A Living Shoreline: Charles River

**ENVIRONMENTAL**
Re-imagine the Charles River edge as a natural, living shoreline hosting rich and diverse native ecosystems that mitigate impacts of pollution.

**SOCIAL**
Cultivate diverse open spaces and network of circulation systems that promote access and a sense of ownership to all.

**ECONOMIC**
Replace existing failing infrastructure with resilient and green infrastructure.

**Results**
- Improved water quality
- 1,750 linear feet of new multi-modal promenades and boardwalks
- 10 acres of parks and wetlands
- 6.6 acres of wetlands absorb water, and filter nitrogen, heavy metals, and phosphorous
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The Charles River Esplanade is Boston’s signature waterfront open space. Reconstructing the I-90 viaduct where the highway most closely approaches the river holds the potential to expand public access through the park’s most spatially comprised segment. Shifting focus to restoring aquatic health and enhancing connectivity reframed the conversation around ecological and community benefits, building consensus among advocates.

Understanding the Context

- **126 acres of new development** between Harvard’s Enterprise Research Campus and Beacon Yards
- **2 new rail stations** linking to Kendall Square and Seaport District innovation hubs
- **$1 billion transportation project** to rebuild and realign Interstate 90 interchange, Soldier’s Field Road, and railway facilities
- **18,600 daily riders** on the Boston to Framingham and Worcester Commuter Rail lines

[Map of the area with locations marked]
Charles River: A Vast Hydrological Network

The Charles is part of a large hydrological network, much of which is at risk to flooding and infrastructural decay.

### Charles River
- 80 miles long
- Includes 23 municipalities
- Fed by 80 streams

### Charles River Drainage Basin
- Incl. 33 lakes and ponds
- Intersects 20 municipalities
- Contains 3 EPA Superfund sites
- Contains 46 Significant or High-Hazard dams

### Sources
- MassGIS, NOAA, USGS, EPA, Charles River Watershed Association

### Sea level rise
- Sea level around Boston has risen 8 inches since 1950, and is now rising by about 1 inch every 8 years.

### Legend
- **At-Risk Dams**
  - Low Hazard
  - Significant Hazard
  - High Hazard
  - N/A (Private)
- **Project Site**
- **Hydrology**
- **Wetland**
- **EPA Superfund Site**
- **Watershed Boundary**

### Maps
- **Lower Middle Watershed**
- **Lower Basin**
- **Upper Watershed**
- **Upper Middle Watershed**
Evolving Edge of the Charles River

The Charles has a long history of geoengineering and infill. Sea level rise projections demonstrate water will likely return to those filled areas.

- 43 industrial mills are constructed along the Charles, including at Causeway Street. Damming changes the river’s flow, capturing sedimentation. Ponds become repositories for industrial waste.
- Boston streets are paved with cobblestones, while an underground drainage system for gray water is created. Paving reduces groundwater recharge while increasing contamination.
- Charles Street is created by cutting the top off Trimountain (now Tremont St.) as marshes are filled.
- A public water supply is introduced, spurring development of a sewer system carrying waste directly to the Charles. Bacteria proliferate as waste accumulates.
- 738 acres of tidal marsh in Back Bay are filled with material from Boston drumlins and Needham quarries, substantially reducing the estuarine environment.
- Other than a portion at entrance of Stony Brook and Muddy River, all of Back Bay is filled. The entire riverine habitat is lost, and combined sewer overflows discharging sewage become more frequent.
- Stony Brook, the largest tributary to the Charles is culverted. Other major tributaries follow suit.
- A dam is constructed between Boston and East Cambridge, eliminating the estuarine environment and creating a heavily polluted anoxic zone.
- In response to the U.S. Environmental Protection Agency/Conservation Law Foundation Boston Harbor Cleanup Lawsuit, the Massachusetts Water Resources Authority (MWRA) creates its CSO program, reducing untreated sewage discharge.

Sources: EPA, Boston Public Library, MassGIS
Open space along the Allston riverbank is narrower than 40 feet wide, providing little area for riparian vegetation and biodiversity.
Riverbank Conditions: Impervious Surfaces

69% of the land within 1,000 feet of the Charles’ Lower Basin is impervious, contributing directly to stormwater runoff entering and polluting the Charles.
Riverbank Conditions: Pollution (Dissolved Oxygen)

The EPA rates water quality in the Charles' Lower Basin as degraded, with low levels of dissolved oxygen, cyanobacteria blooms, and E. Coli threatening aquatic life.
Riverbank Conditions: Bathymetry

The Lower Basin of the Charles River is very shallow, leading to sediment deposit build-up that reduces the hydrological flow.

Sources: MassGIS, MIT Sea Grant, Charles River Alliance of Boaters
Localized Climate Change

**Impervious Surfaces**

Roadways, parking lots, and buildings adjacent to the Charles River prevent natural filtration of contaminants, resulting in higher pollutant levels and reduced water quality.

**Urban Heat Island Effect**

Impervious surfaces drive higher land surface temperatures, adversely impacting human comfort and stressing the adjacent riparian ecology.

**Sea Level Rise Predictions**

The site plays a vital role in protecting critical infrastructure, existing community fabric, and future development from flooding.

Cultural resources along the Charles River inform its civic identity. We explore how design can reconnect communities with an underutilized portion of the riverbank.
Understanding the Challenges

Analysis of the Charles through historical, cultural, and ecological lenses clarifies the environmental and infrastructural challenges that must be addressed to restore the river’s health.
Engagement Framework

**Social**
Identify stakeholders + champions, create an inclusive framework. Analyze data to determine alignment with social equity outcomes.
Raise awareness, develop strategies, and track success indicators for health, environment and economic.

