FLOOD RESILIENCE MITIGATION PLANNING AND FEASIBILITY STUDY FOR LONG WHARF

DRAFT REPORT

October 2025

City of Boston
Planning Department

Mayor Michelle Wu

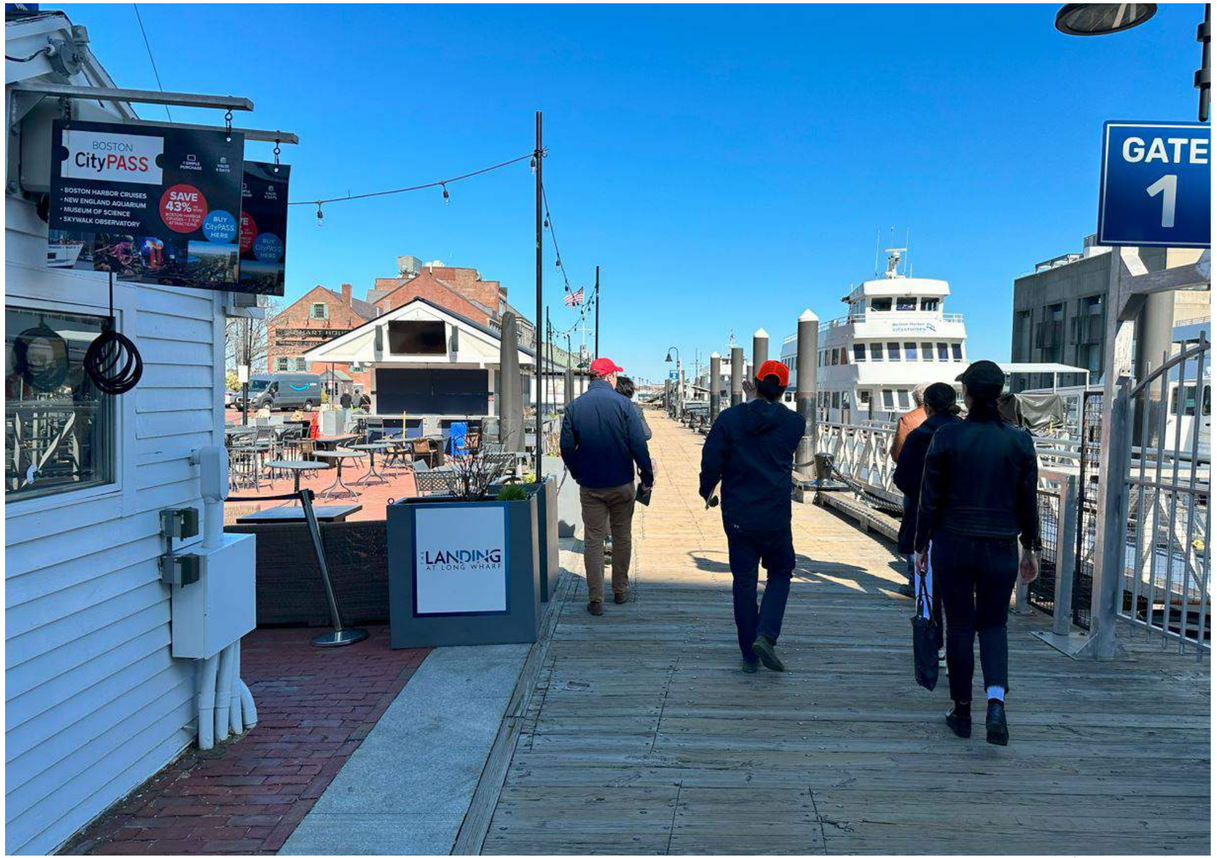


Figure 2 - Long Wharf - Existing Harborwalk

TABLE OF CONTENTS

01 INTRODUCTION 04

02 PROJECT APPROACH 18

03 COASTAL MODELING + PERFORMANCE ANALYSIS 26

04 EXISTING CONDITIONS + VULNERABILITY ASSESSMENTS 64

05 DESIGN ALTERNATIVES 122

06 FEASIBILITY AND IMPLEMENTATION 178

07 EVALUATION OF ALTERNATIVES + COST ESTIMATES 238

08 ADAPTATION DESIGN GUIDELINES 280

09 PROJECT RECOMMENDATIONS + NEXT STEPS 284

10 APPENDICES 294

- A - EXISTING CONDITIONS AND VULNERABILITY ASSESSMENT BASIS FOR CONCEPTUAL ALTERNATIVES REPORT
- B - SUMMARY OF STAKEHOLDER ENGAGEMENT + TAKEAWAYS
- C - WHARF EDGE CONDITIONS
- D - DETAILED ADAPTATION DESIGN GUIDELINES (FOR BUILDINGS)
- E - DETAILED CONSTRUCTION COST ESTIMATES
- F - FUNDING OPPORTUNITIES

KEY DEFINITIONS, ACRONYMS, AND ABBREVIATIONS

AEP	Annual Exceedance Probability
BCB	Boston City Base
BHCC	Boston Harbor City Cruises
CRS	Coastal Resilience Solutions
CZM	Coastal Zone Management
DEP	Department of Environmental Protection
DFE	Design Flood Elevation
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
GIS	Geographic Information System
HAT	High Astronomical Tide
H&H	Hydrologic and Hydraulic
IPCC	Intergovernmental Panel on Climate Change
LSCSF	Land Subject to Coastal Storm Flowage
Massport	Massachusetts Port Authority
MC-FRM	Massachusetts Coast Flood Risk Model
MEPA	Massachusetts Environmental Protection Act
MHHW	Mean Higher High Water
MLLW	Mean Lower Low Water
NAVD88	North American Vertical Datum of 1988
NEAQ	New England Aquarium
NFIP	National Flood Insurance Program
NOAA	National Oceanic & Atmospheric Administration
NPS	National Parks Service
USACE	United States Army Corps of Engineers
WDC	Wharf District Council
WPA	Wetlands Protection Act

DESIGN FLOOD ELEVATION

The Design Flood Elevation represents the goal level of flood risk reduction for an area, building, or asset. MC-FRM DFEs include the stillwater flood elevation and wave crest elevation. Freeboard can be further added for specific uses based on local factors such as exposure, criticality, risk tolerance. The MC-FRM represents the best available coastal flood hazard data and is recommended for use along with FEMA flood maps and Massachusetts Building Code to establish the basis for DFEs and significant wave crest elevation. With the inclusion of the latter, the MC-FRM explicitly models coastal storm processes typically accounted for via freeboard.

FREEBOARD

Freeboard is an additional amount of height above the expected elevation of flooding used as a factor of safety. Freeboard is often defined in increments of one, two, or three feet and is determined based on risk tolerance and criticality.

MASSACHUSETTS COASTAL FLOOD RISK MODEL

Developed for the Massachusetts Department of Transportation, the dataset provides state-wide high resolution coastal flood data, including stillwater flood elevations, wave data, and Design Flood Elevations (DFEs), for a range of annual exceedance probability storms (0.1%, 0.2%, 0.5%, 1%, 2%, and 5%) for 2030, 2050, and 2070. Future sea levels are determined using the Commonwealth of Massachusetts' adopted sea level rise projections, based on the

DRAFT

NAVIGATING THIS REPORT

CONTEXT AND APPROACH

Section 1 - Introduction and **Section 2 - Project Approach** provide key project context and summarize the key design principles and objectives guiding the development of all conceptual design schemes and alternatives.

SITE CONDITIONS, VULNERABILITY & BASIS FOR DESIGNS

In the following pages, the team has provided conceptual designs that seek to address potential flood risks at two different time periods. One approach looks at the near-term conditions relative to 2030, and two other approaches propose design schemes for 2070. The longer-term 2070 schemes are playfully titled the 'Acupuncture' and 'Big Splash' schemes. Each of the proposed conceptual designs takes into account future flood risks and assumes a design flood elevation as outlined in **Section 3 - Design Flood Elevations and Flood Risk Analysis**. These conceptual schemes, both near and far-term, look at ways to enhance the public realm at Long Wharf through shared design principles while providing protection to critical infrastructure, addressing vulnerabilities outlined in **Section 4 - Existing Conditions and Vulnerability Assessments**. **Section 5 - Design Alternatives** introduces information on conceptual designs for a near-term (2030) scheme, as well as two long-term (2070) design alternatives. **Section 6 - Feasibility and Implementation** is focused on the key "how" questions informing the design and cost estimation for each design concept. **Section 7 - Evaluation of Alternatives and Cost Estimates** define key criteria for comparing the relative performance of conceptual designs. **Section 8 - Adaptation Design Guidelines** outlines key design considerations and potential strategies for these structures to 'self-protect' in the near-term. **Section 9 - Project Recommendations and Next Steps** outlines near-term actions that can be undertaken and recommendations informing next steps for district-scale flood mitigation.

SUMMARY OF ENGAGEMENT

In an effort to establish an equitable design process, the team communicated with and learned from a wide variety of stakeholders throughout the duration of the project. Because of the complexity of the project site, the team required in-depth conversations with many different agencies, tenants, abutters, marine transit operators, and regulators through each step of the process. This project also sought to build upon the existing documentation of the site area and feedback provided by stakeholders as part of the various planning efforts, both past and ongoing. For additional information on the engagement process, please see **Appendix B.**

DRAFT

01 INTRODUCTION

INTRODUCTION

WHAT IS THE PROJECT?

The Flood Resilience Mitigation Planning & Feasibility Study for Long Wharf presents short-term and long-term strategies, using 2030 and 2070 climate projections respectively, to address growing flood risks at Long Wharf. Led by the City of Boston Planning Department, in collaboration with several stakeholder groups, the Flood Resilience Mitigation Planning & Feasibility Study for Long Wharf proposes a set of strategies to protect the critical waterfront while also closing off major flood pathways to downtown Boston. The strategies offer co-benefits for improvements to marine transit functions, its supporting infrastructure, and the public realm experience.

WHY IS THIS PROJECT IMPORTANT?

Long Wharf is a key cultural and historic resource in downtown Boston. It is an iconic part of Boston's waterfront, holding significant economic, recreational, cultural and commercial value. Long Wharf, located at the east end of State Street in downtown Boston between Central Wharf and Commercial Wharf, is most notable for its maritime history and marine infrastructure. Since its construction between 1710-1721, the Wharf, and its surroundings, has undergone extensive changes and it remains the oldest continually operated wharf in the country.

The Long Wharf area is already prone to inundation during coastal high water and king tide flooding events and the frequency of such events is expected to increase in the future as sea level rises. Long Wharf is also a critical pathway by which coastal flood waters could reach key inland downtown infrastructure such as the MBTA Aquarium station, 193 Tunnel Portals, Wharf District residential buildings and local services, the Rose Fitzgerald Kennedy Greenway, as well as cultural landmarks including Quincy Market, Faneuil Hall, and others.

This project looks at both the short-term (2030) and the long-term (2070) flood risks and seeks to propose integrated strategies that provide flood control while contributing to an inclusive and accessible public realm.

A summary graphic - depicting the significant volume of prior planning work informing this project – is shown on the following page.

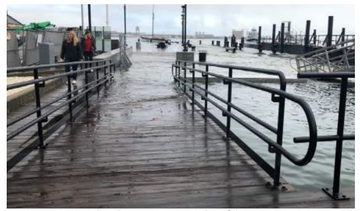


Figure 1-1 - Flooding at Long Wharf (Source: CBS Boston)

Figure 1-2 - King Tide Flood at Long Wharf (Source: Boston Harbor Now)

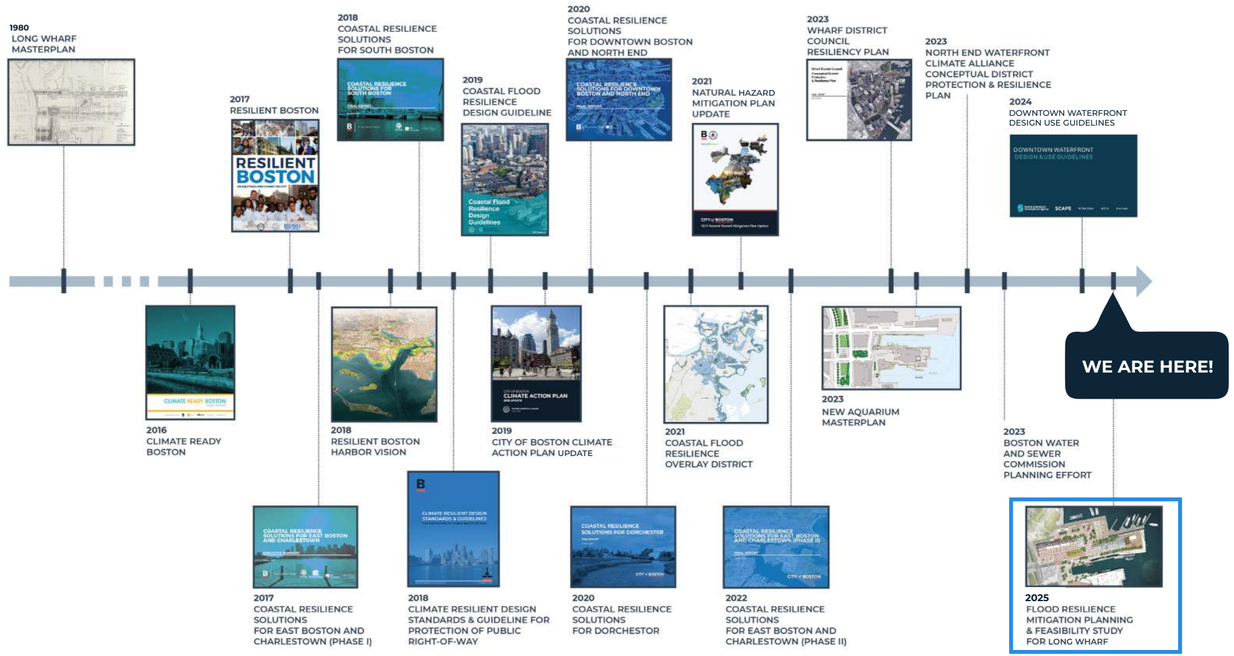


Figure 1-3 - Prior Planning Work

DRAFT

DRAFT

CULTURAL & HISTORIC SIGNIFICANCE

Long Wharf is one of the few remaining "relics of the former coast. Its rich history is integrally tied to the evolution of Boston and has played a role in stimulating economic, cultural, and military movements within the city for more than 300 years. Starting with its construction between 1710 and 1721 , Long Wharf has served as a space of constant change. Initially a private development constructed at the base of what was formerly known as King Street (now, post-Revolutionary War, renamed State Street), Long Wharf was a nexus in early maritime commerce, growing to stretch nearly half a mile from terra firma into Boston Harbor. The resulting length was able to support a bustling economy, with 50 vessels purportedly able to dock along the wharf at once.

As seen in a review of materials depicting Long Wharf, particularly mappings and drawings, the wharf served as one of what would become over eighty protrusions into the harbor. Notably, in its initial form, Long Wharf was depicted as part of the "Barricado," an early defensive measure for the city prior to the wharf's formalization as a commercial center. In the later 1700s, Long Wharf provided both a landing and departure point for various military events, including the entry point for British soldiers coming to uphold the monarchy's taxation policies that would culminate in the Boston Massacre, and, in 1776, the soldiers' evacuation point following the Siege of Boston.

Figure 1-4 - Historic Long Wharf (Images Source: Normal B. Leventhal Map & Education Center collection)

1 *"Long Wharf, Boston (U.S. National Park Service)." National Parks Service, January 8, 2023. https://www.nps.gov/places/long-wharf-boston.htm.*

2-5 *Ibid.*

6 *Taliesin, Julia. "Here's the Story behind the New Middle Passage Marker at Long Wharf." Boston.com, September 7, 2021. https://www.boston.com/news/history/2021/09/07/story-behind-middle-passage-port-marker-long-wharf/.*

DRAFT

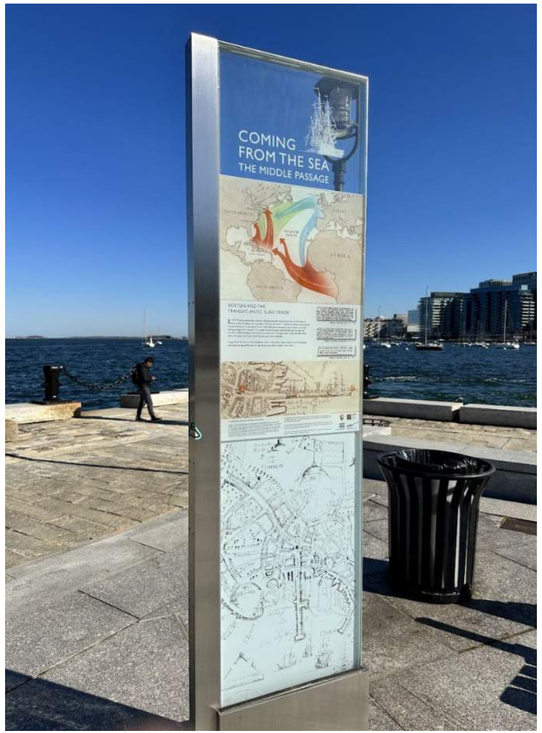


Figure 1-5 - Coming From the Sea - The Middle Passage (Image Source: National Parks Service (NPS), 2023.

A strengthening economy in Boston allowed the wharf to feature prominently in the early Boston skyline, playing a role almost equal to the various civic buildings and churches seen at a distance from the harbor. The various structures and buildings along the wharf are also visible in several historic sources. These structures include the Gardiner Building which formerly served as John Hancock's counting house (now known as the Chart House named for its current restaurant tenant), constructed in the 1830s, and the Customs House Block which was added in 1848 . The National Parks Service, who now has jurisdiction over the entirety of the wharf, has referred to Long Wharf as the former 'nucleus of Boston's maritime trade' due to its role in the import of goods not only from partners in Europe but from the further reaches of the globe, including the East Indies, China, and the Caribbean.

The shipment of wares was not limited to fabrics, produce, and the like, however, but also extended to include the transportation of enslaved African peoples as part of the transatlantic slave trade. This journey, known as the Middle Passage, concluded at Long Wharf nearly 200 times.

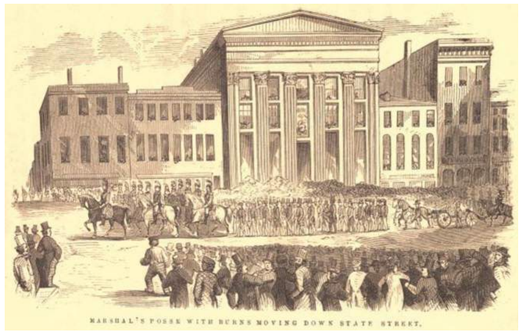


Figure 1-6 - The Trial of Anthony Burns (1854) (Image Source: Encyclopedia Virginia)

DRAFT

drawings describe the large crowds that would gather along Long Wharf in protest of the Fugitive Slave Laws. In particular, the National Parks Service documents the 1854 capture of the escaped man Anthony Burns and the crowd of over 50,000 people that drew up in response to him being marched down Long Wharf to be sent back into slavery in Virginia. Further information about the role of Long Wharf in both slavery and its abolition can be found via the Boston African American National Historic Site and the documentation of Boston as a hub on the Underground Railroad.

The end of the nineteenth century saw Long Wharf continuing to prosper as a center of import, with bananas shipped into the United States through the wharf , and continued trade with Jamaica, Panama, and Cuba. However, post-Civil War, Boston shifted generally from importing goods to a hub for fishing and maritime activity. Long Wharf was supplanted by its neighboring T Wharf as the primary host of a thriving fishing community, one that was particularly bolstered by Italian and Portuguese immigrants at the turn of the century. The Customs House Block on Long Wharf also served as one of Boston's immigration and detention centers through 1920 , providing a processing point for those looking to call Boston their new home.

Long Wharf remained an industrialized space at the water's edge, but by the late 1800s it had fallen into a state of disrepair due to its separation from the city by the construction of Atlantic Avenue and the introduction of rail in 1872. The wharf was further blighted by the construction of the Central Artery in the 1950s, but in 1966 both the entirety of Long Wharf itself and the Customs House Block were designated as National Historic Landmarks and added to the National Register of Historic Places. Shortly after,

Figure 1-7 - Industrialization at Long Wharf (Image Source: Leslie Jones (via Digital Commonwealth)

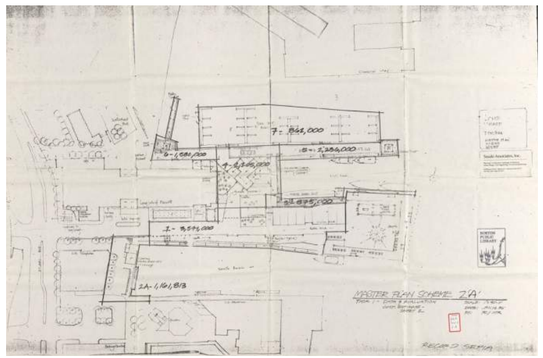


Figure 1-8 - Long Wharf Master Plan (Image Source: Sasaki Associates, "Long Wharf DEM/BRA master plan" (via Digital Commonwealth)

DRAFT

the Boston Redevelopment Authority contracted Sasaki Associates to prepare a master plan which was released in the city's Boston Harbor, Challenges and Opportunities for the 1980s framework . A few years later in 1982, the Boston Long Wharf Hotel, now the Long Wharf Marriott, was completed, solidifying the reinvigoration of the wharf as a new public space.

The Sasaki plan harkens back to the maritime history of Long Wharf in many ways, from the use of oversized bollards and chains at the water's edge to the use of a large compass rose in the paving at the east end of the wharf. It is notable, though, that in its restoration Long Wharf still reflects numerous layers of history. Today the various seawall repair efforts undertaken at various steps in time are visible as evidenced in the images, with striations of blocks and material added at both the south and the north sides of the wharf making clear that the continued work at this site is yet another step in building and rebuilding Boston's history.

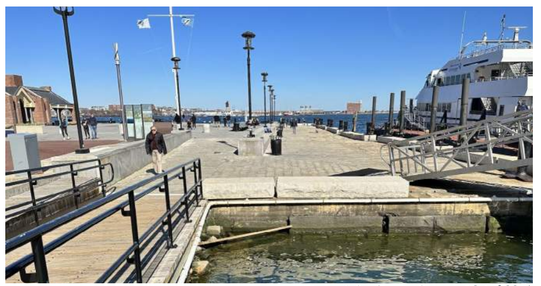


Figure 1-9 - (Image Source: Kleinfelder)

8 Palmer, Jesse T. "The Banana in Caribbean Trade." Economic Geography 8, no. 3 (1932): 262–73. https://doi.org/10.2307/140436.
9 Ibid.
10 Lingering craft at T Wharf. MIT Museum. Massachusetts Institute of Technology. Accessed January 16, 2025. https://mitmuseum.mit.edu/collections/object/1986.107.069.
11 Beckman, Emma. "Long Wharf & Immigration." Walk to the Sea, 2024. https://www.walktothesea.org/locations/long-wharf/.
12 "Long Wharf." The Cultural Landscape Foundation. Accessed January 16, 2025. https://www.tclf.org/long-wharf.
13 Sasaki Associates. Long Wharf, archive. circa 1980. Accessed January 16 2025. https://archive.org/details/longwharf00sasa.
14 "Long Wharf." The Cultural Landscape Foundation. Accessed January 16, 2025. https://www.tclf.org/long-wharf.

Figure 1-10 - (Image Source: Kleinfelder)

Figure 1-11 - (Image Source: Kleinfelder)

DRAFT

Preliminary archeological investigations of Long Wharf have been compiled as part of its National Parks records. Within the National Register of Historic Places nomination form, it is noted that a study was "carried out in 1984 for the Massachusetts Historical Commission... suggest[ing] that additional portions of the historic Long Wharf may survive as archeological resources beneath filled land" and that "...accurate identification of all buried remnants of Long Wharf would require extensive excavation" at a length of "several city blocks". Therefore, the boundaries of the landmarked area do not include this extensive area is not adequately explored.

The development of and planning efforts around Long Wharf were not concluded with the Sasaki masterplan in 1980, though. Following the issuance of the masterplan, the Boston Redevelopment Authority (BRA) sought funding through the National Parks Service Land and Water Conservation Fund (LWCF) to provide updates to the wharf, receiving $800,000.00 to do so and resulting in the construction of the pavilion at the eastern end of the wharf in 1988. The LWCF also stipulates the granted funds are ineligible to be applied to uses other than those supporting public outdoor recreation, and that the land applicable for the grant funding will be designated with this status in perpetuity. This land is protected under Section 6(f)(3) of the LWFC Act , and is captured in the adjacent diagram (next page). As seen in the diagram, the boundary of the "6f" area extends along the entirety of the wharf, including the Chart House and Customs House buildings as well as what is now the Harborwalk.

The map depicted on the opposite page spread, dated 1980, predates a map from 1983 that showed a different, 6f area footprint. This 1983 map had been utilized by the BRA and their partners at the Department of Conservation Services in the 2006-2009 development of a restaurant space in the new pavilion that would not occupy the 6f area and therefore not violate the LWCF terms. However, litigation followed when it was unearthed that the 1980 document was more restrictive and therefore would not permit the restaurant use given it was not promoting the outdoor recreation use. Further, the new restaurant use would be in violation of Article 97 of the Massachusetts State Constitution, which protects open space and requires a two-thirds majority vote from the legislature. The restaurant development was subsequently denied. Presently the pavilion at the end of the wharf provides emergency egress from the MBTA blue line tunnel below as well air supply. The structure remains open, with its small footprint providing one of the only areas of shade and cover out on the end of the wharf.

15 National Parks Service, Polly A Matherly, and Marie A Frank. Accessed January 30, 2025. https://npgallery.nps.gov/GetAsset/e3376902-4065-4708-9511-220678200667.
16 Ibid.
17 Ibid.
18 Bader, Michael. "The Long War over Long Wharf." Sierra Club, June 16, 2017. https://www.sierraclub.org/massachusetts/blog/2017/06/long-war-over-long-wharf.
19 "Federal Court Says Long Wharf Pavilion May Not Be Converted into a Restaurant." District of Massachusetts, August 27, 2015. U.S. Attorney's Office, District of Massachusetts. https://www.justice.gov/usao-ma/pr/federal-court-says-long-wharf-pavilion-may-not-be-converted-restaurant.
20 Bader, Michael. "The Long War over Long Wharf." Sierra Club, June 16, 2017. https://www.sierraclub.org/massachusetts/blog/2017/06/long-war-over-long-wharf.

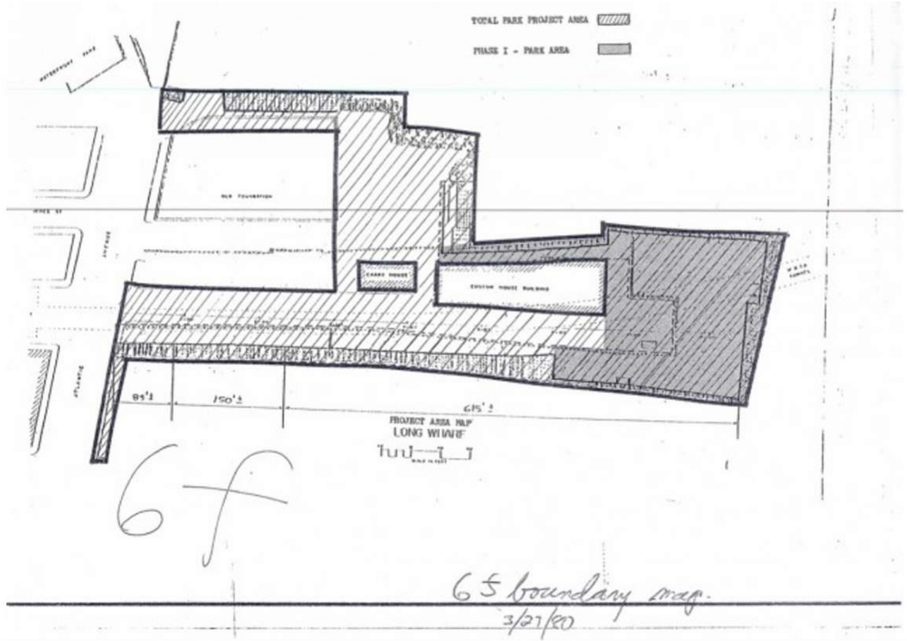


Figure 1-12 - (Image Source: Boston Planning Department)

DRAFT

DRAFT

STUDY AREA

Long Wharf is in a key location both along Boston's waterfront and within Boston's downtown at the end of State Street between Central Wharf and Commercial Wharf. Immediately to the south of the site is the property at 255 State Street and immediately to the north is Christopher Columbus Park. The Rose Kennedy Greenway and Atlantic Avenue provide the western edge of the project site, while the eastern edge is open to the inner harbor, with East Boston across the water. The project study area is roughly 13 acres encompassing Long Wharf proper, and the adjacent properties and water-supported infrastructure as shown in the image to the right.

SUMMARY OF OVERLAYS

Long Wharf is part of Boston's Harborpark: North End Waterfront zoning district and the Downtown Waterfront Subdistrict. The site is also subject to several zoning overlays per the BPDA Zoning Viewer and the State of Massachusetts MassMapper, including the Greenway Overlay District, the Groundwater Conservation Overlay District, Restricted Parking District, area of Open Space protection, and the Coastal Flood Resilience Overlay District, and the Massachusetts Coastal Zone.[1]

Additionally, the City of Boston requires a Parks Design Review by the City of Boston Parks Department and NPS for historic considerations. It is also significant that Long Wharf previously received funding from the Land and Water Conservation Fund through the Department of the Interior.

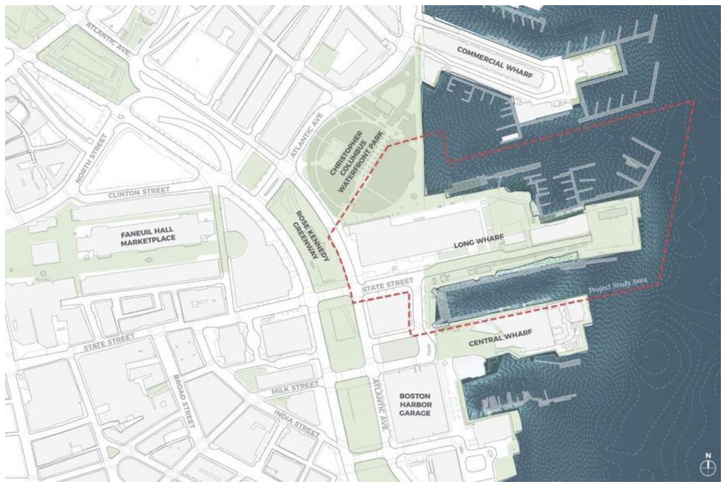


Figure 1-13 - Project Study Area

Figure 1-14 - Project Study Area

DRAFT

DRAFT

PROJECT GOALS

Develop a set of inclusive, welcoming, and implementable alternative designs for Long Wharf that:

- Provide flood control that contributes to closing off the 2030- and long-term flood pathways* while protecting/improving critical infrastructure
- Create an accessible and equitable public realm that strengthens the relationship between people and water while respecting the history of Long Wharf
- Ensure tie-ins and resolve operational, engineering, and other challenges with partner projects and planning initiatives
- Develop design and engineering assessments for grant funding candidacy

*For the purposes of this project, "2030- flood pathways" refer to coastal flood pathways within the Project Study Area mapped on the prior page
(Note: Additional consideration will be necessary for larger district-scale from North End & E India Row pathways; see Section 3 - Coastal Modeling Analysis, 2030 Performance Modeling)

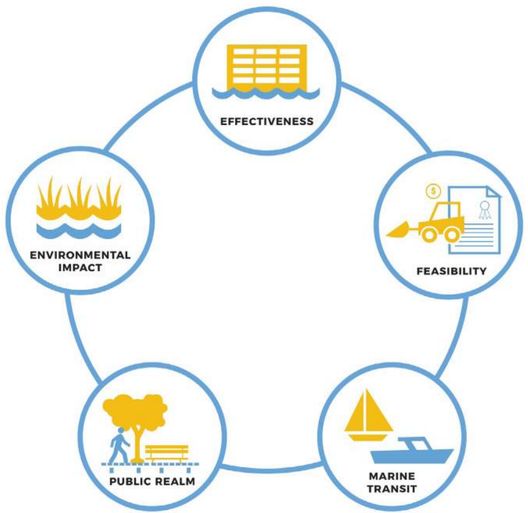


Figure 1-15 - Project Goals

PROJECT TIMELINE

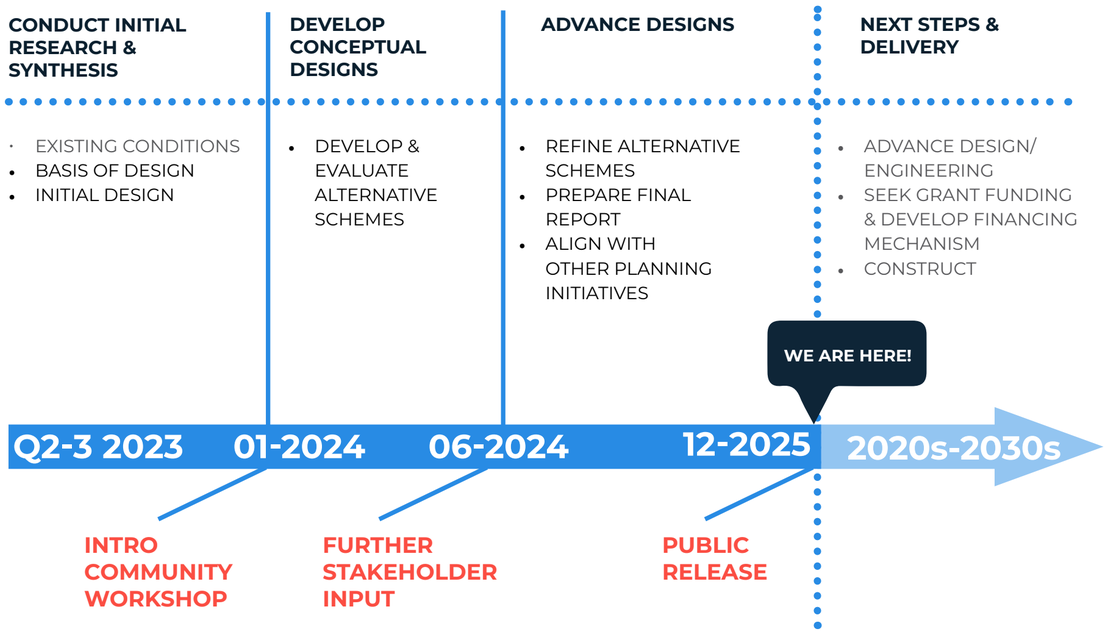


Figure 1-16 - Project Timeline

DRAFT

DRAFT

DESIGN PRINCIPLES

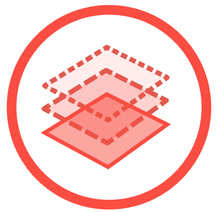
Design principles center on enhancing the site's connection to the harbor while reinforcing its identity as a civic and cultural landmark. Prioritizing **access to the water**, the design promotes both physical and visual engagement through improved circulation, open viewsheds, and expanded opportunities for waterfront interaction. These interventions aim to make Long Wharf a more inclusive and navigable space for the public while celebrating its maritime context.

A strategy of **layering and revealing** is employed to enrich the visitor experience by uncovering historical traces and integrating new elements with care. This principle guides the spatial organization of the site, offering moments of discovery and reflection that unfold through movement across the Wharf. **Considered material choices** support this approach, favoring durable, climate-adaptive materials that reflect the site's industrial past and maritime character while responding to contemporary performance and sustainability standards.

Crucially, the design acknowledges the **cultural histories** embedded in Long Wharf by interpreting its role in trade through thoughtful design gestures and storytelling elements. This sensitivity is paired with **strategic planning** to ensure the resilience and longevity of the site, addressing climate adaptation, maintenance, and programmatic flexibility.

With its rich history, sweeping views of the harbor, and key location along the waterfront, the project must prioritize creating a strong public realm that addresses future risk while knitting into the existing urban context.

ACCESS TO THE WATER



LAYERING + REVEALING

What are the ways this project can add another layer to the ever-changing evolution of Long Wharf? What layers do we maintain, reveal, or deliberately adjust?

How do we ensure high-quality, compatible, and regionally-sourced materials are utilized in the right locations on the wharf?

CONSIDERED MATERIAL CHOICES

RECOGNIZING CULTURAL HISTORIES

How might the site foreground amplify the various narratives + cultural histories that have been part of Long Wharf's history in its spatial composition?

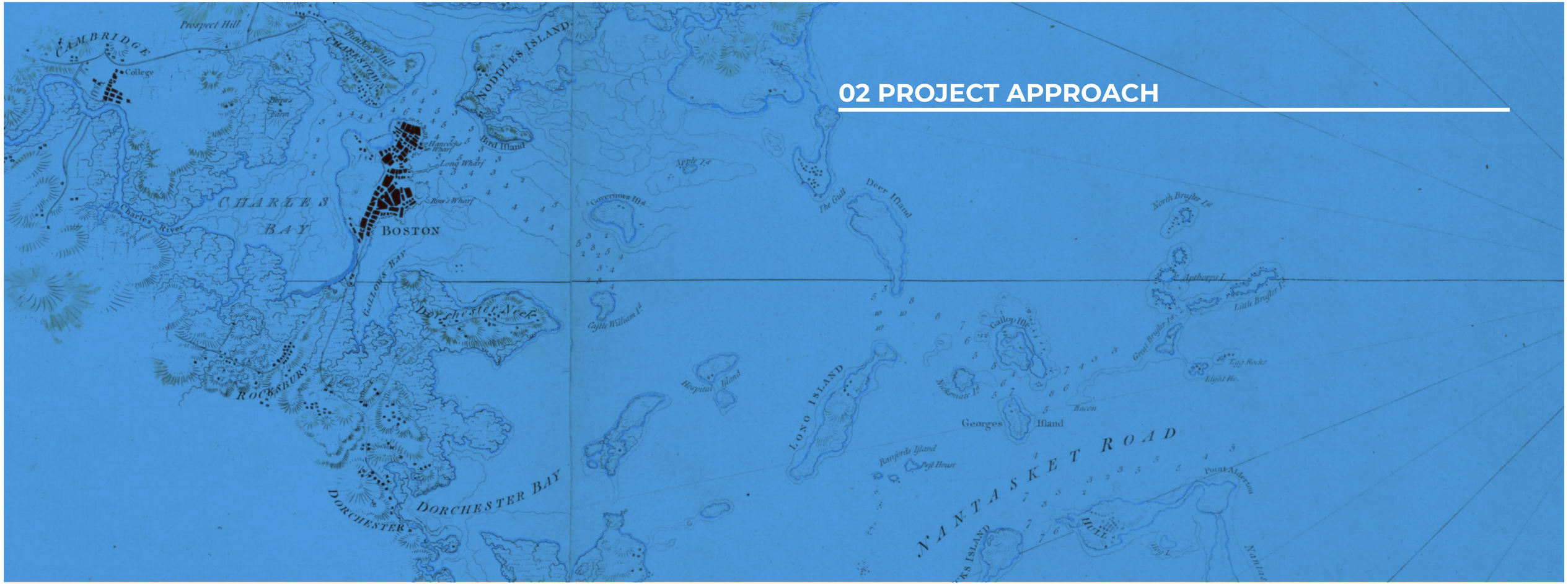
STRATEGIC PLANTING

How can planting and shade be appropriately incorporated for outdoor comfort, increased ecological benefit, and green infrastructure?

DRAFT

DRAFT

02 PROJECT APPROACH



METHODOLOGY

This flood mitigation planning and feasibility study was conducted as a concept-level assessment intended to evaluate flood risks and evaluate viable adaptation strategies for future refinement and implementation. The methodology emphasizes planning, stakeholder engagement, and conceptual analysis. No site-specific surveys, geotechnical or subsurface investigations, or hydraulic/hydrologic modeling were performed as a part of this effort.

This project has four (4) primary components:

- **Examine Existing Conditions: Develop a contextual understanding of the physical, environmental, and infrastructural characteristics of Long Wharf.**
- **Assess Flood Vulnerability: Develop a detailed understanding of flood risk at Long Wharf and the potential benefits of flood risk mitigation options.**
- **Engage Stakeholders: Engage stakeholders to understand operational and other considerations related to the function of marine infrastructure and improvements to the public realm.**
- **Develop a Feasible Flood Adaptation Design: Identify preferred short-, mid- and long-term flood protection strategies for Long Wharf that account for increased flood risk due to sea level rise.**

This report summarizes flood mitigation alternatives developed for Long Wharf. Design alternatives were developed to a conceptual level of design in accordance with the design criteria for the Project. The alternatives are individually defined within this report with their specific design elements, noting the pros and cons of each of the options. A set of evaluation criteria was developed to assess the alternatives within a framework of effectiveness and feasibility. This report provides the results of the evaluation and describes the recommended alternatives to carry out further implementation planning and detailed design development.

Image Source: Boston Harbor Now

DRAFT

DRAFT

STAKEHOLDER ENGAGEMENT

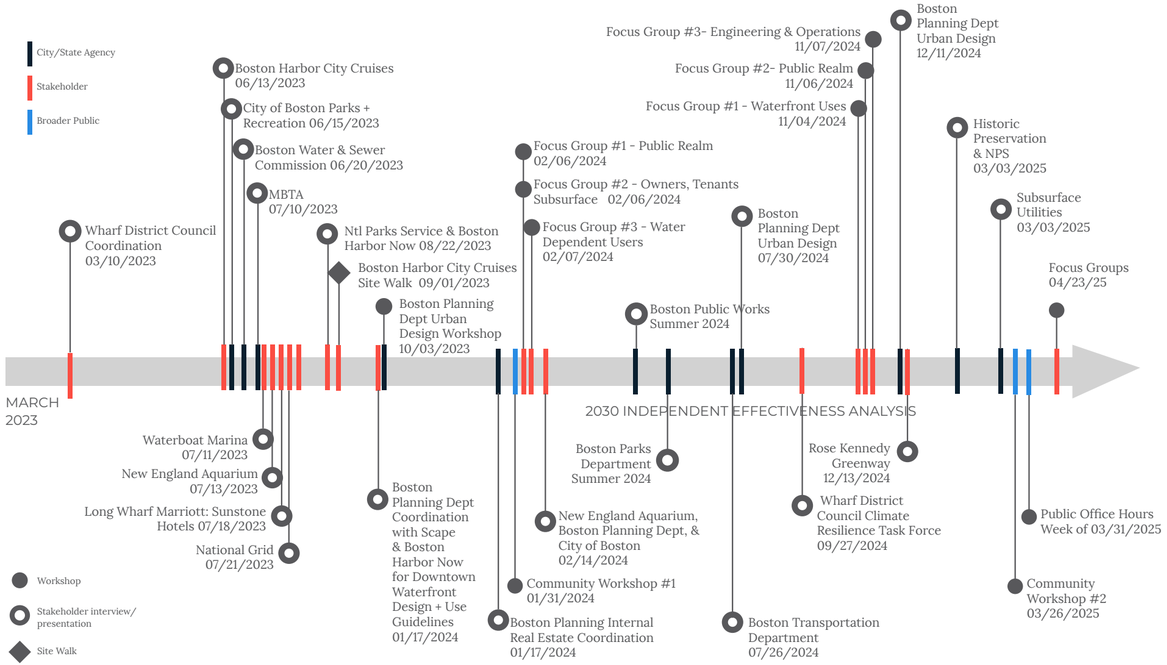
ENGAGEMENT APPROACH

The project team relied on an approach to engagement that utilized various formats to receive meaningful feedback from stakeholders. These approaches included virtual meetings, presentations, and interviews via Zoom, in-person focus group meetings and workshops, and on-site walking tours. During public virtual meetings held in January 2024 and March 2025, the team also incorporated the use of MentiMeter, an online voting platform which allowed participants to use their phone or browser to provide feedback in real time.

These various formats and activities were held throughout the duration of the project so that the public would be informed of the project process and key objectives. Key stakeholders played an active and ongoing role by being repeatedly engaged as the designs and findings were iteratively advanced.

The following timeline summarizes all engagement workshops, interviews/presentations, and site walks held over the course of the project by stakeholder.

Image Source: Kleinfelder



DRAFT

DRAFT

HOW WE INCORPORATED FEEDBACK

Following each interaction with stakeholders, the team recorded comments and questions, which were then addressed through continued conversation and reflection in the design. Because this process relied on the development of implementable and feasible concepts, when the team encountered trouble incorporating feedback, it was brought to the stakeholders attention with reasons for why there might be future difficulties. Additionally, feedback specific to each of the focus groups was reflected back in subsequent conversations so participants could clearly see how their comments were incorporated into design updates.

In an effort to establish an equitable design process, the team deliberately communicated with and learned from a wide variety of stakeholders throughout the project. By utilizing the lived knowledge and cumulative expertise of Long Wharf, the team was able to develop and iterate upon conceptual designs that respond to a shared future vision for this prominent waterfront space.

Because of the complexity of the project site, the team required in-depth conversation with many different agencies, tenants, abutters, marine transit operators, and regulators through each step of the process. This project also sought to build upon the existing documentation of the site area and feedback provided by stakeholders as part of the various planning efforts, both past and ongoing.

For further detail regarding the stakeholder engagement process and feedback, please refer to ***Appendix B.***

Image Source: Kleinfelder

Image Source: Kleinfelder

DRAFT

DRAFT

03 COASTAL MODELING + PERFORMANCE ANALYSIS

DESIGN FLOOD ELEVATIONS

A Design Flood Elevation (DFE) is a flood protection standard to which flood protection measures should be designed to limit coastal storm damages to buildings and other built assets, while also mitigating service interruptions to key transportation and marine transit infrastructure. The DFE should, where feasible, correlate to the flood probability that is in accordance with industry standards and federal, state, and local requirements. Several project-specific DFEs were produced for this project, and were based upon several tidal and coastal flood water levels summarized in Table 1 and Table 2:

Climate Horizon	WSE (ft., NAVD88)
Near-term (2030 1% AEP)	10.6
Mid-term (2050 1% AEP)	12.3
Long-term (2070 1% AEP)	14.0

Table 3-1 - MC-FRM Water Surface Elevations (WSE) (includes runup without waves)

	DFE (ft., NAVD88)	Notes
"Dry Harborwalk" DFE	11.3	Based on estimate of 2070 HAT (10.8 ft.) + 0.5 feet of freeboard
Interim DFE for Near-/Mid-Term Flood Pathways)	12.3	Based on 2050 1% AEP WSE
District-Scale Protection Base DFE	15.0	Based on 2070 1% AEP WSE + 1 ft. of freeboard
Long-term target DFE (for future modular adaptations)	17.5-18.0	Based on 2070 1% AEP WSE + Significant Wave Height (varies spatially)

Table 3-2 - Recommended Project Design Flood Elevations (DFEs)

The coastal flood protection designs and recommended approaches presented in this report were developed based on these DFEs, with a dual focus on providing near- to mid-term inundation and coastal storm/wave protection (up to 12.3' NAVD88) and long-term protections for future sea level rise and increase base flood and wave set-up conditions (up to 15.0' NAVD88). This coordinated approach recommends DFEs that both protect the perimeter Harborwalk and cut off significant near-term coastal flood pathways to 2050, while simultaneously considering how such infrastructure built to this performance standard can be integrated into longer-term designs out to 2070. The long-term DFE recommended in this report (15.0' NAVD88) serves as the base construction level for a Downtown/Wharf district-scale protective alignment, above which any future modular flood protection measures may be added (i.e., up to 17.5-18.0' NAVD88 for 2070 significant wave action).

The long-term DFE (15.0' NAVD88) was also informed by stakeholder considerations with respect to a reasonable height above existing conditions and present-day high tide conditions (~6.5-6.8' NAVD88), including marine transit and maritime infrastructure operators' operability concerns. In the near term, implementing a mostly-passive flood protection alignment above 15.0' was considered to be an extensive jump, creating uncomfortable conditions for maritime infrastructure operators, and undesirable urban design conditions wherein the distance from the top of feature may be 5-9 feet above existing grade (see Table 3), or 8-10 feet above average high tides. At peak low tide water level, the 15.0' elevation could be as much as 20 feet above the water line, a potentially undesirable interim urban condition where adaptations made today appear to far outpace observable sea level rise.

	Location along Wharf		
	Inland Edge (North) i.e., Harborwalk at Columbus Park	Interior Front (South) i.e., Harborwalk at Old Atlantic Ave	Bordering Edges i.e., Mid-Wharf / Plaza to End of Wharf
	Approximate Grade at Shoreline (ft, NAVD88)		
Existing Conditions, 2025	8.0-10.0	8.0-9.0	6.0-9.0
	Approx Height. above Existing Condition		
District-scale Alignment base elevation, 15.0' NAVD88	+5 to 7 feet	+6 to 7 feet	+6 to 9 feet

Table 3-3 - Existing grade versus District-Scale Protection Base DFE at select Long Wharf locations

As part of the implementation strategy for the Project, certain modular elements could be designed to Long-term Target DFE (for future modular future adaptations). The timing and location of such future adaptations may be informed by additional Massachusetts Coastal Flood Risk Model (MC-FRM) modeled parameters, including the Significant Wave Crest DFE, which factors the elevation of larger wave action (i.e., the largest 1/3 of waves). These parameters are summarized in the Table 4, below, for several shoreline segments at Long Wharf.

