Exposure to lightning, flooding, and high winds may cause injuries to first responders. Vehicles and resources may be damaged, leading to impaired response activities. In addition, road conditions may become hazardous as a result of the by-products of the storm. Extreme caution may need to be exercised if thunderstorms produce major rains or hail. Visibility may also decrease significantly, greatly impacting transport activities.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of major thunderstorms that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain COOP based on the hazard's potential to cause power outages, flooding, and wind damage. If the activation of alternate facilities was required, travel may be difficult as well as computer/network access due to long-term power outages caused by thunderstorms.	Delivery of services may be impaired by flooding, obstruction, and destruction of roadways and resources. The ability to deliver goods and services will be impacted locally, regionally, or statewide depending on the magnitude of the event. Goods, equipment, and vehicles may become damaged during transport due to the various elements of a thunderstorm.	Power lines and power generators are most at risk from thunderstorms and their by-products. If lightning were to strike certain power lines, it could create a cascading affect for isolated power outages or full-scale blackouts depending on the severity of the weather. Building and vehicle damage can occur from hail and other debris created by thunderstorms. Properties and critical facilities also may face foundational and physical damage due to flooding, lightning strike, or excessive winds, delaying response and recovery operations. Power outages and physical damage to structures may cause energy supply and water supply systems to be disrupted or fail. Sewerage systems may be compromised and taken off grid.	Flooding and excessive winds may cause foundational and structural damage, leading to the risk of the spread of hazardous waste among populated areas, water ways, and food sources. Waste and debris from structure damage can contaminate sources of water, food, and safety. In addition, debris and by-products of thunderstorms can impact the environment by: possibly spreading debris and pollution; damaging sewer and wastewater treatment plants; and disturbing the wildlife and natural areas. Lightning strikes may also ignite wooded areas or fields, leading to destruction of agricultural crops, critical ecosystems, and natural habitats.	Flooding, high winds, lightning, and hail can drain state and local resources. By-products of thunderstorms can drain state and local resources. Even if some of the costs can be recouped through federal grant reimbursements (should the event warrant a federal disaster declaration), there is a fiscal impact on the local government.	Ineffective thunderstorm response can decrease the public's confidence in the state's ability to respond and govern. Governmental response across local, state, regional, and federal levels requires direct actions that must be immediate and effective to maintain public confidence.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Dam Failure	Dam failures impact those living within the hazard area and surrounding areas and can lead to heavy flooding, power loss, property damage, injury, and even death. Extensive flooding and damage may lead to the evacuation and displacement of those individuals in the impact zone. Roadways may be obstructed or inaccessible to the public, challenging transport and resource acquirement activities. **Public Health Impacts:** Flooding waters may reach high speeds mixed with garbage, structural and natural debris such as tree limbs and building materials, which may cause injury and death to those in the vicinity of the dam failure. Standing water can also pose a public health risk due to the reproduction of disease vectors such as mosquitos.	Heavy flooding may cause inaccessibility of roadways for first responders as well as damage of materials and resources. First responders will also have to facilitate evacuation measures to move people from the flooded area, close roads, pump out flooded homes, and direct traffic away from the flooded area and roads. The timeliness of evacuation notice is critical in getting the community to areas of safety.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a flood caused by dam failure that affects the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. Flooding caused by dam failure may create power outages, debris damage, and road closures. Dam Failure may impact RIEMA's ability to maintain continuity of operations based on the incidents impact on power and transportation to alternate facilities, if required.	Delivery of services may be disrupted due to flood-damaged bridges, pathways and roadways. Transit systems may face closures due to public safety concerns due to inability to operate transportation vehicles such as trains and buses. The ability to deliver food, drinking-water, and services will be impacted locally, regionally, and statewide due to problems with accessibility and transport abilities. Flooding may also interrupt communications, transportation, and governmental services operations due to power failure and accessibility challenges.	Flooding from dam failures impact roads and bridges, businesses, hospitals, and other critical entities directly or indirectly, making roadways inaccessible for transit. Roads and bridges are usually the main infrastructures impacted by a flood. Water and sewer systems may be damaged, leading to the issue of sanitation and waste collection. Property of homes and businesses may be completely destroyed if situated close to the failure point. Following a flood event, the market value of a flooded property may be significantly reduced due to the costly and long-term damage.	The impacts on the environment of dam failures include flooding and moving debris, affecting natural areas and wildlife, spreading pollution and hazardous materials, and overloading water and wastewater plants. Ecosystems and natural habitats may be completely destroyed, causing migration or death of wildlife.	There is a fiscal impact on the state government after a dam failure due to disruption of travel and commerce routes and employee's ability to travel to work. Recourses at all levels are utilized impacting the ability to access resources long-term.	Direct, immediate, and effective actions must be taken in order to maintain public confidence. Response activities must include all levels of government.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Fire	The effect of fire can extend beyond the initial impact caused by fire damage. Deaths from fires and burns are the fifth most common cause of unintentional injury deaths in the United States. People located in the immediate area of the fire face the risk of relocation for unknown periods of time, especially due to complete destruction of a certain area. Since 2003, major changes have occurred in fire prevention and management in public venues, decreasing the risk to the public of a major fire. **Public Health Impacts:** Fire, whether urban or wildfire, can release toxic components which can cause adverse health effects in people as well as animals. The respiratory and cardiovascular systems are most affected by fire and smoke inhalation, and psychological and psychiatric problems may arise as well due to exposure to the traumatic event. Young children and the elderly are especially vulnerable to health and medical issues stemming from fire and smoke exposure.	Fire, police, and emergency responders are called on to evacuate people from the fire area, close roads, create fire breaks, attend to the injured, and direct traffic away from the area. First responders may also have to deal with the psychological reactions of the public during an extreme event, such as trauma and shock. Firefighters are at a higher risk of smoke inhalation, burns, and health problems due to working in close proximity to fires and the subsequent smoke.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of fires affecting the state's operations, the agency will enact the plan appropriately to the situation. To date, only one (1) fire-related incident has reached the level of necessitating a potential Emergency Operations Center (EOC) activation. While expectation is minimal, this threat may impact RIEMA's ability to activate the COOP plan based on the hazards potential to impact critical infrastructure. If the activation of alternate facilities was required, ensuring that facilities are not in the path of a fire would be critical to continuing operations.	Fires can cause disruption of services in the event of an urban or wildfire in the impacted area If a fire does occur, the ability to deliver goods and services efficiently will be impacted locally, regionally, or statewide depending on the magnitude of the event and level of service disruptions. Normal operations would be affected and could lead to a reduction of services or inability to provide certain services. Goods and facilities may also be damaged or destroyed by fire, smoke, or extremely high temperatures. There may also be an increased demand on health services due to the challenge of access to healthcare facilities by patients with chronic healthcare conditions.	Fire can damage or completely destroy property and critical facilities, as well as lead to interruption of the power supply system. A fire of significant strength can cause major damage to buildings or farmland. Large fires may also interrupt transportation systems such as train and bus lines, creating a challenge for public transit, especially during evacuation. The 2003 nightclub Fire at The Station in West Warwick showed major weaknesses in fire prevention policies and equipment. Since then, major improvements have increased safety standard of buildings and facilities as a whole.	Fires can cause significant impact to the environment by: spreading pollution; creating health problems; carrying ash and smoke; damaging agricultural crops; and disturbing the wildlife and natural areas. Water and soil pollution caused by fire can cause longer term threats to human and ecosystem health. Fire damage may also affect soil formation, nutrient cycling, and carbon sequestration and storage. An important component of recovery also includes restoring sensitive habitats and environments that were damaged.	Fires drain state and local resources. There is a fiscal impact on the local government even if costs can be recouped by federal grants. Rhode Island's agriculture, tourism and aquaculture are a major component of the local, county and state economy. Major fires can cause significant impact to those sectors, further draining state resources. Costs may be associated with loss of income from the land following incidents, the cost of damage to property, firefighting, and restoring sensitive habitats and environments.	Governmental response, on all levels – state and local – requires direct actions that must be immediate and effective to maintain public confidence.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Sea Level Rise	SLR vulnerability is restricted to the coastal communities and shoreline in Rhode Island. **Public Health Impacts:** Closures of hospitals and clinics is a major public health concern if overland flooding due to sea level rise causes the buildings to be uninhabitable. Water sources may also become contaminated with toxic material or human waste, and water or sewer systems may be completely disrupted.	Extensive and consistent flooding caused by sea level rise may result in direct damage to critical infrastructure. Power outages would likely lead to communications and water outages; complicating response and recovery operations. Water and sewer systems may be disrupted, causing dangerous public health risks and significantly impeding the ability of first responders to perform critical job functions. Roadways would become flooded, possibly resulting in essential facilities becoming isolated or emergency services rerouted in response to calls. A catastrophic flood could lead to injury or death. Flooding may result in significant delays in responding to emergency calls for assistance and possibly death. Depending on the extent of the flooding, first responders may face increased risk of injury themselves.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of SLR that affects the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain COOP based on the hazard's potential to cause flooding, which would in turn, cause outages of critical infrastructure (e.g., communications, power, water). Additionally, flooding caused by SLR may result in limited access to primary and alternate facilities depending on the extent of the flooding and the number of access points.	Delivery of services may be impacted by secondary effects of SLR, such as flooding or storm surge, causing food, water, and resource systems to be delayed or halted, as well as personal transportation by the public. Waterway infrastructure may be impacted by rising waters, changing the capacity of ports to accommodate barges or ships. Flooding related to SLR may also damage or destroy goods if exposed for longer periods of time.	As the sea level rise inundation zone height increases, the number of residential units identified within each inundation zone increases as well. A number of critical infrastructure facilities may be susceptible to SLR over time. If these facilities are damaged as a result of SLR, the provision of state services may be disrupted or more expensive to provide given increased costs of maintaining or repairing damaged facilities or assets, however this outcome is unlikely.	There may be increased risk of damage to the environment caused by factors of SLR. More frequent and severe instances of flooding, storm surge, and coastal erosion. Flooding caused by sea level rise may cause contamination of food or water resources (e.g., water treatment facilities, agricultural crops) with toxic material or human waste, and water or sewer systems may be completely disrupted. Storm surge may also cause flooding (and subsequent contamination of resources). When coastal areas flood, there is a chance that some of the built-up land will be washed away with the water, resulting in coastal erosion. This could be detrimental to environments or habitats located directly on shorelines.	SLR may eventually pose a fiscal impact on the local and state governments, even if some of those costs can be recouped through federal grant reimbursements or other federal funding programs. Additionally, the temporary disruption of services caused by secondary flooding impacts of SLR may drive up the costs of response and recovery. Local, county, and state resources may not be sufficient to cover the costs of implementing mitigation projects to manage the effects of SLR.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high. Earning the public's trust will also depend on the state's ability to demonstrate that mitigation projects are effective. For example, refusing to reconstruct repetitive loss properties without completing additional mitigation projects or considering relocation.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Epidemic	Depending on the scale of outbreak and type of disease, residents of the State of Rhode Island may be at risk of illness or death if they are exposed to the disease. Population density may play a role in the spread of disease; urban areas are more likely to be impacted than rural areas. **Public Health Impacts:** An epidemic will have significant impacts on public health. Specific impacts to residents will be dependent upon the type of disease or infection that is spread.	Epidemics pose a unique risk to first responders because they are more likely to be exposed to a virus before it has been identified. If the virus infects first responders and healthcare practitioners, the provision of public safety and public health services may be significantly impacted. Rapid identification of epidemic outbreaks is critical to preventing the spread of disease and minimizing the impact to their operations.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of fires affecting the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While the expectation is minimal, this threat may impact RIEMA's ability to implement COOP based on the hazards potential to create high levels employee absenteeism. Employee absenteeism could in turn, hinder the ability to fulfill critical state operations described in the COOP plan, as well as implementation and maintenance of the plan itself.	Epidemics may, under extreme circumstances or large outbreaks, cause disruption of services in the event of employee absenteeism.	It is highly unlikely that an epidemic would have direct effects on critical infrastructure or other facilities or structures. However, under very extreme cases of absenteeism, it is possible that regular maintenance or repairs would not be performed, resulting in disrepair.	In some cases, disease outbreak is caused by infections spread from animals to humans. Under these circumstances, infections may be spread as the result of normal care (proximity) to sick animals or consumption of byproducts of infected animals. Infected animals may die as a result of the disease; timely removal of infected animal carcasses may help to reduce the spread of the disease among animals. It is unlikely that an epidemic would have any additional direct impacts on the environment.	Depending on the scale of outbreak and type of disease, a localized infectious disease outbreak could impact the State of Rhode Island significantly. In the event residents and workers became infected from an epidemic, employee absenteeism would increase and the length of time necessary to recoup and regain lost time and money could be six (6) months or longer.	Governmental response, on all levels – state and local – requires direct actions that must be immediate and effective to maintain public confidence. If government functionality is reduced by absenteeism, the public's confidence in governance may be reduced. The ability of Department of Health to perform critical functions will directly impact the community's perception of government during an epidemic. Maintenance of these operations will be critical to response and recovery operations.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Drought	The entire state is susceptible and vulnerable to the occurrence of a drought event. The vulnerability of the state to drought is increasing as water use and land use change. **Public Health Impacts:** If the drought coincides with warmer months, vulnerable populations of Rhode Island may face an increased risk of exposure to hot weather (e.g., dehydration, death, heat-related illness, heat stroke). If individuals are desperate for water, they may be more inclined to consume water that is not safe to drink to alleviate thirst. Lower quantities of water may also increase the likelihood of contamination due to higher concentrations of bacteria. During droughts, dry soils and often wildfires increase the number of airborne particles, such as pollen and smoke. These particles can irritate the airways and worsen chronic respiratory illnesses such as asthma. Poor air quality can also increase the risk of respiratory infections.	Reduced freshwater availability would likely to complicate firefighting efforts in urban and suburban areas where standard wildfire-fighting tactics, such as chemical retardants and controlled burns, are less suitable. Some fire suppression equipment requires a minimum level of water pressure to activate and work properly. Decreased functionality of equipment may result in greater risk of injury to first responders. If the drought coincides with warm months, first responders may face increased risk of heat-related injuries or death.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of fires affecting the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While the expectation is minimal, this threat may impact RIEMA's ability to implement COOP based on the hazard's potential to impact power, communications, or water outages. Critical life-saving activities and fire suppression will be directly impacted by these outages.	Delivery of services may be impacted by reduced functionality of waterway transportation conditions, causing food, water, and resource systems to be delayed or halted. Waterways can decline in height, impacting the size of ships that can navigate shallower waters. Droughts may also impact the delivery of goods and services if there are shortages of raw materials.	Even though there is minor variation throughout the state in terms of areas more prone to experience drought conditions, it is assumed that the drought hazard would impact buildings in a fairly uniform and negligible manner. Drought conditions may threaten levels or quality of municipal public water supplies or impact small community or private potable water wells. During a drought, the availability of fresh water may be reduced, resulting in increased risk of contamination (bacterial or chemical) or the need to drill deeper wells. Residents may have inadequate access to fresh water.	The most immediate consequence of drought is a decrease in crop production, due to inadequate and poorly distributed rainfall. The potential of drought-related impacts on corn and other crops will have significant impacts on supplies of animal feed, livestock, meat and dairy products, and processed grain products, including ethanol. Drought conditions may also increase the potential for fires. Drought is also associated with insect infestations, plant disease, wind erosion of soil, and decrease in levels of water produced by natural aquifers. Droughts may also increase the potential for loss of natural resources.	Impacts will be costly in both social and economic terms. The economic and social impacts from such an event could be significant for Rhode Island. Droughts have the potential to drain state, and local resources, which will have a significant fiscal impact on the local government.	Droughts can adversely affect the public, first responders, infrastructure, agriculture, economy, and overall state operations. Direct, effective, and timely response by all levels of government is required for public confidence in the state's governance, especially in recognizing and mitigating economic impacts of the drought.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Earthquake	Earthquakes may cause injury or death to people by causing vehicle accidents, falling large or heavy objects, or structure failure. **Public Health Impacts:** There may be a large number of people seeking treatment for traumatic injuries. Ground shaking may result in broken service lines or pipelines, triggering the release of hazardous materials or waste materials. Contamination of food and/or water supplies as a result of the earthquake may trigger illnesses if these resources are consumed before the threat is identified.	The extent of the damage caused by an earthquake can greatly impact first responders' ability to access or transport victims. Equipment, facilities, or other assets may be damaged as the result of an earthquake and inhibit first responders' capacity to respond to calls for assistance. Disruptions to service lines due to ground shaking may also reduce the speed and efficiency of response.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of earthquakes that affects the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to activate COOP including the damage or destruction of primary or alternative facilities. Earthquakes could potentially impact critical infrastructure resulting in power outages, access to roadways or public transportation, damage to facilities or infrastructure, including alternate locations.	Delivery of services may be impacted by dangerous transportation conditions, causing food, water, and resource systems to be delayed or halted, as well as personal transportation by the public. Waterway infrastructure may be damaged or malfunction, stopping barge and ship traffic. Ground shaking may also damage or destroy goods if exposed for longer periods of time.	The New England region has an abundance of older, unreinforced masonry structures that are inherently brittle and very vulnerable to seismic forces. All critical facilities in the planning areas are exposed to the earthquake hazard. In addition, increased risk is associated with Transportation corridors and pipelines can be disrupted during an earthquake. Ground shaking can lead to the collapse of buildings and bridges, and disrupt gas, life lines, electric, and phone service.	Earthquakes have the potential to trigger secondary hazards such as fire, flash flooding, hazardous materials release, slope failure, dam failures, and tsunamis—all potentially devastating to the environment. Toxins released during fires, hazardous materials incidents, and tsunamis may have detrimental effects on the environment, not only to animals and livestock, but to rivers, streams, and agricultural crops. Flooding, slope failure, and dam failure can completely wipe out habitats and environments, cause significant injury to animals or livestock, or contaminate certain components of the environment (e.g., rivers, streams) with materials picked up by the hazards along the way to their final resting place.	Earthquakes pose a fiscal impact on the local and state governments, even if some of those costs can be recouped through federal grant reimbursements. Local, county, and state resources may be drained by initially responding, providing mass care services clearing debris after, and rebuilding during recovery after an earthquake. Additionally, a severe earthquake would affect the ability of businesses to maintain operations. If the private sector is not able to re-establish operations this would also impact the state economy.	Governmental response, on all levels – state and local – requires direct actions that must be immediate and effective to maintain public confidence. If the state takes a long time to begin recovery operations, or for the public to see recover operations, this would have a negative impact on the public's confidence in the state's governance.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Tornado	The damage from tornadoes comes from the strong winds they contain. It is generally believed that tornadic wind speeds can be as high as 300 mph in the most violent tornadoes. Wind speeds that high can cause automobiles to become airborne, destroy homes, and turn broken glass and other debris into projectiles. The biggest threats to people caused by tornadoes result from flying debris and from being tossed about in the wind, which may cause injury or death. **Public Health Impacts:** Tornadoes may cause public health impacts by exposing hazardous materials or causing contamination of water or food sources. Significant agricultural losses may impact food stability in the state or region. There will also be an increased demand for medical treatment for traumatic injuries caused by the tornado. Significant portions of the population may be displaced by the destruction and those individuals may not have access to personal documents or medical records.	First responders may be injured as the tornado passes, resulting in employee absenteeism that impacts the overall capacity to respond to the event. In addition, the deposit of debris on major roadways, the location of the event, damage to equipment or facilities may increase the amount of time required for first responders to complete rescue operations. Exposed wires or hazardous materials may cause injury to first responders in the process of conducting search and rescue operations.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of tornadoes affecting the state's operations, the agency will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to COOP based on the hazard's potential to impact power or communications infrastructure, or equipment at primary or alternate or facilities. If the activation of alternate facilities was required, travel may be difficult due to reduced transportation options, power outages, or damage to facilities.	Delivery of services may be impacted by dangerous conditions or lack of adequate access to transportation options, causing food, water, and resource systems to be delayed or halted, as well as personal transportation by the public. Waterway infrastructure may be damaged or malfunction, stopping barge and ship traffic. Goods may be damaged, destroyed, or carried off by high winds.	Damages from lower intensity tornadoes (EF-0) can range from chimney damage to uprooted shallow trees. A significant tornado (EF-2) would cause damage to roofs on frame houses, complete destruction of mobile homes and large trees and utility lines snapping. A devastating tornado (EF-4) would result in well-constructed houses being leveled, weak foundations blown away some distance, and cars thrown. Mobile homes within the state are especially vulnerable. Communications or power infrastructure may be damaged or destroyed, resulting in service disruptions. Tornadoes may also disrupt transportation services	Tornadoes may cause significant damage to the environment by exposing hazardous materials, causing contamination of water or food sources, or uprooting vegetation. Animals may be injured by flying debris or being lifted by the tornado. Agricultural crops may be lost due to contamination or being uprooted.	Tornadoes pose a fiscal impact on the local and state governments, even if some of those costs can be recouped through federal grant reimbursements. Local, county, and state resources may be drained by the occurrence of a tornado.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Cybersecurity Incident	The public is heavily reliant on technology for daily life, including cell phones, handheld devices such as tablets, and computers. Any disruption to this technology caused by a cyber incident could impair the ability for the public to conduct basic activities, such as communications and mobile banking. **Public Health Impacts:** Although mostly indirect, public health impacts of cybersecurity incidents may include loss of access of important medical information and services, personal information, and unwanted sharing or dissemination of that information to other parties. Disruption in attaining medical help or resources may delay receiving proper medical attention or care.	If a cybersecurity incident, accidental or intentional, were to directly impact the communications infrastructure relied upon by first responders, it would create severe disruptions in jurisdictions ability to provide its citizens response services. If a cybersecurity event were to effect the 911 operations, response capabilities would be greatly impacted significantly increasing critical response times.	The threat of a cybersecurity incident, whether an accidental or intentional incident, may impact RIEMA's ability to maintain continuity of operations COOP based on the hazard's potential to impact power or communications infrastructure. Specifically, agencies that rely on electronic backup of critical files are vulnerable to cyber incident. A cyber incident that disrupts access to technology at both the primary and alternative facilities would be catastrophic.	In today's world, the delivery of goods and services is heavily reliant of technology for the facilitation of transactions. A cyber incident could significantly disrupt the delivery of goods and services to the extent upon which businesses and entities rely on technology for the delivery of their materials.	Property and facilities may become either uninhabitable or unusable as a result of a cyber incident, particularly if their infrastructure if reliant on technology for sustainability. In addition, a significant majority of critical infrastructure systems are in some way tied to technology, oftentimes through virtual operations and supervisory control and data acquisition (SCADA) systems. Therefore, a cyber incident could disable the vast majority of systems which control these pieces of critical infrastructure, as well as traffic control, dispatch, utility, and response systems.	Targeted cyber incidents can impact water or wastewater treatment facilities. The disruption of the virtual systems tied to this infrastructure could cause water pollution or contamination and subsequent environmental issues. In addition, a cyber incident could impact the environment if a release of a hazardous material was triggered as a cascading effect of the incident.	A significant cyber incident could have glaring ramifications on the state economy. Society is heavily reliant on electronic-based commerce through mobile banking, automated teller machines, and electronic trading. Any disruption to daily activities by a cyber incident can have disastrous impacts to the economy, effectively halting the ability to conduct transactions electronically.	In the case of a cyber incident in which significant amounts of data is stolen, the government's inability to protect confidential personal data would impact confidence in the state. Such an incident would also subsequently cause pause regarding the security of using electronic systems for government services.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Chemical Incident	Cities within Rhode Island with dense populations, particularly along major travel routes, are the most vulnerable (with an emphasis on any particularly vulnerable groups, such as infants and young children in day-care centers, children in schools, the elderly in residential facilities, hospital patients, etc.). **Public Health Impacts:** Varying chemicals will have different effects on the population as well as environmental effects which will dilute or increase the chemical releases potency. Protective measures will need to be taken particularly for those of the most vulnerable communities.	Varying chemical incidents can create a dangerous environment and significant challenge for first responders. First responders may have to manage the evacuation of people from the area impacted by a chemical incident, as well as direct traffic, close roads, operate shelters, and take care of the injured and sick. First responders must control their own exposure to the chemical incident and ensure the correct PPE is utilized. Equipment may also be damaged or destroyed due to the impact of the chemical incident, which may lead to a decrease in response capabilities.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a chemical incident that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain continuity of operations based on the chemical incidents potential to cause workforce absenteeism, contamination, or destruction of public facilities.	The ability to deliver services can be impacted locally, regionally, or statewide depending on the characteristics of the chemical incident. To reduce the publics potential exposure to dangerous chemicals, roadway and bridge closures may be required, as well as transit service disruptions. Businesses and places of commerce may completely shut down due to chemical incidents, which leads to the disruption of goods and services.	Transportation, governmental operations, and infrastructure facilities may be disrupted during a significant chemical incident. Roads and bridges can be completely obstructed by chemical releases and required cleanup. Chemical incidents can impact access to homes and critical entities such as hospitals, schools, and supermarkets, as well as other critical facilities. Safe access to homes, vehicles, structures, and resources may adversely affect response activities. Power loss can lead to disruption of critical infrastructure and technology.	Agriculture crops and livestock are extremely susceptible to the adverse effects of chemicals and the potential of a spill or contamination of a large area of land. Chemical incidents may impact the environment directly by causing pollution, damaging sewer and wastewater treatment plants; or disturbing or killing wildlife and adversely affecting nature preserves.	Severe chemical incidents pose a fiscal impact on the local and state governments. Local, county, and state resources may be required during a large chemical incident therefore reducing their availability for future events. Additionally, private businesses may not be able to maintain operations during or after an incident if they are impacted, which would impact the economy.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Terrorism	Terrorist activities that pose a direct threat to people and would cause considerable injury and death include bombings, kidnappings, shootings, and hijackings. A WMD attack could kill and injure hundreds to thousands of people, which could overwhelm hospitals in the five (5) counties and the surrounding areas. **Public Health Impacts:** Terrorist attacks will have varying effects on the population including injury, death, and significant psychological impacts. These impacts may be immediate or long-term depending on the terrorist attack which occurs.	Terrorism and the associated attacks can create a dangerous environment and significant challenge for first responders. First responders may have to manage the evacuation of people from the area impacted by terrorism, as well as direct traffic, close down roads, operate shelters, and take care of the injured. First responders may also become the direct target of terrorism themselves either immediately or as a secondary attack during response activities. Based on the type of terrorist attack utilized the correct PPE may be required to protect the first responder. Equipment may also be damaged or destroyed due to the impact of the attack, which may lead to a decrease in response capabilities.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a terrorist attack that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain continuity of operations based on the attacks potential to cause a significant injury to staff or impede travel to an alternate facility if relocation was required. If the act of terrorism involves primary or alternative facilities, access may be denied affecting COOP activation.	The ability to deliver services can be impacted locally, regionally, or statewide depending on the characteristics of the terrorist attack. To reduce the publics potential exposure to the effects of an attack, roadway and bridge closures may be required, as well as transit service disruptions. Businesses and places of commerce may completely shut down due to terrorism, which leads to the disruption of goods and services.	Transportation, governmental operations, and infrastructure facilities may be disrupted during a significant terrorism both directly and indirectly. Roads and bridges may be heavily impacted by terrorist attacks especially if explosive devices are utilized in the attack. Terrorist attacks and the response and recovery from those attacks can impact access to homes and critical entities such as hospitals, schools, and supermarkets, as well as other critical facilities. Safe access to homes, vehicles, structures, and resources may adversely affect response activities. If power loss occurs following an attack, it may lead to disruption of critical infrastructure and technology.	Terrorist attacks involving bombings and arson pose considerable negative impacts to the environment in the form of smoke and destruction of vegetation. A terrorist attack utilizing chemical, nuclear, and biological weapons pose a significantly higher risk to the environment by causing pollution, damaging sewer and wastewater treatment plants; or disturbing or killing wildlife and adversely affecting nature preserves.	Events of terrorism pose a fiscal impact on the local and state governments. Local, county, and state resources may be required during a terrorist attack therefore reducing their availability for future events. Private businesses may not be able to maintain operations during or after an incident if they are impacted, which would impact the economy.	If government employees or facilities are targeted directly by terrorism, it will have a significant impact on the state's ability to govern. The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Biological Incident	Cities within Rhode Island with dense populations, particularly along major travel routes, are the most vulnerable (with an emphasis on any particularly vulnerable groups, such as infants and young children in day-care centers, children in schools, the elderly in residential facilities, hospital patients, etc.) to biological incidents including pandemic outbreaks. **Public Health Impacts:** Biological incidents will have significant effects on the population as well as environmental effects based on the type of biological incident. Protective measures, including isolation and quarantine, will need to be taken particularly for those of the most vulnerable communities.	Biological incidents will create a dangerous environment and significant challenge for first responders. First responders may need to have direct contact with individuals who are suffering from a communicable disease. First responders must control their own exposure to the biological incident and ensure the correct PPE is utilized.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a biological incident that affect the State's operations, will enact the plan appropriately to the situation. To date, there have no biological incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain continuity of operations due to high amounts of employee absenteeism. This absenteeism would directly effect RIEMAs ability to implement COOP potentially requiring devolution.	The ability to deliver services can be impacted locally, regionally, or statewide during a biological incident. Transit services may be directly impacted due to the potential spread of communicable diseases during a biological incident. Businesses and places of commerce may completely shut down due to biological incidents and the resulting employee absenteeism, which leads to the disruption of goods and services.	Transportation, governmental operations, and infrastructure facilities may be directly or indirectly disrupted during a significant biological incident due to the facilities exposed during the biological incident or due to absenteeism of employees after the incident.	Agriculture crops and livestock are extremely susceptible to the adverse effects of biological incidents that may cause contamination of a large area of land livestock. biological incidents may impact the environment long-term by disturbing or killing wildlife and adversely affecting nature preserves.	Biological incidents pose a fiscal impact on the local and state governments. Local, county, and state resources may be required during a biological incident therefore reducing their availability for future events. Significant employee absenteeism during a biological incident will have a direct and significant impact on the state economy.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. The ability for the state to maintain the necessary functions to provide mass care and proper medical treatment for those affected by a biological incident during response operations is critical in maintaining public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Radiological Incident	Cities within Rhode Island with dense populations, particularly along major travel routes, are the most vulnerable (with an emphasis on any particularly vulnerable groups, such as infants and young children in day-care centers, children in schools, the elderly in residential facilities, hospital patients, etc.). **Public Health Impacts:** Radiological incidents will have varying effects on the population based on the size, location, and current environmental conditions during the incident (i.e., wind direction, temperature, etc.). Protective measures will need to be taken particularly for those of the most vulnerable communities.	Radiological incidents will create a dangerous environment and significant challenge for first responders. First responders may have to manage the evacuation of people from the area impacted by a radiological incident, as well as direct traffic, close down roads, operate shelters, and take care of the injured and sick. First responders must control their own exposure to the radiological incident and ensure the correct PPE is utilized. Equipment may also be damaged or destroyed due to the impact of the radiological incident, which may lead to a decrease in response capabilities.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a radiological incident that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been no radiological incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain continuity of operations due to high amounts of employee absenteeism due to a potential release of radiation as well as restricted access to primary and alternate facilities due to radiological contamination.	The ability to deliver services can be impacted locally, regionally, or statewide following a radiological incident. To reduce the publics potential exposure to radiation, roadway and bridge closures may be required depending on the plume models, as well as transit service disruptions. Businesses and places of commerce may completely shut down due to radiological incidents, which leads to the disruption of goods and services.	Transportation, governmental operations, and infrastructure facilities may be disrupted during a radiological incident. Roads and bridges can be completely obstructed by radiological releases and required security perimeter. Radiological incidents can impact access to homes and critical entities such as hospitals, schools, and supermarkets, as well as other critical facilities. Safe access to homes, vehicles, structures, and resources may adversely affect response activities.	Agriculture crops and livestock are extremely susceptible to the adverse effects of radiological incidents that may cause contamination of a large area of land. Radiological incidents may impact the environment long-term by disturbing or killing wildlife and adversely affecting nature preserves.	Radiological incidents pose a fiscal impact on the local and state governments. Local, county, and state resources may be required during a radiological incident therefore reducing their availability for future events. Private businesses may not be able to maintain operations during or after an incident if they are impacted, which would impact the economy.	The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions to secure the radiological site and ensure the population is adequately informed of the risks posed by the incident. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Civil Unrest	Civil unrest may pose a direct threat to people and are more likely to occur when large groups of people are congregated together at localized events therefore creating a situation where local medical resources and response capabilities may be overwhelmed. **Public Health Impacts:** Civil unrest will have varying effects on the population including injury, death, and significant psychological impacts. These impacts may be immediate or long-term depending on the incident.	Civil unrest can create a dangerous environment and significant challenge for first responders. First responders may have to manage the evacuation of people from the area impacted by the disturbance, as well as direct traffic, close down roads, and take care of the injured. First responders may also become the direct target of the incident themselves. Equipment may also be damaged or destroyed due to the impact of the attack, which may lead to a decrease in response capabilities.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a large-scale civil unrest incident that affect the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. While expectation is minimal, this threat may impact RIEMA's ability to maintain COOP based on the disruptions potential to cause a significant injury to staff or impede travel to an alternate facility if relocation was required.	The ability to deliver services can be impacted locally, regionally, or statewide depending on the size and characteristics of the civil unrest. To reduce the impact to the public, roadway and bridge closures may be required, as well as transit service disruptions. Businesses and places of commerce may completely shut down due to property destruction, which leads to the disruption of goods and services.	Transportation, governmental operations, and infrastructure facilities may be disrupted during a significant civil unrest both directly and indirectly. Roads and bridges may be heavily impacted by large civil unrest especially if property damage and road blocks are present. Civil unrest can impact access to homes and critical entities such as hospitals, schools, and supermarkets, as well as other critical facilities. Safe access to homes, vehicles, structures, and resources may adversely affect response activities. If power loss occurs during an incident, it may lead to disruption of critical infrastructure and technology.	Civil unrest involving violence, property damage, and arson pose considerable negative impacts to the environment in the form of smoke and destruction of vegetation. Debris and biproducts of the disturbance have the potential to cause pollution to rivers, lakes, and streams, as well as air pollution.	Events of civil unrest involving violence or property destruction will have a fiscal impact on the local and state governments. Local, county, and state resources may be required during a civil unrest incident therefore reducing their availability for future events. Private businesses may not be able to maintain operations during if the area of unrest was near or involved their business, which would impact the economy.	If government employees or facilities are targeted directly by civil unrest, it will have a significant impact on the state's ability to govern. The public's confidence in the state's governance is affected by immediate local and state response through direct and effective actions. Efficiency in response and recovery operations is critical in keeping public confidence high.

