Enhancing Flood Resilience in the Wood-Pawcatuck Watershed Using Nature-Based Approaches

Connecticut Association of Flood Managers 2019 Annual Conference and Meeting

## October 30, 2019



Wood-Pawcatuck Watershed Association



# **Project Team**

- Wood-Pawcatuck Watershed Association
- Fuss & O'Neill, Inc. and Field Geology Services

### Project Steering Committee

- Municipal representatives from the most heavily-impacted watershed communities
- State and federal agencies
- Other organizations

## Project Funding

• NFWF/DOI Hurricane Sandy Coastal Resilience Grant







# **Project Objectives**

- **1.** Assess the vulnerability of the Wood-Pawcatuck Watershed to flooding
- 2. Develop a watershed-based management plan
  - Enhance flood resilience
  - Focus on nature-based approaches that strengthen natural ecosystems
  - Identify prioritized actions and implementation projects
- **3.** Encourage local decision-makers to think more strategically about natural systems approaches





# What are Nature-Based Approaches?

- Rely on ecological processes to achieve climate/flood resilience objectives
- Use natural systems, mimic natural processes, or work in tandem with traditional approaches
- Benefits beyond flood mitigation





Stormwater Green Infrastructure







# Why Develop a Watershed Plan?

- Water flow does not follow political boundaries
- Upstream activities affect downstream flooding
- Watersheds are logical frameworks to address water resource issues
- A comprehensive, science-based management plan developed with public input improves chances of success and future funding





# Watershed Planning Process

- Stakeholder and Community Involvement
  - Steering Committee
  - Watershed Survey
  - Community Meetings
  - Coordination with RIDEM
- Technical Assessments
  - Series of technical reports
  - Included in Plan Appendices





# Wood-Pawcatuck Watershed

- 317 square miles in RI and CT
- Major portions of 11 municipalities
- Population of 84,000
- 380 stream miles
- Drains to Pawcatuck River Estuary and Little Narragansett Bay
- Mostly rural and forested with development in villages/town centers





# Flooding in the Wood-Pawcatuck

- History of flooding in the watershed
- The Great Flood of 2010 (>"500-Year Flood")







# Pawcatuck River, Westerly, RI







# **River Corridor & Floodplain Development**







# **Road-Stream Crossings**



# **More Frequent Extreme Storms**



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# Flood Resiliency Management Plan

- Plan Development Process
- Watershed Overview
- Management Recommendations
  - Actions
  - Lead entities
  - Timeframe
  - Relative costs
  - Possible funding sources



### Wood-Pawcatuck Watershed

Flood Resiliency Management Plan

prepared by **f** FUSS&O'NEILL

AUGUST 2017





## **Town Summaries**

August 2017

Wood-Pawcatuck Watershed Flood Resiliency Management Plan

### **Recommended Actions Summarv** Town of Charlestown, RI

The Wood-Pawcatuck watershed is vulnerable to flood-related damages, as evidenced by the devastating flooding that occurred in 2010. The Wood-Pawcatuck Watershed Association, working with the watershed municipalities and partner agencies, has developed a watershed-based management plan to enhance the resiliency of the watershed communities to future flooding and protect river and stream ecosystems, including water quality and habitat. The following is a summary of key findings and recommendations of the watershed plan for the Town of Charlestown.

#### Road Stream Crossings

- 7 crossings are hydraulically undersized
- 12 crossings have high geomorphic vulnerability
- 11 crossings have high flood impact potential
- 9 crossings limit or restrict aquatic passage

### **Recommendations:**

- Replace and upgrade priority crossings (see table below) to meet flood resilience and aquatic organism passage (AOP) goals
- Consider other upstream and downstream crossings and dams on the same river system
- In general, replace downstream crossings first Perform site-specific data collection, geotechnical
- evaluation, hydrologic and hydraulic evaluation, and structure type evaluation to support design

### Priority Stream Crossings (Sorted in Order of Priority)

Road	Stream	Crossing Type
Burlingame State Park - Management Area	Unnamed	Double 24" Concrete Circular Conduit
Burlingame State Park - Management Area	Unnamed	12" Concrete Circular Conduit
Narragansett Trail	Unnamed	12" Concrete Circular Conduit
Buckeye Brook Road	Poquiant Brook	38" and 12" Concrete Circular Conduit (2 total)
Shumankanuac Hill Road	Unnamed	36" Concrete Circular Conduit
Saw Mill Road	Unnamed	12" Concrete Circular Conduit
Kings Factory Road	Pawcatuck River	57'W x 9'H Concrete Bridge
Shannock Road	Pawcatuck River	67.5'W Concrete Bridge; openings 3.3'H 7.8'H
Old Shannock Road	Pawcatuck River	48'W X 9.4'H Concrete Bridge

roject funding was provided by the National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Gr