	Location along Wharf		
	Inland Edge (North) i.e., Harborwalk at Columbus Park	Interior Front (South) i.e., Harborwalk at Old Atlantic Ave	Bordering Edges i.e., Mid-Wharf / Plaza to End of Wharf
Climate Horizon	*MC-FRM-derived Significant Wave Crest DFE (WSE + Significant Wave Crest Elevation), (ft., NAVD88)*		
Mid-term (2050 1% AEP)	13.2	14.1	13.6-14.3
Long-term (2070 1% AEP)	15.4	16.0	16.2-16.4

Table 3-4 - Significant Wave Crest DFEs derived from the MC-FRM at select Long Wharf locations

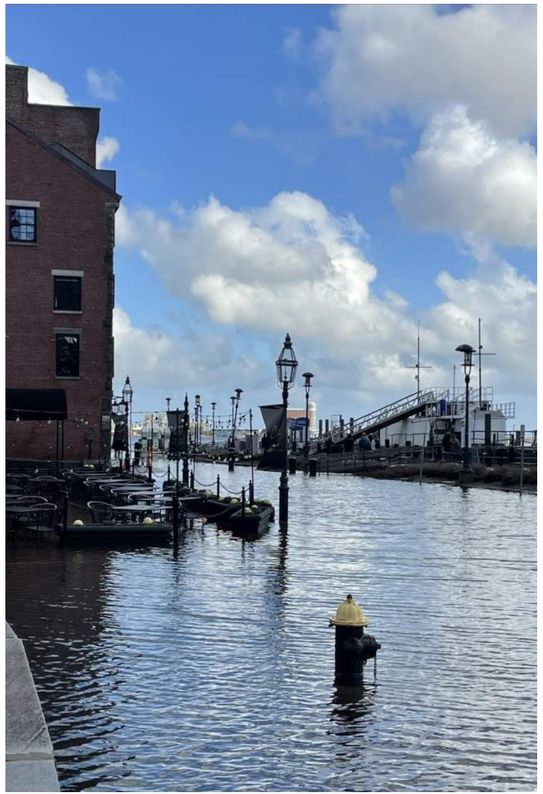


Figure 3-1 - King Tide Flood at Long Wharf. Image Source: Boston Planning Department

DRAFT

DRAFT

FLOOD RISK ANALYSIS

A coastal flood risk assessment was performed to establish a detailed understanding of current and future risk within the Long Wharf project area.

This assessment revisits prior flood risk analysis from the Coastal Resilience Solutions for Downtown and North End report (2020), updating this analysis with data from the Massachusetts Coast Flood Risk Model (MC-FRM) to help better understand the phasing and development of primary and secondary coastal flood pathways and a high-level assessment of the flood exposure of buildings and populations that can be mitigated via implementation of coastal flood protection measures.

This risk assessment also analyzed flood exposure of specific structures, critical infrastructure assets, roadway transportation, and other marine transit assets adjacent to and servicing the Wharf. This assessment captures observations and summarizes existing efforts and investments made to bolster adaptive capacity, noting where coastal flood retrofit projects have been undertaken by owners or asset managers – and their estimated levels of protection. Note that the assessment described in this section does not include precipitation-based (inland stormwater runoff) or directly quantify the frequency or magnitude of compound flood risks, however future precipitation considerations are taken into account elsewhere in the conceptual design.

SPATIAL EXTENTS, DATA, AND ASSUMPTIONS INFORMING THE FLOOD RISK ANALYSIS

The flood risk assessment was performed at two spatial extents: (1) the Downtown/Wharf District neighborhood and (2) the Long Wharf project area. The neighborhood extent encompasses the Downtown/Wharf District area and accounts for areas outside of the project area potentially impacted by flooding originating at Long Wharf.

DISTRICT-SCALE FLOOD RISK OVERVIEW

Long Wharf, Columbus Park, and portions of the Harborwalk between New England Aquarium and East India Row flood today during elevated tide events and during larger storms.

Present-day flood risks will be exacerbated by rising sea levels and climate change, and future flooding will progress along the coastal flood pathways shown on the flood risk map in Figure 3-2.

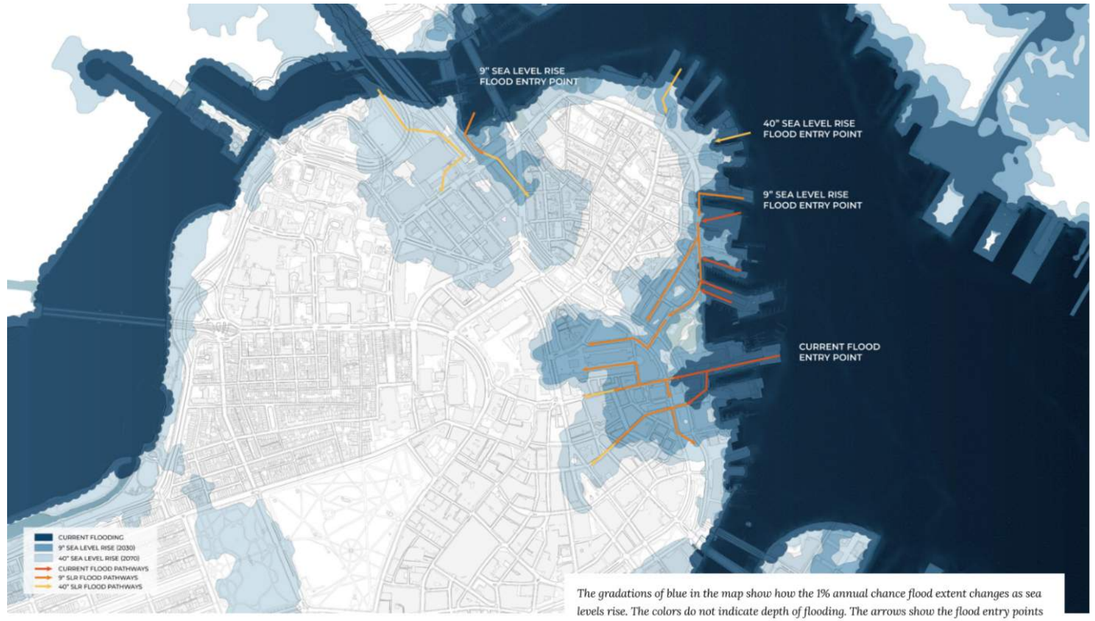


Figure 3-2 - Coastal Flood Pathways. (source: Coastal Resilience Solutions for Downtown and North End report, 2020)

DRAFT

DRAFT

OVERVIEW OF DATA AND ASSUMPTIONS

SEA LEVEL RISE SCENARIOS AND PROJECTIONS

Rising sea levels will exacerbate high tide flooding and coastal flooding. While a significant degree of uncertainty exists around the amount of future sea level rise that can be expected over a given horizon, for planning and design purposes, specific sea level rise projections and scenarios can be used based on an evaluation of available data, long-term needs, and risk tolerance.

The Commonwealth of Massachusetts has selected the high scenario as the preferred sea level rise projection for the assessment of vulnerability and flood risk. These sea level rise projections provide the background sea level estimates used for the Massachusetts Coast Flood Risk Model (MC-FRM) hydrodynamic modeling. MC-FRM modeling projections are appropriate and the best available for current risk and vulnerability assessments for the Boston harbor while acknowledging that this area of science and research is ongoing and evolving. For this reason, updates to the flood projections might be required in the future as the scientific understanding evolves.

Table 5 and Figure 3, below, describe the sea level rise data sources and assumptions for values used within this flood risk analysis:

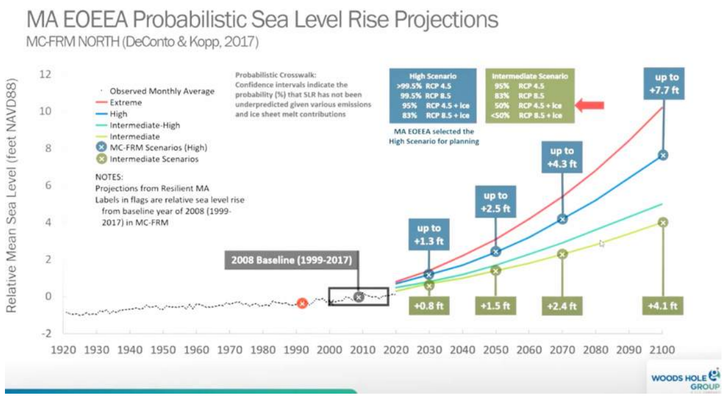


Figure 3-3 - MC-FRM Sea Level Rise Scenario (MA EOEEA and Woods Hole Group)

TIDAL FLOODING DATA

Tidal data was used in this project to understand potential everyday flood risks and vulnerabilities in the future due to "high tide flooding." NOAA defines high tide flooding as "the overflow or excess accumulation of water that covers typically dry coastal land and occurs during high tides." Such flooding creates short-term impacts like overflowing storm drains, inundation of the Harborwalk and pedestrian areas, roadway and delivery/loading zone disruptions, and temporary business closures. As relative sea levels rise, high tide flooding will occur more frequently, even on sunny days. With even modest sea level rise, high tide flooding that is seen as "nuisance" flooding today may result in regular inundation of the Wharf.

For this project, tidal flooding analysis was used to help illustrate impacts and inform future-focused minimum design performance criteria for the Harborwalk and other high foot-traffic areas, operational roadways, delivery and loading docks, and long-term coastal storm protections along the edges of the wharf. This section summarizes the data used to inform the tidal flooding assessment.

Tidal Benchmark Datasets

- The Massachusetts Coast Flood Risk Model's (MC-FRM) "Tidal Benchmark" dataset is a Level 2 model output that was provided in shapefile format. Projected future tidal flood data from this dataset present the approximate shore-parallel extent of tidal datums across coastal Massachusetts for 2030, 2050, and 2070 sea level rise scenarios. These shapefile data do not represent a spatial extent of the tidal benchmark, but rather the tidal benchmark values that should be applied over each of the geospatial zones, including Mean Higher High Water, Mean High Water, Mean Tide Level, Mean Low Water, and Mean Lower Low Water. Data for these benchmarks are provided in units of feet relative to the North American Vertical Datum of 1988 (NAVD88); see Table 6 on the next page.
  - For the flood risk assessment, Mean Higher High Water (MHHW) was the primary tidal benchmark used to evaluate tidal flood exposure for each of the time horizons: 2030 (elev. 6.5 ft NAVD88), 2050 (elev. 7.7 ft NAVD88), and 2070 (elev. 9.7 ft NAVD88). MHHW represents the average of the higher of the two daily high tides.

Other tidal flooding benchmark criterion used in this flood risk analysis include:

- NOAA / National Ocean Service's (NOS) Minor Flood threshold (6.82' NAVD88).
- The High Astronomical Tide (HAT) is a scientifically defined term for the highest predicted tide level based on astronomical calculations, meaning it's the maximum possible high tide under average conditions.
  - The present-day HAT registered at the Boston Harbor Tide Gauge (station 8443970) is 6.82' NAVD88 .
  - An estimated future 2070 HAT (10.8' NAVD88) was approximated by adding the 2070 Sea Level Rise (4.3 feet) to the average monthly high tide for Present Day conditions (~6.5' NAVD88).
- While similar and close in value, the HAT differs from a "king tide," which is a widely-popularized yet non-scientific term referring to the singular highest high tide of a given year. A king tide is essentially the biggest tide in a given location, and measured by the High Tide Line (HTL).
  - Due to recent sea level rise occurring over the past few decades, the calculated present-day HTL at Long Wharf is ~6.88' NAVD88 , which is several inches above the historic value (6.51') observed at the Boston Harbor Tide Gauge within the accepted National Tidal Datum Epoch (which covers the 18-year period from 1983- 2001) .

DRAFT
DRAFT

COASTAL STORMS AND FUTURE WATER LEVEL PROJECTIONS

Coastal flooding, also referred to as storm surge, is defined by the National Oceanic and Atmospheric Administration (NOAA) as "an abnormal rise in water level in coastal areas, over and above the regular astronomical tide, caused by forces generated from a severe storm's wind, waves, and low atmospheric pressure."
A number of available datasets from federal, state, and regional entities can be used to examine exposure to coastal flooding, but most are not sufficient for coastal resilience planning due to limited consideration of future conditions, spatial extent, and/or the range of storm intensities.

The Massachusetts Coastal Flood Risk Model (MC-FRM) represents the best available flood hazard data for Long Wharf as it is the most recent, has the highest spatial resolution, and considers the widest range of present and future storm scenarios. This dataset was developed for the Massachusetts Department of Transportation (MassDOT) to assess coastal flood risk to transportation systems and is used by the ResilientMass Action Team for the Commonwealth's Climate Resilience Design Standards Tool. The dataset provides a range of state-wide high resolution coastal flood risk data including annual flood exceedance probability, inundation depth maps based on stillwater flooding, water surface elevations, maximum wave heights, and maximum wave crest elevations for Present Day, 2030-, 2050- and 2070-time horizons.

This project utilized MC-FRM datasets listed below to evaluate flood risks and vulnerabilities. Data for all datasets noted below were provided in units of feet relative to the North American Vertical Datum of 1988 (NAVD88):

WATER SURFACE ELEVATION (WSE) RASTER DATASET

- Derived from the output of the MC-FRM for 2030, 2050, and 2070 sea level rise across thousands of coastal storm simulations.
- For each of the three future sea level rise scenarios, water surface elevation model output were provided for six separate coastal flood annual exceedance probabilities (AEP) including 1%, 2%, 5%, 0.5%, 0.2%, 0.1% probability levels.

MAXIMUM WAVE HEIGHT AND MAXIMUM WAVE CREST ELEVATION RASTER DATASETS

- These raster datasets were produced based upon the maximum wave height and water surface elevation raster files previously described and are provided as geoTIFF raster files derived from the output of the MC-FRM for 2030, 2050, and 2070 sea level rise and coastal storm simulations (see Table 3-6).
- For each of the three sea level rise scenarios, maximum wave crest elevation model output was provided for six separate AEP including 1%, 2%, 5%, 0.5%, 0.2%, 0.1% probability levels.

SIGNIFICANT WAVE HEIGHTS AND SIGNIFICANT WAVE CREST ELEVATIONS

(TABULAR DATA FROM WOODS HOLE GROUP)

- Tabular data for the MC-FRM's Significant Wave Height and Significant Wave Crest Elevations were provided at several locations along Long Wharf's perimeter and adjacent public Harborwalk areas for 2050, and 2070 sea level rise and coastal storm simulations.

DRAFT

DRAFT

For more information on how these values informed site DFE analysis, see ***Section 5: Coastal Modeling Analysis, Performance Modeling (2030).***

TIMEFRAME	VALUE (FEET)	VALUE (INCHES)*
2030	1.3	15.6
2050	2.5	30
2070	4.3	51.6

**Values based on High SLR scenario (DeConto & Kopp, 2017), as utilized within the MC-FRM*

Table 3-4 - Sea Level Rise Assumptions

PRESENT DAY TIDAL		2030 TIDAL		2050 TIDAL		2070 TIDAL	
DATUM	VALUE (NAVD88)	DATUM	VALUE (NAVD88)	DATUM	VALUE (NAVD88)	DATUM	VALUE (NAVD88)
MLLW	-5.51	MLLW	-3.8	MLLW	-2.7	MLLW	-1.0
MLW	-5.16	MLW	-3.5	MLW	-2.4	MLW	-0.7
MTL	-0.42	MTL	1.3	MTL	2.5	MTL	4.3
MHW	4.33	MHW	6.1	MHW	7.4	MHW	9.3
MHHW	4.77	MHHW	6.5	MHHW	7.8	MHHW	9.7
Observed HAT	6.82						
HTL (2025)*	6.88						

All values from Boston Harbor Tide Gauge (NOAA gauge 8443970), per accepted National Tidal Datum Epoch (1983-2001), unless otherwise noted.
**Value calculated for 2025; via interactive Tidal Datum Viewerl; accessed Jan. 2025*

Table 3-5 - Summary of Tidal Benchmark and Tidal Flood Elevations at Long Wharf

INLAND EDGE (HARBORWALK NEAR OLD ATLANTIC AVE.)

NEAR-TERM (BASED ON 2030 1% AEP)

PARAMETER	VALUE (NAVD88)
2030 1% AEP WATER SURFACE ELEVATION	10.6
2030 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	2.5
2030 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	1.5

MID-TERM (BASED ON 2050 1% AEP)

PARAMETER	VALUE (NAVD88)
2050 1% AEP WATER SURFACE ELEVATION	12.3
2050 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	3.0
2050 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	1.8

LONG-TERM (BASED ON 2070 1% AEP)

PARAMETER	VALUE (NAVD88)
2070 1% AEP WATER SURFACE ELEVATION	14.0
2070 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	5.0
2070 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	2.9

END OF WHARF (EASTERN EDGE)

NEAR-TERM (BASED ON 2030 1% AEP)

PARAMETER	VALUE (NAVD88)
2030 1% AEP WATER SURFACE ELEVATION	10.6
2030 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	4.0
2030 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	2.3

NEAR-TERM (BASED ON 2050 1% AEP)

PARAMETER	VALUE (NAVD88)
2050 1% AEP WATER SURFACE ELEVATION	12.3
2050 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	4.5
2050 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	2.6

LONG-TERM (BASED ON 2070 1% AEP)

PARAMETER	VALUE (NAVD88)
2070 1% AEP WATER SURFACE ELEVATION	14.0
2070 1% H_{MAX} (MAX. WAVE CREST HEIGHT)	5.5
2070 1% H_{SIG} (SIG. WAVE CREST HEIGHT)	3.2

Table 3-6 - Summary of Coastal Flood Elevations at Long Wharf

FLOOD EXPOSURE AND IMPACTS ANALYSIS

The Long Wharf area is among the most flood vulnerable locations in the City of Boston. In the near-term the entirety of the wharf and adjacent areas (e.g., Old Atlantic Ave/State Street, Columbus Park) will be exposed to flooding from coastal storm surge, with parts of the Wharf already experiencing regular inundation during High Astronomical Tide events.

Nuisance and tidal flooding already occur along Wharf during King Tides (i.e., 4-5 times per year). Flooding from everyday tidal conditions is not projected to occur within the project area through 2070. However, per Figure 4, the frequency of high tide flooding could triple by 2050 with flooding reaching Atlantic Avenue on an approximately monthly basis.

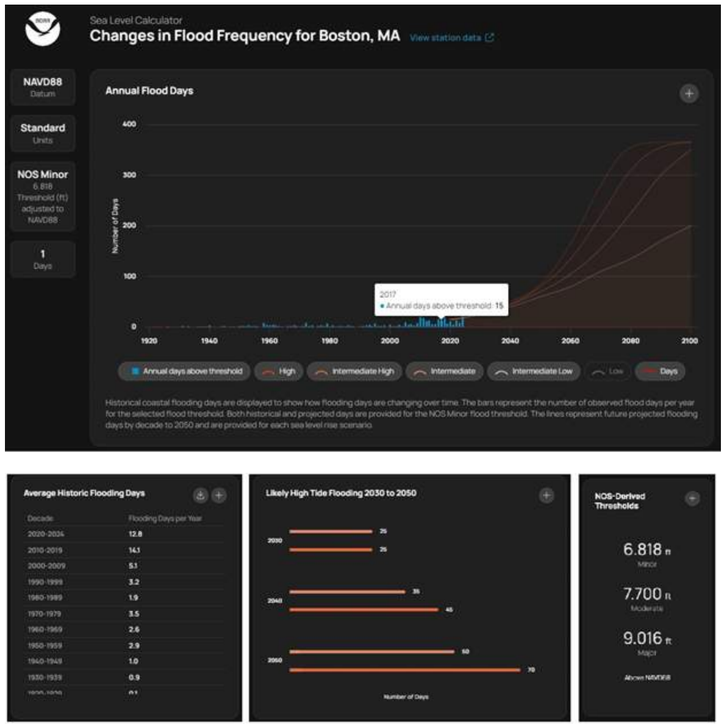


Figure 3-4 - Summary of High Tide Flood Frequency in Boston (source: NOAA Sea Level Calculator, 2024)

Longer-term sea level rise anticipated through 2070 and beyond will significantly increase the frequency of tidal inundation, while increasing the risk of impactful coastal storm flooding across Atlantic Avenue, the Rose Kennedy Greenway, and into the Downtown neighborhood. By 2070, the projected MHHW elevation from the MC-FRM (9.70' NAVD88) is a water level similar to today's storm of record (9.66' NAVD88) experienced during winter storm flooding in March 2018. In 2070, tidal inundation could be occurring up to 270 days per year, a scenario in which Long Wharf is flooding more days than it is dry.

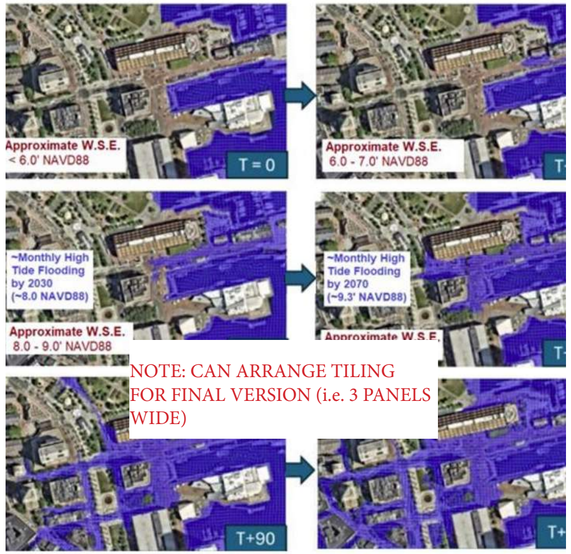
Figure 5 presents the projected flood extents at Long Wharf and the Downtown area for projected future tidal flood extents.

Tidal flood scenarios were not explicitly modeled within the MC-FRM site sub-model developed for this project, however the progression of District-scale tidal flood progression is approximated in Figure 6 on the next page.

Figure 3-5 - Projected Future MHHW Daily Flood Extents at Long Wharf

DRAFT

DRAFT



NOTE: CAN ARRANGE TILING FOR FINAL VERSION (i.e. 3 PANELS WIDE)

Note: graphic adapted by Kleinfelder from Woods Hole Group sub-model run for 'representative 2030 1% storm' for existing conditions at Long Wharf (without adaptations; max W.S.E. = 10.6' NAVD88)

* **Time (T)** for 'representative 2030 1% storm' inundation progression, shown in minutes from start of site inundation

* Annotated flood elevations (NAVD88) are ***approximate only***, based on LiDAR and pre-project site topographic survey data provided by BPD and others

Note: graphic adapted by Kleinfelder from Woods Hole Group sub-model run for 'representative 2030 1% storm' for existing conditions at Long Wharf (without adaptations; max W.S.E. = 10.6' NAVD88)

** Time (T) for 'representative 2030 1% storm' inundation progression, shown in minutes from start of site inundation*

** Annotated flood elevations (NAVD88) are approximate only, based on LiDAR and pre-project site topographic survey data provided by BPD and others*

Figure 3-6 - Approximated Future Tidal Inundation and Flood Projection at Downtown/Wharf District near Long Wharf

The following figures present projected flood extents at Long Wharf and the Downtown area for the) 5% AEP coastal event and 1% AEP coastal event across the 2030-, 2050-, and 2070-time horizons.

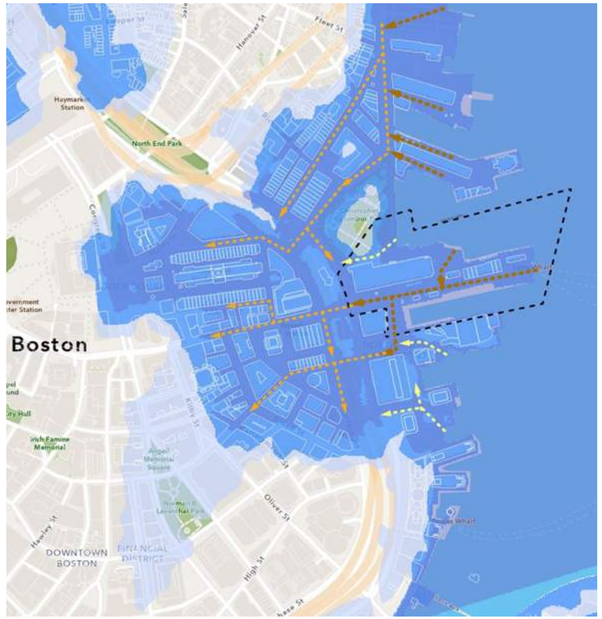


Figure 3-7 - Projected Future Coastal 5% AEP Storm Surge Floaod Extents and Flood Pathways

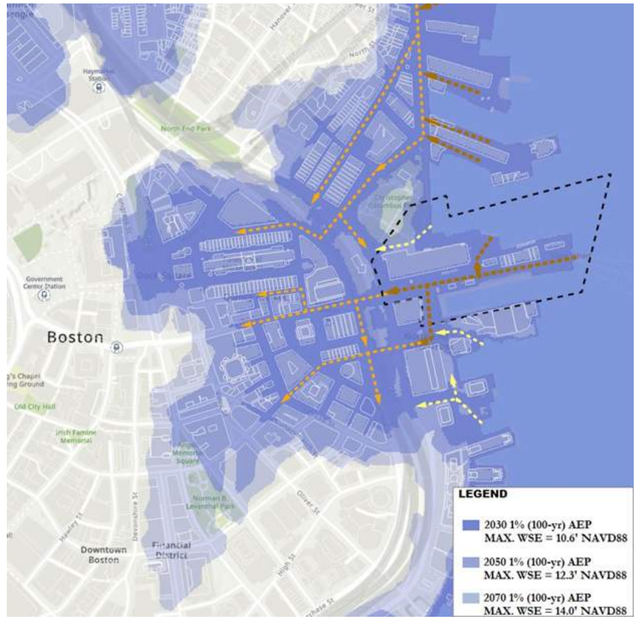


Figure 3-8 - Coastal 1% AEP Storm Surge Flood Extents and Flood Pathways

DRAFT

DRAFT

WHAT IS AT RISK IF NO ACTION IS TAKEN?

Present-day coastal flood risks in the project area have significant consequences. Consequences refer to the losses (physical, economic, and social) that may result from a coastal storm event. These consequences are expected to increase in lower probability events with a longer return period (i.e., more extreme flood events).

Due to sea level rise and the predicted increased severity of coastal storms caused by sea level rise and climate change, the low-lying coast around Long Wharf, Columbus Park, and the New England Aquarium is particularly vulnerable to flooding. Although the landmass was originally constructed above the historic high tide, sea level rise is driving the need for additional elevation. Boston's sea levels could rise approximately 40 inches by the 2070s, affecting 50,000 people working within the modeled 2070 one (1) percent floodplain. High resolution data from MC-FRM show the location of flood pathways and how they would impact properties and streets.

Some of the key flood-related impacts, including impacts to critical and essential facilities, transportation and maritime infrastructure, and other buildings and built assets are summarized below.

CRITICAL AND ESSENTIAL FACILITIES AND SERVICES

Critical and essential facilities and services include structures and infrastructure that are integral to public safety and wellbeing. Within and immediately adjacent to Long Wharf there are several facilities, critical to both operations within the facility and to the broader Boston transportation network. In addition, Long Wharf hosts a number of public and commercial facilities, outbuildings, and operational assets, such as MBTA ferries and excursion boats to the Boston Harbor Islands, which make Long Wharf a critical hub for water-dependent public transit and maritime transportation uses.

The presence of numerous outbuildings and kiosks supporting these water-dependent uses, all built at or near grade level, also increase the overall risk to essential facilities, as do the current condition, materials and inherent structural integrity of such structures. Ground settlement issues are also occurring on the south side of the wharf and the seawall is fairly porous in this location. Furthermore, the distributed locations, and operational needs of these structures often make site- and asset-level adaptation measures difficult to implement while maintaining operational continuity for the business. For example, by 2050, the Boston Harbor City Cruises ferry center and maintenance shed could experience flooding damages from king tide events, absent a major coastal storm. The wood ticket booth would likely be destroyed with any wave action during a coastal storm event as the wood structure cannot resist any flood forces. It was noted by tenants that sea level rise is already affecting the foundations of the land-ward structures and that the floors of ticket offices have already been replaced twice.

As outlined in Table 8 and reflecting the degree of overall coastal flood risk at Long Wharf, all critical facilities are at medium to high risk of damage due to coastal flooding. The risk analysis for critical facilities includes both the tiered criticality of the structure or use and the degree of flood exposure for the structure or use. Facilities with both high criticality and high flood exposure would represent the most at-risk facilities and the highest priority for mitigation.

The overall risk determination also factors retrofit flood hardening measures that bolster the adaptive capacity of some assets in the near- to mid-term. Other facilities may have lower criticality or flood risk due to location or design features intended for flood risk mitigation and may be lower priority as a result.

KEY TRANSPORTATION INFRASTRUCTURE AND MOBILITY

Coastal flooding and tidal inundation also pose a significant threat to key transportation infrastructure, including but not limited to:

- Interstate-93 Tunnel
- Massachusetts Bay Transit Agency (MBTA) Blue Line Aquarium Station and #4 Bus
- Connect Historic Boston Bike Trail

There are multiple roadways and vehicle accessways that are subject to increased flooding at and adjacent to Long Wharf. The present-day and future flood risk for these is summarized.

Site / Facility	Criticality	Flood Exposure	Risk	Lowest Surface Elevation(s), ft. NAVD88	Existing Adaptive Capacity / Level of Protection, ft. NAVD88	Comment(s) on adaptive capacity / existing floodproofing measures
On Wharf						
MBTA Aquarium Station (East Headhouse)	High	High	High	8.8	~12.8	Deployable perimeter drop-in flood plank system
Chart House	Medium	High	High	6.8	n/a	
Custom House	Medium	High	High	8.3	10.7	Water-filled perimeter barrier
Custom House - Electrical Room	Medium	Medium	Medium	8.4	12.4	Interior flood wall and gate (passive)
Long Wharf Marriott	Medium	Medium	Medium	9.5	~12.0	Sandbags at north entrance
MBTA Pavilion (Egress/Ventilation)	High	Medium	Medium	9.9	14.1	Flood door and retrofit panels over vent shaft louvers
Eversource vaults (below grade)	Medium	High	Medium	~7.5 - 8.0	n/a	Vaults have submersible pumps
Outbuildings (café, kiosks, ticket booths)	Low	High	Medium	~7.5 - 10.0	n/a	
Gravel Parking Lot (Chart/Custom House)	Low	High	Medium	~7.0 - 7.5	n/a	
Inland (west of Atlantic Ave.)						
I-93 Tunnel SB Exit Portal	High	Medium	High	~10.5	n/a	
255 State Street (entryway at Old Atlantic Ave.)	Medium	High	High	8.25	12.25	Deployable drop-in flood plank system
C/AT Headhouse (on SB Atlantic Ave. south of East India Row)	High	Medium	Medium	~9.5-10.0	n/a	
MBTA Aquarium Station - Southwest Headhouse / Marketplace Center (across Atlantic Ave.)	High	Medium	Medium	9.6 - 10.3	13.3 - 13.6	Deployable perimeter drop-in flood plank systems at Southwest Headhouse; deployable drop-in flood plank system at Marketplace Center
Boston Harbor Garage	Medium	Medium	Medium	~9.5	n/a	
Boston Harbor Islands Welcome Center (at Greenway)	Medium	Medium	Medium	~11.0-12.0	n/a	

Table 3-7 - Critical and Essential Facilities Risk Analysis (On-wharf and Landward Assets)

DRAFT

DRAFT

STATE STREET (ALONG WHARF) AND CHART HOUSE/CUSTOM HOUSE PARKING LOT

Flooding occurs multiple times per year already, with parts of the parking lot and low-lying roadway around the Chart House flooding 3-4 times per year. In the future, tidal flooding will increasingly disrupt services on the Wharf (e.g., fire lane access, waste management services, deliveries and service dock access). Impacts to deliveries and services to the Chart House and Custom House could become frequent in the 2030s, and to Long Wharf Marriott by 2050. By 2050, the whole Wharf could see monthly tidal flooding. By 2070, State Street will likely be regularly inundated at high tide.

OLD ATLANTIC AVE. / CENTRAL AND MILK STREETS

Flooding along State Street or overtopping the seawall at Old Atlantic Ave occurs irregularly today and is projected to occur with more frequency by 2030 (i.e., between 2- and 5-year recurrence). By 2050, Old Atlantic Avenue, Central Street and Milk Street could all see tidal flooding on a monthly basis. By 2070, Old Atlantic Avenue, Central Street and Milk Street could see daily inundation at high tide.

ATLANTIC AVENUE

Atlantic Avenue and Cross Street are a one-way pair that follow the coast line on the east side of downtown Boston, carrying a combined 51,109 vehicles per day. During flood events, these corridors will flood and travelers will be detoured to other corridors in the system. While the annual chance of a flood reaching Atlantic Avenue is only 1 percent at present, it increases to 10 percent with 9 inches of sea level rise (2030s). By 2050, monthly high tide flooding could reach Atlantic Avenue. By 2070, high tide flooding could render the roadway impassable on a daily basis.

EAST INDIA ROW

While the annual chance of a flood reaching East India Row is only 0.5 percent (i.e., 200-year recurrence) at present, this increases to 10 percent with 9 inches of sea level rise (2030s). By 2050, East India Row itself becomes a coastal flood pathway to Atlantic Avenue and into the Downtown area. By 2070, access to East India Row would be cut off from the inland side, as inundation of Atlantic Avenue could occur on a ~daily basis. The East India Row roadway itself could be inundated on a ~monthly basis in 2070.

BUILDINGS / LAND USES AT RISK

Figure 3-9 summarizes the number of structures and population exposed to flooding in the Downtown Boston / Wharf District area.

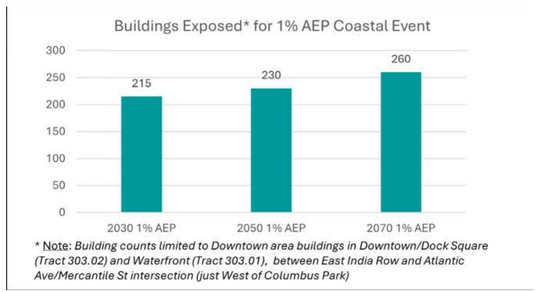


Figure 3-9 - Coastal 1% AEP Storm Surge Flood Exposure for Downtown/ Waterfront neighborhoods inland of Long Wharf

MARINE INFRASTRUCTURE AND THE HARBORWALK

Due to their location, flood risks to marine infrastructure and the Harborwalk are near- to and mid-term concerns, particularly from storm surge and coastal flooding.

Infrastructure supporting these water-dependent uses, such as marine pilings and moorings, marina infrastructure and supporting utilities (e.g., fueling, electricity), ramps, gangways, and ADA-accessible walkways, and timber decking will see increasing risks with near-term sea level rise.

As noted by operators, a bunch of the fixed ramps connecting to floating infrastructure that rise with the tide are increasingly stressed. Gangway mountings have already undergone repairs on the north side of the wharf as these cantilever and bottom out (not by design) during king tide events. On the south side of the wharf, the piles anchoring the floating docks have already been extended twice, with plans to go higher to prevent the docks from floating off the piles.

On the north side of the wharf, dock anchor piles currently extend to 15.5' NAVD88, which is only six inches higher than the target design flood elevation of 15.0 NAVD88. By 2050 there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm. For marine infrastructure, it is more critical that MC-FRM data for Maximum Wave Crest Elevation be taken into account.

The Harborwalk itself, particularly timber decking and frame materials, are also at risk of increased damage or deterioration with additional sea level rise. On the south side, the top of the Harborwalk wood deck is at approximately elevation 8.6' NAVD88. Much of the existing decking on the north side is about elevation 9.3' NAVD88, with subfloor structures at about 8.7 NAVD88. At these elevations, the decking could be exposed to inundation on an approximately monthly basis by 2050 and on an approximately daily basis by 2070.

For more information, refer to the 'Existing Conditions and Vulnerability Assessment' within the Basis for Conceptual Alternatives report (see Appendix A, Section 2).

DRAFT

DRAFT

Figure 10 also depicts the number of buildings (and corresponding uses) that are subject to flooding in the projected 2030 5% annual exceedance probability (AEP) (20-year) coastal flood scenario. Buildings within the 2030 5% AEP are color-coded, whereas other building footprints are shown in white border.

Note: The 2030 5% AEP reflects the largest event at which a near-term (2030 scheme) project at Long Wharf would be independently effective, without significant flood contributions from the North End flood pathway. For more information on performance modeling and independent effectiveness, see Section 5: Coastal Modeling Analysis, Performance Modeling (2030).

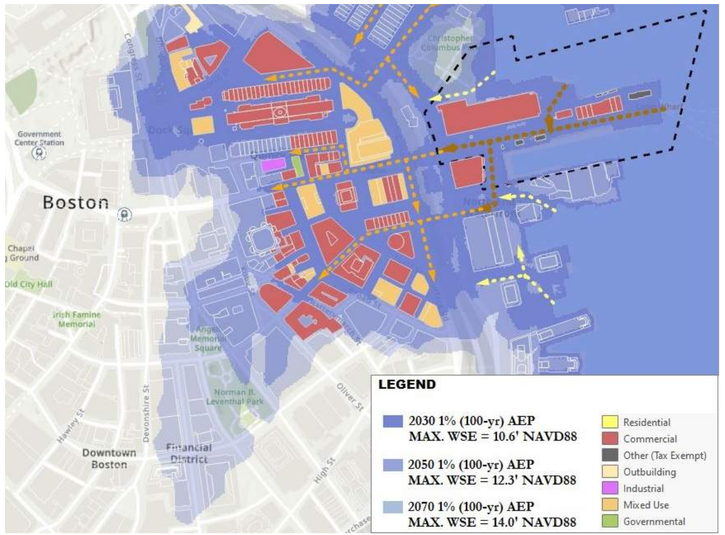


Figure 3-10 - Coastal 1% AEP Storm Surge Flood Extents, with Building Exposure

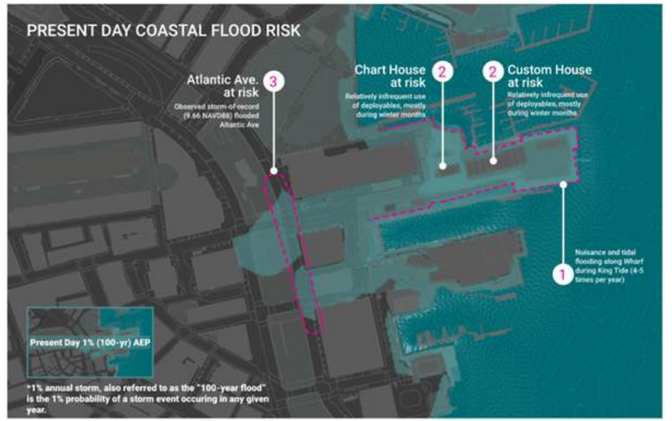


Figure 3-11 – Present-Day Coastal Flood Risk

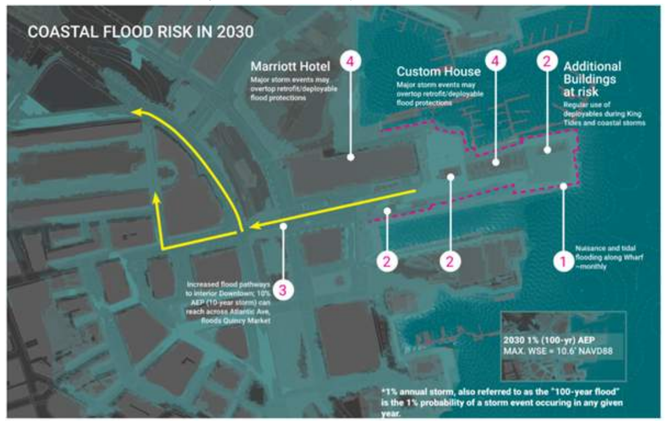


Figure 3-12 – Coast Flood Risk in 2030

DRAFT

DRAFT

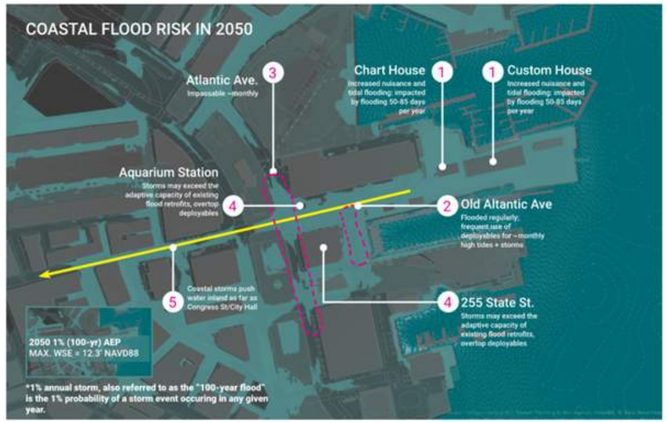


Figure 3-13 – Coastal Flood Risk in 2050

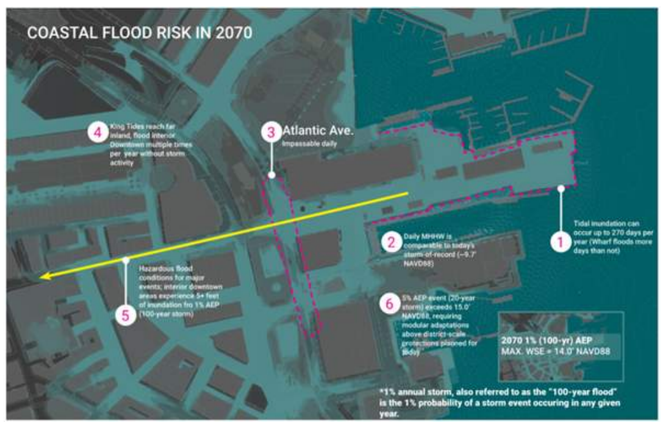


Figure 3-14 – Coastal Flood Risk in 2070

DRAFT

COASTAL MODELING ANALYSIS, PERFORMANCE MODELING (2030)

The Long Wharf area of the Downtown Boston waterfront has repeatedly flooded in the past, and is anticipated to experience more frequent and extreme flooding in the future due to sea level rise and increasing storm surge intensity caused by climate change.

In support of this project, Woods Hole Group performed a hydrodynamic coastal flood modeling assessment of a representative '2030 Intervention Scheme,' which was developed for the purpose of assessing the feasibility and independent effectiveness of near-term coastal flood mitigation strategies at the Wharf and its immediately adjacent properties. Specifically, the goal of this Scheme is to mitigate near-term (2030-time horizon) coastal flood risks to the Downtown waterfront area and vulnerable transportation assets inland of the Wharf.

The '2030 Intervention Scheme' consists of a continuous alignment of permanent walls and deployable flood barriers between Christopher Columbus Park and Central Wharf, as shown in Figure 1:

The main objective of Woods Hole Group's modeling assessment was to assess the 2030 Intervention Scheme's performance in a representative 1% annual coastal flood exceedance probability event in 2030, including the extent to which it:

- Mitigates coastal flood exposure (i.e., reduce flood extent or depth)
- Redirects flood waters to adjacent areas (i.e., increase flood extent or depth)
- Affects flood velocities (i.e., due to channelization of flow)
- In addition, the assessment aimed to:
- Identify potential flanking pathways around the 2030 Intervention
- Scheme that impact its coastal flood adaptation performance

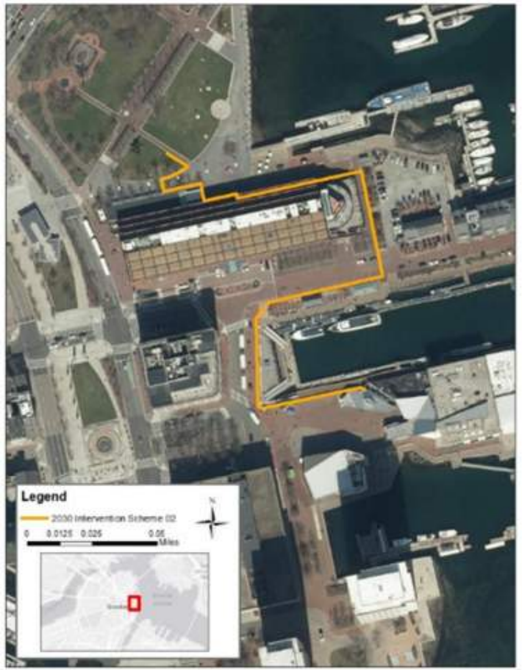


Figure 3-15 – Representative 2030 Intervention Scheme. The crest elevation of the proposed 2030 Intervention Scheme is 12.3 ft NAVD88, with the possibility of further expansion to 15 ft.

DRAFT

MASSACHUSETTS COAST FLOOD RISK MODEL & STORM SELECTION

To conduct this assessment, Woods Hole Group used data from the Massachusetts Coast Flood Risk Model (MC-FRM) and a hydrodynamic sub-model for the Downtown/North End Waterfront, developed specifically for this project. These models do not include potential underground flood pathways, such as tunnels, utility conduits, or stormwater or sanitary sewers. Therefore, the findings of the analysis apply only to how the 2030 Intervention Scheme affects overland coastal flooding. Assessing and mitigating underground flood pathways will be addressed in 2070 intervention schemes.

The MC-FRM served as the foundation for the modeling assessment. The MC-FRM is a high-resolution, probabilistic, hydrodynamic model that evaluates coastal flood risk under current and changing climate conditions. The MC-FRM was built using a two-way coupled version of Advanced Circulation (ADCIRC) and Unstructured Simulating Waves Nearshore (UnSWAN) models. The model simulates the dynamic flow of water during extreme coastal storm events, including flow overland with varying topography and frictional elements. Within the model, the movement of water is driven by varying winds, waves, and currents that occur during storm events.

The MC-FRM was used to simulate an ensemble of thousands of coastal storms coupled with future sea level rise scenarios, and results were statistically analyzed to produce probabilistic distributions of coastal flood extents, water surface elevations, and waves across the entire Massachusetts coast for three future time horizons. The MC-FRM incorporated the Commonwealth of Massachusetts "High" sea level rise projections of 1.3 ft by 2030, 2.5 ft by 2050, and 4.3 ft by 2070, relative to a 2008 baseline. These sea level rise numbers and the MC-FRM results are recommended by the Commonwealth of Massachusetts Climate Resilience Design Standards as the basis for understanding coastal risk and resilient coastal design.

Figures 2 through 4 on the following pages show the annual coastal flood exceedance probability, or annual exceedance probability (ACFEP, or AEP) results from the MC-FRM for the project area in the 2030-, 2050-, and 2070-time horizons. Each figure shows the local area with the 2030 Intervention Scheme alignment (brown line) and the full distribution of ACFEP extents (multi-colored contours) overlaid on an aerial image. The ACFEPs can also be expressed as return periods. For example, a 1% ACFEP corresponds to a 100-year return period, where a 100% ACFEP corresponds to an annual storm event (once a year). The figures illustrate how the risk of flooding from coastal storms is expected to increase over time due to climate change.

It is important to note that the 2050- and 2070-time horizon results from the MC-FRM account for projections of more intense tropical storms and hurricanes.

The MC-FRM is regularly used to assess the performance of potential flood mitigation interventions (e.g., dam modifications, coastal barriers, levees, berms, seawalls, land regrading, etc.) under a range of possible coastal storm scenarios that may occur under present day or future climate conditions. While the full distribution of MC-FRM flood probabilities shown in Figures 2 through 4 is statistically generated from thousands of storms, it is impractical to simulate all those storms again for a site-specific flood mitigation intervention assessment.

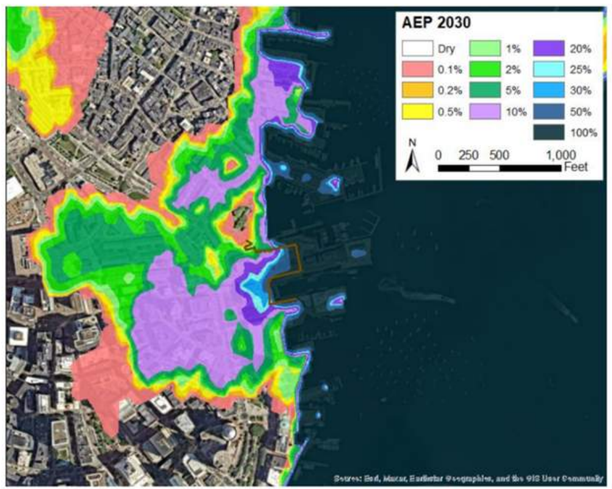


Figure 3-16 - Annual Coastal Flood Exceedance Probability (ACFEP) of coastal flooding within the project site, from the MC-FRM, for the year 2030.

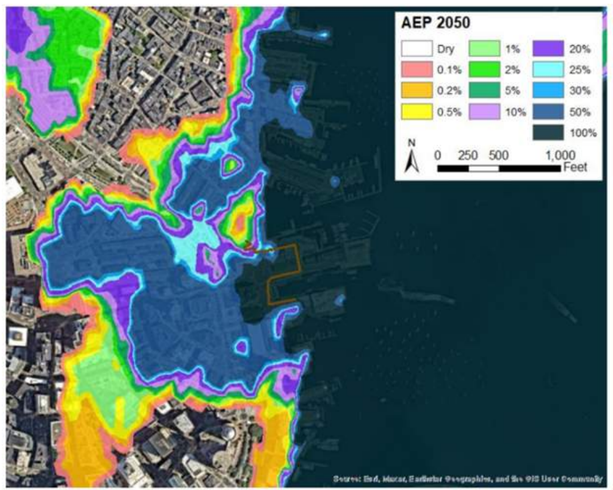


Figure 3-17 - Annual Coastal Flood Exceedance Probability (ACFEP) of coastal flooding within the project site, from the MC-FRM, for the year 2050.

DRAFT

DRAFT

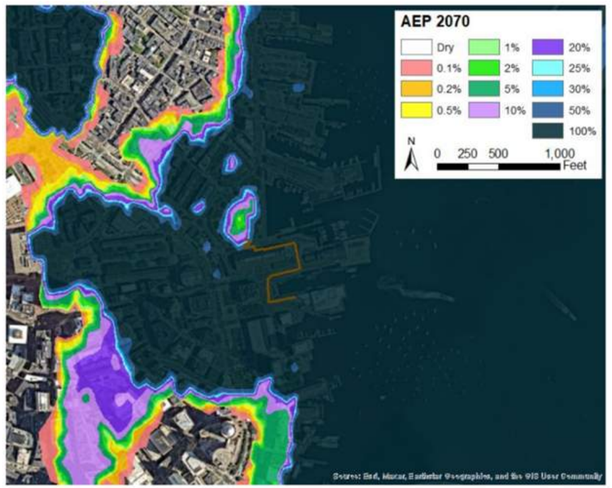


Figure 3-18 - Annual Coastal Flood Exceedance Probability (ACFEP) of coastal flooding within the project site, from the MC-FRM, for the year 2070

An individual storm was therefore selected that results in a peak water surface elevation (just offshore of the property) representative of a 1% ACFEP in 2030 (see Table 1) to evaluate the 2030 Intervention Scheme for Long Wharf. This storm was selected as a benchmark to assess the intervention's ability to mitigate 2030 flood exposure in the project area.

