

TECHNICAL MEMORANDUM

TO: Project Steering Committee
Wood-Pawcatuck Watershed Flood Resiliency Management Plan

FROM: Erik Mas, P.E.

DATE: May 5, 2017

RE: Land Use Policy and Regulatory Review
Wood-Pawcatuck Watershed Flood Resiliency Management Plan

1. Introduction

Flood resiliency can be enhanced through well-informed land use planning and municipal land use regulations. Municipal land use policies and regulations can help communities become more resilient to flooding by preserving undeveloped land, siting development in locations less vulnerable to flooding, and promoting designs that reduce runoff and are less likely to be damaged in a flood. Municipal land use policies and regulations also play an important role in protecting water quality and natural resources.

A review was conducted of the existing land use policies, plans, and regulations of the municipalities in the Wood-Pawcatuck watershed. The land use policies, plans, and regulations were reviewed relative to flood management, stormwater management, and related issues. The objective of this review is to recommend new or modified land use policies and/or regulations that could be implemented by the watershed municipalities to enhance flood resiliency in the Wood-Pawcatuck watershed.

The land use policy and regulatory review, along with a number of other technical evaluations of the watershed, supports the development of a flood resiliency management plan for the Wood-Pawcatuck watershed. This technical memorandum presents the methodology, results, and recommendations of the land use policy and regulatory review.

Existing Regulatory Context

Most of the communities in the Wood-Pawcatuck watershed have a similar land use regulatory structure that includes municipal comprehensive plans, zoning ordinances/regulations, land development and subdivision regulations, and local hazard mitigation plans. Municipal land use policies and regulations are periodically revised in response to development pressure, shifts in attitude toward flood mitigation and natural resource protection, and political and socioeconomic factors. Differences also exist in the land use policies and regulations of the watershed communities due to differences in the statutory framework, state regulatory programs, and local implementation in Rhode Island and Connecticut.

In Connecticut, the Office of Policy and Management plays a significant role in guiding and coordinating municipal land use policy and planning. In Rhode Island, the Department of Administration, Division of

Planning performs a similar function. Although the regulatory structure in both states is similar, there are some differences; the most significant one being that in Connecticut, the Inland Wetlands and Watercourses Act is implemented by municipalities, with guidance from the Connecticut Department of Energy and Environmental Protection (CTDEEP). In Rhode Island, wetlands are regulated both by the Rhode Island Department of Environmental Management (RIDEM) and the Coastal Resources Management Council (CRMC). In addition, approximately 20 Rhode Island communities enforce wetland buffers or setbacks through zoning regulations.¹

Increasingly, federal and state policy initiatives significantly influence land use policies and regulations at the local level. Examples include the National Pollutant Discharge Elimination System (NPDES) Phase II municipal separate storm sewer (MS4) permitting program, which requires municipalities in urbanized areas to develop and implement municipal stormwater management programs to address stormwater quality and related water quality issues. Communities participating in the National Flood Insurance Program (NFIP) are required to adopt, enforce, and maintain a local floodplain ordinance or regulation to be in compliance with the program. New initiatives to address climate change are also impacting local regulations. For instance, 2011 revisions to the Rhode Island Comprehensive Planning and Land Use Act (RIGL 45-22.2), required municipalities to address “natural hazards” (including flooding) in their comprehensive plans by 2016. This requirement is a driving force behind current efforts to update many of the comprehensive plans reviewed as part of this assessment, several of which are either under review or in draft form.

In 2014, the State of Rhode Island completed an update of the state *Hazard Mitigation Plan*. The plan includes comprehensive information for all Rhode Island towns relative to hazardous mitigation, including the number of current flood insurance policies and information regarding each town’s hazardous mitigation plans.

2. Review Method

A review was conducted of the existing land use policies, plans, and regulations of the watershed communities that comprise the majority of the land area in the Wood-Pawcatuck watershed (*Table 1*). The watershed communities of Coventry, East Greenwich, and North Kingstown were excluded from the review since each community comprises 1 percent or less of the total watershed area and each has less than 10 percent or less of their land area within the Wood-Pawcatuck watershed.

Table 1. Wood-Pawcatuck watershed municipalities included in the land use regulatory review.

Rhode Island	Connecticut
Charlestown	Stonington
Exeter	North Stonington
Hopkinton	Sterling
Richmond	Voluntown
South Kingstown	
West Greenwich	
Westerly	

The land use policies, plans, and regulations were reviewed relative to flood management and stormwater management, although related issues such as erosion and sediment control and wetlands

protection were also addressed as secondary issues, where applicable. The review incorporated elements of the U.S. Environmental Protection Agency's "Flood Resilience Checklist" and accompanying report "Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities" which was developed as part of EPA's Smart Growth Implementation Assistance project in the state of Vermont. The checklist and report include strategies to improve flood resilience through policy and regulatory tools, including comprehensive plans, hazard mitigation plans, local land use codes and regulations, and non-regulatory programs implemented at the local level.² Concepts and strategies contained in the Federal Emergency Management Agency (FEMA) "Integrating Hazard Mitigation into Local Planning Case Studies and Tools for Community Officials"³ were also used to guide the review.

For each town, the currently-available versions (as of the date of our review) of the following policy and planning documents and regulations were reviewed:

- Comprehensive Plans – a comprehensive plan (referred to as "Plan of Conservation and Development" in Connecticut) sets the overall policy direction and guides future land use decisions in a community. Local land use policy and related development regulations are required to conform to comprehensive plan policies. Through comprehensive planning, communities can reinforce the importance of flood resilience in their land use policies and identify priority areas for resource protection or development, including areas susceptible to flooding such as floodplains for limited or low impact development and less susceptible areas targeted for future development. In Rhode Island, communities are required to address natural hazards (including flooding) in their comprehensive plans.⁴
- Zoning, Subdivision, and Land Development Regulations – Zoning, subdivision, and other land development regulations control the location, type, and intensity of land uses, and often contain provisions to regulate height, bulk dimensions, setbacks, stormwater management, and other physical characteristics of development. Such regulations, including overlay zones, can be used to guide development away from flood hazard areas. Zoning ordinances and subdivision regulations of the watershed communities also contain floodplain management provisions.
- Flood/Hazard Mitigation Plans or Natural Hazard Plans – Hazard Mitigation Plans can affect community flood resilience by informing how communities plan for and reduce or eliminate risk from natural hazards such as floods. A Hazard Mitigation Plan is required for a community to receive Hazard Mitigation Grant Program funding from FEMA. Hazard Mitigation Plan recommendations are typically incorporated into a community's municipal comprehensive plan.

Tables 2 and 3 identify the versions of the land use plans and regulations that were reviewed, including the most recent revision. Several of the town documents were in draft form or were undergoing revision at the time of our review and are noted accordingly in the tables. Town summaries highlighting existing policies and regulations are described in *Section 3*.

Most of the regulations reviewed were available on municipal web sites in PDF or Word format. Some regulations were only available on commercial websites, such as MUNICODE. Regulations on the

MUNICODE website are generally not as well-annotated and may have standard formatting that differs slightly from the original source documents (town regulations). Regulations from some of the smaller towns were not available in digital format and required review of hard copy documents in municipal offices.

Table 2. Rhode Island Municipal Land Use Plans and Regulations – Year Revised

Plan or Regulation	Charlestown	Exeter	Hopkinton	Richmond	South Kingstown	West Greenwich	Westerly
Comprehensive Plan	2006 (update in progress)	2003	2011	2014	2014	2008	2010
Land Development and Subdivision Regulations	2015	2013	2014	2015	2012	2015	2016
Zoning/ Floodplain Ordinance	2015 (2013 Flood Damage Prevention Ordinance)	2016 (2010 Special Flood Hazard Areas Ordinance)	2007	2011	2016	2015 (2010 Floodplain Ordinance)	2015
Hazard Mitigation Plan	2016	2005	2012	2015	2010	2005	2012
Stormwater Management Plan	2005	2004	2013	2007	Undated	2003	2008

Table 3. Connecticut Municipal Land Use Plans and Regulations – Year Revised

Plan or Regulation	Stonington	North Stonington	Sterling	Voluntown
Plan of Conservation and Development	2015	2013	2009	2010
Subdivision Regulations	2006	2015	2010	2011
Zoning Regulations/ Floodplain Ordinance	2015	2015	2015 (2014 Floodplain Management Ordinance)	2012 (2011 Flood Damage Prevention Ordinance)
Hazard Mitigation Plan	2005 (Town)	2013	2016	2013
Stormwater Management Plan	2017	Not regulated by the MS4 Permit	Not regulated by the MS4 Permit	Not regulated by the MS4 Permit

For most of the watershed communities, floodplain and flood management requirements are incorporated into the municipal zoning ordinance/regulations (or stand-alone floodplain ordinance) and subdivision regulations, and were therefore reviewed as part of these ordinances/regulations. Similarly, stormwater management requirements for new development and redevelopment projects are also typically addressed in municipal zoning ordinances and subdivision regulations.

The National Flood Insurance Program (NFIP) provides flood insurance to property owners in participating communities. This program is a direct agreement between the federal government and the local community that flood insurance will be available to residents in exchange for the community's compliance with minimum floodplain management requirements such as the adoption of a floodplain management or flood damage prevention ordinance. In order for property owners to purchase flood insurance through the NFIP, their community must be in good participant standing in the NFIP. Communities participating in the NFIP must:⁵

- Adopt the FIRMs as an overlay regulatory district or through another enforceable measure
- Require that all new construction or substantial improvement to existing structures in the SFHA will be compliant with the construction standards of the NFIP and State building code, which is implemented at the local level by municipal building officials
- Require additional design techniques to minimize flood damage for structures being built in high hazard areas, such as floodways or velocity zones.

All communities within the watershed participate in the National Flood Insurance Program (NFIP) and have minimum standards in their zoning and subdivision regulations to ensure review of proposed development activities proposed within areas subject to flooding. A few towns have adopted flood protection ordinances with provisions that have not yet formally been adopted into the published zoning, land development and subdivision regulations. Although the ordinances are generally enforced by building officials or land use staff, consistent enforcement of these provisions may be enhanced with formal adoption into land use ordinances and regulations.

