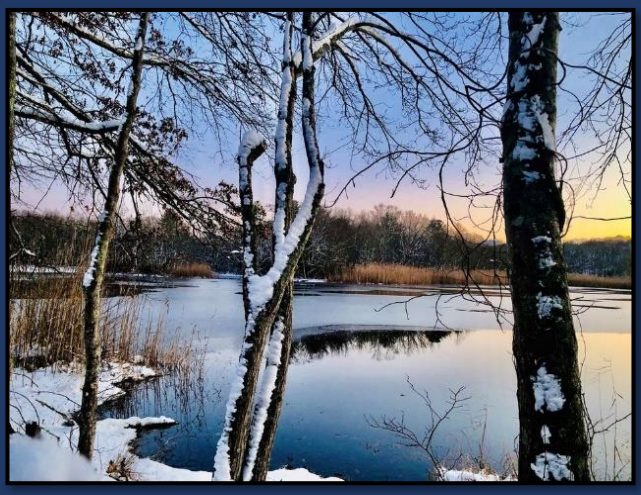
Town of Westerly 2023 Hazard Mitigation & Flood Management Plan








Prepared By:
Kim Jacobs, Civil Engineer & Resilience Planning Consultant

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U.S. Department of Homeland Security
FEMA Region I
99 High Street, Sixth Floor
Boston, MA 02110-2132

FEMA

March 21, 2023

Marc R. Pappas, Director
Rhode Island Emergency Management Agency
645 New London Avenue
Cranston, Rhode Island 02920

Director Pappas:

The U.S. Department of Homeland Security, Federal Emergency Management Agency (FEMA) Region I Mitigation Division has approved the Town of Westerly 2023 Hazard Mitigation & Flood Management Plan effective **March 21, 2023** through **March 20, 2028** in accordance with the planning requirements of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (Stafford Act), as amended, the National Flood Insurance Act of 1968, as amended, and Title 44 Code of Federal Regulations (CFR) Part 201.

With this plan approval, the jurisdiction is eligible to apply to the Rhode Island Emergency Management Agency for mitigation grants administered by FEMA. Requests for funding will be evaluated according to the eligibility requirements identified for each of these programs. A specific mitigation activity or project identified in this community's plan may not meet the eligibility requirements for FEMA funding; even eligible mitigation activities or projects are not automatically approved.

The plan must be updated and resubmitted to the FEMA Region I Mitigation Division for approval every five years to remain eligible for FEMA mitigation grant funding.

Thank you for your continued commitment and dedication to risk reduction demonstrated by preparing and adopting a strategy for reducing future disaster losses. Should you have any questions, please contact Alexis Meehan at (617) 832-4923 or Alexis.Meehan@fema.dhs.gov.

Sincerely,

DEAN J SAVRAMIS Digitally signed by DEAN J SAVRAMIS
Date: 2023.03.30 08:29:58 -04'00'

Dean Savramis
Mitigation Division Director
DHS, FEMA Region I

DS:am

cc: Melinda Hopkins, Mitigation Planning Supervisor, RIEMA
Rae-Anne Culp, State Hazard Mitigation Officer, RIEMA

Town of Westerly Rhode Island

Town of Westerly 2023 Hazard Mitigation & Flood Management Plan

State Acknowledgements

The Town would like to thank the Rhode Island Emergency Management Agency for their continued support and mitigation planning resources. The guidance provided by the Rhode Island State Hazard Mitigation Committee is essential for implementing the strategy presented in this Plan.

The Honorable Daniel McKee, RI Governor

Marc R. Pappas, Director, Rhode Island Emergency Management Agency

Rae-Anne Culp, State Hazard Mitigation Officer, Rhode Island Emergency Management Agency

Melinda Hopkins, Planning Branch Chief, Rhode Island Emergency Management Agency

Adopted by Westerly Town Council

February 27, 2023

Approved by FEMA

March 21, 2023

Local Acknowledgements

This Plan was made possible through the commitment of the Town of Westerly Hazard Mitigation & Flood Management Plan (HM&FMP) Advisory Committee and leadership and support from the Westerly Town Manager and Town Council. Further, as much of the Plan is built upon the good work of past plans, studies, and projects, the Town would like to acknowledge that effort and thank all those involved in past initiatives, such as the 2020-2040 Comprehensive Community Plan and Community Resilience Building Workshop.

Westerly Town Manager

Shawn M. Lacey

Westerly Town Council

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Kevin J. Lowther, II, Vice President
Philip M. Overton, Jr.
William J. Aiello
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HM&FMP Advisory Committee

Alyse Oziolor, Principal Planner - Committee Chair; Nancy Letendre, Town Planner

David Murphy, Building Official/Resident

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Kyle Zalaski, P.E., Town Engineer

Paul Gingerella, Chief of Police and Harbormaster; Kimberlie Rayner-Russell, Assistant Harbor Master/Resident

Fawatih Mohamed-Abouh, MD, MPH, Healthcare Professional/Age Friendly Westerly

Michelle Pinto, Westerly Business Owner/Resident

Gina Fuller, District Manager Southern Rhode Island Conservation District/Resident

Dan Lathrop, Westerly Business Owner/Ocean Community Chamber of Commerce/Resident

Joan Beth Brown, Fire District Moderator Watch Hill Fire District/Resident

John Mackay, Fire Chief Westerly Fire Department/Resident

Marc Doherty, Land Stewardship Manager Westerly Land Trust/Resident; Jennifer Fusco, Executive Director Westerly Land Trust/Resident

Principal Author

Kim Jacobs, Civil Engineer & Resilience Planning Consultant was the Technical Advisor to the Advisory Committee and Principal Author of this Plan

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EXECUTIVE SUMMARY

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- Action Plan
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- Implementation and Plan Maintenance

KMJ – CE/RP

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Executive Summary

In 1995 the Federal Emergency Management Agency (FEMA) enacted a National Mitigation Strategy, which promoted the partnership of government and the private sector to effectively "build" safer communities. The strategy encourages the identification of natural hazards that may affect individuals or communities and thereupon take action to permanently reduce or eliminate the associated risk (FEMA. National). The subsequent passage of the Disaster Mitigation Act (DMA) of 2000 provided the legal basis for FEMA to require natural hazard mitigation planning at both the State and local level as a condition of mitigation grant assistance (FEMA. Disaster). Pre-disaster planning and investment in preventative measures can minimize the economic and social disruption that can result from natural hazard events, and significantly reduce the cost of post-disaster clean-up and recovery, and help post-disaster operations become more efficient.

The Town of Westerly's first Hazard Mitigation Plan (HMP) was initiated in 2003, with updates and expansion of that document occurring in 2012 and 2018. Over the past five years, the Town has proactively collaborated with partners to reduce Westerly's vulnerabilities while reinforcing its strengths, and serving as a model for other communities throughout the region. While much progress has been made, the Town recognizes the continued need to increase hazard mitigation and adapt to a changing climate and its impacts – from extreme weather events to sea level rise.

In November 2022 the Town Council authorized the update and expansion of the 2018 HMP, hired Civil Engineer & Resilience Planning Consultant Kim Jacobs as technical advisor and principal author of the Plan, and formed an Advisory Committee to guide plan development. The Advisory Committee is comprised of Town staff, members of the public, business owners, conservation organizations, and other stakeholders, and chaired by the Principal Planner for the Town of Westerly. The Advisory Committee assisted the Town's Consultant throughout the planning process, with the over-riding task of identifying natural hazards considered to pose the greatest threat to Westerly and to arrive at practical, meaningful, attainable, and cost-effective mitigation solutions to reduce both human and property losses should such hazards occur.

In recognition of the Town's current and projected future vulnerability to flooding, the Town opted to intensify their focus on flooding within the HMP Update. Further, as the Town participates in FEMA's Community Rating System (CRS) program, it was determined advantageous to integrate CRS Activity 510 - Floodplain Management Planning in the HMP update. As such, this document was developed coordinating the DMA Planning Regulations and the CRS Activity 510 Planning Process into a single plan that meets the goals, intent, and requirements of each program. As discussed in **Section 2**, an integral part of the planning process was community and stakeholder engagement. In addition to the seven (7) publicized Advisory Committee meetings being open to the public, thirteen (13) other outreach activities were held to ensure the community, neighboring municipalities, and other stakeholders had the opportunity to provide input and feedback on the *Plan*. Public engagement is important as it ensures the *Plan* reflects community values and priorities, and builds a constituency educated in hazard mitigation and supportive of implementing activities and projects that will minimize community impacts and disruptions from natural hazards.

The integrated and community centric DMA and CRS planning process was highly successful, culminating in this document: *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan (HM&FMP).*

At the end of a three week public review period, this *HM&FMP* was adopted by the Westerly Town Council at the Public Hearing on February 27, 2023, with the acknowledgment from the Town solicitor that during the subsequent review/approval process by RIEMA/FEMA, any required revisions would be accepted by this approval. It was subsequently reviewed by the Rhode Island Emergency Management Agency (RIEMA), and approved by the Federal Emergency Management Agency (FEMA) on March 21, 2023.

ASSESSMENT

As detailed in **Section 4**, the Advisory Committee discussed all of the natural hazards identified in the Rhode Island State Hazard Mitigation Plan (RI-SHMP) for possible inclusion in this *Plan*. Recognizing that the Town has limited fiscal and staffing resources, those hazards determined to pose little threat to the Town have not been considered herein. Using a priority ranking process, this *Plan* focuses on those hazards considered as having a greater likelihood of occurring or potentially having a greater impact on the community should they occur. These include: Flood-Related Hazards; Wind-Related Hazards; Winter-Related Hazards; Infectious Disease-Related Hazards (Vector-borne Diseases Transmitted by Ticks or Mosquitoes, Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses); and Other Hazards (Earthquake, Extreme Heat, Drought, Brush Fire). The *Plan* also addresses how climate change and sea level rise will exacerbate the risks from many of these hazards.

To determine how to mitigate these threats, it was first necessary to understand Westerly's community profile (**Section 3**) and evaluate the Town's vulnerable community assets (**Section 4**). A capability assessment (**Section 5**) to understand what measures the Town currently implements in terms of hazard mitigation was also undertaken. The assemblage of this information was used as a basis in determining goals and strategies to minimize long-term vulnerabilities to the identified hazards (**Section 6**).

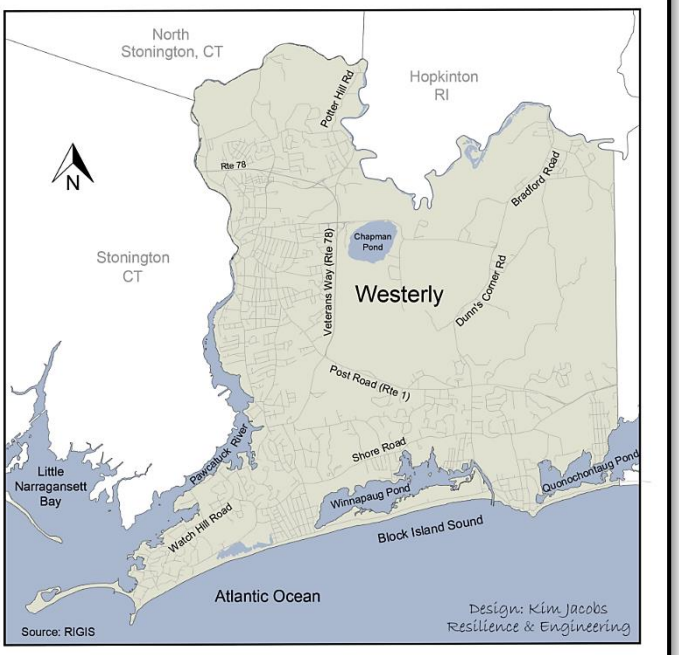
This *Plan*, which will supersede the Town's 2018 Hazard Mitigation Plan (HMP), pays tribute to and builds upon the good work that created that document. Portions of the 2018 HMP have been revised, eliminated, or restructured as deemed appropriate. A number of the Town's other key planning documents, technical reports, historical data, and other resources were also used in preparing this *Plan* (**Appendix 5-1**). Appreciation and gratitude are extended to all the resources used herein, including local knowledge from the Advisory Committee, community members, and other stakeholders.

Advances in the ability to predict the occurrence and effects of natural disasters, including model simulations and GIS data and mapping capabilities, provided the Town with significant updated and improved information. As such, new information and some new sections were added to this *Plan* to reflect the most current understanding of natural hazards that pose significant threats to Westerly and how the Town can better prepare for these risks.

Major Findings

With an extensive Atlantic Ocean coastline, the Pawcatuck River flowing along the north and west border of the Town, and significant low-lying areas, Westerly is one of Rhode Island's most vulnerable communities to the natural hazard of flooding and storm surge. The community's vulnerability will increase in the coming decades as climate change increases the potential for more frequent and intense rainfall events and sea level rise (SLR). As reflected in the *Plan*, climate change will also exacerbate a number of the other profiled hazards. Major findings of this *Plan* include:

Figure Ex-1 Town of Westerly



Flood-Related Hazards

- Flood waters can damage structures and personal property including mold contamination which can lead to indoor air quality problems; disrupt potable water, stormwater, and sewer system operations; flood roadways creating dangerous conditions for motorist; increase the water table resulting in subsurface issues such as wet basements; and create stagnant pools of water, which provide a breeding ground for mosquitoes.

- Floodwater can pick up pollutants like oils and salt from roadways, fertilizers and pesticides from lawns, effluent from failing septic systems, industrial chemicals, sediment, and debris as it makes its way down gradient. If sufficient polluted floodwater flows into a waterbody or inundates well water, it can harm wildlife or contaminate drinking water, and increases the chance of spreading waterborne diseases, such as hepatitis A and cholera.

- Westerly has several freshwater waterbodies that represent a risk of riverine flooding for low-lying inland neighborhoods: the Pawcatuck River, which flows along the entire northern and western boundaries of the Town has the potential to impact properties along its banks and portions of Downtown Westerly, the North End neighborhood, White Rock, Bradford, Avondale, and Watch Hill; low-lying properties along smaller streams (Aguntaug Brook, Mastuxet Brook, McGowan Brook, Perry Healy Brook, and Springbrook), and near Chapman Pond and Aguntaug Swamp in the north central section of Westerly, are also vulnerable to flooding

- With roughly 9 miles of shoreline, coastal flooding and coastal erosion are highly probable and may have long-term serious consequences for the Town of Westerly. The VE and coastal A Zones includes low-lying portions of Watch Hill, Misquamicut Beach, and properties around Maschaug, Little Maschaug, Winnapaug, and Quonochontaug Salt Ponds. The VE Zone experiences coastal erosion, produced by wave action, which can be destructive, damaging natural and manmade structures, battering solid objects, and scouring sand from around foundations. As storms erode the shoreline, narrowing beaches, depleting dunes, and compromising coastal salt marshes, adjacent upland properties become more at-risk.

- Flood inundation impacts sections of the following roadways and adjacent low-lying properties: Airport Road, Ann Street, Atlantic Avenue, Bay Street, Beach Street near Westerly Yacht Club, Bowling Lane, Bradford Road, Breach Drive, Bridge Road, Canal Street, Cottage Street, Dunn's Corners Road, Friendship Street, intersection of Route 78 and Route 1, Langworthy Road, Main Street, Maplewood Avenue, Narragansett Avenue, Perkins Avenue, Pierce Street, Pleasant Street, Pond Street, Pound Road, Ranger Road, Route 91, Springbrook Road, Spruce Street, Sunset Avenue, Wall Street, Watch Hill Road, Wauwinnet Avenue, Weekapaug Road, and White Rock Road. Compromised roads may hamper rescue efforts, stranding residents in flooded areas.

- FEMA's high risk flood zones (the V and the A Zone) which FEMA denotes as the Special Flood Hazard Area (SFHA) are the most vulnerable to flooding during major precipitation events. The total assessed value for properties with any portion of the parcel intersecting the SFHA represents approximately 35% of Westerly's property tax base. There are no critical facilities structures in the VE zone. There are two critical facilities structures with at least some part of their building footprint located in the AE flood zone. These properties include two National Register of Historic Places: Flying Horse Carousel (151-153 Bay Street Watch Hill), and Weekapaug Inn (25 Spray Rock Road).

- The Rhode Island Coastal Resources Management Council (CRMC) has adopted the NOAA SLR high curve projection for use in planning and coastal permitting. Based on NOAA's 2022 "worst-case" high curve projection, Rhode Island could experience 1.6± feet of SLR by 2050, 4.2± feet of SLR by 2080, and 6.5± feet of SLR by 2100. Irrespective of the specific timeline, the potential impact from SLR on the Town cannot be understated.

- Future increases in relative sea level will intensify coastal flooding and may displace coastal populations; threaten roads, bridges, and other infrastructure including reducing the effectiveness and integrity of existing seawalls and revetments, designed for historically lower water levels; contaminate water supplies through saltwater intrusion into aquifers; lead to the loss of recreation areas and public space; and have a deleterious impact on coastal wetlands, which are critical for flood control and habitat viability.

Wind-Related Hazards

- High winds can down trees and branches, and cause damage to structures, property, vehicles, and infrastructure including utility lines; cause storm surge damage, particularly in the VE flood zone; cause bodily injury from flying debris or structures collapsing; and may exacerbate fire conditions by drying out the ground cover, propelling fuel around the region, and increasing the ferocity of existing fires.

- Damage to electrical or communication lines can cause a loss of electricity resulting in dangerous conditions, including no phone/internet service available for storm advisories and medical emergencies; spoil refrigerated food; and lack of heat, which if occurring in conjunction with freezing temperatures, can lead to dangerous health conditions and the potential for pipes to freeze and burst. Loss of power can also interrupt daily activities and cause business and school closings.

- Westerly can expect an event characterized as *High Wind* roughly once or twice a year and some of those will include thunderstorms.

- Thunderstorms can produce lightning and hail. 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; electrical-based utilities are also vulnerable to direct lightning strike, and resulting damage has the potential to cause power outages for businesses, residents, and critical facilities; and lightning can spark fires. Hail generally does little structural damage, but depending on the growing season, may cause damage to vegetation.

- While there is a low probability of a tornado occurring, it is more likely during peak hurricane season (mid-August through October). Early warning tornado alerts, such as through CodeRED, can save lives.

- There is a high probability of a Tropical Cyclone (Tropical Depressions/Storms and Hurricanes) occurring over the ensuing 5-year period. The Intergovernmental Panel on Climate Change (IPCC) climate models predict hurricanes becoming more intense, with stronger winds and heavier precipitation, through the 21st century.

- Major hurricanes pose a significant threat to sections of Town, particularly due to surge inundation. Under modeled scenarios, even Category 1 and 2 hurricanes can produce storm surges that inundate the Town's southern coastline to Shore Road (Route 1A) and along the Pawcatuck River from Little Narragansett Bay to approximately Stonington, Connecticut's northern boundary. The built environment along the southern shoreline is at higher risk to wind-related damage; commercial and residential properties along Atlantic Avenue in the community of Misquamicut, and in Watch Hill, Weekapaug, and Shelter Harbor have in the past been impacted by high-wind events.

- The Town has critical facilities located in areas at risk from hurricane storm surge inundation. Weekapaug Inn (25 Spray Rock Road), which is on the Natural Register of Historic Places, is at risk from a Category 1 (or higher) hurricane. The Flying Horse Carousel (151-153 Bay Street Watch Hill), which is on the Natural Register of Historic Places, and the Johnnycake Center (23 Industrial Drive), which is a social services organization including a food pantry and thrift store, are at-risk from a Category 2 (or higher) hurricane. The Lewis-Card-Perry House (12 Margin Street), which is on the Natural Register of Historic Places, as well as the PACE Adult Day Center and Transition Academy (both serving special populations at 5 Union Street),

and the Westerly Preschool (13 Cross Street) are at risk from storm surge associated with a Category 3 (or higher) hurricane. The U.S. Post Office (5 High Street),which is on the Natural Register of Historic Places, as well as the Clark Street Daycare (11 Clark Street), Westerly Head Start (34 Pond Street), Tri County Community Action (34 Pond Street), Misquamicut Fire Department (65 Crandall Avenue), and Westerly Library & Wilcox Park (44 Broad Street) are at risk from storm surge associated with a Category 4 (or higher) hurricane.

Figure Ex-2 Hurricane of 1938 – Westerly RI (Photo Credit: SeeWesterly)

Winter-Related Hazards

- There is a high annual probability of a winter weather event impacting the Town. NCEI data suggests that annually, all Rhode Island counties can expect to experience about one nor'easter and two to seven winter weather events of some significance. That being said, it is likely that the extreme cold temperatures will only occur for short periods of time.

- Heavy snow and ice accumulation can weigh down and damage utility wires or cause trees/tree limbs to come down which may damage utility wires and block roadways. Damaged utility wires may lead to power loss which could disrupt critical infrastructure, technology, and phone/internet service, and result in medical emergencies, lack of heat, spoil refrigerated food, and pipes rupturing. Loss of power can also interrupt daily activities and cause business and school closings.

- Snow, ice, and freezing temperatures may create treacherous walking and driving conditions; cause transportation delays; create transportation challenges for first responders or others who may need to be on the roads including those trying to access emergency shelters; impact access to homes and critical facilities such as hospitals, schools, and supermarkets; and damage vegetation and tree limbs.
- Flooding may occur after the rapid melting of a heavy snowfall.

- Extreme cold may increase the potential for house fires and carbon monoxide poisoning due to increased use of supplemental heating devices.

- A number of critical facilities have flat roofs and may therefore be at greater risk of failure from heavy snow. These include all of the public schools (Dunn's Corners Elementary (8 ½ Plateau Road), Springbrook Elementary (39 Springbrook Road), State Street Elementary (35 State Street), Westerly High School (23

Ward Avenue), Westerly Middle School (10 Sandy Hill Road), the School District Administration building (23 Highland Avenue), Town Hall White Rock Building (68 White Rock Road), Tower Street Community Center (93 Tower Street), Ocean Community YMCA-Westerly (95 High Street), U.S. Post Office (110 Tom Harvey Road), Westerly Hospital (25 Wells Street), and the Westerly Armory (41 Railroad Avenue), which is on the Natural Register of Historic Places.

- Exposure to extreme cold for an extended period can lead to health concerns including frost bite and hypothermia, which is of particular concern for infants and older adults; certain medications, medical conditions, or the consumption of alcohol can also make people more susceptible to the cold.

- Prolonged snow/ice cover and exposure to extreme cold may negatively impact outdoor animals/wildlife and disrupt ecosystems

Figure Ex-3 January 2022 Blizzard – Westerly RI (Photo credit: Harold Hanka | The Westerly Sun)

Vector-borne Diseases Transmitted by Ticks or Mosquitoes

- There is a low probability of mosquito-transmitted Eastern Equine Encephalitis (EEE) or West Nile Virus occurring in Westerly over the upcoming 5-year period. However, there is a high probability that a number of Westerly residents will be infected by Lyme disease transmitted by ticks.

- As climate change shortens our winters, ticks and mosquitoes will extend their life cycle and ticks will expand their habitat range. The resulting impact may be more cases of vector-borne diseases in people from mosquito and tick bites.

- Westerly residents living or engaging in outdoor activities in close proximity to areas more conducive to mosquito breeding (forested areas, and standing water along rivers, ponds, and wetlands) are at higher risk of being bitten; Westerly residents living or engaging in outdoor activities in close proximity to wooded and grassy areas where higher populations of ticks tend to be found are at greater risk of being bitten.

- If infected, elderly residents, children, and anyone with a weakened immune system may suffer more severe illness related to mosquito- and tick-borne diseases.

Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses

- It is uncertain when the current Coronavirus (COVID-19) pandemic will end. It is highly likely that Westerly will continue to experience some level of Coronavirus cases, as well as influenza cases, during the ensuing 5-year period.

- The CDC identifies those highest at risk of getting serious complications from flu as children younger than 5, but especially younger than 2 years old; adults 65 years or older; pregnant women; people with any chronic illness, especially heart, lung (including asthma), or kidney disease; and people with weak immune systems**.**

- The CDC has indicated that a number of factors increase a person's vulnerability to get severely ill from COVID-19, including age (greater risks for those over 50), weakened immune system, obesity, certain medical conditions (including chronic lung diseases, serious heart conditions, diabetes, and some neurologic conditions).

- Over three-fourths of the identified critical facilities are considered places where sufficient people are in contact and therefore more vulnerable to the spread of Influenza or Coronavirus; those facilities include all of the Public Schools, Day Care/Early Learning Centers, Special Population Centers, and Government/Emergency Centers. It also includes some of the institutional/commercial facilities, namely the Ocean Community YMCA, Westerly Education Center, Westerly Hospital, and Westerly Library.

Earthquake

- The probability of a significant earthquake impacting Westerly over the next five years is low.

- If a significant earthquake occurred with an epicenter relatively close to Westerly, all buildings may be at risk to some level of damage. However, as Westerly complies with State Building Codes, it is unlikely that most structures would sustain much damage from a moderate earthquake occurring in Rhode Island or Connecticut; there may be some residential and commercial structures sporadically located throughout the Town that are of older construction and may be at higher risk of damage or collapse due to an earthquake.

Extreme Heat

- As the annual number of high heat days (over 90°F) is expected to increase, extreme heat events remain a danger, particularly to sectors of the population more at risk (infants and young children, seniors, low-income residents, people with chronic medical conditions, outdoor workers, pregnant women, athletes, etc.).

- As seniors may be more at risk from the impacts associated with extreme heat, critical facilities that serve this population should be cognizant of the health impacts associated with extreme heat and the potential benefit of having air conditioning available in some area of the facility. Critical facilities that serve seniors include the Apple Rehab Clipper, Golden Years Assisted Living Community, PACE Adult Day Center, Royal Health Westerly, The Elms Retirement Residence, Westerly Rehabilitation & Healthcare Center, and Westerly Senior Center.

- Physical effects of heat can cause major health problems, dehydration, and may lead to death.

- Increased energy demands, particularly related to AC usage, may cause power shortages/ outages.

- Extreme heat leads to the Town beaches being overpopulated, causing an increase in beach inventory expenses (garbage bags, toiletries, cleaning supplies, and staff overtime); parking passes do not cover the cost of these additional expenses.

Drought

- The probability of a long-term drought occurring over the next five years is low. Although some models suggest that less frequent but more intense precipitation events coupled with a projected warming trend may increase the probability of a short-term (one to three month) drought, the probability over the next 5 years is considered moderate.

- Residences that rely on private wells (6±% of the Town) may be more vulnerable to drought conditions; these areas are generally located on Westerly-Bradford Road (between Pound Road and Dunn's Corner Road), the northern end of Pound Round including Hesspar Road, in the area directly surrounding the Rawson Quarry located on Old Hopkinton Road, and the northern end of South Woody Hill including Fallon Trail.

- During droughts, dry soils may increase the number of airborne particles, such as pollen, which can irritate the airways and worsen chronic respiratory illnesses such as asthma; those suffering from asthma or other respiratory illnesses may be at higher risk.

Brush Fire

- Westerly's relatively flat topography, along with the overall humid weather, puts the Town at a low risk for brush fires.

- Brush fires that occur in more remote, harder to access areas pose a greater risk of spreading as they may go unnoticed for longer and/or take longer to access by fire protection services – these areas include portions of the Woody Hill Management Area and the Potter Hill area, including the Town Forest.

MITIGATION STRATEGY

The *Mitigation Strategy* is the culmination of the planning process. It provides the Town with the basis for action to reduce the risk to people and property from hazards and assists the Town in achieving compatible economic, environmental, and social objectives. The *Hazard Mitigation & Flood Management Plan (HM&FMP)* Advisory Committee used the assessment information to develop a broad-based mission statement, goals, policies, and actions which are intended to guide the Town's day-to-day operations and long-term approach to reduce the impacts of hazards and improve flood management.

It was important to the Town of Westerly to develop a comprehensive and aggressive *Mitigation Strategy* that will lead to a safer and more sustainable community. The Town has and will continue to implement and institutionalize hazard mitigation and flood management through its human, legal, and fiscal resources; effective coordination and communication with the state, neighboring jurisdictions, stakeholders, community members, and across Town departments; and use of knowledge and tools to analyze and cope with hazard risks. The *Mitigation Strategy* includes a mix of mitigation and non-mitigation actions. Non-mitigation actions include activities that are emergency response or operational preparedness in nature.

Goals and Policies

The mitigation strategy *Goals* are the foundation behind the development of a comprehensive range of specific attainable mitigation actions for the Town. During the development process, the 2018 HMP goals were reviewed for relevancy. In addition to updating the goals for this *Plan*, policies were also developed.

Goal 1: Protect public health and safety against impacts of natural hazards.

Policy 1.1: Improve the community's awareness and capacity to reduce or adapt to impacts from natural hazards.

Policy 1.2: Provide services critical to the community's continued health, safety, and well-being, especially during hazard events and to vulnerable populations.

Policy 1.3: Reduce the municipality's contribution to climate change, which is a threat multiplier for natural hazards.

Goal 2: Sustain a local economy that is resilient to natural and human-caused disasters.

Policy 2.1: Prepare for the occurrence and anticipate the impact of extreme weather events and develop mitigation policies and procedures that best reduce fiduciary risk and impact on the local economy.

Policy 2.2: Reduce the burden of climate change impacts on municipal finances and the local and regional economies.

Goal 3: Sustainable infrastructure will be in place to ensure water quality, efficient wastewater treatment, effective stormwater management, and efficient transportation and transmission of essential utilities in the face of natural hazards and climate change impacts.

Policy 3.1: Ensure that the municipal transportation system, including but not limited to, roads, bridges, and culverts, effectively and resiliently meets the community's needs.

Policy 3.2: Enhance the resiliency of Westerly's drinking water and wastewater systems by developing programs and projects that improve maintenance and provide protection, redundancy, and resilient design.

Policy 3.3: Improve stormwater drainage treatment and conveyance systems.

Policy 3.4: Ensure transmission of essential private utilities (electric, gas, internet, cell services) is resilient to natural hazard impacts.

Goal 4: Enhance the capability of the natural environment to protect Westerly from flooding, storm surge and sea level rise.

Policy 4.1: Provide long-term conservation of natural resources, particularly in vulnerable areas of Westerly.

Policy 4.2: Ensure the sustainable use and management of natural resources.

Policy 4.3: Anticipate new development, redevelopment, structural elevations, and, as necessary, retreat from or management of coastal shorelines and riparian zones in especially vulnerable areas.

Action Plan

To comprehensively address the *2023 Goals*, the Advisory Committee reviewed an extensive array of possible actions (**Appendix 6-1**). The possible actions originated from other Town planning documents and the 2022 Public Opinion Survey, as well as from input from the Advisory Committee or members of the public. Through combining some of the possible actions and eliminating others, the Committee developed 33 specific actions to be considered for implementation by the Town during the five-year duration (2023-2028) of this *Plan* and beyond.

The *Mitigation Action Plan* (**Section 6**) includes a mix of physical initiatives through capital improvement projects and programming, as well as passive initiatives through regulatory and policy measures. All 33 actions have been deemed feasible, reflect updated priorities including response to climate change and accelerated sea level rise, and address the Town's current and projected future needs.

The *Action Plan* is organized by *Goal* and *Policy* and includes a description of the action, along with other descriptors such as the lead authority, magnitude of cost, mitigation category (prevention, property protection, public education and awareness, natural resource protection, structural projects, and emergency services), and the STAPLEE priority ranking. The STAPLEE method (Social, Technical, Administrative, Political, Legal, Economic, and Environmental) was the process the Advisory Committee used to prioritize the proposed actions (**Appendix 6-2**). The inclusion of actions focused on public education and awareness was deemed essential to encourage residents, property owners, and local businesses recognize measures they can take to become more resilient to natural hazards.

The actions will be implemented through the Town's personnel, legal, and fiscal resources; intergovernmental coordination and communication; academic resources and analysis tools; and through the involvement of the Town's residents, business owners, conservation organizations, and institutional leaders. The Town also recognizes the need to work collaboratively across municipal lines, and with State and Federal agencies, to effectively address actions that will improve not only the Town, but the region, and, by extension, the State.

Plan Adoption

After the Advisory Committee determined the objectives of the *Plan* had been met, a *Public Review Draft* was made available to the public-at-large. The Committee established a 3-week review period culminating in a Public Hearing which was hosted by the Westerly Town Council on February 27, 2023. The Public Review Period and Public Hearing were well advertised through a press release and Public Hearing Legal Notice in the local newspaper, the Town's website, an informational kiosk at the public library, an agenda item on the February Economic Development Commission and Planning Board meetings, a Town Council Workshop, and notice of the Public Hearing posted on the Secretary of State website, Clerkbase, on the Town website calendar, and a notice posted in the Town Hall and Police Station. Additionally, the Town sent an email publicizing the *Draft Plan* and Public Hearing to the groups and organizations listed in **Appendix 2-3**, which includes the Westerly Town Council, Town Boards and Commissions, neighboring municipalities, and numerous local, regional, and State stakeholders. Community members and other stakeholders were encouraged to provide input and feedback throughout the Public Review Period to the Planning Department and/or at the Public Hearing. During the Public Review Period the Town received written comments from 2 members of the public (one from a resident and one from Save The Bay), which have been addressed in the *Final Draft*.

At the Public Hearing, the Town's Consultant gave a brief project presentation, followed by questions from the Town Council, and then a public comment period, during which no members of the public chose to speak. The Town Council voted unanimously to adopt the *HM&FMP*, with the acknowledgment from the Town solicitor that during the subsequent review/approval process by RIEMA/FEMA, any required revisions would be accepted by this approval. The Town Council Resolution adopting the *HM&FMP* is included in **Appendix 7-2**. The Town worked diligently to produce a detailed plan with the intent of satisfying all DMA requirements, and therefore does not

anticipate any substantial RIEMA/FEMA required revisions. However, should RIEMA/FEMA request substantial revisions, the Town Council may choose to re-adopt the *Plan* after said revisions are made.

The Town Council adoption of the *Plan* recognizes it as a guidance for Town-wide natural hazard mitigation, enabling Westerly to continue to work toward building a safer, disaster resilient, and sustainable community through the implementation and maintenance of mitigation actions.

On March 21, 2023, the *Plan* received approval from FEMA, which confirmed that the *HM&FMP* met all requirements. The FEMA approved/Town Council adopted *HM&FMP* makes Westerly eligible for federal grants available through FEMA's Hazard Mitigation Assistance Grants, including the Hazard Mitigation Grant Program (HMGP), Flood Mitigation Assistance (FMA) Program, Building Resilient Infrastructure & Communities (BRIC), and Pre-Disaster Mitigation (PDM) program. The *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan* will be maintained on the Town's website and replaces the Town's 2018 HMP.

Implementation and Plan Maintenance

The Town of Westerly is committed to implement the *Action Plan* (**Section 6**) on an ongoing basis, as well as support a process by which the local government will integrate hazard mitigation planning into other departmental measures.

When creating this *Plan*, numerous local plans, policies, codes, and programs that guide development in Westerly were consulted (**Section 5**). The Town intends to continue plan integration, ensuring that whenever appropriate, the *HM&FMP* strategies will be integrated into new or updated local plans and policies.

With respect to the *HM&FMP*, the Town considers it a dynamic document. To ensure it remains effective over the 5-year implementation period, it will be reviewed at minimum, on an annual basis (preferably on a semi-annual basis), and as readily as possible following a natural disaster, should one occur. These reviews will serve as opportunities to assess the progress and effectiveness of implemented mitigation measures, and to update the *Plan* as deemed appropriate to reflect items such as changes in the community, availability of funding and staffing resources, or an improved understanding of the Town's strengths and vulnerabilities.

For the *Plan* to remain relevant, continued community involvement throughout the implementation and maintenance process will be essential. Ongoing community engagement is an asset to the process as it continues the hazard risks discussion and builds support for mitigation activities. Throughout the 5-year implementation period, community members will be given the opportunity to affect the content and outcomes of the *HM&FMP* through outreach, public meetings, and community forums.

In addition to the annual reviews, the *Plan* will undergo a 5-year full update. The 5-year update will be completed in accordance with Disaster Mitigation Act requirements, in order to maintain eligibility for FEMA mitigation grant funding. To ensure that the revised plan will be approved within the 5-year cycle, it is proposed that the Town commence the update on the fourth anniversary of the *Plan* adoption date.

SECTION 1

Introduction

Subsections

KMJ – CE/RP

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1 Introduction

The *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan (HM&FMP)* is a critical planning document for the Town. With extensive coastline, the Pawcatuck River flowing along the north and west border of the Town, and significant low-lying land within the Special Flood Hazard Area (SFHA), Westerly is one of Rhode Island's most vulnerable communities to the impacts from natural hazards. For the purposes of this mitigation plan, a natural hazard is considered "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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-1). The potential impacts from natural hazards range from minor short-term events such as street flooding and snowstorms, to catastrophic events, such as the Hurricane of 1938. Risks will continue to grow in the coming decades due to sea level rise and other anticipated deleterious effects of climate change. By planning ahead, Westerly becomes pro-active rather than reactive, and can significantly reduce the damaging effects of future disasters, minimizing loss of life, injuries, destruction of property, infrastructure, and the environment, and economic and social disruption.

1.1 PURPOSE AND MISSION STATEMENT

The objective of this *Plan* is to guide hazard mitigation efforts by identifying natural hazards with a higher likelihood of occurring or potentially having a greater impact on the community should they occur; determining the vulnerability of the community to these hazards; and establishing clear goals and strategies that mitigate the risks. The Mission Statement, adopted by the HM&FMP Advisory Committee, forms the foundation upon which the *Mitigation Strategy* is built.

Mission Statement

The purpose of the *Town of Westerly Hazard Mitigation & Flood Management Plan (HM&FMP)* is to reduce Westerly's vulnerability to impacts of natural hazards, including safeguarding against the threat multipliers of sea level rise and other deleterious climate change impacts, thereby fostering a safe, resilient community that preserves and enhances quality of life for all generations. The Town of Westerly, through the *HM&FMP*, by identifying areas and resources at risk to natural hazards and planning for feasible, sustainable mitigation measures, intends to reduce the adverse impacts of natural hazards on Westerly's people, critical facilities and services, infrastructure, natural and built environment, historic and cultural resources, and economic vitality.

As both inland and coastal flooding have historically been a problem for the Town of Westerly, and climate change and sea level rise (SLR) models indicate flood-related hazards will continue to worsen in the future, the Advisory Committee chose to expand the FEMA required 5-year Hazard Mitigation Plan (HMP) update to include additional focus on flooding and flood management. The resulting *Hazard Mitigation & Flood Management Plan (HM&FMP)* was prepared pursuant to the requirements of the Federal Disaster Mitigation Act of 2000, integrates the 10-step planning process outlined in Community Rating System (CRS) Activity 510, and aligns with the State of Rhode Island's objectives for natural hazard mitigation included in the RI State Hazard Mitigation Plan (RI-SHMP).

The hazards addressed in this *Plan* include: Flood-Related Hazards; Wind-Related Hazards; Winter-Related Hazards; Infectious Disease-Related Hazards (Vector-borne Diseases Transmitted by Ticks or Mosquitoes, and Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses); and Other Hazards (Earthquake, Extreme Heat, Drought, Brush Fire). The *Plan* also addresses how climate change, including sea level rise, poses a significant threat to the community in terms of exacerbating many of the identified hazards.

1.2 ORGANIZATION OF THE DOCUMENT

This *Hazard Mitigation & Flood Management Plan (HM&FMP)* is organized as described below. As noted, the CRS Activity 510 planning process guided plan development. This process proved successful, encouraging community and stakeholder engagement, and the integration of key planning documents and other resources. The planning process led to a well-structured, community-centric *Plan* that addresses risk and vulnerability through a variety of hazard mitigation measures.

Executive Summary: provides an overview of the planning process and collaborative effort undertaken by the Town to create this document. The Executive Summary also sets forth the major assessment findings, goals, how the *Action Plan* was developed, and how *Plan* adoption, implementation, and maintenance will help ensure the Plan remains relevant and provides effective guidance as Westerly continues to build a safer, disaster resilient, and sustainable community.

Section 1 - Introduction: identifies the purpose and structure of the *Plan*. A brief summary of the information presented in each Section is provided.

Section 2 - Planning Process with Public Input: provides a description of the overall planning process and identifies the HM&FMP Advisory Committee members. As the Town participates in the Community Rating System (CRS) program, the CRS Activity 510 planning process was used to guide plan development. As shown in Section 2, that process aligns with the Disaster Mitigation Act (DMA) of 2000 Hazard Mitigation Plan requirements. Section 2 also provides a discussion of public involvement, identifying how the community, neighboring jurisdictions, and other stakeholders were given the opportunity to provide input and feedback on the *Plan*. It further outlines the extensive plan integration effort undertaken as part of the planning process.

Section 3 – Community Profile: provides a glimpse of the history and character of the Town, as well as general information about the government structure, population, and demographics.

Figure 1-1 Watch Hill Cove from Napatree Point
Photo Credit: Juliancolton/Wikimedia Commons

Section 4 – Risk Assessment: comprises two key elements: Hazard Identification and Vulnerability Analysis. The Hazard Identification reviews and ranks the natural hazards that are likely to impact all or part of Westerly. Ranking is used to determine which hazards have a higher likelihood of occurring, or potentially having a greater impact on the community should they occur. The hazards addressed in this *Plan* have been grouped into the following categories: **Flood-Related Hazards** (Inland Flooding including Dam Failure, Coastal Flooding including Storm Surge, Coastal Erosion); **Wind-Related Hazards** (High Winds, Thunderstorms including Lightning and Hail, Tornadoes, Tropical Cyclones - Tropical Depressions, Tropical Storms, and Hurricanes); **Winter-Related Hazards** (Heavy Snow, Ice, Extreme Cold); **Infectious Disease-Related Hazards** (Vector-borne Diseases Transmitted by Ticks or Mosquitoes, Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses); and **Other Hazards** (Earthquake, Extreme Heat, Drought, Brush Fire). A profile for each of these hazards is provided with the following information: description and extent (strength or magnitude of impact); location (geographic area affected); previous occurrences; climate change impacts; and probability of future events.

The Vulnerability Analysis considers how vulnerable the community is to the various identified hazards. The analysis addresses what is at risk (built environment including public infrastructure, natural environment, local economy, and people) and what the impacts might be (structural and environmental damage, economic loss, inconvenience to residents, physical and emotional harm, and loss of life). The Vulnerability Analysis employed both a quantitative analysis (wherein data was available) and a qualitative analysis that relied on local knowledge and rational decision making.

Section 5 – Capability Assessment: provides an overview of what mitigation mechanisms are already in place. In other words, what policies, programs, regulations, authorities, personnel, funding, and other resources are available to the Town to accomplish mitigation and reduce long-term vulnerability. A Capability Assessment is an important step because understanding what is already in place and the effectiveness of those capabilities provides the opportunity to identify where additional measures or revisions to existing measures are needed.

Section 6 – Mitigation Strategy: is the culmination of the planning process, built upon the preceding Sections, particularly the findings from the *Risk Assessment (Hazard Identification and Vulnerability Analysis), and Capability Assessment*. Section 6 includes a broad-based mission statement, goals, policies, and actions which are intended to guide both the Town's day-to-day operations and long-term approach to reduce the impacts of hazards and improve flood management.

The *Action Plan*, which will serve as a roadmap for the next 5 years, was developed by reviewing and prioritizing an array of possible actions. To comprehensively address the mitigation *Goals*, actions across a number of mitigation categories (prevention, property protection, public education & awareness, natural resource protection, structural projects, and emergency services) have been included in the *Action Plan*. As the Town has limited fiscal and staffing resources, the *Action Plan* places greater focus on mitigation measures for the higher ranked hazards.

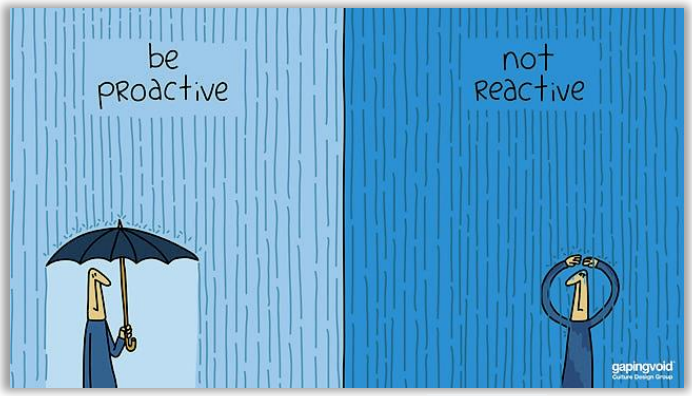

Figure 1-2 (Image Credit: gapingvoid)

Section 7 – Plan Adoption, Implementation, and Maintenance: provides the *Plan* adoption process which represents community and local government support. In addition, by adopting the *Plan* the Town is eligible for FEMA Hazard Mitigation Assistance Grants and CRS credit points.

Section 7 also identifies a process for monitoring the overall progress of mitigation strategies and completed initiatives. The *Action Plan* includes descriptors for each mitigation action, such as lead authority and timeframe, which will aid implementation by providing a clear course for how the measure is to be incorporated into departmental and committee-based work plans and budgets. To ensure the *Plan* remains relevant, Section 7 stipulates an annual review and five-year update. Structured maintenance of the *Plan* provides a defined opportunity to evaluate the effectiveness of implemented mitigation measures, address changing conditions, identify funding mechanisms, and facilitate integration of the *HM&FMP* into other Town planning documents and strategies.

Appendices: contain supporting documents.

Appendix 2-1 CRS Credit for Activity 510
Appendix 2-2 Outreach Activities
Appendix 2-3 Coordination with Agencies & Organizations

Appendix 4-1 Hazard Impacts & Risk Assessment
Appendix 4-2 Maps
Appendix 4-3 Critical Facilities Vulnerability Analysis

Appendix 5-1 Planning and Regulatory Capabilities
Appendix 5-2 Administrative and Technical Capabilities
Appendix 5-3 Financial Capabilities

Appendix 6-1 Possible Actions
Appendix 6-2 STAPLEE Analysis

Appendix 7-1 Local Mitigation Plan Review Tool
Appendix 7-2 Westerly Town Council Resolution

SECTION 2

Planning Process with Public Input

Subsections

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2 Planning Process with Public Input

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirements ➔
44 CFR Subsection D §201.6(b): An open public involvement process is essential to the development of an effective plan. In order to develop a more comprehensive approach to reducing the effects of natural disasters, the planning process shall include:

1) An opportunity for the public to comment on the plan during the drafting stage and prior to plan approval;
2) An opportunity for neighboring communities, local and regional agencies involved in hazard mitigation activities, and agencies that have the authority to regulate development, as well as businesses, academia, and other private and nonprofit interests to be involved in the planning process; and
3) Review and incorporation, if appropriate, of existing plans, studies, reports, and technical information.

44 CFR Subsection D §201.6(c)(1): The plan shall include the following:

1) Documentation of the planning process used to develop the plan, including how it was prepared, who was involved in the process, and how the public was involved.

CRS - Flood Management Plan: The Town of Westerly has successfully met the following Mitigation Strategy requirements based on the 10-step planning process for CRS Activity 510 ➔
Organize to Prepare the Plan (Step 1); Involve the Public (Step 2); and Coordinate (Step 3)

2.1 ORGANIZE

The Town of Westerly is cognizant of the importance of updating and coordinating local planning initiatives. As the 2018 *Hazard Mitigation Plan* (HMP) was scheduled to be updated in 2023, and as a prevalent natural hazard facing the Town of Westerly is flooding, the Town decided to expand the update process to effectively create a combined *Hazard Mitigation & Flood Management Plan (HM&FMP)*.

CRS CREDIT:

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase I - Planning Process	1. Organize to Prepare the Plan	15

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

The Town of Westerly participates in FEMA's Community Rating System (CRS) Program. The Town entered into the CRS Program on May 1, 2013 and currently has a CRS Class 7 rating. As discussed further in **Subsection 2.3.1.1**, this rating provides a significant discount to property owners who purchase flood insurance through the National Flood Insurance Program (NFIP). As the Town intends to continue participation in this program, it was determined that the *Plan* should be created using the CRS Activity 510 planning process. This process allows the Town to maximize CRS credit for this *Plan* while meeting the Disaster Mitigation Act (DMA) 2000 Hazard Mitigation Plan requirements. This coordinated approach strengthened the planning process and led to a well-structured, community-centric plan that addresses risk and vulnerability through a variety of hazard mitigation measures. The Town contracted with Civil Engineer & Resilience Planning Consultant Kim Jacobs (KMJ-CE/RP) to draft the *Plan*, provide technical assistance to the HM&FMP Advisory Committee, facilitate meetings, organize outreach efforts in collaboration with the Southern Rhode Island Conservation District, and coordinate plan review with RIEMA.

> Planning is essential.
>
> *- Dwight D. Eisenhower*

2.1.1 10-Step Planning Process

By implementing the CRS Activity 510 planning process outlined in **Table 2-1**, this *HM&FMP* meets DMA requirements while maximize CRS Activity 510 credit. An overview of the estimated CRS credit achieved by this *Plan* has been included in **Appendix 2-1**.

Table 2-1 shows the alignment of the DMA planning regulations to the 10-Step planning process. It should be noted that Steps 2 and 3 were implemented throughout the entire planning process.

Table 2-1 10-Step Planning Process & DMA Planning Regulations

CRS Activity 510 Planning Process	DMA Planning Regulations (44 CFR 201.6)
Phase I – Planning Process	
Step 1. Organize to Prepare the Plan	§201.6(c)(1)
Step 2. Involve the Public	§201.6(b)(1)
Step 3. Coordinate	§201.6(b)(2) & (3)
Phase II – Risk Assessment	
Step 4. Assess the Hazard	§201.6(c)(2)(i)
Step 5. Assess the Problem	§201.6(c)(2)(ii) & (iii)
Phase III – Mitigation Strategy	
Step 6. Set Goals	§201.6(c)(3)(i)
Step 7. Review Possible Activities	§201.6(c)(3)(ii)
Step 8. Draft an Action Plan	§201.6(c)(3)(iii)
Phase IV – Plan Maintenance	
Step 9. Adopt the Plan	§201.6(c)(5)
Step 10. Implement, Evaluate, and Revise the Plan	§201.6(c)(4)

2.1.2 Local Government Involvement: Advisory Committee

The first draft of Westerly's Hazard Mitigation Plan was prepared in the summer of 2003 by a University of Rhode Island intern and titled, *Natural Hazard Risk Assessment & Mitigation Strategy – Town of Westerly RI*. Additional contributions to the draft plan were made by Town staff members. An update to this document occurred in 2012, and again in 2018 when the title was changed to *Local Hazard Mitigation Plan Update*.

At the Westerly Town Council meeting on November 7, 2022, the Council authorized the update and expansion of the 2018 Hazard Mitigation Plan. In support of the CRS Activity 510 planning process, the Town Council also authorized the formation of an Advisory Committee, comprised of Town staff, residents, and other stakeholders, to guide plan development. The HM&FMP Advisory Committee members are listed in **Table 2-2**, with public representation comprising more than 50% of the membership. The Town's Consultant for the *HM&FMP*, served on the Committee throughout the planning process in an advisory capacity.

The HM&FMP Advisory Committee met seven (7) times throughout the development of this *Plan*, and their input and feedback were integral to its success. The date and key agenda items for each of the Advisory Committee meetings have been provided in **Table 2-4**. As shown, the Advisory Committee was actively engaged in all aspects of plan development, with emphasis on reviewing the impact of hazards on people and property; considering a variety of ways to reduce and prevent damage from flooding and other hazards; recommending appropriate and feasible measures to improve community resilience through implementation of mitigation actions; ranking both the hazards and the mitigation measures; and engaging the public in the plan development process. The Committee meetings were open to the public and publicized on the RI Secretary of State website, Westerly RI ClerkBase, and the Town website, and hard copies of the agenda were posted in the Town Hall and Police Station.

Table 2-2 HM&FMP Advisory Committee

Westerly Town Staff	Members of the Public/Stakeholders
Planning Department Committee Chair: Alyse Oziolor, Principal Planner *or designee* Nancy Letendre, Town Planner	Age Friendly Westerly/Healthcare Professional Fawatih Mohamed-Abouh, MD, MPH
Building Department David Murphy, Building Official/Resident	Westerly Business Owner/Resident Michelle Pinto
Department of Public Works/Utilities Peter Chiaradio, Assistant Director of Public Works-Highway Division/Resident *or designees* Max Sposato, Assistant Director of Public Works-Utilities Division/Resident Arianna Zurell, Project Manager-Utilities Division	Southern Rhode Island Conservation District/Resident Gina Fuller, District Manager
Emergency Management Shawn M. Lacey, Town Manager/Resident *or designee* Amy Grzybowski, Emergency Management Coordinator	Ocean Community Chamber of Commerce/ Westerly Business Owner/Resident Dan Lathrop, President Lathrop Insurance
Engineering Department Kyle Zalaski, P.E., Town Engineer	Watch Hill Fire District/Resident Joan Beth Brown, Fire District Moderator
Police Department/Harbor Management Paul Gingerella, Chief of Police and Harbor Master/Resident *or designee* Kimberlie Rayner-Russell, Assistant Harbor Master/Resident	Westerly Fire Department/Resident John Mackay, Fire Chief
	Westerly Land Trust Marc Doherty, Land Stewardship Manager/Resident *or designee* Jennifer Fusco, Executive Director/Resident
Committee Facilitator and Technical Advisor *Kim Jacobs, Civil Engineer & Resilience Planning Consultant*	

The Town was honored to have two of the Fire Districts represented on the Committee as stakeholders. It should be noted that fire protection services in the Town of Westerly are provided by incorporated Fire Districts and paid through fire district taxation. The seven Westerly Fire Districts function outside of the municipal government, but have a strong working relationship with the Town.

The Town departments represented on the Advisory Committee are responsible for implementing the majority of the *Plan's* recommendations and, as shown in **Table 2-3**, collectively have authority over all six categories of flood mitigation activities. The Planning Department, having primary responsibility for the community's land use and comprehensive planning, served as Chair of the Advisory Committee, and was actively involved in all aspects of the planning process.

Table 2-3 Town of Westerly Department Responsibility

Department	Land Use and Comprehensive Planning	6 Categories of Flood Mitigation					
		Prevention	Property Protection	Public Education & Awareness	Natural Resource Protection	Structural Projects	Emergency Services Protection
Planning & Zoning	x	x	x	x	x	x	
Building	x	x	x	x	x	x	
Emergency Management		x	x	x	x	x	x
Police Department & Harbor Master		x	x	x	x		x
Public Works	x	x	x	x	x	x	x
Engineering	x	x	x	x	x	x	

2.2 PUBLIC INVOLVEMENT

Public participation is a central component of the planning process which helps to provide critical information about the local occurrence of hazards, qualify past successful mitigation measures, and identify where additional work is needed to reduce the potential damages from hazard events. Public participation also builds understanding of the concept of hazard mitigation and climate change, therein helping to create a base of support for implementing *Plan* activities.

CRS CREDIT:

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase I - Planning Process	2. Involve the Public	120

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

It was important to the Town of Westerly that this *Plan* reflects the community's values and priorities. For that reason, the Town wanted an equal or greater public representation on the Advisory Committee. Additionally, to engage the public-at-large, the Town conducted an extensive public outreach process that included the opportunity for residents, business owners, local boards and commissions, neighboring communities, academia, private and non-profit organizations, state agencies, and other interested stakeholders to attend and participate in public meetings, provide input through an online survey, and ask questions of or provide comments to the Planning Office about the *HM&FMP* as it was being drafted. All input received was appreciated and considered in finalizing this *Plan*.

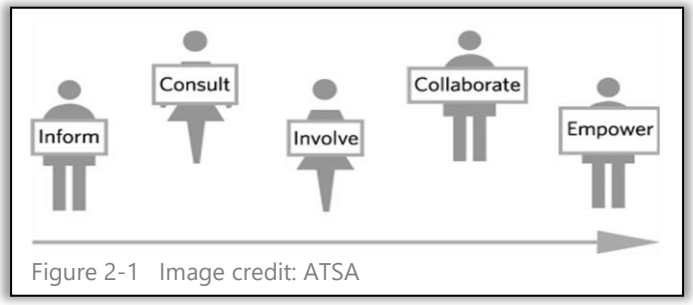


Figure 2-1 Image credit: ATSA

Following is an overview of public engagement that was essential to the development of the *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan*.

2.2.1 Prior to HM&FMP Planning Process

It should be noted that even prior to the commencement of the *HM&FMP* planning process, several initiatives with highly successful public engagement took place; the outcomes of which have helped to shape this *Plan*. Two of those initiatives have been documented below.

2.2.1.1 Public Outreach Associated with: Comprehensive Community Plan

The Town of Westerly Comprehensive Community Plan (CCP) was recently updated. The revised and adopted 2020-2040 CCP embraced the *Rhode Island Comprehensive Planning and Land Use Act* goal of encouraging "the involvement of all citizens in the formulation, review, and adoption, or amendment of the comprehensive plan" (Rhode Island Comprehensive).

Opportunities for public input and feedback were provided throughout the development of the CCP including:

- The formation of a Comprehensive Plan Citizens Advisory Committee (CPCAC)
- Approximately 20 public meetings - including a workshop addressing natural hazards, other topical workshops, and a day-long stakeholders review workshop
- A survey of Westerly businesses comprised of 28 questions which was mailed to all "Businesses with Taxable Assets" (1,507 businesses in September 2019)
- A 3+ month *Public Review Period* during which the Draft CCP was posted on the Town's website and both the Planning Board and Town Council held work sessions that were open to the public
- A Public Hearing facilitated by the Planning Board and two Public Hearings facilitated by the Town Council

After having undergone an extensive community outreach process which resulted in public and stakeholders input and feedback being incorporated into the document, the Westerly Town Council, on January 20, 2021 voted to incorporate the CCP into the Code of Ordinances as Chapter 10 (Town of Westerly RI. *Comprehensive,* 9-11*)*. As will be further discussed in **Section 2.3**, the Town's CCP was used extensively to inform and develop this *Plan*, including many of the action items.

2.2.1.2 Public Outreach Associated with: MRP CRB Workshop

In August 2019 the Town held a Community Resilience Building Workshop, led by the Rhode Island Infrastructure Bank (RIIB) in partnership with The Nature Conservancy (TNC). The Workshop brought together Town staff and local, regional, and state stakeholders, in an effort to identify and prioritize steps to reduce risks and improve resilience within the Town and region. The Workshop provided a key opportunity to discuss and advance comprehensive community resilience planning and hazard mitigation efforts. An overview of the discussion and outcome from the Workshop is documented in the *CRB Workshop Summary of Findings Report,* which was used to inform the resiliency policies in the CCP and further used in the development of this *Plan*, including the *Action Plan.*

Figure 2-2 CRB Workshop
Photo Credit: Adam Whelchel/TNC

2.2.2 Throughout HM&FMP Planning Process

A key element in the mitigation planning process is creating a plan that accurately reflects the community's values and priorities and promotes discussion among community members about creating a safer, more disaster-resilient community.

As previously indicated, the public was involved in the planning process from the onset, comprising more than 50% of the Advisory Committee membership. In addition, throughout the planning process, the public was given opportunities to be involved through outreach efforts that sought to deepen the public's understanding of hazard risks and encourage input on the development of resilient solutions. Community members provided local knowledge of past hazard occurrences, described problem areas and issues of concern, helped identify community assets and mitigation alternatives, and provided ideas for continuing public involvement after *Plan* adoption. All input and feedback received was appreciated and taken into consideration in finalizing this *Plan,* including the *Action Plan*.

Successful Outreach

- 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

Source: FEMA Local Mitigation Planning Handbook 2013, page 3-2

The Town engaged in a total of thirteen (13) outreach activities which included an informational project webpage, several newspaper articles, social media posts on various platforms **(**Town of Westerly News Flash, Email Notices, and Facebook**)**, local radio broadcasts on WBLQ, informational posters, public opinion survey, public information meeting, press release for Public Review Period, 3-week Public Review Period commencing with disseminating the *Public Review Draft*, kiosk at the Public Library, including HM&FMP as an agenda item for the February Economic Development Commission and Planning Board meetings, and Town Council Workshop, and a Public Hearing. An overview of the outreach activities has been included in Table 2-4. Additional information for each activity, including copies of the newspaper articles, results of the survey, and examples of the posters has been provided in Appendix 2-2. Just as public involvement throughout the planning process was a priority, after the Town Council adopts *the HM&FMP*, it is important to the Town that the public continue to be involved in the ensuing implementation and maintenance phase.

Because community and stakeholder engagement are important, the public informational meeting and Public Hearing were publicized in the local newspaper, on the RI Secretary of State website, the Town's website, Westerly RI ClerkBase, and hard copies of the agenda were posted in the Town Hall and Police Station. In addition, an email highlighting these and other outreach activities was sent to the 13 local government & school district groups, including the Westerly Town Council and other Boards and Commissions, and 36 stakeholders from various agencies and organizations outside of Westerly's governmental structure listed in **Appendix 2-3.**

Table 2-4 Summary of Advisory Committee Meetings and Public Outreach

Event	Overview	Date
Advisory Committee Meeting #1	• The Committee members and Technical Advisor (TA) introduced themselves. • The TA presented a brief overview of the Disaster Mitigation Act, Community Rating System program, and the proposed structure and planning process for the HM&FMP. • The proposed meeting schedule was reviewed • The Committee discussed the importance of engaging the public in the process and potential outreach projects.	Nov 21, 2022 (9-10:30am)

Event	Overview	Date
Advisory Committee Meeting #1 continued	• The importance of Plan Integration was discussed and a list of local planning documents to be reviewed as part of developing the Hazard Mitigation & Floodplain Management Plan (HM&FMP) was reviewed. • The Committee reviewed the Major Disaster Declarations (Federal) and Emergency Disaster Declarations (State), and aggregate number of various hazard events/associated property damage in Washington County over approximately the past 25 years. • The impacts of climate change were discussed with the recognition that for the foreseeable future, climate change (including sea level rise) will have a significant impact locally, nationally, and globally. In the Plan, climate change will be recognized as a present threat and an ongoing amplifier to some of the natural hazards. • A discussion took place on what hazards are more likely to impact Westerly and should/should not be included in the 2023 HM&FMP. • The Committee briefly discussed Critical Assets. • Public Comment: No one from the public spoke.	Nov 21, 2022 (9-10:30am)
Outreach Activity #1	**Project Webpage:** A HM&FMP project webpage was created on the Town's website as a mechanism to provide the community and other stakeholders with information about the planning process and promote upcoming meetings and outreach activities. The webpage was maintained throughout the duration of the Project and updated on several occasions. At the beginning of the Public Review period, the *Public Review Draft* was posted on the project webpage. A link to the project webpage was included on the Town's website (Emergency Management webpage, Hazard Mitigation webpage, under Government-Current Projects, and in the News Flash).	Launched on Nov 22, 2022 (continued throughout the project)
Outreach Activity #2	**Newspaper Articles:** An article was published in the local newspaper, *The Westerly Sun*, on November 22, 2022, informing the public about the project and encouraging the public to participate in the planning process, including the public opinion survey and Public Informational meeting. A second article was published in *The Westerly Sun* on December 8, 2022, and a third article on December 21, 2022 after the Pubic Informational Meeting.	Nov 22, 2022 edition; Dec 8, 2022 edition; and Dec 21, 2022 edition
Outreach Activity #3	**Social Media Posts:** Information about the project, public outreach activities, and other opportunities for the public to provide input and feedback was posted in various formats on various platforms, including the Town of Westerly's Website News Flash, Email Notices, and Facebook Posts, as well as a number of private Facebook pages.	Beginning Nov 22, 2022 (various posts throughout the project)
Outreach Activity #4	**Radio Broadcasts:** Information publicizing the HM&FMP and how residents and interested stakeholders can provide input and feedback, was the topic on three WBLQ radio programs as well as broadcast in over 30 WBLQ public service announcements.	Nov 17 - Dec 15, 2022
Outreach Activity #5	**Informational Posters:** Several styles of posters were created, with input from the Advisory Committee, to publicize the project and the various ways that the public could become involved. Approximately 15 posters were put up in Town buildings and around Town in high pedestrian traffic areas. The posters were also sent out to Town Departments, the school community via the School Superintendent, and various other individuals and groups.	Nov 22 - Dec 15, 2022
Outreach Activity #6	**Public Opinion Survey:** An integral element in hazard mitigation planning is broad public participation. Information provided by residents and stakeholders can illuminate local hazard concerns, gauge a community's awareness and preparedness for hazards, and inspire innovative solutions to reduce impacts of future hazard events. As online public opinion surveys are a highly accessible mechanism for gathering qualitative and quantitative data to inform the planning process, the Advisory Committee published an on-line survey hosted by SurveyMonkey.com.	Nov 22 - Dec 15, 2022

Event	Overview	Date
Outreach Activity #6 continued	The survey was promoted through the Town's website, two (2) newspaper articles, posts on several Facebook pages, and project posters hung in high pedestrian traffic areas in Town and sent out to the School Community and other groups. The survey was also publicized through emails sent to various groups including the 13 local government & school district groups and the 36 agencies and organizations outside of Westerly's governmental structure listed in **Appendix 2-3**. The survey was accessible from November 22 - December 15, 2022 and had a total of 204 respondents. Survey results were used by the Committee to help guide and focus mitigation planning efforts.	Nov 22 - Dec 15, 2022
Advisory Committee Meeting #2	• The Committee reviewed the status of items from the previous meeting (meeting dates, and public outreach activities). • The Committee reviewed and modified the draft Critical Facilities list. • A discussion took place on the elements included in a hazard profile which is part of the Risk Assessment. The Committee began their profile review for each of the identified hazards. • Public Comment: o Peter Ogle of Westerly - expressed that he is concerned about flooding along Canal Street; concerned over deforestation in the watershed that may impact flooding in Westerly; and indicated that there is debris from the former Stillmanville Dam which blocks the flow of the waterway. o Carl Rosen of Hopkinton – indicated that in 2010 the Rockville dam break caused most of the flood problems that Westerly experienced; and that when the Town remediates the mill, the sluiceway will be eliminated which will minimize or alleviate some of the issues with the Potter Hill Dam.	Nov 30, 2022 (9-10:30am)
Advisory Committee Meeting #3	• The Committee reviewed the status of items from the previous meeting (public outreach activities). • The Committee discussed the benefit of additional public outreach - it was determined that a newspaper article would be submitted to The Westerly Sun highlighting the Survey and the upcoming Public Information Meeting on 12/20/2022, and Gina would continue to discuss the project on WBLQ. • The TA provided a brief overview of the Hazard Ranking Form which the Committee will complete at their 12/20/22 meeting. • The Committee continued their profile review for each of the identified hazards. • The TA provided a brief overview of the Vulnerability Categories for each hazard: Built Environment, Natural Environment, Local Economy, and People. • Public Comment: o Peter Ogle of Westerly – in reference to the discussion on brush fires, indicated that he would consider the coastal grasslands and wetlands around the salt ponds to be a vulnerable area. He noted that the old growth of phragmites can become dry and therefore during drought conditions may be vulnerable to brush fires.	Dec 7, 2022 (9-10:30am)
Advisory Committee Meeting #4	• The Committee reviewed the status of items from the previous meeting (public outreach activities). • The Committee finished their profile review for each of the identified hazards. • The Committee had the opportunity to provide input on the draft vulnerability tables (Built Environment/Infrastructure, Natural Environment, Local Economy, and People). • The TA provided a brief overview of the *Critical Asset Vulnerability Analysis* and *Capability Assessment*. • The TA provided a brief overview of how the *2023 Action Plan* will be developed (mission statement, goals, review possible actions, finalize actions for inclusion). • The majority of the meeting focused on the Committee completing the *Hazard Probability, Impact, and Vulnerability Assessment* in order to prioritize the hazards potentially impacting Westerly over the upcoming five-year period. The	Dec 20, 2022 (4:45-6pm)

Event	Overview	Date
Advisory Committee Meeting #4 continued	Committee used a scoring rubric based on *Likelihood of Occurrence, Likely Range of Impact,* and *Likely Magnitude of Impact*. • The Committee voted to approve the meeting notes from the first three (3) meetings as written. • Public Comment: No one from the public spoke.	Dec 20, 2022 (4:45-6pm)
Outreach Activity #7	**Public Information Meeting**: A public informational meeting, hosted by the HM&FMP Advisory Committee, was held on December 20, 2022 to inform the public about the Plan and to promote discussion about creating a safer, more resilient community, and to solicit input for consideration and integration into the development of the Plan. The Town's Project Consultant directed a PowerPoint presentation followed by an open public discussion/Q&A period. Several members of the public engaged in discussion with the HM&FMP Advisory Committee on the hazards identified, possible mitigation actions, and the process for Plan adoption.	Dec 20, 2022 (6-7pm)
Advisory Committee Meeting #5	• The Committee reviewed the status of items from the previous meeting: the TA provided a brief overview of the Public Informational Meeting; the TA noted that the Public Opinion Survey Results was provided to the Committee for review and the Capability Assessment was updated based on Committee input; and the Committee reviewed and discussed the overall hazard ranking. • The majority of the meeting focused on developing the 2023 Action Plan (Mission Statement, Goals, Policies, and Actions). • The Committee reviewed the upcoming public outreach activities including: Press Release & Public Hearing Notice; disseminate Public Review *Draft Plan*; kiosk at the Public Library; Public Hearing; and email to stakeholder groups and organizations publicizing the *Draft Plan* and Public Hearing. • To ensure the Committee has adequate time to complete the remining items, holding an additional meeting (January 30) was discussed. • Public Comment: No one from the public spoke.	January 18, 2023 (9-10:30am)
Advisory Committee Meeting #6	• The Committee deferred approval of previous meeting notes. • The Committee reviewed the status of items from the previous meeting (public outreach activities). • The majority of the meeting focused on continued development of the 2023 Action Plan (Mission Statement, Goals, Policies, and Actions). • The Committee began discussion of the STAPLEE Analysis to prioritize the 2023 Actions. The Planning Department will draft a cost/benefit basis for the actions which will be sent to the Committee for review. The Committee will discuss and finalize the STAPLEE Analysis at their January 30, 2023 meeting. • Public Comment: No one from the public spoke.	January 25, 2023 (9-10:30am)
Advisory Committee Meeting #7	• The Committee voted to approve the #4, #5, and #6 meeting notes. • The Committee reviewed the status of items from the previous meeting (public outreach activities). • The majority of the meeting focused on discussing and finalizing the STAPLEE Analysis to prioritize the 2023 Actions. • The Committee discussed and modified some minor changes to the actions. • The Committee entertained two motions – which were both unanimously approved: o **Motion 1:** The HM&FMP Advisory Committee directs the Town's Project Consultant, Kim Jacobs, to finalize the *Public Review DRAFT* under the guidance and approval of the Committee Chair; and in conjunction with the Committee Chair, disseminate the *Public Review DRAFT*. o **Motion 2**: The HM&FMP Advisory Committee directs the Town's Project Consultant, Kim Jacobs, to assist the Committee Chair in coordinating a Public Hearing with the Town Council at the end of the public review period; and at the Public Hearing, direct a project presentation and public comment/Q&A session.	January 30, 2023 (9-10:30am)

Event	Overview	Date
Advisory Committee Meeting #7 continued	• Public Comment: o Pete Ogle commented that the Canal Street flooding hasn't been adequately addressed in the plan. The Chair thanked him for his comment and indicated that he will have the opportunity to review the Draft Plan and can provide specific feedback as to where to better incorporate that information.	January 30, 2023 (9-10:30am)
Outreach Activity #8	**Press Release for Public Review Period:** A **press release** was issued in the local newspaper, *The Westerly Sun*, informing the public that the *HM&FMP Public Review Draft* would be available for viewing and/or download through the Town's website/Planning Office. The press release explained the purpose and content of the *DRAFT* and how to provide input and feedback to the Planning Department and/or at the Public Hearing.	Feb 7, 2023 edition
Outreach Activity #9	**Disseminate Public Review Draft (Public Review Period):** The preliminary *HM&FMP-Administrative Draft* was developed and modified throughout the planning process with Advisory Committee, community, and stakeholder input and feedback incorporated into the document. At the Advisory Committee's January 30, 2023 meeting, members were satisfied with all key elements of the project and authorized the Town's Consultant to finalize the document (under the guidance and approval of the Committee Chair) and disseminate a *Public Review (PR) Draft*. The *PR Draft* was posted on the Town's Project webpage on February 7, 2023, initiating a three-week public review period which allowed the community and stakeholders ample time to read, evaluate, and provide input and feedback on the *PR Draft* prior to or at the Public Hearing. The public review period and Public Hearing were widely advertised, including a press release and Public Hearing legal notice in *The Westerly Sun,* information on the Town's website and at the library kiosk, an agenda item on the February Economic Development Commission and Planning Board meetings, a Town Council Workshop, notice of the Public Hearing posted on the Secretary of State website, Clerkbase, Town website calendar, and in the Town Hall and Police Station, and an email to the groups, agencies, and organizations listed in **Appendix 2-3**. During the Public Review Period the Town received written comments from 2 members of the public (one from a resident and one from Save The Bay), which have been addressed in the *Final Draft*.	Feb 7 - 27, 2023
Outreach Activity #10	**Kiosk at the Public Library:** A kiosk was set up at the Westerly Library to publicize that the *PR Draft* was available to the public-at-large and encourage the community to provide input and feedback either prior to or at the Public Hearing.	Feb 13-27, 2023
Outreach Activity #11	**Agenda Topic for Local Boards:** A number of local Boards and Commissions, including the Economic Development Commission (EDC) and Planning Board (PB), were included on the stakeholder list in **Appendix 2-3**. In addition, the HM&FMP was included as an agenda item for both the EDC and PB at their February meetings.	EDC - Feb 7, 2023; and PB - Feb 21, 2023
Outreach Activity #12	**Town Council Workshop:** A brief presentation of the HM&FMP was presented to the Town Council at their February 13, 2023 meeting, followed by a Q&A session. Several council members asked questions about the plan, council adoption, and submittal to RIEMA/FEMA for review and approval.	Feb 13, 2023
Outreach Activity #13	**Public Hearing Notice and Public Hearing:** At the end of the three-week *Public Review Period*, a Public Hearing was hosted by the Town Council. At the beginning of the Public Hearing, the Town's Consultant directed a Power Point presentation providing an overview of the benefits of a *HM&FMP*, the planning process, the hazards included, what is at risk, development of the *Action Plan*, and *Plan* implementation.	Feb 27, 2023 (5:30pm)

Event	Overview	Date
Outreach Activity #13 continued	As several members of the public provided opinions regarding whether Potter Hill Dam should be removed, during a pre-public hearing public comment period, the Town's Consultant indicated that the *Action Plan* provides a general action related to all five of the Town's dams (Action 2023-4.2-A: Monitor and manage dam conditions to assess need for repair, reconstruction or removal), but no determination on how to proceed with Potter Hill Dam. Whether to remove or make improvements to the Potter Hill Dam is an ongoing issue as the Town gathers and reviews technical data. After the presentation, several Town Council members asked questions which were answered by the Consultant and/or the HM&FMP Advisory Committee Chair. A public comment period was then provided for input and feedback on the *HM&FMP*. No members of the public chose to speak. **Town Council Adoption of HM&FMP:** After the public comment period, the Town Council voted unanimously to adopt the *HM&FMP*, with the acknowledgment from the Town solicitor that during the subsequent review/approval process by RIEMA/FEMA, any required revisions would be accepted by this approval. Should RIEMA/FEMA request substantial revisions be made to the *HM&FMP* to meet DMA requirements, the Town Council may choose to re-adopt the *Plan* after said revisions are made.	Feb 27, 2023 (5:30pm)
RIEMA Review & FEMA Conditional Approval	**Final Draft Plan Submitted to RIEMA/FEMA:** Under the guidance of the HM&FMP Chair, the Town's Consultant finalized the *Plan* and submitted it to RIEMA for review. It was then forwarded by RIEMA to FEMA for review/approval. The Town received FEMA approval on March 21, 2023.	March 21, 2023

2.3 PLAN INTEGRATION AND COORDINATION

Hazard mitigation planning involves identifying existing policies, tools, and actions that will reduce a community's risk and vulnerability to hazards. Coordination with other community planning efforts and organizations is therefore paramount to the success of the *Plan*.

CRS CREDIT: NFIP/CRS

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase I - Planning Process	3. Coordinate	35

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

2.3.1 Plan Integration

For the purpose of developing a comprehensive and community-centric *HM&FMP*, numerous local plans, policies, codes, and programs that guide development in Westerly were consulted in order to complement and build on past planning initiatives. As demonstrated in **Appendix 5-1**, a detailed review of Westerly's existing studies, reports, and technical documents was undertaken to ensure that the community's needs, goals, and actions prioritized in those documents were recognized and incorporated, wherein appropriate, into the *HM&FMP*. This is specifically evidenced in **Appendix 6-1**, where actions and initiatives from many of these planning initiatives were compiled and subsequently reviewed by the HM&FMP Advisory Committee for possible inclusion in the *2023-2028 Action Plan*.

The planning documents and measures included in **Appendix 5-1 and 5-2**, supplemented by the knowledge and experiences of the HM&FMP Advisory Committee members, community, and other engaged stakeholders have successfully created a community-based hazard mitigation strategy.

A ***Bibliography & Works Cited*** section has been provided to recognize and pay tribute to the broad array of resources that were used in the development of this *Plan*. In addition to Westerly's key planning documents, special recognition is made to the numerous FEMA, NOAA, RIEMA, URI-Coastal Resources Center, and RI Statewide Planning resources relied upon for the development of this Plan. The *2023 HM&FMP* adheres to the guidelines outlined in the Disaster Mitigation Act of 2000; FEMA's *Local Mitigation Plan Review Guide (October 2011), Local Mitigation Planning Handbook (March 2013)*, and *CRS Coordinators Manual (2017)*.

A brief overview of several of the key planning programs and documents integrated into the *HM&FMP* follows.

2.3.1.1 Community Rating System (CRS)
2.3.1.2 2018 Hazard Mitigation Plan (HMP)
2.3.1.3 2019 MRP CRB Workshop Summary of Findings (SOF)
2.2.1.4 2020-2040 Comprehensive Community Plan (CCP)

2.3.1.1 Community Rating System (CRS)

The Community Rating System (CRS) is a voluntary incentive program designed to encourage communities to engage in various community focused activities that promote a comprehensive approach to floodplain management beyond the minimum National Flood Insurance Program (NFIP) requirements. The Town entered into the CRS Program on May 1, 2013 and currently has a CRS Class 7 rating.

As an active participant in FEMA's CRS Program, it was determined that this *Plan* should be created using the planning process outlined in CRS Activity 510. This process allows the Town to maximize CRS credit for this *Plan* while meeting the *Disaster Mitigation Act (DMA) 2000* Hazard Mitigation Plan requirements. A CRS activity credit checklist has been included in **Appendix 2-1**. It lists the 10 planning steps associated with CRS Activity 510 (Floodplain Management Planning) and references the section within this document that describes the completion of the step and the corresponding anticipated credit.

CRS uses a Class Rating System to determine flood insurance premium reductions for residents. CRS Classes are rated from 10 (lowest rating) to 1 (highest rating). **Table 2-5** shows the CRS credit points required for each Class and the corresponding premium reductions provided to those purchasing flood insurance through the National Flood Insurance Program (NFIP). As a community engages in additional mitigation activities, its residents become eligible for increased premium discounts (FEMA. *Community*).

Table 2-5 CRS Credit Points, Classes and Premium Discounts (FEMA. *Community*)

Credit Points	Class	Premium Reduction SFHA	Premium Reduction Non-SFHA
0 – 499	10	0	0
500 – 999	9	5%	5%
1,000 – 1,499	8	10%	5%
1,500 – 1,999	7	15%	5%
2,000 – 2,499	6	20%	10%
2,500 – 2,999	5	25%	10%
3,000 – 3,499	4	30%	10%
3,500 – 3,999	3	35%	10%
4,000 – 4,499	2	40%	10%
4,500+	1	45%	10%

Note: Premium reductions are subject to change.

Westerly currently has a Class 7 Rating

2.3.1.2 2018 Hazard Mitigation Plan (HMP)

Westerly adopted its local Hazard Mitigation Plan update in February 2018 to help better organize the future allocation of the Town's finite resources, determine what actions are feasible and appropriate to address local vulnerabilities, and to enhance community resiliency (Town of Westerly RI. *Comprehensive*, 251).

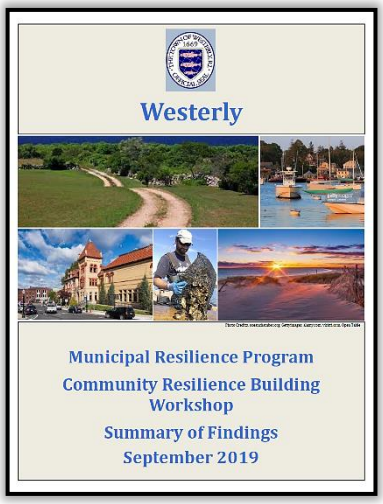
This *Plan* serves as the 5-year update to the Town's 2018 Hazard Mitigation Plan (HMP). As the Town is a CRS participating community, and because flooding is a prevalent natural hazard facing the Town, it was determined beneficial to expand the scope of the HMP update to include additional focus on floodplain management. As such, the document has been renamed the *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan (HM&FMP)*. The *HM&FMP* has been guided by the planning process outlined in CRS Activity 510 and meets the Disaster Mitigation Act (DMA) 2000 Hazard Mitigation Plan requirements.

In developing this *Plan*, portions of the 2018 HMP were restructured, eliminated, or revised. New sections were added in order to reflect the most current understanding of natural hazards that pose significant threats to Westerly and how the Town has and can effectively continue to mitigate these threats. New actions or modifications to the 2018 actions were primarily the result of an extensive plan integration process (incorporating actions from the CCP, SOF, and other plans) combined with HM&FMP Advisory Committee, community, and stakeholder input.

2.2.1.3 2019 MRP CRB Workshop Summary of Findings (SOF)

In July 2018 Governor Raimondo introduced the Resilient Rhody: Municipal Resilience Program (MRP), which outlined a comprehensive Climate Resilience Action Strategy for the State. Through the MRP program, the State is providing support to communities to engage in a municipal-driven process referred to as Community Resilience Building (CRB), which was developed by The Nature Conservancy (TNC). The Nature Conservancy has honed their highly successful CRB program for over a decade in an effort to respond to the need for communities and other organizations and enterprises to build resilience and adapt to the extreme weather and hazards resulting from climate change (TNC, 2).

In March 2019, the Town of Westerly submitted an application to participate in the Municipal Resilience Program and was selected as a first round recipient to complete the CRB process, be designated as Resilient Rhody Municipality, and serve as a model for other communities throughout the region.



In August 2019 the Town held a Community Resilience Building Workshop led by the Rhode Island Infrastructure Bank (RIIB) in partnership with The Nature Conservancy (TNC). The Workshop brought together more than 50 community stakeholders and engaged professionals, in an effort to identify and prioritize steps to reduce natural hazard risks and improve resilience within the Town and region.

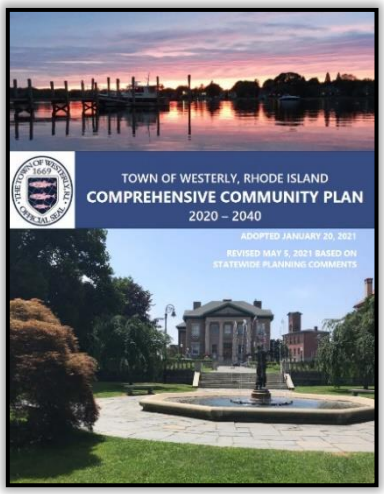
The Workshop Objectives included:

- Defining top local natural- and climate-related hazards of concern;
- Identifying existing and future vulnerabilities and strengths;
- Developing prioritized actions for the Town of Westerly; and
- Identifying opportunities to collaboratively advance actions to increase resilience (TNC and RIIB, 2).

The Town of Westerly appreciated the opportunity afforded to them by the Rhode Island Infrastructure Bank and The Nature Conservancy to engage in a CRB Workshop. The Workshop successfully helped to advance comprehensive community resilience planning and hazard mitigation efforts, and informed the resiliency policies in the Comprehensive Community Plan. An overview of the discussion and outcome from the Workshop was documented in the *Summary of Findings* Report; an important resource for the Town which has been integrated into the development of this *Plan*. A link to the report is available on the Town's website and activities from this report that were reviewed for possible inclusion in the *2023 Action Plan* are listed in **Appendix 6-1**.

2.3.1.4 2020-2040 Comprehensive Community Plan (CCP)

The planning efforts associated with the *HM&FMP* have been coordinated with the Town's Comprehensive Community Plan (CCP). Westerly's Planning Department in conjunction with the Planning Board led the effort to develop the 2020 Comprehensive Community Plan. The CCP includes a *Natural Hazards and Resiliency* element which describes critical issues, planning opportunities, and sets of goals, policies, and actions related to natural hazards, including the threat of sea level rise. To ensure alignment between the documents, the Natural Hazard and other applicable elements in the CCP were reviewed in developing this *HM&FMP*.



2.3.2 Coordination with Agencies and Organizations

The HM&FMP Advisory Committee recognized that the planning process would be greatly enhanced by inviting local, regional, state, and federal agencies and organizations to participate in the process. Coordination with these key groups was initiated at the beginning of the planning process through an email informing them of the development of the *Plan* and welcoming them to provide information or opinions, and participate in meetings, the public opinion survey, and other outreach activities.

As information from some of these groups was used in the development of the *Plan*, it was important to the Town that they were provided an opportunity for pre-adoption review of the *HM&FMP*. In a subsequent emails sent to these groups by the Town's Project Consultant, a link to the *Public Review Draft* and notification of the Public Hearing was provided.

As shown in **Appendix 2-3**, the Town coordinated with 13 local government boards & commissions, including the school committee, as well as 37 agencies and organizations outside of Westerly's governmental structure. This group included representatives from business associations, conservation organizations, the local library and hospital, neighboring municipalities, state representatives, and numerous state offices and other organizations with expertise related to hazard mitigation planning.

