NATURAL & NATURE-BASED SOLUTIONS FOR VULBERABILITY REDUCTION & RESILIENCE

The Nature Conservancy
Protecting nature. Preserving life.

Sara Burns
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What We've Learned Today

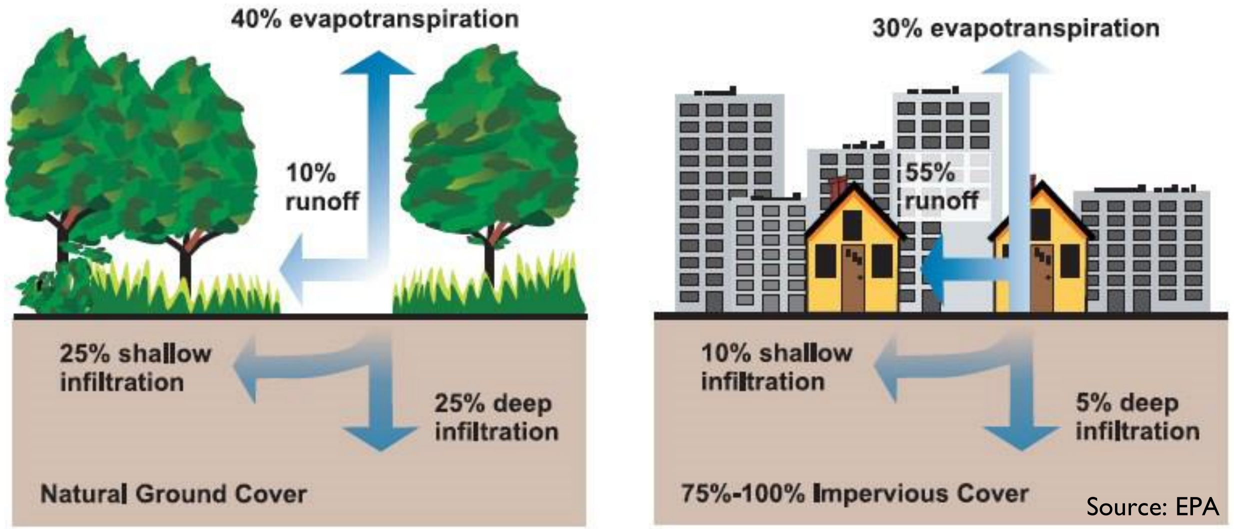
- We are all here to be proactive and find solutions!
- Climate change is already affecting how we experience storms.
- Winthrop is a great place with many strengths and coming challenges.

Key Observed Climate Changes in Suffolk County

Annual Average Temperature	4.9°F
Days Above 90°F	19 Days
Sea Level Rise	2.4 feet
Days with >2” Precipitation	44%

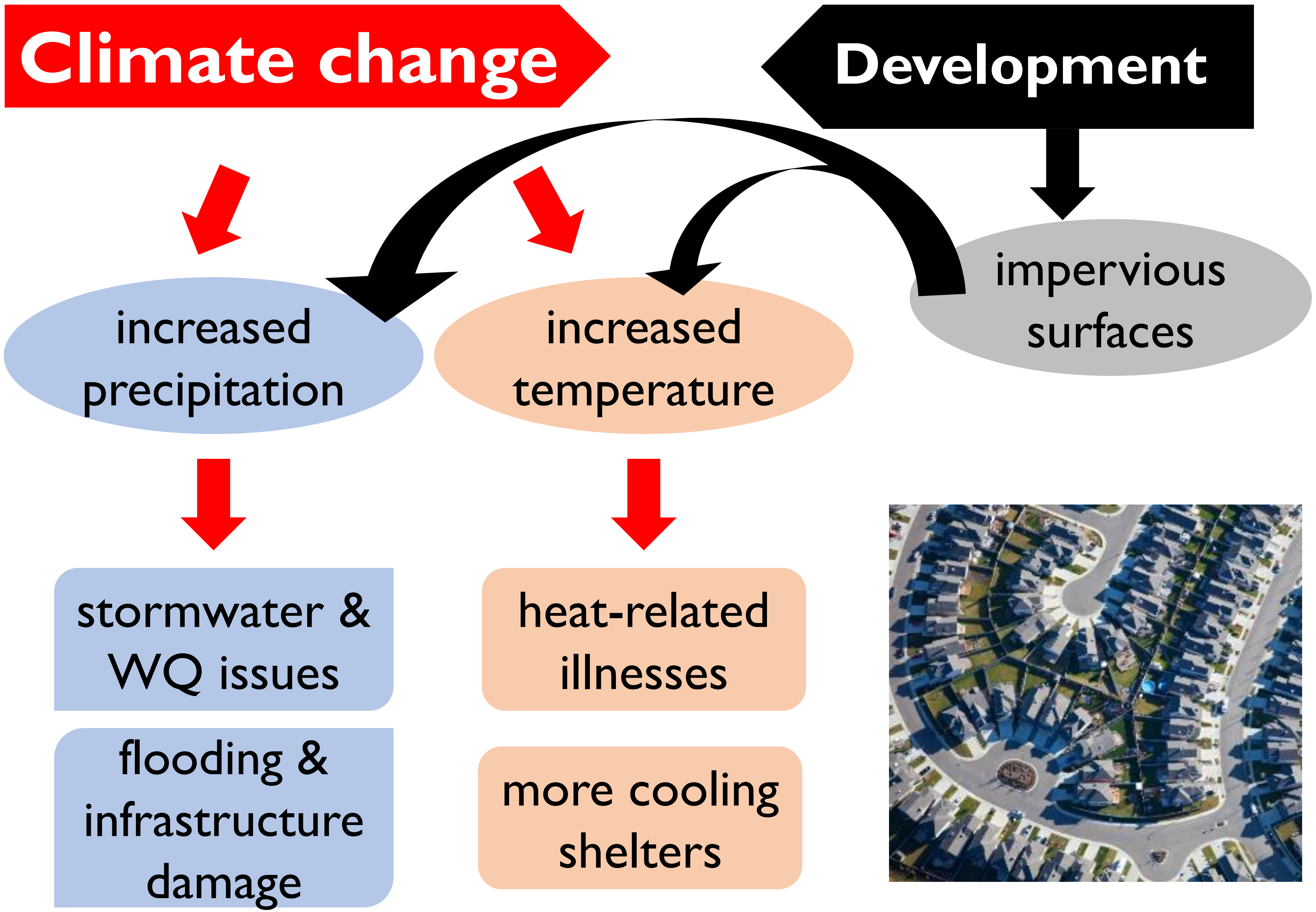
Source: Northeast Climate Science Center, MassClimateChange.org, Values shown for the Blackstone River Watershed.

