Charles River Neighborhoods

The Charles River focus area consists of the neighborhoods that lie along the Charles River, including Beacon Hill, Back Bay, Fenway/Kenmore, and Allston/Brighton.

These neighborhoods have been grouped in a focus area because they are all expected to be exposed to flooding upon overtopping or flanking of the Charles River Dam.

Beacon Hill is located in the center of the Shawmut Peninsula. The area originally had three hills, two of which were leveled for Beacon Hill development. Construction of the Massachusetts State House occurred on the south slope in the 1790s. Residential squares were laid out according to the English model on the north slope.

The Back Bay neighborhood was created through fill during the late nineteenth century, adding 450 acres to the city. In 1814, the Boston and Roxbury Mill Corporation started building a dam blocking the tidal Back Bay, which extended from Brookline to Boston Common. The dam was economically unsuccessful, so Boston started filling in the tidal area in 1857, with the process completed by 1882. Back Bay became an elegant residential district, with blocks of three- to four-story brownstones organized along linear boulevards (Beacon Street, Marlborough Street, and Commonwealth Avenue), according to the Parisian model.

Fenway/Kenmore consists of land annexed from Brookline during the 1870s, as well as land filled in during the creation of the Back Bay Fens, the first park in Frederick Law Olmstead's Emerald Necklace. Olmstead designed the Fens, a set of constructed marshes, to address drainage and sanitary challenges associated with the Muddy River, which flows into the Charles River. While originally intended as a high-end residential district, Fenway/Kenmore subsequently attracted a large number of educational and cultural institutions. Fenway/Kenmore is connected to Allston/Brighton through a small strip of land along Brookline. Allston was annexed by Boston in 1874. During the 1800s, Allston/Brighton had significant industry, with stockyards, slaughterhouses, and meatpacking operations in Allston and northeast Brighton.

The Charles River focus area is unified by the Charles River. The first Charles River Dam was completed in 1910, converting it from a tidal estuary into a freshwater basin. The dam served to control the surface water level in the basin and upstream and to prevent seawater from the Boston Harbor from entering. The Charles River Esplanade was constructed at the same time to take advantage of the new recreational possibilities created by the basin. The Esplanade has been expanded and enhanced over time, with the present-day Hatch Shell added in 1940, although the Esplanade did lose some land to the construction of Storrow Drive in 1949. Storrow Drive, a high-speed access road, separates Beacon Hill, the Back Bay, and Fenway/Kenmore from the river. Soldiers Field Road does the same in Allston. The New Charles River Dam was completed in 1978.

Today, Beacon Hill and the Back Bay are among the most expensive residential neighborhoods in Boston. Charles Street, which extends from Massachusetts General Hospital to the Public Garden, is Beacon Hill's primary commercial corridor. Back Bay has commercial corridors along Newbury Street, Boylston Street, St. James Street, and Huntington Avenue. Fenway/Kenmore is a mixed-use district, with a diverse housing stock of brownstones, brick row housing, and newer apartment and condominium towers. Allston is also a mixed-use district that has experienced conversion of industrial uses to commercial, residential, and institutional uses over time and has also become a site of recent expansion by Harvard University.

Image courtesy of Sasaki

FLOOD PROGRESSION

In the near-term and through the middle of the century, buildings and infrastructure in the Charles River focus area have limited exposure to coastal flooding.

DEFINITIONS

Near term: Beginning 2030s, assumes 9 inches of sea level rise

Midterm: Beginning 2050s, assumes 21 inches of sea level rise

Long term: Beginning 2070s or later, assumes 36 inches of sea level rise

Exposure: Can refer to people, buildings, infrastructure, and other resources within areas likely to experience hazard impacts. Does not consider conditions that may prevent or limit impacts.

Vulnerability: Refers to how and why people or assets can be affected by a hazard. Requires site-specific information.

Consequence: Illustrates to what extent people or assets can be expected to be affected by a hazard, as a result of vulnerability and exposure. Consequences can often be communicated in terms of economic losses.

Annualized losses: The sum of the probability-weighted losses for all four flood frequencies analyzed for each sea level rise scenario. Probability-weighted losses are the losses for a single event times the probability of that event occurring in a given year.

*For a full list of definitions, refer to the Glossary on p. Y.

The Charles River neighborhoods are exposed to climate change impacts including heat, increased precipitation and stormwater flooding, and sea level rise and coastal and riverine flooding. Exposure to heat and stormwater flooding are addressed in the Citywide Vulnerability Assessment (see p.12), while exposure and consequences to coastal and riverine flood risk are further discussed in this section.

The primarily flood pathway in the Charles River neighborhoods is around and over the Charles River Dam. The New Charles River Dam was constructed in 1978 and is a complex sluice, lock, and pump system used to manage freshwater draining from the Charles River Basin, salt water from the Boston Harbor, and vessel navigation.[1] In the event of a storm, pumps are activated to proactively reduce the water level to accommodate for surge.