#### Quick Facts - Charlestown

- 66% of town within watershed
- Includes portions of the Pawcatuck River (Charlestown's northern boundary), smaller tributaries,
- freshwater ponds, and their associated watersheds 27 stream crossings assessed
- 1 dam assessed

### Dams

 A single low hazard dam – Burdickville Dam – was assessed in Charlestown, on the Charlestown/ Hopkinton border

### Recommendations:

#### Burdickville Dam (Pawcatuck River)

- Consider dam removal
- Burdickville Dam has been partially breached but may currently prevent passage of some fish species, such as shad
- The impoundment does not appear to support any active uses





Dual concrete culverts at a high priority stream crossing in Burlingame State Park Management Area



### Wood-Pawcatuck Watershed Flood Resiliency Management Plan

### Green Infrastructure

A screening-level assessment of potential green infrastructure (GI) retrofit sites was performed within the Wood-Pawcatuck watershed. When applied throughout the watershed, GI can help mitigate flood risk resulting from outdated and undersized storm drainage systems and increase flood resiliency, as well as improve water quality.

#### Sites Identified for GI Retrofits:

 Vin Gormley Trailhead Parking Retrofit parking lot with underground infiltration and a bioretention basin Cost: \$123,000

#### St. Mary's Catholic Church

Install a bioretention practice in the grassed island at the Carolina Back Road and Old Carolina Back Road intersection Cost: \$143,000



View of a typical bioretention cell with mature plantings.

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

#### **Recommendations:**

A review was conducted of the land use policies, plans, and regulations of the watershed municipalities. Key recommendations of this review include:

roject funding was provided by the National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Grant Prov

### **River Corridor**

A detailed geomorphic assessment was performed for approximately 40 miles of rivers and streams in the watershed. Based on the results of the geomorphic assessment, river corridor planning recommendations were developed to identify restoration projects that will reduce flood hazards and downstream sediment loading and improve aquatic habitat

August 2017

#### **Recommendations:**

- Remove granite blocks confining channel downstream of Route 112 to allow floodplain access; use granite blocks to build in-stream habitat structures
- Protect wetlands, including Indian Cedar Swamp, as well as stream connections to wetlands and floodplains
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and reform meanders



Granite-lined, straightened mill-race channel with restricted floodplain access, located downstream of Route 112.

- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Amend zoning ordinance to strengthen flood management standards
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards Consider amendments to the existing
- conservation/cluster development provisions in the zoning ordinance and subdivision regulations to strengthen flood management provisions
- Amend street and parking lot design standards to reduce impervious cover and remove barriers to LID
- Update design storm precipitation amounts Implement road stream crossing standards for new and replacement culverts and bridges





Land Use Policy and Regulations

# **Recommendations by Category**

- **1.** Dams
- **2.** Culverts and Bridges
- **3.** Floodplains and River Corridors
- 4. Stormwater





# Dams

- Over 160 documented dams in watershed
- Many no longer used for original purpose and are in poor condition
- None constructed for flood control
- Backwater during floods and downstream hazard in event of dam failure
- Barriers to fish and other aquatic life
- Important recreational, habitat, and cultural values

**Objective:** Reduce the flood risk posed by dams in the watershed, and restore the connectivity of streams for fish and other aquatic organism passage.







# **Dams – Alternatives Assessment**







## **Dams Assessment Results**



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# **Dams – Recommendations**

- Incorporate priority dam management recommendations into local hazard mitigation plans
- Perform site-specific feasibility studies to confirm feasibility of recommendations and to support design and permitting
- Obtain funding for and implement dam removal projects
- Dam removal costs are highly site-specific
  - Most projects: \$100,000 to \$1 million
  - Lower Shannock Falls Dam (2011): \$825,000
  - White Rock Dam (2015): \$950,000





# **Road Stream Crossings**

- Undersized crossings (culverts and bridges) can be flooding and washout hazards
- Barriers to fish and other aquatic life

**Objective:** Reduce the flood risk and erosion hazards posed by culverts and bridges in the watershed, and restore the connectivity of streams for fish and other aquatic organism passage.