What's the problem?

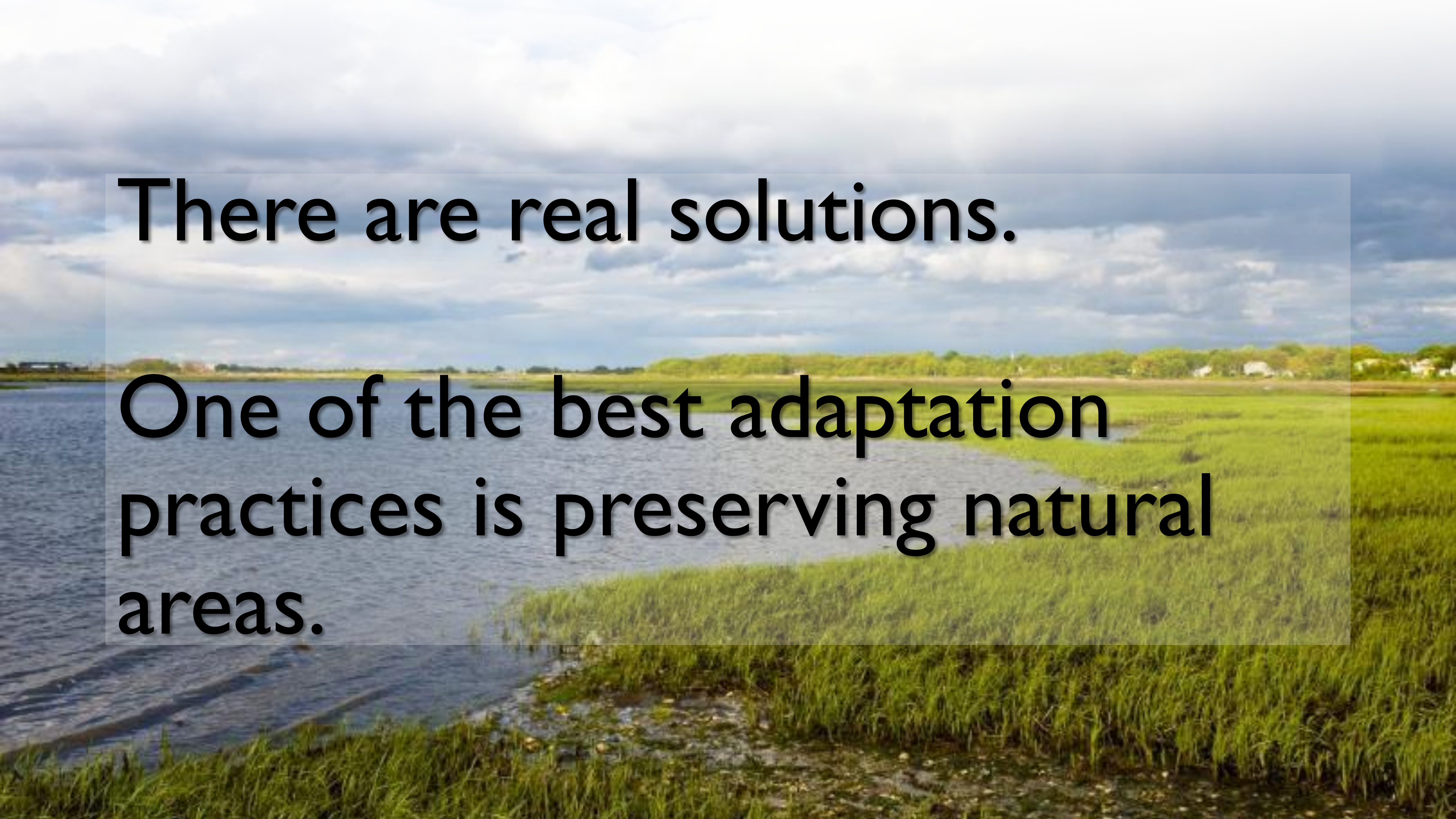


Impervious surface → Runoff →

Large lawns → Fertilizer →


Climate change
Development
increased precipitation
increased temperature
impervious surfaces
stormwater & WQ issues
flooding & infrastructure damage
heat-related illnesses
more cooling shelters

Impacts: dry rivers, flooding, algae blooms, erosion, beach closures


There are real solutions.
One of the best adaptation practices is preserving natural areas.

Nature-Based Solutions

Nature-Based Solutions *use* natural systems, *mimic* natural processes, or *work in tandem with* traditional approaches to address natural hazards like flooding, erosion, drought, and heat islands.

Green Infrastructure

Low Impact Development (LID)

Solutions for Every Place

Conserve the natural green infrastructure already providing free ecosystem services

Integrate LID and green infrastructure design into development

Restore the resiliency of landscapes through LID

Conserve

Conserve the natural green infrastructure already providing free ecosystem services

Integrate LID and green infrastructure design into development

Restore the resiliency of landscapes through LID

Integrate

Conserve the natural green infrastructure already providing free ecosystem services