Because of the presence of the Charles River Dam, the Charles River neighborhoods have limited exposure to coastal flooding through the middle of the century. By the end of the century, Beacon Hill, Back Bay, Fenway/Kenmore, and Allston/Brighton, Charlestown, and Cambridge are expected to be exposed to flooding by flanking and overtopping of the dam for low-probability events. In low-probability flood events (1 percent annual chance) expected later in the century, flooding from the dam is expected to enter inland Boston through the Public Garden, contributing to the extensive flooding expected to collect in the South End from Fort Point Channel and Dorchester Bay during the same time frame (refer to the 36-inch flood exposure map). Very low-probability events (0.1 percent annual chance) are expected to have high enough storm surge that lands along the majority of the Charles River will be exposed to flooding.

Image courtesy of Sasaki

In the near term and through the middle of the century, buildings and infrastructure in the Charles River neighborhoods have or will have limited exposure to coastal flooding.

Of the Charles River neighborhoods, Allston has the greatest exposure in the near term due to low-lying open space. By the end of the century, the Charles River neighborhoods will begin to have some flood exposure to 1 percent annual chance events and may have hundreds of acres exposed to very low-probability events (0.1 percent chance).

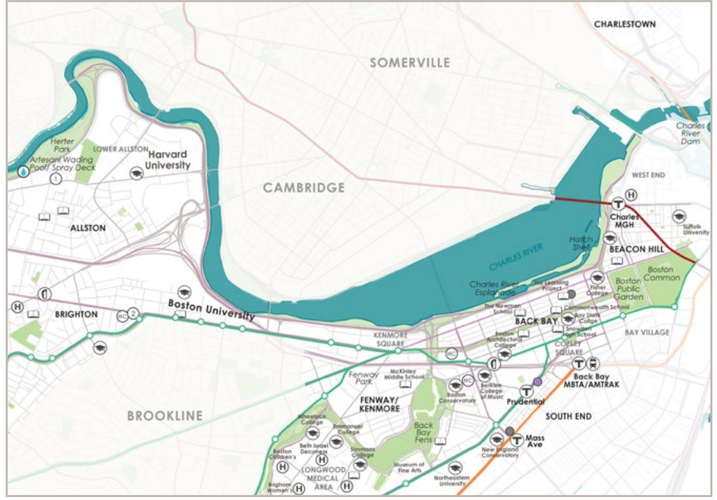
[1] MassDOT FHWA Report citation: Bosma, Kirk, et. al. "MassDOT-FHWA Pilot Project Report: Climate Change and Extreme Weather Vulnerability Assessments and Adaptation Options for the Central Artery." Jun. 2015, https://www.massdot.state.ma.us/Portals/8/docs/environmental/SustainabilityEMS/Pilot_Project_Report_MassDOT_FHWA.pdf.

CHARLES RIVER ASSET EXPOSURE

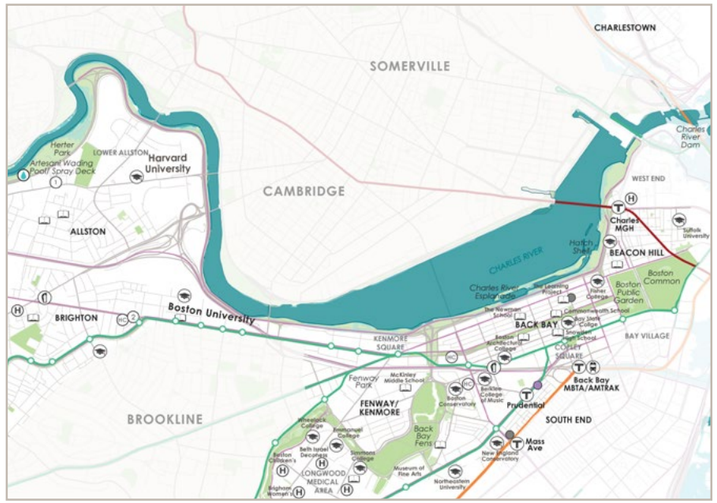
ASSET	SEA LEVEL RISE SCENARIO 9"	21"	36"
	HT 10% 1%	HT 10% 1%	HT 10% 1% 0.1%
TRANSPORTATION			
MBTA			
Arlington (T)	○○○	○○○	○○●●
Prudential (T)	○○○	○○○	○○●●
EMERGENCY RESPONSE			
EMS			
Joseph M. Smith Community Health Center (1)	○○○	○○○	○○●●
Station 14, Ambulance 14 (2)	○○○	○○○	○○●●
OTHER FACILITIES			
SCHOOLS, COLLEGES, AND UNIVERSITIES			
Harvard Business School	○○○	○○○	○○○●
Northeastern University	○○○	○○○	○○○●
Boston University (various buildings)	○○○	○○○	○○○●
Snowden High School	○○○	○○○	○○●●
Emmanuel College	○○○	○○○	○○○●
Simmons College	○○○	○○○	○○○●
Park Street School	○○○	○○○	○○○●
Commonwealth School	○○○	○○○	○○○●
The Learning Project	○○○	○○○	○○○●
HISTORICAL/CULTURAL ASSETS			
Boston Public Garden	○○○	○○○	○○●●
Charles River Esplanade & Hatch Shell	○○○	○○○	○○●●
Soldiers Field Athletic Area	○○○	○○○	○○●●

Later in the century, exposure of the Charles River neighborhoods to severe coastal storms with a low probability of occurrence increases significantly due to the possibility of overtopping and flanking of the Charles River Dam.

