RESILIENT NJ

RARITAN RIVER AND BAY COMMUNITIES

RESILIENCE STRATEGIES TOOLKIT

MARCH 2022

PURPOSE AND VALUE OF THE TOOLKIT

There are many possible solutions that can be implemented to address flooding. The toolkit includes physical and nature-based solutions, policy and governance solutions, and individual and community-based actions. Physical and nature-based solutions include projects that change the built environment to address flood risk. Policy and governance related solutions are solutions that affect what decisions related to flooding are made, how, and by whom. Individual and community-based solutions are solutions that increase the social resilience of a community. The goal of the toolkit is to identify potential tools that we will draw on for the development of the scenarios. The toolkit summarizes key information about each solution including:

- Types of hazards the solution addresses
- The types of areas in which the solution could be applied
- Scale of the intervention (individual site, multiple sites, etc.)
- Possible co-benefits (benefits other than reduced flooding)
- Level of potential disruption from construction or implementation
- Other constraints and considerations

The toolkit also groups solutions into three approaches to resilience: Protecting from the water, Adapting to the water, and Moving away from the water. These approaches are described further in the following pages.

While tools are sorted by applicable areas to guide the development of scenarios, implementing individual solutions is highly dependent on unique site conditions. Additional siting constraints could restrict the use of solutions at specific sites but siting constraints are not universal across all solutions. For example, a high groundwater table could restrict the use of green infrastructure solutions for stormwater management but would be considered a favorable condition for restoration or expansion of wetland areas.

The toolkit is not intended to be inclusive of all possible solutions but was a helpful starting point to identify solutions and outline the decision-making process for selecting a specific solution for an area. The goals of the toolkit are to:

- Communicate the types and range of solutions possible, as well as when they might be appropriate and their limitations
- Provide a framing tool for both the technical team and stakeholders, to help us begin from similar places of understanding, about the technical considerations that often guide these types of decisions

HOW TO READ THE TOOLKIT

TOOLKIT ICONS

STRATEGY

PROTECT ASSETS FROM WATER

ADAPT ASSET TO PRESENCE OF WATER

MOVE ASSET AWAY FROM WATER

HAZARD ADDRESSED

COASTAL

RIVERINE

STORMWATER

SEA LEVEL RISE

SCALE OF IMPLEMENTATION

SITE

LINEAR

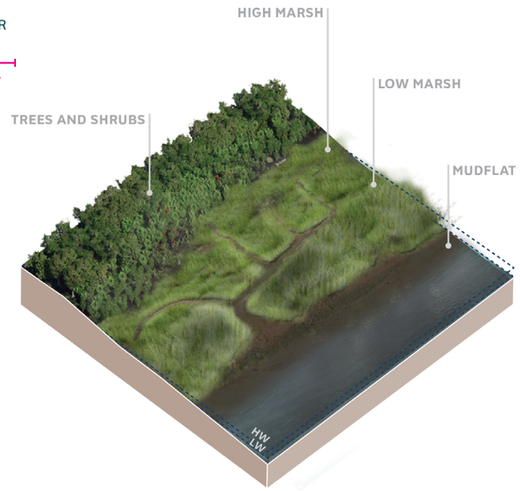
MULTIPLE SITES

NETWORK

ADAPT TO PRESENCE OF WATER

WETLAND PRESERVATION/ RESTORATION/EXPANSION

STRATEGY TYPE



DESCRIPTION

Wetland restoration involves returning the natural functions of former or degraded wetlands that have been filled, drained, or impounded to promote stable water exchanges into and out of the wetland.

PHYSICAL CATEGORY

CATEGORY: ***RIPARIAN MANAGEMENT***

TOOLKIT EVALUATION CRITERIA

HAZARD ADDRESSED

RIVERINE

STORM WATER

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECOLOGICAL EDUCATIONAL RECREATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

RIVERINE OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

PERMITTING $ $$$

CONSTRUCTABILITY ↘ ↘↘↘

TOOLKIT LIST: STRUCTURAL STRATEGIES

COASTAL / RIVERINE BARRIERS

- Floodwalls
- Bulkheads
- Berms And Levees
- Setback Levees
- Deployable Floodgates
- Deployable Tide Gates

ELEVATION / RAISING

- Raise Land
- Create Redundant Emergency Routes
- Elevate Structures Above DFE
- Raise Critical Systems

FLOODPROOFING / HARDENING

- Fill Levels Below DFE
- Wetproof Levels Below DFE
- Dryproof Levels Below DFE

TOOLKIT LIST: NATURE-BASED STRATEGIES

URBAN STORMWATER MANAGEMENT

- Rain Garden
- Planted Swale
- Right-of-way Bioswale
- Green Roof/ Blue Roof
- Retention / Wet Ponds (Stormwater Basins)

RIVERINE NATURAL SYSTEMS (INLAND FLOW)

- Stream Daylighting & Restoration
- Culvert Modification / Enlargement
- Natural Erosion Control Stream Bank Restoration
- Tidal Wetland Preservation/ Restoration/ Expansion

COASTAL SYSTEMS (WAVE ACTION)

- Coastal Wetland Preservation/ Restoration/ Expansion
- Dune / Beach System
- Coastal Living Shorelines
- Constructed Reefs
- Revetments*

** Opportunities for Ecological Enhancement of Hard Flood Protection Infrastructure*

TOOLKIT: NON-PHYSICAL STRATEGIES

GOVERNANCE AND POLICY TOOLS

- Increasing Floodplain Construction Standards
- Increasing Standards For On-Site Stormwater Management
- Land Use Planning And Zoning
- Incorporating Resiliency In Capital Infrastructure Planning
- Adapting Governance Structures To Advance Resiliency
- Acquisition of Highly Vulnerable Properties

INDIVIDUAL OR COMMUNITY-BASED ACTIONS

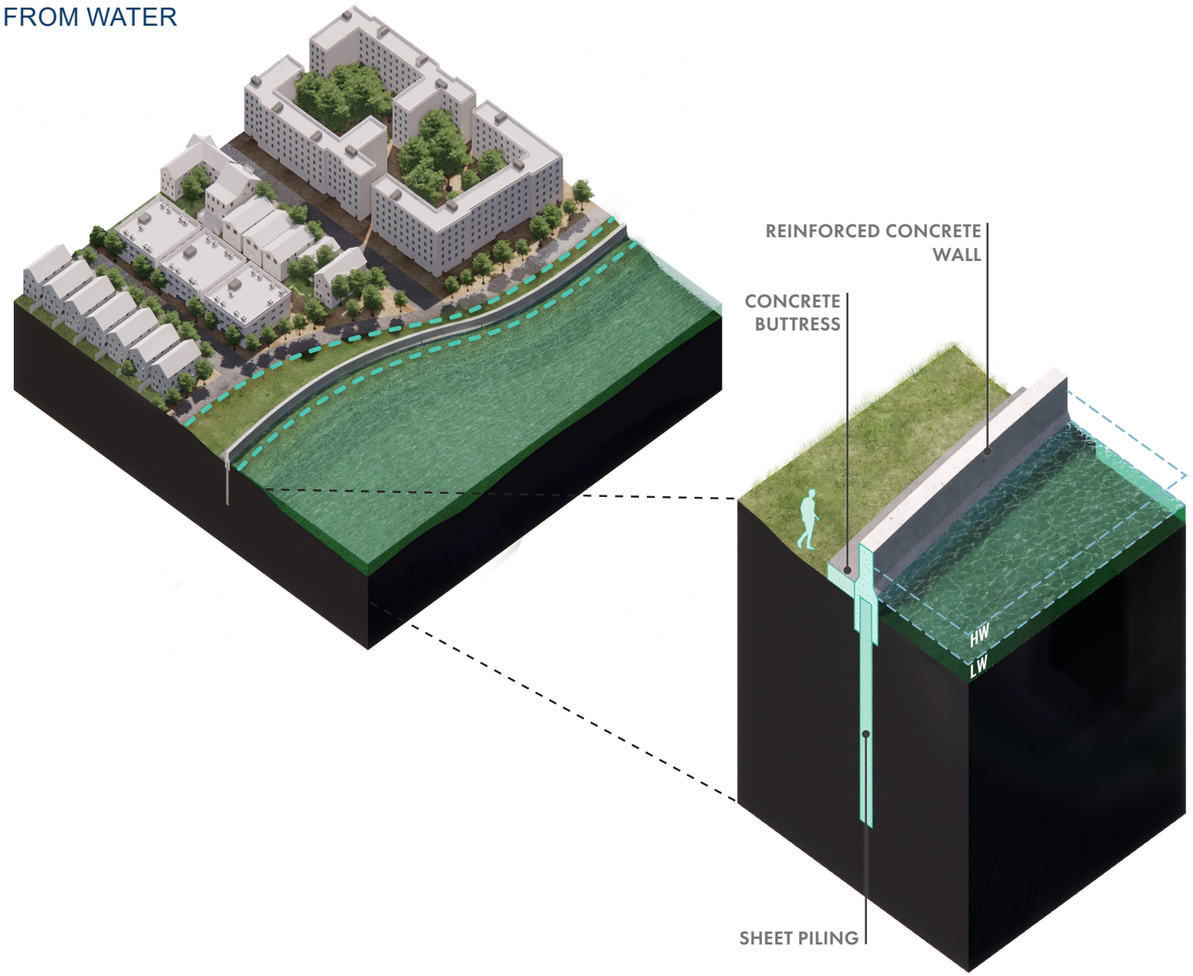
- Resilience Hubs
- Emergency Preparedness
- Business & Industry Emergency Preparedness
- Community Planning
- Community Stewardship Of Green Spaces
- Workforce Development
- Public-Private Partnerships For Resiliency Infrastructure

COASTAL/RIVERINE BARRIERS

FLOODWALLS

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Floodwalls are concrete structures designed to keep water out by physically blocking storm surges and floodwaters. Various types of floodwalls may be applicable to different areas and regions.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME	
IMPACT TO PUBLIC ACCESS AND USE	

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · URBAN · SUBURBAN · OPEN SPACE

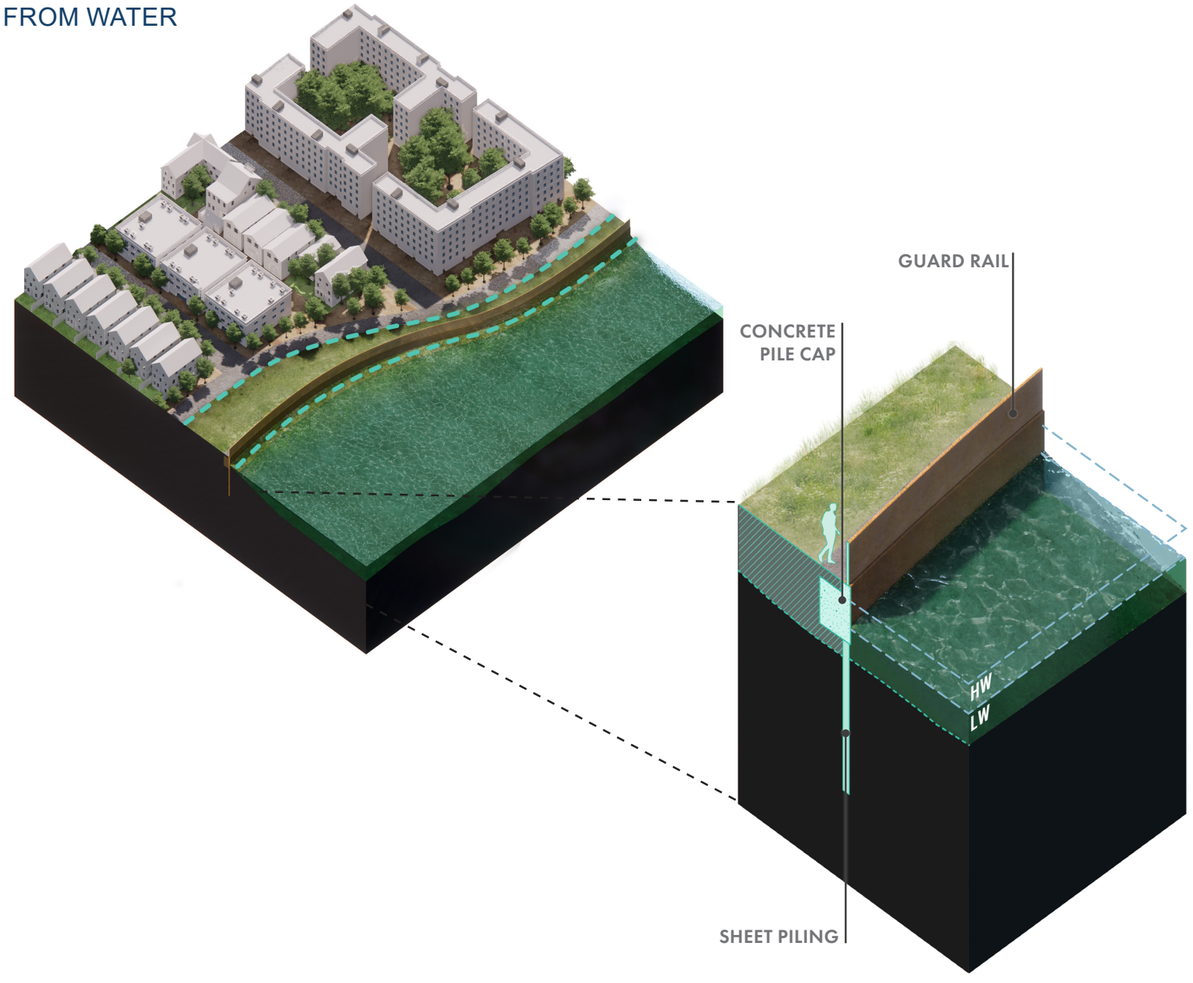
CONSTRAINTS AND CONSIDERATIONS

COSTS	$	$$$
PERMITTING		
CONSTRUCTABILITY	↘	↘↘↘

BULKHEADS

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Bulkheads are concrete structures along shorelines of large bodies of water that protect from flooding, wave action and erosion. an be integrated into recreational greenways and provide waterfront access to users.