ACFEP	Return Period	Climate Horizon	Peak Water Surface Elevation (ft, NAVD88)
1%	100-year	2030	10.6

Table 3-8 - Selected Storm Scenarios

As the intervention site is within the 2030 1% ACFEP extent, simulation of this event in proposed conditions was expected to illustrate the extent to which flood redirection or channelization may occur as unintended consequences. Based on the MC-FRM 2030 ACFEPs shown in Figure 1, simulation of the 2030 Intervention Scheme in the selected storm event was also expected to yield insights into the dynamics and volumetric contributions of interconnected flood pathways in the Downtown Waterfront and North End at a high resolution which may inform future phasing to achieve independent effectiveness at desired ACFEPs.

DRAFT

SUB-MODELING APPROACH AND DEVELOPMENT

Construction of new buildings, fill, vertical barriers (i.e. berms, flood walls), and other topographic changes can result in channelization of flow and influence flood water velocities in the vicinity of an intervention, which may negatively impact adjacent property, infrastructure, or natural resources. Wetlands regulators frequently request assessments of these types of impacts for projects located in Land Subject to Coastal Storm Flowage as part of State and local permitting. The MC-FRM can evaluate flow diversions and changes in flood risk at a high-resolution. However, while the MC-FRM is a high-resolution model, it does not explicitly account for the three-dimensional nature of buildings, including flow diversions and concentration of velocities around these structures. It also cannot resolve very fine-scaled features or the localized impact of adding them to a landscape. In cases where understanding of flow around buildings or along narrow alignments is required, the MC-FRM platform also consists of various sub-models that integrate these structures into the model domain to represent flow dynamics at a higher resolution. These sub-models also allow for representing individual structures, buildings, landscape features, and grading changes at an even higher resolution (less than 10 feet). This sub-model approach was utilized to assess the proposed development at the Long Wharf site to understand the complex urban flood flow patterns under both existing and proposed conditions.

Two high resolution sub-model grids were created for this project assessment, one representing existing conditions at the site, and one representing the addition of the proposed 2030 Intervention Scheme alignment. The existing conditions sub-model grid was created using data from the MC-FRM model as well as updated site-specific contour and building data provided by two LiDAR DEM datasets: 1887 - 2016 USGS CoNED Topobathy DEM and 2021 USGS Lidar. In the vicinity of Long Wharf, these datasets were then checked against existing conditions survey plan sets provided by Kleinfelder and corrected in the modeling grid (if needed). Figure 5 shows the existing conditions sub-modeling grid within the MC-FRM modeling domain. The larger map on the left shows the MC-FRM regional mesh (black polygons), which has a spatial resolution of 2 meters (6.56 feet), and the extent of the sub-modeling grid. The extent of the sub-model included the whole Downtown Waterfront and North End to capture the multiple potential flood pathways that may contribute to flooding in the project area, extending roughly one-quarter to three-quarters of a mile from the site in all directions. Variations in color indicate the topographic changes within the sub-modeling grid, with red and orange colors representing high elevations and green and blue colors

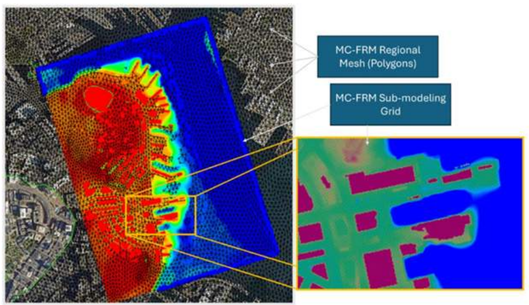


Figure 3-19 - Sub-modeling grid developed for the Long Wharf project site. Variations in color indicate the topographic changes within the modeling grid, with orange and red colors representing higher elevations and blue and green colors representing lower elevations.

DRAFT

representing low elevations. The smaller map on the bottom left shows a zoomed-in view of the submodel grid (small black polygons) and topography. The smaller map also shows how buildings were represented in the sub-model as high-elevation barriers to flow.

A second sub-model grid was then developed by integrating the '2030 Intervention Scheme' (see Figure 1) into the existing conditions sub-model grid with a crest elevation of 12.3 ft NAVD88 to simulate the top of the neat-term flood protection elements (e.g., permanent walls and deployable flood barriers).

SUB-MODEL RESULTS

Two total sub-model simulations (1 storm for both the existing and proposed conditions) were simulated to evaluate potential impacts of the proposed project on flood extent, flood depth, and flood velocities. Water surface elevations from the model were primarily evaluated to (1) validate the performance of the proposed design relative to flood mitigation of the proposed development, and (2) to ensure there was not a significant expansion of flood extent or flood depths caused by the project.

Figure 3-20 - Water Surface Elevations from sub-model with and without 2030 Intervention Scheme, with differential in depth

DRAFT

Figure 6 also presents the change in water surface elevation (i.e., change in flood depth) between existing and proposed conditions (left panel), the water surface elevation for existing conditions (center panel), and the water surface elevation for proposed conditions (center panel) for the representative 1% ACFEP storm in 2030. The right panel shows that in this storm scenario the proposed intervention results in minor reductions in flood extent and modest reductions in flood depths (on average, 0.6 ft reduction) inland of the alignment. Several areas (shown in dark green) remain fully dry under this storm as a result of the 2030 Intervention Scheme.

Further analysis of the modeling results indicates that the significant residual flood risk in this scenario is driven by unmitigated flood pathways from the North End waterfront, Central Wharf, and Harbor Towers/East India Row which flank the proposed barrier. Figure 6 also shows that the intervention does not result in flood redirection to adjacent sites (i.e., does not cause flood extent or depth increases in adjacent areas).

Figure 7 presents the change in maximum velocity between existing and proposed conditions (left panel), the maximum velocity for existing conditions (center panel), and the maximum velocity for

Figure 3-21 - Water Surface Elevations from sub-model with and without 2030 Intervention Scheme, with differential in depth

DRAFT

proposed conditions (right panel) occurring during the representative 1% ACFEP storm in 2030. The left panel shows that the intervention causes increases in velocities (orange/red) within the paved East India Row and Atlantic Ave rights-of-way and through the Central Wharf Harborwalk access ramp next to Simons Theater. However, these increases are offset from the adjacent building footprints. The increases in velocity are likely occurring because under existing conditions, flow from higher elevation flanking flood pathways is slowed down by flood water from the lower elevation Long Wharf flood pathway that has already pooled in the receiving area. In the proposed condition, the Long Wharf flood pathway is blocked, so the receiving area is dry when the higher elevation flood pathways are activated, resulting in a higher velocity movement of flood water into the receiving areas than in existing conditions. The left panel also shows that the intervention causes decreases in velocities (blue/purple) in other areas, including along the Rose Kennedy Greenway and between Quincy Market and Fanueil Hall. The color contours in the center and right panels indicate areas of high flow (>3 feet per second, or ft/s) in dark green and low flows (<1 ft/s) in yellow.

Maximum velocities of 4 ft/s occur within the overall region for both existing and proposed conditions. This level of velocity may pose a safety hazard and result in some scouring of the natural landscape, carry debris, or otherwise damage smaller structures or equipment.

PROJECT AREA FLANKING PATHWAYS AND CRITICAL ELEVATIONS

Flanking flood pathways that activate in the 1% ACFEP storm event in 2030 and undermine the independent effectiveness of the 2030 Intervention Scheme are evident from the performance modeling results. Specifically, significant residual flood risk in this scenario is driven by unmitigated flood pathways from the North End waterfront, Central Wharf, and Harbor Towers/East India Row which flank the

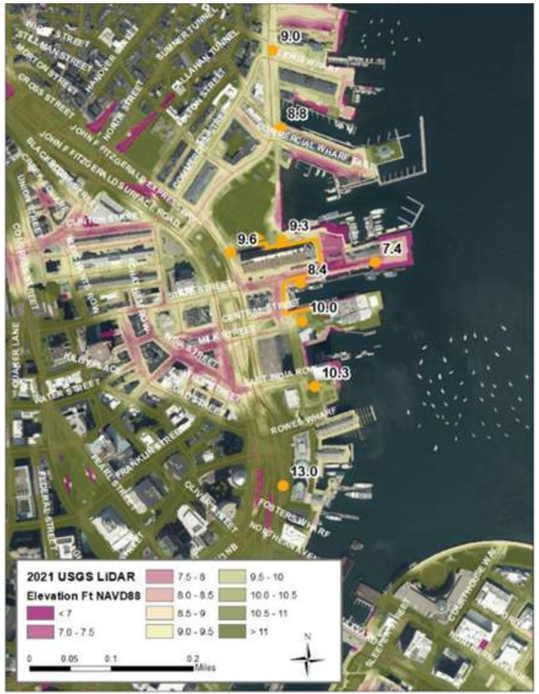


Figure 3-22 - LiDAR elevations from the 2021 USGS dataset overlain with specific tipping point flanking elevations, at their specific locations. All elevations are reported in feet, NAVD88. The location of the 2030 Intervention Scheme is highlighted in orange. [Note: All elevations are based on the best available LiDAR datasets and are considered approximate.]

DRAFT

proposed barrier. By the time the water surface elevation reaches approximately 9.6 ft NAVD88, the proposed 2030 Intervention Scheme is flanked by floodwaters arriving from the combined flood pathways from the North End waterfront, along Commercial Street and Atlantic Avenue. Specifically, the flood pathway at Commercial Wharf along Atlantic Avenue activates at roughly 8.8 ft NAVD88, whereas the flood pathway from Lewis Wharf activates slightly later, at approximately 9.0 ft NAVD88. At approximately 10 ft NAVD88, the project is flanked by flood waters arriving from south of the site, from Harbor Towers/East India Row and the Central Wharf Harborwalk ramp. These "tipping point" elevations are highlighted in Figure 8.

ASSESSMENT OF INDEPENDENT EFFECTIVENESS OF 2030 INTERVENTION SCHEME

It is anticipated that adding additional coastal flood mitigation measures to block the northern and southern flanking flood pathways will mitigate both expected flanking to the Long Wharf area, as well as increased velocities associated with these flanking pathways.

To assess the independent effectiveness of flood protections (i.e., to determine the flood mitigation efficacy of a near-term project implemented only at Long Wharf and immediately adjacent properties), Woods Hole Group assessed a sequence of different 'tipping point' elevations accompanying different build-out assumptions for a progressively longer district-scale flood protection alignment, and expansion to elevation 15 ft NAVD88 in a future flood protection improvement (any of the 2070 schemes). Independent effectiveness of the 2030 Intervention Scheme is summarized in Table 2.

The same information is then depicted step-wise in Figures 9 through 13, showing the level of flood protection (shown as an approximate return period at each of four time horizons: Present Day, 2030, 2050, and 2070).

Figure 3-23 - Long Wharf's Flanking Flood Pathways

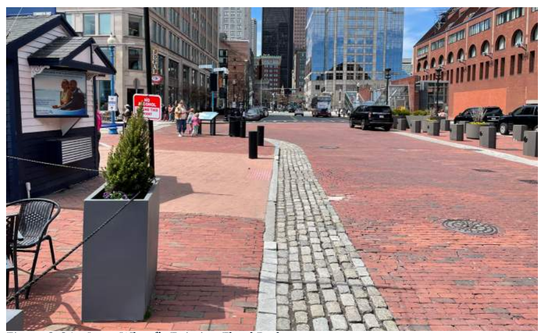


Figure 3-24 - Long Wharf's Existing Flood Pathways

DRAFT

Potential Project Phases	Description	Independent effectiveness for Long Wharf Area			
		Present Day	2030	2050	2070
Phase 1: Proposed 2030 Intervention	2030 Intervention Scheme 02 consisting of crest elevations of walls and deployable systems at 12.3 ft NAVD88. This Phase would be flanked by flood waters arriving from the north (Atlantic Avenue) at approximately 9.6 ft NAVD88.	Provides protection up to approximately the **150-year return period event** (area will flood for events above this return period)	Provides protection up to approximately the **20-year return period event** (area will flood for events above the return period)	Provides protection up to approximately the **2-year return period event** (area will flood for events above the return period)	Does not provide any significant protection to the area by 2070 (daily flooding)
Phase 2: Extension of Phase 1 Intervention to the North	Added flood adaptation measures to mitigate flood pathway along Atlantic Avenue at Commercial Wharf. This Phase would be flanked by flood waters arriving from the south (East India Row and Aquarium) at approximately 10 ft NAVD88.	Provides added protection up to approximately the **200-year return period event** (area will flood for events above this return period)	Provides added protection up to approximately the **40-year return period event** (area will flood for events above this return period)	Provides added protection up to approximately the **4-year return period event** (area will flood for events above this return period)	Does not provide any significant protection to the area by 2070 (weekly to monthly tidal flooding)
Phase 3: Extension of Phase 1 Intervention to the North and South	Added flood adaptation measures to mitigate flood pathway along East India Row and Aquarium flood pathways. This Phase would ultimately be overtopped over the 12.3 ft elevation crest of the Phase 1 adaptation at Long Wharf.	Provides added protection for all storm events except a black swan condition.	Provides added protection for all storm events except a black swan condition.	Provides added protection up to approximately the **100-year return period event** (area will flood for events above this return period)	Provides added protection up to approximately the **7-year return period event** (area will flood for events above this return period)
Phase 4: – Longer-term Long Wharf adaptation (e.g., Big Splash)	Increased mitigation measures at Long Wharf area that increase level of protection up to 15 ft NAVD88. This Phase would ultimately be flanked by flood waters arriving from the Fort Point Channel flood pathway at approximately 13 ft NAVD88.	Provides added protection for all storm events except a black swan condition.	Provides added protection for all storm events except a black swan condition.	Provides added protection up to approximately the **300-year return period event** (area will flood for events above this return period)	Provides added protection up to approximately the **20-year return period event** (area will flood for events above this return period)
Phase 5 – Full 2070 Protection	Added flood adaptation measures to mitigate the flanking flood pathway arriving from Fort Point Channel.	Provides added protection for all storm events except a black swan condition.	Provides added protection for all storm events except a black swan condition.	Provides added protection for all storm events except a black swan condition.	Provides added protection up to approximately the **100-year return period event** (area will flood for events above this return period).

Table 3-9 – Summary of Independent Effectiveness of 2030 Intervention Scheme at Long Wharf and Potential Future Phasing of District-Scale Protections

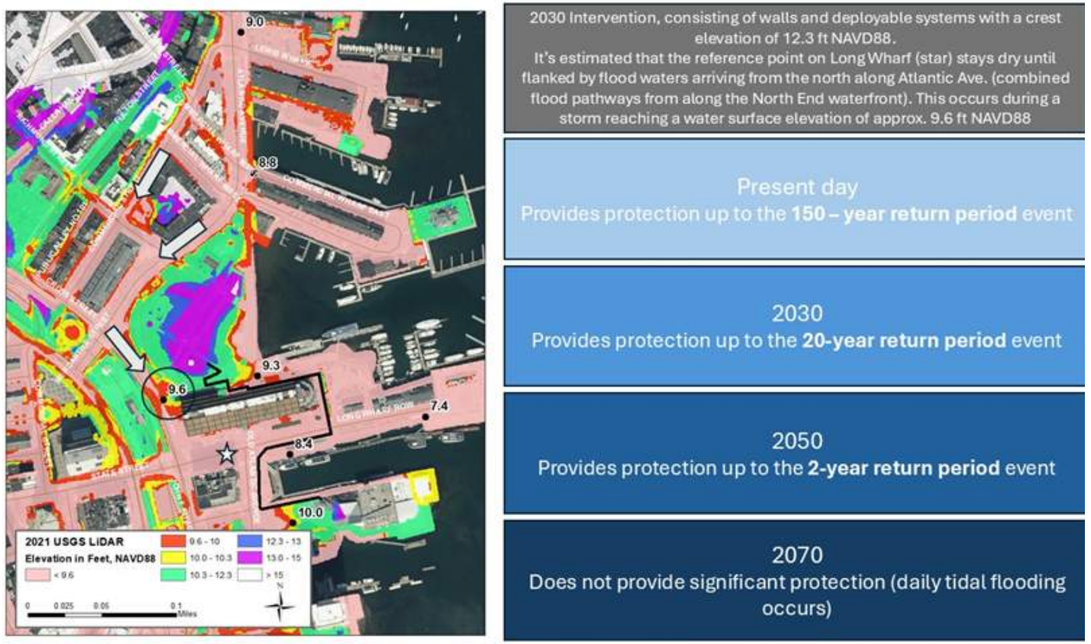
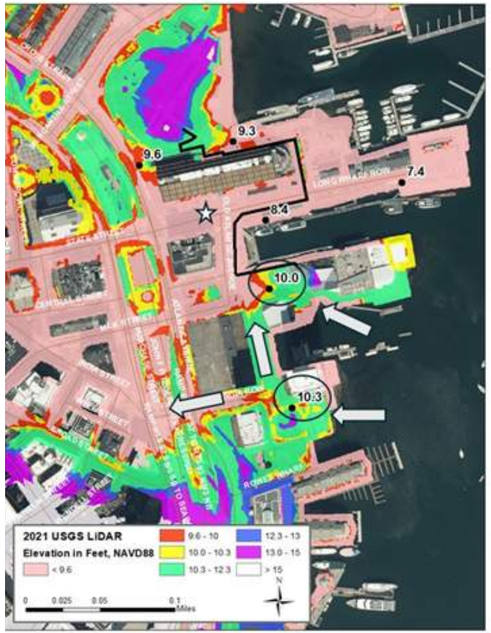


Figure 3-25 – Effectiveness of 2030 Intervention Scheme alone (Phase 1)

DRAFT

DRAFT



2030 Intervention, consisting of walls and deployable systems reaching a crest elevation of 12.3 ft NAVD88, with an extended intervention with an equivalent crest elevation along Atlantic Ave to mitigate flood waters from the north. It's estimated that the reference point on Long Wharf (star) stays dry until flanked by flood waters arriving from the south via East India Row and Simons Theatre. This occurs during a storm reaching a water surface elevation of approx. 10.3 ft NAVD88

Present day
Provides protection up to the **200 – year return period** event

2030
Provides protection up to the **40-year return period** event

2050
Provides protection up to the **4-year return period** event

2070
Does not provide significant protection (weekly to monthly tidal flooding occurs)

Figure 3-26 - Effectiveness of 2030 Intervention Scheme, extended to the North along Atlantic Ave (Phase 2). [The extension itself is not depicted.]

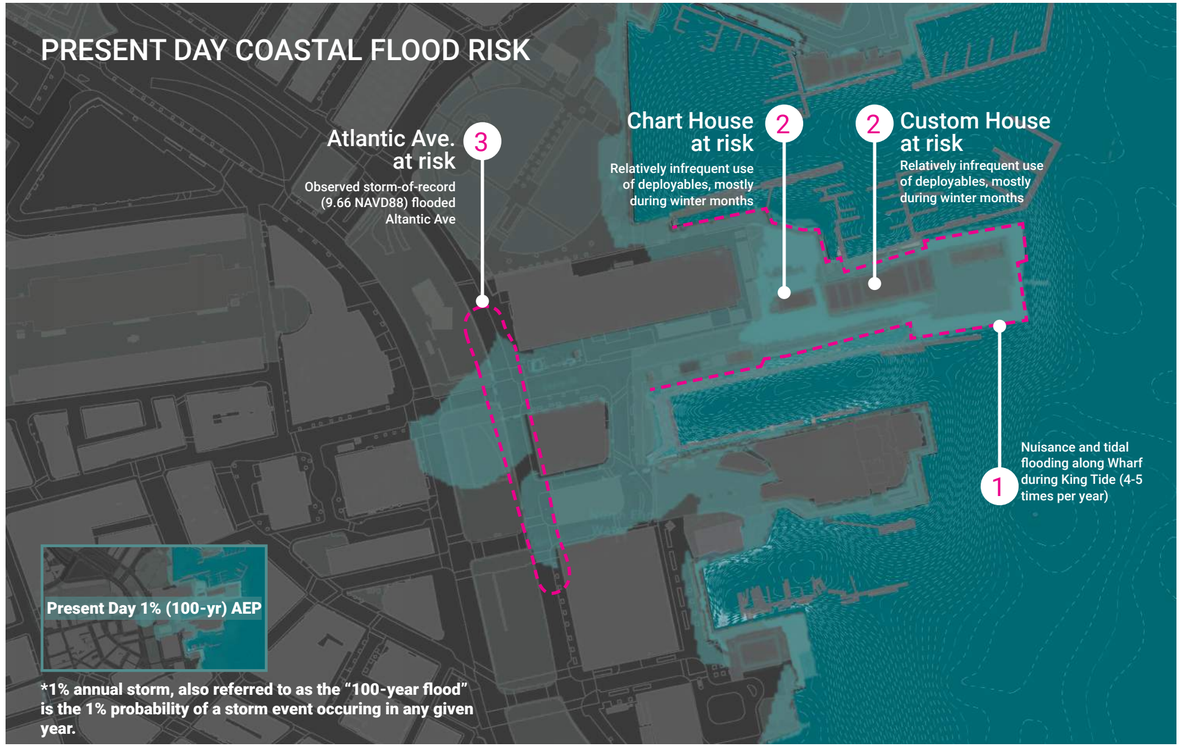


Figure 3-27 - Effectiveness of 2030 Intervention Scheme, extended both to the North along Atlantic Ave, and south to block off immediate flood pathways from the Simons Theatre at NEAQ and at East India Row (Phase 3). [The extensions themselves are not depicted.]

DRAFT

DRAFT

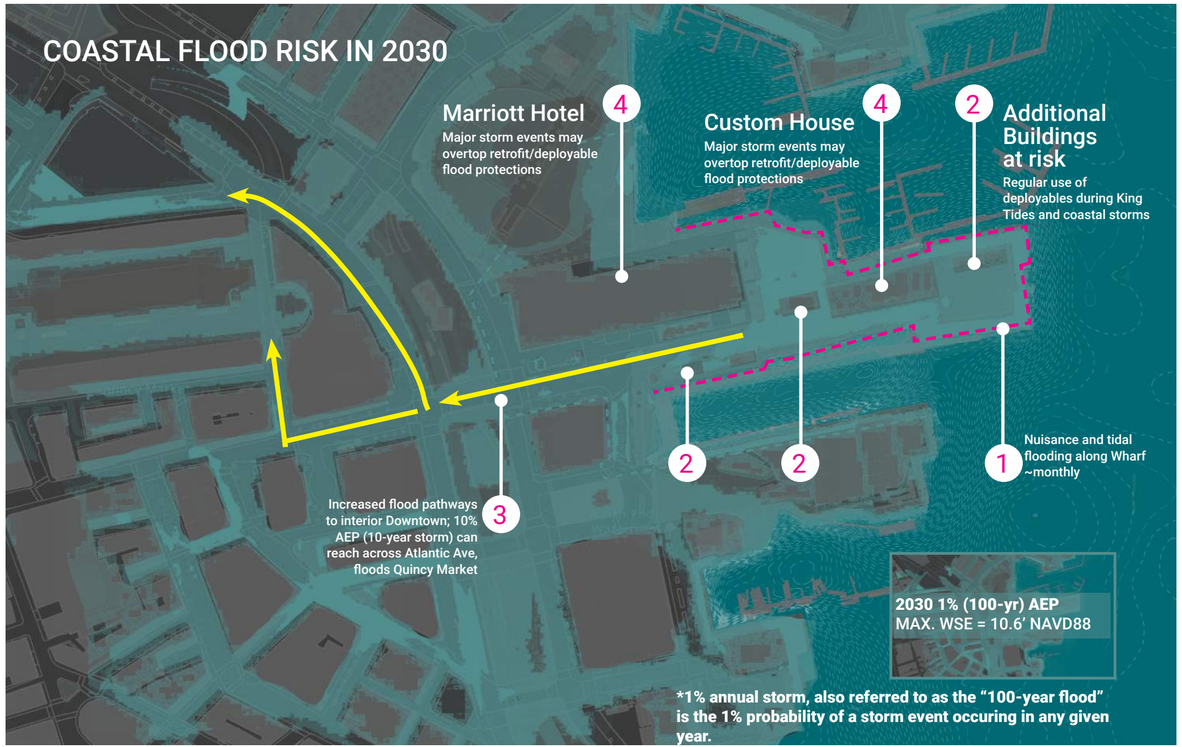


Figure 3-28 - Effectiveness of longer-term Long Wharf adaptation, with alignment elevated to 15' NAVD88 (e.g. 2070 Big Splash scheme)

DRAFT

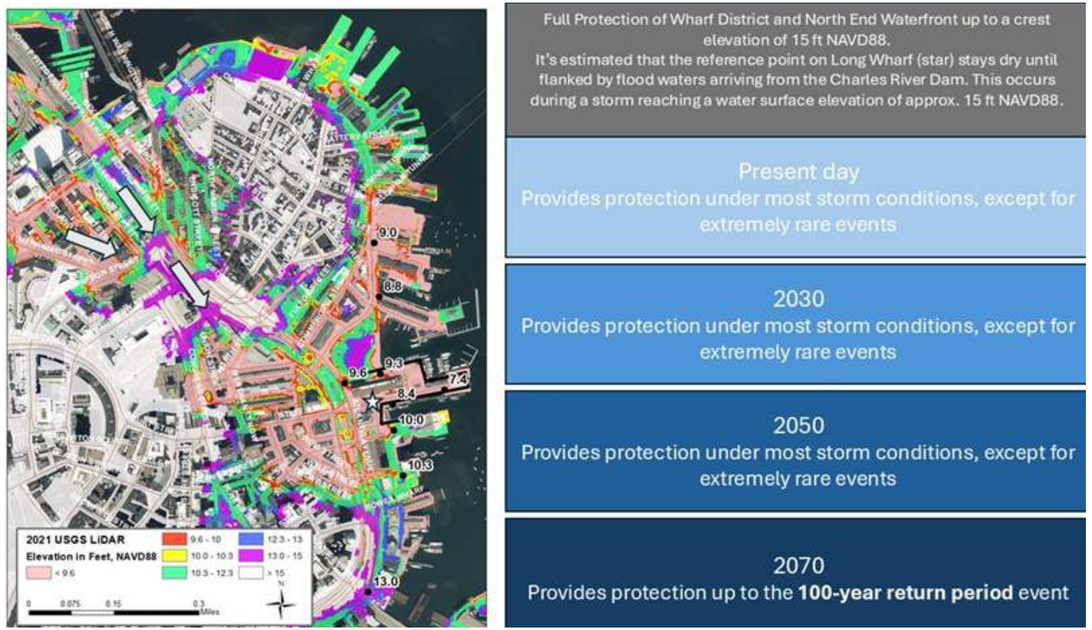


Figure 3-29 - Effectiveness of longer-term district-scale solution for the Wharf District (inclusive of Long Wharf) and North End

DRAFT

SUMMARY & KEY FINDINGS FROM SUB-MODEL

- A hydrodynamic modeling assessment was completed to identify any impacts to flood extent, flood depth, or flood velocities that may be caused by the proposed 2030 Intervention Scheme at Long Wharf, which primarily consists of the building of a vertical flood barrier alignment between Christopher Columbus Park and Central Wharf, as well as regrading of the site around the new structure. Potential changes to flooding were evaluated for the area surrounding the site.

- The MC-FRM probabilistic results indicate that this property is vulnerable to coastal storms under a changing climate, with the ACFEP of flood waters impacting the site increasing from a range of 0.5% - 100% in 2030, to 5% - 100% in 2050, and finally to 100% (or greater) in 2070.

- The modeling assessment completed for this project site included a sub-modeling approach that was designed to be a site-specific assessment, which includes the dynamics of high-resolution flow around buildings. This sub-model was linked to the MC-FRM model and included more up-to-date topography data for both existing and proposed conditions.

- One coastal storm event, taken from the overall MC-FRM ensemble, representing a 1% ACFEP (100-year return period) water surface elevation event in 2030, was simulated for both the existing (without project) and proposed (with project) conditions.

- In the simulated storm event, the 2030 Intervention Scheme results in a minor reduction in flood extent and a moderate reduction in flood depth inland of the proposed alignment. It does not result in any increases in flooding or redirection of flood water on adjacent properties.

- In the simulated storm event, the 2030 Intervention Scheme results in increases in velocity in some areas (primarily roadway rights-of-way and not directly at building footprints) and reductions in velocity in other areas (e.g., Rose Kennedy Greenway and between Quincy Market and Faneuil Hall).

- Flanking flood pathways that activate in the 1% ACFEP storm event in 2030 and undermine the independent effectiveness of the 2030 Intervention Scheme are evident from the performance modeling results.

- Mitigating these flanking pathways in a phased approach could provide district-wide flood protection that extends to the 1% 2070 storm event.

DRAFT

04 EXISTING CONDITIONS + VULNERABILITY ASSESSMENTS

EXISTING CONDITIONS AND VULNERABILITY ASSESSMENTS

OVERVIEW

Available data was reviewed and evaluated related to Long Wharf buildings and infrastructure to understand existing conditions and the Wharf's vulnerability to flooding today and in the future. Field visits were made to observe existing conditions. Appendix A contains an Existing Conditions and Vulnerability Assessment Report dated May 2023, which contains detailed information and photographs about buildings and infrastructure on Long Wharf. Below is a synopsis of the findings from this report.

EXISTING CONDITIONS

The existing conditions assessment provides a comprehensive overview of the buildings, seawalls, and Harborwalk on Long Wharf, and evaluates their current, near-term, and long-term flood vulnerabilities. This assessment identifies vulnerabilities to coastal flooding and sea level rise over time, offering a baseline understanding of how each structure may be impacted under future flooding scenarios. The findings informed the design team's approach to resilience planning and adaptation strategies.

FLOOD VULNERABILITY

The Flood Vulnerability section outlines the risks Long Wharf faces from coastal flooding now and in the future, providing a detailed assessment of present-day conditions, near term vulnerabilities through 2050, and long-term risks anticipated in 2070 and beyond. This analysis incorporates both observed impacts - such as past flood damage, drainage limitations, and operational issues - and projected sea level rise and storm surge scenarios. By examining how existing challenges may be exacerbated over time, this section establishes a critical foundation for identifying areas of concern and informing adaptive strategies that support the long-term resilience of Long Wharf's infrastructure, public spaces, and cultural assets.

Figure 4-1 - Image Source: Digital Commonwealth

Figure 4-2 - Image Source: Digital Commonwealth

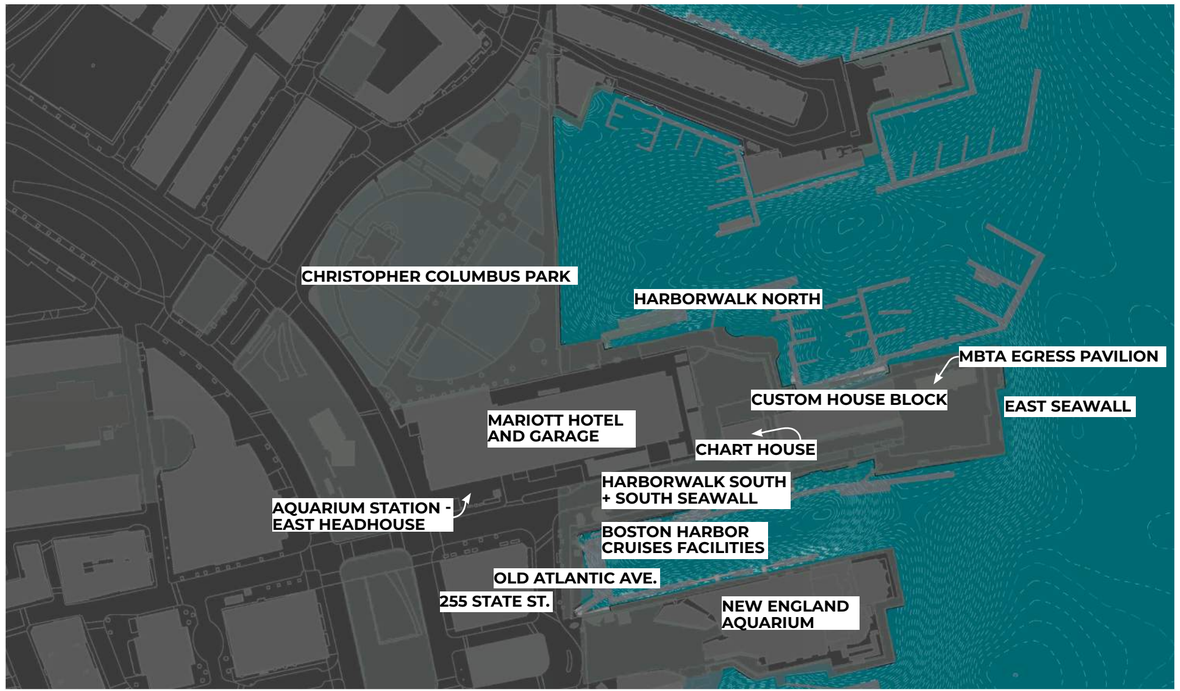


Figure 4-3 - Project Site Plan

DRAFT

DRAFT

THE GARDINER BUIDLING (CHART HOUSE)

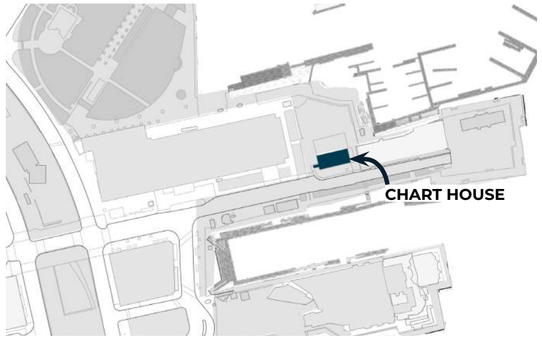


Figure 4-4 - Project Site Plan - Chart House

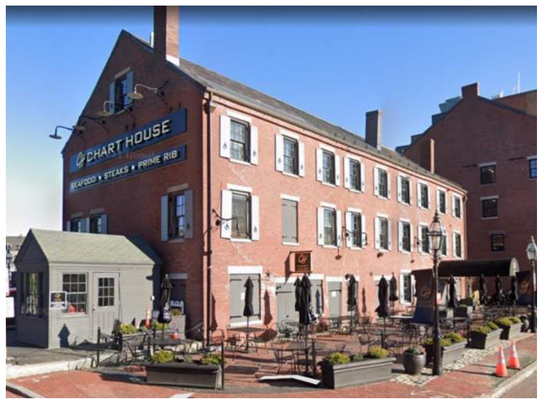


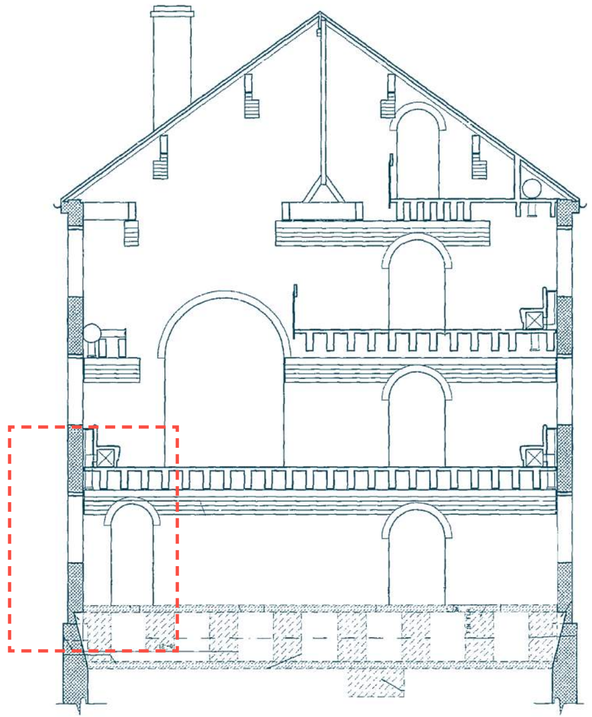
Figure 4-5 - The Gardiner Building (Chart House)

The Chart House, formerly known as the Gardiner Building, is a four-story brick masonry building located on Long Wharf, which is privately owned by Capital Properties. The four-story building, which now houses the Chart House restaurant, was built around 1763 and served as an office to Thomas Hancock and, subsequently, his nephew John Hancock. Often referred to as "Hancock's Counting House," it is the oldest building on Long Wharf. The Boston Chart House restaurant, which opened in July 1973, is a popular restaurant for locals. Guests will note many original fixtures such as Hancock's safe, broad wooden beams, floors, staircase, and red brick walls. The latest records show the building underwent a major renovation in 1999. The renovation included foundation, façade, and interior repairs. The record drawings indicate below-grade excavation was done for the placement of piles and grade beams, plus excavation for an areaway for post-tensioning of new cast concrete beams. The space was then backfilled after post-tensioning. There is no indication of any special waterproofing having been installed, except a layer of "vapor barrier". The Gound floor elevation is approximately EL. 7.2' NAVD88.

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The Chart House is vulnerable to flooding under present day conditions. The EL. 9.66' NAVD88 flood-of-record during the January 4, 2018, nor'easter flooded the ground floor of the restaurant. The restaurant has also flooded several times under lesser events. Based on discussions with the restaurant staff, the previously experienced water levels have not caused significant damage to the electrical system.
Near-term Flood Vulnerabilities (to 2050)	The near term DFE of EL. 15.0 NAVD88 will cause significantly more flood damage on the ground floor of the restaurant, including to the building's electrical system.
Long-term Flood Vulnerabilities (2070 and beyond)	For flood events higher than the near term DFE of 15.0 NAVD88, the flooding damage will only get worse.

DRAFT



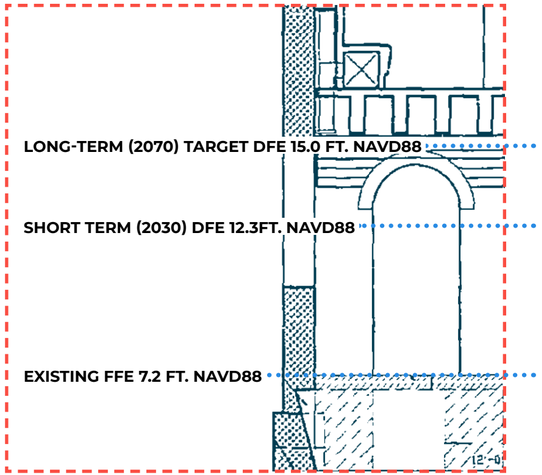


Figure 4-6 - The Gardiner Building (Chart House) - Section

DRAFT

CUSTOM HOUSE BLOCK

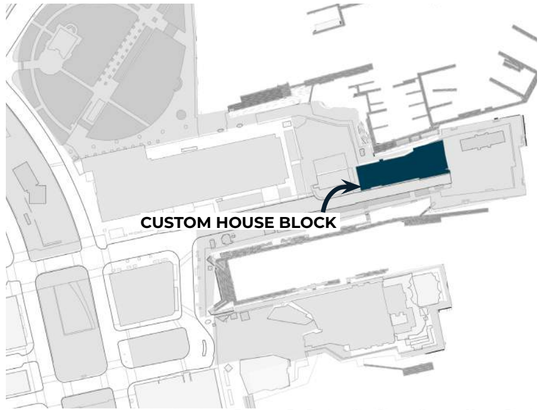


Figure 4-7 - Project Site Plan - Custom House Block

Figure 4-8 - Custom House Block

The Custom House Block is a five-story brick and granite masonry building located on Long Wharf. The building is believed to be constructed in or about 1848. It is currently privately owned by Capital Properties. The interior floor of the building consists of wood framing supported by the masonry structure. The Custom House Block originally served as a warehouse along Long Wharf and today is used as commercial office space. The ground-level floor is at about EL. 8.91 +/- NAVD88 and the basement/crawlspace level floor is at EL. 0.0 +/- NAVD88. The foundation system is believed to be stacked granite blocks supported on wood pilings. The wood pilings are anticipated to be deriving their load-carrying capacity from the marine clay deposits located below the organic silt and fill layers at depths estimated to be 35-40 ft. below the existing ground surface. The MBTA Blue Line tunnel passes under the southeast corner of the building. The building's basement/crawl space is subject to daily tidal flooding today - it has flooded since at least the early 1940s. Originally, the basement was kept dry by a below-grade clay dam around the building's exterior. The flooding is believed to be associated with the clay dam being compromised when trenches were excavated and backfilled with more porous materials to bring below-grade utilities into the building. There is also evidence of passages on the north side of the building that connect the basement with the harbor, allowing tidal waters to enter.

DRAFT

During Capital Properties' 2017 redevelopment of the Custom House Block, part of the ground floor timber beam and wood plank deck structure were renovated. Construction was coordinated around ocean tides, with the basement level flooding twice a day. The timber flooring in three of the ground floor bays was replaced with 8" precast concrete planks with a 2" concrete topping slab (Bays 64, 66, and 68). Although the drawings show the timber flooring in Bay 64 being replaced with concrete, it appears that it was actually done in Bay 65. These floor replacements were part of a waterproofing strategy for these bays to prevent water from coming up through the floor. At Bay 65, the north electrical room, a full structural slab was constructed from masonry wall to masonry wall, along with a 42" high concrete perimeter curb flood protection wall inside the building on the ground floor, with a surface-mounted jamb frame and floodgate (refer to pictures in the site visit report). The top of the interior flood wall is at approximately El. 12.41' NAVD88. The transformer room is located in Bay 66. The adjacent Eversource transformer does not appear to have any flood protection as the exterior of the transformer room walls are protected with louvers that would let flood waters above about El. 8.91 NAVD88 pass through into the transformer room. We were unable to obtain information from Eversource if the transformer is a waterproof transformer.

Figure 4-9 - Surface-Mounted Jamb Frame and Floodgate. (Image Source: Kleinfelder)

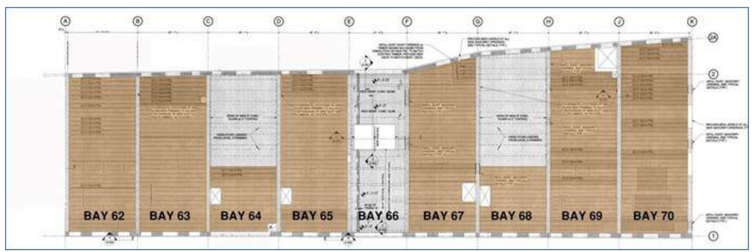


Figure 4-10 - Custom House Block

DRAFT

CUSTOM HOUSE BLOCK

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The ground floor of the Custom House Block is subject to flooding under present day conditions. The EL. 9.66 NAVD88 flood-of-record during the January 4, 2018 nor'easter was above the first floor of all of the units. Building management has on hand some deployable barriers that they can deploy at doorways to help slow the movement of water into the building. The main electrical room located in Bay 65 is fairly well protected from flooding to EL. 12.41 NAVD88 under present day conditions by the concrete floor and interior perimeter flood wall and flood gate. We do not have information from Eversource on the vulnerability of the transformer to flooding under temporary conditions.	*Long-term Flood Vulnerabilities (2070 and beyond)*	At water depths greater than the near term DFE of 15.0 NAVD88, the flood damage to the building would only increase.
Near-term Flood Vulnerabilities (to 2050)	At the near term DFE of 15.0 NAVD88, the first floors of the building will be completely inundated. In addition, the main electrical room in Bay 65 will also flood because the water will be higher than the interior concrete perimeter flood wall. It is likely that the glass storefront windows and doors would also be damaged at a DFE of 15.0 NAVD88. The masonry walls can likely withstand the water pressure at this depth of water, with some leakage through cracks in the masonry. Areas with timber floor would also flood through the timber flooring from the basement below.		

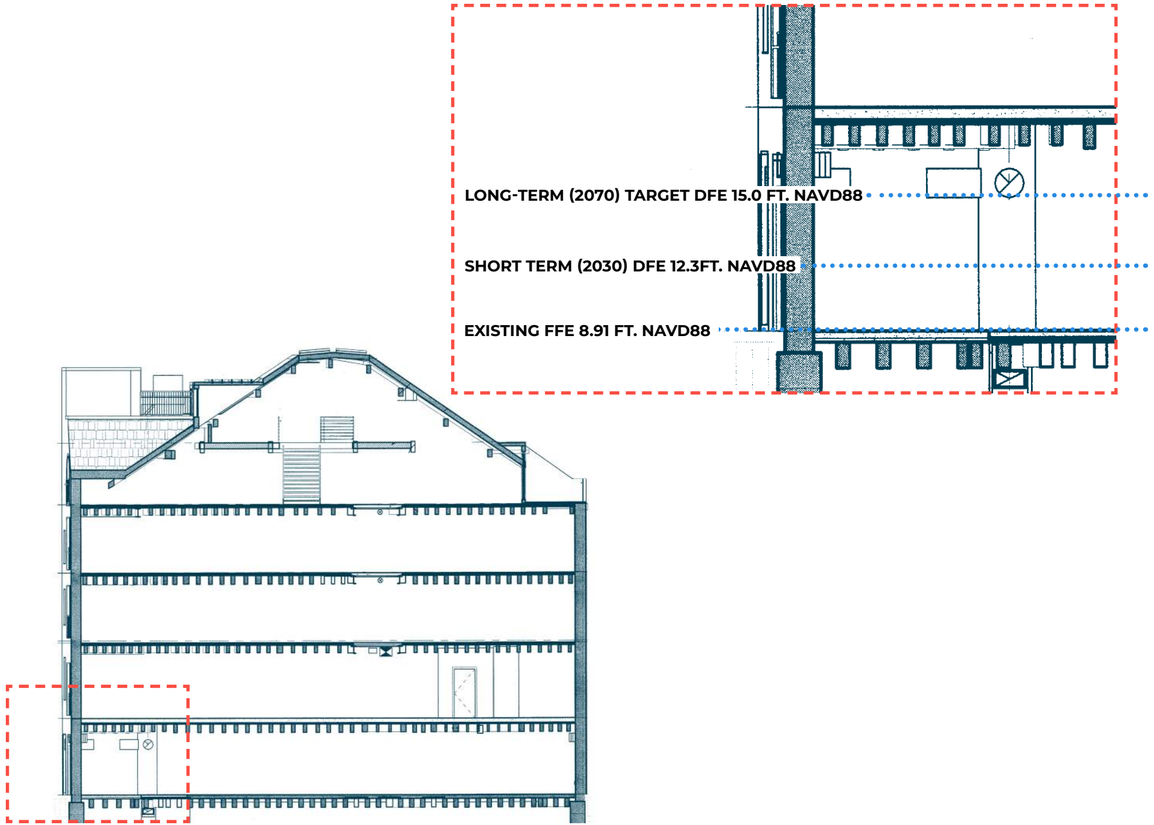


Figure 4-11 - Custom House Block - Section

DRAFT

DRAFT

MBTA EGRESS PAVILION

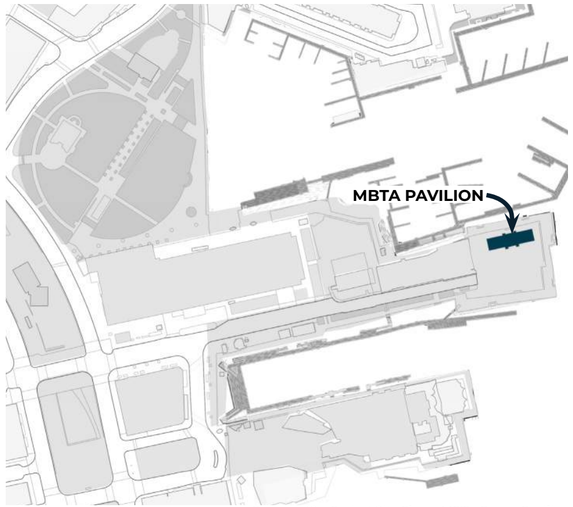


Figure 4-12 - Project Site Plan - MBTA Egress Pavilion

The Long Wharf Pavilion MBTA Pavilion was constructed in 1983 to serve as an MBTA vent building and emergency egress from the Blue Line tunnel below. There is a fan room and electrical substation one level below grade, which are accessible by interior stairs. There is a headhouse to protect the Blue Line egress stair with a finished floor at El. 9.86 NAVD88. Waterproofing was applied to the top of the structural slab and extended roughly 3 ft. down along the cast-in-place concrete structural wall below grade. In 2020, the glass block headhouse was demolished and replaced with a new floodproof reinforced concrete, brick-faced headhouse with a floodproof door. Permanent flood protection panels were installed at the four emergency ventilation shaft louver openings including anchorage to prevent flood waters from entering the louvered vent shafts. The ground floor elevation of the egress door is EL. 9.86' NAVD88. The structure was designed to protect up to a design flood elevation (DFE) incorporating 4 feet of freeboard above the MassDOT Boston Harbor - Flood Risk Model 1% annual chance flood elevation in 2030.

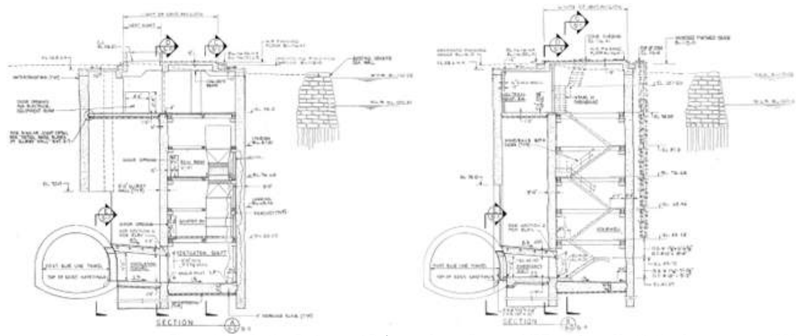


Figure 4-13 - Section Background Reference Image Source - MBTA Subway Ventilation Improvements 1983

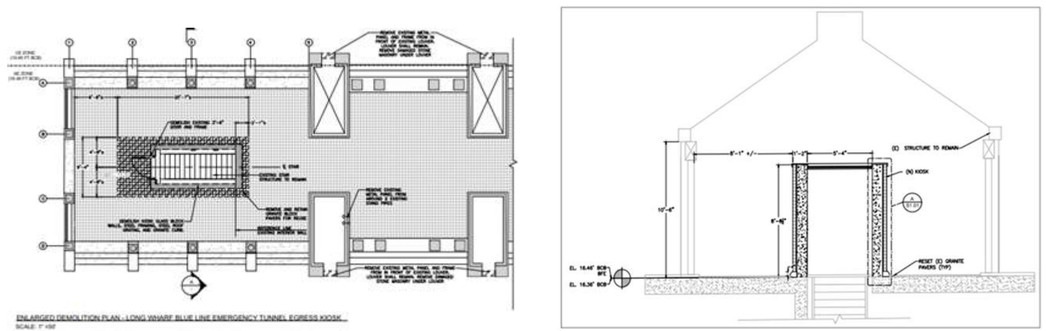


Figure 4-14- Plan and section background reference for MBTA Blue Line Aquarium Station Floodproofing Improvements - 10/23/2019 (MBTA/Kleinfelder)

DRAFT

DRAFT

MBTA EGRESS PAVILION

Present Day (Existing Flood Vulnerabilities)	The MBTA Pavilion structure is not vulnerable to coastal flooding in the near term: • The Pavilion structure – which serves as an MBTA emergency egress from the Blue Line Tunnel – can become unusable as tunnel egress during major coastal storms, because floodwaters overtopping Long Wharf would make it impossible to open the flood door and evacuate the tunnel. But flood waters will not enter into the tunnel through the floodproof egress headhouse structure. • The Pavilion structure was previously retrofitted in 2020 to add dry floodproofing measures, including the installation of a flood door (watertight door), replacement of glass block walls with solid reinforced concrete walls faced with brick, and floodproofing of the exterior structure vent louvres (metal sheeting added) up to an elevation of 14.1' NAVD88. Present Day vulnerabilities are limited to underground leakage through the egress shaft walls and utility conduits (not necessarily storm-related risk): • The subsurface structure is not watertight. The MBTA is separately investigating ways to control underground leakage, but this is not within the scope of this project. The MBTA did note that much of the earth fill material on Long Wharf is very porous due to the nature of the fill material (old debris typically is in the fill). The porosity of the fill makes it easier for tidal waters and storm surges to migrate quickly through the fill to underground structures.
Near-term Flood Vulnerabilities (to 2050)	By 2050, the frequency at which the Blue Line Tunnel egress is impeded at this location could increase. At the DFE of 15.0 NAVD88, the water levels would exceed the height of the flood panels on the ventilation louvers and would flood the Blue Tunnel below.
Long-term Flood Vulnerabilities (2070 and beyond)	By 2070, the Pavilion structure would experience regular flooding during elevated tide events, even absent a storm (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)). The shaft itself is protected up to El. 14.81 NAVD88. By 2070, a major coastal flood event could overtop the maximum height of dry floodproofing at the exterior structure vent louvres (~14.1' NAVD88).