Integrate LID and green infrastructure design into development

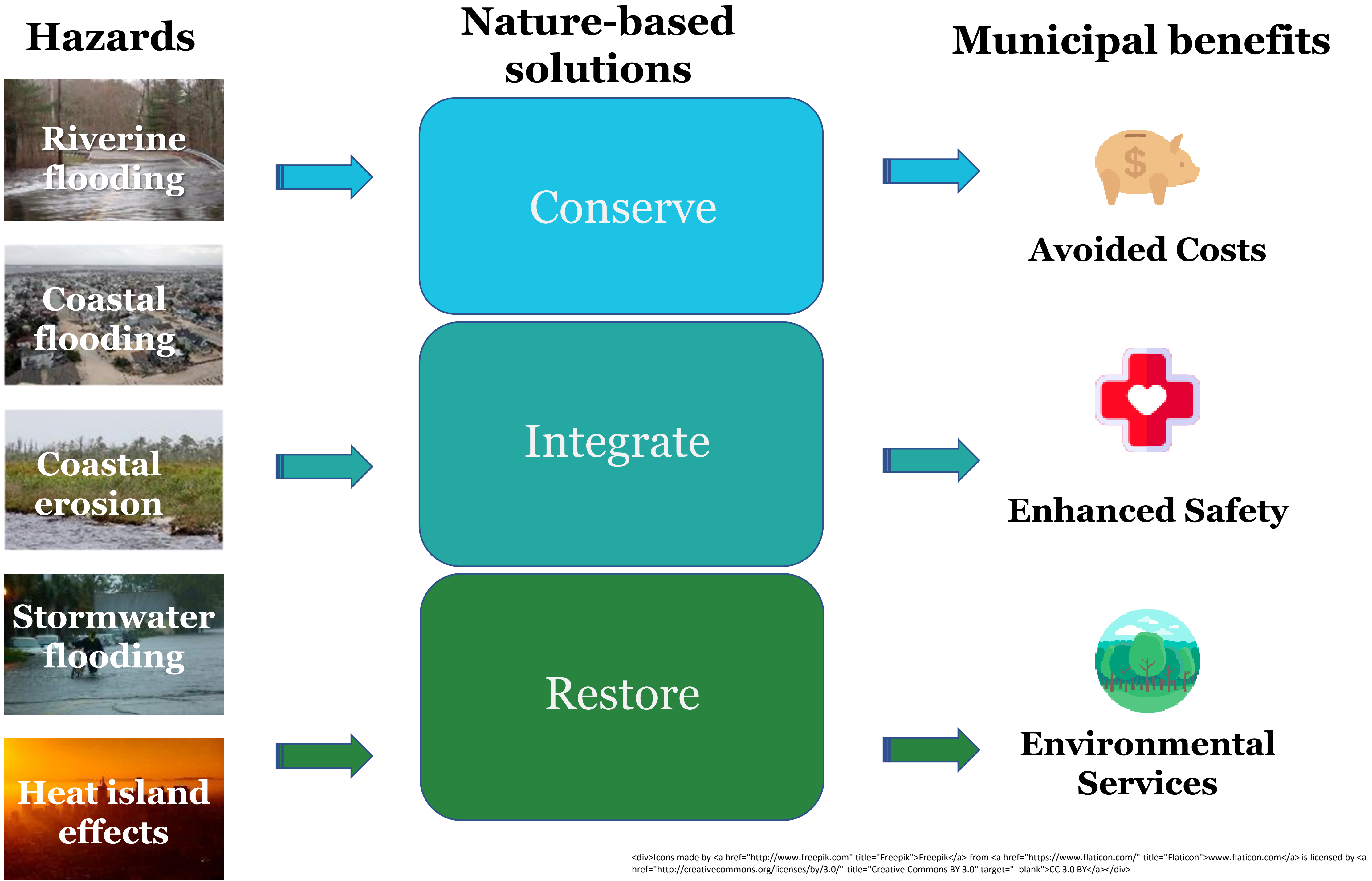
Restore the resiliency of landscapes through LID

Restore

Conserve the natural green infrastructure already providing free ecosystem services

Integrate LID and green infrastructure design into development

Restore resiliency of landscapes through nature based solutions


Hazards
Nature-based solutions
Municipal benefits
Riverine flooding
Coastal flooding
Coastal erosion
Stormwater flooding
Heat island effects
Conserve
Integrate
Restore
Avoided Costs
Enhanced Safety
Environmental Services
<div>Icons made by Freepik from www.flaticon.com is licensed by CC 3.0 BY</div>

Co-benefits

Benefit	Reduces Stormwater Runoff											Improves Community Livability						
Practice	Reduces Water Treatment Needs	Improves Water Quality	Reduces Grey Infrastructure Needs	Reduces Flooding	Increases Available Water Supply	Increases Groundwater Recharge	Reduces Salt Use	Reduces Energy Use	Improves Air Quality	Reduces Atmospheric CO_2	Reduces Urban Heat Island	Improves Aesthetics	Increases Recreational Opportunity	Reduces Noise Pollution	Improves Community Cohesion	Urban Agriculture	Improves Habitat	Cultivates Public Education Opportunities
Green Roofs	Yes	Yes	Yes	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Maybe	Maybe	Yes	Yes
Tree Planting	Yes	Yes	Yes	Yes	No	Maybe	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Maybe	Yes	Yes
Bioretention & Infiltration	Yes	Yes	Yes	Yes	Maybe	Maybe	No	No	Yes	Yes	Yes	Yes	Yes	Maybe	Maybe	No	Yes	Yes
Permeable Pavement	Yes	Yes	Yes	Yes	No	Maybe	Yes	Maybe	Yes	Yes	Yes	No	No	Yes	No	No	No	Yes
Water Harvesting	Yes	Yes	Yes	Yes	Yes	Maybe	No	Maybe	Maybe	Maybe	No	No	No	No	No	No	No	Yes

Yes Maybe No

Source: Center for Neighborhood Technology's The Value of Green Infrastructure

Avoided costs

Land Protection as Water Protection

- Quabbin & Wachusett Reservoirs serve 2.5 million
- Over 20 years, Massachusetts Water Resources Authority spent $130M to protect 22,000 acres of watershed lands
- Avoided ratepayer cost of $250M on a filtration plant and $4M/yr in operations

Avoided Costs

Enhance Safety: Charles River Natural Valley Storage Area. US Army Corps of Engineers

- 8,095 Acres Conserved
- From 1977 - 2016, the project has provided $11,932,000 in flood protective services
- Co-benefits include recreation and natural resource benefits

http://www.nae.usace.army.mil/Missions/Civil-W... ...k-Management/Massachusetts/Charles-River-NVS...