The Community Rating System (CRS) is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. The CRS program emphasizes the reduction of flood losses, facilitating accurate insurance rating, and promoting the awareness of flood insurance. By participating in the CRS program, communities can earn a discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community. Currently, four (4) communities in the Wood-Pawcatuck watershed – Charlestown, North Kingstown, Westerly, and Stonington – participate in the CRS program, receiving discounts for flood insurance premiums of between 5% and 15%.⁶

All of the Rhode Island communities in the watershed developed Stormwater Management Plans (SWMPs) in response to the NPDES Phase II municipal stormwater permit program, which regulates stormwater discharges from small municipal separate storm sewer systems in urbanized areas. Charlestown and Hopkinton are expected to be regulated under a potential future reissued Rhode Island MS4 Permit because of existing water quality impairments and TMDLs established for waters in those towns and/or expected changes in population. Enhanced enforcement of the existing RI MS4 Permit is anticipated regardless of whether the permit is reissued. This is evidenced by recent RIDEM enforcement actions against other Rhode Island municipalities. In the Connecticut portion of the watershed, only Stonington is a regulated MS4 community. The Connecticut MS4 Permit was re-issued in January 2016 and becomes effective in July 2017. MS4 Permit programs in both states require regulated communities to review and update their local land use regulations to require post-construction stormwater management for new development and redevelopment, as well as promote and remove barriers to the use of Low Impact Development (LID), and implement stormwater infrastructure retrofits to address water quality impairments and TMDLs.

The land use regulatory review also included selected findings from the “Ordinance Checklist for LID Stormwater Site Planning and Design,”⁷ which was previously completed by each of the municipalities in the Rhode Island portion of the watershed. The Ordinance Checklist was developed by RIDEM and is designed to allow communities to determine what specific LID site planning and design techniques they have adopted or may need to adopt to more effectively encourage LID practices for new development and redevelopment. Significant recommendations from the checklist are incorporated selectively in the recommendations below. However, no effort was made to reproduce or include all of the LID recommendations from the checklist. Recommendations from the checklist that are included in this review are measures that serve to address both flooding and water quality.

Inland Wetland and Watercourses Regulations of the four Connecticut towns were reviewed but are not discussed in detail in this memorandum. As a result of revisions to the Connecticut Inland Wetland and Watercourses Act in 1996, municipalities are limited in the scope of their authority, and must adhere to narrow jurisdictional limits. For instance, prohibitive wetland buffers are not permitted in the Act or in municipal regulations. Most municipalities have regulations that adhere to the 2006 Model Regulations put forth by the State of Connecticut. The regulations define a permitting structure based on the qualitative review of applications based on a defined “Criteria for Decisions.” All municipal wetland regulations in the state are relatively consistent and have few differences that impact considerations for floodplain and stormwater management.

3. Summary of Existing Land Use Policies and Recommendations

This section provides a summary of the local land use context, existing land use policies and regulations, and key recommendations for each of the watershed communities. The tabular summaries highlight aspects of the existing land use policies and regulations that are considered particularly beneficial or effective in reducing impacts associated with flooding and/or those that address stormwater management. Specific recommendations are provided for each town to further enhance flood resiliency in the Wood-Pawcatuck watershed. General recommendations that potentially apply to one or more towns are provided after the individual town reviews.

Charlestown, RI

The Town of Charlestown is located between the Pawcatuck River to the north and the south shore of Rhode Island. Charlestown is a rural community with small areas of low density development and a 2015 population of 7,941, with roughly 5,500 estimated residents living in the watershed. The town has a land area of approximately 59.3 square miles, with approximately 25 square miles (66.3%) located within the southern portion of the Wood-Pawcatuck watershed. The town comprises 8.3% of the watershed. Flood-prone areas of Charlestown within the Wood-Pawcatuck watershed are primarily located along the Pawcatuck River. Municipal land use policies and regulations are primarily implemented by the following boards and commissions (Zoning Boards of Appeals are not listed below for Charlestown or any of the other watershed communities, as they are typically not involved in policy decisions):

- Planning Commission
- Zoning Board of Review
- Conservation Commission.

The Charlestown Building and Zoning Department administers the Town's floodplain management program and participation in the National Flood Insurance Program (NFIP) and associated Community Rating System (CRS), as well as implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – Charlestown, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Floodplain Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2006 (update in progress)	2015 (2013)	2015	2016
Flood Management	<p>Contains numerous references to the protection of natural resources, water quality, and the reduction of flood hazard potential.</p> <p>The 2016 plan update will contain goals and policies related to and supportive of the Charlestown Natural Hazard Mitigation Plan. The updated Comprehensive Plan will address natural hazards from a long-term planning perspective.</p>	<p>Any construction or development within special flood hazard areas is subject to Flood Hazard Areas overlay district requirements. Twelve restrictions apply to activities within special flood hazard areas. Discourages development or redevelopment within natural hazard areas with restrictions on development, including the Town's rezoning procedures which limit zoning changes in identified vulnerable areas.</p> <p>A separate Flood Damage Prevention Ordinance (adopted in 2010 and amended in 2013) contains additional provisions and use regulations for Special Flood Hazard Areas.</p>	<p>Addresses flood hazards in a comprehensive manner, including requirements to conduct additional analysis for any development that includes areas in designated floodplains and requirements that the Planning Commission makes several determinations and finding of fact when designated flood zones are involved. Provide for low density "residential compounds" and cluster subdivisions, which are mandatory for 6 or more lots to provide open space and direct development to suitable land.</p>	<p>The plan describes an integrated approach to land use regulations to reduce hazards in flood zones. Recommends consideration of climate change impacts on inland flooding. Recommends that the Town use the Wood-Pawcatuck Watershed Flood Resiliency Management Plan in future land use planning efforts to promote resiliency and protection from flooding. Plan will be referenced in the Comprehensive Plan for consistency and Capital Improvement Plan for potential funding of projects.</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Floodplain Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2006 (update in progress)	2015 (2013)	2015	2016
Stormwater Management	Includes a policy provision to require stormwater management for any new or rehabilitated road and encourages developers to reduce paved surfaces and encourage infiltration of runoff through conservation subdivision design.	Zoning regulations conform to the Comprehensive Plan. Erosion control plans are required for disturbance of more than ½ acre. Charlestown adheres to standards in the RIDEM Stormwater Design and Installation Manual and RI Soil Erosion and Sediment Control Handbook through zoning ordinance and subdivision regulations.	Several elements have been recently updated to reduce impervious cover. The regulations include a general provision requiring LID measures to be used over traditional stormwater management systems.	Promotes the use of LID and green infrastructure for flood resiliency and other related benefits. Identifies the storm attenuation function of natural areas such as wetlands, riparian areas, and floodplains.

Recommendations – Charlestown

- Building on Charlestown’s participation in the NFIP Community Rating System and as recommended in the Town’s 2016 Natural Hazard Mitigation Plan, consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program and municipal Comprehensive Plan (see General Recommendation 7).
- Consider the following amendments to the Town’s zoning ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendation 2).
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider amendments to the existing conservation/cluster development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to street and parking lot design standards in the zoning ordinance and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Exeter, RI

Exeter is located in the upper third of the Wood-Pawcatuck watershed, including portions of the Wood River, Queen River, and Chipuxet River. Over 90% or 48 square miles of the town land area is located within the Wood-Pawcatuck watershed. The 2010 population of the town was 6,425, with the majority of the population living in the watershed. Flooding is not identified as a critical issue in either the Comprehensive Plan or Natural Hazard Mitigation Plan. However, these policy documents pre-date the 2010 flood. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning Board
- Zoning Board
- Conservation Commission
- Building Board.

The Exeter Building Department administers the Town's floodplain management program and participation in the NFIP, as well as implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – Exeter, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Special Flood Hazard Area Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2003	2016 (2010)	2013	2005
Flood Management	<p>Flooding is not listed as a critical issue in the plan. The plan pre-dates the 2010 flood.</p> <p>The updated plan will address natural hazards from a long-term planning perspective, as required by statute.</p>	<p>Establishes Special Flood Hazard Areas ordinance overlay district. Uses within the overlay district are limited and must comply with NFIP provisions and all applicable state and federal codes and standards.</p> <p>Conservation Developments are encouraged to conserve natural resources, including floodplains.</p> <p>Floodplains must be mapped on site plans.</p> <p>Drainage systems are defined as systems that prevent or alleviate flooding.</p>	<p>Modifications to the floodplain are regulated and subdivisions must be developed in such a way to reduce flood damage or increases in flooding.</p> <p>All approvals are contingent on a positive finding that the site design and street location minimize flooding.</p> <p>Open Space design requirements include conservation of floodplains.</p>	<p>The town rates vulnerability to flooding as low. There are six flood insurance policies identified in town and no known flood losses recorded since 1978. The plan pre-dates the 2010 flood. The 2014 updated state Hazard Mitigation Plan lists 8 flood insurance policies.</p>
Stormwater Management	<p>Policies include the encouragement to use innovative land use techniques to minimize impacts to natural resources and reduce impervious</p>	<p>All projects subject to development plan review require the use of stormwater controls that meet the standards of the Rhode Island Stormwater Design and Installation</p>	<p>Conservation Developments are allowed to provide for the maintenance of open space for stormwater drainage and other features.</p>	<p>Recommends the review of the Comprehensive Plan and other regulations to ensure that stormwater does not contribute to</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Special Flood Hazard Area Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2003	2016 (2010)	2013	2005
	surfaces.	Standards Manual and are of nonstructural character to the extent possible. Special uses must demonstrate that BMPs will minimize adverse effects to water quality, and stormwater runoff. Development standards include general provision for stormwater runoff and soil erosion, such that water quality and storm drainage is not affected. Must be consistent with RI Runoff and Erosion and Sediment control Handbook.	Conservation Developments must use infiltration measures, instead of traditional detention.	flooding.

Recommendations – Exeter

- The Hazard Mitigation Plan is due to be updated and should address flood-prone areas identified during the 2010 flood and subsequent flood events. Street flooding was identified as an issue in the 2010 flood.
- Update and integrate the hazard mitigation plan and comprehensive plan, and reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program, including the next Hazard Mitigation Plan and municipal Comprehensive Plan updates (see General Recommendation 7).
- Consider the following amendments to the Town's Zoning and Special Flood Hazard Area ordinances to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider amendments to the existing conservation development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).