Hazard	Impact on Public	Impact on Responder	Continuity of Operations (COOP)	Delivery of Services	Property, Facilities, and Infrastructure	Impact on Environment	Impact on State Economy	Public Confidence in the State's Governance
Infrastructure Failure	Critical infrastructure failures impact those living within the hazard area and surrounding areas and can lead to heavy flooding, power loss, property damage, injury, and even death. Extensive flooding and damage may lead to the evacuation and displacement of those individuals in the impact zone. Roadways may be obstructed or inaccessible to the public, challenging transport and resource acquirement activities. **Public Health Impacts:** A Failure of critical infrastructure, regardless of which piece, would have a direct impact on public health. Power outages, transit failures, access to clean water would all be critical infrastructure failures which would create severe and immediate public health impacts.	Infrastructure failure would have a direct and immediate impact on first responder's ability to respond effectively. Critical infrastructure failure may cause inaccessibility of roadways for first responders as well as damage of materials and resources. Communications system failure would impact the responders' ability to communicate their status or communicate through their command system identify areas that they needed to respond to.	Rhode Island Emergency Management Agency maintains a COOP plan and in the event of a critical infrastructure failure that affects the State's operations, will enact the plan appropriately to the situation. To date, there have been few or no major incidents that have shut down state, county, or municipal governmental operations. Critical infrastructure failure may trigger the activation of the COOP plan and the threat posed by the failure may impact RIEMA's ability to maintain those operations based on the incidents impact on a multitude of factors, including access to facility by transportation systems and usability of the facility by availability of utilities, including communications, energy, and water and wastewater systems.	Delivery of services will be disrupted due to critical infrastructure failure. Transit systems may face closures due to public safety concerns due to inability to operate transportation vehicles such as trains and buses. The ability to deliver food, drinking-water, and services will be impacted locally, regionally, and statewide due to problems with accessibility and transport abilities. Communications, transportation, and governmental services operations would be impacted due to power failure and accessibility challenges.	Roads and bridges may be impacted, water and sewer systems may be damaged, leading to the issue of sanitation and waste collection. Property of homes and businesses may be completely destroyed if situated close to the failure point.	The impacts on the environment of critical infrastructure would vary based on the event and impact. For example, dam failures include flooding and moving debris, affecting natural areas and wildlife. Failure of waste water plants would result in spreading pollution and hazardous materials throughout the environment including large bodies of water. Ecosystems and natural habitats may be destroyed, causing migration or death of wildlife.	Critical infrastructure failure would have a direct and considerable fiscal impact on the state government, even after some of the costs have been paid through federal disaster declarations if the failure was caused by another hazard. Additionally, infrastructure failure in every sector has the potential to impact the ability of businesses to operate. If the private sector was not able to maintain operability, there would be continued revenue loss until operability was restored.	Critical infrastructure failure would have a direct and immediate impact on the state's ability to provide governance, maintain order, and ensure the continuity of public services. If there were delays in restoring infrastructure, and any services contingent on this infrastructure, the public would become increasingly distrustful of the government's ability to restore services and ensure public safety and well-being. Direct, immediate, and effective actions must be taken in order to maintain public confidence. Response activities must include all levels of government.

Appendix D: Capability Assessment

D.1 Agency Contacts

Significant time and energy went into the compilation of the agency/program specific Capability Assessment profiles. Multiple people were involved in this initiative, Contacts for agency specific profiles are shown in Table D-1.

Table D-1 Agency Contacts

Affiliation	Contact
Federal Emergency Management Agency	Kerry Bogdan
	Christopher Rolleston
	Melissa Surette
National Grid	John Kennedy
	Gary Lataille
	Mike McCallan
	Kara Morris
National Weather Service	Nicole Belk
	Tracy McCormick
	Dave Vallee
	Edward Capone
Rhode Island Building Code Commission	Warren Ducharme
	John Leyden
Rhode Island Coastal Resources Management Council	Jim Boyd
	Grover Fugate
Rhode Island Department of Administration - Division of Planning	Caitlin Greeley
Rhode Island Department of Administration - Office of Housing and Community Development	Laura Sullivan
	Michael Tondra
Rhode Island Department of Environmental Management	Jim Ball
	Janet Coit
	Alicia Good
	Terry Gray
	Bill Patenaude
Rhode Island Department of Health	Nicole Alexander-Scott
	Laura Bozzi
	Nicholas Larmore

Affiliation	Contact
	Alysia Mihalakos
Rhode Island Department of Transportation	Peter Alviti
	Joseph Bucci
	Peter Healey
Rhode Island Emergency Management Agency	Mark Bennett
	Peter Gaynor
	Melinda Hopkins
	Erin Norris
	Samantha Richer
Rhode Island Historic Preservation & Heritage Commission	Jeffrey Emidy
Rhode Island Infrastructure Bank	Shaun O'Rourke
	Michael Baer
Rhode Island Water Resources Board	Kathy Crawley
United States Army Corp of Engineers	Brian Balukonis
	Ellen Berggren
	Chris Hatfield
	John Kennelly
	Matt Walsh
United States Geologic Survey	Gardner Bent
	Greg Stewart

D.2 Program Descriptions

Programs related to hazard mitigation are summarized in the following sections.