HAZARD ADDRESSED

COASTAL RIVERINE SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL RIVERINE URBAN SUBURBAN OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

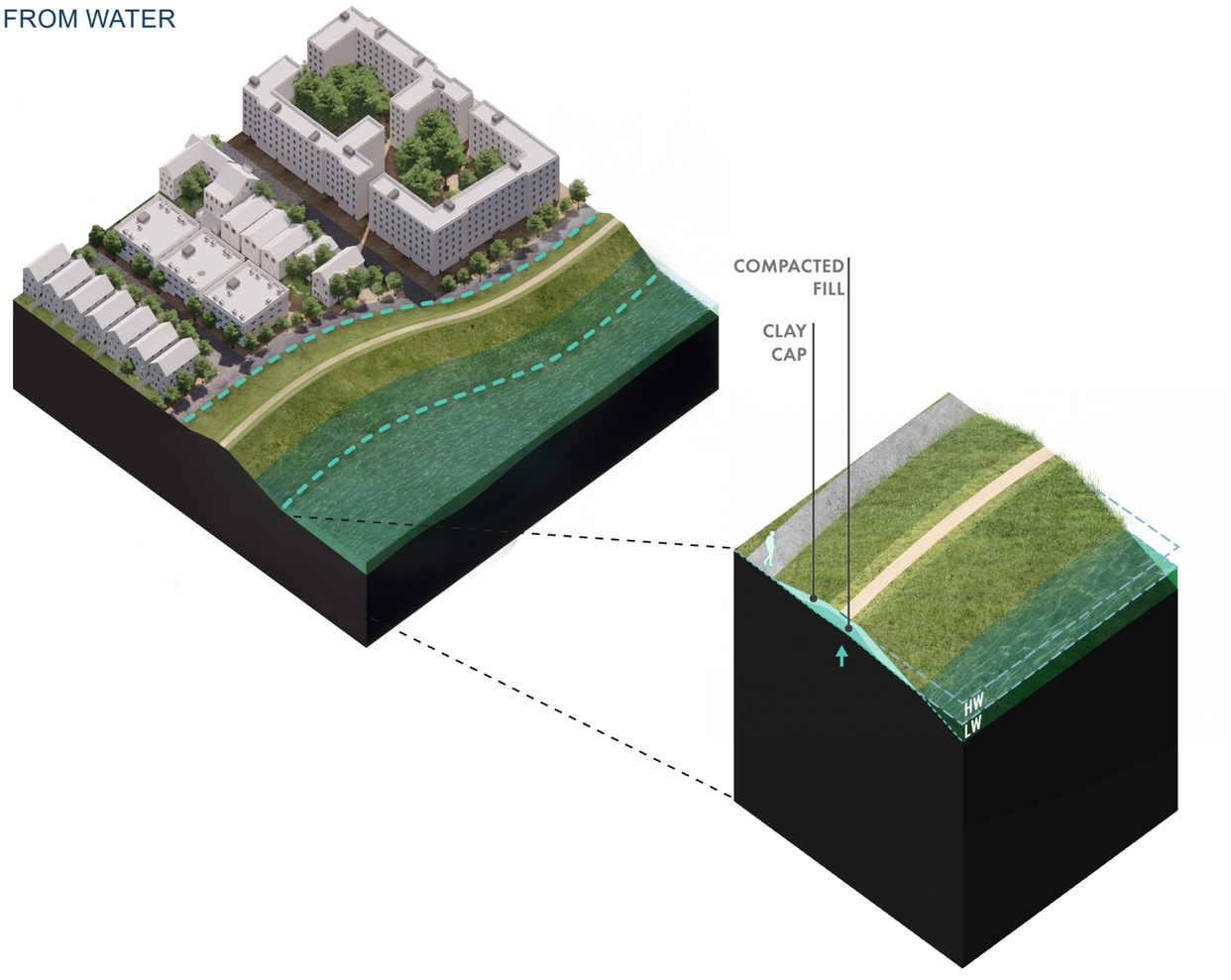
PERMITTING

CONSTRUCTABILITY

BERMS AND LEVEES

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Berms and levees are raised earthen structures erected to protect from flooding. They can be integrated with recreational boardwalks, walkways and bike paths. Their natural sloped sides can be populated with recreational features.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

RECREATIONAL · ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · SUBURBAN · OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ — $$$

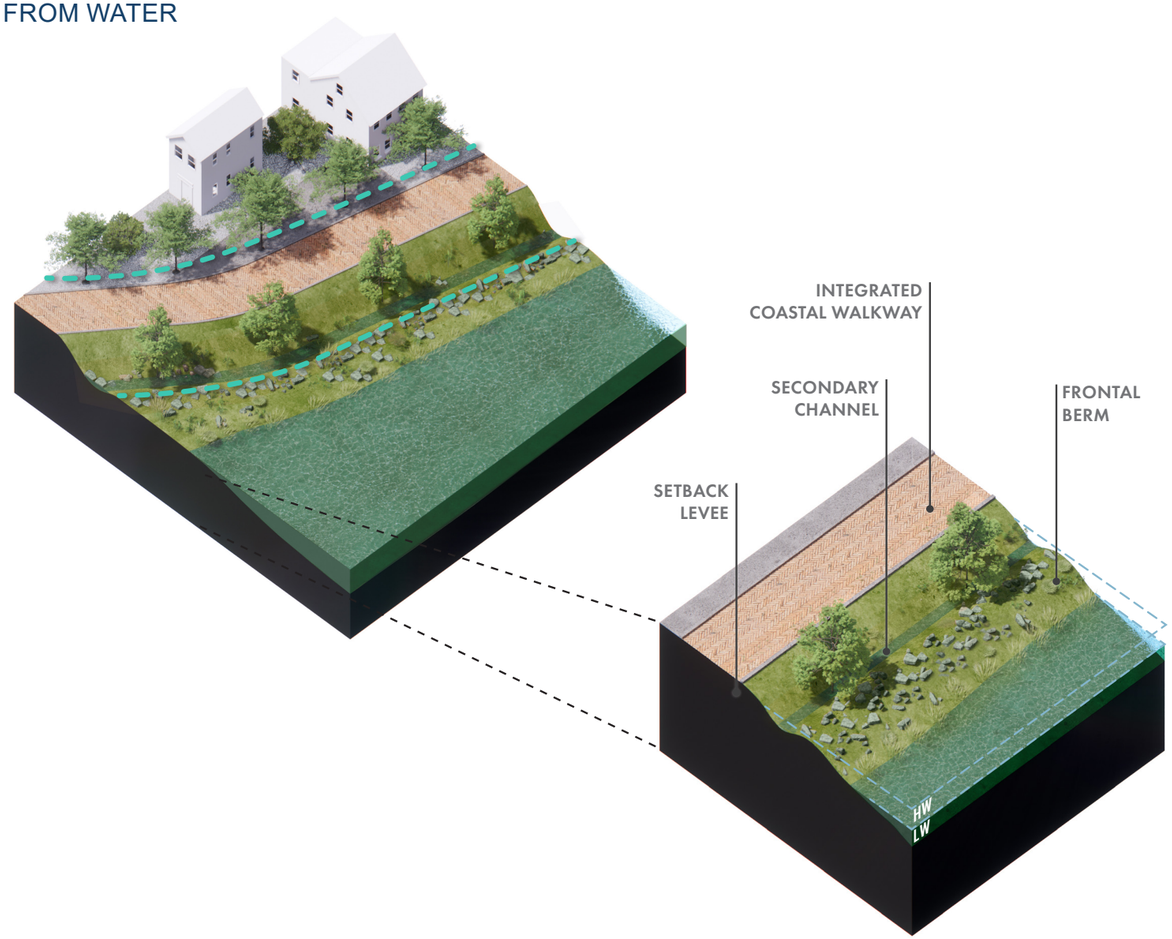
PERMITTING —

CONSTRUCTABILITY ↘ — ↘↘↘

SETBACK LEVEES

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Setback levees are earthen embankments set back from a river edge or coastline, usually paired with another berm, levee or other flood protection measure. They provide an added layer of protection from high waters and storm surges by creating a redundant system of physical protection.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

RECREATIONAL · ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · URBAN · SUBURBAN · OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

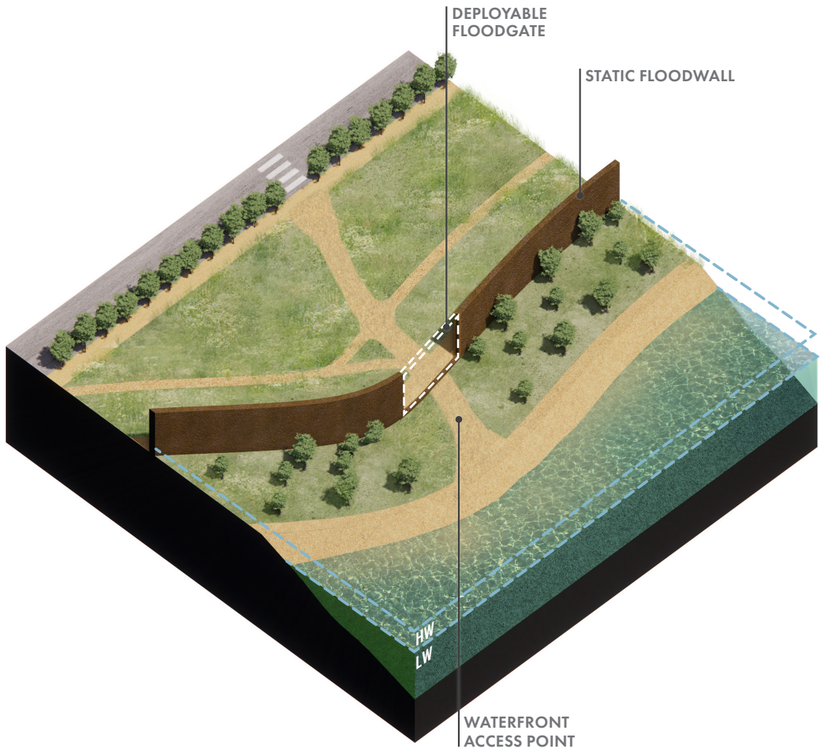
PERMITTING

CONSTRUCTABILITY

DEPLOYABLE FLOODGATES

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Deployable floodgates are mobile elements, integrated into static flood barriers, that are closed during flood events to fill gaps in protective barriers and prevent floodwater intrusion.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER

SCALE OF IMPLEMENTATION

NETWORK

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · URBAN · SUBURBAN · OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ – $$$

