Recommended Actions Summary
Town of South Kingstown, 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 South Kingstown.

Quick Facts - South Kingstown

- 46% of town within watershed
- Includes portions of the Pawcatuck, Chickasheen, Chipuxet, Usquepaug, and Queen Rivers and their watersheds
- 44 stream crossings assessed
- 6 dams assessed

Road Stream Crossings

- 18 crossings are hydraulically undersized
- 16 crossings have high geomorphic vulnerability
- 5 crossings have high flood impact potential
- 27 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

Road	Stream	Crossing Type
Liberty Road	Unnamed	36” Concrete Circular Conduit
South County Trail	Unnamed	Double 28” Concrete Circular Conduit
Worden Pond Family Campground	Alewife Brook	Triple 12” HDPE Circular Conduit
Ministerial Road	Alewife Brook	24” CMP Circular Conduit
Ministerial Road	Mink Brook	12” Concrete Circular Conduit
Peckham Farm Road	Unnamed	20” Concrete Circular Conduit
Walking Path	Unnamed	Triple 36”H x 48”W Concrete Box Culvert
Plains Road	Unnamed	24” Concrete Circular Conduit
Flagg Road	Unnamed	24” Concrete Circular Conduit
Glen Rock Road	Unnamed	30” Concrete Circular Conduit
Curtis Corner Road	White Horn Brook	No data

Dams

- 1 significant hazard dam and 5 low hazard dams
- All of the dams are deteriorating or in disrepair
- Glen Rock Reservoir Dam, the downstream-most dam on the Usquepaug River, completely prevents fish passage to the Usquepaug River

Recommendations:

Glen Rock Reservoir Dam (Usquepaug River)
- Repair deteriorating structure
- Install aquatic organism passage structure to permit fish passage to the Usquepaug

Glen Rock Upper, Middle, and Lower Pond Dams (Glen Rock Brook)
- Consider removal if supported by the owner

Great Swamp Goose Marsh Dam (Pawcatuck River)
- Repair dam
- Maintain impoundment within Great Swamp Management Area (provides bird habitat)

Yawgoo Pond Dam (Chickasheen River)
- Construct a small rock ramp or nature-like fishway up the spillway to allow for fish passage

Glen Rock Reservoir Dam

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

FUSS & O’NEILL

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:

- Tennis Courts at Boss Arena, URI
  - Install rain gardens in the lawn between the arena and tennis courts
  - Cost: $44,000
- Parking lot at Boss Arena, URI
  - Underground infiltration in main parking lot
  - Cost: $557,000
- Courthouse Center for the Arts
  - Retrofit drainage swale and parking lot with bioretention basins
  - Cost: $121,000
- Tuckertown Park
  - Bioretention
  - Cost: $169,000
- West Kingston Elementary School
  - Bioretention and underground infiltration
  - Cost: $122,000

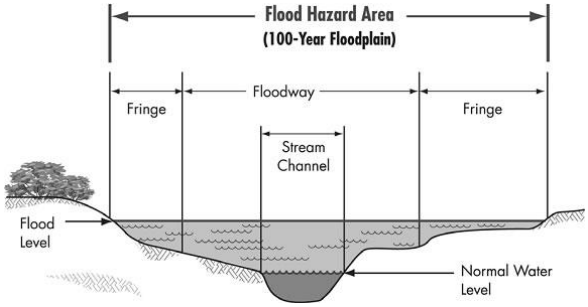
View of a typical bioretention cell with mature plantings.

River Corridor

A detailed field 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. While field geomorphic assessments were not conducted within South Kingstown, these recommendations apply in the town and throughout the watershed.

Recommendations:

- Protect existing wetlands as well as stream connections to wetlands and floodplains
- Remove floodplain constraints, such as levees or berms, where possible
- Protect and enhance riparian buffers
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders (where human conflicts with meander formation are not present)
- Avoid or limit alterations that will straighten or channelize stream channels
- Consider removing bank armoring where possible once a protected river corridor is established



Conceptual view of a typical floodplain cross section.

Land Use Policy and 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

Recommendations:

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

- 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
- Amend zoning ordinance and subdivision regulations to require all development projects to comply with LID standards and the Rhode Island Stormwater Design and Installation Standards Manual
- 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

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

FUSS & O'NEILL

Recommended Actions Summary
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.

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

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

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

Burdickville Dam

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

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

FUSS & O'NEILL

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

Typical installation of underground infiltration system below an existing parking lot.

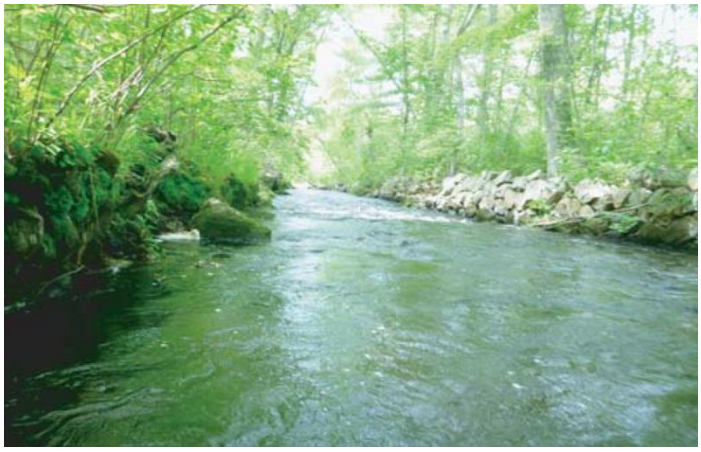
View of a typical bioretention cell with mature plantings.

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.

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 re-form meanders



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

Land Use Policy and 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

Recommendations:

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

- 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Exeter, 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 Exeter.