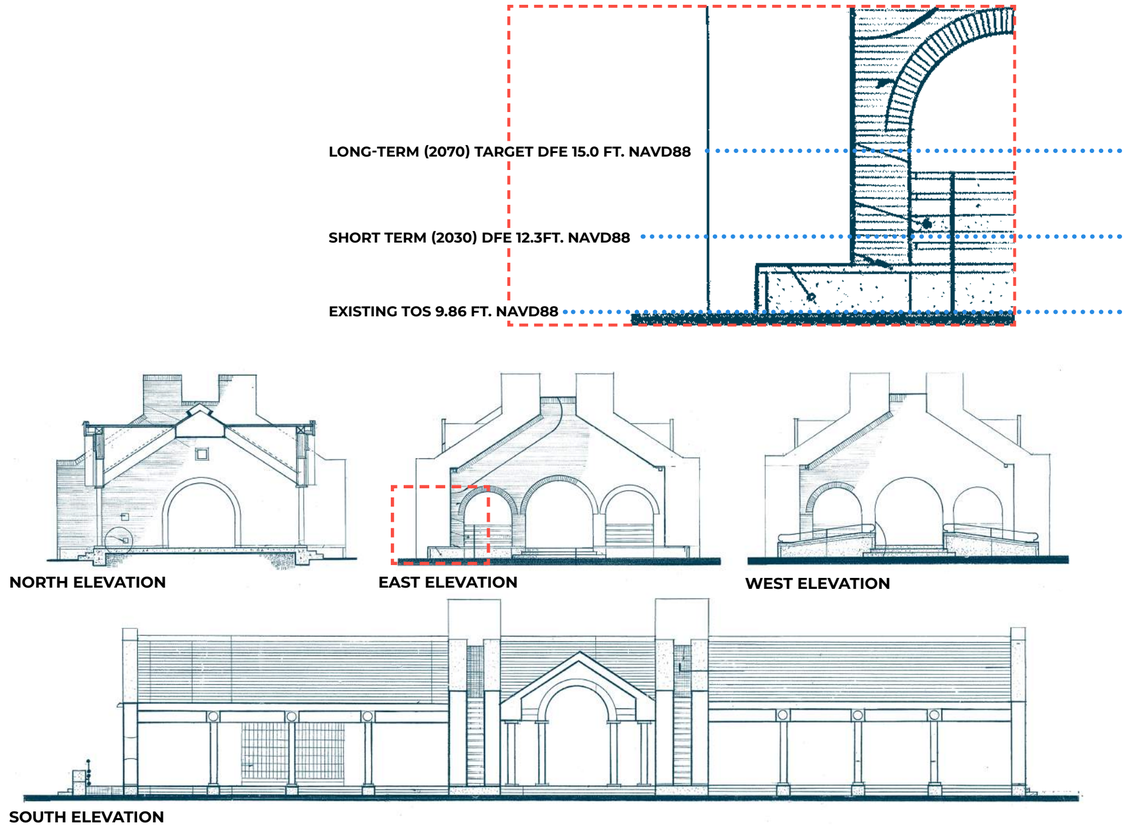


Figure 4-15 - MBTA Egress Pavilion - Elevations

DRAFT

DRAFT

HARBORWALK SOUTH

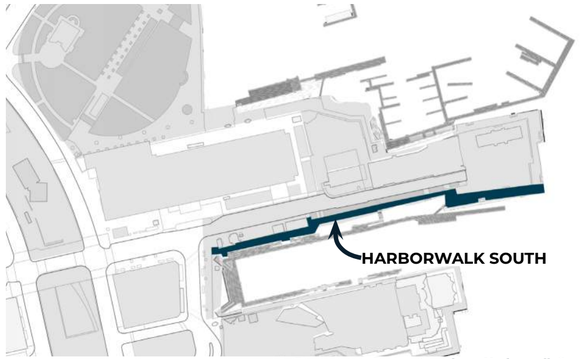


Figure 4-16 - Project Site Plan - Harborwalk South

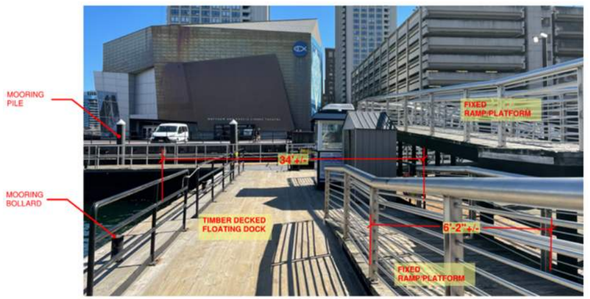


Figure 4-17 - ADA Ramp above The Float Platform at Long Wharf South

Harborwalk South is where the MBTA Ferry's Long Wharf South dock is located. The MBTA operates three year-round water commuter services through contracts with Boston Harbor City Cruises (BHCC) from this location. Public ferries to six of the Boston Harbor Islands leave from gateways at Long Wharf South. Two main MBTA service lines at Long Wharf South include ferries to Charlestown and to Lynn.

BPDA's Long Wharf and Central Wharf Marine Transportation Facilities, Old Atlantic Avenue Berth project, was constructed in 2000. The project included construction of ADA-compliant decking, railing, platforms, ramps and float updates. The project provided upgraded decking and float arrangements. The majority of the 3"x8" timber decking was constructed on 6"x12" timber stringers. The timber deck is flush with the top of the adjacent brick pavers. Details at this section include:

- Existing concrete cap at the edge of old Atlantic Avenue is at 8.75' +/- NAVD88
- A 6-foot-wide ADA accessible ramp from the street level to the ferry dock
- 16" diameter steel pipe mooring piles. The tops of piles are at approximately EL. +15.5' NAVD88

Reconstruction at Harborwalk South along State Street was one of the BPDA's 2006 construction projects. Harborwalk timber decking and timber stringers were constructed above piles and steel beams and cantilevered over the existing granite seawall. The existing seawall was also repaired and stabilized during the Harborwalk reconstruction. Elevations at the top of the existing seawall vary, ranging from EL +8.02' to +10.57' NAVD88, and the top of the Harborwalk decking is at an average elevation of 8.6' NAVD88.

DRAFT

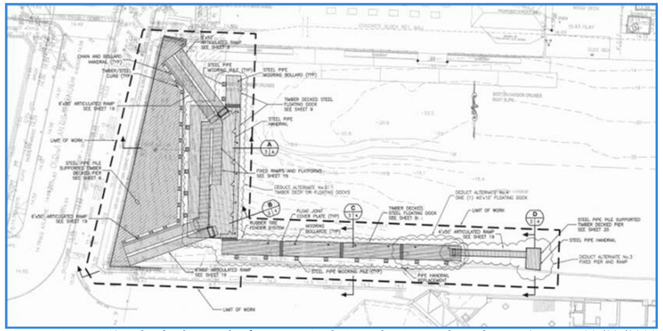


Figure 4-18 - Plan background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)

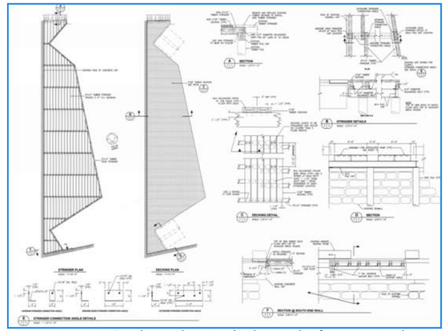


Figure 4-19 - Plan and section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)

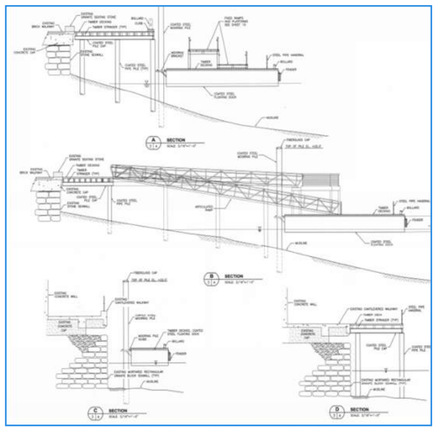


Figure 4-20 - Section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)

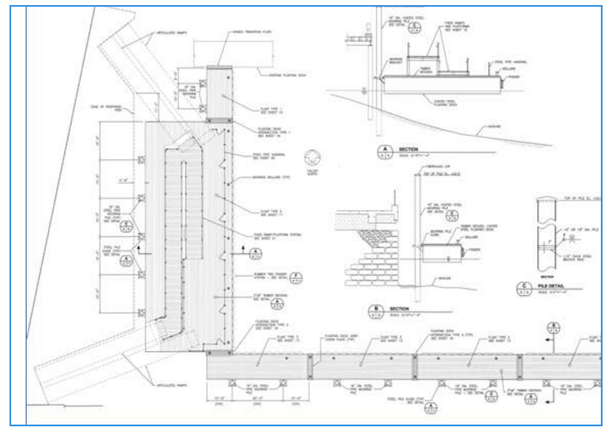


Figure 4-21 - Plan and section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)

DRAFT

HARBORWALK SOUTH

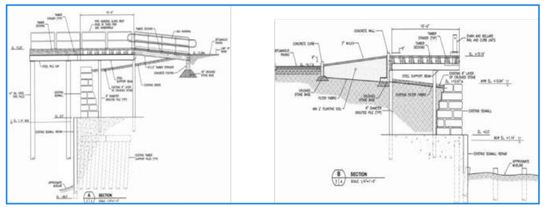


Figure 4-22 - Plan and section background reference - Harborwalk South Reconstruction along State Street at Long Wharf South - 01/11/2006 (BPDA/Childs)

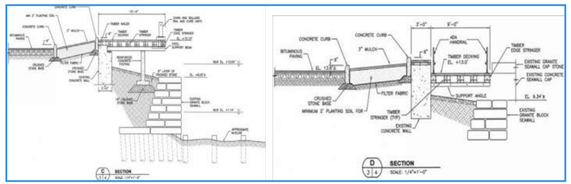


Figure 4-23 - Section background reference - Harborwalk South Reconstruction along State Street at Long Wharf South - 01/11/2006 (BPDA/Childs)

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The existing Harborwalk structures are relatively immune to flood issues in the present day.
Near-term Flood Vulnerabilities (to 2050)	Pilings currently extend to 15.5 NAVD88, which is only six inches higher than the near-term target DFE of 15.0 NAVD88. By 2050 there is an increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.
Long-term Flood Vulnerabilities (2070 and beyond)	By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the steel pipe mooring pile) during a major coastal storm. By 2070, the existing seawall and Harborwalk would be overtopped more regularly (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)), with potential inundation twice a day at high tide.

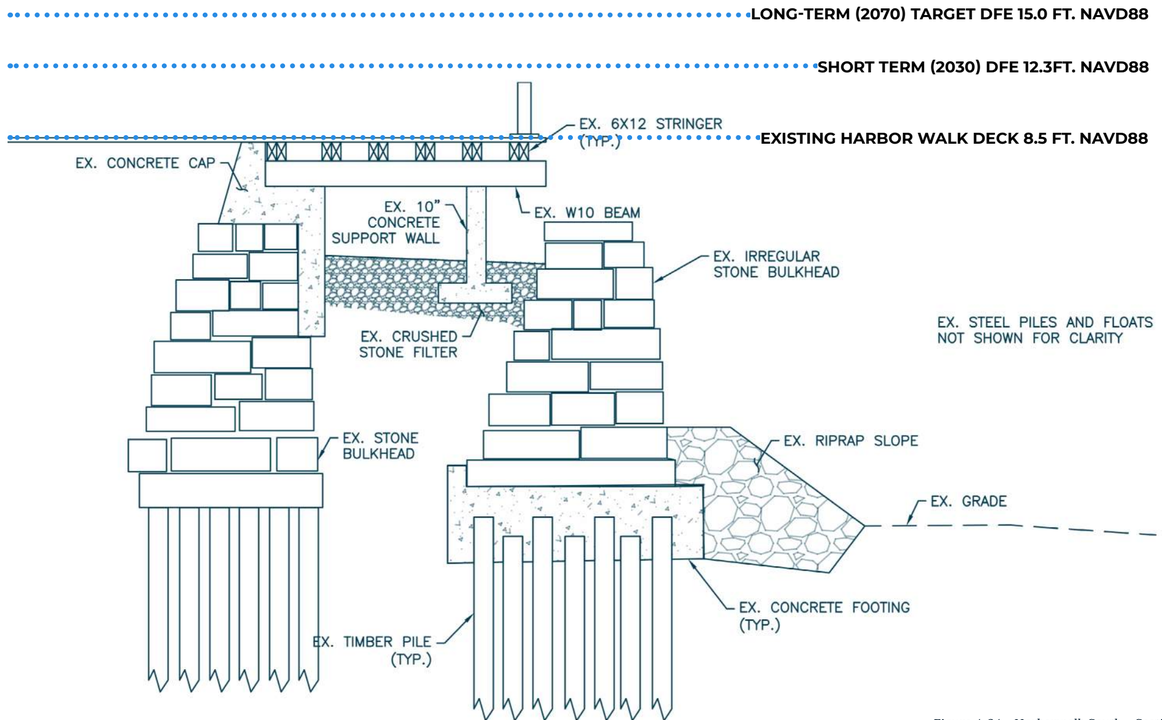


Figure 4-24 - Harborwalk South - Section

DRAFT

DRAFT

HARBORWALK NORTH

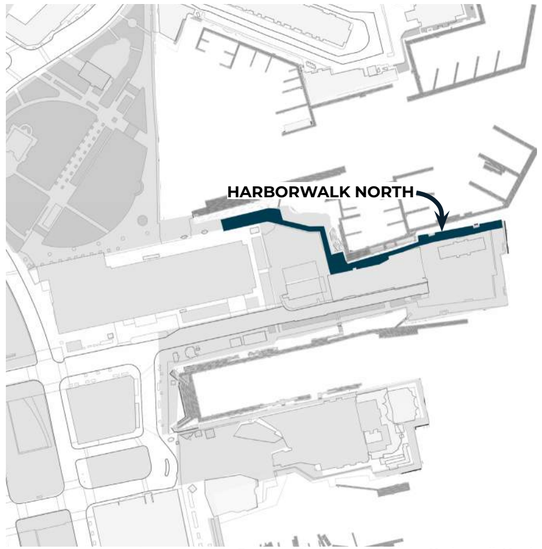


Figure 4-25 - Project Site Plan - Harborwalk North

Harborwalk North, where the MBTA ferry's Long Wharf North dock is located, provides ferry service between Logan Airport-Hull, MA-Hingham, MA, East Boston Lewis Mall and free ferry service to the Encore Casino. In 2007, BPDA conducted its Long Wharf North Site Improvements project.

- The timber decking and timber stringers were constructed above reinforced concrete footings.
- The decking was set to align with the existing walkway at EL +9.35' NAVD88.
- The top of the steel mooring pile is at EL +15.5' NAVD88.

A new accessible steel gangway connector ramp was designed to reduce issues associated with slope inversion with the floating ferry dock.

Figure 4-26 - Long Wharf North MBTA Ferry Gate Entry Platform looking east

DRAFT

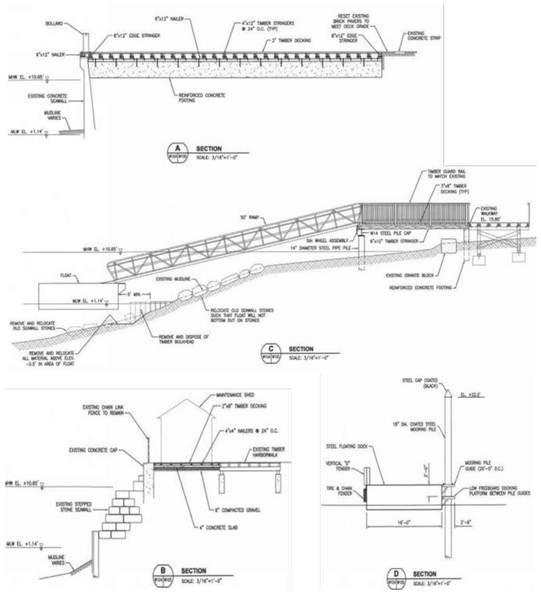


Figure 4-27 - The section background reference - Long Wharf North Site Improvement _01/2007 (BPDA/Childs)

Harborwalk North along the north side of the Custom House Block was extended towards the harbor during a year 2000 construction/ renovation project. The old chain-link fence, timber deck, ramp, and stairs were removed, and a new timber boardwalk was constructed and extended towards the harbor. This walkway was considered an interim condition anticipating later improvements to the area and parking site. The timber decking and timber stringers were constructed above the existing granite seawall with steel bracing braced back to the existing fence footing. The top of the Harborwalk North was indicated at EL. 8.96 NAVD88.

DRAFT

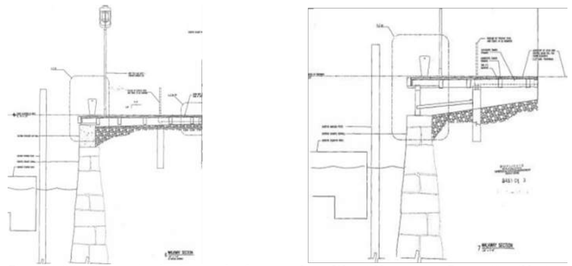


Figure 4-28 - The section background reference - Long Wharf Harborwalk Renovation (North Side along Custom House Block)_ 09/29/2000 (ELV/ArrowStreet)

The Ferry Center/ Ticket Booth on the site is a 10'X20' wood structure constructed on a concrete slab. It is not floodproofed and has no ability to withstand any external water pressure from flooding.

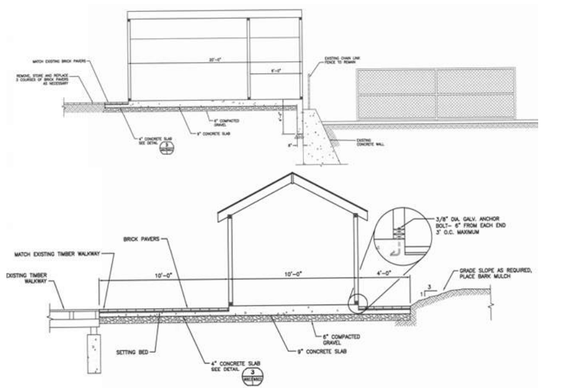


Figure 4-29 - The section background reference _ Long Wharf North Site Improvement _01/2007 (BPDA/Childs)

HARBORWALK NORTH

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	• No major past damage or existing operational issues were noted. • The 50' ramp to the MBTA/Encore ferry float can be inverted (negative slope) when coastal storm raises total water levels above ~9.35' NAVD88 (the elevation of existing walkway and timber decking). • The existing seawall is not watertight. Tidal flow of water through the seawall is causing loss of fines that causes settlements of grade behind the seawall, and eventual structural issues with the seawall stones themselves.
Near-term Flood Vulnerabilities (to 2050)	• Pilings currently extend to 15.5' NAVD88, which is only six inches higher than the near-term target design flood elevation of 15.0 NAVD88. By 2050 there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm. • Increased risk of damage or displacement of the wood ticket booth during a coastal storm event. By 2050, the ferry center / maintenance shed could experience flooding damages from king tide events, even absent a major coastal storm. The wood structure cannot resist any flood forces and would leak and be likely destroyed with any wave action.
Long-term Flood Vulnerabilities (2070 and beyond)	• By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm. • By 2070, the wooden ticket booth would experience regular flooding (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)). • Decking could be inundated twice a day at high spring tides, even without storm surge.

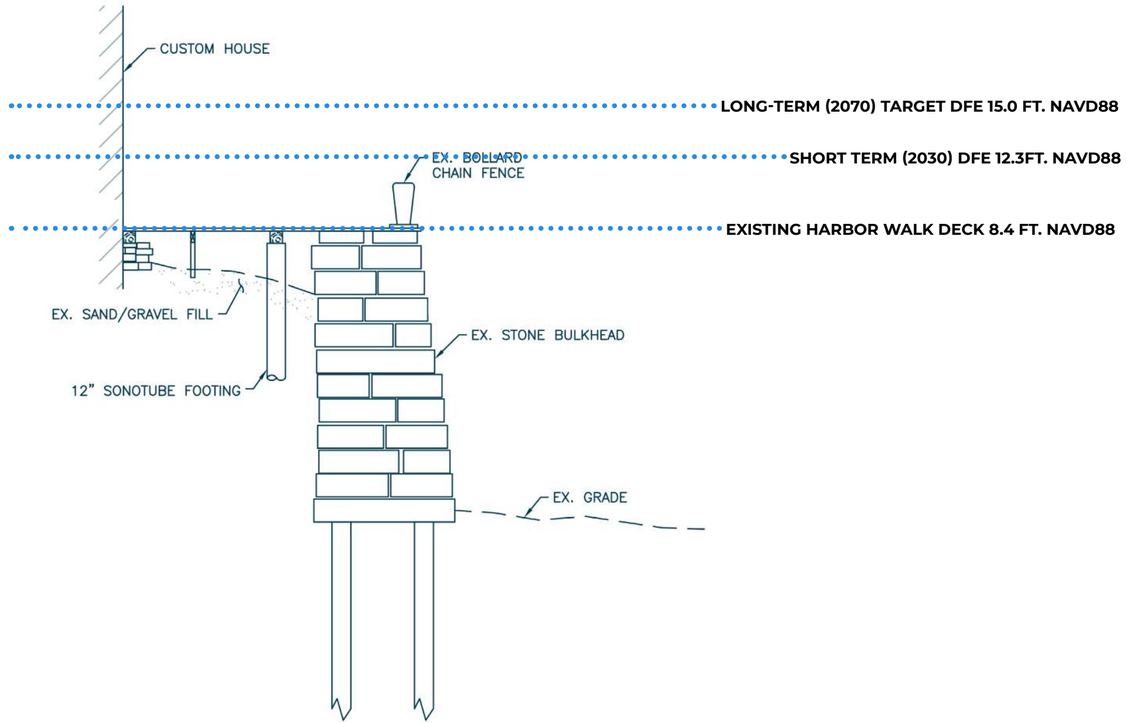


Figure 4-24 - Harborwalk North - Section

DRAFT

DRAFT

BOSTON WATERBOAT MARINA

The Boston Waterboat Marina, located on the north side of Long Wharf, is owned and operated by the Cannon family, a private BPD tenant. The business started in the 1860's supplying casks of potable water to ships. This operation lasted until 1960, when the family transitioned their business from water delivery to marina operations, establishing the Boston Waterboat Marina in 1965. The tenant owns and maintains all of the docking facilities. In August 2025, a request for authorization was made to the Boston Planning Board extend the lease of the Waterboat Marina until March 31, 2032, with a single five-year extension term option.

The inner docks accommodate boats up to 42 ft. in length The outer docks can accommodate much larger yachts. The owner says that they do not have issues with ferry traffic going to and from the Long Wharf North ferry docks. The marina has sewage pump-out service but no fueling facilities. There are bathroom and shower facilities in the Marina for marina guests only (not for the general public).

The oldest docks were installed in 2007. Docks float on 66' piles that extend approximately 20 ft. into the mud. The marina is accessed by a single non-ADA compliant ramp from the parking lot area on the north side of the Custom House Block. The marina has experienced storm damage from various storms, the most significant being in 2022 and later due to wave action. The landing at the top of the access ramp was reconstructed in 2016. The marina has an upcoming project to replace the outer docks with deeper, wave-attenuating docks.

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The Waterboat Marina is potentially vulnerable to storm damage and flooding from coastal storm events under present day conditions. The most significant vulnerability is due to wave damage, more so than from flooding. The docks float up and down with tide on piles. In the severe coastal floods of 2018 and 2022, the docks floated up so high that the access ramp was damaged and they lost access to the docks until the ramp could be repaired.
Near-term Flood Vulnerabilities (to 2050)	The marina's ramp, landing area and electrical system will be very vulnerable to the near term DFE of EL. 15.0' NAVD88. In addition, the tops of pilings may not be high enough to prevent the docks from floating off the piles at El. 15.0' NAVD88. Frequency of damage to the ramp and electrical facilities will increase dramatically.
Long-term Flood Vulnerabilities (2070 and beyond)	For flood events higher than the near term DFE of 15.0' NAVD88, the flooding damage will only get worse. In 2070 the high tide cycles will likely be too high for the existing access ramp configuration to operate properly.

DRAFT

BOSTON HARBOR CRUISES FACILITIES

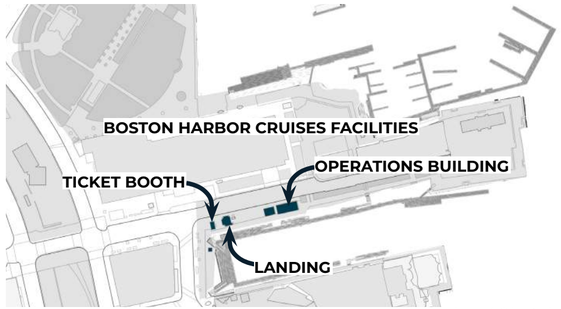


Figure 4-25 - Project Site Plan - BHC Facilities

Figure 4-26 - Existing Condition Plan of some of BHC facilities on Long Wharf

There are three structures in the southwest of the Long Wharf area that Boston Harbor Cruises (BHC) uses for various operations, including ticket sales for the various excursion boats and other ferries operating from Long Wharf, as well as the sale of food, souvenirs, and other merchandise. BHC operates a number of different boats, including New England Aquarium Whale Watch, the Provincetown Fast Ferry, the Godzilla thrill-ride boat, private charters, the Salem Fast Ferry, Sunset Cruises, sightseeing cruises, Harbor Islands cruises, among others. The three structures include a ticket booth, The Landing at Long Wharf bar and a Marine Operations building.

Figure 4-27 - Existing timber Harborwalk along the south side of Long Wharf with BHC docking facilities on the right

DRAFT

BOSTON HARBOR CRUISES FACILITIES

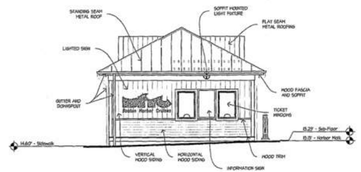


Figure 4-28 - Existing timber Harborwalk along the south side of Long Wharf with BHC docking facilities on the right

Boston Harbor Cruises' operation office was constructed around the year 2000. The construction included a BHC operation office and a wood timber harbor walk. The building is a wood frame structure, which is not floodproofed and cannot resist external water pressure from flooding. The nearby ticket booth and The Landing at Long Wharf bar structure were constructed in a similar fashion.

- Floor deck: ¾" plywood flooring with 1-½" Styrofoam insulation between 4x12 joists floor framing. Top of the subfloor structure EL. +8.73+/- NAVD88
- Exterior cladding: 2x4 studs w/ ½" plywood sheathing and wood siding
- Harborwalk: Wood decking with wood frame. Top of the Harborwalk wood deck EL. +8.65' +/- NAVD88
- Mooring Pile: 16" dia. steel pipe mooring pile, top of the extended Pile EL. +15.5'+/- NAVD88

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The existing buildings are all subject to flooding under present day conditions. The EL. 9.66' NAVD88 flood-of-record during the January 4, 2018 nor'easter was above the first floor of all of the buildings. The method of structure tie-down is unknown. The buildings are all wood-framed construction, which are not watertight and cannot resist externally applied water pressure from flooding.
Near-term Flood Vulnerabilities (to 2050)	At the proposed DFE of 15.0 NAVD88, the structures will likely be severely damaged and could possibly float away. If the wood-framed structures were subject to any wave action, the structures would likely be destroyed. Dock pilings currently extend to 15.5' NAVD88, which is only six inches higher than the near-term target DFE of 15.0' NAVD88. By 2050 there is an increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.
Long-term Flood Vulnerabilities (2070 and beyond)	At water depths above the DFE of 15.0 NAVD88, the wood framed structures would likely be destroyed or float away. By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the steel pipe mooring pile) during a major coastal storm.

DRAFT

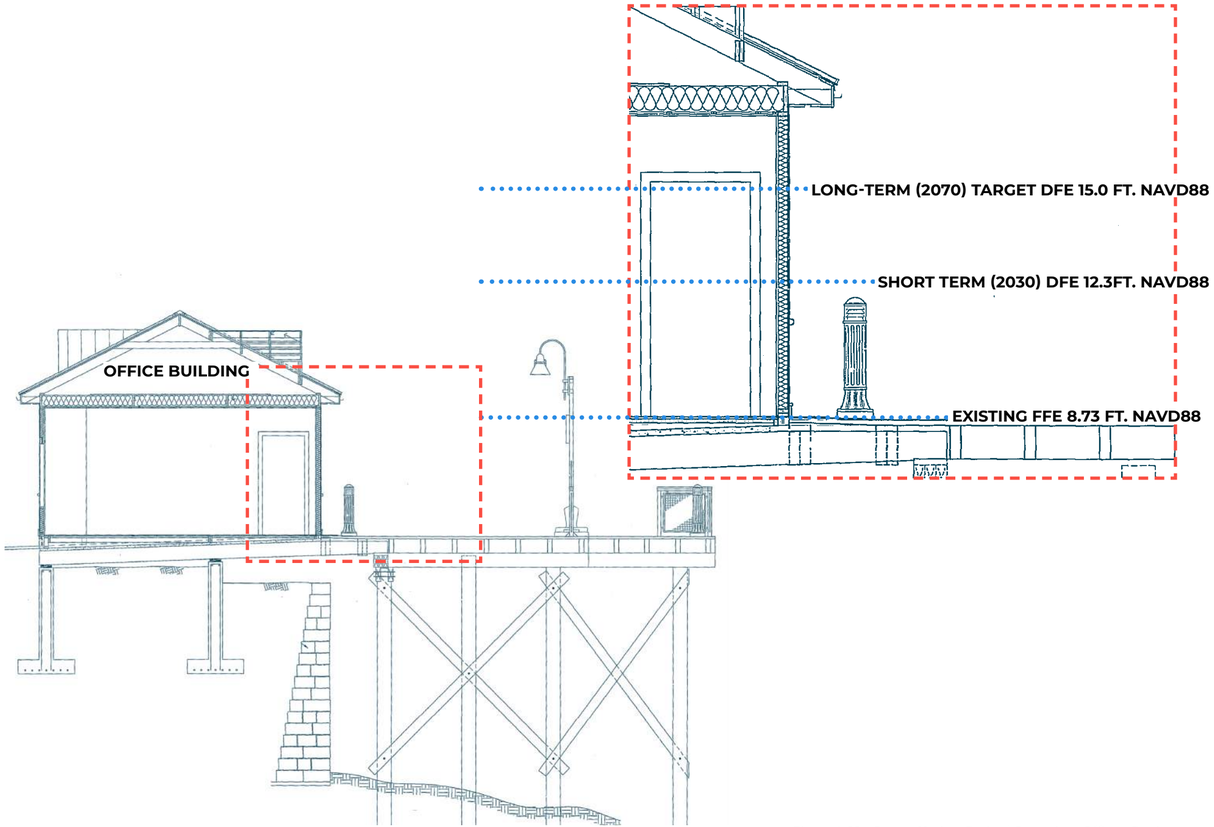


Figure 4-29 - Boston Harbor Cruises' Operations Office - Section

DRAFT

CHRISTOPHER COLUMBUS PARK

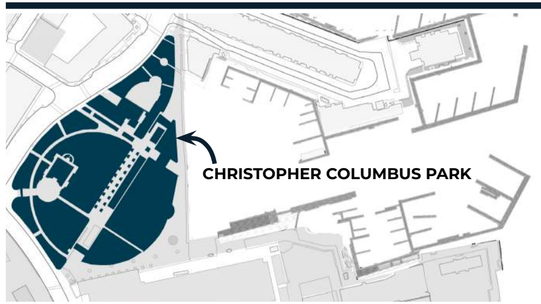


Figure 4-30 - Project Site Plan - Christopher Columbus Park

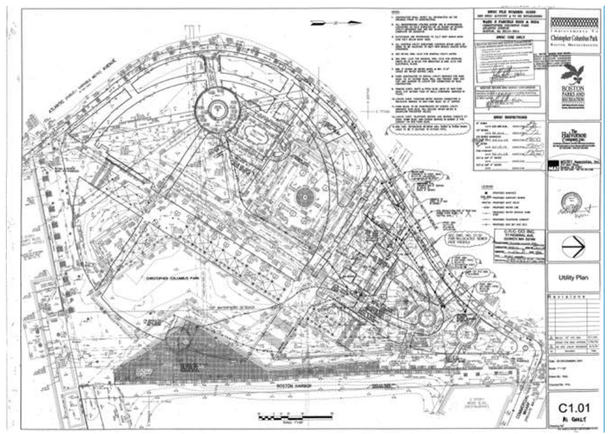


Figure 4-31 - Plan background reference - Improvements to Christopher Columbus Park - 12/20/2001 (City of Boston Parks and Recreation Department)

Located between Boston's Commercial Wharf and Long Wharf, this site was once populated by industrial buildings serving the city's shipping industry. In the 1960s, as a part of urban renewal planning, the Boston Redevelopment Authority (now d/b/a the BPD) Waterfront Urban Renewal program envisioned a concept for a "Walk to the Sea" from Government Center to Quincy Market to the waterfront. In 1974, Sasaki, Dawson & DeMay created a waterfront park on filled land that became an important public access point to Boston Harbor.

In 1999 a new design, by the landscape architecture firm Halvorson Company, produced a new performance area and additional lawn space with expanded views of Boston Harbor. Framed by Atlantic Avenue, Christopher Columbus Park is screened from traffic by generous landscaping, including numerous trees. A central lawn is bordered by a paved walkway connecting the park's central features, including Rose Kennedy Garden and an open promenade framed by a shade structure draped in wisteria vines. A circular fountain marks the park's southwest entrance, while, along the northerly edge, a linear brick path leading from the street to the harbor separates the playground and the Massachusetts Beirut Memorial (1992) from the lawn. A statue honoring the park's namesake was moved to storage in 2020 after protests and vandalism surrounding Columbus' legacy.

- The park's high point is along the trellised walkway at EL. 14'+/- NAVD 88. The low point is at the water's edge ranging from EL. 7'+/- NAVD 88 to EL. 8' +/- NAVD 88.

The Columbus Park Building was constructed around the year 2003. The building includes a garage, staff room, meter room, electrical room and two unisex toilet rooms.

Figure 4-32 - Christopher Columbus Park Elevation Diagram (all elevations shown relative to NAVD88 datum)

Figure 4-33 - Christopher Columbus Park Seawall East Edge (all elevations shown relative to NAVD88 datum)

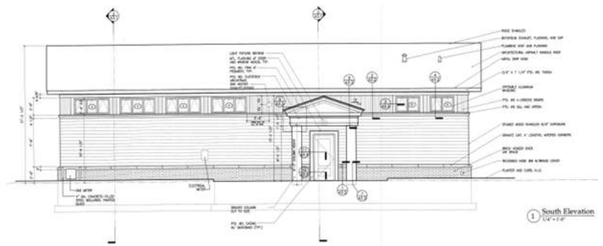
DRAFT

DRAFT

CHRISTOPHER COLUMBUS PARK

The wood-framed building envelope is not designed to resist flooding. Details for this structure include:

- Stained wood shingles with 6" exposure over building paper and ¾" plywood.
- Granite cap over brick veneer as the building base
- The top of the slab is at El. 12.18' +/- NAVD 88)



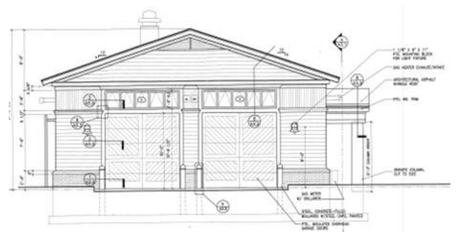


Figure 4-34 - Elevation and section background reference _ Christopher Columbus Park Building _ 05/28/2002 (Boston Parks and Recreation/ The Halvorson Company, Inc./ Carlone Dick LaFleche)

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	Overtopping of the existing seawall has occurred in the past along the paved Harborwalk pathway during severe flood events. There has not been any reported flood damage or other operational issues to the park building or the trellis walkway structure from past flood events.
Near-term Flood Vulnerabilities (to 2050)	By 2070, there is risk interior flooding (beyond the paved Harborwalk section of the park), with propagated flooding from the drainage system accompanying coastal storms with significant precipitation. The building will be subject to flood damage at the proposed DFE of El. 15.0 NAVD88.
Long-term Flood Vulnerabilities (2070 and beyond)	By 2070, the park would experience regular flooding (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)), with potential inundation of the paved Harborwalk section of the park twice a day at high tide during spring tide events. Water levels at or above El. 15.0' NAVD88 would flood the Park building and trellis walkway, possibly causing severe damage from wave action.

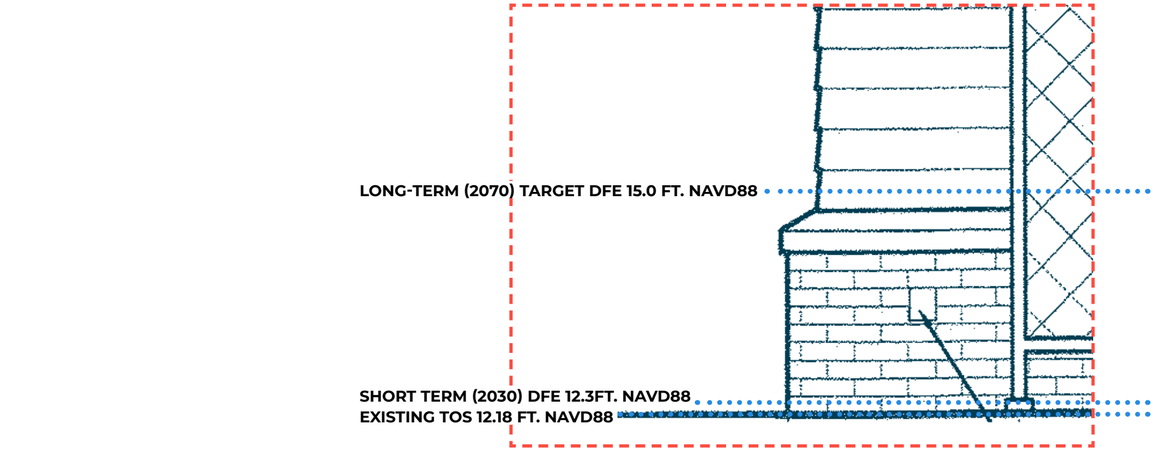


Figure 4-35 - Christopher Columbus Park Building - Elevation

DRAFT

DRAFT

OLD ATLANTIC AVENUE

Old Atlantic Avenue connects State Street, Central Street and Milk Street in a north south direction. It is bounded by the 255 State Street Building and Central Wharf Plaza on the west side and the New England Aquarium and Boston Harbor on the east. It is a two-lane paved road with no markings. Tourist buses, including the Duck Boat Tours, embark and disembark passengers on the east side. There is also a drop area on the east side for the New England Aquarium.

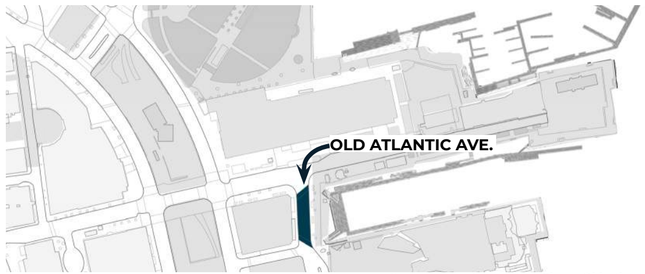
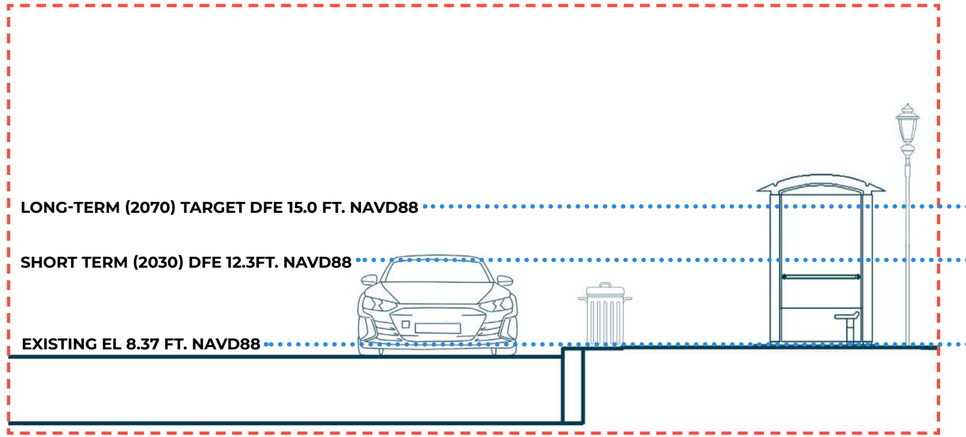


Figure 4-36 - Project Site Plan - Old Atlantic Avenue

Figure 4-37 - View from Old Atlantic Avenue looking north towards Long Wharf

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	Old Atlantic Avenue is vulnerable to flooding today. It has flooded in past major coastal storms, including the January 4, 2018 flood-of-record nor'easter. The road can become impassable, but otherwise does not sustain major damage once the water recedes.
Near-term Flood Vulnerabilities (to 2050)	Flooding of the roadway will likely increase in the future. At the DFE of 15.0 NAVD88, the road will be substantially flooded.
Long-term Flood Vulnerabilities (2070 and beyond)	Old Atlantic Avenue will be subject to extensive tidal flooding events in the long-term.



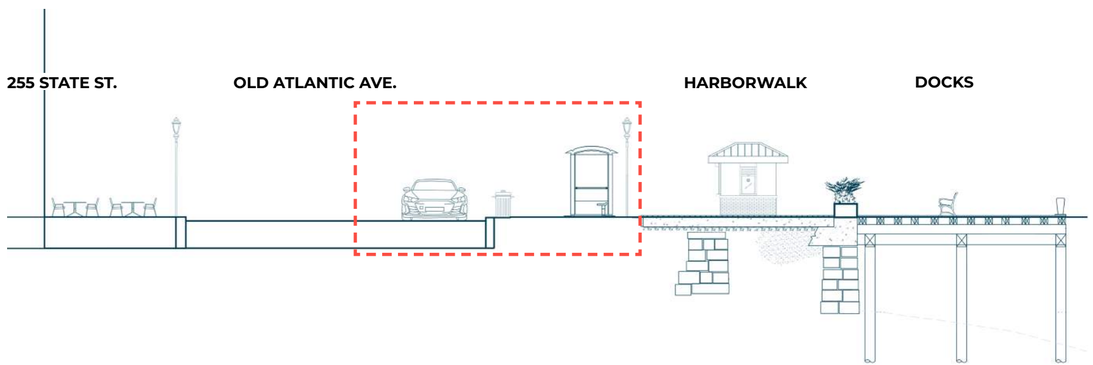


Figure 4-38 - Old Atlantic Avenue - Section

DRAFT

DRAFT

AQUARIUM STATION (MBTA) - EAST HEADHOUSE

The MBTA Blue Line Aquarium Station modernization project was constructed in 1996. It is located under State Street at Atlantic Avenue on the eastern edge of Boston's Financial District, near Boston Harbor and adjacent to Long Wharf. The east mezzanine is located at the west end of Long Wharf, near the New England Aquarium. Two glass headhouses—one with escalators and stairs, the other with an elevator—provide access from the surface. The elevator glass tower also includes an emergency egress stair from the MassDOT Tip O'Neal highway tunnel.

Since the 1996–2003 reconstruction, the Aquarium Blue Line station has experienced repeated underground water leakage issues. The location of the east headhouse near Boston Harbor has resulted in additional coastal flooding during storm surge events. On January 4, 2018, the station was flooded by ocean water, which reached a record level of 9.66 NAVD88. A nor'easter, two months later in March 2018, which was the third highest flood of record after the Blizzard of '78, also caused flooding that again briefly closed the station.

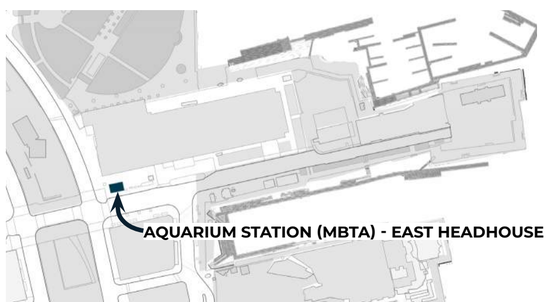


Figure 4-39 - Project Site Plan - Aquarium Station (MBTA) - East Headhouse

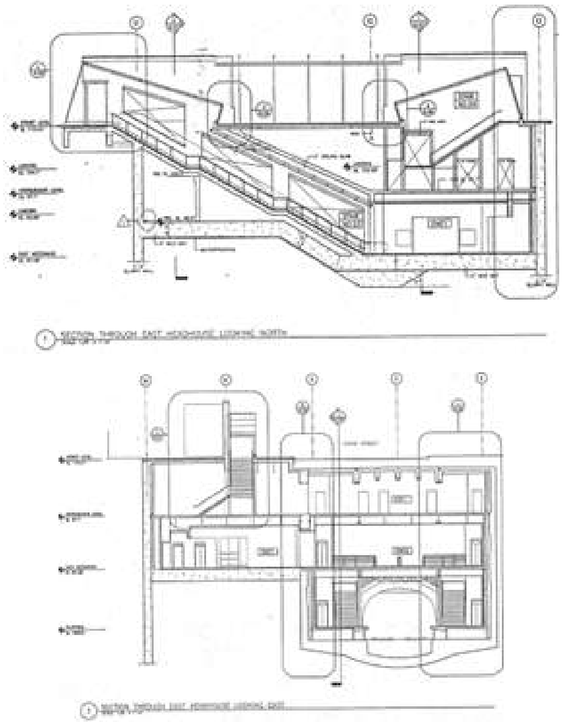


Figure 4-40 - Section background reference - MBTA Aquarium Station Blue Line Station Modernization Project - 07/10/95 (MBTA/Ellenzweig Associates)

DRAFT

In 2020, Kleinfelder designed a temporary deployable flood barrier system to protect the Blue Line Aquarium Station headhouses located at Long Wharf and on State Street across the Rose Kennedy Greenway. At the East Station headhouse on the corner of Atlantic Avenue and State Street, flood proofing measures included:

- Removal of existing brick pavements and replacement with cast-in-place concrete slabs and foundations.
- Restoration of existing brick pavers to meet new concrete pavement.
- Installation of anchors in cast-in-place concrete foundations.
- Deployment, flood testing, and storage of deployable drop-in-panel flood barriers and intermediate removable support posts.
- Installation of waterproofing.
- Installation of an in-line backflow preventer on an existing trench drain line to prevent water from backing up in the drain line under the flood barrier system.

The Aquarium Station East Headhouse structure also includes MassDOT tunnel egress door TE-434, immediately adjacent to the East Headhouse elevator. This tunnel egress door leads directly to the Tip O'Neill Tunnel below. The deployable flood barrier also prevents flood water from flooding the Tip O'Neill tunnel.