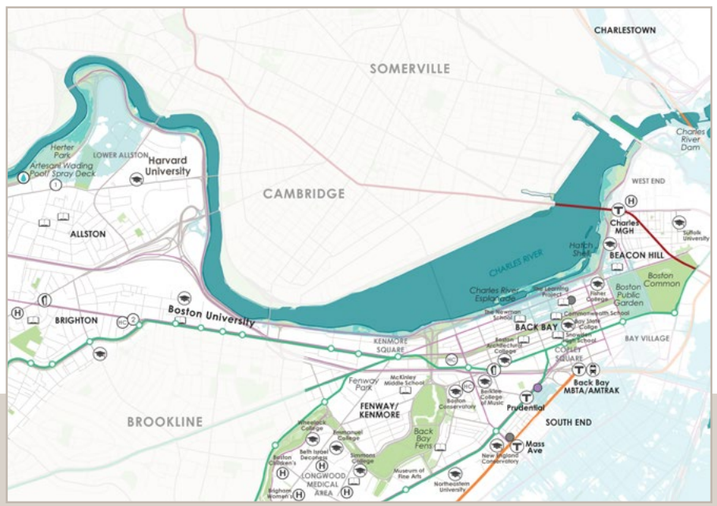
Climate resilience planning must consider that the primary flow pathway is over and around the Charles River dam. Adaptation of or around the dam would also benefit Charlestown, Downtown, and Cambridge.



9 INCHES SEA LEVEL RISE



21 INCHES SEA LEVEL RISE

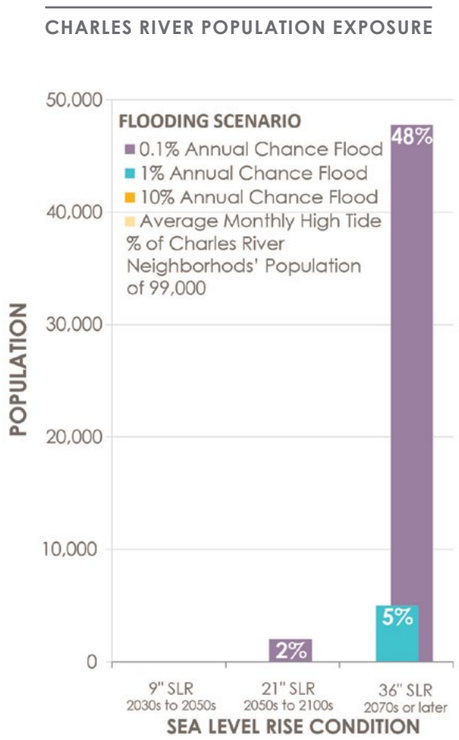


36 INCHES SEA LEVEL RISE

LEGEND

- Average Monthly High Tide
- 10% Annual Chance Storm
- 1% Annual Chance Storm
- Parks
- Roads
- Major Roads
- Major Tunnels
- Evacuation Route
- Evacuation Route Tunnels
- MBTA Blue Line
- MBTA Station
- MBTA B-Line Tunnel Entrance
- MBTA C-Line Tunnel Entrance
- MBTA D-Line Tunnel Entrance
- MBTA E-Line Tunnel Entrance
- College or University
- School
- Police Station
- Fire Station
- Hospital
- Health Care Facility
- EMS Station 14, Ambulance 14
- Jackson Mann Community Center
- BHA Public Housing
- Senior Housing
- Longterm Care Facility
- DCR Spray Deck or Pool

EXPOSURE
POPULATION & INFRASTRUCTURE



POPULATION & SOCIAL VULNERABILITIES

Residents of the Charles River neighborhoods comprise about 22 percent of Boston's overall population, or about 142,000 people. The Charles River neighborhoods are relatively affluent compared to the city as a whole; it has just one public housing development and 25 percent of the population in low- to no-income categories. Nevertheless, **Back Bay and Beacon Hill have among the highest percentage of people with a medical illness (42 percent) and older adults (12 percent) throughout Boston.**

Shelter needs in the Charles River neighborhoods are expected to be around 200 individuals for the area for the low-probability (1 percent annual chance) event later this century. Seven public emergency shelters are located within the Charles River neighborhoods, with the capacity to shelter 1,000 individuals. Only the Boston Arts Academy shelter will be exposed to the 0.1 percent annual chance event, which has a capacity of 151. The remaining shelters are not expected to be exposed to flood impacts and may be able to shelter some residents from other neighborhoods in an event. Unexposed colleges, universities, and hospitals in the Charles River neighborhoods may be able to provide shelter as well.