Environmental Services

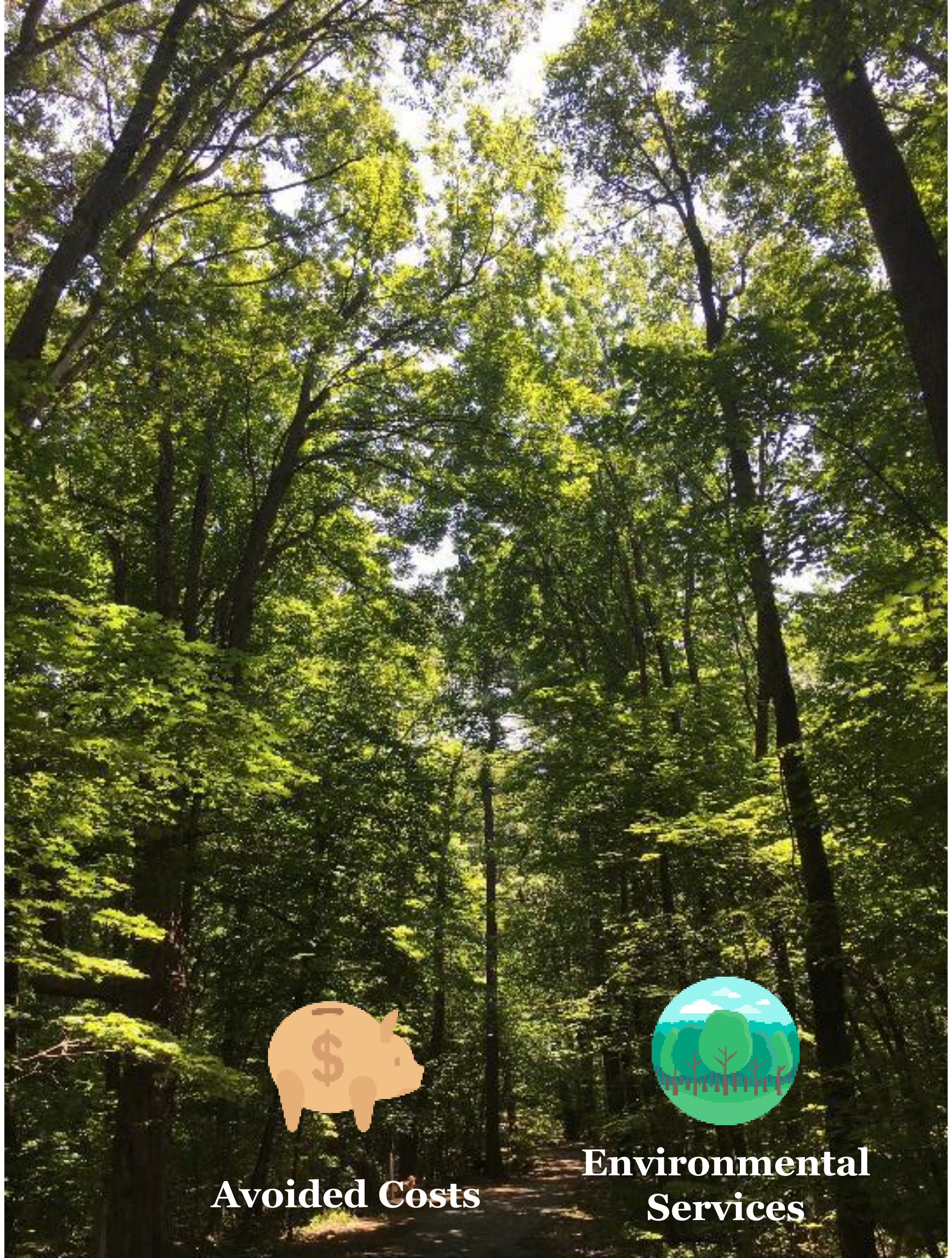
Massachusetts Forests Mitigate Climate Change

- MA forests **sequester 14%** of the state's gross annual carbon emissions
- Average acre stores **85 tons carbon**
- Capacity **increases** over time as forests mature

Environmental Services

Return on Investment Studies in MA
Trust for Public Land

- Outdoor recreation generates:
    - $10 billion in consumer spending
    - $739 million in state and local tax revenue
    - 90,000 jobs
    - $3.5 billion in annual wages and salaries
- Agriculture, forestry, commercial fishing, and related activities generate:
    - $13 billion in output
    - 147,000 MA Jobs
- **Conservation Projects Return $4 : $1 spent**



Return on Investment Studies in MA
Div. of Ecological Restoration

Massachusetts Department of Fish and Game
Division *of* Ecological Restoration
Invested in Nature and Community

Restoration results in

- **12.5 jobs** and
- **$1.75 Million economic output**
- "Restoration economy" in Massachusetts

Return on Investment Studies Northeast US
Scientific Reports

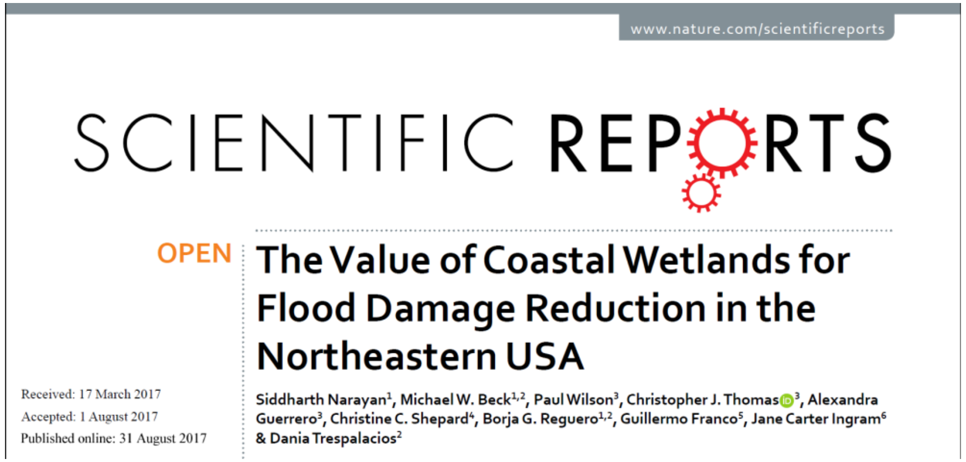
- Wetlands saved $625,000,000 in direct flooding damages in New Jersey