- Consider amendments to street and parking lot design standards in the zoning ordinance and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Hopkinton, RI

The Town of Hopkinton, with a 2010 population of 8,188, is bordered on the east by the Wood River and by the Pawcatuck River to the south. The town is situated entirely within the Wood-Pawcatuck watershed, comprising approximately 14.6% of the watershed land area. Municipal land use policies and regulations are primarily implemented by the following boards and commissions.

- Planning Board
- Zoning Board
- Conservation Commission.

The Town's Building Official is the Hopkinton NFIP coordinator and implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – Hopkinton, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2011	2007	2014	2012
Flood Management	<p>The plan notes that State Guide Plan encourages services in Urban Service Boundaries. This may be in conflict with municipal concerns that Wyoming and Hope Valley are currently developed beyond carrying capacity regarding critical resources, including floodplains.</p> <p>Recommends partnering with the Wood-Pawcatuck Watershed Association to prioritize areas for river use and grant development.</p> <p>Floodplains are defined as critical resources.</p>	<p>Establishes a floodplain overlay district with specific standards.</p> <p>All encroachments, including, fill, new construction, substantial improvements to existing structures, and other development in floodway are prohibited unless certification by a registered professional engineer is provided by the applicant demonstrating that such encroachment shall not result in any increase in flood levels during the 100-year flood.</p> <p>Additional development restrictions in floodplain zones define permitted uses. No uses are allowed that will interfere with flood flows, or increase flooding.</p> <p>Includes residential cluster development.</p>	<p>Policies include the preservation of natural resources, including floodplains and conformance with State and Federal laws, with particular attention to areas on FIRMs.</p> <p>A positive finding must be made for approved projects that the proposed development minimizes flooding (and erosion).</p> <p>Public Improvement Standards include a provision that proposed construction in floodplains is avoided whenever possible.</p> <p>Includes provisions for Residential Cluster Subdivisions to protect open space and existing natural areas, and to prevent the sprawl of conventional subdivisions.</p>	<p>The plan identifies flooding as the hazard with the highest risk of occurring, considering frequency, duration, and impact.</p> <p>Critical facilities and roads are identified related to specific hazards.</p> <p>Chapter 7 is dedicated to a comprehensive review of flood hazards within the municipality.</p> <p>Identifies existing land use regulations as the most effective protective measures to address flooding.</p> <p>Recommends review of existing Floodplain Ordinance, while noting the strength of existing regulations.</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2011	2007	2014	2012
Stormwater Management	<p>Recommends implementing a stormwater management ordinance emphasizing LID strategies.</p> <p>LID requirements were included in the 2014 revisions of the Subdivision and Land Development Regulations.</p>	<p>General provisions require submission of erosion control and stormwater control plans.</p>	<p>Requires the use of LID approaches, including a combination of natural and manmade elements, for drainage design consistent with the RI Stormwater Design and Installation Standards Manual.</p> <p>Drainage shall be designed to reduce runoff, encourage infiltration, prevent flooding, control peak discharges, and provide pollutant remediation.</p> <p>Prohibits the use of hard surfaces for recreational walkways.</p>	<p>References subdivision regulations with standards for reducing stormwater-related flooding.</p>

Recommendations – Hopkinton

- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program and municipal Comprehensive Plan (see General Recommendation 7).
- Consider the following amendments to the Town's zoning ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendation 2).
- Consider amendments to the existing conservation/cluster development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to street and parking lot design standards in the zoning ordinance and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).

- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Richmond, RI

Richmond, with a 2010 population of 7,708, is located entirely within the Wood-Pawcatuck watershed and comprises approximately 13.5% of the watershed land area. Richmond is bordered to the west by the Wood River and to the south by the Pawcatuck River. Several other north-to-south flowing tributaries flow through Richmond, feeding the Pawcatuck River. Roughly 11% of the land area in Richmond is located in a flood hazard area. Municipal land use policies and regulations are primarily implemented by the following boards and commissions.

- Planning Board
- Zoning Board of Review
- Conservation Commission
- Rural Preservation Land Trust.

The Richmond Building Department administers the Town's floodplain management program and participation in the NFIP, as well as implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – Richmond, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2014	2011	2015	2015
Flood Management	Includes a number of general planning policies to protect sensitive resources, including floodplains and to encourage land uses that are appropriate based on land capacity and suitability. References the Flood Hazard Overlay District as a specific provision that limits development in areas subject to flooding.	Establishes a Flood Hazard Overlay District. All development in the overlay district must be reviewed by the Building Official to ensure compliance with most recent building codes for flood resistant siting and construction. Contains provisions for conservation development, which replaced earlier cluster development provisions.	Defines floodplains as land unsuitable for development. Floodplains and wetlands are areas to be included in open space. Residential site design must prevent flooding. Every major and minor subdivision shall be designed as a Conservation Development unless Planning Board finds that a conventional design would be more appropriate because of the location or characteristics of the site or the proposed use or uses.	Identifies flooding as the most common natural hazard. Recognizes the importance of land use regulation for flood protection. References cluster and conservation developments as opportunities to protect vulnerable resources and reduce stormwater and flooding impacts.
Stormwater Management	References the Stormwater System Protection Town Ordinance. States that the preferred	General provisions require submission of erosion control and stormwater control plans.	Requires post development peak flows are not increased. Requires LID practices to be incorporated to the extent practical.	Recognizes the importance of adequate stormwater management for flood control. References specific

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2014	2011	2015	2015
	development strategy is to promote Low Impact Development techniques.		Preference is given to open systems over closed systems.	locations in town that are subject to flooding and current investigation of stormwater management issues in those localities.

Recommendations – Richmond

- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program and municipal Comprehensive Plan (see General Recommendation 7).
- Consider the following amendments to the Town's zoning ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendation 2).
- Consider amendments to the existing conservation/cluster development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to street and parking lot design standards in the zoning ordinance and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

South Kingstown, RI

South Kingstown, with a 2010 population of 30,639 and roughly 13,000 residents living in the watershed, is situated in the southwestern portion of the Wood-Pawcatuck watershed. Approximately 46% of the land area in South Kingstown is located within the watershed, most of which is primarily rural in character. South Kingstown is home to Worden Pond, Great Swamp, Chickasheen Brook, Chipuxet River, and several smaller headwater tributaries. Kingston, a historic residential village at the north end of town, is dominated by the University of Rhode Island campus, while Usquepaugh village is defined by the Queen and Usquepaug Rivers. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning Board (and Technical Review Committee)
- Zoning Board of Review
- Conservation Commission
- Building Code Board of Appeals
- Sustainability Committee.

The Town's Building Inspection and Zoning Department administers the Town's floodplain management program and participation in the NFIP, as well as implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – South Kingstown, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2014	2016	2012	2010
Flood Management	<p>Floodplains identified in the inventory of resources.</p> <p>References the adoption in 2010 of a "Floodplain Management Ordinance" to regulate development in Special Flood Hard Areas.</p> <p>Protection of floodplains from development mentioned in several sections.</p>	<p>Establishes a special flood hazard overlay district. All development projects within the overlay district require a permit.</p> <p>Uses within the overlay district are limited, and development is regulated to reduce flood impacts and increases to base flood elevations.</p>	<p>The Design and Public Improvement Standards section includes several special provisions for development in flood zones, including provisions to elevate utilities.</p>	<p>Coastal flooding is the primary focus of the NHMP. Inland/riverine flooding is not identified as a specific issue.</p>
Stormwater Management	<p>The Plan includes many specific references to storm water management and a "watershed approach" to addressing stormwater</p>	<p>Zoning regulations only require the use of Low Impact Development techniques in the Post Road District to minimize or eliminate the loss of annual groundwater</p>	<p>The regulations include measures to maintain existing drainage patterns and to maintain existing peak flows.</p>	<p>No specific references to stormwater.</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2014	2016	2012	2010
	<p>regulation. References compliance with the RI Phase II Stormwater Management program as a goal.</p> <p>Promotes LID stormwater measures as an opportunity to improve overall stormwater management.</p>	<p>recharge. Discourages the placement of stormwater infrastructure in floodplains.</p>	<p>Public improvement standards include stormwater infrastructure.</p> <p>Encourages the use of existing drainage patterns and open systems.</p> <p>No specific provisions for LID or green infrastructure.</p>	

Recommendations – South Kingstown

- Amend zoning ordinance and land development/subdivision regulations to require that all new development and redevelopment projects comply with LID standards consistent with the Rhode Island Stormwater Design and Installation Standards Manual (see General Recommendation 13).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program and municipal Comprehensive Plan (see General Recommendation 7).
- Consider the following amendments to the Town's zoning ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendation 2).
- Consider amendments to the existing conservation development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to street and parking lot design standards in the zoning ordinance and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).

- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

West Greenwich, RI

West Greenwich makes up approximately 8.7% of the Wood-Pawcatuck watershed. Approximately 51% of the Town's land area and an estimated 3,200 residents are located within the watershed. The western half of the Town is situated at the headwaters of the Wood River, while a small portion of the southeastern corner of the town includes Dead Swamp and tributary streams that drain to the Queen River. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning Board
- Zoning Board
- Conservation Commission
- Land Trust.

The Planning Department is responsible for the Town's stormwater management and hazard mitigation programs, while the Building Official administers the Town's floodplain management program and participation in the NFIP, as well as implements and enforces the State Building Code.