INFRASTRUCTURE

Transportation systems within the Charles River neighborhoods are not likely exposed to coastal flooding and sea level rise until later in the century. Even so, major impacts are only expected for low-probability events.

[2]Based on 2014 MBTA ridership and service statistics. Number only captures station entries and does not include all passengers traveling on the line as is passes through the station.

As soon as the 2050s, parts of Storrow Drive are expected to be exposed to low-probability storms. Later in the century, additional sections of Storrow Drive, as well as sections of Beacon Street and River Street in Back Bay and Beacon Hill, may be impacted by low-probability flood events (1 percent chance). Flooding along these roads will not only impact safe evacuation from the area, but potential damage and traffic interruptions may also affect crosstown connections and quick access to Downtown. Delivery of resources such as food supplies and research materials may also be disrupted in the case of flooded roads surrounding the campuses, in addition to student commutes to Boston University, Harvard's Business School and Stadium, and the Soldiers Field athletic area. Very low-probability flood events (0.1 percent annual chance) later in the century have the potential to impact Mass Pike, which may further limit transportation connections Downtown.

Portions of MBTA's Green Line within Back Bay and Beacon Hill, including the Arlington and Prudential T Stations, are exposed to flood impacts later in the century. The Green Line runs at grade for much of the western portion of its route and also has the potential to be interrupted by stormwater flooding between Packard's Corner and Harvard Avenue Stations. Service interruptions at the aforementioned stations could result in over 12,000 daily riders[2] needing alternative transportation, especially affecting those who use the Green Line to commute from Boston's inland neighborhoods to Downtown. Expected impacts to transportation patterns will grow significantly with a 0.1 percent chance event later in the century. Green Line exposure will extend from Back Bay and Beacon Hill into Fenway/Kenmore, while Red Line connections from Back Bay and Beacon Hill to Cambridge may also be affected by flooding.

Charles River emergency response assets are not expected to be exposed to flood impacts this century.

Areas adjacent to the Charles River neighborhoods with emergency response facilities exposed to coastal flood damage include Downtown, the South End, and northern Roxbury. If emergency response facilities in these areas are impacted by flooding, fire, police, and EMS stations in the Charles River neighborhoods may be called upon for support, in which case capacity, response times, and transportation routes between neighborhoods must be better understood.

Very low-probability events expected later in the century may impact many colleges and universities in the Charles River neighborhoods; colleges and universities provide the second-largest number of jobs in the area.

The Charles River neighborhoods are home to many well-known colleges and universities, including Boston University, portions of Harvard and Northeastern University, and other institutions associated with the Longwood Medical Area such as Simmons College and Emmanuel College. All of the aforementioned campuses have at least some portion exposed to the 0.1 percent chance event per the statistical expectation later in the century. Damages to campus assets or roads may not only disrupt class schedules and affect research, but the area's economy may suffer if there is prolonged interruption in operations. Site-specific reviews of each college and university asset are required to assess expected impacts.

EXPOSURE AND CONSEQUENCES
BUILDINGS AND ECONOMY

RISK TO BUILDINGS

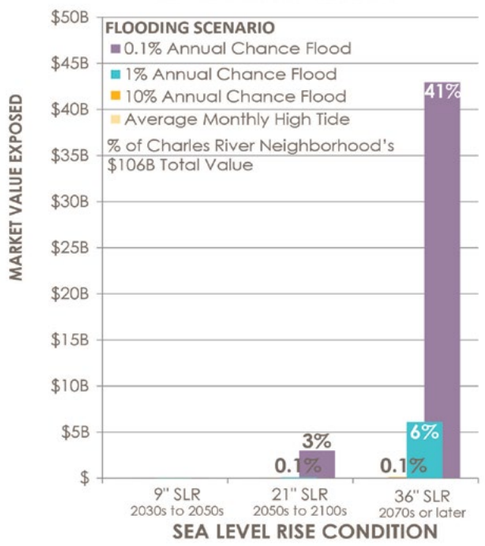
The Charles River neighborhoods are generally less exposed than other Climate Ready Boston focus areas in the near term and throughout the mid-century. Nevertheless, without mitigation, impacts may still be expected, particularly for the lower-probability flood events later this century.

The Charles River neighborhoods are not expected to experience structure and content damage until mid-century. Even so, damages may be comparatively low when considering impacts in other focus areas. As soon as the 2050s, approximately $13,000 in annualized structure and content losses are expected under the low-probability (1 percent annual chance) event. Mid-century losses are expected to be concentrated along the Charles River Esplanade.

Structures exposed in the Charles River neighborhoods increase significantly from the 1 percent annual chance event (low probability) to the 0.1 percent annual chance event (very low probability) later in the century. Overall, nearly $15 million in annualized structure and contents losses could be expected as soon as the 2070s.