- In New England, wetlands reduce storm damage by approximately 16%

Environmental Services

Enhanced Safety

Avoided Costs


www.nature.com/scientificreports

SCIENTIFIC REPORTS

OPEN

The Value of Coastal Wetlands for Flood Damage Reduction in the Northeastern USA

Received: 17 March 2017
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Published online: 31 August 2017

Siddharth Narayan[1], Michael W. Beck[1,2], Paul Wilson[3], Christopher J. Thomas[3], Alexandra Guerrero[3], Christine C. Shepard[4], Borja G. Reguero[1,2], Guillermo Franco[5], Jane Carter Ingram[6] & Dania Trespalacios[2]

https://www.nature.com/articles/s41598-017-09269-z

Resources for Nature-Based Solutions

Guidance/Case Studies

- Naturally Resilient Communities successful project case studies from across the country to help communities learn and identify nature-based solutions
- EPA's Soak Up the Rain stormwater outreach tools, how-to guides and resources
- EPA's RAINE database of vulnerability, resilience and adaptation reports, plans and webpages at the state, regional and community level.
- Climate Action Tool explore adaptation strategies and actions to help maintain healthy, resilient wildlife communities in the face of climate change.

Mapping/Planning

- Mapping and Prioritizing Parcels for Resilience (MAPPR) ID priority parcels for protection and climate change resilience
- Living Shorelines in New England: State of the Practice and Profile Pages for Solutions are case studies, siting criteria, and regulatory challenges for coastal resilience in New England.
- Low Impact Development Fact Sheets cover valuing green infrastructure, conservation design, development techniques, regulations, urban waters, and cost calculations.

Cost/Benefit

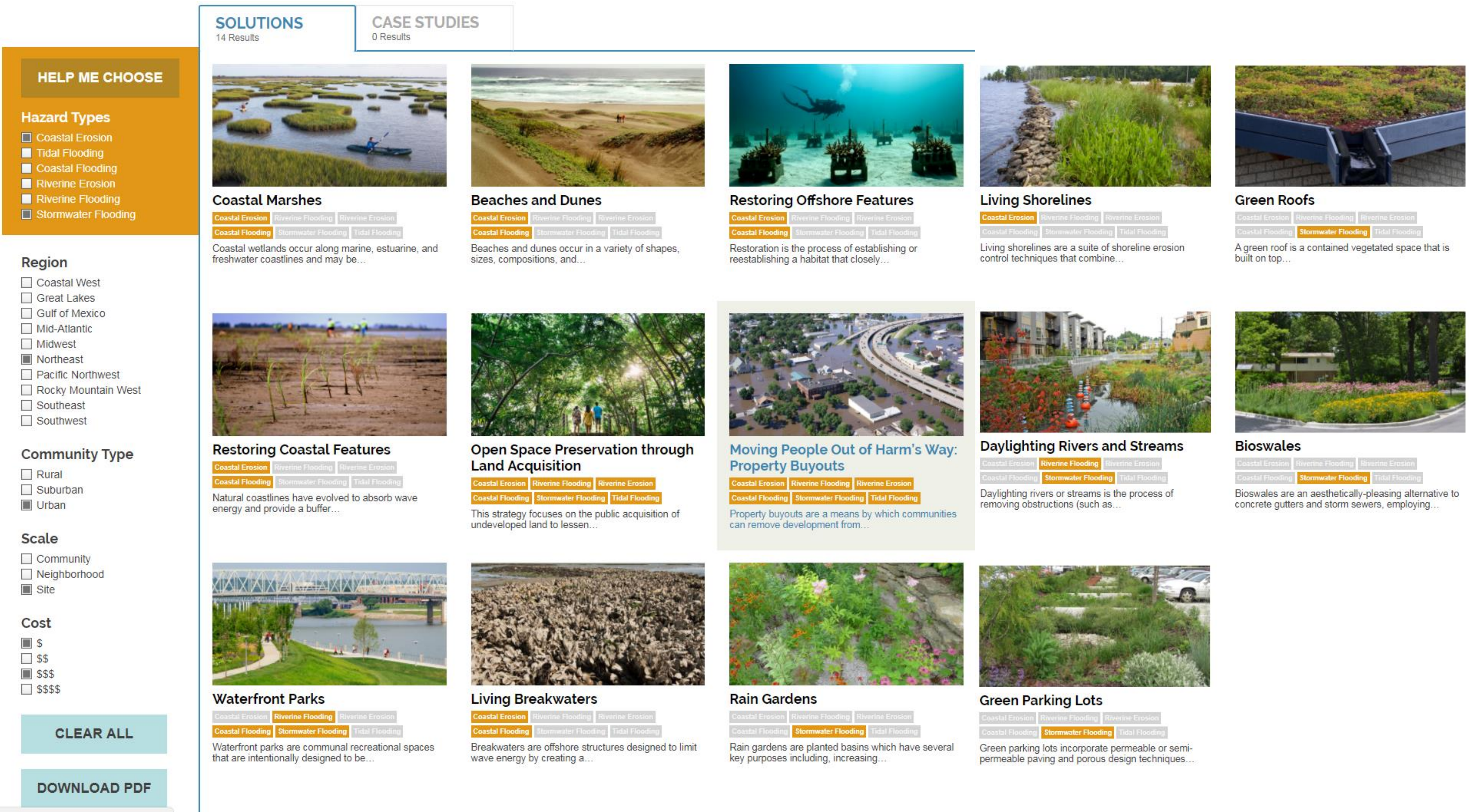
- EPA's Green Infrastructure cost/cost-benefit/tools Database of tools for comparing solution costs
- Massachusetts Division of Ecological Restoration's economic benefits of aquatic restoration based on MA case studies

Bylaws/Ordinances

- EEA's Smart Growth Toolkit access to information on planning, zoning, subdivision, site design, and building construction techniques
- Guide for Supporting LID in Local Land Use Regulations provides a framework for communities to review their zoning, rules, and regulations for a number of factors.