D.2.1 National Flood Insurance Program

The National Flood Insurance Program (NFIP), established by Congress in 1968, provides flood insurance to property owners in participating communities. This program is a direct agreement between the Federal Government and the local community that flood insurance will be available to residents in exchange for the community's compliance with minimum floodplain management requirements such as the adoption of a floodplain management or flood damage prevention ordinance. Since homeowners' insurance policies do not cover flooding, a community's participation in the NFIP is vital to protecting property in the floodplain and ensuring that federally backed mortgages and loans can be used to finance property and improvements within the Special Flood Hazard Area (SFHA).

Pursuant to the Flood Disaster Protection Act of 1973, many forms of federal financial assistance, including disaster assistance and federally-insured loans, related to structures located in the SFHA

are contingent on the purchase of flood insurance. Such federal assistance includes not only direct aid from agencies, but also products and assistance from federally insured institutions.

In order for property owners to purchase flood insurance through the NFIP, their community must be participant in good standing in the NFIP. There is no requirement that the property be located within an identified SFHA. Instead, any property in the community can be insured through the NFIP as long as the community maintains its good participant standing.

Communities participating in the NFIP must:

- Adopt the FIRMs as an overlay regulatory district or through another enforceable measure;
- Require that all new construction or substantial improvement to existing structures in the SFHA will be compliant with the construction standards of the NFIP and the Rhode Island State Building Code; and
- Require additional design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones (V zones).

In Rhode Island, the majority of the NFIP construction standards are contained in the Rhode Island State Building Code, which is implemented at the local level by municipal building inspectors. All 39 cities and towns and one (1) Tribal nation in Rhode Island are participants in the NFIP and all are in good standing.

Community Rating System (CRS) is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. The CRS program emphasizes three goals: the reduction of flood losses, facilitating accurate insurance rating and promoting the awareness of flood insurance. By participating in the CRS program, communities can earn a 5-45% discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community. Participating Rhode Island communities can be found in Section 3.

D.2.2 Hazard Mitigation Assistance Program

In an effort to streamline the grant application and management process, the Federal Emergency Management Agency (FEMA) created the Hazard Mitigation Assistance (HMA) program. This program created unified program guidance for three (3) mitigation grant programs currently funded by FEMA:

- Flood Mitigation Assistance Program (FMA)
- Hazard Mitigation Grant Program (HMGP)
- Pre-Disaster Mitigation Grant Program (PDM)

The grant programs are managed by Rhode Island Emergency Management Agency (RIEMA) Mitigation staff. In addition, all programs except HMGP use FEMA's e-Grants system for application submission and review. RIEMA has a Rhode Island-specific HMGP application format which is consistent with FEMA required program elements.

The following sections describe the HMA programs in more detail.

D.2.2.1 Flood Mitigation Assistance Program

Type of Assistance: Pre-disaster Cost-Share Grants

Funding Source: 75% federal share, 25% non-federal share (local government or other organization)

Authorized by the National Flood Insurance Reform Act of 1994, FMA provides funds in the form of a grant to assist States and communities in the implementation of measures that reduce or eliminate the long-term risk of damage to buildings and structures insured under the NFIP. Three (3) types of grants are available to States and communities:

Planning Grants to prepare Flood Mitigation Plans. Only NFIP-participating communities with approved Flood Mitigation Plans can apply for FMA Project grants.

Project Grants to implement measures to reduce flood losses, such as elevation, acquisition, or relocation of NFIP-insured structures. States are encouraged to prioritize FMA funds for applications that include repetitive loss properties; these include structures with two (2) or more losses each with a claim of at least $1,000 within any 10-year period since 1978.

Management Cost Grants for the State to help administer the FMA program and activities. Up to 10% of Project Grants may be awarded to states as Management Cost Grants

FEMA provides a federal share of up to 75% of the cost of the plan or project while communities and/or homeowners contribute a minimum of 25%. FMA is funded through an annual federal appropriation. Statutory limits exist on the amount of FMA funding a State may receive:

- The total amount of FMA funds provided during any five-year period shall not exceed $10 million to any State agency or $3.3 million to any community.
- The total amount of FMA funds provided to any State, including all communities located in the State, shall not exceed $20 million during any five-year period.
- Individual planning grants using FMA funds shall not exceed $150,000 to any applicant or $50,000 to any sub-applicant. FMA funds only can be used for the flood hazard component of a hazard mitigation plan that meets the planning criteria outlined in 44 Code of Federal Regulations (CFR) Part 201.
- The total planning grants using FMA funds made in any fiscal year to any State and the communities located within the State shall not exceed $300,000.
- No more than 7.5% of FMA funds shall be used for planning in any fiscal year.
- A planning grant shall not be awarded to a State or community more than once every five years.
- FEMA may waive the above limits when a major flood-related disaster or emergency is declared pursuant to the Stafford Act.
- Applicants for FMA funding must submit their applications through the e-Grants system during the application window, as established by the *HMA Unified Guidance.*

D.2.2.2 Hazard Mitigation Grant Program

Type of Assistance: Post-disaster Cost-Share Grants

Funding Source: 75% federal (FEMA), 25% non-federal (local government or other organization)

Unlike the other HMA programs, HMGP is not a nationwide competitive program. Established pursuant to Section 404 of the Stafford Disaster Relief and Emergency Relief Act (Public Law [PL] 100-707), this program provides matching grants (75% Federal, 25% non-Federal) for FEMA-approved hazard mitigation projects following a Presidential Disaster Declaration.

The purpose of the HMGP is to reduce the loss of life and property due to natural disasters and to enable mitigation measures to be implemented during the immediate recovery from a disaster. Eligible state, local and tribal governments, as well as some non-profit organizations, may apply for the funding. Individual citizens are not eligible to apply, though communities may apply on their behalf.

HMGP is not funded annually. Available funding is derived from a formula based on the estimated aggregate grant funding under the Stafford Act assistance programs (Public Assistance [PA], Individual Assistance [IA], and Disaster Unemployment Assistance). The State is allocated a percentage of the program funds expended by the Federal Government on each specific disaster recovery effort for 360 days after the date of the Presidential Declaration of Emergency. States with Standard Mitigation Plans, such as Rhode Island, are allocated the following:

- 15 % of the first $2,000,000,000 for HMGP
- 10% of the next $10,000,000,000 for HMGP
- 7.5% of any amount over $10,000,000,000 for HMGP

For States with a Standard Mitigation Plan, the total allocation to the State for HMGP cannot exceed $35,333,000,000. The grants are specifically directed toward reducing future hazard losses, and can be used for projects protecting property and other resources against the damaging effects of floods, hurricanes, earthquakes, high winds, and other natural hazards. Rhode Island prioritizes its HMGP funds for non-structural hazard mitigation measures, such as:

- Acquisition and demolition of vulnerable structures followed by permanent deeding the land by the community for open space or recreational use;
- Relocating damaged or flood prone structures out of a high hazard area; or
- Retrofitting properties to resist the damaging effects of natural hazards. Retrofitting can include wet or dry-flood proofing, elevation of the structure above flood level, elevation of utilities, or proper anchoring of the structure.

D.2.2.3 Pre-Disaster Mitigation Competitive Program

Type of Assistance: National, competitive grant program for multiple hazard mitigation projects and "all hazards" mitigation plans

Funding Source: 75% federal (FEMA) 25% non-federal (local government or other organization)

The PDM Program was authorized by §203 of the Robert T. Stafford Disaster Assistance and Emergency Relief Act (Stafford Act), 42 US.C. Chapter 68, as amended by §1 02 of the Disaster Mitigation Act of 2000. Funding for the program is provided by annual appropriation through the National Pre-Disaster Mitigation Fund to assist states, local governments, Indian Tribal governments, territories, and universities in implementing cost effective hazard mitigation activities that complement a comprehensive mitigation program. All applicants must be participating and in good standing in the NFIP if they have been identified through the NFIP as having a SFHA.

44 CFR Part 201, *Hazard Mitigation Planning*, establishes criteria for State and local hazard mitigation planning authorized by §322 of the Stafford Act, as amended by §104 of the Disaster Mitigation Act of 2000 (DMA 2000). After November 1, 2004, local governments and Indian Tribal governments applying for PDM funds through the State were required to have an approved local mitigation plan prior to receipt of mitigation project grants. States are also be required to have an approved Standard State mitigation plan in order to receive PDM funds for State or local mitigation projects. Therefore, the development and maintenance of State and local hazard mitigation plans is critical to maintaining eligibility for future PDM funding. The program contingent on the federal budget and may not be available in future funding cycles.

Funding plans and projects reduces overall risks to people, property and infrastructure, while also reducing reliance on funding from actual disaster declarations. PDM grants are awarded on a competitive basis and with nominal state set-aside annual allocations. PDM is a part of FEMA HMA Program, and is guided by the *HMA Unified Guidance* for the applicable fiscal year.

Sub-applicants (i.e., local governments, universities, etc.) submit their plan or project applications to the State (also called the Applicant) for review and prioritization through the e-Grants system during the application cycle. The State, in turn, submits the prioritized sub-applications to their FEMA Regional Office. Sub-applications will be initially reviewed by FEMA to ensure all minimum requirements are met for the PDM program. FEMA provides additional ranking points for all eligible mitigation planning and project sub-applications on the basis of predetermined, objective, quantitative factors to calculate a final National Ranking Score for each sub-application as shown in Table D-2.

Table D-2 FEMA PDM National Ranking Scores

National Ranking Factors and Point Values
The priority given to the sub-application by the Applicant in their PDM grant application.
Assessment of frequency and severity of hazards.
Whether the Applicant has a FEMA-approved Enhanced State / Tribal Mitigation Plan by the application deadline.
Community mitigation factors such as Community Rating System class, Cooperating Technical Partner, participation as a FireWise Community, and adoption and enforcement of codes including the International Code Series and National fire Protection Association 5000 Code, as measured by the Building Code Effectiveness Grading Schedule.
The percent of the population benefitting, which equals the number of individuals directly benefiting divided by the community population.
Whether the project protects critical facilities.
Status of the local sub-applicant as a small and impoverished community.

Project and plan sub-applications that are selected for further review are sent for final review by the National Evaluation Panel. These are panels composed of representatives from FEMA, State, Territories, local governments, federally recognized Indian Tribal governments, and other Federal agencies who peer evaluate project and planning sub-applications on the basis of qualitative factors.

PDM, competitive program. While there is no set limit on how much funding a single State or community may receive, there are restrictions in place, which are as follows:

- Up to $800,000 Federal share may be requested in a sub-application for a planning grant to develop a new hazard mitigation plan.
- Up to $400,000 Federal share may be requested in a sub-application for a planning grant to update a hazard mitigation plan.
- Up to $3 million Federal share may be requested in a sub-application to implement a mitigation project.
- The cumulative Federal award for sub-applications awarded during a single application cycle to any one Applicant shall not exceed 15% of the total appropriated PDM program funds for that application cycle. The amount of funding allocated for PDM fluctuates from year to year.

D.2.3 Emergency Management Performance Grant

Type of Assistance: Pre-disaster Cost-Share Grants

Funding Source: 50% federal (FEMA) 50% non-federal (local government or other organization)

Established pursuant to as authorized by Section 662 of the *Post-Katrina Emergency Management Reform Act* (6 U.S.C. § 762) and the *Robert T. Stafford Disaster Relief and Emergency Assistance Act* (42 U.S.C. §§ 5121 et seq.), this program provides matching grants 50% Federal, 50% non-Federal) for FEMA-approved projects. The Emergency Management Performance Grant (EMPG) Program is funded annual basis and is derived from a formula detailed in Title Consolidated Security, Disaster Assistance, and Continuing Appropriations Act of 2009, Public Law 110-329.

The purpose of the EMGP is to implement all-hazard preparedness measures for state, local, tribal, and territorial governments. Eligible state governments and territories may apply for the funding. Individual citizens are not eligible to apply. EMGP prioritizes for funding include capability targets and gaps in the Threat and Hazard Identification and Risk Assessment (THIRA), Stakeholder Preparedness Review (SPR) process, and areas identified in the National Preparedness Report (NPR).[1]

D.2.4 State Homeland Security Program

Type of Assistance: Pre-disaster Grants

Funding Source: Federal government

The State Homeland Security Program (SHSP) is part of the federal Homeland Security Grant Program (HSGP). Authorized pursuant to Section 2002 of the *Homeland Security Act of 2002*, as amended (Pub. L. No. 107-296), (6 U.S.C. § 603) and the *Department of Homeland Security Appropriations Act,* 2018 (Pub. L. No. 115-141), this program provides grants for FEMA-approved preparedness projects.

The funding from HSGP is divided among three (3) grant programs. Allocation for SHSP is determined by minimum amounts as legislatively mandated, and DHS's risk methodology. The purpose of the

[1] US Department of Homeland Security (DHS), n.d. Notice of Funding Opportunity (NOFO)
Fiscal Year (FY) 2018 Emergency Management Performance Grant (EMPG). Retrieved at: https://www.fema.gov/media-library-data/1526578379064-1a52c022786d147e1509a186a2764889/FY_2018_EMPG_REGULAR_NOFO_5_11_2018_FINAL_508.pdf

SHSP is to assist State, local, Tribal and Territorial governments by supporting projects that meet the Department of Homeland Security (DHS) Quadrennial Homeland Security Review goal to strengthen national preparedness and resilience. Eligible States and Territories may apply for the funding, and each state and territory receives a minimum allocation determined by *Homeland Security Act of 2002* thresholds.[2]

D.2.5 Public Assistance Program (Section 406 Mitigation)

Type of Assistance: Post-disaster Cost-Share Grants

Funding Source: FEMA

The objective of the FEMA PA Grant Program is to provide assistance to State, Tribal and local governments, and certain types of Private Non-Profit (PNP) organizations so that communities can quickly respond to and recover from major disasters or emergencies declared by the President.

Through the PA Program, FEMA provides supplemental Federal disaster grant assistance for debris removal, emergency protective measures, and the repair, replacement, or restoration of disaster-damaged, publicly owned facilities and the facilities of certain PNP organizations. The PA Program also encourages protection of these damaged facilities from future events by providing assistance for hazard mitigation measures during the recovery process.

The Federal share of assistance is not less than 75% of the eligible cost for emergency measures and permanent restoration. The grantee (usually the State) determines how the non-Federal share (up to 25%) is split with the sub-grantees (eligible applicants).

After a natural or man-made event that causes extensive damage, FEMA coordinates with the State to implement the PA Grant Program. The funding process consists of the following steps:

1. Preliminary Damage Assessments (PDA)
2. Presidential Disaster Declaration
3. Applicants' Briefing by Grantee
4. Submission of Request for PA by Applicant
5. Kick-off Meeting with the Public Assistance Coordinator (PAC)
6. Project Formulation and Cost Estimating
7. Project Review and Validation
8. Obligation of Federal Funds and Disbursement to Sub-grantees
9. Appeals and Closeout

The PA Program is administered through a coordinated effort between the FEMA, the State applicant (grantee), and the sub-applicants (sub-grantees).

The Robert T. Stafford Disaster Relief and Emergency Assistance Act gives FEMA the authority to fund the restoration of eligible facilities that have sustained damage due to a Presidentially declared

[2] US Department of Homeland Security (DHS), n.d. Notice of Funding Opportunity (NOFO) Fiscal Year (FY) 2018 Homeland Security Grant Program (HSGP). Retrieved at: https://www.fema.gov/media-library-data/1526578809767-7f08f471f36d22b2c0d8afb848048c96/FY_2018_HSGP_NOFO_FINAL_508.pdf

disaster. Commonly called Section 406 Mitigation, this program provides some mitigation funding to facilities damaged or destroyed by the present disaster.

Section 406 Mitigation provides discretionary authority to fund mitigation measures in conjunction with the repair of the disaster-damaged facilities. These opportunities usually present themselves during the repair efforts. The mitigation measures must be related to eligible disaster-related damages and must directly reduce the potential of future, similar disaster damages to the eligible facility. Normally, this work is performed on the parts of the facility that were actually damaged by the disaster. In some instances, an eligible mitigation measure may not be an integral part of the damaged facility.

There is no pre-set limit to the amount of Section 406 funds a community may receive. Section 406 Mitigation measures must be determined to be cost effective. Any one of the following means may be used to determine cost-effectiveness:

- Mitigation measures may amount to up to 15% of the total eligible cost of the eligible repair work on a particular project.
- Certain mitigation measures have been determined to be cost effective, as long as the mitigation measure does not exceed 100% of the eligible cost of the eligible repair work on the project.
- For measures that exceed the above costs, the Grantee or sub-grantee must demonstrate through an acceptable benefit/cost analysis methodology that the measure is cost effective.

D.2.6 Community Development Block Grant – Disaster Recovery Funding

Type of Assistance: Pre-disaster aid to state and local governments

The US Housing and Urban Development (HUD) provides flexible grants to help cities, counties, and States recover from Presidentially declared disasters, especially in low-income areas, subject to availability of supplemental appropriations. Community Development Block Grant – Disaster Funding (CDBG-DR) is authorized under Title I of the Housing and Community Development Act of 1974, as amended. Program rules are published in the Federal Register pursuant to specific appropriation acts. The Office of Community Planning and Development (CPD) administers the program.

In response to disasters, Congress may appropriate additional funding for the CDBG program as disaster recovery grants to rebuild the affected areas and provide crucial seed money to start the recovery process. Since CDBG-DR assistance may fund a broad range of recovery activities, HUD can help communities and neighborhoods that otherwise might not recover due to limited resources. CDBG-DR grants often supplement disaster programs of the FEMA, the Small Business Administration (SBA), and the US Army Corps of Engineers (USACE).

HUD generally awards noncompetitive, nonrecurring CDBG-DR grants by a formula that considers disaster recovery needs unmet by other federal disaster assistance programs. CDBG-DR funds are made available to states, units of general local governments, Trial Nationals, and insular areas designated by the President as disaster areas. These communities must have significant unmet recovery needs and the capacity to carry out a disaster recovery program (usually these are governments that already receive CDBG allocations). At times, supplemental appropriations restrict funding solely to States rather than the local cities and/or counties.

CDBG-DR grants primarily benefit residents, governments and businesses in communities impacted by a Presidential Declaration of Disaster. Generally, grantees must use at least half of CDBG-DR funds for activities that principally benefit low-and moderate-income persons. Grantees may use CDBG-DR funds for recovery efforts involving housing, economic development, infrastructure and prevention of further damage to affected areas, if such use does not duplicate funding available from the FEMA, the SBA, the USACE or other federal agencies or programs.

Examples of eligible activities include:

- Buying damaged properties in a floodplain and relocating residents to safer areas;
- Relocation payments for people and businesses displaced by the disaster;
- Debris removal not covered by FEMA;
- Rehabilitation of homes and buildings damaged by the disaster;
- Buying, constructing, or rehabilitating public facilities such as streets, neighborhood centers, and water, sewer and drainage systems;
- Code enforcement;
- Homeownership activities such as down payment assistance, interest rate subsidies and loan guarantees for disaster victims;
- Public services (generally limited to no more than 15% of the grant);
- Helping businesses retain or create jobs in disaster impacted areas; and
- Planning and administration costs (limited to no more than 20% of the grant).

Eligible activities must meet at least one (1) of three (3) program national objectives:

- Benefit persons of low and moderate income, or
- Aid in the prevention or elimination of slums or blight, or
- Support to urgent community development needs if existing conditions pose a serious and immediate threat to the health and welfare of the community and other financial resources are not available.

HUD notifies eligible state and local governments that they must then develop and submit an Action Plan for Disaster Recovery before receiving CDBG-DR grants. The Action Plan must describe the needs, strategies, and projected uses of the CDBG-DR funds.