Summary of Existing Land Use Policies and Regulations – West Greenwich, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Floodplain Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2008	2016 (2015)	2015	2005
Flood Management	<p>Floodplains are included in the inventory of resources and reference is made to development restrictions based on state and federal mandates.</p> <p>Wetland systems are recognized for their ability to provide flood storage.</p> <p>Compliance with NFIP is assured by the review of proposed development by the building inspector, as designated by the floodplain ordinance.</p>	<p>Floodplain ordinance establishes provisions for construction or other development and uses in special flood hazard areas.</p> <p>Establishes special flood hazard area regulations prohibiting development from the regulatory floodway, creation of new lots that would constrict development to occur partly or wholly within special flood hazard areas, and outdoor storage of certain materials and equipment.</p>	<p>The floodplain ordinance includes provisions for the review of the flood impacts of subdivisions and land development.</p> <p>General requirements necessitate that improvements minimize flooding.</p> <p>Floodplains are designated as areas unsuitable for development.</p> <p>Floodplains are promoted as areas to be preserved as open space.</p> <p>Includes conservation design development provisions.</p>	<p>According to the plan, riverine flooding is limited in West Greenwich. Portions of town experience frequent street flooding during heavy rain. Identifies several dams as potential flood hazards. The plan pre-dates the 2010 flood and is due for an update.</p> <p>The plan notes that if the town participates in the FEMA Community Rating System, residents will be eligible for discounts for flood insurance.</p> <p>Recommends review of the Comprehensive Plan for drainage requirements.</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance (Floodplain Ordinance)	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2008	2016 (2015)	2015	2005
Stormwater Management	Recommends the prohibition of direct stormwater discharges into natural waterways.	<p>Statement of purpose includes the protection of public infrastructure including stormwater systems.</p> <p>Encourages limits on road and utility lengths to reduce the need for stormwater infrastructure.</p>	<p>Requires that Stormwater Management Plans conform to state design standards.</p> <p>Provides for the use of infiltration basin, trenches, and subsurface chambers.</p> <p>Developers strongly encouraged to use structural stormwater measures which promote volumetric mitigation in addition to peak flow rate mitigation, specifically by means of stormwater infiltration, where practicable.</p> <p>Encourages the use of LID provisions in landscaping plans.</p> <p>Specifies non-structural LID measures for stormwater management including reduction of impervious cover and the use of vegetated conveyance systems.</p>	Notes the relationship between storm drainage and flooding.

Recommendations – West Greenwich

- Update and integrate the hazard mitigation plan and comprehensive plan, and reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program, including updated hazard mitigation plan and municipal Comprehensive Plan (see General Recommendation 7).
- Consider the following amendments to the Town's floodplain ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements

- Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendation 2).
- Consider amendments to the existing conservation development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Westerly, RI

The Town of Westerly has the largest population living in the watershed, at just over 21,000 according to the 2010 Census. Approximately 77% of the town's land area is located within the watershed. The Pawcatuck River flows along the Town's northern boundary with Hopkinton, ultimately discharging to Little Narraganset Bay between Westerly and Stonington, Connecticut. Many areas of Westerly are susceptible to riverine and drainage-related flooding, as well as coastal and storm surge flooding along the lower, tidal portion of the Pawcatuck River. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning Board
- Zoning Board
- Conservation Commission
- Municipal Land Trust.

The Emergency Management Department and Building Official implement the Town's floodplain management program and participation in the NFIP and Community Rating System (CRS).

Summary of Existing Land Use Policies and Regulations – Westerly, RI

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2010	2015	2016	2012
Flood Management	The plan recognizes the importance of wetlands to provide flood storage. Crandall Swamp is noted for its importance for flood storage.	<p>Establishes a Special Flood Hazard overlay district.</p> <p>Specific elevations are set for structures, depending on use.</p> <p>All encroachments that will increase flooding are prohibited.</p> <p>Commercial buildings cannot be converted to residential uses.</p> <p>The plan review process has special provisions to address floodplains, wetlands, and drainage.</p>	<p>Preliminary and Master Plan Review procedures require mapping of floodplains.</p> <p>Regulations require that land in floodplains be preserved as undeveloped open space</p> <p>Land in floodplains must be preserved as undeveloped open space.</p>	<p>The plan was updated in 2012 and references severe river flooding that occurred in 2010.</p> <p>Structures must be elevated or flood-proofed in flood hazard areas.</p> <p>All demolition and reconstruction build to FEMA and local standards for flood zones, and incorporate RIDEM requirements for stormwater management.</p> <p>The plan references comprehensive strategies for flood protection through Open Space Acquisition, construction of flood control structures, debris removal, and other municipal-led efforts to alleviate flood</p>

Plan or Regulation	Comprehensive Plan	Zoning Ordinance	Land Development and Subdivision Regulations	Natural Hazard Mitigation Plan
Most Recent Revision Date	2010	2015	2016	2012
				<p>hazards.</p> <p>Plan will be referenced in the Comprehensive Plan for consistency. Recommends several measures to improve the Comprehensive Plan to improve flood protection, including focusing open space protection on floodplains.</p>
Stormwater Management	<p>The plan recognizes stormwater as a “stressor” to the Pawcatuck River and acknowledges that extensive stormwater upgrades will be necessary by 2025.</p> <p>Action items regarding stormwater include a general plan of enforcement of BMP's, monitoring the effects of implementation, and modification of the plan as necessary.</p>	<p>Requires consistency for all new development to conform to RIDEM Stormwater Design and Installation Standards Manual.</p> <p>Mixed use developments are promoted to, amongst other goals, encourage on-site treatment of stormwater.</p> <p>Development standards include provisions for Erosion Control and maintenance of pre-development run-off rates.</p> <p>The regulations have standards for maximum impervious coverage, based on zoning district.</p>	<p>Regulations include Design and Improvement standards.</p> <p>Grass swales are permitted as an alternative to closed drainage.</p> <p>Natural drainage patterns are to be maintained and watercourses shall be left open.</p> <p>Development standards include minimization of impervious cover and detailed standards for the use of bioretention for stormwater systems, including requirements for water quality treatment.</p>	<p>Updates to the stormwater system to accommodate flood improvement will conform to RIDEM stormwater requirements.</p>

Recommendations – Westerly

- Consider developing a coastal resiliency plan, similar to the ongoing planning effort being undertaken by the Town of Stonington, to better protect public infrastructure from coastal flooding and sea level rise.
- Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendation 11).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program, including municipal Comprehensive Plan (see General Recommendation 7).

- Consider the following amendments to the Town's zoning ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Conservation Development and Transfer of Development Right (TDR) provisions in the zoning ordinance (see General Recommendations 2 and 4).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Stonington, CT

Approximately 11% of the Town of Stonington's land area is located within the Wood-Pawcatuck watershed, and the town makes up just 1.5% of the watershed area. The lower Pawcatuck River forms the border between Stonington and Westerly, Rhode Island. An estimated 7,600 Stonington residents live in the watershed, primarily concentrated in and around the village of Pawcatuck. The Borough of Stonington is located entirely outside of the Wood-Pawcatuck watershed. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning and Zoning Commission
- Inland Wetlands and Watercourses Commission
- Harbor Management Commission
- Stormwater Task Force
- Climate Change Task Force.

Engineering, Planning, Emergency Management, and the Town's Building Official collectively implement the Town's floodplain management program and participation in the NFIP and Community Rating System (CRS). The Town's Building Department enforces the state building code.

In October 2016, the Town initiated a "Community Coastal Resiliency Plan" process for the town. The purpose of the plan is to:

- Protect public infrastructure from coastal flooding and sea level rise
- Minimize potential for loss of life and destruction to property
- Minimize the expenditures associated with repeated repairs to public infrastructure after storms
- Identify ways to enhance coastal resources.

Overall, the Town of Stonington implements a number of progressive land use policy and regulatory tools related to floodplain management including standards that are more stringent than the minimum NFIP requirements – participation in CRS, more stringent freeboard, cumulative substantial improvement/damage standards, etc.

Summary of Existing Land Use Policies and Regulations – Stonington, CT

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations	Subdivision Regulations	Hazard Mitigation Plan Annex (Town)
Most Recent Revision Date	2015	2015	2006	2005
Flood Management	Notes conflicts between flood and zoning regulations (elevating structures versus maximum allowable building height) in the aftermath of storms Sandy in 2012 and Irene in 2011. Encourage continued improvement in the	Establishes Flood Hazard Overlay District (modified in 2013). Base flood elevation data required for all development which is five acres (total parcel size) or fifty lots. Building allowed in flood plain areas provided that a registered engineer or	Requires that any subdivision in a floodplain have provisions for protective flood control measures. Regulations require that building methods be specified for all construction adjacent to floodplains and waterbodies.	Plan developed in 2005 and is due to be updated. Land use regulation is highlighted as one of the principle techniques used to reduce flood damage. "Prevention" and "Natural Resource Protection" are listed as

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations	Subdivision Regulations	Hazard Mitigation Plan Annex (Town)
Most Recent Revision Date	2015	2015	2006	2005
	<p>hazard mitigation planning process.</p>	<p>architect certifies that the design and methods of construction are in accordance with accepted standards of practice to minimize flooding and flood damage.</p> <p>At least 1 foot of freeboard required for new construction or substantial improvement in flood hazard areas. The town requires elevation certificates to verify that a structure has been elevated to the proper height in and around a flood zone.</p> <p>Include provisions for Flood Hazard Reduction involving utilities, building materials, first floor elevations.</p> <p>Amendments to definitions allow for cumulative Substantial Improvement/Substantial Damage.</p>	<p>Requires setbacks from "natural areas".</p>	<p>alternative flood mitigation measures.</p> <p>Recommended measures for flood protection and mitigation include limiting development in the floodplain and applying a "freeboard" standard for structure elevations.</p> <p>The Annex lists 8 properties that are susceptible to flooding along the Pawcatuck River.</p>
Stormwater Management	<p>Non-structural, green infrastructure measures are to be used where possible.</p> <p>Protection of water quality and quantity is high-lighted as a means to address overall stormwater management issues.</p> <p>LID measures, vegetation management, and reducing impervious coverage are promoted.</p>	<p>Parking lot runoff is to be renovated before discharging into waterways in areas adjacent to the Pawcatuck River. A 100-foot non-infringement area is required where development abuts the Pawcatuck River.</p> <p>Non-structural stormwater measures are encouraged for special use permits and open space developments.</p> <p>Parking lots must be designed to minimize stormwater impacts and porous surfaces are encouraged.</p>	<p>Final subdivision plans must be accompanied by a Stormwater Management Report.</p> <p>One of the stated goals of Open Space Subdivisions is to encourage a reduction in impervious surfaces.</p> <p>All other stormwater measures are addressed in separate document, "Technical Standards for Land Development and Road Construction"</p> <p>Technical standards include an allowance for "Alternative</p>	

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations	Subdivision Regulations	Hazard Mitigation Plan Annex (Town)
Most Recent Revision Date	2015	2015	2006	2005
		<p>Drainage calculations based on a 25-year storm except in a flood hazard area where a 100-year storm is required.</p> <p>Effective impervious coverage may be achieved by connecting building roof leaders to drywells capable of capturing and infiltrating clean stormwater from a 25-year storm into the ground.</p>	<p>Drainage Systems [Report]" which encourages the use of measures to control impervious surfaces and reduce pollutant sources. However, in another section of standards, open channels are discouraged and closed systems are favored.</p>	

Recommendations – Stonington

- Implement the recommendations of the Town's Community Coastal Resiliency Plan, when complete.
- Update the regional hazard mitigation plan annex, and reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program (see General Recommendation 7).
- Consider the following amendments to the flood hazard overlay provisions in the Town's zoning regulations to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Consider more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning regulations (see General Recommendation 2).
- Consider amendments to the existing open space development provisions in the zoning and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove remaining barriers to the use of Low Impact Development (see General Recommendation 14), consistent with the LID requirements of new MS4 General Permit, effective July 1, 2017.

- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

North Stonington, CT

North Stonington comprises 12.7% of the Wood-Pawcatuck watershed, with approximately 70% of the Town's land area located in the watershed and 4,300 residents living in the watershed. The Town is situated in the southwestern corner of the watershed, primarily located with the Shunock River, Wyassup Brook, and Green Falls River subwatersheds. Roughly 8% of the land area in North Stonington is within a flood hazard zone. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning and Zoning Commission
- Inland Wetlands Commission.

Planning and Zoning (Land Use), Emergency Management, and the Building Department collectively implement the Town's floodplain management program and participation in the NFIP. The Town's Building Department enforces the state building code.

Summary of Existing Land Use Policies and Regulations – North Stonington, CT

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations	Subdivision Regulations	Natural Hazard Mitigation Plan Annex
Most Recent Revision Date	2013	2015	2015	2013
Flood Management	<p>The plan notes that although there are restrictions for new development in the floodplain, much of the recent flooding occurs within historically developed areas.</p> <p>The role of wetlands for flood water retention is noted.</p>	<p>Establish Special Flood Hazard Area requirements. Any new development is required to demonstrate that the project is designed to minimize flood damage.</p> <p>Base flood elevation data required for all new or additional development on an area of land totaling five acres or more.</p> <p>New construction and substantial improvements require the lowest floor (including the basement) elevated or flood-proofed to or above the base flood level (no minimum freeboard).</p> <p>Need to minimize flood damage for public utilities within flood-prone areas.</p> <p>No permanent structures allowed to be built in a floodway.</p>	<p>Regulations require that subdivisions provide provisions for flood control, when appropriate.</p> <p>Additional permit submissions are required for any application where there is a watercourse alteration, and the watercourse has a mapped floodplain.</p> <p>Six findings regarding flood protection related to applications for subdivision design and construction must be made prior to approval.</p>	<p>Flood risks are generally associated with inland flooding, including those related to potential dam failure.</p> <p>The plan includes detailed recommendations for flood protection associated with land development, including regulating new development in floodplains, and requiring developers to demonstrate no increases in peak flows.</p> <p>New culvert should be sized using extreme rainfall data.</p>

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations	Subdivision Regulations	Natural Hazard Mitigation Plan Annex
Most Recent Revision Date	2013	2015	2015	2013
Stormwater Management	The plan states that the town has "strong stormwater management regulations".	<p>Design of stormwater management systems in accordance with the CTDEEP "Connecticut Stormwater Quality Manual" and the CTDOT Drainage Manual.</p> <p>Stormwater management plan required for development requiring a Site Plan or for a subdivision that involves the disruption, clearing or removal of ground cover or soil material, or the creation of impervious surfaces in an area greater than one acre, or one-half acre if located in the Seasonal Use or Watershed Protection Overlay district.</p> <p>No net increase in peak discharge and runoff volume for all storm events, to the maximum extent practical.</p> <p>Special provisions for parking lot runoff in Water Supply Protection Overlay District.</p>	<p>Stormwater will be handled in a manner consistent with the CTDEEP "Connecticut Stormwater Quality Manual".</p> <p>Stormwater management plans are required for any development of more than 1 acre.</p> <p>Stormwater design criteria require removal of 80% of TSS, no increases in peak flow or stormwater volume leaving a site.</p>	No direct references to stormwater, except to indicate that systems must be maintained and culverts should be sized for extreme events.

Recommendations – North Stonington

- Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program (see General Recommendation 7).
- Consider the following amendments to the Special Flood Hazard Area requirements in the Town's zoning regulations to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Adopt more stringent freeboard requirements
 - Amend nonconforming use provisions

- Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning regulations (see General Recommendation 2).
- Consider amendments to the existing cluster/open space residential development provisions in the zoning and subdivision regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove remaining barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Sterling, CT

Approximately 22% of the Town of Sterling is located within the Wood-Pawcatuck watershed, and the town makes up roughly 2% of the watershed. Sterling is primarily rural, and much of the land within the watershed is protected as part of the Pachaug State Forest near the headwaters of the Wood River. An estimated 685 Sterling residents live in the watershed. The Town of Sterling regulates the use of land through zoning regulations, subdivision regulations, wetlands regulations, the Connecticut State Building Code, and a code of ordinances. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning and Zoning Commission
- Inland Wetlands and Watercourses Commission.

The Town's floodplain management program and participation in the NFIP is primarily regulated under a floodplain ordinance enforced by the Zoning Enforcement Officer and Building Official, which also enforces the state building code.

Summary of Existing Land Use Policies and Regulations – Sterling, CT

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations (Floodplain Management Ordinance)	Subdivision Regulations	Regional Natural Hazard Mitigation Plan
Most Recent Revision Date	2009	2015 (2014)	2010	2016
Flood Management	Copy of the POCD was unavailable as of the date of this review.	<p>Ordinance Amending the Flood Damage Prevention Ordinance regulates the use of land in all areas with a one percent, or greater, chance of yearly flooding.</p> <p>This ordinance is enforced through the Zoning Regulations for the Town of Sterling and the Sterling Subdivision Regulations.</p> <p>Base flood elevation data required for all new or additional development on an area of land totaling at least five acres or 50 lots.</p> <p>New construction and substantial improvements require the lowest floor (including the basement) elevated or flood-proofed to at least 1 foot above the base flood level. The town requires</p>	<p>References the Flood Management Ordinance, which includes a broad statement restricting any development that will "aggravate flood hazard conditions".</p> <p>Provisions require that utilities, improvements, storm drainage be designed in a manner to minimize flood damage.</p>	<p>The town is covered under a regional hazard mitigation plan.</p> <p>The plan notes that the Town of Sterling amended the Flood Damage Prevention Ordinance regulating uses within the 100 year flood boundary.</p> <p>This is a general regional plan encouraging measures to protect the public and property from natural hazard, including flooding.</p>

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations (Floodplain Management Ordinance)	Subdivision Regulations	Regional Natural Hazard Mitigation Plan
Most Recent Revision Date	2009	2015 (2014)	2010	2016
		elevation certificates to verify that a structure has been elevated to the proper height in and around a flood zone.		
Stormwater Management	Plan not available.	<p>Contains provisions for storm drainage and soil erosion and sediment control.</p> <p>No provisions for Low Impact Development.</p>	<p>Subdivision plans require provisions for stormwater detention.</p> <p>General provisions require stormwater to be designed according with the town ordinance.</p> <p>Note: Several town ordinances address stormwater, including the Sediment and Erosion Control Ordinance and Public Sewer Ordinance. The ordinances require general provisions for detention and discharge of stormwater.</p>	There are no specific references to stormwater in the plan.

Recommendations – Sterling

Most of the land in the Town of Sterling that lies in the Wood-Pawcatuck watershed consists of protected open space. However, the following recommendations can have community resiliency benefits both within and outside of the Wood-Pawcatuck watershed.

- Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Amend zoning and subdivision regulations to require that all new development and redevelopment projects comply with LID standards consistent with the Connecticut Stormwater Quality Manual (see General Recommendation 13).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program (see General Recommendation 7).
- Consider the following amendments to the Town's Floodplain Management Ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain

- Consider more stringent freeboard requirements
- Amend nonconforming use provisions
- Require elevation of all building additions in flood hazard areas
- Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning regulations (see General Recommendation 2).
- Consider amendments to the existing open space provisions in the subdivision regulations and the addition of open space/conservation development provisions in the zoning regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove remaining barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

Voluntown, CT

Approximately 20% of the Town of Voluntown is located within the watershed, and the town makes up approximately 2.7% of the drainage area of the watershed. Nearly all of the 8.2 acres of land in the watershed is protected open space that is associated with the Pachaug State Forest near the headwaters of the Green Fall River and Wood River. The Town of Voluntown regulates land use through zoning regulations, subdivision regulations, wetlands regulations, the Connecticut State Building Code, and a code of ordinances, including a Flood Damage Prevention Ordinance. Municipal land use policies and regulations are primarily implemented by the following boards and commissions:

- Planning and Zoning Commission
- Inland Wetlands and Watercourses Commission.

The Town's floodplain management program and participation in the NFIP is primarily enforced by the Zoning Enforcement Officer and Building Official, which also enforces the state building code.

Summary of Existing Land Use Policies and Regulations – Voluntown, CT

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations (Flood Damage Prevention Ordinance)	Subdivision Regulations	Natural Hazard Mitigation Plan Annex
Most Recent Revision Date	2010	2012 (2011)	2011	2013
Flood Management	<p>There are no specific references to flooding or flood management in the plan. There are several references to the protection of natural resources.</p> <p>The plan acknowledges the general pattern of land use, wherein development is concentrated in the town center, radiating outward into the surrounding area.</p>	<p>Any development activities within special flood hazard areas are subject to the Voluntown Flood Damage Prevention Ordinance, which was updated in 2011. The ordinance provides the minimum regulations required under the NFIP.</p> <p>The Town's Zoning Regulations restrict building within 25 feet of a watercourse.</p> <p>The Town utilizes the 1% annual chance floodplain as defined by FEMA to regulate floodplain and floodway activities and requires 100 percent compensatory storage for any encroachment in the floodplain. The Town also requires freeboard of 12 inches for new construction or substantial renovations.</p>	<p>Considers activities in special flood hazard areas and outlines the minimum requirements under the NFIP as in the Flood Damage Prevention Ordinance.</p> <p>Require that adequate drainage be provided to reduce exposure to flood hazards.</p> <p>Contains open space provisions for subdivisions.</p>	<p>While riverine flooding is a concern, nuisance flooding and poor drainage have historically been the primary flooding issues at several locations in the town. Flooding of roadways is more common than damage to structures.</p>
Stormwater Management	Does not address stormwater or flooding.	Contains provisions for storm drainage and soil erosion and sediment	Contains provisions for storm drainage and soil erosion and sediment	Minimal discussion of drainage-related flooding.