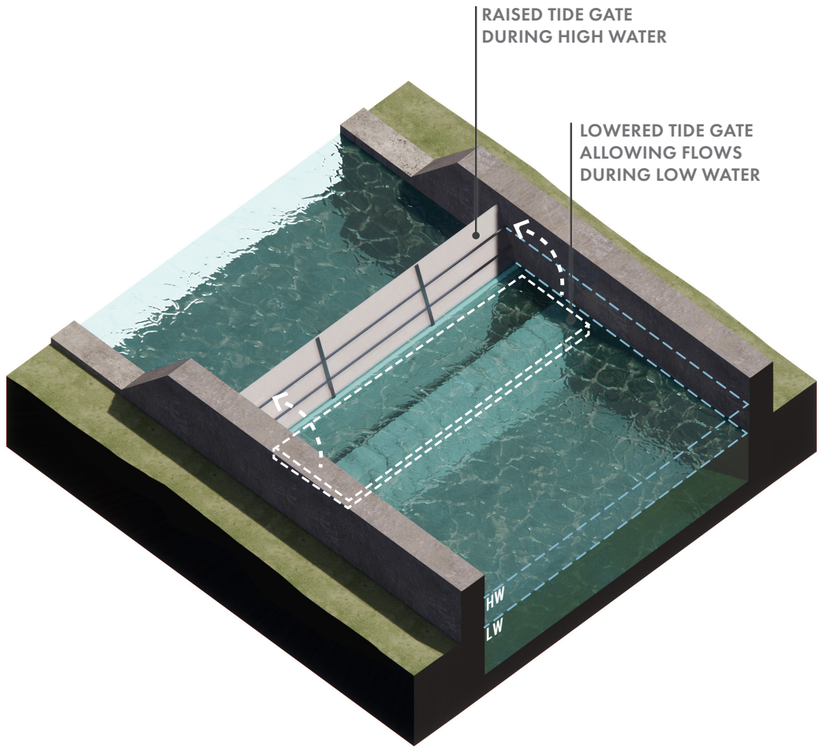
PERMITTING –

CONSTRUCTABILITY ↘ – ↘↘↘

DEPLOYABLE TIDE GATES

CATEGORY: ***COASTAL/RIVERINE BARRIER***

PROTECT
FROM WATER



Tide gates are deployed along drainage and waterways to keep out floodwaters during high tides. They control water levels within urban systems and areas, come in several forms and are usually self-regulating.

HAZARD ADDRESSED

COASTAL SEA LEVEL RISE

SCALE OF IMPLEMENTATION

NETWORK

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL URBAN SUBURBAN OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

PERMITTING

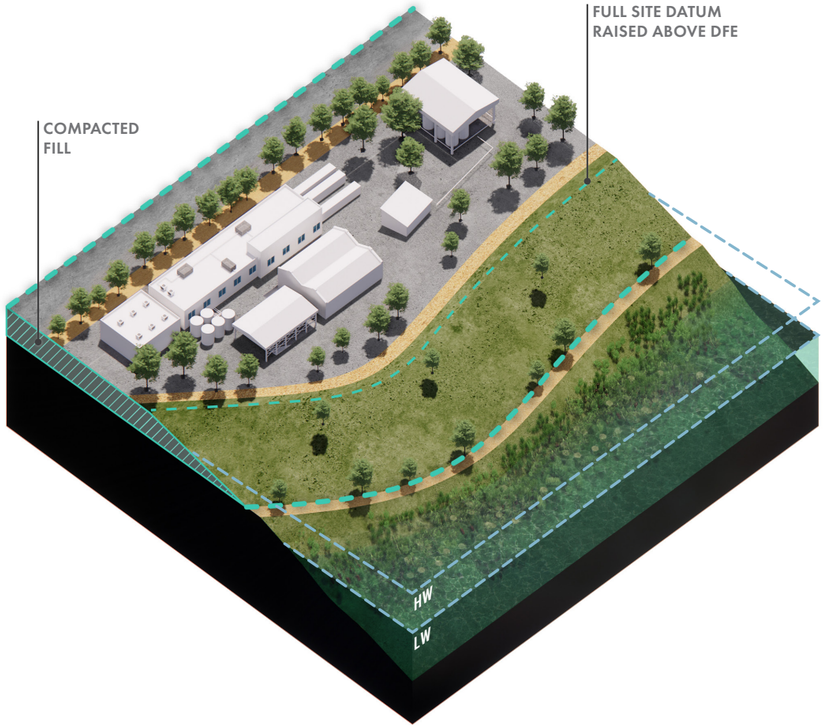
CONSTRUCTABILITY

ELEVATION RAISING

RAISE LAND

ADAPT TO THE
PRESENCE OF WATER

CATEGORY: ***ELEVATION RAISING***



By physically raising land above flood levels a whole site can be protected from regular flooding. Raising land protects the full footprint of important sites like utilities and other public assets. This tool does displace risk to surrounding areas and is susceptible to subsidence. This should be applied only when there is enough space and risks to surrounding areas are considered.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

RECREATIONAL · ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · SUBURBAN · OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

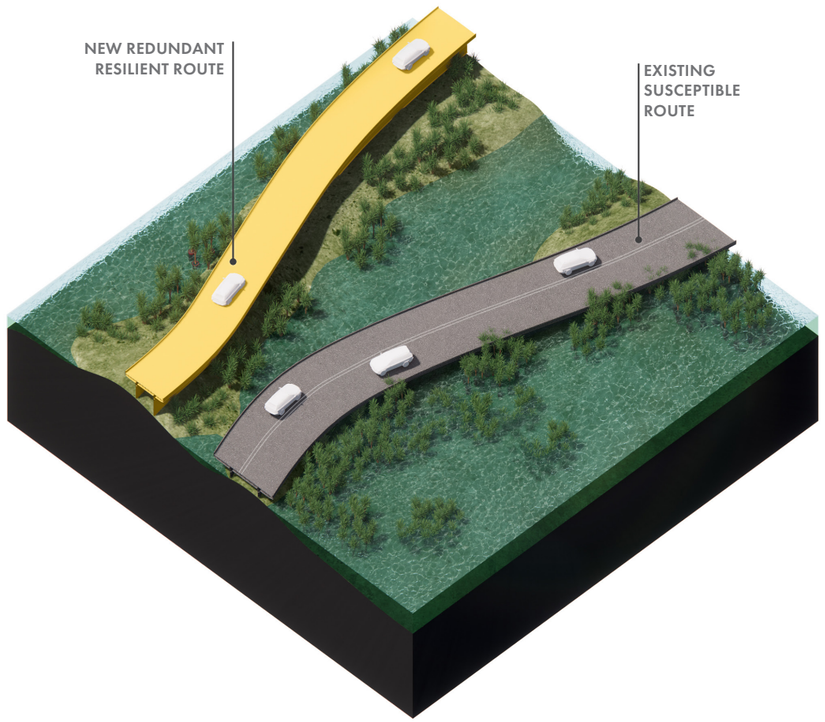
PERMITTING

CONSTRUCTABILITY

CREATE REDUNDANT EMERGENCY ROUTES

ADAPT TO THE PRESENCE OF WATER

CATEGORY: ***ELEVATION RAISING***



By creating redundant routes, residents and emergency services can have mobility options when other, more susceptible routes are impassible. This tool applies to instances where critical emergency routes are often compromised by floodwaters.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · URBAN · SUBURBAN · OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

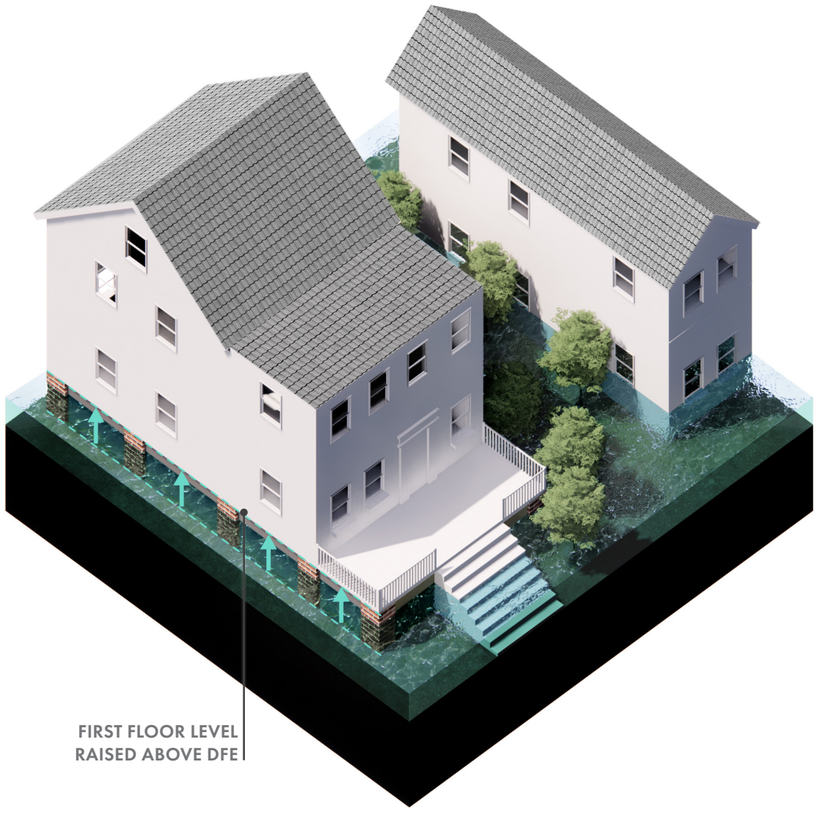
PERMITTING

CONSTRUCTABILITY

CATEGORY: ***ELEVATION RAISING***

ELEVATE STRUCTURES ABOVE DFE

ADAPT TO THE
PRESENCE OF WATER



Physically raising structures above flood levels protects these structures during flood events. Structures can be kept relatively intact during the raising process. Ground level can be used for storage, parking and other temporary uses.

HAZARD ADDRESSED

COASTAL RIVERINE STORM WATER

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL RIVERINE UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

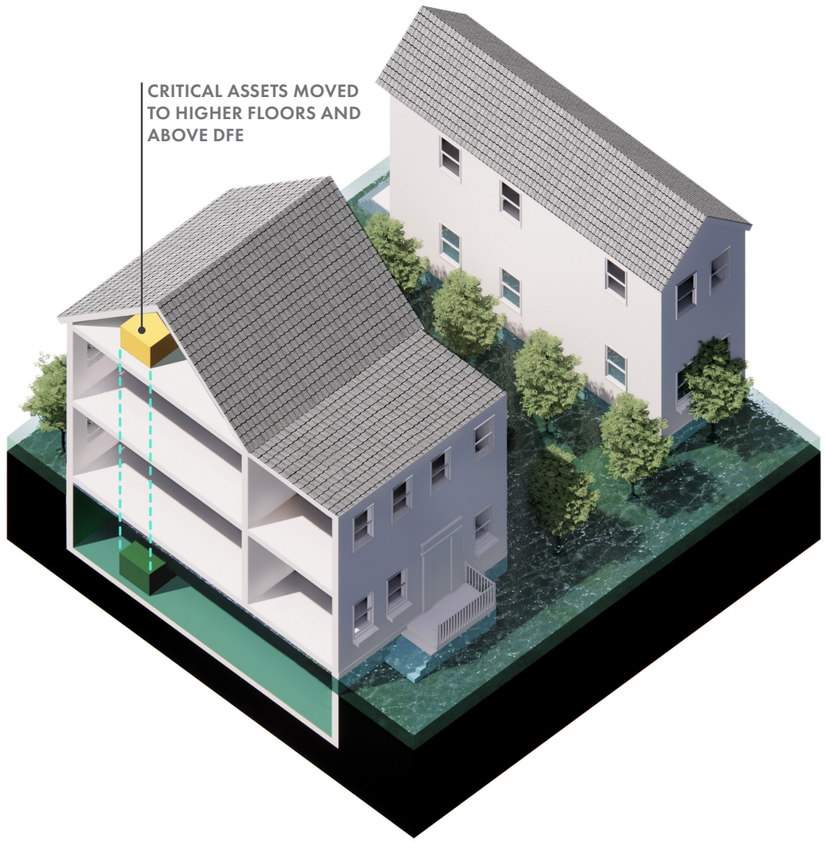
COSTS $ $$$

PERMITTING

CONSTRUCTABILITY

ADAPT TO THE
PRESENCE OF WATER

RAISE CRITICAL SYSTEMS



Relocating critical systems to higher floors within structures reduces the impacts of flooding on critical services and reduces recovery times. This tool increases the resilience of essential services to homes and businesses.