Two key business associations, representing hundreds of local businesses, were included in the stakeholder outreach list and had member representation on the HM&FMP Advisory Committee. The Ocean Community Chamber of Commerce has roots going back to 1708, and represents 900 member businesses, and the Misquamicut Business Association, which recently celebrated 20 years, is 175 members strong.

SECTION 3

Community Profile

Subsections

KMJ – CE/RP

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3 Community Profile

A brief community profile has been included in this Section which is augmented by community asset information in **Section 4** and the community capability assessment in **Section 5**. The planning area addressed in this Plan includes all lands within the geographical boundaries of the Town of Westerly.

3.1 WELCOME TO WESTERLY

Westerly, located in Washington County, Rhode Island, is a quaint New England town, and has been a favorite seaside vacation spot for over a century. Prior to the establishment of an English outpost in 1637, the area, originally known as Mishquamicuk, was home to the Mohegan, Narragansett, and Pequot tribes. Mishquamicuk (anglicized as Misquamicut), or "land of red fish," is in reference to the Atlantic salmon, which were once prevalent in the surrounding waters, and appears on the Town's seal, as does the year 1669, which is when Westerly was formally established (Advisory Council, Town of Westerly RI. *Comprehensive*, 16).

The character of Westerly has been shaped by the Town's extensive shoreline, the Pawcatuck River, and its agricultural and industrial heritage. "Diversification of the population began in the seventeenth century with English colonization. Immigrant families who came to work in the Town's mills and quarries during its industrial boom in the later nineteenth and early twentieth century further diversified the population. Many families who vacationed and summered along the shoreline also came to permanently take residence in the Town" (Town of Westerly RI. *Comprehensive*, 16).

Figure 3-1 Wuskenau Town Beach

Photo Credit: SeeWesterly.com

Westerly is comprised of twenty-nine (29) distinct neighborhoods, each with its individual character and history (Town of Westerly RI. *Comprehensive*, 18). Seven (7) areas of Town have been listed as Historic Districts on the National Register of Historic Places: Bradford Village, Downtown Westerly, Main Street, the North End, Perry Homestead, Watch Hill, and Wilcox Park. Within each historic district are structures and sites that contribute to the area's historic character. There are nine (9) additional properties in Town that have been individually listed on the National Register of Historic Places (NRHP). These include the Babcock-Smith House, Flying Horse Carousel, George Kent Performance Hall of the Chorus of Westerly, Lewis-Card-Perry House, Nursery Site RI-273, Ram Point, US Post Office (Broad and High Streets), Westerly Armory, and Weekapaug Inn (Town of Westerly RI. *Comprehensive*, 143 & 144).

Figure 3-3
Westerly Armory
Photo Credit: Tripadvisor

In 2002 Westerly was recognized as one of America's *Dozen Distinctive Destinations* by the National Trust for Historic Preservation. "The 12 winning communities met these criteria: well-managed growth, a commitment to historic preservation with a protected historic core and meaningful context, interesting and attractive architecture, cultural diversity, activities for families with children, an economic base of locally-owned small businesses, and walkability for residents and visitors. In each community, residents have taken forceful, concrete actions to protect their town's character and sense of place" (Steins).

The Historic Preservation Advisory Council praised Westerly's well-preserved 19th and 20th century commercial center; the industrial villages of Bradford, Potter Hill, and White Rock along the Pawcatuck River, which still reflect their 19th century origins; the maritime community of Avondale; and Watch Hill, home of the oldest operating carousel in the United States (Advisory Council).

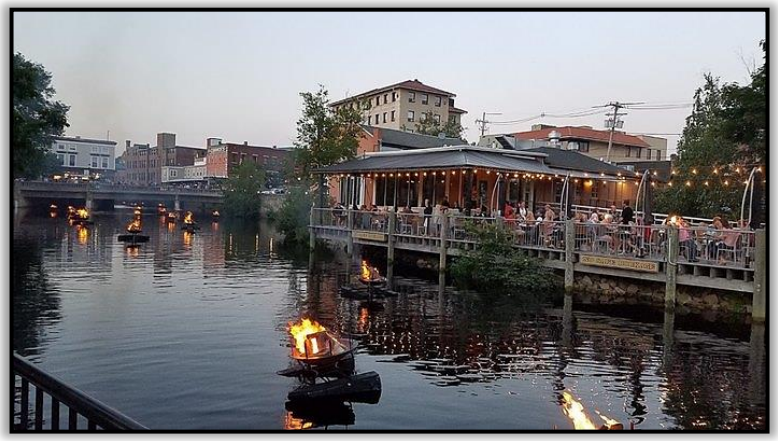

Figure 3-4 Pawcatuck River in Historic Downtown Westerly
Photo Credit: Natalie Clunan

While the Town's inland and coastal water features are integral to the character of Westerly, and embraced by residents and visitors, the adjacent low-lying lands are vulnerable to flooding, coastal erosion, sea level rise, and wind damage from hurricanes. While risks from these hazards are not new, the intensity and frequency of occurrence due to climate change, exacerbates the concern. It also focuses the need to evaluate development in areas with higher risks to natural hazards. The key is "to balance potentially competing needs through careful planning for new residential and commercial development and redevelopment of underutilized areas while providing for public health and safety, environmental resiliency, and community well-being into the future" (Town of Westerly RI. *Comprehensive*, 15).

3.2 GOVERNMENT

The State of Rhode Island has 39 municipalities which are grouped into 5 counties. The Town of Westerly is part of Washington County along with Block Island/New Shoreham, Charlestown, Exeter, Hopkinton, Narragansett, North Kingstown , Richmond, and South Kingstown. While neighboring communities work cooperatively with one another, Rhode Island counties do not have governmental structure. Instead, local governance is provided by each of the eight cities and thirty-one towns.

3.2.1 Municipal Government

The Town of Westerly operates under a charter form of government, which provides for a seven-member Town Council that is elected at-large at the regular biennial elections. In November 2022, a Town referendum passed modifying the Town Council term limits. Starting with the November 2024 elections, the four candidates with the most votes will serve four-year terms, and the following three vote getters will serve two-year terms. Beginning in 2026, at the regular biennial elections Council members will be elected for staggering four-year terms.

The Town Council is responsible for enacting local legislation; making decisions related to the Town's property, affairs, and government; setting the budget for both the municipal side and the school side; and appointing a Town Manager who functions as the Town's Chief Administrative Officer. The Town Manager is responsible for carrying out the policies of the Town Council, appointing all other employees (except for School Department personnel), and overseeing the day-to-day operation of Town Departments and services.

The Town provides a full range of municipal services including economic and development services; high-quality education; maintenance of highways, streets and other infrastructure; public safety protection; recreational activities; waste disposal services; water and sewer utilities; and other administrative services. Town employees, across all departments, work hard to meet the needs of the citizens and to maintain a quality of life that residents have come to expect. An overview of the key Departments engaged in hazard mitigation is provided in **Appendix 5-2** (Town Administration and Departments).

There is an abiding pride in Westerly and its heritage, evident through participation on Westerly's numerous boards and commissions. A list of Town Boards and Commissions is provided below. Notification of board meetings are posted on the Town website's calendar.

Town Boards and Commissions

- ◊ Architectural Review Board
- ◊ Assessment Review, Board of
- ◊ Bike Path and Cycling Advisory Commission
- ◊ Building Code Board of Appeal
- ◊ Canvassers, Board of
- ◊ Concerts On The Beach
- ◊ Conservation Commission
- ◊ Economic Development Commission
- ◊ Finance, Board of
- ◊ Housing Authority
- ◊ Juvenile Hearing Board
- ◊ Licensing Board
- ◊ Multicultural Committee
- ◊ Municipal Land Trust
- ◊ Neighbor Day Committee
- ◊ Planning Board
- ◊ Public Parking Commission
- ◊ Public Works Committee
- ◊ Recreation, Board of
- ◊ Review Min. Standards Non-Residential, Board of
- ◊ School Committee
- ◊ Town Council
- ◊ Veterans Memorial Committee
- ◊ Zoning Board

3.2.2 School Department

The stated mission of Westerly Public Schools is "to create an inspiring, challenging, and supportive environment where students are encouraged and assisted in reaching their highest potential." The enrollment at the beginning of the 2021 school year was 2,433 students (Town of Westerly RI. *FY2020-21, iv)*.

The Westerly School Committee determines and controls all policies affecting the administration, maintenance, and operation of the public schools in Town, which consist of three elementary schools, one middle school, and one high school. The Committee appoints a Superintendent as its chief administrative agent, submits a detailed budget of expenditures and revenue to the Town Council, and determines the allocation of the amount appropriated. The School Committee is comprised of seven members of the community who are elected at-large for staggered four-year terms at the regular biennial elections, and a non-voting Student Representative, who reflects the opinions and concerns of students.

Figure 3-5 Westerly High School (Photo Credit: Mary Adams)

3.2.3 Budget

The annual Town budget runs from July 1st to June 30th, and serves as the foundation for financial planning and control. The Town Manager develops a proposed budget, building off department requests for appropriation and revenue estimates. In March, the proposed budget is submitted to the Board of Finance who holds several budget work sessions with the Town Manager to discuss the proposed budget and make recommended edits. After the Board of Finance recommended budget is provided to the Town Council, the Town Manager and Town Council hold several budget work sessions to revise and, eventually, adopt a preliminary budget. Within eight days following Town Council adoption of the preliminary budget, any qualified elector of the Town may circulate and file a petition contesting any of the proposed budget items. If no petition is filed, the budget is considered adopted. If there is a petition, a referendum must be held within 32 days after the Board of Canvassers validates the petition signatures (Town of Westerly RI. *FY2020-21, iii)*.

Maintaining a resilient local economy is important to enable providing high quality municipal services, including protecting against natural hazard risks. According to the Town's Certified Budget, for the fiscal year FY2021-22, the municipal operating budget was $37,934,672 and the School District budget was $57,137,967. As part of the budget process, each year the Town adopts a five-year Capital Improvement Program identifying projects that should be undertaken during the upcoming five years. This long-range planning process is essential in addressing the future development and growth of the Town. The Town has continually funded its capital requirements aggressively and, to limit borrowing requests, maintains a pay as you go funding for most of its capital needs (Town of Westerly RI. *Certified,* 4).

3.3 GEOGRAPHY

Westerly is a coastal community located in the southwest corner of Rhode Island approximately 40 miles from Providence, RI, 60 miles from Hartford, CT, 90 miles from Boston, MA. The Town is bordered by the Pawcatuck River to the north and west, and the Atlantic Ocean to the south. Adjacent communities include the Town of Charlestown, RI to the east, the Towns of Hopkinton, RI and North Stonington, CT to the north, and the Town of Stonington, CT to the west.

The Town covers approximately 31.0 square miles (19,827 acres), with water accounting for roughly 5.7 square miles (3,648 acres) (Town of Westerly RI. *Comprehensive*, 32 & 33). Westerly is home to two primary sub-watersheds or sub-basins. The ridges along the elevated plateau of the Charlestown Moraine divide the two watersheds. Water falling north of the moraine drains into the Wood-Pawcatuck Basin, and water falling to the south drains into the Coastal Salt Pond Basin (Town of Westerly RI. *Comprehensive*, 107).

The Salt Ponds and the stretch of the Pawcatuck River from the Pawcatuck Bridge to the mouth of the river at Rhodes Point are tidally influenced. The Atlantic Ocean along Westerly's south shore (9± miles) is referred to as Block Island Sound, and that section of coastal water on the inland side between Napatree Point in Westerly and Stonington Point in Connecticut, is referred to as Little Narragansett Bay.

In addition to the Pawcatuck River, there are a number of small streams in Westerly include Aguntaug Brook, Mastuxet Brook, McGowen Brook, Spring Brook, and Perry Healy Brook. The Town's largest freshwater pond, Chapman Pond (180±acres), lies approximately 30 feet above sea level in the north central section of Westerly. Other smaller named freshwater ponds include Dr. Lewis Pond, Long Pond, Mickill Pond, No Bottom Pond, and Spring Pond (Town of Westerly RI. *Comprehensive*, 107 & 108).

Figure 3-6 Watch Hill (Photo Credit: The Watch Hill Conservancy)

3.4 POPULATION AND DEMOGRAPHICS

In 2021, the Town's median household income was $81,051. "Not reflected in the Census average income statistics is the above average income of the more than 17,000 summer inhabitants of the Town and an additional 25,000 summer day-trippers who contribute to the Town's economy" (Town of Westerly RI. *FY2020-21*, ii).

According to the US Census Bureau, Westerly had a population of 22,787 in 2010 and 23,359 in 2020, which represents a growth of 2.5% (572 people) (US Census Bureau. *ACS DEC*). The American Community Survey (ACS) five-year estimates (2017-2021) indicates that the population of Westerly is nearly equal between females (49.6%) and males (50.4%), with 14.2% age 17 or younger, and 41.1% age 55 or older. In terms of race, Westerly's residents were identified as 91.4% White (3.4% is considered Hispanic or Latino), 2.4% Asian, 0.9% Black or African American, 0.1% American Indian or Alaska Native, 2.3% two or more races, and 2.9% some other race (US Census Bureau. *2021 ACS Demographic*).

Approximately 70.0% of the 13,600 housing structures in Town are single family dwellings. The remainder are a mix of 2 units (11.7%), 3 or 4 units (5.9%), and anywhere from 5 to 50 or more units (13.0%). The Town also has a small contingent of mobile homes (0.3%) Most (70.5%) of Westerly's 10,507 occupied housing units are owner occupied (7,407 units), with 29.5% or 3,100 occupied by renters (US Census Bureau. *2021 ACS Housing*). "In 2000, Westerly had a housing stock that was relatively newer than the State but older than that of Washington County and most other comparable communities. The median year for homes built in the Town was 1965, compared to 1958 in the State and 1971 within Washington County" (Town of Westerly RI. *Comprehensive*, 157). "A review of available town data for Residential Housing Types by Year and Structure Type indicates the overwhelming majority of two-family and multi-family structures were built prior to 1940, with 55.8% and 86.3% falling into this category, respectively" (Town of Westerly RI. *Comprehensive*, 157).

In 2021, the Town had a total of 13,600 housing units (US Census Bureau. *2021 ACS Housing*). The data identifies 3,093 as vacant, of which 2,169 (70%) were seasonal. These seasonal housing units alone made-up 15.9% of the total 13,600 housing units within the Town. It is important to note that most of these units are characterized by the U.S. Census Bureau as vacant because they are only occupied by owners for specific time periods (such as summer) and/or for specific events (such as weekends and holidays). Vacant in the traditional sense of a year-round absence of any occupants, regardless of season or occasion, totaled 443 housing units within the Town (US Census Bureau. *2021 ACS Vacant*).

Using Westerly's 2021 average household size of 2.20 people (US Census Bureau. *2021 ACS Households*), and assuming all 2021 seasonal housing units are occupied, Westerly can be estimated to experience a population increase of 4,772 people each summer associated with seasonal housing units. Much of the seasonal population increase is associated with Census Tract, encompassing Watch Hill, Misquamicut, and Weekapaug. The summer population also increases from residents welcoming friends and family to visit the shoreline resort community, and other short-term rental units at hotels and other places of accommodation.

SECTION 4

Risk Assessment

Subsections

KMJ – CE/RP
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4 Risk Assessment

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirement ➔
44 CFR Subsection D §201.6(c)(2): [The plan shall include] A risk assessment that provides the factual basis for activities proposed in the strategy to reduce losses from identified hazards. Local risk assessments must provide sufficient information to enable the jurisdiction to identify and prioritize appropriate mitigation actions to reduce losses from identified hazards.

CRS - Flood Management Plan: The Town of Westerly has successfully met the following Mitigation Strategy requirements based on the 10-step planning process for CRS Activity 510 ➔
Assess the Hazard (Step 4); and Assess the Problem (Step 5)

This *Risk Assessment* evaluates the potential impacts of hazards to the people, economy, and built and natural environments of Westerly, creating a basis for the Mitigation Strategy. As described in FEMA's Local Hazard Mitigation Planning Handbook and illustrated in **Figure 4-1**, the degree of risk can be measured by the overlap between hazards and community assets; the larger the overlap the greater the risk.

This Risk Assessment presented in this Section is organized as follows, with the goal of identifying this overlap:

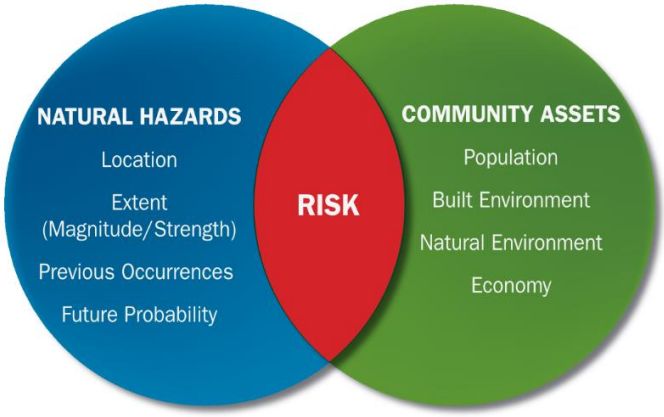
4.1 Climate Change - Sea Level Rise:
Recognizes how climate change and sea level rise may exacerbate natural hazards

4.2 Hazard Identification:
Identifies the hazards with the highest likelihood of negatively impacting Westerly

4.3 Hazard Profiles:
Describes the potential threat of each identified hazard and provides an overview of previous occurrences and the likelihood of future occurrences

4.4 Vulnerability Analysis:
Identifies community assets and analyzes the potential impact the identified hazards might have on them

Figure 4-1 Degree of Risk—Risk Assessment



FEMA Local Hazard Mitigation Planning Handbook, March 2013, Page 5-1

During the Risk Assessment process, natural hazards were identified, profiled, and analyzed using best practices. In support of this process, data and documentation from numerous sources including the following were reviewed: Town of Westerly's 2018 Hazard Mitigation Plan, 2020-2040 Comprehensive Community Plan, and 2019 CRB Workshop Summary of Findings; 2019 Rhode Island State Hazard Mitigation Plan (RI-SHMP); hazard mitigation plans from adjacent and similar communities; information from FEMA, EPA, NASA, CDC, RIEMA, RIDSP, RIDEM, RIDOH, CRMC, URI-Coastal Institute, URI-Climate Change Collaborative, and IPPC; information from the National Oceanic and Atmospheric Administration (NOAA) including the National Climatic Data Center (NCDC) and the National Weather Service (NWS); and other relevant articles, documents, and websites on natural hazards. A complete list of the plan integration and references used in developing Westerly's *HM&FMP* is provided in **Appendix 5-1** and the **Bibliography and Works Cited**.

4.1 CLIMATE CHANGE – SEA LEVEL RISE

For the foreseeable future, climate change will have a significant impact locally, nationally, and globally. In this *Hazard Mitigation & Flood Management Plan (HM&FMP)*, climate change is recognized as a present threat and an ongoing amplifier to the identified natural hazards. As such, each hazard profile in **Section 4-3** addresses associated climate change impacts. That information will assist the Advisory Committee in determining an action strategy that will help to reduce or mitigate existing and future impacts.

This Section will provide a general overview of climate change including sea level rise (SLR) projections.

4.1.1 Climate Change

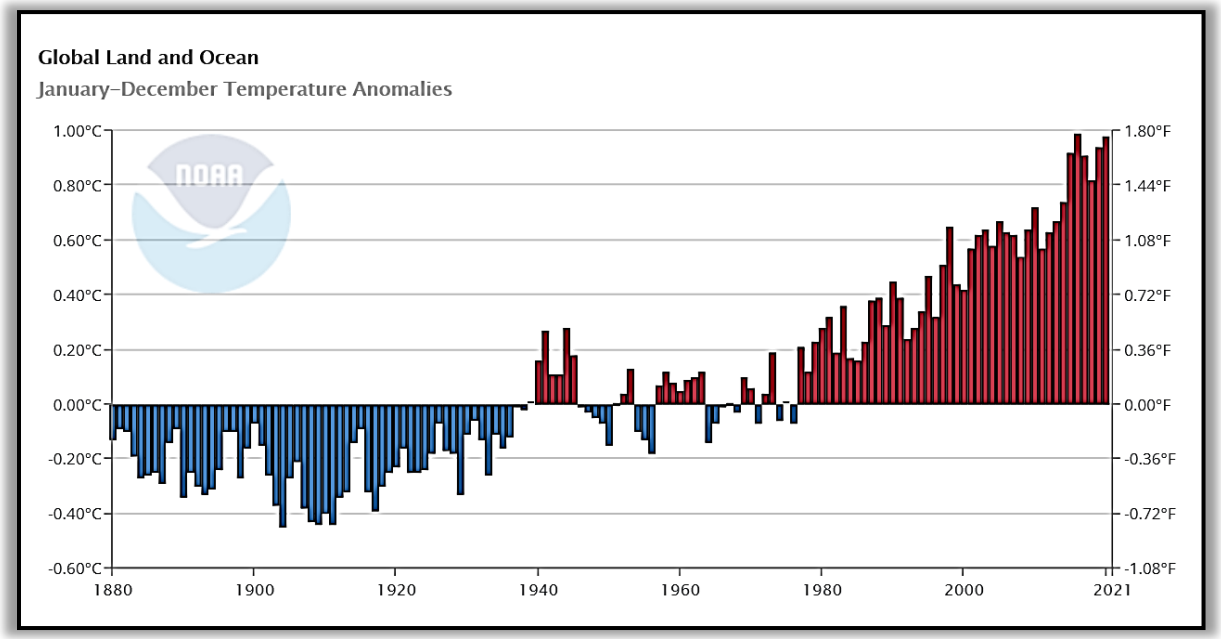
What is meant by Climate Change?

As pointed out by National Geographic, "Climate is sometimes mistaken for weather. But climate is different from weather because it is measured over a long period of time, whereas weather can change from day to day, or from year to year. The climate of an area includes seasonal temperature and rainfall averages, and wind patterns. Different places have different climates… Climate change is the long-term alteration of temperature and typical weather patterns in a place" (National Geographic. *Climate*).

Over geologic time, the earth has warmed and cooled periodically. This slow-paced change in climate may be attributed to natural internal processes or external forces such as modulations of the solar cycles, volcanic eruptions, or persistent anthropogenic changes in the composition of the atmosphere or land use (IPCC. *Annex I*).

In contrast, over the past century the rapid warming of the earth is cause for concern (**Figure 4-2**). Across every region of the Earth's climate system, scientists are observing changes. According to the 2021 Intergovernmental Panel on Climate Change (IPCC) Report, "Many of the changes observed in the climate are unprecedented in thousands, if not hundreds of thousands of years, and some of the changes already set in motion—such as continued sea level rise—are irreversible over hundreds to thousands of years" (IPCC. *Climate Change widespread*).

Figure 4-2 Global Temperatures are Rising (NOAA|NCEI)



Data gathered by NASA and NOAA indicate that the planet's average surface temperature has risen about 2.0 degrees Fahrenheit since the late 19th century, with **most of the warming happening over the past four decades**. NASA Goddard Institute for Space Studies (GISS) Director, Gavin Schmidt, stated that, "Despite colder than average temperatures in any one part of the world, temperatures over the planet as a whole continue the rapid warming trend we've seen over the last 40 years" (NASA|NOAA. *Long-term warming*).

The rapid warming of the earth has been largely driven by the accumulation of human-caused pollutants in the atmosphere. These pollutants, known as greenhouse gases, include carbon dioxide, methane, nitrous oxide, water vapor, and synthetic fluorinated gases. Normally the sunlight and solar radiation that bounces off the earth's surface would escape into space, but the accumulation of these pollutants, which can last for years to centuries in the atmosphere, trap the heat inside the earth's atmosphere and cause the planet to get hotter. The impact of these heat-trapping pollutants in the atmosphere, creating global warming and influencing rapid climate change, is called the greenhouse effect (NRDC. *Global Warming*).

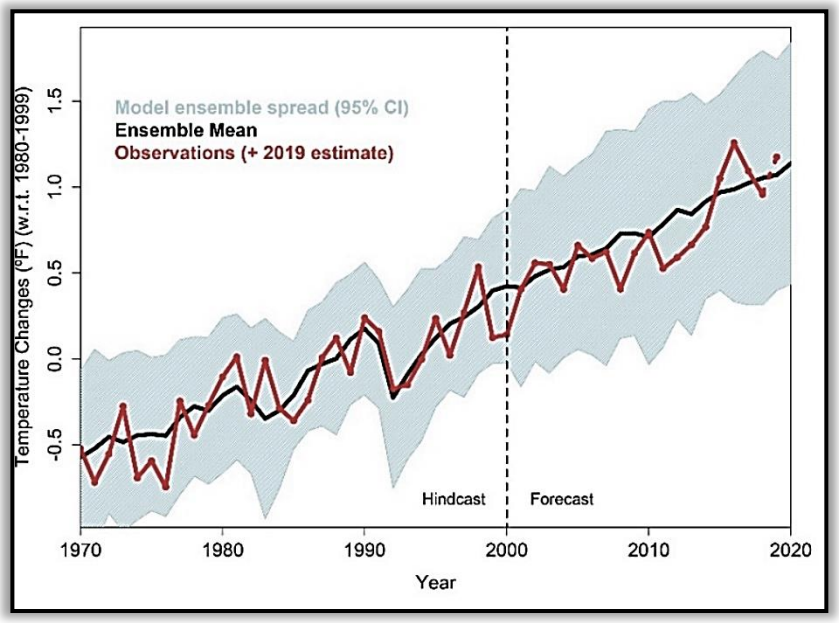
How is Climate Change predicted?

Scientists use climate models, which are complex mathematical computer simulations, to recreate the Earth's past and current climate or predict future climate trends. The foundation of the models requires an accurate representation of the Earth's atmosphere, sun, oceans, ice, and land surface. By solving the relevant mathematical equations, climate models can calculate properties such as atmospheric temperature, pressure, wind, and humidity. Because global warming has widespread effects, global temperature trends are among the most significant predictions.

As climate models are based on physics and the best understanding of the Earth's system, and are verified against real world observations, scientists are confident that climate models accurately represent our climate system. To this point, the University of California, Berkely, conducted a systematic evaluation of the performance of 17 climate models from 1970 to 2007 to determine how reliable they have been. The study looked at how accurately the models predicted temperature changes. The results, depicted in **Figure 4-3**, show that most of the past climate model projections closely matched observations. As public confidence in climate projections is critical, a recognition that even the less sophisticated climate models of 15 plus years ago produced reasonably accurate future temperature trends, should bolster public confidence in climate change predictions (Buis, Alan. *Study Confirms*).

Figure 4-3 Forecast Evaluation for Models Run in 2004 (Buis, Alan. *Study Confirms*)

Models that were used in the IPCC 4th Assessment Report can be evaluated by comparing their approximately 20-year predictions with what actually happened. In this figure, the multi-model ensemble and the average of all the models are plotted alongside the NASA Goddard Institute for Space Studies (GISS) Surface Temperature Index (GISTEMP). Climate drivers were known for the 'hindcast' period (before 2000) and forecast for the period beyond. The temperatures are plotted with respect to a 1980-1999 baseline. (Credit: Gavin Schmidt)



What are some global impacts of Climate Change?

The impacts of a rapidly changing climate are already present. No longer viewed as a future possibility, the effects of climate change, including sea level rise (SLR), are scientifically recognized as exacerbating the impact of other natural hazards.

According to the 2021 IPCC Report, climate change "is not just about temperature. Climate change is bringing multiple different changes in different regions – which will all increase with further warming. These include changes to wetness and dryness, to winds, snow and ice, coastal areas and oceans.

For example:

- Climate change is intensifying the water cycle. This brings more intense rainfall and associated flooding, as well as more intense drought in many regions.
- Climate change is affecting rainfall patterns. In high latitudes, precipitation is likely to increase, while it is projected to decrease over large parts of the subtropics. Changes to monsoon precipitation are expected, which will vary by region.
- Coastal areas will see continued sea level rise throughout the 21st century, contributing to more frequent and severe coastal flooding in low-lying areas and coastal erosion. Extreme sea level events that previously occurred once in 100 years could happen every year by the end of this century.
- Further warming will amplify permafrost thawing, and the loss of seasonal snow cover, melting of glaciers and ice sheets, and loss of summer Arctic Sea ice.
- Changes to the ocean, including warming, more frequent marine heatwaves, ocean acidification, and reduced oxygen levels have been clearly linked to human influence. These changes affect both ocean ecosystems and the people that rely on them, and they will continue throughout at least the rest of this century.
- For cities, some aspects of climate change may be amplified, including heat (since urban areas are usually warmer than their surroundings), flooding from heavy precipitation events and sea level rise in coastal cities" (IPCC. *Climate Change widespread*).

Science is still discovering the breadth and scope of climate change impacts. As recognized by NOAA, it is a complex issue wherein, "The impacts of climate change on different sectors of society are interrelated. Drought can harm food production and human health. Flooding can lead to disease spread and damages to ecosystems and infrastructure. Human health issues can increase mortality, impact food availability, and limit worker productivity… [Further] long-standing socioeconomic inequities can make underserved groups, who often have the highest exposure to hazards and the fewest resources to respond, more vulnerable" (NOAA. *Climate change impacts*).

Intergovernmental Panel on Climate Change (IPCC)

The Intergovernmental Panel on Climate Change (IPCC) is an intergovernmental body of the United Nations responsible for advancing knowledge on human-induced climate change. It was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP), and later endorsed by the United Nations General Assembly. The IPCC is comprised of 195 member states; headquartered in Geneva Switzerland; and has issued 6 Climate Change Assessment Reports.

First Assessment Report (1990)

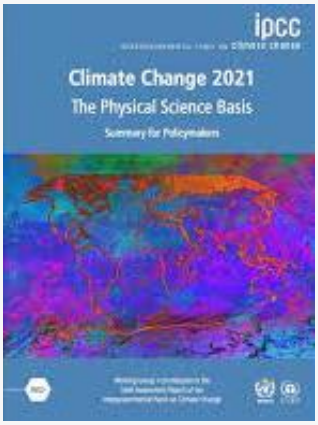
Second Assessment Report (1995)

Third Assessment Report (2001)

Fourth Assessment Report (2007)

Fifth Assessment Report (2014)

Sixth Assessment Report (2021)



Wikipedia. *Intergovernmental*

What are some local impacts of Climate Change?

According to an article by the URI Climate Change Collaborative, "In New England, temperatures are expected to increase by a few degrees by the end of the century. While summers may be 3°F to 7°F warmer, winters will likely be 5°F to 8°F warmer. Likewise, we will continue to see a shift in the seasons. Summer weather potentially will persist longer and with more days over 100°F. Winters will be warmer with more rain and less snow. Wet days will be wetter but droughts will be more frequent. The average annual temperature of Narragansett Bay has warmed approximately 3.6°F (with winters even greater) since the 1960s, and the Bay is expected to continue warming throughout the century. Rates of sea level rise have been increasing as well" (URI Climate Change Collaborative. *Climate*).

According to CRMC, potential effects of climate change and sea level rise include increased vulnerability to storm surges, risk to infrastructure, higher water tables, more extreme high tides, worsening coastal erosion and net loss of coastal marshes.

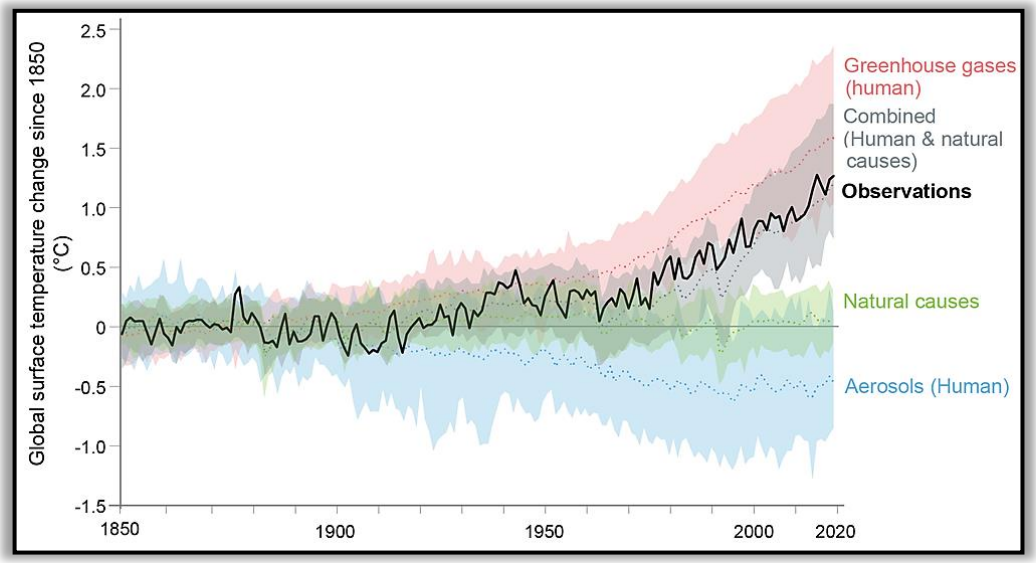
In general, Rhode Island communities may experience the following climate change impacts:

- Warmer air and water temperatures; shorter winters and longer summers
- More extreme weather events including intense precipitation causing increased extent of flood damage to property and infrastructure and greater vulnerability to storm surges in lower elevations
- Higher water tables resulting in subsurface issues such as wet basements
- A significant increase in incidence of extreme high tide levels
- Saltwater intrusion into aquifers contaminating water supplies
- More coastal lands becoming susceptible to erosion due to increased intensity and frequency of storms
- A net loss of coastal marshes that become inundated at a greater rate, resulting in a loss of salt marsh vegetation and an alteration of habitat types

What can be done to slow Climate Change?

As stated on NASA's Global Climate Change website, "A consensus on climate change and its human cause exists... Multiple studies published in peer-reviewed scientific journals show that **97 percent or more** of actively publishing climate scientists agree: Climate-warming trends over the past century are extremely likely due to human activities. In addition, most of the leading scientific organizations worldwide have issued public statements endorsing this position" (NASA. *Scientific Consensus*).

Figure 4-4 How do we know humans are causing climate change? (IPCC)



As depicted in **Figure 4-4**, from IPCC's Sixth Assessment Report, rapid climate change is primarily caused by humans producing large amounts of greenhouse gas emissions (Kopp, Robert).

Scientists around the world are engaged in climate change because it is a global problem. Studies by the Union of Concerned Scientists show that, "Cumulative carbon dioxide emissions are the dominant driver of climate change. These began rising during the Industrial Revolution (especially after 1850)—which means richer countries like the United States, which made an early transition to a heavily fossil fuel-based economic system, have an outsized role in contributing to the climate impacts we see around the world today. Both in terms of cumulative emissions, and current per capita emissions, richer countries rank high" (Union of Concerned Scientist). The top CO2 emitting countries for the period 1750-2020 are shown in **Figure 4-5**.

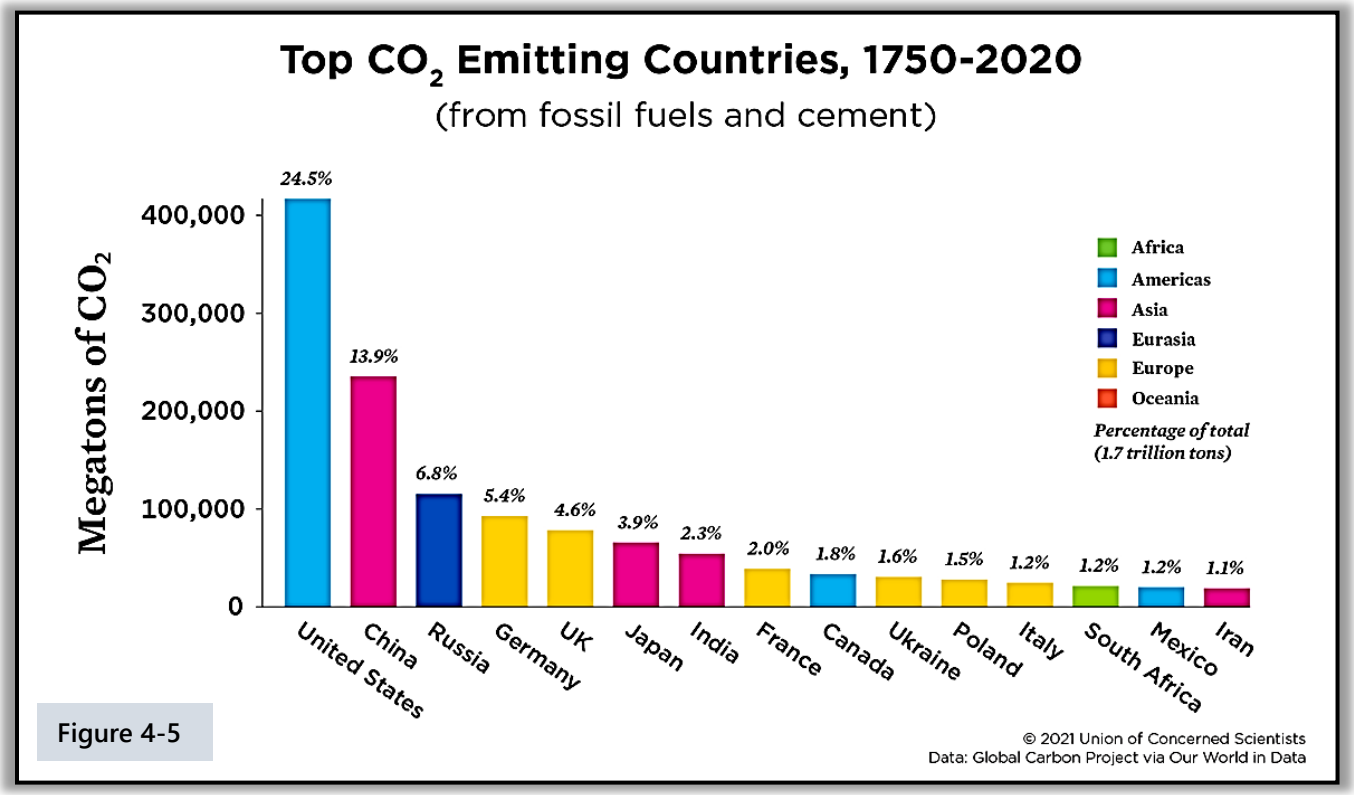


Figure 4-5

The primary human action contributing to climate change is the burning of fossil fuels, like natural gas, oil, and coal, which produce large quantities of carbon dioxide, sulfur oxides, nitrogen oxides, and fine particulates consisting primarily of soot and ash. In addition to burning fossil fuels, other actions such as deforestation and livestock farming also contribute to the greenhouse effect. With respect to the United States CO2 emissions, the EPA tracks total U.S. emissions on an annual basis. As shown in **Figure 4-6**, in 2020 the country's largest source of carbon pollution was in the transportation sector, closely followed by electric power.

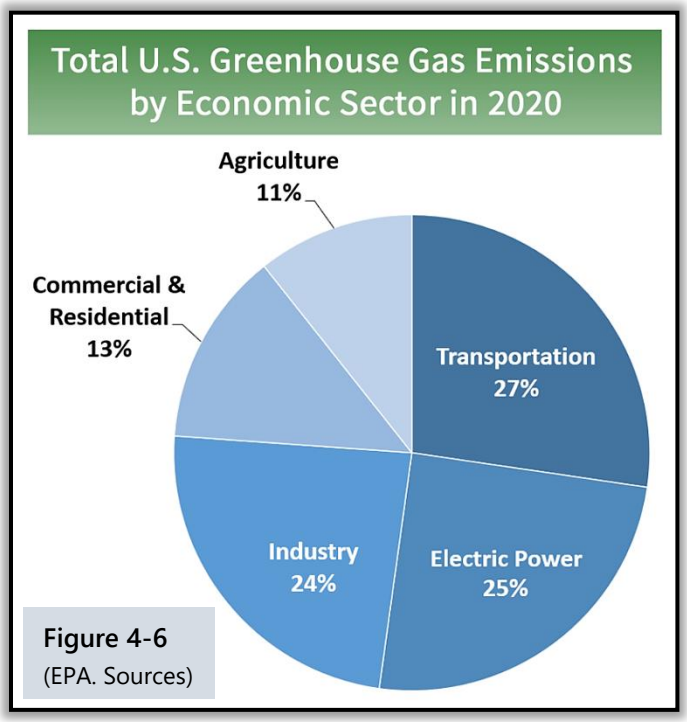


Figure 4-6
(EPA. Sources)

The EPA has provided the following overview of the primary sources of greenhouse gas emissions in the United States for 2020 (EPA. *Sources*):

- **Transportation** (27% of 2020 greenhouse gas emissions) – The transportation sector generates the largest share of greenhouse gas emissions. Greenhouse gas emissions from transportation primarily come from burning fossil fuel for our cars, trucks, ships, trains, and planes. Over 90% of the fuel used for transportation is petroleum based, which includes primarily gasoline and diesel.
- **Electricity production** (25% of 2020 greenhouse gas emissions) – Electric power generates the second largest share of greenhouse gas emissions. Approximately 60% of our electricity comes from burning fossil fuels, mostly coal and natural gas.
- **Industry** (24% of 2020 greenhouse gas emissions) – Greenhouse gas emissions from industry primarily come from burning fossil fuels for energy, as well as greenhouse gas emissions from certain chemical reactions necessary to produce goods from raw materials.
- **Commercial and Residential** (13% of 2020 greenhouse gas emissions) – Greenhouse gas emissions from businesses and homes arise primarily from fossil fuels burned for heat, the use of certain products that contain greenhouse gases, and the handling of waste.
- **Agriculture** (11% of 2020 greenhouse gas emissions) – Greenhouse gas emissions from agriculture come from livestock such as cows, agricultural soils, and rice production.

Understanding what is contributing to the greenhouse effect provides an opportunity to take proactive measures. "According to the World Economic Forum's Global Risks Report 2021, the failure to mitigate and adapt to climate change is 'the most impactful' risk facing communities worldwide - ahead of even weapons of mass destruction and water crises. Blame its cascading effects: As climate change transforms global ecosystems, it affects everything from the places we live to the water we drink to the air we breathe" (Denchak).

The good news is that there is a general understanding of the key steps that need to be taken to curb global climate change. Many of these steps were outlined in the 2015 Paris Agreement which is a "legally binding international treaty on climate change" (United Nations). The goal of the Agreement is to limit global warming to below 2 degrees Celsius**,** compared to pre-industrial levels (United Nations). Although announced by President Trump in June 2017, the U.S. did not formally withdraw from the Paris Agreement until November 2020 (McGrath). The withdrawal was short-lived as President Biden rejoined the Paris Agreement on his first day in office (January 20, 2021) with membership becoming official on February 19, 2021 (US Secretary).

Although there is a general global understanding of what needs to be done, as noted by the Natural Resources Defense Council (NRDC), "The not-so-good news is that we're not working fast enough. To avoid the worst impacts of climate change, scientists tell us that we need to reduce global carbon emissions by as much as 40 percent by 2030. For that to happen, the global community must take immediate, concrete steps: to decarbonize electricity generation by equitably transitioning from fossil fuel-based production to renewable energy sources like wind and solar; to electrify our cars and trucks; and to maximize energy efficiency in our buildings, appliances, and industries" (NRDC. *Global Warming*).

The State of Rhode Island and the Town of Westerly are committed to move toward carbon neutrality, a state of net-zero carbon dioxide emissions. On January 17, 2020 Governor Raimondo signed an Executive Order mandating the State to move toward 100% renewable energy by 2030 – which at the time was the most ambitious ten-year renewable energy target of any state in the nation (Clarcq).

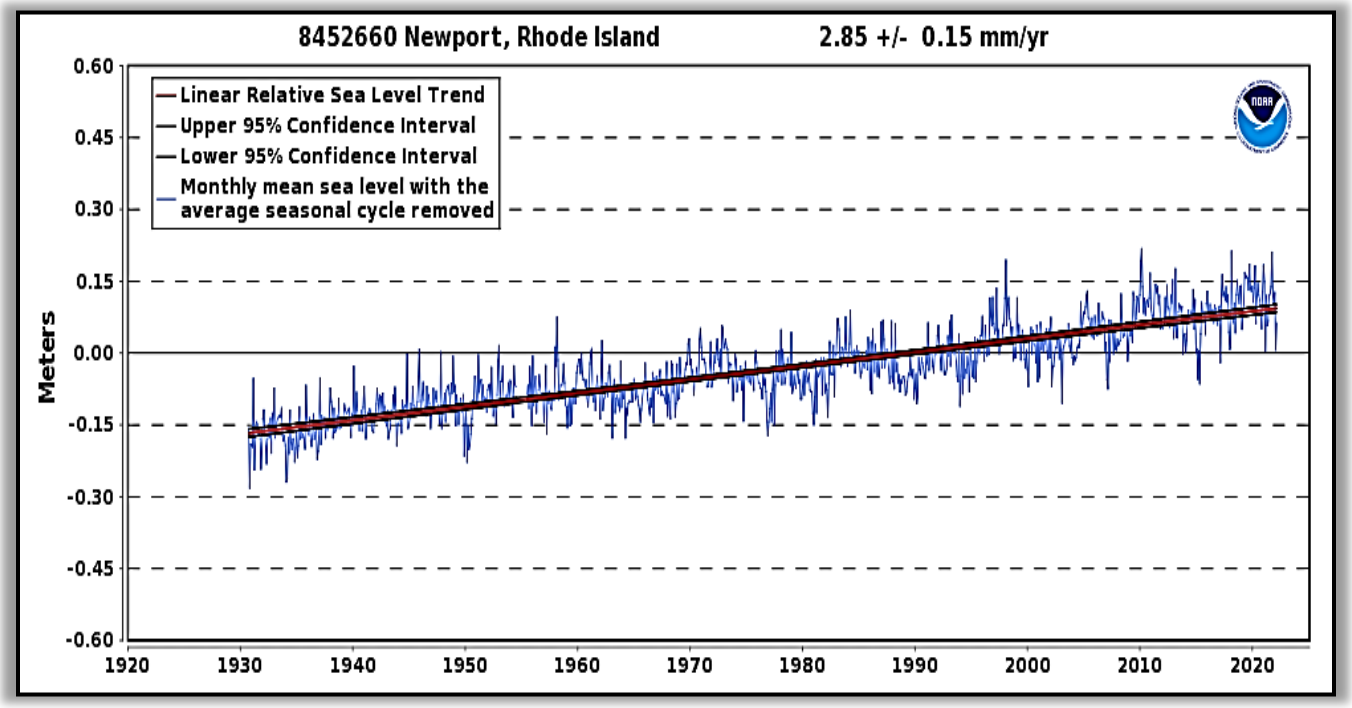
4.1.2 Sea Level Rise (SLR)

Greenhouse gas emissions released to the atmosphere increase surface warming, which in turn, warms ocean waters and accelerates the melting of glacial ice. Both the melting of land ice and the expansion of warm seawater increase the overall Global Mean Sea Level (GMSL). Although the rate of sea level rise is accelerating, it is not expected to be globally uniform, due to a number of factors including prevailing winds and powerful ocean currents (CRMC. *Sea Level and Climate*).

As the average water level of the oceans rise, previously dry land will be permanently inundated. Findings suggest that for about 2000 years prior to the 20th century, there was little change in the global average sea level. During the 20th century the rate of change accelerated with global sea level rise averaging 0.06 inches per year from 1880 to 2013 and roughly twice as fast (0.12 to 0.14 inches per year) from 2013 onward (EPA. *Climate Change Indicators: Sea Level*).

Since the 1930s, NOAA has maintained two stations in Rhode Island, one in Newport and the other in Providence, that measure sea level rise. Based on recordings from the Newport Tide Gage (**Figure 4-7**), sea levels have risen over 10 inches since 1930 (CRMC. *Shoreline Change SAMP*, 2-3). Because greenhouse gas emissions continue to increase, it is expected that this trend will accelerate in the coming decades.

Figure 4-7 Relative Sea Level Trend
8452660 Newport, Rhode Island (NOAA. *Tides*)



The relative sea level trend is 2.85 millimeters/year with a 95% confidence interval of +/- 0.15 mm/year based on monthly mean sea level data from 1930 to 2021 which is equivalent to a change of 0.94 feet in 100 years.

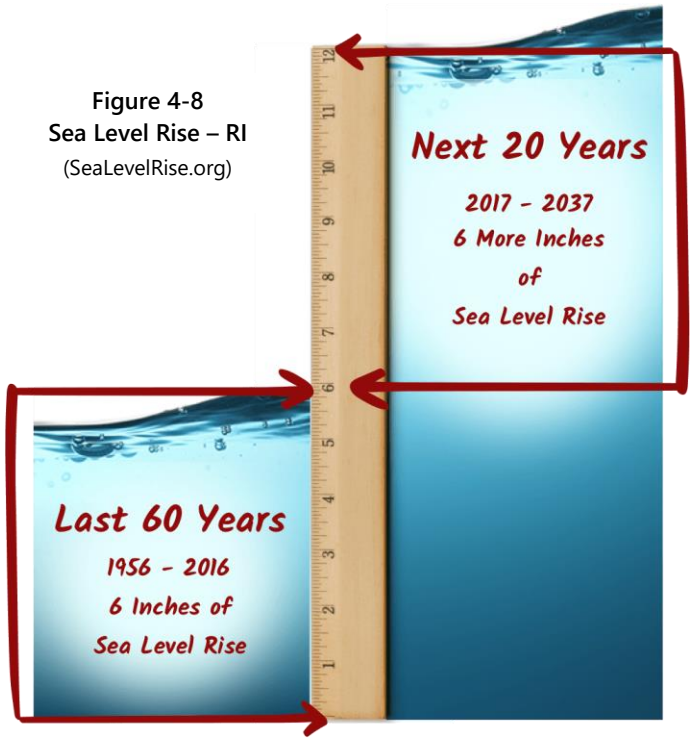


Figure 4-8
Sea Level Rise – RI
(SeaLevelRise.org)

In the last decade, the speed at which Rhode Island sea level is rising has increased, and is now rising by as much as 1 inch every 8 years. As illustrated in **Figure 4-8**, it took around 60 years for the sea level to rise approximately 6 inches. Scientists forecast that in the 20-year period from 2017-2037, the sea will rise by another 6 inches (SeaLevelRise.org. *The Future*).

According to NOAA, sea levels in the Northeast Region will rise significantly faster than the global average. The annual relative sea level since 1960 is shown in **Figure 4-9**, as well as NOAA's most recent best through worst case regional SLR projections up to 2100.

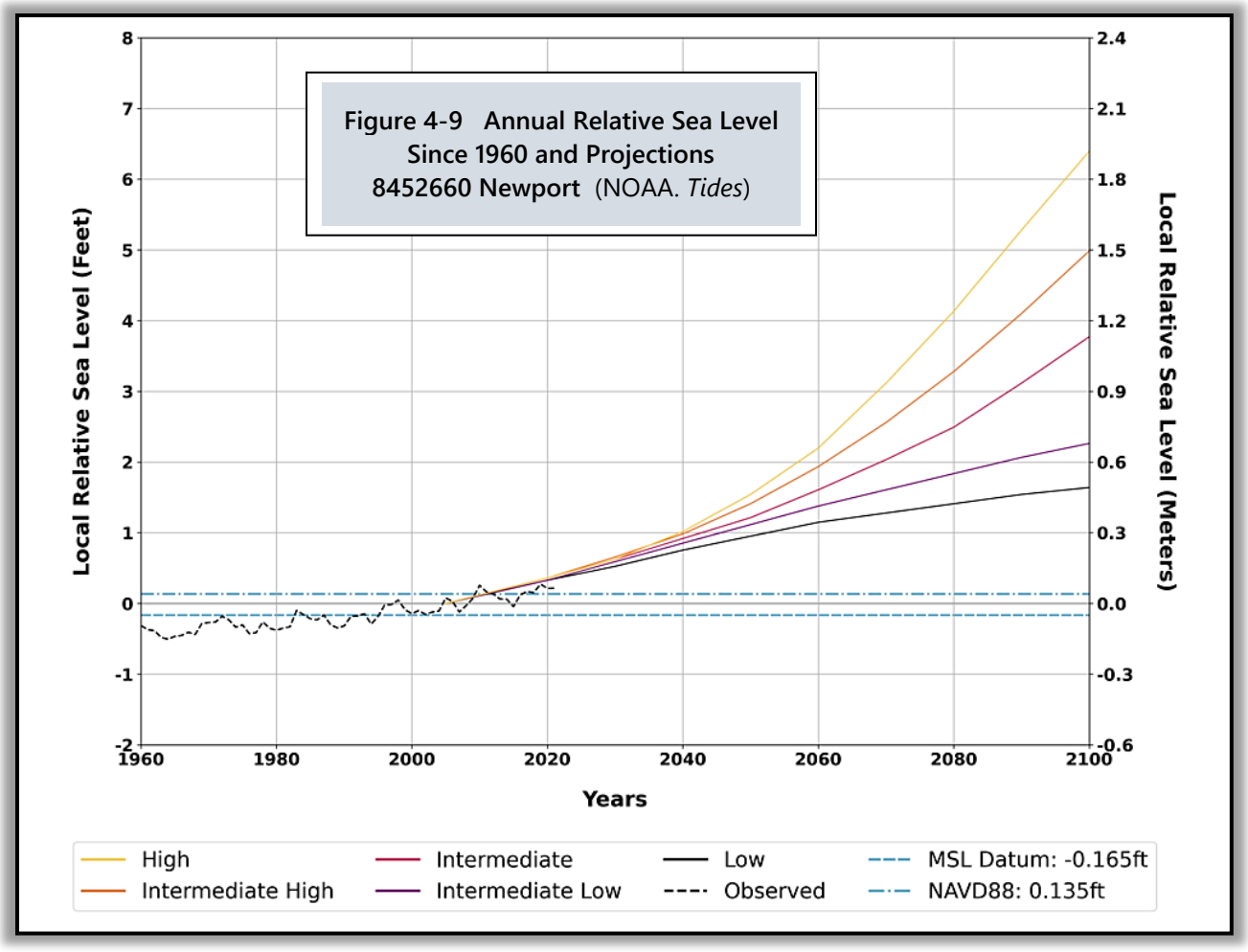


Figure 4-9 Annual Relative Sea Level Since 1960 and Projections
8452660 Newport (NOAA. *Tides*)

In February 2022 NOAA released their ***Sea Level Rise Technical Report*** which updates their 2017 SLR projections and provides additional information on tide, wind, and storm-driven extreme water levels affecting current and future coastal flood risk. The 2022 SLR Technical Report "provides the most up-to-date sea level rise projections for all U.S. states and territories by decade for the next 100 years and beyond, based on a combination of tide gauge and satellite observations and all the model ensembles from the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). NOAA's 2022 SLR Technical Report projects sea levels along the coastline will rise an additional 10-12 inches by 2050 with specific amounts varying regionally, mainly due to land height changes" (NOAA. *U.S. coastline*).

The Rhode Island Coastal Resources Management Council (CRMC) adopted NOAA's "worst-case" high curve projection to guide planning in Rhode Island (CRMC. *Shoreline Change SAMP*, 2-5). As shown in **Table 4-1**, the current worst-case sea level rise projections for Rhode Island based on the 2022 NOAA high curve, are lower than projected in 2017. Although this is welcome news, the projected levels remain a threat to Rhode Island's coastline. As noted by CRMC, "While the 2022 NOAA high curve projections appear to have decreased for 2050, there is far more certainty with these future sea level rise projections based on multiple lines of evidence, and the CRMC and RI must remain vigilant in its planning for coastal adaption and resiliency" (CRMC. *Statement*).

Table 4-1 Sea Level Rise Projections for Rhode Island

NOAA Worst-case projections for Rhode Island based on high curve	2030	2050	2080	2100
2022 SLR Projections	0.71 feet	1.60 feet	4.19 feet	6.47 feet
2017 SLR Projections	1.67 feet	3.25 feet	6.69 feet	9.60 feet

CRMC. *Shoreline Change SAMP*, 2-5; NASA. *Interagency*

The impacts of SLR are already being experienced through:

- increased frequency of low-level inundation
- exacerbated flood elevations during storm events
- increased rates of coastal erosion
- increased saltwater intrusion into groundwater

The impact of sea level rise is extensive and must be considered in long-term land use, development, and critical infrastructure planning. The RI Emergency Management Agency's (RIEMA) Risk Assessment states that, "Sea level rise 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 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 wastewater treatment systems in the coastal zone" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-174 & 3-175).

4.2 HAZARD IDENTIFICATION

In accordance with the planning guidelines outlined in Section 322 of the Disaster Mitigation Act of 2000 (DMA 2000), this *Plan* addresses only **natural hazards**, and does not consider man-made hazards (e.g., structural fires, hazardous materials, chemical spills, or weapons of mass destruction). The Rhode Island State Hazard Mitigation Plan (RI-SHMP) defines a natural hazard 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-1).

CRS CREDIT: NFIP/CRS

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase II – Risk Assessment	4. Assess the Hazard	35

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

In an effort to determined what natural hazards should be addressed in this *Plan* the Advisory Committee reviewed the hazards included in the Town's 2018 Hazard Mitigation Plan, the 2019 Rhode Island State Hazard Mitigation Plan (RI-SHMP), plans from neighboring communities, and documentation/ research from various sources related to previous hazards that have impacted Westerly. An overview of RI disaster declarations from the 1950's forward, which were reviewed as part of the hazard identification process, has been included in **Table 4-2**.

The Committee also discussed the group of hazards identified by the State as not having a high risk to Rhode Island. Due to Westerly's topography and subsurface conditions, the Advisory Committee concurred with the State's assessment and determined that the Town's exposure to the following hazards was unlikely, and will therefore not be addressed in this update: *Avalanches, Expansive Soils, Land Subsidence, Landslides, Volcanoes, and Tsunamis*. In addition, the Committee determined that urban fires caused by lightning strikes or as an earthquake byproduct are unlikely to occur or cause substantial damage in Westerly.

As Town resources are limited, it is important that staff time and funding be devoted to hazards with a higher likelihood of occurring or potentially having a greater impact on the community. While there is always the possibility for an unexpected natural hazard to occur, it should be recognized that the intent of this *Plan* is to understand what natural hazards have a higher probability of impacting Westerly over the ensuing 5-year period. The Advisory Committee determined that in addition to the hazards addressed in the Town's 2018 HMP, the following hazards should also be considered: Extreme Heat, Drought, Hail, Vector-borne Diseases Transmitted by Ticks or Mosquitoes and Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses. Effectively, the Town will address all of the natural hazards identified by the State of Rhode Island in their most current Hazard Mitigation Plan.

The hazards that are addressed in this *Plan* have been grouped into the following categories:

4.3.1 Flood-Related Hazards (Inland Flooding including Dam Failure, Coastal Flooding including Storm Surge, Coastal Erosion)

4.3.2 Wind-Related Hazards (High Winds, Thunderstorms including Lightning and Hail, Tornadoes, Tropical Cyclones - Tropical Depressions, Tropical Storms, and Hurricanes)

4.3.3 Winter-Related Hazards (Heavy Snow, Ice, Extreme Cold)

4.3.4 Infectious Disease-Related Hazards (Vector-borne Diseases Transmitted by Ticks or Mosquitoes, Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses)

4.3.5 Other Hazards (Earthquake, Extreme Heat, Drought, Brush Fire)

4.2.1 Disaster Declaration History

To assist in identifying the likelihood and potential severity of future hazards, the Advisory Committee reviewed past events that triggered a State or Federal Disaster Declaration for Rhode Island. Disaster declarations are issued when the severity of an event overwhelms and exhausts a local government's or state government's resources. A summary of Federal and State Disaster Declarations for Rhode Island, adapted from the RI-SHMP and supplemented from FEMA's Declared Disaster website, is shown in **Table 4-2**. The majority of the emergency declarations and major disaster declarations were issued as the result of hurricanes and winter weather-related events. The first five events listed, occurred after the 2018 Hazard Mitigation Plan update.

Table 4-2 Disaster and Emergency Declarations in Rhode Island, 1954 – 2022

Disaster Number	Declaration Type *	Declaration Date	Description	Individual Assistance Total	Public Assistance Total	Hazard Mitigation Grant Program Total
4653	DR	5/12/2022	Severe Winter Storm and Snowstorm	Not currently available		
3563	EM	8/21/2021	Hurricane Henri	Not currently available		
4505	DR	3/30/2020	Covid-19 Pandemic	$10,489,049	$562,531,956	$621,033
3440	EM	3/13/2020	Covid-19 Pandemic	Not currently available		
3515	EM	3/13/2020	Narragansett Indian Tribe Covid-19 Pandemic	Not currently available		
4212	DR	4/3/2015	Severe Winter Storm Juno 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
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	Hurricane	N/A	N/A	N/A

State of Rhode Island Hazard Mitigation Plan and FEMA Declared Disaster Website

Note: DR = Major Disaster Declaration; EM = Emergency Disaster Declaration

In support of the Risk Assessment process, **Table 4-3** was created from NOAA's National Centers for Environmental Information (NCEI) Storm Events Data for Washington County data displayed in the RI-SHMP. Over the past several decades, wind, winter storms, thunderstorms, and flooding have been the most prevalent disasters faced by Washington County. While the total property damages are believed to be underrepresented due to unreported or difficult to quantify losses, it is clear that damages associated with flooding are the most extensive (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-12 & 3-13).

Table 4-3 Overview of Hazard Events and Related Property Damage in Washington County, Rhode Island

Hazard	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*
Total Number of Events	36	4	113	2	72	8	0	3	78
Total Reported Property Damages	$33,427,000	$75,000	$554,900	$50,000	$220,000	---	---	---	$941,750
Total Annualized Reported Damages	$1,453,348	$3,261	$8,670	$725	$9,565	---	---	---	$14,715

NOAA's National Centers for Environmental Information (NCEI) Storm Events Data for Washington County

Figure 4-10 Hurricane Carol Hits Rhode Island (1954)

Photo Credit: Rhode Island Historical Society

4.2.2 Hazard Priority Ranking

Due to Westerly's geographic location and land characteristics, including being bordered on the north and west by the Pawcatuck River, extensive shoreline on Block Island Sound, and considerable low-lying property, it is subject to a wide range of natural hazards that have the potential to adversely affect public health and safety. To assist the Advisory Committee in analyzing and prioritizing each hazard, a standard methodology was used. The methodology was based on three semi-quantitative factors (probability of occurrence, likely range of impact, and likely magnitude of impact). The Advisory Committee assessed the hazards based on review of Disaster and Emergency Declarations, review of the hazard profiles, input from the community via the Public Opinion Survey, and from personal experience. In the Committee's risk summary (**Table 4-4**) each of the three semi-quantitative factors were given equal weight when calculated to determine the overall numeric ranking. The full ranking and criteria have been provided in **Appendix 4-1**. The narrative included in **Appendix 4-1** explains the methodology of scoring the vulnerability for the profiled hazards and creating the overall ranking.

This exercise assisted the Committee in determining if any hazards should be excluded from further consideration and which ones should be more heavily weighted in terms of the Town's mitigation strategy. The hazards ranked the highest by the Advisory Committee were: Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses; Heavy Snow & Ice; Coastal Flooding including Storm Surge; Inland Flooding; Tropical Cyclone (Tropical Depression, Tropical Storm & Hurricane); Coastal Erosion; Extreme Heat; and Vector-borne Diseases Transmitted by Ticks or Mosquitoes.

Some of the key information used in profiling the hazards came from the resources listed below. The specific documents or websites used can be found in the **Bibliography and Works Cited Section.**

FLOOD-RELATED HAZARDS

- Climate Central
- Coastal Resources Management Council (CRMC)
- Environmental Protection Agency (EPA)
- Federal Emergency Management Agency (FEMA) – including FEMA Flood Insurance Rate Maps (FIRMs), National Flood Insurance Program (NFIP), and repetitive loss properties
- Intergovernmental Panel on Climate Change (IPCC)
- National Geographic
- National Oceanic and Atmospheric Administration (NOAA) – including NOAA|NCEI Storm Events Database
- Rhode Island Climate Change Collaborative
- Rhode Island Department of Environmental Management (RIDEM)
- Rhode Island Division of Statewide Planning (RIDSP)
- Rhode Island Emergency Management Agency (RIEMA) – State HMP
- Rhode Island Geographic Information System (RIGIS) – GIS Data
- United States Army Corps of Engineers (USACE) National Inventory of Dams database

WIND-RELATED HAZARDS

- American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures
- Intergovernmental Panel on Climate Change (IPCC)
- National Geographic
- National Oceanic and Atmospheric Administration (NOAA) – including National Weather Service (NWS), NOAA National Hurricane Center (NHC), NOAA Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model, and NOAA|NCEI Storm Events Database
- Rhode Island Emergency Management Agency (RIEMA) – State HMP
- Rhode Island Geographic Information System (RIGIS) – GIS Data

WINTER STORM-RELATED HAZARDS

- American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures
- Intergovernmental Panel on Climate Change (IPCC)
- National Oceanic and Atmospheric Administration (NOAA) – including National Weather Service (NWS) snowfall data, and NOAA|NCEI Storm Events Database
- Rhode Island Emergency Management Agency (RIEMA) – State HMP

INFECTIOUS DISEASE-RELATED HAZARDS

- Centers for Disease Control and Prevention (CDC)
- Environmental Protection Agency (EPA)
- Rhode Island Department of Environmental Management (RIDEM)
- Rhode Island Department of Health (RIDOH)
- Rhode Island Emergency Management Agency (RIEMA) – State HMP
- World Health Organization (WHO)

OTHER HAZARDS

- American Society of Civil Engineers (ASCE) Minimum Design Loads for Buildings and Other Structures
- Climate Central
- Intergovernmental Panel on Climate Change (IPCC)
- National Aeronautics and Space Administration (NASA)
- National Oceanic and Atmospheric Administration (NOAA) – including National Weather Service (NWS) average annual rainfall data (drought conditions), and NOAA|NCEI Storm Events Database
- Rhode Island Department of Health (RIDOH)
- Rhode Island Emergency Management Agency (RIEMA) – State HMP
- United States Department of Agriculture Natural Resources Conservation Service (USDA)
- United States Geological Survey (USGS)

Table 4-4 Risk Summary: Overview

Hazard	Overall Ranking	Risk Category
Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses	3.00	High
Heavy Snow & Ice	3.00	
Coastal Flooding including Storm Surge	2.67	
Inland Flooding	2.58	
Tropical Cyclone (Tropical Depression, Tropical Storm & Hurricane)	2.50	
Coastal Erosion	2.42	
Extreme Heat	2.42	
Vector-borne Diseases Transmitted by Ticks or Mosquitoes	2.42	
High Winds	2.33	Medium
Drought	2.17	
Extreme Cold	2.08	
Dam Failure	2.00	
Thunderstorm including Lightning and Hail	2.00	
Brush Fire	1.33	Low
Earthquake	1.00	
Tornado	1.00	

4.3 HAZARD PROFILES

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirement ➔
44 CFR Subsection D §201.6(c)(2)(i): [The risk assessment shall include] A description of the type, location, and extent of all natural hazards that can affect the jurisdiction. The plan shall include information on previous occurrences of hazard events and on the probability of future hazard events.

As indicated in **Table 4-4**, based on Committee input, the lowest ranked hazards were determined to be Brush Fires, Earthquakes, and Tornadoes. Although these hazards are not currently considered a significant threat to Westerly, it was determined prudent to maintain their inclusion in this document. As our climate is rapidly changing, some of these hazards may become more significant in future years. That being said, in terms of the Town's ensuing 5-year mitigation strategy, those three hazards will have a lower standing.

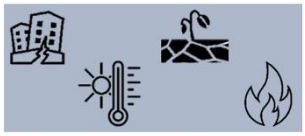
The identified hazards are profiled in the following sub-sections:

4.3.1 Flood-Related Hazards (Inland Flooding including Dam Failure, Coastal Flooding including Storm Surge, Coastal Erosion)

4.3.2 Wind-Related Hazards (High Winds, Thunderstorms including Lightning and Hail, Tornadoes, Tropical Cyclones - Tropical Depressions, Tropical Storms, and Hurricanes)

4.3.3 Winter-Related Hazards (Heavy Snow, Ice, Extreme Cold)

4.3.4 Infectious Disease-Related Hazards (Vector-borne Diseases Transmitted by Ticks or Mosquitoes, Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses)



4.3.5 Other Hazards (Earthquake, Extreme Heat, Drought, Brush Fire)

Each profile includes a description and extent (strength or magnitude of impact); is locally defined (geographic areas affected); identifies previous occurrences; addresses climate change impacts; and discusses the probability of future events.

FLOOD-RELATED HAZARDS

4.3.1 Flood-Related Hazards

Flooding, the accumulation of a substantial amount of water in areas that are typically dry, generally results from heavy rainfall, storm surges, and melting snow. FEMA defines a flood as:

- "A general and temporary condition of partial or complete inundation of two or more acres of normally dry land area or of two 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" (FEMA. *Glossary*).

The RI Geographic Information System (RIGIS) has made available FEMA's Digital Flood Insurance Rate Map (D-FIRM) database for the State, which the Town has used in developing this *Plan*. The most current D-FIRMs for Westerly's southern coastline are from October 16, 2013; the rest of the Town was updated April 3, 2020. The Flood Insurance Rate Maps show FEMA designated flood zones according to varying levels of flood risk. High risk areas in Westerly are designated as Zones A, AE, and VE. The first letter (A or V) represents the flood zone, and if denoted, the second letter (E) indicates that base flood elevations have been provided. The term AE is used on new format FIRMs instead of A1-A30 Zones (FEMA. *Unit 3,* 3-29).

FEMA considers the A and V Zones as the **Special Flood Hazard Area (SFHA)**. **Zone A**, or the 100-year floodplain, identifies areas with a one percent or greater chance of flooding in any given year. **Zone V**, the Velocity Zone, identifies coastal areas with a one percent or greater chance of flooding in any given year plus the additional hazard of storm-induced waves, or velocity action. Both the A and V Zones have a 26% chance of flooding over the life of a 30-year mortgage (FEMA. *Unit 3,* 3-4 & 3-5).

The flood hazard mapping depicted in **Figure 4-11,** serves as the basis for NFIP regulations and flood insurance requirements. Based on the 2020 FEMA FIRM data, 23 percent (4282 acres) of Westerly's land area is within the Special Flood Hazard Area (the 100-year floodplain): approximately 13 percent (549 acres) within Zone VE, 41 percent (1765 acres) within Zone A, and 46 percent (1968 acres) within Zone AE. **Figure 4-11** is also included at a larger scale in **Appendix 4-2**.

"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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-112).

The location of flood events generally varies based on the type of flooding. In this Section, flood-hazards will be discussed in terms of the following three categories:

4.3.1.1 Inland Flooding (Riverine Flooding, Shallow Flooding, and Dam Failure)

4.3.1.2 Coastal Flooding including Storm Surge

4.3.1.3 Coastal Erosion

Flooding

According to FEMA, between 2010 and 2018 the annual cost of flood damage in the United States was approximately $17 billion and was four times more than was recorded in the 1980s (FEMA. TESTIMONY, 5)

FEMA Flood Insurance Rate Map Zone Definitions

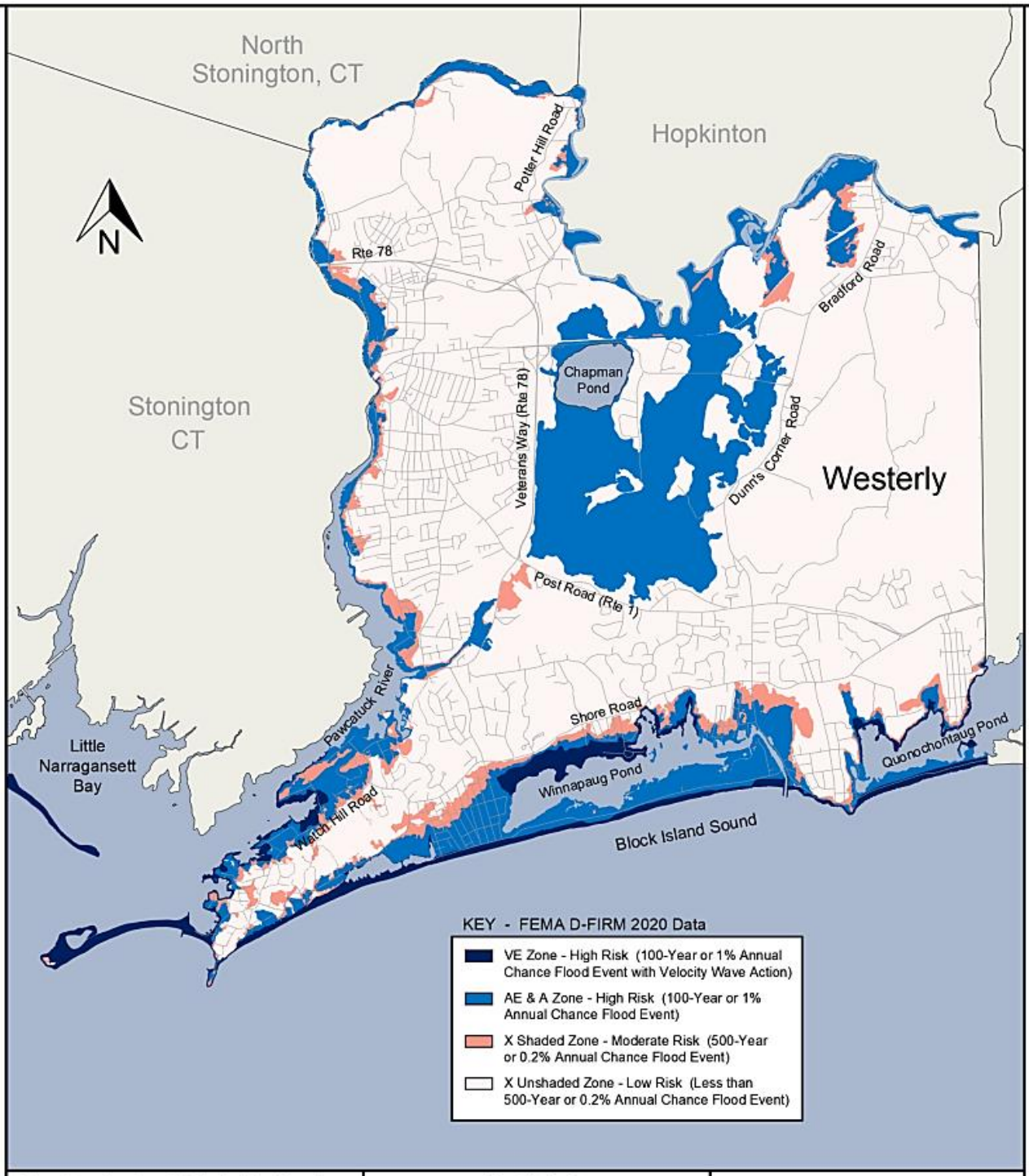
High Risk: Zone V (1% annual chance): Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplain that has additional hazards associated with storm waves. Mandatory flood insurance purchase requirements apply. For areas within the V Zone where detailed hydraulic analyses has been performed and Base Flood Elevations (BFEs) identified, it is classified as VE replacing the old format V1-V30.

High Risk: Zone A (1% annual chance): Zone A is the flood insurance rate zone that corresponds to the 100-year floodplain that is determined in the Flood Insurance Study (FIS) by approximate methods. Mandatory flood insurance purchase requirements apply. For areas within the A Zone where detailed hydraulic analyses has been performed and Base Flood Elevations (BFEs) identified, additional classifications (AE replacing the old format A1-30; AH; AO; AR; or A99) are made.

Moderate Risk: Zone X (shaded) (0.2% annual chance)**:** Zone X (shaded) is the flood insurance rate zone that is considered moderate risk. Flood Zone X (shaded) indicates the area between the limits of the 100- year and 500-year floods. The Zone X (shaded) is determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Low Risk: Zone X (unshaded) (less than 0.2% annual chance): Zone X (unshaded) is the is the flood insurance rate zone that is considered low risk. Flood Zone X (unshaded) is the area outside of (higher in elevation than) the 500-year flood level.

FEMA Flood Zones



This map is not the product of a Professional Land Survey. It was created by the Town of Westerly for general reference, informational, planning or guidance use, and is not a legally authorized source as to location of natural or manmade features. Proper interpretation of this map may require the assistance of appropriate professional services. The Town of Westerly makes no warranty, express or implied, related to the spatial accuracy, reliability, completeness, or currentness of this map.

Graphic Scale

0 3000 6000 12000

1 inch = 3000 Feet

February 2023 | Source: RIGIS

Figure 4-11

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

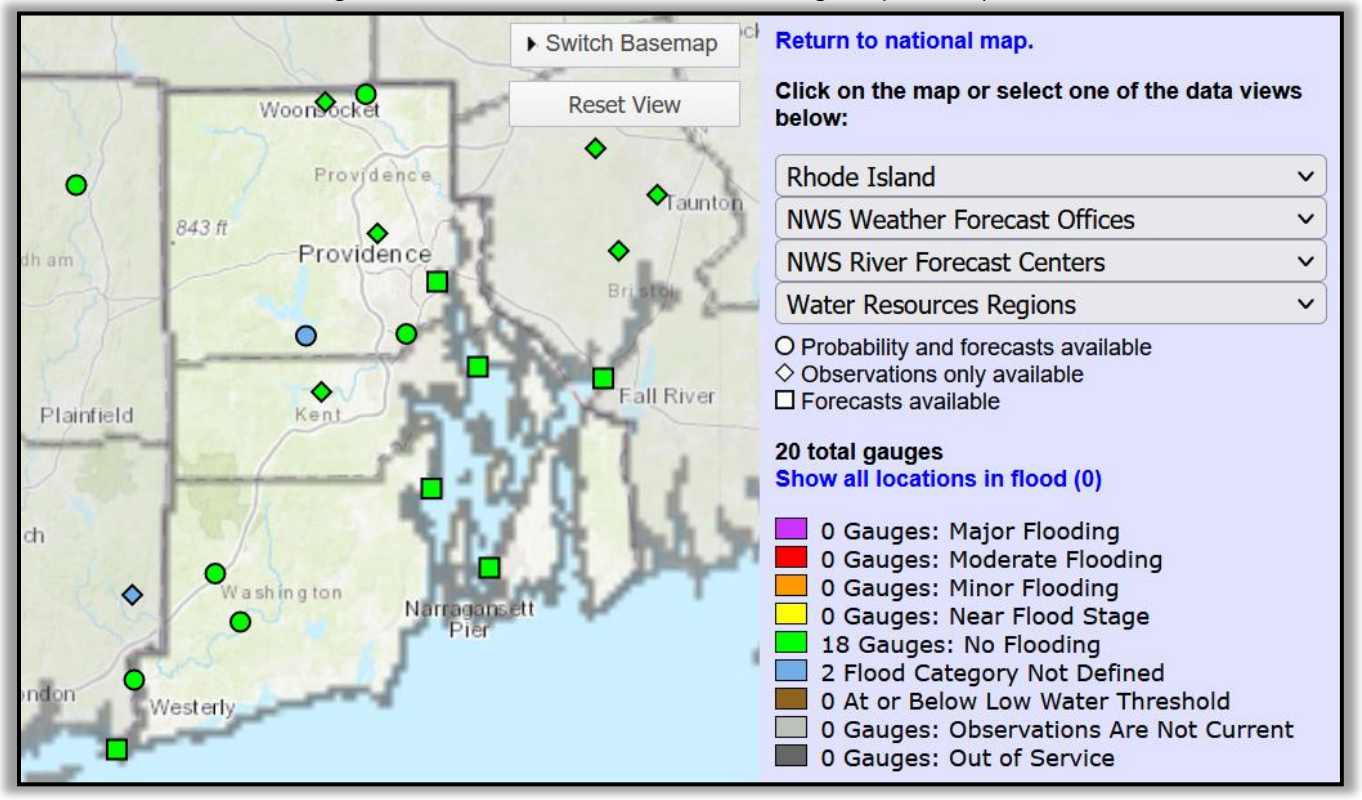
4.3.1.1 Inland Flooding (Riverine Flooding, Shallow Flooding, and Dam Failure)

Description and Extent

"Inland flooding can occur when the volume of water on land exceeds the capacity of natural and built drainage systems" (mass.gov). While there is no universally accepted scale for measuring flooding, some inland flooding may be measured by stream gauges, installed in bodies of water located near populated areas, designed to determine the risk of flooding. The most commonly used stream gauge is the Automated Local Evaluation in Real-Time (ALERT) which continuously sends water level data through a satellite or phone telemetry. The United States Geological Survey (USGS) installs, operates, and collects stream gauge data from thousands of sites around the country. **Figure 4-12** shows the location of National Weather Service (NWS) flood gauges in and near Rhode Island. The data is sent to and analyzed by the NWS River and Flood program who is responsible for issuing flood warnings to local, state, and federal decision-makers. It is then up to the decision-makers what action should be taken (Restoration Master).

As Westerly's creeks and streams are part of small basins, which have smaller flood storage capacity, significant flood events may occur without sufficient warning time to prepare. Streams and small rivers are also susceptible to flooding from more localized weather systems that may cause intense rainfall over only a small area. Significant inland flooding can cause extensive damage to structures and personal property; disrupt potable water, stormwater, and sewer system operations; and flooded roadways can cause dangerous conditions for motorist. Additionally, flood water can carry debris, toxic material, or contaminants spreading pollution which can negatively impact ecosystems. Inundated structures that aren't addressed quickly, may also provide an opportunity for mold contamination. Further, standing water following a flooding event can provide a conducive environment for breading mosquitos.

Figure 4-12 Rhode Island: NWS Observed Gauge Map (NOAA|NWS)



The types of flooding that present a risk within inland (non-coastal) areas in Westerly include: riverine flooding, shallow flooding, and dam failure.

❖ *Riverine Flooding (overbank flooding, flash floods)*

Riverine flooding is defined as flooding that occurs along a channel. Overbank flooding is the overflow of water from a river or stream into the adjacent floodplain due to an increase in the volume of water within a channel. Floodplains are low-lying lands adjacent to rivers, lakes, and oceans that are periodically flooded. The connections between a waterway and its floodplain becomes more apparent after major flood events (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-112).. Maintaining floodplains helps to provide natural flood and erosion control. In addition, floodplains support a variety of natural resources and function as a natural filtering system for groundwater recharge (FEMA. *Unit 1,* 1-7).

As defined by FEMA, and shown in **Figure 4-11**, floodplains in Westerly include VE, A, AE, X (shaded), and X (unshaded) zones. The VE, A, and AE zones (also referred to as the Special Flood Hazard Area) comprise the area inundated by a 100-year flood, the X zone (shaded) is the area between the limits of the 100- year and 500-year floods, and the X zone (unshaded) is the area above or outside of the 500-year flood level.

"While riverine flooding in Westerly is a typical by-product of coastal storms, it can also occur during late winter and early spring due to melting snow and ice as well as seasonal precipitation. These flood conditions are exacerbated by constrictions of movement that can occur when large amounts of ice, debris, and/or fallen trees are obstructed by bridge piles or low-lying bridge decks" (Town of Westerly RI. *Comprehensive*, 247). Including the Amtrak Railway Bridge, there are 9 bridges crossing the Pawcatuck River that connect Westerly to surrounding municipalities. These bridges are vulnerable to flood surge with several constructed before structures were designed to pass floodwaters from a 100-year storm event. A bridge failure may also cause a downstream catastrophe if a flood surge, laden with debris, piles up against a dam or bridge abutments further down the River (Town of Westerly RI. *Comprehensive*, 247).

Flash floods occur with little warning, move quickly, and can carry a huge amount of debris. They have the power to tear out trees, and destroy buildings and bridges. Flash floods are primarily caused by severe storms that drop significant rainfall over a short period of time. Steep slopes and narrow stream valleys increase a community's vulnerability to flash floods and resultant damage, as do areas with poor drainage. The construction of impervious surfaces such as asphalt roads, parking lots, driveways, sidewalks, and expansive roofs, accelerates the potential for flash flooding because these surfaces do not allow natural absorption by open ground. As a result, storm drains are often overwhelmed, and water rushes to low spots such as basements and underpasses. Flash floods can also be caused by a dam or levee failure or the release of ice-jam flooding (FEMA. *Unit 1,* 1-8).

❖ *Shallow Flooding (sheet flow, ponding)*

"Shallow flooding occurs in flat areas where a lack of channels means water cannot drain away easily" (FEMA. *Unit 1,* 1-11). Urbanization exacerbates the accumulation of floodwater due to increased impervious surfaces, and is of particular concern in areas that have a high groundwater table, where development has occurred within floodplains, or with marginal urban drainage systems. Often urban drainage systems, which include swales, ditches, storm sewers, retention ponds, and other facilities constructed to store or carry runoff to a receiving waterbody, are insufficient in size or due to lack of maintenance to accommodate heavy rainfall. Two categories of shallow flooding are

- ◊ **Sheet flow** – A lack or insufficiency of defined channels creates conditions where floodwater spreads over a large area at a roughly uniform depth.
- ◊ **Ponding** – This condition occurs when stormwater runoff collects in depressions and cannot drain out; the water remains until it infiltrates into the soil, evaporates or is pumped out (FEMA. *Unit 1,* 1-11 & 1-12). (This does not include stormwater retention ponds specifically designed to collect stormwater and retain the water until it infiltrates into the soil; typically, within a matter of hours).

❖ ***Dam Failure (Special Flood Hazard)***

"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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-48).

NOAA defines a dam as "any artificial barrier that diverts or impounds water" and dam failure as a "catastrophic event characterized by the sudden, rapid, and uncontrolled release of impounded water" (NWS. *National Weather Service Glossary*). The RI-SHMP indicates that the most common cause of dam failure is overtopping which can occur due to prolonged periods of rainfall and flooding. "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 away, 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-46).

Weather conditions will impact extent. During high precipitation and flooding events, the potential for overtopping or breaches has a higher probability and may exacerbate the impact. A dam breach unrelated to a precipitation event may have an overall lesser impact; however the population will likely receive less warning which could create more life threatening situations. Dam failures can create the most damaging flash flood events because generally there is little or no warning time, limiting the opportunity to prepare and evacuate (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-46, 3-48).

Inventoried dams in Rhode Island are classified by size and hazard rating by the Rhode Island Department of Environmental Management (RIDEM). "The size classification provides a relative description of small, medium, or large dams, 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-46).