Quick Facts - Exeter

- 91% of town within watershed
- Includes portions of the Chipuxet, Chickasheen, Beaver, Usquepaug, Wood, and Queen Rivers and their watersheds
- 63 stream crossings assessed
- 11 dams assessed

Road Stream Crossings

- 25 crossings are hydraulically undersized
- 30 crossings have high geomorphic vulnerability
- 6 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

Road	Stream	Crossing Type
Deer Brook Lane	Unnamed	36” Concrete Circular Conduit
Tarbox Drive	Queens Fort Brook	48” and 24”” Concrete Circular Conduit (Total 2)
Mail Road	Unnamed	12” Concrete Circular Conduit
Purgatory Road	Unnamed	24” Concrete Circular Conduit
Wolf Rocks Road	Chipuxet River	5.3’ x 5.9’ Concrete Box Culvert
Yawgoo Valley Road	Chipuxet River	Triple 48” Concrete Circular Conduit
William Reynolds Road	Unnamed	12” HDPE Circular Conduit
Liberty Road	Unnamed	Triple 18” HDPE Circular Conduit
South Country Trail*	Chickasheen Brook, Mud Brook, Unnamed	Multiple crossings
Summit Road*	Roaring Brook	Triple 48” Concrete Circular Conduit

*These crossings were not scored as high priority, but flooding has been reported at these locations.

Dams

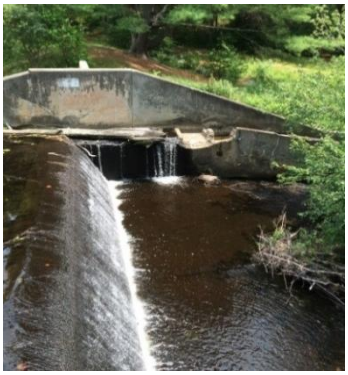
- 5 high hazard dams, 1 significant hazard dam, and 5 low hazard dams
- Several dams provide recreational or other uses and are undergoing or were recently repaired
- Several dams are recommended for repair or removal due to poor condition and lack of maintenance

Recommendations:

Breakheart Pond Dam (Breakheart Brook)
- Located within Arcadia Management Area
- Downstream watercourse has obstructions to fish passage
- Dam is in poor condition and repairs are therefore recommended

Browning Mill Pond Dam (Roaring Brook)
- RIDEM owns the dam and operates a hatchery downstream
- Browning Mill Pond has significant public recreational value
- Repairs are recommended for this deteriorating dam

Edward’s Pond Dam (Queen River)
- Owned by Exeter Country Club
- No apparent active uses of impoundment
- Consider dam removal



Breakheart Pond Dam

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

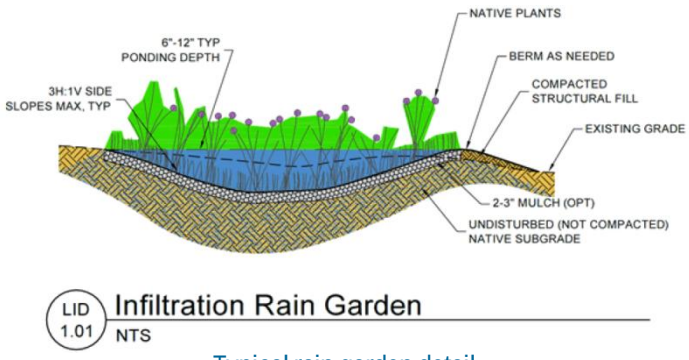
FUSS & O’NEILL

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:

- Exeter Town Animal Shelter
  - Install bioretention along the northern roadside of South Country Trail to treat approximately one quarter mile of roadway
  - Cost: $107,000
- Exeter Town Hall
  - Bioretention and rain garden at parking lot
  - Cost: $103,000
- Browning Mill Pond Parking Access
  - Bioretention and forested buffer to protect adjacent Browning Mill Pond
  - Regrade and till parking lot to alleviate some erosional issues and improve infiltration
  - Cost: $32,000



Typical rain garden detail.

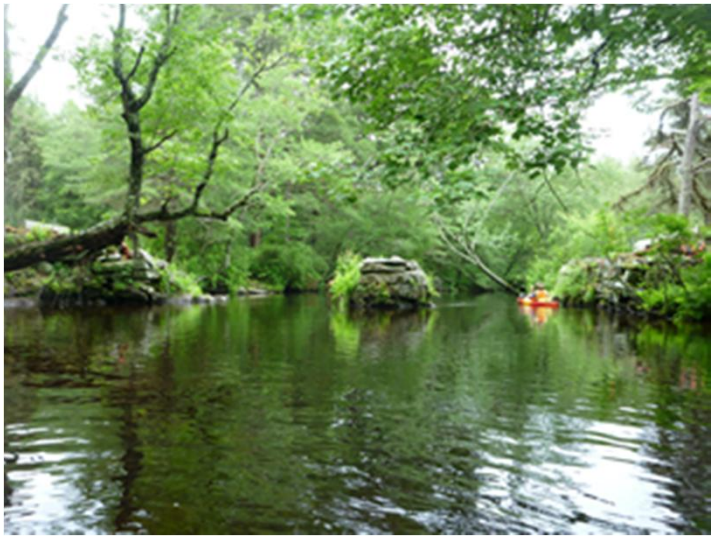
River Corridor

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.

Recommendations:

Arcadia Management Area south of Ten Rod Road (Upper Wood River)

- Add wood cover structures along river banks (a.k.a. marginal wood cover) and wood to river to encourage meander formation and sediment storage within artificially straightened channel
- Area is popular for fly fishing
- Area is owned and managed by the Wood-Pawcatuck Watershed Association



Straightened river channel and old bridge abutments

Land Use Policy and 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

Recommendations:

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

- The Hazard Mitigation Plan is due to be updated and should address flood-prone areas identified during the 2010 flood and subsequent flood events, including street flooding identified as an issue in 2010
- 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
- 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Hopkinton, 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 Hopkinton.