In the second half of the century, approximately 700 structures are expected to be exposed to the low-probability flood event (1 percent annual chance), with $4 million expected in annualized structure and contents losses. Most of these losses may be concentrated in Back Bay, with over 60 structures expected to be impacted in Allston and less than ten in Fenway. Very low-probability flood events (0.1 percent annual chance) expected as soon as the 2070s may present significant risk, with nearly 3,640 structures expected to be exposed. Considering all storm frequencies analyzed, nearly $15 million in annualized structure and contents losses are expected in the late century.

CHARLES RIVER REAL ESTATE MARKET VALUE EXPOSED



CHARLES RIVER BUILDING EXPOSURE

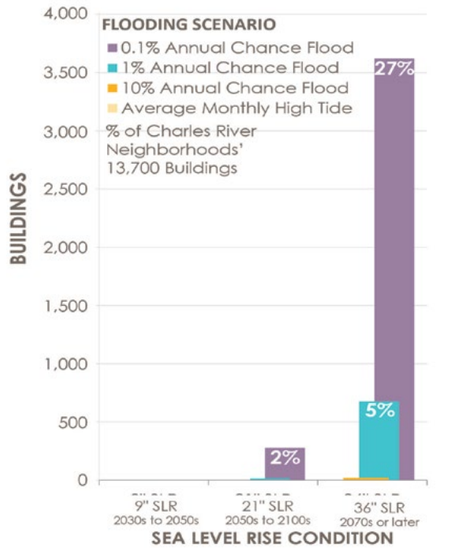
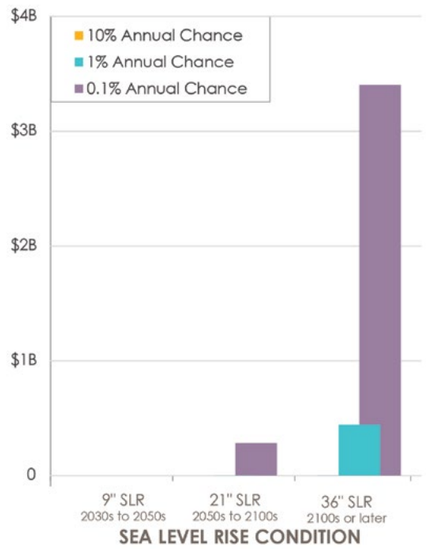


Image courtesy of Sasaki

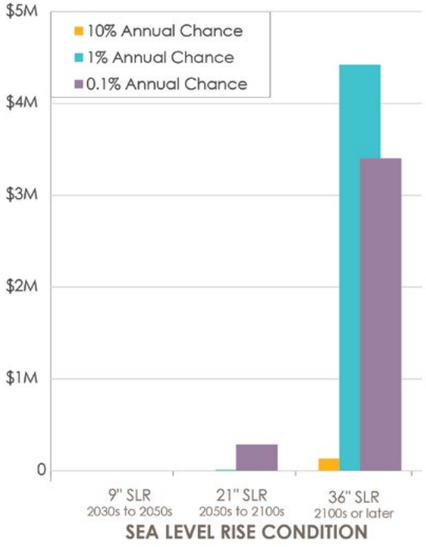
RISK TO THE ECONOMY

The Charles River neighborhoods contribute over 237,000 jobs and $46 billion in annual output (sales and revenues) to the Boston economy. Top industries in terms of employment are hospitals, restaurants, and colleges, universities, and professional schools due to the presence of the Longwood Medical Area and large institutions. Hospitals, real estate, insurance, and financial investment activities are the area's current top-producing industries when considering sales and revenues. I**n contrast to South Boston, many of the area's top industries are vulnerable to business interruption, as it is extremely difficult for many large institutions to operate remotely or relocate operations quickly in the event of a coastal storm.** Nevertheless, business interruption is not expected in the Charles River neighborhoods in the near-term, and mid-century business interruption is limited in comparison to other focus areas, though not insubstantial. In the second half of the century, the Charles River neighborhoods can expect close to $90,000 in annualized output losses due to expected flood damage to structures.[3] As soon as the 2070s, annualized output losses as a result of business interruption are expected to be around $6.3 million with approximately 40 annualized jobs lost. These estimates include interruption from businesses directly exposed to flood impacts, as well as the reverberations that impact may have throughout Suffolk County's economy.[4] **Industries expected to be most affected are the performing arts, restaurants, and entertainment and recreational facilities, likely due to the exposure at the Soldiers Field Athletic Area and other entertainment industries present along the Charles River.**

CHARLES RIVER ECONOMIC LOSSES



CHARLES RIVER ANNUALIZED LOSSES



ECONOMIC RISK ASSUMPTIONS

Job and output loss includes direct, indirect, and induced consequences of flood impacts. Direct results are impacts felt within a neighborhood, while indirect and induced results are those expected to be felt throughout Suffolk County as a result of changes in spending patterns. Results for both job and output losses are the sum of annualized values for the four flood frequencies analyzed for each sea level rise scenario. This represents a lower-bound estimate for several reasons. First, not all probabilistic events are considered. Second, the analysis assumes that all impacted businesses eventually reopen, though FEMA estimates that almost 40 percent of small businesses—and up to 25 percent of all businesses—never reopen after experiencing flood impacts. Third, only building areas directly impacted by floodwater are assumed to experience business interruption. This does not consider interruptions of businesses due to loss of power or utility functions. Finally, the analysis only considers existing populations, businesses, and buildings and does not include projections for future growth. Refer to the Appendix for a more detailed explanation of the exposure and consequence analysis.