Plan or Regulation	Plan of Conservation and Development	Zoning Regulations (Flood Damage Prevention Ordinance)	Subdivision Regulations	Natural Hazard Mitigation Plan Annex
Most Recent Revision Date	2010	2012 (2011)	2011	2013
		control. No provisions for Low Impact Development.	control.	

Recommendations – Voluntown

Nearly all of the land in the Town of Voluntown that lies in the Wood-Pawcatuck watershed consists of protected open space. However, the following recommendations can have community resiliency benefits both within and outside of the Wood-Pawcatuck watershed.

- Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents (see General Recommendations 10 and 11).
- Amend zoning and subdivision regulations to require that all new development and redevelopment projects comply with LID standards consistent with the Connecticut Stormwater Quality Manual (see General Recommendation 13).
- Consider incorporating a No Adverse Impact (NAI) Floodplain Management policy into the local floodplain management program (see General Recommendation 7).
- Consider the following amendments to the Town's Floodplain Management Ordinance to further strengthen flood management standards (see General Recommendation 9):
 - Amend zoning ordinance to require all new critical facilities (emergency operations centers, hospitals, police stations, fire departments, etc.) to be located outside of flood-prone areas, including the 500-year floodplain
 - Consider more stringent freeboard requirements
 - Amend nonconforming use provisions
 - Require elevation of all building additions in flood hazard areas
 - Adopt more stringent substantial improvement standards.
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards (see General Recommendation 3).
- Consider implementing Transfer of Development Right (TDR) provisions in the zoning regulations (see General Recommendation 2).
- Consider amendments to the existing open space provisions in the subdivision regulations and the addition of open space/conservation development provisions in the zoning regulations to strengthen flood management provisions (see General Recommendation 4).
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove barriers to the use of Low Impact Development (see General Recommendation 14).
- Update design storm precipitation amounts in local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design (see General Recommendation 12).
- Implement road stream crossing standards for new and replacement culverts and bridges (see General Recommendation 17).

4. General Recommendations

The following are over-arching land use policy, planning, and regulatory recommendations that should be considered by the watershed municipalities, where applicable, to enhance flood resiliency (and provide related habitat and water quality benefits). The objective of these recommendations is to help communities become more resilient to flooding by preserving undeveloped land, siting development in locations less vulnerable to flooding, and promoting designs that reduce runoff and are less likely to be damaged in a flood.

Floodplain Management

Conserve land and discourage development in floodplains and along river corridors.

One of the most effective ways for communities to enhance flood resilience is by conserving land and discouraging development in flood-prone areas. Vulnerable land in floodplains and river corridors can be protected by purchasing land or acquiring conservation easements from willing sellers, coordinating buyouts of properties that are repeatedly flooded, implementing a Transfer of Development Rights program, and through floodplain/wetland restoration.

- Recommendation 1: Communities should continue to partner with willing landowners and land trusts or other organizations such as the Wood-Pawcatuck Watershed Association to purchase land outright or acquire conservation easements.

Conservation easements allow local governments (or designated land trusts) to acquire easements on land of environmental value as a means to protect property containing natural resources. This is often accomplished by purchasing development rights from a landowner, which will then attach a deed restriction prohibiting any further development that would alter the environment.

- Recommendation 2: Communities should consider implementing a Transfer of Development Right (TDR) ordinance modeled after similar programs in Exeter, North Kingstown, and other communities in the region.

A TDR ordinance allows the transfer of development rights of one parcel to another, thereby shifting density from areas designated for protection (such as floodplain and other sensitive natural areas) to areas more suitable for development. The program is designed to limit potential development in vulnerable areas, while compensating property owners for the reduction. The municipality can identify vulnerable “sending” areas, where development intensity should be lowered, and upland “receiving” areas where higher density can be incorporated. A market can be established where landowners in the sending area can be compensated for the transfer of some of their development rights to a property owner in the receiving area. Localities may also choose to compensate these landowners through tax credits. A TDR program can protect ecologically valuable land like floodplains and wetlands that have flood mitigation benefits. It can also help shift development upland, where it will be less susceptible to flooding and sea level rise.

TDR programs are used in areas where there is significant development pressure and no alternate mechanism to exceed density levels. If rezoning or variance is easier to obtain, a TDR program will likely not be used by a developer.

Exeter and North Kingstown are the only communities in the Wood-Pawcatuck watershed that currently have a TDR ordinance and program. The Exeter and North Kingstown TDR programs, a shared program which was originally intended to protect open space and farmland from development, is designed to preserve sensitive resources including groundwater reserves, wildlife habitat, agricultural lands and public access to surface water as well as to direct development to places better suited for increased development. The program could be used to include conservation of floodplains and riparian wetlands. TDR programs also exist in Narragansett, RI and Windsor, CT.

- Recommendation 3: Consider implementing fluvial erosion hazard zoning.

The Pawcatuck River and its tributaries are prone to flooding-induced erosion that can threaten human infrastructure given the legacy of human alteration in the watershed, which creates channel instabilities. While overbank flooding and the inundation of homes, agricultural fields, and other infrastructure causes significant damage in the watershed, the most dangerous and costly hazards are often caused by rapid bank erosion. Riverine erosion damages can be more serious than flood inundation damages in several ways:

- Riverine erosion can affect structures located outside, as well as inside the regulatory floodplain, and elevating structures above the 100-year base flood elevation may not provide adequate protection from erosion damages.
- Erosion can not only damage a structure, it can completely remove the land underneath the structure, making it impossible to rebuild on the site.
- Riverine erosion damage can occur not only during a single large flood event, but may also occur during smaller long-duration floods, or from the cumulative impacts of a series of small floods over a long time period.

Federal guidelines for flood hazard mapping and model floodplain ordinances do not address riverine erosion hazards. Federal legislation authorizing riverine erosion mapping and integration of erosion hazards into the NFIP has been enacted, but not implemented.

To further protect vulnerable land and avoid exacerbating downstream flooding, communities in the watershed should explore fluvial erosion hazard zoning for land along rivers and streams. Such zoning, which is based on river corridors and flood hazard areas, can limit or prohibit development in fluvial erosion hazard areas. This technique is being implemented by communities in Vermont and New Hampshire, although it requires fluvial erosion hazard mapping.

Fluvial erosion hazard mapping has been developed as part of this watershed planning effort for the Wood-Pawcatuck watershed, at varying levels of detail. River Corridor Protection (RCP) areas – corridors of a defined width along the river within which the river is considered to have the potential to migrate through time and re-establish equilibrium channel dimensions altered by past human disturbances – has been developed based on geomorphic assessments of the watershed. RCP areas are similar to the concept of “River Corridors” or “Active River Areas.”

RCP areas are not the same as the 100-year flood zone on FEMA flood insurance rate maps (FIRMs), but the areas of both often overlap. The FIRMs show areas that are likely to be inundated by floodwaters that overtop the riverbanks during a flood with a one percent probability of occurring in any given year. In contrast, the RCP area maps identify areas, sometimes outside the 100-year flood zone, where the channel can potentially migrate over time through bank erosion or channel avulsions. Discrepancies between RCP area maps and FIRMs are possible especially along incised channels where a large flood may not spread across the floodplain, but may have sufficient force to cause bank erosion, channel widening, and meander formation – processes that would occur within the designated RCP area but outside the 100-year FEMA flood zone.

- Recommendation 4: Review and amend existing conservation development or cluster development ordinances and subdivision regulations.

Many of the watershed communities already have existing conservation development or cluster development ordinances and regulations that encourage or require new development to protect tracts of intact open space (including sensitive natural areas like rivers, floodplains, and stream corridors) while clustering development into a smaller section of the parcel.

Watershed communities with conservation/cluster development ordinances should consider the following changes or additions to their regulatory requirements:

- Require the floodplain to be conserved, and require that new lots have adequate buildable areas above the natural 100-year flood elevation.
- Consider density bonus provisions, such as a maximum 10% increase in exchange for creation of contiguous (not fragmented) greenspace, the addition of trails, or an increase in riparian buffer widths.
- Permit density bonuses when coupled with restrictive covenants and easements. Require conservation and drainage easements in floodplain communities where lots may not be developed.
- Conservation development ordinances are generally preferred over older, “cluster zoning” ordinances. Older cluster style projects successfully created open spaces but often resulted in less useful open spaces uncoordinated with the surrounding properties and fragmentation of natural habitat and recreation areas.⁸

Watershed communities that do not have conservation (or cluster) development ordinances should consider adopting one to protect floodplains and other intact open space.

- Recommendation 5: With proper planning and design, integrate public uses that are compatible with floodplains.

Floodplains can typically support a number of recreational uses that can provide additional benefits to the community, including recreational fields, multi-use trails, and water access.

- Recommendation 6: Explore a combination of traditional and innovative funding for acquisition of open space properties subject to flooding.

There are a number of funding sources that can be combined to preserve floodplains and river corridors in a natural state. The most successful programs typically include a mix of funding sources including General Funds, municipal bonds, grants, and other sources such as stormwater utilities.

Consider going beyond minimum NFIP standards.

Most of the watershed communities regulate land use in floodplains based on National Flood Insurance Program (NFIP) recommended minimum standards, which allow new structures, fill, and other uses in the floodplain, as long as the development meets minimum protective standards (i.e., residential structures are elevated 1 foot above base flood elevation). The experiences of communities across the country demonstrate that simply adopting the minimum standards does not guarantee avoidance of flood damage and losses. Standards and ordinances that exceed NFIP minimum requirements will make communities more resilient to future flooding⁹.

Higher regulatory standards also require increased documentation and enforcement at the local level. Therefore, the watershed communities should assess their administrative and enforcement capacity when considering higher floodplain standards. Overall, higher standards can potentially reduce administrative burden by preventing flood damage and post-flood permitting associated with repairs.