Quick Facts - Hopkinton

- 100% of town within watershed
- Includes portions of the Wood, Ashaway, and Pawcatuck Rivers and their watersheds
- 83 stream crossings assessed
- 19 dams assessed within the Town; 6 dams assessed that lie on the border between Hopkinton and adjacent towns (25 dams total)

Road Stream Crossings

- 21 crossings are hydraulically undersized
- 35 crossings have high geomorphic vulnerability
- 32 crossings have high flood impact potential
- 47 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

Road	Stream	Crossing Type
Vuono Road	Unnamed	36" HDPE Circular Conduit
Woodville Road	Unnamed	12" Concrete Circular Conduit
Woodville Alton Road	Unnamed	18" Concrete Circular Conduit and 18" CMP Circular Conduit
Nooseneck Hill Road	Unnamed	30"W x 24"H Stone Masonry Box Culvert
Tomaquag Road	Unnamed	48"W x 48"H Concrete Box Culvert
Clarks Falls Road	Parmenter Brook	Four (4) 24" CMP Circular Conduits
Harningstuns Crossing	Unnamed	Double 24" Concrete Circular Conduit
Woodville Road	Wood River	123'W x 8'H Concrete Bridge
Sawmill Road	Brushy Brook	Triple 36" Concrete Circular Conduit
Woodville Road	Unnamed	Concrete Bridge – No Dimension Data

Dams

- 3 high hazard dams, 8 significant hazard dams, and 14 low hazard dams
- 8 dams are considered high priority
- 6 of the dams assessed lie on the border of Hopkinton and either Richmond or Charlestown
- Condition, purpose, and level of community use vary widely between dams

Recommendations:

Consider Dam Repair– High Priority:

- Harris Pond Dam (Tomaquag Brook Tributary)
- Wyoming Pond Upper Dam (Wood River)

Consider Dam Removal – High Priority:

- Alton Pond Dam (Wood River)
- Ashaway Line Pond Dam (Ashaway River), Ashaway Mill Pond Dam (Ashaway River), and Bethel Pond Dam (Ashaway River) (collectively consider removal of all 3 dams)
- Ashville Pond Dam (Blue Pond Brook)
- Potter Hill Dam (Pawcatuck River)

Potter Hill Dam

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

FUSS & O'NEILL

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:

- Hopkinton Recreation Department
  - Linear bioretention practice along roadway
  - Cost: $72,000
- Trinity Lutheran Church
  - Bioretention and rain gardens
  - Cost: $61,000
- U.S. Post Office (Ashaway, RI)
  - Underground infiltration under public roads
  - Cost: $282,000
- Chariho Little League
  - Rain gardens adjacent to parking areas
  - Cost: $39,000
- Ashaway Elementary School
  - Underground infiltration and bioretention
  - Cost: $229,000

View of a typical bioretention cell or rain garden with mature plantings

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.

Recommendations:

- Protect dynamic reaches with high quality habitat, located along the Ashaway River, from encroachment by future development
- Enhance meander development in artificially straightened channels along the Lower Wood and Ashaway Rivers to slow flows, increase flood storage, and conserve or improve habitat
- Coordinate floodplain restoration along the Lower Wood River with site remediation of former Charbert Facility site
- Breach and/or remove confining berm downstream of Bradford Dam to allow floodplain access during high flows and thereby increase flood storage and slow flood flows

View of straightened channel along Ashaway River, with limited habitat or flood storage

Land Use Policy and 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

Recommendations:

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

- 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of North Kingstown, 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 North Kingstown.

Quick Facts - North Kingstown

- 7.3% of town within watershed
- Includes portions of the Chipuxet River and its watershed
- 6 stream crossings assessed
- 2 dams assessed

Road Stream Crossings

- 1 crossing is hydraulically undersized
- 1 crossing has high geomorphic vulnerability
- All 6 crossings have medium flood impact potential
- 4 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
Kayla Ricci Way	Drainage Ditch	24" Concrete Circular Conduit
Sylvan Court	Unnamed	3.5'W x 1.5'H Concrete Box Culvert
Explorer Drive	Unnamed	Five (5) 24" Concrete Circular Conduits
Indian Corner Road	Chipuxet River	Double 6'W x 3'H Concrete Box Culvert
Glen Hill Road	Unnamed	24" Concrete Circular Conduit
Slocum Road	Unnamed	10.5'W x 2.5'H Concrete Box Culvert

Dams

- 2 high hazard dams

Recommendations:

Slocum Road Upper Dam (Chipuxet River Tributary)

- NOVs were issued in 2011 and 2012; owner indicated that repairs were made but DEM has not confirmed
- Impoundment supports limited recreational use
- Dam removal should be considered if owner is amenable
- Maintain if owner is not amenable to removal

Slocum Woods Dam (Chipuxet River Tributary)

- Dam was in good condition in 2013 (last documented inspection)
- Dam is owned by Slocum Woods Homeowners Association and is used for recreational purposes
- The impoundment appears to be used for irrigation for turf farming operations (Sodco)
- No action beyond maintenance is recommended for this dam; this recommendation is low priority

Slocum Road Upper Dam

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

FUSS & O'NEILL

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.

No site-specific GI retrofit concepts were developed for North Kingstown due to the town's small land area within the Wood-Pawcatuck watershed and the limited scope of the GI assessment. The Town should incorporate GI approaches into municipal stormwater infrastructure planning and capital improvement plans to address drainage, flooding, and water quality priorities including MS4 Permit requirements, both within and outside of the Wood-Pawcatuck watershed. GI can be implemented on public sites including municipal parking lots and within the public right-of-way.

Rendering of a typical bioretention area

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.