"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. 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-48). The Rhode Island Department of Environmental Management's 2021 Annual Dam Safety Report, classifies all of Westerly's inventoried as *Low Hazard* dams. As such, these dams present minimal threat to the community should they fail (RIDEM. *2021 Annual Report*).

Location

❖ *Riverine Flooding (overbank flooding, flash floods)*

Riverine flooding is more likely to result from an event with a slower speed of onset that causes stream and creek banks to overtop. In Westerly this is generally the result of tropical storms, but it can also occur during late winter due to melting snow, ice, and persistent spring rain. Areas bordering rivers may also be affected by large discharges caused by heavy rainfall over upstream areas. Large amounts of impervious surfaces, such as in Westerly's Downtown area, increase runoff amounts and decrease the lag time between the onset of rainfall and stream flooding. Man-made channels and incorrectly sized culverts may also constrict stream flow and increase flow velocities (FEMA. *Unit 1,* 1-7).

Westerly has several freshwater waterbodies that represent a risk of riverine flooding for inland neighborhoods. The most prominent is the Pawcatuck River, which flows along the entire northern and western boundaries of the Town and has the potential to impact properties along its banks and portions of Downtown Westerly, the North End neighborhood, White Rock, Bradford, Avondale, and Watch Hill. In addition, Westerly has a number of small streams including the Aguntaug Brook, Mastuxet Brook, McGowan Brook, Perry Healy Brook, and Springbrook. Low-lying properties along these waterways are vulnerable to flooding. Low-lying properties near Chapman Pond and Aguntaug Swamp in the north central section of Westerly, are also at risk.

"Flood conditions are exacerbated by constriction of river waters that can occur when large amounts of ice or debris such as fallen trees, tree limbs pile up behind low-lying bridge decks or narrow bridge spans. There are nine bridges located on Westerly's section of the Pawcatuck River, several of which date to a period before structures were designed to pass floodwaters from a 100-year storm event. The collapse of one of these structures could cause a downstream catastrophe, as a flood surge laden with trees or buildings could pile up against a dam or set of bridge abutments" (VHB, 48)

❖ *Shallow Flooding (sheet flow, ponding)*

New development is subject to the State and Town's stormwater regulations, requiring bioretention basins, swales, dry wells, and/or other measures to capture and treat stormwater from streets, rooftops, and other impervious surfaces. However, as development in many areas of Town predate such requirements, a significant amount of stormwater runoff flows overland, some of which is handled by catch basins and roadside ditches. During high precipitation events, runoff in excess of that managed by stormwater controls may accumulate in low-lying areas, such as floodplains, particularly the 100-year floodplain. As depicted in **Figure 4-11**, besides the floodplain along the Pawcatuck River and the coastline, Westerly has a large 100-year floodplain located roughly in the central portion of Town; comprised generally of the area bordered by Veterans Way (Route 78) to the west, Post Road (Route 1) to the south, Dunn's Corner Road to the east, and Westerly Bradford Road (Route 91) to the north. This area is largely undeveloped and dominated by Chapman Pond and Aguntaug Swamp, one of the largest freshwater wetland complexes in Rhode Island (Town of Westerly RI. *Comprehensive*, 20).

❖ *Dam Failure (Special Flood Hazard)*

According to the *2021 Annual Report to the Governor on the Activities of the Dam Safety Program*, all five of Westerly's dams are designated as low hazard dams. Hence, were any of these dams to fail, it is not anticipated to cause loss of life or significant economic losses.

Westerly Dams:

- Dam No. 254 - Potter Hill Dam on the Pawcatuck River
- Dam No. 454 - Woody Hill Reservoir Dam on Perry Healy Brook
- Dam No. 493 - Olaf Farm Pond Dam on Cedar Swamp Brook
- Dam No. 547 - Misquamicut Country Club Pond
- Dam No. 752 - Boiling Spring Dam on Mastuxet Brook

In addition to the dams listed above, three of Westerly's dams spanning the Pawcatuck River that were originally constructed to provide hydropower to textile mills have been removed. The White Rock Dam (Dam No. 255) was removed in 2015 and the Bradford Dam (Dam No. 253) was removed in 2018 and replaced by a nature-like fish-way. The Stillmanville Dam (Dam No. 256) was constructed to provide power to the former Stillmanville Woolen Mill in Stonington Connecticut. Although the dam was not formally removed, it has not been functional for years. Debris from the dam remains in the Pawcatuck riverbed and at times constricts flow in the channel.

Potter Hill Dam

The Potter Hill Dam, last rebuilt in 1903 (the original dam was built here in 1762), is in poor condition, according to the latest condition assessment (Pare, 2022). It is also the only remaining dam on the Pawcatuck River with inefficient fish passage. The Wood-Pawcatuck Watershed Association (WPWA), in conjunction with project partners, and project consultant Fuss & O'Neill, developed the Wood- Pawcatuck Watershed Flood Resiliency Management Plan (2017). The report indicates that, "Although the [Potter Hill] dam has a fish ladder, removal of the dam should be considered to enhance AOP [aquatic organism passage] and flood resiliency." (Fuss & O'Neill. *Wood-Pawcatuck,* 45).

The Potter Hill Dam was given a low-hazard classification by the Rhode Island Department of Environmental Management (RIDEM) roughly 20 years ago. Based on this classification, RIDEM assesses that if dam failure occurs, there would be no probable loss of human life, and the failure would potentially result only in low economic/environmental losses. Other adverse effects have not been accounted for in this classification. However, RIDEM spokesperson Michael Healey indicated that RIDEM has never conducted a thorough hydraulic analysis to determine whether the structure should be a reclassified dam (Drummond). To add, "NOAA [National Oceanic and Atmospheric Administration] restoration ecologist, James Turek, said it was a mistake to assume that the dam does not pose a hazard" (Drummond).

It is important to distinguish between dam hazard classification and dam condition. RIDEM generally does not inspect low-hazard dams, and when they do, such as in 2005 for Potter Hill Dam, it is only a visual inspection. An updated assessment of the dam condition was authorized by the Town Council in July 2022. The Town contracted Pare Engineering to assess the condition of the Potter Hill Dam, identify immediate or near-term repair and maintenance actions for Potter Hill Dam, and determine if the dam presents an imminent threat of failure. In September 2022, Pare completed a Condition Assessment, which notes that it too is only a visual inspection (albeit underwater diver inspection) and has certain limitations. This assessment found the dam to be in poor condition (defined as a "component(s) that has deteriorated beyond a maintenance issue and requires repair; the component no longer functions as it was originally intended") and lists a number of deficiencies including significant deterioration of the concrete, including spalling, cracks, scour, and leakage in the spillway, sluiceways, raceways, and fish ladder.

As a result of the 2019 Municipal Resilience Program (MRP) Community Resilience Building (CRB) Workshop identifying "securing funding and removing Potter Hill Dam" as a "higher priority" resilience measure, the Town of Westerly engaged watershed partners (RIDEM, Rhode Island Saltwater Anglers Association, WPWA, Southern Rhode Island Conservation District, The Nature Conservancy, NOAA, U.S. Fish and Wildlife Service, and U.S. Geological Survey) and applied for and was awarded NOAA grant funding in 2020 to address the Potter Hill Dam. The funded project serves multiple purposes: improve river connectivity and effective fish passage, and restore riparian wetland habitat while reducing flood risk, protecting infrastructure, and improving public safety, access, and recreational opportunities.

In October 2021, as part of the NOAA grant, Fuss & O'Neill engineers presented a draft assessment regarding *Improving Pawcatuck River Resiliency and Ecology at Potter Hill*. The 2021 assessment "identifies a set of project alternatives to partially or fully remove the Dam to restore a natural channel providing unimpeded migratory fish passage" (Fuss & O'Neill. *Improving,* vii). The report discussed several technical options and recommended the pursuit of full dam removal with the creation of a riffle-pool channel. This option was recommended for the benefits obtained in flood resiliency, as originally sought in 2019, and to provide the greatest benefit to fish passage, which was a primary goal of the awarded NOAA funds.

At a Town Council Workshop on October 25, 2021, Fuss & O'Neill outlined the technical alternatives contained in the report. Residents expressed concerns that removal of the dam and resulting lowering of the impoundment height could impact wells, lower riverfront property values, impact fire protection services that rely on impounded water, affect existing wetlands created by the dam, and impact motor boating opportunities. The "partial removal with full height riffle-pool channel" alternative was favored by the Council. At a subsequent Town Council Workshop, the project consultant and other project partners expressed concerns about the chosen alternative and its feasibility, citing challenges with fulfilling the goals of the project originally proposed and funded, and the substantial cost to implement the alternative. The Town is continuing to consider refined alternatives for the Potter Hill Dam, in discussion with project partners, to ensure long-term resiliency in the built and natural environment.

Previous Occurrences

❖ ***Riverine and Shallow Flooding (overbank flooding, flash floods, sheet flow, ponding)***

As shown in **Table 4-5**, which was created from the NOAA|NCEI Storm Events Database, Westerly regularly experiences inland and urban flooding events that result in localized street and stream flooding. The term urban flooding refers to inundation of land or property in a built environment. "Urban flooding occurs when water flows into an urban area faster than it can be absorbed into the soil, conveyed in a stormwater system, or stored in a lake or reservoir. 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-113). The Downtown area of Westerly is almost entirely impervious and experiences flooding during high precipitation events.

On a number of occasions, including in 1978, 1982, and 2010, heavy rains caused the Pawcatuck River to overflow its banks. In the spring 2010 event, the floodwaters lasted nearly two weeks and caused road blockages along Canal Street and on Route 91 between Downtown Westerly and Bradford, and a mile of train track was inundated, resulting in a suspension of Amtrak services. Residents living to the east of Chapman Pond were reliant on marine transport to get to out of their neighborhoods. A number of commercial buildings suffered damage, with one partially collapsing. Flooding along Canal Street, predominately the result of the Blue Pond Dam breach in Hopkinton, caused a complete failure of the National Grid substation (Town of Westerly RI. *Comprehensive*, 247). Nearly 10,000 Westerly residents were impacted by the flooding and power outages. Some homes were flooded up to their rooflines, and some residents were not allowed back in their homes over a month. The damage from the 2010 flooding across Rhode Island resulted in a Presidential Major Disaster Declaration for the State; with property damage for Washington County estimated at $24,760,000. (NOAA|NCEI. *Storm Events*)**.**

Although less frequent, flash floods have occurred in Westerly on several occasions, including related to the spring 2010 storm events. In March 2014, a storm producing 4 to 5 inches of rain resulted in flash flooding along Canal Street. The White Rock section of Town also experienced flooding when both Spring Brook and the Pawcatuck River overflowed their banks (NOAA|NCEI. *Storm Events*).

❖ ***Dam Failure (Special Flood Hazard)***

Since 1889, Rhode Island has experienced 111 dam incidents (e.g. embankment erosion, vegetative growth, structural deterioration, inflow flood-hydrologic event); seven of which resulted in some degree of breach failure (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-49). Although there are no records of dam breach having occurred in Westerly, the historic spring flooding in 2010 did cause the dam over the Pawcatuck River in the Bradford section of Westerly to overtop its embankment and flood the section of Route 216 near the Bradford Dyeing Association plant (Benson). According to RIDEM, several other dams overtopped their embankments during the 2010 precipitation events, but only three breaches occurred in Rhode Island. Those dams were in Hopkinton, Exeter, and South Kingstown (Benson).

Table 4-5 Inland and Urban Flooding Events – Washington County 1990-2021 (NOAA|NCEI. *Storm Events Database*)

Begin Date	Key Event Information (no deaths or injuries reported for any of these events)	Property Damage
09/18/1996; 10/08/1996; 10/20/1996; 12/07/1996; 08/29/1997; 11/01/1997; 02/18/1998; 02/23/1998; 03/08/1998; 04/01/1998 05/09/1998; 06/13/1998; 10/08/1998; 01/03/1999; 01/15/1999; 05/23/1999; 09/10/1999; 09/16/1999; 03/11/2000; 11/10/2000; 03/30/2001; 03/29/2003	**Note:** these dates have been identified on the NCEI database as **heavy rain events** but are **NOT** listed as flood events. This does not necessarily mean that local flooding didn't occur, but rather that it was not recorded as part of this database.	-----
08/29/1997	**Event:** Flash Flood **General Description:** A redeveloping area of showers and thunderstorms produced intense rainfall amounts of three to nearly five and one-half inches in one to three hours in parts of Washington and Newport Counties. A flash flood occurred in Charlestown where police reported extensive flooding along a portion of Route 1.	-----
02/18/1998	**Event:** Flash Flood **General Description:** Strong northeast winds gusting to 30 to 40 mph occurred across the south portion of Narragansett Bay and along the south coast from Little Compton to Westerly. Rainfall totals were in the range from 2.0 to 3.5 inches during a 12-hour period.	400K
03/28/2005	**Event:** Flood **General Description:** Low pressure tracking south of New England brought 3 to 4 inches to much of Rhode Island, resulting in significant urban and poor drainage flooding.	-----
10/15/2005	**Event:** Flood **General Description:** A low pressure system interacted with a plume of tropical moisture as the low slowly moved parallel to the Long Island and south Massachusetts coasts, resulting in excessive rain and flooding across Rhode Island. Between 2.5 and 4.5 inches of rain fell from this event.	300K
10/28/2006	**Event:** Flood (*also Coastal Flood*) **General Description:** This system brought damaging winds to much of central and southern Rhode Island, where trained spotters and amateur radio operators reported many downed trees and power lines. Wind gusts were estimated near 60 mph on Block Island. About 10,200 customers were left without power throughout the state, as reported by the media. Rainfall totals of 2 to 4 inches produced significant urban flooding from greater Providence to South Kingstown. Significant coastal flooding occurred as a result of the storm.	5K
03/02/2007	**Event:** Flood **General Description:** Snow quickly changed to heavy rain as the storm reached Rhode Island, when milder air was drawn into the region. Rainfall totals of 2 to 3 inches caused widespread urban and small stream flooding.	5K
04/16/2007	**Event:** Flood (*also Coastal Flood*) **General Description:** This storm brought a variety of impacts, including damaging winds in excess of 60 mph, widespread river and stream flooding, and significant coastal flooding through several high tide cycles. East to northeast winds gusted as high as 60 mph. There were widespread reports of downed trees, large branches, and power lines, especially in southern Rhode Island and as far inland as Providence. Rainfall totals of 3 to 5 inches, combined with wet antecedent conditions, resulted in widespread river and stream flooding, as well as significant flooding of urban areas. Many small streams throughout Rhode Island also rose out of their banks and flooded nearby areas, including roadways. Along the South Coast, the worst flooding occurred with the morning high tide on the 16th, where flood waters and debris closed several shore roads. Large boulders that washed ashore had to be removed with snow plows, according to media reports.	10K
07/27/2008	**Event:** Flood **General Description:** A slow moving cold front moved through southern NE and produced a long line of showers and thunderstorms that tracked east across the area.	10K

Begin Date	Key Event Information (no deaths or injuries reported for any of these events)	Property Damage
07/01/2009	**Event:** Flash Flood/Flood **General Description:** A stationary front combined with an upper level disturbance produced showers and thunderstorms across southern New England. Routes 1 and 78, Main Street, and Airport Road were closed due to flooding. Basements were flooded on River and Watch Hill Roads with up to two and a half feet of water in the basement.	20K
03/14/2010	**Event:** Flood **General Description:** A stacked low pressure system (surface low and upper level low on top of each other) moved southeast of Nantucket, spreading rain across Southern New England. This resulted in widespread rainfall totals of three to six inches. The Pawcatuck River in Westerly and at Wood River Junction rose above flood stage after three to six inches of rain fell in southern Rhode Island. This resulted in flooded basements and yards. While the bulk of the flooding occurred on the 14th and 15th, it took until the 20th for the waters to recede below flood stage.	40K
03/29/2010	**Event:** Flood **General Description:** A low pressure system sat just south of Long Island for two days, bringing heavy rain to much of Southern New England during that time. Rivers across much of Massachusetts and Rhode Island were still high from the previous heavy rainfall event, as well as a second lesser rain event about a week prior. Officials estimated that statewide more than 500 people were evacuated from their homes because of rising water or the threat of rising water. The Governor's office estimated that tens of thousands of properties were impacted by the flooding and about 4,000 workers were affected when the businesses they worked in were closed during and after the flooding. Numerous schools and many businesses, as well as the state government were closed for at least a day because of the flooding. President Obama issued a federal disaster declaration for the entire state of Rhode Island and residents received an automatic extension for filing their state and federal income taxes. The disaster declaration encompassed both the mid-March storm and this storm. Five to ten inches of rain fell across Washington County, resulting in rises on the Pawcatuck River at Westerly and at Wood River Junction. The Pawcatuck River set a record of nearly fifteen and a half feet at Westerly and just over eleven feet at Wood River Junction. Pawcatuck River flooding in Westerly left some homes flooded up to their roof lines. Nearly 10,000 residents of Westerly were impacted by the flooding and power outages that occurred, some of them were no allowed back in their homes over a month. Chapman Pond and Newton Swamp flooded and along with flooding from the Pawcatuck River cut off an entire neighborhood from goods and services for at least a week. Residents were encouraged to evacuate after electricity was cut off for safety reasons for nearly a week. However, 20 of the 36 families stayed in their homes to protect them from the rising water. The Broad Street Bridge was closed for safety reasons, blocking the main route in and out of Westerly from Connecticut. Several portions of Route 91, a main east-west artery, were flooded and closed. This wreaked havoc with bus schedules and daily commutes. Six National Grid substations were flooded and four were close, disrupting electrical service in Westerly and Warwick. Shell fishing grounds in the southern part of the state were closed temporarily over concerns of sewage and other contaminants in the water. They reopened about a week and a half later.	24.76M
08/10/2012	**Event:** Flood **General Description:** Southerly winds drew tropical moisture over the area, resulting in very heavy rain in showers and thunderstorms that developed. In addition, strong winds in the upper levels and 30-40 knots of deep layer shear resulted in wind damage with the strongest of these storms.	-----
06/07/2013	**Event:** Flood **General Description:** The remnants of Tropical Storm Andrea tracked across southeastern Massachusetts bringing heavy rain (3-5 inches) to much of southern New England. This resulted in significant urban flooding, particularly across eastern Massachusetts and Rhode Island, as well as river and small stream flooding. It also contributed to record high rainfall across the area for the month of June.	-----

Begin Date	Key Event Information (no deaths or injuries reported for any of these events)	Property Damage
03/30/2014	**Event:** Flash Flood/Flood **General Description:** This system was anomalously moist with precipitable waters two to three standard deviations above normal for late March. Four to five inches of rain fell across portions of Washington County. This resulted in flash flooding in Westerly. Canal Street was flooded. Spring Brook overflowed its banks in the White Rock section of Westerly. Water overflowed four to five yards nearing the foundations of those houses. The Pawcatuck River also overflowed its banks in the White Rock section of town. White Rock Road had 2-3 inches of flowing water over the road near a soccer field entrance.	5K
07/15/2015	**Event:** Flood **General Description:** Showers and thunderstorms developed across the area as a result of an upper level disturbance and a cold front. A couple of these slow moving storms resulted in flooding or flash flooding.	-----
07/28/2015	**Event:** Flood **General Description:** A strong upper level disturbance sparked showers and thunderstorms across much of southern New England. A few of these storms became severe, producing damaging winds. Others produced heavy rain that resulted in flooding.	20K
07/13/2017	**Event:** Flash Flood **General Description:** An east-west aligned cold front slowly moved south through Southern New England. This along with an extremely humid air mass brought heavy afternoon downpours to Connecticut and Rhode Island.	2K
07/22/2019	**Event:** Flood **General Description:** Low pressure tracked along a frontal boundary that was draped across CT, RI and southeast MA at night. It was accompanied by scattered strong thunderstorms with heavy downpours and isolated wind damage. In Westerly, there were multiple cars stuck in flooding on Route 1 near the Haversham Tavern. The road was temporarily closed.	-----
08/17/2019	**Event:** Flood **General Description:** Typical summer weather prevailed with some widely scattered showers and thunderstorms, a few of which produced locally heavy rain. Flooding was reported on Sunset Avenue, Ocean View Highway, and Atlantic Avenue.	-----

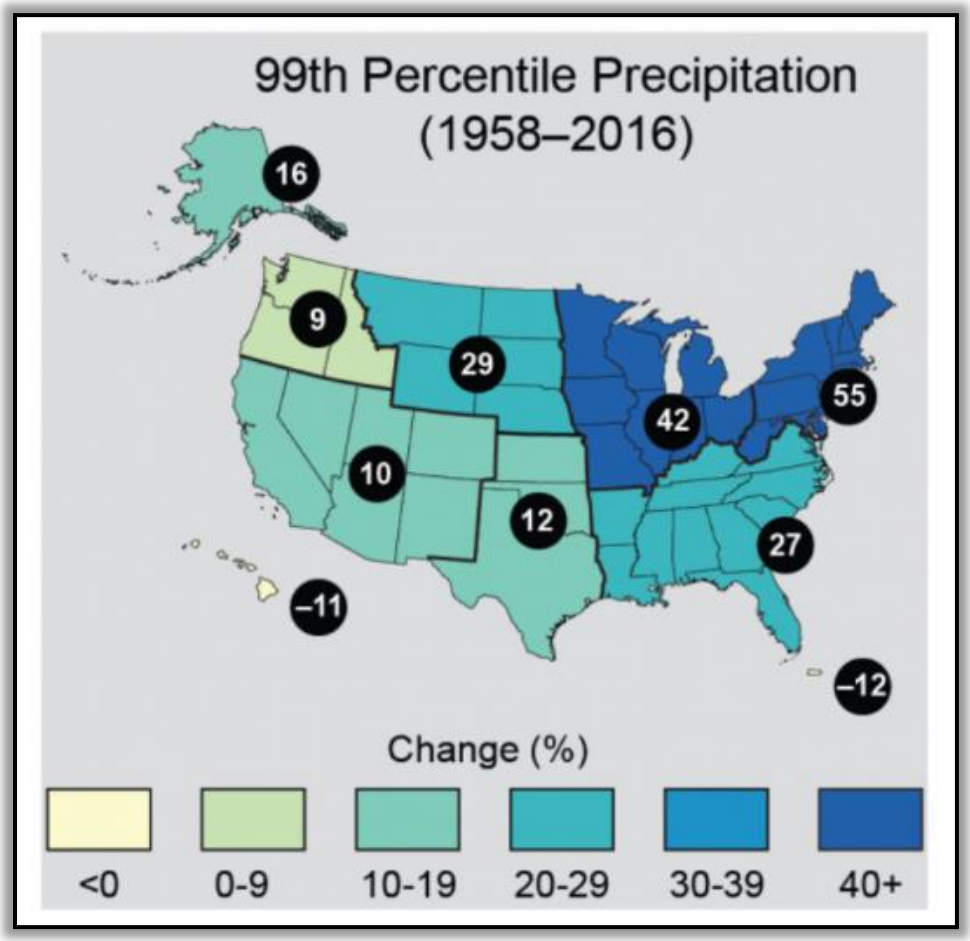
Climate Change Impacts

In their 2017 Climate Science Special Report, the U.S. Global Change Research Program states that, "Changes in the characteristics of extreme events are particularly important for human safety, infrastructure, agriculture, water quality and quantity, and natural ecosystems. Heavy rainfall is increasing in intensity and frequency across the United States and globally and is expected to continue to increase. The largest observed changes in the United States have occurred in the Northeast" (USGCRP, Executive Summary).

As reported by Climate Central, "More than 70% of the planet's surface is water, and as the world warms, more water evaporates from oceans, lakes, and soils. Every 1°F rise also allows the atmosphere to hold 4% more water vapor" (Climate Central. *POURING*). Climate warming, predicted to increase the intensity and frequency of storm events, translates to increases in flooding. The problem will be exacerbated as winters become wetter saturating the ground prior to heavier rainfall periods. Increased construction within floodplains, destroying these natural protective systems, will also yield greater risks from flooding. Curbing humanity's greenhouse gas emissions would limit the increase in downpours. Scenarios modeled in the 2017 Climate Science Special Report suggest that, "If greenhouse emissions continue unchecked, the frequency of a once-in-five-years rain event could increase two-to-threefold by late century" (Climate Central. *POURING*).

Figure 4-13 "Shows the percent increases in the amount of precipitation falling in daily events that exceed the 99th percentile of all non-zero precipitation days (top 1 percent of all daily precipitation events) from 1958 to 2016 for each region of the United States. The number in each black circle is the percent change over the entire period (1958–2016)" (US Climate Resilience Toolkit).

Figure 4-13 Observed Change in Heavy Precipitation (US Climate Resilience Toolkit)



Probability of Future Events

❖ ***Riverine and Shallow Flooding (overbank flooding, flash floods, sheet flow, ponding)***

The likelihood of riverine and shallow flooding occurring in Westerly every year is high based on previous occurrences and climate change projections. The Town has been active to mitigate the effects of these types of flood events by constructing culverts under repetitive flood roads, removing pavement associated with end-of-road retrofits, and working to maintain well-functioning storm drains. With the help of the University of Rhode Island NEMO Program, Westerly recently completed the Low-Impact Development (LID) Self-Assessment, and is preparing to revise the Zoning Ordinance to improve stormwater management and sustainable development in Town. Additionally, Westerly is partnering with the Southern Rhode Island Conservation District on a downtown stormwater project on Main Street called "Resilient Riverfront Renewal". Through this project, a master plan for stormwater retrofits along Main Street has been created, and the SRICD and the Town are working with local property owners to implement green infrastructure downtown.

❖ ***Dam Failure (Special Flood Hazard)***

While the State identifies the five dams in Westerly as low hazard, meaning should they fail the probability of loss of life or significant property damage is low, the structural integrity of the dams is unclear. Without a clear understanding of the structural condition of the dams, it is difficult to address the probability of failure. The probability increases with increased major flood events, and decreases with preventative measures, such as routine inspection, maintenance, repair, and proper operation.

4.3.1.2 Coastal Flooding including Storm Surge

Description and Extent

Coastal flooding occurs when surges of waves inundate the shores of bays, tidally influenced rivers, streams, and inlets. These conditions are produced by tropical cyclones (tropical storms and hurricanes) during the summer and fall as well as Nor'easters during the fall, winter, and spring (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-113). Storm surge is being addressed in this Section due to the resultant hazard of coastal flooding. Additional information about the winds associated with Tropical Cyclones and Nor'easters that cause storm surge, will be addressed in **Section 4.3.2.**

Storm Surge:

According to the National Hurricane Center, storm surge is an abnormal rise of coastal water generated by a storm, over and above the predicted astronomical tides. The rise in water level occurs primarily due to winds pushing water toward the shore (NOAA|NHC. *Storm Surge*). More specifically, "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 that, 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-219).

The magnitude of storm surge within a coastal basin is governed by the meteorological parameters of the storm event and the physical characteristics of the basin. Rather than characterize the extent of storm surge itself, it is more functional to characterize the extent of the event causing the surge. As outlined in the RI-SHMP (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-219), the meteorological aspects of storm surge include:

- Hurricane size – measured by the radius of the 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 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

Storm surge may push sea water up coastal rivers and inlets, blocking the downstream flow of inland runoff; inundate large swaths of developed and forested land with saltwater or freshwater; damage coastal habitats; damage natural and manmade structures; erode beach material; carry debris out to sea; strand residents in flooded areas and hamper rescue efforts by cutting off escape routes; and pose a serious threat of death by drowning (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-113). When storm surge coincides with normal high tide or higher king tides, coastal flooding can be exacerbated. In the future, as sea levels continue to rise, the inundation area subject to coastal flooding and storm surge will continue to move inland.

NOAA tracks coastal flooding from tidal gauges, such as the one in Providence, which continuously measure water levels. The data collected measures the height of the tides, tracks long-term local relative sea level rise (SLR), and is used to detect coastal floods. Warnings of coastal storms usually occur several days before impact allowing areas vulnerable to storm surge to prepare and evacuate if necessary.

High Tide Flooding:

High tides may cause *nuisance* coastal flooding. "Tides are long-period waves that roll around the planet as the ocean is "pulled" back and forth by the gravitational pull of the moon and the sun as these bodies interact with the Earth in their monthly and yearly orbits" (NOAA. *What*). "Unlike a 24-hour solar day, a lunar day lasts 24 hours and 50 minutes. This occurs because the moon revolves around the Earth in the same direction that the Earth is rotating on its axis. Therefore, it takes the Earth an extra 50 minutes to "catch up" to the moon. Since the Earth rotates through two tidal "bulges" every lunar day, we experience two high and two low tides every 24 hours and 50 minutes. High tides occur 12 hours and 25 minutes apart, taking six hours and 12.5 minutes for the water at the shore to go from high to low, and then from low to high" (NOAA. *Tides and Water*).

"Sea level isn't the same every single day, according to Bryan Oakley, a WHC science advisor, Westerly resident, and professor of environmental geoscience at Eastern Connecticut State University. Spring tides are a foot or two more above an average high tide, and king tides are even greater" (Sherman). "King tides occur during a perigean (when Moon is closest to Earth) spring tide (full and new moon); in other words, a full or new moon must co-occur when the Moon is closest to Earth in its elliptical orbit. Due to their astronomical nature, king tides are regular and predictable events, reoccurring multiple times a year" (North Carolina).

"During extremely high tides, the sea literally spills onto land in some locations, inundating low-lying areas with seawater until high tide has passed. Because this flooding causes public inconveniences such as road closures and overwhelmed storm drains, the events were initially called nuisance flooding. To help people understand the cause of these events, they are now referred to as high-tide floods. Over longer periods, chronic flooding can strain city budgets and compromise infrastructure. As global sea level rises, so will the frequency and depth of high-tide flooding" (US Climate Resilience Toolkit. *High-Tide*).

Location

Coastal flooding is a particular concern to Westerly because of its extensive southern shoreline. Most of Westerly's coast is low-lying and therefore vulnerable to flooding. There are only a few elevated shoreline areas such as southeast of Bluff Avenue and Larkin Road, and Bear Hill located east of Lighthouse Road.

The areas most susceptible to storm surge are those in the Velocity Zone (**Figure 4-11**) and those impacted by a Category 1 or higher hurricane (**Figure 4-16**). Based on 2020 FEMA FIRM data, approximately 13 percent (549 acres) of Westerly's landmass is within Zone VE. The Velocity Zone includes the coastal barrier beaches that separate the Maschaug, Little Maschaug, Winnapaug, and Quonochontaug Salt Ponds from Block Island Sound. Portions of the land along the north perimeter of these salt ponds are also in the VE Zone. The Velocity Zone also includes a portion of the Watch Hill peninsula (the most southwestern point of Rhode Island) and a smaller peninsula known as Napatree Point. Flood protection along the southern shoreline is minimal, "limited to the natural protection offered by the barrier beaches themselves, a stretch of sand fill placed by the State of Rhode Island at Misquamicut Beach in 1959 and 1960, and a few seawalls" (FEMA. *Flood Insurance Study - 44009CV001B*, 20).

The Town also has considerable coastal area within the A Zone (100-year) along Block Island Sound and the mouth of the Pawcatuck River. The coastal A Zone includes low-lying portions of Watch Hill, Misquamicut Beach, and properties around Maschaug, Little Maschaug, Winnapaug, and Quonochontaug Salt Ponds.

As water depth over a given surface increases with storm surge, large waves can be generated. Storm surge heights in Westerly have ranged from a few feet higher than normal tides during nor'easters to more than 10 feet during the hurricane of 1938. **Figures 4-14 and 4-15** show the impact of storm surge on several areas of Westerly and **Figure 4-16** depicts the areas of Westerly susceptible to storm surge from Category 1-4 hurricanes. **Figure 4-16** is also included at a larger scale in **Appendix 4-2**.

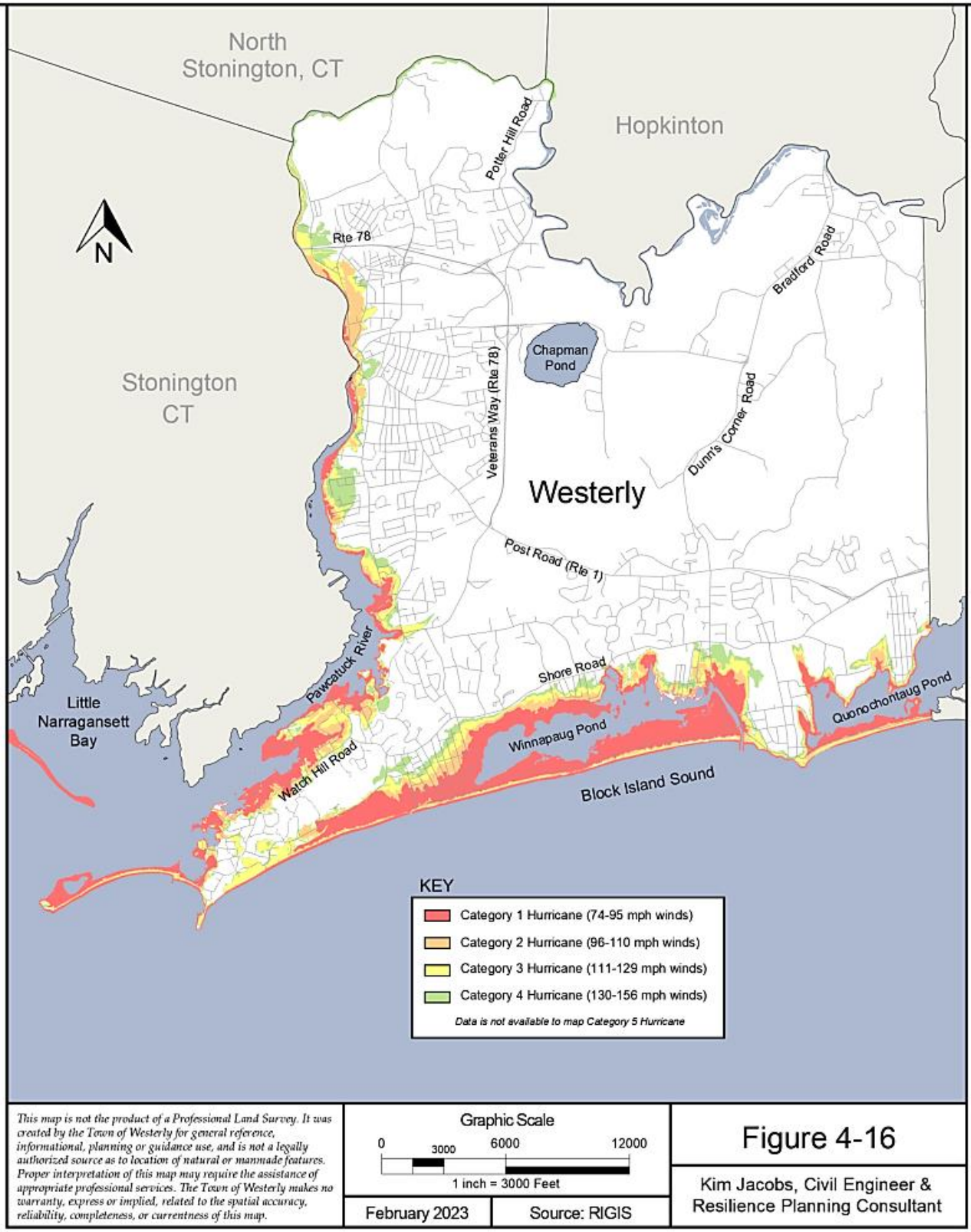
Figure 4-14 Storm Surge Flooding from Superstorm Sandy (October 2012)

Watch Hill Yacht Club and flooding near Bay Street gazebo
Photo Credit: Watch Hill Fire Department

Figure 4-15
Storm Surge Flooding from Tropical Storm Henri (August 2021)

East Beach in Watch Hill
Photo Credit:
Harold Hanka, The Westerly Sun

Hurricane Surge Inundation Areas



This map is not the product of a Professional Land Survey. It was created by the Town of Westerly for general reference, informational, planning or guidance use, and is not a legally authorized source as to location of natural or manmade features. Proper interpretation of this map may require the assistance of appropriate professional services. The Town of Westerly makes no warranty, express or implied, related to the spatial accuracy, reliability, completeness, or currentness of this map.

Graphic Scale

0 3000 6000 12000

1 inch = 3000 Feet

February 2023 | Source: RIGIS

Figure 4-16

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

Previous Occurrences

As shown in **Table 4-6**, which was created from the NOAA|NCEI Storm Events Database, incidents of coastal flooding since 1996 include both minor and significant coastal flooding. Superstorm Sandy, a hybrid storm with both tropical and extra-tropical characteristics, hit Rhode Island in October 2012. Coastal flooding from the storm caused extensive damage to Westerly's beaches, including Misquamicut. In Watch Hill, Main and Bay Streets were flooded. Sand from the dunes was carried several hundred feet, inundating houses and buildings on Atlantic Avenue. Maria's Seaside Café was reported to have 6-feet of sand inside, and the beachside patio at the Andrea Hotel and Resort was pushed through the building causing structural damage (Goonan).

The impacts associated with coastal flooding and storm surge are further identified in Table 4-12, which lists tropical depressions/storms and hurricanes that have impacted the region. The two hurricanes with the largest storm surge in Rhode Island were the Hurricane of 1938 (15 feet) and Hurricane Carol of 1954 (14 feet). Both of these resulted in widespread destruction in the community. **Coastal flooding can also occur as a result of snow melt from significant winter storms, such as those identified in Table 4-14.**

Table 4-6 Coastal Flooding Events - Washington County 1996-2021 (NOAA|NCEI. *Storm Events Database*)

Begin Date	Key Event Information (no deaths or injuries reported for any of these events)	Property Damage
01/10/1997	**Event:** Coastal Flood **General Description:** A combination of a new-moon high tide and southeast winds that became southwest and gusted to 40 to 50 mph resulted in a storm tidal surge which reached 2 to 4 feet on Narragansett and Mount Hope Bays. There is the possibility that a "gravity wave" (which results in rapid changes in wind and atmospheric pressure fields) may have played a part in this sudden and unexpected flooding event. Overall, the flooding was considered minor and there was no structural damage or road washouts**.**	-----
10/28/2006	**Event:** Coastal Flood (*also Flood*) **General Description:** This system brought damaging winds to much of central and southern Rhode Island, where trained spotters and amateur radio operators reported many downed trees and power lines. Wind gusts were estimated near 60 mph on Block Island. About 10,200 customers were left without power throughout the state, as reported by the media. Rainfall totals of 2 to 4 inches produced significant urban flooding from greater Providence to South Kingstown. Significant coastal flooding occurred as a result of the storm.	2K
04/15/2007	**Event:** Coastal Flood (*also Flood*) **General Description:** This storm brought a variety of impacts, including damaging winds in excess of 60 mph, widespread river and stream flooding, and significant coastal flooding through several high tide cycles. East to northeast winds gusted as high as 60 mph. There were widespread reports of downed trees, large branches, and power lines, especially in southern Rhode Island and as far inland as Providence. Rainfall totals of 3 to 5 inches, combined with wet antecedent conditions, resulted in widespread river and stream flooding, as well as significant flooding of urban areas. Many small streams throughout Rhode Island also rose out of their banks and flooded nearby areas, including roadways. Along the South Coast, the worst coastal flooding occurred with the morning high tide on the 16th, where flood waters and debris closed several shore roads. Large boulders that washed ashore had to be removed with snow plows, according to media reports.	48K
03/08/2008	**Event:** Coastal Flood **General Description:** Heavy rain coinciding with spring snowmelt contributed to river flooding, especially along the Connecticut River. In addition, rainfall totals of two to three inches resulted in areal flooding across much of the region. In coastal areas, high astronomical tides combined with rough seas and storm surge to produce minor coastal flooding.	-----
08/22/2009	**Event:** Coastal Flood **General Description:** Although well offshore, Hurricane Bill resulted in heavy rainfall, high surf, and coastal flooding along portions of the Southern New England shoreline.	-----

Begin Date	Key Event Information (no deaths or injuries reported for any of these events)	Property Damage
10/29/2012	**Event:** Coastal Flood **General Description:** Superstorm Sandy, a hybrid storm with both tropical and extra-tropical characteristics, brought high winds and coastal flooding to southern New England. In Southern New England, Rhode Island was hardest hit. A peak wind gust of 86 mph occurred in Westerly, and nearly the entire Rhode Island shoreline experienced moderate to major coastal flooding. Numerous power outages occurred with winds gusting to 60 mph over the interior and to 80+ mph along the south coast. Major coastal flooding struck the Rhode Island ocean exposed south coast during the Monday evening high tide. This storm tide, especially destructive across shorelines in Westerly, Charlestown, South Kingston, Narragansett, and Block Island, rivaled the impact from Hurricane Bob in 1991. Along the Rhode Island south coast, the damaging coastal flooding was fueled by a storm surge around 5 feet and waves of 30+ feet that propagated on a long fetch into Block Island and Rhode Island Sounds. A survey of impact along Misquamicut Beach revealed an inundation extent consistent with the upper boundary of a category 1 Hurricane and very severe erosion. It should also be noted that the previous high tide during Monday morning produced minor to moderate impacts along the Rhode Island coast and likely weakened dunes and other coastal structures in advance of the more destructive Monday evening high tide. The Rhode Island coastline in Washington County, stretching from Westerly to Narragansett was devastated by coastal flooding associated with Superstorm Sandy. Much of the coastline is composed of barrier beaches, very shallow strips of land with the Atlantic Ocean on the south side and ponds on the north side. As Sandy moved northward up the eastern seaboard, it built strength, and as it turned to the west, eventually making landfall in New Jersey, these high seas (measured at 31 feet on the Block Island buoy) hit the Rhode Island coast over multiple tide cycles. This continuous battering of high seas, washed beaches inland exposing bedrock and other sand dune anchors. Some houses on the beach were washed clean off their foundations. Others with breakaway construction on the ground level indeed broke away with ocean water flooding the oftentimes now finished ground levels through to the other side of the house. There were four beaches/areas that were particularly hard hit – Roy Carpenter's Beach and Green Hill Beach in South Kingstown, Charlestown Breachway in Charlestown, and Misquamicut Beach in Westerly. The area of Misquamicut Beach was asked to evacuate and remained evacuated through at least Tuesday. Sand dunes missing from the beaches washed through houses onto Atlantic Avenue, normally some 200 feet from the ocean, piling up to six feet high in spots, completely blocking Atlantic Avenue. The Andrea Hotel and Resort's beachside patio was pushed through the building on ocean waters. Six feet of sand was washed into Maria's Seaside Cafe and crashing ocean waves caused significant structural damage. Several other beach side businesses sustained extensive damage. In Watch Hill, Main and Bay Streets were flooded with ocean water.	7.8M
02/09/2016	**Event:** Coastal Flood **General Description:** A very powerful low pressure system tracked up the east coast, bringing heavy snow and gusty winds.	-----

High Tide Flooding along Westerly Coastline:

Westerly has some extremely low-lying coastal areas which regularly experience high-tide flooding. These include sections along Atlantic Avenue, Breach Drive, and Winnapaug Road, as well as areas in Watch Hill and Napatree Point. "The Napatree Point access route and Larkin Square in Watch Hill are on the verge of inundation. The water level is mere inches below the adjacent concrete on a calm day. During high and king tides, waves easily breech the seawall near the Watch Hill Yacht Club, submerging parts of the parking lot and blocking the access point to a popular conservation area. In 2019 alone, Napatree Point access was flooded and became impassable on 121 days, according to Peter August, chair of the WHC (*Watch Hill Conservancy*) science advisors and retired professor of ecology at the University of Rhode Island" (Sherman).

Repetitive Loss:

The National Flood Insurance Program (NFIP) documents 55 Repetitive Loss (RL) properties in Westerly as of August 4, 2022. There are currently 32 residential and 23 commercial RL properties. However, the Town has submitted for removal of 9 structures from this list due to various modifications (demolition, elevation, etc.). A Repetitive Loss (RL) property is any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling ten-year period, since 1978. A RL property may or may not be currently insured by the NFIP. Additional information on FEMA Flood Zones, Repetitive Loss Properties, and the National Flood Insurance Program is provided in **Section 4.4.2.1**.

Figure 4-17
Coastal Flooding in Watch Hill During a High Tide
Photo Credit: Janice Sassi

Climate Change Impacts

As highlighted by Climate Central in **Figure 4-18**, coastal floods driven by climate-linked sea level rise, are increasing. The EPA recognizes that, "Climate change threatens coastal areas, which are already stressed by human activity, pollution, invasive species, and storms" (EPA. *Climate Impacts on Coastal Areas*). Sea level rise will impact development along the coast and could erode and inundate coastal ecosystems and eliminate wetlands. As the sea level rises, high tide flooding will become more destructive. "Coastal areas are also vulnerable to increases in the intensity of storm surge and heavy precipitation. Storm surges flood low-lying areas, damage property, disrupt transportation systems, destroy habitat, and threaten human health and safety" (EPA. *Climate Impacts on Coastal Areas*). Additional general information associated with the impacts of sea level rise (SLR) is provided in **Section 4.1.2**.

"According to the National Climate Assessment, coastal flooding in the northeast has increased due to a rise in sea level of around one foot since 1900. And in the future, if we continue to emit greenhouse gases, global sea levels are expected to rise one to four feet by 2100. Specifically in the coastal Northeast, due to the natural sinking of land, sea levels are likely to rise even ***higher*** than the global average. A sea level rise of two feet would more than triple the frequency of coastal flooding across the Northeast, without any change in storms" (Di Liberto).

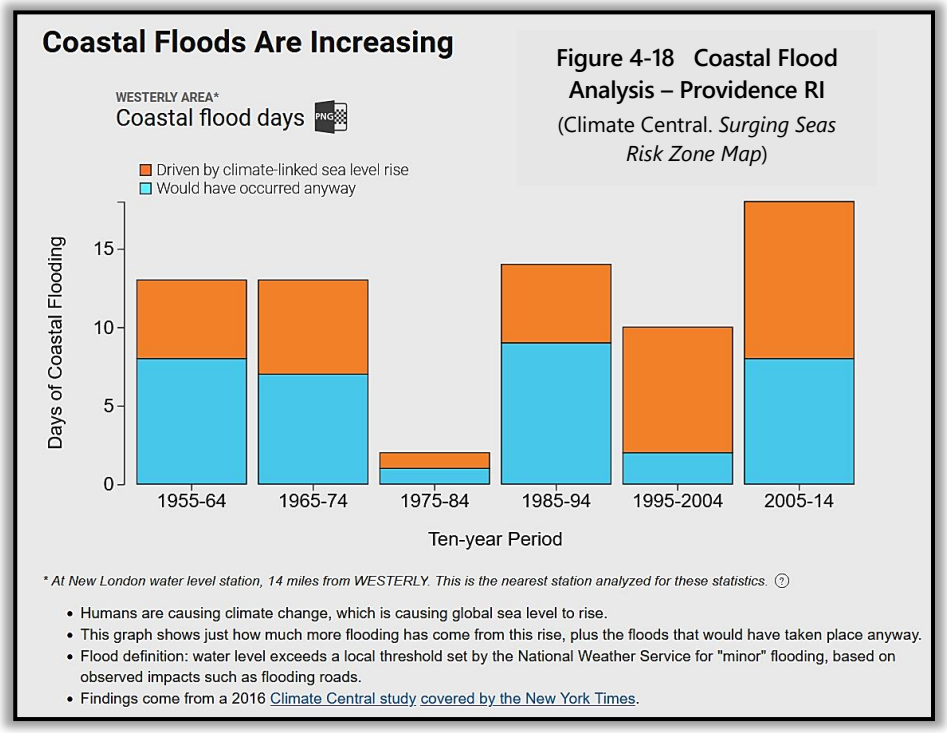


Figure 4-18 Coastal Flood Analysis – Providence RI
(Climate Central. *Surging Seas Risk Zone Map*)

Probability of Future Events

Flooding is the most prevalent and frequent natural hazard that impacts Rhode Island. As a low-lying community with roughly nine miles of shoreline, coastal flooding is highly probable and may have serious consequences for the Town of Westerly. FEMA has determined that properties in A or V Zones have a 26% chance of flooding over the life of a 30-year mortgage (FEMA. *Unit 3,* 3-4 & 3-5).

Climate change and sea level rise will further exacerbate the impacts from flooding. Long term, even in the absence of a storm event, the projected rise in sea level alone would have a dramatic impact on the base flood elevations in Westerly. As sea levels continue to rise, the inundation area subject to coastal flooding and storm surge will continue to move inland.

> As a low-lying community with 9± miles of coastline exposure to Block Island Sound, coastal flooding is highly probable and may have serious consequences for the Town of Westerly.

If currently undeveloped coastal land, including wetlands, along the shoreline remain undeveloped, it will help minimize the effects of localized flooding until SLR engulfs the land. Westerly has a fair amount of undeveloped coastal property including the coastal barrier beaches that separate the Maschaug, Little Maschaug, Winnapaug, and Quonochontaug salt ponds from Block Island Sound, and the Napatree Point Conservation Area. There are also significant tracts of undeveloped land along the north shorelines of Winnapaug and Quonochontaug Ponds, which also provide flood storage capacity when the ponds have reached their limits.

4.3.1.3 Coastal Erosion

Description and Extent

"Coastal erosion is the process by which local sea level rise, strong wave action, and coastal flooding wear down or carry away rocks, soils, and/or sands along the coast. All coastlines are affected by storms and other natural events that cause erosion; the combination of storm surge at high tide with additional effects from strong waves—conditions commonly associated with landfalling tropical storms—creates the most damaging conditions. The extent and severity of the problem is worsening with global sea level rise, but it differs in different parts of the country, so there is no one-size-fits-all solution" (US Climate Resilience Toolkit. *Coastal*). In addition to the natural processes that cause coastal erosion, human influences, such as development or manmade structures along the shoreline, impedes the natural dynamic coastal system and increases erosion.

While measurable coastal erosion may occur during a storm event, for planning purposes the extent is assessed over extended periods of time. Comparing aerial photographs provides insight into coastal erosion trends. According to the State Coastal Council, the average coastal erosion rate is 1.9 feet per year in Rhode Island (CRMC. *Shoreline Change SAMP Volume I*, 2-14). Extreme high tides, or king tides, occur several times a year, inundating low-lying shoreline areas such as sections of Watch Hill and Misquamicut. Such events threaten to worsen erosion if coupled with wave energy produced by storms.

"The beaches, barrier spits, and coastal bluffs of Rhode Island are vital economic, environmental, and cultural resources. A wide, healthy sand beach provides protection against the effects of storm surge, coastal flooding, and high surf impacts. The beach and barrier environment provide habitat for marine and terrestrial organisms with beach dependent life stages and are home to species of indigenous and endemic Rhode Island plants. Beaches, barrier spits, and coastal bluffs are also the basis for the tourism industry" (Town of Westerly RI. *Comprehensive*, 247).

"Coastal erosion threatens both waterfront property and fragile shoreline habitats, and can affect Westerly's shoreline even during moderate coastal storms. In addition, the predicted increase in global sea-level rise will exacerbate coastal erosion as lower intensity storms cause greater amounts of damage and flooding than their historic counterparts. Westerly is composed of headland beaches and barrier beaches, which experience erosion at different rates. Barrier beaches tend to be more dynamic, losing sand at times and then regaining it through natural processes, while headland beaches tend to only erode, resulting in lost beach area" (VHB, 51).

In 2018 the State adopted the RI Shoreline Change Special Area Management Plan (Beach SAMP) which is an outstanding tool to plan for climate change, including coastal erosion, increased storm events, and flooding from sea level rise. In addition to STORMTOOLS, an online mapping tool that shows storm surge and sea level rise scenarios for the entire Rhode Island coastline, the SAMP also provides shoreline change maps showing the extent of coastal erosion over time. The links to access the shoreline change maps for Westerly have been included under ***Previous Occurrences***.

A report prepared for FEMA by the Heinz Center in 2000, stated that "Over the next 60 years, erosion may claim one out of four houses within 500 feet of the U.S. shoreline" (Heinz Center, 150). Sea wall failure and coastal erosion are related issues which will increasingly impacting some of Westerly's coastal neighborhoods. Rising sea levels have led to increased rates of erosion along beaches and coastlines and the undermining of protective walls, some of which are many decades old. Sea walls protect the structures behind them and their failure can lead to increased property damage from storms. Similarly, intact beaches with dunes dissipate wave energy, protecting buildings behind them. As beaches erode, this protection is lost. Rather than sea walls, the top choice for new shoreline protection projects are beaches, marshes, or other natural improvements that more closely mimic coastlines because these do a better job dissipating/absorbing wave energy.

Location

All of Westerly's shoreline, is susceptible to the impacts of coastal erosion. While storm surges can cause abrupt changes, many areas are also being continually impacted by the regular movement of the tides. Of particular concern are the following areas: Atlantic Beach, Maschaug Pond, Misquamicut Headland, Napatree Beach, Quonochontaug Barrier, Watch Hill, Weekapaug Breachway, and Weekapaug Headland.

Westerly is composed of headland beaches and barrier beaches. "The headlands and barrier beaches of the south shore, ranging from Watch Hill in Westerly to Point Judith in Narragansett, are generally eroding at a higher rate than other shorelines along the Rhode Island coast. According to the Rhode Island Sea Grant program, East Matunuck State Beach, Misquamicut State Beach, and South Kingstown Town Beach combined lost over 400 feet of beach combined from 1974 to 2014, in comparison to 250 feet lost on average for Rhode Island's total coastline from 1964 to 2014. Of the six shoreline types found in Rhode Island, beaches and barrier spits are the most susceptible to erosion. About seven of Westerly's nine miles of coastline are comprised of these unconsolidated sediments, with the exceptions being rocky headlands located at Watch Hill Point and Weekapaug Point" (Town of Westerly RI. *Comprehensive*, 247).

The Watch Hill Fire District maintains a revetment in Watch, which if undermined by coastal erosion may fail and compromise adjacent roadway, infrastructure, and upland public and private properties.

In addition, as the coastline moves inland, coastal salt marshes that have nowhere to migrate will be lost. This may occur in the areas surrounding the salt ponds, such as Weekapaug and Weekapaug Terrace, Watch Hill, Misquamicut, and Shelter Harbor.

Previous Occurrences

Over time, sea level rise coupled with severe coastal storms, has caused erosion along Westerly's shores. Coastal erosion has narrowed beaches; compromised coastal salt marshes; and undermined revetments, road beds, public infrastructure, and coastal homes.

In October 2012, "Superstorm Sandy caused significant erosion to beaches and dunes in Misquamicut. In the following year, with assistance from the USACE, the Town began a project to repair the damage on the beach caused by the storm through a sand replacement project. A significant portion of the sand, unfortunately, washed out to sea in succeeding years. The most significant local example of the impact of coastal erosion diminishing or resulting in the loss of beach area, though, is Sandy Point. In 1938, Sandy Point was permanently severed from mainland Rhode Island as a result of the high winds and storm surge resulting from the 1938 New England Hurricane" (Town of Westerly RI. *Comprehensive*, 248).

Figure 4-19 Erosion along Westerly Town Beach (October 2018)

Photo Credit: Save The Bay

The Coastal Resources Management Council (CRMC) has documented shoreline change and average erosion rates for coastal areas throughout Rhode Island. Although coastal erosion does not occur linearly over time, the maps depict an average annual historic rate of change. This rate of change is recognized solely as a planning tool and used to guide CRMC regulatory decisions related to coastal activities, including setbacks from coastal features.

The Town of Westerly Shoreline Change Maps produced by CRMC, documenting the erosion from 1939 to 2014 in the following eight areas, are provided below:

- Westerly_Atlantic-Beach
- Westerly_Maschaug-Pond
- Westerly_Misquamicut-Headland
- Westerly_Napatree-Beach
- Westerly_Quonochontaug-Barrier
- Westerly_Watch-Hill
- Westerly_Weekapaug-Breachway
- Westerly_Weekapaug-Headland

Climate Change Impacts

Climate change is expected to continue intensifying storms and produce rising sea levels. "Coastal erosion is expected to increase due to the increase in storm intensity and associated flooding. The IPCC (2017) found that coastal and low-lying areas have been experiencing increased erosion, and will continue to do so, due to sea level rise, in North America and throughout the world. Erosion has been noted to be of particular concern in the northeastern U.S. In their study of climate change impacts in the Northeastern U.S., Horton et al. (2014) noted that increased rates of coastal erosion are likely to compromise aging coastal infrastructure, including transportation, communications, and energy infrastructure" (CRMC. *Shoreline Change SAMP*, 2-13 & 2-14).

To assist communities to predict the potential impact to Rhode Island shorelines, CRMC, in partnership with the University of Rhode Island, developed the Shoreline Change Special Area Management Plan (Beach SAMP). As recognized in the SAMP, "In Rhode Island, coastal erosion is of particular concern because it is characterized by a storm-driven coastline…Studies of shoreline change in Rhode Island have documented an average annualized rate of shoreline change of 0.57 meters/year (1.9 feet/year), though these annualized rates should be used with caution because coastal erosion is not a gradual process, but rather the result of abrupt changes due to storms" (CRMC. *Shoreline Change SAMP*, 2-14). CRMC further indicates that, "Scientists' understanding of coastal erosion and other coastal processes is rapidly evolving, particularly with regard to how processes are changing due to changing climate trends and what may happen in the future" (CRMC. *Shoreline Change SAMP*, 2-14).

Probability of Future Events

The likelihood of continued coastal erosion is high and will be accelerated with sea level rise and more frequent and intense storms.

It should be noted that FEMA's post hazard event management practices indicate that reconstruction or repair funding for coastal protection structures will only be made available where the damage can be directly attributed to the storm event. Therefore, in order to receive this funding, the Town must maintain records of maintenance and repair activities that demonstrate the status of each structure. The Town's aerial imagery will be beneficial in qualifying future storm damage claims.

WIND-RELATED HAZARDS

4.3.2 Wind-Related Hazards

Wind is the natural movement of air caused by a difference in pressure from one place to another. Local wind systems are created by the immediate geographic features in a given area, such as mountains, valleys, or large bodies of water. Wind effects can include blowing debris, interruptions in elevated power and communications utilities, and intensification of the effects of other hazards related to winter weather and severe storms (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-134). In this Section, wind-related hazards will be discussed in terms of the following four categories:

4.3.2.1 High Winds

4.3.2.2 Thunderstorms including Lightning and Hail

4.3.2.3 Tornadoes

4.3.2.4 Tropical Cyclones (Tropical Depressions, Tropical Storms, and Hurricanes)

4.3.2.1 High Winds

Description and Extent

The wind is air moving from an area of high pressure to an area of low pressure. As identified below, there are several types of damaging winds, and high winds can accompany various types of storms including thunderstorms, tropical cyclones (which includes tropical depressions, tropical storms, and hurricanes), and nor'easters. Thunderstorms and tropical cyclones are discussed in **Subsections 4.3.2.2 and 4.3.2.4**, respectively, and nor'easters are addressed in **Section 4.3.3 Winter-Related Hazards**

Types of Damaging Winds (NOAA|NSSL. *Severe Weather 101 - Damaging Winds*)

- **Straight-line wind:** is a term used to define any thunderstorm wind that is not associated with rotation, and is used mainly to differentiate from tornadic winds.
- **Downdraft:** is a small-scale column of air that rapidly sinks toward the ground.
- **Macroburst:** is 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. To visualize this process, imagine the way water comes out of a faucet and hits the bottom of a sink. The column of water is the downdraft and the outward spray at the bottom of the sink is the macroburst. Macroburst winds may begin over a smaller area and then spread out over a wider area, sometimes producing damage similar to a tornado. Although usually associated with thunderstorms, macrobursts can occur with showers too weak to produce thunder.

- **Microburst:** is a small concentrated downburst that produces an outward burst of strong winds at or near the surface. Microbursts are small — less than 4 km across — and short-lived, lasting only 5 to 10 minutes, with maximum windspeeds sometimes exceeding 100 mph. There are two kinds of microbursts: wet and dry. A wet microburst is accompanied by heavy precipitation at the surface. Dry microbursts, common in places like the high plains and the intermountain west, occur with little or no precipitation reaching the ground.

Table 4-7 Beaufort Wind Scale (NOAA)

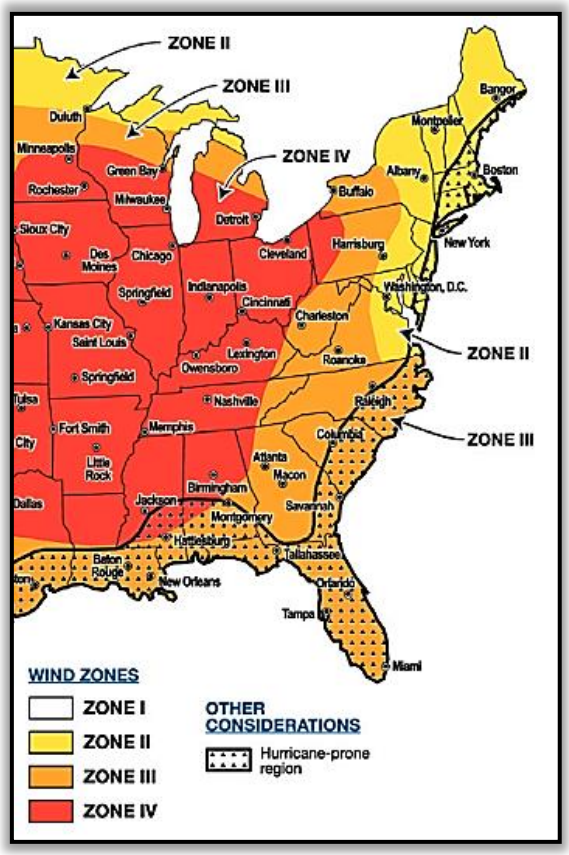
Beaufort Number	Wind Speed (mph)	Description
0	< 1	Calm
1	1-3	Light Air
2	4-7	Light Breeze
3	8-12	Gentle Breeze
4	13-18	Moderate Breeze
5	19-24	Fresh Breeze
6	25-31	Strong Breeze
7	32-38	Moderate Gale
8	39-46	Fresh Gale
9	47-54	Strong Gale
10	55-63	Whole Gale
11	64-72	Storm
12	> 73	Hurricane Force

Although anemometers, which measure wind speed and wind pressure, can be found at almost all weather stations, the Beaufort Wind Scale (**Table 4-7**), created in 1805, is still used today as a standardized scale for characterizing observed wind conditions.

FEMA has produced a Wind Zone Map (**Figure 4-20**) based on historic tornado and hurricane data, that depicts maximum wind speeds and is applicable in designing structures to withstand these forces. Rhode Island is included in Wind Zone II which identifies the maximum speed for the design of safe rooms (160 mph).

High winds can cause damage to structures, property, vehicles, utility lines, vegetation, and the shoreline, as well as bodily injury from flying debris or structures collapsing. Loss of power and internet/telephone cable can disrupt daily routines and businesses, spoil refrigerated food, and result in lack of heat, which can lead to dangerous health conditions and the potential for pipes to freeze and burst if occurring in conjunction with freezing temperatures. Additionally, high winds may exacerbate fire conditions by drying out the ground cover, propelling fuel around the region, and increasing the ferocity of existing fires.

Figure 4-20 Wind Zone Map (FEMA)



Location

While all of Rhode Island is at risk from high winds(120 mph), due to its proximity to the coast, Washington County has the greatest risk. As discussed in other Subsections, the south shore of Rhode Island is particularly susceptible to tropical cyclones (which includes tropical depressions, tropical storms, and hurricanes).

The Town of Westerly has two wind zone designations 110 and 120 mph. The delineating line follows Rt1A heading south and then west along Shore Road, turning north along Winnapaug Road until it intersects with Watch Hill Road. Westerly enforces the RI State Building Code, which currently requires new buildings south of Rt1A be designed to withstand wind speeds of 120 mph (Category 3 hurricane). However, there are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to damage from high winds.

The natural and built environment along the southern shoreline in Westerly is at higher risk to wind-related damage. Commercial and residential properties along Atlantic Avenue, in the community of Misquamicut, and in Watch Hill, Weekapaug, and Shelter Harbor have been impacted by high-wind events on numerous occasions. Key vulnerable natural environments prone to wind damage include Westerly's two municipal beaches, Misquamicut State Beach, the "Sand Trail", a barrier beach on the south shore of Quonochontaug Pond, and Napatree Point Conservation area, which is a sandy spit extending westward from Watch Hill's commercial zone.

Previous Occurrence

Most of the damaging wind events that occur in Westerly will be associated with another hazard category (tropical storm, hurricane, tornado, or nor'easter).

Figure 4-21 Large tree Downed from Wind Gusts (November 2, 2020)
Photo Credit: Harold Hanka, The Westerly Sun

Climate Change Impacts

In November 2019, *Scientific American* published an article titled *The World's Winds Are Speeding Up*. It discussed the recent findings from a study published in the *Nature Climate Change* journal. For several decades, starting in the 1970s, global winds had been decreasing. The study found that, "winds across much of North America, Europe and Asia have been growing faster since about 2010. In less than a decade, the global average wind speed has increased from about 7 mph to about 7.4 mph. Using models to investigate the factors that influence the behavior of global winds, the researchers found that big climate patterns - which affect temperatures in certain parts of the world - have a major influence on wind speeds" (Harvey). While it is widely agreed that temperatures all over the Earth are steadily rising as a result of human-caused climate change, the study speculates that within that larger, long-term warming pattern, there will be natural cycles - which could last decades at a time - that osculate between warmer and cooler periods. The shifting between these cycles may trigger shifts from slower to faster wind speeds. Continued research is needed to determine how the overall warming trend from climate change will impact long-term wind speeds (Harvey).

Probability of Future Events

Based on historical occurrences and climate change projections, Westerly can expect an event characterized as *High Wind* to occur annually.

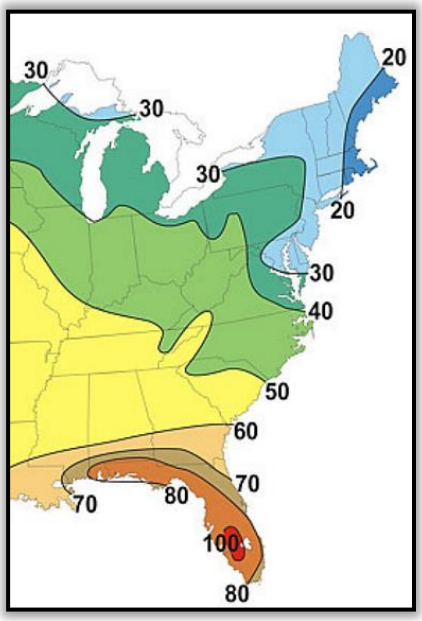
4.3.2.2 Thunderstorms including Lightning and Hail

Description and Extent

"Thunderstorms typically develop in the warmer months of spring, summer, and fall, but they can occur at any time of the year over most of the United States. There are three basic ingredients needed for thunderstorm development: moisture, an unstable atmosphere, and some way to start the atmosphere moving" (NOAA|NWS. *Understanding*). Thunderstorms "have the potential to produce lightning, hail, tornadoes, powerful straight-line winds, and heavy rains that produce flash flooding" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-199).

A warning is issued if a thunderstorm is classified as severe - having destructive winds exceeding 58 mph, hail at least one (1) inch in diameter, or a tornado. However, as thunderstorms can form within 30 minutes, the opportunity for warnings to be issued and heeded is limited. As illustrated in **Figure 4-22**, on average 20 thunderstorms occur annually in Rhode Island. However, according to NOAA, only about 10% of thunderstorms are categorized as severe (NOAA|NWS. *Introduction to Thunderstorms)*.

Figure 4-22 Average Annual Number of Thunderstorms (NOAA|NWS)



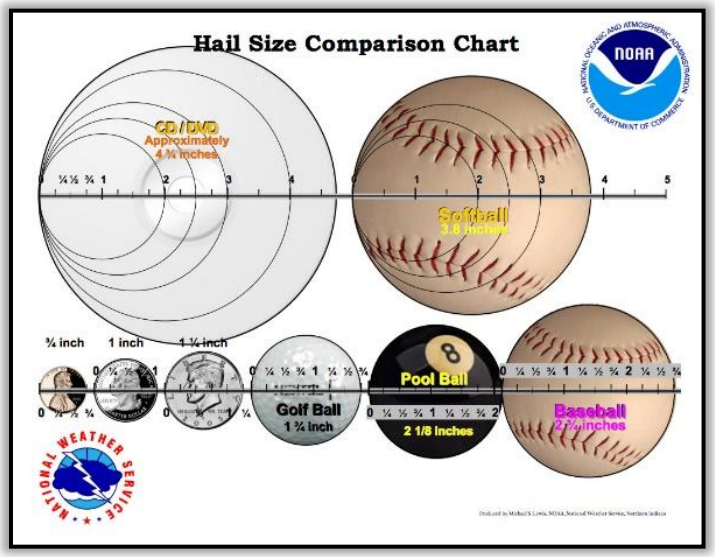


Figure 4-23 Hail Size Comparison Chart (NOAA|NWS)

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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-199). Hail primarily occurs during the summer months in Rhode Island and has the potential to damage cars and buildings, as well as devastate farm fields during the growing season. The National Weather Service (NWS) classifies hail by diameter size (5 mm diameter or greater) and relates it to everyday objects as shown in **Figure 4-23**.

Lightning

All thunderstorms produce lightning, which causes the thunderous noise. Lightning can strike from any part of the storm, as far as 10 miles away from the rainfall area, or strike after the storm has passed. "Lightning is a giant spark of electricity in the atmosphere between clouds, the air, or the ground. In the early stages of development, air acts as an insulator between the positive and negative charges in the cloud and between the cloud and the ground. When the opposite charges build up enough, this insulating capacity of the air breaks down and there is a rapid discharge of electricity that we know as lightning. The flash of lightning temporarily equalizes the charged regions in the atmosphere until the opposite charges build up again. Lightning can occur between opposite charges within the thunderstorm cloud (intra-cloud lightning) or between opposite charges in the cloud and on the ground (cloud-to-ground lightning)" (NOAA|NSSL. *Severe Weather 101 – Lightning*). Higher lightning flash density indicates a more severe lightning hazard event. Lightning events are generally measured by the damage they produce. Lightning injures hundreds of people in the U.S. annually, with strike victims often suffering from long-term weakness and fatigue, muscle spasms, chronic pain, sleep disorders, memory loss, and depression. Lightning strikes can also ignite urban and wildland fires (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-199).

Location

Although Rhode Island has a low incidence of lightning-related fatalities and damages, all areas of Westerly are vulnerable to severe thunderstorm.

Previous Occurrences

As depicted in **Figure 4-19**, Rhode Island experiences approximately 20 thunderstorms a year. According to NOAA, only about 10% of thunderstorms that occur are categorized as severe (NOAA|NWS. *Introduction to Thunderstorms)*. One of the most recent events occurred on August 4, 2015. A line of severe thunderstorms, with wind gusts of 60 to 80 mph, caused significant damage across Rhode Island. There were widespread power outages, downed trees and limbs, and massive traffic delays. In Westerly, between 25 and 30 trees were downed, blocking roads in numerous areas of Town. The storm also toppled the Misquamicut drive-in theater screen (NOAA|NCEI. *Storm Events Database*).

The reported severe thunderstorm events (including hail and lightning) for Washington County over the past 20 years has been included in **Table 4-8**. Of these events, only one resulted in injury and death. On November 8, 2004 two men were struck by lightning while fishing at East Matunuck State Beach in Narragansett; both were injured and one succumbed to the injuries a few days after being struck (NOAA|NCEI. *Storm Events Database).*

Table 4-8 NCEI Reported Events for Washington County, RI from 2002-2021

Type	Number of Events	Annualized Events	Property Damages	Annualized Damages
Hail/Marine Hail	16	0.80	---	---
Lightning	6	0.30	$39,000	$1,950
Thunderstorm/Marine Thunderstorm	33	1.65	$164,600	$8,230

NOAA|NCEI. *Storm Events Database*

Climate Change Impacts

Based on a recent article in *Inside Climate News*, "Climate change is making the air warmer, which allows it to hold more moisture, and both of those factors can boost the chance of thunderstorms. One major study from 2014 estimated that, if warming continues at its current pace, the number of lightning strikes in the U.S. could increase by as much as 50 percent by the end of the century, with each additional 1 degree Celsius of warming generating about 12 percent more strikes" (Tigue). In addition to increasing the potential for lightning, global warming also exacerbates drought conditions. This combined result could lead to an increase in lightning strikes igniting wildland/brush fires (Tigue).

Climate change is creating dynamic shifts in weather. A study published in *Geophysical Research Letters* in June 2022 assessed how increasing greenhouse gas concentrations may modify regional climates and influence regional thunderstorm activity. The study concluded that by the end of the century southern Plains states will be getting fewer intense storms, with the East and Northeast getting more. Climate models are increasingly more accurate and being down-scaled to take into consideration regional data. One simulation from this study projects that the Northeast could see more than two weeks of thunderstorm-rich days, with the east coast states getting three to nine more days of storms. This potential shifting thunderstorm trend has ramifications for the eastern states, but is perhaps more dire for the Plains states. The mid-west relies on frequent thunderstorms as a vital water source for crops, many of which are staples for the country (Borunda).

Probability of Future Events

Based on the RI-SHMP, in a given year Rhode Island is highly likely to experience up to 5 thunderstorm wind events, three hail events, and two lightning events (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-204). As thunderstorm events generally have a small range of impact, Westerly may not experience all such events, and can expect less events than the State as a whole.

4.3.2.3 Tornadoes

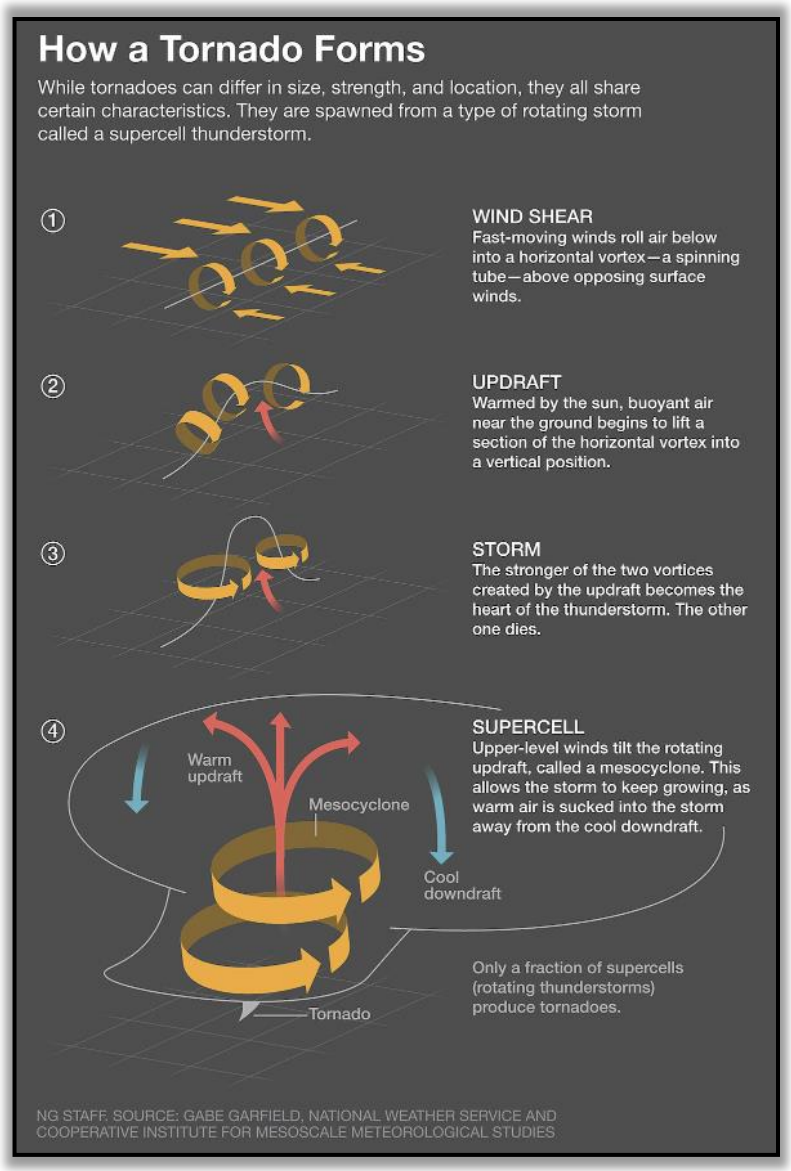
Description and Extent

According to NOAA, "Exactly how and why tornadoes form is not completely understood" (NOAA. *Tornadoes*). However, as illustrated in **Figure 4-24**, scientist do know that **tornadoes develop from thunderstorms** when cold air overrides a layer of warm air, causing the warm air to rise rapidly. They are vertical funnels of violently rotating air extending between a cloud and the surface of the earth. Wind speeds can reach up to 250 mph and create damage paths in excess of one mile wide and 50 miles long. Most tornadoes move southwest to northeast, but tornadoes have been known to move in any direction (National Geographic. *Tornadoes*).

NOAA has observed that the tornado season nationally lasts from March to August, with peak tornado activity normally occurring in April, May, and June. Historically, the highest concentrations of tornadoes have been in the Central U.S. and portions of the Gulf Coast states (NOAA|NSSL. *Severe Weather 101 – Tornadoes*).

"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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-209).

Figure 4-24 How a Tornado Forms (National Geographic)



NOAA|NWS Storm Prediction Center issues tornado and severe thunderstorm watches. 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 should a tornado develop or if a tornado warning is issued. Local National Weather Service 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 (NOAA. *Severe Weather Definitions*).

Tornadoes can be devastatingly destructive to everything in their path, including homes, property, and infrastructure, particularly electrical utilities and communications. In addition to lost revenues, downed power lines present a threat to personal safety. Further, downed wires and lightning strikes have been known to spark fires. A structure's tornado vulnerability is based in large part on building construction and standards. In general, mobile homes and wood-framed structures are more vulnerable to damage from a tornado than steel framed structures. Other factors, such as location and condition/maintenance of trees, also play a significant role in determining vulnerability.

The Fujita scale is used to characterize tornadoes based on the damage they produce and relating that damage to the fastest quarter-mile wind at the height of a damaged structure. The 2007 Enhanced Fujita Scale, shown in **Table 4-9,** improves upon the original scale by including more damage indicators, taking into account construction quality and variability, and providing a more definitive correlation between damage and wind speed (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-210).

Table 4-9 Fujita Scale and Enhanced Fujita Scale (RI-SHMP)

Fujita Scale			Enhanced Fujita Scale	
F Number	Fastest ¼ 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

Location

The area of the U.S. with the highest tornado activity is in the central part of the states between Texas and North Dakota, informally known as Tornado Alley. Though Rhode Island is not a region that is highly susceptible to tornados, it is possible for one to occur anywhere in the region. All areas of Westerly are considered equally exposed to a tornado.

Westerly enforces the RI State Building Code, which currently requires certain buildings along the coast be designed to withstand wind speeds of 120 mph (Category 3 hurricane). This requirement is considered effective in preserving structures from less severe categories of tornadoes and all but the most severe microbursts. There are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to damage from a tornado.

Previous Occurrences

New England does not frequently suffer destruction from tornados, with the region's most serious tornado event occurring in Worcester Massachusetts on July 9, 1953. In that event, 90 people were killed and 1,300 injured. A tornado is reported in southern New England, on average, once every two to three years (NASA - Earth).

Based on NOAA|NCEI Storm Events Database, since 1978 , thirteen tornadoes have impacted Rhode Island; two resulting in 23 people being injured; and nine resulting in property damages totaling 4.71 million dollars. Three of the tornadoes were in Washington County. On August 8, 2018, a tornadic waterspout moved northward over the southern portion of Block Island downing numerous trees and caused about $50,000 in property damages. On November 13, 2021 three tornadoes touched down in Rhode Island – one in Providence County and the other two in Washington County. In Washington County, one tornado (EF0) touched down just southwest of Dillon Avenue in North Kingstown and caused about $50,000 in property damages. The other tornado (EF1) initially touched down in Stonington, CT and then continued on a northeast track into Westerly, touching down in the vicinity of Center Street. Numerous hardwood trees were uprooted and property damage was approximately $50,000 (NOAA|NCEI. *Storm Events Database*).

Climate Change Impacts

According to the Center for Climate and Energy Solutions (C2ES), "The link between tornadoes and climate change is currently unclear. Current data on tornadoes is inconsistent because measuring the presence of tornadoes relies on eyewitness accounts and aftermath damage assessments rather than quantifiable data. Additionally, it is difficult to identify long-term trends in tornado records, which only date back to the 1950s in the U.S" (C2ES. *Tornadoes*). Additionally, tornadoes are considered too geographically small to be accurately modeled. That being said, multiple studies do suggest that, "the conditions that produce the most severe thunderstorms from which tornadoes may form are more likely as the world warms" (C2ES. *Tornadoes*).

Probability of Future Events

Although tornadoes are a rare occurrence in Rhode Island, a risk does exist, particularly during peak hurricane season (mid-August through October). The RI-SHMP indicates that based on NOAA|NCEI Storm Events Database, "As a whole, Rhode Island has less than 1% probability of a tornado incident occurring in a given year" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, *3-213*).

NOAA's Storm Prediction Center constantly monitors changing weather conditions and is able to provide short-term tornado predictions, but unfortunately, there is no long-term forecasting system that can accurately predict the likelihood of a tornado event. Because of predictive limitations, and because Rhode Island residents do not expect severe tornadoes and may be ill-prepared to respond to such an event, it is important for the community to be signed up for CodeRED Emergency notifications, which are administered by the Town of Westerly. Broadcasting tornado warnings through an extensive communication network is currently the best means for mitigating tornado hazards.

4.3.2.4 Tropical Cyclones (Tropical Depressions/Storms, and Hurricanes)

Description and Extent

"Tropical cyclones, a general term for tropical storms and hurricanes, are low pressure systems that usually form over the tropics. These storms are referred to as 'cyclones' due to their rotation. Tropical cyclones rotate counterclockwise and are among the most powerful and destructive meteorological systems on earth. Their destructive features include very high winds, heavy rain, lightning, tornadoes, and storm surge. As tropical storms move inland, they can cause severe flooding, downed trees and power lines, and structural damage" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-218).

"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 73 mph

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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-218).

According to NOAA, the Atlantic hurricane season runs from June 1 to November 30, with the peak between mid-August and late October (NOAA|NHC. *Tropical*). Hurricanes are categorized according to the Saffir-Simpson Scale depicted in **Table 4-10**, with ratings determined by wind speed and central barometric pressure. Hurricane categories reflect damage potential, which helps to provide public officials and the public-at-large with an understanding of the potential flooding and wind damages an impending storm may inflict. The categories range from one (1) through five (5), with Category 5 being the strongest (winds greater than 157 mph) (NOAA|NHC. *Saffir-Simpson*).

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. The reliability of predicting the path of hurricanes and wind speed has helped allow communities to better prepare for these storms, which lessens the amount of damage to people and property (NOAA|NHC. *NHC Issuance*).

Although the Saffir-Simpson Scale is widely accepted, because storm surge is a complex interaction between storm meteorology, storm track, and the topography of the impacted shoreline, there is no statistical relationship between the Saffir-Simpson classification of a tropical storm and the resulting storm surge (citation, 2018). This is an important distinction because lower category hurricanes may end up causing an unexpected level of destruction due to associated storm surge, as was the case in 2018 when Hurricane Florence was downgraded from a Category 4 to a Category 1 hurricane. Meteorologists warned that the flood and surge potential were still major threats, but many Carolinians chose not to evacuate after Florence was downgraded, resulting in trapping and stranding tens of thousands of people (Young).

Table 4-10 Saffir-Simpson Scale of Hurricane Intensity (NOAA|NHC)

Wind Speed	Type of Damage Due to Hurricane Winds
Category One Hurricane	
74-95 MPH (64-82kt)	Very dangerous winds will produce some damage: Well-constructed frame homes could have damage to roof, shingles, vinyl siding, and gutters. Large branches of trees will snap and shallowly rooted trees may be toppled. Extensive damage to power lines and poles likely will result in power outages that could last a few to several days.
Category Two Hurricane	
96-110 MPH (83-95kt)	Extremely dangerous winds will cause extensive damage: Well-constructed frame homes could sustain major roof and siding damage. Many shallowly rooted trees will be snapped or uprooted and block numerous roads. Near-total power loss is expected with outages that could last from several days to weeks.
Category Three Hurricane	
111-129 MPH (96-112kt)	Devastating damage will occur: Well-built framed homes may incur major damage or removal of roof decking and gable ends. Many trees will be snapped or uprooted, blocking numerous roads. Electricity and water will be unavailable for several days to weeks after the storm passes.
Category Four Hurricane	
130-156 MPH (113-136kt)	Catastrophic damage will occur: Well-built framed homes can sustain severe damage with loss of most of the roof structure and/or some exterior walls. Most trees will be snapped or uprooted and power poles downed. Fallen trees and power poles will isolate residential areas. Power outages will last weeks to possibly months. Most of the area will be uninhabitable for weeks or months.
Category Five Hurricane	
Greater than 157 MPH (137kt)	Catastrophic damage will occur: A high percentage of framed homes will be destroyed, with total roof failure and wall collapse. Fallen trees and power poles will isolate residential areas. Power outages will last for weeks to possibly months. Most of the area will be uninhabitable for weeks or months.

Hurricanes can damage structures, property, and infrastructure, as well as disrupt transportation routes and pose threats to public safety. While strong winds from hurricanes can pose a threat to life and property, the greatest threat posed by hurricanes in Rhode Island is generally heavy rainfall and flooding caused by storm surge. As discussed in **Subsection 4.3.1.2**, wind and pressure forces of a tropical storm, hurricane, or Nor'easter moving across water can create an abnormal rise in water level known as storm surge. When coupled with normal tides, storm surge can raise the mean water level 15 feet or more and cause substantial property damage and risk of injury and death. Hurricanes also have the potential to cause coastal erosion. As storms erode the shoreline, they put adjacent properties at greater risk. A home constructed in the V-zone may be destroyed as the beach erodes and the barrier or headland is washed over by high water in a storm.