# Wood-Pawcatuck Bridges and Culverts

- 573 structures identified using GIS
- 421 structures were inspected
- Standard assessment protocols (NAACC)





# **Prioritization Criteria**







# **Road Stream Crossings – Findings**

- 38% are hydraulically undersized (less than 25-year design flow capacity)
- Only 40% of road stream crossings provide for full passage of aquatic organisms









# **Road Stream Crossings – Priority Ratings**





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# **Road Stream Crossings – Recommendations**

- Incorporate priority stream crossings into local hazard mitigation plans and CIPs
- Strategically upgrade vulnerable stream crossings
- Implement local and state stream crossing standards modeled after neighboring states
- Update design storm precipitation amounts
- Provide training to highway departments
- Implement ongoing inspection and maintenance program









# **Floodplains and River Corridors**

- Areas along rivers and streams subject to flooding and erosion hazards
- Most stream reaches sensitive to change
- Channel straightening and bank armoring
- River corridor development
- Floodplain and channel restrictions

**Objective:** Conserve and restore floodplains and river corridors in a natural condition to mitigate flood and erosion hazards, attenuate sediment loads, and create and enhance habitat.

Restore impacted stream channels to an equilibrium condition by addressing the underlying causes of channel instability.





# **Geomorphic Assessment**

- Phase 1 (desktop) 111 stream miles
- Phase 2 (field) 39 stream miles



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## **Stream Restoration**



Marginal Log Jams



Boulder and Log Deflectors



**Root Wad Revetments** 



Willow Stakes above Root Wad Revetments





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# **Floodplain Restoration**







Creation of Floodplain Terrace for Incised Channels

Wood Addition



## Floodplain & River Corridor – Recommendations

- Stream & floodplain restoration projects identified in *River Corridor Plan* (Appendix I)
- Over 40 potential projects identified (10 concepts)
- Costs highly site specific
  - \$200 to \$1,000 / LF
  - Recent projects (\$300K -\$800K)

### PAR12 - Middle Pawcatuck River

Downstream of the Bradford Pond Dam, the Pawcatuck River is channelized and confined by a berm along the left bank that continues the entire length of the reach. Behind the berm a series of man-made ponds contribute water to the river through bank seeps and outflow pipes. Propose berm breaching and/or removal to allow floodplain access, reducing flood and fluvial erosion hazards in the reach and downstream while increasing bank stability and creating sediment storage opportunities.





## Floodplain & River Corridor – Recommendations

- Consider fluvial erosion hazard zoning, or less formal adoption in local hazard mitigation and comprehensive plans
- Consider changes to zoning and subdivision ordinances/regulations to go beyond minimum NFIP standards
  - Incorporate ASFPM "No Adverse Impact Floodplain Management" Policy
  - Increase participation in NFIP Community Rating System
  - Adopt more stringent flood management standards
- See Land Use Policy and Regulatory Review (Appendix K) for more details





# **Stormwater**

- Stormwater runoff contributes to drainage-related and riverine flooding
- Source of water quality problems
- Communities using green stormwater infrastructure to alleviate drainagerelated flooding and improve water quality

**Objective:** Reduce runoff volumes, flooding, and water quality impacts through improved stormwater management and the use of green stormwater infrastructure throughout the watershed.





# **Potential GI Retrofit Sites**



Document Path: J:\GIS\P2011\1470\B10\GreenInfrastructure\WatershedWideMap\_20160411.mxd

### Retrofit Site 272A – Westerly Senior Center Bioretention

State Street, Westerly, Rhode Island

### **Site Description**

The proposed retrofit concept is located at the Westerly Senior Center near the intersection of Westminster and State Streets in Westerly, RI. The site consists of an asphalt parking lot divided into multiple parking areas. There is a swale located between two sections of the parking lot, and some runoff is directed to the swale but no overflow or formal BMP exists, nor does the swale capture all of the runoff that could be directed to it.

### **Proposed Concept**

Retrofit the current swale as a bioretention/infiltration practice. The practice would be designed to accept runoff from the surrounding parking lot and additional areas of the site and parking lot. If desired, an overflow structure could be incorporated into the design and connected to current stormwater drainage infrastructure located on Westminster Street.