D.2.7 Volunteer Fire Assistance Grants

Type of Assistance: Pre-disaster Grants

Funding Source: US Department of Agriculture (USDA) Forest Service

The Volunteer Fire Assistance Grants (VFA) Program was originally authorized in Title IV of Public Law 92-419, "The Rural Development Act of 1972." The Act authorized up to $7,000,000 to organize, train, and equip local fire forces to prevent, control and suppress fires in rural areas. In FY1975 the first appropriation of $3.5 million was provided for financial, technical, and other assistance to the State Foresters to carry out this Program. Title IV was later repealed by the Cooperative Forestry Assistance Act (CFAA) of 1978 (Public Law 95-313). Section 7 of the CFAA became the authority, which authorized the Cooperative Fire Protection (CFP) programs.

The CFAA was amended by the Forest Stewardship Act of 1990, better known as the "1990 Farm Bill." This Act moved the CFP programs to Section 10 of the CFAA, so the authority for the VFA Program is now contained in Section 10(b)3 of the CFAA. This change did not alter the original language of the CFAA with respect to VFA.

VFA provides funds for fire equipment, training, and initial fire department organization to fire departments serving small communities under 10,000 in population. Congressionally-appropriated VFA funds are provided to State forestry agencies through the USDA Forest Service. The State forestry agencies pass this money on to needful fire departments within their states. A fire department may buy equipment, pay for training or training materials, or cover the cost of department incorporation, as long as the funds are matched. VFA funds are granted on a 50/50 matching basis. In other words, the department must match the dollars, dollar for dollar, in money, time, or equipment. Most grants are $5,000 or less. Actual amounts depend on the VFA funding allocated to the particular State, which in turn depends on Congressional action.

This strategy will contribute to the overall mitigation strategy of improving training and communications relative to hazard mitigation issues.

D.2.8 Assistance to Firefighters Grants Program – Fire Prevention and Safety Grants

Type of Assistance: Pre-Disaster Grants

Managing Agencies: Local or community organizations, including fire departments, state, regional and national organizations

The primary goal of the Assistance to Firefighters Grants (AFG) Program is to meet the firefighting and emergency response needs of fire departments and nonaffiliated emergency medical service organizations. Since 2001, AFG has helped firefighters and other first responders to obtain critically needed equipment, protective gear, emergency vehicles, training, and other resources needed to protect the public and emergency personnel from fire and related hazards.

The Fire Prevention and Safety (FP&S) Grants are part of the AFG, and are under the purview of the Grant Programs Directorate in the FEMA. FP&S Grants support projects that enhance the safety of the public and firefighters from fire and related hazards. The primary goal is to target high-risk populations and reduce injury and prevent death. In 2005, Congress reauthorized funding for FP&S and expanded the eligible uses of funds to include Firefighter Safety Research and Development. This federal grant program awards grants to national, regional, State, departments (private or public) that are recognized for their experience and expertise in fire prevention or safety programs and activities. Projects under the *Fire Prevention and Safety Activity* are designed to lessen the number of deaths and injuries from fire-related hazards to a high-risk group of people. This risk must be determined and documented through an objective, reasoned approach, or risk assessment.

Appendix E: Local Plan Integration

E.1 Status of Local Plans and Updates

The following sections address local hazard identification, and provide an evaluation of capabilities, mitigation strategies, and plan information. For the 2019 Plan Update, the results processed from the local plan reviews are incorporated into Section 5. Table E-1 details the information about each local hazard mitigation plan, including plan status, plan expiration date, date of plan reference, and the award that funded the plan. Awards include the Hazard Mitigation Grant Program (HMGP), and Pre-Disaster Mitigation Grant Program (PDM). Plans that are approved, but pending adoption are classified as Approved Pending Adoption (APA).

Table E-1 Local Plan Status

Community	Award	Plan Status	Expiration Date	Date of Plan Referenced
Barrington	HMGP DR-4107	Approved	8/20/2022	8/21/2017
Bristol	PDM 2012	Approved	1/4/2022	1/5/2017
Burrillville	PDM 2010	Approved	1/13/2020	1/4/2015
Central Falls	Unspecified	APA*	N/A	N/A
Charlestown	PDM 2010	Approved	7/24/2022	7/25/2017
Coventry	HMGP DR-4089	Approved	2/14/2023	2/15/2018
Cranston	HMGP DR-4027	Approved*	1/21/2021	1/22/2016
Cumberland	HMGP DR-4089	Approved	7/18/2022	7/19/2017
East Greenwich	Unspecified	Approved	10/1/2020	10/2/2015
East Providence	Unspecified	Approved	4/6/2022	4/7/2017
Exeter	N/A	No Plan- Expired	7/10/2010	7/11/2005
Foster	HMGP DR-4212	APA*	N/A	N/A
Glocester	HMGP DR-4027	APA	N/A	N/A
Hopkinton	PDM 2015	Approved	3/12/2023	3/13/2018
Jamestown	HMGP DR-4027	Approved	3/23/2022	3/24/2017
Johnston	PDM 2015	Expired	5/9/2016	5/10/2011
Lincoln	Unspecified	Approved	7/25/2021	7/26/2016
Little Compton	HMGP DR-4027	APA	N/A	N/A

Community	Award	Plan Status	Expiration Date	Date of Plan Referenced
Middletown	Unspecified	Approved	1/15/2020	1/16/2015
Narragansett	Unspecified	Expired	2/10/2018	2/11/2013
New Shoreham	Unspecified	Approved	7/24/2022	7/25/2017
Newport	Unspecified	Approved	1/4/2022	1/5/2017
North Kingstown	Unspecified	Expired	6/12/2010	6/13/2005
North Providence	HMGP DR-4027	Approved*	8/19/2023	8/20/2018
North Smithfield	Unspecified	Expired	8/25/2010	8/26/2005
Pawtucket	PDM 2015	APA*	N/A	N/A
Portsmouth	PDM 2015	Expired*	5/27/2014	5/28/2009
Providence	PDM 2016	Approved	12/12/2018	12/13/2013
Richmond	HMGP DR-4089	Approved	6/14/2022	6/15/2018
Scituate	HMGP DR-4027	Approved*	9/4/2022	9/5/2017
Smithfield	N/A	No plan-Comprehensive plan used	N/A	N/A
South Kingstown	PDM 2016	Expired	3/26/2017	3/27/2012
Tiverton	HMGP DR-4027	Approved*	2/8/2023	2/9/2018
Warren	Unspecified	Approved	10/8/2020	10/9/2015
Warwick	HMGP DR-4212	Expired	8/13/2017	8/14/2012
West Greenwich	Unspecified	Expired	8/25/2010	8/26/2005
West Warwick	PDM 2015	Expired	3/25/2017	3/26/2012
Westerly	HMGP DR-4027	Approved	2/28/2023	3/1/2018
Woonsocket	PDM 2015	Expired*	7/22/2017	7/23/2012

*Indicates draft plan was reviewed in the development of this section.

E.2 Local Hazard Identification and Risk Assessment

Local hazard rankings are highly variable; as a result, each one has its own set of criteria to develop monetary loss values. These criteria were not consistent during the 2014 Plan update and this was the case with the 2019 Plan update. This variability does not lend itself to comparison of relative loss values for each hazard in the statewide plan. To fully utilize the local plan efforts, Rhode Island will need to develop standardized procedures for estimating losses. One continued goal of the State plan update is to standardize the data analysis process

so that future State and local plan updates are consistent and utilize comparable methodologies.

Consistent with the Code of Federal Regulations (CFR), the State Hazard Mitigation Plan (SHMP) integrates Hazard Identification and Risk Assessment (HIRA) information from local hazard mitigation plans. The following section provides a summary of hazards identified in local hazard mitigation plans. While jurisdictions conduct loss estimates and vulnerability assessments as part of their local hazard mitigation plans, incongruities and inconsistencies in the data and methodologies used by local communities made it impractical to directly incorporate the results of the local hazard mitigation plan loss and vulnerability analyses into this Plan update. Therefore, integration of local hazard mitigation plan risk assessment results is only possible in a limited manner:

- Help the State Interagency Hazard Mitigation Committee (SIHMC) prioritize grant awards based on the type of mitigation proposed, when considered in relation to the frequency of hazard identification in the local hazard mitigation plans; and
- Identify opportunities to improve the integration of local hazard mitigation plan data into the State Plan for future updates.

These opportunities present themselves in several areas:

- Establishing consistent hazard-identification terms, nomenclature and definitions;
- Establishing a system for creating and maintaining consistent data sources/ Geographical information system (GIS) sources related to hazards, demographics, risk, etc.; and
- Establishing consistent risk assessment and loss estimation methodologies.

These opportunities are reflected in specific recommendations that have been incorporated into the State Hazard Mitigation Action Strategy (Section 6) that will improve the quality of the local hazard mitigation plans, as well as the State's ability to integrate this information into future Plan Updates.

Prevalent hazards were identified in each local hazard mitigation plan, using the same hazard terminology or using comparable hazard terminology to one another. Some hazards identified in local hazard mitigation plans are not directly addressed in the 2019 Plan update. Generally, these hazards appear in a small number of local municipal plans. There are three (3) basic reasons why the 2019 Plan update does not directly address mitigation for these hazards.

- These hazards may have profiles that lead to similar mitigation measures as hazards that are addressed directly by the 2019 Plan update;
- These hazards may be sufficiently addressed by another State or federal agency or (local) entity; or
- These hazards may have been deemed by the SIHMC to not be among the most serious threats to the State.

Table E-2 shows hazards identified in local hazard mitigation plans. Because there are not yet standards that regulate how hazards are ranked, some local plans describe hazards by level of risk, while others used priority levels, or simply identified hazards without ranking or

prioritizing them. Therefore, in the table below, communities who ranked their hazards show the rankings as High (H), Medium (M), Low (L), or an intermediate ranking (e.g. M/H, L/M). For jurisdictions who only listed their hazards and did not rank them, identified hazards are marked with an X. These results show the prevalent hazards on the local level, and the prioritization of these hazards by different communities.

Table E-2 Hazards identified in local plans

County	Municipality	Hurricanes	Earthquake / Geologic	Wildfires / Conflagration	Winter Storms	Tornadoes	Windstorm / Wind Related	Nor'easter	Hail	Heavy Rains and Floods	Lightning	Flooding	Dam Failure	Severe Thunderstorms	Drought	Ice storm	Coastal Erosion	Heat Wave	Extreme Temperature	Storm Surge
Bristol	Barrington	X	X	X	X	X	X		X	X						X				
	Bristol	X	X	X	X	X	X			X			X		X		X			
	Warren	H	L	M	H	M			M			H			L					
Kent	Coventry	M	L	L	M	L	M/H	M	L		L	M	H		L	M			L	
	East Greenwich	X	X	X		X	X					X	X		X	X	X		X	X
	Warwick	X	X		X	X		X	X		X	X		X	X		X		X	X
	West Greenwich	M	L	M/H	H		H	H	L	M	M	M								
	West Warwick	X	X	X	X	X		X				X	X	X		X				
Newport	Jamestown		L	M	H		M					M			L				L	
	Little Compton	X			X	X	X	X			X	X	X			X	X		X	X
	Middletown	H	L	L								H	L	H	L					
	Newport		L	M	H		M					M			L				L	
	Portsmouth	H	L	L	H	L	M	H	L		L	H	L		M	M			M	
	Tiverton	H	L	L	H	L	M	H	L		L	H	L		L				M	

County	Municipality	Hurricanes	Earthquake / Geologic	Wildfires / Conflagration	Winter Storms	Tornadoes	Windstorm / Wind Related	Nor'easter	Hail	Heavy Rains and Floods	Lightning	Flooding	Dam Failure	Severe Thunderstorms	Drought	Ice storm	Coastal Erosion	Heat Wave	Extreme Temperature	Storm Surge
Providence	Burrillville	x	x	x	x	x		x				x	x		x				x	
	Central Falls																			
	Cranston	H	L	L	H	L	M/L		M/L		M/L	H		M/L			L			
	Cumberland	H	M	L	H	H	H	H	M	H	M	H	L	M	L	H			L	
	East Providence	x	x	x	x	x		x	x			x	x	x	x	x	x		x	x
	Foster	H	L	M	H	L	H	H	L		M	M/L	L		M	H			M	
	Glocester	L			H		H			M	H		H			H			M	
	Johnston	X			X	X	X				X	X		X		X				
	Lincoln	M	L	M	H		H	M	L		L	M								
	North Providence	M	L	L	H	L	M	M	L		M	H	L		L				M	
	North Smithfield	M	L	M	H		H	H	L		L	H								
	Pawtucket																			
	Providence	H	L		M	L	M	M				H		L	L	L			M	
	Scituate	H	L/H	L	M	L	M		M		M	H	H		L	M			M	
	Smithfield	X	X		X	X						X	X		X				X	
	Woonsocket	M	L	L	M	L	M	M	L		L	L	L		L	M			M	

County	Municipality	Hurricanes	Earthquake / Geologic	Wildfires / Conflagration	Winter Storms	Tornadoes	Windstorm / Wind Related	Nor'easter	Hail	Heavy Rains and Floods	Lightning	Flooding	Dam Failure	Severe Thunderstorms	Drought	Ice storm	Coastal Erosion	Heat Wave	Extreme Temperature	Storm Surge
Washington	Charlestown	H			M		H		L	H	L	H	L	H		M			M	
	Exeter																			
	Hopkinton	H	L	L	M/H	L	L	H	L		L	M	M		M	H			L	
	Narragansett	H																H		
	New Shoreham (Block Island)	H	L	L	M	M	H			M				H	L		M			H
	North Kingstown	X	X	X	X	X						X	X		X		X			X
	Richmond	M	L	L	M	L		M			M	H	M	M	M					
	South Kingstown	H	L/H		M/H					H		M/H	M		L		H			
	Westerly	X	X	X	X	X	X					X	X			X	X		X	X

E.3 Local Hazard Mitigation Draft Template

Future local plan updates present an opportunity to address some of the ambiguity between hazard naming conventions, facility analysis and loss estimate methodology. Rhode Island Emergency Management Agency (RIEMA) will encourage local plan revisions to approach classifying hazards in a similar fashion as used in this revised risk assessment.

RIEMA has worked with the Federal Emergency Management Agency (FEMA) Region I to develop a local hazard mitigation template for local planners to use during local hazard mitigation plan creation/updates. This template provides a recommends content and structure of the plan, while also linking users to FEMA's local guidance. The template is available on the following pages in Figure E-1 and also available electronically on RIEMA's website.[1]

Section 7 of this plan update includes a maintenance and implementation schedule that weaves in the local plan results during the Fourth Quarter meeting of the SIHMC. The tracking tools developed for the plan update will be used in tandem with RIEMA local plan review tool and guide.

[1] RIEMA, n.d. Recommended Rhode Island Local Hazard Mitigation Plan Template. Retrieved at: http://www.riema.ri.gov/resources/citizens/mitigation/documents/RI%20LHMP%20Final%20Template.pdf

Figure E-1 Rhode Island Local Hazard Mitigation Plan Template

Recommended Rhode Island Local Hazard Mitigation Plan Template

- **Cover Page**
  - Title (*City or Town of … Rhode Island Local Hazard Mitigation Plan*)
  - Jurisdiction info
    - Name(s) of participating jurisdiction(s)
    - New Plan or Update? Jurisdiction(s) previous FEMA approval date(s)
  - Version (with submittal dates)
  - Funding Assistance **[Optional]**
- **Table of Contents**
- **Executive Summary [Optional]**
- **Adoption Documentation**

SECTION 1 – Background [Optional]

1.1 Introduction to Hazard Mitigation and the HMP / HMP Update

1.2 Community Planning Area

a. Location info & Geography
b. Demographics/ Census, Housing
c. Land Use & Infrastructure
d. Community Development & Development Trends
e. Historic and Natural Resource/Environmental significance
f. Commerce, Industry, Academic
g. NFIP, CRS Community (highlights)

1.3 Significant Events since the last plan update (major disasters, major developments, conditions effecting risk in the community)

SECTION 2 - Planning Process

2.1 Purpose, Overview and Background

2.2 Building Support: Community Involvement, Roles & Responsibilities

a. The Planning Team, Technical Assistance & Local Leadership
b. Stakeholders
c. Public

2.3 Understanding the Community's Risks

a. Discovery & Gathering of Resources
b. Review and Incorporation of Information with Stakeholder and Public Exchange
c. Developing / Updating the Risk Assessment (Continued in Section 3)

2.4 Developing & Updating the Mitigation Strategy (Continued in Section 4)

a. Identification & Review of Goals, Actions, Priorities, Changes, Progress
b. Review and Incorporation of Stakeholder and Public Exchange

2.5 Bringing the Plan to Life: Implementation & Maintenance

a. Method, Responsibilities, & Schedule
   i. Plan [Update] Review, Adoption, and Approval
   ii. Monitoring

iii. Evaluation (Additional documents in Appendices)
iv. Updates

b. Continued Public Involvement (Also see Appendix – Outreach Strategy)

SECTION 3 - Risk Assessment

3.1 Defining Risk & Methodology

3.2 Hazards

a. Hazard Identification
   i. Statewide Hazards & Jurisdiction's Identification Table (to be provided by State)
   ii. Hazards Excluded from Risk Assessment/explanation

b. Hazard Profiles (each applicable hazard)
   i. Natural
      1. Description (standard description to be provided by the State)
      2. Location
      3. Extent
      4. Previous Occurrence, Disasters, and Probability of Future Events
   ii. Technological and Human-Caused **[Optional]**
      1. Description (standard description to be provided by the State)
      2. Location
      3. Extent
      4. Previous Occurrence, Disasters, and Probability of Future Events

c. Climate Change (this could be addressed separately here)

3.3 Vulnerability

a. Community Assets (exposure to loss)
   i. People
   ii. Economy
   iii. Built Environment
      1. Existing structures
      2. Infrastructure
      3. Critical facilities
      4. Historic and Cultural resources
      5. Future development
   iv. Natural Environment
      1. Water Resources, Watershed
      2. Protected Natural Areas
      3. Other

3.4 Risk Analysis & Assessment Matrix

a. Methodology
   i. Exposure Analysis
   ii. Historical Analysis
      1. Repetitive & Severe Repetitive Loss Properties
   iii. Scenario Analysis (if applicable)
   iv. Changes in Development Analysis [For Plan Update]

b. Vulnerability Summary (for each hazard)
   i. Identified Risk in the Community
   ii. Matrix

SECTION 4 – Capability Assessment

4.1 Purpose – Capabilities for both existing and future risk

4.2 Types & Evaluation of Capabilities (this can be outlined by program areas, or recommended by authorities, policies, programs, resources, community support/leadership, and the ability to expand/improve)

a. Local Government & Program Areas - Highlight applicability of local authorities, staffing, funding, and planning tools or mechanisms for hazard mitigation including but not limited to:

i. Form of government (town council, selectboard, planning board, home rule, MPO, etc.)
ii. Planning, Building, Housing - Community Development
iii. Transportation, Public Works, Utilities,
iv. Floodplain Management/Stormwater, Open Space, Land Conservation, Local Forestry
v. Emergency Management
vi. Economic (Re-)Development
vii. Health
viii. GIS (including database, modeling abilities of HAZUS, SLOSH, planning scenarios)
ix. Dam Safety

b. National Flood Insurance Program, CRS
c. Partnerships and Other Community Affiliations, Programs, Resources

4.3 Integration with Existing Plans & Local Processes (Other Planning Mechanisms)

a. Accomplishments
b. Opportunities and Process for Integration

i. Community Planning Mechanisms or Activities (e.g. next Comp Plan Update)
ii. Method & Timeline

4.4 Capability Needs/Challenges - Summary

SECTION 5 - Mitigation Strategy

5.1 Goals (and Vision, Objectives if available)

5.2 Development & Update of Strategy & Actions – Methodology (or in Section 2)

a. Identifying Types of Mitigation Actions (identify Preparedness separately or consider in Appendix)

i. Existing & New Actions
ii. Existing & Future Development
iii. NFIP
iv. Climate Change Adaptation – Future Risk

b. Analysis of Actions
c. Prioritization

i. STAPLEE

5.3 For Plan Updates: 2008-2013 Actions: Meeting Targets & Progress

5.4 2013-2018 Action Plan

a. Actions Using Risk Assessment Matrix by Vulnerable Area

i. Descriptions
ii. Action Type
iii. Pre or Post Disaster
iv. Priority Level (low, medium, high)
v. *Change in Priority [For Plan Update]*
vi. Lead
vii. Supporting
viii. Time Frame
ix. Financing Options

x. Cost Estimate
xi. Benefit

5.5 Table/Matrix

SECTION 6 – Moving towards a safe, resilient, and sustainable Rhode Island community

6.1 Evaluation: Progress & Challenges [For Plan Update]
   a. Involvement, Capabilities, Meeting Goals & Targets
   b. Changes in Development – Impacts to Risk
   c. New Disasters – Changes in Risk

6.2 Changes in Priorities [For Plan Update]

6.3 Success Stories and Best Practices **[Optional]**

References

Appendices

A. Assessing Risk - Maps
B. Building Support: Planning Process Additional Documentation
   1. Outreach Strategy & Materials
   2. Meeting Summaries, Notes, Sign-In Sheets
   3. Invites, Public Mtg Announcements, Web/Ad postings
   4. Surveys, Questionnaires, Evaluations, etc.
C. Capability Assessment [Additional documentation, if needed]
D. Determining Technical and Financial Assistance for Mitigation and Climate Change Adaptation
E. Emergency/Preparedness Strategy Actions **[Optional]**
F. Final Local Mitigation Plan Review Tool from Approved Plan
G. Glossary

E.4 Local Plan Capabilities Assessment

Local municipalities have primary authority over land use and development in Rhode Island. With regard to hazard mitigation, local government has the primary role in developing policy, making all land use decisions, establishing annual capital budgets, and implementing hazard mitigation and floodplain management activities. The table on the next page includes an overview of the local departments and/or organizations that have a responsibility in overseeing and/or implementing the local hazard mitigation projects, programs and policies within each community, and the evaluation of the function as it relates to risk reduction.