Location

The RI-SHMP indicates that Rhode Island is particularly vulnerable to tropical cyclones (tropical depressions, tropical storms, and hurricanes) due to its geographic location and features such as Little Narragansett Bay, which can funnel storm surge northward into the narrower Pawcatuck River, which subsequently amplifies the surge height (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-219, 3-220).

Westerly's coastal location and low elevation town-wide, makes it particularly susceptible to hurricanes with the majority of properties vulnerable to some extent. Hurricane surge values for Category 1 through 4 hurricanes were developed by the National Hurricane Center using the SLOSH (Sea Lake and Overland Surge from Hurricanes) Model. The U.S. Army Corps of Engineers, New England District created a Hurricane Surge Inundation Areas (Worst Case) for Rhode Island GIS layer (2009) to assist emergency management officials in hurricane preparedness and operations. This GIS data was used to produce **Figure 4-16 (provided in Subsection 4.3.1.2)** which depicts Hurricane Surge Inundation areas for Westerly. Under modeled scenarios, even Category 1 and 2 hurricanes can produce storm surges that inundate the Town's southern coastline to Shore Road (Route 1A) in the area of Winnapaug Pond; the area surrounding Quonochontaug Pond; the majority of Watch Hill including Napatree Point; and along the Pawcatuck River from Little Narragansett Bay to approximately Stonington, Connecticut's northern boundary. Although Westerly enforces the RI State Building Code, which currently requires buildings be designed to ultimate wind speeds of 130 mph (Category 2 hurricane), there are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to damage from a tropical storm or hurricane.

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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-223).

As shown in **Table 4-11,** since 1938, there are thirteen documented tropical cyclones that have significantly impacted Rhode Island. An additional fourteenth entry that occurred outside of Rhode Island was included as it impacted Westerly. Tropical storm/depression Hermine (September 5, 2016) had minimal impact on Rhode Island as a whole, but it did cause about $60K in property damage in Westerly.

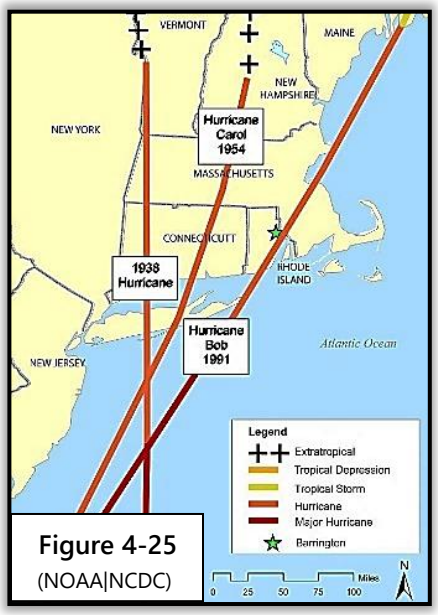


Figure 4-25
(NOAA|NCDC)

Figure 4-25, Hurricane Paths of Significant New England Hurricanes: 1938, 1954, 1991 - illustrates the hurricane paths for three Category 3 hurricanes that directly impacted Rhode Island, causing millions of dollars in damage and hundreds of deaths.

Impacts on Westerly from three historic hurricanes:

Great New England Hurricane of 1938

The Great New England Hurricane of 1938, caused a 12-foot storm surge above high tide in Westerly. In the Watch Hill area, storm surge destroyed Fort Road connecting Napatree Point to the rest of Watch Hill, severed Sandy Point from Napatree Point (creating a 35-acre island in Little Narragansett Bay), damaged numerous vessels in Watch Hill Cove, devastated the forty-four summer cottages on Napatree Point, and caused 24 deaths. The Misquamicut area was also hard hit with storm driven waves passing completely over the narrow barrier beach and destroying over 500 cottages and causing over 50 deaths. The seven inches of rainfall swelled streams within the Pawcatuck River watershed and, combined with the storm surge moving upriver, floodwater overtopped the banks and flooded many homes and businesses in the downtown area. Some homes reportedly had water up to eight feet deep. Throughout Westerly, the high winds flattened trees, steeples, and telephone poles and crippled the Town for weeks (VHB, 32, 33).

Hurricane Carol - 1954

During the post-World War II building boom, many structures were built along Westerly's shoreline in locations leveled by the 1938 hurricane. In 1954, Hurricane Carol pummeled the southern Rhode Island coast at the astronomical high tide, creating a storm surge of roughly 11-feet. Westerly suffered extensive damage but due in part to the National Weather Service warning system that was implemented after the 1938 storm, there were far fewer deaths associated with Hurricane Carol (VHB, 33).

Hurricane Sandy - 2012

Hurricane Sandy in October 2012 is the most recent hurricane to strike Westerly and much of the East Coast. Although Sandy had been downgraded to a Tropical Storm by the time it reached Rhode Island, many parts of the State still experienced considerable damage and approximately 122,000 people in Rhode Island were without power, some for as long as five days. In Westerly, Hurricane Sandy flooded historic Watch Hill village, destroyed many of the sand dunes along Misquamicut Beach, deposited much of the sand along Atlantic Avenue, and as shown in **Figure 4-26**, caused extensive property damage to a number of residences and businesses along Atlantic Avenue. Rhode Island sought and received a federal emergency declaration which provided $39.4 million in support from federal disaster relief programs (VHB, 33).

Figure 4-26 Aerial view of damage along Atlantic Avenue in Misquamicut

Photo Credit: Kris Craig, Providence Journal

Table 4-11 Significant Tropical Cyclones Affecting Rhode Island Since 1938

Name/Date	Category	Wind Speed (mph)	Damage to RI
Great New England Hurricane - 1938 (Sept 21, 1938)	Hurricane: 3	Sustained to 91, gusts to 121	The Rhode Island coastline experienced widespread damage estimated at $100 million, and 262 people lost their lives. 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 – with 10% of electric customers without power for 12 days.
Great Atlantic Hurricane - 1944 (Sept 14-15, 1944)	Hurricane: 3	Sustained to 49, gusts to 90	Affected Rhode Island and southeastern Massachusetts; $2 million in property damage with 701 homes and businesses destroyed and over 12,000 damaged; no loss of life.
Carol (August 31, 1954)	Hurricane: 3	Sustained to 100, gusts to >125	Coastal communities were hit hard; downtown Providence had 13 feet of flooding; storm surge in upper bay was 14 feet; regionally $90 million in damages; 19 fatalities in New England; and most of Rhode Island was without power with some customers not regaining power for 7 days.
Edna (Sept 11, 1954)	Hurricane: 3	Sustained to 95, gusts 110	Inland flooding. Rivers rose several feet above flood stage. Knocked out electrical power.
Diane (August 17-20, 1955)	Tropical Storm	Gusty winds 25-45	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.
Donna (Sept 12, 1960)	Hurricane: 2	Sustained to 95, gusts 130	Moderate storm surge, extensive beach erosion. Wind damage to trees and utility poles causing major power outages.
Esther (Sept 20-21, and 25, 1961)	Hurricane: 3	Strong gales 35-50	Heavy shore damage at Sakonnet Point in Little Compton and Misquamicut in Westerly.
Gloria (Sept 27, 1985)	Hurricane: 2	Sustained to 81, gusts 100	Minor coastal flooding and erosion. Scattered power outages.
Bob (August 19, 1991)	Hurricane: 2	Sustained to 100, gusts >105	Storm surge of 5 to 8 feet, extensive beach erosion; wind damage to trees and utility poles; and 60% of southeast RI lost power.
Irene (August 27, 2011)	Tropical Storm	Sustained to 44, gusts up to 71	Irene knocked down trees and power lines, leaving up to half of Rhode Island residents without power. Storm surge (2-4 feet) in Narragansett Bay caused some coastal damage. However, the majority of damage was caused by wind. Mandatory evacuations were ordered for several Rhode Island areas, including Westerly. High winds caused damage to commercial and private property along Westerly's coast. Flooding fueled by storm surge inundated much of the Misquamicut area.
Sandy (October 29, 2012)	Hurricane: 1	60-80+ gusts	Significant damage all along the coast; beaches along Westerly, including Misquamicut, were devastated; more than 122,000 people lost power; roughly $40 million in support from disaster relief programs helped Rhode Island recover.
Hermine (September 5, 2016)	Tropical Storm/ Depression	Sustained 39-44	Hermine was a hurricane as she made landfall in Florida, then weakened to a tropical storm and finally a tropical depression as she moved off the coast of North Carolina and meandered along southern New England. Hermine had minimal impact in most of RI, but because trees were still fully leaved, the higher gusts did down some branches and trees. In Westerly, wires were downed on Wall Street and property damages across Washington County were estimated at $60K.
Isaias (August 4, 2020)	Tropical Storm	Gusts to 51 in Westerly	Tropical Storm Isaias caused widespread wind damage from Virginia through parts of New England. There was no damage reported in Washington County, but statewide property damages were estimated at $32.1K.
Henri (August 22, 2021)	Tropical Storm	60-70 gusts in Washington County	Tropical Storm Henri made landfall in southwest RI and then moved slowly northwestward across northern CT where it weakened. The worst flash flooding occurred in northeast CT, and Henri spawned three tornadoes and a waterspout in MA. There was significant damage and widespread power outages. In Washington County, 33 homes were damaged, and in Westerly numerous trees were down across town, there was two feet of water on Main Street, and Atlantic Avenue was impassable up to First Street due to flooding from rainfall and storm surge. Property damages across the state were estimated at $1.82 million.

RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-224 through 3-226; NOAA|NCEI. *Storm Events Database*, and Vallee, David

Climate Change Impacts

"There is a strong consensus in the tropical cyclone climate community that the incidence of high-category events will increase, and that storms will precipitate more" (Berardelli). An increase in the rainfall rates and destructive potential of future tropical cyclones is consistent with NOAA's findings. According to NOAA, due to wind intensity, 85% of all damage from hurricanes come from Category 3, 4, and 5 storms. Coupled with rising sea levels, these more intense hurricanes will amplify impacts to coastal communities (Knutson). The Intergovernmental Panel on Climate Change (IPCC) has also created long-term global climate models that indicate the probability of hurricanes becoming more intense, with stronger winds and heavier precipitation, through the 21st century.

Probability of Future Events

According to the RI-SHMP, Westerly has between 50% and 89.9% annual probability of experiencing a hurricane (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-228). While high magnitude events, such as Category 4 or Category 5 hurricanes, are less likely to occur, this may change in the future. Climate change models from NOAA, the IPCC, and other sources, suggest there is a high probability of hurricanes becoming more intense, with stronger winds and heavier precipitation, through the 21st century.

As their impact can be devastating, it is important for the Town to continue to enforce RI State Building Codes, educate the community about steps they can take to become more resilient to hurricanes and other high wind storm events, and remain apprised of improvements in forecasting and understanding the impact from hurricanes.

WINTER-RELATED HAZARDS

4.3.3 Winter-Related Hazards

The winter-related hazards of heavy snow, ice, and extreme cold, detailed in this Section, can occur in combination or independently.

Description and Extent

❖ ***Heavy Snow***

"A heavy snow is generally defined as having more than nine (9) inches of accumulation in less than 24 hours. 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-183).

According to the National Severe Storms Laboratory (NOAA|NSSL. *Severe Weather 101 – Winter Weather*) key winter weather alerts include:

- **Blizzard Warning:** Issued when winds of 35 mph or greater are combined with blowing and drifting snow with visibilities of 1/4 mile or less. Seek indoor shelter immediately and stay indoors until the severe conditions end.
- **Winter Storm Warning:** Issued when a combination of hazardous winter weather in the form of heavy snow, heavy freezing rain, or heavy sleet is imminent or occurring. Winter Storm Warnings are usually issued 12 to 24 hours before the event is expected to begin.
- **Winter Storm Watch:** Issued 12-48 hours in advance of the onset of severe winter conditions. The watch may or may not be upgraded to a winter storm warning, depending on how the weather system moves or how it is developing.

In the northeastern United States, the term nor'easter is used to describe storm events that have northeasterly winds that blow in from the ocean. A nor'easter, is an extratropical cyclone, meaning that it no longer has tropical characteristics. Nor'easters exhibit a counter-clockwise wind circulation around a low-pressure center and pick up strength from cold air in the atmosphere. Nor'easters are a common winter occurrence in New England and often result in flooding, and wave/erosion-induced damage to structures and natural resources. The erosion of coastal features (such as beaches, dunes, and coastal bluffs) commonly results in greater potential for future storm damage to shoreline development. The amount of coastal erosion caused by nor'easters depends on the intensity and the duration of the storm, the tidal phase at the time of the storm, the path of the storm, and the time interval between storms (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-218).

The storm radius of a nor'easter, traveling up the eastern United States coast, is often as large as 1,000 miles, and the horizontal storm speed is generally around 25 miles per hour (mph). Sustained wind speeds of 10-40 mph are common during a nor'easter, with short term wind speeds gusting up to 70 mph. Unlike hurricanes and tropical storms, nor'easters can sit off shore, wreaking damage for days (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-218). Although these storms occur between October and April, they are most severe in the winter when the difference in temperature between the converging cold polar air and warmer air over the Atlantic Ocean is the greatest (NOAA|NHS. *What is*).

While the winds from nor'easters are not as powerful as hurricane winds, their wind gusts can approach hurricane force, which means nor'easters also have the potential to tear off roofs and topple structures. If a nor'easter hits the coast as a blizzard, the ensuing snowfall can collapse weak roofs, as well. Because nor'easters are prolonged events, the winds produce storm surges that can continue through multiple high tides. Wind surges during high tides present a high risk of flooding along Westerly's coastline. Additionally, heavy snow accumulation and freezing temperatures can create dangerous driving conditions.

Other than characterizing a winter storm as an ice storm, snow squall, or blizzard, there is no universally accepted scale to measure them. However, the Northeast Snowfall Impact Scale (NESIS), developed by the National Weather Service (NWS), is commonly used to characterize and rank significant Northeast snowstorms with 10 inches or greater accumulation. The NESIS index is unique in that in addition to meteorological measurements, it uses population information that provides a framework for the storm's societal impacts, particularly in terms of transportation and economic impact. **Table 4-12** provides the NESIS values which are a function of the area affected, the amount of snow, and the number of people living in the path of the storm, as well as a descriptive adjective related to hazard impact (NOAA|NCDC. *The Northeast*).

Table 4-12 NESIS Index (NOAA|NCDC)

Category	NESIS Value	Description
1	1—2.49	Notable
2	2.5—3.99	Significant
3	4—5.99	Major
4	6—9.99	Crippling
5	10+	Extreme

❖ *Ice Storm*

The term ice storm is used to describe the weather phenomena involving rain or snow being converted to ice with accumulations that create hazardous conditions on the ground. Ice storm warnings are issued for one-half inch or greater accretion of freezing rain (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-183). Even small accumulations of ice can create hazards for motorists and pedestrians. Heavy accumulations of ice can bring down trees and utility poles resulting in disruptions to electrical power and internet communication.

❖ *Extreme Cold*

What is considered an excessively cold temperature varies according to the normal climate of a region. Extreme cold for Rhode Island is characterized by temperatures well below zero degrees Fahrenheit for an extended period of time. This event may coincide with winter storms, occur after a storm, or occur without storm activity at all (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-88). Extreme cold can lead to hypothermia and frostbite, which are both serious medical conditions. Infants and seniors are more susceptible to extreme cold. If extreme cold conditions are combined with low/no snow cover, the cold can better penetrate downward through the ground and potentially create problems for underground infrastructure as well. When utilities are affected and heaters do not work, water and sewer pipes can freeze and even rupture (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-92).

Rather than simply the outside temperature, extreme cold is typically measured in terms of the NWS Wind Chill Temperature (WCT) index shown in **Figure 4-27**. The index attempts to quantify the cooling effect of wind with the actual outside air temperature to provide a more realistic representation of how cold people and animals feel, based on the rate of heat loss from exposed skin (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-88).

"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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-88).

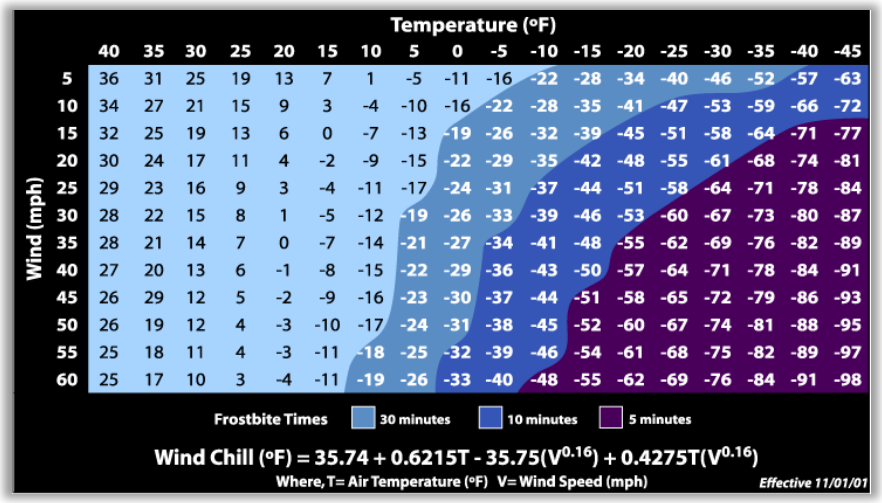


Figure 4-27 Wind Chill Index Chart (NOAA|NWS)

Location

Westerly's coastal location makes it somewhat less prone to heavy snowfall than inland communities, but virtually any area of Town could be impacted by a severe winter storm. All areas of Westerly are considered exposed to winter-related hazards, with the shoreline areas more vulnerable to nor'easter wind gusts and associated flooding.

There are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to roof collapse due to heavy snow loads.

Previous Occurrences

Winter storms are a regular occurrence in Westerly, with snowfall ranging from a few inches to blizzard conditions, including sustained winds or frequent gusts of 35 mph or greater. These storms can create hazardous and disruptive conditions due to broken tree limbs, loss of power, school closings, business/civic service interruption, dangerous driving conditions with reduced visibility to less than a quarter mile, coastal erosion, and flooding conditions when the snow melts.

Figure 4-28 Blizzard of 1978 Providence, RI

Photo Credit: Providence Journal

Figure 4-29 Clearing a Path to Junk 'n Java (Blizzard - January 30, 2022)

Photo Credit: Grace White, Special to The Westerly Sun

As shown in **Table 4-13**, the frequency of winter storms in Washington County has varied over the past several decades. Based on information obtained from NOAA|NCEI Storm Events Database, between 1996 and November 2022 there have been 58 events categorized as either blizzard, winter storm, or heavy snow. Only six of the events caused property damage, with a cumulative total of approximately $203,000. Many of the events did, however, result in traffic difficulties or school and commercial closings.

Over the past 100 years, the most significant nor'easter to impact Rhode Island was the Blizzard of 1978 (**Figure 4-27**). Westerly received 24 inches of snow (VHB, 43), with other parts of the State receiving up to 4 feet. Wind speeds exceeded 60mph and downed power lines across the state. The heavy snow stranded more than 10,000 people on roadways throughout Rhode Island. Regrettably, 232 injuries and 26 deaths resulted from the storm, and damages totaled more than $15 million (Strauss).

More recently, the state experienced a powerful nor'easter in February 2013 (**Figure 4-28**), known as Winter Storm Nemo. Isolated thunderstorms were common across the entire region during the height of the storm and Washington County received about 20 inches of snow. The Providence Journal reported that almost 170 people sought treatment for storm-related heart attacks, falls, and other injuries (NOAA|NCEI. *Storm Events Database*). Governor Lincoln Chafee declared a state of emergency in Rhode Island and enacted a statewide travel ban that lasted nearly 24 hours (Rapoza). National Grid estimated more than 180,000 customers lost power. Rhode Island received $1 million in reimbursements from the Federal Emergency Management System (FEMA) for snow removal costs from the storm (Cicilline).

Another significant nor'easter, Winter Storm Juno, occurred in January 2015. The blizzard inundated Rhode Island with roughly 16 inches of snow, produced strong winds with gusts of 50 to 65 mph, caused several fatalities, and caused approximately $8.4 million in damages statewide. The Governor declared a statewide travel ban beginning at midnight on January 27 and continuing through 8 pm on January 28, 2015. President Obama issued a Presidential Major Disaster Declaration for the State, allowing federal assistance for emergency work and repairs to facilities damaged by the storm (NOAA|NCEI. *Storm Events Database*).

Table 4-13 Significant Winter Storms for Washington County 1996-2020 (NOAA|NCEI. *Storm Events Database*)

Begin Date	Category	Description (statewide snow totals unless specified otherwise)	Damages
1/7/1996	Blizzard	Blizzard of 1996 – 1-2 feet	School and commercial closings; transportation difficulties
2/2/1996	Heavy Snow	6-8 inches	Transportation difficulties
2/161996	Heavy Snow	5-7 inches	Transportation difficulties
3/2/1996	Heavy Snow	6-11 inches; 7.5 inches in Westerly	Numerous automobile accidents
4/9/1996	Heavy Snow	Up to 21.5 inches in northern RI	Heavy wet snow on power lines; downed trees and power lines; power outages; lightning
3/31/1997	Heavy Snow	Up to 15 inches; 60-70mph winds along the coast	Heavy wet snow; widespread power outages; transportation difficulties
4/1/1997	Heavy Snow	Near blizzard conditions; 30 inches northern RI; 4 inches along the coast	Heavy wet snow; downed trees and power lines; power outages; school closings; approximately $100,000 in property damage
2/25/1999	Heavy Snow	Up to 15 inches in northern RI	School closings; transportation difficulties
3/15/1999	Heavy Snow	7-12 inches	School and commercial closings; transportation difficulties
2/18/2000	Heavy Snow	3-5 inches along south coast	Treacherous driving conditions
1/20/2001	Heavy Snow	Up to 8 inches	Minor accidents

Begin Date	Category	Description (statewide snow totals unless specified otherwise)	Damages
12/5/2002	Heavy Snow	2- 7 inches	
2/7/2003	Winter Storm	6-12 inches	Minor automobile accidents
2/17/2003	Winter Storm	19 inches in South Kingstown	Occurred during school vacation so only minor transportation disruption
3/6/2003	Winter Storm	6-10 inches	Minor transportation disruption; approximately $50,000 in property damage
12/5/2003	Winter Storm	Major storm; strong winds; 10-20 inches; 12 inches in Westerly	Major transportation disruption
12/27/2004	Winter Storm	4-9 inches; 9 inches in South Kingstown	Treacherous driving conditions
2/18/2004	Winter Storm	2-4" along south coast	
12/26/2004	Winter Storm	Powerful storm; strong winds - 50mph along south coast; 6-10 inches	Treacherous driving conditions
1/22/2005	Winter Storm	Major storm; near blizzard conditions; 60mph winds; 20 inches in Westerly	Coastal flooding; treacherous driving conditions
2/24/2005	Heavy Snow	10 inches along south coast	
3/1/2005	Winter Storm	Gusty winds; 4-9 inches	
2/12/2006	Winter Storm	Nor'easter; blizzard-like conditions; 9-14 inches	approximately $10,000 in property damage
3/16/2007	Winter Storm	4-7 inches	
12/19/2008	Heavy Snow	9-10 inches in Washington County	Downed trees; approximately $1,000 in property damage
12/31/2008	Heavy Snow	4-10 inches	
3/1/2009	Heavy Snow	7-8 inches in Washington County	
12/19/2009	Heavy Snow	18-20 inches	Treacherous driving conditions; school and commercial closings; flights cancelled
2/10/2010	Winter Storm	6-10 inches in Washington County	
12/26/2010	Winter Storm	Strong winds; near blizzard conditions; 6-12 inches in Washington County	
1/12/2011	Heavy Snow	10-11 inches in Washington County	
1/26/2011	Heavy Snow	9-11 inches in Washington County	
1/21/2012	Heavy Snow	8-12 inches along the coast	
12/29/2012	Heavy Snow	6-8 inches in Washington County	
2/8/2013	Blizzard	Blizzard of 2013 – Winter Storm Nemo; 19-20 inches in Washington County	Downed trees and power lines; power outages; 170 people reported to have sought treatment at RI Lifespan Hospitals for storm-related injuries
1/2/2014	Heavy Snow	Bitter temperatures; strong winds; 7-8 inches in Washington County	
1/21/2014	Heavy Snow	strong winds; 3-10 inches in Washington County	
2/15/2014	Heavy Snow	Strong winds; 6-9 inches in Washington County	
1/26/2015	Blizzard	Blizzard conditions; gusty winds; limited visibility; 12-21 inches in Washington County	President Obama issued a federal disaster declaration; RI Governor declared a statewide travel ban; school and commercial closings; flights cancelled; several fatalities occurred as a result of the storm

Begin Date	Category	Description (statewide snow totals unless specified otherwise)	Damages
2/14/2015	Heavy Snow	Near blizzard conditions; 5-9 inches in Washington County	Coastal flooding
3/1/2015	Heavy Snow	4-8 inches in Washington County	
3/5/2015	Heavy Snow	8-12 inches in Washington County	
1/23/2016	Heavy Snow	High winds; 5-12 inches in Washington County	approximately $40,000 in property damage on Block Island
2/5/2016	Heavy Snow	4-8 inches in Washington County	Heavy wet snow; downed tree limbs
2/8/2016	Heavy Snow	5-8 inches in Washington County	
1/7/2017	Winter Storm	11-16 inches in Washington County	
2/9/2017	Winter Storm	6-13 inches in Washington County	
3/10/2017	Winter Storm	5-6 inches along south coast	
1/4/2018	Blizzard	11-14 inches in Washington County; wind gusts up to 56mph at Westerly Airport	
1/29/2018	Winter Storm	6-9 inches in Washington County	
3/12/2018	Winter Storm	7-15 inches in Washington County; 50mph wind gusts	
3/3/2019	Blizzard	4-8 inches in Washington County	
12/16/2020	Heavy Snow	5-12 inches in Washington County; wind gusts 45-50mph	
2/1/2021	Winter Storm	7-12 inches in Washington County; wind gusts 46mph in Westerly	Some downed trees and wires; approximately $1,900 in property damage
2/7/2021	Heavy Snow	5-8 inches in Washington County	
1/7/2022	Heavy Snow	6 inches in Westerly	Dangerous driving conditions
1/28/2022	Blizzard	Blizzard conditions at Westerly Airport; 11-21 inches in Washington County; wind gusts 40-60mph	

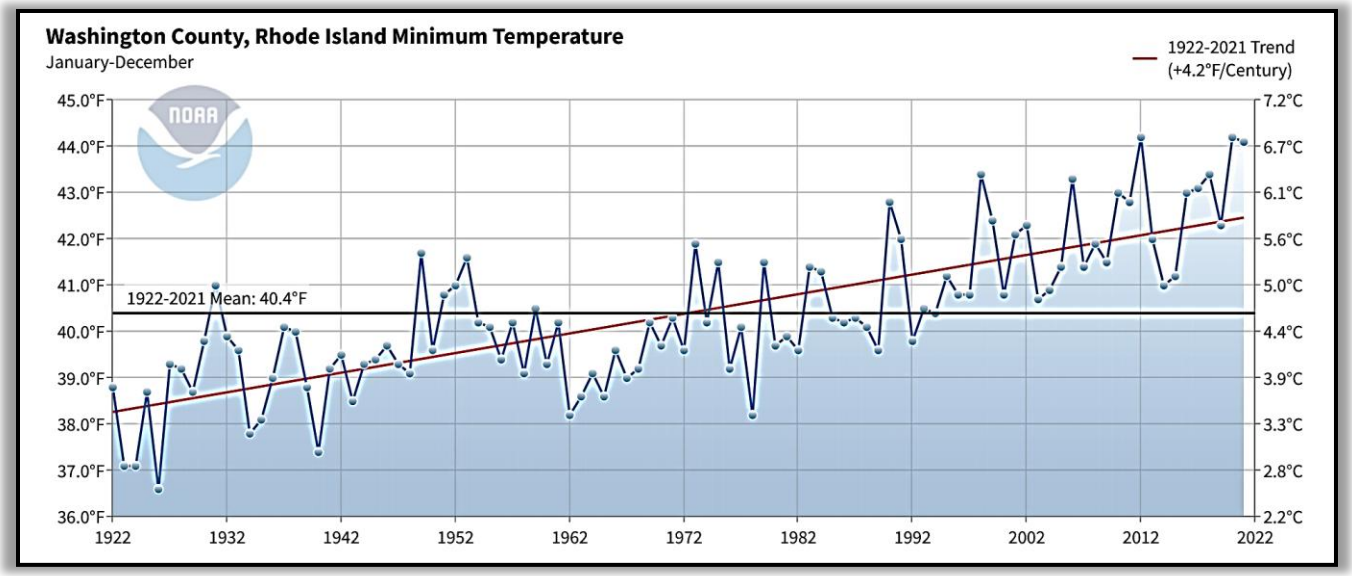
Climate Change Impacts

The number and strength of storms during colder months have increased in the Northern Hemisphere since 1950; however, the total amount of snowfall averaged across the Northern Hemisphere is in decline due to global warming (Di Liberto). In the northern and eastern U.S. in particular, extremely heavy snowstorms have increased in frequency over the last century (Di Liberto).

As illustrated in **Figure 4-30** (NOAA|NCEI. *Climate at a Glance*), temperatures in Washington County have been steadily climbing since the 1920s. A decrease in extreme cold days has been documented and is expected to continue. For example, prior to 1980, Rhode Island experienced at least 120 days a year with temperatures at or below freezing. This has not occurred since 2000 (Vallee and Giuliano).

More research and better predictive models are needed to determine if, despite a decline in total snowfall, the winter storms that Rhode Island and other areas experience will become more intense. Further, some studies that have been done suggest that although the total amount of snowfall may be decreasing, the overall precipitation rate is increasing. Coupled with sea level rise, more precipitation is problematic in terms of flooding hazards (Di Liberto).

Figure 4-30 Washington County Annual Minimum Temperature 1922-2022 (NOAA|NCEI)



Probability of Future Events

Winter weather events for the Town, as in most of the northeast, can be described as unpredictable. Days with below freezing temperatures may be followed by days with mild temperatures in the 40s or 50s. Based on history and climatic conditions, the RI-SHMP states that there is a high annual probability (between 50% and 89.9%) of extreme cold affecting Rhode Island. However, it is likely that the extreme cold temperatures will only occur for short periods of time (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-89, 3-90).

As shown in **Table 4-14**, winter storms regularly occur in Rhode Island. Based on the NCEI data, on an annual basis, approximately two to seven winter weather events of some significance will occur in Washington County. It is probable that one of these events will be a nor'easter (RIEMA. State of Rhode Island Hazard Mitigation Plan, 3-187).

INFECTIOUS DISEASE-RELATED HAZARDS

4.3.4 Infectious Disease-Related Hazards

Profiles for the following natural hazards have been included in this Section.

4.3.4.1 Vector-borne Diseases Transmitted by Ticks or Mosquitoes

4.3.4.2 Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses

4.3.4.1 Vector-Borne Diseases Transmitted by Ticks or Mosquitoes

Description and Extent

Vector-borne diseases are infections transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes and ticks.

❖ ***Mosquitoes***

Mosquitoes are carriers (vectors) for many diseases. There are 46 mosquito species in Rhode Island, including the species that carry West Nile Virus (WNV) and Eastern Equine Encephalitis (EEE) (RIDEM. *About Mosquitoes*). Female mosquitoes have a mouthpart made to pierce skin and siphon off blood, which is required to complete their egg production cycle. As the mosquito fills itself with blood, it injects saliva into the host's skin. If disease-causing organisms are present in the blood from one of the mosquito's victims, those organisms could then be injected into other victims' bloodstreams when the mosquito feeds again. Mosquitoes can spread disease from animal to animal, animal to man, and from person to person in this manner (Mayo Clinic. *Mosquito Bites*).

➢ **West Nile Virus (WNV)**

"West Nile virus (WNV) is the leading cause of mosquito-borne disease in the continental United States, with 970 known human infections in 2022 (CDC. *West Nile Virus*). Only one human case was reported in Rhode Island in 2022. It is most commonly spread to people by the bite of an infected mosquito. Cases of WNV occur during mosquito season, which starts in the summer and continues through fall. There are no vaccines to prevent or medications to treat WNV in people. Fortunately, most people infected with WNV do not feel sick. About 1 in 5 people who are infected develop a fever and other symptoms. About 1 out of 150 infected people develop a serious, sometimes fatal, illness. You can reduce your risk of WNV by using insect repellent and wearing long-sleeved shirts and long pants to prevent mosquito bites" (CDC. *West Nile Virus*).

➢ **Eastern Equine Encephalitis (EEE) Virus**

The EEE virus is rare, but the impacts of infection can be deadly. Nearly 30 percent of the people that contract the disease die. EEE can cause brain infections including meningitis and encephalitis, and many survivors have ongoing neurologic problems. The CDC indicates that there are no preventative vaccines or medical treatments for EEE. Between 2011 and 2020 there were a total of 110 reported cases in the U.S., with a higher than average mortality rate of 43 percent. Three of the cases occurred in Rhode Island - all in 2019 (CDC. *Eastern Equine Encephalitis*).

❖ *Ticks*

Another type of blood-feeding arthropod, the tick, is also common in North America, and can spread disease in the same manner. According to RIDOH, "Ticks feed on small wild rodents, deer, pets, and humans. When a tick becomes infected and continues to feed on various hosts, the bacteria, virus, or parasite can be transmitted. Ticks that are located in the brush and on tall grasses come into contact with humans as we pass through these environments" (RIDOH. *Tick*). Not every tick is a carrier, but if you are bitten by an infected tick, the disease may be transmitted to you.

"Lyme disease, Anaplasmosis, and Babesiosis are the most frequently reported tick-borne diseases in Rhode Island" (RIDOH. *Tick*). In 2016, Rhode Island had their first case of Powassan virus, which is currently not treatable. Although the risk of being bitten is greater in the spring and summer when the nymphs are feeding, you may find ticks any time the temperature is above freezing (RIDOH. *Tick*). "If you have become infected, symptoms can present themselves between a few days and a few months later, or may not appear at all. The type and severity of symptoms vary with the specific disease, but there are some common symptoms, which include tiredness, body/muscle aches, joint pain, fever, rash, stiff neck, and facial paralysis. Early diagnosis is helpful in successfully treating tick-borne diseases, so it is important to contact your healthcare provider if you are experiencing symptoms" (RIDOH. *Tick*).

➢ Lyme Disease

According to the EPA, Lyme disease is the most common vector-borne disease in the U.S. and is prevalent in Rhode Island which had the nation's fifth-highest rate of cases in 2018 (RI.gov Press Releases). The CDC has determined that, generally, for the Lyme disease bacterium to be transmitted, the tick (most often a nymph, or immature tick) must be attached for 36 to 48 hours. Of those infected, about 70 percent develop a rash at the bite site, which sometimes resembles a "bull's eye." If left untreated, other symptoms may occur involving the skin, eyes, heart, nervous system, brain, or joints, some of which may be permanent. Early detection is important in the treatment of Lyme disease (CDC. *Lyme Disease*).

➢ Anaplasmosis

Anaplasmosis is caused by the bacterium *Anaplasma phagocytophilum* and spread to people primarily from the blacklegged tick and western blacklegged tick. Symptoms include fever, headache, chills, and muscle aches (CDC. *Anaplasmosis*).

➢ Babesiosis

Most people won't experience symptoms if infected with babesiosis (red blood cell parasite), but some may have fatigue, fever, malaise, jaundice, and anemia. A more severe and prolonged illness or possibly death may occur for those elderly or immunocompromised (RIDOH. *Babesiosis*).

Monitoring Mosquitoes and Ticks

Both the Rhode Island Department of Health (RIDOH) and the University of Rhode Island (URI) have programs that monitor the extent of mosquito and tick populations and/or disease incidents. From June through October, RIDOH's Arboviral Surveillance program monitors the epidemiology, incidence, and geographic distribution of West Nile Virus, Eastern Equine Encephalitis Virus, and other arboviruses in Rhode Island for early detection and prevention of any human transmission (RIDOH. *Arboviral Surveillance*).

The State requires health care providers to report positive tick-borne laboratory results to RIDOH. The Department of Health then monitors and analyzes the tick-borne disease data to detect potential increases in disease and to identify opportunities for outreach (RIDOH. *Tick*). The University of Rhode Island Tick Encounter Resource Center has set up a program called *TickSpotter* to help keep track of tick activity across North America. The program has an app that allows participants to take a photo of the tick they found, use the *Tick Identification Guide* to correctly identify the tick, and then submit the information. The submissions help to monitor tick population trends and tickborne disease risk (URI. *Tick Encounter*).

Location

Mosquitoes breed in standing water which can be found along the river, creek, and pond areas as well as in swimming pools, birdbaths, ditches, and just about any outdoor vessels that can hold even a small amount of water. As such, conditions conducive for breeding can be found town-wide. That being said, higher concentration of mosquitoes will be found in wetland and forested areas. Westerly has approximately 2,905 acres (15%) of forested wetlands, with the largest tracts south of Chapman Pond, north of Route 1, and in sections of the Woody Hill Management Area. Additionally, there are approximately 608 acres of scrub-shrub wetland (3% of the Town), 151 acres of freshwater emergent wetlands (less than one percent of the Town), and 303 acres of estuarine emergent wetlands (less than two percent of the Town)" (Town of Westerly RI. *Comprehensive*, 121). The Town implements a mosquito maintenance program that includes treating catchment basins with larvicide briquets and aerial spraying of Newton Swamp These measures help to decrease the mosquito population.

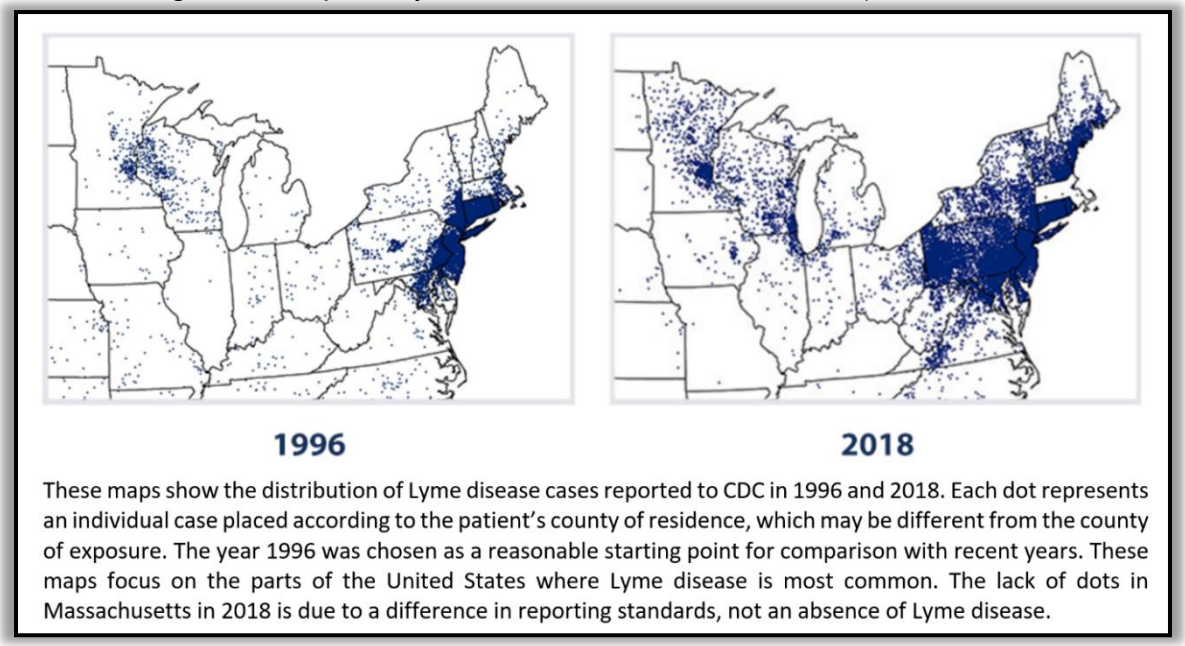
Although ticks can be found in urban areas and along coastlines, higher populations tend to be found in wooded and grassy areas where the creatures they feed on live and roam, including deer, rabbits, birds, lizards, squirrels, mice, and other rodents. Typically, ticks climb to the top of a grass blade or the tips of a bush or branch and wait for potential prey to pass by. They latch onto the fur, hair, or clothing of their prey by extending their hooked front legs. Once on their host they tend to climb upward before attaching and feeding (IGeneX).

Previous Occurrences

According to the CDC, in 2019 the United States saw a large increase in the total number of Eastern Equine Encephalitis cases (38) and deaths (19). Three cases were found in Rhode Island, but none of those resulted in death (CDC. *Eastern Equine Encephalitis*). The CDC reports a low incidence of West Nile Virus in Rhode Island over the past two decades (15 cases from 1999 to 2018) (CDC. *West Nile Virus*).

As illustrated in **Figure 4-31**, the incidence of Lyme disease in the United States has significantly increased over the past two decades. Cases documented by the CDC have nearly doubled between 1991 and 2018 and recent estimates suggest that approximately 300,000 people may get Lyme disease each year in the United States (EPA. *Climate Change Indicators*). In 2020, Rhode Island had 839 cases of Lyme disease – 77 cases per 100,000 people, almost 10x the national average of 7.95 cases per 100,000 (EPA. *Climate Change Indicators in the United*). According to RIDOH, between 2014 and 2018, Westerly has had between 39 and 55 cases of Lyme per year (RIDOH. Lyme Disease *Surveillance,* 16).

Figure 4-31 Reported Lyme Disease Cases in 1996 and 2018 (adapted from CDC)



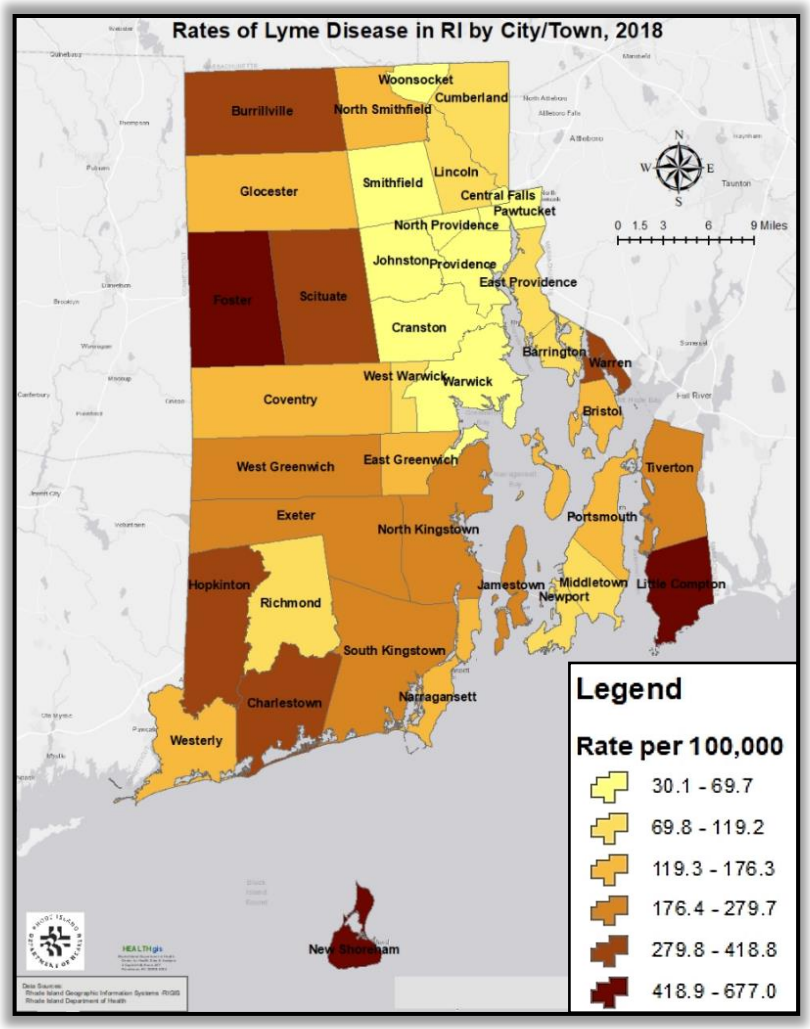


Figure 4-32 Rates of Lyme Disease in RI by City/Town, 2018
(RIDOH)

Figure 4-32 shows the 2018 rates of Lyme disease by City/Town in Rhode Island. During that period, Westerly had a total of 39 cases, which corresponds to an incidence rate of approximately 224 per 100,000 (RIDOH. *Lyme Disease Surveillance,* 20).

Climate Change Impacts

Climate change is expected to cause heavier precipitation, longer warm seasons, and warmer winters. These changing temperature and precipitation patterns could make conditions more hospitable for mosquitos and ticks and impact survival and spread of the diseases they transmit to humans (RIDOH. *Mosquitoes*).

"Both the infectious agent (protozoa, bacteria, viruses, etc.) and the associated vector organism (mosquito or tick) are very small and devoid of thermostatic mechanisms. Their temperature and fluid levels are therefore determined directly by the local climate. Hence, there is a limited range of climatic conditions - the climate envelope - within which each infective or vector species can survive and reproduce. It is particularly notable that the incubation time of a vector-borne infective agent within its vector organism is typically very sensitive to changes in temperature, usually displaying an exponential relationship. Other climatic sensitivities for the agent, vector, and host include level of precipitation, sea level elevation, wind and duration of sunlight" (Patz, 104).

Probability of Future Events

Although mosquitoes will continue to be prevalent and the population may increase, based on past occurrences there is a low probability of Eastern Equine Encephalitis or West Nile Virus occurring in Westerly over the upcoming 5-year period.

There is a high probability that a number of Westerly residents will be infected by Lyme disease, most likely at a rate similar to or exceeding 2014-2018 rates of between 39 and 55 cases per year.

4.3.4.2 Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses

Description and Extent

The terms epidemic and pandemic are used to describe the degree at which a disease is spreading. An epidemic is an outbreak of a disease that occurs in a community, geographical area, or several countries which spreads quickly and affects many people at the same time. An epidemic becomes a pandemic when it spreads over several countries or continents, usually affecting a large percent of the population in a country or around the world. A pandemic often creates social disruption and economic loss with a lengthy response and recovery period. Many diseases throughout the history of the world have been pandemic (Rochester Regional).

Global, federal, state, and local agencies closely monitor diseases that have the potential to cause outbreaks and work to develop strategies to contain their spread, including medical countermeasures such as antibiotics and antiviral medications (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-157).

❖ ***Influenza (Flu)***

According to the RIDOH, "Flu is a contagious respiratory illness caused by viruses. People get sick from seasonal flu viruses every year. Flu can cause illness ranging from mild to severe. In some cases, flu can lead to hospitalization and even death. Most people who get the flu will have a fever and cough or sore throat. They may also have a runny or stuffy nose, body aches, a headache, chills, fatigue, vomiting, or diarrhea" (RIDOH. *Flu*).

Epidemics of influenza typically occur during the winter months. The CDC estimates that annually in the United States, between 2010 and 2020, the flu resulted in 9-41 million illnesses, 140,000-710,000 hospitalizations, and 12,000-52,000 deaths (CDC. *Disease Burden*). Although rates of infection are highest among children, rates of serious illness and death are highest among persons aged 65 and over and those with serious underlying health conditions (Harper, Scott).

A 2018 Centers for Disease Control and Prevention (CDC) study suggests, "that on average, about 8% of the U.S. population gets sick from flu each season, with a range of between 3% and 11%, depending on the season" (CDC. *Seasonal Influenza*). To prevent contracting seasonal flu people can take precautions such as regularly washing their hands and avoiding people who are sick, but the best way to prevent the flu is to get vaccinated every year. The effectiveness of a vaccine to protect a person from the flu depends on several factors including the match between the flu virus strain in the community and the vaccine strain, and the characteristics of the person being vaccinated (such as their age and health) and their body's ability to use the vaccine to fend off the virus (CDC. *Seasonal Influenza*).

An influenza pandemic is a global outbreak of a new strain of the *Influenza A Virus* that has been transmitted to humans from another animal species. Species that are thought to be important in the emergence of new human strains are pigs, chickens, and ducks. Because the virus is new to humans, very few people will have immunity and an effective vaccine might not be widely available. The new strain can therefore spread rapidly infecting a large number of people (CDC. *Seasonal Influenza*).

❖ ***Coronavirus Disease 2019 (COVID-19)***

According to the RIDOH, "Coronavirus Disease 2019 (COVID-19) is a virus strain that has only spread in people since December 2019" (RIDOH. *Covid-19 Information*). On March 11, 2020 the Coronavirus Disease was declared a pandemic by the World Health Organization and on March 13, 2020 the United States declared the outbreak a national emergency (CDC. *New ICD*).

Symptoms of COVID-19 range in severity and may include fever or chills, cough, shortness of breath or difficulty breathing, muscle or body aches, sore throat, headache, nausea or vomiting, diarrhea, runny or stuffy nose, fatigue, and recent loss of taste or smell. RIDOH recommends that anyone with COVID-19 symptoms, or exposed to someone with symptoms or who tested positive should be tested. Prior to receiving test results, individuals should try to isolate from those who are not sick. Anyone diagnosed with COVID-19 must isolate until they are well and test negative (RIDOH. *Covid-19 Information*). To prevent infection with COVID-19, the CDC recommends frequent handwashing with soap and warm water; coughing and sneezing into your elbow or a tissue; avoid touching mouth, nose, and eyes; and if you are sick, stay at home.

The CDC established a National Notifiable Diseases Surveillance System that enables states and other jurisdictions to share infectious and non-infectious disease-related data. Data for both Influenzas and Coronaviruses are collected through this system. Reporting is mandated by state laws or regulations and should follow uniform reporting criteria. The CDC has a Pandemic Severity Index (PSI) to assess the potential magnitude of the impact and resulting Community Mitigation Strategies to help guide the states and jurisdictions (CDC. *Pandemic Influenza*).

As outlined in the RI-SHMP (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-157, 3-158) the extent of an infectious disease's impact depends on a number of factors including:

- The disease's virulence, transmissibility, and pathogenesis
- Individuals' vulnerability factors, such as underlying medical conditions, malnutrition, behavior, and pregnancy
- Immunization prevalence
- Quality and availability of healthcare services
- Availability and accessibility of medical countermeasures that protect against and treat the disease
- Modes of transmission
- Environmental conditions, including temperature and rainfall

Figure 4-33 Coronavirus (CDC. *Photo ID #23313)*

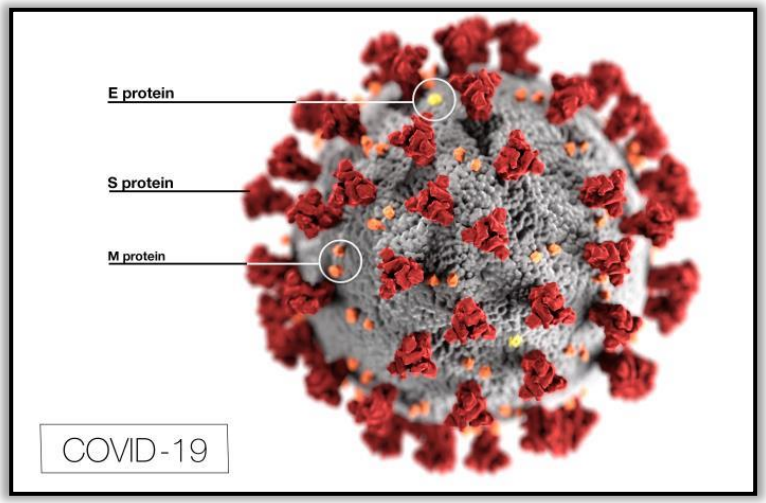


Photo Credit: Alissa Eckert, MSMI; Dan Higgins, MAMS

Figure 4-33, "created at the Centers for Disease Control and Prevention (CDC), reveals ultrastructural morphology exhibited by coronaviruses. Note the spikes that adorn the outer surface of the virus, which impart the look of a corona surrounding the virion, when viewed electron microscopically. In this view, the protein particles E, S, and M, also located on the outer surface of the particle, have all been labeled as well. A novel coronavirus, named Severe Acute Respiratory Syndrome coronavirus 2 (SARS-CoV-2), was identified as the cause of an outbreak of respiratory illness first detected in Wuhan, China in 2019. The illness caused by this virus has been named coronavirus disease 2019 (COVID-19).

Location

Factors like high population density, where people are in routine close contact with one another, can aid transmission of infectious diseases (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-157). Overall, the Town of Westerly has a low population density which is favorable in terms of minimizing the spread of communicable diseases. Areas of potentially higher risk in Town include senior living facilities, group homes, homeless shelters and food pantries, schools, and day care facilities where people are in close contact and where people may be more vulnerable to communicable diseases. However, as COVID-19 is a highly contagious communicable disease, the entire Town is considered at risk.

Previous Occurrences

❖ ***Influenza (Flu)***

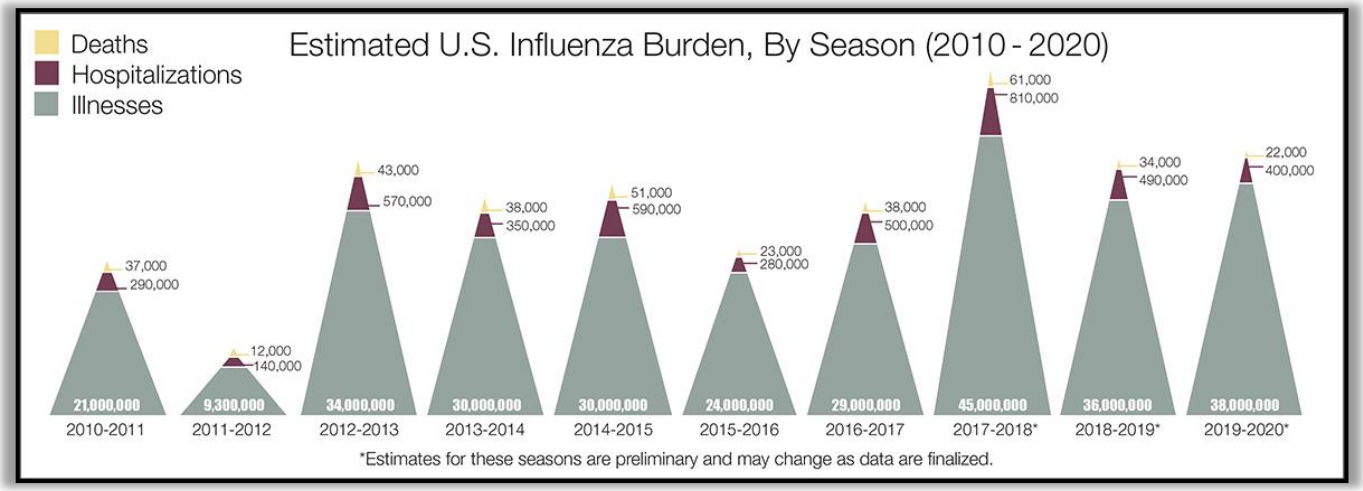
Due to public awareness, vaccines, and past immunity, it is rare that the flu season becomes epidemic or pandemic. There have however been four influenza pandemics in the 20th century (CDC. *Pandemic Influenza*):

- Spanish flu - H1N1 virus (1918-1920)
- Asian flu - H2N2 virus (1957-1958)
- Hong Kong flu - H3N2 virus (1968-1969)
- 2009 flu pandemic - H1N1pdm09 virus (2009-2010)

Cases of influenza are common every year in Rhode Island and across the United States. Generally mid-September through mid-May is considered the flu season, peaking between December and February. As illustrated in **Figure 4-34**, over the past decade, the worst flu season was 2017-2018, when 61,000 people nationwide died from the flu. During the 2018-2019 flu season, the CDC estimates the U.S. experienced approximately 34,000 deaths and during the 2019-2020 flu season, approximately 22,000 deaths (CDC. *Seasonal Influenza*).

Interestingly, during the 2020-2021 flu season, which coincided with the COVID-19 pandemic, the U.S. experienced extremely low flu numbers. According to Scientific American, "the drop-off in flu numbers following COVID's arrival was swift and global. Since then, cases have stayed remarkably low. 'There's just no flu circulating,' says Greg Poland, who has studied the disease at the Mayo Clinic for decades. The U.S. saw about 700 deaths from influenza during the 2020–2021 season" (Peek).

Figure 4-34 (CDC. *Seasonal Influenza*)



With respect to Rhode Island, the 2019-2020 Flu Season (October 6, 2019 - May, 22, 2020) was a moderately severe season with 948 hospitalizations for influenza, resulting in 20 deaths. This was lower than during the 2018-2019 season which reported a total of 1,032 hospitalizations and 39 deaths. According to RIDOH's Influenza Surveillance Report for the 2020-2021 Flu Season (September 27, 2020 - May 22, 2021), Rhode Island paralleled the national trend with unprecedented low levels of influenza. Of the 12 positive influenza tests, only 2 were hospitalized, and there were no deaths. These numbers may be skewed however, because there is so much overlap in the symptoms of COVID-19 and influenza, that people may have assumed they were experiencing COVID-19 and did not get tested for influenza. Conversely, the extensive mask wearing to protect against COVID-19 may have also protected against influenza (RIDOH. *Influenza Surveillance*).

RIDOH data indicates that the 2021-2022 Flu Season was mild, with 301 influenza-associated hospitalizations and 3 influenza-associated deaths between October 3, 2021 and May 28, 2022 (RIDOH. *Surveillance,* 2). The CDC has indicated that in some areas of the country, the seasonal influenza viruses have continued to circulate into June 2022, creating a remarkably prolonged influenza season (Austin). As of the end of November 2022, Rhode Island topped the list as the state with the highest flu vaccine rate (66.1%); 14.7% points higher than the national rate (Stacker).

❖ *Coronavirus Disease 2019 (COVID-19)*

In 2007, WHO reported that since 1970 over 40 infectious diseases had been discovered (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-160). Hence, it is not surprising that at some point a new infectious disease will create an epidemic or pandemic. This is what appears to have happened with the Coronavirus Disease 2019 (COVID-19), which according to RIDOH, "is a virus strain that has only spread in people since December 2019" (RIDOH. *Covid-19 Information*). As depicted in **Figure 4-35**, the Coronavirus spread rapidly, creating a worldwide pandemic (WHO. *Coronavirus Dashboard*).

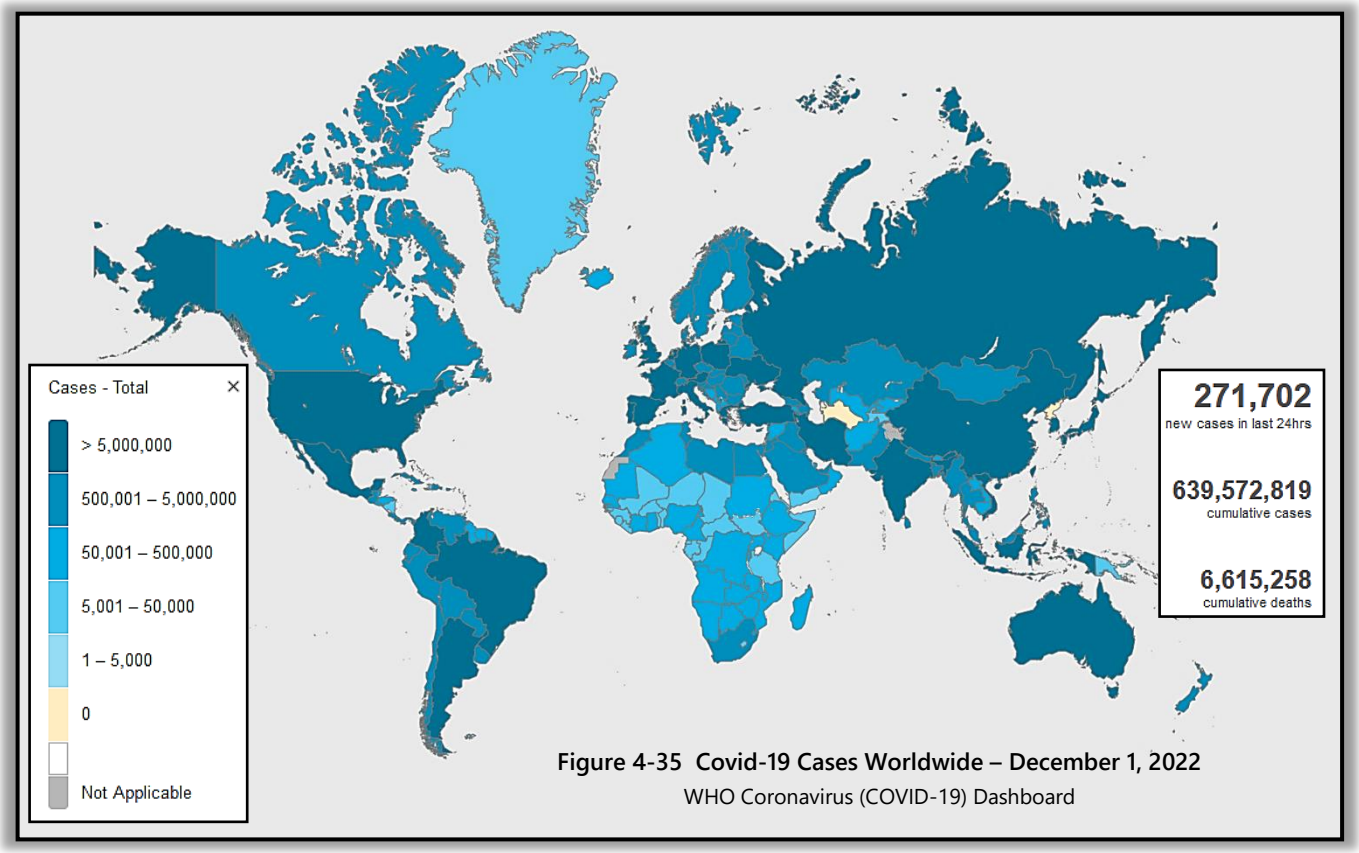


Figure 4-35 Covid-19 Cases Worldwide – December 1, 2022
WHO Coronavirus (COVID-19) Dashboard

Worldwide:
Globally, as of December 1, 2022, there have been 639,572,819 confirmed cases of COVID-19, including 6,615,258 deaths, reported to WHO. As of November 30, 2022 a total of 13,042,112,489 vaccine doses have been administered worldwide (WHO. *Coronavirus Dashboard*).

United States:
In United States, between January 20, 2020 (first confirmed case in U.S.) and December 1, 2022 there have been 97,329,491 confirmed cases of COVID-19 with 1,069,757 deaths, reported to WHO. Between the U.S. vaccination start date of December 14, 2020 and November 25, 2022, a total of 645,581,549 vaccine doses were administered in the U.S. (WHO. *Coronavirus Dashboard*).

Rhode Island:
In Rhode Island between March 2020 and December 1, 2022 - excluding out-of-state residents - there have been 408,652 confirmed cases of COVID-19 with 2,360 reported deaths (RIDOH. *COVID-19 Data Tracker)*. On July 1, 2021, Rhode Island became the fifth state to reach 70% of adults fully vaccinated against COVID-19 (Taylor). As of December 1, 2022 Rhode Island has approximately 83.8% of residents at least partially vaccinated (RIDOH. *COVID-19 Data Tracker)*.

Table 4-14, shows the number of COVID-19 cases, hospitalizations, and deaths for the State of Rhode Island, Washington County, and Westerly. The data was obtained from RIDOH for the period of March 2020 to December 1, 2022.

Table 4-14 COVID-19 Cases, Hospitalizations, and Deaths (March 2020 to December 1, 2022)

Municipality of Residence	Population 2020 Census	Total cases	Total hospitalizations	Total deaths	Total percent of population at least partially vaccinated
Rhode Island	1,097,379	408,652 (37.2%)	10,284 (0.9%)	2,360 (0.2%)	83.8%
Washington County	129,839	40,979 (31.6%)	447 (0.3%)	261 (0.2%)	86.2%
Westerly	23,359	7,867 (33.7%)	324 (1.4%)	57 (0.2%)	85.8%

Notes:
- Out-of-state residents are excluded (RIDOH. *Rhode Island COVID-19)*
- The percentage rates shown represent the percent of the TOTAL population based on 2020 Census data (US Census Bureau. *Explore Data*) – note: percentages on the States website are based on 2018 census data estimates

It is normal and expected for variants of viruses to occur, and there are currently a number of variants of the virus that causes COVID-19 (RIDOH. *COVID-19 Variants*). According to RIDOH, as of August 2022, "nearly all COVID-19 cases in Rhode Island are caused by the Omicron variant. Omicron is highly contagious and spreads more easily than the original virus that causes COVID-19 and the Delta variant" (RIDOH. *COVID-19 Variants*). "Numerous variants of the virus that causes COVID-19 are being tracked in the United States and globally during this pandemic. CDC is working with public health officials to monitor the spread of all variants and provide an estimate of how common they are in the nation and at the regional level " (CDC. *COVID-19 Variants*).

In November 2022 the CDC reported that the Omicron variant (BQ.1) and a new subvariant (BQ.1.1) constituted nearly half of cases nationwide. The subvariant may pose a greater threat to immunocompromised people, but for the majority of **fully vaccinated** people, it should not be a serious health threat. However, Dr. Jeremy Luban, a professor at UMass Chan Medical School, suggests that because the BQ.1.1 variant may be more transmissible, as winter approaches and more people are indoors – especially if they choose to be in crowed spaces – there may be an upturn in infection rates.

Numerous studies are being conducted to determine how well antibodies fare against emerging variants. While the outcomes vary, some findings suggest antibody immunity against new variants such as BQ.1.1 are lower than scientists prefer. This suggests that to minimize breakthrough cases, vaccine companies will need to continue to modify vaccines to better combat emerging variants. According to Dr. Dan Barouch, director of the Center for Virology and Vaccine Research at Beth Israel Deaconess Medical Center (Cross), "The current vaccines are likely not going to provide substantial and sustained protection against infection, even with boosters… but these vaccines will likely still provide substantial protection against severe disease, and that is the most important goal of vaccines" (Cross).

Climate Change Impacts

Researchers warn that the sudden weather changes associated with climate change, could fuel future flu epidemics (Preidt). Zhaohua Wu, from Florida State University's Department of Earth, Ocean and Atmospheric Science, explains, "The historical flu data from different parts of the world showed that the spread of flu epidemic has been more closely tied to rapid weather variability, implying that the lapsed human immune system in winter caused by rapidly changing weather makes a person more susceptible to flu virus" (Preidt).

Probability of Future Events

It is highly likely that Westerly will continue to experience some level of influenza and Coronavirus cases during the ensuing 5-year period. For both of these viruses, following the CDC and RIDOH vaccination guidelines and suggestions for minimizing the spread of the diseases should have a positive impact on reducing incident rate and severity of infections.

4.3.5 Other Hazards

Profiles for the following natural hazards have been included in this Section.

4.3.5.1 Earthquake
4.3.5.2 Extreme Heat
4.3.5.3 Drought
4.3.5.4 Brush Fire

4.3.5.1 Earthquake

Description and Extent

According to the U.S. Geological Society (USGS), an earthquake is the vibration (rapid shaking of the earth's surface in both horizontal and vertical directions) of the ground, produced by the sudden release of slowly accumulated energy. This energy can be generated by a sudden dislocation of segments of the crust, volcanic eruptions, or manmade explosions. The sudden dislocation of segments of the crust generally produces the most destructive quakes. Earthquakes tend to occur along faults which are fractures between two blocks of rock, known as tectonic plates. More specifically, tectonic plates are massive, irregularly shaped slabs of rock within the lithosphere, the rigid outermost shell of a planet, and are continually slowly moving because of convection in the mantle. When plates come in contact, the force of their movement against one another will cause deformation or strain on the rocks, building up potential energy. If the stress becomes too great, the weaker segments of rocks may suddenly snap, releasing large amounts of energy. This energy, in the form of seismic waves travels outwardly, in all directions, from its origin, commonly referred to as the focus or hypocenter. The location on the Earth's surface directly above the focus is called the epicenter and usually sustains the greatest damage in an earthquake event (Shedlock).

The depth to the center of the earth's core is approximately 3,960 miles. Earthquakes originate in relatively shallow parts of the earth's interior, generally the crust and upper mantle. Shallow earthquakes have focal depths from the surface to about 43.5 miles; intermediate earthquakes range from greater than 43.5 to about 186 miles; and deep earthquakes range from greater than 186 miles and may reach depths of more than 435 miles below the earth's surface (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-72).

As discussed in the RI-SHMP, the severity of an earthquake can be expressed in terms of magnitude and intensity. Magnitude is a measure of earthquake size based on the amount of seismic energy released at the hypocenter of the earthquake which is recorded on uniformly calibrated seismographs. It is represented by a single, instrumentally determined Richter Magnitude Scale value. The magnitude of an earthquake is not used to express damage and therefore remains unchanged with distance from the earthquake (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-74). Earthquakes with a magnitude of 2.0 or less on the Richter Scale are generally not felt by people, only recognized by local seismographs, and considered micro earthquakes. Around the world, hundreds of these events occur daily. Earthquakes with a magnitude of at least 4.5 are strong enough to be recorded by sensitive seismographs worldwide. Great earthquakes which have a magnitude of at least 8.0 occur about once a year. The largest earthquake ever recorded was in Chile in 1960 with a magnitude of 9.5 (IRIS).

The intensity of an earthquake is based on observation of the damage impact of an earthquake and therefore changes based on location; generally decreasing with distance from the epicenter. The intensity considers the effects of the ground shaking on people, manmade structures, and natural features. "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 (Modified Mercalli 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-74).

Table 4-15 relates the Modified Mercalli Intensity (MMI) scale to the Richter Scale. The MMI scale is used to evaluate the effects of earthquakes. This scale is designated by Roman numerals and rather than a mathematical basis, is based on observed effects. The level of intensity ranges from imperceptible shaking (I) to catastrophic destruction (XII).

Table 4-15 Intensity and Effects of Earthquakes defined by the Richter and Modified Mercalli Intensity (MMI) Scales (adapted from USGS)

Richter Magnitude Scale	MMI Rating	Description
1.0 - 2.9	I Instrumental	Not felt except by a very few under especially favorable conditions.
3.0 - 3.9	II Weak	Felt only by a few persons at rest, especially on upper floors of buildings.
	III Slight	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.
4.0 - 4.9	IV Moderate	Felt indoors by many, outdoors by few during the day. At night, some awakened. Dishes, windows, doors, disturbed; walls make cracking sound. Sensation like truck striking building. Standing vehicles rocked noticeably.
	V Rather Strong	Felt by nearly everyone; many awakened. Some dishes, windows broken. Unstable objects overturned. Pendulum clocks may stop.
5.0 - 5.9	VI Strong	Felt by all, many frightened. Some heavy furniture moved; a few instances of fallen plaster. Damage slight.
	VII Very Strong	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.
6.0 - 6.9	VIII Destructive	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 Violent	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.
7.0 and higher	X Intense	Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations. Rails bent.
	XI Extreme	Few, if any (masonry) structures remain standing. Bridges destroyed. Rails bent greatly.
	XII Catastrophic	Damage total. Lines of sight and level are distorted. Objects thrown into the air.

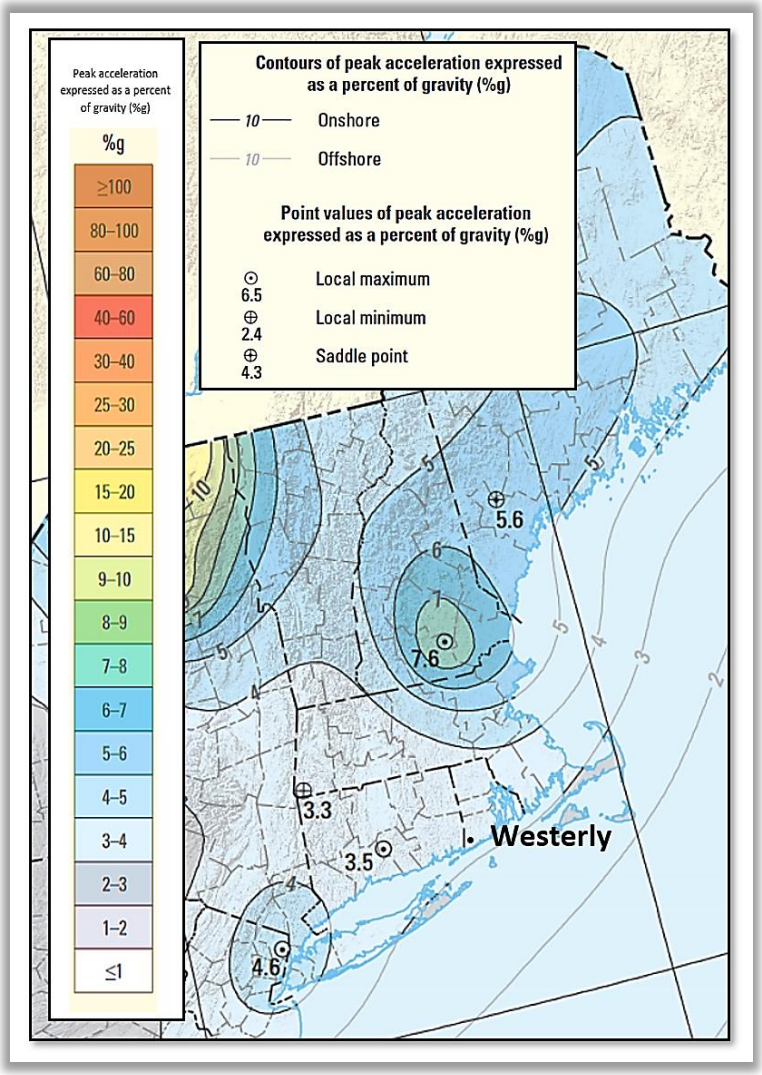
Earthquakes can affect large areas, cause extensive damage to property, result in loss of life and injury to many people, and disrupt the social and economic functioning of the affected area. Most property damage and earthquake-related deaths are caused by the failure and collapse of buildings, bridges, and other structures due to the amplitude and duration of the ground vibrations. Ground movement can also cause flooding, dam failure, failure in above ground utilities, and rupture underground utilities which can result in various secondary hazards including flash floods, fires, and landslides. A shallow marine earthquake event that displaces the seafloor has the potential to trigger a tsunami (immense sea waves) which provides an additional risk to coastal areas, particularly the west coast in the U.S.

Location

Rhode Island is on the North Atlantic tectonic plate and there are no significant geologic fault lines in Rhode Island or New England. The USGS Earthquake Hazards Program identifies the State of Rhode Island as a low seismic risk area. This is illustrated in the USGS 2014 Seismic Hazard Map (**Figure 4-36**) showing Westerly in an area on the lower end of the scale for potential peak acceleration (i.e. how hard the earth shakes at a given geographic point) of a potential earthquake.

Earthquakes occur infrequently in Rhode Island and surrounding New England, but historically earthquakes originating in other states have been felt in various parts of Rhode Island. "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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-73).

Figure 4-36
Seismic-Hazard Map:
Peak Horizontal Acceleration with 10% Probability of Exceedance in 50 Years
(adapted from USGS)



Because the impact from an earthquake can be experienced hundreds of miles from the epicenter, all areas of Town are considered vulnerable to some degree. Should an earthquake strike or its effects be felt in Westerly, people may experience shaking. Damage in structures that are up to current building codes is expected to be minimal. However, old masonry structures that do not meet current earthquake codes could potentially be at higher risk of damage or collapse. There are some residential and commercial structures sporadically located throughout the Town that are of older construction and may be more susceptible to earthquakes.

Previous Occurrences

Between 1678 and 2016, the New England region experienced 2,030 felt earthquakes. During that time, 34 were centered in Rhode Island, with the first occurring on August 25, 1776 (NESEC). "Of these felt earthquakes, only one caused some slight damage. That event took place at 12:20 pm on June 10, 1951 and had a magnitude of 4.6. The earthquake was centered a few miles south of Westerly, RI, and it was felt across Connecticut, Rhode Island and the south coast of Massachusetts to Cape Cod. Some dishes were knocked from shelves and plaster was reported cracked in a few buildings in Newport, RI. Many people in Westerly, RI were so frightened by the shaking that they ran from their homes. Residents jammed the telephones lines following the earthquake in their attempts to find out what had happened" (NESEC).

Rhode Island has experienced minor impacts from a number of earthquakes with epicenters outside of the State. On August 23, 2011 a 5.8 magnitude earthquake struck Virginia and was felt up and down the Eastern seaboard, including Rhode Island (NPR). On January 12, 2015 a 3.3 magnitude quake occurred with an epicenter in Wauregan, Connecticut (a village in the northwestern corner of Plainville). Effects of the quake were predominately felt along the border in the Plainfield CT and Foster RI area. However, weak intensity effects were also reported in Westerly (VHB, 62). In November 2020 there was a small 3.6 magnitude earthquake felt by many in Southern New England. The epicenter was in Buzzards Bay, MA (MVTimes). More recently, on May 14 & 15, 2022, three small earthquakes hit off of the coast of Rhode Island along the fault line near the Narragansett Pier. The first had a magnitude of 2.2, followed about 17 hours later by a 2.5 magnitude aftershock and then a 2.2 magnitude aftershock roughly 4 and a half hours later (Boston.com).

Climate Change Impacts

According to an article from NASA's Jet Propulsion Laboratory, "most earthquakes occur far beneath Earth's surface, well beyond the influence of surface temperatures and conditions" (Buis, Alan. *Can*). That being said, scientist have determined some relationships between climate change and earthquakes. The amount of stress on a fault can trigger or inhibit earthquakes. "The largest climate variable that could change fault stress loads is surface water in the form of rain and snow" (Buis, Alan. *Can*). Scientist have found a correlation between surface water and microseismicity (small earth tremors with magnitudes less than zero – which humans can't feel), but as yet have not been able to apply it to a quake of any size that people can feel (Buis, Alan. *Can*).

Research has shown that "changes in stress loads on Earth's crust from periods of drought can, in fact, be significant. Similarly, pumping of groundwater from underground aquifers by humans, which is exacerbated during times of drought, has also been shown to impact patterns of stress loads by 'unweighting' Earth's crust" (Buis, Alan. *Can*). While such stresses on a fault may be small compared to the normal buildup of stress from tectonic processes, it could potentially hasten the onset of an earthquake (Buis, Alan. *Can*).

"Another climate-related phenomenon that's believed to have connections to tectonic processes is glaciation. The retreat of a glacier can reduce stress loads on Earth's crust underneath, impacting the movement of subsurface magma. The rapid movement of glaciers has also been shown to cause what are known as glacial earthquakes. Glacial earthquakes in Greenland peak in frequency in the summer months and have been steadily increasing over time, possibly in response to global warming" (Buis, Alan. *Can*).

Probability of Future Events

The RI-SHMP indicates that the likelihood of an earthquake occurring in Washington County is unlikely (less than 1% annual probability), and should one occur the probable impact to structures and facilities would be negligible with limited short-term impact to critical infrastructure RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-81).

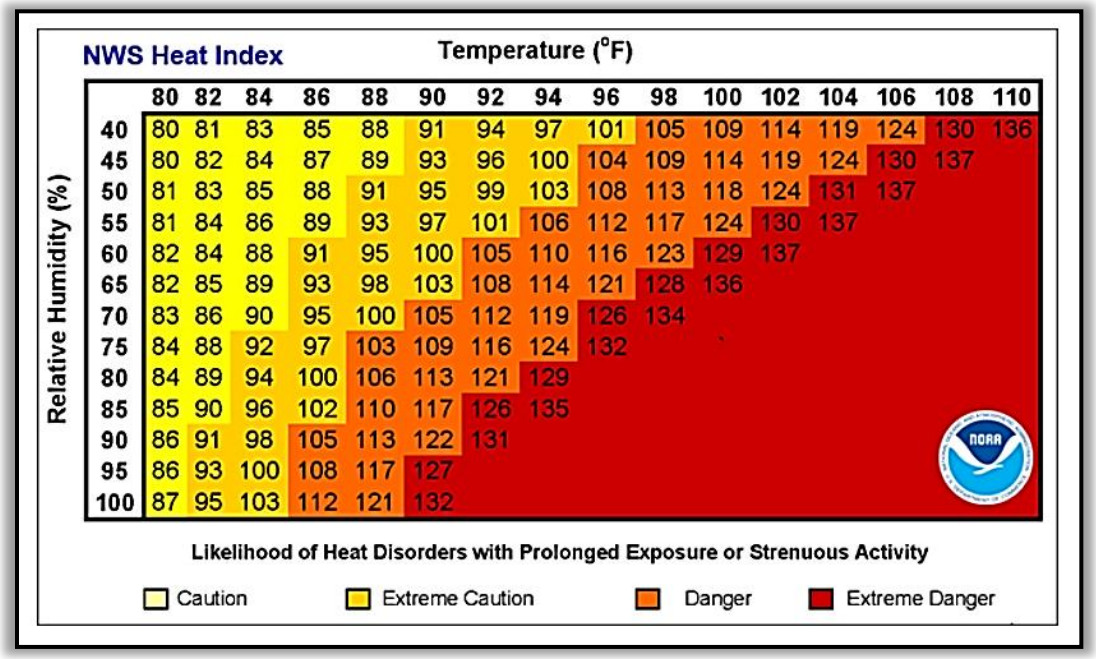
4.3.5.2 Extreme Heat

Description and Extent

According to the CDC, extreme heat is defined as a period of abnormally high temperature (>10° F above average regional temperatures) that lasts for several weeks. Humid or muggy conditions occur when a "dome" of high pressure, humid air remains near the ground. The increased water vapor in the air traps solar radiation near the surface of the earth, which raises temperatures. Humidity prevents the evaporation of sweat and the associated cooling effects on the human body (CDC. *Climate Change and Extreme Heat*).

The RI-SHMP identifies a heat wave occurring if the outside temperature goes above 90 degrees Fahrenheit for three or more consecutive days. The NOAA|NWS Heat Index Program is used to alert the public of hazardous heat/humidity conditions. The Heat Index (HI), shown in **Figure 4-37**, is a measure of how hot it actually feels from the combined effect of humidity and temperature (RIEMA. *State of Rhode Island Hazard Mitigation Plan***,** 3-94). In Rhode Island, a heat advisory is issued when the heat index value is expected to reach 100 -104 degrees for any amount of time, or between 95 to 99 degrees for 2 consecutive days (NOAA|NWS. *National Weather Service is Lowering*).

Figure 4-37 Heat Index (NOAA|NWS. *Heat Forecast Tools*)



Extreme heat events "are the leading cause of extreme weather-related deaths in the United States" (RIDOH. *Extreme Heat*). According to the CDC, "Despite the fact that all heat-related deaths and illnesses are preventable, each year an average of about 658 people succumb to extreme heat" (CDC. *Heat-Related, 1*).

Heat-related illness (hyperthermia) results from exposure to extreme heat over a period of time, taxing the human body beyond its ability to properly cool. Normally body heat is removed through the evaporation of sweat. However, if the humidity is high, sweat does not evaporate as quickly. If the body is unable to shed heat, the temperature of the body's inner core begins to rise and heat-related illness may develop. Exposure to excessive heat can also exacerbate many preexisting conditions, including heart and respiratory disease (CDC. *Heat-Related, 1*).

Negative effects of extreme heat include but are not limited to:

- Heat-related illnesses such as sunburn, fatigue, heat cramps, heat exhaustion, and heat stroke
- Health concerns created by stagnant atmospheric conditions trapping pollutants
- Excessively dry and hot conditions can provoke dust storms resulting in low visibility and respiratory problems
- Power shortages/outages caused by increased energy demands
- Increased demand on health care facilities by individuals suffering from various heat related health effects
- Disruption of commerce as a result of increased energy demand
- Disruption of municipal services as a result of decreased human productivity or increased energy demands
- Damage to structures and infrastructure (such as asphalt) due to softening

Location

All areas of Westerly are considered susceptible to extreme heat. Although Westerly is a suburban community, the Downtown area is predominately hardscaped and can be considered to produce an *urban heat island effect*. An *urban heat island effect* occurs when natural land cover is replaced by dense concentrations of buildings and pavement that absorb and retain heat. The heat is slowly released after dark, resulting in higher nighttime temperatures.

Previous Occurrences

"Temperatures in Rhode Island have risen almost 4°F since the beginning of the 20th century**.** The number of hot days has been above the long-term average since the 1990s with the greatest number occurring during the most recent 6-year period of 2015–2020. The greatest number of warm nights also occurred during the 2015–2020 period" (NOAA|NCEI. *State*). As depicted **in Figure 4-38**, the number of extreme heat days has risen in Rhode Island over the last several decades from 52.6 to 71. A study by Brown University linked temperature rises above 80 degrees to Rhode Islanders being more likely to end up in the hospital or die (News from Brown). The overall warming trend in Washington County Rhode Island is further illustrated in **Figure 4-39**.