The watershed municipalities should consider the following modifications to their zoning and subdivision ordinances/regulations to go beyond the minimum NFIP standards and make their communities more resilient to future flooding:

- Recommendation 7: Incorporate the Association of State Floodplain Managers (ASFPM) "No Adverse Impact Floodplain Management" policy into local floodplain management programs and municipal plans.

No Adverse Impact (NAI) Floodplain Management is based on the principle that the actions of one property owner are not allowed to adversely affect the rights of other property owners in terms of increased flood peaks, increased flood stages, higher flood velocities, increased erosion and sedimentation, or other impacts. An "adverse impact" can be measured by an increase in flood stages, flood velocity, flows, the potential for erosion and sedimentation, degradation of water quality, or increased cost of public services.

NAI Floodplain Management extends beyond the floodplain to include managing development in the watersheds where floodwaters originate. NAI does not mean no development. It means that any adverse impact caused by a project must be mitigated, as required by local planning, land use regulations, or watershed-based plan.

- Recommendation 8: Increase participation by the watershed communities in the National Flood Insurance Program Community Rating System.

The National Flood Insurance Program Community Rating System (CRS) is a voluntary program that recognizes and encourages a community's efforts that exceed the NFIP minimum requirements for floodplain management. The CRS program emphasizes the reduction of flood losses, facilitating accurate insurance rating, and promoting the awareness of flood insurance. Many of the credits awarded by the CRS are specific to a community's floodplain programs

and/or for protecting a community's natural floodplain functions, similar to the NAI Floodplain Management principles described above. In 2013, significant changes were made to the CRS credits that provide greater incentives to preserve and protect floodplains. By participating in the CRS program, communities can earn a discount for flood insurance premiums based upon the activities that reduce the risk of flooding within the community.

Currently, only four (4) communities in the Wood-Pawcatuck watershed – Charlestown, North Kingstown, Westerly, and Stonington – participate in the CRS program, receiving discounts for flood insurance premiums of between 5% and 15%.¹⁰ The relatively low level of participation may be due to the administrative cost of participating, which can be a burden for towns with few permanent staff.¹¹ Another real or perceived impediment to communities joining the CRS is the need for a non-compliant community to resolve all past compliance issues before becoming eligible.

RIEMA and CTDEEP should continue to provide education and outreach to the communities (municipal officials and residents) in the Wood-Pawcatuck watershed regarding the benefits of participation in the CRS and to encourage participation by additional communities. Both agencies should consider possible changes to how the CRS is implemented in their respective states to enhance participation in the CRS. The State of Florida is implementing a pilot program to help communities enroll in the CRS, which may provide insight and lessons learned for Rhode Island and Connecticut.

- Recommendation 9: Consider the following amendments to local zoning ordinances/regulations to adopt more stringent flood management standards.

The watershed communities should consider adopting more stringent standards into local zoning ordinances, as recommended by the Association of State Floodplain Managers (ASFPM).¹² Several of these requirements can increase a community's score under the CRS and increase the likelihood of reduced flood insurance premiums. Suggested model language for incorporating these standards into existing zoning ordinances/regulations is provided in the ASFPM guidance document cited above.

- States and municipalities should continue to adopt and enforce future revisions of the International Building Code (IBC) and the International Residential Code (IRC). Using flood-resistant local building codes is an effective way to ensure new and rebuilt structures are designed and constructed to a more resilient standard. Rhode Island and Connecticut have both adopted the most current version of the model building codes.
- Adopt more stringent freeboard requirements. Communities should consider requiring at least 2 feet of freeboard (above the base flood elevation) for new construction and substantial improvement to provide an extra margin of safety. Where State or local building codes or standards already require minimum elevations, the higher of the competing minimums should apply.
- Amend nonconforming use provisions. Most of the watershed communities prohibit enlarging or extending a nonconforming use when located in a special flood hazard

area, including elevating a building to make it more flood resistant. If a nonconforming structure or use is reconstructed or redeveloped following significant damage, the new structure or use is required to be in full compliance with all current standards. Because full compliance with current standards might be costly, property owners might choose to undertake only minor repairs to make their structures habitable rather than invest in major renovations that might trigger nonconformity provisions. This unintended consequence of nonconformity provisions might lead to less investment in a storm-damaged area and might mean that property is still vulnerable to future floods.¹³

Communities should consider amending the nonconforming use provisions in their zoning ordinances/regulations to recognize partial compliance with development standards and incorporate incentives for property owners to redevelop and/or reconstruct nonconforming structures using more flood-resilient techniques, such as building elevation and flood-proofing of buildings. Incentives for redeveloping or expanding nonconforming structures, when coupled with requirements for greater flood resilience, can help existing vulnerable development in flood-prone areas better withstand future floods, can help home and business owners justify the costs of achieving compliance, and can foster redevelopment that is more consistent with current zoning and building codes. Providing incentives for redevelopment and requiring partial compliance with key development regulations (e.g., flood damage prevention standards within special flood hazard areas) may improve overall flood resilience more than if full compliance with all development regulations is required.

- Require elevation of all building additions. Consider requiring all new horizontal additions in special flood hazard areas to have the lowest floor and all HVAC elevated or dry flood proofed to one foot (or more) above the base flood elevation.
- Adopt more stringent substantial improvement standard. The NFIP's substantial improvement provisions allow each improvement project valued at up to 50% of the building's pre-improvement value to be permitted without meeting the flood protection requirements. Over the years, a community may issue a succession of permits for different repairs or improvements to the same structures, which can significantly increase the overall flood damage potential. Most communities in the Wood-Pawcatuck watershed have adopted this definition of substantial improvement. As an alternative, communities should consider improvements cumulatively, so that when the total value of all improvements or repairs permitted over the years (life of the structure, or 10 to 20 years) exceeds 50%, the original building must be protected according to the requirements for new buildings. The Town of Stonington, Connecticut amended the definitions of "Substantial Improvement" and "Substantial Damage" in its zoning regulations in 2013 to incorporate such provisions. Communities could also consider a lower threshold for substantial improvements such as to less than 50%. Substantial improvement could also be defined to include any addition which increases the original floor area of a building by 25% or more. The watershed communities should review and amend, as appropriate, the definitions of Substantial Improvement and Substantial Damage in their zoning ordinances/regulations, using the Stonington language as an example.

Municipal Planning Documents

- Recommendation 10: The watershed communities should update and integrate their Comprehensive Plans and Hazard Mitigation Plans.

Local planning and zoning staff are often not involved in the preparation of Hazard Mitigation Plans, and emergency management personnel are often not involved in the comprehensive land use planning process. If the two planning processes are not coordinated, they could result in plans that are inconsistent and potentially conflicting. Coordinating these two planning processes can ensure that stakeholders involved in resilience planning, such as emergency managers, also help develop the Comprehensive Plan and that planners help develop the Hazard Mitigation Plan. The Town of Charlestown is a good example of a community in the Wood-Pawcatuck watershed that has used an integrated approach to update its Comprehensive Plan and Hazard Mitigation Plan.

- Recommendation 11: Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents.

Future updates to Comprehensive Plans and Hazard Mitigation Plans of the watershed communities should include or incorporate by reference recommendations of the Wood-Pawcatuck Watershed Flood Resiliency Management Plan.

Road Stream Crossings

- Recommendation 12: Implement road stream crossing standards for new and replacement culverts and bridges.

The watershed municipalities should incorporate improved stream crossing standards into local land use regulations for new permanent stream crossings (roads, driveways, paths, etc.) and replacing existing permanent crossings to enhance flood resiliency and improve stream continuity for aquatic organisms. Local stream crossing standards could be modeled after statewide standards in Connecticut and Massachusetts, as well as similar stream crossing requirements that apply to activities subject to Army Corps of Engineers permit programs.

Green Stormwater Infrastructure and Low Impact Development

- Recommendation 13: Amend local land use regulations to require all development and redevelopment projects comply with LID pursuant to statewide stormwater guidance manuals.

Most of the watershed communities have adopted requirements for green infrastructure or LID in their local land use regulations and policies, and most reference the LID standards and design guidance contained in the respective statewide stormwater manuals - Rhode Island Stormwater Design and Installation Standards Manual and the Connecticut Stormwater Quality Manual (including LID Addendum). However, not all of the watershed communities have land use regulations that specifically require the use of LID or green infrastructure, as the first option, for all new development and redevelopment projects. For example, South Kingstown's zoning regulations include provisions for the use of LID only in one specific zoning district, rather than Town-wide. The watershed communities should amend local land use regulations to require that

new development and redevelopment projects comply with LID standards consistent with the respective statewide stormwater guidance manuals.

- Recommendation 14: Amend local zoning ordinances and subdivision regulations to update local requirements that affect the creation of impervious cover and remove barriers to the use of LID.

As indicated by the findings of RIDEM's *Ordinance Checklist for LID Stormwater Site Planning and Design*, many of the watershed communities still have provisions in their zoning ordinances and subdivision regulations that promote the creation of impervious cover and limit the use of certain LID techniques. Since streets and parking lots typically account for a significant percentage of the impervious surfaces in a watershed, the watershed municipalities should amend the design standards for streets and parking lots in their zoning ordinances and subdivision regulations to minimize the creation of impervious cover and more effectively promote the use of LID.

- Recommendation 15: Update municipal NPDES Phase II Stormwater Management Programs (SWMPs).

The Rhode Island watershed communities should review and update their municipal NPDES Phase II Stormwater Management Programs (SWMPs) in anticipation of potential future reissuance of the MS4 Permit in Rhode Island or enhanced enforcement of the existing MS4 Permit. Stonington, the only MS4 regulated community in the Connecticut portion of the watershed, should implement its revised SWMP to comply with the new Connecticut MS4 General Permit, including review and update of its land use regulations to incorporate LID and green infrastructure provisions of the new MS4 Permit.

- Recommendation 16: Consider stormwater utilities (utility districts, enterprise funds, etc.) to finance municipal stormwater programs.

A stormwater utility operates much like a drinking water or sewer utility. Fees collected from property owners go into a dedicated fund to pay for the operation and maintenance of stormwater infrastructure. Stormwater utilities, which create a more equitable relationship between revenues collected and runoff generated from a site, are common in many parts of the U.S., although only a few have been implemented in New England and none to date in Rhode Island or Connecticut.