Recommendations:

Between Slocum Reservoir Dam and area downstream of Railroad Road (Chipuxet River)

- Encourage riparian plantings along the left bank of the river where residential properties abut the channel, to reduce risk of erosion and promote high quality habitat

General Recommendation: Protect and enhance floodplains, wetlands, and riparian buffers in order to reduce flood impacts and improve habitat.

Proposed area of riparian plantings where residential properties are located on the left bank of the Chipuxet River

Land Use Policy and 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

Recommendations:

A review was conducted of the land use policies, plans, and regulations of the watershed municipalities. North Kingstown was excluded from the review since it comprises 1 percent or less of the total watershed area and less than 10 percent of the community's land area is within the Wood-Pawcatuck watershed. General recommendations that apply to North Kingstown include:

- 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
- 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of North Stonington, CT

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 North Stonington.

Quick Facts - North Stonington

- 70% of town within watershed
- Includes portions of the Green Fall/Ashaway, Shunock, Pawcatuck Rivers, Wyassup Brook, and their watersheds
- 63 stream crossings assessed
- 3 dams assessed

Road Stream Crossings

- 27 crossings are hydraulically undersized
- 29 crossings have high geomorphic vulnerability
- 11 crossings have high flood impact potential
- 43 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

Road	Stream	Crossing Type
State Highway 49	Unnamed	24” CMP Circular Conduit
Loin Hill Road	Unnamed	12” HDPE Circular Conduit
Main Street	Shunnock River	11'W x 7'H Stone Masonry Bridge
Mains Crossing	Unnamed	18” Concrete Circular Conduit
Chester Main Road	Unnamed	42” CMP Circular Conduit
Wyassup Road	Unnamed	30” CMP Circular Conduit
Wyassup Road	Unnamed	Double 24” CMP Circular Conduits
Grindstone Hill Road	Wyassup Brook	Double 42” CMP Circular Conduit
Yawbux Valley Road	Unnamed	24” CMP Circular Conduit
Pine Woods Road	Glade Brook	Double 24” Concrete Circular Conduit + Single 5'W X3'H CMP
Reutemann Road	Unnamed	Double 24” Concrete Circular Conduit

Dams

- 1 significant hazard dam and 2 low hazard dams

Recommendations:

Green River Pond Dam (Green Fall River Tributary)

- Consider formalizing breach and replacing downstream culvert
- The dam has not been maintained and is partially breached; current uses are unknown
- The culvert downstream of this impoundment is likely undersized and contributing to backwater flooding

Lewis Pond Dam (Pawcatuck River Tributary)

- Consider dam removal
- Current uses are unknown; owner may use impoundment as a cattle watering hole

Spaulding Pond Dam (Wyassup Brook)

- Consider dam removal
- The impoundment supports recreational uses
- Once the dams on the Ashaway River are removed, removal of this dam would become a higher priority

Spaulding Pond Dam

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

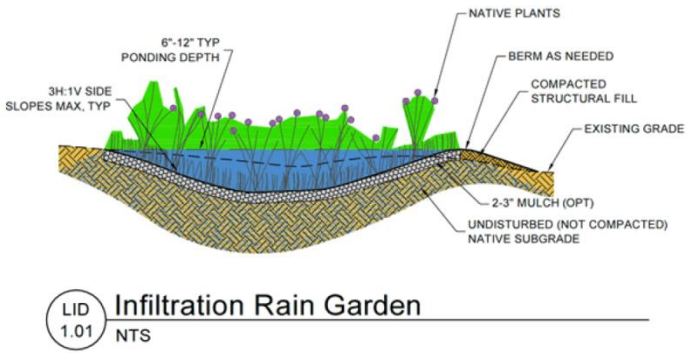
FUSS & O'NEILL

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:

- Wheeler High School
  - Install two bioretention basins at the front of the building
  - Cost: $81,000
- Wheeler Library
  - Install two bioretention basins to treat runoff from the parking area, roof, and driveway
  - Cost: $53,000
- North Stonington Elementary and Administration
  - Install multiple bioretention areas within parking lot islands and adjacent to administration building
  - Cost: $212,000



Typical rain garden detail.

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.

Recommendations:

Upstream of Puttker Road to confluence with Shingle Mill Pond Brook (Green Fall River)

- Protect corridor from encroachment by development to protect valuable archaeological sites and areas with good habitat potential
- Install log jams along channel margins to encourage meander formation downstream of Puttker Road and thereby reduce flood impacts

Straightened channel downstream of Puttker Road

Land Use Policy and 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

Recommendations:

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

- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Amend zoning regulations 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 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Richmond, 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 Richmond.

Quick Facts - Richmond

- 100% of town within watershed
- Includes portions of the Wood, Beaver, Pawcatuck, Usquepaug, and Queen Rivers and their watersheds
- 61 stream crossings assessed
- 10 dams assessed, 5 of which lie on the border between Richmond and Hopkinton

Road Stream Crossings

- 21 crossings are hydraulically undersized
- 31 crossings have high geomorphic vulnerability
- 24 crossings have high flood impact potential
- 22 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

Road	Stream	Crossing Type
New London Turnpike	Unnamed	Double 24" CMP Circular Conduit
Buttonwood Road	Unnamed	36" Concrete Circular Conduit
New London Turnpike	Unnamed	42" CMP Circular Conduit
Hillsdale Road	Beaver River	Double 36" CMP Circular Conduit + Overflow Conduit
Shannock Hill Road	Beaver River	12'W x 4'H Concrete Bridge
Schoolhouse Road	Beaver River	8'W x 4'H Concrete Box Culvert
New London Turnpike	Beaver River	46" CMP Circular Conduit
Unnamed	Beaver River	13'W x 4'H Concrete Bridge
Pine Hill Road	Meadow Brook	7'W x 3'HConcrete Box Culvert
Old Mountain Road	Beaver River	Double 36" Concrete Circular Conduit
Church Street	Meadow Brook	6.6'W x 7.7'H Concrete Box Culvert