INDUSTRY	ANNUALIZED LOSS OF ECONOMIC OUTPUT
Performers and Performing Arts Companies	$ 1,000,000
Restaurants	$ 630,000
Entertainment and Recreational Facilities, including sports centers, museums, and parks	$ 940,000
Real Estate	$ 730,000
All other industries	$ 2,900,000
Total	**$ 6,300,000**

[3]Expected flood damages are calculated for the 10%, 2%, 1%, and 0.1% annual chance flood events only.

[4]Losses to particular industries are based on current development and economic activity in the area, and considering that South Boston is in a period of intense growth, may differ as development continues.

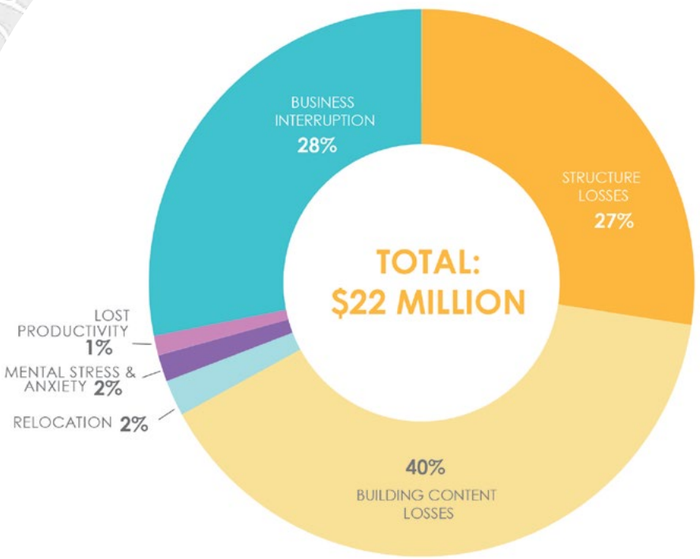
EXPECTED ANNUALIZED LOSSES TO STRUCTURES AND CONTENTS

36 INCHES OF SEA LEVEL RISE AT 10%, 2%, 1%, 0.1% ANNUAL CHANCE COASTAL FLOOD EVENTS.

Probable annualized losses are based on generalized assumptions, as opposed to site-specific assessment of structures. Site-specific evaluations of vulnerability are beyond the scope of this assessment and should be reserved for detailed evaluation of specific resilience initiatives or a next phase of this project.

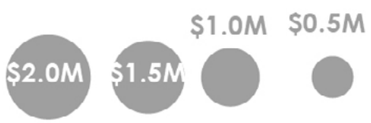
CHARLES RIVER ANNUALIZED LOSSES

36 INCH SEA LEVEL RISE CONDITION



- Commercial ($2.5M)
- Cultural/Religious, Edu, Rec ($6.1M)
- Essential Services ($.5M)
- General Government ($.1M)
- Industrial/Transportation($.145M)
- Mixed Use ($1.3M)
- Residential ($3.9M)

Total ($14.5M)



Each circle represents annualized losses suffered by an individual building. Larger circle size indicates higher contents and structures losses. Annualized losses take into consideration the annual probability of an event occurring, as well as the projected impacts of such an event.

CHARLES RIVER NEIGHBORHOODS
APPLICATION OF RESILIENCE INITIATIVES

PROTECTED SHORES

PRIORITIZE AND STUDY THE FEASIBILITY OF DISTRICT-SCALE FLOOD PROTECTION

To reduce the risk of coastal flooding at major inundation points, the City should study the feasibility of constructing district-scale flood protection at the primary flood entry points for the Charles River neighborhoods (see Potential Flood Protection Locations below for a preliminary identification of locations and potential benefits). As described below, flood protection systems that would benefit these neighborhoods would likely be located by the New Charles River Dam, in South Boston, and in Dorchester.

These feasibility studies should feature engagement with local community stakeholders, coordination with infrastructure adaptation, and considerations of how flood protection would impact or be impacted by neighborhood character and growth. Examples of prioritization criteria include the timing of flood risk, consequences for people and the economy, social equity, financial feasibility, and potential for additional benefits beyond flood risk reduction.

