

# Sliver by the River - Green Infrastructure Alternatives Analysis Summary Sheet

## Project Introduction

Sliver by the River has the potential to lead the transformation of Bridgeport's riverfront and catalyze economic growth along with the five other "Opportunity Sites" identified in the Waterfront Bridgeport plan. The Trust for Public Land and the City of Bridgeport are working with stakeholders to establish a waterfront trail and park system along Bridgeport's shoreline. At the Sliver by the River, proposed elements include trails, waterfront access, kayak launches, and potentially a commercial oyster growing operation.

Ecological consultants, Biohabitats, evaluated types of green infrastructure that could be used at the site to improve water quality, provide wildlife habitat, increase access to the waterfront, and enhance resilience to sea level rise and coastal flooding. Unlike traditional, "grey" infrastructure, green infrastructure harnesses the power of nature to provide services to people and the broader, ecological community.

## Existing Site Conditions

Currently an overflow parking lot, the site consists of decrepit asphalt, debris, sparse vegetation, and eroding shoreline structures. The entire site is within the 100-year floodplain and its northeastern third is inundated multiple times per month at high tide, which will be exacerbated with sea level rise. The adjacent Pequonnock River is impaired due to nutrients, low dissolved oxygen, and contaminants resulting from urban runoff, industrial uses, and sewage overflows. Built on urban fill, the site has contaminated soils and groundwater. Several pieces of existing utility infrastructure remain on the site, including a United Illuminating (UI) underground transmission line and drainage easements.



## Constraints

Among the six types of site constraints identified, flooding is the most significant.

Type	Constraints
Flooding	<ul style="list-style-type: none"> <li>Daily tidal flooding</li> <li>Storm surge flooding</li> <li>Elevation of adjacent Stratford Ave. limits ability to berm</li> </ul>
Groundwater	<ul style="list-style-type: none"> <li>Shallow groundwater limits ability to use infiltrating green infrastructure</li> </ul>
Contamination	<ul style="list-style-type: none"> <li>Requires non-infiltrating green infrastructure</li> <li>Requires removal or capping of soil on site</li> </ul>
Erosion	<ul style="list-style-type: none"> <li>Shoreline practices must withstand wave and wake action</li> <li>Adjacent shorelines will continue to be raised and hardened, which will increase erosive forces at the site</li> </ul>
Existing Infrastructure	<ul style="list-style-type: none"> <li>Opportunity to use existing structures and materials</li> <li>UI easement requires coordination with utility</li> <li>Drainage easement restrictions</li> </ul>
Proposed Infrastructure	<ul style="list-style-type: none"> <li>Potential coordination required with commercial oyster operation</li> <li>Requires compatibility with recreational site uses</li> </ul>

## Typical Existing Site Conditions

Degrading Asphalt Pavement



Tidal Flooding in Northeast of Site



Existing Shoreline



## Site Constraints

Daily Flooding with 20" Sea Level Rise



10-year Flood Event



30-year Flood Event



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## Site Zones

Based on the site constraints, Biohabitats divided the site into four zones based on site topography<sup>1</sup>, which relates to flooding, groundwater, and erosion.

Zone	Elevation	Description
Shoreline	< 3 ft.	Intertidal area, most exposed to erosive forces of Pequonnock River
Tidal	3 ft. – 5 ft.	Flooded daily as sea levels rise, shallow groundwater, erosion during storms
Transition	5 ft. – 7 ft.	Flooded during minor storms, periodic tidal flooding with sea level rise
Upland	> 7 ft.	Flooded during storms, deepest groundwater on site

<sup>1</sup>All elevations in NAVD88 feet



## Green Infrastructure Alternatives

Description of potential green infrastructure alternatives for the Sliver by the River. Color indicates association with each zone in the map above.

### Living Shoreline

Use natural, living materials to improve shoreline stability, ecology, and water quality. Regrade to create a more gradual slope, add a shellfish bed toe, and install marsh plantings along the slope.



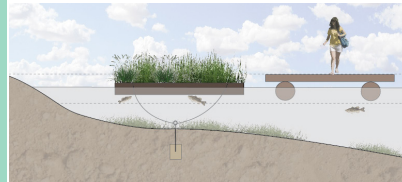
### Enhanced Riprap and Concrete

Integrate natural and nature-inspired elements into existing shoreline protection. Includes modifying the existing riprap and concrete shoreline with vegetation or structural changes that mimic tide pool habitat to improve ecology and water treatment capacity.



### Floating Wetlands

Install anchored, floating structures planted with live marsh vegetation, which provide wildlife habitat both above and below the surface of the water while also taking up nutrients and buffering waves.