E.5 Evaluation of Departments/Organizations Supporting Hazard Mitigation

Table E-3 below details the departments, organizations, and associated roles that have responsibilities in supporting local hazard mitigation.

Table E-3 Local Departments and Organizations Supporting Hazard Mitigation

Function	Description	Opportunities	Evaluation and Effect on Loss Reduction
Building Officials	The Building Inspector implements and enforces the Rhode Island Building Code, which incorporates the National Flood Insurance Program (NFIP) construction criteria. The Rhode Island Building Code also includes sections on wind, snow loading, structural loads and seismic retrofitting. The building official also enforces locally adopted ordinances (e.g. zoning and subdivision ordinances)	RIEMA continues to provide training opportunities in coordination with the State Building Commissioners Office for all building officials and inspectors regarding floodplain regulations.	Ensures that the NFIP standards and other construction standards are consistently applied statewide.
Emergency Management Director	Each Rhode Island community has a local Emergency Management Director whose primary responsibility is local response and recovery.	Need to more strongly develop the relationship between the local Emergency Management Agency (EMA) Director, NFIP Coordinator, Building Official and Community Planner in order to leverage assets/resources to strengthen the effectiveness of hazard mitigation	EMA Directors play a critical role in the development of the Local Emergency Operations Plan and the Hazard Mitigation Plan. Both of these plans address opportunities to minimize loss of life and property damage.
Hazard Mitigation Committee	Established at the onset of the local hazard mitigation planning process. Committee has a diverse representation linking together many community departments and the public and private sectors. The committee meets annually to review the plan and track action implementation.	Depending upon the diversity of the Committee and its dedication to the implementation of the mitigation plan, hazard mitigation can be readily implemented in the consideration of all local land use decisions	This Committee has the primary responsibility of developing and updating the Local Hazard Mitigation Plan and identifying potential mitigation projects for funding.

Function	Description	Opportunities	Evaluation and Effect on Loss Reduction
Local NFIP Coordinators	Each NFIP community has an appointed local NFIP Coordinator who oversees compliance with the NFIP. Flood determinations, mapping issues, and construction standards within SFHAs are all addressed by the NFIP Coordinator.	Should develop a stronger relationship between the planning, public works and building departments relative to floodplain management. Should also pursue and offer outreach activities regarding sound floodplain management practices (e.g. *No Adverse Impact)* and identifying and pursuing projects to address repetitive loss properties.	Implementation can occur at the local level typically by an official that has the knowledge of local land use and construction issues.
Public Works Departments	The local department of Public Works and/or Water and Sewer Departments, which are primarily responsible for municipal drainage and storm water management systems, take the lead in ensuring the communities' compliance with the EPA's Phase II Storm water Regulations.	Public works staff is integral in implementing local hazard mitigation plans, especially in identifying and implementing local hazard mitigation projects.	Because storm water flooding is one of the major flood hazards in Rhode Island, ongoing maintenance and upgrading of local storm water systems by local public works departments is critical to reducing flood risks.
Conservation Commissions	The Conservation Commission has primary responsibility for overseeing issues relating to natural resources areas, critical areas of concern (per local comprehensive community comprehensive plans) and other environmentally sensitive areas. Also, primary implementers of soil and erosion control ordinances.	All new development and substantial improvement with potential impacts on any river, stream, ponds wetlands or coastal areas must be reviewed by the local Conservation Commission that plays an important role in enforcing regulations that minimize flood impacts.	Strong advocates for open space acquisition and preserving the natural and beneficial resources of wetlands and other SFHAs. Protection of wetland areas and buffer zones adds additional layer of protection to promote flood loss protection.

Function	Description	Opportunities	Evaluation and Effect on Loss Reduction
Planning Director/ Planning Boards	Per the State Enabling Act, the Planning Board, with the Town Planner, implements local subdivision regulations. The Planning Board responsibilities include recommending land use regulations to protect public health, safety and welfare. The Planning Board is the primary vehicle at the local level that ensures new development and substantial improvements incorporate	Planning boards can often bring in more holistic perspectives (i.e., watershed context and longer-term issues of a sustainable community).	The Planner or Planning Board often coordinates with the NFIP Local Coordinator and the Local Hazard Mitigation Committee through the mitigation planning process and the implementation of the plans (particularly when land use is involved). Can provide expertise in grant development and drafting of local ordinances and bylaws.
Town/City Council	Rhode Island cities and towns are governed by Mayors, Town Managers and Administrators, and city/town councils. This body approves subdivision, zoning and land ordinances and bylaws. Also facilitates annual financial town meeting overseeing the local capital improvements budget and plan.	Much more education needed concerning the beneficial uses of floodplains, hazard mitigation and other national policies and programs such as ASFPM's No Adverse Impact Initiative.	These bodies are comprised of the chief elected officials and provide leadership and approval for local hazard mitigation plans, projects, grants and programs.

Each community has unique programs, policies, and organizations related to hazard mitigation. The local hazard mitigation plans have been reviewed for this Plan update and Table E-4 provides an overview of those capabilities identified in the local plans. As shown, many communities have a fully approved comprehensive plan, which can be utilized to implement hazard mitigation techniques throughout the community.

In an effort to sufficiently evaluate the capabilities of each local jurisdiction, a simplified version of the state capability assessment ranking was completed and summarized in the following table. The capabilities presented in the local hazard mitigation plans have been grouped into the following categories:

- Planning Capability
- Development Policy and Program Capability
- Staffing, Technical Assistance, and Training Capabilities
- Demonstration of Capabilities: Active mitigation projects
- Eligible for funding to complete mitigation actions

An evaluation of local capabilities was completed by determining if the community demonstrated capabilities for each of the five (5) categories listed above. The categories were then further reviewed in 12 fields outlined in the table below. Similar to the State capability assessment, effectiveness of local policies, programs, and capabilities were grouped into three (3) classifications of High, Medium, and Neutral. Communities whose capabilities totaled 11 or 12 were assigned a High ranking, communities with values of nine (9) or 10 received an effectiveness of Medium and communities that either have plans in development or have expired plans received a neutral effectiveness.

The following communities have been ranked with a High capability to effectively implement hazard mitigation:

- Bristol County
  - Bristol
- Kent County
  - Coventry
  - East Greenwich
  - West Warwick
- Newport
  - Jamestown
  - Middletown
  - Newport
  - Tiverton
- Providence County
  - Cranston
  - Cumberland
  - East Providence
  - Foster
  - Glocester
  - Lincoln
  - Providence
- Washington County
  - Charlestown
  - Hopkinton
  - Narragansett
  - North Kingstown
  - Richmond
  - South Kingstown

The highest-ranking communities, receiving scores of 12, were Bristol, Coventry, East Greenwich, Glocester, West Warwick, Jamestown, Middletown, Newport, Cumberland, East Providence, Providence, Narragansett, South Kingstown, representing their commitment to mitigation planning and implementation.

It should be noted that the capabilities shown are solely based on the information in the local hazard mitigation plans and may not be a complete representation of all capabilities, at the local level, related to mitigation.

RIEMA is currently working with communities undergoing updates to ensure local capabilities are captured and to expand on the effectiveness of existing local mitigation policies, programs and capabilities. RIEMA will work closely with communities that received a Neutral ranking to determine how to increase mitigation effectiveness for the locality.

E.6 Identified Capabilities by Municipality/County

Local capability assessments also reviewed capabilities identified by each municipality and county, which are seen in Table E-4 below.

Table E-4 Identified Municipality Capabilities

County	Municipality	Planning				Development Policies and Programs			Staffing, Technical Assistance, Training			Active Mitigation Projects & Improvements	Eligible for Mitigation Funding	Effectiveness (high, medium, neutral)
		Approved LHMP	Approved Comprehensive Plan	Municipal Plans*	Emergency Shelter Facilities	Building Codes	Regulations / Ordinances/ Policies / Zoning	NFIP Compliant	Training (Fire Safety, Emergency Management, Planning)	GIS Modeling (HURREVAC, Hazus, SLOSH)	Outreach Initiatives			
Bristol	Barrington	x	x	x		x	x	x		x	x	X	x	Medium
	Bristol	x	x	x	x	x	x	x	x	x	x	x	x	High
	Warren	x	x	x	x	x	x	x		x		x	x	Medium
Kent	Coventry	x	x	x	x	x	x	x	x	x	x	x	x	High
	East Greenwich	x	x	x	x	x	x	x	x	x	x	x	x	High
	Warwick	x	x	x	x	x	x	x				x	x	Medium
	West Greenwich	x	x	x	x	x	x	x			x	x		Medium
	West Warwick	x	x	x	x	x	x	x	x	x	x	x	x	High
Newport	Jamestown	x	x	x	x	x	x	x	x	x	x	x	x	High
	Little Compton		x	x	x	x	x	x	x				x	Neutral

County	Municipality	Planning				Development Policies and Programs			Staffing, Technical Assistance, Training			Active Mitigation Projects & Improvements	Eligible for Mitigation Funding	Effectiveness (high, medium, neutral)
		Approved LHMP	Approved Comprehensive Plan	Municipal Plans*	Emergency Shelter Facilities	Building Codes	Regulations / Ordinances/ Policies / Zoning	NFIP Compliant	Training (Fire Safety, Emergency Management, Planning)	GIS Modeling (HURREVAC, Hazus, SLOSH)	Outreach Initiatives			
	Middletown	x	x	x	x	x	x	x	x	x	x	x	x	High
	Newport	x	x	x	x	x	x	x	x	x	x	x	x	High
	Portsmouth		x	x	x	x	x	x		x	x	x	x	Medium
	Tiverton		x	x	x	x	x	x	x	x	x	x	x	High
Providence	Burrillville	x	x	x	x	x	x	x	x			x	x	Medium
	Central Falls													
	Cranston		x	x	x	x	x	x	x	x	x	x	x	High
	Cumberland	x	x	x	x	x	x	x	x	x	x	x	x	High
	East Providence	x	x	x	x	x	x	x	x	x	x	x	x	High
	Foster		x	x	x	x	x	x	x	x	x	x	x	High
	Glocester		x	x	x	x	x	x	x	x	x	x	x	High
	Johnston	x	x	x	x	x	x	x	x		x	x		Medium
	Lincoln	x	x	x	x	x	x	x		x	x	x	x	High
	North Providence		x	x	x	x	x	x		x			x	Neutral
	North Smithfield	x	x	x	x	x	x	x				x	x	Medium
	Pawtucket													

County	Municipality	Planning				Development Policies and Programs			Staffing, Technical Assistance, Training			Active Mitigation Projects & Improvements	Eligible for Mitigation Funding	Effectiveness (high, medium, neutral)
		Approved LHMP	Approved Comprehensive Plan	Municipal Plans*	Emergency Shelter Facilities	Building Codes	Regulations / Ordinances/ Policies / Zoning	NFIP Compliant	Training (Fire Safety, Emergency Management, Planning)	GIS Modeling (HURREVAC, Hazus, SLOSH)	Outreach Initiatives			
	Providence	x	x	x	x	x	x	x	x		x	x	x	High
	Scituate		x	x	x	x	x	x	x		x	x	x	Medium
	Smithfield		x	x			x	x	x	x				Neutral
	Woonsocket		x		x	x	x	x	x	x	x	x	x	Medium
Washington	Charlestown		x	x	x	x	x	x	x	x	x	x	x	High
	Exeter													
	Hopkinton	x	x	x	x	x	x	x		x	x	x	x	High
	Narragansett	x	x	x	x	x	x	x	x	x	x	x		High
	New Shoreham	x	x	x	x	x	x	x		x		x	x	Medium
	North Kingstown	x	x	x	x	x	x	x		x	x	x	x	High
	Richmond	x	x	x	x	x	x	x		x	x	x	x	High
	South Kingstown	x	x	x	x	x	x	x	x	x	x	x	x	High
	Westerly	x	x		x	x	x	x	x		x	x	x	Medium

*Types of municipal plans included at least one (1) of the following: Debris Management, Evacuation, Engineering, EOP, Water Supply, Medical, Facilities, Open Space, Wastewater

E.7 Local Plan Mitigation Strategy

Table E-5 below lists the jurisdictions that have not reported any completed actions since the 2014 SHMP. In many cases, the plans for these communities are in the process of being updated. It is likely that mitigation actions have in fact been implemented and relevant information will be included in the local plan updates and future updates of the SHMP.

Table E-5 Communities with No Identified Completed Mitigation Actions Since 2014

Communities with No Identified Completed Mitigation Actions Since 2014 (or Most Recent Plan for Expired Jurisdictions)
Central Falls
Pawtucket
Jamestown
North Providence
North Smithfield
Richmond
Scituate
Little Compton
West Greenwich

Several communities have completed mitigation actions since the 2014 SHMP. The SIHMC reviewed these actions for compatibility with the SHMP and found that all completed actions are in accord with the goals described in this update. Table E-6 below provides a description of each completed mitigation action, organized by community and project type.

Table E-6 Implemented Hazard Mitigation Actions Identified in Local Hazard Mitigation Plans

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
Barrington	Planning and Regulatory Activities	Relocate Police Station
		Building Codes
		Floodplain ordinance
		Wetlands Overlay Zoning Ordinance
		Land Development and Subdivision Regulations
		Stormwater Ordinance
		National Flood Insurance Program Participation
	Structural Mitigation Measures	Repair and Maintain Coastal Areas
		Coastal Protection and Restoration Projects
		Replacement of Central Bridge
		Ongoing Maintenance and Repair to Infrastructure
	Public Education and Outreach	Town Website Upgrades
		Flood Zone Mapping Added to GIS Database
		CodeRed Promoted on Town Website
		Provision of Flood Hazard Information
		Public Notification
	Land Acquisition and Relocations	Acquisition of Freshwater/Inland Wetlands
Bristol	Planning and Regulatory Activities	Comprehensive Plan Open Space Plan Flood Protection Services Flood Hazard Development Permit/Development Standards Subdivision and Development Review Regulations Chapter 29 Soil Erosion, Runoff and Sediment Control Revised Phase II Stormwater Management Plan Rhode Island Climate Change Commission Rhode Island Sea Grant Fact Sheets/Climate Change Science Summary Adapting to Climate Change: A Planning Guide for State Coastal Managers, National Oceanic and Atmospheric Association (NOAA) Storm Preparedness and Hazard Mitigation Plan Harbor Management Plan

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
	Administrative and Technical Activities	Community Emergency Response Team (CERT) Coordination with Local Business Community Coordinating with Neighboring Municipalities Coordination with Roger Williams University Municipal Administration and Staff Safewater RI: Ensuring Safe Water for Rhode Island's Future CRMC's Section 145 Climate Change and Sea Level Rise Policy Rhode Island Coastal Property Guide StormSmart Coasts Rhode Island
Burrillville	Planning and Regulatory Activities	Floodplain Protection District Aquifer Overlay Zone District Wetlands Protection Regulations Slope Protection Regulations Road Construction Standards International Building Codes State Fire Code Zoning Ordinance Height Limitations Sanitary Sewer Standards Drinking Water Standards
	Structural Mitigation Measures	Storm Water Drainage Areas Hazardous Tree Removal
Central Falls	Information Unavailable	Information Unavailable
Charlestown	Planning and Regulatory Activities	Charlestown GIS Database Enforce Floodplain Standards Develop Post-Storm Recovery Plan Formalize Mutual Aid with Neighboring Towns Maintain Disaster Recovery Team Incorporate best management practices (BMP) into Public Works Improvement Projects Develop Standardized Policies for Risk Areas Document Gaps for Future Mitigation Activities

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
	Structural Mitigation Measures	Implement Structural and Non-Structural Retrofit Programs Document Areas of Destruction and Risk Post-Disaster Develop a Shoreline Overlay Upgrade Public Beach Facilities
	Public Education and Outreach	Pre- and Post-Financial Incentives for Mitigation Distribute Information on Location of Hazard-Prone Areas Educate Public About Fire Safety Improve Fire Fighting Capability Support Public/Private Partnerships to Create Financial Incentives Provide Information on Individual Sewage Disposal System (ISDS) Upgrade Options Provide Training Programs for Natural Hazard Mitigation Develop a List of appropriate Techniques for Homeowners Landscaping to Reduce Erosion and Damage from Wind Evacuation Maps and Signs Posted Along State Roads Re-Evaluate Evacuation Plan Discuss Current Standards on Building, Renovation, Floodplain Management
Coventry	Structural Mitigation Measures	Stockpile Sandbags and Gravel at Rhode Island Department of Public Works (RIDPW), Publish on Website Preceding Event Catch Basin and a "Vortex" Drainage System at Rawlinson Dr., Mohawk St., Mead St. & Seneca St. Box Culvert on Westerly Side of Club House Rd. Box Culvert at Maple Valley Rd. Culvert at Hammet Rd. Detention Basin at Maple. St, Ginger Trail Flat River Reservoir New Culvert and Spillway for Tiogue Lake Increase Number of Dry Hydrants and Cisterns in the Rural Area Buy a Storm Tracking Device Repairs to Tiogue Land Dam, Flat River Reservoir Dam, and Spillways

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
	Public Education and Outreach	Establish Pet Safe Areas Near Shelters Purchase Illuminated Weather Advisory Signs Provide a NOAA Radio in Public Safety Complexes and Emergency Operation Centers (EOC) Identify Measures to Evacuate and Accommodate Vulnerable Populations
Cranston	Planning and Regulatory Activities	Storm Preparedness and Hazard Mitigation Plan Inventory 18 Floodplain Management Activities Credited by Community Rating System (CRS)
	Structural Mitigation Measures	Sewage Infiltration and Inflow Study Pump Stations in the Floodplain Floodproofed Bridge Retrofitting and Repair Acquisition of Flood Damaged Properties
Cumberland	Public Education and Outreach	Flood Protection Services
	Planning and Regulatory Activities	Valley Falls Emergency Action Plan
East Greenwich	Planning and Regulatory Activities	Debris Management Plan
	Structural Mitigation Measures	Generators for mass care and other public facilities
East Providence	Planning and Regulatory Activities	Assess Vulnerability of Public Buildings Assess Vulnerability of Public Records Protect Library Resources Inventory of Long-Term Care and Child Care Facilities Examination of Land Uses Maintain National Incident Management System (NIMS) Compliance Inventory of Bridges with Utilities Inventory of Commercial and Industrial Buildings in Floodplain Carefully Planned Future Waterfront Development
	Public Education and Outreach	Encourage Underground Utilities
Exeter	Information Unavailable	Information Unavailable
Foster	Structural Mitigation Measures	Culvert Replacement and Paving on Shippee and Schoolhouse Rd. Identify Funding Sources and Purchase Generator for Shelter Facility