Naturally RESILIENT Communities

http://nrcsolutions.org/

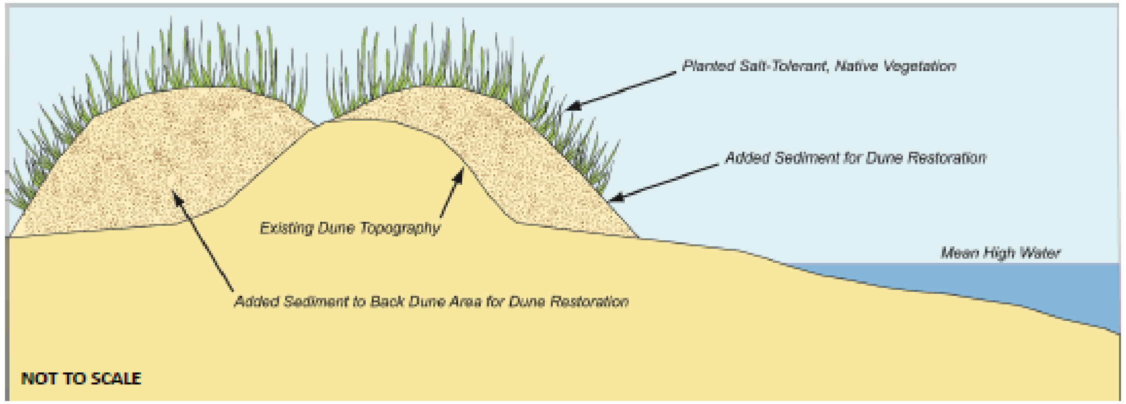


Dune - Natural

Dune building projects involve the placement of compatible sediment on an existing dune, or creation of an artificial dune by building up a mound of sediment at the back of the beach.[1] This may be a component of a beach nourishment effort or a stand alone project.

Objectives: erosion control; shoreline protection; dissipate wave energy; enhanced wildlife and shorebird habitat.

Design Schematics



Case Study

Ferry Beach, Saco, Maine

Relatively high beach and dune erosion (approximately 3 feet per year) prompted the FBPA to undertake a dune restoration project to help protect roads and homes from flooding and erosion. Given the relatively high erosion rate, it was decided that placing sediment for restoration seaward of the existing dune would be short-lived. A secondary frontal dune ridge landward of the existing dune crest was constructed instead, allowing native vegetation to establish.

Ferry Beach, Saco, ME
Photo courtesy of Peter Slovinsky

Project Proponent	Ferry Beach Park Association (FBPA)
Status	Completed 2009
Permitting Insights	Permit-by-Rule needed from Maine DEP
Construction Notes	An 800 foot long secondary dune was built to 1 foot above the effective FEMA 100-year BFE. A secondary dune was built because erosion of the front dune was considered too high (>3 feet per year) to have a successful project. 1,800 cy of dune-compatible sediment was delivered via truck from a local gravel pit. Construction and planting occurred in early spring. Volunteers planted native American Beach grass.
Maintenance Issues	Sand fencing was used to help trap sediment in the constructed dune, and to help maintain the seaward edge of the original dune. However, shoreline erosion has continued; as of May 2017 the restored dune has started to erode.
Final Cost	$29,000 and volunteer hours
Challenges	Trucking 90 dump-truck loads of sediment through the community. Construction and planting timing windows associated with piping plover nesting. Continued erosion.

Overview of Technique

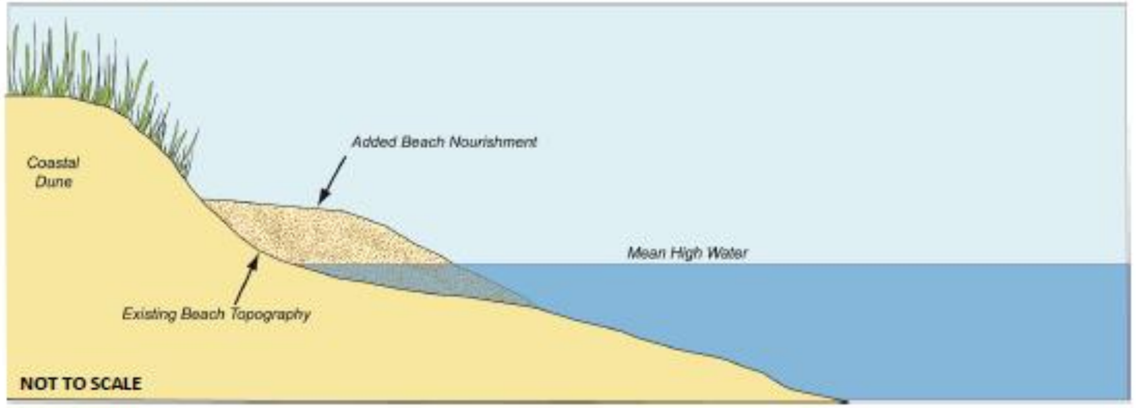
Materials	Sediment is brought in from an offsite source, such as a sand and gravel pit or coastal dredging project.[1] Planting the dune with native, salt-tolerant, erosion-control vegetation (e.g., beach grass *Ammophilia breviligulata*) with extensive root systems is highly recommended to help hold the sediments in place.[1,11] Sand fencing can also be installed to trap windblown sand to help maintain and build the volume of a dune.[1,11]
Habitat Components	Dunes planted with native beach grass can provide significant wildlife habitat.[9]
Durability and Maintenance	The height, length, and width of a dune relative to the size of the predicted storm waves and storm surge determines the level of protection the dune can provide.[1] To maintain an effective dune, sediment may need to be added regularly to keep dune's height, width, and volume at appropriate levels.[1] The seaward slope of the dune should typically be less steep than 3:1 (base:height).[1,9] Dunes with vegetation perform more efficiently, ensuring stability, greater energy dissipation, and resistance to erosion.[10] If plantings were included, plants should be replaced if they are removed by storm or die.[1]
Design Life	Dunes typically erode during storm events. In areas with no beach at high tide, dune projects will be short lived as sediments are rapidly eroded and redistributed to the nearshore.[1] Designs should consider techniques that enhance or maintain the dune (e.g. sand fencing and/or vegetation to trap wind blown sand).
Ecological Services Provided	The added sediment from dune projects supports the protective capacity of the entire beach system (i.e., dune, beach, and nearshore area). Any sand eroded from the dune during a storm, supplies a reservoir of sand to the fronting beach and nearshore area.[1,9] Dunes dissipate rather than reflect wave energy, as is the case with hard structures.[1] Dunes also act as a barrier to storm surges and flooding, protecting landward coastal resources,[9] and reducing overwash events.[10] Sand dunes provide a unique wildlife habitat.[9]
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	Shorter planting and construction window due to shorter growing season. Utilization of irrigation to establish plants quickly. Presence of sensitive species may require design (e.g. slope, plant density) and timing adjustments.