Figure 4-41 - Image Above (Left) - Deployable drop-in-panel Flood Barriers at Blue Line Aquarium Station East Headhouse Entrances Image Above (Right) – Tench Drain at the East Headhouse Entrance

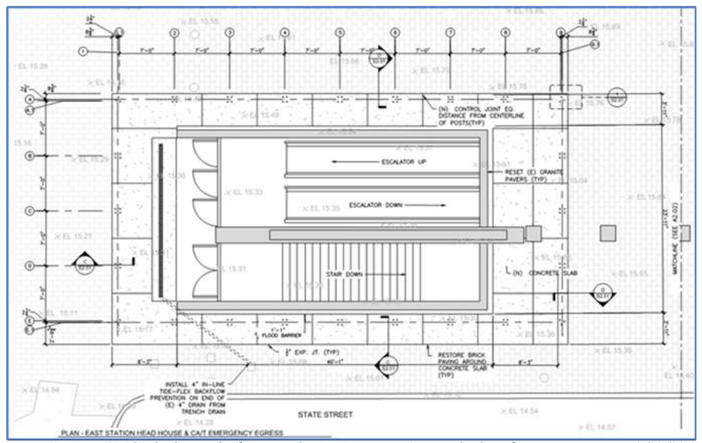


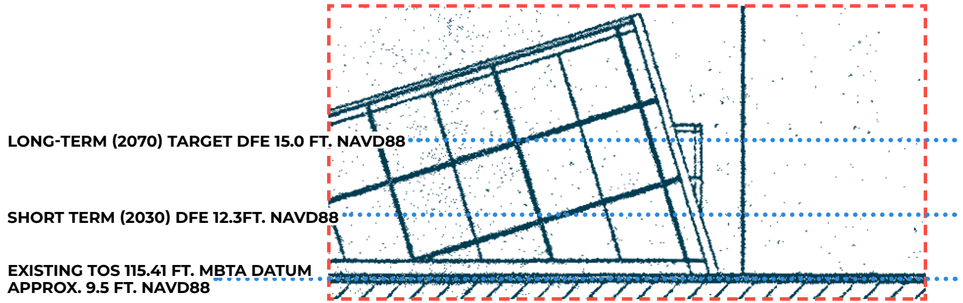
Figure 4-42 - Plan background reference - Blue Line Aquarium Station Floodproofing Improvements - 10/23/2019 (MBTA/Kleinfelder)

DRAFT

AQUARIUM STATION (MBTA) - EAST HEADHOUSE

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The Blue Line Aquarium Station East Headhouse at Long Wharf is vulnerable to present day flooding as evidenced by previous flood damage at the station in 2018. Since 2021, the MBTA uses a temporary deployable drop-in flood barrier system to provide flood protection up to approximately EL. 13.0 NAVD88. Present Day vulnerabilities also include significant underground leakage through the underground structure and utility conduits (not necessarily storm-related risk). The subsurface structure is not watertight. The MBTA is currently investigating ways to control underground leakage, but this is not within the scope of this project.
Near-term Flood Vulnerabilities (to 2050)	By 2050, the frequency at which flood waters will affect the Blue Line Aquarium Station East Headhouse will increase. The proposed project DFE of 15.0 NAVD88 will exceed the height of the temporary flood barrier, resulting in flooding of Aquarium Station below. This elevation would also cause flooding across Atlantic Avenue into the Blue Line Aquarium Station West Headhouse on State Street.
Long-term Flood Vulnerabilities (2070 and beyond)	By 2070, high tides will flood the East Station headhouse twice a day, which will essentially require shutting down the East Headhouse.



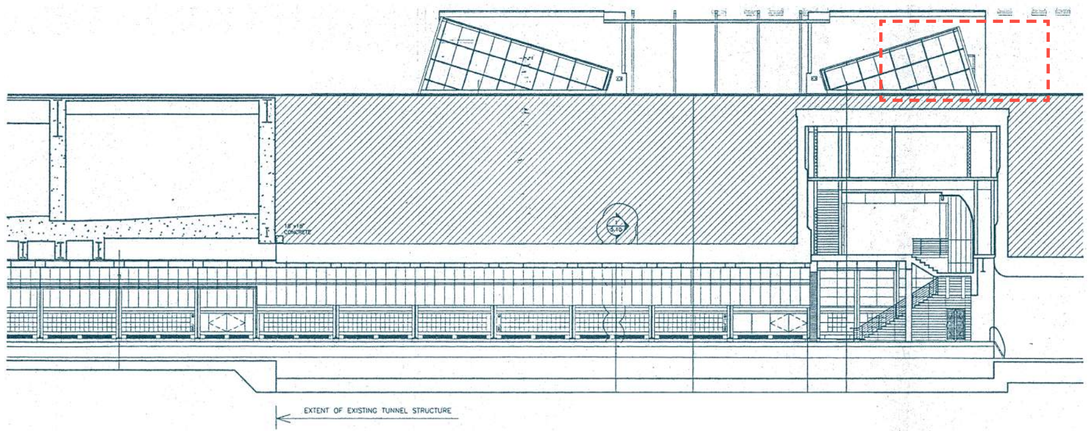


Figure 4-43 - Aquarium Station (MBTA) East Headhouse - Section

DRAFT

DRAFT

SEAWALLS

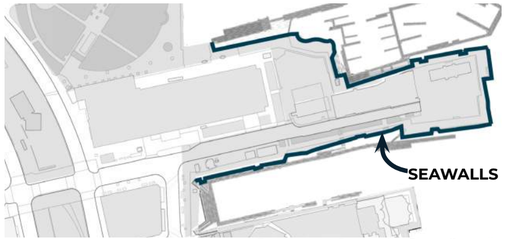


Figure 4-44 - Project Site Plan - Seawalls

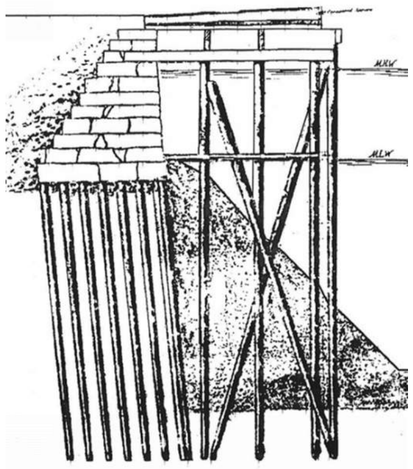


Figure 4-45 - Section Showing Proposed Blukhead at Long Wharf, 1869

Long Wharf's perimeter is bounded by various granite walls of varying construction dates. The image below was taken from the "Restoration of Long Wharf's 18th and 19th Century Bulkheads" by Maurice Freeman, March 1984. The granite gravity walls are founded on timber piles, which were designed to be completely buried by several feet.

All of the granite walls are gravity structures and portions are supplemented with steel toe protection (either through AZ-steel sheeting or road plates). There have been previous repairs along the seawall to stabilize structurally compromised areas, most recently at the southeast corner where steel sheeting toe protections was added to help prevent undermining of the wall. Additionally, historic plans indicate that granite blocks along the northeast part of the seawall were restacked during the installation of the MBTA Blue Line ventilation shaft.

The Long Wharf east-facing seawall intersects the MBTA Blue Line tunnel. Based on historic plans, the center of the tunnel is located approximately 42' ft. below the top of the seawall. The tunnel is shown as approximately 30' in diameter at this location. The MBTA has established a Zone of Influence extending 30' on either side of the tunnel. In this Zone of Influence, no construction can occur that will affect the structural integrity of the MBTA Blue Line tunnel structure. The approximate location of the tunnel and the 30' Zone of Influence are shown in a figure below.

The entire site is located within an AE-FEMA flood zone at elevation 10.0 ft. NAVD88, indicating that there is a 1.0% probability of a storm surge reaching an elevation of 10.0 NAVD88. Given that the top of existing seawall elevation varies between elevations 7.0 ft. and 8.5 ft. NAVD88, the seawalls can be expected to be overtopped during extreme coastal storms. In fact, sections of the seawalls regularly are overtopped during high current extreme high tide events and coastal storms.

Granite gravity walls are considered to be some of the most resilient coastal infrastructure that historically exist in urban settings. The pyramidal structures are able to be raised slightly without significant modifications to the foundations. It should also be noted that these sea walls would have been exposed to much higher historical live loading behind the walls than they will experience in the future due to previous port-related operations that occurred on Long Wharf.

DRAFT

LONG WHARF NORTH SEAWALLS

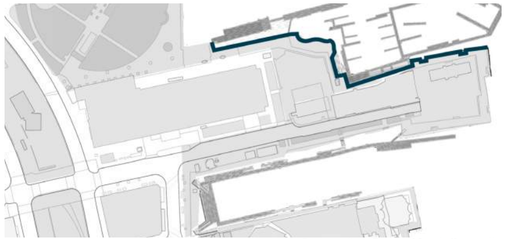


Figure 4-46 - Project Site Plan - North Seawalls

The granite seawall along the north side of Long Wharf is immediately adjacent to an intertidal area. The gravity wall structure in this area experiences minimal wave exposure compared to the south and east sides of Long Wharf. The north seawall typically has smaller granite blocks than the south and east seawalls. The existing seawall has numerous voids between the dry-laid granite blocks and some of the granite courses have shifted. No critical stability issues were documented along the north seawall.

DRAFT

LONG WHARF SOUTH SEAWALLS

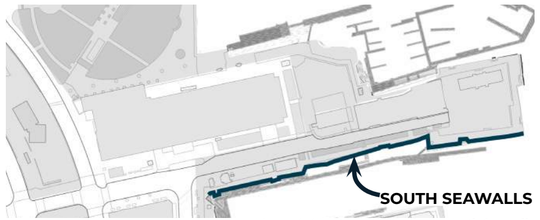


Figure 4-47 - Project Site Plan - North Seawalls

Figure 4-48 - Image Above (Left) - Grout Bag Toe Repair Image Above (Right) – H-Beam/Road Plate Toe Repair

Figure 4-49 - AZ-Sheet Pile Toe Repair STA 10+50 to 12+50

Conditions observed during a 2018 underwater inspection of the southeast section of the seawall indicated that the granite wall was exhibiting signs of global failure due to either subsidence or through deterioration of the original timber foundation piles. Scour in this area is likely due to the large vessel traffic and associated propellor wash immediately adjacent to the seawall as well as its southeast exposure to waves. Aerial imagery clearly showed high velocity propellor wash directly impacting and reflecting off the granite seawall. In 2020, BPD undertook a Long Wharf South Seawall Stabilization project to address the structural stability issues.

A sheet pile toe-protection bulkhead was constructed adjacent to the seaward face of the existing seawall near the east end. The area between the bulkhead and the existing seawall was backfilled with flowable fill concrete. The top elevation of the sheet pile bulkhead and fill material was (-)5.51 ft. NAVD88, which is the elevation of Mean Lower Low Water (MLLW). The repairs originally included installing a geotextile fabric behind the existing seawall, however plans showing existing fabric were located and this element was removed from the project scope. In addition to the toe protection, an existing granite staircase was closed.

The 2020 repairs at the southeast end were the third such over-sheeting toe stabilization repair detail along the toe of the south seawall. Previous repairs in the 1990's were constructed of AZ steel sheet piles (see Photo 3 below) and steel road plates (see Photo 2 below). Inspections in 2018 determined that these repairs remain intact.

Methodologies involving placing grout bags along the base of the seawall have been used along the structure (see Photo 1 below), however these have not provided significant service life and are now found to be completely absent.

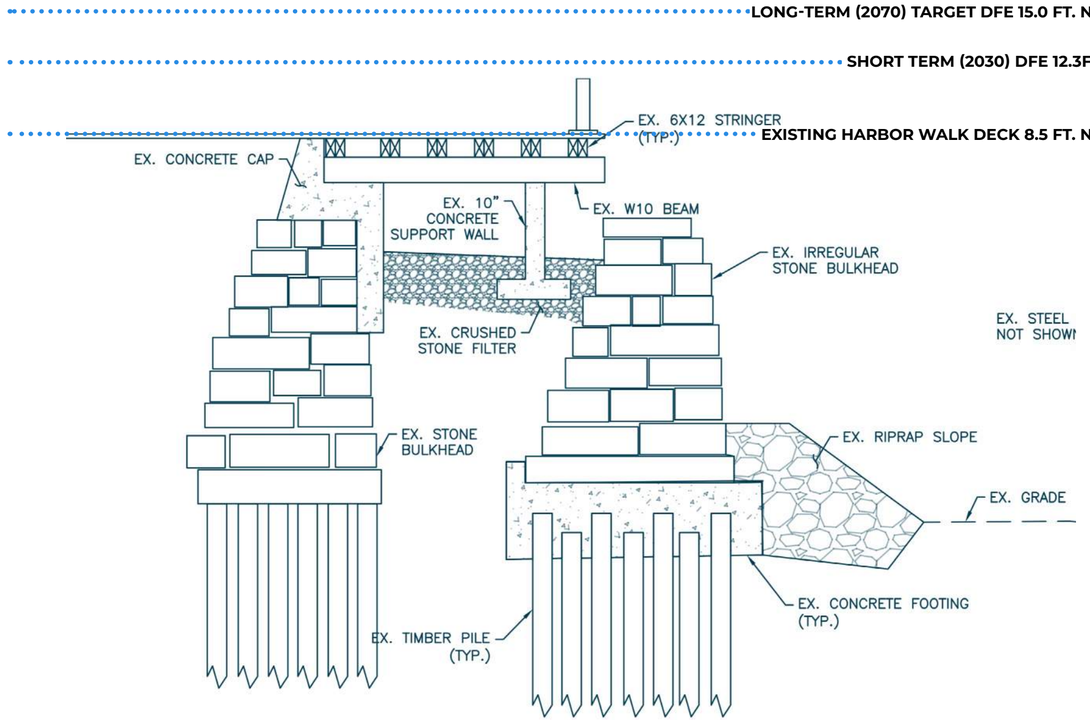


Figure 4-50 - South Seawalls - Section

DRAFT

DRAFT

LONG WHARF EAST SEAWALLS

Figure 4-51 - Project Site Plan - East Seawalls

Figure 4-52 - Long Wharf East Seawalls

Constructed identically to the south face, the east face of Long Wharf consists of granite blocks founded on timber pile foundations. The 2018 inspection noted irregular courses and significant undermining of the south half of the east seawall. The east face, is the 228 linear foot portion of the wall which extends furthest from the shoreline. The topside of this area consists of granite block pavers and cobblestones set and jointed with mortar.

The perimeter of the wharf is topped with approximately 16" high granite coping blocks of varying lengths. In areas where there are spaces between the coping blocks, bollards are mounted to the blocks and a chain is draped between bollards to create a barrier. There are two historic stair access points along the East face, referred to as "steps to the sea." The gap between granite copings on either side of these steps is spanned by a steel pipe rail.

The first course of the wall along the east face of Long Wharf consists of either a concrete slab, or granite block slab. The granite block slabs are approximately 14" thick and the concrete slab varies in thickness along the east face. The remainder of the courses below the top course are made up of granite blocks. Historic plans show that the bottom course of granite blocks is supported by timber piles.
Typical observations noted during the inspection of the granite block seawall included miscellaneous debris scattered along the toe of the seawall, small gaps (2" to 3") between adjacent blocks in the upper four (4) courses, weathering and cracking of granite blocks, and minor spalling along the bottom of the concrete slabs on the upper course.

The wall was observed to be relatively plumb overall and courses were generally parallel, with the exception of a small portion of the wall in the northeast corner, where stones in the second course from the top appear to be of slightly different size than typical.

DRAFT

Typical observations noted during the inspection of the granite block seawall from included voids of an unknown origin, spanning up to 48" wide along the bottom course of the wall. These voids were observed to be rectangular in cross section, having a block above and below them, and on both sides. Ten (10) of these voids were observed along the bottom of the seawall, with the width varying among them and depths of at least 60", with several voids extending an unknown distance back.

Additional observations noted for this section of the wall included scattered debris along the toe of the seawall, some of which were observed to be stones of a similar size to the typical seawall blocks, several gaps between adjacent blocks ranging from between 3" to 6" both horizontally and vertically, loose blocks at the toe, and several timbers along the toe of the wall which were cut at the mudline. The top course of concrete blocks were observed to have several areas of spalling with exposed steel reinforcement, typically within the bottom half of the block.

A previous repair consisting of steel bracing to support wall stones was observed to still be in place, however stones in this area of the wall were displaced and courses are no longer parallel along the southeast corner. All stones were observed to have larger than typical voids between adjacent stones in this area.

The east face of Long Wharf is the most susceptible to coastal damage given the long southeasterly fetch length and the vertical face of the granite seawall. Potential improvements to address wave and surge impacts will be complicated by the presence of the MBTA Blue Line Tunnel and the associated Zone of Influence limitations. Currently any loading within the 30' of the Zone of Influence will require coordination and approval of the MBTA. Foth has previously proposed a solution to bridge this area using a steel bridge beam supported by driven steel-piles shown in Figure below.

Figure 4-53 - Dislocated corner at the intersection of the south and east sides. (Image Source: Foth)

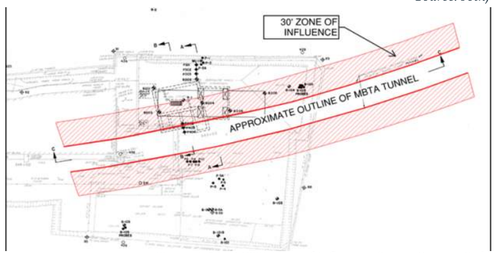


Figure 4-54 - MBTA Zone of Influence. (Image Source: Foth)

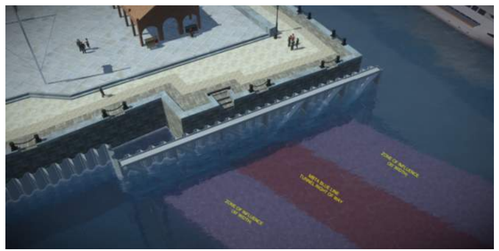


Figure 4-55 - MBTA Zone of Influence. (Image Source: Foth)

DRAFT

LONG WHARF EAST SEAWALLS

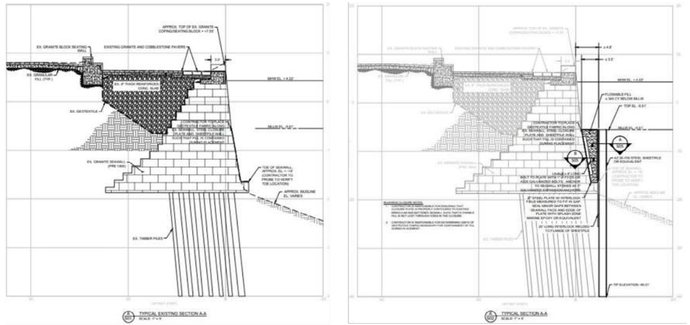


Figure 4-56 - Typical Sections through Long Wharf Seawalls

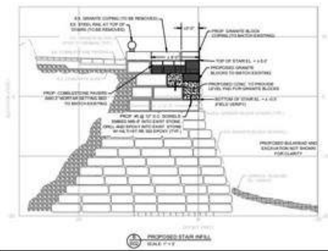


Figure 4-57 - Plan and section background reference - BPDA Long Wharf Seawall Stabilization - 01/24/2020 (BPDA/Foth)

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The existing Long Wharf granite seawalls along the south and east sides are frequently overtopped by storm surge and King Tide events under present day conditions. There is evidence of existing structural damage to the south and east walls that needs to be addressed to preserve the long-term functionality of these walls.
Near-term Flood Vulnerabilities (to 2050)	The near term DFE of 15.0 NAVD88 will likely cause more ongoing damage to the existing seawalls if additional structural repairs are not performed to help stabilize the walls, primarily due to increase wave action on the south and east facing walls.
Long-term Flood Vulnerabilities (2070 and beyond)	As water depths increase above the near term DFE of 15.0 NAVD88, the overtopping of the walls will only increase with more chance of wave-induced damage.

DRAFT

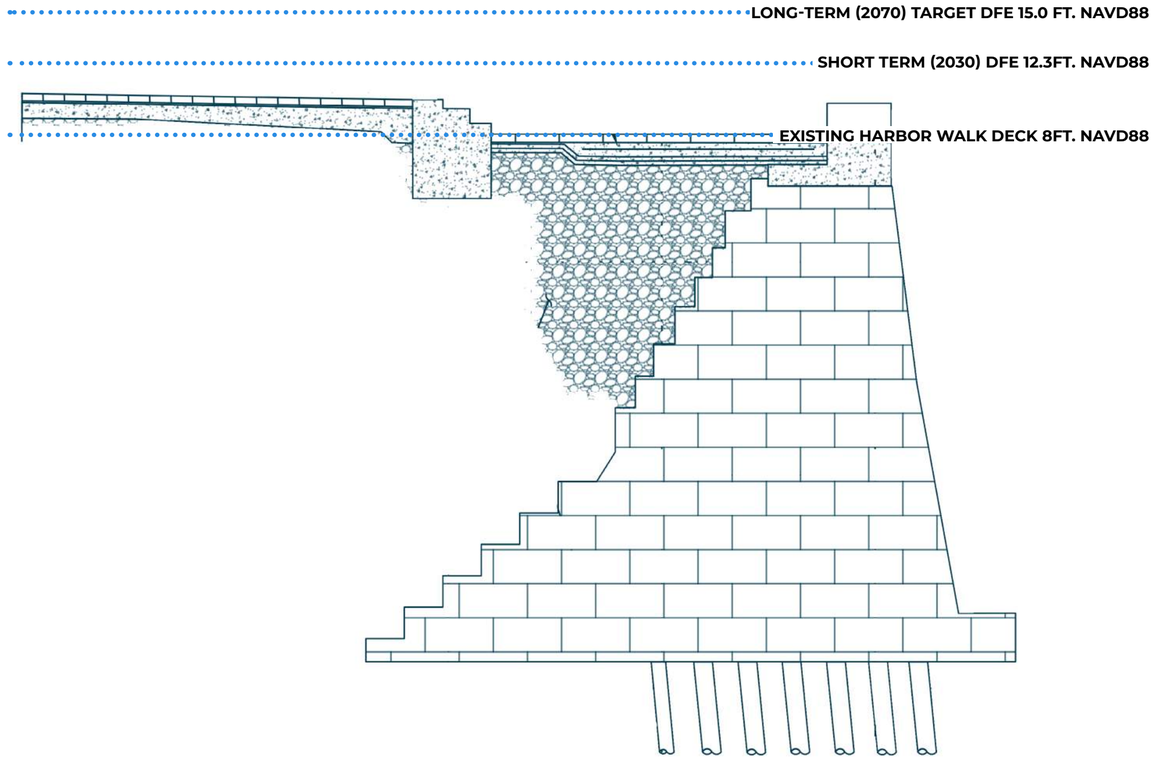


Figure 4-58 - East Seawalls - Section

DRAFT

MARRIOTT HOTEL AND GARAGE

Sunstone Realty owns the Marriott Hotel property, which they acquired in 2007. There are four main flood path entries into the Hotel building:

- The main lobby entries on the ground floor with entrances on the north and south sides of the building. The doors are glass storefront systems that are not water-tight.
- The garage entry portal on the south side of the building. There are no doors on this entry.
- The loading dock on the south side of the building.
- Tia's Restaurant on the north side of the building.

The hotel currently has some deployable flood barriers that can be deployed at the lobby entries to help to minimize water intrusion into the building for very low-level flood events. It is our understanding that there are no deployable flood barriers for the garage entry, the loading dock or Tia's restaurant. Hotel management said that at this time there are no plans to develop long-term flood barriers for the entire building or to elevate the interior lobby..

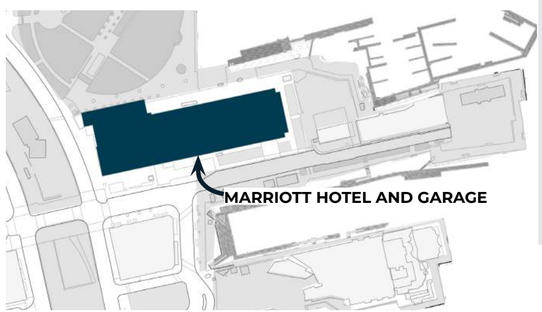


Figure 4-59 - Project Site Plan - Marriott Hotel and Garage

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The Long Wharf Marriott is vulnerable to flooding and storm events under present day conditions. For example, during the January 4, 2018 flood-of-record storm, water did flow into the ground floor lobbies. The flood level during that storm was apparently not high enough to cause flooding of the lower levels of the garage or through the loading dock. Flooding from the 2018 storm did not affect electrical equipment or the elevators.
Near-term Flood Vulnerabilities (to 2050)	Without significant flood adaptation measures, the Long Wharf Marriott will be highly vulnerable to coastal flooding at the proposed near term DFE of 15.0 NAVD88. We understand that there is some electrical equipment on the ground floor that would be susceptible to flood damage as well as elevators and the ground floor public bathrooms.
Long-term Flood Vulnerabilities (2070 and beyond)	For flood events higher than the near term DFE of 15.0 ft. NAVD88, the Long Wharf Marriott will experience significant flood damage without significant flood adaptation measures. By 2070, high tide cycles from King Tides will likely cause nuisance flooding.

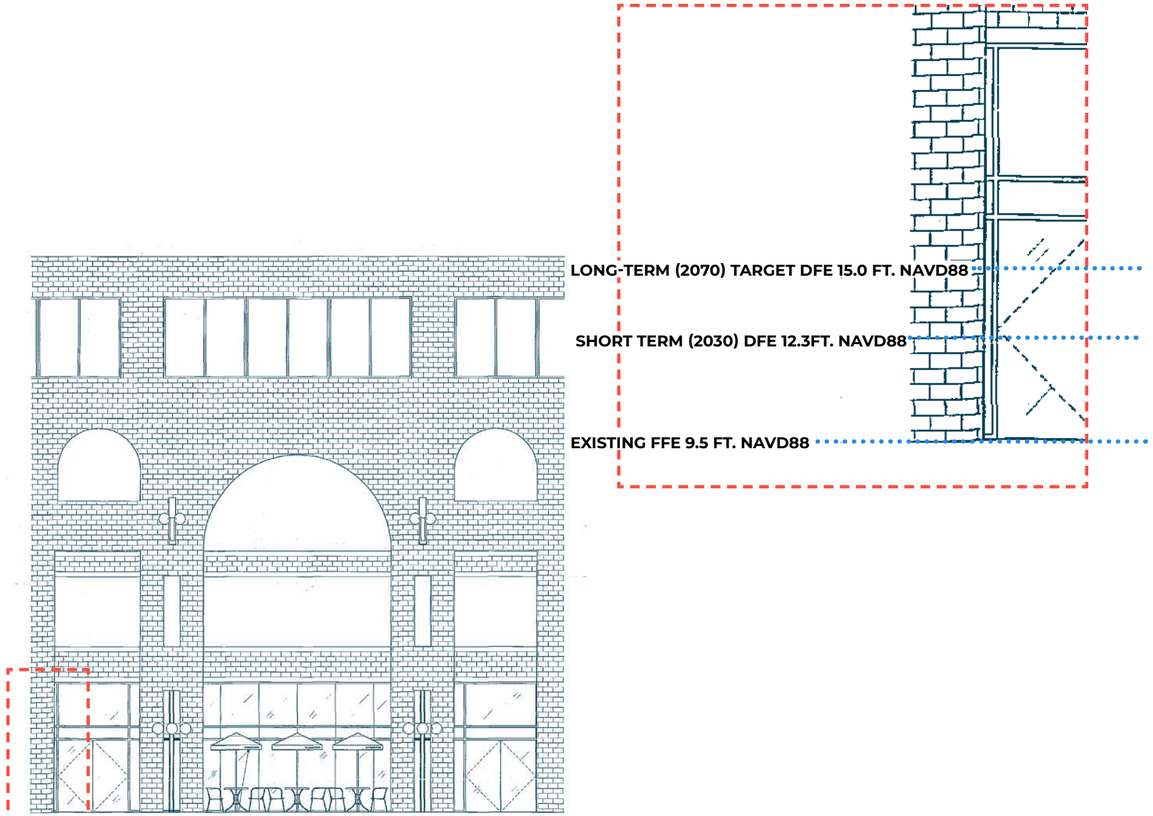


Figure 4-60 - Marriott Hotel and Garage - Elevation

DRAFT

DRAFT

NEW ENGLAND AQUARIUM

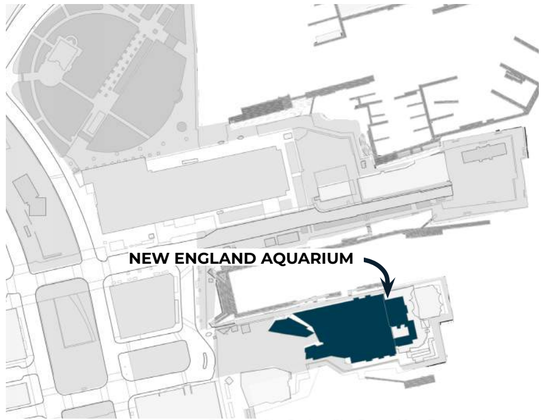


Figure 4-61 - Project Site Plan - New England Aquarium

The New England Aquarium (NEA) is a major tourist draw to the Long Wharf area. The NEA is in the process of developing their own 50-year Master Plan, which will include major flood resiliency adaptation improvements. The extent of their flood resiliency adaptation measures is not known at this time.

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The NEA is vulnerable to flooding and storm events under present day conditions. For example, during the January 4, 2018 flood-of-record storm, the facility had to close due to flooding and they sustained over $1.0 million in damage.
Near-term Flood Vulnerabilities (to 2050)	Without significant flood adaptation measures, the NEA will be highly vulnerable to coastal flooding at the proposed near term DFE of 15.0 ft. NAVD88.
Long-term Flood Vulnerabilities (2070 and beyond)	For flood events higher than the near term DFE of 15.0 ft. NAVD88, the NEA will experience significant flood damage without significant flood adaptation measures. By 2070, high tide cycles from King Tides will likely cause nuisance flooding.

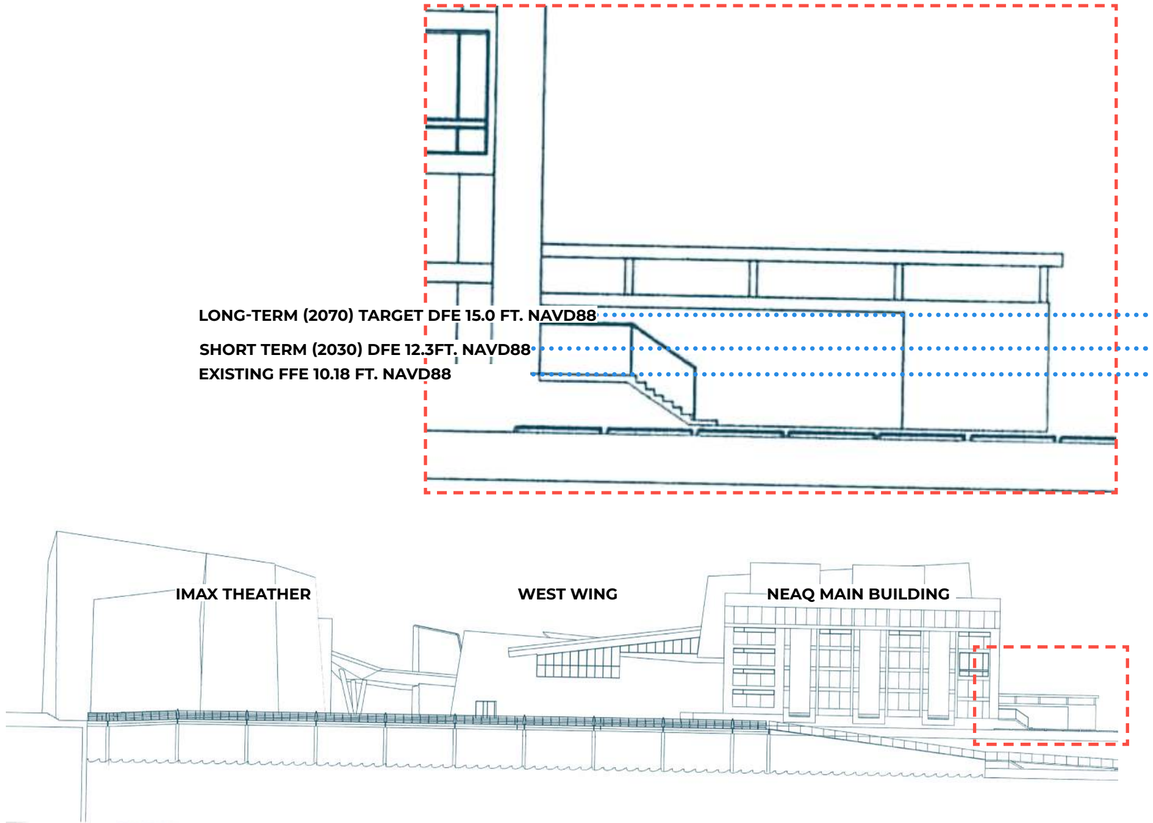


Figure 4-62 - New England Aquarium - Elevation

DRAFT

DRAFT

255 STATE STREET

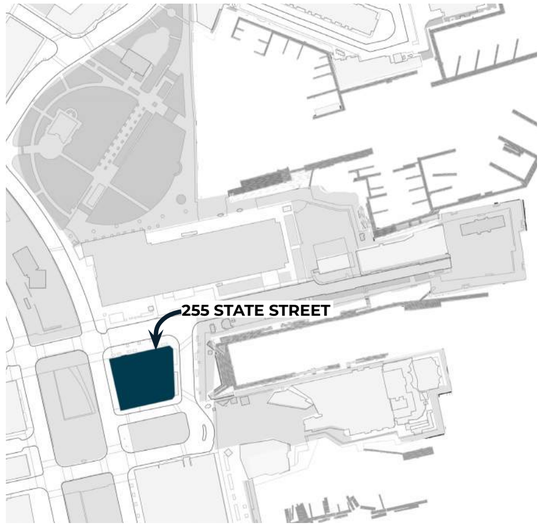


Figure 4-63 - Project Site Plan - 255 State Street

255 State Street is located on the west side of Old Atlantic Avenue, across from the New England Aquarium. Atlantic Avenue and the Rose Kennedy Greenway are located to the west of the building. The 12-story 1913 warehouse building was transformed into a boutique office community in a 1998 redevelopment by Pembroke Real Estate. The building has a 42 in. high (+/-) deployable flood plank system to protect the building from flood waters entering through the building's entrances and windows. The estimated top of the plank is at EL: 12.25 ft. NAVD88.

Figure 4-64 - 255 State Street Entrance Active/Deployable Flood Plank System

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	With deployment of temporary flood barriers, 255 State Street appears to be protected against present day flooding events up to an estimated EL 12.25 NAVD88.
Near-term Flood Vulnerabilities (to 2050)	The existing deployable flood barriers at 255 State Street would be overtopped at the proposed near term DFE of 15.0 NAVD88, causing significant damage to the building.
Long-term Flood Vulnerabilities (2070 and beyond)	For flood events higher than the near term DFE of 15.0 ft. NAVD88, 255 State Street will experience significant flood damage without significant flood adaptation measures. By 2070, high tide cycles from King Tides will likely cause nuisance flooding.

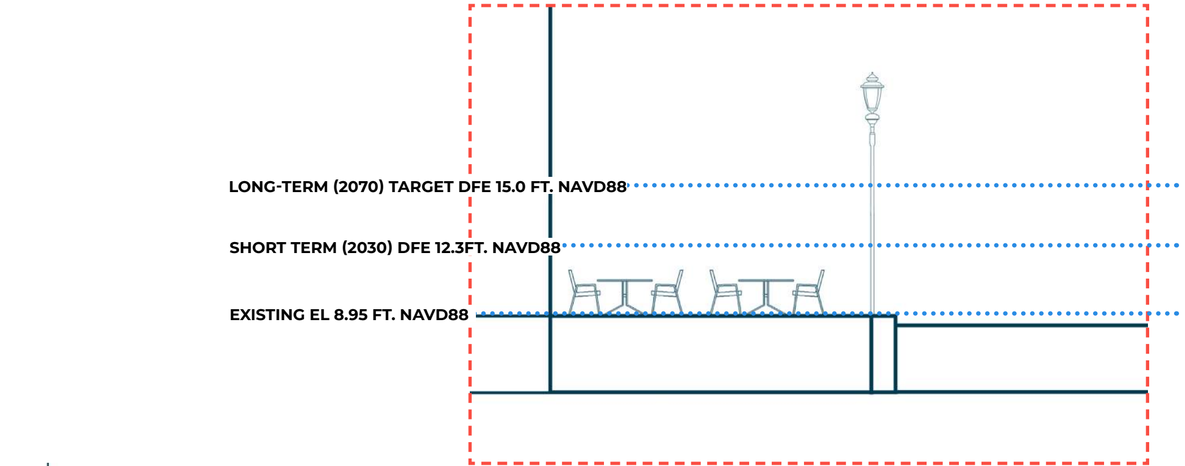


Figure 4-65 - 255 State Street - Section

DRAFT

DRAFT

SITE DRAINAGE

A desk-top review of existing record drawings from BWSC, MBTA, National Grid, and Eversource was performed to understand what existing subsurface stormwater drainage and utilities system could be affected by construction of floodproofing improvements on Long Wharf and how these systems are vulnerable to flooding.

Stormwater Drainage

There are three stormwater outfalls on Long Wharf that are currently unprotected from tidal backflow, while an additional two outfalls tie into BWSC drainage systems that include a tide gate. An overview of the stormwater drainage infrastructure on the project site as documented in BWSC's GIS database and MBTA record drawings are shown in the maps shown in Figures 4-41 and 4-42.

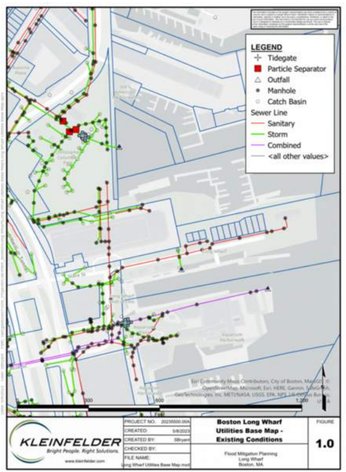


Figure 4-66 - Utilities Base Map - Existing Conditions

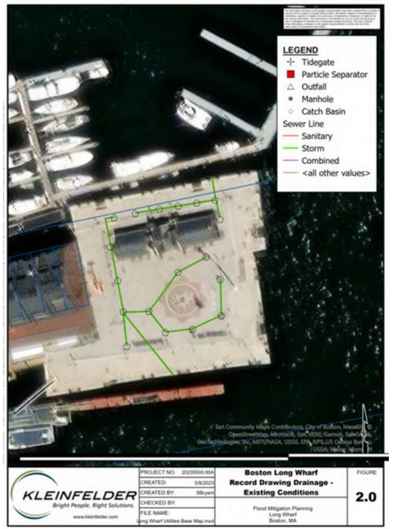


Figure 4-67 - Existing Stormwater Drainage at East End of Long Wharf

Three small drainage networks on Long Wharf currently lack tide gate protection and present potential flood pathways onto the wharf during extreme high tides through existing catch basins. On the eastern side of the wharf, flow is collected in a series of catch basins and split via 12-inch drain lines to two outfalls sitting on the northern and southern sides of the wharf. An overview of the flow paths from these two drainage networks are shown in Figure 4-43. All drainage pipes are relatively shallow and are believed to be above other utilities on the wharf with no shared manholes or interconnections.

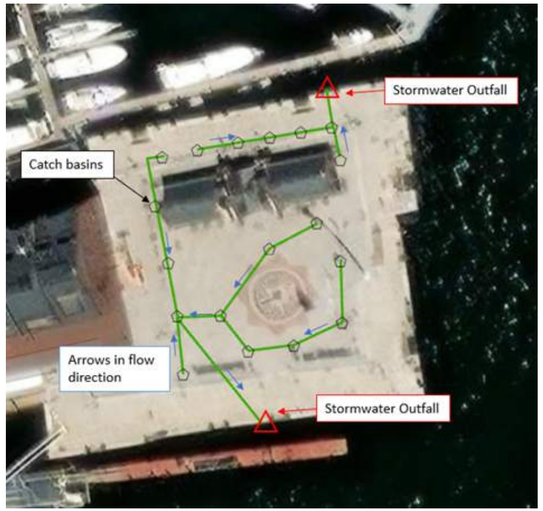


Figure 4-68 - Drainage Network in Plaza at Eastern End of Long Wharf

The remaining unprotected stormwater outfall sits to the southeast of the Long Wharf Marriot and collects stormwater runoff from a single catch basin that sits between the Marriot and the Chart House restaurant. The drain line was included in both BWSC's GIS database as well as multiple record plans obtained for the wharf and is conveyed through a single 12-inch PVC drain line. The drainage pipe crosses over the path of a sanitary sewer pipe running from the east end of the wharf, however, has no direct connection with the sanitary line. The remaining unprotected drain line is shown in Figure 4-44.

Figure 4-69 - Drainage Network for Catch Basin Between Marriot and Chart House

All remaining catch basins located on the wharf are routed to larger BWSC drainage networks that include runoff from parcels outside of the scope of the Long Wharf flood study. Flow is routed either north to a stormwater outfall in Christopher Columbus Park, or south where it joins Boston's combined sewer system with a combined sewer outfall located at the end of the New England Aquarium's Central Wharf. Figure 4-45 shows the existing drainage system on the north side of Long Wharf and Figure 4-46 shows the existing drainage system on the south side of Long Wharf.

DRAFT

DRAFT

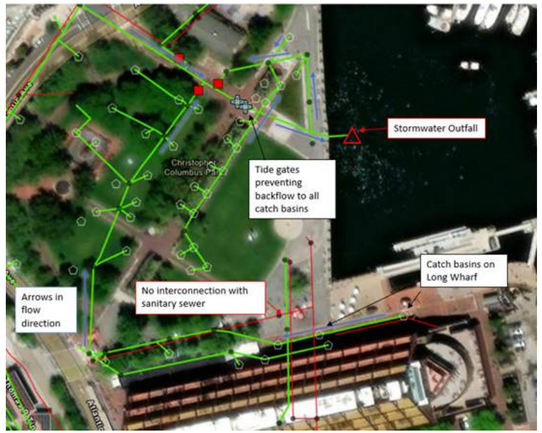


Figure 4-70 Long Wharf North Side Drainage to Christopher Columbus Park

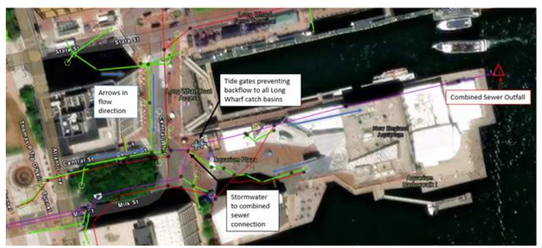


Figure 4-71 Long Wharf South Side Drainage to New England Aquarium

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The existing drainage pipe and catch basin located between the Long Wharf Marriott and Chart House restaurant is vulnerable to coastal flooding under present day conditions. As the outlet for this pipe does not have a tide gate, water is often observed backing out of the catch basin during extreme high tides or coastal flood events. It should be noted that since the time of the initial vulnerability assessment, BPD has installed a tide gate on this pipe. The catch basins at the east end of Long Wharf, which have drainage outlets without tide gates, are high enough on the upper plaza not to be vulnerable under present day conditions.
Near-term Flood Vulnerabilities (to 2050)	At the proposed near-term DFE of EL. 15.0, the existing catch basins on Long Wharf, which now have two outlets without tide gates, will all be vulnerable to backflow through the outlet pipes on the plaza if a perimeter flood proofing system is constructed. Tide gates would need to be installed to prevent backflow under a perimeter flood barrier system. If a perimeter flood barrier is constructed, precipitation falling over Long Wharf will need to be collected and temporarily stored until it can be discharged when the tides are at a lower stage. Without on-site storage, there is a chance that mild flooding could occur behind a perimeter flood barrier system from precipitation during extreme precipitation events
Long-term Flood Vulnerabilities (2070 and beyond)	The same vulnerabilities identified in the 2050 near-term flood scenarios described above would only increase by 2070 with higher predicted extreme precipitation events.

DRAFT

SANITARY SEWER

The main branch of the sanitary sewer collection system on Long Wharf is along the South side of the multi-story buildings on Long Wharf (See sanitary sewer in red in Figure 4-1). This is a is a 12-inch diameter line from the connection with mains on State Street that reduces first to 10-inch south of the Long Wharf Marriott, then to 6-inch at the upstream end at the MBTA pavilion on the east end of Long Wharf. Line inverts are shown to range from the shallowest of 3.5 ft. NAVD88 at the east end pavilion to below 0.0 ft. NAVD88 at the southeast corner of the Long Wharf Marriott on the 2015 Existing Conditions Plan of Land by Feldman Land Surveyors. At the time of writing, it is not known if these manhole access points have water-tight or gasketed bolt-down covers.

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	It does not appear that the sanitary sewer system is vulnerable to flooding today.
Near-term Flood Vulnerabilities (to 2050)	At the proposed near-term DFE of EL. 15.0, it can be assumed that existing sanitary sewer manholes will flood and surcharged water will backflow out of existing flood drains, sinks, toilets located behind a Long Wharf perimeter floodproofing solution.
Long-term Flood Vulnerabilities (2070 and beyond)	The same vulnerabilities identified in the 2050 near-term flood scenarios described above would only increase by 2070 with higher predicted extreme precipitation and flooding events.

DRAFT

ELECTRIC POWER

Subsurface electrical power duct banks and manholes are located in paved brick and cobble areas along the south side of the Custom House Block, Chart House and Long Wharf Marriott. electrical man holes (EMH) access the lines serving the buildings and infrastructure along the wharf, and electrical hand holes (EHH) are shown along the street lighting between the Long Wharf Marriott and Harbor Walk.

The existing 100A service owned by City of Boston for street lighting is located at deck elevation on the North side of Long Wharf. This service also supplies power to the two proposed wood structures: a maintenance shed and a ticket booth with floor elevations approximately four feet above MHW (both floors EL. 8.0 +/- NAVD88). One 60A service is shown for each structure, with PP, EUH, electric baseboard heater, receptacles, lighting, and outdoor receptacles on bollards. Conduits for these systems are shown to be run on the underside of decking in this area.

The 2015 Existing Conditions Plan of Land by Feldman Land Surveyors shows transformers located close to the wharf edge to the North and South of the Custom House Block. These are presumed to be at grade, no size or cabinet rating details are known.

As discussed above under the Custom House, there is an Eversource electrical room in Bay 65 and an Eversource transformer in Bay 66. The electrical room is protected with a concrete floor and an interior perimeter flood wall to El. 12.41' NAVD88. The transformer room has slatted louvers on the exterior wall, which will let flood waters enter the room. It is unknown if the transformer is a waterproof model.

There is also some Eversource electrical switchgear located in an underground electrical vault flush with the roadway pavement immediately to the east of the Chart House. We presume that this electrical equipment is waterproof because it has vents in the roof of the structure and this area has previously flooded.

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	The existing electrical room located in the north side of Custom House Block Bay 65 is protected from present day flooding by an interior concrete perimeter flood wall and a concrete floor up to a water elevation of approximately 12.41 NAVD88. The existing Eversource transformer located in Bay 66 of the Custom House does not appear to be vulnerable to flooding in the present day.
Near-term Flood Vulnerabilities (to 2050)	At the proposed near-term DFE of EL. 15.0, the existing electrical room located in Bay 65 of the Custom House would be flooded from overtopping of the interior concrete perimeter flood wall. The electrical equipment in this room would be subject to damage. In addition, electrical equipment such as heaters, receptacles, elevator machine equipment and fire alarms located below El. 15.0 NAVD88 will be subject to damage.
Long-term Flood Vulnerabilities (2070 and beyond)	Flood levels above the near-term DFE of 15.0 NAVD88 would likely cause significant damage to electrical equipment associated with most infrastructure on site.

DRAFT

NATURAL GAS

National Grid is the utility provider for natural gas. Figure 4-7 shows the gas distribution system in the Long Wharf and Central Wharf areas. There is a 2-inch service line to the Chart House Restaurant and an unknown-sized gas line servicing the Custom House Block.

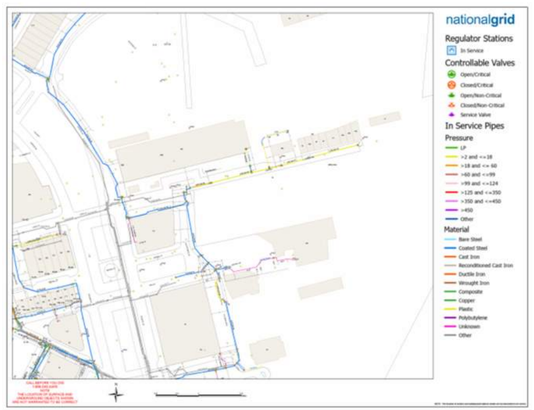


Figure 4-72 - National Grid Gas Distribution System for Long Wharf and Central Wharf Areas

VULNERABILITY TO FLOODING

Present Day (Existing Flood Vulnerabilities)	National Grid confirmed that there are no underground vaults that would be susceptible to flooding within the project area. National Grid said that the only part of the gas transmission system that would be vulnerable to flooding are small vent pipes at gas meters. Typically, the meter vents to the atmosphere using a small pipe. If the pipe is underwater that would be a problem. It does not appear that any of the gas meter vents are susceptible to present day flooding.
Near-term Flood Vulnerabilities (to 2050)	Gas meter vents would be vulnerable to flooding at the proposed near-term DFE of 15.0 NAVD88. The vent pipes can be extended relatively easily to above the DFE. Some gas infrastructure piping may have to be relocated to allow construction of any larger flood barrier systems as part of a near-term solution.
Long-term Flood Vulnerabilities (2070 and beyond)	Aside from the gas vents, the underground gas infrastructure has relatively little vulnerability to flooding above the near-term DFE of 15.0 NAVD88.

DRAFT

WATER INFRASTRUCTURE

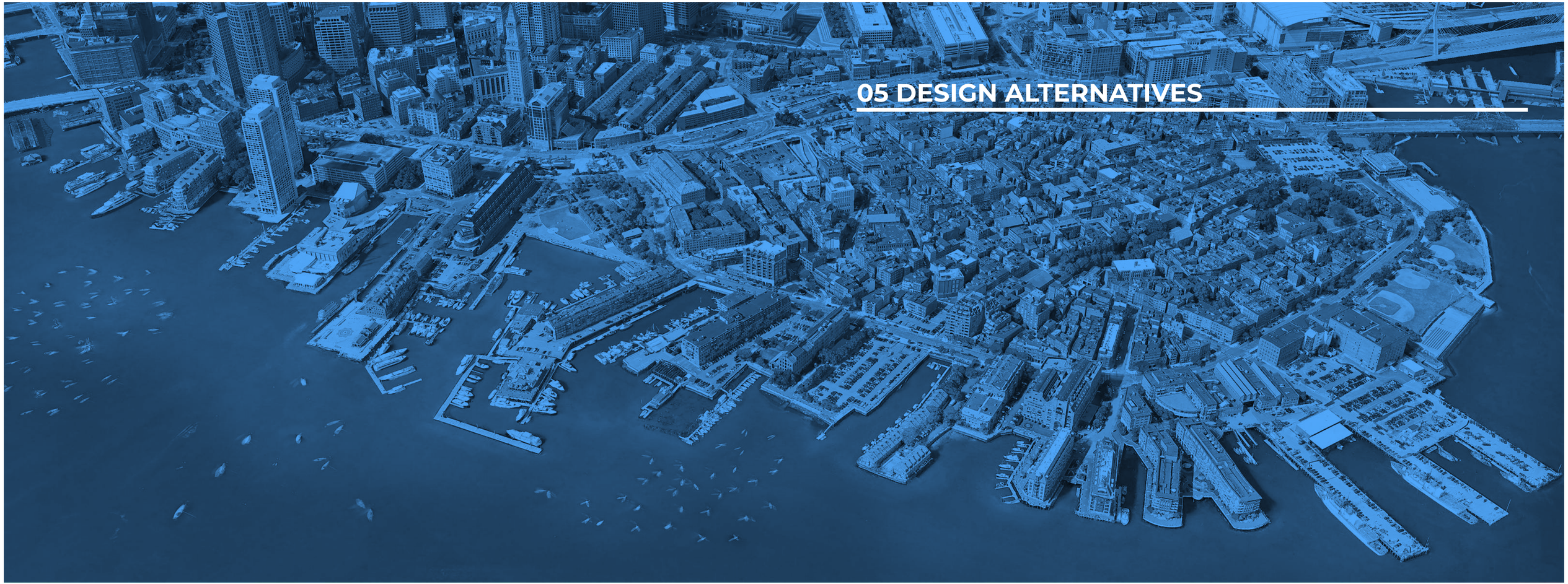
The 2015 Chart House and Custom House Block figure by DGT shows a 12-Inch water branch line approximately along the Long Wharf brick paved area south of the multi-story buildings. The existing piping is not vulnerable to flooding damage as it is buried and already underwater much of the time. Some water infrastructure piping may have to be relocated to allow construction of any larger perimeter flood barrier systems as part of a near- or long-term solution.