Image 1: Close-up view of proposed bioretention/infiltration area.

### **Retrofit Concept Summary**

Total Drainage Area: 1.2 acres Total Impervious Area: 1.0 acres Total Water Quality Volume: 3,794.0 ft<sup>3</sup> Runoff Reduction Volume: 379.4 ft<sup>3</sup>

### **Estimated Pollutant Removal**

Bioretention Area Total Phosphorus ≈ 0.5 lbs/year Total Nitrogen ≈ 10.5 lbs/year Total Suspended Solids ≈ 410.2 lbs/year Bacteria (FC) ≈ 307.5 billion colonies/year

Estimated Cost Bioretention Area: \$51,032



Image 2: Rendering of a typical bioretention area. (Image source: Johnson County Soil and Water District)



Image 3: View of proposed bioretention/infiltration area and some of the parking area that would drain to it.



Green Infrastructure Assessment - Wood-Pawcatuck Watershed Flood Resiliency Management Plan

# **Stormwater – Recommendations**

- Incorporate GI into municipal stormwater infrastructure planning and capital projects
- Update municipal land use regulations to require GI/LID for new development and redevelopment and to meet MS4 Permit requirements
- Update design storm precipitation amounts
- Pursue sustainable, long-term funding for GI









# **Funding & Implementation**

### **Rhode Island**

- Narragansett Bay and Watersheds Restoration Fund (BWRF)
- **RI Green Economy Bond**
- RI Infrastructure Bank
- 319 NPS Grants

### Connecticut

• CIRCA, STEAP, 319 NPS

### **Federal/Other**

- FEMA Hazard Mitigation
- NRCS Regional Conservation Partnership Program (RCPP)
- Southeast New England Program
  (SNEP)



In addition to traditional municipal funding sources (i.e., the use of General Funds and municipal bonds), a variety of state and federal sources are also available to provide financial assistance for implementation of the plan recommendations. The funding sources highlighted in this section provide the best opportunities for funding of projects associated with the short- and mid-term plan recommendations. The funding sources should be re-evaluated periodically to account for potential changes to existing funding programs (i.e., priorities, eligibility, funding cycles, and amounts) and to identify new or emerging sources of funding for flood mitigation, climate resiliency, and habitat restoration projects.

### 5.1 State Funding Sources

### Narragansett Bay and Watersheds Restoration Fund (BWRF)

RIDEM has proposed changes in its regulations that govern the financial assistance program known as the Narragansett Bay and Watersheds Restoration Fund. The goal of the Narragansett Bay and Watersheds Restoration Fund is to restore and protect the water quality and enhance the economic viability and environmental sustainability of Narragansett Bay and the state's watersheds. This established fund provides financial assistance on a competitive basis in the form of grants for various projects that protect and restore water quality and aquatic habitats.

Under the new Flood Prevention and Mitigation Sub-fund of the BWRF, RIDEM is seeking proposals for projects that will address the flooding of coastal or inland areas in a manner that incorporates and enhances natural ecosystem functions including the maintenance of natural hydrologic regimes. These projects would be expected to mitigate a known flooding problem while also delivering ecological cobenefits. Examples of projects eligible for the Flood Prevention and Mitigation Sub-fund include:

- Restoration of floodplains
- Restoration/re-vegetation of stream banks that reduce peak flows and/or velocities
- Removal of impervious surfaces and associated re-vegetation to increase the on-site retention of stormwater in flood-prone areas
- Replacement of culverts that prevent flooding through improved management of peak flows and enhanced stream continuity
- Creation of floodplain storage capacity
- Aquifer recharge that reduces flooding while maintaining a natural hydrologic regime
- Repairs/enhancements to dams that result in increased capacity for upstream flood storage
- Removal of dams to reduce the risk of flooding in flood-prone areas
- Projects that enhance the resiliency of vulnerable coastal and inland habitats in specific locations that mitigate flooding risks to building, structures or other infrastructure.

Proposed projects submitted for funding should be consistent with approved local hazard mitigation plans or updated hazard mitigation plans that have been formally submitted to the Federal Emergency Management Agency (FEMA) for review and approval. RIDEM will award grants of up to fifty percent

Wood-Pawcatuck Watershed Flood Resiliency Management Plan



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# **Questions?**

### **Contact Information**

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http://wpwa.org/flood\_resiliency.html