HAZARD ADDRESSED

COASTAL RIVERINE STORM WATER

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL RIVERINE UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

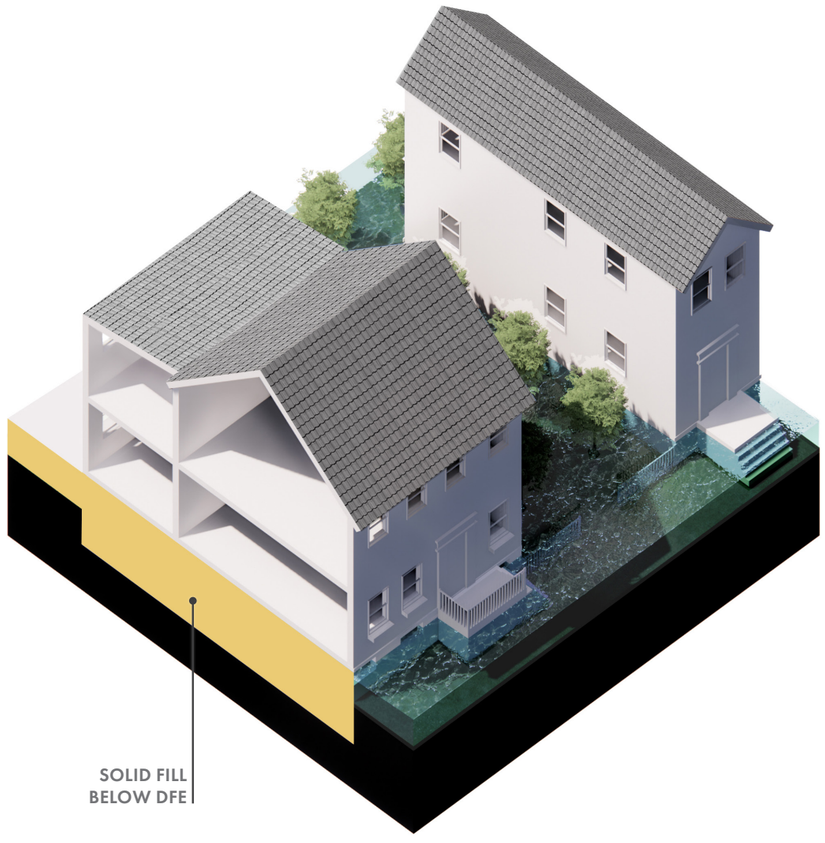
PERMITTING

CONSTRUCTABILITY

FLOODPROOFING/ HARDENING

ADAPT TO THE
PRESENCE OF WATER

FILL LEVELS BELOW DFE



Filling floors that are below flood elevations physically keeps floodwaters from entering structures. This tool increases structural stability and resilience.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · URBAN · SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ — $$$

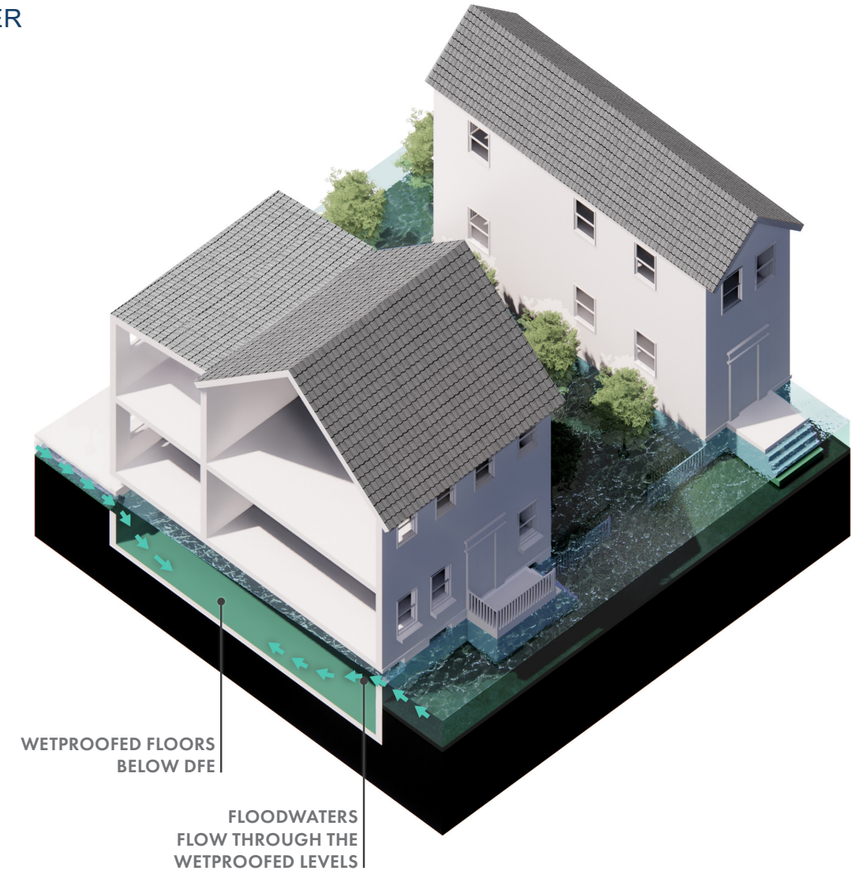
PERMITTING

CONSTRUCTABILITY

CATEGORY: ***FLOODPROOFING/HARDENING***

WETPROOF LEVELS BELOW DFE

ADAPT TO THE
PRESENCE OF WATER



Wetproofing of floors below grade involves sealing susceptible levels to water infiltration. This allows for flood water to move into and through these levels while limiting infiltration to the rest of the structure.

HAZARD ADDRESSED

COASTAL RIVERINE STORM WATER

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL RIVERINE UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

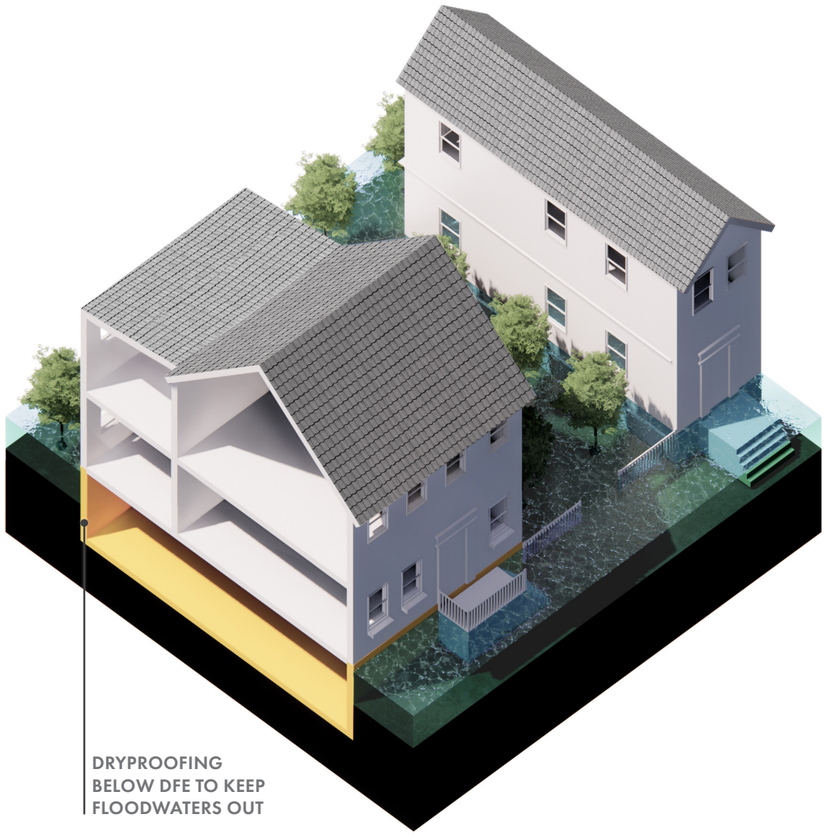
PERMITTING

CONSTRUCTABILITY

ADAPT TO THE
PRESENCE OF WATER

DRYPROOF LEVELS BELOW DFE

CATEGORY: ***FLOODPROOFING/HARDENING***



Dryproofing below flood levels involves fully blocking out floodwaters with both permanent and deployable structures. This tool retains usability of floors below grade for permanent and temporary uses. Allows for assets and utilities to remain below DFE with a lessened chance of flooding.

HAZARD ADDRESSED

COASTAL · RIVERINE · STORM WATER · SEA LEVEL RISE

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL · RIVERINE · UPLAND · URBAN · SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ – $$$

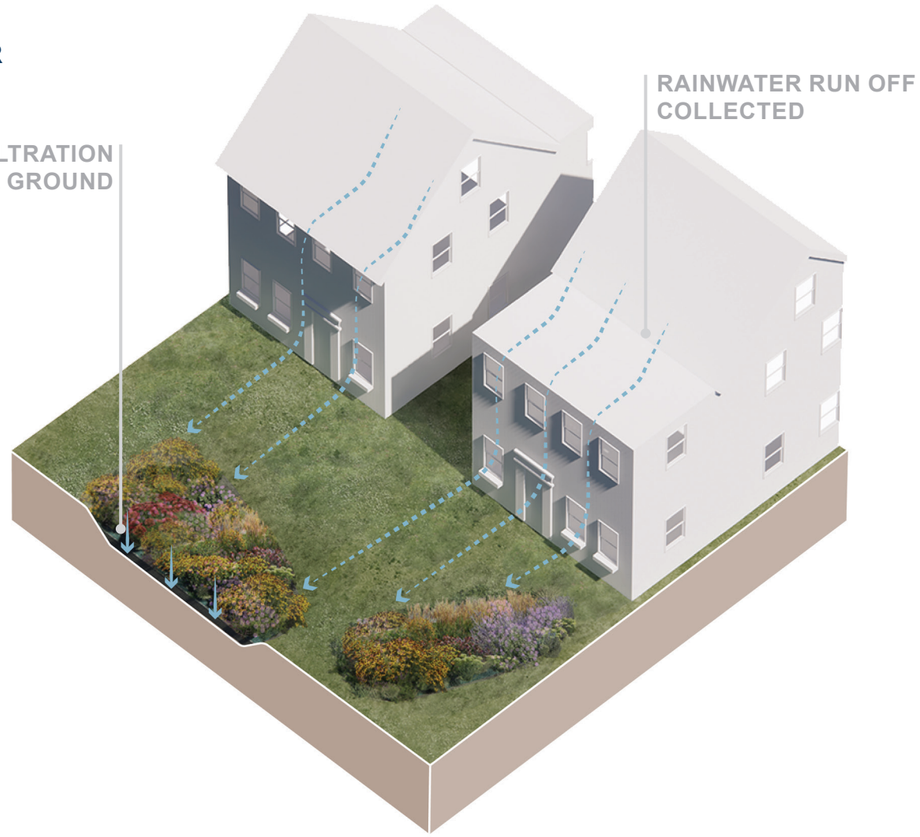
PERMITTING

CONSTRUCTABILITY

URBAN STORMWATER MANAGEMENT

RAIN GARDEN

ADAPT TO
PRESENCE OF WATER



A rain garden collects rainwater runoff from impervious surfaces like roofs, streets, and paved surfaces, thereby reducing risk associated with rainfall flooding.