Dams

- 2 high hazard dams, 3 significant hazard dams, and 5 low hazard dams
- 8 of the 10 dams are considered High or Intermediate priority for recommended actions

Recommendations:

Alton Pond Dam (Wood River)
- Consider dam removal
- Downstream-most dam on the Wood River, restricting aquatic passage to the river
- Replacement or reconfiguration of the Church Street Bridge would be required to accommodate dam removal

DeCoppett Pond Dam (Beaver River)
- Consider dam removal
- The dam is located on the Beaver River, which is one of the most valued cold water streams in RI and has a known population of Brook Trout
- The impoundment does not appear to support any active uses; dam is deteriorating

Wood River Junction Dam (Meadow Brook)
- Consider dam removal
- Dam in generally poor condition and not maintained

Tug Hollow Pond Dam (Beaver River)
- Consider dam removal to restore connectivity and water quality to this high-value stream

DeCoppett Pond Dam

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

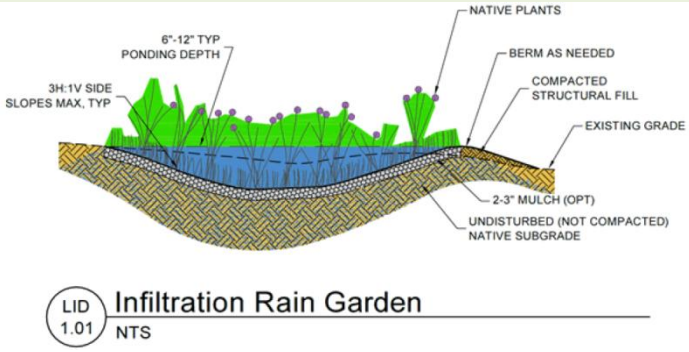
FUSS & O'NEILL

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:

- Richmond Elementary School
  - Install bioretention basins in school lawn
  - Cost: $188,000
- Richmond Police Department
  - Underground infiltration under parking lots
  - Cost: $41,000
- Rhode Island State Police Barracks
  - Install bioretention basin next to barracks
  - Cost: $39,000
- Wyoming Dam Fishing Access
  - Bioretention and Pervious Pavers to promote infiltration and prevent erosion
  - Modify boat ramp with articulated concrete block matting to prevent erosion and sediment transport to river
  - Cost: $161,000



Typical rain garden detail.

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.

Recommendations:

Downstream of undersized culvert at Route 138 (Meadow Brook)

- Replace undersized culvert at Rte. 138 (Kingstown Road) with larger bottomless arch culvert that spans full channel width
- Add roughness elements in channel to encourage aggradation and reduce incision

Village of Carolina along Route 112 (Upper Pawcatuck River

- Breach granite bank/berm that confines the channel and cuts off side channel access to allow access to floodplain
- Use granite from berm to construct instream structures

Bermed, straightened reach of Pawcatuck River along Route 112

Land Use Policy and 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

Recommendations:

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

- 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

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Sterling, CT

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 Sterling.

Quick Facts - Sterling

- 22% of town within watershed
- Includes portions of the Wood River and its watershed
- 6 stream crossings assessed
- 1 dam assessed

Road Stream Crossings

- All 6 crossings are hydraulically undersized
- All 6 crossings have high geomorphic vulnerability
- 3 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
Cedar Swamp Road	Wood River	5'W x 4'H Stone Masonry Box Culvert
Newport Road	Carson Brook	3'W x 1.5'H Stone Masonry Box Culvert
Gallup Homestead Road	Unnamed	20" Concrete Circular Conduit
Gallup Homestead Road	Unnamed	12" Concrete Circular Conduit
Pachaug Trail	Wood River	9'W x 3'H Timber Bridge
Brown Road	Wood River	8'W x 6'H Stone Masonry Bridge

Dams

- 1 significant hazard dam assessed
- Only a portion of Sterling was assessed; other dams outside the Wood-Pawcatuck watershed may impact flooding in other parts of the town

Recommendations:

Porter Pond Dam (Wood River)

- Consider dam removal
- Dam is not being maintained and is in disrepair
- Owner of dam could not be identified
- Impoundment supports limited recreational uses

Porter Pond Dam

Stream Crossing over Carson Brook at Newport Road

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

FUSS & O'NEILL

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.

No site-specific GI retrofit concepts were developed for Sterling due to the town's small land area and limited development within the Wood-Pawcatuck watershed and the limited scope of the GI assessment. The Town should incorporate GI approaches into municipal stormwater infrastructure planning and capital improvement plans to address drainage, flooding, and water quality priorities including MS4 Permit requirements, both within and outside of the Wood-Pawcatuck watershed. GI can be implemented on public sites including municipal parking lots and within the public right-of-way.

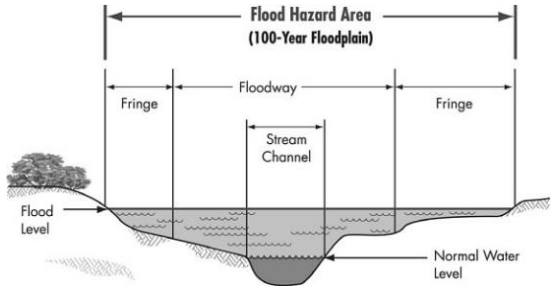
Rendering of a typical bioretention area.

River Corridor

A detailed field 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. While field geomorphic assessments were not conducted within Sterling, these recommendations apply in the town and throughout the watershed.

Recommendations:

- Protect existing wetlands as well as stream connections to wetlands and floodplains
- Remove floodplain constraints, such as levees or berms, where possible
- Protect and enhance riparian buffers
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders (where human conflicts with meander formation are not present)
- Avoid or limit alterations that will straighten or channelize stream channels
- Consider removing bank armoring where possible once a protected river corridor is established



Conceptual view of a typical floodplain cross section.