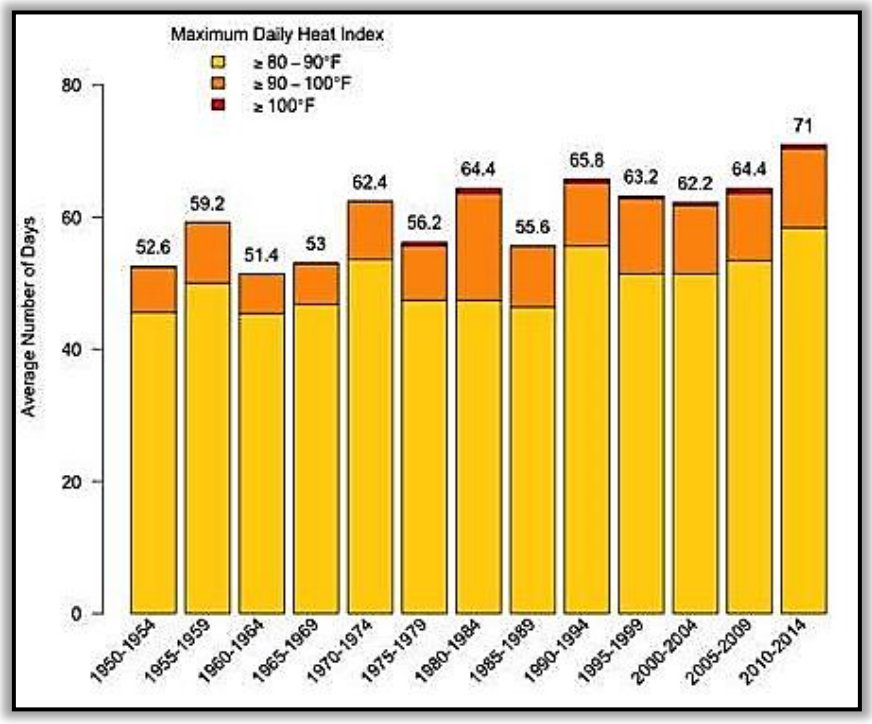
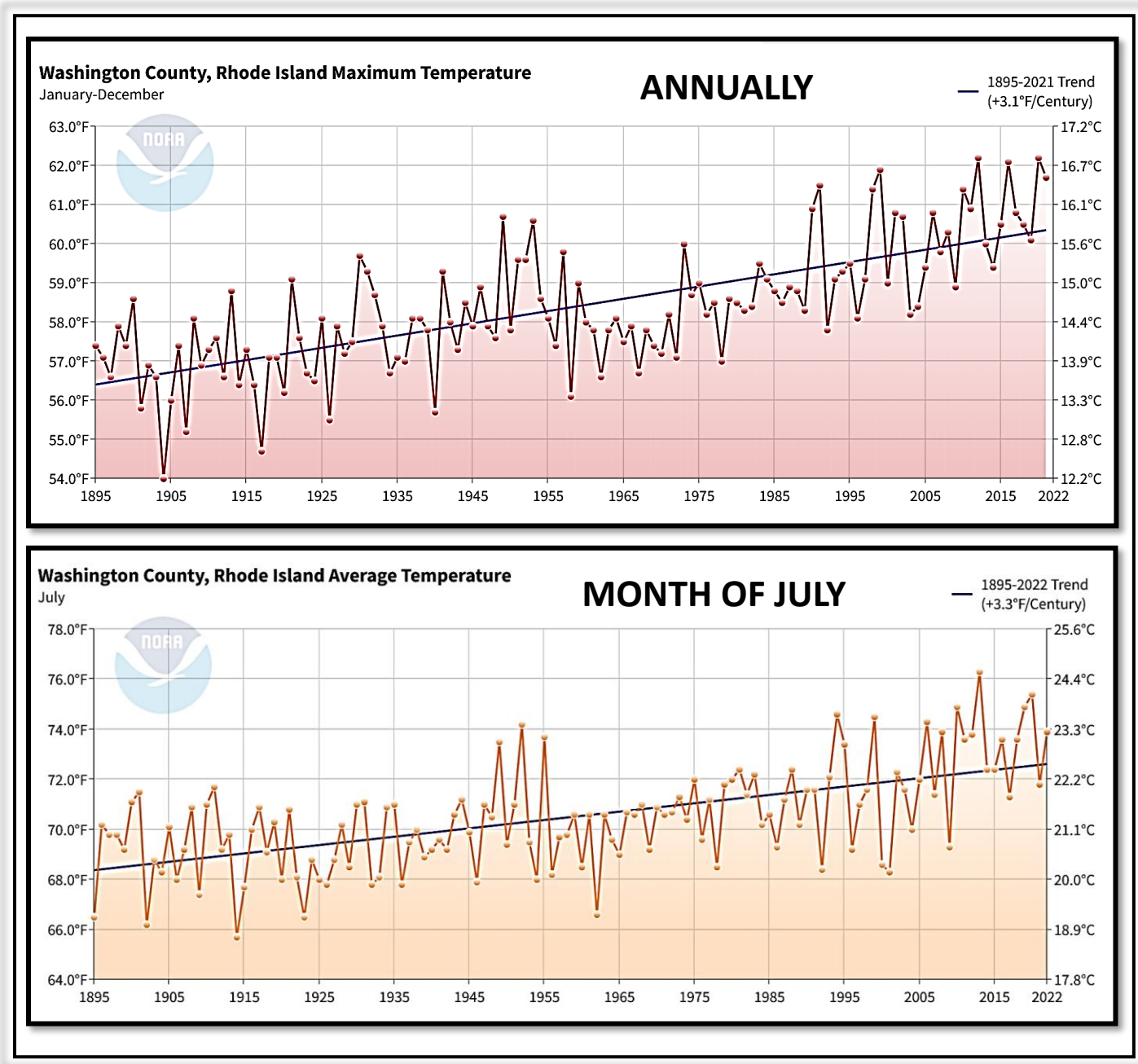


Figure 4-38
Number of Extreme Heat Days in RI by Year
(News from Brown)

Figure 4-39 Temperature Trends from 1895-2022 in Washington County Rhode Island
(NOAA|NCEI. *Climate at a Glance*)



Climate Change Impacts

"Temperatures in Rhode Island have risen almost 4°F since the beginning of the 20th century" (NOAA|NCEI. *State*). NOAA's 2022 State Climate Summary for Rhode Island further states, "The number of hot days has been above average since the mid-1990s. The highest number of such days occurred in the most recent 6-year period (2015–2020), with an average of 14 hot days occurring each year" (NOAA|NCEI. *State*). RIDOH predicts that over the ensuing 80 years, the number of days over 90°F is expected to increase significantly due to climate change (RIDOH. *Extreme Heat*).

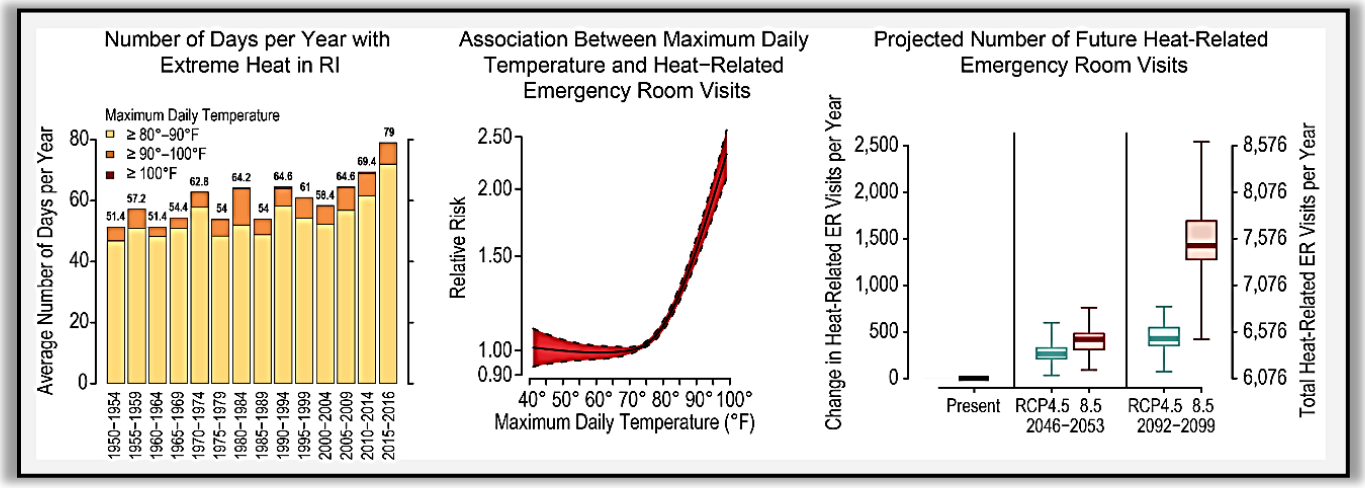
According to Climate Change RI (Climate Change RI. *Impacts on Rhode Island*):

- The long-term warming trend continued in 2019 with the Earth having its second warmest year on record; making the 2010s the hottest decade on record.
- The water in Narragansett Bay is getting warmer. The surface temperature of the Bay has increased 2.5-2.9°F (from 1960-2010). Wintertime water temperatures are warming most rapidly.

As recognized by the U.S. Global Change Research Program *Climate Science Special Report*, climate-related weather extremes are expected to continue over climate timescales. "This assessment concludes, based on extensive evidence, that it is extremely likely that human activities, especially emissions of greenhouse gases, are the dominant cause of the observed warming since the mid-20th century. For the warming over the last century, there is no convincing alternative explanation supported by the extent of the observational evidence" (Wuebbles, Executive Summary).

According to the Fourth National Climate Assessment, "Moderate and extreme heat events already pose a health risk today, and climate change could increase this risk" (U.S. Global Change Research Program. *Fourth National Climate Assessment – Chapter 18*). **Figure 4-40** shows the maximum daily temperature in Rhode Island, which has been increasing over the last 60 summers, resulting in three more weeks of health-threatening hot weather compared to the 1950s (left); incidence rate of heat-related ER visits which rose sharply as maximum daily temperatures climbed above 80°F (middle); and the observed and projected impacts of excess heat on emergency room visits in Rhode Island, based on climate change predictions (right). Under the higher modeled climate change scenario, the study projects that Rhode Islanders could experience an additional 400 (6.8% more) heat-related ER visits each year by 2050 (U.S. Global Change Research Program. *Fourth National Climate Assessment – Chapter 18*).

Figure 4-40 Observed and Projected Impacts of Excess Heat on Emergency Room Visits in Rhode Island
(U.S. Global Change Research Program. *Fourth National Climate Assessment – Chapter 18*)



Probability of Future Events

As noted in the RI-SHMP, the increased trend of high heat days (over 90°F) is expected to continue. Climate change studies predict that Rhode Island could have up to 50 days over 90°F per year by 2070. Hence, it is highly likely that Westerly will experience an extreme heat event over the ensuing 5-year period (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-97).

4.3.5.3 Drought

Description and Extent

Drought is a natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a period of time. According to NOAA, lack of precipitation for a few weeks or months can create a short-term drought. Long-term droughts occur when the atmospheric circulation pattern creates a precipitation deficit for several months to several years. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought (NOAA|NIDIS).

The National Drought Mitigation Center classifies droughts as follows (NDMC):

- **Agricultural drought:** related to agricultural impacts from lack of precipitation, reduced ground water levels, and dry soils
- **Hydrological drought:** related to the effects of periods of precipitation (including snowfall) shortfalls on surface or subsurface water supply (stream flow, reservoir and lake levels, ground water)
- **Meteorological drought:** refers to a reduction in the normal rainfall for a given geographic area; it is area-specific, as the average rainfall can vary greatly in different areas
- **Socioeconomic drought:** measures the impact that the statements above have on people/businesses

Table 4-16 Palmer Drought Severity Index (NDMC)

Severity	Index Value
Extreme Drought	-4 or less
Severe Drought	-3.0 to -3.99
Moderate Drought	-2.0 to -2.99
Mild Drought	-1.0 to -1.99
Incipient Dry Spell	-0.5 to -0.99

NOAA's National Climate Data Center (NCDC) recognizes that, "The wide variety of disciplines affected by drought, its diverse geographical and temporal distribution, and the many scales drought operates on make it difficult to develop both a definition to describe drought and an index to measure it" (NOAA|NCEI. *Measuring Drought*). Of the various quantitative measures of drought, the Palmer Z index is widely used to measure short-term (monthly) drought, and the Palmer Drought Severity Index (PDSI) (shown in **Table 4-16**) is used to measure the duration and intensity of long-term drought. Long-term drought is cumulative and the PDSI uses temperature and precipitation levels to determine dryness as compared to normal rainfall patterns for a particular locale (NOAA|NCEI. *Measuring Drought*).

Precipitation in Rhode Island averages about 45 inches per year (NOAA|NCEI. *State Climate Summaries*). This amount of precipitation generally ensures a plentiful water supply for Westerly's daily requirements, which are dominated by potable water needs. However, long-term drought conditions, may threaten groundwater availability.

Westerly's potable water supply is drawn from three (3) major aquifers all located within the Pawcatuck Basin, a sole-source aquifer designated in 1988. The Utilities Division is responsible for managing the Town's water supply distribution system and for ensuring there is enough water to meet public health and safety needs of the Town (Town of Westerly RI. *Comprehensive*, 249). "The White Rock WHPA [Wellhead Protection Area] draws approximately 70% of the Town's average daily potable water supply from the Pawcatuck Basin. During seasonally dry months, the Pawcatuck River's flow through the WHPA provides recharge to groundwater" (Town of Westerly RI. *Comprehensive*, 250).

In 2012, the State Planning Council adopted *Rhode Island Water 2030*, which provides guidance to the Rhode Island Water Resources Board (RIWRB) and local governing authorities. The Rhode Island Water Resources Board (RIWRB) is "charged with managing the proper development, utilization and conservation of water resources. Its primary responsibility is to ensure that sufficient water supply is available for present and future generations, apportioning available water to all areas of the state, if necessary" (RIDSP. *RI Water Resources*).

"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. The Rhode Island Water Resources Board works with the National Weather Service and the U.S. Geological Survey to assess and report monthly water conditions (precipitation, PDI [Palmer Drought Index], groundwater and surface water). Graphic and text summaries of current and projected drought conditions are updated on a weekly basis and are available through the Drought Monitor website" (RIEMA. *State of Rhode Island Hazard Mitigation Plan***,** 3-63). Based on this information, the RIWRB issues notices to the State regarding drought conditions.

RIWRB regulations require that local *Water Supply System Management Plans* (WSSMP) include an emergency component to assess system risks, including droughts. "The Town has the lead role in preparing for and managing all stages of drought at the local level and drought preparedness measures are included in Westerly's WSSMP. Policies are included that promote water conservation wherever possible, including a provision for local ordinances to ensure that established regulations and procedures can effectively respond" (Town of Westerly RI. *Comprehensive*, 250). Westerly's WSSMP provides procedures for several drought phases including Drought Watch/Advisory Phase, Conservation Phase, and Expanded Restriction Phase (Town of Westerly RI. *Comprehensive*, 222).

During a drought or extended dry conditions that require an emergency response to reduce water usage, the Town Manager is responsible for coordinating with the RIWRB.

Location

All areas of Westerly are considered susceptible to drought conditions. As depicted in **Figure 4-41**, the majority of Westerly (94±%) is served by the Town's Water Distribution System. As the Town's system is reliant on aquifers in the Pawcatuck Basin, a severe drought could impact public water service.

Those properties reliant on wells (6±%) are considered at greater risk to drought. Most of the properties with wells are located in the areas of South Woody Hill Road, Pound Road, Westerly-Bradford Road, and a portion of Boombridge Road/Potter Hill.

Previous Occurrences

Droughts, while not frequent in Rhode Island, do occur. Rhode Island does experience extended periods of dry weather generally in the late spring and the first half of summer, during which crops and lawns may require irrigation. "Though short-term droughts 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" (RIEMA. *State of Rhode Island Hazard Mitigation Plan***,** 3-65).

However, according to the *RI Water 2030* plan, there have been just six historical drought events since 1929. The last long-term drought in the state was in the early to mid-1960s. This drought lasted for three summers (1965-1967) and included long periods of below normal precipitation during the winter, spring, and summer months. Historically, Rhode Island's driest year on record is 1965, with less than 26 inches of rainfall (RIDSP. *RI Water 2030*).

As the Town's water system is reliant on aquifers, during extended dry periods and drought conditions, as a precaution, Westerly's Utility Division has placed bans on water use. Over the past five years restrictions on water use have occurred once. A severe drought impacted ponds and rivers in the Westerly area during the summer and fall of 2016. A ban was placed for 60 days.

July 2022 was the second driest July on record, and caused drought conditions in various parts of the state including Westerly. From July-Sept 2022 the Utilities Division placed a ban to curb high water demand related to lawn maintenance and beach goer activity.

Climate Change Impacts

There are a number of ways climate change may contribute to worsening drought conditions. For example, the Center for Climate and Energy Solutions indicates that "Warmer temperatures can enhance evaporation from soil, making periods with low precipitation drier than they would be in cooler conditions" (C2ES. *Drought*).

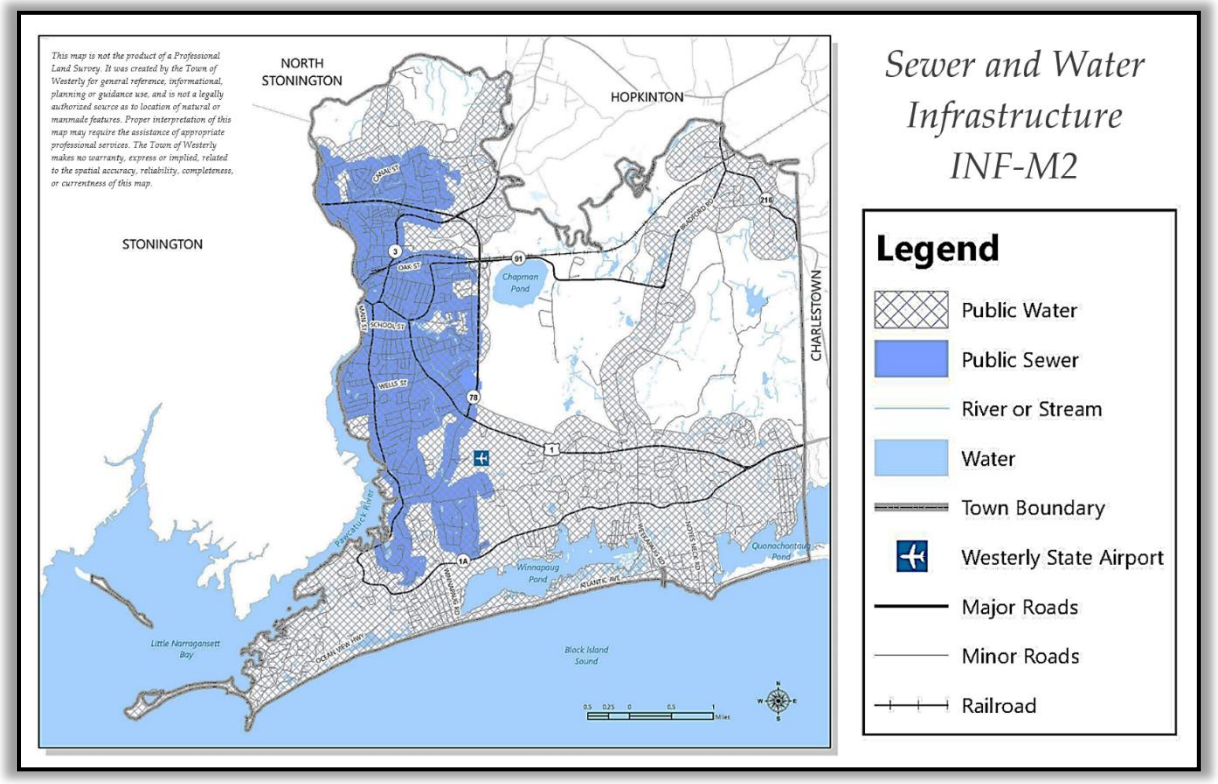
Although most precipitation models predict an increasing trend in overall precipitation for Rhode Island, they further suggest that simultaneous warming trends and less frequent but more intense precipitation events favor an increase in short-term (one to three month) drought intensity (RIEMA. *State of Rhode Island Hazard Mitigation Plan***,** 3-62, 3-63).

Probability of Future Events

The last major drought in Rhode Island was more than 50 years ago, and based on future precipitation projections, a long-term drought in Rhode Island is unlikely. However, over the next five years, the Town may experience periodic short-term drought conditions.

Figure 4-41 Sewer and Water Infrastructure

(Courtesy Town of Westerly 2020 Comprehensive Community Plan, produced by NEGEO and Mason & Associates)



4.3.5.4 Brush Fire

Description and Extent

The U.S. Forest Service has established the National Fire Danger Rating System (NFDRS) to determine the daily risk to fire experienced by different regions of the country. The system uses mathematical formulas including wind speed and fuel type to determine a fire index. As shown in **Table 4-17**, the updated 2016 version (NFDRS 2016) is simpler than previous versions and has a 5 color-coded system to help the public understand fire potential (USFS|USFS. *Understanding*).

Rhode Island Department of Environmental Management (RIDEM) Division of Forest Management is responsible for predicting the risk of fires igniting in the State. Forewarning of dangerous fire conditions aids firefighters and can result in reducing the severity of a fire thereby mitigating risks to life and property (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-105). In 2020, RIDEM updated their *Forest Action Plan* which provides communities key information on how to prepare, respond, educate, and fund fire-related protection programs.

Table 4-17 National Fire Danger Rating System (NFDRS 2016)

Color Code	Rating	Description
	LOW	Fuels do not ignite readily from small firebrands although a more intense heat source, such as lightning, may start fires in duff or punky wood. Fires in open cured grasslands may bum freely a few hours after rain, but woods fires spread slowly by creeping or smoldering, and burn in irregular fingers. There is little danger of spotting.
	MODERATE	Fires can start from most accidental causes, but with the exception of lightning fires in some areas, the number of starts is generally low. Fires in open cured grasslands will burn briskly and spread rapidly on windy days. Timber fires spread slowly to moderately fast. The average fire is of moderate intensity, although heavy concentrations of fuel, especially draped fuel, may burn hot. Short-distance spotting may occur, but is not persistent. Fires are not likely to become serious and control is relatively easy.
	HIGH	All fine dead fuels ignite readily and fires start easily from most causes. Unattended brush and campfires are likely to escape. Fires spread rapidly and short-distance spotting is common. High-intensity burning may develop on slopes or in concentrations of fine fuels. Fires may become serious and their control difficult unless they are attacked successfully while small.
	VERY HIGH	Fires start easily from all causes and, immediately after ignition, spread rapidly and increase quickly in intensity. Spot fires are a constant danger. Fires burning in light fuels may quickly develop high intensity characteristics such as long-distance spotting and fire whirlwinds when they burn into heavier fuels.
	EXTREME	Fires start quickly, spread furiously, and burn intensely. All fires are potentially serious. Development into high intensity burning will usually be faster and occur from smaller fires than in the very high fire danger class. Direct attack is rarely possible and may be dangerous except immediately after ignition. Fires that develop headway in heavy slash or in conifer stands may be unmanageable while the extreme burning condition lasts. Under these conditions the only effective and safe control action is on the flanks until the weather changes or the fuel supply lessens.

Brush Fire versus Wildland Fire

According to the local Fire Departments, in Westerly, fires ignited by a natural cause (e.g. lightning), are infrequent and when occurring, are generally limited to small (less than 0.5 acre) brush fires. The USDA Forest Service defines a brush fire as a fire burning in vegetation that is predominantly shrubs, brush, and scrub growth. Wildland fires are generally associated with thousands of acres of trees burning, whereas brush fires tend to be smaller, more manageable, and generally confined to the understory (National Park Service).

Weather conditions and topography impact fires fueled by natural cover, including native and non-native species of trees, brush and grasses, and crops. Fuel quantity and quality impact the extent of a brush or wildland fire. Climatic and meteorological conditions that influence the moisture content of wood and leaf litter, thereby impacting brush or wildland fires, include solar insulation, atmospheric humidity, and precipitation. Dry spells, heat, wind, and low humidity increase vegetative susceptibility to fire. Favorable fire conditions arise from extended periods of hot, dry weather and accumulated vegetation. Peak fire season in Rhode Island is typically between mid-March and mid-May when dry windy weather can occur increasing the potential for fires (RIEMA. *State of Rhode Island Hazard Mitigation Plan,* 3-102, 3-105).

Larger brush fires and wildland fires can disrupt and endanger wildlife and ecosystems, destroy crops and timber resources, impact above ground utility lines affecting power, internet, and phone service, and if they reach the built environment can damage structures and other property and pose a threat to human safety.

Location

The coastal town of Westerly has large areas of open space, including beaches, wetlands, and other unimproved land. Based on RIGIS 2011 land cover dataset, Westerly has approximately 370 acres (2.3%) agricultural land, 5,229 acres (32.3%) conservation/open space, and 4,056 acres (25.0%) of undeveloped/unprotected land. (Town of Westerly RI. *Comprehensive*, 32).

Under the right conditions, including during a drought, the threat of brush fires increase. Brush fires that occur in more remote, harder to access areas of Town pose a greater risk of spreading as they may go unnoticed for longer and/or take longer to access by fire protection services. Portions of the Woody Hill Management Area and the Potter Hill area, including the Town Forest, are largely inaccessible to motor vehicles creating potential difficulties for fire suppression.

Other areas of Town where dry conditions could provide fuel for a brush fire (such as the old growth of phragmites) include the coastal grasslands of Avondale and Watch Hill, and the local salt pond region. While these grassland areas are relatively small, their distance from hydrants would necessitate the transport of water for suppression. If not controlled quickly, brush fires in these areas could threaten nearby structures.

According to Marc Doherty, Land Stewardship Manager for the Westerly Land Trust, "During the summer of 2022, drought conditions in Westerly led to elevated wildland fire threats in specific zones. Hilltops with shallow, sandy, and well-drained soils and thinner canopy cover became most susceptible. These areas include the higher elevations along Shore Road, and upland pockets within areas such as Riverwood Preserve, Grills Preserve, Woody Hill State Management Area, and the Town Forest, particularly along the transmission lines."

Previous Occurrences

Wildfires are not common in Rhode Island, but there have been a few significant ones. The most devastating was the Coventry Fire in April 1942, which consumed over 24,000 acres of forest and injured approximately 180 people. Another substantial wildfire occurred in Exeter in 1951, which consumed roughly 7,400 acres and caused a fatality (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-106).

As previously indicated, brush fires tend to occur during the spring and summer months when dormant brush, dead twigs, and small branches provide a good fuel source. Although less common, they can occur during the summer and fall, particularly during drought conditions. Early spring 2021 saw a number of days where the fire danger was high. By March 15, 2021, twenty-six brush fires had occurred (albeit mostly small) across the State. At the time, to help raise awareness to the potential risk of brush fires, the Watch Hill Fire Department released a social media post indicating that warm spring weather, coupled with the lack of rain and strong winds had elevated the risk of forest and brush fires to critical levels (Vallee, Jason).

According to local Fire Departments, in Westerly, although occasional brush fires occur, they are generally the result of permitted or illicit open air burning that were not managed correctly. Fires ignited by a natural cause (e.g. lightning) are infrequent, but do occur. Due to improved fire prevention and firefighting efforts, brushfires are generally extinguished quickly, with no significant impact.

Climate Change Impacts

Wildland and brush fire risk depends on a number of factors, including temperature, soil moisture, and the presence of potential fuel (tree, shrubs, etc.). These factors have direct or indirect ties to climate variability and climate change. Changes in climate that create warmer, drier conditions increase the fire season and help fires spread making them harder to put out.

Probability of Future Events

It is estimated that Westerly has a low probability of brush fires from natural causes occurring. "The National Oceanic and Atmospheric Administration (NOAA) places the Town of Westerly within the humid continental climate zone, described as having mild to warm summers and cold winters" (Town of Westerly RI. *Comprehensive*, 17). In general Westerly's overall humid climate does not favor brush fires. The probability of future events is further diminished as open air burning permits are required from the local Fire District, highly restricted, and only issued when risk of wildfires is low. Permits for fireworks are also required by Fire Districts and require fire detail supervision.

Due to the infrequency of brush and wildland fires occurring, it is important that the community continue to be educated about the risks of brush and wildland fires, in particular, those who live in heavily forested areas of Westerly,

4.4 VULNERABILITY ANALYSIS

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirement ➔
44 CFR Subsection D §201.6(c)(2)(ii): [The risk assessment shall include] a description of the jurisdiction's vulnerability to the hazards described in paragraph (c)(2)(i) of this section. This description shall include an overall summary of each hazard and its impact on the community. All plans approved after October 1, 2008 must also address NFIP insured structures that have been repetitively damaged by floods. The plan should describe vulnerability in terms of:

(A) The types and numbers of existing and future buildings, infrastructure, and critical facilities located in the identified hazard areas;

(B) An estimate of the potential dollar losses to vulnerable structures identified in paragraph (c)(2)(ii)(A) of this section and a description of the methodology used to prepare the estimate; and

(C) Provide a general description of land uses and development trends within the community so that mitigation options can be considered in future land use decisions.

With Westerly's hazards identified and profiled (**Sections 4.1-4.3**), the Advisory Committee conducted a *Vulnerability Analysis* to describe the impact that each identified hazard might have on the Town. The term vulnerability indicates what is likely to be damaged by a particular hazard and how severe that damage could be. The *Vulnerability Analysis*, in conjunction with the *Capability Assessment* (**Section 5**), was used in developing the *Mitigation Strategy* and *Action Plan* (**Section 6**).

CRS CREDIT:

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase II – Risk Assessment	5. Assess the Problem	52

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

The vulnerability assessment used the process described in the FEMA publication *Understanding Your Risks - Identifying Hazards and Estimating Losses* as a guideline for the analysis. In assessing the Town's vulnerability to the identified hazards, the Advisory Committee considered what community assets are at risk (built environment including public infrastructure, natural environment, local economy, and people) and what the impacts might be (structural and environmental damage, economic loss, inconvenience to residents, physical and emotional harm, and loss of life). The Advisory Committee also identified a list of critical facilities to be assessed. The *Vulnerability Analysis* presented in this Section is organized as follows:

4.4.1 Critical Facilities

4.4.2 Built Environment and Infrastructure

4.4.3 Natural Environment

4.4.4 Local Economy

4.4.5 People

4.4.6 Future Development Trends

Two distinct methodologies were used in the *Vulnerability Analysis*. The first consists of a quantitative analysis that relies upon best available data and technology, while the second approach consists of a somewhat qualitative analysis that relies on local knowledge and rational decision making. For hazards that do not have the data to support quantitative analysis, vulnerability is discussed in more general qualitative terms.

CRITICAL FACILITIES

4.4.1 Critical Facilities

Although the Town as a whole is considered in the overall vulnerability assessment, it is important to identify critical facilities that, if adversely affected by a hazard event, may result in more severe consequences to public health and safety or interrupt essential services and operations for the community. Westerly's Critical Facilities have been classified into six categories: Schools; Day Care/Early Learning Centers; Government/Emergency Centers; Special Population Centers; Institutional/Commercial; and National Register of Historic Places.

A *Vulnerability Analysis* was conducted to determine the potential susceptibility of each critical facility to the profiled hazards. A summary of the analysis in tabular format has been provided in **Appendix 4-3**, and discussed in the narrative of **Subsections 4.4.2-4.4.5**. A list of the critical facilities is included in **Table 4-18**, and their locations depicted in **Figure 4-43** (a larger scale of this map is included in **Appendix 4-2**).

Table 4-18 Critical Facilities with Map Number Identification

Schools	Day Care/ Early Learning Centers	Government/ Emergency Centers	Special Population Centers	Institutional/ Commercial	National Register of Historic Places
1 Dunn's Corners Elementary School	**6** Cadence Academy Preschool	**13** Animal Shelter Department	**25** Apple Rehab Clipper	**36** The Ocean Community YMCA	**43** Babcock-Smith House
2 Springbrook Elementary School	**7** Central Nursery School	**14** Department of Public Works	**26** Frank Olean Center	**37** US Post Office (110 Tom Harvey Road)	**44** Flying Horse Carousel
3 State Street Elementary School	**8** Clark Street Daycare	**15** Dunn's Corners Fire Department	**27** Golden Years Assisted Living Community	**38** US Post Office (416 Bradford Road)	**45** George Kent Performance Hall
4 Westerly High School	**9** Dunn's Corners Early Learning	**16** Misquamicut Fire Department	**28** Johnnycake Center	**39** Westerly Ambulance Corps	**46** Lewis-Card-Perry House
5 Westerly Middle School	**10** Littlebrook Child Dev. Center	**17** Watch Hill Fire Department	**29** Joy Community Center	**40** Westerly Education Center	**47** Nursery Site (arch. site)
	11 Westerly Head Start	**18** Westerly Fire Department	**30** PACE Adult Day Ctr. & Transition Academy	**41** Westerly Hospital	**48** Ram Point
	12 Westerly Preschool	**19** Police Department	**31** Royal Health Westerly	**42** Westerly Library & Wilcox Park	**49** U.S. Post Office (5 High St)
		20 Town Hall	**32** The Elms Retirement Residence		**50** Weekapaug Inn
		21 Town Hall White Rock Building	**33** Tri County Community Action		**51** Westerly Armory
		22 Tower Street Comm. Center	**34** WARM Shelter		
		23 Westerly Sch District Admin.	**35** Westerly Rehab & HC Center		
		24 Westerly Senior Center			

In addition to the Critical Facilities listed in **Table 4-18**, the Advisory Committee recognized that many of Westerly's businesses play a vital role in the ongoing, day-to-day community needs, and may provide essential services during and after a natural hazard event. These include, but are not limited to, the following:

Gas Stations

- 7-Eleven (11 Post Road)
- Cumberland Farms (149 Granite Street)
- Ginger's (110 Oak Street)
- Gulf (74 Friendship Street)
- Mobil (249 Post Road & 10 East Avenue)
- Shell (155 Main Street)

Groceries Stores

- Aldi (5 Langworthy Road)
- McQuades Marketplace Grocery Store (106 Main St)
- Sandy's Fine Food Emporium (15 Post Rd)
- Stop & Shop Grocery Store (149 Franklin Street)
- Walmart (258 Post Road)
- Westerly Packing Co. (15 Springbrook Rd)

Home Repair Businesses

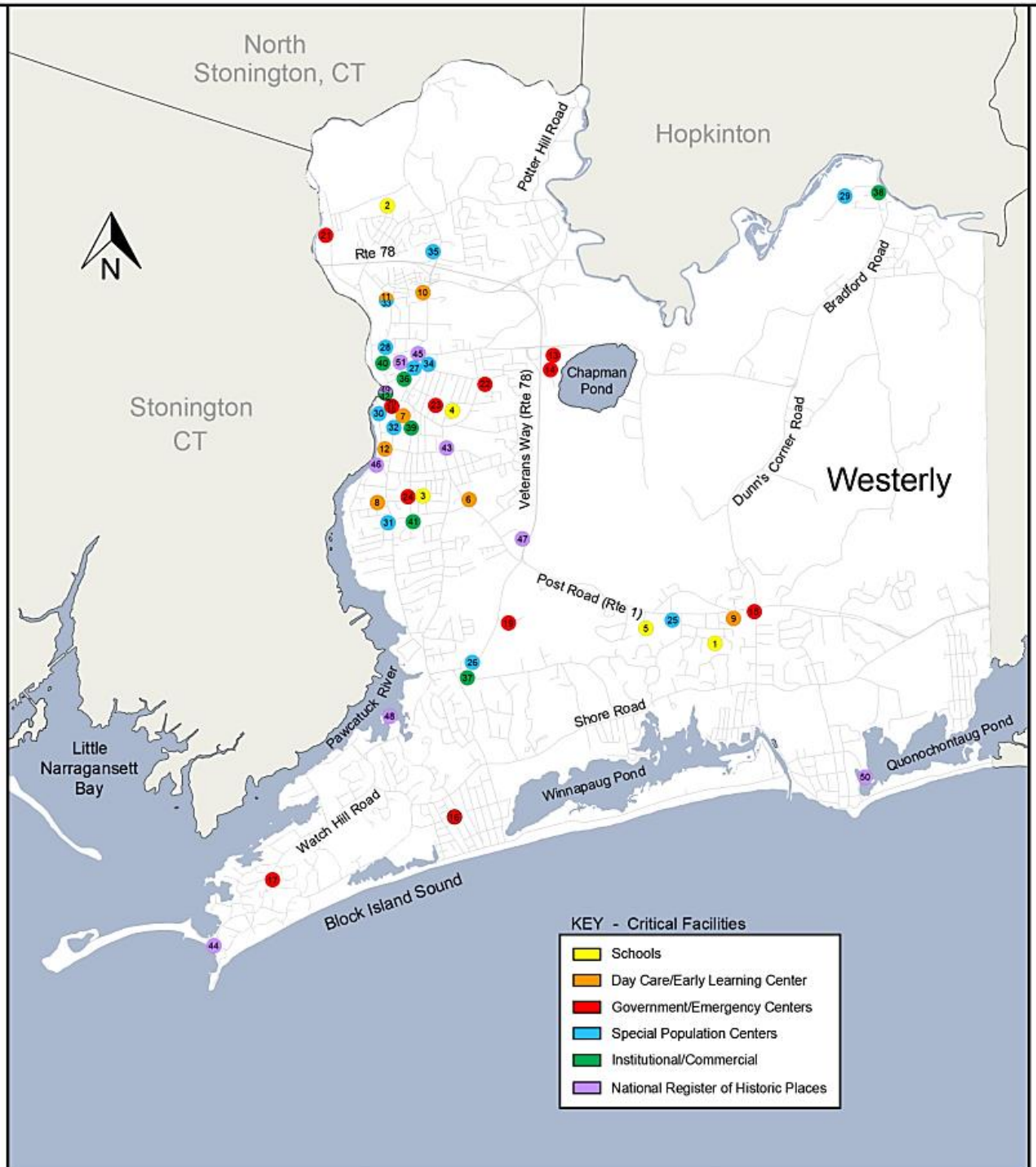
- Arnold Lumber (124 Oak Street)
- Home Depot (120 Franklin Street)
- McQuades Ace Hardware (105 Franklin Street)
- Riverhead Building Supply (10 Oak Street)

Auto Repair Businesses

- Advance Auto Parts (146 Granite Street)
- AutoZone (138 Granite Street)
- NAPA Auto Parts (100 Franklin Street)

Figure 4-42 Westerly Town Hall
Built in 1912 and designed by William Walker & Son in the Academic Revival style
Photo Credit: Wikipedia

Critical Facilities



This map is not the product of a Professional Land Survey. It was created by the Town of Westerly for general reference, informational, planning or guidance use, and is not a legally authorized source as to location of natural or manmade features. Proper interpretation of this map may require the assistance of appropriate professional services. The Town of Westerly makes no warranty, express or implied, related to the spatial accuracy, reliability, completeness, or currentness of this map.

Graphic Scale

0 3000 6000 12000

1 inch = 3000 Feet

February 2023 | Source: RIGIS, Town

Figure 4-43

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

BUILT ENVIRONMENT AND INFRASTRUCTURE

4.4.2 Built Environment and Infrastructure

Westerly's built environment, including public infrastructure, is an important resource. Due to its coastal location and extensive low-lying land, the primary hazards that will impact the built environment, including public infrastructure, are inland flooding, coastal flooding, and coastal erosion caused by rain and snow events, and storm surge from hurricanes or other high-wind events. These hazards will be exacerbated by sea level rise. Many developed areas within Westerly pre-date zoning ordinances which presents unique challenges to hazard mitigation. It must be recognized that there are many older buildings in flood- and wind-prone areas that would benefit from current regulations, but unless the owners are proposing changes or modifications that require local permit approvals, they most likely will not be retrofit to the new standards. In addition to the items identified in **Table 4-19**, the vulnerability to Westerly's built environment/infrastructure will be further explored in the following subsections: **4.4.2.1 FEMA Flood Zones** and **4.4.2.2 Flooding, Storm Surge, and SLR.**

Table 4-19 Built Environment and Infrastructure Vulnerability

Hazard Group	Vulnerability *(What is at Risk)*
 **Flood-Related Hazards** (Inland Flooding/Dam Failure; Coastal Flooding/Storm Surge; Coastal Erosion)	• Significant flooding can lead to extensive damage to structures and personal property; disrupt potable water, stormwater, and sewer system operations; flood roadways creating dangerous conditions for motorists; and increase the water table resulting in subsurface issues such as wet basements. • Properties and structures in the SFHA (V and A Flood Zones) are at highest risk to the impacts from flooding. • Inland flooding: Westerly has several freshwater waterbodies that represent a risk of riverine flooding for inland neighborhoods; the most prominent is the Pawcatuck River, which flows along the entire northern and western boundaries of the Town and has the potential to impact properties along its banks and portions of Downtown Westerly, the North End neighborhood, White Rock, Bradford, Avondale, and Watch Hill; low-lying properties along smaller streams (Aguntaug Brook, Mastuxet Brook, McGowan Brook, Perry Healy Brook, and Spring Brook) and near Chapman Pond and Aguntaug Swamp in the north central section of Westerly, are also vulnerable to flooding. • Coastal Flooding: the VE and coastal A Zones include low-lying portions of Watch Hill, Misquamicut Beach, and properties around Maschaug, Little Maschaug, Winnapaug, and Quonochontaug Salt Ponds. • Flood inundation impacts sections of the following roadways and adjacent low-lying properties: Airport Road, Ann Street, Atlantic Avenue, Bay Street, Beach Street near Westerly Yacht Club, Bowling Lane, Bradford Road, Breach Drive, Bridge Road, Canal Street, Cottage Street, Dunn's Corners Road, Friendship Street, intersection of Route 78 and Route 1, Langworthy Road, Main Street, Maplewood Avenue, Narragansett Avenue, Perkins Avenue, Pierce Street, Pleasant Street, Pond Street, Pound Road, Ranger Road, Route 91, Springbrook Road, Spruce Street, Sunset Avenue, Wall Street, Watch Hill Road, Wauwinnet Avenue, Weekapaug Road, and White Rock Road. • Low-lying areas along the coast are at higher risk to storm surge and coastal erosion; located in the southwest corner of Rhode Island along Block Island Sound, Westerly experiences high storm surge elevations; when coupled with normal tides, storm surge can raise the mean water level 10 feet or more; coastal erosion produced by wave action can become very destructive, damaging natural and manmade structures, battering solid objects, and scouring sand from

Hazard Group	Vulnerability *(What is at Risk)*
Flood-Related Hazards continued	around foundations; as storms erode the shoreline, they put adjacent upland properties at greater risk.. • Future increases in relative sea level will: intensify coastal flooding and may displace coastal populations; threaten infrastructure including reducing the effectiveness and integrity of existing seawalls and revetments, designed for historically lower water levels; and contaminate water supplies through saltwater intrusion into aquifers. • **Refer to Sections 4.4.2.1 and 4.4.2.2 for additional flood-related vulnerabilities, including the vulnerability of critical facilities.**
 **Wind-Related Hazards** (High Winds – Thunderstorms/ Lightning/Hail; Tornadoes; Tropical Cyclones)	• High winds, including those associated with tornadoes and tropical cyclones can cause damage to structures, property, vehicles, and infrastructure including utility lines. • Westerly enforces RI State Building Code, which currently requires residential and commercial structures be designed to ultimate wind speeds of 130 mph (Category 2 hurricane); some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to damage from high winds. • Under modeled scenarios, even Category 1 and 2 hurricanes can produce storm surges that inundate the Town's southern coastline to Shore Road (Route 1A) and along the Pawcatuck River from Little Narragansett Bay to approximately Stonington, Connecticut's northern boundary. • The built environment along the southern shoreline is at higher risk to wind-related damage; commercial and residential properties along Atlantic Avenue, in the community of Misquamicut, and in Watch Hill, Weekapaug, and Shelter Harbor have been impacted by high-wind events on numerous occasions. • Facilities, such as the Beach Pavilion, sheds, garbage cans and dumpsters, portable bathrooms, etc. at the Town beaches (365 and 316 Atlantic Avenue) and the Tourist Booth Center (318 Atlantic Avenue) are prone to high wind damage. • Downed trees and branches during wind-events are anticipated to create some travel disruption and occasionally damage structures or electrical utilities and communications lines; power outages or downed communication lines can pose threats to public safety, including inability to access emergency services or use medical equipment. • Structure vulnerability to hail is determined mainly by construction and exposure; metal siding and roofing is better able to stand up to the damages of a hailstorm; exposed windows are also susceptible to damage. • 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; electrical-based utilities are also vulnerable to direct lightning strike and damage to them has the potential to cause power outages for businesses, residents, and critical facilities. • **Refer to Sections 4.4.2.2 for additional wind-related vulnerabilities, including the vulnerability of critical facilities.**
 **Winter-Related Hazards** (Heavy Snow; Ice; Extreme Cold)	• Snow and ice can impact access to homes and critical facilities such as hospitals, schools, and supermarkets. • Snow, ice, and freezing temperatures may create treacherous driving conditions, cause transportation delays, and create transportation challenges for first responders or others who may need to be on the roads. • Westerly has sidewalks along most key roadways in Town; walking along roadways can be dangerous if sidewalks aren't cleared of snow and ice. • Heavy snow and ice accumulation can weigh down and damage utility wires or cause trees/tree limbs to come down which may damage utility wires and block roadways; damaged utility wires may lead to power loss which could disrupt critical infrastructure and technology; lack of household heat could cause water and sewer pipes to freeze and even rupture. • There are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to roof collapse due to heavy snow loads. • If extreme cold conditions are combined with low/no snow cover, the cold can better penetrate downward through the ground and potentially create problems for underground infrastructure.

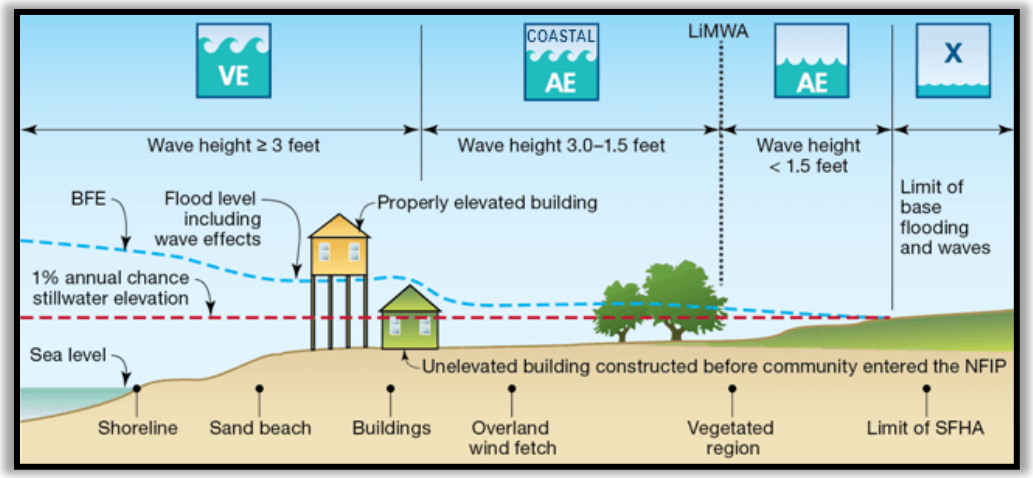
Hazard Group	Vulnerability *(What is at Risk)*
Winter-Related Hazards continued	• **Critical Facilities:** A number of critical facilities have flat roofs and may therefore be at greater risk of failure from heavy snow, these include all of the public schools (Dunn's Corners Elementary (8 ½ Plateau Road), Springbrook Elementary (39 Springbrook Road), State Street Elementary (35 State Street), Westerly High School (23 Ward Avenue), Westerly Middle School (10 Sandy Hill Road), the School District Administration building (23 Highland Avenue), Town Hall White Rock Building (68 White Rock Road), Tower Street Community Center (93 Tower Street), Ocean Community YMCA-Westerly (95 High Street), U.S. Post Office (110 Tom Harvey Road), Westerly Hospital (25 Wells Street), and the Westerly Armory (41 Railroad Avenue), which is on the Natural Register of Historic Places.
 **Infectious Disease-Related Hazards**	**Mosquitoes & Ticks** • The tick and mosquito populations are not expected to have an impact on Westerly's built environment & infrastructure. **Influenza Viruses or Coronaviruses** • The influenza viruses or coronaviruses are not expected to have an impact on Westerly's built environment & infrastructure.
 **Other Hazards** (Earthquake; Extreme Heat; Drought; Brush Fire)	**Earthquakes** • If a significant earthquake occurred with an epicenter relatively close to Westerly, all buildings may be at risk to some level of damage. • As Westerly complies with State Building Codes, it is unlikely that most structures would sustain much damage from a moderate earthquake occurring in Rhode Island or Connecticut; there may be some residential and commercial structures sporadically located throughout the Town that are of older construction and may be at higher risk of damage or collapse due to an earthquake. • Critical Facilities: Although an earthquake of significance is considered a low probability for Westerly, should one occur, depending on the magnitude and epicenter, all critical facilities structures could experience some level of damage. **Extreme Heat** • Although extreme heat can cause pavement to soften and expand (creating rutting and potholes), as heat waves in the near future are expected to be of short duration, the impact to Westerly is expected to be minimal. • Increased energy demands, particularly related to air conditioning usage, may cause power shortages/ outages. **Drought** • Long-term drought conditions may threaten levels or quality of municipal public water supplies – however as climate change models predict more precipitation for the Northeast, the probability of a long-term drought in the near future is considered low for Westerly. • Residences that rely on private wells (6±% of the Town) may be more vulnerable to drought conditions; these areas are generally located on Westerly Bradford Road (between Pound Road and Dunn's Corner Road), the northern end of Pound Round including Hesspar Road, in the area directly surrounding the Rawson Quarry located on Old Hopkinton Road, and the northern end of South Woody Hill including Fallon Trail. • Long-term droughts or short-term droughts coinciding with extreme heat, may impact crop production on agricultural land. **Brush Fires** • Brush fires are not expected to have an appreciable impact on Westerly's built environment & infrastructure.

4.4.2.1 FEMA Flood Zones

FEMA's Federal Insurance and Mitigation Administration (FIMA) manages, among other things, the National Flood Insurance Program (NFIP). In addition to providing flood insurance and reducing flood damages through floodplain management regulations, the NFIP identifies and maps the Nation's floodplains. Mapping flood hazards creates broad-based awareness of this issue and provides the data needed for floodplain management programs and to actuarially rate new construction for flood insurance. The Flood Insurance Rate Map (FIRM) is the legal document for determining flood zone location and may be viewed at Westerly's Town Hall or on the Town's website: Westerly FIRMs.

Figure 4-44 depicts FEMA's coastal flood hazard mapping, which "is the process where the overland wave modeling results are assimilated with the topography data to delineate the boundary of the Special Flood Hazard Area (SFHA) for the 1% annual chance stillwater elevation (100-year conditions), along with mapping the location and extent of Zones VE, AE, and X" (FEMA Region III).

Figure 4-44 Typical Shoreline - Coastal Flood Hazard Mapping (FEMA Region III)



A map of the Town depicting the Flood Zones and location of critical facilities is provided as **Figure 4-45** (refer to **Table 4-18** for the critical facilities map numbers; a larger scale of this map is included in **Appendix 4-2**). A summary of the total assessed value for each flood zone and the critical facilities in the SFHA follows:

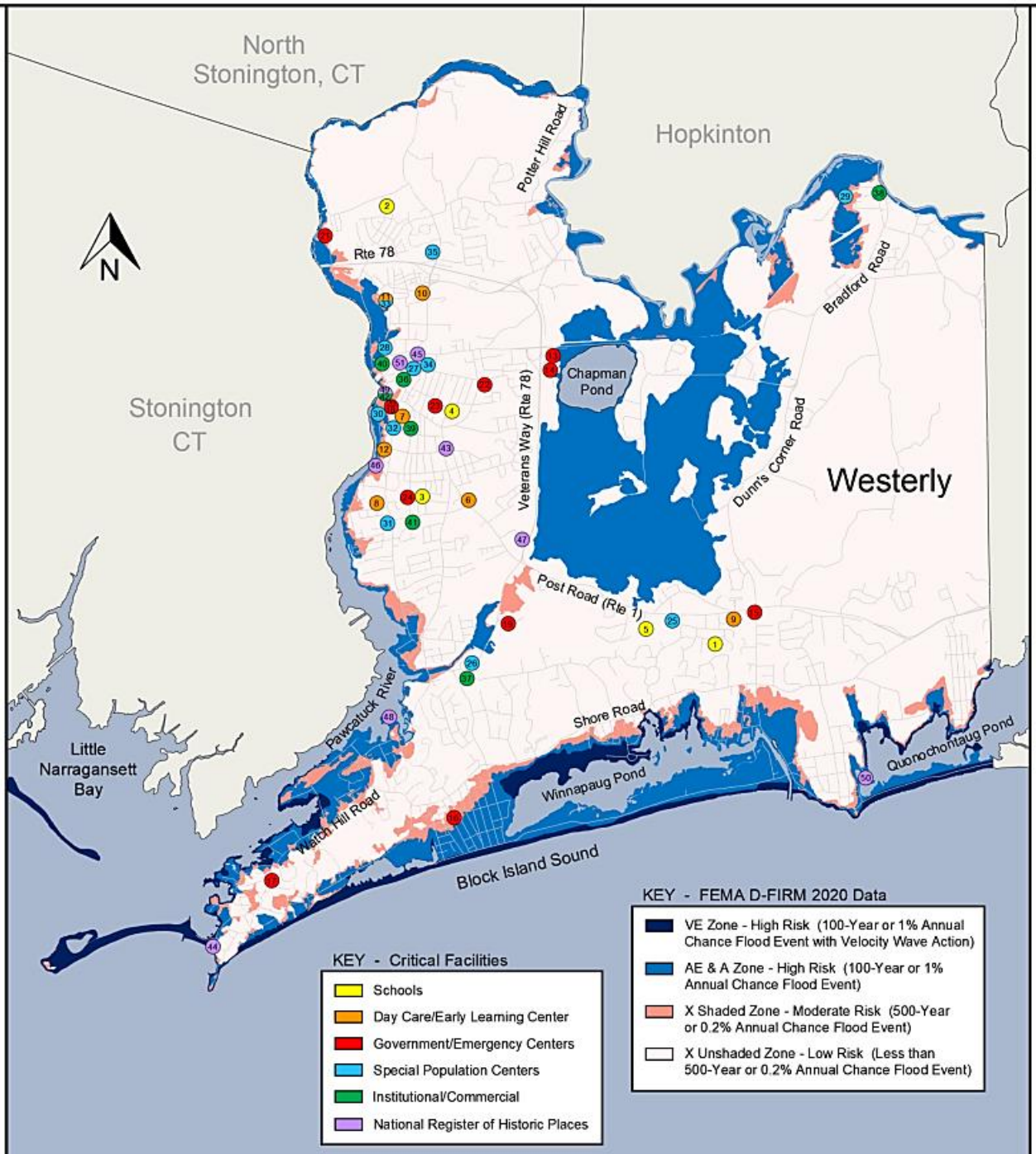
High Risk: VE Zone (1% annual chance of flooding and wave action hazard)
The analysis summarized in **Table 4-21** shows that the total assessed value for properties with any portion of the parcel intersecting the VE Zone is $1,387,253,100 (approximately 17% of tax base).
Critical Facilities: The Flying Horse Carousel (151-153 Bay Street Watch Hill), a National Register of Historic Places site, is in the VE flood zone.

High Risk: AE/A Zone (1% annual chance of flooding)
The analysis summarized in **Table 4-21** shows that the total assessed value for properties with any portion of the parcel intersecting the AE/A Zone is $1,482,418,750 (approximately 18% of tax base).
Critical Facilities: There are two critical facilities structures with at least some part of their building footprint located in the AE flood zone: the Johnnycake Center (23 Industrial Drive) that serves a vulnerable population, and the Weekapaug Inn (25 Spray Rock Road), a National Register of Historic Places site.

Moderate Risk: X shaded (0.2% annual chance of flooding)
The analysis summarized in **Table 4-21** shows that the total assessed value for properties with any portion of the parcel intersecting the X shaded Zone is $659,643,750 (approximately 8% of tax base).

Low Risk: X unshaded (less than 0.2% annual chance of flooding)
The analysis summarized in **Table 4-21** shows that the total assessed value for properties with any portion of the parcel intersecting the X unshaded Zone is $4,736,078,697 (approximately 57% of tax base).

FEMA Flood Zones with Critical Facilities Overlay



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Graphic Scale

0 3000 6000 12000

1 inch = 3000 Feet

February 2023

Source: RIGIS, Town

Figure 4-45

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

Seven (7) areas of Town have been listed as Historic Districts on the National Register of Historic Places, and within each district are structures and sites that contribute to the area's historic character. **Table 4-20** identifies if any properties within the Historic District are in the SFHA.

Table 4-20 Flood Vulnerability of Historic Districts

Property	Location	Properties in SFHA
Bradford Village Historic District	Bounded roughly by Bowling Lane, Bradford Road, Church Street, Dorr Street, Joseph Lane, North Main Street, River Avenue, South Main Street, Vars Lane, and the Pawcatuck River	A Zone
Downtown Westerly Historic District	Portions of High, Canal, Broad, Union, and Main Streets, and Railroad Avenue (7/19/84) with boundary increase to include 7 Union Street	A Zone
Main Street Historic District	Short sections of Main and School Streets and adjacent Maple Street	A Zone
North End Historic District	Bounded roughly by Pierce, Pond, Pearl, High, Friendship, Pleasant, and Canal Streets	A Zone
Perry Homestead Historic District	Located at the corner of Margin Street and Beach Street and encompasses 4 parcels including the Margin Street Inn and the Lewis Card Perry House	A Zone
Watch Hill Historic District	Bounded roughly by Watch Hill and East Hill Roads, Ocean View Highway, Block Island sound, Little Narragansett Bay, and Pawcatuck River	V and A Zones
Wilcox Park Historic District	Portions of Elm Street, School Street, Broad Street, Grove Avenue, Granite Street, High Street, Newton Avenue, and Wilcox Avenue.	X (shaded) Zone

Flood Zone Analysis

A GIS analysis, summarized in **Table 4-21**, was conducted for the entire Town to approximate the 2023 assessed valuation of properties in the various flood zones. The flood zone for a parcel was determined using a spatial intersection of the parcel (Westerly Tax Assessor January 2023 data) and the current FEMA Digital FIRM (DFIRM, last updated April 2020) GIS layers. Recognizing that sea levels rise will continue to move the floodplain designations inland, a property's flood zone was categorized based on the highest risk flood zone any portion of the parcel intersected.

It should be noted that there currently exists a disconnect between the Town's GIS tax parcel data and the tax assessor's data. The error is primarily due to condominiums not being recognized in the GIS. With condominiums, the parcel and the structures associated with the parcel, are independent. Introducing additional GIS points (one per each condominium) on the corresponding parcel is a possible solution. For the purpose of the flood zone analysis, the assessed value for all condominiums on a given parcel was tallied and the total was applied to the data for the corresponding parcel. Some condominium parcels were large and structures associated with the parcel were in different flood zones. As such, in some cases, to better represent the assessed value in the appropriate flood zone, the condominium building valuations were applied to another parcel in the appropriate flood zone for analysis purposes. Other discrepancies noted in the GIS geodatabase were also manually corrected to reasonably represent the assessed value in a particular flood zone. The results of the flood zone analysis are for general reference, informational, planning or guidance use, and provide an approximation of the assessed value in each flood zone.

General Methodology

Table 4-21 - Parcel Vulnerability Based on Flood Zones, was created using January 2023 data from the Westerly Tax Assessor's Office and the Town's GIS database (which includes RIGIS layers). The flood zone for a parcel was determined using a spatial intersection of the parcel and the FEMA Digital FIRM (DFIRM, last updated April 2020) GIS layers. A property's flood zone was categorized based on the highest risk flood zone any portion of the parcel intersected.

Table 4-21 Parcel Vulnerability Based on Flood Zones (Westerly Tax Assessor Data/Town GIS/RIGIS)

HIGH RISK: Velocity Flood Zone (VE) – 1% Annual Chance with additional hazards associated with wave action				
Land Use		**Assessed Value ($)**		
		Buildings	**Land**	**Total**
RESIDENTIAL	Single-Family	139,413,800	515,980,600	655,394,400
	Multifamily (2-5 units)	2,716,700	13,544,900	16,261,600
	Apartments & Residential Condos	10,275,300	3,880,200	14,155,500
	Luxury Estate	56,474,200	173,139,200	229,613,400
	Seasonal & Beach	47,852,300	229,976,300	277,828,600
	Combination (includes some commercial)	-----	-----	-----
MUNICIPAL/INSTITUTIONAL/ COMMERCIAL/INDUUSTRIAL	Public-owned (Municipal & School)	199,200	5,458,000	5,657,200
	Businesses (Small & Large)	13,302,400	31,813,900	45,116,300
	Commercial & Industrial Condos	61,940,800	5,548,200	67,489,000
	Industrial	-----	-----	-----
	Community-Based Services (library, churches, charitable, hospitals, cemeteries, etc. - some qualifying as exempt)	-----	444,400	444,400
	Federal, State, Railroad, and Utilities	1,583,100	22,085,800	23,668,900
VACANT	Residential Vacant	109,800	19,517,200	19,627,000
	Commercial & Industrial Vacant, Improved Land, and Other Vacant	2,537,800	12,591,500	15,129,300
OTHER	Ex-Charter	-----	1,102,900	1,102,900
	Farm Forest Open Space	4,892,700	10,871,900	15,764,600
Subtotal: Velocity Zone (VE)		**341,298,100**	**1,045,955,000**	**1,387,253,100**

HIGH RISK: 100-Year Flood Zone (AE & A) – 1% Annual Chance

Land Use		Assessed Value ($)		
		Buildings	Land	Total
RESIDENTIAL	Single-Family	287,407,900	472,836,300	760,244,200
	Multifamily (2-5 units)	20,649,400	27,363,800	48,013,200
	Apartments & Residential Condos	70,339,400	5,610,600	75,950,000
	Luxury Estate	30,575,100	53,646,900	84,222,000
	Seasonal & Beach	67,244,150	214,142,700	281,386,850
	Combination (includes some commercial)	13,789,900	19,960,000	33,749,900
MUNICIPAL/INSTITUTIONAL/ COMMERCIAL/INDUUSTRIAL	Public-owned (Municipal & School)	25,975,300	17,239,800	43,215,100
	Businesses (Small & Large)	32,494,100	47,327,100	79,821,200
	Commercial & Industrial Condos	270,500	1,358,100	1,628,600
	Industrial	4,360,900	3,228,200	7,589,100
	Community-Based Services (library, churches, charitable, hospitals, cemeteries, etc. - some qualifying as exempt)	1,898,600	7,461,100	9,359,700
	Federal, State, Railroad, and Utilities	1,036,000	6,469,200	7,505,200
VACANT	Residential Vacant	903,500	31,361,300	32,264,800
	Commercial & Industrial Vacant, Improved Land, and Other Vacant	364,800	9,850,000	10,214,800
OTHER	Ex-Charter	333,700	236,100	569,800
	Farm Forest Open Space	3,117,900	3,566,400	6,684,300
Subtotal: 100-Year Zone (AE & A)		**560,765,850**	**921,652,900**	**1,482,418,750**

MODERATE RISK: 500-Year Flood Zone (X shaded)
0.2% Annual Chance

Land Use		Assessed Value ($)		
		Buildings	Land	Total
RESIDENTIAL	Single-Family	148,738,600	205,048,000	353,786,600
	Multifamily (2-5 units)	12,929,100	7,385,900	20,315,000
	Apartments & Residential Condos	14,175,700	-----	14,175,700
	Luxury Estate	29,406,850	45,418,800	74,825,650
	Seasonal & Beach	26,487,600	79,888,400	106,376,000
	Combination (includes some commercial)	1,599,800	612,100	2,211,900
MUNICIPAL/INSTITUTIONAL/ COMMERCIAL/INDUUSTRIAL	Public-owned (Municipal & School)	4,551,500	1,333,800	5,885,300
	Businesses (Small & Large)	18,888,400	8,085,400	26,973,800
	Commercial & Industrial Condos	-----	-----	-----
	Industrial	1,408,400	1,031,800	2,440,200
	Community-Based Services (library, churches, charitable, hospitals, cemeteries, etc. - some qualifying as exempt)	13,778,300	6,717,000	20,495,300
	Federal, State, Railroad, and Utilities	1,706,500	14,005,800	15,712,300
VACANT	Residential Vacant	208,600	13,496,200	13,704,800
	Commercial & Industrial Vacant, Improved Land, and Other Vacant	12,500	401,100	413,600
OTHER	Ex-Charter	419,800	858,300	1,278,100
	Farm Forest Open Space	313,400	736,100	1,049,500
Subtotal: 500-Year Zone (0.2%)		**274,625,050**	**385,018,700**	**659,643,750**

LOW RISK: Less than 500-Year Flood Zone (X unshaded) < 0.2% Annual Chance

Land Use		Assessed Value ($)		
		Buildings	Land	Total
RESIDENTIAL	Single-Family	1,674,686,420	1,244,755,901	2,919,442,321
	Multifamily (2-5 units)	198,519,000	114,416,900	312,935,900
	Apartments & Residential Condos	398,987,616	12,040,160	411,027,776
	Luxury Estate	24,346,400	41,476,000	65,822,400
	Seasonal & Beach	61,658,000	198,150,800	259,808,800
	Combination (includes some commercial)	24,721,500	15,761,200	40,482,700
MUNICIPAL/INSTITUTIONAL/ COMMERCIAL/INDUUSTRIAL	Public-owned (Municipal & School)	93,689,400	16,873,100	110,562,500
	Businesses (Small & Large)	171,511,500	136,846,200	308,357,700
	Commercial & Industrial Condos	11,540,600	-----	11,540,600
	Industrial	17,921,400	9,822,600	27,744,000
	Community-Based Services (library, churches, charitable, hospitals, cemeteries, etc. - some qualifying as exempt)	80,249,200	21,711,800	101,961,000
	Federal, State, Railroad, and Utilities	4,076,400	5,826,400	9,902,800
VACANT	Residential Vacant	12,235,200	95,176,800	107,412,000
	Commercial & Industrial Vacant, Improved Land, and Other Vacant	12,489,500	20,280,700	32,770,200
OTHER	Ex-Charter	4,513,200	3,009,300	7,522,500
	Farm Forest Open Space	4,778,300	4,007,200	8,785,500
Subtotal: Less than 500-Year Zone (< 0.2%)		**2,795,923,636**	**1,940,155,061**	**4,736,078,697**

Flood Insurance Analysis

FEMA's Mitigation Division manages the National Flood Insurance Program (NFIP) which was established by the *National Flood Insurance Act of 1968*, with the intent of reducing the need for post-disaster federal aid by offering flood insurance and providing mitigation incentives to properties that have significant flood risks. Legislation associated with the NFIP has undergone a number of changes over the years including that set forth in the *Flood Insurance Protection Act of 1973*, *Flood Insurance Reform Act of 2004*, *Biggert-Waters Flood Insurance Reform Act of 2012*, and *Homeowner Flood Insurance Affordability Act of 2014* (FEMA. *50 Years*).

Flood insurance through the NFIP is available to property owners in communities who comply with the minimum NFIP floodplain management requirements. Participating NFIP communities must adopt Flood Insurance Rate Maps (FIRMS), FEMAs Flood Insurance Study (FIS) for the community, and a FEMA compliant floodplain management ordinance that regulates activity in the community's floodplains. The Town of Westerly (CID 445410) has been a participant in the NFIP program since July 28, 1972, providing Westerly residences and businesses the opportunity to obtain their flood insurance through that program, and intends to continue participation. Communities that participate in NFIP currently have the opportunity to participate in the Community Rating System (CRS) program. The Town of Westerly will continue to comply with NFIP requirements and has participated in the CRS program since 2013.

Most homeowners' insurance policies do not cover flooding. As a condition of a mortgage from a lender that is federally regulated, flood insurance is required (either through NFIP or a private insurer) for buildings located in the Special Flood Hazard Area (comprised of the V and A Flood Zones). Those without federally backed mortgages or outside of the SFHA are also able to purchase flood insurance through NFIP (or private insurers) to protect their home and/or content from physical losses caused by a flood. Policyholders pay premiums that are based on the level of flood risk at an identified location in the community. To accurately identify the risk, FEMA produces Flood Insurance Rate Maps (FIRMs) that show areas subject to flooding. The flood risk information presented on the FIRMs is based on historic, hydrologic, and hydraulic data, as well as on open-space conditions, flood-control works, and development.

The 100-year flood is a regulatory standard used by federal agencies, states, and NFIP-participating communities to administer and enforce floodplain management programs and is also used nationwide by the NFIP as the basis for insurance requirements. The precipitation from a 100-year flood is expected to inundate the area designated as the 100-year floodplain or the Special Flood Hazard Area (SFHA). Statistically, there is a 1 percent chance of a 100-year flood occurring in any given year – which translates to a 26 percent chance over a 30-year mortgage period.

The NFIP maintains flood insurance data for active policies and past claims. This data is a valuable resource for analyzing the impact of flood hazards. As shown in **Table 4-22**, according to FEMA, as of December 4, 2022, Westerly had 617 active policies with a total coverage of over $174 million. Of the active policies, 314 are listed in the V zone, and 31 in the A Zone (**Table 4-23**). The Town does not have access to data related to those who purchase flood insurance through the private sector. Hence, the total number of properties with flood insurance in Westerly may be higher.

Three Town-owned buildings are located in the SFHA: Misquamicut Business Association – public restrooms (316 Atlantic Avenue), Westerly Marina boathouse (23 Margin Street), and Westerly Town Beach Pavilion (365 Atlantic Avenue). All three buildings are insured, with the Town Beach Pavilion having additional flood insurance coverage.

Based on information provided from FEMA Region I, from January 1, 1976 to December 4, 2022, there have been 865 NFIP claims, of which 680 were paid with a net total payment of $27,712,371 (**Table 4-24**).

Table 4-22 National Flood Insurance Program Statistics – Westerly RI (FEMA – December 4, 2022)

Occupancy Type	Total NFIP Policies in Force	Total Coverage in Force	Annual Premium Total
1-4 Family Residential	507	$144,795,300	$541,213
Other Residential	45	$18,993,700	$153,528
Business	65	$10,670,000	$14,791
Total	**617**	**$174,459,000**	**$709,532**

Table 4-23 Properties with NFIP Flood Insurance Per Flood Zone – Westerly RI (FEMA – December 4, 2022)

Flood Zone	Total Residential and Business Parcels	NFIP Coverage
Velocity Zone (V)	314	$102,523,000
100-Year Zone (A)	31	$11,298,700
X zone (shaded & unshaded)	188	$66,005,300
Unknown	46	$18,810,700

Table 4-24 NFIP Claim Statistics – Westerly RI, CID 445410 (FEMA – December 4, 2022)

Total Number of Claims (Jan 1, 1976 to Dec 4, 2022)	Net Total Payments (Building & Contents)	Average Net Payment	Non-Mitigated Repetitive Loss Properties as of Dec 4, 2022
V Zone-CWP (251); CWOP (73) A Zone- CWP (120); CWOP (12) X Zone- CWP (8); CWOP (29) Unknown - CWP (301); CWOP (71) (Total – 680 CWP; 185 CWOP)	$27,712,371	$32,000	62 (39 Residential; 23 Commercial)

Note: CWP = Closed With Payment; CWOP = Closed Without Payment

Repetitive Loss Properties

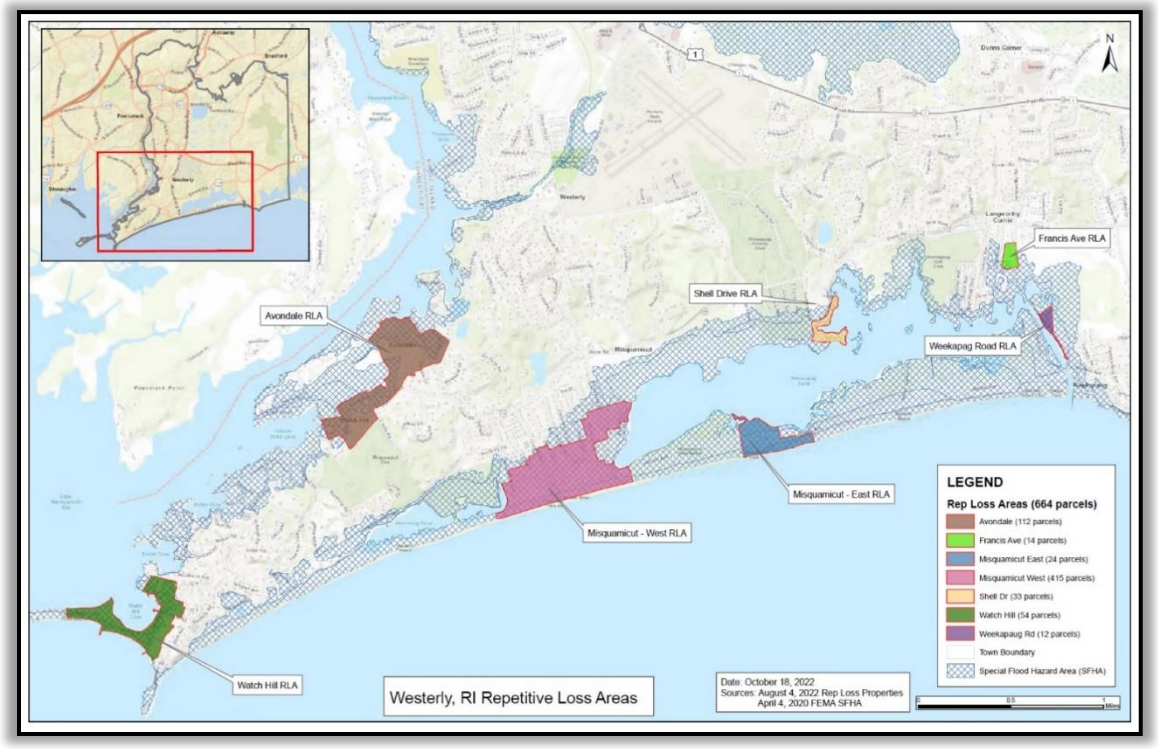
As shown in **Table 4-24**, based on FEMA data, Westerly has 62 Repetitive Loss properties. The general locations of these repetitive flood loss areas are represented in **Figure 4-46**. No properties in Town have been identified by FEMA as Severe Repetitive Loss properties.

The National Flood Insurance Program currently defines properties that have had more than one flood insurance claim as follows:

- **Repetitive Loss**: Any insurable building for which two or more claims of more than $1,000 were paid by the NFIP within any rolling 10-year period, since 1978 (claims made within 10 days of each other are counted as one claim). A repetitive loss property may or may not be currently insured by the NFIP (FEMA. Repetitive Loss Structure).

- **Severe Repetitive Loss**: Any NFIP-insured single-family or multi-family residential building that has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000; or for which at least two separate claim payments (building payments only) have been made, with the cumulative amount exceeding the market value of the building. In both instances, at least two of the claims must be within any rolling 10-year period, since 1978, and claims made within 10 days of each other are counted as one claim (FEMA. *Appendix I: Severe*).

Figure 4-46 General Representation of Repetitive Loss Properties (Courtesy Westerly Planning Office)



Coastal Barrier Resources Act

"In 1982, the United States adopted the Coastal Barrier Resources Act (CBRA) to establish the John H. Chafee Coastal Barrier Resources System (CBRS). The CBRS is comprised of several coastal areas along the Atlantic (including the Gulf of Mexico and the Caribbean Sea) and Great Lakes shorelines of the United States - designated in the CBRS as units - which buffer inland areas from storm surge and heavy winds and often support significant bio-diversity. While private development is allowed in CBRS units, federal expenditures and federal financial assistance for developments are prohibited. This means, among other restrictions, a structure built in a CBRS unit is ineligible for flood insurance and cannot receive funds from the Federal Emergency Management Agency (FEMA) for elevation, rehabilitation, or reconstruction" (Town of Westerly RI. Comprehensive, 247). Maps identifying the Coastal Barrier Resources System Units in the Town of Westerly are posted on the Town website and available through the following links:

CBRS - East Beach Unit D06 (10-15-1992)

CBRS - Maschaug Ponds Unit D07 and Misquamicut Beach Unit RI-13P (10-23-1992)

CBRS - Napatree Point Units D08 and D08P (10-24-1990)

4.4.2.2 Flooding, Storm Surge, and Sea Level Rise

is an overview of the impact on the built environment (buildings, transportation system, and utilities) from flooding and storm surge coupled with projected sea level rise.

Hurricane Storm Surge

Westerly, located along Block Island Sound, has in the past experienced high surge elevations associated with hurricanes. High winds push the water toward the shore creating storm surge. As shown in **Figure 4-47**, the most vulnerable areas to hurricane surge inundation are those along Block Island Sound and along the Pawcatuck River on the western border of the Town.

A detailed list of Westerly's critical facilities vulnerable to various hazards, including storm surge inundation, has been included as **Appendix 4.3**. Following is an overview of the critical structures determined vulnerable to hurricane surge inundation. These properties are also identified on **Figure 4-47** (refer to **Table 4-18** for the critical facilities map numbers; a larger scale of this map is included in **Appendix 4-2**). *Please note that GIS data to map the storm surge impact from a category 5 hurricane is not available for Rhode Island.*

Critical Facilities at risk from a Category 1 (or higher) Hurricane

No critical facilities are at risk from storm surge associated with a Category 1 hurricane.

Critical Facilities at risk from a Category 2 (or higher) Hurricane

One critical facility that serves a vulnerable population, the Johnnycake Center (23 Industrial Drive) is at risk from storm surge associated with a Category 2 (or higher) hurricane. The Flying Horse Carousel (151-153 Bay Street Watch Hill) and the Weekapaug Inn (25 Spray Rock Road), both on the National Register of Historic Places, are vulnerable to a Category 2 (or higher) hurricane.

Critical Facilities at risk from a Category 3 (or higher) Hurricane

Two critical facilities that serve vulnerable populations, the PACE Adult Day Center and Transition Academy (both housed at 5 Union Street) are at risk from storm surge associated with a Category 3 (or higher) hurricane. The Lewis-Card-Perry House (12 Margin Street) and the U.S. Post Office (5 High Street), both on the National Register of Historic Places, are vulnerable to a Category 3 (or higher) hurricane.

Critical Facilities at risk from a Category 4 (or higher) Hurricane

Four critical facilities that serve vulnerable populations, the Clark Street Daycare (11 Clark Street), Westerly Head Start (34 Pond Street), Westerly Preschool (13 Cross Street), and Tri County Community Action (34 Pond Street) are at risk from storm surge associated with a Category 4 (or higher) hurricane. In addition, the Misquamicut Fire Department (65 Crandall Avenue) and Westerly Library & Wilcox Park (44 Broad Street) are also vulnerable to a Category 4 (or higher) hurricane.

Sea Level Rise

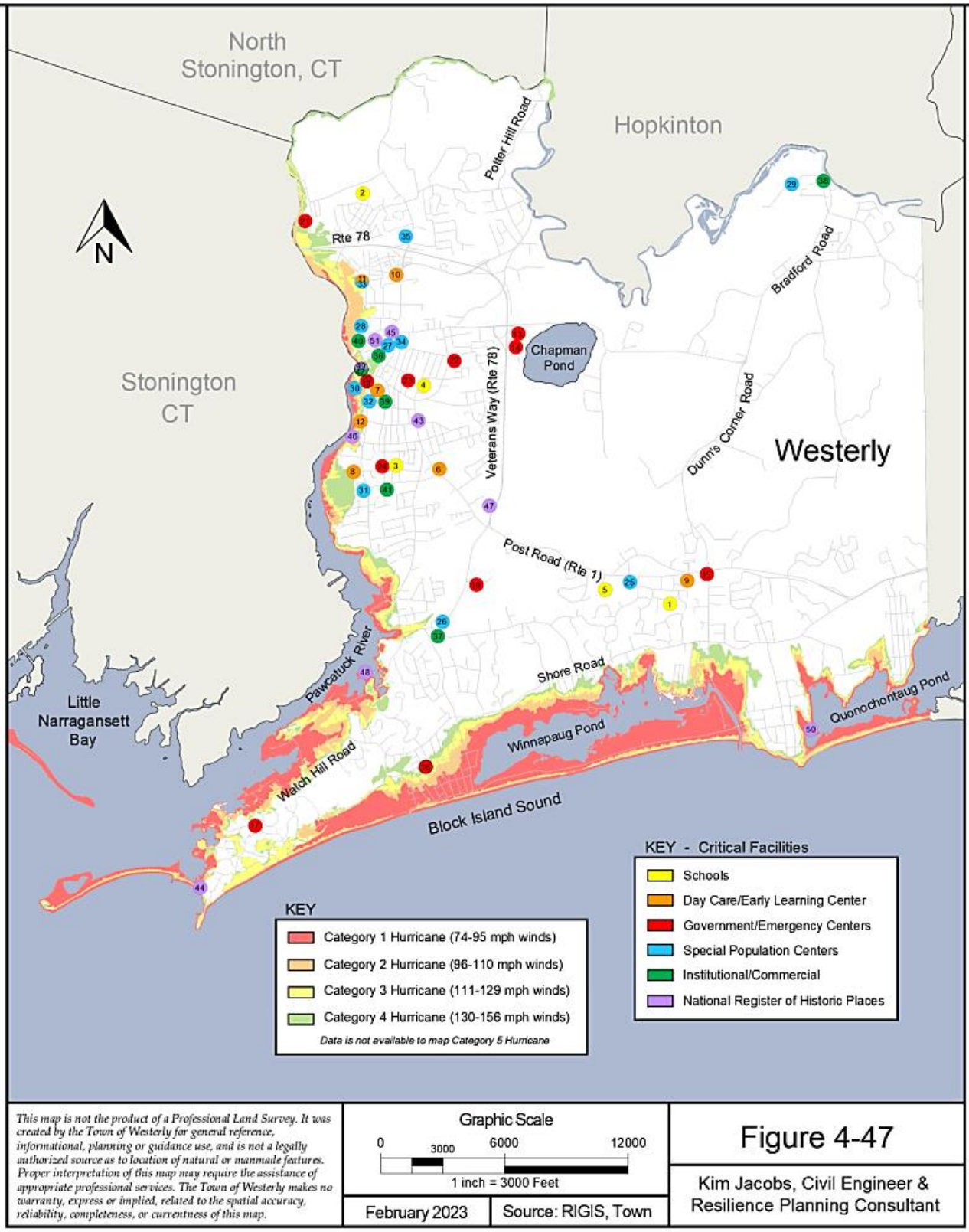
The Town of Westerly already experiences effects of flooding and storm inundation under current sea levels. During periods of extremely high tide or "king tides," a reverse storm flow can cause sea water to percolate up from storm drains onto the roadways. Because large portions of the Town are low-lying (i.e., less than 20 feet above sea level) even minor storms can cause significant flooding. If, as projected by climate scientists, the frequency and intensity of storms will increase in the near future, buildings and infrastructure in Westerly's low-lying areas along the shore, and along the tidally influenced stretch of the Pawcatuck River from Rhodes Point to the Pawcatuck Bridge, may be subjected to greater risk of flood and wind damage in the future.

A key consequence of climate change is sea level rise (SLR). With an extensive coastline, SLR will expand the higher risk flood zones inland, thereby impacting more of Westerly's properties, and amplifying the effects of storm surge. Coastal erosion and encroachment resulting from rising seas increase Westerly's exposure to cascading damages. The CRMC warns that the threat of sea level rise will grow significantly in the coming decades and has adopted NOAA's "worst-case" high curve projection to guide planning in Rhode Island (**Table 4-25**). **Figure 4-48** shows the locations of critical facilities overlaid with the current Mean High-Water level and projected 1, 3, and 5-foot SLR scenarios (refer to **Table 4-18** for the critical facilities map numbers; a larger scale of this map is included in **Appendix 4-2**).

Table 4-25 Sea Level Rise Projections for Rhode Island (NASA. *Interagency*)

NOAA 2022 SLR Scenarios	2030	2050	2080	2100
Worst-case projections based on high curve	0.71 feet	1.60 feet	4.19 feet	6.47 feet

Hurricane Surge Inundation Areas with Critical Facilities Overlay



This map is not the product of a Professional Land Survey. It was created by the Town of Westerly for general reference, informational, planning or guidance use, and is not a legally authorized source as to location of natural or manmade features. Proper interpretation of this map may require the assistance of appropriate professional services. The Town of Westerly makes no warranty, express or implied, related to the spatial accuracy, reliability, completeness, or currentness of this map.

Graphic Scale

0 3000 6000 12000

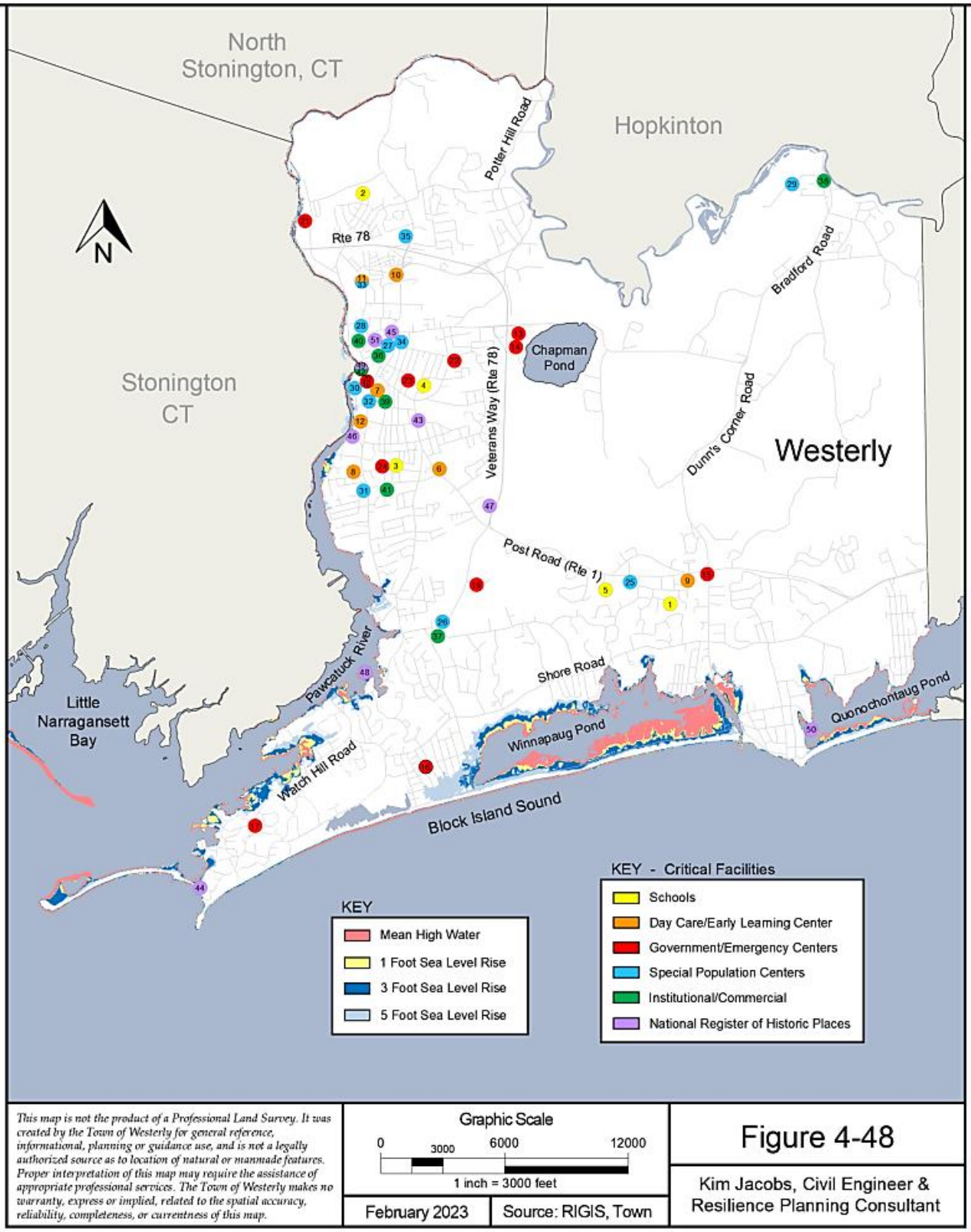
1 inch = 3000 Feet

February 2023 | Source: RIGIS, Town

Figure 4-47

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

Sea Level Rise with Critical Facilities Overlay



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Graphic Scale

0 3000 6000 12000

1 inch = 3000 feet

February 2023

Source: RIGIS, Town

Figure 4-48

Kim Jacobs, Civil Engineer & Resilience Planning Consultant

Transportation System Analysis

The Engineering Division implements programs for the rehabilitation and maintenance of local roads and bridges which support the community's transportation network. In the event of a natural disaster, Westerly must coordinate interstate response and recovery efforts with the bordering Connecticut towns of Stonington and North Stonington, with a particular focus on maintaining these critical transportation links. Of particular concern are bridges that span the Pawcatuck River that are located in a FEMA-designated flood hazard zone that connect Westerly with these two towns.