DOCKAGE UTILITIES

The transportation docking facilities on the north and south sides of Long Wharf and the Waterboat marina on the north side have electrical service for boat shore power as well as site lighting and miscellaneous receptacles. The Boston Harbor Cruise docks on the south side of Long Wharf and the Waterboat Marina on the north side have sewage pump-out facilities to service the boats. We understand that the Boston Harbor Cruises pump out station connects directly to the sanitary sewer pipe on Long Wharf. The landside sewer connections should have a check-valve system to prevent back-up of sewerage from the subsurface sanitary sewer pipe. The system components are located on the floating dock, so they should not be vulnerable to flooding.

DRAFT

DRAFT

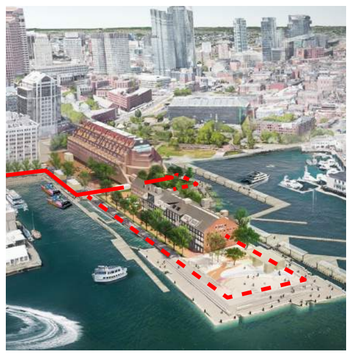


05 DESIGN ALTERNATIVES

DESIGN APPROACH

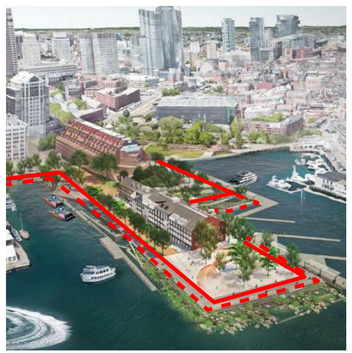
Building from the Climate Ready Boston Downtown and North End Report (2020), this project seeks to develop designs for Long Wharf and its study area that follow the proposed alignments (see image on facing page). Designs were developed for the two critical project timelines, near-term (2030) and long-term (2070) and evaluated for feasibility, cost, and effectiveness. The resulting designs are documented in the subsequent sections and include one scheme for the short-term and two for the long-term, referred to as Acupuncture and Big Splash.

In all proposed schemes, the project team endeavored to create a public realm that emphasizes universal access to the water's edge while prioritizing historic views, materials, and layered conditions. Each of the schemes offers a different level of flood protection and an interchangeable series of programmatic elements that can accommodate the existing wharf uses (marine transit, ticket sales, etc.) as well as proposed new public experiences, creating four-season destinations to draw people to the water's edge.



2070- ACUPUNCTURE

Figure 5-1 - Acupuncture Scheme



2070- BIG SPLASH

Figure 5-2 - Big Splash Scheme

+12.3'

+15.0'

LEGEND

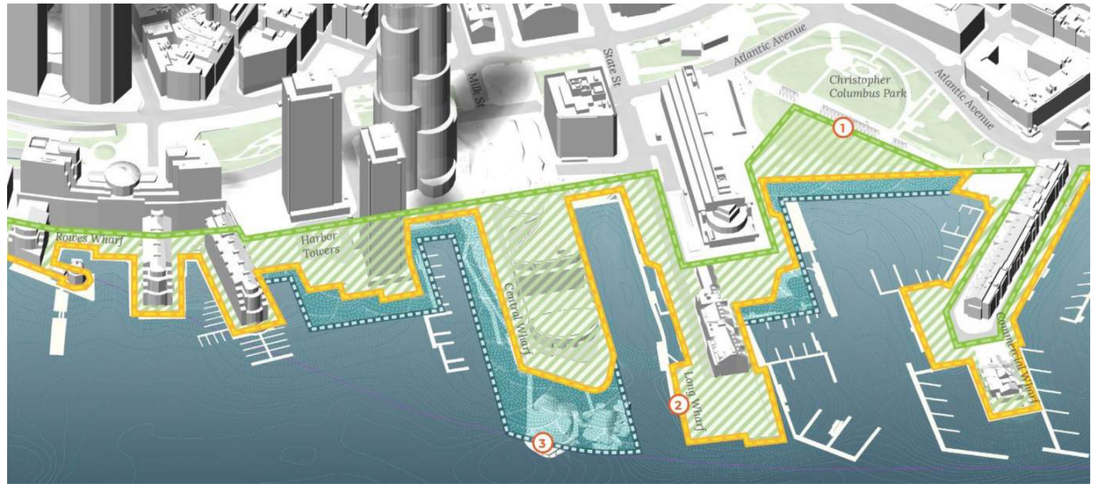


Figure 5-3 - Source: Coastal Resilience Solutions for Downtown and North End 2020

2030 NEAR-TERM OBJECTIVES

- Prevent storm-driven flooding of State Street & Columbus Park, mitigating near-term coastal flood pathways into downtown Boston
- Protect to 2050 1% Storm elevation (12.3' NAVD88)
- Maintain existing marine transportation configurations
- Allow for future incorporation of 2070 solutions, avoiding actions that preclude future adaptation or require costly demolition/ replacement
- Employ combination of passive and active (deployable) flood control systems
- Target less-intrusive interventions, avoiding unsightly public realm designs

2070 LONG-TERM OBJECTIVES

- Provide 2 alternative strategies with increasing levels of flood protection as envisioned within *Coastal Resilience Solutions for Downtown and the North End* study
- Focus on improving public experience, walkability, and "continuity of public realm"
- Solutions should be universally accessible and consistent with Harbor Use Design Guidelines
- Incorporate Marine Transit Improvements for all solutions
- Protect downtown Boston flood pathways to Elevation 15.0' NAVD88, with flexibility to increase to a higher DFE
- Provide for 'dry Harborwalk' conditions up to high astronomical tides in 2070 and alignment with 'Harborwalk 2.0' Vision

DRAFT

DRAFT

CONCEPTUAL 2030 DESIGN

DESIGN INTENT

In considering the investments this project will entail, and the flood pathway present at the project site, it is key to understand potential for a near-term protection strategy that responds to 2030 flood projections. As noted in **Section 3 (Coastal Modeling and Performance Analysis)**, the overall planning effort considers elevations +11.3', +12.3', and +15.0' NAVD88 as critical target DFEs. In evaluating the effectiveness of a conceptual 2030 design, the near-term scheme utilizes elevation +12.3' NAVD88 as the target for flood protection.

This +12.3' NAVD88 elevation is conceived as a NEW concrete flood wall, with an alignment as shown in the plan to the right. The flood wall alignment for 2030 is similar to the alignment shown in the 2070 acupuncture scheme and seeks to tie into existing walls and higher elevations where possible. The solid red line indicates where the wall is intended to be a continuous passive line of defense, with the dashed lines indicating areas that would remain open for service and access but be able to be closed with a deployable flood barrier prior to a storm event.

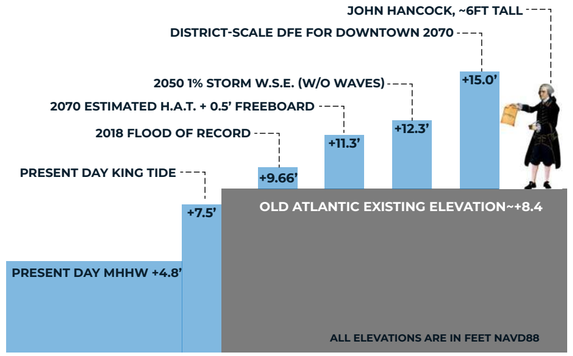


Figure 5-4 - Critical Target DFEs

MULTI-BENEFICIAL INFRASTRUCTURE

Although new a wall will provide flood protection in this configuration, inserting just a wall would not benefit the public realm substantially. Therefore, a series of enhancements should be considered to create a more comfortable urban realm. For instance, the flood wall would provide defense while simultaneously allowing for a shade structure, planting, and/or seating, all elements of the wharf experience that the public and stakeholders resoundingly asked for in its next iteration. In addition, the flood wall is proposed to be adaptable to the 2070 proposed schemes and could be embedded in future designs as an additional level of defense.

DRAFT

PROPOSED 2030 ALIGNMENT

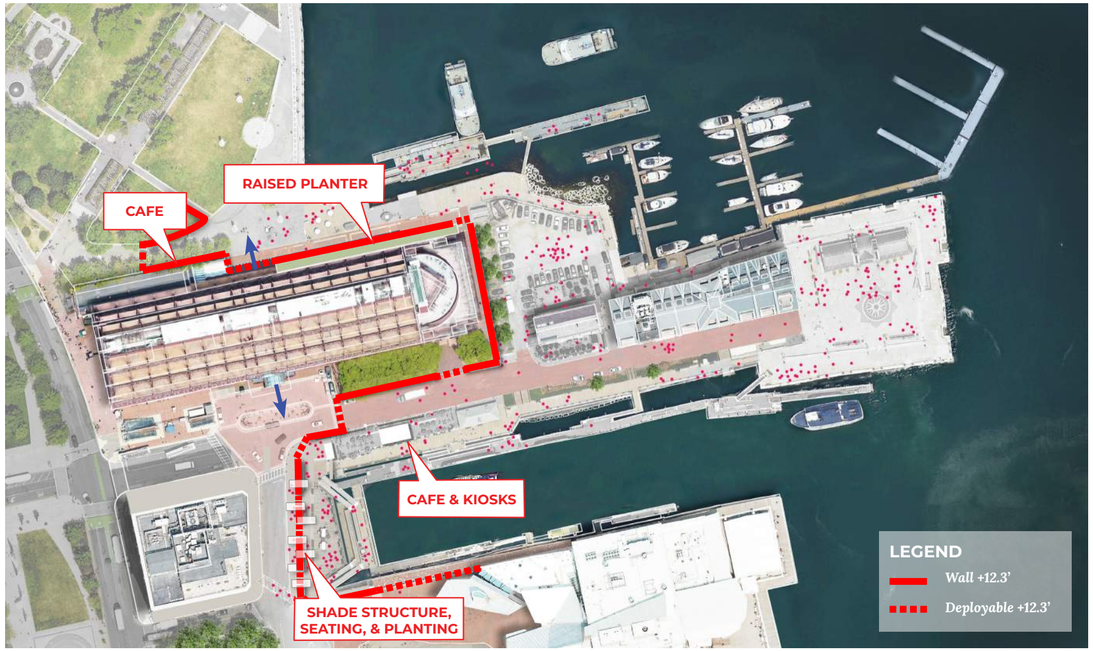


Figure 5-5 - Proposed 2030 Alignment

DRAFT

2030: NEAR-TERM CONEPTUAL DESIGN

SOUTH ALIGNMENT

At its south end, the flood wall is proposed to tie into an existing low wall at the New England Aquarium. The wall then runs parallel to Old Atlantic Avenue as it moves to the north. Here, the wall is perforated by a series of openings to allow for continued access to the existing docking and marine infrastructure. It is proposed that these openings are able to be closed off with deployables prior to a storm. As the floodwall continues to the north, it jogs across State Street and picks up the alignment of the existing southern curb line at the large planter east of the Marriott hotel. A significant deployable would be required to close off State Street during a flood event, but this access point would otherwise remain open and provide access for emergency and delivery vehicles. A deployable flood barrier would also be required to close off the flood wall at the Marriott loading dock. The existing program elements directly to the south of the flood wall, including the cafe kiosks and ticketing booths, are proposed to remain on the exterior of the wall and would be subject to flooding during storms.

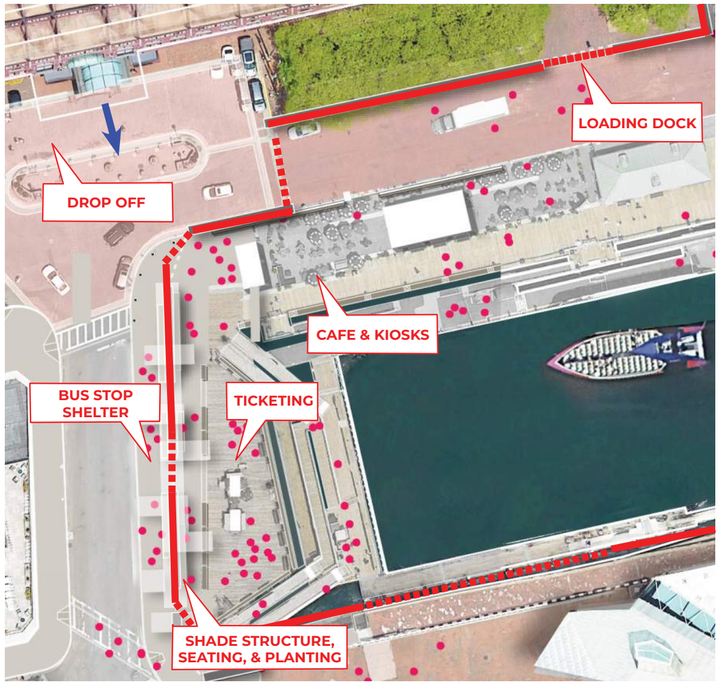


Figure 5-5 - Proposed 2030 South Alignment

DRAFT

Figure 5-6 - Proposed 2030 South Alignment

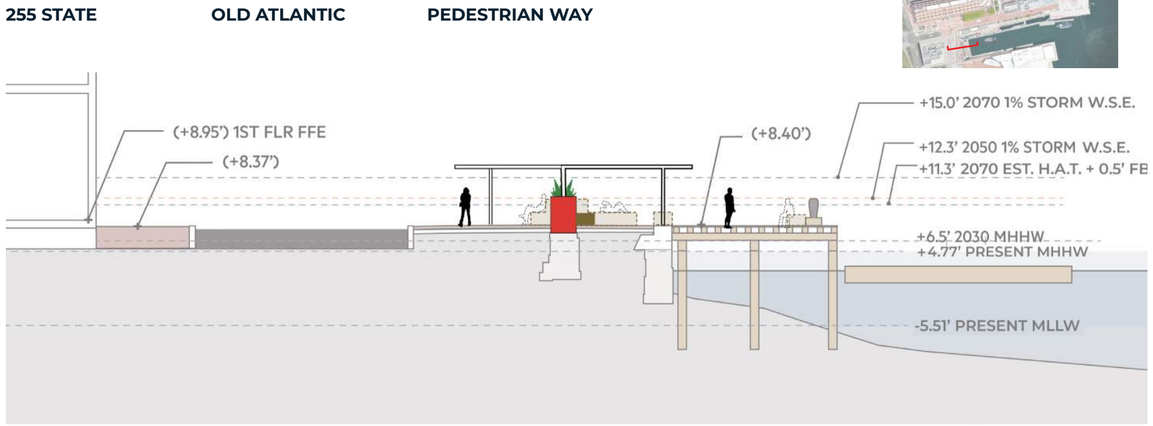


Figure 5-7 - Section - Proposed 2030 South Alignment

DRAFT

SOUTH ALIGNMENT

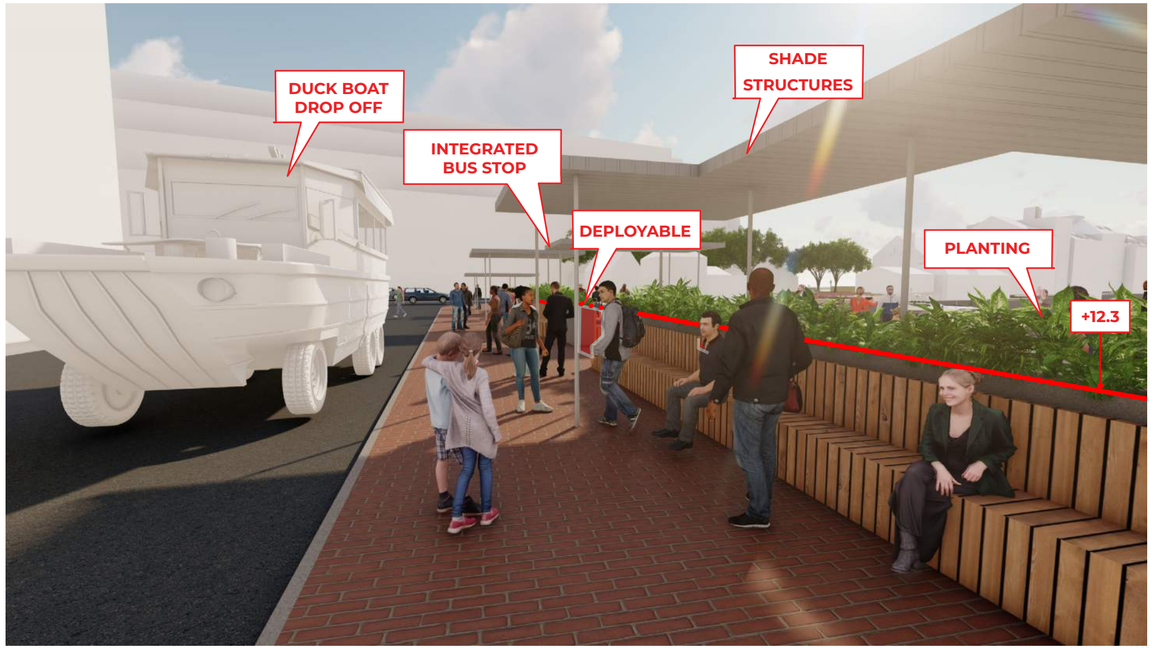


Figure 5-8 - Proposed 2030 South Alignment at Duck Boat Drop Off

DRAFT

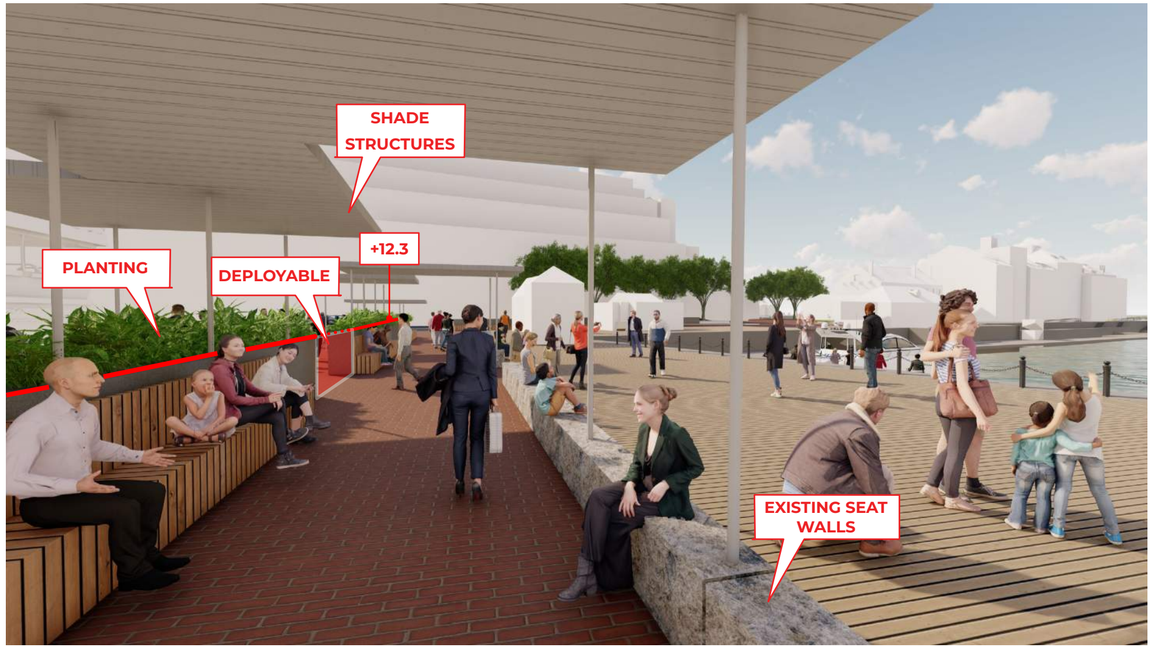


Figure 5-9 - Proposed 2030 South Alignment at Shade Structures

DRAFT

2030: NEAR-TERM CONEPTUAL DESIGN

NORTH ALIGNMENT

At the north end of the proposed 2030 installation, the flood wall follows the eastern edge of the Marriott and turns to the west alongside a new planter. In this location, the wall is again multifunctional and serves as a planter that can produce shade and seating opportunities. As the flood wall meets the north entry of the Marriott, the wall breaks and can be infilled with a deployable barrier in a storm event. The existing edge of the cafe is proposed to be extended vertically to meet elevation +12.3' and then turn to run alongside the existing curb line at Christopher Columbus Park. Since Columbus Park offers an existing higher elevation, the flood wall can feasibly meet the required defensible elevation by feathering into the grade, resulting in a seating opportunity along the park's edge. It is anticipated that Boston Parks and Recreation - with federal funding support - will be leading a project in the year ahead that designs for climate resilience and park improvements. Such a project will be an opportunity for coordinating a flood protection tie-in elevation for the Long Wharf project.

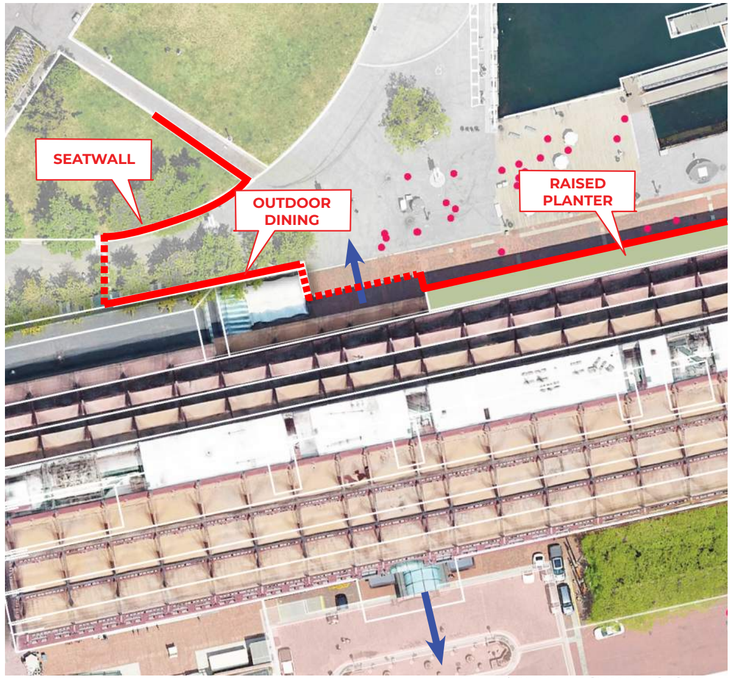


Figure 5-10 - Proposed 2030 North Alignment

DRAFT

SECTION A

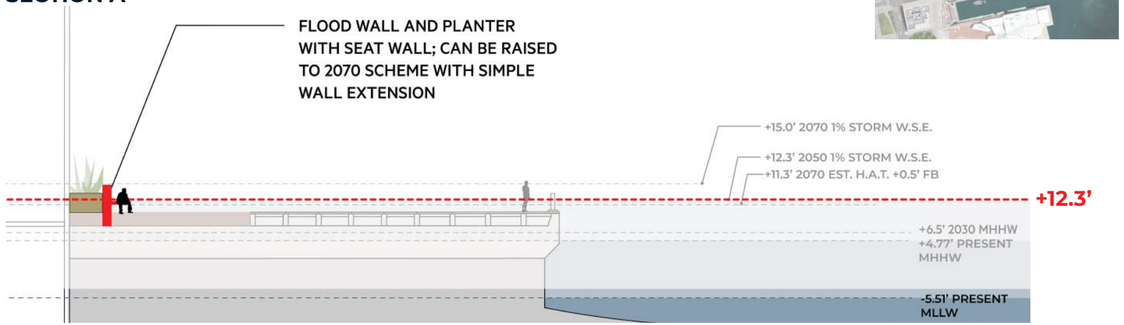


Figure 5-11 - Section A - Proposed 2030 North Alignment

SECTION B

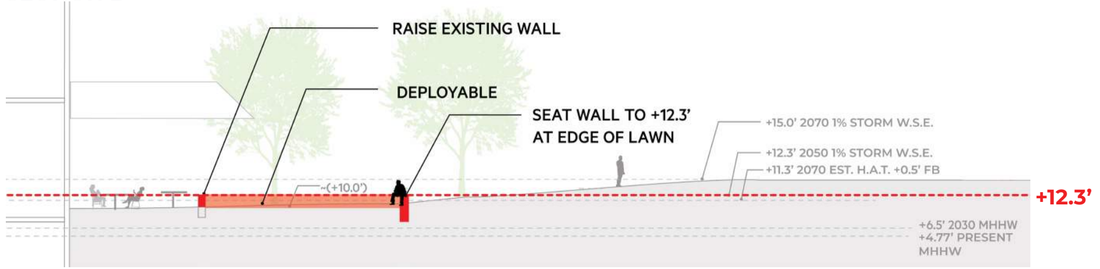


Figure 5-12 - Section B - Proposed 2030 North Alignment

DRAFT

NORTH ALIGNMENT

Figure 5-13 - Proposed 2030 North Alignment at New Stem Wall

DRAFT

2030: NEAR-TERM CONEPTUAL DESIGN

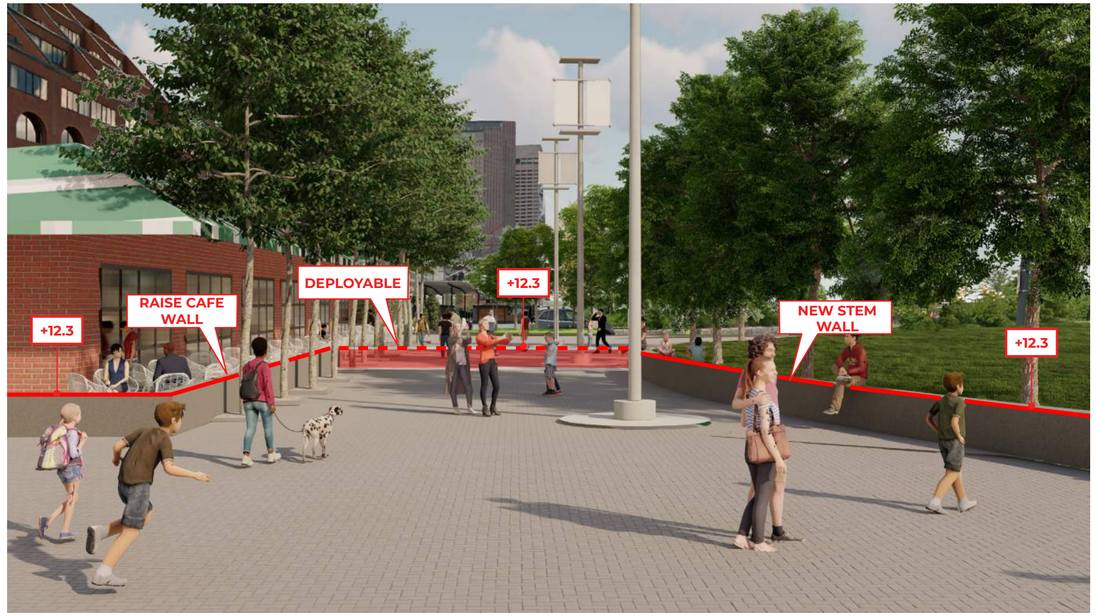


Figure 5-14 - Proposed 2030 North Alignment at New Stem Wall

DRAFT

CONCEPTUAL 2070 DESIGN ALTERNATIVES

ACUPUNCTURE

In looking at the 2070 schemes, the Acupuncture proposal seeks to elevate the perimeter of the wharf to elevation +12.3'NAVD88 as a first layer of defense, effectively creating dry Harborwalk conditions from all but the most extreme storm events. Acupuncture also elevates a portion at the western edge of the wharf to elevation +15.0'NAVD88. Between these two critical elevations, there is flexibility and the opportunity to extend key walls to reach elevation 12.8', as required. This scheme allows for the careful construction of flood walls and infrastructure into the existing condition while limiting the amount of new

Figure 5-15 - 2070 Concept - Acupuncture

Figure 5-16 - 2070 Concept - Acupuncture

DRAFT

NOTE: IT IS ANTICIPATED THAT BOSTON PARKS AND RECREATION WILL BE UNDERTAKING CLIMATE RESILIENCE AND PARK IMPROVEMENTS FOR COLUMBUS PARK. THE TIE-IN IS NOT YET COORDINATED, BUT PASSIVE FLOOD PROTECTION CAN POTENTIALLY BE ACHIEVED TO +12.3' NAVD88, EXTENDING THIS TARGET ELEVATION FROM THE HARBORWALK INTO THE PARK'S INTERIOR.

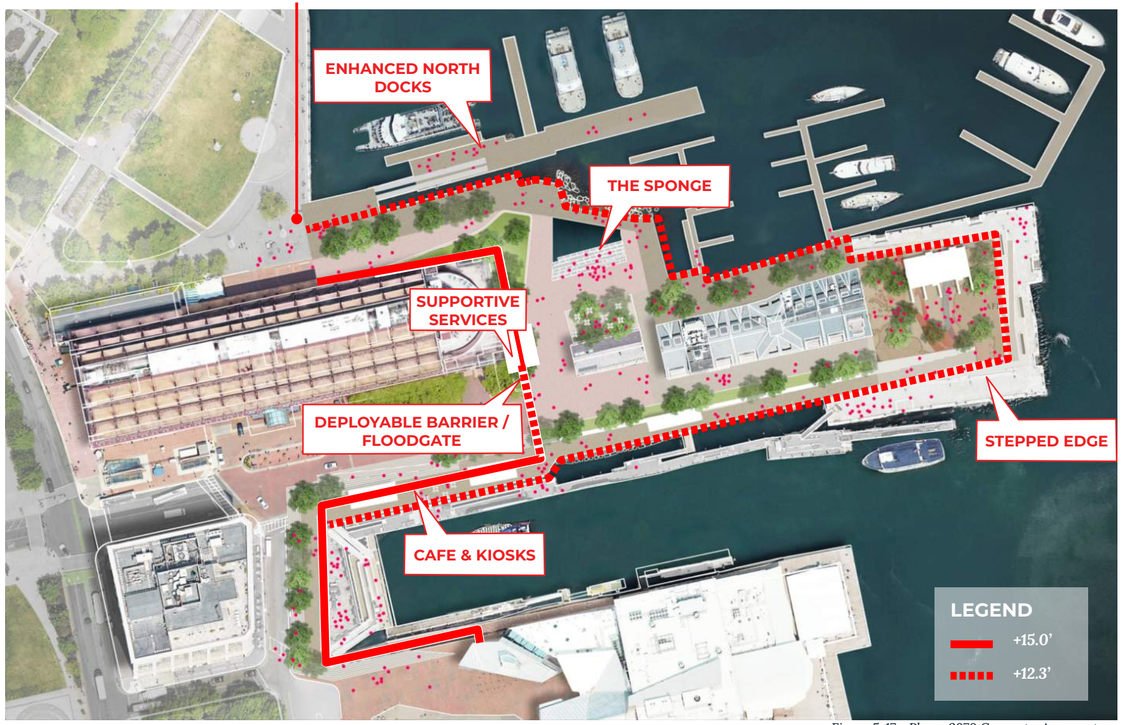


Figure 5-17 - Plan - 2070 Concept - Acupuncture

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

fill, particularly in areas above the Blue Line tunnel.

The public realm seeks, as in all schemes, to extend access to the water's edge, and does so through primarily between stepped and sloped social edges. In the following pages, a series of images describe the sectional relationships between existing and proposed conditions, along with rendered views of what the project might look and feel like.

MOMENTS ALONG THE WHARF

OLD ATLANTIC + STATE STREET

In the Acupuncture scheme, a low flood wall follows the southern perimeter of the wharf. Here, the existing cafe, ticketing, and kiosk programming along the water's edge along with the Harborwalk are elevated through a series of ramped and stepped terraces, culminating in a new raised harborwalk surface at +11.3'. The stem wall, which conveniently creates an 18" seating opportunity, includes an aquarium glass infill that achieves elevation +15.0' for the highest level of district-level protection. The Old Atlantic Avenue roadway is assumed to be maintained in its existing condition, as is the access along State Street, including building entrances, loading docks, etc..

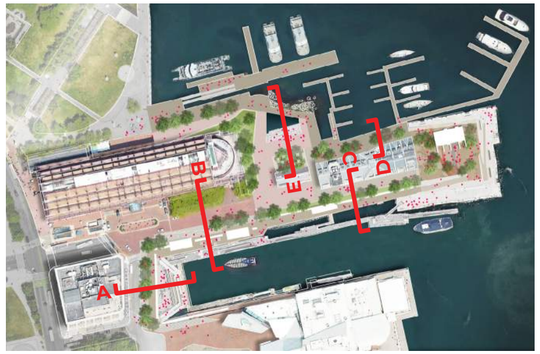


Figure 5-18 - 2070 Concept - Acupuncture - Sections Overview

SOUTH LENGTH OF WHARF

The elevated Harborwalk extends along the southern edge of the wharf, creating a new space to incorporate planting for shade and increased biodiversity. The Chart House and Customs House Block are proposed to remain as they presently are, with no change in their main entries. A gradual slope up to the eastern end of the wharf begins at the eastern edge of the Customs House Block, providing an accessible slope to the water's edge.

NORTH LENGTH OF WHARF

The northern stretch of the wharf is very limited in space and constrained by the Customs House Block directly to the south and open water to the north. Instead of building in the waterway, this space becomes an elevated passthrough and allows for continued higher elevation at 12.3' to wrap around the back of the structures to what is presently a parking lot behind the Chart House.

The parking lot is proposed to be reimagined as public opening space, per its designation by the Land and Water Conservation Fund Section 6(f)(3). Here, a new form of nature-based experience is proposed, a feature designated as 'the sponge' where the elevated Harborwalk becomes a boardwalk and extends over the existing rocky intertidal edge. A series of stepped blocks down to the water become a social seating edge that interfaces with the water and becomes a space for flood waters to be accommodated in the future.

A large planted berm is proposed along the eastern edge of the Marriott Hotel to provide the final +15.0' NAVD88 edge protection. The berm allows for further planting to shade the new elevated plaza alongside the sponge.

DRAFT

VIEW FROM STATE STREET TO EAST

The vision for the intersection of State Street and Old Atlantic Avenue is a bustling urban environment with vibrant cafe and ticketing spaces along a new elevated plinth. An aquarium glass wall completes the line of defense to +15.0' NAVD88 while preserving views out to the harbor, tying into new kiosk and cafe spaces. These reimagined amenities can be integrated into flood defenses while activating this space and drawing people to the water.

Figure 5-19 - Acupuncture - View from State Street

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

SECTION A

EXISTING CONDITION

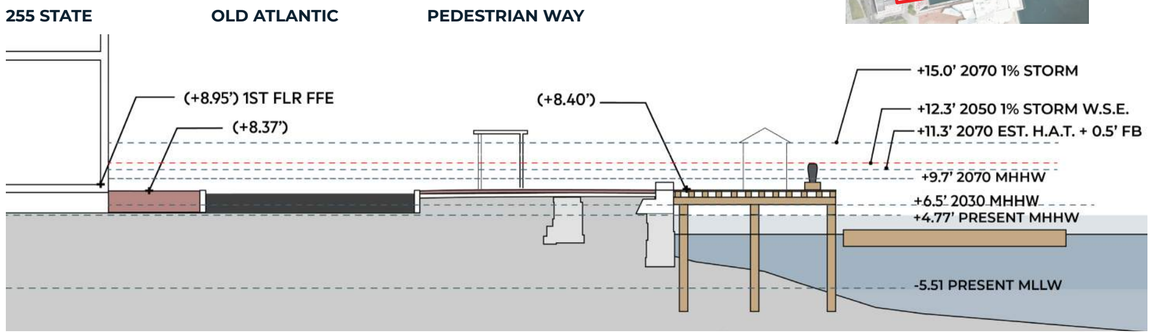


Figure 5-20 - Existing Condition - Section A

PROPOSED CONDITION

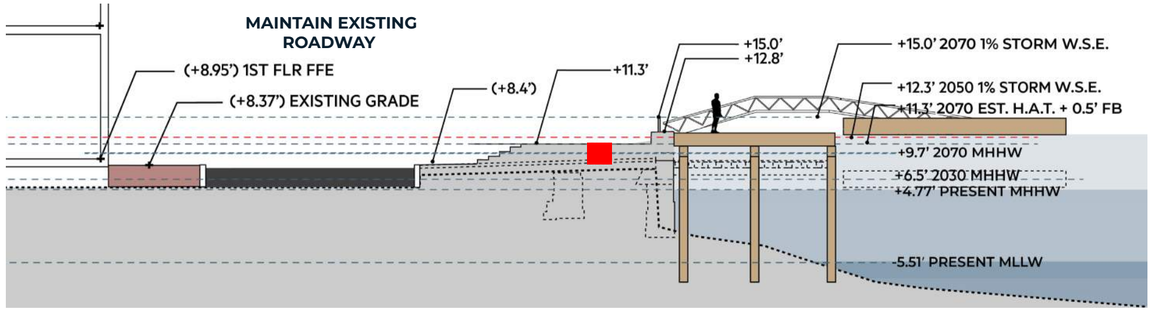


Figure 5-21 - Acupuncture - Section A

DRAFT

SECTION B

EXISTING CONDITION

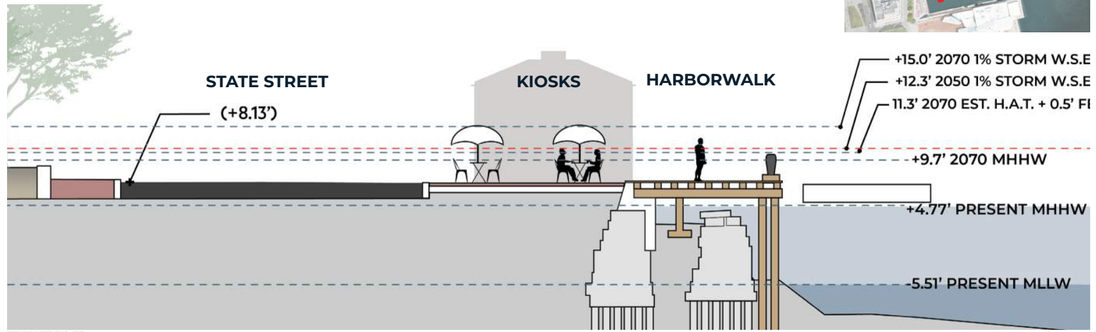


Figure 5-22 - Existing Condition - Section B

PROPOSED CONDITION

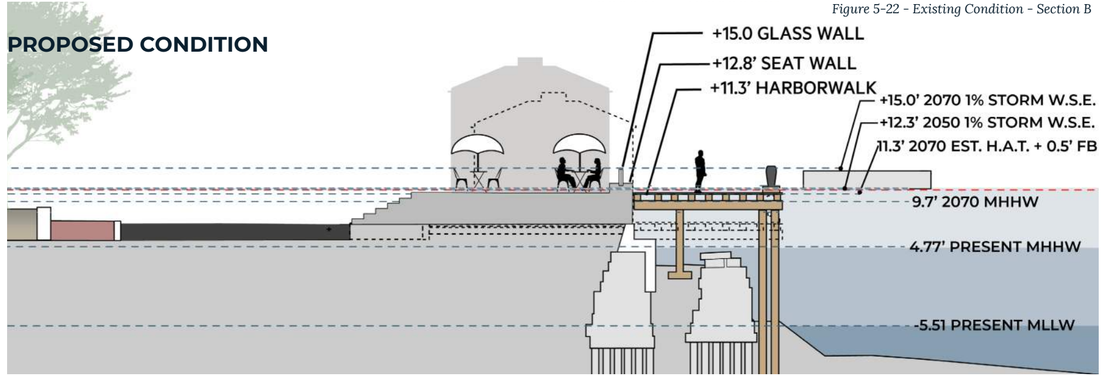


Figure 5-23 - Acupuncture - Section B

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

SECTION C

EXISTING CONDITION

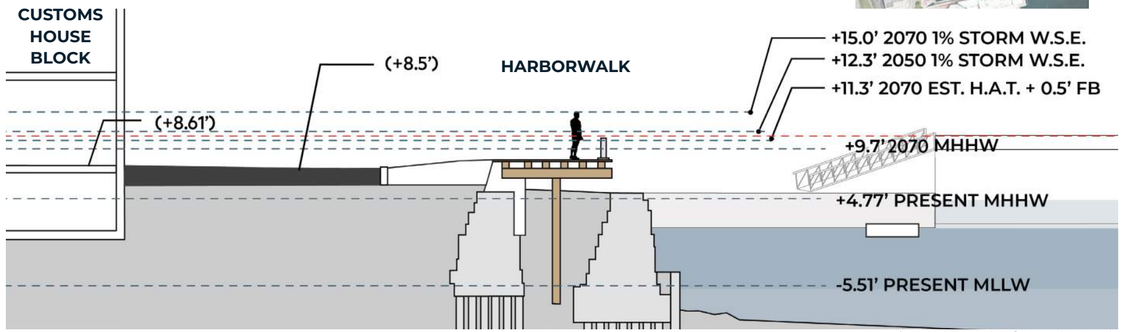


Figure 5-24 - Existing Condition - Section C

PROPOSED CONDITION

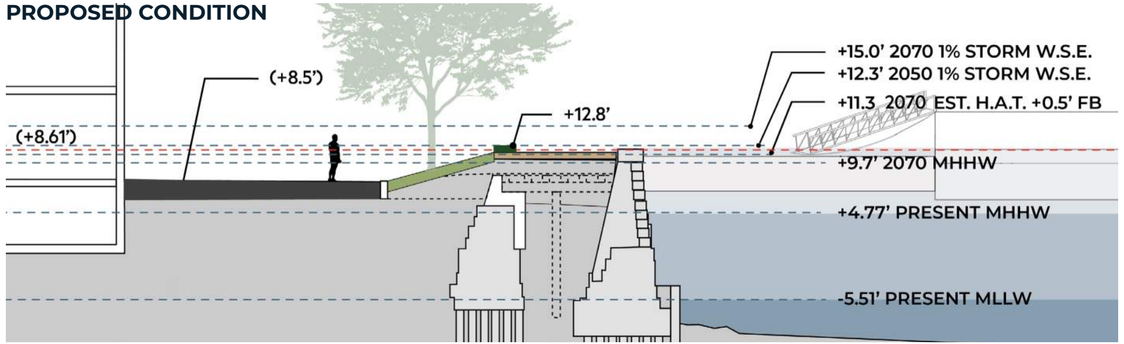


Figure 5-25 - Acupuncture - Section C

DRAFT

VIEW AT CHART HOUSE LOOKING EAST

In the Acupuncture scheme, the existing roadway is maintained with the Harborwalk raised to elevation +11.3'. A clear view corridor is maintained from the Marriott Hotel to the eastern end of the wharf and out towards the water and serves as an upland connector between the city and the harbor.

Figure 5-26 - Acupuncture - View at Chart House Looking East

DRAFT

VIEW AT END OF WHARF LOOKING WEST

At the end of the wharf, visitors can enjoy sweeping views of the harbor and the surrounding maritime activity. Here, the design proposes embedding elements of the wharf's history into the new paving materials. For example, the below image shows the elevated plaza incorporating graphics of the middle passage slave trade, a route with a terminus formerly at Long Wharf.

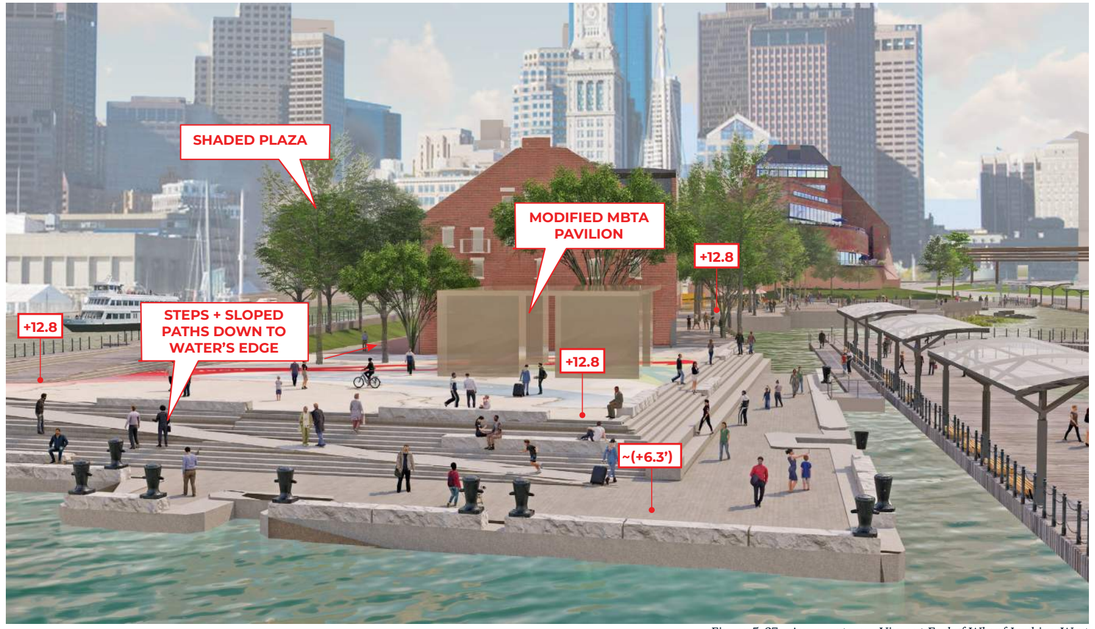


Figure 5-27 - Acupuncture - View at End of Wharf Looking West

VIEW AT END OF WHARF LOOKING WEST IN POTENTIAL FUTURE FLOOD EVENT

During a future flood event, the eastern end of the wharf could experience moderate flooding. The full level of district protection can be seen in the background of this image running along the berm adjacent to the Marriott Hotel.