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
Glocester	Structural Mitigation Measures	Develop and Maintain List of Roads and their Conditions Repairs to Roads Subject to Flooding
	Public Education and Outreach	Provide Communications to Privately Owned Campgrounds During Storm Events
Hopkinton	Structural Mitigation Measures	Install Appropriately Sized Generator to Crandall Property
	Planning and Regulatory Activities	Flood Control System Designed to Prevent Repetitive Flood Issue on South Dr. Utilize GIS to Develop a Storm Drain Database and Map Update Current GIS Hardware and Software to Meet Standards
Jamestown	Information Unavailable	Information Unavailable
Johnston	Structural Mitigation Measures	Drainage improvements Vegetation clearing on Oak Swamp Reservoir and Jillson/Almay Reservoir
	Planning and Regulatory Activities	Review of proposed developments Soil and Erosion Control Ordinance implemented Emergency Watershed Protection Participation in Operation Hurricane Providence
Lincoln	Pre-Mitigation Activities	Evaluation of Structural Integrity of Dams Establish a Priority List of Dam Repair Evaluation of Functionality of Local Utilities Establish a Priority List for Utilities Evaluate Structural Integrity of Bridges Establish A Priority List for Repairs Priority List of Street Repair Subject to Flooding
	Planning and Regulatory Activities	Create a Standard to Review Drainage on New Developments/Projects Join CRS
	Public Education and Outreach	Continue Working Relationship with Tree Companies Develop Working Relationship with School Departments Continue Working with Police and Fire Districts on Natural Hazard Planning Develop Working Relationship with Privately Owned Medical Facilities
Little Compton	Information Unavailable	Information Unavailable

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
Middletown	Planning and Regulatory Activities	Complete Watershed Analysis and Update Flood Maps as Needed
	Structural Mitigation Measures	Increase Capacity at Wave Avenue Pump Station Install OptiCom Sensors on Traffic Signals
	Pre-Mitigation Activities	Assess Impact of the Privatization of Navy Housing
Narragansett	Planning and Regulatory Activities	Evacuation Plan
	Public Education and Outreach	Mark Roads with Evacuation Signs Parks Closed during Severe Hurricanes
	Structural Mitigation Measures	Install Utility Shut-Off Valves Plan for Elevation and Breakaway Structure of Future Beach Pavilions
New Shoreham	Structural Mitigation Measures	New Fire Rescue Building New Town Hall and Fire-Proof Records Vault Sprinkler System Old Harbor Dock Rebuild Portable Generator
Newport	Pre-Mitigation Activities	Study of Existing Evacuation Routes
North Kingstown	Planning and Regulatory Activities	Relocation Study Emergency Action Plan for Town Dams
	Public Education and Outreach	Hazard mitigation web page Educational Brochure
	Structural Mitigation Measures	Rehabilitated Police and Fire Headquarters
North Providence	Information Unavailable	Information Unavailable
North Smithfield	Information Unavailable	Information Unavailable
Pawtucket	Information Unavailable	Information Unavailable
Portsmouth	Planning and Regulatory Activities	Certification as "Storm-Ready" Community Adopt Policy to Keep Public Away from Park Ave. During Storm Events Structural Evaluation of Escape Bridge Develop a Plan for Regular Tree Trimming Along Town Roads Develop Plans for Debris Removal/Sand Overwash Repair to Breakwater on Prudence Island Complete Establishment of EOC Update and Codify Emergency Operation Plan (EOP)

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
	Public Education and Outreach	New Automated External Defibrillator (AED) Plus PI Rescue Wagon Upgrade Evacuation Route and Direction to Shelter Signage Identify and Upgrade Additional Shelter Capacity
Providence	Planning and Regulatory Activities	Revisions to Emergency Operations Plan
	Structural Mitigation Measures	Bridge Improvements
Richmond	Information Unavailable	Information Unavailable
Scituate	Information Unavailable	Information Unavailable
Smithfield	Information Unavailable	Information Unavailable
South Kingstown	Planning and Regulatory Activities	Emergency Action Plan for Town Dams Engineering/Planning Study on Matunuck Beach Road
	Structural Mitigation Measures	Riprap Repairs
Tiverton	Planning and Regulatory Activities	Identify Alternate Evacuation Routes Identify Alternate Routes in the Event of Dam Failure Perform American Red Cross (ARC) Mass Care Facility Inventory of Stored Supplies
	Structural Mitigation Measures	Replace Sakonnet Bridge Replace Main Road Bridge Purchase New Front-End Loader
	Public Education and Outreach	Notify Dam Owners of Their Dam Responsibility
Warren	Pre-Mitigation Activities	Complete Survey of Main Roads/Properties that Flood Develop a Town-Wide Inventory of Small Streets that Flood/Wash Out

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
	Structural Mitigation Measures	Work with Rhode Island Department of Transportation (RIDOT) to Begin Drainage Improvements Purchase High Output Emergency Generators for the three (3) Emergency Shelters Purchase Generators for the Government Center and Town Hall Establish a Satellite Communications Center for the Fire Department Upgrade Marine Communications Equipment Retrofit/Replace Communication Tower at Town Hall to Withstand High Winds Replace/Elevate Bridge at Warren/Barrington Town Line
	Planning and Regulatory Activities	Complete Parcel Mapping and Street Centerline Using GIS Periodically Inspect and Evaluate School Buildings for Code Compliance
Warwick	Planning and Regulatory Activities	Road Inventory Infrastructure Inventory
	Structural Mitigation Measures	Repair Roof of Thayer Arena Critical Road Reconstruction Annual Debris Removal Cooperative Program Implemented
	Public Education and Outreach	Hurricane Preparedness Materials Published Boat Ramp Education Materials Distributed New EMA Procedures Established
West Greenwich	Information Unavailable	Information Unavailable
West Warwick	Planning and Regulatory Activities	Enforce NFIP Guidelines Identify Evacuation Routes Review Kent County Water Authority Mitigation Plan
	Pre-Mitigation Activities	Acquire New Pumper Truck

Community	Mitigation Project Type	Implemented Actions per Hazard Mitigation Plan
Westerly	Structural Mitigation Measures	Improve Water Conveyance Along Canal Street Elevate Larry Hirsh Way Relocate Utility Downtown Flood Damage Mitigation Clean and Maintain Clogged Drainage at Wilcox Park Verizon Telephone Switching Station Flood Protection
	Planning and Regulatory Activities	Hazard Mitigation Element Added to Comprehensive Plan
Woonsocket	Structural Mitigation Measures	Flood Control Project Woonsocket Falls Dam Painted to Prevent Corrosion

These completed mitigation actions are a marker by which RIEMA and the SIHMC can determine the State's progress towards achieving and maintaining its mitigation goals. These completed actions can also serve as examples or case studies to other communities, who may be interested in discussing or considering new or different types of mitigation actions as they update their own mitigation plans.

E.8 Prioritizing Local Assistance

The process used by the State of Rhode Island to review, evaluate and select projects for the various mitigation grant programs is based on years of public participation and supports the State's home-rule form of government. Home rule provides that government at the lowest-possible level is the one best prepared to make decisions that affect it the most - including hazard mitigation projects.

Rhode Island's concept is to support all local mitigation efforts. Typically, hazard mitigation funds following a disaster are available to all eligible agencies and organizations statewide for projects that reduce the risk of future damage, regardless of the hazard being addressed (i.e., funds available following a hurricane disaster can address problems presented by other hazards).

Potential projects are evaluated using a scoring process emphasizing protection of life and property, reduction of risk, and cost-effectiveness. As indicated in the Capability Assessment, RIEMA staff will work with each potential grant applicant to ensure that proposed projects provide as great a public benefit as possible.

When mitigation planning funds are available to support local plan updates, however, funds will be distributed according to the 2018 Preparedness Grant State priorities, which were derived from the THIRA process:

- Supply chain integrity and security
- Logistics and supply chain management
- Mass Care Services
- Situational Assessment
- Economic Recovery
- Risk and Disaster Resilience Assessment
- Planning
- Community Resilience
- Screening, Search, and Detection[2]

All local plans are reviewed by RIEMA staff and forwarded onto FEMA Region I for final approval. While some plans addressed all hazards that have even the most remote chance of occurring in Rhode Island, generally the strategies proposed in the local plans and in the State plan are very similar. As these plan updates are completed and submitted to FEMA for review and approval, the local hazard mitigation measures will be incorporated into the SHMP. The following subsection explains RIEMA criteria for project funding eligibility and selection.

E.9 Criteria for the Prioritization of Mitigation Grants

In evaluating hazard mitigation applications for grant funding, a scoring system is used to prioritize projects according to both federal eligibility criteria and the State eligibility criteria as published in the grant application guidance. For each round of grant funding, RIEMA reviews the applications.

When prioritizing grant applications, the seriousness of risk is emphasized when considering an applicant's response to the following federal and State eligibility criteria. Among the criteria receiving greatest weight in scoring are those dealing with reduction of risk posed by hazards, prevention of repetitive loss structures, and protection of critical areas including frequently flooded areas and geologically hazardous areas.

E.9.1 Project Eligibility

The State criteria used for prioritizing local eligible projects for pre-disaster and post-disaster hazard mitigation funding in Rhode Island requires that the project:

1. Must be in conformance with a FEMA-approved local and/or multi-jurisdictional all hazards mitigation plan which meets the mitigation planning requirements per the Disaster Mitigation Act of 2000 (DMA 2000). (Note: this criterion became effective November1, 2004).
2. Must be in conformance with the Rhode Island SHMP developed as a requirement of the DMA 2000. Rhode Island places a priority on local mitigation projects that involve non-structural, or "low cost" solutions (i.e. updating and enforcing local flood ordinances), retrofitting high-risk structures (i.e. elevating residences in coastal flood zones) and/or the acquisition of repetitive loss structures.
3. Must be located in, or have a beneficial impact upon, past declared disaster areas; or in a high-

[2] Rhode Island Emergency Management Agency, 2018. FY 18 DHS/FEMA Preparedness Grants Kickoff Meeting [Presentation]. Retrieved at: http://www.riema.ri.gov/grants/index.php

risk area for potential impacts from one (1) or more natural hazards, such as a floodplain, high wind area, coastal zone, etc. This also includes SRL properties. The high-risk area should be identified in either the local, regional or State mitigation plan.

4. Must be in compliance with all existing Rhode Island Laws and Regulations for construction, land alterations, and natural resource protection, such as the Rhode Island State Building Code, the Rhode Island Coastal Resources Management Plan, and all legislation pertaining to the protection and preservation of wetlands. Must be in compliance with municipal ordinances and zoning regulations
5. Must be in conformance with 44 CFR, Part 9, Floodplain Management and Protection of Wetlands, and 44 CFR, Part 10, Environmental Considerations.
6. Must provide a solution to a problem independently, or provide a significant functional portion of a solution being addressed in a combined project. If the project constitutes a significant functional portion of a solution being addressed, the status of any associated dependent or supporting projects must be given. There must be reasonable assurance that the total mitigation project will be completed. The identification or analysis of a problem does not automatically qualify for eligibility.
7. Must meet FEMA's cost-effective criteria such as the need to substantially reduce the risk of future damage, hardship or losses resulting from a major disaster. Documentation will be required that demonstrates that:
    - The problem is repetitive and/or poses a significant risk if left unsolved. Therefore, a brief history of previous occurrences of the problem at the project location, including dates and impact of each event, and/or an analysis of projected potential damages if the project is not completed must be given.
    - Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.
    - Sufficient information to allow comparison of the cost of the project with the anticipated value of future direct damage reduction or negative impacts to the area.
    - The proposal has been determined to be the most practical, effective, and environmentally sound alternative found after consideration of all available options.
    - The project contributes to the long-term solution of the problem it addresses. Therefore, an estimate of the effective life of the project and a listing of influence factors should be included.
    - Development of the project considers any long-range alterations to the area and the entities that it protects, has future maintenance requirements that are financially feasible and can be modified, if necessary, without changing the impact on the area.

Preference is given to projects that exhibit greater cost-effectiveness as established by a benefit cost ratio calculated using the FEMA Benefit-Cost Analysis software as suggested in requirement eight (8) above, and to projects or plans that contribute the greater solutions to stated problems as suggested in requirement seven (7) above. Preference is given to communities with the highest risk. When ranking potential projects, particular consideration will be given for projects that address repetitive flood loss. Finally, particular consideration will be given to projects proposed by communities with the most intense development pressure.

E.9.1.1 Project Selection

Available federal funds for pre-disaster and post-disaster Hazard Mitigation Assistance Program (HMA), Emergency Management Performance Grant (EMPG), and State Homeland Security Program

(SHSP) will most likely not be sufficient to support all eligible project applications. An attempt will be made to award grants to the maximum number of eligible projects.

Recommendations for funding will be made to the FEMA Region I office by the SHMO in consultation with NFIP State Coordinator, under advisement by the SIHMC. FEMA will make the final selection of grants to be awarded. The mitigation measure proposed should not be intended to only replace what was damaged, but rather should provide more protection to life and property than what existed prior to the storm.

E.9.2 Technical Assistance

RIEMA has worked with local jurisdictions to encourage and support local hazard mitigation planning since the recovery efforts after Hurricane Bob in 1991. At that time, every effort was made to address future losses through the reduction of damages to property by integrating ongoing growth management, sustainability and land use management initiatives with hazard mitigation planning. Rhode Island has mandated that communities develop local hazard mitigation plans (approximately ten years prior to the passing of the federal DMA 2000) that address land use issues and can be implemented through existing local comprehensive community plans.

Technical assistance to communities has consisted of statewide planning workshops to train locals on how to develop a hazard mitigation plan (prior to DMA 2000) and providing GIS maps of the communities' risks and vulnerabilities. FEMA contractors facilitated one- and two-day workshops on how to develop local hazard mitigation plans and how to identify sound hazard mitigation projects. Tabletop exercises were also held with local officials in which a simulated "real time" hurricane and/or flood exercise hit a community and the participants were expected to respond and identify the proper actions to take throughout the response and recovery process. Based on that experience, participants were asked to identify mitigation actions, policies, programs and projects that they would take to lessen the impact of disasters the next time the hazard hit their community.

RIEMA encourages a community to establish a Local Hazard Mitigation Committee (LHMC) prior to receiving technical assistance. This committee usually consists of various municipal officials including the community's planner, emergency management director, NFIP Coordinator, fire chief, engineer, building official, town administrator and public works director, or any other local official who may have a role or will be responsible for implementing the strategy. The committee is responsible for identifying the hazards, incorporating public input, developing and prioritizing mitigation actions and implementing and revising the strategy.

Twenty-five local plans included mitigation actions related to acquiring lands/repetitive loss structures in hazard prone areas. RIEMA will continue to provide technical assistance those communities without such an action and those without hazard mitigation plans to address repetitive loss properties.

E.9.3 Monitoring and Tracking Local Hazard Mitigation Plans

All of Rhode Island's communities are working toward completing their plans and receiving approval from FEMA. Once the local hazard mitigation plans have been completed, they will be reviewed by the State for hazard risk and vulnerability locations, mitigation actions, local capacity assessments, programs, policies and projects.

Since 1993, Rhode Island has been providing technical assistance to communities in the manner of assisting in local hazard mitigation planning, training and statewide workshops on hazard mitigation planning for local cities and towns. The first efforts to develop local hazard mitigation plans commenced in 1993 when RIEMA formed a partnership with RISG to develop two (2) prototype hazard mitigation strategies: a coastal community plan and a riverine community plan. Guidance was developed so that other communities could write their local plans and become involved and ultimately integrated into neighboring communities' hazard mitigation process planning efforts and initiatives. Pre-disaster funding from FEMA to local communities for hazard mitigation was not available until Project Impact in 1998.

Several communities have expired plans (12 communities) or do not have hazard mitigation plans developed (one [1] community). RIEMA has made it a priority to work with these communities to provide technical assistance related to plan development.

In addition to the technical assistance and monitoring activities, RIEMA will monitor the progress of local hazard mitigation plans and projects through the 3rd Quarter SIHMC meeting, quarterly reports, site visits, phone calls, workshops, questionnaire, mitigation project tracking database, and the State Grants Administrative Plan. Table E-7 below summarizes the various activities that RIEMA uses to monitor and evaluate local mitigation plans.

Table E-7 Monitoring program for local mitigation plans

Monitoring Activity	Agency(ies) or Organization(s)	Responsibility	Timeframe
Site Visits	RIEMA	Evaluate the potential project, to monitor progress, and to ensure that the contracted work has been completed	Before a grant is awarded, during construction, and upon completion of a project
Questionnaire	RIEMA	Send out a questionnaire to participating communities to determine and document progress on the mitigation planning progress as well as the mitigation project and gather information to evaluate successes/area of needed improvement	Completion and approval of local hazard mitigation plans
Quarterly Reports	RIEMA	Each recipient of a mitigation grant must file quarterly reports with RIEMA	Quarterly
Mitigation Project Tracking System & Database	RIEMA	Review current mitigation grant and project guidelines and make updates as appropriate, specifically as federal regulations are updated or amended Monitor expiration date of local mitigation plans and identify communities without current plans	Immediate upon plan approval by FEMA

Monitoring Activity	Agency(ies) or Organization(s)	Responsibility	Timeframe
State Grant Administration Plan	RIEMA	Review current mitigation grant and project guidelines and make updates as appropriate, specifically as federal regulations are updated	Must be updated after every disaster declaration or every three (3) years

This plan and Local Hazard Mitigation Plans are living documents. Contact RIEMA for an up to date version of the Local Mitigation Tracker Tool as this tool is revised following the quarterly SIHMC meetings and review of Local Hazard Mitigation Plans.

Appendix F: Mitigation Strategy

F.1 Development of 2019 Mitigation Action Plan

The following pages outline the completed Mitigation Activity Worksheets by the SIHMC, identifying new mitigation actions.

State of Rhode Island Hazard Mitigation Plan Update

Mitigation Action Worksheet

Instructions

The following instructions will help you to fill out the worksheet. Please feel free to return any completed worksheets to Hope Winship, with Hagerty Consulting, Hope.Winship@hagertyconsulting.com. We will discuss this worksheet in more detail at the September 5th meeting, when there will be an opportunity to use it to develop new mitigation actions.

Activity Description: Describe the mitigation activity, and please be as specific as possible. In order to meet FEMA requirements, proposed activities must include specific risk reduction measures and not be focused on emergency preparedness or response activities.

Lead Agency: Identify the lead department and division/office with primary responsibility for implementation of the activity. Please be as specific as possible. It is also acceptable to list secondary agencies that may provide implementation support

Estimated Cost: Provide a general estimate of the anticipated total costs required to complete the activity. In addition to dollar estimates, it is acceptable to include "staff time" or "in-kind resources" or simply "N/A" for those actions not requiring direct funding assistance.

Current and Potential Funding Sources: Identify potential funding sources, including any known Federal, State, or non-governmental funding sources. Identify if benefit-cost reviews will be used to determine cost effectiveness of projects.

Timeframe for Completion: Target timeline (duration) or specific completion date (month/year) for the proposed activity. It is acceptable to include "ongoing/continuous" for those actions already underway and/or to be continued with no end date.

Hazard(s) to be Addressed: Identify the hazards that the activity is designed to mitigate against. This may include any combination of one or more hazards. Proposed activities should be focused on mitigating the highest risk hazards for the state.