HAZARD ADDRESSED

STORM
WATER

SCALE OF IMPLEMENTATION

MULTIPLE
SITES

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC
ACCESS AND USE

APPLICABLE AREAS

UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

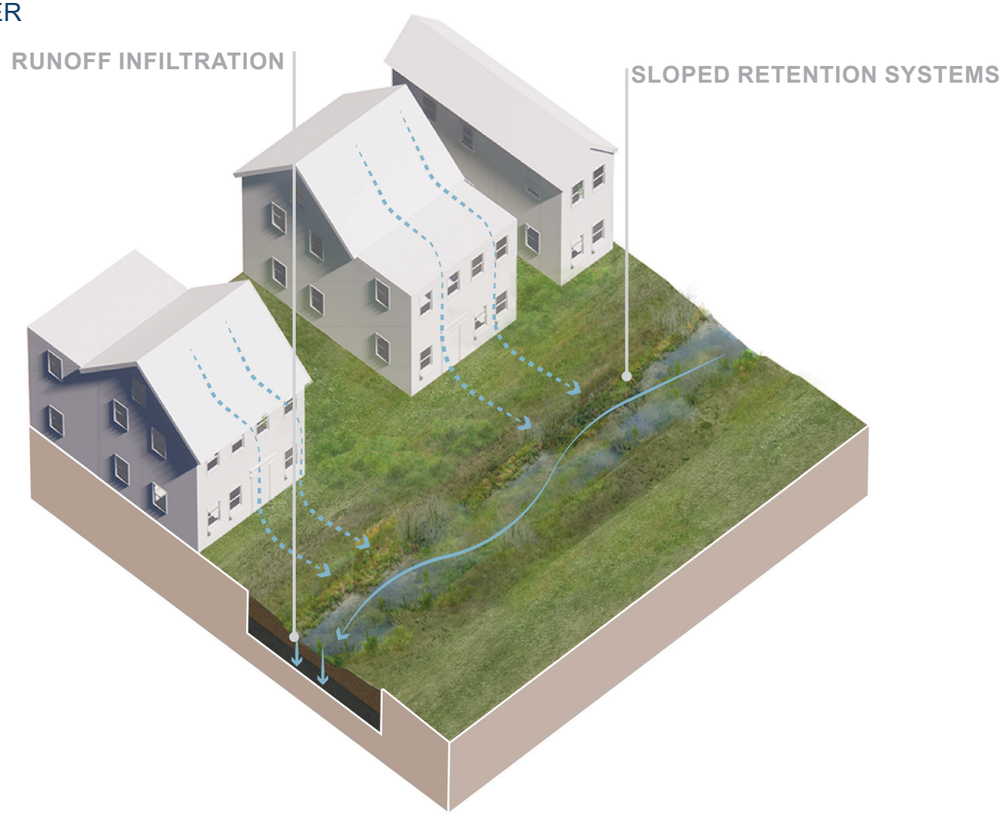
PERMITTING

CONSTRUCTABILITY

CATEGORY: ***STORMWATER MANAGEMENT***

PLANTED SWALE

ADAPT TO
PRESENCE OF WATER



Planted swales are linear sloped conveyance and retention systems for stormwater runoff that can absorb low flows and help reduce flood risk associated rainfall flooding.

HAZARD ADDRESSED

STORM
WATER

SCALE OF IMPLEMENTATION

MULTIPLE
SITES

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC
ACCESS AND USE

APPLICABLE AREAS

UPLAND SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

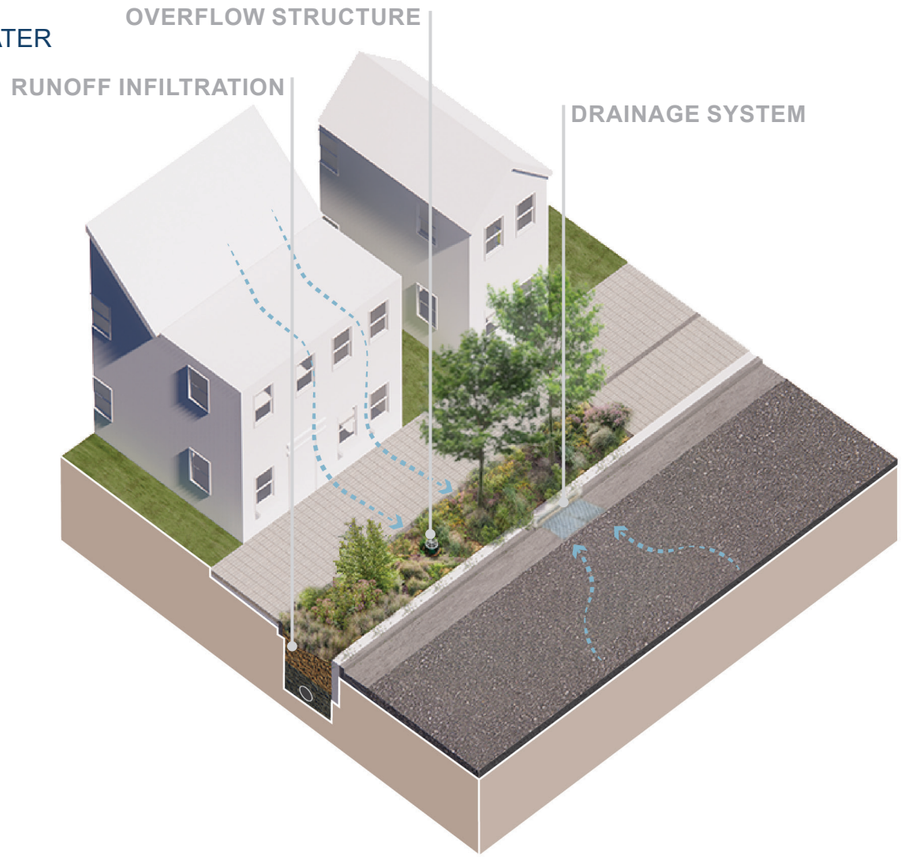
PERMITTING

CONSTRUCTABILITY

CATEGORY: ***STORMWATER MANAGEMENT***

RIGHT-OF-WAY BIOSWALE (URBAN)

ADAPT TO
PRESENCE OF WATER



Right-of-way bioswales are vegetated drainage courses located in sidewalks to capture, detain, and infiltrate runoff from streets, allowing any excess rain water to enter the piped stormwater system.

HAZARD ADDRESSED

STORM
WATER

SCALE OF IMPLEMENTATION

MULTIPLE
SITES

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC
ACCESS AND USE

APPLICABLE AREAS

UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

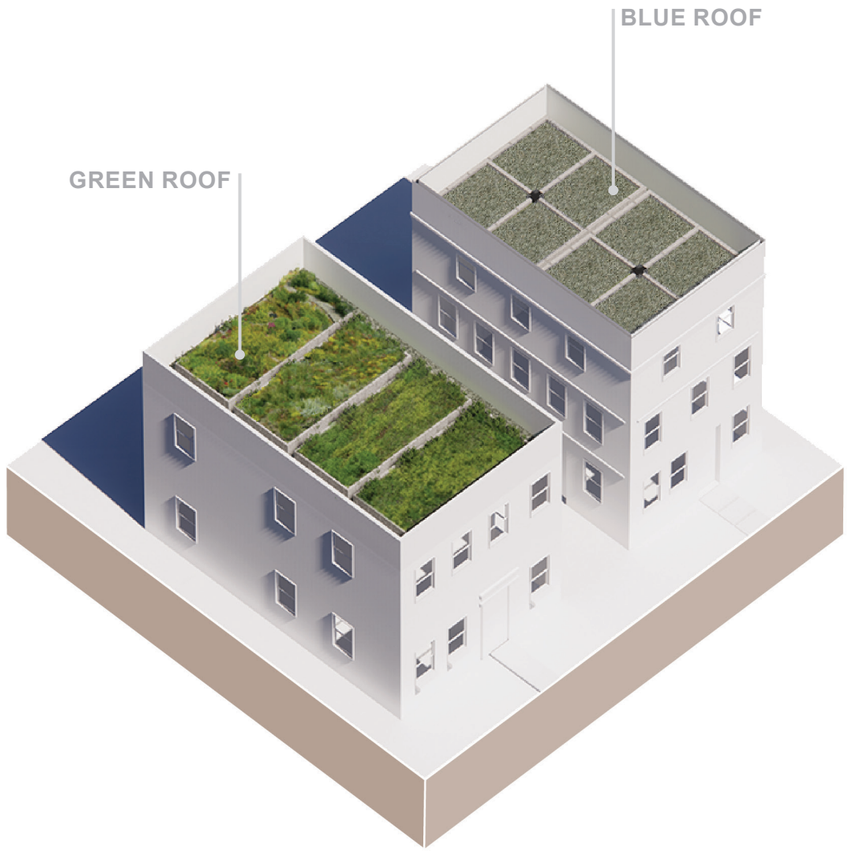
PERMITTING

CONSTRUCTABILITY

GREEN ROOF & BLUE ROOF

CATEGORY: ***STORMWATER MANAGEMENT***

ADAPT TO
PRESENCE OF WATER



A green roof is a layer of growing medium for vegetation installed over a waterproofing system, slowing down runoff by retaining rainwater and gradually releasing it back into the atmosphere through condensation and transpiration. Blue roofs provide temporary water storage systems that allow for the gradual release or evaporation of stored water.

HAZARD ADDRESSED

STORM
WATER

SCALE OF IMPLEMENTATION

MULTIPLE
SITES

CO-BENEFITS

ECOLOGICAL EDUCATIONAL RECREATIONAL ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC
ACCESS AND USE

APPLICABLE AREAS

UPLAND URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

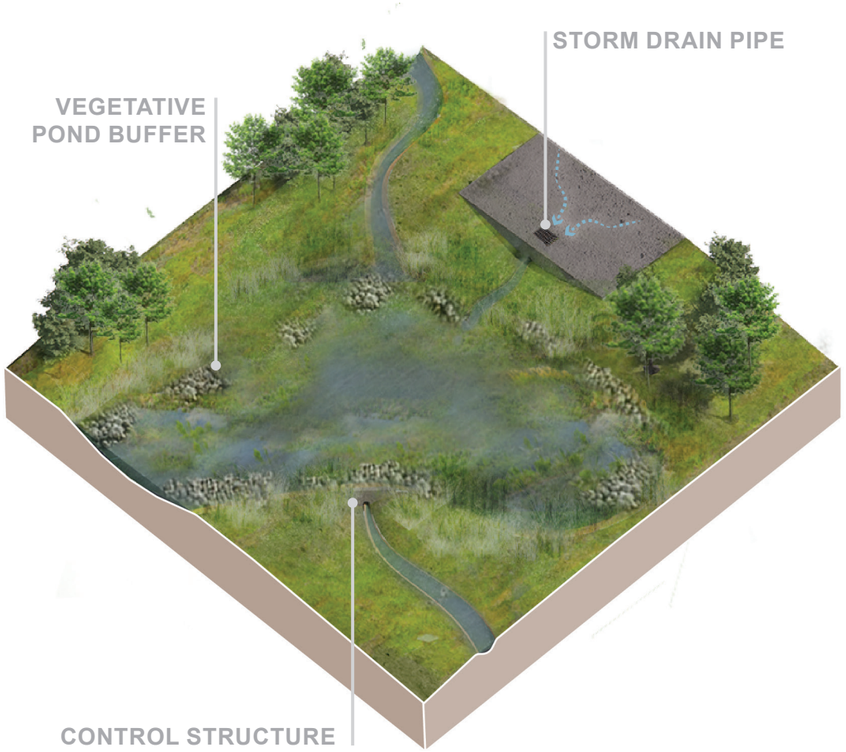
PERMITTING

CONSTRUCTABILITY

RETENTION / WET PONDS (STORMWATER BASINS)

CATEGORY: ***STORMWATER MANAGEMENT***

ADAPT TO
PRESENCE OF WATER



Retention ponds are artificial basins used to manage stormwater runoff and promote infiltration. Capturing runoff, they can reduce downstream or localized flooding and enable groundwater recharge.