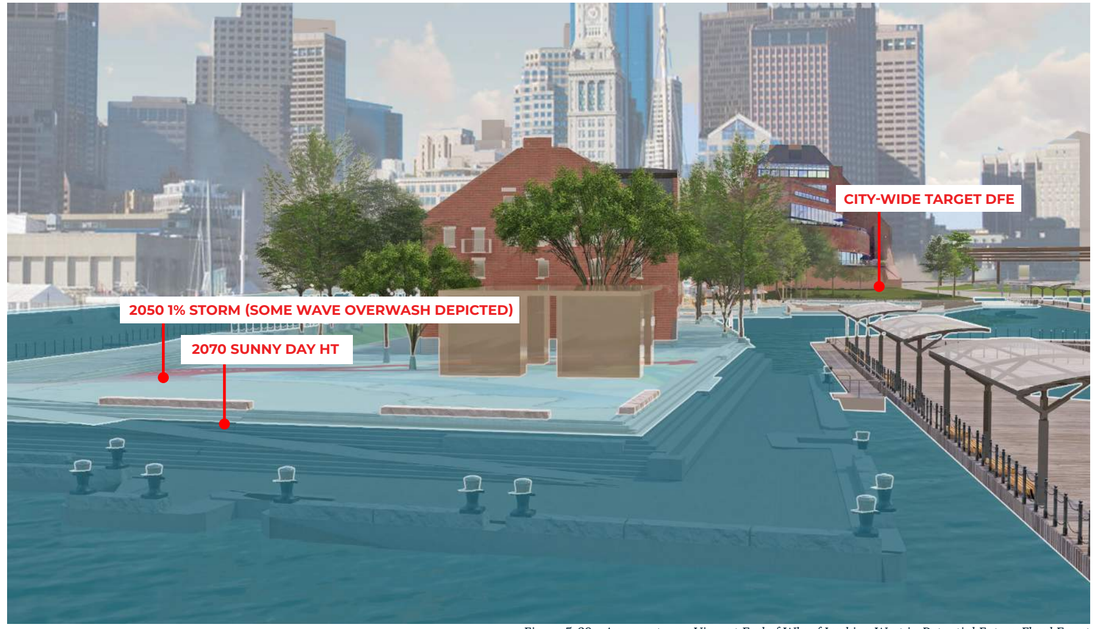


Figure 5-28 - Acupuncture - View at End of Wharf Looking West in Potential Future Flood Event

DRAFT

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

SECTION D

EXISTING CONDITION

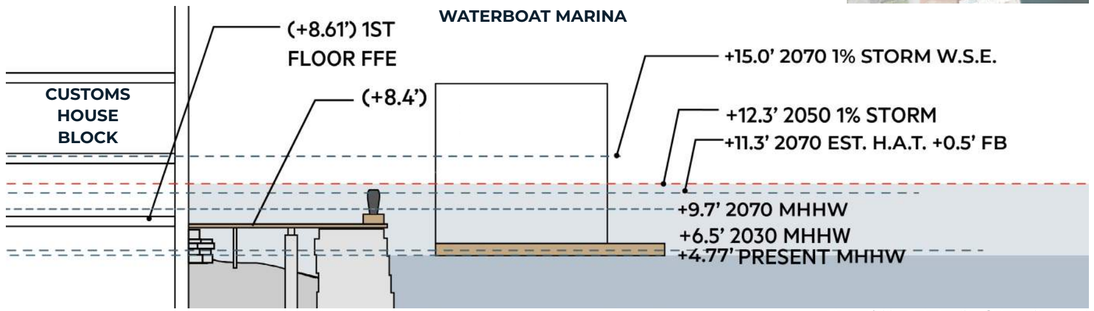


Figure 5-29 - Existing Condition - Section D

PROPOSED CONDITION

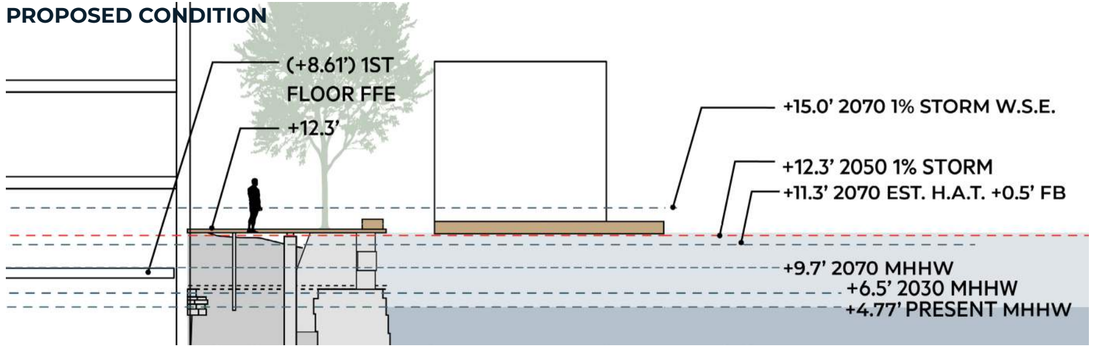


Figure 5-30 - Acupuncture - Section D

DRAFT

SECTION E

EXISTING CONDITION

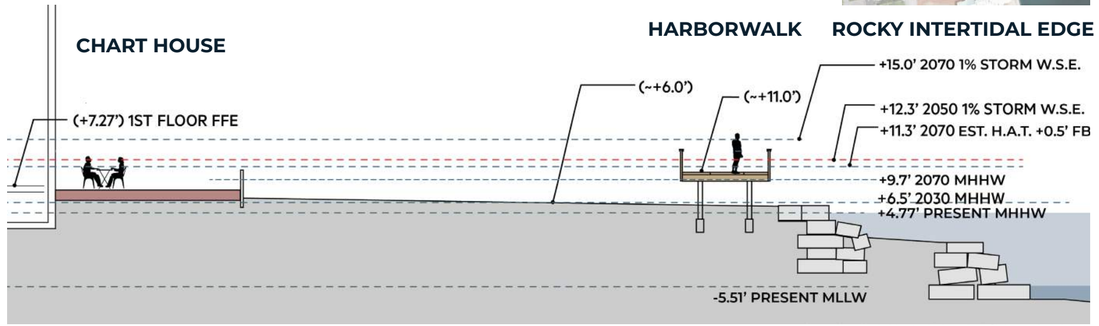


Figure 5-31 - Existing Condition - Section E

PROPOSED CONDITION

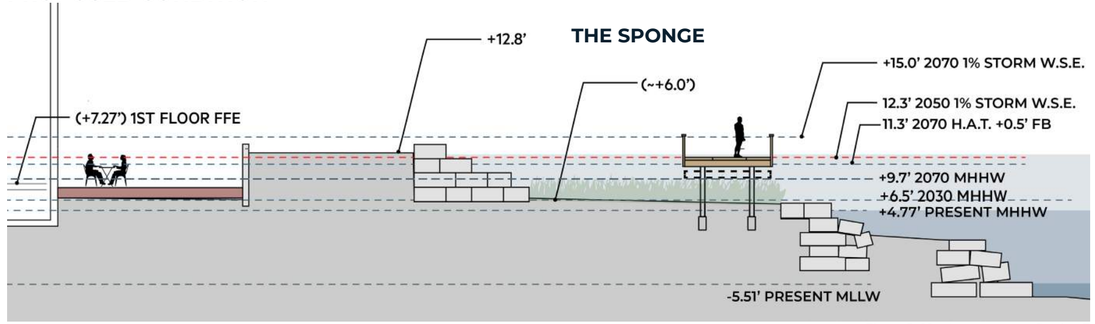


Figure 5-32 - Acupuncture - Section E

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

VIEW AT NORTH SIDE OF WHARF LOOKING EAST

The proposed sponge feature at the north side of the wharf could feature the dynamism of the harbor by allowing visitors to interact with the water's edge at an intertidal rocky zone. The elevated Harbowalk becomes a boardwalk that floats over the water and offers a great vantage point over the reconfigured marine transit.

Figure 5-33 - Acupuncture - View at North Side of Wharf Looking East

VIEW AT BERM LOOKING EAST

The Acupuncture scheme utilizes a berm to close the district-wide +15.0' NAVD88 flood protection. This berm is proposed to be multifunctional and provides a space for seating and planting, offering much-needed shade and an opportunity to increase biodiversity on site.

Figure 5-34 - Acupuncture - View at Berm Looking East

DRAFT

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

BIG SPLASH

As an alternative to the Acupuncture scheme, the Big Splash scheme considers creating a more intensive approach to flood protection and utilizes fill throughout the entirety of the wharf to achieve a higher elevation of +15.0' NAVD88 closer to the western edge of the site. Because of this higher elevation baseline, Big Splash is able to integrate multiple edges of new stepped social spaces and higher vantage points for views over the harbor. This scheme requires modification to the existing Chart House and Customs House Block structures, which in detailed in Appendix C - Adaptation Design Guidelines.

Figure 5-35 - 2070 Concept - Big Splash

Figure 5-36 - 2070 Concept - Big Splash

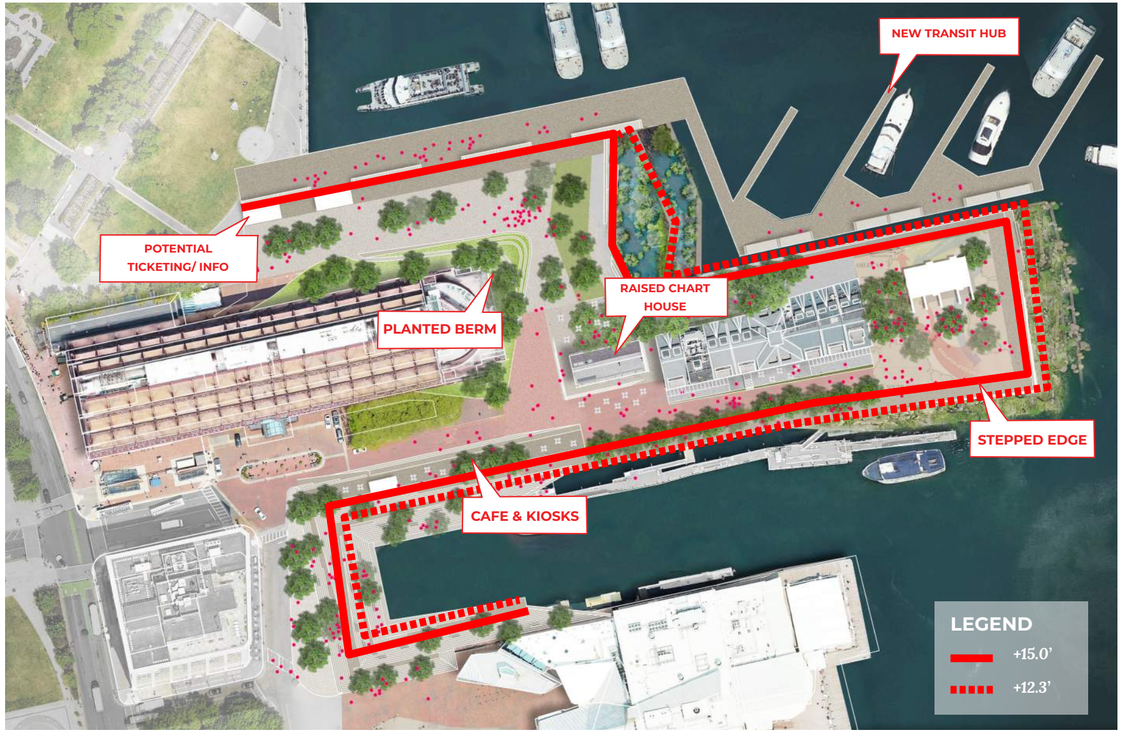


Figure 5-37 - Plan - 2070 Concept - Acupuncture

DRAFT

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

MOMENTS ALONG THE WHARF

OLD ATLANTIC + STATE STREET

In the Big Splash scheme, a new plinth is created along Old Atlantic Avenue. While the existing grade is maintained along the roadway, the entirety of the public way and the space between the watersheet is filled to achieve a high point of +15.0'. This is achieved by a series of stepped edges that are embedded with accessible sloped paths. Once the terraces reach elevation +15.0' NAVD88, the proposed stepped edges terrace back down to just above the water's edge with the Harborwalk being held at elevation +11.3' NAVD88. Should a 2030 scheme be constructed, the low flood wall would be able to be incorporated into the new plinth along Old Atlantic Avenue as indicated in the sections on the following pages. As the line of protection turns from Old Atlantic Avenue to State Street, the cafe, kiosk, and ticketing uses are proposed to be repositioned at the new plinth behind the +15.0' NAVD88 highest elevation.

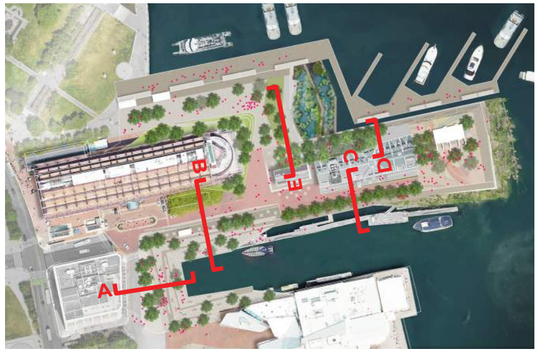


Figure 5-38 - 2070 Concept - Big Splash - Sections Overview

SOUTH LENGTH OF WHARF

Fill along the entirety of the wharf will result in the elevation of the southern side and therefore a new relationship to the existing entries for both the Customs House Block and the Chart House. Because the Chart House is presently located in one of the lowest existing points on site, this scheme proposes raising the entire structure so that the first floor is at elevation +15.0' NAVD88. Entry to the building would be supported by a sloped path that slopes from the newly filled State Street up to a new plinth. At the Customs House Block, which is a much larger structure, the building is proposed to remain in place, but new access would be provided to its existing floors. Because of the elevated finish grade, the first floor would become a partially subterranean space. To provide access to this area, a new split-level entry sequence could be established with sloped paths and steps down to the existing first floor and a new set of steps up to the existing second floor. This entry sequence would be similar to what is presently seen at Newbury Street and in other parts of Boston.

EAST END OF WHARF

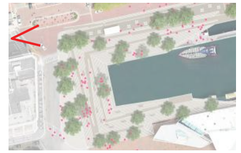
The gradual fill along the length of the wharf in the Big Splash scheme results in the eastern end being elevated to +15.0' NAVD88. The plaza at the end of the wharf is positioned to provide great views paired with district-level protection. As with the far western side of the wharf, this end provides a series of steps and sloped paths towards the water's edge, but instead of allowing full access to the water as in the Acupuncture scheme, this configuration proposes a new floodable living edge. This edge could be composed of wave attenuating materials and planting and suggests a new relationship to the water and wet landscapes.

NORTH LENGTH OF WHARF

As in the Acupuncture scheme, the northern stretch of the wharf is very limited in space and constrained by the Customs House Block directly to the south and open water to the north. Instead of building in the waterway, this space becomes an elevated passthrough, staying high at elevation +15.0' and then sloping back down to elevation +12.8 NAVD88 at the existing parking lot.

DRAFT

VIEW FROM STATE STREET TO NORTHEAST



At the western end of the wharf, a new raised edge along Old Atlantic Avenue and State Street provides protection up to elevation +15.0 NAVD88 and then provides an interface between the ciy and the water via a dramatic series of steps and accessible sloped paths. This 'cove' is shaded by new plantings and creates a get-down to the water's edge for visitors to enjoy. For this scheme, the MBRA ferry service is relocated to the north side of the wharf. Other recreational boat service would remain along the north and south edges of the inlet.

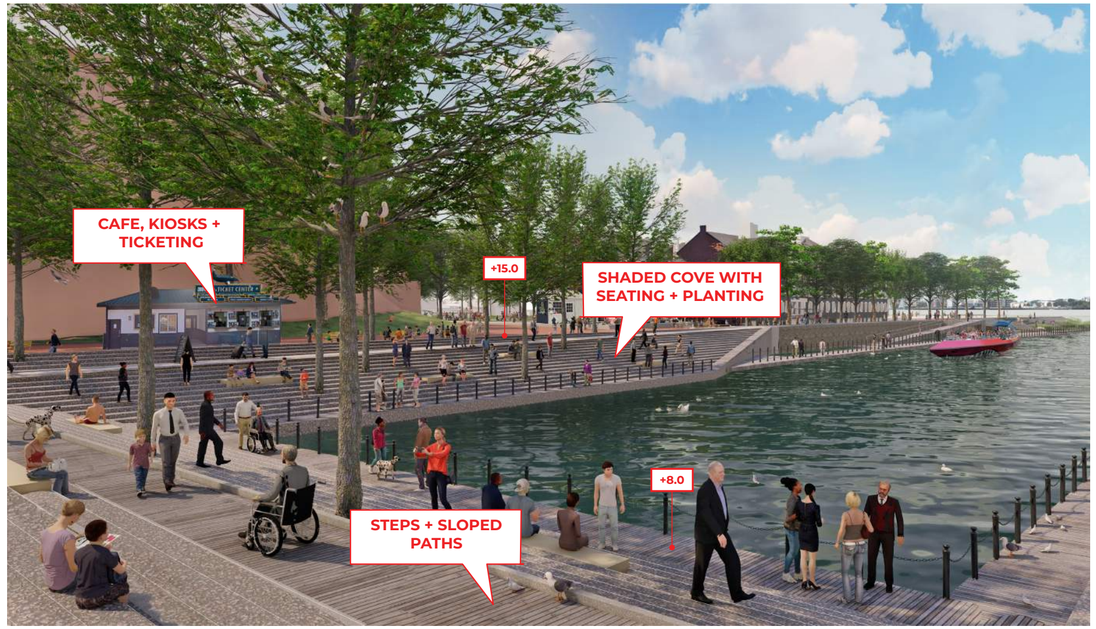


Figure 5-39 - Big Splash - View from State Street to Northeast

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

SECTION A

EXISTING CONDITION

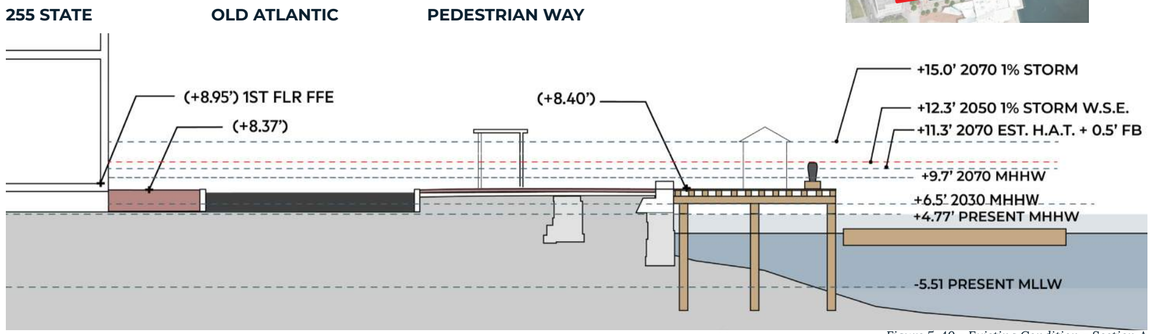


Figure 5-40 - Existing Condition - Section A

PROPOSED CONDITION

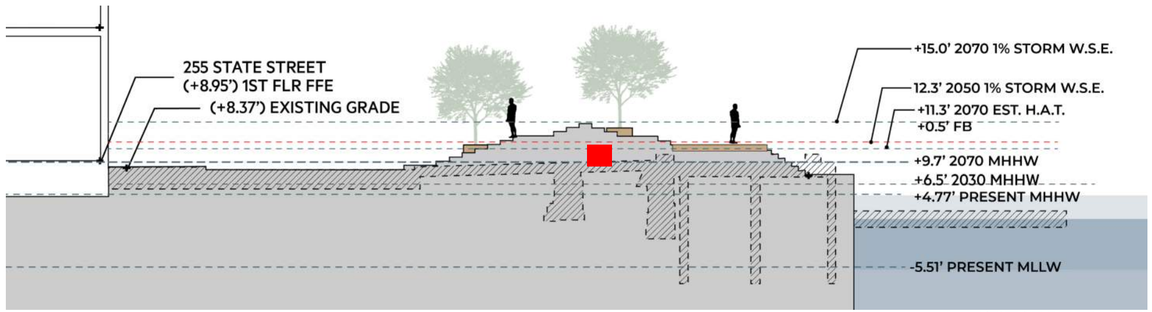


Figure 5-41 - Big Splash - Section A

DRAFT

SECTION B

EXISTING CONDITION

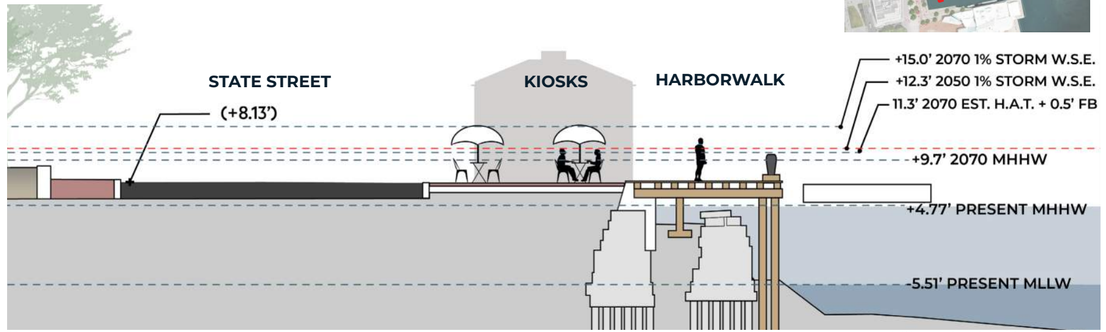


Figure 5-42 - Existing Condition - Section A

PROPOSED CONDITION

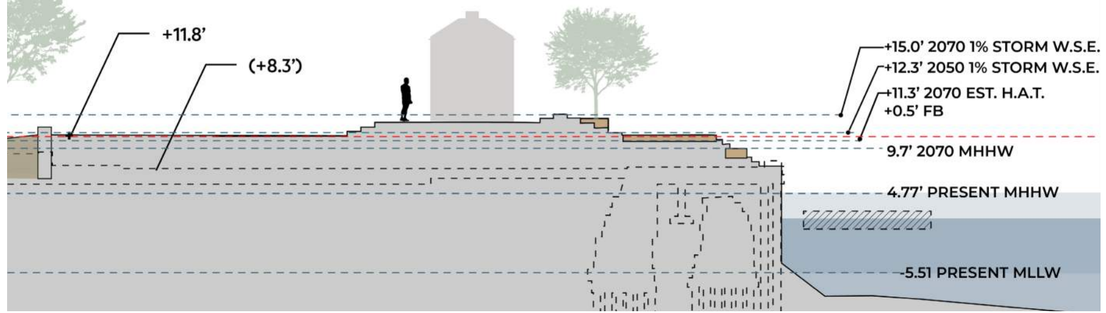


Figure 5-43 - Big Splash - Section A

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

SECTION C

EXISTING CONDITION

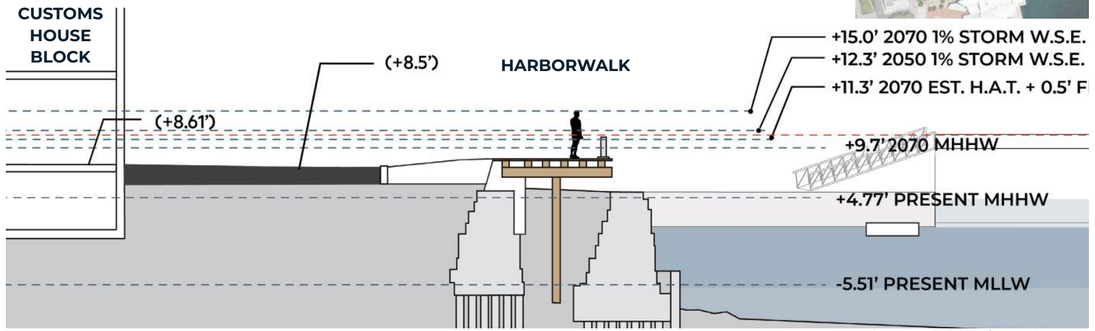


Figure 5-40 - Existing Condition - Section C

PROPOSED CONDITION

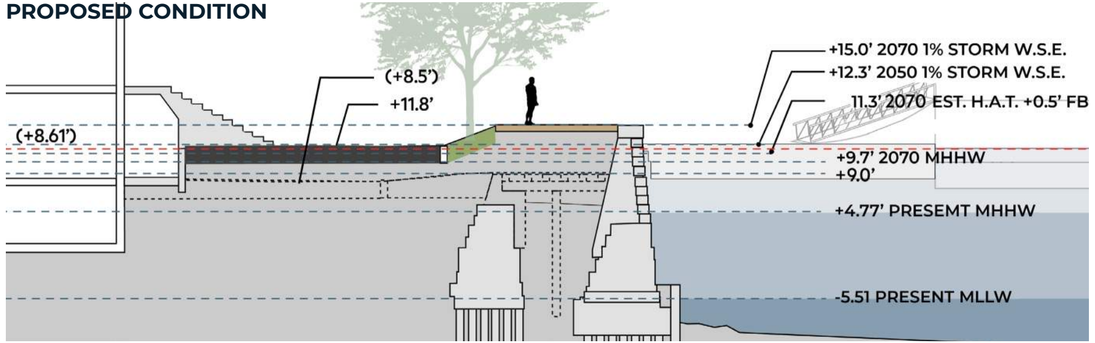


Figure 5-41 - Big Splash - Section C

VIEW AT CHART HOUSE LOOKING EAST

In the Big Splash scheme, both the Chart House and the Customs House access are modified, as seen in this image. The roadway along the wharf remains open with clear views to the harbor and ample space for seating and social space.

Figure 5-42 - Big Splash - View at Chart House Looking East

DRAFT

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

VIEW AT CUSTOMS HOUSE BLOCK LOOKING WEST

Looking back at the city, the relationship between the new raised grade along the wharf and the existing structure of the Customs House Block is made apparent. The split-level space that allows access to the existing first floor of the building offers a space for seating and additional planting, with opportunities for increased public realm activation with active building frontages and more welcoming public spaces along the waterfront.

Figure 5-43 - Big Splash - View at Custom House Block Looking West

VIEW AT END OF WHARF LOOKING WEST

At the east end of the wharf, the Big Splash scheme is elevated to +15.0' NAVD88, providing a new platform for sweeping views across the harbor. The stepped, planted edge adds texture, habitat space, and potential wave attenuation features and can serve as an educational tool for visitors to the wharf.

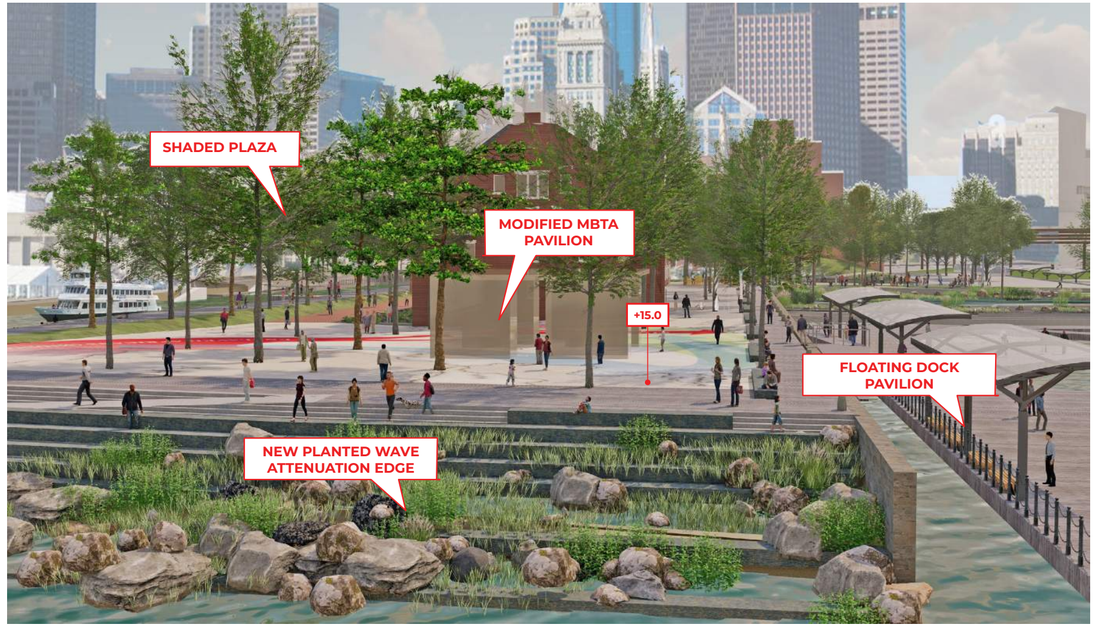


Figure 5-44 - Big Splash - View at End of Wharf Looking West

DRAFT

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

SECTION D

EXISTING CONDITION

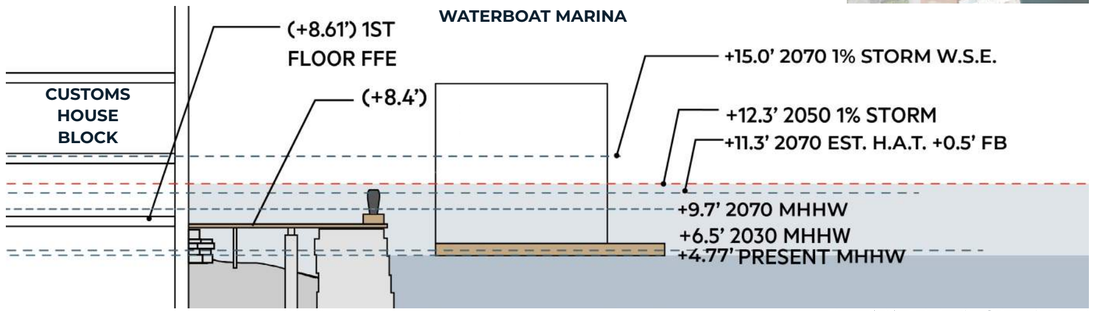


Figure 5-45 - Existing Condition - Section D

PROPOSED CONDITION

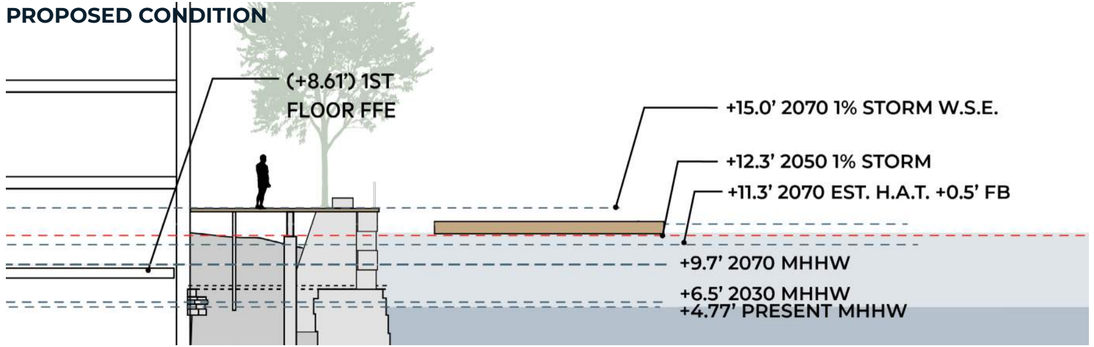


Figure 5-46 - Big Splash - Section D

DRAFT

SECTION E

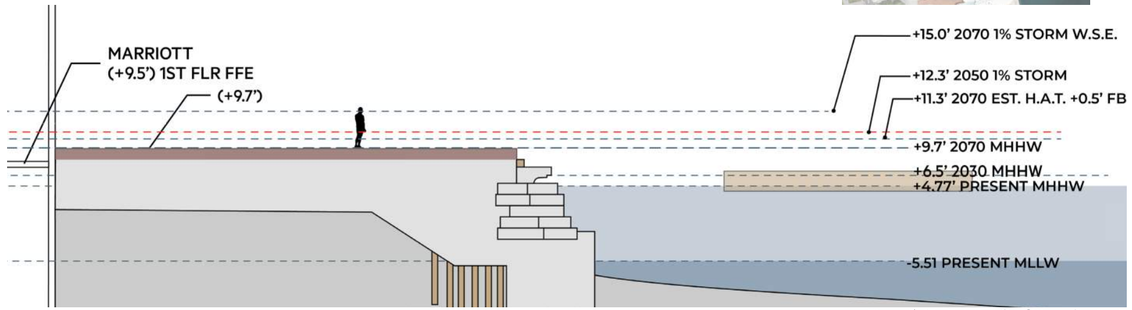


Figure 5-47 - Existing Condition - Section E

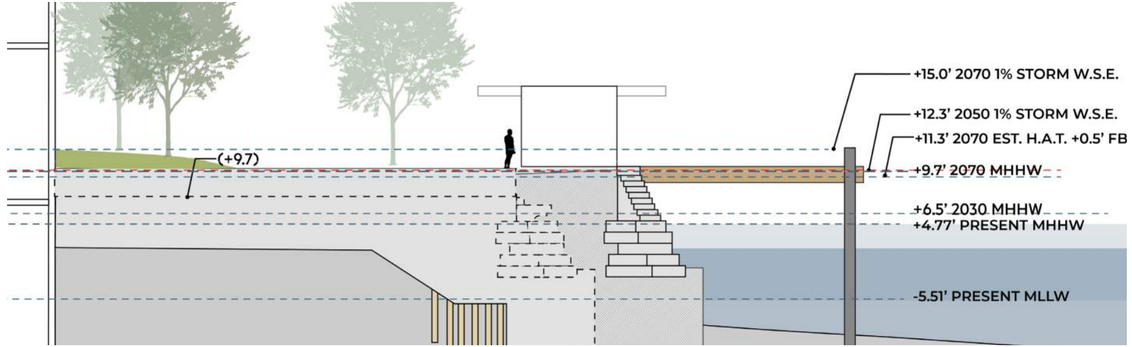


Figure 5-48 - Big Splash - Section E

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

VIEW FROM BERM LOOKING EAST

The elevated berm creates a space for seating and planting, resulting in a more comfortable outdoor experience. An adjacent plaza and lawn terrace extend the open space from Christopher Columbus Park towards the harbor and marine transit.

Figure 5-49 - Big Splash - View at Berm Looking East

VIEW FROM BERM TO NORTHEAST IN POTENTIAL FUTURE FLOOD EVENT

During a future flood, the elevated plaza and lawn remain dry and accessible. The adjacent planted terraces could hold water and serve as a feature to highlight a working, resilient landscape for visitors to the water's edge.

Figure 5-50 - Big Splash - View at Berm to Northeast in Potential Future Flood Event

DRAFT

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

MARINE TRANSIT REALIGNMENT

MARINE TRANSIT REALIGNMENT

EXISTING CONDITIONS

One of the objectives of this project is to find ways to improve maritime transit, whether as part of coastal resiliency improvements or as a stand-alone adjacent project.

Land-based water transportation infrastructure and accessory uses will need to be replaced or adapted to address flooding risks. These facilities should be replaced or adapted to accommodate improved ferry services and berthing.

Maritime transportation, including public transit ferries, commercial vessels, and recreational excursions, remains central to the identity of Long Wharf. The Wharf serves as an iconic gateway to the City from the water side, and is the most prominent and centralized of the water transit hubs in the Harbor.

However, the existing layout is not particularly intuitive, with ferries departing to the south (from the north side) and vice versa. The mixture of public ferries and private excursion vessels, regional and seasonal ferries can add to passenger confusion.

It was noted during these conversations and site walks that the numerous docking and ramp locations, lack of wayfinding signage, high volume of foot traffic, and at-times chaotic waterfront activity often result in confusion for those unfamiliar with locations of specific ferries. During summer months, the site is full of pedestrian foot traffic, with crowds from New England Aquarium and queuing passengers for Harbor excursions mixing in a busy drop-off zone at Old Atlantic Avenue.

Commercial ferry operators also confirmed that in-water space constraints – particularly on the south side of wharf – limit maneuverability for operators in tight quarters. Absent further build-out, today's conditions already require near constant communication between commercial operators and public ferries, and excursion vessels often wait on public transit ferries to arrive/depart before maneuvering their own vessels. The current leased private use at Waterboat Marina operates on a 5-year lease, and it was noted that the highest and best future use of this watersheet should consider public uses of this space.

DESIGN INTENT

One of the priorities of this project was to find ways to better consolidate public marine transit to one centralized location, opening up more space for maneuverability and/or expansion of commercial and recreational vessels on the south side of the wharf. Consolidation of marine public transit operations was a clear priority emerging from stakeholder conversations.

Throughout engagement, operators also consistently noted that more berthing space can always be utilized if space is made available. One of the key reservations or limitations that stakeholders saw with the concepts in prior concept plans for this area was the outward expansion at the end of Long Wharf (in-water towards Central Wharf), which was noted as an already challenging environment for vessel operators. "Land-based relocation" of supporting infrastructure, landing areas, and ancillary facilities (e.g., ticketing, storage, office space) were also concepts that frequented conversations.

Other desired outcomes included preserving universal accessibility to the dock, creating a clearer connection from the Greenway to serve as a "gateway to the Harbor Islands", and providing more dedicated space and shade for queuing of passengers

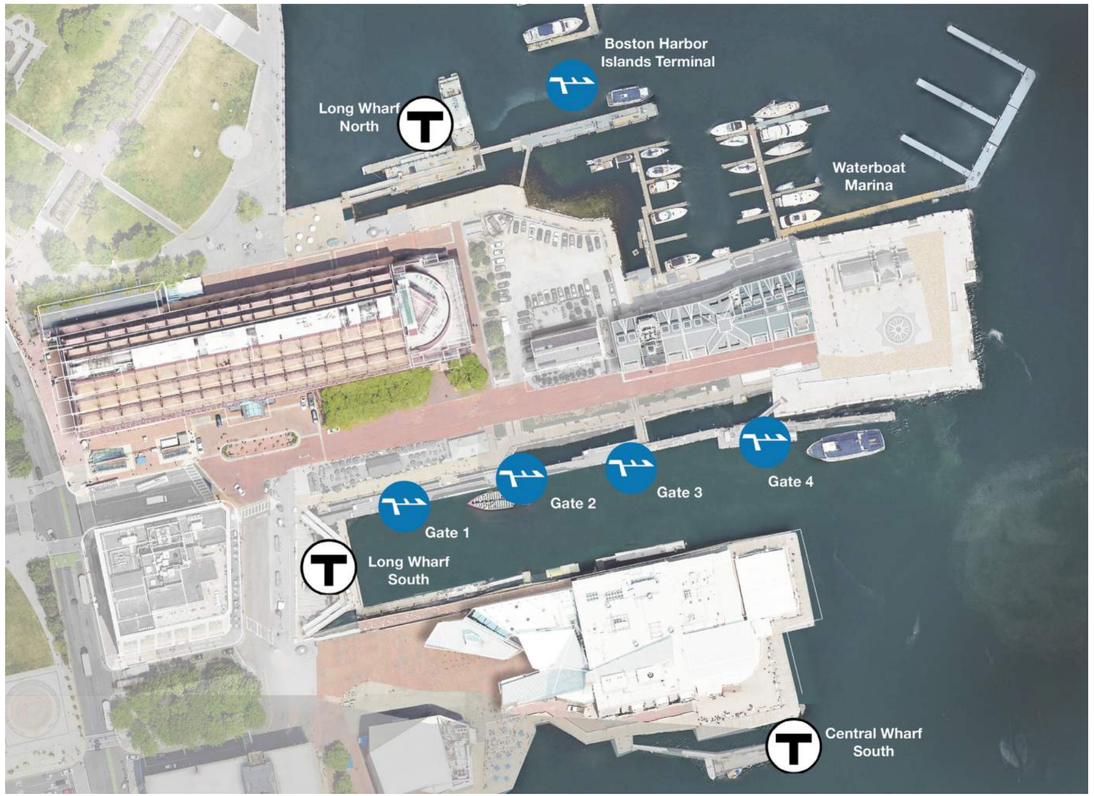


Figure 5-51 - Existing marine transportation water-dependent and transportation uses at Long Wharf

DRAFT

DRAFT

EARLIER VISIONING & INSPIRATION

Conceptual ideas - such as restoring or re-imagining the historic T Wharf – were explored as part of Coastal Resilience Solutions for Downtown & North End (2020) and the current project. Each re-explored ideas from the 1980's Long Wharf Master Plan by Sasaki (opposite page), which reintegrated a wharf/marina to the north of the Chart House.

RESTORING LONG LOST CONNECTIONS – T WHARF

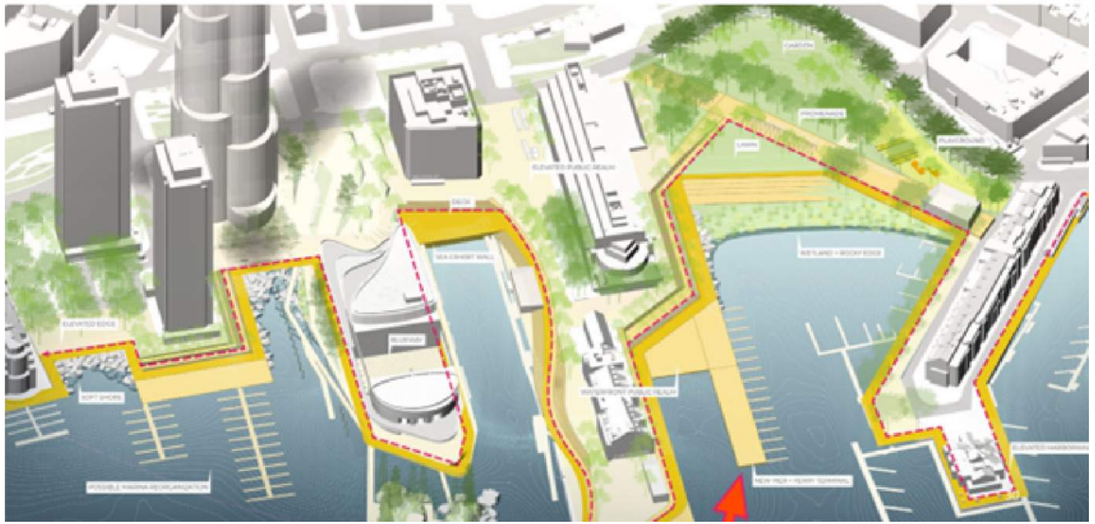


Figure 5-52 - Source: Coastal Resilience Solutions for Downtown and North End 2020

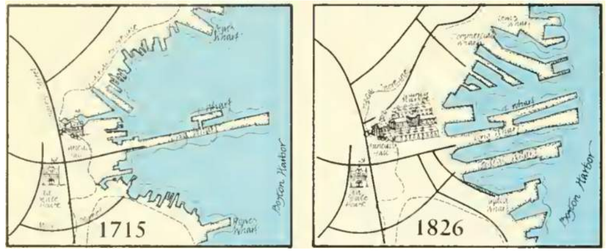


Figure 5-53 - Historic Long Wharf - 1715 and 1826

T Wharf

No history of Long Wharf is complete without mention of T Wharf, the T-shaped wharf attached to Long Wharf's northern face. It was constructed in the 18th century to take advantage of the deep water available midway down Long Wharf.

T Wharf became the center of Boston's fishing industry during the late 19th and early 20th centuries. Sometime after the decline of the fishing trade in Boston, T Wharf became a favored residential address for artists and the home of the very popular Blue Ship Tea Room until the wharf's disintegration in the 1960's.

Figure 5-54 - Historic T Wharf at Long Wharf

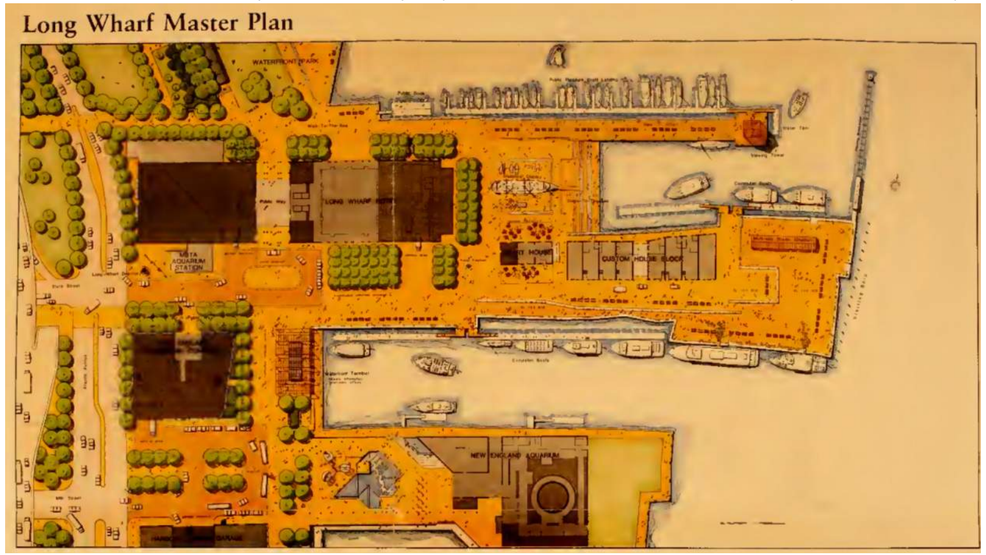


Figure 5-55 - Historic Long Wharf Master Plan

DRAFT

DRAFT

PROPOSED DESIGN

Consolidation of marine infrastructure (particularly public ferry transit) and upgrades to supporting infrastructure were noted as priorities. There is strong support for these improvements, even if implemented independently – or ahead of - long-term flood resiliency objectives for the wharf.

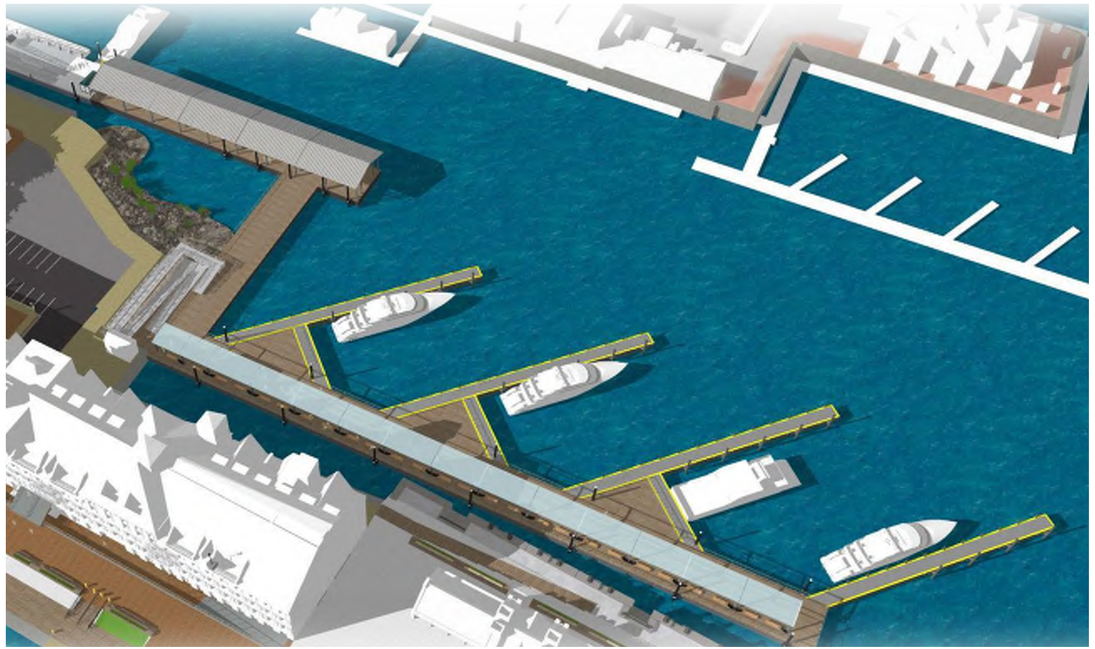


Figure 5-56 - Proposed Marine Transit Realignment

Major design issues & considerations –

- Increasing shade and comfort for passengers
- Space for passenger queueing is limited on land side so provide it on the floating docks
- Public safety concerns – especially for children (railings, slippery surfaces, etc.)
- Include capability for bow-loading ferries
- Future electrification of ferries / other marine infrastructure
- Stability during range of wave and tide conditions requires naval architect to design floating dock structure
- ADA-accessible vehicle drop-off location would be needed further out onto wharf (but can be a drop off zone instead of parking)

Figure 5-57 - Proposed Marine Transit Realignment

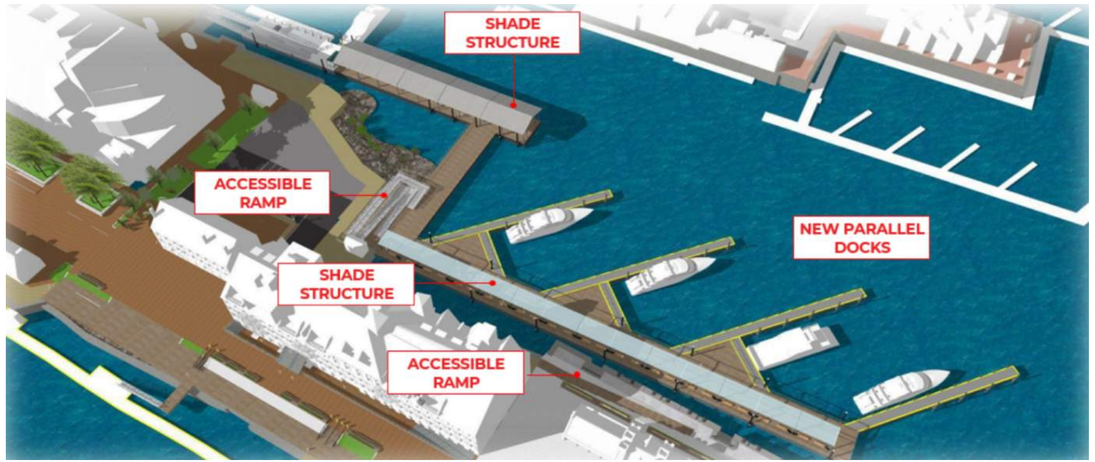
DRAFT

DRAFT

MARINE TRANSIT - FUTURE VISIONING

NORTH WHARF CONFIGURATION

ALL FERRY AND TRANSIT SERVICE MOVES TO NORTH SIDE



EXCURSIONS AND PRIVATE BOAT SERVICES REMAIN ON SOUTH SIDE

Figure 5-58 - Marine Transit Realignment - North Wharf Configuration

DRAFT

MARINE TRANSIT - FUTURE VISIONING

VIEW WEST ON FLOATING DOCK / WAITING AREA

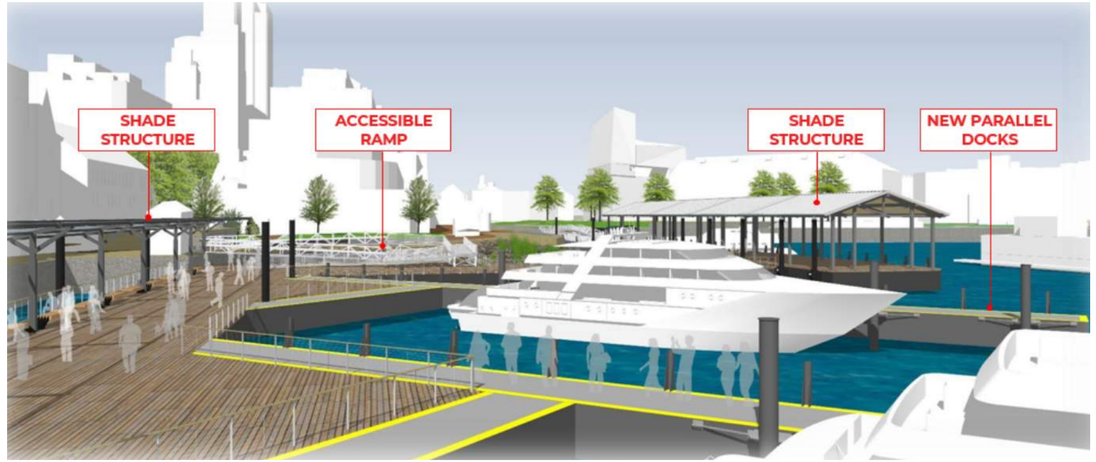


Figure 5-59 - Marine Transit Realignment - View West on Floating Dock / Waiting Area

DRAFT

6- FEASIBILITY AND IMPLEMENTATION

STRUCTURAL & GEOTECHNICAL CONSIDERATIONS

EXISTING ISSUES

HISTORIC STRUCTURAL LOADINGS AND SURFACE SETTLEMENT

In meetings with Boston Engineering Department, it was noted that the wharf was designed for higher structural loading, historically, than what is currently there. For instance, there used to be warehouse buildings that fully enclosed the outer portion of the wharf, and there has been a variety of different configurations that have contributed to a good deal of assumed "pre-compaction" of the present-day materials. However, there are some known structural issues at the existing seawalls. It had been noted that the fast ferry operations had been putting a lot of energy on Long Wharf for the first time in a long time and that dynamic shoaling has been observed. From 2018 to 2021, work has been performed to stabilize the southeast seawall, and another project is currently underway to stabilize the Long Wharf east seawall after an opening in the seawall was identified on the east face that was rapidly deteriorating due to tidal action.

Figure 6-1 - Model Renderings by Foth

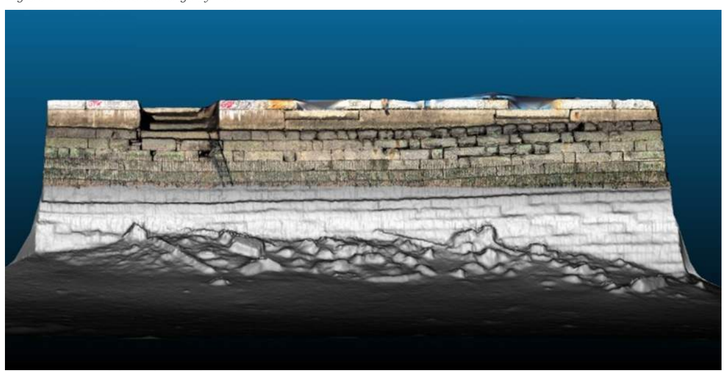


Figure 6-2 - Model Renderings by Foth

There are also areas at (or adjacent to) the existing Harborwalk on the south side of the wharf that are experiencing ground settlement, including the floors of outbuilding structures near The Landing bar and restaurant.