ROADWAYS: "Route 78, also known as Westerly Bypass, serves as the longest arterial in Westerly and connects Connecticut to Westerly's beaches without disruption to local traffic in Downtown Westerly. Nearly all of Route 1, including Broad Street, Franklin Street, Granite Street, and Post Road, is a principal arterial which provides service through the central-southern portion of the Town and generally runs east-west. The scenic alternative to Route 1, Route 1A, also traverses the Town from east to west. It encompasses Beach Street, Elm Street, Shore Road, and Watch Hill Road and provides a collector route for traffic to and from coastal neighborhoods. Other arterials in Westerly include Route 91 (Oak Street and Westerly-Bradford Road) and Route 216 (Church Street and portions of Ross Hill Road). Route 3 begins on Grove Avenue as a principal arterial and continues to High Street and Ashaway Road" (Town of Westerly RI. *Comprehensive,* 232).

The Rhode Island Public Transit Authority (RIPTA) provides public transportation service for the State. RIPTA offers the 95 express route between Westerly and Providence during commute times on weekdays (bus stop is at the Westerly Railroad Station). Additionally, RIPTA offers public transportation via FlexService, which allows passengers to reserve curb-to-curb van transportation within Westerly on week days. In addition, the Rhode Island Office of Healthy Aging provides curb-to-curb transportation for older adults (60+) to various community services such as to and from medical appointments, adult day care, and meal sites. These services are intended for individuals without any other means/access to transportation. The RIde Program provides paratransit services to those protected under the Americans with Disabilities Act (ADA) and Medicaid recipients. This service requires advance reservations. The Town of Westerly, in conjunction with the Senior Center, offers free van transportation for Westerly residents age 60 and older to Westerly grocery stores, department stores, banks, Senior Center, Library, and other personal needs not covered by the State RIde program.

Although the above public transportation options exist, public transit is not offered on a regular schedule throughout town and is not widely used in Westerly. According to the 2021 ACS 5-year Estimates Data Profiles, for workers 16 years and older, just 196 workers (2.0%) commute to work by public transportation. The same survey estimated that only 3.1% of workers 16 years and older do not have a vehicle available (US Census Bureau. *2021 ACS Economic).* Hence, Westerly is largely dependent on the use of private vehicles.

Maintaining roadway viability is critical to Westerly. Statewide Planning reports that, "Sea level rise presents a major challenge to Rhode Island's transportation infrastructure, both via daily tidal flooding of coastal assets and making storm surge events more severe" (RIDSP. *Technical Paper 167*, 4). Unlike storm surge or flooding, sea level rise is a long-term, permanent trend with implications for coastal transportation infrastructure. To assist municipalities in preparing for sea level rise and storm surge in their local planning efforts, Statewide Planning utilized STORMTOOLS, developed by the Coastal Resources Management Council (CRMC) in collaboration with the University of Rhode Island (URI), to identify the transportation assets at risk of damage/disruption from SLR and storm surge. Although there are some inherent limitations in the modeled scenarios (compounding impacts from erosion, riverine flooding, and such), the findings provide municipalities valuable information regarding the effects SLR and storm surge will have on their local transportation infrastructure. This analysis illuminates the need to design with respect to future climate change impacts based on the life expectancy of the transportation asset (road- 30 years, bridge-50 years).

According to Statewide Planning's SLR analysis, with 7 feet of SLR, Westerly can expect 15 miles of roadway to be inundated, ranking it the sixth municipality most vulnerable to sea level rise in the state of Rhode Island. Based on Statewide Planning's analysis, the top ten road assets in Westerly vulnerable to SLR are shown in **Table 4-26**. Two of these roads are part of the Army Corps of Engineers (USACE) Hurricane Evacuation Route (RIDSP. *Westerly*, 2).

The USACE Hurricane Evacuation Route Maps were provided to Rhode Island's 21 coastal communities in 2013 as a product of the Army Corps Hurricane Evacuation Study. The maps depict evacuation zones that are recommended to be evacuated during potential worst-case Hurricane Surge Inundation. Portions of Westerly's Evacuation Route are in low-lying areas of Misquamicut, Weekapaug, and Watch Hill may become inundated with flood waters. In the event of an emergency, waterfront residents who ignore evacuation warnings could easily be cut off from escape due to roadway inundation.

Table 4-26 Top 10 Road Assets in Westerly Vulnerable to Sea Level Rise (SLR) (RIDSP. *Westerly*, 2)

Town Rank	Road Name	Length of Roadway Impact from SLR (LF)					Evacuation Route	Functional Classification
		1 Ft SLR	3 Ft SLR	5 Ft SLR	7 Ft SLR	Total Impact		
1	Weekapaug Road	0	1,828	782	418	3,028	Yes	Major Collectors
2	Ocean View Hwy	0	0	0	2,229	2,229	No	Major Collectors
3	Atlantic Avenue	345	10,199	4,587	1,468	16,599	No	Minor Collectors
4	Breach Drive	0	1,979	102	0	2,081	No	Local Roads
5	State Highway 78N	0	0	0	69	69	Yes	Freeways
6	Sand Trail	0	0	1,321	2,678	3,999	No	Local Roads
7	Harbor Drive	177	996	628	0	1,801	No	Local Roads
8	Pasadena Avenue	0	1,123	610	83	1,817	No	Local Roads
9	Avondale Road	0	144	1,669	1,447	3,261	No	Local Roads
10	Main Street	0	9	324	1,136	1,469	No	Minor Collectors

Additionally, Statewide Planning looked at the impact of 100-year storm surge events on roadways. As shown in **Table 4-27**, the analysis considered no SLR through 7 feet of SLR. According to Statewide Planning's analysis, Westerly can expect 35 miles of roadway to be inundated if a 100-year storm event occurs in conjunction with 7 feet of SLR. Under this analysis, Westerly is ranked as the eighth most vulnerable municipality in the State (RIDSP. *Westerly*, 4).

Table 4-27 Top 10 Road Assets in Westerly Vulnerable to 100-Year Storm Surge Events (RIDSP. *Westerly*, 4)

Town Rank	Road Name	Length of Roadway Impact from SLR (LF)						Evacuation Route	Functional Classification
		No SLR	1 Ft SLR	3 Ft SLR	5 Ft SLR	7 Ft SLR	Total Impact		
1	State Hwy 78N	76	3	7	46	20	151	Yes	Freeways
2	Weekapaug Rd	3,534	56	116	119	99	3,925	Yes	Major Collectors
3	Main Street	3,051	143	7	0	0	3,201	No	Minor Arterials
4	Winnapaug Rd	2,937	384	574	281	138	4,314	Yes	Major Collectors
5	Canal Street	1,606	803	1,459	301	123	4,293	No	Minor Arterials
6	Watch Hill Road	5,167	732	1,445	1,291	581	9,216	Yes	Major Collectors
7	Bay Street	1,450	0	0	0	0	1,450	No	Major Collectors
8	Atlantic Avenue	16,723	0	0	0	0	16,723	No	Major Collectors
9	Bridge Road	141	3	1	2	3	151	No	Major Collectors
10	State Hwy 78S	75	3	3	59	20	160	No	Freeways

BRIDGES: An inaccessible or collapsed bridge can have major implications, including preventing emergency vehicles from reaching their destinations, creating difficulties in obtaining important lifeline supplies such as food and medicine reaching the community, disrupting residents from access to/from their homes, work, or other destinations, and a general loss of productivity.

Westerly's bridges, particularly those crossing the Pawcatuck River or the Winnapaug Pond breach way, are at risk due to flooding or storm surge. A bridge failure may have a domino effect as debris carried downstream may create additional hazard conditions.

Bridges in the Town of Westerly

- ◊ Boombridge Road Bridge (Boombridge Road over Pawcatuck River)
- ◊ Cottrell Bridge (Route 91 over McGowan Brook)
- ◊ High Street Bridge (RI 3 over Amtrack Railway)
- ◊ Old Hopkinton Road Bridge (over Amtrack Railway)
- ◊ Pawcatuck Bridge (US 1 Broad Street over Pawtucket River)
- ◊ Stillman Avenue Bridge (Stillman Avenue over Pawcatuck River)
- ◊ Water Works Bridge (RI 78 West By-Pass over Pawtucket River)
- ◊ Weekapaug Bridge (Atlantic Avenue over Weekapaug Breachway)
- ◊ Weekapaug Cove Bridge (Weekapaug Road over Weekapaug Tidal Cove)
- ◊ Westerly Train Station Bridge (Amtrack over Canal Street)
- ◊ White Rock Bridge – also pedestrian bridge - (White Rock Road over Pawtucket River & Mill Trench)

The Statewide Planning vulnerability assessment further determined that two of the 90 bridges throughout the State that are vulnerable to sea level rise are located in Westerly (**Table 4-28**). The Town's bridge infrastructure is the 15th most vulnerable in the State to sea level rise.

Table 4-28 Westerly Bridge Assets Vulnerable to 7-Foot Sea Level Rise (RIDSP. *Westerly*, 3)

Town Rank	Bridge Name	Facility Carried	Feature intersected	Inches of Freeboard Relative to 7 Ft SLR	Terrain Crossed	Landing Access	Evacuation Route	AADT
1	Weekapaug	Atlantic Avenue	Weekapaug Inlet	22	MHHW	Problem	No	1,616
2	Weekapaug Cove	Weekapaug Road	Weekapaug Tidal Cove	145	Water	Problem	No	1,000

Definitions:

Freeboard (bridge clearance) – the space between the bottom of a bridge's structure and the surface of the water underneath the bridge

Landing Access – where the bridge connects to the land

AADT – average 24hour traffic volume at a given location calculated over a 365 day period

MHHW (Mean Higher High Water) – There are two high tides in each day, and one of those two is always higher than the other. The higher of the two high tide lines is called "Higher High Water." The National Oceanic Observatory Administration defines the MHHW as the average of the Higher High Water readings in a location over a 19 year period.

When SLR is coupled with a 100-year storm surge event, there are seven bridges of concern in Westerly because of potential free-board height or accessibility problems (**Table 4-29**). One bridge is a non-motorized facility and one is an Amtrak facility. Westerly's bridge infrastructure is the 11th most vulnerable to storm surge coupled with SLR in the State (RIDSP. *Westerly*, 3 & 5). The analysis demonstrates that rising seas will make traversing underneath certain bridges difficult, if not impossible, especially during coastal storms. For example, 7 feet of SLR would leave *negative* 98 inches of freeboard for the Weekapaug Bridge when storm surge is present.

Table 4-29 Westerly Bridge Assets Vulnerable to 7-Foot SLR Plus a 100-Year Storm Surge (RIDSP. *Westerly*, 5)

Town Rank	Bridge Name	Facility Carried	Feature intersected	Inches of Freeboard Relative to 7 Ft SLR	Terrain Crossed	Landing Access	Evac. Route	AADT
1	Pawcatuck	US 1 Broad Street	Pawcatuck River	12	MHHW	Problem	No	19,797
2	Water Works	RI 78 West By-Pass	Pawcatuck River	168	MHHW	Problem	Yes	13,100
3	Weekapaug Cove	Weekapaug Road	Weekapaug Tidal Cove	17	Water	Problem	Yes	1,000
4	Weekapaug	Atlantic Avenue	Weekapaug Inlet	-98	MHHW	Problem	No	1,616
5	White Rock	White Rock Road	Pawcatuck River & Mill Trench	5	MHHW	Problem	No	3,000
6	White Rock Pedestrian OP	Pedestrian Bridge	Pawcatuck River & Mill Trench	16	MHHW	Problem	No	0
7	Westerly Train Station Bridge	Amtrak	Canal Street	-31	Water	Access	No	0

Definitions: refer to beneath Table 4-27

RAIL SERVICE: The Westerly Train Station (14 Railway Avenue), is located between Downtown and the North End neighborhood. The current station was built in 1912 and underwent substantial renovations in 1999 to restore it to its original state. Amtrak operates two services on the Northeast Corridor (NEC), the Northeast Regional and Acela Express, with stops in major cities including Boston, New York, Philadelphia, and Washington. RIDOT has determined that the location of the Westerly station is suitable for commuter rail service due to its walkability and surrounding high density (Town of Westerly RI. *Comprehensive,* 236). The Westerly Train Station is not in the SFHA or a hurricane inundation zone.

BOAT ACCESS: There are numerous public and private boat launches throughout the Town of Westerly. Boats can be launched during the operating season at the Westerly Marina (41 Margin Street), which is free to all Westerly residents. The marina was operated under a lease agreement between the owners of the marina and the Town for several decades, but the lease expired in 2022 and was not renewed. The Town is currently working to identify the best mix of uses for this site; however, the public boat launch and slips will remain in the future. The Rhode Island Department of Environmental Management (RIDEM) manages a free public boat launch (on Town property) with trailer parking at the northwest side of Chapman Pond, adjacent to the Animal Shelter, Public Works Building, and dog park (39 Larry Hirsch Lane). RIDEM also offers a free boat launch area on the Pawcatuck River with parking for boat trailers at 99 Main Street. There are several other marinas on the Pawcatuck River where boat ramps are available for a fee. Additional smaller public launches and rights-of-way for nonmotorized boats (kayaks, canoes, etc.) exist along the Pawcatuck River, Winnapaug Pond, and the shoreline. Westerly's Harbor Management Plan may help manage the growing activity within the Pawcatuck River, salt ponds, and Little Narragansett Bay.

WESTERLY STATE AIRPORT: The Westerly State Airport (WTS; 56 Airport Road) is state-owned and operated by the Rhode Island Airport Corporation (RIAC) and serves the aviation needs of Westerly and nearby communities. In addition to general aviation which includes corporate and business flight, recreational flight, and flight instruction, WST provides the only regularly scheduled commercial passenger and cargo service to Block Island via New England Airlines. There is substantial private aircraft traffic, particularly in the summer, which complements both the local tourism and resident economies (Town of Westerly RI. *Comprehensive,* 241). The airport is not in the SFHA or a hurricane inundation zone.

Public Utilities Analysis

Public utilities keep communities running effectively. Following is an overview of the public utilities that service the Town of Westerly.

❖ Stormwater Management

The Town of Westerly owns and maintains a stormwater drainage system classified by RIDEM as a Municipal Separate Storm Sewer System (MS4). Under the MS4 program, municipal stormwater systems need to comply with the requirements of the Clean Water Act to protect the nation's streams, rivers, and beaches from polluted stormwater runoff. The Town submits an annual report to RIDEM that tracks the progress of compliance with MS4 requirements. The system is comprised of approximately 85 outfalls, most of which flow by gravity into the Pawcatuck River or wetlands. The maintenance program includes cleaning catch basins and pipes, and replacing aging infrastructure. There is one primary pump station, the Misquamicut Stormwater Pump Station, located on Fisherman's Avenue, and has an associated detention basin located across from the exit of Misquamicut State Beach. Three (3) new pumps were recently purchased for the Misquamicut Stormwater Pump Station, and the pump station has been equipped with new Variable Frequency Drives, wiring, and floats.

The Town also manually operates a small stormwater pump at a detention basin located at the intersection of Wildflower Drive and Argyle Drive on an as-needed basis during heavy rainfall events. Stormwater from this basin is pumped to a large stormwater retention area located on the northern portions of the properties of 171 Post Road and 181 Post Road.

The *RI Stormwater Design and Installation Standards Manual* was adopted in December 2010 and serves to regulate stormwater runoff from most new developments. The Town enforces these regulations ensuring that new private infrastructure is sized appropriately and will operate effectively. As needed, the Town may require maintenance easements and/or bonding on projects to ensure the long-term viability of these private drainage systems. Over the past 10-15 years, most developments in Town handle stormwater via underground injection systems or stormwater retention basins or ponds.

Stormwater infrastructure can be damaged from high volume rainfall events due to high flow velocity causing erosion or from floodwater carrying debris which can clog storm drains, pipes, and outfalls. Coastal flooding at stormwater outfalls may drive backflow into the system, causing upland flooding through street drains and drainage ditches. In addition to flooding, prolonged presence of saltwater can damage stormwater infrastructure. Coastal erosion can also expose infrastructure along the shoreline which may lead to damage.

It is important to not have crossover between the stormwater system and the sanitary sewerage system. No known combined sewer overflow (CSO) connections exist. However, the Town has experienced some high bacteria levels (fecal coliform and enterococci) in stormwater samples in the Downtown and Wilcox Park areas which suggest that contamination may be occurring from domestic sewage – possibly septic tanks, cesspools, or illicit connections to the stormwater network. Sampling conducted by the State and/or Save The Bay along the Pawcatuck River in the vicinity of the Mastuxet Brook outfall also indicate similar ongoing bacterial issues.

Staff and equipment resources limit maintenance of the Town's extensive stormwater network (i.e., closed-circuit drainage systems), detention basins, and retention basins. Non-maintained detention and retention basins (BMPs) may become ineffectual due to sediment deposits or vegetation. Residents adjacent to some of these BMPs utilize them as a depository for yard waste, creating more of a maintenance burden for the DPW.

Another concern is the presence of historical culverts that are located throughout the Town. Most of these culverts are not mapped, and are constructed with stone walls and earthen bottoms. Some of these culverts pass through private properties and directly underneath residential and commercial buildings. Due to their construction, they are very difficult to inspect, may be structurally deficient, pose a threat of collapse, and may be contributing to the elevated bacteria levels in stormwater due to potential illicit discharge connections and/or sanitary sewer cross-connections.

The increased frequency of high-intensity storm events due to climate change, as well as SLR will further tax the storm drainage system. The high tides and shallow (tidally influenced) groundwater tables cause increased infiltration into stormwater drainage networks and submerge stormwater outfalls, which cause the systems to operate inefficiently or become inoperable altogether.

Over the past 5-years the Town has made significant improvements to the stormwater drainage system. Some of the most recent improvements include:

2023:

- Currently working with the Watch Hill Fire District to make improvements to an existing drainage system located at 21 Bay Street

2022:

- Installed a stormwater runoff drainage system at a localized low-lying point of Wauwinnet Avenue
- Removed and replaced the entire stormwater drainage network located on Wildflower Drive
- Created a detention pond at the outfall of the Weekapaug Road drainage system network on property owned by the Weekapaug Foundation for Conservation
- Removed and replaced a failed drainage pipe on Cove Road
- Resurfaced Benson Avenue, between Atlantic Avenue and First Street, and correctly pitched the road to influence stormwater runoff to flow towards existing catch basins
- Installed a stone infiltration trench just outside of a Town right-of-way on Atlantic Avenue
- Reconstructed School Street, including removal and replacement of all stormwater infrastructure
- Improved the drainage network located on Robin Way (work completed in 2020 & 2022)

2021:

- Resurfaced two abutting sections of Atlantic Avenue (12,425± linear feet) and superelevated to influence stormwater runoff to reach collection systems and infiltration areas much easier
- Replaced the entire drainage network along Riverview Avenue and resurfaced the road using the reclamation method to improve the drainage conditions
- Deteriorating asphalt was removed and replaced with 3" stone at the Town's Misquamicut Stormwater Detention Basin

❖ Waste Removal

Westerly owns and operates a solid waste transfer station located at 39 Larry Hirsch Lane. The Town sells orange trash bags that residents fill and return to the transfer station on their own. Larger items can be disposed through a pay as you throw (PAYT) program. The trash is compacted at the transfer station and then trucked to the RI Resource and Recovery Corporation (RIRRC) facility in Johnston, Rhode Island where it is landfilled. If residents prefer, they can contract for curbside pickup with a licensed private hauler. Adjacent to the transfer station, Westerly also owns and operates a recycling facility which currently allows for approximately 25 categories of materials to be recycled. There is no charge for dropping off recyclables.

Portions of the transfer station and recycling facility are located within SFHA (A Zone). This low-lying area is part of the Chapman Pond floodplain. The property is vulnerable during extreme flooding events, such as the spring 2010 floods when portions of the property were inundated. Floodwater inundation may create multiple hazards: a waste stream hazard if residents are not able to use the facility and an environmental hazard with the floodwaters potentially being contaminated by the waste and polluting waterways.

Should a brush fire occur in the vicinity of the Transfer Station, it may be vulnerable as it is not equipped with fire sprinklers. Water is provided to the building from a nearby well and submersible pump. Due to the property's former use as the Town landfill, the well water is considered non-potable, and the well is unreliable due to poor hydraulic conditions, especially during droughts. Although there is a fire hydrant located next to the main DPW office building, there are none in the immediate vicinity of the Transfer Station. The Transfer Station building is approximately 40 feet from the nearest vegetated land.

❖ Public Drinking Water System

Westerly's public drinking water supply system is owned by the Town and operated by the Department of Public Works (DPW) Utility Division. It is a self-sustaining enterprise fund whereas the water rates are established to cover all costs associated with operating the water utility. The Town maintains a *Water Supply System Management Plan* (WSSMP) which describes existing conditions, includes a long-range program to improve the quality and quantity of water, and describes critical component inspections to be taken in the event of a natural hazard. The water supply comes from groundwater accessed via wells. There are a total of 12 wells located in White Rock, Bradford, and Crandall Swamp. The wells draw water from the Pawcatuck River Aquifer, which is comprised of the Westerly, Bradford, and Ashaway aquifers. The viability of the water system is a high priority for Westerly and the Town continues to actively acquire land for aquifer protection with the acquisitions funded primarily through the RI Water Resources Board (RIWRB) Grant program. The water quality is good, and the Town continuously upgrades the disinfection system annually.

The majority of Westerly is serviced by Town water (approximately 14,500 service connections) as well as a portion of the Village of Pawcatuck in the neighboring Town of Stonington, Connecticut. The Total Available Capacity is 7.72 to 9.02 MGD easily meeting the current Average Day Demand of 3.33 MGD and Maximum Day Demand of 6.29 MGD. During the summer months, the population in Westerly nearly doubles, causing a high demand for water. This puts stress on the water supply network. If periods of high use are coupled with extended extreme heat or drought conditions, water rationing may be necessary.

Major system components include:

- ◊ **Distribution Pipes:** 207± miles of distribution network, with pipes ranging from 1.25 to 20 inches and of varying material (newer - polyvinyl chloride-PVC and ductile iron; historic - asbestos-cement and cast iron)
- ◊ **Hydrants:** 920 public hydrants (most having been replaced and upgraded over the past 30 years)
- ◊ **Storage Tanks (5):** 11 Tower Street; 26 Hillview Drive; 156 Winnapaug Road; 102 Woody Hill Road; and the Hinckley Hill Tank located in Stonington CT - No storage tanks are located in the SFHA
- ◊ **Pump Stations (7):** 236 Bradford Road; 16 Old Carriage Road; 22 Old Carriage Road; 87 Pound Road; 28 White Rock Road; 38 White Rock Road; 68 White Rock Road. Generators are provided at several wells to ensure a constant supply of water is available in the event of a power failure. No pumps are located in the SFHA.
- ◊ **Booster Pump Stations (2):** 62 Potter Hill Rd (Intersection of Randeau Passage & Potter Hill); 113 Beach Street (at Washington Street)

The Town regularly maintains the Public Drinking Water System and makes improvements as needed. Some of the most recent improvements include:

2021/2022:

- Removed and replaced water mains on 13 roads located throughout the Town
- Installed a new water main loop on Spray Rock Road (between Weekapaug Fire District Road and Shawmut Avenue) for quality and flow redundancy

2019:

- Removed and replaced approximately 1 mile section of water main on Canal Street

Ongoing from 2018:

- Upgrading all of the Miox water treatment systems
- Replacing older well pumps
- Station 1 Well D has been redeveloped and a new pump purchased

Only a small portion of Town (approximately 6 percent) depends on private wells. These areas are generally located on Westerly Bradford Road (between Pound Road and Dunn's Corner Road), the northern end of Pound Round including Hesspar Road, in the area directly surrounding the Rawson Quarry located on Old Hopkinton Road, and the northern end of South Woody Hill including Fallon Trail. Wells may be vulnerable to high floodwater which can deposit mud or sediment in the wells or cause structural damage if the floodwater is carrying with it large pieces of debris. Wells may also be more vulnerable to drought conditions.

❖ Wastewater Treatment and Collection System

As a self-sustaining enterprise fund, the Town owns a wastewater treatment and collection system that serves approximately 45% of all properties in Westerly. The remaining properties rely on on-site wastewater systems (OWTS) such as septic tanks with on-site infiltration (Town of Westerly RI. *Comprehensive*, 224).

Westerly's Wastewater Treatment Facility (WWTF), 87 Margin Street, was constructed in 1920 and over the years has undergone numerous upgrades. "In February 2019, the Town's WWTF received a Regional Wastewater Treatment Plant Excellence Award from EPA for its operations and maintenance" (Town of Westerly RI. *Comprehensive*, 225). The Facility is managed and operated by Jacobs (formerly d/b/a CH2M). Although part of the property is in the SFHA, currently the building footprint is in the X zone. The effluent, discharge into the Pawcatuck River, is regulated by RIDEM through the RIPDES program. The effluent outfall is located in the AE Zone. As the facility is approaching treatment capacity, the Town is implementing improvements to limit the amount of groundwater that infiltrates the system. The Town has approximately 62 miles of sanitary sewer. Since 2018, the Town has lined approximately 10% of the collection system (6.3± miles).

As New England storms often result in power outages, it is critical that the sewer pump stations have reliable backup power. If pump stations are not able to pump wastewater to the WWTF, where contaminants can be controlled and treated in a centralized fashion, backups in the collection system and overflows at the stations may occur. Overflows can create public health issues as wastewater carries germs, bacteria, and parasites which can cause mild sickness to deadlier diseases like cholera and hepatitis. Further, if the wastewater makes its way to rivers and streams it could impact water quality and degrade aquatic habitat. All nine sewage pump stations have backup generators. As denoted below, four of the pump stations are located in the SFHA. In 2022 the Town completed floodproofing (above the 100-year FEMA flood elevation) of the New Canal and Old Canal Pump Stations. All of the pumping stations discharge into the wastewater treatment plant for processing.

Collection System Pump Stations:

- ◊ Apache Drive – inline grinder and effluent flow chopper pump
- ◊ Beach Street – inline grinder on influent flow, centrifugal pump on effluent flow (within SFHA)
- ◊ Bradford Road – chopper pump on effluent flow
- ◊ Branch Street – chopper pump on effluent flow
- ◊ Cimalore Field – submersible pumps on effluent flow, no grinder pump
- ◊ Margin Street – submersible pumps on effluent flow, no grinder pump (within SFHA)
- ◊ New Canal Street – inline grinder on influent flow, centrifugal pump on effluent flow (within SFHA)
- ◊ Old Canal Street – chopper pump on effluent flow (within SFHA)
- ◊ Riverdale Gardens – chopper pump on effluent flow

❖ Non-Sewered Area

On-site Wastewater Treatment Systems (OWTS), formerly referred to as Individual Sewage Disposal System (ISDS) are used by roughly 61 percent of the Town's residential properties. "Negligence, improper operation, and/or unsatisfactory site conditions can lead to the failure of an OWTS, a potential threat to the health of surrounding residents due to the contamination of groundwater and other environmental damage" (Town of Westerly RI. *Comprehensive*, 225). To assist low- to moderate income property owners with improvements to their septic systems, the Town partners with RI Housing, RI Infrastructure Bank, and the RIDEM to provide (low interest) Community Septic System Loans.

In Westerly, non-sewered coastal areas, particularly along Atlantic Avenue, Misquamicut, and the communities on the north edge of Winnapaug Pond, are vulnerable to OWTS damage from the rising groundwater table, storm surge, and sea level rise. Dr. Alissa Cox, Clinical Assistant Professor and Director of New England Onsite Wastewater Training Program, discussed this topic at a Charlestown Town Council meeting in 2020. A summary of Dr. Cox's findings suggest that "groundwater tables along the southern Rhode Island coast are rising at a rate of about ½ inch (1.4 cm) per year. This means that in the past half century, groundwater tables may have risen by as much as 27 inches (70 cm) overall" (Cox, 2).

To effectively treat septic tank effluent before it reaches groundwater, OWTS drainfields require a minimum of 4 ft separation distance between the infiltrative surface and the groundwater table. Dr. Cox's analysis suggests that older systems may no longer have adequate separation distance and, it will become increasingly more difficult to achieve adequate separation distance in new systems. The problem is expected to worsen in the future due to climate change related increases in frequency and magnitude of precipitation events, and rising sea levels. OWTSs not functioning optimally may contribute to the degradation of coastal aquifers and estuaries through nutrient and pathogen loading (Cox, 1-4).

❖ Electric and Natural Gas

"The electric grid is one of the most critical infrastructure systems for modern life, but it is also one of the most vulnerable" (Korbatov, 3). Above-ground utilities like transmission and distribution lines can be impaired by strong winds, as well as by heavy snow and ice associated with winter storms. In 2015, the U.S. insurance industry identified an annual financial loss from power outages caused by flooding, hurricanes, and extreme temperatures to be in the range of 20–55 billion dollars (Korbatov, 3). Power outages can impact the Town's ability to manage emergencies and keep residents safe.

On February 23, 2022 the Pennsylvania-based PPL Corporation received approval from the Rhode Island Division of Public Utilities and Carriers to acquire The Narragansett Electric Company from National Grid USA. PPL is based in Allentown, Pennsylvania, and provides electricity and natural gas to approximately 2.5 million customers in the U.S. (PPL). After the acquisition, PPL changed the name from National Grid to Rhode Island Energy. Westerly's gas and electric service is provided by Rhode Island Energy, who also owns and maintains the Town's utility poles, electric lines, substations, and gas mains.

The natural gas mains only service the following sections of Town: the Airport Road area, Beach Street, portions of Boiling Springs, Bradford, Bradford Road, Dunn's Corner Road, portions of Dunn's Corner adjacent to Route 1, Downtown/Main Street, East Avenue, a significant portion of Misquamicut (west of and including Winnapaug Road), North End, Sea Glen, Setting Sun Road and the roads that loop to it, Route 1 (Broad Street, Granite Street, Franklin Street, and Post Road), Tower Street, Westerly-Bradford Road, White Rock, Potter Hill, and Woody Hill.

There are two substations in Town, Langworthy Corner 86 (55 Langworthy Drive) and Westerly 16 (69 Canal Street). The Westerly 16 substation is located in the SFHA (AE Zone) and vulnerable to flooding. In 2010, after it was impacted by the spring floods, National Grid proposed/ implemented a number of flood proofing measures and additional on-site compensatory flood storage.

During previously completed road reconstruction projects, the Town observed that the subsurface sections of some utility poles have been subject to rot and require replacement. This occurred recently on School Street, where RI Energy indicated that they intended to replace several poles due to their deteriorating condition. In areas vulnerable to flooding, rather than relacing compromised utility poles, consideration should be given to burying utilities. Key areas to consider burying utilities include: Misquamicut (bound by Atlantic Avenue, Winnapaug Road, Maplewood Avenue, and Shore Road), neighborhoods adjacent to the Pawcatuck River (i.e., sections of Watch Hill, Avondale, Riverbend, Downtown/Main Street, North End, and White Rock, Weekapaug Road, and the neighborhood of Weekapaug Terrace - roads adjacent to and including Cove Road).

In 2019, through a public-private partnership between the Town and the Watch Hill Conservancy, utility lines were buried below ground along a half-mile segment of Bay Street, from the property at 14 Wauwinnet Avenue to the intersection of Larkin Road and Bluff Avenue. There is interest among some residents to bury existing utility lines in other areas, such as Main Street in Downtown, though the high cost restricts the Town's ability without funding partners. Burying the utilities would minimize power disruptions during storm events. In addition, as many utility poles throughout the Town are located within sidewalks, removal would allow for the required ADA 3'-0" clearance for passing.

4.4.3 Natural Environment

Westerly's natural features are important resources, providing potable water for the Town, serving as habitat for wildlife, providing passive recreational opportunities for the public, and enhancing the scenic characteristics of the community. The natural environment also plays a role in reducing natural hazard impacts and increasing the community's resilience to climate change. For example, vegetated buffers along streams and rivers help absorb and hold excess water, thereby reducing flooding; coastal marshes offer shoreline protection and help reduce the impacts of storms, including erosion, by acting as a physical barrier and reducing wind and wave energy; freshwater wetlands and coastal marshes help absorb flood waters, effectively buffering upland development; vegetated land cover reduces erosion and helps to reduce flooding and its subsequent impacts; vegetated land cover intercepts and absorbs water replenishing groundwater resources and guarding against drought; trees and other vegetation aid in mitigating the effects of heat-related hazards by shading areas and reducing surface temperatures; and trees and other vegetation, as well as wetlands, sequester carbon helping mitigate the greenhouse effect (EPA. *EnviroAtlas*).

Due to its coastal location and significant low-lying land, the primary hazards that will impact the natural environment are flooding and coastal erosion from rain and snow events, and storm surge from hurricanes and other high-wind events. These hazards will be exacerbated by sea level rise. In addition to the vulnerabilities identified in **Table 4-30**, risks to the natural environment will be further explored in subsections **4.4.3.1 Freshwater & Saltwater Resources and their Floodplains** and **4.4.3.2 Conservation Land.**

Table 4-30 Natural Environment Vulnerability

Hazard Group	Vulnerability *(What is at Risk)*
 **Flood-Related Hazards** (Inland Flooding including Dam Failure; Coastal Flooding including Storm Surge; Coastal Erosion)	• Because so much of Westerly's land is low-lying, the natural environment is highly vulnerable to flood-related hazards. • Flood waters can carry toxic material or contaminants spreading pollution which can negatively impact ecosystems and contaminate well sources. • Standing water following a flooding event can provide a conducive environment for breeding mosquitos. • The Crandall Swamp (which includes the Newton Swamp Management Area) is a large inland low-lying area subject to flooding from high precipitation events and/or overspill of the Pawcatuck River or other inland waterways – is it also part of the much larger Aguntaug (Chapman) Swamp. • With a substantial coastline (9± miles), Westerly is highly susceptible to impacts from coastal flooding exacerbated by wind-driven storm surge. • High precipitation events and storm surge can cause coastal erosion which may narrow beaches and compromise coastal salt marshes; areas along Westerly's shoreline vulnerable to coastal erosion include the salt ponds and surrounding lowlands (including the barrier beaches), Napatree Point, Sandy Point, and Little Narragansett Bay. • Due to increased intensity and frequency of storms, more coastal lands will be susceptible to erosion; eroded beach material and debris can be carried out to sea. • As coastal wetlands - critical for flood control and habitat viability – are lost, Westerly's inland property will be increasingly exposed to cascading damages. • With respect to the natural environment, future increases in relative sea level will lead to the loss of recreation areas and public space; as coastal marshes become inundated at a greater rate, salt marsh vegetation will be lost and an alteration of habitat types will result; wide-scale systematic changes in the terrestrial and marine environments will result; changes in surface water and groundwater characteristics will occur; salt intrusion into aquifers will contaminate drinking water supplies (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-175). • Refer to Sections 4.4.3.1 & 4.4.3.2 for additional flood-related vulnerabilities.

Hazard Group	Vulnerability *(What is at Risk)*
 **Flood-Related Hazards** (Inland Flooding including Dam Failure; Coastal Flooding including Storm Surge; Coastal Erosion)	• Because so much of Westerly's land is low-lying, the natural environment is highly vulnerable to flood-related hazards. • Flood waters can carry toxic material or contaminants spreading pollution which can negatively impact ecosystems and contaminate well sources. • Standing water following a flooding event can provide a conducive environment for breeding mosquitos. • The Crandall Swamp (which includes the Newton Swamp Management Area) is a large inland low-lying area subject to flooding from high precipitation events and/or overspill of the Pawcatuck River or other inland waterways – is it also part of the much larger Aguntaug (Chapman) Swamp. • With a substantial coastline (9± miles), Westerly is highly susceptible to impacts from coastal flooding exacerbated by wind-driven storm surge. • High precipitation events and storm surge can cause coastal erosion which may narrow beaches and compromise coastal salt marshes; areas along Westerly's shoreline vulnerable to coastal erosion include the salt ponds and surrounding lowlands (including the barrier beaches), Napatree Point, Sandy Point, and Little Narragansett Bay. • Due to increased intensity and frequency of storms, more coastal lands will be susceptible to erosion; eroded beach material and debris can be carried out to sea. • As coastal wetlands - critical for flood control and habitat viability – are lost, Westerly's inland property will be increasingly exposed to cascading damages. • With respect to the natural environment, future increases in relative sea level will lead to the loss of recreation areas and public space; as coastal marshes become inundated at a greater rate, salt marsh vegetation will be lost and an alteration of habitat types will result; wide-scale systematic changes in the terrestrial and marine environments will result; changes in surface water and groundwater characteristics will occur; salt intrusion into aquifers will contaminate drinking water supplies (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-175). • Refer to Sections 4.4.3.1 & 4.4.3.2 for additional flood-related vulnerabilities.
 **Wind-Related Hazards** (High Winds; Thunderstorms including Lightning & Hail; Tornadoes; Tropical Cyclones)	• As discussed above under flood hazards, for Westerly the most significant impact to the natural environment from high winds is storm surge damage to shoreline ecosystems. • High winds may exacerbate fire conditions by drying out the ground cover, propelling fuel around the region, and increasing the ferocity of exiting fires; lightning associated with thunderstorms have been known to spark fires. • High winds and hail can cause damage to vegetation. • Tornadoes can kill or disrupt wildlife if their habitat is impacted. • Refer to Sections 4.4.3.1 & 4.4.3.2 for additional wind-related vulnerabilities.
 **Winter-Related Hazards** (Heavy Snow; Ice; Extreme Cold)	• Heavy snow and/or ice accumulation can weigh down and damage vegetation and tree limbs • Prolonged snow/ice cover and exposure to extreme cold may negatively impact outdoor. animals/wildlife and disrupt ecosystems. • Flooding may occur after the rapid melting of a heavy snowfall.


Infectious Disease-Related Hazards
	Mosquitoes or Ticks
	• As climate change shortens our winters, ticks and mosquitoes will extend their life cycle and ticks will expand their habitat range.
	  ○ In the short term, the tick and mosquito population are not expected to have an appreciable impact on Westerly's natural environment.
	  ○ Long-term, if the tick and mosquito population continue to increase, it may alter the health of local ecosystems.
	
	Influenza Viruses or Coronaviruses
	• The influenza viruses or coronaviruses are not expected to have an impact on Westerly's natural environment.

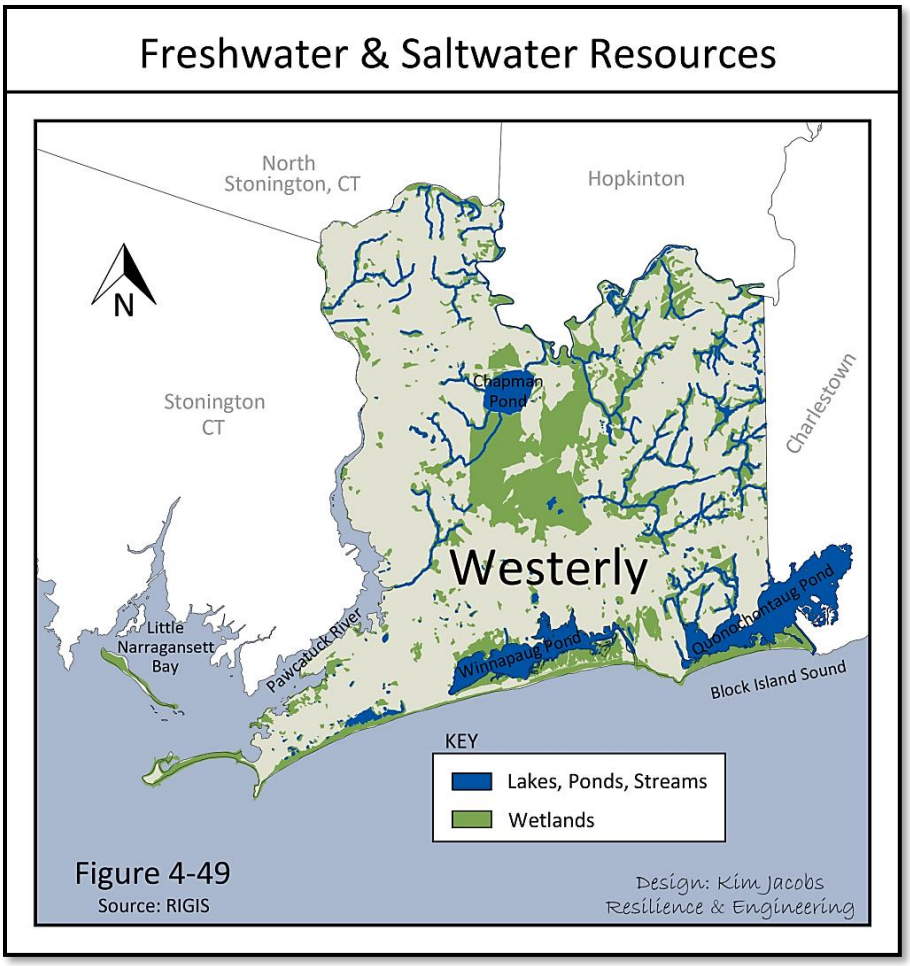
Hazard Group	Vulnerability *(What is at Risk)*
 **Other Hazards** (Earthquakes; Extreme Heat; Drought; Brush Fires)	**Earthquake** • If an earthquake occurred in the region, it is not expected to have an appreciable impact on Westerly's natural environment. **Extreme Heat** • Over the long term, extreme heat trends may alter the life cycle of plants and animals and could create a cascading effect to the surrounding environment (Columbia). • Sporadic periods of extreme heat may stress plants and deplete food and water resources for local wildlife. **Drought** • Sporadic periods of short-term drought may stress plants and deplete food and water resources for local wildlife; there is a relatively small portion of Town in agricultural use (primarily along Dunn's Corners Bradford Road, Shore Road, Boombridge Road, and Airport Road) which is more at risk to short-term droughts. • The fields at the Cimalore Sports Complex, as well as all of the Town's athletic fields are adversely impacted by drought. Large sections of grass burn occurred on a number of the fields during the watering bans of 2022. Fields were closed during this time until the water bans were lifted. • Long-term drought conditions are associated with insect infestations, plant disease, loss of biodiversity, wind erosion of soil, degrading water quality, and decrease in levels of water produced by natural aquifers (NOAA|NIDIS. *Drought*); however as climate change models predict more precipitation for the Northeast, the probability of a long-term drought in the near future is considered low for Westerly. **Brush Fire** • Brush fires that occur in more remote, harder to access areas pose a greater risk of spreading as they may go unnoticed for longer and/or take longer to access by fire protection services – these areas include portions of the Woody Hill Management Area and the Potter Hill area, including the Town Forest. • While relatively small, the distance from hydrants to the coastal grasslands of Avondale and Watch Hill, and the local Salt Pond region, would necessitate the transport of water for fire suppression. • Extreme heat and drought conditions can elevate brush fire threat, particularly in hilltop areas with thinner canopy cover such as the higher elevations along Shore Road, and upland pockets within areas such as Riverwood Preserve, Grills Preserve, Woody Hill State Management Area, and the Town Forest, particularly along the transmission lines.

4.4.3.1 Freshwater and Saltwater Resources and their Floodplains

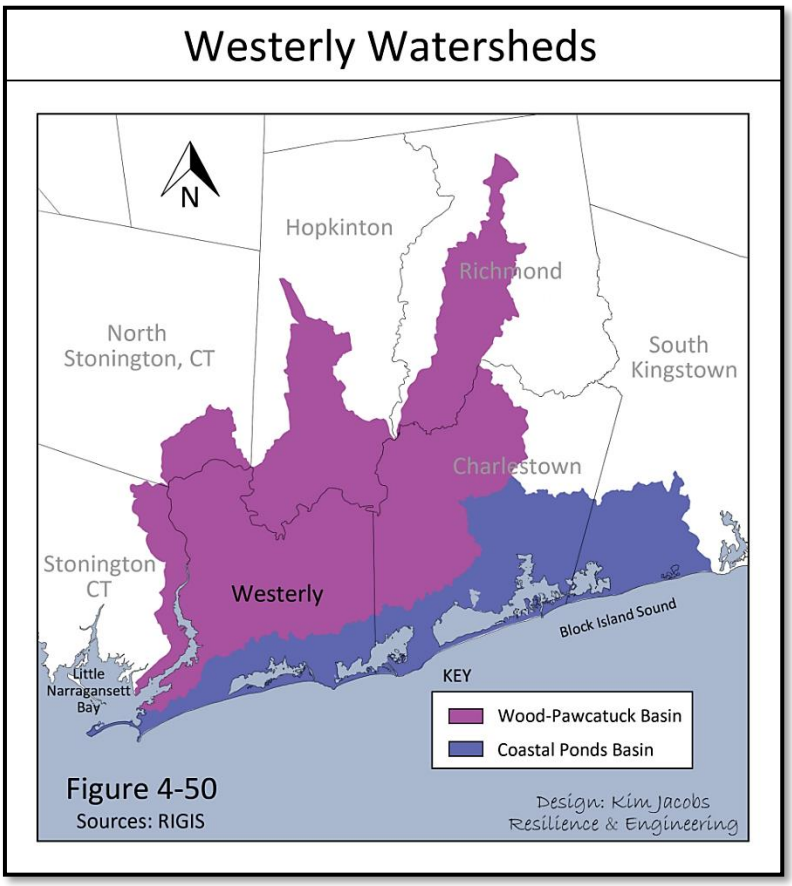
As evidenced in **Figure 4-49**, Westerly has an abundance of freshwater and saltwater resources. The Town's character is intertwined with these important resources and it is essential to understand how natural hazards, exacerbated by climate change including sea level rise, will impact the community's waterbodies.

Water Resources

In addition to providing scenic beauty, Westerly's aquatic resources provide valuable fish, plant, and wildlife habitats; help control flooding, erosion and pollution; offer year-round active and passive recreation; and accommodate fin and shell fishing.



The two primary sub-watersheds or sub-basins in Westerly, the ***Wood-Pawcatuck Basin*** and the ***Coastal Salt Ponds Basin***, are shown in **Figure 4-50**. In Westerly, the ridges along the elevated plateau of the Charlestown Moraine divide the two watersheds. The Charlestown Moraine is a significant geological feature created from deposited material (primarily soil and rock) as the glacial ice sheet retreated northward, roughly 19,000 years ago during the last glacial period. Water falling north of the moraine drains into the Wood-Pawcatuck Basin, and water falling to the south drains into the Coastal Salt Pond Basin (Town of Westerly RI. *Comprehensive*, 107).



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, as shown below, also aid hazard mitigation in a number of ways. When a river is divorced from its floodplain with dams, levees, or other flood control structures, the natural benefits are either lost, altered, or significantly reduced (RIEMA. *State of Rhode Island Hazard Mitigation Plan*, 3-111).

Benefits of Coastal and Freshwater Wetlands and their Floodplains

The Town recognizes that wetlands and floodplains provide an array of benefits and will therefore continue to protect these resources, support development trends that do not hinder the important ecological service they provide, and integrate wetland and floodplain management efforts with other community goals and objectives.

Wetlands and floodplains:

- Provide flood storage area, reducing storm damage to upland property and structures
- Control stormwater runoff flow rate, reducing erosion
- Act as natural sediment traps, limiting the amount of sedimentation from surface water runoff that might otherwise negatively impact other ecosystems
- Filter runoff pollution and excess nutrients, helping to maintain and enhance water quality
- Recharge groundwater to preserve water supplies
- Maintain surface water flow during dry periods
- Provide natural coastal barriers to stabilize shorelines, dissipate waves, and protect upland areas from storm surge, flooding, and erosion
- Produce nutrients for organisms that form the base of the food web
- Provide fish and wildlife habitat and contribute to biodiversity and support commercial fishery
- Support large and diverse populations of plants
- Provide recreational opportunities (fishing, bird watching, hiking, etc.)
- Store carbon within their plant communities and soil, helping to moderate the effects of climate change
- Add aesthetic scenic value to the natural environment

Coastal Salt Ponds Basin: Salt Ponds, Coastal Waters, Coastal Wetlands

The Coastal Salt Ponds Basin along Westerly's south shore encompasses the Town's salt ponds or coastal lagoons (shallow, productive embayments separated from the ocean by barrier spits). Westerly's three major salt ponds are Quonochontaug Pond, Winnapaug Pond, and Maschaug Pond. Quonochontaug Pond (733 acres) is connected to the ocean by a breachway built in the 1950s. It is the deepest and most saline of Rhode Island's salt ponds, with about a third located in Westerly, surrounded by Weekapaug and Shelter Harbor, and the eastern two-thirds in neighboring Charlestown. Winnapaug Pond (446 acres), is located amidst the densely developed neighborhoods of Misquamicut, Weekapaug, and Weekapaug Terrace. It is the shallowest of Rhode Island's salt ponds and is connected to the ocean via the Weekapaug Breachway. Westerly's Town Beach and Misquamicut State Beach are located on the barrier beach along the south shore of the pond. The smallest of the ponds, Maschaug Pond (42 acres), is landlocked between Misquamicut and Watch Hill (Town of Westerly RI. *Comprehensive*, 114; Salt Ponds Coalition). Little Maschaug Pond to the east is separated from Maschaug Pond by a narrow stretch of land with a culvert maintaining hydrologic connectivity.

The salt ponds and the stretch of the Pawcatuck River from the Pawcatuck Bridge to Rhodes Point are tidally influenced. The Atlantic Ocean along Westerly's south shore (9± miles) is referred to as Block Island Sound, and that section of coastal water on the inland side between Napatree Point in Westerly and Stonington Point in Connecticut, is referred to as Little Narragansett Bay.

Figure 4-51 Westerly Land Trust Properties

Winnapaug Pond at Winnapaug Farm Preserve
Photo Credit: Marc Doherty

Kettle pond at Dr. John Champlin Glacier Park
Photo Credit: Westerly Land Trust

Coastal wetlands include salt marshes and coastal freshwater or brackish wetlands contiguous to salt marshes. Westerly has approximately 303 acres of estuarine emergent wetlands (less than two percent of the Town) (Town of Westerly RI. *Comprehensive*, 121). In 2011, the Town established a Salt Pond Overlay District "to recognize and protect the sensitive nature of the coastal environment and to coordinate with the policies and regulations of the Rhode Island Coastal Resources Management Council (CRMC) [*who functions as the coastal wetlands regulatory body for RI*] and its Salt Pond Region Special Area Management Plan for Westerly" (Town of Westerly RI. *§260-53*). Salt ponds and coastal wetlands support ecosystem services. The salt ponds are utilized by over 100 species of finfish and shellfish at some stage of their life cycle. The surrounding marshes are crucial habitat for a variety of wildlife and birds, including the piping plover, a federally threatened species (Town of Westerly RI. *Comprehensive*, 125).

There are eight public/quasi-public beaches located in the Coastal Salt Ponds Basin. From east to west along Westerly's shoreline, they are the:

- ◊ Shelter Harbor Fire District Beach - for residents in the Shelter Harbor Fire District
- ◊ Weekapaug Fire District Beach (Wawaloam Drive) - for residents in the Weekapaug Fire District; with 6 parking spots available for Westerly Residents; public use based on land grants from as early as 1909
- ◊ Westerly Town Beach (342/362/365 Atlantic Avenue) - open to the public; to obtain a Westerly Town Beach parking sticker, you must be a Westerly Town Resident or Westerly taxpayer
- ◊ Wuskenau Town Beach (303/305/311/312/316/318 Atlantic Avenue) - open to the public
- ◊ Misquamicut State Beach (251 Atlantic Avenue) - offers over a half-mile of oceanfront recreation with a parking area that can accommodate 2,100 cars; the state facility has a large pavilion, shade structures, rest rooms/changing rooms/showers, concessions, and first-aid station
- ◊ Watch Hill Fire District Beach (Bay Street/Fort Road) - for residents in the Watch Hill Fire District
- ◊ Napatree Point Beach - is a long sandy spit that extends roughly 1.5 miles westward from the Watch Hill business district forming a protected harbor; it is a public beach and wildlife preserve protected by the Watch Hill Conservancy and Fire District
- ◊ DEM RI Fish and Wildlife parking areas (Wawaloam Drive and Atlantic Ave at the Weekapaug Breachway) - paths lead down to the beach for fishing access

Flooding after major precipitation events is an issue for the Westerly Town Beach and Town property across from the beach, adjacent to Winnapaug Pond. The Winnapaug Pond has shown evidence of grass dying off due to being submerged under water creating anoxic pools of deteriorating high marsh. To mitigate the loss of salt marsh, Capital Funding was requested in 2022 for dredging projects and salt marsh restoration. Save the Bay and the Westerly Land Trust dug runnels to aid in the draining of these anoxic pools. Town parcels 156-017 and 156-016, located on Winnapaug Pond west of Breach Drive on the north side of Atlantic Avenue, are potential points for marsh restoration and sand deposits from proposed bi-annual dredging.

The coastal area is subject to heavy surf and is in a storm surge warning area during hurricanes. Both the Westerly and Wuskenau Town beaches have experienced a drastic reduction of beach front and are encroaching on the dunes. In 2006 and again after Hurricane Sandy in 2012, the Town implemented a dune restoration project. This project was successful in creating a healthy berm to protect the beach front and Town Beach septic system and prevent large sand deposits from entering the roadways and the pond. The Town of Westerly Recreation Maintenance planted all of the dune grass, replenished sand, and annually for the winter season, installs natural wood snow fencing around the perimeter of all dunes. While flooding and wind damage can create a fair amount of coastal damage, extreme heat and drought can increase water temperature in the Coastal Salt Ponds, leading to fish kills, rise in bacteria levels, and disease. In 2019 there were beach closures at Dunes Club beachfront and shellfish bans in Winnapaug Pond due to high levels of bacteria in the water. Excessive heat and drought can also negatively impact the vegetation around the salt ponds and on the Town's beach properties. Also, during heat waves, the Town beaches tend to be overpopulated which can cause the public toilet denitrification systems to overflow and require more frequent pump outs.

Wood Pawcatuck Basin: Freshwater Wetlands, Rivers & Streams, Freshwater Ponds

The Wood-Pawcatuck Watershed (192,000 acres) spans four towns in southeastern Connecticut and eight towns in southwestern Rhode Island, including Westerly. By July 16, 2018, the *Wood-Pawcatuck Wild and Scenic Stewardship Plan* had been adopted by all twelve towns. In March 2019, the seven rivers within the watershed became the first federally-designated *Wild and Scenic* River system in Rhode Island (WPWA).

The seven major rivers and their tributaries in the watershed drain to the Pawcatuck River and Little Narragansett Bay. Rivers, along with other surface water bodies, are critical natural resources that are interconnected to groundwater (receiving groundwater inflow and/or recharging groundwater), provide water for agricultural production, are important wildlife habitats, and provide outdoor recreation.
"The wellheads that supply the public water for the Town of Westerly source exclusively from the Wood-Pawcatuck Watershed. It is a sole source aquifer, meaning the Town has no other surface or groundwater reservoir source to obtain potable water from" (Town of Westerly RI. *Comprehensive*, 107).

Freshwater Wetlands

At both the Federal and State levels, there is legislation to protect and regulate the use of wetlands. At the State level, RIDEM regulates non-coastal or freshwater wetlands. New RIDEM rules and regulations governing protection of freshwater wetlands took effect on July 1, 2022. Wetlands (including floodplains) are regulated because of the many important functions they perform. RIDEM has a broad definition of freshwater wetlands that includes swamps, marshes, bogs, ponds, rivers, and streams, as well as other smaller areas and certain adjacent areas known as perimeter wetlands, riverbank wetlands, and floodplain. Freshwater wetlands are areas that are flooded or that have water at or near the surface for part of most growing seasons and commonly occur between uplands and water bodies, but may stand alone surrounded by upland (RIDEM. *Freshwater Wetlands*).

Forested wetlands, dominated by the presence of 20 feet or taller woody vegetation, are the most abundant freshwater wetland type in the Town of Westerly and within the State. Westerly has 2,905± acres of forested wetlands (15±% of the Town), and a smaller amount of scrub-shrub wetland (608± acres) and freshwater emergent wetlands (151± acres) (Town of Westerly RI. *Comprehensive*, 121).

Freshwater wetlands are scattered along the Pawcatuck River and throughout the Town, including in the Potter Hill/Boombridge Road neighborhood, northern area of the North End neighborhood, Bradford neighborhood, Woody Hill Management Area, Dunn's Corner neighborhood, Aguntaug/Crandall Swamp neighborhood, and near the Westerly Airport. Approximately 34% of the Town's wetlands are in public or private conservation areas. Westerly's largest freshwater wetland system, which is the second largest in the State, is the Aguntaug Swamp (also known as Chapman Swamp or Crandall Swamp). It is located south of Chapman Pond between Route 78 and Dunn's Corners-Bradford Road. The swamp is approximately 2,000 acres, and contains a diversity of wetland vegetation including extensive stands of Atlantic white cedar, and provides habitat for a variety of mammals, amphibians, waterfowl, and other water birds, including several rare species. Several bird species nesting in the swamp include osprey (federally protected), bitterns (identified as endangered and threatened by the State), and herons (identified as a species of concern by the State). It also serves as an important groundwater resource and flood control area for the Pawcatuck River (Town of Westerly RI. *Comprehensive*, 121 & 125).

Figure 4-52 Westerly Land Trust Properties

Grills Preserve (Polly Coon Bridge)
Photo Credit: Westerly Land Trust

Grills Preserve (Pawcatuck River)
Photo Credit: Larry Orlando

Rivers & Streams

There are numerous small streams in Westerly include Aguntaug Brook, Mastuxet Brook, McGowen Brook, Spring Brook, and Perry Healy Brook. Westerly is also home to a large section of the Pawcatuck River. The Pawcatuck River's headwaters initiate in South Kingstown at the outlet from Worden Pond and flow generally westward to Westerly. In Westerly, the river continues meandering westward, creating the northern border with Hopkinton and North Stonington, Connecticut, and then flows southward, creating the Town's western border with Stonington, Connecticut. The mouth of the thirty-six mile river opens into Little Narragansett Bay. The southern stretch of the Pawcatuck River from the Rt 1/Broad Street Bridge to the mouth of the river is tidally influenced (Wood-Pawcatuck, 97 & 98).

The Town is currently considering implementing a River Corridor Overlay District "to protect, preserve, and enhance the outstandingly remarkable values of the Pawcatuck River, a nationally recognized Wild and Scenic River. The purpose of the overlay district would be to assess the impacts of development on the River, assure safe public access to the River, preserve the natural, historical, and cultural resources, protect water quality, and achieve long-term resiliency planning" (Town of Westerly RI. *Comprehensive*, 61).

Freshwater Ponds

The Town's largest freshwater pond, Chapman Pond (180±acres), lies approximately 30 feet above sea level in the north central section of Westerly. Other smaller named freshwater ponds include Dr. Lewis Pond, Long Pond, Mickill Pond, No Bottom Pond, and Spring Pond (Town of Westerly RI. *Comprehensive*, 107 & 108).

Impact of Flooding and Climate Change including SLR

While periodic flooding can have positive impacts on ecosystems, including rejuvenating floodplain vegetation and recharging groundwater supplies in aquifers, it can also have negative impacts on waterbodies. Floodwater can cause erosion and it picks up pollutants like oils and salt from roadways, fertilizers and pesticides from lawns and agricultural lands, effluent from failing septic systems, industrial chemicals, sediment, and debris as it makes its way down gradient. If sufficient polluted floodwater flows into a waterbody or inundates well water, it can harm wildlife or contaminate drinking water.

Flooding, which is expected to increase due to climate change impacts, is thought to have played a role in the degraded water quality in several of Westerly's water bodies. The Pawcatuck River and Mastuxet Brook, along with their tributaries, are listed in the State's *2022 Impaired Waters Report* as impaired due to enterococcus bacteria and the presence of non-native aquatic plants. Further, the tidal portion of the Pawcatuck River and Little Narragansett Bay are listed as impaired due to fecal coliform bacteria, and Chapman Pond is listed due to mercury being found in fish tissue and the presence of non-native aquatic plants (RIDEM. *State,* pages 15, 19, 21, 22, 27 & 28). In addition, much of the bottom of Little Narragansett Bay is covered in a blanket of algae that creates low-oxygen zones that suffocate eelgrass, oysters, and scallops. The algal blooms are thought to result from lawn fertilizers carried by stormwater runoff (Town of Westerly RI. *Comprehensive*, 113).

Hurricanes and other high-wind events that produce storm surge can transport sand from the oceanside of the barrier beach into the ponds. In addition to depleting the barrier dunes separating the salt ponds from the ocean, the shoals (sandbars) created can impact the existing ecosystem. In Winnapaug Pond, a layer of sand that was deposited by prior storm events was recently dredged to encourage eel grass recolonization (Salt Ponds Coalition). As evidenced in the aftermaths of the spring 2010 historic flooding and 2012 Hurricane Sandy, the salt ponds and surrounding lowlands, Napatree Point, Sandy Point, and Little Narragansett Bay are particularly vulnerable to storm surge (Town of Westerly RI. *Comprehensive*, 111).

A number of Town properties located in the Wood/Pawcatuck Basin are adversely impacted by natural hazards. Flooding had become a chronic issue at the Town's Kayak Launch Area (48-50 White Rock Road). In 2021, DEM awarded the Town a grant to create a safe launch area that will work with fluctuating water levels. Design and engineering of this project is ongoing.

Over the past five years, high winds have also felled a number of trees along the access road to the kayak launch. The Town includes this area in their tree maintenance program. The DEM Bradford Fishing Area located at 155 Bradford Alton Road in Bradford, also experiences flooding in the parking area.

As the sea level rises, increasing deleterious impacts on the Natural Environment will occur, including loss of salt marshes and other important habitat, increased damage and erosion to inland areas due to loss of salt marshes acting as a natural barrier, shifts in species diversity affecting commercial and recreational fishing industries, and a reduction in freshwater resources due to brackish infiltration.

In March 2015, CRMC and its partners developed Sea Level Affecting Marshes Model (SLAMM) Maps for the coastal wetlands throughout Rhode Island. "The purpose of these SLAMM maps is to show how coastal wetlands will likely transition and migrate onto adjacent upland areas under projected sea level rise scenarios of 1, 3 and 5 feet in the coming decades. These maps are intended to support state and local community planning efforts and to help decision makers prepare for and adapt to future coastal wetland conditions despite the inherent uncertainties associated with future rates of sea level rise" (CRMC. *Sea Level Affecting*, 1). According to the technical findings from the SLAMM Project, "Coastal wetlands, especially tidal marshes, are one of the most susceptible ecosystems to climate change and in particular accelerated sea level rise. A considerable percentage of coastal wetlands may be permanently lost by the end of this century unless upland areas directly abutting coastal wetlands are protected or otherwise set aside for the purpose of providing wetland migration in response to sea level rise" (CRMC. *The Rhode*, Executive Summary).

As sea levels rise, marshes may be established in some adjacent upland areas, which may effectively produce a net gain in coastal marshes in some locations. However, this upland encroachment will replace the eco-service currently provided in that area. Wetlands abutting developed areas will not have room to migrate inland and will be lost in the future unless such development is removed. Eleven (11) SLAMM Map Panels were created for Westerly. Each Panel has four maps showing the initial (1990 sea level) wetland condition, followed by level rise scenarios above the 1990 levels of 1-, 3-, and 5-feet. All 44 SLAMM Maps prepared for Westerly can be accessed via the following link: Westerly SLAMM Maps

4.4.3.2 Conservation Land

In addition to being integral to the character of the community and providing scenic and recreational enjoyment, Westerly's open space also aids in mitigating the impacts of natural hazards. The following types of open space contribute to resilience against natural hazards impacts:

- *Undeveloped property in floodplains:* preserves the ability for that land to act as flood storage, effectively buffering upland development; helps filter pollutants and nutrients before flood waters reach rivers and streams
- *Coastal marshes:* offer shoreline protection and help reduce the impacts of storms, including erosion, by acting as a physical barrier and reducing wind and wave energy;
- *Freshwater wetlands:* provide flood storage capacity and water quality treatment; sequester carbon, helping mitigate the greenhouse effect and combat climate change
- *Coastal dunes and barrier beaches:* reduce erosion and the effects of storm surge on coastal areas further inland
- *Vegetated land cover:* intercepts and absorbs water, replenishing groundwater resources and guarding against drought while also reducing flooding; reduces erosion and its subsequent impacts; mitigates the effects of heat-related hazards by shading areas and reducing surface temperatures; sequesters carbon, helping mitigate the greenhouse effect and combat climate change (EPA. *EnviroAtlas*).

As shown in **Figure 4-53**, conservation land is scattered throughout the Town but is more largely concentrated in the eastern and northern portions of Westerly. One of the largest contiguous open space land masses in Rhode Island sits on Westerly's eastern border. It is comprised of three tracts of conservation land: Woody Hill Management Area (820± acres) owned by the State of Rhode Island; Wahaneeta Preserve (75± acres) owned by the Westerly Land Trust; and the Lucey Properties (490± acres) owned by the Westerly Municipal Land Trust. Although not as extensive in acreage, the south shore boasts highly valued publicly accessible coastal open space, including Westerly's two Town beaches, Misquamicut State Beach, Napatree Point Conservation Area, Weekapaug Fishing Area, and several beaches owned by fire districts (Town of Westerly RI. *Comprehensive*, 129).

In Westerly, public and private organizations have together maintained over 5,000 acres as open space, translating into about 26% of the Town's total land area (Town of Westerly RI. *Comprehensive*, 128). As shown in **Table 4-31**, approximately 3,297 acres are conservation land that is publicly accessible. Some of these lands include Bradford Preserve, Grills Preserve, Misquamicut State Beach, and Wilcox Park. The other 1,703± acres of land that is not publicly accessible includes private lands (such as farms), Fire District lands, and conservation properties meant to be protected in their natural state without human interventions.

Figure 4-53 Conservation Lands

Courtesy Town of Westerly 2020 Comprehensive Community Plan, produced by NEGEO and Mason & Associates

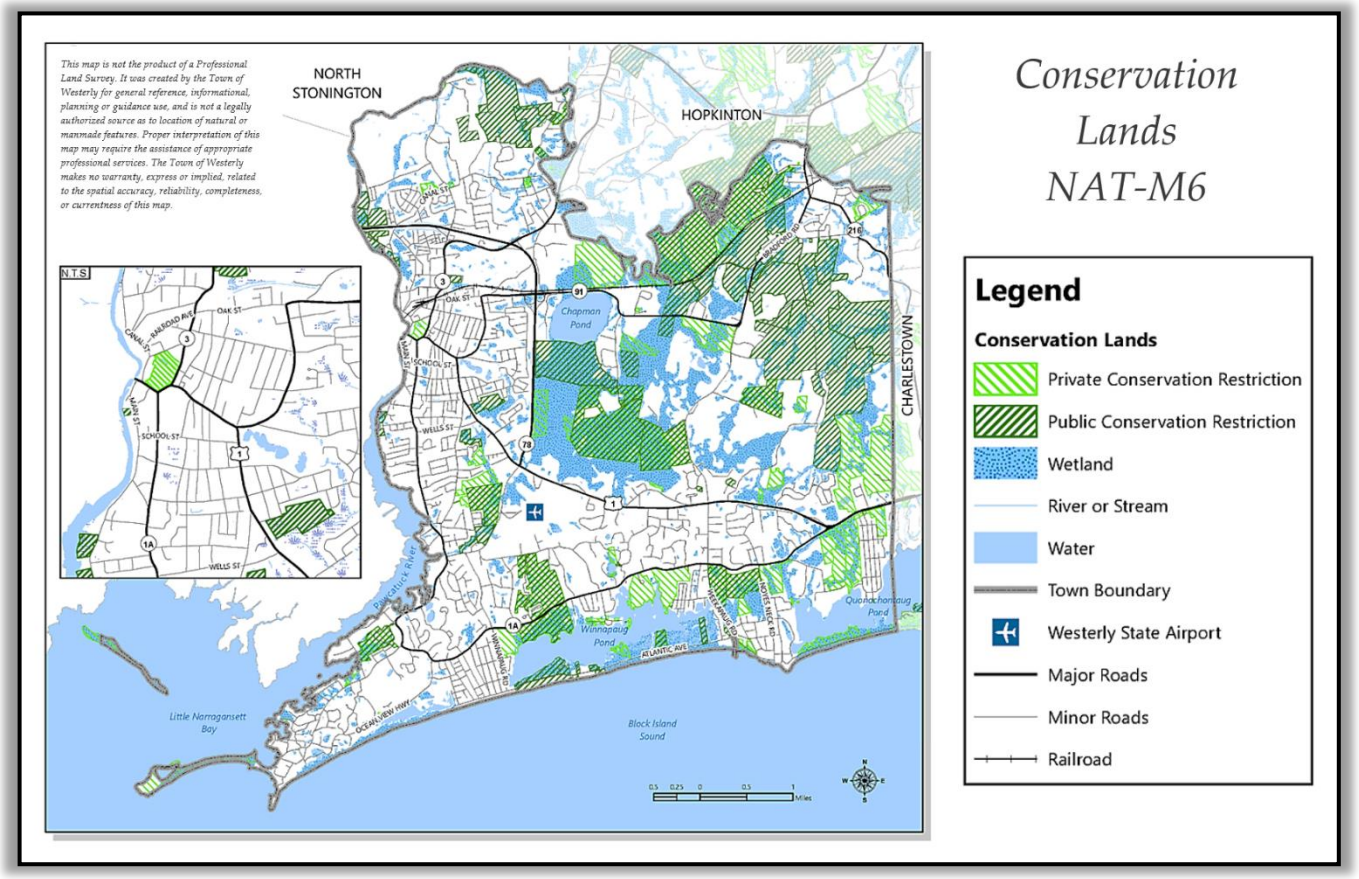


Table 4-31 Conservation Land by Owner (Town of Westerly RI. *Comprehensive*, 128)

Owner	Acreage	Percentage	Public Access Acreage
State of Rhode Island	975.1	18.6%	975.1
Town of Westerly	792.1	15.1%	580.9+
Westerly Municipal Land Trust	476.4	9.1%	419.6+
Public Ownership Subtotal	2,243.6	42.9%	1,975.6+
Audubon Society of Rhode Island	95.5	1.8%	86+
Avalonia Land Conservancy	38.8	0.7%	38.8
H. C. Moore Foundation	31.5	0.6%	31.5
Memorial & Library Assoc. of Westerly	14.5	0.3%	14.5
The Nature Conservancy	119.8	2.3%	0+
Nopes Island Conservation Association	4.1	<0.1%	4.1
Shelter Harbor Fire District	93.5	1.8%	0
Watch Hill Conservancy	8.14	0.2%	2.71
Watch Hill Fire District	66.88	1.3%	66.88
Weekapaug Fire District	51.8	1.0%	0
Weekapaug Foundation for Conservation	108.9	2.1%	19.8+
Westerly Fire District	1.7	<0.1%	0
Westerly Land Trust	1687	32.3%	1057
Other Private	663.3	12.7%	0
Private Ownership Subtotal	2,985.4	57.1%	1,321.3+
Total	**5,229.0**	**100%**	**3,296.9+**

LOCAL ECONOMY

4.4.4 Local Economy

The economic condition of the Town of Westerly is strong in terms of both municipal finances and economic growth. As of April 2021, Westerly's credit rating on the General Obligation debt was affirmed Aa3 (High Grade - Investment Grade) by Moody's bond rating agency. The agency noted that the Town has a healthy economy and tax base, a light debt burden and a moderate pension liability (Moody's, 1).

Maintaining a resilient local economy is important to providing high quality municipal services, including protecting against natural hazard risks. According to the Town's Certified Budget, for the fiscal year FY2021-22, the municipal operating budget was $37,934,672 and the School District budget was $57,137,967. As part of the budget process, each year the Town adopts a five-year Capital Improvement Program identifying projects that should be undertaken during the upcoming five years. This long-range planning is essential in addressing the future development and growth of the Town. The Town has continually funded its capital requirements aggressively and, to limit borrowing requests, maintains a pay as you go funding for most of its capital needs (Town of Westerly RI. *Certified,* 4).

Westerly is primarily a suburban residential community, with property taxes financing most government activities, supplemented by charges for services and state funding. Properties are comprised of four major types: year-round residents, seasonal home residents, short-term tourist destination, and a regional service and retail center. According to the Town of Westerly Tax Assessor, in FY 2021-22, residential property accounted for 94% of the total tax roll.

As Westerly is located in the southwest corner of Rhode Island, the Town's economy is closely linked to both Rhode Island and southeastern Connecticut. According to the RI Department of Labor and Training, based on 2011-2015 American Community Survey data, 47.6% of Westerly residents work in Westerly, 18.8% work in other Rhode Island communities, 31.5% work in Connecticut, and 2.1% work in Massachusetts or other states/countries (RIDLT, *RI Commuting*, 41).

In 2021, the average annual, seasonally unadjusted unemployment rate was 6.2% in Westerly compared to 5.6% State-wide in the same 12-month period (RIDLT. *Local).*

The Town of Westerly is a significant employer for the community and its neighbors. The approved FY2021-22 budget provided for a total of 664 full-time equivalent (FTE) positions in the Municipal (172) and School Departments (492), as well as the part-time seasonal employment in support of parks and recreation activities, beaches, and other summer programs (Town of Westerly RI. *FY22, page 155*).

Westerly has a well-established commercial base and small pockets of industry and recreational facilities. Sectors with higher employment rates include health care, hospitality, retail, manufacturing, banking, finance, service industry, the arts, the schools, textiles, printing, and construction. Most of the 1500+ local businesses employ relatively few people. One of the largest employers is the Westerly Hospital (640± total employees) which was established in 1925 and currently operated by the Yale New Haven Health System. Another large employer is the Washington Trust Company (300± employees in Westerly), the oldest community bank in the United States (established in 1800), and the largest State-chartered bank in Rhode Island (Town of Westerly RI. *Comprehensive*, 184 & 186). According to the Assessment Department, the Town's commercial tax base has increased in recent years, growing by $38,451,600 (5.7 percent) between December 31, 2020 and December 31, 2021. As of December 31, 2021, commercial properties represented approximately 9.1 percent of the Town's overall tax base.

Westerly's tourism-based industries are an important economic sector. They have grown over the years and in the summer season hospitality, entertainment, and commercial recreation are major focuses of the local economy, as vacationers from around the region flock to Westerly to enjoy its natural resources including seven miles of ocean beaches, coastal salt ponds, and the Pawcatuck River, along with many other local attractions and events. The Town's location between two large and influential regional markets (Boston and New York), and proximity to key regional attractions such as Mystic Aquarium and Seaport and casinos in nearby Connecticut, help to support Westerly's tourist industry (Town of Westerly RI. *Comprehensive*, 183 & 185).

In support of a robust local economy, Westerly's Economic Development Commission (EDC) which functions as an advisory board to the Town, has the objective of attracting and retaining a qualified workforce. There are several business associations in Town that are also important advocates for promoting Westerly businesses, including the Ocean Community Chamber of Commerce (with over 700 members) and the Misquamicut Business Association (Town of Westerly RI. *Comprehensive*, 185 & 186).

Roughly a third of Westerly residents work in nearby Connecticut communities (RIDLT, *RI Commuting*, 1). Significant employers include the U.S. Naval Submarine Base, General Dynamics Electric Boat Division, and Pfizer, all located in Groton, Connecticut; Mystic Seaport and Aquarium and Davis-Standard located in Stonington, Connecticut; Foxwoods Resort Casino in Ledyard, Connecticut which is owned and operated by the Mashantucket Pequot Tribal Nation; and Mohegan Sun in Uncasville, Connecticut, which is owned and operated by the Mohegan Tribe. As Electric Boat anticipates hiring several thousand new employees through 2031, they have established themselves as an anchor tenant of the Westerly Education Center, which opened in the spring of 2017. The Center, administered by the State, has multiple shared-use classrooms and a 14,500± square foot job skills training center (Town of Westerly RI. *Comprehensive*, 185).

The impact from most of the profiled hazards is not anticipated to have a long-term economic effect on the Town. Two of the profiled hazards, heavy and sustained precipitation events, which are expected to worsen in the future due to climate change and sea level rise, and the Coronavirus-19 Pandemic (ongoing since December 2019), could have long-term economic consequences for Westerly. In addition to the items identified in **Table 4-32**, the vulnerability to Westerly's local economy will be further explored in the following subsection: **4.4.4.1 Flood-Related Hazards.**

Figure 4-54
Westerly Annual Outdoor Art Festival
photo credit:
Ocean Community Chamber of Commerce

Table 4-32 Local Economy Vulnerability

Hazard Group	Vulnerability *(What is at Risk)*
 **Flood-Related Hazards** (Inland Flooding including Dam Failure; Coastal Flooding including Storm Surge; Coastal Erosion)	• In Westerly, a group at higher risk from flooding are those residing in the Special Flood Hazard Area (SFHA) comprised of the VE, AE, or A Flood Zones; flood damage to homes or businesses may present an economic challenge for residents. • If residences and businesses are destroyed as a result of flooding, the corresponding decrease in the tax base would need to be shouldered by the remaining property owners. • The higher concentration of impervious surface due to building size and large parking areas makes commercial properties more susceptible to flooding and snow hazards; the most significant commercial development is in the Downtown area, and the waterfront commercial areas (marinas and associated businesses) in Watch Hill and Misquamicut. • **Refer to Sections 4.4.4.1 for additional flood-related vulnerabilities.**
 **Wind-Related Hazards** (High Winds; Thunderstorms including Lightning & Hail; Tornadoes; Tropical Cyclones)	• The Town may recognize an increase in municipal spending related to downed tree removal. • A study conducted in 2010 by Montclair State University suggests that individuals with lower incomes may not have the financial resources to maintain trees on their property, putting them at higher risks for tree-related damage associated with high-wind events (Prioleau). • Although generally short-term, individuals may experience lost revenues due to business closures, inability to get to work, or inability to provide services. • Loss of electric power due to damaged power lines can interrupt businesses; while disruptions that continue for days, weeks, or longer can impact the normal operation of businesses and even result in closures which would decrease revenues to proprietors, loss of wages to employees, and reduce state and local tax revenues – disruptions to Westerly are expected to be short-term and have minimal impact on the local economy.
 **Winter-Related Hazards** (Heavy Snow; Ice; Extreme Cold)	• The Town may recognize an increase in municipal spending related to plowing and road surface treatments. • Although generally short-term, individuals may experience lost revenues due to business closures, inability to get to work, or inability to provide services. • Loss of electric power due to damaged power lines can interrupt businesses; while disruptions that continue for days, weeks, or longer can impact the normal operation of businesses and even result in closures which would decrease revenues to proprietors, loss of wages to employees, and reduce state and local tax revenues – disruptions to Westerly are expected to be short-term and have minimal impact on the local economy.
 **Infectious Disease-Related Hazards** (Vector-borne Diseases Transmitted by Ticks or Mosquitoes; Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses)	**Mosquitoes & Ticks** • As needed (or requested), the Town uses mosquito larvicide briquets to control mosquito larvae in catch basins or other areas with standing water. • The Town's Cimalore Sports Complex uses mosquito mitigation through the summer months to abate and control mosquitoes for patrons. **Influenza Viruses or Coronaviruses** • Influenza viruses are not expected to have an appreciable impact on Westerly's local economy. • During periods throughout the Covid-19 Pandemic, many indoor sports considered high risk of spreading the disease were cancelled leading to loss of revenue for the venue. • It is difficult to assess how Coronavirus-19 may impact Westerly's economy over the upcoming 5-year period. Relating to Town finances, over the past two years the pandemic caused some additional burden including staff related sick leave, and PPE and cleaning supply expenses (some of which was reimbursed through FEMA). • Due to the pandemic, Westerly (as was true Nationwide) experienced an increase in unemployment rate. The unemployment rate in 2020 was 10.7%; although the rate decreased to 6.2% in 2021, that is still higher than the preceding non-pandemic years of 2017 (5.1%), 2018 (4.3%), or 2019 (3.7%) (RIDLT. *Local).*

Hazard Group	Vulnerability *(What is at Risk)*
 **Other Hazards** (Earthquakes; Extreme Heat; Drought; Brush Fires) continued	**Earthquake** • Earthquakes are not expected to have an appreciable impact on Westerly's local economy. **Extreme Heat** • Although residents may recognize higher energy bills due to increased energy use, primarily associated with air conditioning, extreme heat is not expected to have an appreciable impact on Westerly's local economy. • Extreme heat leads to the Town beaches being overpopulated causing an increase in beach inventory expenses (garbage bags, toiletries, cleaning supplies, and staff overtime); parking passes do not cover the cost of these additional expenses. **Drought** • Droughts are not expected to have an appreciable impact on Westerly's local economy. • Drought may impact crop yields for local farmers, a minor component of the local economy. More widespread drought affecting regional farmers may result in financial burdens being passed on to the consumer. **Brush Fires** • Brush fires are not expected to have an appreciable impact on Westerly's local economy.

4.4.4.1 Flood-Related Hazards

As climate change exacerbates seasonal flooding, and SLR permanently changes the landscape, properties in FEMA's Special Flood Hazard Area (SFHA) are at high risk. Recognizing that sea level rise will continue to move the floodplain designations inland, a property's flood zone was categorized based on the highest risk flood zone any portion of the parcel intersected. As summarized in **Table 4-33**, approximately 35% of the tax base is derived from properties that are fully or partially in the SFHA (the VE, AE, or A Zones).

Table 4-33 Property Vulnerability Based on FEMA Flood Zones (2022 Tax Assessment Data)

Land Use	Special Flood Hazard Area (SFHA)	
	V Zone Total Value	A Zone Total Value
Residential	$1,193,253,500	$1,283,566,150
Municipal/Institutional Commercial/Industrial	$142,375,800	$149,118,900
Vacant	$34,756,300	$42,479,600
Other	$16,867,500	$7,254,100
TOTAL	**$1,387,253,100 (approximately 17% of tax base)**	**$1,482,418,750 (approximately 18% of tax base)**

Based on NOAA's high-curve, sea level rise in Rhode Island could be 1.67 feet by 2030. Unlike flooding related to a precipitation event, where the floodwater eventually recedes, sea level rise is a permanent feature. As existing landmass is permanently inundated, structures in those environs may become uninhabitable. If SLR continues as currently projected, displacement of those residents living in the most vulnerable properties will occur and the corresponding decrease in the tax base resulting from property abandonment would need to be shouldered by the remaining property owners.

PEOPLE

4.4.5 People

The Town's *Continuity of Operations Plan* (COOP) addresses the planned response to extraordinary emergency situations, including those related to natural disasters. The COOP is a preparedness document that outlines the concepts and methods for dealing with potential large-scale disasters while continuing to provide day-to-day essential services. The COOP provides procedures for warning and evacuation of residents and visitors should it become necessary. In the event of such an emergency, coordination and cooperation of Town, State, and Federal agencies will be essential.

It is important to know the number of people that are considered to be at a higher risk in a natural hazard event in order to plan for their needs and safety. According to the 2020 Census, the population of Westerly is 23,359. Approximately 3,310 residents (14.2%) are under 18 years and about 5,427 (23.2%) are 65 or older (US Census Bureau. *2021 ACS Age)*. In 2021 the Town had a total of 13,600 housing units, of which 10,507 were occupied and 3,093 vacant. Of those listed as vacant, 2,169 (70%) were identified as for seasonal, recreational, or occasional use (US Census Bureau. *2021 ACS Vacancy)*.

To expedite assistance response, it is important for the Town to have a registry of those individuals who may require assistance. The Town encourages residents who due to special healthcare needs, chronic conditions, or disabilities, may require assistance response to enroll in the Rhode Island Special Needs Emergency Registry. This registry, which is overseen by the RI Department of Health, provides a reliable system for the identification of Rhode Islanders who may require special assistance during emergencies (RIDOH. *Special*). A link to this registry can be accessed through the Town's website.

The majority of participants in the Public opinion Survey (165 out of 204 – or 81%) indicated that either they or someone in their household had been negatively impacted by a natural disaster while living or doing business in the Town of Westerly. More people were impacted by Wind-Related Hazards (59%), Coastal Flooding/Erosion (46%), Influenza/Coronaviruses (40%), and Winter-Related Hazards (36%).

An often-overlooked impact of a natural hazard is emotional and physical stress. Stress can affect residents if they have witnessed people hurt or their home or belongings destroyed; are forced to evacuate their home; have personal finances compromised; are subject to an extended period without electric power or with a shortage of supplies and necessities; and/or are not receiving effective communication regarding the hazard event. To help offset these impacts, the Town recognizes the continued need to bring emergency preparedness and response awareness to the community and to provide or support the additional services required as the result of a disaster.