Beach Nourishment

Beach nourishment is the placement of sediment along the shoreline of an eroding beach from outside source. It widens and/or elevates the beach and usually moves the shoreline seaward, increasing the natural protection that a beach can provide against wave energy and storms. This may be a component of a dune restoration/creation effort or a stand alone project.

Objectives: erosion control; shoreline protection; enhance recreation; increased access; dissipate wave energy; enhanced wildlife and shorebird habitat.

Design Schematics



Design Overview

Design Overview	
Materials	Sediment is brought in from an offsite source, such as a sand and gravel pit or coastal dredging project.[1]
Habitat Components	Beaches nourished with compatible sediments can provide significant wildlife habitat.[5,6]
Durability and Maintenance	A coarser sand may erode more slowly than a finer sand.[6] To maintain an effective beach berm, sediment may need to be added regularly maintain the desired beach profile.[6,11] The need to replenish the beach depends upon the rate of erosion at the particular site, but is typically once every 1-5 years.[6]
Design Life	To increase erosion and flooding protection, nourished beaches are frequently built higher and wider than would occur naturally.[11] Grain size (e.g. sand, gravel, cobble) drives appropriate design slopes; gentler slopes generally perform better than steep areas. However, coarser grain sizes allow for steeper project slopes.
Ecological Services Provided	A nourishment beach can provide additional beach habitat area. Added sediment used for the nourishment can also provide a sand source for surrounding areas. The increased width and height of the beach berm can help attenuate wave energy.[10]
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	Beach nourishment sites subject to ice impacts are generally most successfully stabilized with gentler slopes (e.g., 6:1-10:1).[13] Presence of sensitive species may require design (e.g. slope, plant density) and timing adjustments.

Case Study

Winthrop, MA Beach Nourishment

Applied Coastal Research & Engineering, Inc. designed the Winthrop Beach Nourishment Program to provide storm protection to an upland urban area fronted by a seawall originally constructed in 1899. The project utilized 460,000 cy of compatible sediment to nourish approximately 4,200 linear feet and to create the equilibrated designed berm width of 100 feet. Once the beach nourishment was completed in late 2014, the high tide shoreline was pushed more than 150 feet from the seawall, with a gradual slope extending approximately 350 feet offshore.

Winthrop Shores, Winthrop, MA
Photo courtesy of Applied Coastal Research & Engineering

Project Proponent	Massachusetts Division of Conservation and Recreation (DCR)
Status	Phase 1: 2013; Phase 2: 2014
Permitting Insights	Offshore sediment source was denied by Army Corps after a 12-year permitting process. Conservation Permit required from NHESP to address potential impacts to Piping Plovers.
Construction Notes	Upland derived mix of sand, gravel and cobble to match the existing beach sediments was required, where the nourishment was provided from two sources: sand borrow (80%) and naturally rounded cobble & gravel (20%).
Maintenance Issues	Cobble berms have begun forming along the beach, which conflicts with community recreation goals, requiring additional sand for aestheitcs.
Final Cost	Permitting: $2,000,000 (including attempt to permit offshore borrow site. Construction: $22,000,000 (included work on coastal engineering structures).
Challenges	Trucking through the community: urban community with two roads in and out, as well as roadway damage and air quality impacts associated with 16,000+ truck trips. Public perception of compatible sediment.

Revere Beach, MA
Photo courtesy of MA CZM

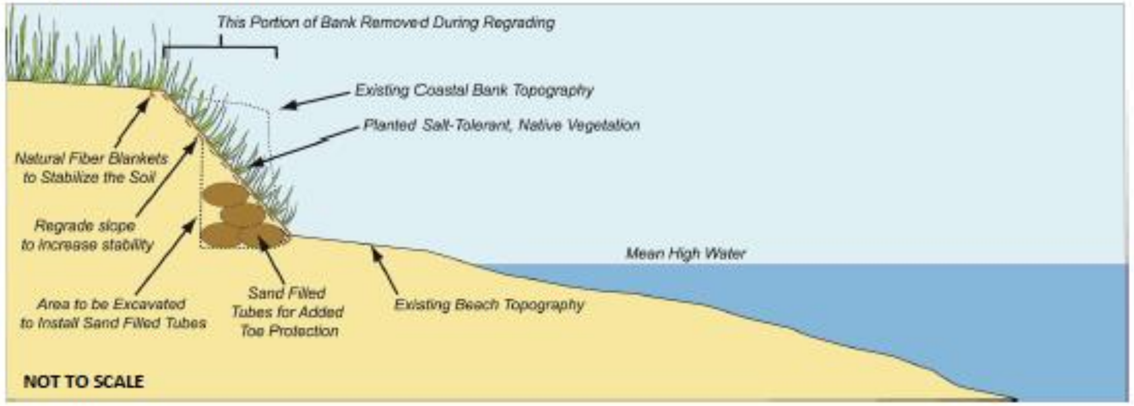
Long Beach, Barnstable, MA
Photo courtesy of MA CZM

Coastal Bank – Engineered Core

Coastal bank protection, including slope grading, terracing, and toe protection and vegetation planting will reduce the steepness and protect the toe of the bank from further erosion. Engineered cores, of sand filled tubes, provide added protection from future bank erosion.

Objectives: erosion control; shoreline protection; dissipate wave energy; enhanced wildlife habitat.

Design Schematics



Case Study

Stillhouse Cove, Cranston, RI

Stillhouse Cove is the site of a public park and a previous salt marsh restoration project that was completed in 2007. Restoration of the coastal bank was initiated after Superstorm Sandy caused extensive erosion which over-steepened the bank and washed fill and soil into the adjacent marsh. Save The Bay and EWPA, working closely with the USDA Natural Resources Conservation Service, developed a design to reinforce and protect the eroding bank by reconfiguring the slope and using natural materials and vegetation.