### Green Bulkhead

Integrate natural and nature-based features with hardened shoreline structures. Attach “biohuts®,” cages containing wood or oyster shells that provide habitat for fish and macroinvertebrates, to the bulkhead, for example.



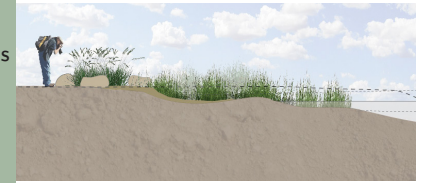
### Marsh Restoration

Restore native marsh ecosystem. Regrade area to create a gradual coastal gradient and plant native salt marsh species to provide valuable habitat, improve water quality, and protect against flooding.



### Tidal Swale

Regrade portions of the area into vegetated depressions to retain and slowly filter tidal floodwaters while also providing habitat benefits.



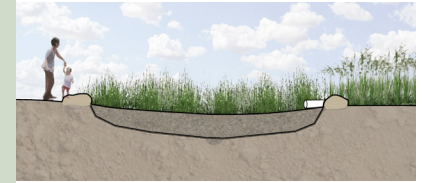
### Wet Meadow Restoration

Remove asphalt and plant native grasses, sedges and flowering species, which will filter runoff from the upland, provide valuable habitat to birds and pollinating insects, and add beauty to the waterfront.



### Stormwater Treatment Wetland

Remove asphalt and grade small areas into vegetated wetlands to capture runoff from the upland area. This will permit other activities on higher ground while filtering runoff and providing some habitat.



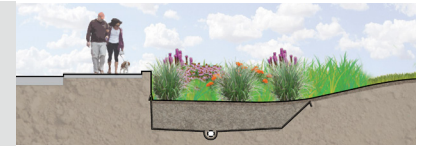
### Riparian Forest Restoration

Remove asphalt and plant native trees and shrubs to help reduce upland runoff, improve soil health, and provide habitat for wildlife and shade for park visitors.



### Bioretention

Create rain gardens and bioswales, isolated vegetated depressions, that will capture and treat stormwater while providing some habitat to pollinators.



### Permeable Pavement

Where hardscape is proposed, use permeable options such as pervious concrete, permeable pavers, grass pavers, or pervious asphalt to capture runoff, but they provide no habitat value.



# Sliver by the River - Green Infrastructure Alternatives Analysis Summary Sheet

## Green Infrastructure Alternatives Summary

The table below summarizes the details of each green infrastructure alternative for the Sliver by the River. This includes typical design elements and site specific considerations that highlight the challenges and opportunities associated with each alternative and how they relate to the Sliver by the River site. For a more detailed description of the benefits and site-specific constraints associated with each alternative, please see the full report.