HAZARD ADDRESSED

STORM WATER

SCALE OF IMPLEMENTATION

MULTIPLE SITES

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

UPLAND SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

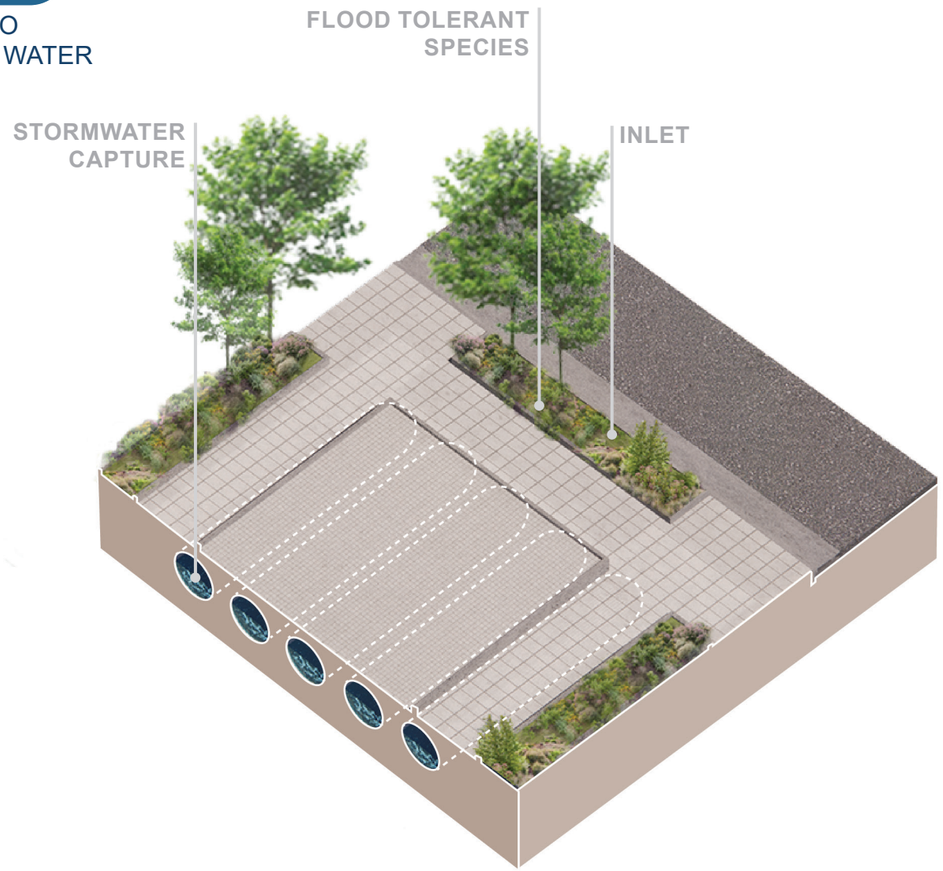
COSTS $ $$$

PERMITTING

CONSTRUCTABILITY

UNDERGROUND STORAGE / WATER SQUARES

ADAPT TO
PRESENCE OF WATER



Underground storage accomplishes the capture and storage of stormwater collected from impervious areas. Stored water is then released directly through an outlet pipe back into natural waters at rates designed to reduce peak water flows during storms.

HAZARD ADDRESSED

STORM WATER

SCALE OF IMPLEMENTATION

MULTIPLE SITES

CO-BENEFITS

RECREATIONAL ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

PERMITTING

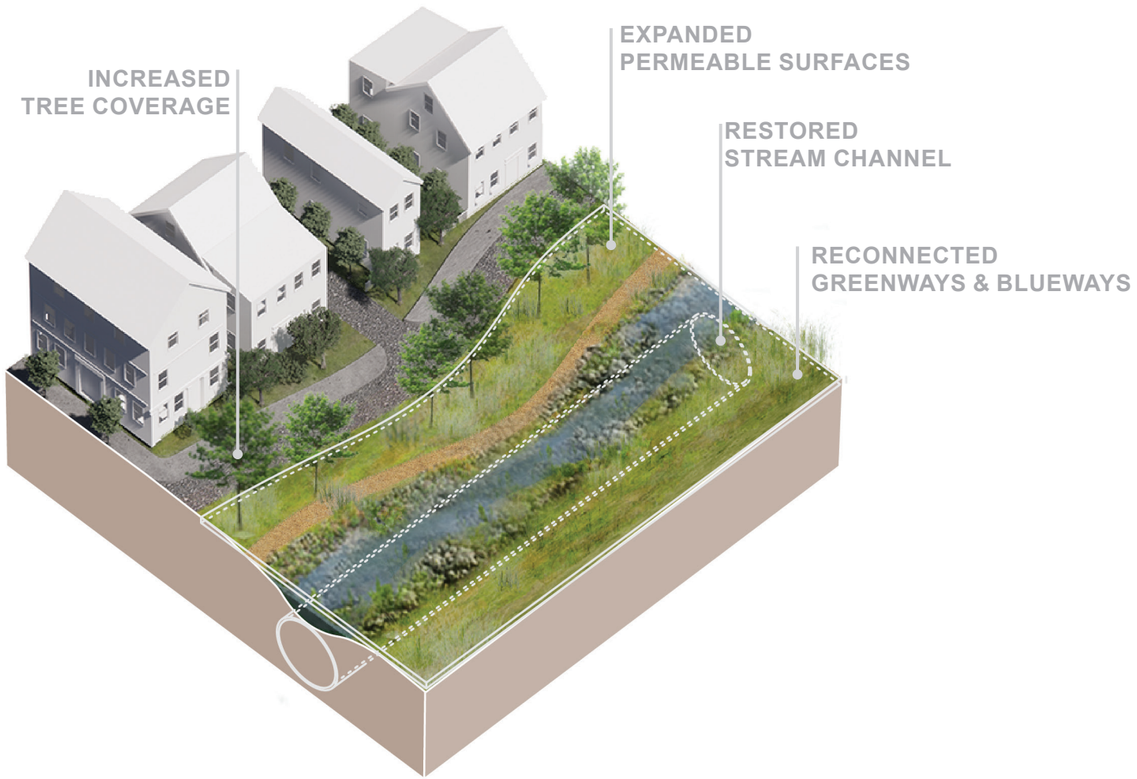
CONSTRUCTABILITY

RIVERINE SYSTEMS

STREAM DAYLIGHTING & RESTORATION

CATEGORY: ***RIPARIAN MANAGEMENT***

ADAPT TO
PRESENCE OF WATER



Stream daylighting is the exposure of some or all of the flow of waterways covered in piped or culverts. Stream daylighting and restoration of natural drainage systems can help eliminate flooding issues by re-connecting piped stream channels with the floodplain and re-creating a functioning floodplain and riparian area.

HAZARD ADDRESSED

RIVERINE

STORM WATER

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL EDUCATIONAL RECREATIONAL ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

RIVERINE SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

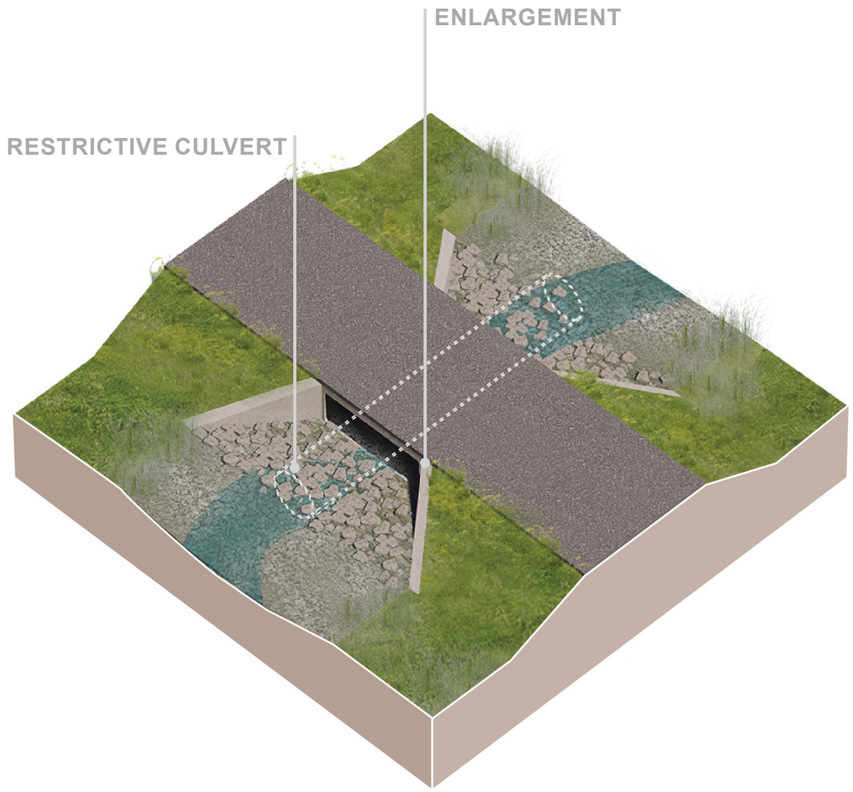
PERMITTING

CONSTRUCTABILITY

CULVERT MODIFICATION / ENLARGEMENT

CATEGORY: ***RIPARIAN MANAGEMENT***

ADAPT TO
PRESENCE OF WATER



Enlargement of culverts that are not able to manage large flow surges during heavy rain events or spring thaw can help reduce likelihood of localized flooding upstream of the culverts, assuming additional floodwater doesn't exacerbate flooding issues downstream.

HAZARD ADDRESSED

RIVERINE

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

RIVERINE URBAN SUBURBAN

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

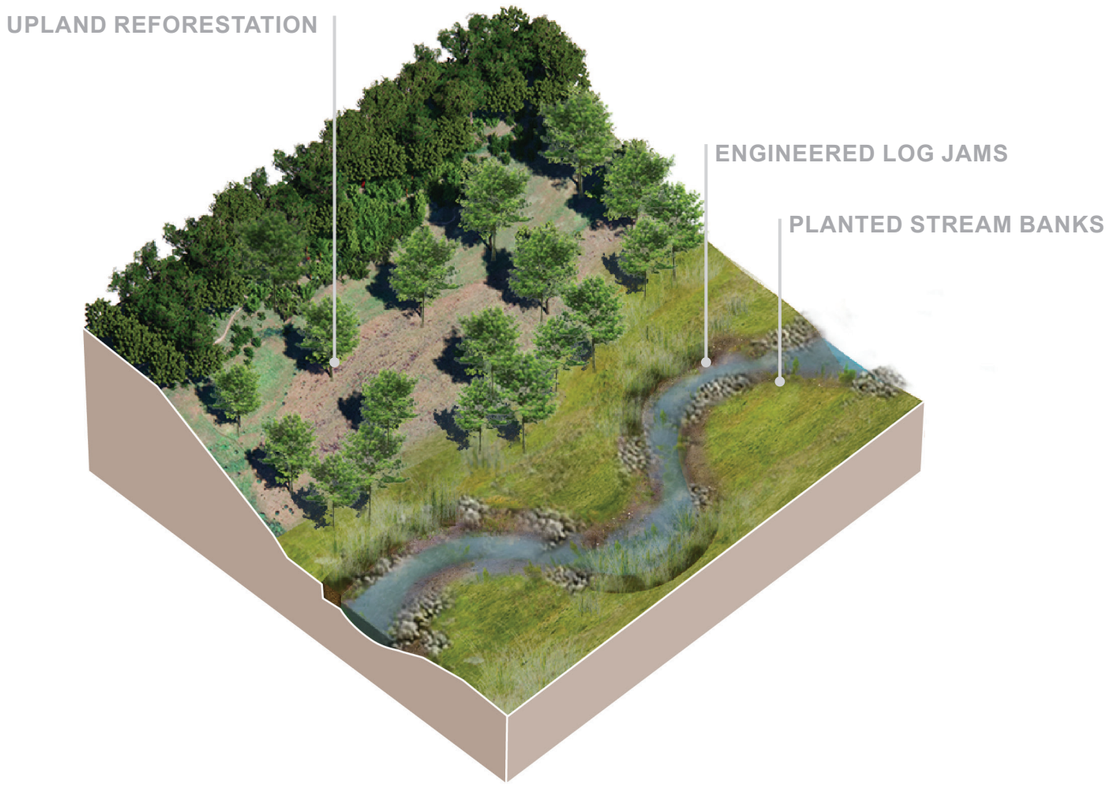
PERMITTING

CONSTRUCTABILITY

NATURAL CHANNEL DESIGN/ STREAM RESTORATION

CATEGORY: ***RIPARIAN MANAGEMENT***

ADAPT TO
PRESENCE OF WATER



Streams that are artificially modified through straightened channels or altered stream banks result in instability where bed and bank erosion is a common consequence. Natural streams and floodplains provide stability to manage floodwaters safely, minimizing impacts to infrastructure.