POTENTIAL DISTRICT-SCALE FLOOD PROTECTION LOCATIONS[5]

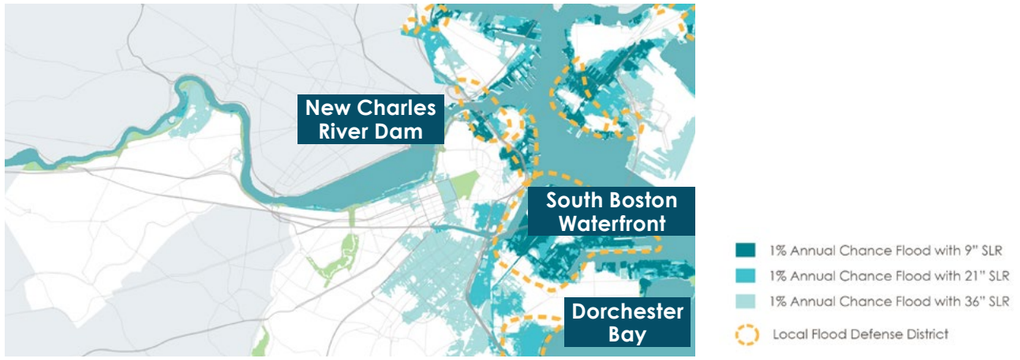
See District-Scale Flood Protection Systems section for a citywide perspective on district-scale flood protection. District-scale flood protection is only one piece of a multi-layered solution that includes prepared and connected communities, resilient infrastructure, and adapted buildings.

[5] These preliminary coastal flood protection concepts are based on a high-level analysis of existing topography, rights-of-way, and urban and environmental conditions. Important additional factors, including existing drainage systems, underground transportation and utility structures, soil conditions, zoning, as well as any potential external impacts as a result of the project have not been studied in detail. As described in Initiatives 5-2 and 5-3, detailed feasibility studies, including appropriate public and stakeholder engagement, are required in order to better understand the costs and benefits of flood protection in each location.

[6] Additional flood protection may be required for flood events more severe than the 1% annual chance flood. See Appendix for more detailed information on expected effectiveness of flood protection systems, including analysis of additional flood protection locations and flood frequencies.

[7] Benefits of district-scale flood protection would be modest.

[8] While it is expected that flood protection that would not be independently effective would have some effect on flood loss, this effect could be positive or negative, and understanding the extent of the effect would require more detailed evaluation. As such, any benefits or costs above the identified level of protection (the point beyond which the flood protection measure can no longer maintain independent effectiveness) have not been evaluated.



In the near term, coastal and riverine flood risk along the Charles River is modest and likely does not require district-scale flood protection.

Later in the century, combined flood protection at multiple locations will become critical:

- At the **New Charles River Dam,** addressing potential overtopping or flanking of the dam.
- At the **South Boston Waterfront,** addressing inland flood pathways originating from Fort Point Channel, Boston Harbor, and the Reserve Channel; and
- At **Dorchester Bay,** addressing inland flood pathways originating from the Old Harbor and Savin Hill Cove.

SLR SCENARIO	DISTRICT SCALE FLOOD PROTECTION FOR 1% ANNUAL CHANCE FLOOD[6]
9" SLR (2030s–2050s)	None[7]
21" SLR (2050s–2100s)	The New Charles River Dam
36" SLR (2070s or later)	The New Charles River Dam, South Boston Waterfront, and Dorchester Bay Locations combined

LOCATIONS

- **The New Charles River Dam location,** described in the Charles River and Downtown focus areas (see pp. 174, 216), addresses potential overtopping or flanking of the dam.
- **The South Boston Waterfront location,** described in the South Boston focus area (see p.282), addresses flood entry points along the edge of the district.
- **The Dorchester Bay location,** described in the Dorchester focus area (see p.194), addresses flood pathways from the Old Harbor and Savin Hill Cove.

DETAILED CONSIDERATIONS

- **Multiple neighborhoods protected:** The largest flood protection benefit for neighborhoods along the Charles River comes from protection at the New Charles River Dam. In addition, flood protection at the dam is expected to have near-term benefits for portions of Downtown and Charlestown.
- **Need for multiple alignments late century:** Flood protection at the dam alone will not protect against late-century flooding from Fort Point Channel, the Old Harbor, and Savin Hill Cove, for which interventions at the South Boston Waterfront and Dorchester Bay will be needed.

PREPARED & CONNECTED COMMUNITIES

CONDUCT AN OUTREACH CAMPAIGN TO PRIVATE FACILITIES THAT SERVE VULNERABLE POPULATIONS TO SUPPORT PREPAREDNESS AND ADAPTATION

In the long term, the City should conduct outreach to managers of facilities in the Charles River neighborhoods that serve significant concentrations of vulnerable populations and are not required to have operational preparedness and evacuation plans under current regulations. Targeted facilities should include affordable housing complexes, substance abuse treatment centers, daycare facilities, food pantries, small nonprofit offices, and others. The City should conduct outreach in the long term because there are no populations exposed under the 1 percent annual chance flood event until 36 inches of SLR, meaning that the Charles River neighborhoods has a longer adaptation window than other focus areas in the Boston. An illustrative example of the type of facilities to which the City could do outreach is the Bright Horizons Family Center, which will be exposed to damage later in the century.[9]

EXPAND BOSTON'S SMALL BUSINESS PREPAREDNESS PROGRAM

The City can reach out to small businesses in the Charles River neighborhoods exposed to stormwater flooding in the near term to help them develop business continuity plans, evaluate insurance coverage needs, and identify low-cost physical adaptations. The Charles River neighborhoods have roughly 160 commercial buildings exposed to stormwater flooding in the near term. In addition, the Brighton and the Allston Village Main Street Districts are expected to have isolated portions exposed to stormwater flooding in the near term and throughout the century. The Charles River neighborhoods do not have any small businesses exposed to coastal flooding during the 1 percent annual chance flood event with 9 inches of SLR.