Vulnerabilities Addressed: Similar to hazards to be addressed, identify vulnerabilities that this action will address. This can be completed through a statement of what the problem/gap currently is, for example a lack of public education of individual hazard mitigation measures.

Mitigation Action Worksheet

Name/Title of Activity	Drinking water supply resiliency study	
Activity Description	RIDOH's Center for Drinking Water Quality is engaged in reviewing existing public drinking water systems and areas of the State that are not currently serviced by public drinking water systems, with the hope of identifying ways in which those areas of the State not serviced by public drinking water systems might adopt their use to improve resilience.	
Lead Agency	RIDOH	
Current & Potential Funding Sources	RIDOH DWQ Budget, FEMA HMA Grants, other ☐ Cost Benefit considered/completed	
Timeframe for Completion	☐ Short-term (0 – 6 months) ☐ Medium-term (6 – 24 months) ■ Long-term (>24 months)	or ☐ Date known:
Hazard(s) to be Addressed	■ Biological Incident ■ Chemical Incident ☐ Civil Unrest ■ Cybersecurity ☐ Dam Failure ■ Drought ■ Earthquake ☐ Epidemic ■ Extreme Cold ■ Extreme Heat	☐ Fire ■ Flood ■ High Winds ■ Hurricanes and Tropical Storms ■ Infrastructure Failure ■ Sea Level Rise ■ Severe Winter Weather ■ Thunderstorms ■ Tornado
Vulnerabilities Addressed	Ensuring redundant and resilient drinking water infrastructure throughout the State will reduce the risk posed by a number of hazards, both natural and human-caused.	
Point of Contact	Name: Form is broken -- see contact info below Phone: Form is broken -- see contact info below Email: Form is broken -- see contact info below	
Notes	Anthony Sylvia 401-222-7776 anthony.sylvia@health.ri.gov	

Mitigation Action Worksheet

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Lead Agency	RIDOH	
Current & Potential Funding Sources	RIDOH DWQ Budget, FEMA HMA Grants, other ☐ Cost Benefit considered/completed	
Timeframe for Completion	☐ Short-term (0 – 6 months) ☐ Medium-term (6 – 24 months) ■ Long-term (>24 months)	or ☐ Date known:
Hazard(s) to be Addressed	■ Biological Incident ■ Chemical Incident ☐ Civil Unrest ■ Cybersecurity ☐ Dam Failure ■ Drought ■ Earthquake ☐ Epidemic ■ Extreme Cold ■ Extreme Heat	☐ Fire ■ Flood ■ High Winds ■ Hurricanes and Tropical Storms ■ Infrastructure Failure ■ Sea Level Rise ■ Severe Winter Weather ■ Thunderstorms ■ Tornado
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Current & Potential Funding Sources	RIDOH DWQ Budget, FEMA HMA Grants, other ☐ Cost Benefit considered/completed	
Timeframe for Completion	☐ Short-term (0 – 6 months) ☐ Medium-term (6 – 24 months) ■ Long-term (>24 months)	or ☐ Date known:
Hazard(s) to be Addressed	■ Biological Incident ■ Chemical Incident ☐ Civil Unrest ■ Cybersecurity ☐ Dam Failure ■ Drought ■ Earthquake ☐ Epidemic ■ Extreme Cold ■ Extreme Heat	☐ Fire ■ Flood ■ High Winds ■ Hurricanes and Tropical Storms ■ Infrastructure Failure ■ Sea Level Rise ■ Severe Winter Weather ■ Thunderstorms ■ Tornado
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Lead Agency	RIDOH	
Current & Potential Funding Sources	RIDOH DWQ Budget, FEMA HMA Grants, other ☐ Cost Benefit considered/completed	
Timeframe for Completion	☐ Short-term (0 – 6 months) ☐ Medium-term (6 – 24 months) ■ Long-term (>24 months)	or ☐ Date known:
Hazard(s) to be Addressed	■ Biological Incident ■ Chemical Incident ☐ Civil Unrest ■ Cybersecurity ☐ Dam Failure ■ Drought ■ Earthquake ☐ Epidemic ■ Extreme Cold ■ Extreme Heat	☐ Fire ■ Flood ■ High Winds ■ Hurricanes and Tropical Storms ■ Infrastructure Failure ■ Sea Level Rise ■ Severe Winter Weather ■ Thunderstorms ■ Tornado
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Lead Agency	RIDOH	
Current & Potential Funding Sources	RIDOH DWQ Budget, FEMA HMA Grants, other ☐ Cost Benefit considered/completed	
Timeframe for Completion	☐ Short-term (0 – 6 months) ☐ Medium-term (6 – 24 months) ■ Long-term (>24 months)	or ☐ Date known:
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Notes	Anthony Sylvia 401-222-7776 anthony.sylvia@health.ri.gov	

F.1.1 Mitigation Action Prioritization

Table F-1 STAPLEE Analysis

2019 Activity Number	Title	Social	Technical	Administrative	Political	Legal	Environmental	Economic	Total	Prioritization
2019-1	THIRA & HMP Integration	0	1	1	0	1	0	1	4	Medium
2019-2	Flood modeling/mapping	0	1	1	0	1	0	1	4	Medium
2019-3	Partnerships with High Education	0	1	1	0	1	0	1	4	Medium
2019-4	State Interagency Hazard Mitigation Committee	0	1	1	0	1	0	1	4	Medium
2019-5	Facilities database and vulnerability	0	1	1	0	1	0	0	3	Low
2019-6	Stormwater and Floodplain Management Coordination	0	1	1	1	1	0	1	5	High
2019-7	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	0	1	1	1	1	0	1	5	High
2019-8	Small Public Water System Emergency Preparedness Planning	0	1	1	1	1	0	0	4	Medium
2019-9	Extreme Heat Action Plan	0	1	1	0	1	0	1	4	Medium
2019-10	RIPTA Continuity of Operations	1	1	0	1	1	0	0	4	Medium
2019-11	Expand RIWARN membership	0	0	1	0	1	0	1	3	Low
2019-12	MEDS full-scale exercise	0	1	1	0	1	0	0	3	Low
2019-13	Local Water Supplier Emergency Interconnection Programs	0	1	1	0	1	0	0	3	Low
2019-14	Develop a Petroleum Set-Aside Program	1	1	0	1	0	0	0	3	Low
2019-15	Rhode Island Mitigation Resources and Technical Assistance	0	1	1	1	1	0	1	5	High
2019-16	Emergency Planning for Patient Care Centers	1	1	0	1	0	0	1	4	Medium
2019-17	Spillway Management and Coordination	0	0	0	0	1	0	1	2	Low
2019-18	Agency and Municipality Data Consistency	0	1	-1	0	0	0	1	1	Low
2019-19	Newport Climate Change Outreach for Vibrant Waterfronts	0	1	1	1	1	0	1	5	High
2019-20	Technological and human-caused Vulnerability Database	0	1	0	0	1	0	1	3	Low
2019-21	Comprehensive Planning Guidance Integration	0	1	1	0	1	0	1	4	Medium

2019 Activity Number	Title	Social	Technical	Administrative	Political	Legal	Environmental	Economic	Total	Prioritization
2019-22	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown	0	1	1	0	1	0	1	4	Medium
2019-23	Urban Tree Inventory & Urban Forest Master Plan	1	1	1	0	1	0	1	5	High
2019-24	Municipal disaster preparedness and resilience building activities incentives	0	1	1	1	1	0	1	5	High
2019-25	State and Local Professional Development	0	1	1	1	1	0	0	4	Medium
2019-26	Facility-level impacts storm predictions	0	1	1	0	1	0	1	4	Medium
2019-27	Resilient Coastal Communities	0	1	0	1	1	0	0	3	Low
2019-28	Water Conservation	0	0	0	0	0	1	1	2	Low
2019-29	Increase participation in NFIP and CRS	0	1	0	1	1	0	1	4	Medium
2019-30	Disaster Evacuation Route and Shelter Location Outreach	1	1	-1	1	1	0	1	4	Medium
2019-31	Cyber Education	1	1	0	1	1	0	1	5	High
2019-32	Partnerships with Private and Non-Profits	0	0	1	0	1	0	1	3	Low
2019-33	Coordination Between Utilities and State Agencies	0	1	0	1	1	0	1	4	Medium
2019-34	Hazard Mitigation Training	0	1	0	0	1	0	1	3	Low
2019-35	Dam Remediation Prioritization	0	1	1	1	1	1	1	6	High
2019-36	Green Stormwater Infrastructure	0	1	1	1	1	1	1	6	High
2019-37	Stormwater infrastructure flood mitigation	1	1	1	1	1	1	0	6	High
2019-38	Repetitive Loss Property Mitigation	0	1	1	1	1	0	1	5	High
2019-39	ISR program for National Grid Gas	0	1	1	1	1	0	1	5	High
2019-40	Assessment of facility generator needs	0	1	1	1	1	0	1	5	High
2019-41	Acquire generators for drinking water systems	0	1	1	1	1	0	1	5	High
2019-42	Power Outage Reduction	1	1	1	1	1	0	0	5	High
2019-43	Treatment System and Pumping Station Hardening Projects	0	1	1	0	1	0	1	4	Medium
2019-44	Fuel Terminal Hardening and Resilience Measures	0	1	1	1	1	0	0	4	Medium

2019 Activity Number	Title	Social	Technical	Administrative	Political	Legal	Environmental	Economic	Total	Prioritization
2019-45	Evacuation Route Reassessment	1	1	-1	1	1	0	1	4	Medium
2019-46	Wildfire Fuels Management	0	1	0	0	1	1	0	3	Low
2019-47	State-owned property retreat	0	1	0	0	1	1	0	3	Low
2019-48	Beach Ecosystem Preservation	1	1	-1	0	1	1	0	3	Low
2019-49	Integrate climate resilience into the school construction process.	1	1	0	0	1	0	0	3	Low
2019-50	Coastal Wetland Habitat Preservation	0	1	-1	0	1	1	0	2	Low
2019-51	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas	0	0	1	0	0	0	0	1	Low
2019-52	Coastal Drinking Water Reservoir Assessment	0	1	1	0	1	0	0	3	Low

F.1.2 Implementing Mitigation Actions

The table below (Table F-2) outlines the 2019 Mitigation Action Plan and provide an opportunity for the SHIMC to provide tracking during the interim period of the five-year plan update. An additional document, the 2019 Mitigation Action Plan Tracker, has been provided to the SHIMC. This document provides additional detail on activity project examples and vulnerabilities addressed per activity. This tool is flexible, so that if the SHIMC finds additional details to track throughout the monitoring process additional details can be added.

Table F-2 2019 Mitigation Action Plan

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-1	THIRA & HMP Integration	Integrate the findings of the THIRA into the Rhode Island Hazard Mitigation Plan. Ensure the THIRA is updated on a yearly basis in accordance with FEMA guidance.	1	1.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA; SIHMC		Medium	
2019-2	Flood modeling/mapping	Expand flood modeling/mapping efforts within inland areas. Map inland areas and share data with other agencies. Data should include statewide precipitation projections.	1	1.1	HMGP/PDM/ FMA	No	Medium-Term (6-24 months)	RIDEM; EC4	URI	Medium	
2019-3	Partnerships with High Education	Develop a partnership between institutes of higher education, focusing on hazard mitigation. Identify points of contacts within each institute of higher education to join SIHMC.	1	1.2	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium	
2019-4	State Interagency Hazard Mitigation Committee	Add members to the SIHMC that will represent federal, state and local agencies and additional relevant stakeholders from both non-profit and the private sector. Establish a regular meeting schedule for the SIHMC to occur quarterly. Invite state and local officials to hazard mitigation workshops, meetings and all other relevant functions in which they can learn more about hazard mitigation programs, polices and projects.	1	1.2	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA; SIHMC		Medium	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-5	Facilities database and vulnerability	Perform a more comprehensive examination of state and critical facility vulnerability to natural hazards, using the 2019 Risk Assessment results as a baseline. State facilities data is currently being updated and revised by RIEMA; coordinate efforts of the Interagency Hazard Mitigation Committee to determine facility attribute collection that will be able to feed into vulnerability analysis (i.e. first floor elevation, construction material, roof type, building and contents value, occupancy, Hazus-MH attributes). Coordinate with the Rhode Island Division of Public Utilities and Carriers to determine what/how facilities are prioritized during power outages, how utilities report back on as a result of storms, and how this can be improved and used in the vulnerability assessment. Maximize the utilization of best technology through the incorporation of a progressive GIS as the primary tool for spatial data management.	1	1.3	Agency fiscal budget	No	Medium-Term (6-24 months)	DPU; RIEMA; SIHMC		Low	
2019-6	Stormwater and Floodplain Management Coordination	Work with stormwater and floodplain management agencies and organization to improve coordination with state agencies in addressing storm water management and other riverine and floodplain management-related issues.	2	2.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIDEM; RIDOT; RIEMA		High	
2019-7	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	Rewrite DWQ's EOP to streamline the process of responding to emergencies concerning public water systems. This revised EOP will work as a tool to assist DWQ staff to implement its response and assistance to a PWS rapidly and effectively in an all-hazards environment.	2	2.1	RIDOH DWQ Budget	No	Short-Term (0-6 months)	RIDOH		High	
2019-8	Small Public Water System Emergency Preparedness Planning	Assist small public water systems to develop and implement emergency preparedness plans and communication and public notification strategies.	2	2.1	RIDOH DWQ Budget	No	Medium-Term (6-24 months)	RIDOH		Medium	
2019-9	Extreme Heat Action Plan	Convene interagency and nongovernmental partners to develop and implement a state extreme heat action plan.	2	2.1	FEMA HMA Grant	No	Medium-Term (6-24 months)	RIEMA		Medium	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-10	RIPTA Continuity of Operations	Install generators and identify funding source for conversion of diesel transit fleet to electric or other zero-emission technologies. This will allow for continuity of RIPTA operations following extreme weather events through implementation of backup power generation at key facilities.	2	2.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIPTA	RIIB	Medium	
2019-11	Expand RIWARN membership	Encourage key public drinking water systems to participate in the RIWARN. Ensuring proper representation and participation will ensure that RIWARN is prepared to support its members during disasters.	2	2.1	RIDOH DWQ Budget; FEMA HMA Grant	No	Medium-Term (6-24 months)	RIDOH		Low	
2019-12	MEDS full-scale exercise	Conduct a full-scale exercise to test RHODE ISLAND's MEDS and its ability to rapidly dispense medical countermeasures to the general public at PODs and to predefined populations in hospitals and nursing homes. MEDS is intended to mitigate the spread of morbidity and mortality during public health emergencies (such as a large-scale disease outbreak or bioterrorism attack) through the timely provision of countermeasures.	2	2.1	RIDOH MEDS Budget; FEMA HMA Grant; EMPG	No	Long-Term (>24 months)	RIDOH		Low	
2019-13	Local Water Supplier Emergency Interconnection Programs	Assist water suppliers in developing local Emergency Interconnection Programs. Emergency water system interconnections provide redundancy of supply and the ability to address water emergencies rapidly and efficiently across water supply districts particularly in small systems throughout the state.	2	2.1	Drinking water state revolving fund	No	Long-Term (>24 months)	RIDOH	Water suppliers, WRB	Low	
2019-14	Develop a Petroleum Set-Aside Program	A petroleum set-aside program should specify best practices to ensure fuel delivery to priority end-users, such as hospitals, police and fire stations, water and sewage treatment plants, senior centers and nursing homes, shelters, correctional facilities, fueling stations, and grocery stores. This program should also define best practices and prioritize critical infrastructure assets.	2	2.1	Agency fiscal budget	No	Medium-Term (6-24 months)	OER		Low	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-15	Rhode Island Mitigation Resources and Technical Assistance	Develop a website/clearinghouse of mitigation resources in Rhode Island. Identify what utilities are vulnerable to hazards throughout the state. Determine a list of interested parties that should contribute to this initiative and be a recipient of its products. Increase capacity of all state agencies to be able to provide technical assistance.	2	2.2	Agency fiscal budget	No	Short-Term (0-6 months)	DPU; National Grid; RIEMA; SIHMC		High	
2019-16	Emergency Planning for Patient Care Centers	Enact legislation that requires facilities that are caring for patients to create and exercise evacuation plans, SOPs, and emergency plans.	2	2.2	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA	American Red Cross, local EMDs	Medium	
2019-17	Spillway Management and Coordination	Advance common goal setting and communication between water suppliers that manage reservoirs and downstream municipalities. Ensure downstream flood mitigation via proactive spillway management without adverse impacts on safe yield.	2	2.3	Drinking water state revolving fund	No	Short-Term (0-6 months)	RIDOH/ WRB	WRB; URI; PUC; RIIB; PWSB	Low	
2019-18	Agency and Municipality Data Consistency	Ensure that data is consistent across agencies and municipalities. Updating, coordinating, and standardizing foundational resilience data including GIS layers (e.g., STORMTOOLS, critical infrastructure, precipitation projections) and related metadata should be centralized. Hosting coordinated data will provide support for municipal/agency decision-making on infrastructure/public facility investments. This is critical to maximizing limited resources and capacity.	2	2.3	Agency fiscal budget	No	Short-Term (0-6 months)	EC4	EC4, URI EDC, RIGIS, DOIT, CRMC, RIDOT, Statewide Planning	Low	
2019-19	Newport Climate Change Outreach for Vibrant Waterfronts	Map exposure of transportation, infrastructure, and real property to SLR. Provide outreach to the public and targeted stakeholder groups when exposure is identified.	3	3.1	Private Foundation	No	Short-Term (0-6 months)	URI CRC; City of Newport		High	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-20	Technological and human-caused Vulnerability Database	Develop a statewide database of how technological and adversarial threats and hazards impact communities throughout Rhode Island. Includes documenting frequency and intensity of past threats and future probabilities. Threat-prone areas will be made available to local communities to ensure integration with local risk assessments and mitigation activities.	1	1.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Low	
2019-21	Comprehensive Planning Guidance Integration	Integrate natural, adversarial, and human-caused hazards section into local comprehensive planning guidance and provide workshops to disseminate guidance.	3	3.2	Agency fiscal budget	No	Short-Term (0-6 months)	Statewide Planning		Medium	
2019-22	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown	Collaboratively develop a comprehensive community plan element to address climate change adaptation as it relates to transportation and land use issues with North Kingstown. Prepare with the town and the state a detailed listing of priority transportation and land use projects that support the climate change adaptation effort and are appropriate for inclusion in TIP and CIP proposals. This is phase II of a project that looked at NK as a pilot community to identify exposure to SLR and then identify ways to adapt. "	3	3.2	Statewide Planning Challenge Grant	No	Short-Term (0-6 months)	North Kingstown Planning Department; Statewide Planning; URI CRC		Medium	
2019-23	Urban Tree Inventory & Urban Forest Master Plan	Support municipalities in developing urban tree inventories and implementing urban forest master plans in order to mitigate urban heat.	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDEM		High	
2019-24	Municipal disaster preparedness and resilience building activities incentives	Provide state support to municipal emergency services to incentivize disaster preparedness and resilience building activities.	3	3.3	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA		High	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-25	State and Local Professional Development	Encourage professional development and certification through outside continuing education programs. Create master list of personnel with current licenses and certifications.	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium	
2019-26	Facility-level impacts storm predictions	Improve predictions of facility-level impacts of approaching storms. Providing predictions several days before a storm makes landfall will assist facilities in their preparedness efforts. By developing a more resilient facility, the cascading effects to other facilities and services can be eliminated, resulting in a more resilient community that is better able to provide services to its residents before, during, and after major storms.	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium	
2019-27	Resilient Coastal Communities	Build the capacity of targeted sectors or community decision-makers to identify general strategies and implement actions which they can put in practice to increase their resilience to SLR and future storms. This will be done through outreach, technical assistance and sharing of lessons learned.	3	3.3	Private Foundation and NOAA Sea Grant	No	Long-Term (>24 months)	URI CRC; RI Sea Grant		Low	
2019-28	Water Conservation	Encourage municipalities to adopt local water use restriction ordinances to ensure that proper water conservation measures are implemented during periods of severe to extreme drought and other water emergencies.	3	3.3	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDOH		Low	
2019-29	Increase participation in NFIP and CRS	Increase CRS participation through education and outreach as a means for local communities to soften the likely increase in many flood insurance policy rates resulting from new reforms to the NFIP.	4	4.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-30	Disaster Evacuation Route and Shelter Location Outreach	Compile a definitive list of shelters and their capabilities in the state. Implement a public outreach initiative to inform citizens about evacuation routes and shelter locations (including any updates) through homeowner associations, nonprofit organizations, and state and local governments. Doing so will help citizens be better prepared for the impacts of future severe storm events and increase the overall resilience of the community.	4	4.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIEMA	American Red Cross, local EMDs	Medium	
2019-31	Cyber Education	Educate the public and private sector on ways to mitigate cyber threats effecting personal, private, and state security and other sensitive information.	4	4.2	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		High	
2019-32	Partnerships with Private and Non-Profits	Develop partnerships with businesses to provide a public-private link for coordinated mitigation, preparedness, response and recovery. During initial outreach to businesses, inquire about Business Continuity Plans and if they have one.	4	4.2	Agency fiscal budget	No	Long-Term (>24 months)	RIEMA		Low	
2019-33	Coordination Between Utilities and State Agencies	Enhance coordination between National Grid and Public Utility capabilities and state initiative.	4	4.3	Agency fiscal budget	No	Long-Term (>24 months)	DPU; National Grid; RIEMA		Medium	
2019-34	Hazard Mitigation Training	Increase awareness and knowledge of hazard mitigation principles and practices. Develop programs (i.e. website, PSA) to increase public awareness of the importance of mitigating the damage caused by natural hazards, through a coordinated effort with multiple stakeholders. Determine and schedule training focused on hazard mitigation education, and invite all appropriate state, legislators, and local organizations to participate.	4	4.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Low	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-35	Dam Remediation Prioritization	Evaluate actions and investments as identified in RIDEM's Dam Safety Annual Report to ensure compliance and downstream safety.	5	5.1	PDM	No	Short-Term (0-6 months)	RIDEM	Newport; BCWA; Barrington; Warren; Bristol; Save the Bay; Burrilville	High	
2019-36	Green Stormwater Infrastructure	Enhance the capacity of traditional stormwater systems through the use of green infrastructure.	5	5.1	PDM	No	Long-Term (>24 months)	RIDOT; RIDEM	RIIB, Middletown, Portsmouth, AIPC, Farm Fresh RI, Pawtucket, NBC, Providence	High	
2019-37	Stormwater infrastructure flood mitigation	Mitigate impacts of coastal and riverine flooding on stormwater infrastructure and its performance. Begin by identifying at-risk structures, then enact projects and/or policies to address risks, and lastly establish process for maintenance of stormwater ponds.	5	5.1	PDM/ HMGP	No	Long-Term (>24 months)	RIDEM	Newport, Bristol, West Warwick, OHCD, CRMC, RIDOT, local DPWs, NBC, Central Falls, Providence, Bonne Shores Fire District and Beach Club, Warren	High	
2019-38	Repetitive Loss Property Mitigation	Identify and devise a comprehensive mitigation strategy for repetitive loss and severe repetitive loss properties.	5	5.1	Agency fiscal budget	Yes	Medium-Term (6-24 months)	RIEMA		High	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-39	ISR program for National Grid Gas	Support and fund ISR program annually. The ISR program is mandated in R.I.G.L. §39-1-27.7.1 which was enacted in 2010. The cost/benefit analysis is an integral part of the annual review. The FY 18 Program budget is set at $101.76 million.	5	5.1	Annual funding is generated by ratepayers as approved by the Commission.	Yes	Long-Term (>24 months)	DPU		High	
2019-40	Assessment of facility generator needs	Acquire and install emergency generators at state-owned critical facilities. Draft an infrastructure safety and reliability document, focusing on substation hardening.	5	5.1	Agency fiscal budget	Yes	Long-Term (>24 months)	DPU		High	
2019-41	Acquire generators for drinking water systems	Identify and develop courses of action to address gaps in emergency redundant power in Rhode Island's drinking water systems.	5	5.1	RIDOH DWQ Budget; FEMA HMA Grants	Yes	Medium-Term (6-24 months)	RIDOH		High	
2019-42	Power Outage Reduction	Reduce the number and extent of power outages during and after hazard events.	5	5.1	Bonds	No	Long-Term (>24 months)	DPUC		High	
2019-43	Treatment System and Pumping Station Hardening Projects	Identify and implement water treatment and pumping station hardening projects.	5	5.1	PDM	No	Long-Term (>24 months)	RIDEM	Westerly; Smithfield; Newport; Narragansett; South Kingstown	Medium	
2019-44	Fuel Terminal Hardening and Resilience Measures	Identify and implement fuel terminal hardening and resilience measures in order protect their facilities from future storms and have made provisions to restore operations after storms.	5	5.1	PDM	No	Short-Term (0-6 months)	OER		Medium	
2019-45	Evacuation Route Reassessment	Assess current evacuation routes and signage and update as needed.	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIEMA		Medium	
2019-46	Wildfire Fuels Management	Implement a wildfire fuels management program to reduce hazardous vegetative fuels threatening critical infrastructure and private homes/property.	5	5.1	Agency fiscal budget	No	Medium-Term (6-24 months)	RIDEM		Low	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-47	State-owned property retreat	Identify and implement opportunities for retreat and infrastructure removal on state-owned properties. Implemented restoration projects should continue to be monitored to evaluate the effectiveness of different restoration practices and can serve as demonstration sites for shoreline adaptation.	5	5.1	Agency fiscal budget	No	Short-Term (0-6 months)	RIDEM; CRMC	Westerly, Save the Bay, Warwick, Municipalities, Providence Parks, Warren	Low	
2019-48	Beach Ecosystem Preservation	Preserve the dynamic nature of beaches and barriers in future management of these critical natural systems. Differentiation between developed and undeveloped systems is necessary when considering management approaches. New development should be minimized in undeveloped beach and dune areas and retreat incentivized as a coastal adaptation strategy where possible. Offshore sand sources suitable for beach replenishment should be identified and beaches should be prioritized for re-nourishment.	5	5.1	HMGP/PDM/ FMA	No	Ongoing	CRMC	Barrington, Save the Bay, UNH Stormwater Center, Westerly, Cranston, Edgewood Waterfront Protection Association, Providence, Newport	Low	
2019-49	Integrate climate resilience into the school construction process.	Identify school buildings located in flood zones and offer guidance on ways to increase resilience as part of local and state planning efforts by recommending specific projects.	5	5.1	Efficient Buildings Fund	No	Medium-Term (6-24 months)	RIIB	RIDE	Low	