HAZARD ADDRESSED

RIVERINE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL EDUCATIONAL RECREATIONAL ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

RIVERINE OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

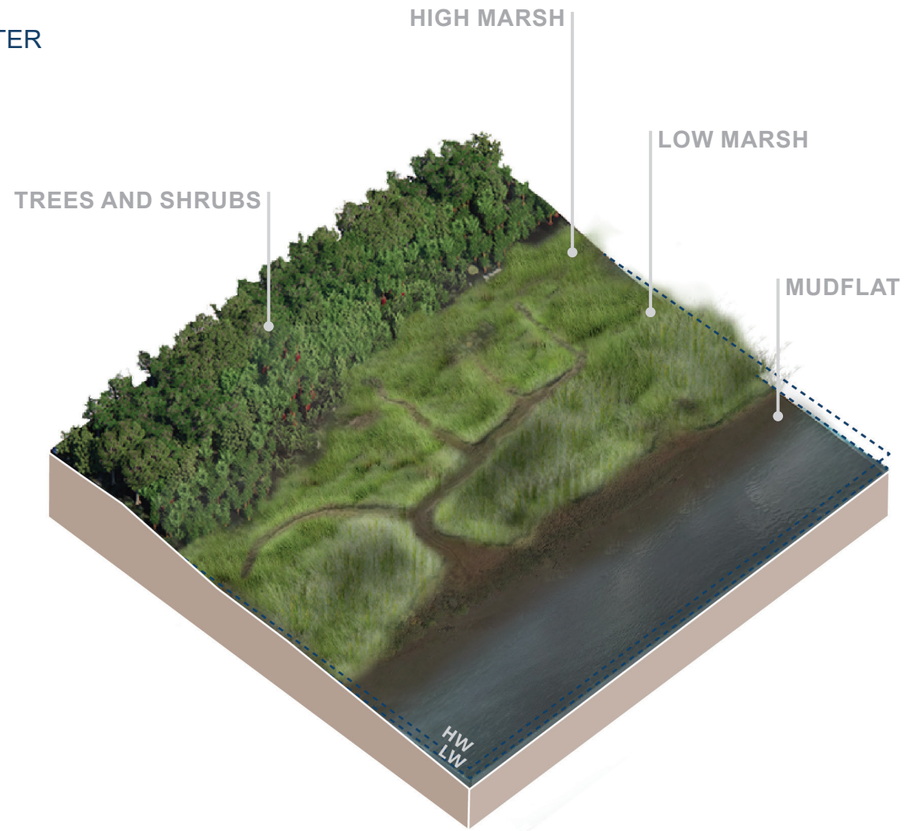
COSTS $ $$$

PERMITTING

CONSTRUCTABILITY

WETLAND PRESERVATION/ RESTORATION/EXPANSION

ADAPT TO
PRESENCE OF WATER



Wetland restoration involves returning the natural functions of former or degraded wetlands that have been filled, drained, or impounded to promote stable water exchanges into and out of the wetland.

HAZARD ADDRESSED

RIVERINE
STORM WATER

SCALE OF IMPLEMENTATION

SITE

CO-BENEFITS

ECOLOGICAL
EDUCATIONAL
RECREATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME
IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

RIVERINE
OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

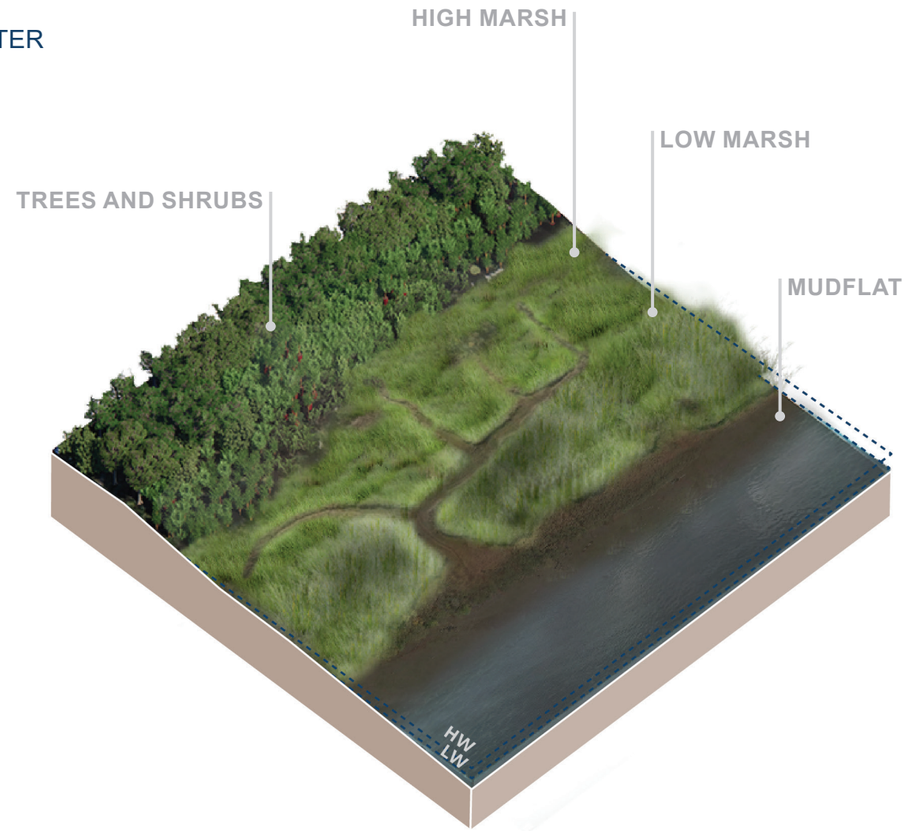
COSTS $ $$$
PERMITTING
CONSTRUCTABILITY

COASTAL SYSTEMS

COASTAL WETLAND PRESERVATION/ RESTORATION/EXPANSION

CATEGORY: ***SHORELINE RESTORATION***

ADAPT TO
PRESENCE OF WATER



Low-lying tidal wetlnd ecosystems are among the most vulnerable environments to sea level rise. The resilience of tidal wetlands to sea level rise depends on the potential for horizontal migration to upland areas and the vertical accretion rate of the wetland, which can be supported through restoration and expansion.

HAZARD ADDRESSED

COASTAL
SEA LEVEL RISE

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL
EDUCATIONAL
RECREATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME
IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL
OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$
PERMITTING
CONSTRUCTABILITY

BERM / DUNE SYSTEM

CATEGORY: ***SHORELINE RESTORATION***

PROTECT
FROM WATER

Dunes are landforms that occur with the sufficient transportation of sand or sediment and rely on the presence of a healthy and extensive root system from dune grasses and other vegetation to maintain their shape and help reduce flood risk associated with coastal storms. Dunes can act as a buffer, attenuating storm waves and reducing damage to communities.

HAZARD ADDRESSED

COASTAL

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

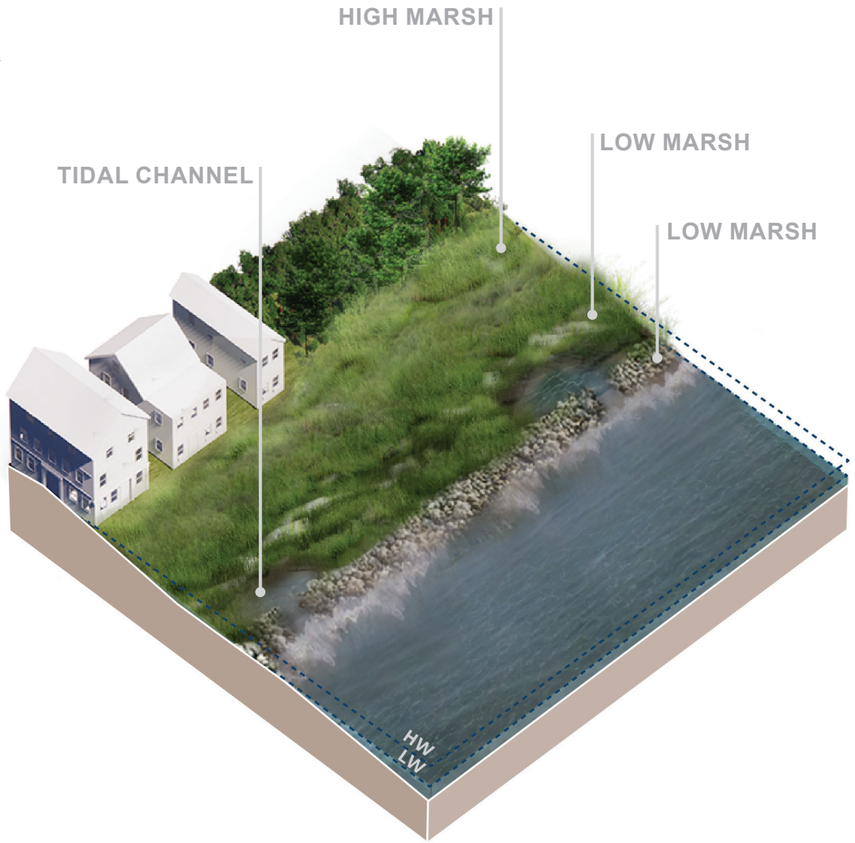
PERMITTING

CONSTRUCTABILITY

CATEGORY: ***SHORELINE RESTORATION***

LIVING SHORELINE

ADAPT TO
PRESENCE OF WATER



Shoreline stabilization approaches along estuarine coasts, bays, sheltered coastlines, and tributaries incorporate natural features, including vegetation or submerged aquatic vegetation alone, or hybrid systems in combination with harder shoreline structures for added stability such as stone, sand fill, rock sills and other structural and organic materials.

HAZARD ADDRESSED

COASTAL

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL EDUCATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL OPEN SPACE

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

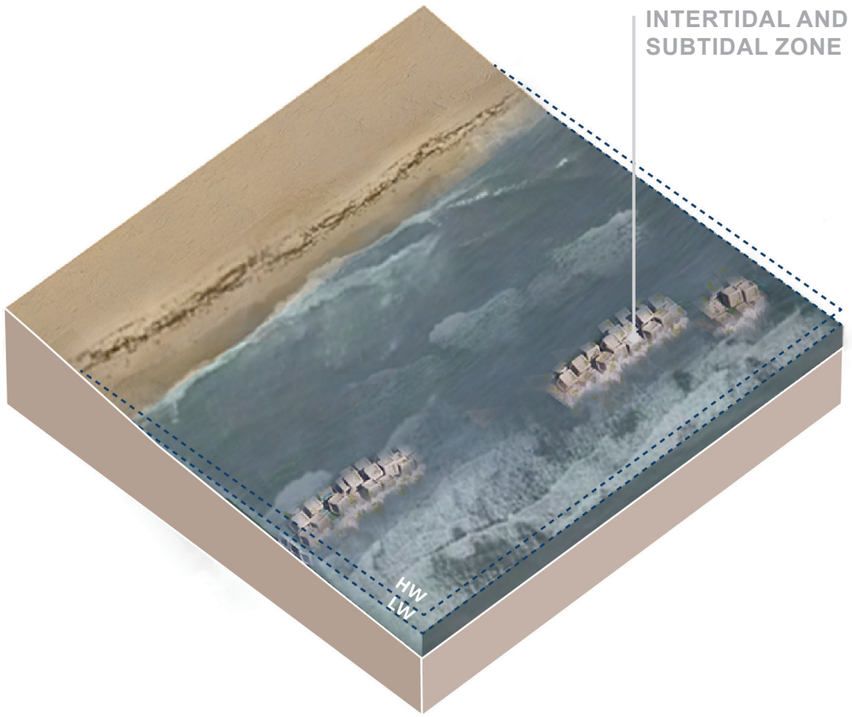
PERMITTING

CONSTRUCTABILITY

CONSTRUCTED REEFS / BREAKWATERS

CATEGORY: ***SHORELINE RESTORATION***

ADAPT TO
PRESENCE OF WATER



Constructed reefs are subtidal and sometimes intertidal submerged structures that promote marine life and break waves, limiting the wave energy reaching the shoreline. Breakwaters are partially or fully emergent structures that extend above mean high water. They are built with armor units to help attenuate storm waves to improve safety and prevent damage to buildings and infrastructure.