Land Use Policy and 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

Recommendations:

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

- 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
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove barriers to use of LID
- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Amend Floodplain Management Ordinance to strengthen flood management standards
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards
- Update design storm precipitation amounts
- Implement road stream crossing standards for new and replacement culverts and bridges

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Voluntown, CT

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 Voluntown.

Quick Facts - Voluntown

- 21% of town within watershed
- Includes portions of the Ashaway and Wood River watersheds
- 7 stream crossings assessed
- 1 dam assessed

Road Stream Crossings

- 4 crossings are hydraulically undersized
- 4 crossings have high geomorphic vulnerability
- 1 crossing has high flood impact potential
- 2 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
Bailey Pond Road	Carson Brook	Double 30" CMP Circular Conduit
Sand Hill Road	Unnamed	12" CMP Circular Conduit
Tom Wheeler Road	Unnamed	24" Concrete Circular Conduit
Sand Hill Road	Green Fall River	36" Stone Masonry Box Culvert
Green Fall Road	Unnamed	36" Concrete Circular Conduit
Sand Hill Road	Peg Mill Brook	6'W x 7'H Stone Masonry Box Culvert
Green Fall Road	Unnamed	10'W x 4.4'W Stone Masonry Box Culvert

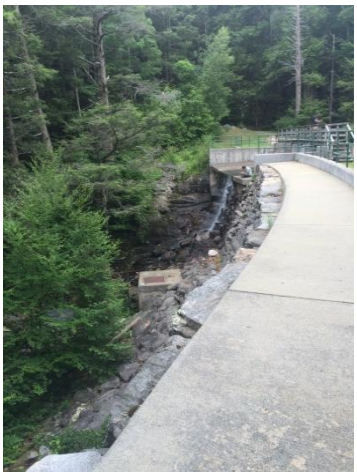
Dams

- 1 significant hazard dam

Recommendations:

Green Falls Reservoir Dam (Green Fall River)

- Recommended action is to maintain dam in its current state; this dam is considered a low priority
- Impoundment is located in the Pachaug State Forest and has significant public recreational value
- Dam is in fair condition



Green Falls Reservoir Dam

Stream Crossing over an unnamed stream at Tom Wheeler Road

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

FUSS & O'NEILL

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.

No site-specific GI retrofit concepts were developed for Voluntown due to the limited development and protected nature of the land within the Wood-Pawcatuck watershed and the limited scope of the GI assessment. The Town should incorporate GI approaches into municipal stormwater infrastructure planning and capital improvement plans to address drainage, flooding, and water quality priorities including MS4 Permit requirements, both within and outside of the Wood-Pawcatuck watershed. GI can be implemented on public sites including municipal parking lots and within the public right-of-way.

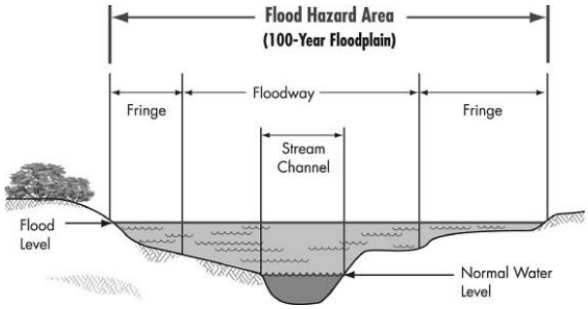
Rendering of a typical bioretention area.

River Corridor

A detailed field 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. While field geomorphic assessments were not conducted within Voluntown, these recommendations apply in the town and throughout the watershed.

Recommendations:

- Protect existing wetlands as well as stream connections to wetlands and floodplains
- Remove floodplain constraints, such as levees or berms, where possible
- Protect and enhance riparian buffers
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders (where human conflicts with meander formation are not present)
- Avoid or limit alterations that will straighten or channelize stream channels
- Consider removing bank armoring where possible once a protected river corridor is established



Conceptual view of a typical floodplain cross section.

Land Use Policy and 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

Recommendations:

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

- 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
- Consider amendments to the zoning and subdivision regulations to promote reduction of impervious surfaces and remove barriers to use of LID
- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Amend Floodplain Management Ordinance to strengthen flood management standards
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards
- Update design storm precipitation amounts
- Implement road stream crossing standards for new and replacement culverts and bridges

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

FUSS & O'NEILL

Recommended Actions Summary
Town of West Greenwich, 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 West Greenwich.

Quick Facts – West Greenwich

- 51% of town within watershed
- Includes portions of the Wood, Usquepaug, and Queen Rivers and their watersheds
- 21 stream crossings assessed
- 2 dams assessed

Road Stream Crossings

- 10 crossings are hydraulically undersized
- 12 crossings have high geomorphic vulnerability
- 14 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
Shetucket Turnpike	Unnamed	2'W x 1'H Stone Conduit
Tillinghast Pond Road	Coney Brook	4' W x 2'H Stone Masonry Box Culvert
Hazard Road	Wood River	Triple 36" CMP Circular Conduit
Falls River Road	Wood River	10.5'W x 6.5'H Stone Masonry Bridge
Shetucket Turnpike	Unnamed	24" Concrete Circular Conduit
Henry Brown Road	Fisherville Brook	48" CMP Circular Conduit
Plain Meeting House Road	Phillips Brook	36" Concrete Circular Conduit
Shetucket Turnpike	Factory Brook	Double 60" Concrete Circular Conduit
Henry Brown Road	Unnamed	36" Concrete Circular Conduit
Plain Meeting House Road	Breakheart Brook	Double 30" CMP Circular Conduit

Dams

- 2 low hazard dams
- Both dams are considered low priority dams

Recommendations:

Hazard Pond Dam (Falls River)
- Consider dam removal
- There are no known uses of the impoundment
- Next dam downstream on the Wood River (Barberville Pond Dam) should be considered for removal

Kasella Farm Pond Dam (Breakheart Brook)
- Current use of the impoundment is unknown
- Dam recently reconstructed to build a road across crest, but needs repair (crest is not compacted)
- Removal should be considered and could be achieved by enlarging the culverts beneath the roadway to sufficiently drain the impoundment, thereby maintaining the roadway

Kasella Pond Dam

Stream Crossing over an unnamed stream at Shetucket Turnpike

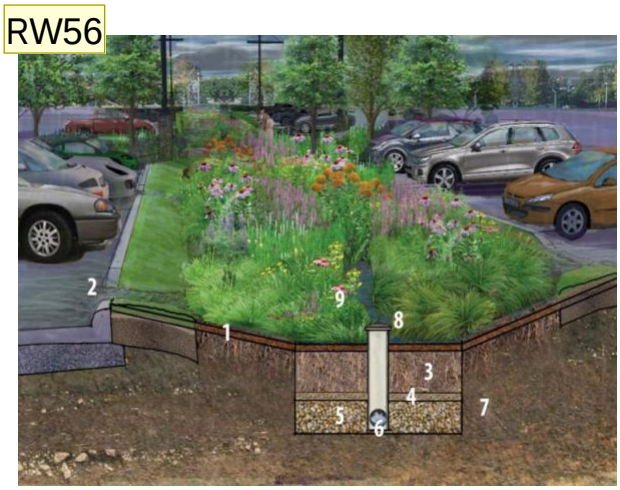
Project funding was provided by the National Fish and Wildlife Foundation Hurricane Sandy Coastal Resiliency Competitive Grant Program

FUSS & O'NEILL

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.

No site-specific GI retrofit concepts were developed for West Greenwich due to the limited scope of the GI assessment. The Town should incorporate GI approaches into municipal stormwater infrastructure planning and capital improvement plans to address drainage, flooding, and water quality priorities including MS4 Permit requirements, both within and outside of the Wood-Pawcatuck watershed. GI can be implemented on public sites including municipal parking lots and within the public right-of-way.



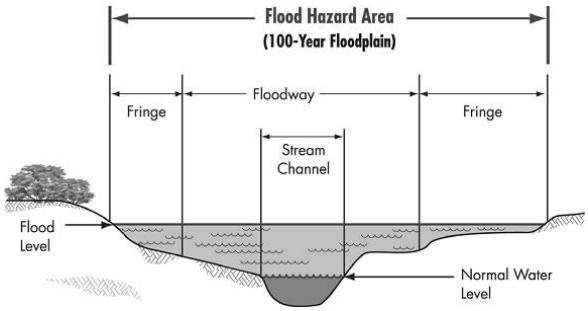
Rendering of a typical bioretention area.

River Corridor

A detailed field 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. While field geomorphic assessments were not conducted within West Greenwich, these recommendations apply in the town and throughout the watershed.

Recommendations:

- Protect existing wetlands as well as stream connections to wetlands and floodplains
- Remove floodplain constraints, such as levees or berms, where possible
- Protect and enhance riparian buffers.
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders (where human conflicts with meander formation are not present)
- Avoid or limit alterations that will straighten or channelize stream channels
- Consider removing bank armoring where possible once a protected river corridor is established



Conceptual view of a typical floodplain cross section.

Land Use Policy and 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

Recommendations:

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

- Update and integrate the Town hazard mitigation plan and comprehensive plan to address flood-prone areas
- 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
- Implement road stream crossing standards for new and replacement culverts and bridges

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Westerly, 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 Westerly.

Quick Facts - Westerly

- 77% of town within watershed
- Includes portions of the lower Pawcatuck River, smaller tributaries, and associated watersheds
- 40 stream crossings assessed
- 2 dams assessed, one of which lies on the Connecticut border

Road Stream Crossings

- 15 crossings are hydraulically undersized
- 21 crossings have high geomorphic vulnerability
- 19 crossings have high flood impact potential
- 18 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

Road	Stream	Crossing Type
Forrestal Drive	Unnamed	Double 32" Concrete Circular Conduit
Westerly-Bradford Road	McGowan Brook	24" CMP Circular Conduit
Broad Street	Pawcatuck River	74'W x 14.5'H Concrete Bridge
Potter Hill Road	Unnamed	6" CMP Circular Conduit
White Rock Road	Unnamed	Triple 24" Concrete Circular Conduit
West Arch Street	Unnamed	18" Concrete Circular Conduit
Ross Hill Road	Perry Healy Brook	12" CMP Circular Conduit
Hiscox Road	Unnamed	32" Concrete Circular Conduit
Stillman Avenue	Pawcatuck River	117"W X 11'H Concrete Bridge
Boom Bridge Road	Pawcatuck River	23.4'W x 9.6'H Concrete Bridge
Post Office Lane	Pawcatuck River	4.3'W X 8.5'H Stone Masonry Bridge
White Rock Road	Pawcatuck River	Stone Masonry Bridge

Dams

- 2 low hazard dams
- Both dams are deteriorating or in disrepair but are considered low priority dams

Recommendations:

Stillmanville Dam (Pawcatuck River)

- The concrete structure does not prevent fish passage or have a significant impact on flow regime
- Consider removal to provide river restoration benefits

Olaf Farm Pond Dam (Cedar Swamp Brook)

- Repairs are recommended at this dam. Dense vegetation should be removed and erosion that has occurred at the informal secondary spillway should be addressed.
- The owner is currently maintaining the dam and wishes to maintain the impoundment
- The owner is opposed to removal.
- If the owner would agree to removal in the future, removal should be considered (low priority)

Stillmanville Dam

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

FUSS & O'NEILL

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:

- Grace United Methodist Church
  - Bioretention adjacent to parking lot
  - Cost: $36,000
- Bradford School
  - Underground infiltration and green roof demonstration project
  - Cost: $219,000 ($56,000 for underground infiltration)
- State Street School
  - Bioretention and rain gardens
  - Cost: $83,000
- Westerly High School
  - Underground infiltration under parking area
  - Cost: $29,000
- Tower Street School and Community Center
  - Bioretention along parking area perimeter
  - Cost: $18,000

Typical installation of underground infiltration system below an existing parking lot.