The items addressed above, as well as the vulnerabilities identified in **Table 4-34**, represent risks to people from the identified hazards.

Table 4-34 Human Vulnerability

Hazard Group	Vulnerability *(What is at Risk)*
 **Flood-Related Hazards** (Inland Flooding including Dam Failure; Coastal Flooding including Storm Surge; Coastal Erosion)	• Flooding events increase the chance of spreading waterborne diseases, such as hepatitis A and cholera; the health risks to residents impacted may be significant during and after a flood event; at higher risk are those residing in the SFHA, and in areas subject to hurricane surge inundation. • Water intrusion into buildings can result in mold contamination, leading to indoor air quality problems; populations living in damp indoor environments experience increased prevalence of asthma and other upper and lower respiratory tract symptoms (CDC. *Precipitation*). • Receding floodwaters can create stagnant pools of water, which provide the perfect breeding ground for mosquitoes (See *Infectious Diseases* for more information on potential effects of mosquitoes on humans). • Significant flooding can lead to extensive damage to structures and personal property which can cause emotional stress to those impacted. • Injuries may occur due to flooded roadways creating dangerous conditions for motorists. • Based on data from **Climate Central's Surging Seas Risk Finder** (Climate Central. Surging): ➢ The number of people in Westerly who live on land below 3 feet above sea level is approximately 18. The localized projection based on the intermediate sea level rise scenario in the NOAA Technical Report for the 2018 U.S. National Climate Assessment points to a 100% risk of at least one flood over 3 feet taking place between today and 2050 in the Westerly area. ➢ The number of people in Westerly who live on land below 5 feet above sea level is approximately 48. The localized intermediate sea level rise scenario points to a 93% risk of at least one flood over 5 feet taking place between today and 2050 in the Westerly area. ➢ The number of people in Westerly who live on land below 7 feet is approximately 100. The localized intermediate sea level rise scenario points to a 23% risk of at least one flood over 7 feet taking place between today and 2050 in the Westerly area. • Escape routes may be cut off due to flooding, stranding residents in flooded areas, hampering rescue efforts, limiting access to health/emergency facilities, and hampering life support services; those at higher risk include seniors, those with mobility issues, and lower income individuals who may rely on public transportation.
 **Wind-Related Hazards** (High Winds; Thunderstorms including Lightning & Hail; Tornadoes; Tropical Cyclones)	• Westerly residents and businesses in close proximity to the shoreline are generally at higher risk to the impacts from high wind events. • High wind events, particularly hurricanes, that cause a loss of electricity can result in dangerous conditions including no phone/internet service available for storm advisories and medical emergencies; spoiling of refrigerated food; lack of heat, which, if occurring in conjunction with freezing temperatures can lead to dangerous health conditions and the potential for pipes to freeze and burst. • If downed power lines are arcing they present a threat to personal safety. • High winds can cause bodily injury from flying debris or structures collapsing. • Over the years, building codes have improved the structural integrity of buildings, taking into account the impact of high winds and other factors; those residing in older homes that have not been renovated to meet current building standards may be at higher risk to wind-related damage which could put residents at higher risk of injury or death. • The availability, reception, and understanding of early warnings tornado alerts and access to a substantial shelter will impact vulnerability. Once warned of an impending tornado hazard, seeking shelter indoors on the lowest floor of a substantial building away from windows is recommended as the best protection against bodily harm. • Swimming, boating, and fishing are particularly dangerous during periods of frequent lightning strikes, which can also cause power outages, topple trees, and spark fires. Individuals who immediately seek shelter in a sturdy building or metal roofed vehicle are much safer than those who remain outdoors. Early warnings of severe storms are also vital for aircraft flying through the area.

Hazard Group	Vulnerability *(What is at Risk)*
 **Winter-Related Hazards** (Heavy Snow; Ice; Extreme Cold) continued	• Heavy snow and ice events that cause a loss of electricity can result in dangerous conditions including no phone/internet service available for storm advisories and medical emergencies; lack of heat which can lead to dangerous health conditions and the potential for pipes to freeze and burst. • Snow, ice, hail, and freezing temperatures may create treacherous driving conditions, cause transportation delays, and create transportation challenges for first responders or others who may need to be on the roads, including those trying to access emergency shelters. • Heavy snow may cause school and business closures. • Exposure to extreme cold for an extended period can lead to health concerns including frost bite and hypothermia (of particular concern for infants/seniors); certain medications, medical conditions, or the consumption of alcohol can also make people more susceptible to the cold. • Ice can create dangerous walking conditions – seniors or others who may be less stable are at more risk of falling and injuring themselves. • Extreme cold may increase the potential for house fires and carbon monoxide poisoning due to increased use of supplemental heating devices. • Pets may be affected by severe winter weather, especially those that are kept outdoors. • There are some residential and commercial structures sporadically located throughout Westerly that are of older construction and may be more susceptible to roof collapse due to heavy snow loads which could put residents at higher risk of injury or death.
 **Infectious Disease-Related Hazards** (Vector-borne Diseases Transmitted by Ticks or Mosquitoes; Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses)	**Mosquitoes & Ticks** • Increased tick and mosquito populations resulting from climate change may lead to more vector-borne diseases in people. • The CDC states that everyone is at risk from mosquito bites (CDC. *Mosquito*); Westerly residents living or engaging in outdoor activities in close proximity to areas more conducive to mosquito breeding (forested areas, and standing water along rivers, ponds, and wetlands) are at higher risk of being bitten; Westerly residents living or engaging in outdoor activities in close proximity to wooded and grassy areas where higher populations of ticks tend to be found are at greater risk of being bitten. • As mosquitoes lay eggs in standing water, conditions conducive for breeding can be found town-wide; residents who minimize standing water on their properties (including in outdoor vessels, etc.) will lessen the mosquito population in the vicinity of their homes. • Pets can be potential hosts for ticks, putting their owners at potentially greater risk • If infected, elderly residents, children, and anyone with a weakened immune system may suffer more severe illness related to mosquito- and tick-borne diseases. • Several of the Town's natural resources may provide environmental conditions more favorable for tick and mosquito populations, including Crandall Swamp, Newton Swamp, Woody Hill Management Area, Dr. John Champlin Glacier Park, Grills Preserve, Town Forest, Riverwood Preserve, Moore Woods, and the salt ponds and coastal grasslands. Higher populations of ticks and mosquitoes increase the opportunity for residents using those facilities to be bitten and infected. Signage at these locations educating the community to use appropriate repellants and check for ticks after outdoor activities may help to decrease mosquito or tick related diseases. • Some Town property, including the Cimalore Sports Complex, employs mosquito mitigation measures through the summer months to abate and control mosquitoes for patrons. **Influenza (Flu)** • The CDC identifies those highest at risk of getting serious complications from flu as children younger than 5, but especially younger than 2 years old; adults 65 years or older; pregnant women; people with any chronic illness, especially heart, lung (including asthma), or kidney disease; and people with weak immune systems (CDC. *Seasonal Influenza*). • Critical Facilities: Over three-fourths of the critical facilities are considered places where sufficient people are in contact and therefore more vulnerable to the spread of Influenza or the Coronavirus; those facilities include all of the Public Schools, Day Care/Early Learning Centers, Special Population Centers, and Government/Emergency Centers. It also includes some of the institutional/commercial facilities, namely The Ocean Community YMCA, Westerly Education Center, Westerly Hospital, and Westerly Library.

Hazard Group	Vulnerability *(What is at Risk)*
 **Infectious Disease-Related Hazards** (Vector-borne Diseases Transmitted by Ticks or Mosquitoes; Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses) continued	**Coronavirus Disease 2019 (COVID-19)** • The CDC has indicated that there are many factors that increase a person's vulnerability to get severely ill from COVID-19. The severity risk increases for: o people in their 50s and further increases for people in their 60s, 70s, and 80s; people 85 and older are the most likely to get very sick; o people with chronic lung diseases, including COPD (chronic obstructive pulmonary disease), asthma (moderate-to-severe), interstitial lung disease, cystic fibrosis, and pulmonary hypertension; o people who have certain underlying medical conditions, including Chronic kidney disease; o Obesity (BMI of 30 or higher), immunocompromised state (weakened immune system) from solid organ transplant; and o Serious heart conditions, such as heart failure, coronary artery disease, or cardiomyopathies, Sickle cell disease, Type 2 diabetes, asthma, high blood pressure, neurologic conditions such as dementia, cerebrovascular disease such as stroke, pregnancy. (Sources for the preceding list: CDC. *COVID-19 Risks*; CDC. *Press Release*; and CDC. *People*) • Systemic health and social inequities may increase the risk of getting sick and dying from COVID-19 among certain racial and ethnic minority groups and people with disabilities. Factors affecting health equity include (CDC. *Health Equity*): o **Discrimination**: can lead to chronic and toxic stress, and shapes social and economic factors that increase risk for COVID-19; o **Healthcare access and use:** multiple barriers to accessing health care, for example lack of insurance, transportation, child care, or the ability to take time off of work may increase risk for COVID-19; o **Occupation:** work in essential settings such as healthcare facilities, farms, factories, grocery stores, and public transportation can lead to more chances of exposure to COVID-19; o **Educational, income, and wealth gaps:** less access to high-quality education may limit job opportunities that minimize exposure to COVID-19; and o **Housing:** living in crowded conditions can make it very difficult to isolate when you are or may be sick with COVID-19. • It should be recognized that the more underlying medical conditions or systemic health and social inequities a person is subject to, the higher their overall risk to COVID-19. • A number of factors associated with the COVID-19 Pandemic, including uncertainty, social isolation, closures/disruption to work and school has created significant emotional stress for many. • Critical Facilities: Over three-fourths of the critical facilities are considered places where sufficient people are in contact and therefore more vulnerable to the spread of Influenza or the Coronavirus; those facilities include all of the Public Schools, Day Care/Early Learning Centers, Special Population Centers, and Government/Emergency Centers. It also includes some of the institutional/commercial facilities, namely The Ocean Community YMCA, Westerly Education Center, Westerly Hospital, and Westerly Library.
 **Other Hazards** (Earthquakes; Extreme Heat; Drought; Brush Fires)	**Earthquakes** • People who are socially isolated or less mobile may be at greater risk. • There are some residential and commercial structures sporadically located throughout Westerly that are of older masonry construction and may be more at risk for structural failure or failing debris which could put residents at higher risk of injury or death. • Critical Facilities: Although an earthquake of significance is considered a low probability for Westerly, should one occur, older brick/masonry structures may be more at risk to damage; structural failure or failing debris may put residents using those facilities at higher risk of injury or death.

Hazard Group	Vulnerability *(What is at Risk)*


Other Hazards
(Earthquakes; Extreme Heat; Drought; Brush Fires)
	Extreme Heat
	• Physical effects of heat can cause major health problems, dehydration, and may lead to death.
	• Certain populations are particularly sensitive to extreme heat for various reasons including health conditions such as cardiac or breathing problems, living and working conditions, mobility, and limited financial resources. RIDOH lists the following populations at risk to extreme heat (RIDOH. *Extreme Heat*):
	  ○ Infants and young children
	  ○ People with chronic, long-term medical conditions
	  ○ Disabled
	  ○ Outdoor workers
	  ○ People who use certain medications/illegal drugs
	  ○ Low-income residents
	  ○ People who are overweight/obese
	  ○ Pregnant women
	  ○ Athletes
	  ○ People who are socially isolated
	• A number of the Town's natural resources have limited shaded areas and therefore visiting those areas on hot days may put them at higher risk to the impacts of extreme heat.
	• Critical Facilities: Senior populations may be more at risk from the impacts associated with extreme heat. As such, critical facilities that serve this population should be cognizant of the health impacts associated with extreme heat and the potential benefit of having air conditioning available in some area of the facility; Senior complexes include the Apple Rehab Clipper, Golden Years Assisted Living Community, Royal Health Westerly, The Elms Retirement Residence, Westerly Rehabilitation & Healthcare Center, and Westerly Senior Citizens Center.
	
	Drought
	• With the majority of water users in Westerly reliant on public water, the community's vulnerability to drought is directly related to the viability of the Town's aquifers.
	• Water rationing may be necessary and impact sanitary conditions.
	• During droughts, dry soils may increase the number of airborne particles, such as pollen, which can irritate the airways and worsen chronic respiratory illnesses such as asthma; those suffering from asthma or other respiratory illnesses may be at higher risk.
	• The roughly 6 percent of residents reliant on well water are at higher risk during a drought. Some of the larger agricultural areas of Westerly are vulnerable to impacts of drought including Barlow Vineyards, Everbreeze Farm, Hillandale Farm, Manfredi Farms, and Ocean Breeze Dairy Farm.
	
	Brush Fire
	• Smoke particles from fire can cause adverse health effects in people, particularly those with respiratory and cardiovascular conditions.
	• Brush fire also poses a direct risk to human life, should the fire reach the wildland-urban interface and ignite structures/infrastructure.

FUTURE DEVELOPMENT TRENDS

4.4.6 Future Development Trends

Westerly is a coastal community located in the southwest corner of Rhode Island, bordered to the north and west by the Pawcatuck River and to the south by Block Island Sound. Westerly is comprised of twenty-nine (29) distinct neighborhoods, each with its individual character and history (Town of Westerly RI. *Comprehensive*, 18). Seven (7) areas of Town have been listed as Historic Districts on the National Register of Historic Places: Bradford Village, Downtown Westerly, Main Street, the North End, Perry Homestead, Watch Hill, and Wilcox Park. (Town of Westerly RI. *Comprehensive*, 143).

Downtown Westerly is the commercial and civic center of the Town. Architecturally it is an eclectic area with late 19th and early 20th century masonry structures, and stately 19th century houses and buildings in Greek Revival, Gothic Revival, Italianate, and Second Empire styles. There are several mill districts in Town which originally developed as workforce housing along the Pawcatuck River. These areas are comprised of low, medium and high density residential, industrial, and open space/recreation, with predominately two or two-and-a-half story structures. Seasonal and summer homes are prevalent in the shoreline communities of Avondale, Watch Hill, Misquamicut, Weekapaug and Shelter Harbor. Each of these areas have a distinctive character, with Watch Hill and Misquamicut having commercial sections, heavily frequented during the summer months. The areas of Town with the lowest density zoning and largest working farmlands are Dunn's Corner and the Bradford Road area. The Route 1 Corridor includes commercial and residential uses, including subdivisions of single family homes and single-story strip malls (VHB. *Local*, 7). A few multi-family and mixed use developments exist, but they are not the norm.

4.4.6.1 Development Over the Past Five Years

Key development over the past five years is listed in **Table 4-35**. **None of the development efforts initiated or completed since the previous hazard mitigation plan have had a significant impact on the Town's vulnerability.** Development within hazard prone areas follow the State Building Code and Town's permitting guidelines that are in place to prevent an increase to the vulnerability.

Following is additional information on the four development projects identified in **Table 4-35** as being in the SFHA and Hurricane Surge Inundation Zone:

The Weekapaug Inn & Cottages consisted of two new structures associated with the historic hotel. Both newly constructed buildings were elevated above the design flood elevation, with the grade level being utilized for storage and parking only. Both structures have flood vents installed in compliance.

Hotel Maria was also a newly constructed building with hotel rooms being elevated above the design flood elevation. Open parking and building access are at grade level, with flood vents and breakaway walls installed in the enclosed area.

Pluck Properties, LLC renovated an existing building in Downtown Westerly and the project demonstrated full compliance with dry flood proofing requirements. The lowest floor is utilized as a bar and office spaces, the upper floors consist of restaurant, retail and living areas.

Weekapaug Yacht Club was an existing yacht club building that was completely torn down and rebuilt in roughly the same footprint. The new building is elevated on piles with breakaway walls and installed flood vents. The area below is for storage and building access only, a major resiliency improvement compared with the prior building.

Table 4-35 Development Over the Past 5-Years (2018-2022)

Project	Location	Number and Type of Units	SFHA/ Hurricane Surge Inundation Area	Completion Date
Spinnaker Landing	222 Post Road	48 residential units	No	2018
Weekapaug Inn & Cottages	25 Spray Rock Road	2 hotel suites & 78-seat meeting facility	Yes/Yes	2020
Fieldstone Estates	Fieldstone Way	52 single family residential units	No	2021
Hotel Maria	132 Atlantic Ave	26 hotel rooms	Yes/Yes	2021
United Theatre	5 Canal St	Theatre/assembly/ classrooms	No	2021
Pluck Properties, LLC	12 High St	restaurant/retail/13 multi-family units	Yes/Yes	2022
Weekapaug Yacht Club	23 Spray Rock Road	1 yacht club/meetinghouse rebuild	Yes/Yes	2022

In addition, the Town has been successful in efforts to encourage property owners of Repetitive Loss properties and other properties susceptible to flood inundation to take action to lessen the vulnerability of the structure:

- 2018 - 8 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder.
- 2019 - 12 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder.
- 2020 - 13 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder.
- 2021 - 7 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance.
- 2022 - 8 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, four were substantial improvements (SI) by choice of the owner/builder.

Figure 4-55 Elevated Homes in Westerly (photo credit: CRMC)

4.4.6.2 Land Use and Buildout Analysis

Land use in Westerly is divided among competing uses. Based on data from the Comprehensive Community Plan, currently the largest land cover category is conservation/open space (32.3±%), followed by residential (30.2±%), and then undeveloped/unprotected land (25.0±%). The remaining categories comprise considerably smaller land mass, including community facilities (3.6±%), commercial (3.2±%), developed recreation (2.4±%), agriculture (2.3±%), and industrial (0.9±%) (Town of Westerly RI. *Comprehensive*, 32).

A Buildout Analysis was conducted as part of the 2020 Comprehensive Community Plan. The potential new development capacity was based on the developable vacant and agricultural land. "Such development includes infill and redevelopment possibilities based on zoning density allowances and to the extent that natural resource constraints are not present" (Town of Westerly RI. *Comprehensive*, 43). The analysis was performed using a GIS program with recognized limitations; the method does not account for the possibility of new residential development in non-residential zoning districts, assumes the mapped wetland boundaries (provided by the State and federal government) are correct, and assumes new development will occur at the maximum density allowed by current zoning. Despite these limitations, the method was considered suitable for estimating the magnitude and location of potential new development (Town of Westerly RI. *Comprehensive*, 43).

The residential "build-out analysis estimates that, under the existing Zoning Ordinance, approximately 1,868 additional residential dwelling units can be built in Westerly. With an average of 85 new dwelling units being constructed per year since 2000, it is estimated that the year by which residential build-out is likely to occur is 2038" (Town of Westerly RI. *Comprehensive*, 45).

The commercial "build-out analysis estimates a total of 471,981 square feet of commercial space over 39.72 acres can be added in the Town. This coverage includes commercial space with current land zoned Neighborhood Business (NB; 24,164 square feet), Highway Commercial (HC; 278,854 square feet), and Professional (P-15; 108,837 square feet) and excludes Commercial Recreation (CR) and Shore Commercial-General (SC-G)" (Town of Westerly RI. *Comprehensive*, 46).

The industrial "build-out analysis estimates a total of 3,132,026 square feet of industrial space over 312.43 acres can be added in the Town. This estimate includes commercial space with current land zoned Light Industrial (393,399 square feet), General Industrial (2,731,360 square feet), and ORAT (7,267 square feet)" (Town of Westerly RI. *Comprehensive*, 47).

4.4.6.3 Future Development

The Town of Westerly's Comprehensive Community Plan (CCP), "is the community land-use program that will guide all land-use and physical development in Westerly from now to the end of 2040" (Town of Westerly RI. *Comprehensive*, 3). The CCP "recognizes the need for both preservation and development and the importance of establishing a balance between them, while also placing a heavy emphasis on rehabilitating and revitalizing existing buildings in order to preserve open spaces and views to the extent possible. Included among its goals are maintaining Westerly's character and heritage and preserving open space and irreplaceable natural resources" (Town of Westerly RI. *Comprehensive*, 48).

The history of preserving open space in Westerly is impressive, with over 5,000 acres (26% of the Town's total land area) preserved by public and private organizations (Town of Westerly RI. *Comprehensive*, 128). The Town remains committed to the preservation of open space and limiting development to non-vulnerable environmental areas. Currently, about twenty-five percent (25%) of land in Westerly (4,056 acres) is categorized as undeveloped/ unprotected, much of which has development potential (Town of Westerly RI. *Comprehensive*, 35). In addition, there are large tracts of working farmland in the Dunn's Corner and the Bradford Road area, currently zoned low density, which may at some point be developed.

Key issues the Town is facing related to land use planning include:

- ◊ Mitigating impacts of rising sea levels near Westerly's extensive shoreline and low-lying inland areas.
- ◊ Growing the non-residential tax base.
- ◊ Preserving community character as pressure mounts to redevelop lots in established neighborhoods and build in areas without adequate infrastructure.
- ◊ Providing adequate municipal, school, and recreational facilities that are well-maintained.
- ◊ Protecting environmentally sensitive areas, such as aquifers, wetlands, watercourses, and the barrier beaches.
- ◊ Retaining farming as a viable land use.

The Zoning Ordinance is a critical tool for controlling the type, density, and appearance of development within the Town. Five of the actions (Action 2023-3.4-B, -4.1-A, -4.3-A, - 4.3-B, and -4.3-C), included in the *Action Plan* (**Section 6**), propose reviewing and potentially amending the Zoning Ordinance and/or Land Development and Subdivision Regulations, to improve resilience to natural hazards. In particular Action 2023-4.3-B, identifies the need to comprehensively study existing and future land uses in coastal areas most vulnerable to sea level rise, storm surge, and coastal erosion, and, through robust public engagement (including local stakeholders such as conservation agencies, non-profit organizations, and the business community), evaluate alternatives to mitigate risk. Revisions to the Zoning Ordinance and/or Land Development and Subdivision Regulations may impact future development.

Westerly's Emergency Management Coordinator, in collaboration with the Planning Department and the HM&FMP Advisory Committee will monitor development trends and determine any resulting changes in vulnerabilities that natural hazards will present.

As identified in **Table 4-36**, there are several significant ongoing development efforts in progress in Westerly. All new developments must be in compliance with current floodplain, State building code, and stormwater standards, and therefore should not have a significant impact on the Town's vulnerability to natural hazards. As indicated below, all of the projects currently proposed are considered low risk to natural hazards, and are located outside of the SFHA and the hurricane surge inundation zones.

Table 4-36 Potential Development Over the Next 5-Years (2023-2028)

Project	Location	Number and Type of Units	SFHA/Hurricane Surge Inundation Area	Anticipated Completion Date
Harbor Ridge Condominiums	165 East Avenue	20 residential duplex units	No	2023
Merchants Village Apartments	21 Clark Street	25 multi-family residential units	No	2023
South Drive Condominiums	19 South Drive	24 residential condos	No	2024
Champlin Woods (Phase II)	11 Compass Way	50-74 multi-family residential 55+ units	No	2025
Dakota Partners	111 Wells Street	72 multi-family residential units	No	2025
Ledward Ave Subdivision	60 Ledward Avenue	8 single-family residential units; 2- two family units	No	2025
Venice Restaurant and Hotel	159, 163 & 165 Shore Rd	34 hotel suites & 290-seat banquet hall	No	2025
St Pius X Multifamily	28 School Street	44 multi-family residential units	No	2026

In addition, in response to Superstorm Sandy, the Army Corps of Engineers undertook a feasibility study to find solutions for flood control and navigation across four municipalities in southeastern New England. As a second project phase, the Army Corp is currently working on a federal grant project to elevate 17 homes in Westerly.

4.4.6.4 Town's Ability to Expand and Improve Capabilities

As further discussed in **Section 5**, and exemplified in the ***2023-2028 Action Plan*** **(Section 6)**, the Town of Westerly has numerous ongoing capabilities (authorities, policies, programs and resources), and intends to expand on and improve many of these, including the following which relate to future development:

Building Official
The Town's Building Official implements and enforces the State Building Code ensuring new structures or those substantially renovated are compliant. In addition, Westerly has implemented several zoning ordinances which place even greater restrictions on certain types and locations of development. To ensure that no violations exist, routine, daily, on-site inspections are made while work is in progress. The capability of the Building Official is continually expanded through ongoing education on the current NFIP policies and ordinances, floodplain management practices, and professional engagement with the Association of State Floodplain Managers (ASFPM), Rhode Island Emergency Management Agency (RIEMA), and the State Building Commissioner's Department.

Town Engineer
The Engineering Department provides engineering advice and support to the Town Manager's Office, other municipal departments, boards, and the Town Council. The Department provides in-house engineering or oversees consultants for water, wastewater, roads, and stormwater drainage projects. The Town Engineer functions as the Town's CRS Coordinator. The capability of the Town Engineer is continually expanded through ongoing education on the current NFIP policies and ordinances, floodplain management practices, and professional engagement in the Association of State Floodplain Managers (ASFPM).

Improved Floodplain Drainage
In compliance with the RI Nonpoint Source Pollution Management Plan and the RI Pollutant Discharge Elimination System regulations, the Town of Westerly has an ongoing effort to improve stormwater drainage infrastructure in flood prone areas. Both riverine and coastal flooding can be relieved through a well-designed and maintained drainage system that efficiently directs the flow of stormwater to points where the impacts of flooding will be minimized. As identified in the Action Plan (**Section 6**), the following actions include implementing drainage projects to improve stormwater management.

- **Action 2023-3.1-B**: Assess, monitor, maintain, and plan for replacement/upgrades of existing roadways and associated drainage infrastructure (including culverts) to mitigate flooding and incorporate resilient designs to ensure continued service during hazard events.
- **Action 2023-3.3-A**: Expand stormwater management capacity through monitoring, maintenance, and upgrade/retrofitting of existing systems and integration of green infrastructure and Low-Impact Development (LID) standards throughout Town.

Regulations and Ordinances

The Town has enacted regulatory restrictions designed to reduce the potential impacts of flooding to property by limiting development in and around wetlands and flood-prone areas. The Town intends to continue to enforce Article III of the *Land Development and Subdivision Regulations* which identifies land that may be unsuitable for development, including freshwater wetlands, coastal wetlands, and within the SFHA as designated by FEMA. Within the SFHA, all proposed construction or other development requires a permit – not just projects where building permits are required. Construction or other development in the SFHA not covered by a building permit would be subject to approval by CRMC or RIDEM, as applicable.

As identified in the Action Plan (**Section 6**), the following actions include reviewing and potentially amending the Zoning Ordinance and/or Land Development and Subdivision Regulations, to improve resilience to natural hazards. An excellent resource available in the Westerly Development Services Department is *Subdivision Design in Flood Hazard Areas*, produced jointly by FEMA and the American Planning Association. This publication discusses site-specific measures to minimize flood damage and preserve natural functions of floodplains, including coastal high hazard areas and low lying areas near rivers.

- **Action 2023-3.4-B**: Work with private developers and utility companies to mitigate the vulnerability of existing infrastructure, including burying above-ground infrastructure like electric and telecommunications systems, especially in high wind and ice hazard areas.
- **Action 2023-4.1-A**: Develop a priority map and plan for the preservation of such natural areas across the municipality that are not currently protected and will enhance resilience.
- **Action 2023-4.3-A**: Amend the Zoning Ordinance and Land Development and Subdivision Regulations to enhance Low-Impact Development (LID) design requirements, incorporation of green infrastructure and greenspace, and reduction in impervious surface, particularly in areas vulnerable to natural hazard areas.
- **Action 2023-4.3-B**: Comprehensively study existing and future land uses in coastal areas most vulnerable to sea level rise, storm surge, and coastal erosion, and, through robust public engagement (including local stakeholders such as conservation agencies, non-profit organizations, and the business community), evaluate alternatives to mitigate risk.
- **Action 2023-4.3-C**: Amend the Zoning Ordinance and Land Development and Subdivision Regulations to ensure appropriate resiliency and environmental protection is incorporated in new private and public development and redevelopment, especially in vulnerable areas.

Management of Open Space

The Town recognizes the importance of managing conservation lands held in public and private ownership. "Since the adoption of Westerly's Comprehensive Plan in 1992, substantial areas of open space have been acquired for preservation and recreation. Public/private and non-profit entities have been active and successful in the purchase/dedication of lands for open space and, in some cases, the purchase of development rights… Most recently, 433 acres in Bradford, known as the Lucey properties, was acquired for passive recreation, open space, and aquifer protection. This parcel is contiguous with the state-owned Woody Hill Management Area (722 acres) and the non-profit Westerly Land Trust's Wahaneeta Preserve (84 acres), thus creating Westerly's first green belt - extending more than 12,000 contiguous acres" (Town of Westerly RI. *Comprehensive*, 23).

In addition to continued interest in acquiring/supporting the acquisition of open space for conservation, the Town promotes the Farm Forest and Open Space (FFOS) program. The FFOS is a tax incentive program that helps to achieve open space protection, but does not provide permanent protection. Property owners enter into an agreement with the Town to keep their properties undeveloped for at least 15 years in exchange for lower property tax assessments.

While great achievements have been made to protect important natural resource areas, the Town is cognizant that climate change, including the threat of SLR, makes it imperative to preserve low-lying areas adjoining the ocean, salt ponds and the Pawcatuck River. These conservation efforts reduce the potential for development in flood prone areas subject to the adverse effects of hurricanes, coastal storms, and riverine flooding.

As identified in the *Action Plan* **(Section 6)**, the Town intends to continue working with the State and conservation organizations, such as the Westerly Land Trust, Watch Hill Conservancy, Weekapaug Foundation for Conservation, and Save The Bay, to restore degraded wetlands and shorelines in critical areas, which helps reduce the risk of damages from flooding events.

- **Action 2023-4.1-A**: Develop a priority map and plan for the preservation of such natural areas across the municipality that are not currently protected and will enhance resilience.
- **Action 2023-4.1-C**: Coordinate with the local land trusts, conservation organizations, state and federal agencies, and local property owners in the acquisition and maintenance of open space, especially in flood hazard areas, aquifers, coastal migration areas, and other natural resource areas (ex. agricultural land) to improve resiliency.
- **Action 2023-4.2-B**: Develop an Environmental Management Plan for the municipality, addressing forest and open space, and management strategies to mitigate natural hazard impacts and improve resilience in our natural environment.

SECTION 5

Capability Assessment

Subsections

KMJ – CE/RP

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5 Capability Assessment

The Town of Westerly has the capacity to implement and institutionalize hazard mitigation through its personnel, legal, and fiscal resources; intergovernmental coordination and communication; and academic and analysis tools. In addition, Westerly is fortunate to have a community base - residents, business owners, organizations, and institutional leaders - that support hazard mitigation and other critical issues important to the Town's future. A collaborative and engaged local governance and community are necessary to ensure Westerly's preparedness for natural hazards.

In **Section 4**, the planning process identified the natural hazards posing a threat to Westerly and described the vulnerability of the Town to those risks. In this Section, the *Capability Assessment* provides the opportunity to evaluate what mitigation mechanisms are already in place. In other words, what policies, programs, regulations, authorities, personnel, funding, and other resources are available to the Town to accomplish mitigation and reduce long-term vulnerability.

The *Capability Assessment* is an important step because understanding what is already in place and the effectiveness of those capabilities provides the opportunity to identify where additional measures or revisions to existing measures are needed. The Town has the capacity to expand and improve certain capabilities through measures included in the *Action Plan*; through the passage and enforcement of additional codes and regulations; by integrating mitigation measures into other Town planning documents; and by continually increasing community and stakeholder engagement, including expanding those involved in the HM&FMP Advisory Committee to reflect growth and change in the community.

The *Capability Assessment* is structured in part as an inventory of existing mitigation capabilities, which may help decrease the community's hazard risk and/or impact the way pre- and post-hazard events are handled. In addition to the inventory, the *Capability Assessment* includes an overview of the Town's partnerships with various agencies and organizations that support hazard mitigation, public outreach efforts, and the status of the 2018 Hazard Mitigation Action Plan. This information has been provided in the following subsections:

5.1 Capability Inventory

5.2 Partnerships and Public Outreach

5.3 Assessment of 2018 Hazard Mitigation Action Plan

5.1 CAPABILITY INVENTORY

The Capability Inventory identifies existing mitigation capabilities that in some way contribute to or inform the hazard mitigation process in the Town of Westerly. The inventory includes Local, Regional, State, and Federal measures and has been organized into three categories. Although a number of the capabilities overlap between the planning/regulatory and administrative/technical categories, each capability has been included in only one of those categories.

As evidenced by the citations throughout the *HM&FMP*, relevant information from a significant number of the resources included in the Capability Inventory have been incorporated into the *Plan*. Familiarization with the Town's existing capabilities helped to shape the mitigation goals and strategy. As documented in the *Action Plan*, a number of *Mitigation Actions*, are taken directly from or build on the good work and priorities identified in other Town planning documents. Some of the proposed mitigation actions were identified to fill gaps within the Town's existing protection matrix in an effort to make the community more resilient.

Over the ensuing five year period, the Town intends and has the ability to further expand on and improve existing policies and programs. This is evidenced in **Appendices 5-1 through 5-3**, as well as in **Sections 6.4 and 4.4.6**. Key examples of Westerly's ability to improve its capabilities over the upcoming 5-year period include:

- In 2021 hiring Westerly's former Police Chief as the Town Manager to, amongst other responsibilities, expand interdepartmental roles in hazard mitigation
- In June 2019 hiring a new Town Planner, who is certified as a land planner by the American Institute of Certified Planners, and previously worked for the Town as Assistant Solicitor for Planning and Zoning, Interim Town Planner, and Interim Zoning Official. The new Town Planner was integral in the development of the 2020 Comprehensive Community Plan and has the ability to assist the Town in expanding hazard mitigation.
- In June 2020 hiring a new Principal Planner, who has a background in environmental science and consulting became a certified Climate Change Professional (CC-P) in 2022. She was engaged in the 2020 Comprehensive Community Plan, and has been integral to the development of this HM&FMP, functioning as the Advisory Committee Chair. The Principal Planner has the ability to assist the Town in improving hazard mitigation implementation.
- The Town Engineer and Building Official are working to become Certified Floodplain Managers
- Expanding the focus of the Emergency Management Coordinator position; and expanding emergency management drills and exercises
- Expanding coordination with the local business community, neighboring jurisdictions, and other stakeholders
- Expanding community outreach activities and public participation in hazard mitigation related activities
- Reviewing and strengthening existing codes and regulations associated with hazard mitigation
- Improving and expanding the Town's Website
- Improving and expanding the Town's GIS
- Further integrating hazard mitigation into future Comprehensive Plan updates
- Generators will be installed at State Street School

5.1.1 Planning and Regulatory Capabilities

As discussed in **Section 2**, an extensive plan integration was undertaken which examined Local, Regional, State, and Federal plans, policies, ordinances, regulations, and programs that support hazard mitigation and flood management goals in the Town of Westerly.

CRS CREDIT: NFIP/CRS

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase III –Mitigation Strategy	7. Review Possible Activities (a & b)	10

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

While there is always room for improvement, the Town is proud of the efforts made to enact regulatory restrictions and undertake studies and activities which have laid the foundation for the mitigation strategy included herein. As part of plan integration, and in accordance with CRS Activity 510 Planning Process - Step 7, the Town reviewed preventive activities including zoning, stormwater management regulations, building codes, subdivision ordinances, and the preservation of wetlands and open space. With respect to floodplain management, how to reduce future flood losses and if the Town should adopt or revise these planning tools to better meet current or future conditions was considered. **Table 5-1** lists the *Planning and Regulatory Capabilities* with a hyperlink where available.

The assessment of these capabilities, including key discussion points and *HM&FMP* integration considerations, has been included in **Appendix 5-1**. In the Appendix, the section related to local capabilities also includes a ***Level of Effectiveness*** rating to assist in determining which measures should continue to be supported or enhanced. Capabilities with a low or moderate rating were further reviewed to determine if the measure should be updated or if the 2020 Comprehensive Community Plan or another planning document will take the place of the less effective capability.

Table 5-1 List of Planning and Regulatory Capabilities (Refer to Appendix 5-1 for Assessment Details)

LOCAL (the capabilities have been listed in alphabetical order)
Comprehensive Community Plan (2020-2040)
Comprehensive Emergency Management Plan (2018)
Continuity of Operations/Government Plan (2015)
Energy Management Plan (2016)
Geographic Information System (GIS)
Harbor Management Plan (2016-Revised 10/28/2019)
*** THIS DOCUMENT - Hazard Mitigation & Flood Management Plan (2023)
Hazard Mitigation Plan (2018)
MRP Community Resilience Building Workshop Summary of Findings (2019)
The Code of the Town of Westerly RI: Chapter 90 Building Construction Rhode Island General Law, Chapter 23-27.3 State Building Code
The Code of the Town of Westerly RI: Chapter 127 Floodplain Management
The Code of the Town of Westerly RI: Chapter 162-2 Burning Restricted
The Code of the Town of Westerly RI: Chapter 224 Stormwater Management
The Code of the Town of Westerly RI: Chapter 260 Zoning
The Code of the Town of Westerly RI: Chapter A261 Land Development and Subdivision Regulations
Westerly Debris Management Plan (2016)
Westerly Route 1 Corridor Report (2022)
REGIONAL/STATE (the capabilities have been listed in alphabetical order)
Association of State Floodplain Managers (ASFPM)
Coastal Resources Management Council (CRMC)
Narragansett Bay National Estuarine Research Reserve (NBNERR)
Resilient Rhode Island Act
Resilient Rhody: Municipal Resilience Program
Rhode Island Building Codes
Rhode Island Department of Administration (RIDOA) - Rhode Island Division of Statewide Planning (RIDSP)
Rhode Island Department of Environmental Management (RIDEM)
Rhode Island Department of Health (RIDOH)
Rhode Island Department of Public Safety (RIDPS)
Rhode Island Department of Transportation (RIDOT)
Rhode Island Emergency Management Agency (RIEMA)
Rhode Island Energy - PPL Corporation (formerly National Grid/Narragansett Electric)
Rhode Island Flood Mitigation Association (RIFMA)
Rhode Island Geographic information System (RIGIS)
Rhode Island Office of Energy Resources (RIOER)
Rhode Island Sea Grant
Salt Ponds Coalition (SPC)

Wood-Pawcatuck Watershed Association (WPWA)
Wood-Pawcatuck Wild & Scenic Stewardship Council
FEDERAL (the capabilities have been listed in alphabetical order)
Americans with Disabilities Act Guide for Small Towns
Clean Water Act
Federal Disaster Mitigation (some key Acts)
Federal Emergency Management Agency (FEMA)
National Oceanic and Atmospheric Administration (NOAA)

5.1.2 Administrative and Technical Capabilities

The *Administrative and Technical Capabilities* include policies, standard operating procedures, public services, trainings, and tools that can be used for mitigation planning and to implement specific mitigation actions. At the local level, it encapsulates the skills and expertise of the Town of Westerly staff in terms of their ability to effectively undertake hazard mitigation planning and implementation, and the coordination of associated resources.

Table 5-2 provides a list of the *Administrative and Technical Capabilities* that were reviewed at the Local, Regional, State, and Federal level. The full assessment has been provided in **Appendix 5-2**. Where applicable, the capability measure includes a hyperlink.

Table 5-2 List of Administrative and Technical Capabilities (Refer to Appendix 5-2 for Assessment details)

LOCAL (the capabilities have been listed in alphabetical order)
Ambulance Services
Boards & Commissions
Coordination with Area Colleges and Universities
Coordination with Neighboring Municipalities
Drills and Exercises
Emergency Shelter
Evacuation Zones and Routes
Fire Protection Services
Map Information Services
Medical Facilities and Services
Senior Citizen Services
The Westerly Land Trust
Town Administration and Departments
Town Communication (Website, Twitter, and Facebook)
Warning and Notification Systems
Westerly Education Center
Westerly Library
Westerly Public Schools
REGIONAL/STATE (the capabilities have been listed in alphabetical order)
New England States Emergency Consortium (NESEC)
Rhode Island Red Cross

Save The Bay
Southern Rhode Island Conservation District (SRICD)
StormSmart Coasts Rhode Island
The Nature Conservancy
University of New Hampshire Stormwater Center (UNHSC)
University of Rhode Island
FEDERAL (the capabilities have been listed in alphabetical order)
National Flood Insurance
National Warning and Alert Systems
Nationwide Programmatic Environmental Documents
Pandemic and All-Hazards Preparedness Act
Voluntary Organizations Active in Disasters (VOAD)

5.1.3 Financial Capabilities

Westerly will use their Capital Improvement Program (CIP) as a primary funding mechanism for implementation of the actions in this *HM&FMP*. In addition, the Town - across all municipal departments - will consider and pursue all applicable Local, Regional, State, and Federal grant opportunities to assist in implementing hazard mitigation programs. The *Financial Capabilities* identified in **Table 5-3** represent potential funding sources the Town has access to, has used in the past, or may be eligible to use in the future for hazard mitigation measures. The full assessment of the financial capabilities has been provided in **Appendix 5-3**. A number of the recent hazard mitigation related grants awarded to Westerly have been listed in **Table 5-4.**

Table 5-3 List of Financial Capabilities (Refer to Appendix 5-3 for Assessment details)

LOCAL (the capabilities have been listed in alphabetical order)
Community Organizations
Flood Relief Funds
Town Budget - Capital Improvement Program (CIP)
REGIONAL/STATE (the capabilities have been listed in alphabetical order)
Narragansett Bay Estuary Program (NBEP)
Rhode Island Department of Environmental Management (RIDEM)
Rhode Island Department of Health (RIDOH)
Rhode Island Department of Transportation (RIDOT)
Rhode Island Emergency Management Agency (RIEMA)
Rhode Island Foundation
Rhode Island Infrastructure Bank (RIIB) – MRP Action Grant
Southern New England Program (SNEP)
Volunteer Organizations
FEDERAL (the capabilities have been listed in alphabetical order)
American Rescue Plan Act (ARPA)
Department of Commerce - US Economic Development Administration (EDA)
Department of Homeland Security Grant Program (HSGP)

Federal Emergency Management Agency (FEMA)
National Oceanic and Atmospheric Administration (NOAA)
US Army Corps of Engineers Programs
US Department of Agriculture Natural Resources Conservation Service (USDA)
US Department of Housing and Urban Development
US Economic Development Administration
US Environmental Protection Agency
US Fish and Wildlife Service

Table 5-4 List of Recent Hazard Mitigation Related Grants Awarded to Westerly
(Refer to **Appendix 5-3** for additional details)

Project Description	Year Award/ Project Status	Awarded Amount
Winnapaug Pond Dredging & Eelgrass Restoration	2019 - Completed	$2,900,000
Flood wall around New Canal Street Pump Station	2020 - Completed	$249,550
Flood wall around Old Canal Street Pump Station	2020 - Completed	$191,000
Potter Hill Dam - Initial Design & Engineering	2020 - Completed	$110,682
Potter Hill Dam Additional Studies-Portion being used for dam assessment	2020 - Completed	$43,500
Chapman Pond Boat Wash Station & Lake Management Plan - Non-Point Source for Chapman Pond	2020 - In progress	$68,500
Installation of Springbrook Road, South & West Fairway infiltration basins	2020 - In progress	$113,000
Potter Hill Dam NOAA Year 2 Match	2020 - Not started	$102,550
Potter Hill Dam Construction Project	2020 - Not started	$600,000
Potter Hill Mill Removal	2020 - Not started	$400,000
Refurbish two ambulances/equipment	2021 - In progress	$310,000
Replace utility tractor and beach rake	2021 - In progress	$92,068
Replace Town Hall HVAC	2021 - In progress	$1,300,000
Replace Town Hall- Windows	2021 - In progress	$400,000
Low Impact Development (LID) Planning & regulation changes	2021 - In progress	Tech Assist
RIDOT/SRICD Charter for Planning of Downtown Stormwater Infrastructure Projects	2021 - In progress	$25,000
ARPA funds for Planning, design, implementation of Downtown Stormwater	2021 - In progress	$250,000
SWIG grant for construction of green infrastructure Downtown	2021 - Not started	$200,000
Hazard Mitigation Plan update	2022 - In progress	$56,250
Emergency Management Director and Assistant stipends	2022 - In progress	$7,500
Emergency Management Training	2022 - In progress	$7,500
USGS Tide Gauge in Watch Hill Cove	2022 - In progress	$12,375
NBEP Grant for Planning of Downtown Stormwater Infrastructure Projects	2022 - Not started	$75,000
MRP Action Grant. Greening Downtown Westerly	2022 - Not started	$500,000

5.1.4 Key Local Mitigation Measures Related to Profiled Hazards

In **Section 4**, the Advisory Committee identified and profiled those hazards thought to have a higher likelihood of occurring or potentially having a greater impact on the Town should they occur. **Table 5-5** relates key local capabilities to each of the profiled hazards. The Town will continue to expand and improve these capacities.

Table 5-5 Key Local Mitigation Measures Related to Profiled Hazards

Hazard	Existing Mitigation Measure
All Hazards Identified in HM&FM Plan	CodeRED™ Communications Equipment Comprehensive Community Plan Continuity of Operations Plan Emergency Power Generators Hazard Mitigation & Flood Management Plan (*this document*) Outreach & Education Professionalism, Expertise, and Dedication of Town Staff Town Website Westerly Emergency Management Agency
Flood-Related	CRS Program Participation Dam Safety Regulations Evacuation Plan Floodplain Regulations Harbor Management Plan Implementing Structural and Non-Structural Projects Land Development & Subdivision Regulations Local Emergency & Warming Shelters Low Impact Development (LID) Municipal Self-Assessment National Flood Insurance Program Participation Overlay Districts: Aquifer and Wellhead Protection and Salt Pond Regional Red Cross Certified Shelter RIPDES Small MS4 Permit Regulations RI STORMTOOLS Roadway Treatments Site Plan Review for Stormwater and Erosion Control State Building Codes Storm Drainage and Catch Basin Maintenance Street Sweeping Town Website: Information on Flood Preparedness Westerly GIS Wetlands and Open Space Acquisition Zoning Ordinance
Wind-Related	Evacuation Plan Local Emergency & Warming Shelters Regional Red Cross Certified Shelter State Building Codes Tree Maintenance Program
Winter-Related	Evacuation Plan Local Emergency & Warming Shelters Regional Red Cross Certified Shelter Roadway Treatments Snow Removal
Vector-borne Diseases Transmitted by Ticks and Mosquitoes	Mosquito Control Maintenance
Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses	Covid-19 Home Testing Kits made available to public Town Covid-19 Testing Facility (Senior Center) Town Website: Information on Covid-19
Earthquakes	Evacuation Plan Local Emergency Shelters Regional Red Cross Certified Shelter State Building Codes
Extreme Heat, Drought, Brush Fires	Local Emergency & Cooling Shelters Local Fire Safety Education Program Permits Required for Outdoor Fire Pits on Public Land State Fire Building Code Tree Maintenance and Replacement Program Water Use Restriction

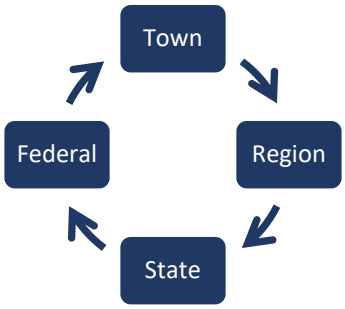
5.2 PARTNERSHIPS AND PUBLIC OUTREACH

The Town of Westerly recognizes the benefit of coordinating and working collaboratively with an array of partners. The list in **Appendix 2-3**, identifies 13 local government & school district groups, as well as 36 agencies and organizations outside of Westerly's governmental structure, that were invited to be part of the *HM&FMP* planning process. The Town has established partnerships with many of those agencies and organizations.

As identified in **Appendices 5-1, 5-2, and 5-3**, many of these partners have helped to enhance an array of Town projects and community outreach through their expertise, resources, and funding support. This *HM&FMP* is a prime example of the integral nature of these partnerships. Stakeholders from Age Friendly Westerly, Misquamicut Business Association, Southern Rhode Island Conservation District, Ocean Community Chamber of Commerce, Watch Hill Fire District, Westerly Fire Department, and Westerly Land Trust are serving on the Advisory Committee. Further, as evidenced through the **Bibliography and Work Cited** documentation, resources from many of these partners have been used throughout this *Plan*.

As part of the *Capability Assessment*, it was determined that it would be beneficial for the Town to continue to build upon existing partnerships to ensure the Town remains current with respect to hazard risks and mitigation. Throughout the *Action Plan*, the Advisory Committee recognized the benefit of partnerships and informational connections.

The Town is particularly grateful of the partnership with the Rhode Island Emergency Management Agency (RIEMA) and the Federal Emergency Management Agency (FEMA) for their knowledgeable staff, databases, tools to perform local risk assessments and other analysis, resources to support development of mitigation strategies, grant funding opportunities, and for their vast collection of public outreach materials, including those that promote flood risk awareness and flood insurance.



Additionally, over the past several years the Town has worked closely with a number of conservation organizations such as the Rhode Island Sea Grant, Salt Ponds Coalition, Save The Bay, Southern Rhode Island Conservation District, The Nature Conservancy, University of Rhode Island Coastal Institute, Westerly Land Conservation Trust, and Wood-Pawcatuck Watershed Association to restore degraded wetlands in critical areas, foster habitat restoration, and implement end of road drainage improvements to help reduce the risk of damages from flooding events.

In an effort to improve the Town's emergency response capability, the Ocean Community Chamber of Commerce, in a cooperative effort with the Westerly Emergency Management Coordinator, surveyed its members to create a database of those who own heavy construction equipment and supplies. This list should be revisited annually to remain current and serve as a reminder to private businesses of their important role in post-disaster clean up.

Partnering with government agencies and other organizations to plan and carry out emergency preparedness, emergency response, and hazard mitigation activities has been a successful strategy that the Town will endeavor to expand in the coming years. In particular the Town recognizes the benefit of expanding the role of these partners in public outreach. As evidenced in the *Action Plan* (**Section 6**), a number of the action items fall into the **Public Education & Awareness Category**. The Town will look for opportunities to involve their partners in community outreach activities that promote a safer, more disaster resilient community. Successful outreach programs provide accurate data and information that serves to make citizens better prepared for potential hazard events. Public outreach and education also builds an understanding of the concept of hazard mitigation and climate change, therein helping to create a base of support for implementing *Plan* activities.

Within the Town administrative structure, two ongoing outreach and educational programming efforts that support hazard awareness and reinforce individual pro-active hazard mitigation measures include:

Information on the Town Website

The IT Department, in conjunction with the Town Departments, maintains and updates the Town website. Throughout the COVID-19 pandemic, the Town regularly provided updates to the community via the Town website. The Town continues to use the website to provide information, as needed, on weather related or planned events.

A critical tool administered by Westerly Emergency Management is the CodeRED™ Emergency Notification System. This system facilitates more rapid citizen notification and warning in advance of or during a disaster.

As part of the *Capability Assessment*, it was determined that it would be beneficial for the Town to continue to improve the scope and breadth of hazard mitigation/emergency preparedness awareness. In the *Action Plan*, the Advisory Committee prioritized the need for expanded public education and outreach efforts including through the Town website (refer to **Section 6.4** - Action 2023-1.1-A).

A number of Town webpages provide information, such as the following, related to hazard mitigation:

- Coastal Barrier Resources System (CBRS)
- Coastal Erosion
- CodeRed Emergency Notification Signup
- COVID-19 Resources
- Elevation Certificates
- Emergency Management
- FEMA Flood Insurance Rate Maps (FIRMs) & Flood Insurance Study (FIS)
- FEMA Technical Bulletins & Publications
- Flood Zone Management & Protection
- HM&FMP Project
- Hurricane Evacuation Information
- Letters of Map Amendments (LOMAs)
- Local Hydrography
- Pawcatuck Watershed Management Plan
- Planning, Fire District Information
- V-Zone and Coastal A Zone Design Certificate

As part of the *Capability Assessment*, it was determined that it would be beneficial for the Town to continue to build their GIS capability and provide additional valuable information to the community through this visual mapping tool. In the *Action Plan*, the Advisory Committee prioritized the need for enhancing the Town's GIS capabilities (refer to **Section 6.4** - Action 2023-1.1-B).

Information on the Town GIS Web Viewer

The Town's on-line *GIS Web Viewer* provides Town departments and the public easy access to Westerly's ArcGIS mapping which includes FEMA flood Insurance Rate Maps (FIRMs). By providing the FIRM flood zone layer, users can navigate to their property and view where flood zones are located in approximate relation to the property lines and building footprints. The flood zone information is beneficial to residents, potential home buyers, insurance agencies, lenders, and Town staff.

Over the ensuing five-year period the Town intends to improve and expand its GIS capabilities.

5.3 2018 HAZARD MITIGATION ACTION PLAN – ASSESSMENT OF ACTIONS

Throughout the life-cycle of the 2018 HMP, the mitigation actions were tracked and assessed by the Town. In accordance with 44 CFR § 201.6 and CRS Activity 510 Planning Process - Step 7, the Advisory Committee conducted a review of the 2018 Mitigation Actions to determine their status and relevance for inclusion in this update. **Of the 17 Actions, 1 has been completed (Action #15), 2 have had no action (Action #3 and #11), and the rest are ongoing.** As evidenced in **Table 5-6**, the Town has been **extremely proactive** and made a great deal of progress on almost all of these actions. After reviewing the work accomplished and what remains to be done, **it was determined that all of the non-completed actions (i.e. all actions except #15) remain relevant and compatible with the updated *Goals*, and have therefore been carried over to the 2023 Action Plan.** Although these actions have formed the foundation of the *2023-2028 Action Plan*, most have been modified to account for work accomplished and/or plan integration of actions and measures from other resources. For cross-referencing, **Appendix 6-1** identifies where the 2018 actions have been incorporated into the *2023 Action Plan*.

Table 5-6 Overview of 2018 HMP Actions

2018 HMP Action Item	Status
5.5.1 Action #1: Elevate Repetitive Loss Structures As grants become available, the Town plans to continue to offer funding obtained through FEMA to assist owners of Repetitive and Severe Repetitive Loss properties, Repetitive Loss Areas, and other properties susceptible to flood inundation in elevating their homes and/or their utilities in order to reduce the vulnerability to flooding and storm surge. The program criteria will be modified as needed throughout the life of this plan.	**Status: Ongoing** • Code Enforcement: The Building Office continues to enforce the State Building Code for substantial improvements in the SFHFA (A and V flood zones) as part of its regular scope of authority within the functioning of the local government. • Acquisition and Elevation Program: ➢ 2018 - 8 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder. ➢ 2019 - 12 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder. ➢ 2020 - 13 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, two were substantial improvements (SI) by choice of the owner/builder. ➢ 2021 - 7 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. ➢ 2022 - 8 dwellings were either torn down, voluntarily elevated, or had a new dwelling built to flood compliance. Of these dwellings, four were substantial improvements (SI) by choice of the owner/builder. ➢ The Building Official reviewed the 2022 FEMA Substantial Damage (SD) list and has submitted the required documents for review to remove 9 of 55 said properties from the list. ➢ The Army Corp is currently working on a federal grant project to elevate 17 homes in Westerly. • Although the Town recognizes the potential flood management benefit of purchasing property adjacent to the Atlantic Ocean to increase open space, reduce debris and repetitive losses, the purchase of property in this area may be cost-prohibitive. • Public Outreach & Education: The Town of Westerly makes available acquisition and elevation resources within the Westerly Town Hall and Westerly Library and on its official government website. The Town continues to update online resources, and includes educational material in public mailings to those located within designated flood area.

2018 HMP Action Item	Status
5.5.2 Action #2: Improve Misquamicut Drainage– Phase II The Town completed the Phase I study for the Misquamicut Beach Drainage Project in 2014. Phase II implementation includes the installation of a collection system, using natural resources such as replenished dunes, planted vegetation, and the removal of impervious surfaces such as paved parking lots. The incorporation of an ISDS management policy is also part of the drainage project.	**Status: Ongoing** • In 2018, the Engineering Department completed improvements to the Misquamicut Storm Water Pump Station to provide better protection during a major storm event. The project included installation of a backup emergency power supply, replacement of PVC air intakes and exhaust vents with new stainless-steel ones at a higher elevation, sealing existing electrical penetrations to the underground vault, and relocation of the pump station's electrical feed, disconnect switch, and emergency power outlet to a new panel located on a new concrete pad. In 2019, the Town was awarded a Community Development Block Grant for Disaster Recovery (CBDG-DR) through the Rhode Island Office of Housing and Community Development (OHCD) to complete replacement and floodproofing of further Misquamicut storm water drainage structures and piping along and within the vicinity of Atlantic Avenue. • In 2020, the Town resurfaced three sections of Atlantic Avenue (approximately 3,800 linear feet between the western property line of the Misquamicut State Beach property and the dead end west of Maplewood Avenue, approximately 540 linear feet between the residential properties of 408 and 432 Atlantic Avenue, and approximately 400 linear feet between the residential properties of 475 and 493 Atlantic Avenue). The section located between the State Beach and Maplewood Avenue was resurfaced by the asphalt reclamation process, during which the road was regraded to promote surface water runoff to flow towards the existing stormwater structures. Portions of the pre-existing asphalt road were narrowed, and the widened shoulders were resurfaced with gravel and/or sand to promote stormwater infiltration. The two smaller sections located between 408 and 493 Atlantic Avenue were resurfaced using the asphalt mill and overlay process. During resurfacing of these two sections, final road elevation grades were established to promote stormwater runoff to flow towards the northern side of the road where the shoulder contains pervious surfaces, which promotes infiltration. • In 2021, the Town resurfaced two abutting sections of Atlantic Avenue between the western property of the Misquamicut State Beach and the bridge at the Weekapaug Breachway, totaling approximately 12,425 linear feet. The road was resurfaced by a mill and asphalt overlay process, during which the road was superelevated to influence stormwater runoff to reach collection systems and infiltration areas much easier. Stone infiltration trenches and stone swales were installed along the north side of Atlantic Avenue at various locations between 162 Atlantic Ave and the Weekapaug Breachway (approx. 2.3 miles). • The Town installed a stone infiltration trench just outside of the Town's Atlantic Ave right-of-way on the property at 651 Atlantic Avenue, owned by the Seaside Beach Club, Inc. • Asphalt was removed and replaced with 3" stone at the Town's Misquamicut Stormwater Detention Basin located across from the State beach, encompassing an area of approximately 5,400 square feet). • Three (3) new pumps have been purchased for the Misquamicut Stormwater Pump Station, and the pump station has been equipped with new Variable Frequency Drives, wiring, and floats. • A large dredging project of the Winnapaug Pond was conducted in October 2021, removing between 60,000 and 90,000 cubic yards of accumulated silt material, as part of a sea grass restoration project. The dredged material was spread on the beaches between the Misquamicut State beach and the Town beaches. • In 2022 the Town resurfaced Benson Avenue, between Atlantic Avenue and First Street, following the watermain replacement project. Resurfacing of the road included correcting the pitch of the road to influence stormwater runoff to flow towards the catch basins that are connected to the Misquamicut Stormwater Pump Station.

2018 HMP Action Item	Status
	• In 2022 the Town started resurfacing of Fisherman's Avenue and Kimball Avenue, between Atlantic Avenue and First Street, using the full-depth reclamation method. The roads have been partially resurfaced to the base course of asphalt. In 2023, the Town intends to install additional piping to connect drainage structures into the Misquamicut Stormwater Pump Station and thereafter will complete resurfacing of the road with the final course of asphalt. • In 2023 the Town intends to resurface Montauk Avenue, between Atlantic Avenue and Rip Tide Drive, with drainage grade consideration. • Incorporation of an ISDS management policy and dune replacement activities have not been conducted.
5.5.3 Action #3: Improve Main Street Drainage Main Street from the Bridge restaurant to Beach Street is particularly susceptible to flooding caused by overflow from the Pawcatuck River. This action considers building a berm along the river with a pump system to pump stormwater over the berm into the river.	**Status: No Action** • Although no direct action has been taken on this item, it is among the alternatives being discussed in the context of the Downtown Stormwater Masterplan (refer to 5.5.9 Action #9).
5.5.4 Action #4: Improve Reliability of Water Distribution Infrastructure and Well Fields The purpose of this action is to upgrade aging waterlines to improve reliability and reduce the likelihood of service disruption or contamination from storm events. The action would also construct a berm to protect well fields White Rock #1 and #2 from flooding.	**Status: Ongoing** Water and sewer infrastructure improvements are assessed in conjunction with proposed paving projects. • Water Mains: ➢ In 2018, the Utilities Division replaced approximately 800 linear feet of existing 8-inch diameter ductile iron water main with 8-inch Schedule 80 polyvinyl chloride (PVC) pipe along Canyon Drive. ➢ In 2019-2020, the Utilities Division replaced approximately 1,200 linear feet of existing 8-inch diameter ductile iron water main with 8-inch Schedule 80 polyvinyl chloride (PVC) pipe along First Street and Millrose Avenue. ➢ Between 2019-2021, the Utilities Division replaced 3,500± LF of existing water main along Millrose Avenue, Breen Road, and Pasadena Avenue. ➢ In 2021-2022, the Utilities Division replaced (upgraded) water mains on 13 roads located throughout town, and the Town installed a new water main loop on Spray Rock Road for quality and flow redundancy. The watermain replacement project consisted of removing cast iron water mains and replacing them with new plastic (PVC) watermains. The roads and corresponding lengths of water main replacement are as follows: ➢ Benson Ave (Atlantic Ave to First Street): 660 LF ➢ Fisherman's Ave (Atlantic Ave to First Street): 730 LF ➢ Governor Ave (Cove Rd to Utter St): 490 LF ➢ Knowles Ave (Wawaloam Drive to Noyes Neck Rd): 2,100 LF ➢ Plateau Road (Urso Drive to Stuart St): 2,050 LF ➢ Babcock Rd (East Ave to Stone Hill Dr): 1,930 LF ➢ Azalea Dr (Daisy Ave to Hazel St): 975 LF ➢ North Joseph St (Canal St to cul-de-sac): 705 LF ➢ Joan Rd (N Joseph St to cul-de-sac): 475 LF ➢ May Dr (Joan Rd to Lorraine Rd): 480 LF ➢ Lorraine Rd (dead end to dead end): 865 LF ➢ Mountain Ave (High St to Hunter Terr): 990 LF ➢ Boombridge Rd (Springbrook Rd to Hardwood Ln): 1,625 LF

2018 HMP Action Item	Status
	• Wells: ➢ Well Rehabilitation at White Rock #1, White Rock #2, and Bradford well fields were conducted in 2019 and 2020 ➢ All public water well heads have berms, and the wells are all caged, capped and locked. ➢ The Utilities Division has been upgrading all of the Miox water treatment systems and have started a program to replace older well pumps. ➢ Station 1 Well D has been redeveloped and new pump was purchased. • Water Tanks: ➢ The Town has five potable water tanks (Bradford Tank, Hillview Tank, Hinkley Tank, Tower Street Tank, and Winnipeg Tank). In addition to regular maintenance performed on the water tanks/properties, all of the tanks are inspected on a 5-year basis. The tanks were last inspected in 2021, and are scheduled to be inspected in 2026.
5.5.5 Action #5: Evaluate Drainage Options for Pierce & Ann Streets The purpose of this action is to conduct an engineering study to map the existing drainage system supporting Pierce and Ann Street. Future actions will be to develop and implement actions to improve drainage infrastructure, inspect, clean, augment, and replace necessary components.	**Status: Ongoing** • The Town began GPS location of all drainage structures located throughout the Town of Westerly in late 2019 and continued in 2020. However, due to the COVID-19 pandemic, field activities were postponed in March 2020 and did not recontinue until October 2020. In 2021 the Engineering Department completed the Town-wide GPS location of stormwater structures for inclusion on the Town's GIS. The completed GPS location (mapping) phase included a visual inspection of all known and accessible structures. The Engineering Department continues the process of verifying pipe configurations that were uncertain during the visual, GPS-location project. This project will take time and funding since it requires a subcontractor with a capability to conduct CCTV inspections for verifying pipe conditions and connections between structures. • The Town conducted CCTV inspection of drainage on Pierce Street, and determined that there are sections of deteriorated pipe that require replacement. The drainage replacement will likely require removal and replacement of sections of sidewalk. This work has not yet been put out to public bid. • The North End, similar to other sections of Town, contain historical underground culverts that were rarely mapped, and have limited points of access at the surface. It is not possible to inspect these culverts with CCTV technology because of the uneven, earthen bottoms, and the uncertainty of structural stability. Many of the culverts throughout Town also intersect private properties. The Town may have to undergo a large-scale investigation using ground penetrating radar and other technologies in order to map the culverts and understand their construction, flow rates and capacities, and any connections that flow into such culverts.
5.5.6 Action #6: Reduce Residential Flooding of North End Neighborhood Promote flood resiliency through adaptive strategies by encouraging higher flood protection standards to reduce future losses. Develop and mail an informational flyer to North End residents. Include flood resistant building design ideas and low impact development suggestions.	**Status: Ongoing** • The Town continues to promote current State flood regulations in this area and throughout the town. However, no new higher flood protection standards have been developed or adopted. The Town engaged with property owners from the North End to discuss flooding and other concerns during a walking tour guided by the Executive Director of the Greater North End Community Development, Inc. Opportunities to reduce residential flooding of the North End neighborhood is intended to be addressed in a later phase of the Stormwater Masterplan for downtown Westerly along Main Street.

2018 HMP Action Item	Status
5.5.7 Action #7: Improve Drainage on Critical Roads Subject to Flooding This action will reduce flooding on critical transportation routes through and roadway elevation and improved drainage by enlarging culverts, providing open drainage swales, and increasing underground stormwater pipe storage. Aging waterlines will be replaced (see action #4) while exposed for roadway improvements. Wherever possible and prudent, overhead utility lines will be placed underground. A memorandum of agreement will be established RIDOT to address issues with state owned roads. **Critical roads subject to flooding**: Atlantic Ave. & adjacent roads*, Bridge Road, Route 91*, Airport Road, Sunset & Wauwinnet Avenues, Watch Hill Road*, Bay Street, Canal Street*, Dunn's Corners, Pound Roads, Perkins Avenue, Langworthy*, Bradford, Bowling Lane, Maplewood*, & Ranger Roads, Weekapaug Road*, Breach Drive, Spruce Street, Narragansett Avenue, Friendship Street, Pierce, Pond, Pleasant Streets, Cottage and Wall streets, Springbrook and White Rock Roads, Main Street at School and Cross Streets *Priority will be given to roads that are part of the evacuation route.	**Status: Ongoing** • The Town has not yet engaged the State of Rhode Island Department of Transportation to establish a *Memorandum of Agreement* that addresses flood mitigation along State-owned roads located within the Town of Westerly. • Pre-2018: Improvements to roadway drainage were previously conducted along a majority of White Rock Road in 2013 and 2014, consisting of drainage swale construction and drainage structure improvements. This work also included the construction of drainage swales along the eastern extent of Gingerella Sports Complex, adjacent to White Rock Road. Reconstruction of Cross Street in its entirety was completed in 2017, which encompassed drainage and water main reconstruction. • In 2018, improvements were made to the portion of Friendship Street located between West Street and Canal Street, consisting of drainage and pavement reconstruction. As discussed under **Action Item 2,** Atlantic Avenue was completely resurfaced with improved surficial grading to enhance roadway drainage conditions and stormwater infiltration. • In the spring of 2020, the water main on First Avenue, between Winnapaug Ave and Lawton Ave was replaced and the road was resurfaced. In 2020 the Department of Public Works also conducted vegetative clearing over several retention basins. • Between 2021 and 2022, School Street was completely reconstructed (complete extent from Main Street to Granite St/Route 1), including removal and replacement of the entire watermain, all stormwater structures and piping/culverts, curbing/sidewalks, and resurfacing of the road by full depth reclamation. • In 2022 the Engineering Department designed, contracted and oversaw the installation of a stormwater runoff drainage system at a localized low-lying point of Wauwinnet Ave, located between Noank Ave and Neowam Ave, that frequently flooded during precipitation events. The system consists of a drop inlet, manhole structure with a sump, a precast concrete drywell surrounded by 3-inch stone and filter fabric, and dual-wall HDPE pipe. • The Engineering Department has been in discussion with the Town of Stonington, CT about future maintenance activities on the bridge that spans the Pawcatuck River on Bridge Street. The maintenance activities were recommended by the RIDOT in Spring 2022. The Town of Stonington contracted with a Wengell, McDonnell & Costello (WMC) for an inspection of the bridge in November 2020, which found the bridge to be in good condition (overall rating 7 out of 10). WMC provided a cost estimate for design, construction, and inspection/oversight of the White Rock Bridge maintenance. The Stonington & Westerly Town Engineers have been communicating about potentially conducting this work in 2023. There is an existing MOU between the municipalities for 50/50 cost sharing of maintenance work. Stonington is currently requesting funding through their annual CIP, and Westerly is assessing the funding availability through existing road bonds and restricted accounts. • In 2022, the Town DPW conducted maintenance to the drainage system located on Weekapaug Road, and create a detention pond at the outfall of the road drainage system network on property owned by the Weekapaug Foundation for Conservation. • Currently, the Town is working with the Watch Hill Fire District to make improvements to an existing drainage system located on the property at 21 Bay Street. The drainage system accepts stormwater runoff from a closed-circuit drainage system located on portions of Bay Street, Sunset Ave, Wauwinnet Ave, and Plimpton Road. The drainage system was installed in 2012, and consists of corrugated metal piping with baffles, and two outfalls with one-way valves that collect, filter and discharge water into the Watch Hill harbor. Flooding occurs during precipitation events when the outfalls are submerged to the localized

2018 HMP Action Item	Status
	parking area where the underground collection system is located, and to the adjacent portion of Bay Street. The Town submitted a Preliminary Determination Letter to the Coastal Resources Management Council (CRMC) in November 2022 to make improvements to the existing system, consisting of installation of a pump station that pumps water out of the collection system once it reaches capacity. The Town intends to prepare a public bid document for a design-build project for construction in 2023. • In 2020, the Town intended to resurface the extent of Bowling Lane using full-depth reclamation; however, during the commencement of work it was discovered that a historical stormwater culvert is located under approximately two-thirds the length of the road. The culvert is constructed of granite stone walls and an earthen bottom. The Town did not continue resurfacing of this road due to the presence of the culvert and its potential structural instability. The Town worked with BETA Group, Inc. for preparation of a 30% design of road reconstruction, including removal of the culvert and replacement with traditional drainage structures and piping, replacement of the watermain, and reconstruction of sidewalks and the roadway. Cost estimates in early 2022 indicated the project would range from $2.5M to $3.0M. The Town is beginning discussion with Pare Corporation to continue preparation of engineering design and bid documents for the reconstruction project. The Town received a CDBG grant in 2022 for $500,000 toward replacement of the water line beneath the roadway as part of this project. • As discussed in **Action Item 5**, the Engineering Department completed GPS location of stormwater structures throughout the Town. In summer of 2022, the Town contracted with National Water Main Cleaning Company to CCTV inspect the drainage network along and connecting to Narragansett Ave. This work was completed in response to elevated detections of bacteria within stormwater runoff located just downgradient of Narragansett Avenue. From this work, the Engineering Department confirmed much of the drainage network configuration, but also discovered a number of unknown pipe connections that contribute to the drainage network on Narragansett Avenue. The Engineering Department is in the process of reviewing the reports from National Water Main Cleaning company. Review of the reports will help the Town understand future maintenance/reconstruction needs of the drainage network on Narragansett Ave. The Town also intends to investigate the unknown pipe connections for potential disconnection from the drainage network, which will help the drainage system work more efficiently. • Public Outreach & Education: The Town of Westerly provides education to residents on the danger of moving water and flooding via this Plan, FEMA publications available at the Westerly Library, the emergency evacuation route map, and the Flood Zone Management & Protection webpage on the official Town website. The Town also uses Code Red to alert and warn residents if evacuation or road closures are needed due to flooding. The Town provides maps on its website to show where road closures will be during a potential storm surge weather event. The Town also uses updates on its website and social media to educate and alert residents of moving water and flooding.
5.5.8 Action #8: Dam Management The purpose of this action is to continue to monitor dams in need of repair, reconstruction or removal. All of the dams in Westerly are classified as a low hazard (Woody Hill Reservoir, Olaf Farm Pond, Misquamicut Country	**Status: Ongoing** • While the responsibility to inspect and monitor dams remains the responsibility of RIDEM, the Town will continue to work with its partners to encourage repairs, reconstructions, and removals as advised by the National Park Service. • The Wood-Pawcatuck Watershed Association Study Committee, which works with the Town of Westerly and other local communities within the watershed, adopted the ***Wood-Pawcatuck Wild and Scenic Stewardship Plan*** in June 2018 which provided updated information regarding dams on the Pawcatuck River. The Town Council appointed 2 people to the Wood-Pawcatuck Wild and

2018 HMP Action Item	Status
Club Pond, Boiling Springs, and Stillmanville). Clarification of responsible parties is needed where there are jurisdictional boundaries. If dam conditions change, additional actions may be required.	Scenic Stewardship Council. There are currently three dams on the Pawcatuck River partly or wholly within the Town's municipal boundaries. ➢ The Bradford Dam was recently converted to a rock ramp fish passage structure and ownership of the structure was transferred to RIDEM. ➢ The Stillmanville Dam was removed decades ago and no longer impounds any water; however remnants of its foundation can still be found anchored in the riverbed. ➢ The Potter Hill Dam was acquired by the Town in 2022. In 2020, prior to acquisition, the Town successfully secured a grant from NOAA to investigate what alternatives would be feasible to improve fish passage at the dam and mitigate flooding associated with it. A Condition Assessment was prepared by Pare Corporation in 2022.
5.5.9 Action #9: Improve Downtown Areas Subject to Pawcatuck River Flooding The purpose of this action is to reduce vulnerability and improve resiliency by educating business owners about retrofitting buildings to mitigate flood water and debris damage. This action may be supplemented by improvements to the drainage systems in the future.	**Status: Ongoing** • The Department of Information Technology is working with the Department of Development Services and the Department of Public Works to provide a detailed, town-wide map of culverts and drainage. As discussed in **Action Item 5**, GPS location of all visual drainage structures began in late 2019 and was completed in 2021. These mapping efforts will help the Town prioritize future stormwater drainage and culvert projects • The Town of Westerly provides awareness of flood insurance through mailings and via the official government website. The official government website also includes links to the digital copies of flood-related FEMA publications; hard copies of these publications are available at the Westerly Library. • The Town is working with the Southern Rhode Island Conservation District (SRICD) and Fuss & O'Neil to design a conceptual **Stormwater Masterplan** for Downtown Westerly along Main Street. The Stormwater Masterplan will integrate a variety of green infrastructure features along the streets and on both Town and private properties that will reduce flooding, filter pollutants from stormwater, provide pollinator and bird habitat, improve air quality, reduce heat and wind effects (via tree planting), and add beauty and walkability to the economic center of Westerly. Numerous business owners along Main Street are partnering on this project, providing education to the public and improvements to resiliency and the drainage system.
5.5.10 Action #10: Reduce Contamination from Textile Mills, Dye Plants, and Hazardous Materials Handlers The purpose of this action is to reduce the potential for hazardous materials contamination resulting from textile mills, dye plants, and hazardous materials handlers located in flood zones through zoning restrictions, acquisition, relocating businesses, and retrofitting sites.	**Status: Ongoing** • The Town of Westerly is a vested party in the cleanup and development of a roughly 60-acre mill site, registered in the National Register of Historic Places. The site has been successfully cleared of all chemical storage barrels and asbestos. However, the wastewater lagoons are still in need of remediation. The Town continues to work with the new owner in developing a plan for the future use(s) of this property. Hazard mitigation, particularly addressing the property's susceptibility to flooding, is a high priority for the project as it develops. • The Town's three Significant Industrial Users (SIUs) in town permitted every 3 years for their discharge. Darlington Fabric and Griswold Textile Print are sampled on a semi-annual basis for most pollutants, and report semi-annually to ensure they are not exceeding the Daily Allowable Discharge Limits established for the Town of Westerly. Grey Sail Brewing Co. is sampled daily, 2x a month and 1x a month depending on the pollutant and 5/6 pollutants are reported on a monthly basis.

2018 HMP Action Item	Status
5.5.11 Action #11: Improve Drainage along Babcock Cove & Mastuxet Brook at Watch Hill Road The purpose of this action is to improve roadway drainage & elevate, cleanup TMDL's in Mastuxet Brook and Airport Road, and maintain wetlands for floodwater storage.	**Status: No Action** • The Town is aware that there are elevated bacteria levels in Mastuxet Brook, based on past reports, and conversations with RIDEM and Save the Bay. Some of the contamination may be related to waterfowl at the impoundment/pond.
5.5.12 Action #12: Construct Breachways/Seawalls/Jetties/Causeways in Avondale, River banks on Canal Street The purpose of these action is to protect the built environment, retail district, and improve submerged vegetative cover. Actions include: (A) Build seawalls on the Pawcatuck River to protect manufacturing district and low lying residential property. (B) Proposed work along Bay Street includes replacement of curbing, sidewalk, pavement, and lighting. Although the elevation will not drastically change, slight changes will allow stormwater to drain to catch basins. (C) Dredge Weekapaug Breachway to improve pond flushing.	**Status: Ongoing** • The Army Corps of Engineers (ACOE) in conjunction with the Rhode Island Coastal Resources Management Council (CRMC), removed approximately 90,000 cubic yards of sediment from Winnapaug Pond as part of an Eel Grass Restoration Project. The Town committed close to $1 million dollars in non-federal match for this project. • As discussed in **Action Item 7**, the Town is currently working with the Watch Hill Fire District to make improvements to the Bay Street drainage network.
5.5.13 Action #13: Reduce Contaminants from Private Septic Systems (OWTS Units) in Flood Prone Areas The purpose of this action is to reduce contamination emanating from private septic systems located with flood prone areas by encouraging owners to inspect, repair, pump out, upgrade, or replace systems. Included in a direct mailing would be information on the Community Septic System Loan Program (CSSLP) which provides low interest loans for septic repairs and replacements.	**Status: Ongoing** • The Westerly Community Septic System Loan Program is offered by Rhode Island Housing in partnership with the Rhode Island Infrastructure Bank (RIIB), the State Department of Environmental Management (RIDEM) and the Town of Westerly. The goal of the program is to safeguard public health, and protect and improve ground and surface water resources, by ensuring that all septic system in Westerly properly function. The program offers low interest rate loans to Westerly residents for the purpose of having their private septic system inspected, repaired, pumped out, upgraded, or replaced. Information and applications for the program are available on the Town's website. • The Town is currently looking into measures to improve the operational efficiency and reaction time of the Misquamicut Stormwater Pump Station. Most of the piping for the closed-circuit stormwater drainage network in Misquamicut is located below the groundwater table, and the piping is not watertight. ➢ Prior to the installation of the pump station, the drainage network formerly gravity drained to the Winnapaug Pond. Several pipes from the former drainage system remain connected to the pump station network. The drainage network piping is constantly submerged due to the high groundwater table. Groundwater in Misquamicut is impacted by leachate from existing and former septic systems and cesspools. ➢ Due to the shallow, tidally-influenced groundwater table, the pump station is activated more frequently than necessary, particularly during times

2018 HMP Action Item	Status
	➢ without any precipitation. The Town intends to conduct an assessment of the elevation at which the pump station activates, in order to reduce the amount of time that the pumps function, increasing the lifespan of the pumps. Furthermore, during precipitation events the pump station takes longer to address flooding conditions since groundwater needs to be evacuated from the system as well. This groundwater is impacted by septic leachate, which is then pumped to the Town's detention basin located across from Misquamicut State Beach, prior to it flowing into Winnapaug Pond. ➢ Removal and/or abandonment of piping associated with the former drainage network will reduce the volume of impacted groundwater within the pump station's drainage network, and improve the reaction time for reduction of flood levels.
5.5.14 Action #14: Expand Stormwater Retention & Detention Ponds The purpose of this action is to improve stormwater retention capacity in developments by incorporating into subdivision design & development plan applications review maintenance schedules during application process, improve design standards for landscaping, and incorporate into zoning & land development regulations. This action also calls for the increasing the detention capacity at Argyle Drive, Westerly Middle School, Springbrook School, Linnate, Davenport, Walton Streets & Yankee Drive Trolley Lane, and Brandywine.	**Status: Ongoing** • Where required by the State and Town, storm water regulations are followed and implemented. During 2020, the Town adopted a new *Development Plan Review Ordinance* and also revised *Chapter 260 Zoning Regulations* to address improvements for stormwater drainage and soil erosion and sediment control measures. Specifically, Section §260-20 Building Height definition was changed to improve adherence to stormwater (FEMA floodplain) and erosion control requirements (existing grade calculation) and provide increased scrutiny by Zoning, Planning, and the Engineering Offices by expanding requirements for a land disturbance permit necessary for land disturbance activity. • The Department of Public Works conducted vegetative overgrowth clearing at several stormwater retention basins, including those located adjacent to Quannacut Road, Blue Sky Drive, Grenolds Way, Holly Drive Extension, and Gallop Street. • Stormwater retention/detention ponds that contain native plantings have been incorporated within several private residential and/or commercial developments. • Public Outreach & Education: educating homeowners on the benefit of establishing residential retention ponds and trench drains in steep driveways to capture runoff is an ongoing goal, typically dealt with on individual project applications. • In 2021 and 2022 the Westerly DPW conducted extensive maintenance and/or expansion of stormwater retention and detention ponds. These include basins located along the following roads: Atlantic Avenue, Weekapaug Road, Quannacut Road, Turtleback Road, Oenoke Lane, Cove Road, Nob Court, Reed Drive, and Yankee Drive.
5.5.15 Action #15: Raise Boombridge Road Bridge Boombridge Road Bridge (Pawcatuck River) has been closed for nearly 10 years due to safety concerns. If the bridge were to be repaired/rebuilt, it should also be elevated. Increasing the clearance beneath bridge will improve flood passage.	**Status: Completed** • The Connecticut Department of Transportation (CT DOT) Final Design Review drawings for the Replacement of Bridge No. 04744 (Boombridge Road over Pawcatuck River) was provided to the Town of Westerly in 2018. The plans indicated that the minimum low chord elevation of the proposed bridge replacement will be set at an elevation above the 100-year flood elevation. Construction of the new bridge was completed in December 2020.
5.5.16 Action #16: Protect Pumping Stations and WWTF from flooding Protect auxiliary power, generators, and other equipment	**Status: Ongoing** • In 2020 and 2021, the Town assessed potential flood mitigation measures for the WWTF and associated pump stations. The Town's WWTF is managed and operated by Jacobs (formerly d/b/a CH2M). Jacobs put together a facility plan that includes flood mitigation measures.

2018 HMP Action Item	Status
from flooding. Specific actions as per the RIDEM study on Implications of Climate Change on Rhode Island Wastewater Treatment Facilities (2016). **Action 16a Protect Secondary Clarifiers at WWTF from Flooding** Protect facility entrances with flood barriers. Replace sludge pumps with submersibles. Store replacement drive components on site. Pumps may be temporarily augmented. **Action 16b Protect Disinfection Components at WWTF from Flooding** Elevate or relocate disinfection system components. **Action 16a Protect New Canal Pump Station from Flooding** Protect facility entrances with flood barriers and relocate building penetrations for louvers. Elevate back-up generator system. **Action 16b Protect Old Canal Pump Station from Flooding** Protect facility entrances with flood barriers. Elevate back-up generator systems. **Action 16c Protect Old Canal Pump Station from Flooding** Protect facility entrances with flood barriers.	• All staff that work at and operate the Town of Westerly WWTF are aware of the Emergency Operations Plan (EOP). A copy of the EOP is maintained at the WWTF. • In 2022 the Westerly Utilities Division completed floodproofing project of the New Canal Pump Station and Old Canal Pump Station. A concrete retaining wall equipped with a floodproof gate was constructed at New Canal Pump Station. Modular, removable floodproof walls were constructed around the generator, building entrances, and wet well hatch at the Old Canal Pump Station. The walls at both locations extend above the 100-year FEMA flood elevation. • For redundancy, all wastewater pumping stations are equipped with a backup generator. • The Town has received significant grant funding to build barrier retaining walls along both the New Canal Street Pumping Station and Old Canal Street Pumping Station in an effort to mitigate future flooding and ensure continued sewer service to Westerly.
5.5.17 Action #17: Protect Homes and Buildings Subject to Wildfire The purpose of this action is to reduce the vulnerability of homes and buildings to wildfire by removing damaged trees, clearing underbrush, and conducting controlled burns. The action also calls for a fire safety program to inform homeowners.	**Status: Ongoing** • The Town of Westerly continues to work with the Westerly Municipal Land Trust and local fire departments as needed to remove hazardous vegetation from public rights-of-way and properties. • Local fire departments continue to provide fire safety information to property owners and residents as part of their general scopes of work.

SECTION 6

Mitigation Strategy

Subsections

KMJ – CE/RP

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6 Mitigation Strategy

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirement ➔
44 CFR Subsection D §201.6(c)(3): [The plan shall include] a mitigation strategy that provides the jurisdiction's blueprint for reducing the potential losses identified in the risk assessment, based on existing authorities, policies, programs and resources, and its ability to expand on and improve these existing tools.

CRS - Flood Management Plan: The Town of Westerly has successfully met the following Mitigation Strategy requirements based on the 10-step planning process for CRS Activity 510 ➔
Set Goals (Step 6); Review Possible Activities (Step 7); and Draft an Action Plan (Step 8)

The *Mitigation Strategy* is the culmination of the mitigation planning process. It provides the Town with the basis for action to reduce the risk to people and property from hazards and assists the Town in achieving compatible economic, environmental, and social objectives. The *Mitigation Strategy* stems from the comprehensive *Planning Process* used in creating this document, and the findings of the *Risk Assessment, Vulnerability Analysis, and Capability Assessment*.

The *Hazard Mitigation & Flood Management Plan (HM&FMP)* Advisory Committee used the information outlined in the previous Sections to update and create a broad-based mission statement, goals, and actions which are intended to guide the Town's day-to-day operations and long-term approach to reduce the impacts of hazards and improve flood management. This updated strategy builds upon the extensive mitigation, climate adaptation, and flood management work the Town of Westerly has previously implemented and will serve as a roadmap for the next 5 years.