2019 Activity Number	Title	Activity Description	Goal Addressed	Objective Addressed	Current and Potential Funding Sources	Cost Benefit	Implementation Timeline	Lead Agency	Supporting Agency	Priority	Action Tracking
2019-50	Coastal Wetland Habitat Preservation	Monitor and assess coastal wetland habitats and management practices to evaluate and prioritize future actions. Statewide models, such as the SLAMM, should be updated to identify opportunities for restoration and assist in planning for future marsh migration. To minimize loss and preserve the benefits of coastal wetland habitats, conservation and management must be approached at multiple scales and timeframes. State agencies and their partners should continue to work with municipalities to identify opportunities for retreat, removal of derelict infrastructure, and enhancement of natural shoreline areas. Where possible, retreat rather than fortification should be emphasized as a coastal adaptation strategy.	5	5.1	Agency fiscal budget	No	Ongoing	CRMC; RIDEM	Save the Bay, URI Coastal Institute, Warwick, TNC, US F&W, Bristol, Warren, URI EDC	Low	
2019-51	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas	Determine and dedicate funding, at least for the local cost share, for beach replenishment as a tool to reduce risks in some of the high hazard coastal areas and/or buyout at risk properties.	5	5.1	Agency fiscal budget	No	Long-Term (>24 months)	CRMC; RI Sea Grant		Low	
2019-52	Coastal Drinking Water Reservoir Assessment	Assess the coastal drinking water reservoirs to determine if the reservoirs are vulnerable to storm surge and SLR.	5	5.2	Drinking water state revolving fund	No	Short-Term (0-6 months)	RIDOH; CRMC		Low	

Table F-3 Analysis of Hazards Addressed per Mitigation Action

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-1	THIRA & HMP Integration	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-2	Flood modeling/mapping												✔							
2019-3	Partnerships with High Education	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-4	SIHMC	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-5	Facilities database and vulnerability	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-6	Stormwater and Floodplain Management Coordination												✔				✔			
2019-7	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-8	Small Public Water System Emergency Preparedness Planning	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-9	Extreme Heat Action Plan										✔									
2019-10	RIPTA Continuity of Operations							✔				✔	✔	✔	✔			✔	✔	✔
2019-11	Expand RIWARN membership	✔	✔		✔		✔	✔		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
2019-12	MEDS full-scale exercise								✔											
2019-13	Local Water Supplier Emergency Interconnection Programs	✔	✔		✔	✔	✔									✔				
2019-14	Develop a Petroleum Set-Aside Program			✔	✔			✔				✔	✔	✔	✔	✔		✔	✔	✔

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-15	Rhode Island Mitigation Resources and Technical Assistance	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-16	Emergency Planning for Patient Care Centers	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-17	Spillway Management and Coordination					✔							✔			✔				
2019-18	Agency and Municipality Data Consistency	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-19	Newport Climate Change Outreach for Vibrant Waterfronts												✔				✔			
2019-20	Technological and human-caused Vulnerability Database	✔	✔	✔	✔	✔										✔				

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-21	Comprehensive Planning Guidance Integration	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-22	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown												✔				✔			
2019-23	Urban Tree Inventory & Urban Forest Master Plan										✔									
2019-24	Municipal disaster preparedness and resilience building activities incentives						✔	✔		✔	✔	✔	✔	✔	✔		✔	✔	✔	✔
2019-25	State and Local Professional Development	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-26	Facility-level impacts storm predictions												✔	✔	✔		✔		✔	✔

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-27	Resilient Coastal Communities												✔		✔		✔			
2019-28	Water Conservation						✔				✔	✔								
2019-29	Increase participation in NFIP and CRS												✔		✔		✔			
2019-30	Disaster Evacuation Route and Shelter Location Outreach												✔		✔		✔			
2019-31	Cyber Education				✔															
2019-32	Partnerships with Private and Non-Profits	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-33	Coordination Between Utilities and State Agencies	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-34	Hazard Mitigation Training	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔	✔
2019-35	Dam Remediation Prioritization					✔														

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-36	Green Stormwater Infrastructure												✔			✔	✔			
2019-37	Stormwater infrastructure flood mitigation												✔			✔	✔			
2019-38	RL Property Mitigation												✔				✔			
2019-39	ISR program for National Grid Gas										✔		✔	✔	✔			✔	✔	✔
2019-40	Assessment of facility generator needs										✔		✔	✔	✔			✔	✔	✔
2019-41	Acquire generators for drinking water systems				✔	✔		✔		✔	✔		✔	✔	✔	✔	✔	✔	✔	✔
2019-42	Power Outage Reduction			✔	✔		✔			✔	✔	✔		✔	✔	✔		✔	✔	✔
2019-43	Treatment System and Pumping Station Hardening Projects												✔	✔	✔	✔		✔	✔	✔

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-44	Fuel Terminal Hardening and Resilience Measures												✔	✔	✔	✔		✔	✔	✔
2019-45	Evacuation Route Reassessment												✔		✔		✔			
2019-46	Wildfire Fuels Management											✔								
2019-47	State-owned property retreat																✔			
2019-48	Beach Ecosystem Preservation												✔				✔			
2019-49	Integrate climate resilience into the school construction process												✔	✔	✔			✔	✔	✔
2019-50	Coastal Wetland Habitat Preservation														✔		✔			

2019 Activity Number	Title	Biological Incident	Chemical Incident	Civil Unrest	Cyber Security	Dam Failure	Drought	Earthquake	Infectious Disease	Extreme Cold	Extreme Heat	Fire	Flood	High Winds	Tropical and Extratropical Storms	Infrastructure Failure	Sea Level Rise	Severe Winter Weather	Thunderstorms	Tornado
2019-51	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas												✔		✔		✔			
2019-52	Coastal Drinking Water Reservoir Assessment													✔		✔	✔			

Table F-4 Analysis of Type of Mitigation Action Per Mitigation Action

2019 Activity Number	Title	Local Plans and Regulations	Structural Projects	Natural Systems Protection	Education Programs	Preparedness and Response Actions
2019-1	THIRA & HMP Integration					✔
2019-2	Flood modeling/mapping					✔
2019-3	Partnerships with High Education					✔
2019-4	SIHMC					✔
2019-5	Facilities database and vulnerability					✔
2019-6	Stormwater and Floodplain Management Coordination					✔
2019-7	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	✔				
2019-8	Small Public Water System Emergency Preparedness Planning	✔				
2019-9	Extreme Heat Action Plan					✔
2019-10	RIPTA Continuity of Operations		✔			
2019-11	Expand RIWARN membership					✔
2019-12	MEDS full-scale exercise					✔
2019-13	Local Water Supplier Emergency Interconnection Programs					✔
2019-14	Develop a Petroleum Set-Aside Program					✔
2019-15	Rhode Island Mitigation Resources and Technical Assistance					✔
2019-16	Emergency Planning for Patient Care Centers	✔				
2019-17	Spillway Management and Coordination					✔
2019-18	Agency and Municipality Data Consistency					✔
2019-19	Newport Climate Change Outreach for Vibrant Waterfronts					✔
2019-20	Technological and human-caused Vulnerability Database					✔
2019-21	Comprehensive Planning Guidance Integration	✔				

2019 Activity Number	Title	Local Plans and Regulations	Structural Projects	Natural Systems Protection	Education Programs	Preparedness and Response Actions
2019-22	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown	✔				
2019-23	Urban Tree Inventory & Urban Forest Master Plan	✔				
2019-24	Municipal disaster preparedness and resilience building activities incentives					✔
2019-25	State and Local Professional Development				✔	
2019-26	Facility-level impacts storm predictions					✔
2019-27	Resilient Coastal Communities				✔	✔
2019-28	Water Conservation	✔				
2019-29	Increase participation in NFIP and CRS				✔	
2019-30	Disaster Evacuation Route and Shelter Location Outreach					✔
2019-31	Cyber Education				✔	
2019-32	Partnerships with Private and Non-Profits					✔
2019-33	Coordination Between Utilities and State Agencies					✔
2019-34	Hazard Mitigation Training					✔
2019-35	Dam Remediation Prioritization		✔			
2019-36	Green Stormwater Infrastructure			✔		
2019-37	Storm water infrastructure flood mitigation		✔	✔		
2019-38	RL Property Mitigation					✔
2019-39	ISR program for National Grid Gas					✔
2019-40	Assessment of facility generator needs					✔
2019-41	Acquire generators for drinking water systems		✔			
2019-42	Power Outage Reduction		✔			✔

2019 Activity Number	Title	Local Plans and Regulations	Structural Projects	Natural Systems Protection	Education Programs	Preparedness and Response Actions
2019-43	Treatment System and Pumping Station Hardening Projects		✔			
2019-44	Fuel Terminal Hardening and Resilience Measures		✔			
2019-45	Evacuation Route Reassessment					✔
2019-46	Wildfire Fuels Management			✔		
2019-47	State-owned property retreat		✔			
2019-48	Beach Ecosystem Preservation			✔		
2019-49	Integrate climate resilience into the school construction process.		✔			
2019-50	Coastal Wetland Habitat Preservation					✔
2019-51	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas					✔
2019-52	Coastal Drinking Water Reservoir Assessment					✔

F.1.3 Mitigation Action Progress (2014-2019)

Table F-5 2014 Mitigation Action Plan Update

2014 Activity Number	Title	Update 2018
1	State and Local Professional Development	No update provided.
2.1	Stormwater and Floodplain Management Coordination	No update provided at this time.
2.2	Tools and strategies to address Salt Marsh Migration with SLR	SLAMM project completed March 2015; ongoing recommendations to coastal communities. See: http://www.crmc.ri.gov/maps/maps_slamm.html.
3.1	Floodplain Management Education and Training	RIEMA continues to provide outreach and technical assistance to stakeholders and partners.
3.2	THIRA & HMP Integration	No update provided.
4	Comprehensive Planning Guidance Integration	Guidance currently in development phase.

2014 Activity Number	Title	Update 2018
5	Coordination Between Utilities and State Agencies	No update provided.
6	Local Mitigation Plan Integration	RIEMA has developed a local mitigation plan template that continues to be refined but is becoming more popular and widely used.
7	Increase participation in NFIP and CRS	There are currently 10 communities participating in the CRS, with two additional communities actively working on their applications.
8	Partnerships with High Education	No points of contact have been added to the SIHMC, but RIEMA did provide Active shooter packs to the institutes of Higher Education to help them in the event of an active shooter.
9	Establish dedicated funding source for beach replenishment projects and/or property buyouts in high hazard areas	No update provided.
10	RL Property Mitigation	No update provided.
11	SIHMC	No update provided.
12	Transportation and Infrastructure Based Climate Change Adaptation Planning for the Town of North Kingstown	No update provided.
13	Coastal Bluff Erosion	Block Island shoreline change maps completed in 2017; mapping protocol for eroding bluffs developed as part of Beach SAMP effort: "Establishing protocols for monitoring bluff erosion using mobile terrestrial laser scanning from study sites along the Rhode Island coastline"(December 2017).
14	Natural Hazard and Climate Change Vulnerability Database	Ongoing.
15	Hazard Mitigation Training	No update provided.
16	ISR program for National Grid Gas	No update provided.
17	Ongoing ISR program for National Grid Gas	No update provided.
18	Mitigation Funding Opportunities	Ongoing; RIDOH and its programs will continue to seek opportunities to develop and implement mitigation activities that benefit and protect the health and safety of Rhode Islanders, both pre- and post-disaster.
19	Facilities database and vulnerability	Underway but not complete.

2014 Activity Number	Title	Update 2018
21	In the long term, better protection of PWS infrastructure from hazards as a result of better PWS response to and hazards identification from emergencies	Implementation of SafeWater Rhode Island-derived initiatives ongoing; have since updated DWQ Regulations' engineering requirements within the 500-year floodplain, making them more stringent.
22	Rhode Island Mitigation Resources and Technical Assistance	Unknown.
23	Update the HEALTH/Drinking Water Quality Emergency Operations Plan	The DWQ EOP has been revised and is awaiting final approval; ongoing activities include updating SOPs to reflect changes in the EOP.
24	Small Public Water System Emergency Preparedness Planning	RIDOH's Center for DWQ is still working to implement CodeRED for both routine and emergent notifications to drinking water system operators.
25	Expand the flood and erosion hazards identification on real estate disclosure forms	Real Estate Disclosure Form update complete.
26	SLR Policies	Ongoing.
27	Newport Climate Change Outreach for Vibrant Waterfronts	No update provided.
28	Resilient Coastal Communities	No update provided.
29	Water Conservation	No update provided.
31	Enhance coordination between federal, state, and local partners in regard to evacuation routes, zones and planning.	Ongoing, but the Rhode Island Simulated Inundation Surfaces tool has been replaced with updated modeling in STORMTOOLS; See: http://www.beachsamp.org/stormtools/. The multiyear coastal evacuation study was completed in 2016; we received the Hurricane Evacuation Study as a result of this.
32	Partnerships with Private and Non-Profits	The Rhode Island Alliance for Business Resilience has been created with six partners and 27-member companies involved. ESF 18 has been established in the EOC. A relationship with NBEOC has been established.
33	Assessment of facility generator needs	No update provided.
34	Rhode Island Shoreline Change Special Area Management Plan	Completed - the Beach SAMP was adopted by the CRMC on June 12, 2018.