Stonington and several other Connecticut communities have explored the feasibility of implementing a stormwater utility, but none has been successful in implementing a utility largely due to insufficient public support. Preliminary feasibility studies have also been completed by several Rhode Island communities including Middletown, Westerly, Bristol, North Providence, and West Warwick. Cities and towns in the Upper Narragansett Bay region also examined the feasibility of implementing a regional stormwater utility, and several of these communities are pursuing individual stormwater utilities.

In the Wood-Pawcatuck watershed, stormwater utilities could provide a dedicated source of funding for municipalities to construct and maintain green stormwater infrastructure, implement

drainage system improvements (including culvert upgrades or replacements), and address MS4 permit compliance.

Climate Change

- Recommendation 17: Update design storm precipitation amounts and peak flows in state and local land use regulations and policies to promote more resilient stormwater drainage and flood mitigation design.

Both mean and extreme precipitation in the region has increased during the last century, with the highest number of extreme events occurring over the last decade. Continued increases in frequency and intensity of extreme precipitation events are projected.¹⁴ According to the National Climate Assessment, “the Northeast has experienced a greater increase in extreme precipitation over the past few decades than any other region in the United States; between 1958 and 2010, the Northeast saw a 74% percent increase in the amount of precipitation falling in very heavy events” (Melillo, Richmond, T.C., & Yohe, G.W., 2014). Rainfall in New England is expected to continue to increase due to climate change, which is expected to increase the risk of river-related flooding in the future. Bridges, roads and dams will be more susceptible to flood damage because of more severe storms and heavy rainfall.

Updated extreme precipitation data is available from Cornell University’s Northeast Regional Climate Center (NRCC). The NRCC design storm rainfall amounts offer significant advantages over previous products (e.g., “Rainfall Frequency Atlas of the United States”, Technical Paper No. 40, U.S. Department of Commerce, Weather Bureau and NOAA Technical Memorandum “NWS Hydro-35”, June 1977, U.S. Department of Commerce, National Weather Service) since the design storm rainfall amounts are based on a much longer period of record, including more recent data. The most recent rainfall frequency statistics for the region were published by NOAA in October 2015 in Atlas 14, Volume 10. This publication replaces the 1961 National Weather Bureau TP-40 report and supersedes the 2013 NRCC data products.

While NOAA Atlas 14 provides more reliable precipitation data for design purposes, it assumes climatic stationarity and therefore does not account for future climate change. Communities should account for potential climate change (i.e., more frequent and intense precipitation) in drainage and flood mitigation design policies and standards. Although reliable projections of precipitation extremes as a result of climate change are not yet readily available in the published climate change literature, guidance is available for estimating potential future changes in extreme rainfall statistics using EPA’s Climate Resilience Evaluation and Awareness Tool (CREAT), SWMM-CAT (Storm Water Management Model Climate Adjustment Tool), and other similar tools.

At a minimum, stormwater and drainage-related infrastructure should be designed with storm intensities based on NOAA Atlas 14 (or NRCC atlas) to represent current precipitation conditions. For more resilient water infrastructure design, consider some percentage increase, such as 15% which is consistent with estimates of future changes in extreme rainfall using the CREAT tool described above, to account for potential future increases in extreme precipitation events. Ongoing review of extreme precipitation projections is recommended.

- Recommendation 18: Update state and local stormwater drainage and BMP design standards and guidance to account for climate change impacts in coastal areas, including the estuarine portion of the Wood-Pawcatuck watershed.

Sea level has risen more than 9 inches since 1930 at Newport, RI, faster than the global average. A recent assessment by the National Oceanic and Atmospheric Administration projects a possible worst-case sea level rise scenario for Rhode Island of 9-10 feet by 2100,¹⁵ which is significantly higher than previous projections of sea level rise in the region, which have generally ranged from 1 to 4 feet by 2100 (Runkle, et al., 2017). Increases in sea level will likely increase coastal flooding and erosion during winter storms (nor'easters) and hurricanes, threatening coastal infrastructure and populations.

Coastal stormwater BMPs are potentially vulnerable to sea level rise resulting in submerged outfalls or inundation of other components of the BMP, rising groundwater and shrinking separation distance between the BMP and the groundwater table, physical impacts of storm surges, and chronic exposure to wind, sand, and salt.

The following recommendations are provided for siting and design of stormwater BMPs and green infrastructure in the tidal portion of the Wood-Pawcatuck watershed (i.e., Westerly and Stonington) to ensure long-term effectiveness of these systems. These recommendations incorporate principles and guidance from the Massachusetts Office of Coastal Zone Management (CZM) and Massachusetts Department of Environmental Protection (MassDEP) funded *Assessment of Climate Change Impacts on Stormwater BMPs and Recommended BMP Design Considerations in Coastal Communities*.¹⁶

- Use a 50-year planning horizon for BMP design and evaluate potential climate change impacts for this period during BMP design to ensure effectiveness of the BMP, including maintenance, over the life of the system.
- BMPs close to the shoreline are at greatest risk of climate change impacts. Select BMPs locations, particularly for retrofits, in conjunction with sea level rise and coastal flood projection maps to understand the implications of climate change over the design life of the BMP. A distributed approach consisting of several smaller structural BMPs and (i.e., LID) and non-structural practices is generally preferred over the use of a single larger BMP located close to the coast.
- If the BMP must be sited close to the shoreline due to other constraints, consider the following:
 - Avoid installing BMPs in areas where they will be exposed to significant storm impacts or sand sources (if clogging is a concern, such as with permeable pavement or infiltration practices).
 - Site the BMP away from salt marsh edges to minimize disturbance and spread of invasive plants.
 - Retain the water quality volume on-site to the extent possible, through the use of retention or infiltration, to minimize the introduction of freshwater into salt marshes and estuarine areas.

- Avoid siting BMPs, particularly infiltration systems, near high groundwater if the BMP cannot function with higher groundwater or will be impacted by groundwater intrusion into the system.
 - Only select infiltration practices (such as subsurface infiltration systems) for areas where the minimum required depth to groundwater can be sustained in light of expected sea level rise and associated groundwater rise.
 - Also ensure the selected BMP can adapt to wetter conditions. Typically, this approach will prioritize above-ground, vegetated practices over below-ground “gray” infrastructure. For example, a rain garden can convert to a wetland over time as groundwater rises, while an underground infiltration chamber will simply fail when groundwater levels rise too high.
 - Choose materials that are appropriate to existing and future site conditions, such as native, salt-tolerant plant species and materials that do not corrode from salt exposure.
 - Increase the size of a sediment forebay to accommodate heavier sediment loads in the BMP drainage area to help prolong the effective lifespan of the BMP.
 - Use flexible designs that allow the system to adapt to new conditions.
 - Green infrastructure practices that rely on vegetated surface systems are generally preferred over underground gray infrastructure. Vegetated BMPs can generally adapt more easily over time in response to storm surge and rising groundwater, provided that the design incorporates redundancy and flexibility.
- BMPs in the coastal zone will require even more maintenance to ensure effective operation than BMPs in other areas.
- Recommendation 19: Implement additional land use and policy recommendations from the ongoing community coastal resiliency planning effort by the Town of Stonington and the ongoing update of the Town of Westerly Comprehensive Plan.

When completed, the Town of Stonington’s Community Coastal Resiliency Plan will provide specific infrastructure and land use/policy recommendations that will be applicable to the portion of the town within the Pawcatuck River watershed. These recommendations, which will focus on impacts from coastal flooding and sea level, will complement the recommendations of this plan, which are focused on inland/riverine flooding.

The Town of Westerly Planning Department should integrate climate change and coastal resiliency considerations into ongoing and future updates of the Town’s Comprehensive Plan and hazard mitigation plan. Westerly should also consider conducting a detailed coastal resiliency vulnerability assessment and developing a community-wide coastal resiliency plan, similar to the ongoing planning effort by the Town of Stonington, to better protect public infrastructure, property, and populations from coastal flooding and sea level rise.

5. References

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- ² EPA, 2014. Planning for Flood Recovery and Long-Term Resilience in Vermont: Smart Growth Approaches for Disaster-Resilient Communities. EPA 231-R-14-003. July 2014.
<https://www.epa.gov/smartgrowth/planning-flood-recovery-and-long-term-resilience-vermont>.
- ³ FEMA, 2013. "Integrating Hazard Mitigation into Local Planning: Case Studies and Tools for Community Officials." <http://www.fema.gov/media-library/assets/documents/31372?id=7130>.
- ⁴ State of Rhode Island. General Laws. Title 45: Towns and Cities, Chapter 45-22.2: Rhode Island Comprehensive Planning and Land Use Act, Section 45-22.2-6: Required Content of a Comprehensive Plan. Revised 2011. <http://webserver.rilin.state.ri.us/Statutes/TITLE45/45-22.2/45-22.2-6.HTM>.
- ⁵ Rhode Island Hazard Mitigation Plan - 2014 Update. Rhode Island Emergency Management Agency. 2014.
- ⁶ Flood Insurance - Rhode Island Community Rating System. Retrieved October 10, 2016, from State of Rhode Island Emergency Management Agency. 2016.
<http://www.riema.ri.gov/resources/citizens/mitigation/insurance.php>
- ⁷ <http://www.dem.ri.gov/programs/benviron/water/permits/ripdes/stwater/pdfs/checkde.pdf>
- ⁸ The Rhode Island Conservation Development Manual: A Ten-Step Process for Planning and Design of Creative Development Projects. Rhode Island Department of Environmental Management. 2003.
- ⁹ A Guide for Higher Standards in Floodplain Management. Association of State Floodplain Managers (ASFPM). Revised March 2013.
- ¹⁰ RIEMA. (2016). Flood Insurance - Rhode Island Community Rating System. Retrieved October 10, 2016, from State of Rhode Island Emergency Management Agency:
<http://www.riema.ri.gov/resources/citizens/mitigation/insurance.php>
- ¹¹ Rhode Island Hazard Mitigation Plan - 2014 Update. Rhode Island Emergency Management Agency. 2014.
- ¹² A Guide for Higher Standards in Floodplain Management. Association of State Floodplain Managers (ASFPM). Revised March 2013.
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