Construction at Stillhouse Cove, RI
Photos courtesy of Janet Freedman

Project Proponent	City of Cranston, RI, Edgewood Waterfront Preservation Association (EWPA), Save The Bay, Natural Resources Conservation Service (NRCS).
Status	Completed in 2013. Maintained in 2014 (added coir logs and plantings).
Permitting Insights	The project had several iterations but was finally permitted as a Sandy Emergency Assent. An extension was required due to challenges of securing funding within the permit time frame.
Construction Notes	A key component of this project was regrading the bank from a vertical cut to create a more gradual slope. Once the slope was regraded, sand filled coir envelopes were installed, covered with soil and planted with salt tolerant vegetation.
Maintenance Issues	3 coir logs were installed at the southern end of project and planted with warm season grasses as part of the Dept. of Interior Hurricane Sandy Relief Grant Program. The base of the bank will be more frequently inundated as sea levels rise.
Final Cost	Permitting: No permit fee for municipalities Construction: $59,006 plus volunteer labor.
Challenges	Funding and coordination with partners and volunteers.

Design Overview

Materials	An engineered core could be constructed using coir envelopes, which are coir fabric filled with sand. Cutback/excavated material should be used to fill the coir envelopes but supplemental offsite material may be required. Anchors are necessary to secure the envelopes. Native vegetation with extensive root systems are often used in conjunction with coir envelopes to help stabilize the site. Also, natural fiber blankets can also be used to stabilize the ground surface while plants become established. (Blankets should be run up and down the slope rather than horizontally across it.)
Habitat Components	Because they are made with natural fibers and planted with vegetation, natural fiber blankets also help preserve the natural character and habitat value of the coastal environment.
Durability and Maintenance	A veneer of sand/sediment should be maintained over the sand filled tubes to prolong their lifetime. Regular maintenance, such as resetting, anchoring, replacement, or recovering, can increase the effectiveness of the project.[6] Invasive species management should be incorporated into the project. Runoff management and groundwater will also be crucial to project success.[6]
Design Life	As the sand tube material and natural fiber blankets disintegrate, typically over 5-10 years, the plants take over the job of site stabilization.
Ecological Services Provided	Upland plantings stabilize bluffs and reduce rainwater runoff.[11]
Unique Adaptations to NE Challenges (e.g. ice, winter storms, cold temps)	Shorter planting and construction window due to shorter growing season. Utilization of irrigation to establish plants quickly. Freeze and thaw processes can damage this design. Consideration should be given to the slope aspect and the implications on plant growth and microbiome from shading and sun exposure.


Completed Stillhouse Cove Project (RI)
Photo courtesy of Janet Freedman


Construction at Allin's Cove, Barrington, RI
Photo courtesy of Janet Freedman

SOLUTIONS
10 Results

CASE STUDIES
0 Results

HELP ME CHOOSE

Hazard Types
- [ ] Coastal Erosion
- [ ] Tidal Flooding
- [ ] Coastal Flooding
- [ ] Riverine Erosion
- [ ] Riverine Flooding
- [x] Stormwater Flooding

Region
- [ ] Coastal West
- [ ] Great Lakes
- [ ] Gulf of Mexico
- [ ] Mid-Atlantic
- [ ] Midwest
- [x] Northeast
- [ ] Pacific Northwest
- [ ] Rocky Mountain West
- [ ] Southeast
- [ ] Southwest

Community Type
- [ ] Rural
- [ ] Suburban
- [x] Urban

Scale
- [x] Community
- [x] Neighborhood
- [x] Site

Cost
- [x] $
- [ ] $$
- [ ] $$$
- [ ] $$$$

CLEAR ALL

DOWNLOAD PDF

Regulatory and Policy Approaches to Address Hazards
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Flooding is a natural process that, in the absence of human settlements,...

Planning Approaches to Reduce Natural Hazards
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Flooding is a natural process that, in the absence of human settlements,...

Enhanced Floodplain Mapping
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Flooding is a natural process that, in the absence of human settlements,...

Bioswales
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Bioswales are an aesthetically-pleasing alternative to concrete gutters and storm sewers, employing...

Open Space Preservation through Land Acquisition
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

This strategy focuses on the public acquisition of undeveloped land to lessen...

Urban Trees + Forests
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Urban forestry is the planned installation and management of trees within an...

Rain Gardens
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Rain gardens are planted basins which have several key purposes including, increasing...

Green Roofs
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

A green roof is a contained vegetated space that is built on top...

Green Parking Lots
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Green parking lots incorporate permeable or semi-permeable paving and porous design techniques...

Daylighting Rivers and Streams
Coastal Erosion | Riverine Flooding | Riverine Erosion | Coastal Flooding | Stormwater Flooding | Tidal Flooding

Daylighting rivers or streams is the process of removing obstructions (such as...

MVP Example: identified intersection that floods?

Bioretention bump outs & street trees can help to…

- capture & filter excess water – alleviate pressure on MS4
- improved pedestrian safety – better visibility, shorter walkway
- enhance aesthetics to encourage visitors & walking

without altering existing parking or bus stops

Environmental Services

Enhanced Safety

Funding

Certified MVP Communities Receive Priority Ranking

- MA Clean Water State Revolving Fund Program (CWSRF)
- MA Office of Coastal Zone Management (CZM)
- MA Department of Agricultural Resources (MDAR)
- MA Executive Office of Energy and Environmental Affairs (EEA)
- MA Department of Environmental Protection (DEP)
- Mass Environmental Trust (MET)

Ten things local homeowners & citizens can do

1. Divert your downspouts
2. Plant a rain garden
3. Replace impervious surfaces
4. Adopt a drain – and encourage others to
5. Don't wash your car in the driveway

6. Pick up pet waste
7. Reduce fertilizer and pesticide use
8. Replace lawn with native plants
9. Reduce lawn watering and mowing
10. Pick up leaf litter (compost/dispose of properly)

Thank you!

Questions!

The Nature Conservancy
Protecting nature. Preserving life.

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