[9]The City did not review the extent of existing preparedness planning as part of this study.

RESILIENT INFRASTRUCTURE

ESTABLISH INFRASTRUCTURE COORDINATION COMMITTEE

The Infrastructure Coordination Committee (ICC) should support coordinated adaptation planning for Charlestown's key infrastructure systems, including transportation, water and sewer, energy, telecommunications, and environmental assets. In the near term, the City should support the MBTA in conducting a full asset-level vulnerability assessment of its system. While the Charles River neighborhoods are not impacted by coastal and riverine flooding in the near term, flooding in Downtown Boston could reduce mobility for residents who depend on the Red, Green, and Orange Lines to access jobs and critical services in the area. In addition, in the later century under the 1 percent annual flood event, the Green Line will be exposed to coastal flooding, via the Arlington and Prudential Stations.

PROVIDE GUIDANCE ON PRIORITY EVACUATION AND SERVICE ROAD INFRASTRUCTURE TO THE ICC

The Office of Emergency Management should work with the Boston Transportation Department, Department of Public Works, and private utilities to provide guidance on critical roads to prioritize for adaptation planning, including those that are part of the City's evacuation network and are required to restore or maintain critical services. In particular, Storrow Drive will be exposed at 9 inches of SLR under the 1 percent annual chance flood event. Storrow Drive is an important cross-town route that runs along the Charles River Esplanade, becoming Soldiers Field Road to the west and David G. Mugar Way to the east.

CONDUCT FEASIBILITY STUDIES FOR COMMUNITY ENERGY SOLUTIONS

The 2016 Boston Community Energy Study identified four sites in the Charles River neighborhoods as potential locations for emergency microgrids, based on their concentration of critical facilities. The Environment Department can work with local stakeholders and utility providers to explore these locations. Two of the sites, adjacent to Fenway Park and Northeastern University, are exposed to coastal and riverine flooding for very low-probability events (0.1 percent annual chance) expected later in the century, with minimal and isolated exposure to stormwater flooding in the near term.

ADAPTED BUILDINGS

PROMOTE CLIMATE READINESS FOR PROJECTS IN THE DEVELOPMENT PIPELINE

Upon amending the zoning code to support climate readiness (see Initiative 9-2, p.135), the Boston Planning and Development Agency (BPDA) should immediately notify all developers with projects in the development pipeline in the future floodplain that they may alter their plans in a manner consistent with the zoning amendments (e.g., elevating their first-floor ceilings without violating building height limits), without needing to restart the BPDA permitting process. Currently, 121 residential and 45 commercial buildings are under construction or permitted in the Charles River neighborhoods, representing 4,511 additional housing units and 360,000 square feet of new commercial space.

INCORPORATE FUTURE CLIMATE CONDITIONS INTO AREA PLANS AND ZONING AMENDMENTS

The Boston Planning and Development Agency should incorporate future climate considerations (long-term projections for extreme heat, stormwater flooding, and coastal and riverine flooding) into major planning efforts in the Charles River neighborhoods.

ESTABLISH A CLIMATE READY BUILDINGS EDUCATION PROGRAM FOR PROPERTY OWNERS, SUPPORTED BY A RESILIENCE AUDIT PROGRAM

The City should develop and run a Climate Ready Buildings Education Program and a resilience audit program to inform property owners about their current and future climate risks and actions they can undertake to address these risks. A resilience audit should help property owners identify cost-effective, building-specific improvements to reduce flood risk, such as backflow preventers, elevation of critical equipment, and deployable flood barriers; promote interventions that address stormwater runoff or the urban heat island effect, such as green roofs or "cool roofs" that reflect heat; and encourage owners to develop operational preparedness plans and secure appropriate insurance coverage. The resilience audit program should include a combination of mandatory and voluntary, market-based and subsidized elements.

REPARE MUNICIPAL FACILITIES FOR CLIMATE CHANGE

To address extreme heat risks, the Office of Budget Management should work with City departments to prioritize backup power installation at municipal facilities that demonstrate high levels of criticality, including Boston Centers for Youth and Family and Boston Public School facilities that serve as emergency shelters. An illustrative example of the type of facility that the City might prioritize to protect the power supply within the Charles River neighborhoods against heat impacts is the Jackson Mann Community Center.