FEMA's Mitigation Strategy is comprised of the three main components represented in **Figure 6-1** and described below:

- ***Goals*** – General guidelines explaining what the plan proposes to achieve. These are usually broad statements with long-term applicability that provide the framework for achieving the intent of the mission statement.
- ***Actions*** – Specific projects for achieving the goals.
- ***Action Plan*** – A plan for implementing the actions. The Action Plan establishes priorities, assigns responsible parties, defines the type of action, and provides a magnitude of cost, potential funding sources, and an estimated timeframe for completion.

Figure 6-1 Mitigation Strategy Components

FEMA Local Hazard Mitigation Planning Handbook, Page 6-1

It was important to the Town of Westerly to develop a comprehensive and aggressive *Mitigation Strategy* that will lead to a safer and more sustainable community. The Town has and will continue to implement and institutionalize hazard mitigation and flood management through its human, legal, and fiscal resources; effective coordination and communication with the state, neighboring jurisdictions, stakeholders, community members, and across Town departments; and use of knowledge and tools to analyze and cope with hazard risks.

As the Town has undertaken to develop a combined hazard mitigation and flood management plan, the *Mitigation Strategy* includes a mix of mitigation and non-mitigation actions. Non-mitigation actions include measures that are emergency response or operational preparedness in nature.

6.1 MISSION STATEMENT

The Town of Westerly is striving to become a disaster resilient community and achieve sustainable development by mitigating hazard impacts before disaster strikes and by restricting infringement on sensitive lands. The following *Mission Statement* forms the foundation upon which the *Mitigation Strategy* is built.

Mission Statement

The purpose of the *Town of Westerly Hazard Mitigation & Flood Management Plan (HM&FMP)* is to reduce Westerly's vulnerability to impacts of natural hazards, including safeguarding against the threat multipliers of sea level rise and other deleterious climate change impacts, thereby fostering a safe, resilient community that preserves and enhances quality of life for all generations. The Town of Westerly, through the *HM&FMP*, by identifying areas and resources at risk to natural hazards and planning for feasible, sustainable mitigation measures, intends to reduce the adverse impacts of natural hazards on Westerly's people, critical facilities and services, infrastructure, natural and built environment, historic and cultural resources, and economic vitality.

6.2 GOALS

DMA Requirement §201.6(c)(3)(i):
The hazard mitigation strategy shall include a description of mitigation goals to reduce or avoid long-term vulnerabilities to the identified hazards.

CRS CREDIT:

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase III –Mitigation Strategy	6. Set Goals	2

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

The *Mitigation Strategy* consists of a coordinated set of goals for reducing or minimizing human and property loss, major economic disruption, and the degradation of ecosystems and environmentally critical habitats from natural disasters by integrating policy and action across functional areas and working with the citizenry to maintain the delicate balance with nature.

As discussed in **Section 2.3**, the Town of Westerly recognizes the benefit of plan integration. The Advisory Committee was therefore cognizant that the *HM&FMP* goals be consistent with and complement the goals and objectives of the Town's 2020 Comprehensive Community Plan and other planning efforts (**Appendix 5-1** has a list of local planning documents reviewed as part of the *HM&FMP* planning process).

In an effort to effectively review the 2018 HMP goals for relevancy, and, as appropriate, modify or add new goals, the Advisory Committee envisioned what they would want the community to look like in the future in terms of resilience to flooding and other hazards. The Committee recognizes the Town's commitment to becoming a safer, more resilient community, through the implementation of mitigation programs and policies, and to achieving sustainable development by striving to mitigate hazard impacts before disasters strike. To support future hazard mitigation and flood management efforts in the Town of Westerly, the following goals were developed.

2023 HM&FMP Goals

Goal 1: Protect public health and safety against impacts of natural hazards.

Goal 2: Sustain a local economy that is resilient to natural and human-caused disasters.

Goal 3: Ensure sustainable infrastructure is in place to safeguard water quality, efficient wastewater treatment, effective stormwater management, and efficient transportation and transmission of essential utilities in the face of natural hazards and climate change impacts.

Goal 4: Enhance the capability of the natural environment to protect Westerly from flooding, storm surge and sea level rise.

6.3 DEVELOPMENT OF ACTION PLAN

The Advisory Committee considered a wide-range of mitigation and non-mitigation actions to incorporate into the *2023 Action Plan*.

DMA Requirement §201.6(c)(3)(ii):
The mitigation strategy shall include a section that identifies and analyzes a comprehensive range of specific mitigation actions and projects being considered to reduce the effects of each hazard, with particular emphasis on new and existing buildings and infrastructure. All plans approved by FEMA after October 1, 2008, must also address the jurisdiction's participation in the NFIP, and continued compliance with NFIP requirements, as appropriate.

CRS CREDIT:

Mitigation Planning Element	CRS Planning Step	Max Pts
Phase III –Mitigation Strategy	7. Review Possible Activities (c-g)	25

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

6.3.1 Review Possible Activities

As discussed in **Section 5**, the Town reviewed possible preventive activities, such as zoning, building codes, and subdivision ordinances, as well as the status of the actions included in the Town's 2018 HMP for potential inclusion in the updated *Action Plan*. To further support CRS Activity 510 Planning Process - Step 7, an array of additional possible activities was also reviewed.

The broad-based list of possible activities was generated from Advisory Committee input, public engagement via the Public Opinion Survey, and through key planning documents. The list of possible mitigation and non-mitigation activities compiled from the documents and Public Opinion Survey is included in **Appendix 6-1**. The possible activities were reviewed based on the following criteria:

- supports the 2023 *HM&FMP* Goals
- supports the 2020 Comprehensive Community Plan objectives
- supports CRS program
- mitigation category
- potential funding capability
- staff and implementation capability
- activity previously completed or no longer a priority

The HM&FMP Advisory Committee's *Risk Assessment* (**Section 4.2.2**) identified the following natural hazards as the most prevalent threats to the Town of Westerly: Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses; Heavy Snow & Ice; Coastal Flooding including Storm Surge; Inland Flooding; Tropical Cyclone (Tropical Depression, Tropical Storm & Hurricane); Coastal Erosion; Extreme Heat; and Vector-borne Diseases Transmitted by Ticks or Mosquitoes. Additionally, in the Public Opinion Survey (**Appendix 2-2**), when asked to rank how concerned you are about the list of identified natural hazards, most people were extremely concerned about ***Coastal Flooding & Coastal Erosion*** *(51%) and then* ***Wind-Related Hazards*** *(40%), which includes tropical cyclones*. With respect to the weighted score, the top five hazards of concern were: Coastal Flooding/Erosion; Wind-Related; Vector-Borne (Ticks/Mosquitoes); Winter-Related; and Inland Flooding. There was significant overlapping between the Advisory Committee's ranking and that from the Public Opinion Survey. The key exceptions were that the Survey results did not rank Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses or Extreme Heat as high as the Committee.

To mitigate the potential impacts from natural hazards, particularly those identified as a greater risk to Westerly or the region, the Advisory Committee performed a systematic review of a broad spectrum of possible activities, including actions from all six of the categories below. As documented **in Appendix 6-1**, under consideration were measures that would reduce flood and other natural hazard damage to buildings and infrastructure through preservation of open space, revisions to zoning and subdivision ordinances, and implementation of green infrastructure and structural projects. Outreach actions to promote awareness and encourage property owners and the private sector to take preventative action to mitigate risks associated with flooding and other hazards was also reviewed, as were actions associated with emergency services and capacity building within the municipal government.

Action Categories:

- **Prevention:** Government administrative or regulatory actions or processes that influence the way land and buildings are developed and built, or otherwise assist in reducing the impacts of a natural hazard. These actions include public activities to reduce hazard losses such as planning and zoning, building codes, capital improvement programs, open space preservation, and stormwater management regulations.

- **Property Protection:** Actions that involve the modification of existing buildings or infrastructure to protect them from a hazard or removal from the hazard area. Examples include acquisition, elevation, relocation, structural retrofits, flood proofing, storm shutters, and shatter resistant glass.

- **Public Education & Awareness:** Actions to inform and educate citizens, elected officials, and property owners about the potential risks from hazards and potential ways to mitigate them. Such actions include outreach projects, real estate disclosure, hazard information centers, and school-age and adult education programs.

- **Natural Resource Protection:** Actions that, in addition to minimizing hazard losses, also preserve or restore the functions of natural systems. These actions include sediment and erosion control, stream corridor restoration, watershed management, forest and vegetation management, tree planting and maintenance, and wetland restoration and preservation.

- **Structural Projects:** Actions that involve the construction of structures to reduce the impact of a hazard. Such structures include storm water controls (e.g., culverts), floodwalls, seawalls, retaining walls, and safe rooms.

- **Emergency Services:** Actions that will protect or enhance emergency services before, during, and immediately after an occurrence. Examples of these actions include protection of critical facilities, and emergency response infrastructure, and protection of or improvements to warning system capability.

6.3.2 Choose Possible Actions

Due to budgetary and other constraints it would be impossible over the ensuing 5-year period to implement all of the possible actions the Committee reviewed. As such, it was necessary to scale back the possible actions based on a number of parameters including: if the action would reduce the impact of one or more of the hazards identified in the risk assessment; compatibility in terms of the Town's vulnerabilities and capabilities; compatibility with other community programs and objectives; if the action supported one or more of the *Mitigation Goals;* continued compliance with the NFIP; possible crossover CRS activity; if the action could realistically be implemented based on staff time; and potential funded sources.

The possible actions which originated from other Town planning documents (refer to the list below) or from the 2022 Public Opinion Survey, have been included in **Appendix 6-1,** and for cross-referencing have been identified as either being included or not in the *2023 Action Plan.* **It should be noted that the specification "included" refers to the general intent of the reviewed action (i.e. the wording may vary or some particular aspects may not be included – however, the action in some form is essentially represented)**. Similar actions from various sources were combined and rewritten for inclusion in the *2023 Action Plan*.

Key Planning Documents:

- Town of Westerly - Hazard Mitigation Plan (2018)
- Town of Westerly - Comprehensive Community Plan (2020)
- Rhode Island State Hazard Mitigation Plan (2019)
- Westerly MRP Community Resilience Building (CRB) Workshop Summary of Findings (2019)
- Westerly Route 1 Corridor Report (2022)
- Harbor Management Plan (2016-Revised 10/28/2019)
- Wood-Pawtucket Watershed Flood Resiliency Management Plan (2017)
- Wood-Pawcatuck Wild & Scenic Stewardship Plan (2018)
- Energy Management Plan (2016)

A total of 33 actions were developed and underwent the STAPLEE analysis by the Advisory Committee as a prioritization mechanism for ranking and inclusion in the *2023-2028 Action Plan.*

6.3.3 Prioritize Actions - STAPLEE Analysis

In accordance with the *Disaster Mitigation Act 2000 (DMA)*, the Advisory Committee undertook a process to prioritize actions in order to develop an implementation guideline toward mitigating risks. Each of the actions reviewed received a priority score based upon a general set of criteria common to public administration officials and planners, known as STAPLEE. The acronym stands for Social, Technical, Administrative, Political, Legal, Economic, and Environmental.

The STAPLEE method includes a general benefit-cost review as part of prioritizing actions. The Committee considered the probable benefits that would result from an action versus a general magnitude of cost. This review was done based on experience and judgment but is not considered a full benefit-cost analysis. When seeking funding assistance or inclusion in the capital improvement program (CIP), a more detailed analysis may need to be conducted. A description of the **criterion and the full STAPLEE evaluation** can be found in **Appendix 6-2**.

All 33 actions, even those with lower STAPLEE rankings, have been included in the *Action Plan*. It was determined that actions receiving lower rankings should be included as they are still relevant to achieving the overall goals of the HM&FMP and circumstances may change to improve their ranking (e.g., political/social support is bolstered, grant funding opportunities arise, etc.). In the *Action Plan*, to recognize the higher prioritized actions, the numeric listing under each policy is from highest to lowest STAPLEE ranking.

6.3.4 Actions Supporting Community Rating System Program

The most common and the most destructive natural disaster in the United States is floods, the damage from which is not covered under a standard homeowner's policy. To protect lives and property and to reduce the financial burden of providing disaster assistance, in 1968, Congress created the National Flood Insurance Program (NFIP) which is administered by the Federal Emergency Management Agency (FEMA). The NFIP offers flood insurance to communities that comply with minimum standards for floodplain management. All Rhode Island municipalities, including the Town of Westerly, currently comply with the minimum standards, allowing residents to purchase federal flood insurance through the NFIP.

As discussed in **Section 2.3**, beyond the minimum NFIP requirements, communities can choose to participate in a voluntary incentive program known as the Community Rating System (CRS), to further improve flood mitigation and achieve discounts on flood insurance premiums for property owners. A community's CRS classification is based on credit points earned for its activities. Any combination of activities that reduce flood losses through better mapping, regulations, public information, flood damage reduction, and flood warning and preparedness programs can be implemented. The discounts on flood insurance premiums range from 5% (rate class 9) up to 45% (rate class 1). It has been shown that CRS incentives have encouraged communities to broaden mitigation programs and keep them going even during periods of budgetary challenges (FEMA. *National Flood*).

NATIONAL FLOOD INSURANCE PROGRAM
Community Rating System

As previously indicated, the Town of Westerly is not only committed to continued compliance with the NFIP, but also participates in the CRS program.

To strengthen the Town's CRS standing, Westerly chose to integrate CRS Activity 510 (Floodplain Management Planning) into their Hazard Mitigation planning process therein creating a *Hazard Mitigation & Flood Management Plan*. Throughout this document both HMP and CRS requirements have been noted.

In the *Action Plan*, cross-over actions that could potentially garner CRS credit, depending on how they are implemented and documented, have been identified.

Participation in the National Flood Insurance Program (NFIP) is voluntary and is based on a community's agreement to adopt and enforce, at a minimum, the Federal standards for building within a Special Flood Hazard Area (SFHA). In exchange, the Federal Government makes flood insurance available as a financial protection against flood losses.

The Town of Westerly participates in the NFIP and oversees the following:

- Issuing or denying floodplain development/building permits
- Inspecting all development to assure compliance with the local ordinance
- Maintaining records of floodplain development
- Assisting in the preparation and revision of floodplain maps
- Helping residents obtain information on flood hazards, floodplain map data, flood insurance, and proper construction measures

6.3.5 Action Descriptors

The *Action Plan* includes the following descriptors:

- **Action Number and Description**. The description is a brief overview of the action. The Action Number has been assigned based on the STAPLEE priority ranking (from highest to lowest) under each Policy.

  For example:

  2023 Action 1.1-A represents the highest prioritized action associated with Policy 1.1

  2023 Action 2.2-B represents the second highest prioritized action associated with Policy 2.2

  If two or more actions received the same priority score, they have been arbitrarily listed one after the other.

- **Lead & Support.** The lead identified is the proposed authority responsible for overseeing implementation of an action. It is likely that most actions will require interdepartmental and stakeholder support. In **Table 6-1**, the anticipated lead has been listed first with some potential supporting partners listed in parentheses.

Acronyms describing leads and supporting partners.

- ◊ BD: Building Department
- ◊ CC: Conservation Commission
- ◊ EDC: Economic Development Commission
- ◊ EM: Emergency Management
- ◊ EN: Engineering Department
- ◊ FC: DPW- Facilities Department
- ◊ FN: Finance Department
- ◊ GA: Grant Administration
- ◊ HOSP: Westerly Hospital
- ◊ HW: DPW-Highway Department
- ◊ IT: Information Technology
- ◊ PD: Planning Department
- ◊ PSIC: Providence Stormwater Innovation Center
- ◊ REC: Recreation Department
- ◊ SRICD: Southern Rhode Island Conservation District
- ◊ STB: Save The Bay
- ◊ TC: Town Council
- ◊ TM: Town Manager
- ◊ UT: DPW- Utilities Department
- ◊ WLT: Westerly Land Trust

- **Cost & Funding Source**. The magnitude of cost was estimated based on analysis of similar initiatives completed in Town and elsewhere. It is recognized that some degree of municipal staff time will be necessary for the successful implementation of all actions. Hence, staff time is represented within each category. As funding is often an obstacle to implementing mitigation actions, preliminary funding sources have been identified in **Table 6-1.**

  Costs are categorized as follows:

  - ◊ Minimal ($): less than $100,000
  - ◊ Moderate ($$): between $100,000 and $250,000
  - ◊ Significant ($$$): over $250,000

- **Timeframe & Kickoff.** The timeframe was based on a combination of factors including STAPLEE priority, complexity of the action, and the current phase of the action (e.g., conceptual, preliminary design, final design). The kickoff indicates in which year of this five-year *Plan* the action is proposed to commence.

- ◊ ST: Short-term - less than 2-years
- ◊ MT: Medium-term - between 2 and 4-years
- ◊ LT: Long-term - over 4-years
- ◊ KO: Kick-off
- ◊ CNT: Continued
- ◊ ON: Ongoing

- **Priority Ranking & CRS Activity.** The priority ranking was determined by the Advisory Committee through the STAPLEE analysis (**Appendix 6-2**). The STAPLEE numeric ranking is provided for each action and the actions have been listed in order of ranking under each Policy. As the Town participates in the CRS program, cross-over actions that could potentially garner CRS credit, depending on how they are implemented and documented, have been identified.

- **Action Category.** In developing the *Action Plan*, the Advisory Committee sought to include a wide-range of actions to comprehensively address the established hazard mitigation *Goals*. The following categories, described in **Section 6.3.1**, were used:

  - ◊ Prevention
  - ◊ Property Protection
  - ◊ Public Education & Awareness
  - ◊ Natural Resource Protection
  - ◊ Structural Projects
  - ◊ Emergency Services

- **Hazard Addressed.** Which hazard(s) a particular action addresses has been recorded in **Table 6-1**. The *Action Plan* has at least one action for each of the hazard categories identified in **Section 4.2** and listed below:

  - ◊ Flood-Related
  - ◊ Wind-Related
  - ◊ Winter-Related
  - ◊ Infectious Disease-Related:
    - ♦ Contagious Respiratory Illness Caused by Influenza Viruses or Coronaviruses
    - ♦ Vector-borne Diseases Transmitted by Ticks or Mosquitoes
  - ◊ Other:
    - ♦ Earthquake
    - ♦ Drought
    - ♦ Brush Fire
    - ♦ Extreme Heat

- **Reference.** Actions from the following planning documents were considered for inclusion in the *2023-2028 Action Plan*. The *Action Plan* identifies which of the following sources reference the measure. Often more than once source is referenced because similar actions in various documents were grouped together and rewritten as individual actions in the *2023 Action Plan*. A more detailed crossover assessment has been included in **Appendix 6.1**.

  - ◊ 2018 HMP: Town of Westerly Hazard Mitigation Plan (2018)
  - ◊ 2020 CCP: Town of Westerly Comprehensive Community Plan (2020)
  - ◊ 2019 RI-SHMP: Rhode Island State Hazard Mitigation Plan (2019)
  - ◊ 2019 SOF: Westerly MRP Community Resilience Building (CRB) Workshop Summary of Findings (2019)
  - ◊ 2022 RTE1: Westerly Route 1 Corridor Report (2022)
  - ◊ 2019 Harbor: Harbor Management Plan (2016-Revised 10/28/2019)
  - ◊ 2017 WPWMP: Wood-Pawtucket Watershed Flood Resiliency Management Plan (2017)
  - ◊ 2018 WPSP: Wood-Pawcatuck Wild & Scenic Stewardship Plan (2018)
  - ◊ 2016 EMP: Energy Management Plan (2016)
  - ◊ 2022 POS: Public Opinion Survey (*HM&FMP Outreach Activity #6*)

6.4 ACTION PLAN (2023-2028)

All of the elected *Actions* support the *Mission Statement* and *Goals*. They reflect updated priorities, including response to climate change and accelerated sea level rise, and address the Town's current and projected future needs. The *Action Plan* is organized by *Goal* and includes a description of the action, along with other descriptors including the STAPLEE priority ranking, which may assist the Town as a guideline for implementation.

The priority ranking, timeframe, and kickoff for each action is provided as a guide and recognized as flexible due to staff and funding availability. It is also recognized that the identified lead for an action may shift from one party to another, or become a shared responsibility. To augment local funding, the Town should aggressively pursue grants to support these actions.

DMA Requirement §201.6(c)(3)(iii):
The mitigation strategy section shall include an action plan describing how the actions identified in section (c)(3)(ii) will be prioritized, implemented, and administered by the local jurisdiction. Prioritization shall include a special emphasis on the extent to which benefits are maximized according to a cost benefit review of the proposed projects and their associated costs.

CRS CREDIT:

Mitigation Planning Elements	CRS Planning Steps	Max Pts
Phase III –Mitigation Strategy	8. Draft an Action Plan	60

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

In addition to the acronyms identified in Section 6.3.5, the following acronyms are provided as reference for the *Action Plan*:

CBRS: Coastal Barrier Resource System

CERT: Citizens Emergency Response Team

CIP: Capital Improvement Program

CRMC: Coastal Resources Management Center

CRS: Community Rating System

CSSLP: Community Septic System Loan Program

FEMA: Federal Emergency Management Agency

GIS: Geographic Information System

LID: Low-Impact Development

NFIP: National Flood Insurance Program

RIDEM: Rhode Island Department of Environmental Management

RIDOT: Rhode Island Department of Transportation

ROW: Right-of-Way

SAMP: Special Area Management Plan

SFHA: Special Flood Hazard Area

SLR: Sea Level Rise

WWTF: Wastewater Treatment Facility

Table 6-1 Town of Westerly 2023-2028 Action Plan

Goal 1: Protect public health and safety against impacts of natural hazards.

Policy 1.1: Improve the community's awareness and capacity to reduce or adapt to impacts from natural hazards.

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-1.1-A **Educate the public (including the business community and students) regarding steps they can take to reduce the impact of all profiled hazards, and regarding hazard response resources.** This action includes education around stormwater management, pollution prevention/water quality, water conservation/drought management, earthquakes, extreme heat, wildfire/brush fire prevention, hurricane and nor'easter awareness (flooding, high-winds, and snow events), and infectious diseases (tick- or mosquito-borne; and influenza or coronavirus). **Potential Outreach & Education Programs include:** • Implement green infrastructure demonstration projects (such as rain gardens, tree selection & planting) at public locations, such as the Main Street and Downtown commercial corridor, and public schools, to increase awareness of its benefits. • Conduct community outreach through the Town's website, GIS web based mapping & data, social media, mailings, and publications to increase awareness and improve preparedness for impacts of natural hazards. • Collaborate with neighborhood groups and business organizations on adaptive strategies for areas prone to flood-related and wind-related hazards. • Conduct outreach regarding public health risks associated with extreme heat, drought, brush fires, earthquakes, and vector-borne diseases transmitted by ticks & mosquitoes; highlight connections between these hazards and address health and safety issues. • Conduct workshop to promote the benefit of shade structures on public property to protect from extreme heat and to	PD (SRICD, PSIC, WLT) EM PD (EDC) EM (HOSP) PD (REC)	$ General Fund	KO-ST (CNT-MT) KO-ST (CNT-LT) LT LT LT	Ranking Score 15 CRS Activity 330, 350, 370, 440	Prevention, Public Education & Awareness	All Hazards	2018 HMP (#6, #9, #13, #17); 2020 CCP (INF-1.1.I); 2019 SOF; 2022 RTE1; 2019 Harbor; 2018 WPSP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
determine potential location, types, and configuration of shade structures to be installed. • Host public forums (possibly at Planning Board or Town Council meetings) to increase awareness about the benefits of wetlands, impacts of climate change and sea level rise, and threats of natural hazards, and facilitate discussion amongst different sectors of the community. • Install no littering signage in strategic locations with information on how littering impacts stormwater system. • Inform homeowners and businesses about actions to decrease the vulnerability of their property to various natural hazards, including brush fires; heat; high winds; flooding; and power loss.	PD (SRICD, STB) HW EM (BD, SRICD)		KO-ST ST KO-ST (CNT-LT)				
Action 2023-1.1-B **Improve the Town's capacity to strategically plan for and operationalize more economic, social, ecological, and infrastructure resilience across the municipality.** This action includes educating decision makers, proactive policy making, cost/benefit discussions, fiscal analysis, assessing staff resources, and organized collaborative responses. **Potential Capacity Building Actions include:** • Establish a Resilience & Energy Committee to coordinate and maintain the Town's resiliency protections. • Maintain and publicize Town resources such as the Notify Me tool, CodeRED notification system, evacuation route maps, the availability and location of emergency shelters and cooling/warming centers, and volunteer opportunities including the citizens emergency response team (CERT). • Stay appraised of, protect, and update early warning systems, emergency protocols, and management of evacuation warnings. • Maintain the website/social media/etc. about impacts from impending/ occurring hazards, including associated risks. • Maintain an inventory of spaces, such as shelters and warming centers, available to the public in times of power outages, loss of heat, and other secondary impacts resulting from natural hazards.	EM EM EM EM EM	$ General Fund	ST KO-ST (CNT-LT) ON ON KO-ST (CNT-LT)	Ranking Score 15 CRS Activity 440	Public Education & Awareness; Emergency Services	All Hazards	2018 HMP (#13); 2020 CCP (RES-1.3.E, NAT-1.1.B, INF-2.1.G, SF-1.2.L, SF-1.2.O, ECON-3.3.B, NRG-2.2.A); 2019 SOF; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
• Explore a Shore Management Division that incorporates harbor and marine management with coastal and riverine operations and maintenance, to effectively prepare for emergency events (removing moored/docked boats, status of hazardous materials, etc.).	TM (TC)		KO-MT (CNT-LT)				
• Publicize State-level and non-profit programs which assist qualifying applicants in home weatherization activities to improve energy efficiency, and other voluntary conservation programs (e.g., the Community Septic System Loan Program [CSSLP]).	UT		ST				
• Enhance Geographic Information Systems (GIS) capabilities including finalizing stormwater conveyance system mapping (including attribute data), mapping wastewater system (including attribute data), mapping drinking water system (including attribute data), mapping shoreline access points, mapping public trees along road ROWs, and identifying major flood events to locate patterns of flooding for future mitigation activities.	IT (EN/UT)		MT (ON)				
• Hold regular drills/practice plans involving government, EMS, fire, police, and hospital to improve emergency response.	EM (TM)		MT				
• Establish a protocol to pre-position public works forces and/or equipment prior to anticipated hazard events to restore services more quickly (e.g., remove flood debris from drainage structures and roadways as it is accumulating, remove snow and ice from roads and sidewalks more effectively).	HW (TM)		MT				
• Provide training opportunities to land-use decision-makers on natural resource protection and management, climate change, and natural hazards mitigation.	PD (SRICD)		KO-ST (CNT-LT)				
Policy 1.2: Provide services critical to the community's continued health, safety, and well-being, especially during hazard events and to vulnerable populations.							
Action 2023-1.2-A **Increase emergency response and recovery coordination amongst community facilities and services, and members of the public, through an emergency services network, CERT program, and local neighbor-helping-neighbor program.** Creating direct connections between the critical service organizations and the public, through defined networks, will help get resources to those in	EM	$ General Fund	MT	Ranking Score 14	Public Education & Awareness; Emergency Services	All Hazards	2019 SOF

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
need quicker during natural disasters. Improved translation services for non-English speakers should also be provided at critical service facilities and municipal facilities.							
Action 2023-1.2-B **Support emergency centers and critical public service facilities (including warming and cooling centers, homeless shelters, food pantries, medical facilities, schools, and animal shelter) by continuing to coordinate with, fund, and recommend improvements (backup generators, sunshades, etc.) and table-top exercises/ drills, that will allow such facilities to operate during hazard events.** When locating new facilities, consider accessibility for senior and low-income populations.	TM (TC)	$ General Fund	ON	Ranking Score 11	Emergency Services	Flood-Related; Wind-Related; Winter-Related; ID-Flu/Covid; Earthquake; Extreme Heat	2019 SOF; 2022 POS
Action 2023-1.2-C **Implement policies and programs to reduce the impacts of infectious diseases (tick- or mosquito-borne; and influenza or coronavirus).** This action includes reviewing and updating the Town's policies and programs for controlling the mosquito and tick populations, and preventing the spread of influenzas and coronaviruses. Infectious disease programming will primarily be focused on public education, but should also include procedures for dealing with outbreaks. The Town will install tick- and mosquito-borne disease warning signs at high risk Town properties and encourage local conservation groups to take similar action.	EM	$ General Fund	MT	Ranking Score 10	Prevention; Public Education & Awareness	ID-Flu/Covid; ID-Tick/ Mosquito	2019 SOF
Policy 1.3: Reduce the municipality's contribution to climate change, which is a threat multiplier for natural hazards.							
Action 2023-1.3-A **Incorporate carbon reduction strategies in Town operations and facilities, through facility efficiency improvements, fleet replacement, tree planting, and review of capital improvement requests.** This action includes updating, maintaining and implementing the Town's Energy Plan to identify and prioritize efficiency improvements for Town and School buildings, planning for use of alternative energy sources and electric vehicles, and requiring new capital requests employ energy efficient technology.	TM (FC/FN)	$-$$ CIP	ON	Ranking Score 9	Prevention; Natural Resource Protection	Flood-Related; Wind-Related; Winter-Related; ID-Tick/ Mosquito; Drought; Brush Fire; Extreme Heat	2020 CCP (NRG-1.2.A, NRG-1.2.C, NRG-2.2.G); 2019 SOF; 2016 EMP

GOAL 2: Sustain a local economy that is resilient to natural and human-caused disasters.

Policy 2.1: Prepare for the occurrence and anticipate the impact of extreme weather events and develop mitigation policies and procedures that best reduce fiduciary risk and impact on the local economy.

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-2.1-A **Create orderly and efficient provision of infrastructure facilities and services through long-range capital facilities planning that addresses long-term resiliency.** Capital planning should include short- and long-term provisions for hazard prevention and mitigation projects.	TM (FC/FN)	$$-$$$ CIP	ON	Ranking Score 14	Prevention; Property Protection; Public Emergency Services	Flood-Related; Wind-Related; Winter-Related	2020 CCP (INF-2.1.C, INF-2.1.F); 2022 POS
Action 2023-2.1-B **Develop an economic action plan for catastrophic events to ensure a foundation for rebuilding that sustains the local economy through the recovery process.**	TM (EDC/ FN)	$$ Grant (General fund match)	KO-ST (CNT-LT)	Ranking Score 7	Property Protection	Flood-Related; Wind-Related; Winter-Related; ID-Flu/Covid	2020 CCP (ECON-3.1.B); 2022 POS
Action 2023-2.1-C **Establish and maintain a municipal register of areas and structures of historical or architectural significance, cemeteries and burial grounds, historical landscapes, and public art, especially in areas vulnerable to natural hazards and under threat of climate change impacts, and investigate resilient ways to preserve and sustain these resources which drive the local economy.** This action includes mitigating natural hazards like flooding and storm surge impacts to these historic and cultural features through resilient retrofits, relocation, and other means.	PD	$-$$ General fund (grants for implementation)	LT	Ranking Score 7	Property Protection	Flood-Related; Wind-Related	2020 CCP (HCR-2.1.A, HCR-2.1.B; 2019 SOF
Action 2023-2.1-D **Protect the built environment, industrial, and retail district by planning for and mitigating inland and coastal flooding and erosion.** This action includes protecting the banks of the Pawcatuck River and coastal areas against erosion by maintaining existing seawalls and investigating the use of living shorelines and other non-structural means (such as dune restoration/ reinforcement) to achieve stabilization and reduce flooding.	TM (PD/UT/ EN)	$ General fund	LT	Ranking Score 5	Property Protection; Natural Resource Protection; Structural Projects	Flood-Related; Wind-Related	2018 HMP (#12); 2020 CCP (RES-1.2.C, RES-1.3.C); 2019 SOF; 2017 WPWMP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Potential Projects include: • Inventory all structural and non-structural coastal and riverine erosion and stabilization measures in the municipality, identify appropriate locations for new living shorelines or non-structural approaches to increase stabilization and reduce erosion, and implement identified projects. • Continue to monitor the Town Beach Pavilion, and stabilize as necessary through non-structural means, or consider relocation.	EN (FC, HW, PD, TM) FC (REC)		LT ON				
Policy 2.2: Reduce the burden of climate change impacts on municipal finances and the local and regional economies.							
Action 2023-2.2-A **Develop a database and strategy of grant funding options and collaborate in obtaining grant funding to support hazard mitigation projects, especially those identified in the Hazard Mitigation & Flood Management Plan.**	GA	$ General fund	ST	Ranking Score 14	Supports All Actions	All Hazards	2020 CCP (SF-1.1.E); 2022 RTE1
Action 2023-2.2-B **Work with relevant Federal and State agencies on shared objectives and guiding principles, such as those identified in Resilient Rhody to reduce the burden of climate change impacts on the local economy and municipal finances.**	TM (TC)	$ General fund	ON	Ranking Score 14	Prevention	Flood-Related; Wind-Related; Winter-Related; ID-Tick/ Mosquito; Drought; Brush Fire; Extreme Heat	2020 CCP (ECON-3.2.A); 2019 SOF; 2022 POS
Action 2023-2.2-C **Quantify the value of all property and resulting tax revenue that would be impacted by increased flooding, SLR, and storm events.**	TM (EDC)	$ General fund	MT	Ranking Score 5	Public Education & Awareness	Flood-Related; Wind-Related	2020 CCP (ECON-3.3.A)

GOAL 3: Ensure sustainable infrastructure is in place to safeguard water quality, efficient wastewater treatment, effective stormwater management, and efficient transportation and transmission of essential utilities in the face of natural hazards and climate change impacts.

Policy 3.1: Ensure that the municipal transportation system, including but not limited to, roads, bridges, and culverts, effectively and resiliently meets the community's needs.

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-3.1-A **Assess, monitor, maintain, and plan for replacement/upgrades of existing bridges and construction of potential new bridges to ensure resiliency in design, continued service during hazard events, and improvements to floodwater conveyance beneath.** This action includes coordination with surrounding municipalities and state and federal agencies with jurisdiction over shared bridges and watercourses, and financial planning for these actions within the Capital Improvement Plan (CIP). To ensure floodwater conveyance and resiliency are maximized in construction and replacement, the Town may propose ordinances requiring that all new bridges fully span watercourses to avoid adding structures within the channels, especially in the Pawcatuck River.	TM (HW/ EN/ PD)	$$$ Road bond/ General Fund/ CIP/ Grants	ON	Ranking Score 11	Natural Resource Protection; Structural Projects; Emergency Services	Flood-Related; Wind-Related; Winter-Related; Earthquake	2020 CCP (RES-1.1.B, RES-1.4.B, INF-2.1.F); 2019 SOF; 2017 WPWMP**;** 2018 WPSP
Action 2023-3.1-B **Assess, monitor, maintain, and plan for replacement/upgrades of existing roadways and associated drainage infrastructure (including culverts) to mitigate flooding and incorporate resilient designs to ensure continued service during hazard events.** The biggest threat to continued service of roadways during hazard events is flooding; thus, management of stormwater along roadway rights-of-way and consideration for elevating roadways is the primary focus of this action. Higher priority roadways include evacuation routes and roads servicing critical facilities and areas of dense development (residential and commercial). A comprehensive study of possible options for raising roadways, especially those that are subject to sea level rise and storm surge and are part of the Town's evacuation routes (including Watch Hill Road, Winnapaug Road, and Weekapaug Road), should be undertaken. For culvert	EN (UT/HW)	$-$$$ Road bond (supplemented by grant funding)	ON	Ranking Score 11 CRS Activity 540	Structural Projects; Emergency Services	Flood-Related	2018 HMP (#3, #5, #7, #11, #14); 2020 CCP (INF-2.1.F); 2019 SOF; 2022 RTE1; 2017 WPWMP; 2018 WPSP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
replacements, perform site-specific data collection, geotechnical evaluation, hydrologic and hydraulic evaluation, and structure type evaluation to support design, and replace downstream culverts first. This action requires coordination with the Rhode Island Department of Transportation (RIDOT) on State roadways and Coastal Resources Management Council (CRMC) on roadways in the vicinity of coastal features and waters. **Higher Priority Roadways/Crossings include:** • **Critical evacuation route roadways subject to flooding** - Atlantic Avenue, Canal Street, Langworthy Road, Maplewood Avenue, Route 91, Watch Hill Road, and Weekapaug Road • **Critical roadways subject to flooding** - Airport Road, Ann Street, Bay Street, Beach Street near Westerly Yacht Club, Bowling Lane, Bradford Road, Breach Drive, Bridge Road, Cottage Street, Dunn's Corners Road, Friendship Street, intersection of Route 78 and Route 1, Main Street, Narragansett Avenue, Perkins Avenue, Pierce Street, Pleasant Street, Pond Street, Pound Road, Ranger Road, Springbrook Road, Spruce Street, Sunset Avenue, Wall Street, Wauwinnet Avenue, and White Rock Road • **Critical culverts to improve flood resilience** - Boom Bridge Road (3'H x 2.5'W Stone Masonry Arched Conduit); Broad Street (74'W x 14.5'H Concrete Bridge); Forrestal Drive (32" Concrete Circular Conduit); Hiscox Road (32" Concrete Circular Conduit); Potter Hill Road (6" CMP Circular Conduit); Ross Hill Road (12" CMP Circular Conduit); Spring Brook Road (1.5'H x 5'W Stone Masonry Box Culvert); Stillman Avenue (11'H x 117"W Concrete Bridge); and White Rock Road (Triple 24" Concrete Circular Conduit)							
Policy 3.2: Enhance the resiliency of Westerly's drinking water and wastewater systems by developing programs and projects that improve maintenance and provide protection, redundancy, and resilient design.							
Action 2023-3.2-A **Reduce or eliminate existing and potential risks to the public water system, ensuring both the quality and quantity of drinking water sources and their contributing areas.** This action includes: preparing a Source	UT (PD)	Grant (general fund match)	LT	Ranking Score 16	Prevention; Property Protection	Flood-Related; Extreme Heat	2020 CCP (INF-1.1.B, INF-2.1.B); 2019 SOF; 2022 RTE1; 2018 WPSP

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Water Protection Plan, protecting the aquifers from hazardous materials, pollution, and development stressors, growth management, including the cumulative effect of development on potential drinking water resources, and considering a private septic system monitoring program.							
Action 2023-3.2-B **Protect, maintain, and ensure resiliency of pumping stations and wastewater treatment facility (WWTF) from flooding by implementing mitigation measures identified in WWTF Facilities Plan.**	UT	Grant (CIP match)	ON	Ranking Score 14	Property Protection; Structural Projects	Flood-Related	2018 HMP (#16); 2020 CCP (INF-2.1.B); 2019 SOF
Action 2023-3.2-C **Study existing and projected effects of drought on local public health and safety, economic activity, and environmental resources in preparation for a drought response plan.**	EM	Grant (General fund match)	MT	Ranking Score 11	Public Education & Awareness; Natural Resource Protection	Drought; Brush Fire; Extreme Heat	2020 CCP (INF-1.1.F)
Action 2023-3.2-D **Improve reliability of water distribution infrastructure and Well Fields, especially during hazard events, through monitoring, maintenance, and short- and long-term planning for protection and upgrades to the systems.** The purpose of this action is to improve the overall resilience and reliability of the systems, and reduce the likelihood of service disruption or contamination from storm events. This action includes monitoring, maintenance, and replacement/ upgrading of existing infrastructure, including the berms constructed around well heads at White Rock #1 and #2. Short- and long-term planning, including financial planning through the Capital Improvement Program (CIP), for improvements, replacements, redundancy, and potential expansion of water service are also intended as part of this action.	UT (TM)	$-$$$ Water enter-prise fund & CIP (supple-mented by grant funding)	ON	Ranking Score 8	Property Protection; Structural Projects	Flood-Related	2018 HMP (#4); 2020 CCP (INF-1.1.C, INF-2.1.F); 2019 SOF; 2022 RTE1; 2022 POS
Policy 3.3: Improve stormwater drainage treatment and conveyance systems.							
Action 2023-3.3-A **Expand stormwater management capacity through monitoring, maintenance, and upgrade/retrofitting of existing systems and integration of green infrastructure and Low-Impact Development (LID) standards throughout Town.** This action includes identifying potential sites for new green infrastructure on Town-owned properties, and retrofitting of existing	PD (EN/ HW)	$-$$ Grants & General fund	KO-ST CNT-LT	Ranking Score 13 CRS Activity 450, 530,540	Prevention; Property Protection; Natural Resource Protection; Structural Projects	Flood-Related	2018 HMP (#2); 2020 CCP (INF-1.3A, INF-2.1.B, INF-2.1.F); 2019 SOF; 2022 RTE1; 2017 WPWMP;

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
infrastructure (such as culverts and catch basins), to expand the capacity for stormwater management and treatment. This action also includes amending the Stormwater Management Ordinance (Chapter 260) to require green infrastructure (such as stormwater infiltration areas and rain gardens) and LID in public and private development. **Potential Projects include:** • Improve Misquamicut drainage using various stormwater infrastructure improvements, such as reduction of impervious surface, restoration of vegetated areas, incorporation of an ISDS management policy, and dune replacement project. To help pump station reaction time during flooding events, obsolete portions of former drainage system (which currently collects groundwater) should be abandoned. • Increase stormwater detention capacity at Argyle Drive, Brandywine Drive, Davenport Street, Dunn's Corner School, Linnate Street, Springbrook School, Trolley Lane, Walton Street, Westerly Middle School, and Yankee Drive. • Identify options to use open space recreation sites for flood and stormwater storage (i.e. Gingerella Sports Complex, Rotary Park, etc.). • Consider implementing a program of incentives for green infrastructure and reduction in the amount of impervious surface at existing uses and as part of redevelopment. • Implement green infrastructure projects at Grace United Methodist Church (Bioretention adjacent to parking lot), State Street School (Bioretention and rain gardens), Westerly High School (Underground infiltration under parking area), and former Tower Street School and Community Center (Bioretention along parking area perimeter).	EN EN REC (EN) PD PD (SRICD, EN)		ST MT ST MT KO-MT (CNT-LT)				2018 WPSP; 2022 POS
Policy 3.4: Ensure transmission of essential private utilities (electric, gas, internet, cell services) is resilient to natural hazard impacts							
Action 2023-3.4-A **Upgrade emergency services radio network to digital along with wireless infrastructure upgrades to reduce impacts of wind-related communication interruptions.**	EM (IT)	$$$ Grants (General fund match)	ST	Ranking Score 8	Emergency Services	Wind-Related	2020 CCP (INF-1.3.E, SF-1.2.N); 2019 SOF

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-3.4-B **Work with private developers and utility companies to mitigate the vulnerability of existing infrastructure, including burying above-ground infrastructure like electric and telecommunications systems, especially in high wind and ice hazard areas.** This action includes: working with utility companies to identify and prioritize existing infrastructure for resiliency improvements and improve maintenance activities like tree trimming; pursuing grant funding opportunities for the Town to improve the resiliency of above-ground utility infrastructure in high risk areas; as well as amending the zoning ordinance to require private developers to install new utilities underground.	TM (TC)	$$$ Grants (General fund match)	LT	Ranking Score 7	Property Protection	Flood-Related; Wind-Related; Winter-Related	2020 CCP (RES-1.1.C, RES-1.1.D, INF-2.1.F); 2019 SOF; 2022 RTE1; 2022 POS

GOAL 4: Enhance the capability of the natural environment to protect Westerly from flooding, storm surge and sea level rise.

Policy 4.1: Provide long-term conservation of natural resources, particularly in vulnerable areas of Westerly.

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-4.1-A **Develop a priority map and plan for the preservation of such natural areas across the municipality that are not currently protected and will enhance resilience.** The priority map shall include areas for future salt marsh advancement zones, floodplains, wetlands and watercourses, aquifers and high quality groundwater, barrier beaches and dunes, salt ponds, forest, agricultural land, and other natural resource areas. The plan for preservation may include policies regarding acquisition and sale of Town properties within these natural areas, implementing zoning districts for conservation and/or agricultural lands, and other preservation techniques.	PD (TM/CC)	$$ General fund	LT	Ranking Score 17	Prevention; Natural Resource Protection	Flood-Related; Wind-Related; Extreme Heat	2020 CCP (RES-1.3.G); 2019 RI-SHMP; 2019 SOF; 2018 WPSP

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-4.1-B **Reduce Contamination from Textile Mills, Dye Plants, and Hazardous Materials Handlers.** Mitigate hazardous materials contamination resulting from textile mills, dye plants, and hazardous materials handlers located in flood zones and other sensitive natural habitats through environmental assessment, acquisition, remediation, and retrofitting sites. Identified sites include the Bradford Dye Association (BDA) site and the Potter Hill Mill site, and the Stillman Avenue Bridge.	TM (PD)	$$$ Grant (General fund match)	LT	Ranking Score 16 CRS Activity 420	Natural Resource Protection	Flood-Related	2018 HMP (#10); 2019 SOF; 2018 WPSP
Action 2023-4.1-C **Coordinate with the local land trusts, conservation organizations, state and federal agencies, and local property owners in the acquisition and maintenance of open space, especially in flood hazard areas, aquifers, coastal migration areas, and other natural resource areas (ex. agricultural land) to improve resiliency.**	TM (TC)	$$-$$$ Grant (General fund match)	LT	Ranking Score 13 CRS Activity 420	Natural Resource Protection	Flood-Related	2020 CCP (RES-1.1.A, NAT-1.1.A, NAT-1.2.A); 2019 RI-SHMP; 2019 SOF; 2018 WPSP; 2022 POS
Action 2023-4.1-D **Collaborate with other influencers on the restoration of the barrier beaches and Salt Pond shoreline access to safeguard both natural and economic value.** This action is intended to include protection and restoration of barrier beaches and dunes, wetlands, eelgrass beds, and beach nesting areas through conservation, restoration projects including revegetation and beach nourishment, limitations on development, and protection of buffers.	TM (EN)	$$ Grant (General fund match)	LT	Ranking Score 12	Prevention; Natural Resource Protection	Flood-Related; Wind-Related; Drought; Brush Fire; Extreme Heat	2020 CCP (ECON-1.3.C); 2019 RI-SHMP; 2019 SOF; 2019 Harbor
Policy 4.2: Ensure the sustainable use and management of natural resources.							
Action 2023-4.2-A **Monitor and manage dam conditions to assess need for repair, reconstruction or removal and clarification of responsible parties**. This action includes removing/retrofitting Potter Hill Dam, coordinating with the private property owner to repair/remove Olaf Farm Pond Dam (Cedar Swamp Brook), and removing the Stillman Avenue Dam debris and other obstructions in the Pawcatuck River or its tributaries.	TM (TC)	$-$$$ Grant & General fund	LT ON	Ranking Score 10 CRS Activity 630	Natural Resource Protection; Structural Projects	Flood-Related	2018 HMP (#8); 2020 CCP (RES-1.4.A, RES-1.4.C); 2019 SOF; 2017 WPWMP; 2018 WPSP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Action 2023-4.2-B **Develop an Environmental Management Plan for the municipality, addressing forest and open space, and management strategies to mitigate natural hazard impacts and improve resilience in our natural environment.** This plan would be developed in collaboration with local conservation agencies and address strategies to mitigate the impacts of forest fire, drought, invasive species, flooding, and other natural hazards on the natural environment.	EM (CC)	$$ Grant (General fund match)	LT	Ranking Score 10	Natural Resource Protection	Flood-Related; ID-Tick/ Mosquito; Drought; Brush Fire; Extreme Heat	2019 SOF
Action 2023-4.2-C **Maintain and manage Winnapaug Pond and western Quonochontaug Pond in an ecologically responsible manner and use soils for local salt marsh restoration and beach nourishment projects.**	TM (EN)	$$$ Grant (General fund match)	ST ON	Ranking Score 9	Natural Resource Protection	Flood-Related; Wind-Related; Drought; Extreme Heat	2018 HMP (#12); 2020 CCP (RES-1.3.F, NAT-1.2.G); 2019 SOF; 2022 POS
Policy 4.3: Anticipate new development, redevelopment, structural elevations, and, as necessary, retreat from or management of coastal shorelines and riparian zones in especially vulnerable areas.							
Action 2023-4.3-A **Amend the Zoning Ordinance and Land Development and Subdivision Regulations to enhance Low-Impact Development (LID) design requirements, incorporation of green infrastructure and greenspace, and reduction in impervious surface, particularly in areas vulnerable to natural hazard areas.** This action is intended to promote LID development across the municipality to reduce solar heat conduction and wind velocities (by incorporation of vegetation and shade trees) and treat and reduce stormwater runoff, especially in coastal areas, floodplains, and other areas subject to flooding. Implementation of a large demonstration project on Main Street in Downtown Westerly is intended as a way to publicize the multi-faceted benefits of LID and green infrastructure and ease of implementation on private properties.	PD	$ Grant (General fund match)	ST	Ranking Score 14 CRS Activity 430,450	Prevention	Flood-Related; Wind-Related; Extreme Heat	2020 CCP (INF-1.3.D, NRG-2.1.B); 2019 SOF; 2017 WPWMP; 2018 WPSP
Action 2023-4.3-B **Comprehensively study existing and future land uses in coastal areas most vulnerable to sea level rise, storm surge, and coastal erosion, and, through robust public engagement (including local stakeholders such as conservation agencies, non-profit organizations, and the business**	EM (TC, PD, SRICD)	$$$ Grant (General fund match)	KO-LT	Ranking Score 9 CRS Activity 440	Prevention; Public Education & Awareness	Flood-Related; Wind-Related	2020 CCP (RES-1.3.A, RES-1.3.B); 2019 SOF; 2017 WPWMP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
community), evaluate alternatives to mitigate risk. This action includes extensive public engagement to create and evaluate strategies to manage development in extremely vulnerable coastal areas, including within the Coastal Barrier Resource System (CBRS), and all areas directly exposed to the Atlantic Ocean (Misquamicut, Watch Hill, Weekapaug, etc.). Consideration may be given toward creating areas or zones where new development, and possibly redevelopment, is managed, and incentivizing the use of portable structures to allow for safe relocation during major hazard events. Consideration will also be given to areas of historic and/or architectural significance, such as Bay Street in Watch Hill, where a study is already underway, to ensure preservation is balanced with the need to mitigate risks from sea level rise.							
Action 2023-4.3-C **Amend the Zoning Ordinance and Land Development and Subdivision Regulations to ensure appropriate resiliency and environmental protection is incorporated in new private and public development and redevelopment, especially in vulnerable areas.** This action is intended to revise existing ordinances and create new ordinances with consideration for climate change and natural hazards in land use planning, with guidance from state and federal environmental agencies like Coastal Resources Management Council (CRMC), RI Department of Environmental Management (RIDEM), Federal Emergency Management Agency (FEMA), and U.S. Fish and Wildlife Service. Incorporation of agency guidance documents, like the Salt Pond Region and Beach SAMPs (Special Area Management Plans) from CRMC, into local regulations is also intended with this action. Ordinance amendments would address development in special flood hazard areas, coastal erosion zones, areas subject to sea level rise, and sensitive natural habitats, and seek to protect carbon sinks and increase green space, thereby reducing carbon emissions and related climate change stressors, and improving the quality of public spaces. Specific ordinances and regulations intended to be revised/created include the Salt Pond Overlay District (Section 260-53), River Corridor Overlay District (Section 260-56), Land Development and Subdivision	PD	$ General fund	ST	Ranking Score 8 CRS Activity 430,450	Prevention	Flood-Related; Wind-Related; Winter-Related; Extreme Heat	2020 CCP (RES-1.2.B, RES-1.2.D, NAT-1.1.C, NAT-1.2.D, NAT-1.2.E, NAT-1.2.H, HCR-1.2.D, NRG-1.2.E, NRG-2.1.A); 2019 RI-SHMP; 2019 SOF; 2017 WPWMP; 2018 WPSP; 2022 POS

Action Number & Description	Lead & Support	Cost & Funding Source	Time-frame & Kickoff	Priority Ranking & CRS Activity	Action Category	Hazard Addressed	Reference
Regulations (particularly Article VI Design and Improvements Standards), and Floodplain Management (Chapter 127).							
Action 2023-4.3-D **Elevate Repetitive Loss Structures and enforce building code requirements and hazard mitigation strategies in flood hazard areas.** As grants become available, the Town will support property owner applications for FEMA funding assistance to address Repetitive and Severe Repetitive Loss properties, and other properties susceptible to flood inundation. The program criteria will be modified as needed throughout the life of this plan. The Building Office will continue to enforce the building code and NFIP requirements, and work with property owners in flood hazard areas to eliminate existing unsafe and non-compliant housing conditions, through hazard mitigation strategies.	BD (GA)	$ General fund	LT	Ranking Score 7 CRS Activity 520, 530	Property Protection; Public Education & Awareness; Structural Projects	Flood-Related; Wind-Related	2018 HMP (#1); 2020 CCP (RES-1.2.A); 2019 SOF; 2022 POS

SECTION 7

Plan Adoption, Implementation, and Maintenance

Subsections

KMJ – CE/RP

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7 Plan Adoption, Implementation, and Maintenance

Hazard Mitigation Plan: The Town of Westerly has successfully met the following requirements ➔
44 CFR Subsection D §201.6(c)(4): [The plan shall include] a plan maintenance process.

44 CFR Subsection D §201.6(c)(5): [The plan shall include] documentation that the plan has been formally approved by the governing body of the jurisdiction requesting approval of the plan.

CRS - Flood Management Plan: The Town of Westerly has successfully met the following Mitigation Strategy requirements based on the 10-step planning process for CRS Activity 510 ➔ Adopt the Plan (Step 9); and Implement, Evaluate, Revise (Step 10)

The Town of Westerly has completed a lengthy community-based process to update their 2018 Hazard Mitigation Plan and expand it to encompass flood management planning in accordance with CRS Activity 510. In doing so, the HM&FMP Advisory Committee has sought to embrace all aspects of the process and create a broad-based *Action Plan* including prevention, property & natural resource protection, structural projects, public education & awareness, and emergency service protection activities. As has been demonstrated through the inclusion of the Code of Federal Regulations (CFR) Local Mitigation Plan requirements throughout this document, and further demonstrated through the use of FEMA's Local Mitigation Plan Review Tool (**Appendix 7.1**), the *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan* meets all 44 CFR §201.6 requirements.

The Town of Westerly and the HM&FMP Advisory Committee are committed to the implementation of this *Plan* and recognize that successful hazard mitigation is an ongoing process that requires:

- endorsement and support from Town Officials and the community
- a strategy for monitoring, evaluating, and updating the *Plan*
- incorporating the mitigation goals and activities into other local planning mechanisms
- continued public participation

Figure 7-1 Tree Collapses on a House in Watch Hill (Nor'easter, October 27, 2021)
Photo Credit: Tim Martin, The Westerly Sun

Figure 7-2 Clean-up Continues along Atlantic Avenue a Month after Superstorm Sandy (November 2012)
Photo Credit: Tom Mooney, The Providence Journal

7.1 ADOPT THE PLAN

The *HM&FMP* went through an extensive iterative process before formal adoption by the Westerly Town Council. Throughout the development of the Plan, the Advisory Committee followed FEMA's CRS floodplain management 10-step planning process, which aligns with Disaster Mitigation Act (DMA) 2000 requirements. The CRS planning process was beneficial as it helped to ensure that the opportunity for public input and feedback occurred throughout the process.

CRS CREDIT:

Mitigation Planning Elements	CRS Planning Steps	Max Pts
Phase IV – Plan Maintenance	9. Adopt the Plan	2

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

As documented in Section 2, during the development of the *Plan*, the Advisory Committee met numerous times to provide input, feedback, and guidance on the document. Once satisfied that all provisions had been successfully met, the Advisory Committee authorized the Town's Consultant, Kim Jacobs, to finalize the *DRAFT Plan* and disseminate it for public review. The public review period occurred from February, 7-27, 2023. During this 3-week public review period, the Town posted the *Public Review DRAFT* on the Town's website, and a hard copy was made available for viewing at the Westerly Planning Office in Town Hall.

In order to further public participation in the process, the Public Review Period and Public Hearing were widely advertised. Publicity included a press release in *The Westerly Sun*, information on the Town's website, an informational kiosk at the Westerly Library, an agenda item on the February Economic Development Commission and Planning Board meetings, a Town Council Workshop, a Public Hearing legal notice in *The Westerly Sun*, and notice of the Public Hearing posted on the Secretary of State website, Clerkbase, on the Town website calendar, and a notice posted in the Town Hall and Police Station. Additionally, the Town sent an email publicizing the *Draft Plan* and Public Hearing to the groups and organizations listed in **Appendix 2-3**, which includes the Town Council and other Town boards and commissions, neighboring jurisdictions, and numerous other local, regional, and State stakeholders.

During the Public Review Period the Town received written comments from 2 members of the public (one from a resident and one from Save The Bay), which have been addressed in the *Final Draft*.

At the end of the *Public Review Period*, on February 27, 2023, a **Public Hearing** was hosted by the Westerly Town Council. At the beginning of the Public Hearing, the Town's Consultant directed a Power Point presentation providing an overview of the benefits of a *HM&FMP*, the planning process, the hazards included, what is at risk, development of the *Action Plan*, and *Plan* implementation. As several members of the public provided opinions regarding whether Potter Hill Dam should be removed, during a pre-public hearing public comment period, the Town's Consultant indicated that the *Action Plan* provides a general action related to all five of the Town's dams (Action 2023-4.2-A: Monitor and manage dam conditions to assess need for repair, reconstruction or removal), but no determination on how to proceed with Potter Hill Dam. Whether to remove or make improvements to the Potter Hill Dam is an ongoing issue as the Town gathers and reviews technical data.

After the presentation, several Town Council members asked questions which were answered by the Consultant and/or the HM&FMP Advisory Committee Chair. A public comment period was then provided for input and feedback on the *HM&FMP*. No members of the public chose to speak.

Town Council Adoption of HM&FMP:

After the public comment period, the Town Council voted unanimously to adopt the *HM&FMP*, with the acknowledgment from the Town solicitor that during the subsequent review/approval process by RIEMA/FEMA, any required revisions would be accepted by this approval. The Town worked diligently to produce a detailed *Plan* with the intent of satisfying all DMA requirements, and therefore does not anticipate any substantial RIEMA/FEMA required revisions. However, should RIEMA/FEMA request substantial revisions, the Town Council may choose to

re-adopt the *Plan* after said revisions are made. The Town Council Resolution adopting the *HM&FMP* is included in **Appendix 7-2**.

On March 21, 2023, the *Plan* received approval from FEMA, which confirmed that the *HM&FMP* met all requirements. The FEMA approved/Town Council adopted *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan* will be maintained on the Town's website and replaces the Town's 2018 HMP.

7.2 IMPLEMENT AND MAINTAIN THE PLAN

DMA Requirement §201.6(c)(4)(i):
[The plan maintenance process shall include] a section describing the method and schedule of monitoring, evaluating, and updating the mitigation plan within a five-year cycle.

CRS CREDIT:

Mitigation Planning Elements	CRS Planning Steps	Max Pts
Phase IV – Plan Maintenance	10. Implement, Evaluate, Revise	26

CRS Coordinator's Manual – Activity 510: Floodplain Management Planning

The success of the *HM&FMP* lies in the ability to effectively implement the mitigation actions, and regularly evaluate and revise the *Plan* for continued relevancy. In doing so, Westerly will continue building a resilient community - one in which critical lifeline systems, including roads, utilities, infrastructure, and other support facilities, will function in the midst of natural hazards, helping to ensure the safety of the community.

7.2.1 Implement the Plan

Implementation of the mitigation activities will be more successful if they are incorporated into the day-to-day functions and priorities of Westerly's government. A number of action descriptors were included in the *Action Plan* (**Table 6-1**)**,** which will aid implementation. For each mitigation action, the descriptors provide a clear course for the actions to be incorporated into departmental and committee-based work plans and budgets.

Over the ensuing 5-years, the 2023-2028 *Action Plan* outlines a substantial amount of mitigation measures the Town could implement. The timeframe for each action is provided as a guide and recognized as flexible due to staff and funding availability. It is also recognized that the identified lead for an action may shift from one party to another, or become a shared responsibility.

7.2.1.1 Incorporate the Plan into Existing Planning Mechanisms

State regulations require that hazard mitigation be addressed within Comprehensive Community Plans (CCP). The Town of Westerly's 2020 Comprehensive Community Plan contains a Natural Hazards and Resiliency Section. It is the intent of the Town to further integrate hazard mitigation into all applicable elements as the CCP is updated. Incorporating pertinent aspects of the *HM&FMP* throughout the CCP will strengthen the Town's position to implement hazard mitigation as it will carry the full legal weight and authority of the Comprehensive Community Plan.

DMA Requirement §201.6(c)(4)(ii):
[The plan maintenance process shall include] a process by which local governments incorporate the requirements of the mitigation plan into other planning mechanisms such as comprehensive or capital improvement plans, when appropriate.

In addition to the CCP, the *HM&FMP* will be incorporated, where appropriate, into other Town planning mechanisms. **Appendix 5-1** includes plan integration considerations for key existing planning documents. Further integration will occur as land use plans & regulations, mutual aid agreements, and such, are updated or developed.

7.2.2 Evaluate and Revise the Plan

As directed by FEMA, "To be useful, planning must be ongoing and plans must be dynamic. Therefore, the community must have an evaluation and update process" (FEMA. *National Flood*, 510-25).

Success of Westerly's *Hazard Mitigation & Flood Management Plan* will be measured by the degree to which actions are sustainably implemented and the *Plan* is maintained. For the development of this *Plan*, an ad hoc Advisory Committee was created by the Town Council. The HM&FMP Advisory Committee is comprised of six Town staff members and seven members of the public. It is proposed that the Advisory Committee, or its successor committee with a similar membership, be charged with monitoring and evaluating implementation of the *Plan*. Doing so will maintain public representation in the implementation process and will afford the Town more CRS credit points for Activity 510-Step 10.

The Town Planning Department will serve as the *Hazard Mitigation & Flood Management Plan* lead, reviewing actions on an ongoing basis in order to identify grant opportunities, and to coordinate with the Emergency Management Coordinator to schedule semi-annual *HM&FMP* Evaluation Meetings and set agenda items. Should the Committee choose to convene on a quarterly basis, additional CRS credit points can be achieved. At a minimum, conducting an annual review is critical to ensure the *Plan* reflects current information and continues to meet the needs of the Town. The annual meeting should align with Westerly's annual municipal budget process in order to identify where capital improvement funding will be required. All meetings will be publicly noticed in accordance with Town and State open meeting laws and the public will be encouraged to attend and participate.

During the semi-annual review, an assessment of progress on each of the goals and activities in the *Plan* will be discussed and documented in an Evaluation Report. Recommendations will be made concerning the various aspects of *Plan* implementation, including timeframes for completion of activities, funding and staffing resources, responsible entities, stakeholder engagement, coordination efforts, and priority standings of activities. Some activities that are found to be unachievable may be removed from the *Plan* and activities addressing problems unforeseen during plan development may be added. Implementation successes, hurdles, and lessons learned will also be identified. Further, the Committee will consider whether there have been any changes to the nature, magnitude, or type of risks, and whether the goals remain current and appropriate. The meeting also provides an opportunity to discuss new recommendations or findings from other planning initiatives, policy changes, studies, research, etc. that may influence plan implementation. As Westerly is a CRS participating community, the annual Evaluation Report must be submitted to the Town Council, released to the media, made available to the public, and submitted with the community's annual CRS recertification.

The Committee will also convene within a month after a natural disaster to discuss the effectiveness of implemented actions, and if deemed appropriate, revise the *Plan* to reflect lessons learned from Town officials and community members ,based on their experiences during and after the hazard event.

7.2.2.1 Continued Public Involvement

For the *Plan* to be effective and relevant over time, continued community involvement throughout the implementation and maintenance process will be essential. Ongoing community engagement continues the hazard risks discussion and builds support for mitigation activities. Community members will be given the opportunity to affect the content and outcomes of the *HM&FMP* through outreach, public meetings, and community forums. Westerly residents, local and regional stakeholders, neighboring community members, and the public-at-large will be encouraged to participate in the process through advertised meetings and events.

DMA Requirement §201.6(c)(4)(iii):
[The plan maintenance process shall include a] discussion on how the community will continue public participation in the plan maintenance process.

The semi-annual *Plan* Evaluation Meetings, which will provide updates and findings on the progress and implementation of the *Plan*, will be open to the public. The public can also stay involved through the use of the Town's website, where updates to the *Plan* as well as other hazard mitigation information is posted.

7.2.2.2 Funding Opportunities

An array of funding can be used to finance improvements that mitigate hazards. The Town of Westerly can budget for such projects in its Capital Improvement Plan (CIP) and finance improvements locally through bonds. Various grants, including the Rhode Island Infrastructure Bank (RIIB) Municipal Resilience Program (MRP) Action Grant and the Narragansett Bay Estuary Program-Green Infrastructure Planning Grant have funded stormwater management and resilience projects in Westerly, and may be utilized in the future. A list of recent hazard mitigation related grants awarded to the Town has been included in **Appendix 5-3**. The State Department of Transportation projects (often through the Federal Highway Administration), can address stormwater runoff and flood management as part of their scope. Further, local college programs, and other organizations, may be able to donate resources to help plan, communicate risks, or implement mitigation activities.

Figure 7-4 FEMA Grant Programs
Image credit: FEMA

Adoption of this *Plan* by the Westerly Town Council will also assist the Town maintain eligibility and enhance application priority for certain federal and State level grants to be utilized in mitigation efforts. FEMA prioritizes municipalities that have completed a risk assessment and established mitigation projects with detailed information on the timeline, cost, and municipal department responsible for completing the project. FEMA grant opportunities for mitigation activities include FEMA's Flood Mitigation Assistance (FMA) Grant Program, Pre-Disaster Mitigation (PDM) Grant Program, Building Resilient Infrastructure & Communities (BRIC), and post-disaster Hazard Mitigation Grant Program (HMGP). Additional information on grant opportunities has been provided in **Appendix 5-3**.

7.2.3 5-Year Plan Update

The *Town of Westerly 2023 Hazard Mitigation & Flood Management Plan* is a dynamic document and, as discussed in **Section 7.2.2**, over the 5-year implementation period there will be an ongoing plan maintenance schedule. Additionally, in accordance with 44 CFR §201.6(d)(3), to maintain eligibility for mitigation project grant funding, the plan needs to undergo a full update every five years to reflect changes in development, progress in local mitigation efforts, changes in priorities, and updated science-based data and tools on hazard tracking, climate change, etc. To ensure that the revised plan will be approved within the five-year cycle, it is proposed that the Town commence the update on the fourth anniversary of the *Plan* adoption date.

It is proposed that the 5-year update follow the CRS Activity 510 - 10 Step Planning Process, as was done for the development of this document. This will ensure that both the 44 CFR §201.6 and CRS Activity 510 requirements are met. The Town appreciates the emphasis placed on public participation in the 10-Step Planning Process. As was part of this planning effort, public meetings will be held and public comments will be solicited on the 5-year plan update.

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GLOSSARY

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Glossary

Action Plan – A sequence of steps to achieve specific goals, including identification of responsible parties, resources required, and a timeline.

American Community Survey – The framework by which the Census Bureau collects and publishes demographic, social, housing, and economic data.

Base Flood Depth (BFD) – The depth shown on the Flood Insurance Rate Map (FIRM) for Zone AO that indicates the depth of water above highest adjacent grade resulting from a flood that has a 1% chance of equaling or exceeding that level in any given year.

Base Flood Elevation (BFE) – The computed elevation to which floodwater is anticipated to rise during the base flood. BFEs are shown on Flood Insurance Rate Maps (FIRMs) and on the flood profiles. The BFE is the regulatory requirement for the elevation or floodproofing of structures. The relationship between the BFE and a structure's elevation determines the flood insurance premium.

Beaufort Scale – Created in 1805, a scale still used today as a standardized scale for characterizing wind.

Berm – A geomorphologic feature usually located at mid-beach and characterized by a sharp break in slope, separating the flatter backshore from the seaward-sloping foreshore.

Brush Fire – A fire burning in vegetation that is predominantly shrubs, brush, and scrub growth. Peak fire season in Rhode Island is typically between mid-March and mid-May when dry windy weather can occur increasing the potential for fires.

Building Code – The Rhode Island State Building Code.

Built Environment – Manmade surroundings including buildings, infrastructure, parks, lawns, etc.

Climate – An area's typical or average weather.

Climate Change – A change in the typical or average weather of a region or city. This could be a change in a region's average annual rainfall, for example. Or it could be a change in a city's average temperature for a given month or season. Climate change is also a change in Earth's overall climate. This could be a change in Earth's average temperature, for example. Or it could be a change in Earth's typical precipitation patterns.

Coastal Barrier – A naturally occurring island, sandbar or other strip of land, including coastal mainland, that protects the coast from severe wave wash.

Coastal Erosion – The process of the gradual wearing away of land masses along the coast.

Coastal Flooding – Inundation of areas along the coast resulting from storm surge, wave action.

Coastal High Hazard Areas – Special Flood Hazard Areas (SFHAs) along the coasts that have additional hazards due to wind and wave action. These areas are identified on Flood Insurance Rate Maps (FIRMs) as zones V, V1-V30 and VE.

Coastal Resources Management Council (CRMC) – The Coastal Resources Management Council is a State of Rhode Island management agency with regulatory functions. Its primary responsibility is for the preservation, protection, development and where possible the restoration of the coastal areas of the state via the implementation of its integrated and comprehensive coastal management plans and the issuance of permits for work with the coastal zone of the state.

Code of Federal Regulations (CFR) – The Code of Federal Regulations (CFR) is the codification of the general and permanent rules and regulations published in the Federal Register by the executive departments and agencies of the federal government.

Community Assets – The people, structures, facilities, and systems that have value to the community.

Community Rating System (CRS) – A voluntary program developed by FEMA to provide incentives for NFIP compliant communities who want to implement extra measures to provide protection from flooding.

Comprehensive Community Plan – A municipal-level plan written in accordance with requirements of the Rhode Island Comprehensive Planning and Land Use Regulation Act.

Coronavirus Disease 2019 (COVID-19) – is a virus strain that has only spread in people since December 2019. On March 11, 2020 the Coronavirus Disease was declared a pandemic by the World Health Organization and on March 13, 2020 the United States declared the outbreak a national emergency.

Critical Facilities – A structure or other improvement that, because of its function, size, service area, or uniqueness, has the potential to cause serious bodily harm, extensive property damage, or disruption of vital socioeconomic activities if it is destroyed or damaged or if its functionality is impaired.

Drought – A natural climatic condition which occurs in virtually all climates, the consequence of a natural reduction in the amount of precipitation experienced over a long period of time, usually a season or more in length. High temperatures, prolonged winds, and low relative humidity can exacerbate the severity of drought.

Earthquake – A sudden motion or trembling that is caused by a release of strain accumulated within or along the edge of the earth's tectonic plates.

Elevated Building – A building that has no basement and that has its lowest elevated floor raised above ground level by foundation walls, shear walls, posts, piers, pilings, or columns. Solid (perimeter) foundations walls are not an acceptable means of elevating buildings in V and VE zones.

Erosion – The collapse, undermining or subsidence of land along the shore of a lake or other body of water. Erosion is a covered peril if it is caused by waves or currents of water exceeding their cyclical levels which result in flooding.

Extent – The strength or magnitude of the hazard. Extent can be described in a combination of ways depending on the hazard.

Farm, Forest, and Open Space Program – A tax incentive program that helps to achieve open space protection, but does not provide permanent protection. The program is intended to encourage property owners to manage their land for forestry, agriculture, and open space. Property owners enter into an agreement with the Town to keep their properties undeveloped for at least 15 years in exchange for lower property tax assessments.

Federal Emergency Management Agency (FEMA) – An agency within the U.S. Department of Homeland Security charged with responding to Presidentially-declared disasters.

Flash Flood – A flood that occurs when excessive water fills normally dry creeks or river beds along with currently flowing creeks and rivers, causing rapid rises of water in a short amount of time. They can happen with little or no warning.

Flood – A general and temporary condition of partial or complete inundation of normally dry land areas from: the overflow of inland or tidal waters; the unusual and rapid accumulation of runoff of surface water from any source.

Flood Insurance Rate Map (FIRM) – Official map of a community on which FEMA has delineated the Special Flood Hazard Areas (SFHAs), the Base Flood Elevations (BFEs) and the risk premium zones applicable to the community. A FIRM that has been made available digitally is called a Digital Flood Insurance Rate Map (DFIRM).

Floodplain – Any land area susceptible to being inundated by floodwaters from any source.

Floodplain Management – The operation of an overall program of corrective and preventive measures for reducing flood damage, including but not limited to, emergency preparedness plans, flood-control works and floodplain management regulations.

Floodproofing – Any combination of structural and nonstructural additions, changes or adjustments to structures, which reduce or eliminate risk of flood damage to real estate or improved real property, water and sanitation facilities or structures with their contents.

Flood Zone A (1% annual chance): Zone A is the flood insurance rate zone that corresponds to the 100-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Mandatory flood insurance purchase requirements apply. For areas within the A Zone where detailed hydraulic analyses has been performed and Base Flood Elevations (BFEs) identified, additional classifications (VE, V1-V30) are made.

Flood Zone V (1% annual chance): Zone V is the flood insurance rate zone that corresponds to the 100-year coastal floodplains that have additional hazards associated with storm waves. Mandatory flood insurance purchase requirements apply. For areas within the V Zone where detailed hydraulic analyses has been performed and Base Flood Elevations (BFEs) identified, additional classifications (AE, AH, AO, AR, A1-A30, A99) are made.

Flood Zone X (0.2% annual chance)**:** Zone X is the flood insurance rate zone that corresponds to the 500-year floodplains that are determined in the Flood Insurance Study (FIS) by approximate methods. Because detailed hydraulic analyses are not performed for such areas, no BFEs (base flood elevations) or depths are shown within this zone.

Foundation Walls – Masonry walls, poured concrete walls or precast concrete walls, regardless of height, that extend above grade and support the weight of a building.

Freeboard (FEMA Definition for Flood Zones) – An additional amount of height above the Base Flood Elevation (BFE) used as a factor of safety (e.g., 2 feet above the Base Flood) in determining the level at which a structure's lowest floor must be elevated or floodproofed to be in accordance with state or community floodplain management regulations.

Freeboard (bridge clearance) – The space between the bottom of a bridge's structure and the surface of the water underneath the bridge.

Freshwater Wetlands (Per RIDEM) – areas that are flooded or that have water at or near the surface for part of most growing seasons. They commonly occur between uplands and water bodies; however, many freshwater wetlands stand alone and are surrounded by upland. Freshwater wetlands are widespread throughout Rhode Island. Swamps, marshes, bogs, ponds, rivers, and streams are considered wetlands in Rhode Island as are other smaller areas and certain adjacent areas known as perimeter wetlands, riverbank wetlands, and floodplain.

Fujita Scale – An intensity scale which rates tornadoes with numeric values from F0 to F5 based on tornado wind speed and damage sustained. An F0 rating indicates light damage such as broken tree limbs or signs, while an F5 rating indicates incredible damage was sustained.

Geographic Information System (GIS) – A computer system that analyzes and displays geographically referenced information. It uses data that is attached to a unique location.

Greenhouse Gas Emissions – Gases that trap heat in the atmosphere, including carbon dioxide and methane.

Hazard – A natural or man-made source or cause of harm or difficulty.

Hazard Identification – The process of identifying hazards that threaten an area.

Hazard Mitigation – Sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards.

Hazard Mitigation Plan – A plan, written to comply with FEMA requirements, that identifies local policies and actions that can be implemented over the long term to reduce risk and future losses from hazards. These mitigation policies and actions are identified based on an assessment of hazards, vulnerabilities, and risks and the participation of a wide range of stakeholders and the public in the planning process.

Hazard Profiles – Profiles of each identified hazard.

Hurricane – A tropical cyclone in which the maximum sustained surface wind is 74 mph or more. The term hurricane is used for Northern Hemisphere tropical cyclones east of the International Dateline to the Greenwich Meridian. (The term typhoon is used for Pacific tropical cyclones north of the Equator west of the International Dateline).

Hydrology – The science of dealing with the waters of the earth. A flood discharge is developed by a hydrologic study.

Impact – The effect of a hazard on the community and its assets.

Inland Flooding – Flooding that presents a risk within inland (non-coastal) areas, including riverine flooding and shallow flooding.

Inundation – The total water level that occurs on normally dry ground as a result of the storm tide, and is expressed in terms of height of water, in feet, above ground level.

Letter of Map Amendment (LOMA) – An amendment to the currently effective FEMA map which establishes that a property is not located in a Special Flood Hazard Area (SFHA). A LOMA is issued only by FEMA.

Letter of Map Revision (LOMR) – An official amendment to the currently effective FEMA map. It is issued by FEMA and changes flood zones, delineations and elevations.

Location –The geographic areas within the planning area that are affected by the hazard, such as a floodplain.

Lowest Floor Elevation (LFE) – The measured distance of a building's lowest floor above the National Geodetic Vertical Datum (NGVD) or other datum specified on the FIRM for that location.

Magnitude – A measure of the strength of a hazard event. The magnitude (also referred to as severity) of a given hazard is usually determined using technical measures specific to a hazard.

Mean Higher High Water (MHHW) – There are two high tides in each day, and one of those two is always higher than the other. The higher of the two high tide lines is called "Higher High Water." The National Oceanic Observatory Administration defines the MHHW as the average of the Higher High Water readings in a location over a 19 year period.

Mission Statement – A statement that drives the process and describes in a short, simple statement the intended outcome.

Mitigation – An effort to reduce the impact or loss from an incident.

Mitigation Strategy – The heart of the mitigation plan is the mitigation strategy, which serves as the long-term blueprint for reducing the potential losses identified in the risk assessment. The mitigation strategy describes how the community will accomplish the overall purpose, or mission, of the planning process.

Modified Mercalli Intensity (MMI) Scale – An intensity scale created to evaluate the effects of earthquakes, the MMI is the one currently used in the United States. Developed in 1931 by seismologists this scale is composed of increasing levels of intensity that range from imperceptible shaking to catastrophic destruction. Each level is designated by Roman numerals. It does not have a mathematical basis; instead it is an arbitrary ranking based on observed effects.

National Centers for Environmental Administration Information – Formerly the National Climatic Data Center, a division of the National Oceanic and Atmospheric Administration responsible for "preserving, monitoring, assessing, and providing public access to the Nation's treasure of climate and historical weather data and information."

National Flood Insurance Program (NFIP) – A program that makes federally-backed flood insurance available in those states and communities that agree to adopt and enforce flood-plain management ordinances to reduce future flood damage.

National Geodetic Vertical Datum (NGVD) of 1929 – National standard reference datum for elevations, formerly referred to as Mean Sea Level (MSL) of 1929. NGVD 1929 may be used as the reference datum on some Flood Insurance Rate Maps (FIRMs).

National Weather Service – A component of NOAA that provides weather, water, and climate data, forecasts and warnings for the protection of life and property and enhancement of the national economy.

Natural Disaster – A natural hazard event, such as a flood or tornado, which results in widespread destruction of property or caused injury and/or death.

Natural Environment – Natural systems with limited human influence. Examples: freshwater wetlands, coastal marshes, woodlands.

Natural Grade – The grade unaffected by construction techniques such as fill, landscaping or berming.

Natural Hazard – An unexpected or uncontrollable natural event of unusual magnitude that threatens the activities of people or people themselves.

Nor'easter – A storm along the East Coast of North America, so called because the winds over the coastal area are typically from the northeast. These storms may occur at any time of year but are most frequent and most violent between September and April.

North American Vertical Datum (NAVD) of 1988 – The vertical control datum established for vertical control surveying in the Unites States of America based upon the General Adjustment of the North American Datum of 1988. It replaces the National Geodetic Vertical Datum (NGVD) of 1929.

Repetitive Loss Structure – Any insurable building for which two or more claims of more than $1,000 were paid by the National Flood Insurance Program (NFIP) within any rolling 10-year period, since 1978 (claims made within 10 days of each other are counted as one claim). A repetitive loss property may or may not be currently insured by the NFIP (FEMA. Repetitive Loss Structure).

Resilience – The ability of systems, infrastructures, government, business, communities and individuals to resist, tolerate, absorb, recover from, prepare for, or adapt to an adverse occurrence that causes harm, destruction or loss.

Return Period – The return period of a storm is a shorthand way for experts and policy makers to standardize and discuss the strength of a theoretical storm event. It is also an expression of the characteristics of that theoretical storm, and an educated guess as to how often such a storm could occur.

Richter Scale – The Richter magnitude scale, developed in 1935 by Charles F. Richter, is a mathematical device to compare the size of earthquakes. The magnitude of an earthquake is determined from the logarithm of the amplitude of waves recorded by seismographs. Adjustments are included for the variation in the distance between the various seismographs and the epicenter of the earthquakes.

Risk – The potential for an unwanted outcome resulting from an incident, event, or occurrence, as determined by its likelihood and the associated consequences.

Risk Assessment – A product or process that collects information and assigns values to risks for the purpose of informing priorities, developing or comparing courses of action, and informing decision making.

Riverine Flooding – Surface water runoff introduced into streams and rivers exceeds the capacity of the natural or constructed channels to accommodate the flow; as a result, water overflows the stream banks, spilling out into adjacent low-lying areas.

Save the Bay – A Providence-based nonprofit organization whose mission is to "protect and improve Narragansett Bay."

Sea, Lake and Overland Surges from Hurricanes (SLOSH) Model – A computerized numerical model developed by the National Weather Service (NWS) to estimate storm surge heights resulting from historical, hypothetical, or predicted hurricanes by taking into account the atmospheric pressure, size, forward speed, and track data. These parameters are used to create a model of the wind field which drives the storm surge. The SLOSH model consists of a set of physics equations which are applied to a specific locale's shoreline, incorporating the unique bay and river configurations, water depths, bridges, roads, levees, and other physical features.

Sea Level Rise – The upward trend in average sea level height.

Severe Repetitive Loss: Any NFIP-insured single-family or multi-family residential building that has incurred flood-related damage for which four or more separate claims payments have been made, with the amount of each claim (including building and contents payments) exceeding $5,000; or for which at least two separate claims payments (building payments only) have been made, with the cumulative amount exceeding the market value of the building. In both instances, at least two of the claims must be within any rolling 10-year period, since 1978, and claims made within 10 days of each other are counted as one claim.

Shallow Flooding – For purposes of the National Flood Insurance Program (NFIP), shallow flooding is defined as that with a depth limited to 3.0 feet or less where no defined channel exists.

Shear Walls – Walls used for structural support but not structurally joined or enclosed at the ends (except by breakaway walls). Shear walls are parallel or nearly parallel, to the flow of the water and can be used in any flood zone.

Sheet Flow Hazard. A type of flood hazard with flooding depths of 1 to 3 feet that occurs in areas of sloping land. The sheet flow hazard is represented by the zone designation AO on the FIRM.

Special Flood Hazard Area (SFHA) – The shaded area on the Flood Insurance Rate Map (FIRM) which identifies an area that has a one percent chance of being flooded in any given year (100-year floodplain). The FIRM identifies these shaded areas as FIRM Zones A, AO, AH, A1 -A30, AE, A99, V, V1 -30, and VE.

Shelter – A place of refuge that provides life-sustaining services in a congregate facility for individuals who have been displaced by an emergency or a disaster.

State Hazard Mitigation Plan (SHMP) – A Plan that provides comprehensive guidance for hazard mitigation in the State of Rhode Island.

Storm Surge – The abnormal rise of water generated by a storm, over and above the normal astronomical tide, and is expressed in terms of height above predicted or expected tide levels. Since storm surge represents the deviation from normal tide levels, it is not referenced to a vertical or tidal datum.

Tornado – A violently rotating column of air extending ground-ward.

Tropical Cyclone – A generic term for a cyclonic, low-pressure system over tropical or sub-tropical waters.

Tropical Storm – A tropical cyclone with maximum sustained winds greater than 39 miles per hour and less than 74 miles per hour.

Variance – A grant of relief by a participating community from the terms of its floodplain management regulations.

Vector-borne diseases – Infections transmitted to humans and other animals by blood-feeding arthropods, such as mosquitoes and ticks.

Vertical Datum - A base elevation used as a reference from which to measure heights (or depths).

Vulnerability – Characteristics of community assets that make them susceptible to damage from a given hazard.

Vulnerability Analysis – An analysis of the risk of hazards impacting community assets.

Wildfire – A wildfire is an unplanned, unwanted fire burning in a natural area, such as a forest, grassland, or prairie. Wildfires can damage natural resources, destroy homes, and threaten the safety of the public and the firefighters who protect forests and communities.

Wildland Urban Interface (WUI) Zone – As building development expands into natural areas, homes and business may be situated in or near areas susceptible to wildfires.

Wind Chill Index – Wind chill index is an attempt 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.

Zoning Ordinance – Regulations that define how property can be used within zones as mapped on a Zoning Map. Regulations specify how property may be used and establish dimensional requirements including lot size, building placement, bulk (or density) and the height of structures.

Glossary Sources

Centers for Disease Control and Prevention (CDC)
Https://www.cdc.gov/

Coastal Resources Management Council (CRMC)
Http://www.crmc.ri.gov/aboutcrmc.html

Federal Emergency Management Agency (FEMA)
Https://www.fema.gov/about/glossary
Https://www.fema.gov/pdf/nfip/manual201205/content/22_definitions.pdf
Https://www.fema.gov/sites/default/files/2020-05/fim_appendix-i-severe-repetitive-loss-properties_apr2020.pdf
Https://www.fema.gov/sites/default/files/2020-06/fema-local-mitigation-planning-handbook_03-2013.pdf

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Https://forecast.weather.gov/glossary.php?
Http://www.nhc.noaa.gov/aboutgloss.shtml
Http://www.nhc.noaa.gov/news/20130806_pa_defineSurge.pdf
Https://www.weather.gov/safety/winter-noreaster

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Https://www.fs.fed.us/nwacfire/home/terminology.html

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Http://www.dem.ri.gov/programs/benviron/water/wetlands/pdfs/scoop.pdf

Save the Bay (STB)
Https://www.savebay.org/

Statewide Planning (RI Dept. of Administration)
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