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.

Recommendations:

Downstream of Bradford Dam; Downstream of Boom Bridge to top of former White Rock Dam impoundment (Pawcatuck River)

- Remove berm on left bank to restore floodplain connection and reduce flood impacts

Downstream of Potter Hill Dam in Ashaway (Pawcatuck River)

- Install instream structures to narrow channel, sort and store sediment, and provide cover for aquatic organisms

At former location of White Rock Dam to Route 78 Bridge (Pawcatuck River)

- Install riparian plantings on right bank near gravel pit to slow or halt bank erosion

Berm confining Pawcatuck River downstream of Bradford Dam

Land Use Policy and 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

Recommendations:

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

- Consider developing a coastal resiliency plan to better protect public infrastructure from coastal flooding and sea level rise
- 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
- 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
- Reference the Wood-Pawcatuck Flood Resiliency Management Plan in municipal planning documents

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

FUSS & O'NEILL

Recommended Actions Summary
Town of Stonington, CT

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 Stonington.

Quick Facts - Stonington

- 11% of town within watershed
- Includes portions of the Pawcatuck and Shunock Rivers and their watersheds
- 12 stream crossings assessed
- 2 dams assessed

Road Stream Crossings

- 4 crossings are hydraulically undersized
- 4 crossings have high geomorphic vulnerability
- 5 crossings have high flood impact potential
- 7 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

Road	Stream	Crossing Type
West Arch Street	Unnamed	Circular Concrete Culvert
Broad Street	Pawcatuck River	Concrete Bridge
Stillman Avenue	Pawcatuck River	Concrete Bridge
White Rock Road	Pawcatuck River	Stone Masonry Bridge
Elmridge Avenue	Unnamed	Stone Masonry Box Culvert
Fairview Drive	Unnamed	Circular Concrete Culvert
Canterbury Lane	Unnamed	Circular Concrete Culvert
Somersett Drive	Unnamed	Circular Concrete Culvert
Timber Ridge Drive	Unnamed	Circular Concrete Culvert
Voluntown Road (Rt. 49)	Unnamed	Circular Concrete Culvert

Dams

- 1 significant hazard dam, 1 low hazard dam

Recommendations:

Liepold Pond Dam (Pawcatuck River)

- The dam is being maintained. Ongoing maintenance is recommended.
- The owner has indicated a desire to maintain the impoundment for private uses

Stillmanville Dam (Pawcatuck River)

- The concrete structure does not prevent fish passage or have a significant impact on flow regime
- Consider removal to provide river restoration benefits

Liepold Pond Dam

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

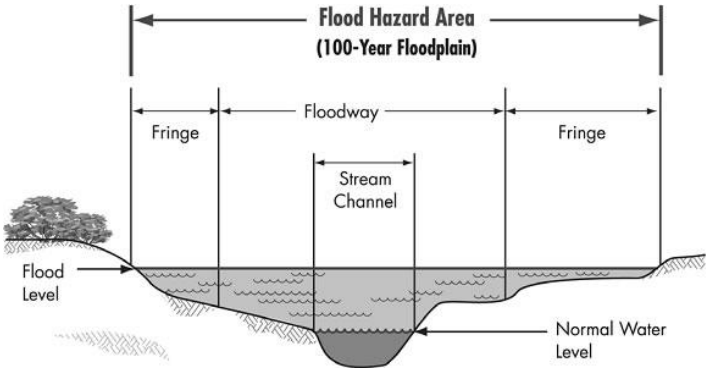
FUSS & O'NEILL

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.

Recommendations:

- Protect existing wetlands as well as stream connections to wetlands and floodplains
- Remove floodplain constraints, such as levees or berms, where possible
- Protect and enhance riparian buffers
- Install log jams in select locations along the stream corridor to protect banks, create habitat, and re-form meanders (where human conflicts with meander formation are not present)
- Avoid or limit alterations that will straighten or channelize stream channels
- Consider removing bank armoring where possible once a protected river corridor is established



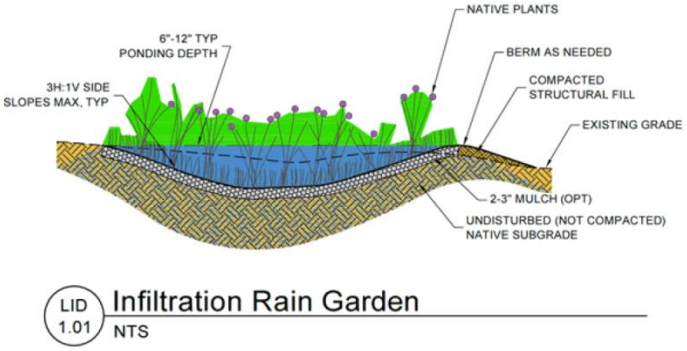
Conceptual view of a typical floodplain cross section.

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:

- West Vine Street School
  - Install rain gardens near the school building and around the bus loop
  - Cost: $22,000



Typical rain garden detail.

View of a typical bioretention cell or rain garden with mature plantings.

Land Use Policy and 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.

Recommendations:

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

- 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
- Consider adopting a No Adverse Impact (NAI) Floodplain Management policy
- Consider amendments to zoning regulations to further strengthen flood management standards
- Consider implementing fluvial erosion hazard zoning to address riverine erosion hazards
- 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

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

FUSS & O'NEILL