HAZARD ADDRESSED

COASTAL

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECOLOGICAL RECREATIONAL

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

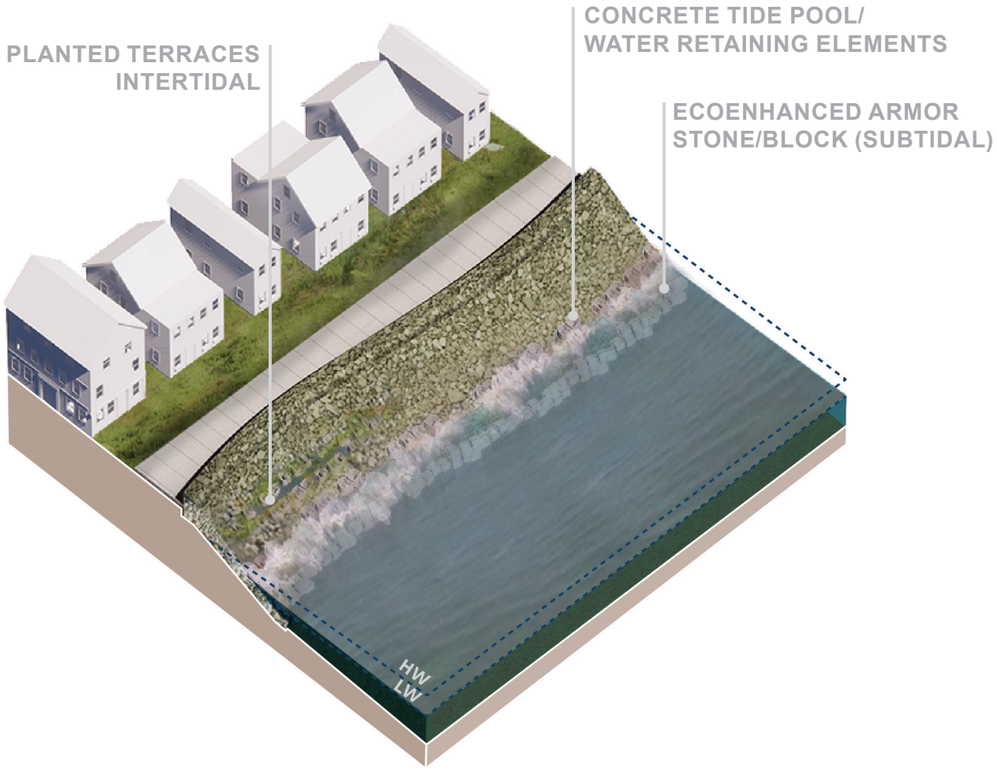
PERMITTING

CONSTRUCTABILITY

REVETMENTS

CATEGORY: ***COASTAL BARRIER***

PROTECT
FROM WATER



Revetments are hard sloping structures, typically constructed using natural stone, or concrete blocks designed to reduce shoreline erosion by absorbing wave energy and minimizing wave run-up.

HAZARD ADDRESSED

COASTAL

SCALE OF IMPLEMENTATION

LINEAR

CO-BENEFITS

ECONOMIC

LEVEL OF POTENTIAL DISRUPTION

CONSTRUCTION TIME

IMPACT TO PUBLIC ACCESS AND USE

APPLICABLE AREAS

COASTAL

CONSTRAINTS AND CONSIDERATIONS

COSTS $ $$$

PERMITTING

CONSTRUCTABILITY

NON-PHYSICAL STRATEGIES

GOVERNANCE & POLICY

GOVERNANCE AND POLICY ROLES

FEDERAL AGENCIES & PROGRAMS

FEMA	• Creates maps of current flood risk and sets national floodplain construction standards • Administers the National Flood Insurance Program (NFIP), through which people in participating municipalities can purchase flood insurance. Reduced rates are available for municipalities that adopt higher construction standards through the Community Rating System (CRS). • Provides hazard mitigation and disaster recovery funding to governments, businesses, and individuals. To be eligible for hazard mitigation funds, states and local entities must have developed a Hazard Mitigation Plan (HMP).
US Army Corps of Engineers	• Conducts flood risk reduction studies • Implements flood risk reduction projects • Coordinates with NJ Department of Environmental Protection (NJDEP) on hazard mitigation and disaster recovery funding efforts
NOAA	• Manages the federal Coastal Zone Management Program

STATE AGENCIES & PROGRAMS

NJDEP	• Coordinates federal, state and local floodplain management programs. These include statewide floodplain management standards and model local ordinances • Leading developing of statement climate resilience planning initiatives, including NJPACT and Resilient NJ. • Relatedly, oversees the Site Remediation Program and sets requirements for combined sewer systems / LTCPs.
NJDCA	• Enforces construction codes • Administers CBDG funds received by the State for Superstorm Sandy assistance
NJBPU	• Regulates utilities, including water supply and wastewater management
NJOEM	• Coordinates with FEMA on hazard mitigation, preparedness, response, and disaster recovery funding

GOVERNANCE & POLICY

COUNTY, REGIONAL, AND LOCAL AGENCIES & PROGRAMS

MIDDLESEX COUNTY	• Responsible for managing county roads, infrastructure, parks • Can adopt site plan and subdivision standards as development impacts their assets • Maintain County Hazard Mitigation Plans
LTCP STAKEHOLDER (MCUA)	• Responsible for wastewater conveyance and treatment and development of Long-Term Control Plans to mitigate impacts on water quality • Advanced internal planning for climate risks and implementation of flood mitigation projects
CARTERET, OLD BRIDGE, PERTH AMBOY, SAYREVILLE, SOUTH AMBOY, SOUTH RIVER, WOODBRIDGE	• As a home rule state, land use, zoning, development regulation rest in local decision makers • Required to have Flood Damage Prevention Ordinances and Municipal Separate Storm System (MS4) “Stormwater Management” plans • Must adopt a Master Plan that meets statewide requirements • Develop hazard mitigation plans and capital improvement programs to address infrastructure and flood protection needs • Submit grant applications to support funding • Raise funding through property taxes, municipal bonds, and improvements associated with redevelopment projects

GOVERNANCE & POLICY

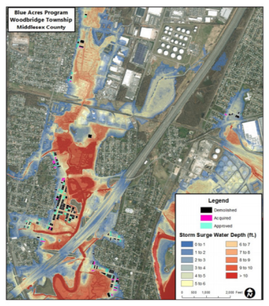
GOVERNANCE AND POLICY: POTENTIAL ACTIONS

STRATEGY	EXAMPLES	HAZARDS ADDRESSED	CO-BENEFITS
Increasing floodplain construction standards	•Higher freeboard •Disclosure laws for sale of land in the floodplain •Require dry access •Non-conversion agreements •Prohibit new critical facilities in high hazard areas	All	•Flood insurance savings
Increasing standards for on-site stormwater management	•Maximum lot coverage standards •Prohibit encroachments on drainage ways	Stormwater	•Water quality improvements •Creation of community green space
Land use planning and zoning	•Plan for growth in areas of lower risk and reduce growth in high hazard areas •Improve access to resources and necessities •Remove zoning barriers to resilient design •Set elevation requirements of buildings, yards, and esplanades •Erosion prevention requirements •Setbacks	All	•Economic development •Quality of life •Environmental benefits
Incorporating resiliency in Capital Infrastructure Planning	•Align Capital Infrastructure Plan with land use plans and hazard mitigation plans •Create resiliency design standards •Prioritize investments based on risk reduction	All	•Improved efficiency of capital spending
Adapting governance structures to advance resiliency	•Resilience District to fund, implement, and maintain community-scale resiliency infrastructure •Task forces and working groups across agencies and jurisdictions to advance	All	•Improved governance and accountability
Acquisition of Highly Vulnerable Properties	•Targeted acquisition programs can be used to buy properties from willing sellers in high-risk areas •Acquired properties are required to remain open space but can be used as passive recreational spaces and for habitat restoration	All	•Creation of open space •Environmental benefits

GOVERNANCE AND POLICY TOOLS

GOVERNANCE & POLICY

CASE STUDY: WATSON-CRAMPTON NEIGHBORHOOD (WOODBRIDGE, NJ)



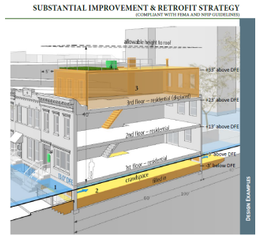
Approx. 150 homes have been bought out so far through this program.

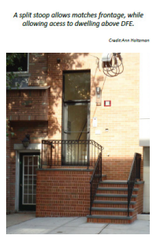
- After Hurricane Sandy, Woodbridge worked with the New Jersey Blue Acres Program (managed by NJDEP) for funding for voluntary buy-outs of homes severely damaged by Sandy.
- Woodbridge rezoned the area to an Open Space Conservation / Resiliency zone, which:
  - Prohibits new development
  - Renovation, reconstruction, sale, or change in tenancy require properties to be elevated one foot above federal requirements
- Woodbridge is working with Rutgers University to plan for the restoration of bought-out properties to serve as a flood buffer.
- Due to these efforts, Woodbridge has been designated a class 6 community through the Community Rating System, which allows residents to earn discount on flood insurance premiums.
- Woodbridge worked closely with residents and the Land Conservancy of New Jersey to educate residents about the program.

CASE STUDY: FLOOD OVERLAY ZONE (JERSEY CITY)

- The **Jersey City Flood Overlay Zone Ordinance** applies to all properties located in the current 1% annual chance floodplain.
- Includes requirements for **green infrastructure** and resilient site design depending on location in the AE or VE zone (VE zone is portion of floodplain where there are wave hazards).
- Strategies such as vegetated walls, green roof, permeable pavement, bioretention, WaterSense fixtures, etc., can be used to meet these requirements.

CASE STUDY: RESILIENT BUILDING DESIGN GUIDELINES (HOBOKEN)





- Provides an overview of the laws and regulations that apply to construction in the floodplain.
- Provides guidance on strategies to reduce flood insurance premiums.
- Recommendation for how to design buildings to be resilient as well enhance the character of a dense, urban city with pedestrian-friendly streets.

GOVERNANCE & POLICY

INDIVIDUAL AND COMMUNITY-BASED ACTIONS

RESILIENCE HUBS

Resilience Hubs are community serving facilities that support residents through coordination resource distribution and services before, during, and/or after a natural hazard event.

Hubs can be used year-round as neighborhood centers and are intended to be supported by local government by led and managed by community members, community-based organization and/or faith-based groups

EMERGENCY PREPAREDNESS

CERT COMMUNITY EMERGENCY RESPONSE TEAM

NJ Health New Jersey Department of Health

Prepare and Maintain an Emergency Kit

Prepare y mantenga al día Equipo para Emergencias

Emergency preparedness efforts include the dissemination of emergency alerts and guidance to residents and community leaders and supporting community-based emergency preparedness programs through partnerships with community organizations and faith-based institutions.

Outreach in multiple languages and through trusted local leaders is key.

More info from the New Jersey Department of Health's Office of Disaster Resilience

https://www.state.nj.us/health/er/

BUSINESS & INDUSTRY EMERGENCY PREPAREDNESS

STAY OPEN OFB-EZ FOR BUSINESS® A PROGRAM OF IBHS

THE EASY WAY TO PREPARE YOUR BUSINESS FOR THE UNEXPECTED.

Outreach and technical assistance to businesses and industries is another key element of emergency preparedness. This includes providing resources and guidance on developing emergency plans and how to navigate recovery programs.

More info from the New Jersey Office of Emergency Management

http://ready.nj.gov/plan-prepare/business-industry.shtml

COMMUNITY PLANNING

One way to build adaptive capacity is to work in close collaboration with neighborhood residents and community-based organizations to identify community needs and develop strategies for improving access to necessary resources. This could include improving access to open space, improving community mobility and connectivity, or addressing food deserts—all things that help a community adapt to changing climate hazards and thrive every day.

COMMUNITY STEWARDSHIP OF GREEN SPACES

Community co-creation and stewardship of green spaces is a way to partner with community-based organizations to maintain green spaces that support community resilience while supporting education, job training, and providing volunteer opportunities.

Ex. Perth Amboy Green Team

WORKFORCE DEVELOPMENT

Job training programs focused on green infrastructure or other resiliency projects help direct investment in infrastructure projects to community and develop the necessary workforce to implement planned projects.

Example: Newark Green Works. More info from New Jersey Water Works: **https://www.jerseywaterworks.org/wp-content/uploads/2020/11/Newark-Local-Hire-Report-November-2020.pdf**

PUBLIC-PRIVATE PARTNERSHIPS FOR RESILIENCY INFRASTRUCTURE

Partnerships with developers can be used to incorporate resiliency improvements, such as barriers like berms, resilient coastline strategies like living shorelines, or on-site stormwater improvements, into redevelopment plans.

Ex. Riverton Waterfront Development, Sayreville