**Environmental**
Analyze disaster + hazards to understand vulnerabilities and risks. Map environmental degradation to natural resources and establish climate projections.
Engage community to develop a design with nature strategies. Create awareness on benefits of environmental stewardship, enhance regional economy. Focus on pilot projects to demonstrate successes and opportunities.

**Economic**
Understand existing and proposed land uses and future drivers.
Find opportunities to foster alliances between public and private sector.
Develop an Advocacy Action Plan that promotes diversity, equity, and inclusivity.
Engagement Process

**Discover**
- Conduct Research
- Collect Data
- Evaluate Existing Conditions

**Envision**
- Conduct Webinars
- Document Site
- Research Precedents

**Ideate**
- Articulate Guiding Principles
- Craft Strategy Toolkit
- Test Multiple Solutions

**Synthesize**
- Craft Framework Plan
- Conduct Site Studies
- Define Quantifiable Metrics

**Advocate**
- Outline Actionable Goals
- Build Strategic Partnerships
- Raise Public Awareness

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**Research & Analysis**
- 400+ years of human intervention
- 4,500 linear feet of shoreline
- 5 competing modalities
- 4 outfall structures
- 15 stakeholder & advocacy groups
- 5 virtual webinars
- 3 visioning sessions

**Toolkit & Framework**
- 11 precedent studies
- 9 riparian transects
- 3 design lenses - social - environmental - economic

**Implementation**
- +10 acres of parkland
- +7 acres of wetlands
- 3 site-specific designs
- 3 newly created biomes
- Public presentations
- Newspaper op-ed
- Advocacy round-tables
- Webinars
Celebrate the rich history and culture of the Charles River

Bio-diverse ecological shoreline that stabilizes the edge condition

Resilient infrastructure systems that benefit generations to come

Social equity and equal access and a sense of ownership for all

Propose a series of landscape systems that mitigate the impacts of pollution discharge and improve environmental conditions.

Address the impacts of climate change to create a resilient riverfront.

Re-imagine the river’s edge as a natural living shoreline of rich and diverse ecosystems.

Introduce robust circulation systems & open spaces connecting surrounding communities to riverfront.

Create a toolkit of landscape strategies that respond to the varying conditions along the river's edge.

Draw upon knowledge gained from precedent examples and best management practices.

Weave individual solutions into comprehensive framework plan that restores the river’s ecology.
Elements of Influence

01: Resilient embankments with elevated pedestrian walkways that protect during storm surge and flood events — 02: Accessible walkways that connect neighborhoods to the riverfront — 03: Natural and planted shoreline to stabilize edge conditions — 04: Raised boardwalks through floating wetlands bring the public into contact with the restored river’s edge — 05: Emergent wetlands that purify water and absorb storm surge to create a resilient park — 06: Overlook and pavilions provide grand views to wetlands park and river — 07: Amphitheater and gathering spaces to view performances and events on the Charles River
Shifting Ecology and Resilient Infrastructure

Existing

a. Steep slopes with overgrown and invasive planting
b. Existing narrow pedestrian path
c. Aging infrastructure an outfall structures
d. Majority of the watershed does not have any pre treatment of pollutants before being discharged into the river

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Agganis Bridge connects pedestrians over the highway

Ampitheater & stage

Naturalized shoreline

Resilient embankments

Floating wetlands & marshes

Elevated walkways

Resilient Promenade

Emergent Wetlands

Marshes

Aquatic Habitat
Experience the Charles

Existing

a. Lack of aquatic habitat
b. Steep slopes that cause erosion and direct discharge of stormwater
c. Existing pedestrian promenade

- Embankment: stabilizes and prevents erosion
- Wetlands & marshes
- Boardwalks & decks: floating
- Bike path: separated
- Buffer planting: reduces vehicular noise
- Resilient Promenade
- Boardwalks and Decks
- Marshes
- Stabilize Slopes
An Accessible Riverfront for All

Existing

- Lack of connectivity limits use of riverfront for cultural uses
- Elevated road disconnects neighborhood
- Overlapping infrastructure chokes parkland
- Multiple levels thwart connectivity between the elevated urban fabric and the river.

boardwalks & wetlands

create a network of a connected riverfront

overlooks and viewing platforms

accessible walkway

sloped lawn areas for informal seating to view river activities

bikeways

with buffer from vehicular traffic
Shifting Ecology and Resilient Infrastructure

Existing

- Invasive species dominate the river’s edge.
- I-90 viaduct severs adjacent neighborhoods from the river
- Constricted by Soldiers Field Road
- Overgrowth prohibits waterfront access
- Narrow 10’ bi-directional pathway

A Living Shoreline: Charles River

- Restore the aquatic habitat
- Foster an urban habitat
- Create social and cultural connections
- Eliminate direct discharge of pollutants and improve water quality
Resilient Park For All

Existing

a. Elevated highway dominates landscape
b. No buffer between pathways and road
c. Steep, unstable banks exacerbate erosion
d. Outfalls discharge untreated stormwater into the river
e. Invasive species crowd out native flora

- A Living Shoreline: Charles River
- Raised embankment to create a resilient park
- Pedestrian bridge connecting park to Allston neighborhood
- Floodable open spaces
- Pre-treatment facilities to purify stormwater and remove pollutants
- Natural and planted shoreline to stabilize edge