Alternative	Design Elements	Site Considerations
<b>SHORELINE</b>		
Living Shoreline	<ul style="list-style-type: none"> <li>Mussel beds</li> <li>Oyster castles/reef balls</li> <li>Rip rap</li> </ul>	<ul style="list-style-type: none"> <li>Submerged vegetation</li> <li>Marsh vegetation</li> <li>Tide pools</li> <li>Woody debris</li> <li>Coir logs</li> <li>Shrubs</li> </ul>
Enhanced Rip Rap and Concrete	<ul style="list-style-type: none"> <li>Planting media</li> <li>Coir logs</li> </ul>	<ul style="list-style-type: none"> <li>Submerged vegetation</li> <li>Marsh vegetation</li> <li>Cored concrete</li> <li>Tide pools</li> </ul>
Floating Wetlands	<ul style="list-style-type: none"> <li>Floating media</li> <li>Growth media</li> </ul>	<ul style="list-style-type: none"> <li>Vegetation</li> <li>Mooring system</li> </ul>
Green Bulkhead	<ul style="list-style-type: none"> <li>Biohuts®</li> </ul>	<ul style="list-style-type: none"> <li>Erosion control</li> <li>Conflict with oyster operation</li> <li>Incorporation of boardwalks, boat launch, and fishing pier</li> <li>Site contamination</li> <li>Salinity of river</li> </ul>
<b>TIDAL ZONE</b>		
Marsh Restoration	<ul style="list-style-type: none"> <li>Planting media</li> <li>Marsh vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Soil contamination</li> <li>Metal uptake in plants</li> <li>Incorporation of boardwalks, access, and boat launch</li> <li>Benefit to fishing activities</li> <li>Conflict with oyster operations</li> <li>UI easement</li> <li>Salinity of river</li> </ul>
Tidal Swale	<ul style="list-style-type: none"> <li>Planting media</li> <li>Marsh vegetation</li> </ul>	<ul style="list-style-type: none"> <li>Soil contamination</li> <li>Metal uptake in plants</li> <li>Creation of berms for trails</li> <li>Compatibility with oyster operations</li> <li>Salinity of river</li> </ul>
<b>TRANSITION ZONE</b>		
Wet Meadow Restoration	<ul style="list-style-type: none"> <li>Wet meadow vegetation</li> <li>Soil amendments (if necessary)</li> </ul>	<ul style="list-style-type: none"> <li>Full sun site conditions are favorable</li> <li>Recreational activities limited to trails and education facilities</li> <li>Compatibility with oyster operations</li> <li>UI easement</li> </ul>
Stormwater Treatment Wetland	<ul style="list-style-type: none"> <li>Forebay (if necessary)</li> <li>Engineered soil</li> <li>Vegetation</li> <li>Impermeable liner</li> </ul>	<ul style="list-style-type: none"> <li>Soil and groundwater contamination</li> <li>Opportunity for more recreational activities</li> <li>Compatibility with oyster operations</li> <li>UI easement</li> </ul>
<b>UPLAND ZONE</b>		
Riparian Forest	<ul style="list-style-type: none"> <li>Trees</li> <li>Shrubs</li> <li>Soil amendments (if necessary)</li> </ul>	<ul style="list-style-type: none"> <li>Shade for park guests</li> <li>Recreational activities limited to trails and picnic areas</li> <li>Lack of parking</li> <li>Compatibility with oyster operations</li> <li>UI easement</li> </ul>
Bioretention	<ul style="list-style-type: none"> <li>Engineered soil</li> <li>Inlet structure (optional)</li> <li>Stone level spreader</li> <li>Vegetation</li> <li>Underdrain</li> <li>Impermeable liner</li> </ul>	<ul style="list-style-type: none"> <li>Soil and groundwater contamination</li> <li>Options for layout (spread out and discrete vs. concentrated at downstream end)</li> <li>Opportunity for more recreational activities and parking</li> <li>Compatibility with oyster operations</li> <li>UI easement</li> </ul>
Permeable Pavement	<ul style="list-style-type: none"> <li>Base course</li> <li>Leveling course</li> <li>Surface treatment</li> <li>Underdrain</li> <li>Impermeable liner</li> </ul>	<ul style="list-style-type: none"> <li>Soil and groundwater contamination</li> <li>Opportunity for more recreational activities and parking</li> <li>Compatibility with nearly all proposed uses</li> <li>Compatibility with oyster operations</li> <li>UI easement</li> </ul>

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## Green Infrastructure Alternatives Evaluation

Biohabitats qualitatively evaluated each alternative based on the ecosystem services they provide, their compatibility with site programming, and feasibility considerations. Darker green means higher value for that ecosystem service. Darker blue means more favorable site compatibility, permitting, and operations and maintenance, and lower cost.



	Shoreline				Tidal		Transition		Upland		
	Living Shoreline	Enhanced Riprap/Concrete	Floating Wetlands	Green Bulkhead	Marsh Restoration	Tidal Swale	Wet Meadow Restoration	Stormwater Treatment Wetland	Riparian Forest	Bioretention	Permeable Pavement
<b>Ecosystem Services</b>											
Water Quality	Dark Green	Light Green	Light Green	Light Green	Dark Green	Dark Green	Dark Green	Dark Green	Dark Green	Dark Green	Light Green
Flood Mitigation	Dark Green	Light Green	Light Green	Light Green	Dark Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green
Soil Health	N/A	N/A	N/A	N/A	Dark Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Light Green
Habitat	Dark Green	Light Green	Light Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Light Green
Carbon	Dark Green	Light Green	Light Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Light Green
Recreation	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green	Light Green
Mental Health	Dark Green	Light Green	Light Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Dark Green	Light Green	Light Green
<b>Site Compatibility and Feasibility</b>											
Oyster Operations	Light Blue	Light Blue	Dark Blue	Light Blue	Light Blue	Light Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue
Recreational Programming	Dark Blue	Light Blue	Dark Blue	Light Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue
Permitting	Light Blue	Dark Blue	Light Blue	Light Blue	Light Blue	Light Blue	Dark Blue	Dark Blue	Light Blue	Dark Blue	Light Blue
Durability	Dark Blue	Light Blue	Light Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Light Blue
Operations and Maintenance	Dark Blue	Light Blue	Light Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Light Blue
Cost	Light Blue	Dark Blue	Light Blue	Light Blue	Light Blue	Dark Blue	Dark Blue	Light Blue	Dark Blue	Light Blue	Light Blue