GROUNDWATER AND SEEPAGE

Long Wharf, itself, is far from a "watertight" structure in its present condition. The current state of perimeter seawalls, pilings, and layering and variability of historic fill materials result in spatially variable conditions with respect to subsurface flow. In some areas, seawater is freely exchanged via tidal flow, such as the open basement of the Customs House Block. Keeping water out of these aeas is very difficult and potentially costly as seepage barriers may require sheetpiling around entire building.

Figure 6-3: Several "inlets/outlets" are found along the Long Wharf north seawall, connecting to the tidally-connected basement of the Customs House Block. (Image Source: Kleinfelder)

In other areas, small openings in the seawall, or unhardened edges below the cantilevered Harborwalk results in mixed exchange. In stakeholder consultations, MBTA has also noted the existence of preferential subsurface flow pathways near the egress structure stairwell at the plaza. Abandoned past utilities may also serve as subsurface flow conduits, especially near the end of the wharf where mapping is less comprehensive.

The MBTA has also noted implications for larger-scale groundwater monitoring and stabilization efforts, informing operations for pumping and water balance around the tunnels.

At this stage, no work was done as part of this project to map groundwater conditions, or to identify further preferential subsurface flow pathways below Long Wharf. The magnitude of potential future groundwater rise associated with sea level rise, was also not explicitly assessed.

DRAFT

DRAFT

STRUCTURAL CONSIDERATIONS FOR PROPOSED WORK

There are multiple structural considerations and design challenges associated with implementing the conceptual designs advanced by this study, several of which will require significant collaboration with future geotechnical analysis and final design.

The most obvious and challenging of these structural considerations is the proposed volumes of earthwork, over-excavation, and new fill work associated with elevating portions of the wharf in areas directly above the MBTA Tunnel and its associated Zone of Influence.

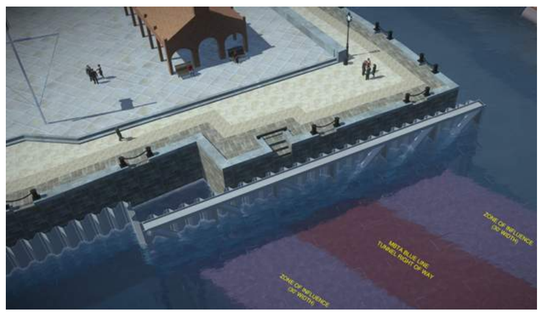


Figure 6-4 - Model Rendering by Foth. Any loading within the 30' Zone of Influence (shown above at the end of the wharf, but extending along the length of Long Wharf) will require coordination and approval of the MBTA.

There are also a variety of structural engineering considerations related to the proposed deployable floodgate (which is incorporated in all 2030 and 2070 designs), the individual floodproofing/retrofitting of existing buildings and Chart House, new stormwater drainage infrastructure and tank buoyancy, and structural containment of the proposed lightweight fill at reconstructed wharf edges.

STRUCTURAL CONSIDERATIONS FOR PERMANENT, HEAVY-DUTY FLOODGATE

Important considerations for the design and implementation of this floodgate include hydrostatic and non-hydrostatic loadings (e.g., wave and debris forces), which influence the overall weight of floodgate apparatus (frame and gate) and the ability to balance such loads in a location that bridges the Blue Line Tunnel below State Street.

The tunnel substructure is approximately 40 ft wide in areas between the Marriott Hotel and Chart House restaurant, with an approximate 30 foot lateral Zone of Influence. It may be challenging to fully "bridge" the loads of a heavy floodgate, given space limitations on the south side between the tunnel and the existing edge (which is a cantilevered timber deck Harborwalk).

Ultimately, the weight of the heavy-duty floodgate and how this gets load-balanced over the street and tunnel are structural engineering parameters for the design of the gate enclosure and foundation. For instance, while a hinged connection (i.e., swing gate) would potentially be most effective in transferring the weight of the gate to the north side of the tunnel (to a new enclosure structure), there may not be adequate 'swing area' given the location of the active Marriott Hotel loading bay. On the other hand, for a rolling or sliding gate, the load balance of the gate in its deployed condition may be significant.

FIGURE 6-4 and 6-5 (above): A heavy-duty floodgate installed along the East River in New York City as part of the East Side Coastal Resiliency project included large hinges to anchor the 32,000-lb (16-ton) gate (Images Source: New York City Department of Design and Construction)

FIGURE 6-6 and 6-7 (above): An automated floodgate at a power station in Yorkshire (U.K.) – shown in open and closed positions - included an aluminum sliding gate that was installed without excavation. (Images Source: RS Flood Control)

DRAFT

DRAFT

Alternatives to sliding or hinged floodgate include flip-up barriers, such as self-deploying hydraulic barriers, or designs like those recently installed in New York City for the Brooklyn Bridge-Montgomery Coastal Resilience (BMCR) project.

Many of the hydraulic self-deploying flip-up barriers, such as NYC's BMCR, can also be operated with a manual ("pushbutton") option, and are also designed with debris impact loads in mind. For the NYC project, the BMCR design accounted for impact loading of intentional strikes by a vehicle from the dry side (i.e., protecting against a potential sabotage effort).

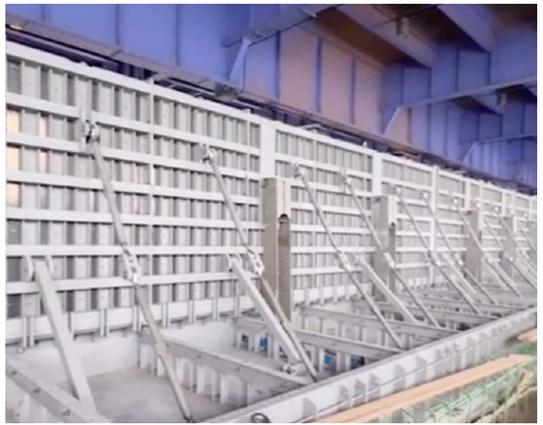
Figure 6-8 (Image Source: Floodbreak)

Another benefit of such options is that they require relatively little excavation "set down" space for the gate, frame, and structural footing below (i.e., only 2-3 feet from ground surface), helping to minimize conflicts with subsurface infrastructure and utilities.

The structural footing load can also be mitigated. This load is typically a combination of the static downward weight of the system plus the upward flood retention load during an event. A hydraulic, in-ground gate at the same size of the hinged floodgate on prior page would be about half the total self weight. During a flood event, the upward load of the flood retention will balance a large part of the downward load of the flood water weight itself. In a typical installation, the flood load is distributed along the length of the gate, which might actually prove to be a benefit for the Zone of Influence during heavy flooding.

Figure 6-9 (Image Source: Floodbreak)

DRAFT



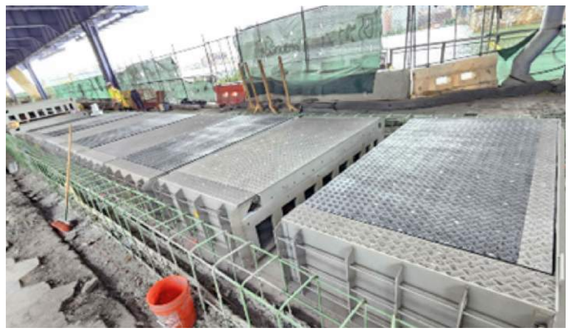


Figure 6-10 and 6-11 (above) - (Images Source: Floodbreak)

Figure 6-12 and 6-13 (above) - (Images Source: Floodbreak)

DRAFT

POTENTIAL ELEVATION OF THE CHART HOUSE ABOVE FUTURE FLOOD ELEVATION

One of the alternative floodproofing strategies for the Chart House includes raising the finished floor of this structure above the long-term Dry Harbor Walk D.F.E. (12.3' NAVD88), or even the long-term coastal storm D.F.E. (15.0' NAVD88). The Chart House is a four-story brick masonry building with a ground floor elevation of approximately EL. 7.2' NAVD88. Raising the finished floor of this structure above 15.0' would effectively add a floor level to this structure, potentially opening up new opporunities (e.g., space for sub-grade conduits, power infrastructure, supplemental drainage capacity or other storage).

The latest records show the building underwent a major renovation in 1999. That effort included foundation work, where excavation was performed for the placement of new unpinning piles and grade beams, plus additional excavation for an areaway for post-tensioning of new cast concrete beams. A structural feasibility analysis to further elevate the building was not performed as part of this study.
The building is offset from the alignment of the Blue Line tunnel, but within the Zone of Influence.

Given the historic nature of this building, it would also be important to consider consistency of such actions with The Secretary of the Interior's Guidelines on Flood Adaptation for Rehabilitating Historic Buildings (National Park Service, 2021) and the City's Resilient Historic Design Guide (City of Boston, 2018).

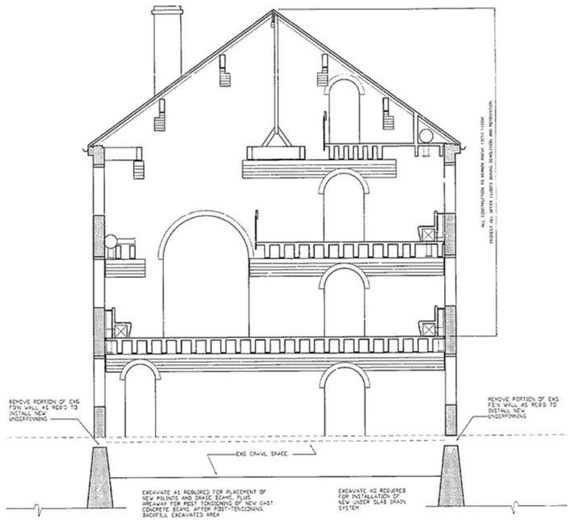


Figure 6-14 - Chart House Building Section

DRAFT

STRUCTURAL CONDITIONS FOR FLOODPROOFING AT EXISTING BUILDINGS

For all dry floodproofing measures, the structure must be evaluated by a structural engineer to verify that the foundation, exterior wall and floor systems can resist the forces generated by the design flood event.

For instance, the existing walls of the Custom House Block and the Chart House are substantial solid masonry walls. However, it was beyond the scope of this project to perform a structural analysis of the building foundation, wall and floor systems to ensure that they can resist the forces generated by the design flood event. While the Long Wharf Marriott Hotel has a substantial concrete core wall (lined with brick façade), this structure should also be evaluated before anchoring any deployable flood barriers to the building.

The smaller ancillary buildings, such as the Harbor Cruises ticket booths, are not designed to withstand pressures from flood water and cannot be sealed. These structures cannot be dry floodproofed. Additional considerations for outbuildings – any future structures reconstructed in these areas are discussed in the following sub-section.

For more information, including wet floodproofing or other treatment actions, refer to the Adaptation Design Guidelines for existing buildings (Appendix D).

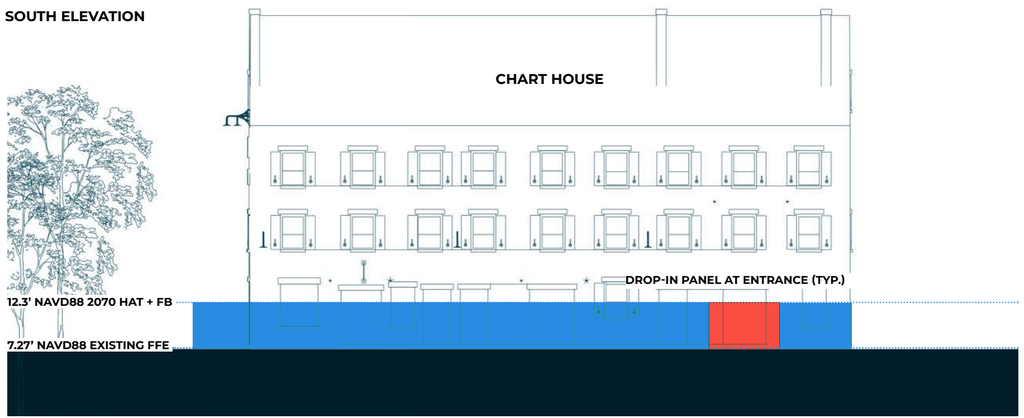


Figure 6-15 - Chart House Building Elevation

DRAFT

POTENTIAL STRUCTURAL LIMITATIONS ON DRY FLOODPROOFING OUTBUILDINGS AND REGULATORY CONTEXT (MA STATE BUILDING CODE & ASCE 24)

In developing the 2030 Scheme, it was noted that the Limits of Moderate Wave Action (LiMWA) – as delineated on the effective FEMA FIRM panel – cut along the edge of the outbuildings on the south side of the wharf. The LiMWA delineates the boundary between Coastal A and non-Coastal A zones. Coastal A zones experience wave heights between 1.5 and 3 feet. While not in a FEMA velocity (VE) zone, where dry floodproofing is not allowed, there can be limitations to dry floodproofing approaches in the coastal A zone. Standards from the latest version of American Society of Civil Engineers (ASCE) in ASCE 24, which provides minimum requirements for flood-resistant design and construction of structures located in flood hazard areas, should be consulted along with the MA State Building Code.

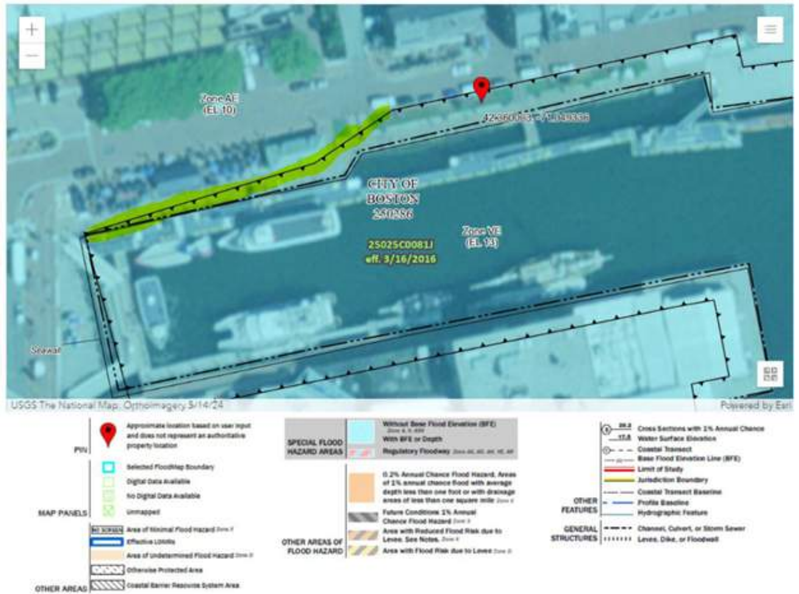


FIGURE 6-16: The highlighted segment of the Long Wharf site along the south edge of the wharf contains built structures situated along FEMA's delineated Limits of Moderate Wave Action. Near-term dry floodproofing measures for such structures may have some limitations based on new guidance from ASCE.

STRUCTURAL CONSIDERATIONS FOR NEW STORMWATER DRAINAGE INFRASTRUCTURE (BUOYANCY/UPLIFT FORCES) AND CONTAINMENT OF NEW LIGHTWEIGHT FILL

All lightweight fill can be used to help "load-balance" additional load on the MBTA tunnel so that the effective soil stress after construction equals the pre-construction effective stress. An additional benefit is that once the light-weight fill cures it reduces or eliminates lateral pressures on the existing seawalls and eliminates water flow through the fill material.
The interplay between lightweight fill and the buoyancy off any new subsurface stormwater storage tanks will need to be further studied. The siting of the proposed stormwater drainage tank system near the end of the plaza would be best suited in areas outside the Blue Line Tunnel Zone of Influence. This might be accomplished using non-rectangular configurations (such as a modular R-Tank system with liner or a custom precast vault) to keep the footprint outside the zone. In considering the overall self-weight of such systems, it is important to consider groundwater levels and the appropriate elevation of submersible pumps. For instance, the weight of water (collected runoff) within the tank may provide some weight against tank buoyancy effects that may otherwise uplift. If the tank materials are lightweight, it may be worth designing in some sump (i.e., dead storage) to ensure some level of water is always contained within the tanks.

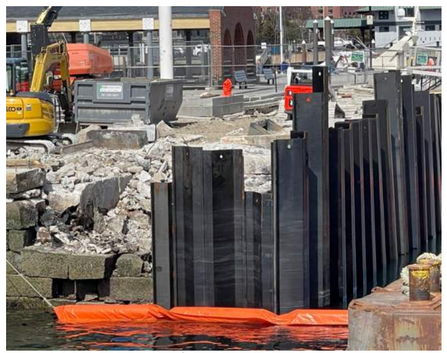


FIGURE 6-17 - Long Wharf East Seawall Face Repair Work, with Mixed Fill Visible on Backside (Image Source: Kleinfelder)

PROPOSED FILL & STRUCTURAL LOADING

Implementing either of the long-term 2070 designs (Acupuncture or Big Splash) will require significant amounts of earthwork, including varying amounts of new fill to meet the near-term perimeter storm protection D.F.E. of 12.3' NAVD88 and/or the long-term district scale D.F.E. of 15.0' NAVD88. In each case, a degree of over-excavation and replacement with light-weight fill would be required to offset new loads to achieve no net load increase above the MBTA Blue Line Tunnel (discussed more in the following section, see **Geotechnical Implications of Proposed Concepts)**.

Figure 6-18 and Figure 6-19 (on next page) show the approximate range of net fill for each of the 2070 concepts, relative to existing grade.

DRAFT

DRAFT

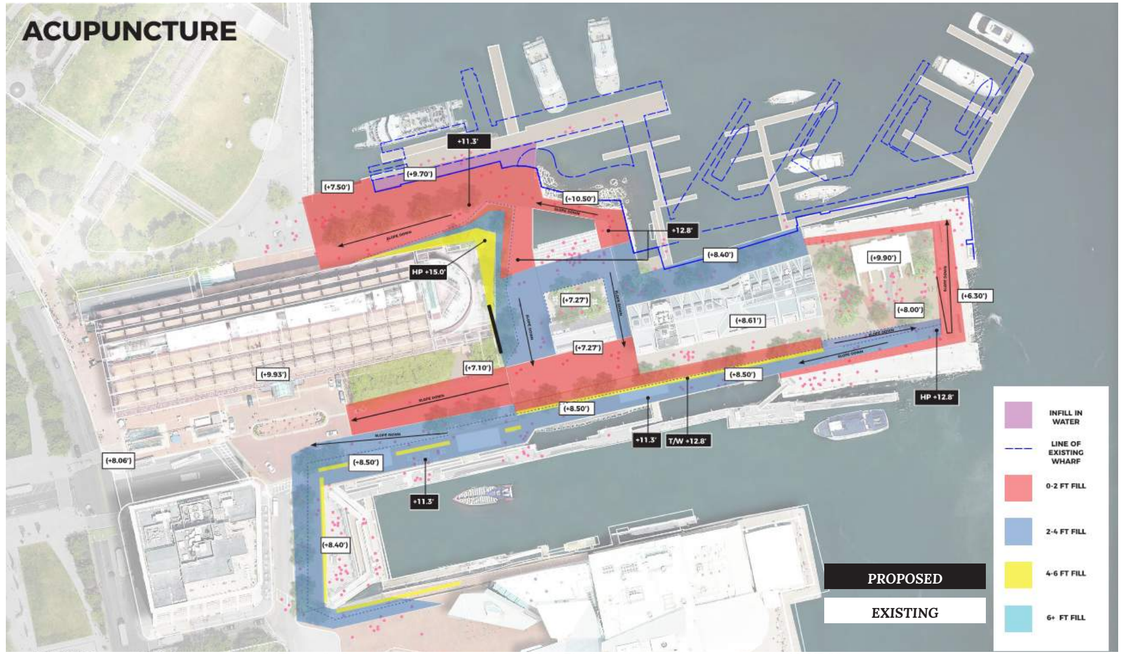


Figure 6-18 - Acupuncture Approximate Next Fill Quantities, with spot grades (ft. NAVD88)

T/W = Top of Wall

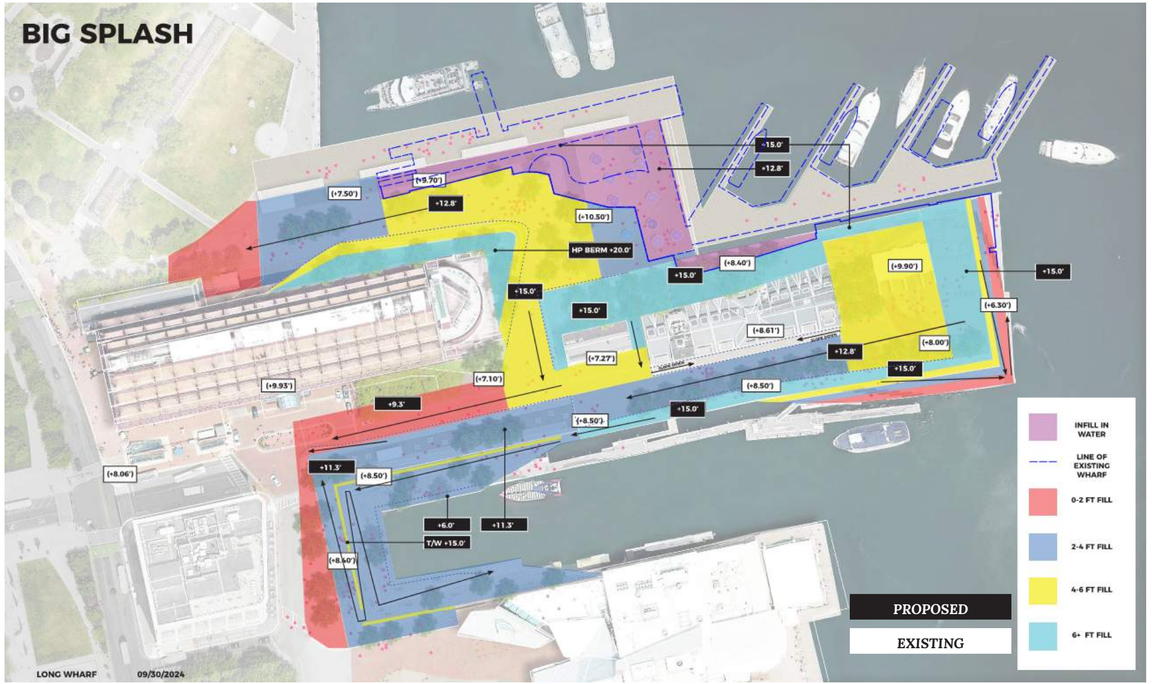


Figure 6-19 - Big Splash Approximate Net Fill Quantities, with spot grades (ft. NAV88)

HP = High Point

DRAFT

DRAFT

GEOTECHNICAL IMPLICATIONS OF PROPOSED CONCEPTS

PREVIOUSLY COMPLETED GEOTECHNICAL INVESTIGATIONS -EAST END LONG WHARF

Review of available geotechnical data indicates that subsurface exploration programs have been conducted at Long Wharf since at least the early 20th century. A significant subsurface exploration program, conducted by Shiner Testing Borings Inc. for the Massachusetts Bay Transportation Authority (MBTA) in 1981-1982, was part of the "Subway Ventilation Improvements MBTA Contract No. 103-103" program. This investigation focused on the eastern portion of Long Wharf and provided valuable subsurface information used to develop an understanding of the stratigraphy below existing grades. While more recent geotechnical investigations may exist, they were unavailable for this report.

Based on the 1981 program, Figure 6-20, Section A-A, presents a representative subsurface profile at the east end of Long Wharf, in the vicinity of the MBTA ventilation access shaft. The borings reveal a complex stratigraphy of fill materials, soft organic sands, and clays overlying the top of a dense till at approximately 110 feet below existing grade. These materials are grouped into three principal strata based on general engineering properties and interpreted origins:

Stratum:	Description:
1: Miscellaneous Fill	This stratum consists of brown, medium-dense to very-dense sand, gravel, and minor silt. The presence of gravel cobbles and organic material indicates a heterogeneous composition likely resulting from historical fill activities. The thickness of this stratum ranges from approximately 25 to 35 feet. Standard Penetration Test (SPT) N-values range from 25 blows per foot (bpf) to refusal, suggesting relatively dense, well-compacted granular fill in situ.
2: Organic Fine Sand and Silts	This stratum comprises dark-gray, medium-stiff to stiff silty-clay with low plasticity. The presence of wood and shell fragments indicates organic enrichment, potentially from past depositional environments. The thickness of this stratum ranges from approximately 8 to 11 feet. SPT N-values range from 3 bpf to 10 bpf, indicating a relatively soft to moderately stiff consistency.
3: Silty Clay	This stratum is composed of olive-green, medium stiff to stiff silty clay, which indicates a higher clay content than Stratum 2. The thickness of this stratum is significant, ranging from approximately 60 to 70 feet. SPT N-values in this stratum vary considerably, ranging from 4 bpf to 41 bpf, indicating a range of consistencies from relatively soft to stiff.

DRAFT

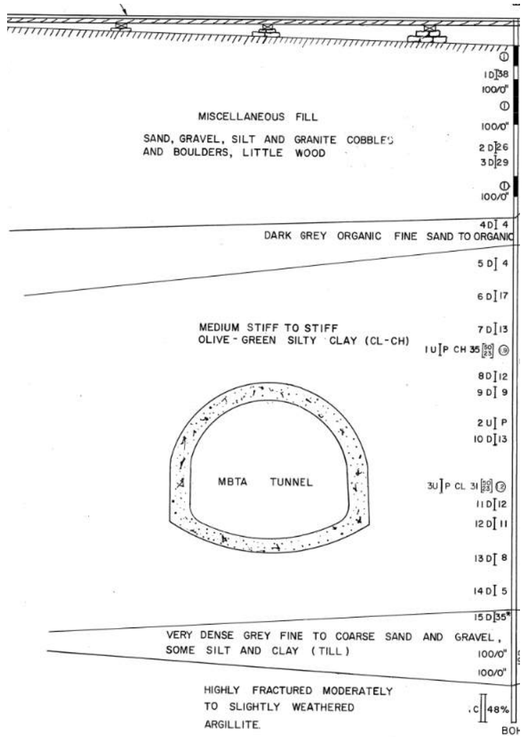


FIGURE 6-20 - Section A-A geologic profile from "Subway Ventilation Improvements Contract No. 103-103" project drawing set dated April, 1983 provided by MBTA.

DRAFT

GEOTECHNICAL CONSIDERATIONS FOR PROPOSED GRADE CHANGES

The geotechnical assessment of proposed grade raising at Long Wharf's east end were developed based on the 2070 conceptual design estimated grade changes (see Figure 6-18 and 6-19) and the proposed wharf edge condition designs in Appendix C. Elevations in the conceptual drawings reference North American Vertical Datum of 1988 (NAVD88). These designs, illustrate potential cross-section designs which show existing grades of +8.00 raised up to +15.00 (NAVD88). Tidal data was sourced from the Boston Tide Gauge in the Fort Point Channel (No. 8443970).

The greatest grade changes are depicted at the east end of Long Wharf in cross-sections H-H, I-I, and J-J in Appendix C. These sections illustrate the potential significant increase in surcharge loads imposed by the proposed grades. The elevations presented in Table 1 outline what increased grade changes can be anticipated and served as inputs for evaluating anticipated stress increases from the anticipated surcharge loading.

Concept[1]	Approx. Existing Ground Elevation	Proposed Ground Elevation	Approximate Elevation of MBTA Tunnel Crown. [3]	Increased Grade Height
Units	*El.*	*El.*	*El.*	*ft.*
Acupuncture	+8.00	+12.30	-35.5	4.3
Big Splash	+8.00	+15.00	-35.5	7.0

Table 6-1: Proposed Increased Grade Height

Notes:

1. *Elevations presented are in North American Vertical Datum (NAVD88)*

2. *Approximate elevation of MBTA Tunnel provided via "Long Wharf Resiliency" concept drawing set courtesy of FOTH Engineering dated March, 2024.*

Raising the grade at Long Wharf's east end introduces potential for significant surcharge loading. This presents considerable geotechnical challenges, particularly given the presence of existing underground structures and the complex, relatively soft subsurface stratigraphy. Increased loads, if not properly mitigated through load balancing measures, could lead to unacceptable settlement, deformation, and potential damage to existing foundations, utilities, and possibly the structural integrity of the MBTA tunnel. As such, the proposed conceptual designs for grade raising prompted a preliminary analysis of potential stress increases on the underlying MBTA tunnel. As part of this procedure, a load balancing calculation was performed to balance imported low density fill with that of existing miscellaneous fill in such a way that total stresses remain a net zero at the MBTA tunnel crown. Figure 6-21 depicts the principal behind the load balancing procedure outlined in the next section.

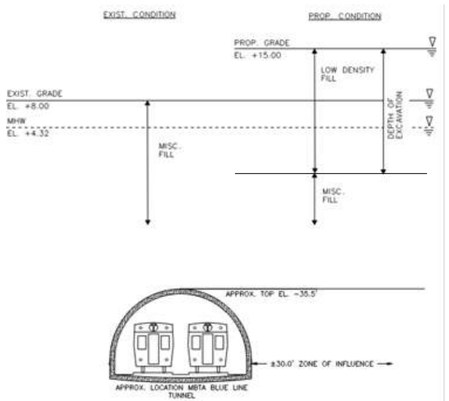


FIGURE 6-21 - *Load Balancing Concept*

MITIGATION OF INDUCED STRESS ON MBTA TUNNEL

To assess potential stress increases on the MBTA tunnel crown from the proposed grade raising, a load-balance analysis was conducted. This analysis determined the excavation depths needed to maintain approximately the same total vertical stress at the tunnel crown. The calculation considered the stresses resulting from replacing existing materials below the initial grade (+8.00 NAVD88) with imported low density fill material up to the proposed final grade. The analysis uses a simplified total stress approach and assumes that the low-density fill would not experience significant compression. Figure 6-22 graphically presents the calculated excavation depths required for various final proposed grades, assuming uniform replacement with the low-density fill. Table 2 outlines the potential excavation depths required to achieve net-zero load balance for the proposed grade changes.

Concept[1]	Final Ground El. (NAVD88)	Excavation Depth below El. 8.00	Final Excavation Depth (NAVD88)
-	*El.*	*Ft.*	*El.*
-	8.00	0.00	-
-	9.00	0.50	+7.50
-	10.00	4.00	+4.00
-	11.00	6.00	+2.00
-	12.00	8.00	+0.00
Acupuncture	12.30	8.60	-0.60
-	13.00	10.00	-2.00
-	14.00	12.00	-4.00
Big Splash	15.00	14.00	-6.00

Table 6-2 - Load Balance

Notes:

1. *Elevations presented are in North American Vertical Datum (NAVD88)*

DRAFT

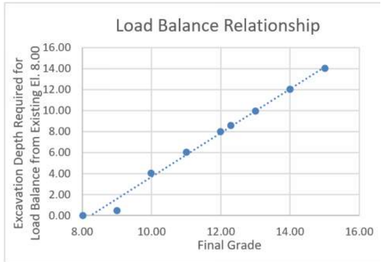


Figure 6-22 - Level of Excavation required to meet proposed final grades

Note that this is a simplified analysis and does not fully consider factors such as soil consolidation, groundwater conditions, and potential interaction between fill and existing subsurface materials. The potential effects due to increased grade changes include differential settlement, stress changes in the tunnel lining, and potential groundwater flow alteration. Future design should address these factors. To mitigate these increases, particularly in the area directly above the tunnel, the use of low-density fill materials is recommended to reduce surcharge loading.

FUTURE GEOTECHNICAL PROGRAMS

To optimize the design and ensure the long-term stability of proposed improvements at Long Wharf's east end, a comprehensive geotechnical investigation is recommended to fully characterize subsurface conditions. This should include sufficient borings and in-situ testing to define soil strata and their spatial variability, including detailed characterization of the fill material, its density, gradation, compressibility, and organic content to inform compaction/ground improvement strategies. Thorough characterization of underlying Strata is also recommended to evaluate their short-term and long-term stability under increased loads. Finally, detailed assessment of groundwater conditions is recommended to evaluate seepage and hydrostatic pressure.

Following completion of the subsurface exploration and testing, a finite element numerical model is recommended to accurately simulate the stress paths above and around the MBTA tunnel under various loading conditions. The numerical model will enable a comprehensive assessment of the potential impacts of the proposed raising of grade on the tunnel and surrounding structures. The model should also incorporate:

- **Proposed Structures:** The model should include the geometry and foundation conditions of proposed structures to assess their interaction with the subsurface soils and the tunnel.
- **Future Adaptability:** The foundation of proposed structures should also be over-engineered to allow for the addition of future modular elements above the 2070 protection level (i.e., up to 17.5' NAVD88 or higher).
- **Constructibility:** The construction sequencing and methods should be considered in the numerical model to evaluate the potential for differential settlement and ground deformation during construction.
- **Tide Fluctuations / Future Conditions:** The model should consider the influence of tide fluctuations on groundwater conditions and the potential for increased seepage pressures during high-tide events and future groundwater rise. Aside from design implications for the wharf perimeter materials, there may be implications for below-ground flooding and the district-scale water balancing. During stakeholder meetings, representatives from MBTA and the Boston Groundwater Trust noted the availability of well monitoring data around Aquarium Station that can inform future efforts.

DRAFT

DRAINAGE CONSIDERATIONS

EXISTING CONDITIONS

A review of existing drainage infrastructure on Long Wharf was completed through a desktop assessment of Boston Water and Sewer Commission (BWSC) GIS data and record plans as well as a site visit to identify any additional drainage infrastructure. Figure 6-23 shows BWSC records of infrastructure in the surrounding area including storm, sanitary, and combined sewer systems.

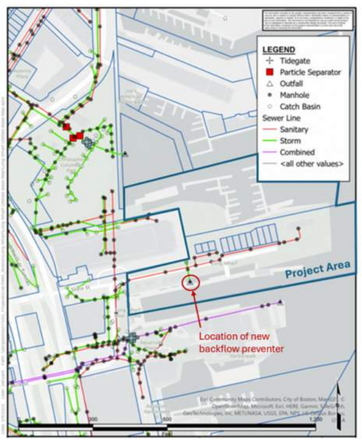


Figure 6-23 - Existing BWSC Infrastructure on Long Wharf and Surrounding Properties

Existing BWSC drainage infrastructure on Long Wharf is limited, with a single catch basin located south of the Chart House building that conveys stormwater runoff from the low point on the wharf to an outfall in the harbor. In 2024, a duckbill backflow preventer was installed on this outfall to prevent frequent flooding from the catch basin during king tides. The location of the catch basin and newly installed backflow preventer is included in Figure 6-20.

At the western side of the project area, flow is directed into the existing BWSC stormwater network and flow either north towards Columbus Park, or south towards the New England Aquarium. Both existing stormwater lines have existing tide protection and do not pose a threat of backflow during high tide events to the wharf. The primary goal of any proposed drainage system will be that the post-development discharge to the BWSC system is less than or equal to the pre-development discharge to ensure that the project does not negatively impact downstream locations.

Additional drainage infrastructure exists on the plaza at the far eastern edge of the wharf, as shown in Figure 6-21. Two drain-lines connected to a series of in-line catch basins collect runoff from the plaza and directs the flow to two outfalls on the northern and southern sides of the plaza. Neither outfall currently has backflow protection and would be subject to backflow during high tide conditions.

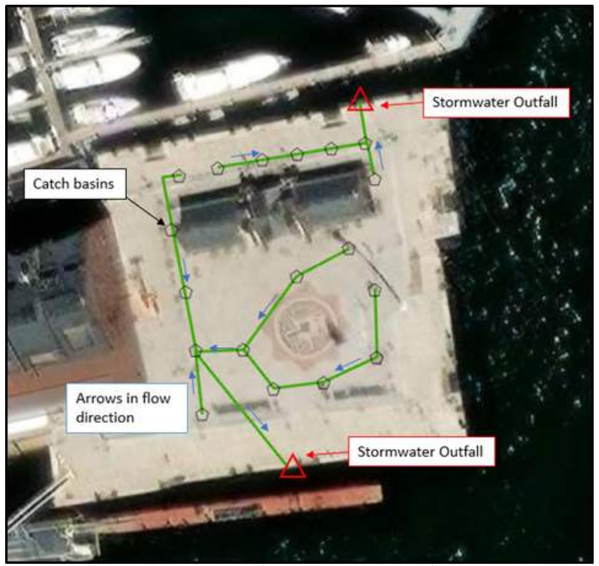


Figure 6-24 - Drainage Infrastructure on Long Wharf East Plaza

DRAINAGE IMPROVEMENT CONCEPTS

For all three proposed floodproofing concepts at Long Wharf, corresponding drainage improvements will be required to manage stormwater runoff on the wharf and protect against precipitation-based flooding. Because the overall floodproofing concepts rely in part on perimeter protection, the wharf will become more susceptible to precipitation-based flooding without providing additional storage or conveyance of water off the wharf. The drainage concepts proposed for all three floodproofing alternatives would capture stormwater runoff in underground storage chambers sized to accommodate the runoff volume from the 10-year, 24-hour storm event for projected 2070 climate change conditions (P = 6.18 inches per BWSC Coastal Stormwater Discharge Analysis, 2023).

Existing drainage infrastructure (including pipes and outfalls) would be replaced and new catch-basins, drainage manholes, and drains would be installed throughout the project area to capture runoff and convey it to two underground storage tanks. To avoid adding hydraulic stress to the existing BWSC system, no runoff from the wharf would be routed to the BWSC systems at the eastern edge of the wharf. This will ensure that any improvements to the wharf will not result in worsened conditions in the abutting properties' drainage systems.

An overview of the drainage concept is shown in Figure 6-24.

DRAFT

DRAFT

Figure 6-25 - Long Wharf Drainage Conceptual Layout

The drainage concept also includes pre-treatment devices installed before the inlet to both stormwater tanks to ensure that all runoff from the site is treated to at least 80% removal for TSS and hydrocarbons. Both detention tanks would have low-flow outlets to the harbor at the bottom invert of the tank to drain stormwater runoff via gravity during normal conditions. The outlets would be installed with backflow preventers, such as duckbills, to prevent high tides or extreme water elevation in the harbor from flowing back into the drainage network. Additionally, pumps in both tanks would be installed to operate during high-flow conditions to pump water directly to the harbor even during high backwater conditions. Pumps would be sized to handle the peak flow for the 10-year, 24-hour storm event under 2070 climate change conditions.

Figures 6-26 and 6-27 show plan view of the east and west stormwater detention tank, respectively. Figures 6-28 shows a typical cross section through an underground stormwater detentiontank. These subsurface stormwater detention tanks would be applicable to any of the three overall floodproofing concepts being considered. Tanks are situated such that a minimum of 1% slope could be used on the proposed storm drains to convey water to the tanks, and the gravity outlets of both tanks would be above low-tide water levels to allow for the tank to drain via gravity. Under the lowest elevation scenario of the three floodproofing concepts, the east and west stormwater tanks would have gravity outlets and tank bottoms situated at 1.5 ft NAVD88 and 2.0 ft NAVD88 respectively.

DRAFT

DRAFT

Figure 6-26 - West Stormwater Tank Concept – Plan View

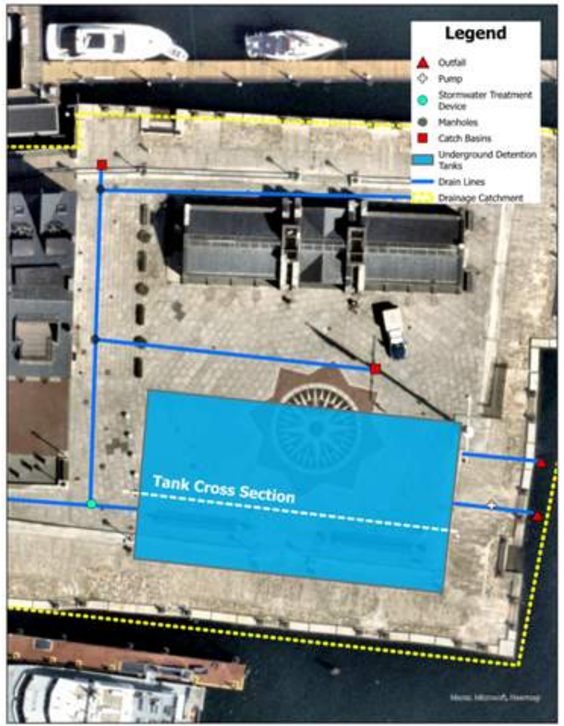


Figure 6-27 - West Stormwater Tank Concept – Plan View

SUMMARY OF KEY CONSIDERATIONS FOR INTERIOR DRAINAGE DESIGN

- The pump activation level of the new stormwater tanks should be below the existing ground surface and the first level of the Custom House (approx. 8-9' NAVD88).
- The top of the new stormwater tanks should be at least 1.5 feet below the new ground surface (these new plaza ground surface elevations range between ~ 9.3' in Acupuncture to 15.0' in Big Splash).
- The invert of the high-flow pump gravity outlet for each tank should be situated above the projected long-term 2070 MHHW elevation (9.7' NAVD88), or include backflow prevention.
- The invert of the low-flow gravity outlet for each tank should be situated above the projected long-term 2070 MLLW elevation (-1.0' NAVD88), and backflow prevention.
- Each new stormwater tanks should have a water quality pretreatment device.
- The buoyancy of each system should be considered during detailed design (i.e., the self-weight of the system to prevent flotation).
- The weight of the East tank system should be sized to prevent flotation when the tank is empty, while also considering overall weight of the system (during surcharge condition when the tank is full of water) and loading implications above the MBTA tunnel.
- Additional considerations:
  - It is assumed that the rooftop drainage from the Custom House and Custom House are included within the contributing drainage area to the new stormwater tanks. A potential alternative – not explored herein – could consider adding above or below-ground cistern(s), or otherwise storing rooftop runoff below the Custom House, so as to reduce the spatial footprint and/or depth of the proposed detention tanks.
  - Other opportunities may exist to divert surface or rooftop runoff to green stormwater infrastructure, planter beds, or other new landscaping at the surface level.

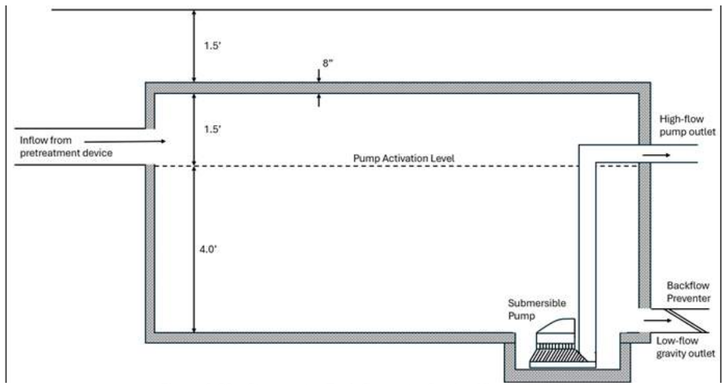


Figure 6-28 - Stormwater Tank Concept – Section View (Typical)

DRAFT

DRAFT

INTEGRATION WITH ABUTTING PROPERTIES

Columbus Park (North)
It is anticipated that Boston Parks and Recreation, with federal funding support, will be undertaking a climate resilience and park improvements project in the year ahead.

Some of the key opportunities for integration of resiliency elements within a short term project include:

- Designing passive floodproofing up to +12.3' NAVD88 by re-grading or using seating and landscaping with integrated flood protection, with adaptability to install modular floodproofing elements up to +15.0' NAVD88 or higher in the future). Consider a cooperative agreement, City easement, and/or operation and maintenance agreement for adapting features into integrated district-scale protection through the park at elevation +15.0' NAVD88 or higher, into which future adjacent projects (such as a North End near-term project) can tie into.
- Mitigating any potential water quality / outfall impacts associated with regrading or previously untreated discharges with green stormwater infrastructure or improved tide gate(s).
- Improving paving / material transitions between Long Wharf, its Harborwalk, and Columbus Park, consistent with the City's Waterfront Design Use Guidelines.

Factoring long-term adaptive capacity

- Identifying areas where additional subsurface stormwater storage and/or pumping can occur (or be phased in at future point) without significant disturbance or re-design. This is identified as an item for coordination with BWSC, as the Park was identified as a location for a strategic intervention for City drainage (BWSC Coastal Stormwater Discharge Analysis, 2023 - see Figures 6-29 and 6-30) and is not included in the cost estimates for the Long Wharf project or the Park's Department's upcoming park redesign.

Figure 6-29 (Image Source: Boston Planning Department)

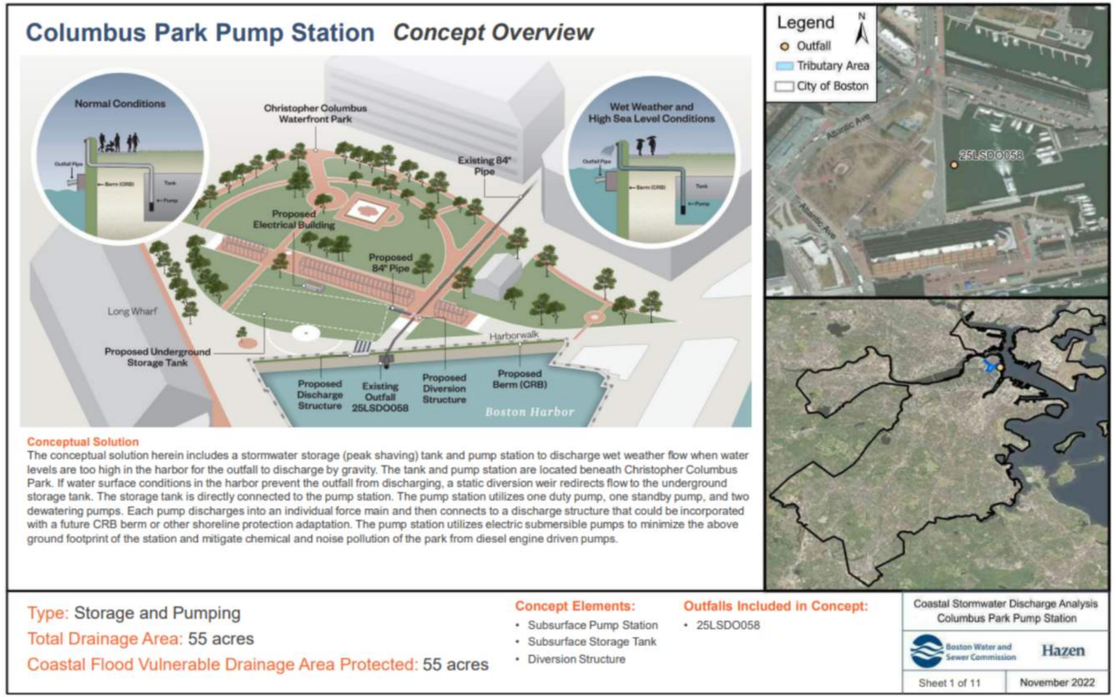


Figure 6-30 - From Coastal Stormwater Discharge Analysis (BWSC 2023)

DRAFT

DRAFT

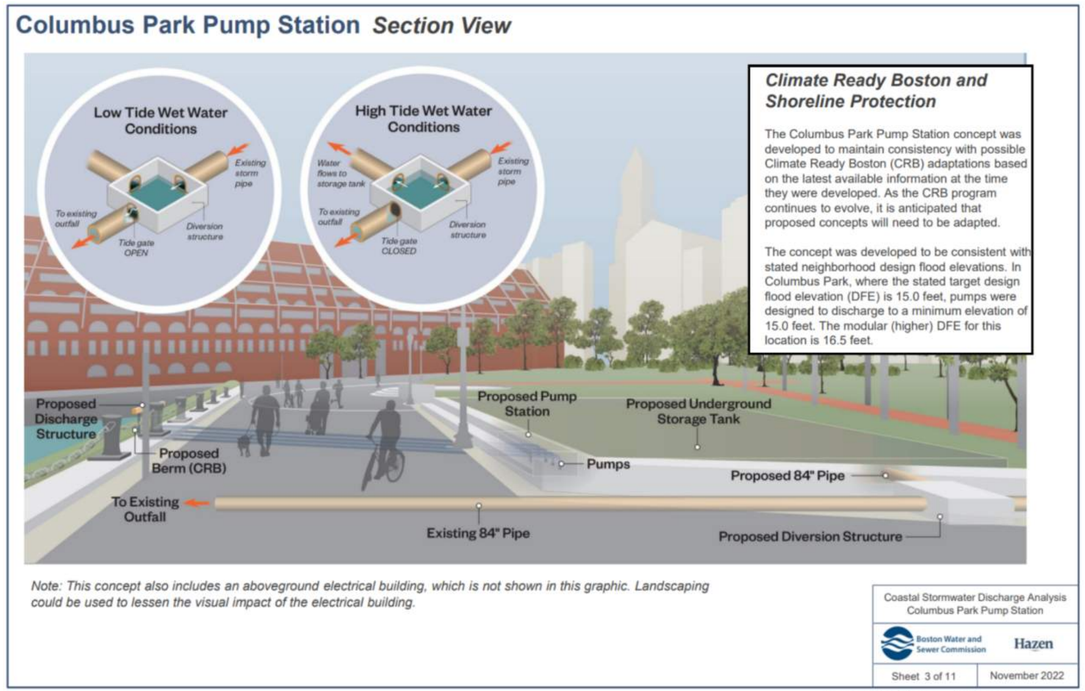


Figure 6-31 - From Coastal Stormwater Discharge Analysis (BWSC 2023)

New England Aquarium (South):

- In the short term, floodproofing measures at Long Wharf can be integrated into an existing wall, running along portions of the north side of Central Wharf.

Beyond elevation +12.3' NAVD88 , further adaptations - such as adding an aquarium-style glass seawall atop this wall - would be required.

In coordination with NEAQ and its consultants supporting development of the forthcoming NEAQ Master Plan, potential adaptations are being targeted at elevations higher than 15.0' for the primary building. The spot grade elevation at NEAQ's main building facility is already at approximately +15.0', however the area between the Simons Theater and the main building facility is a secondary coastal flood pathway (see Section 3-10).

The north dock at Central Wharf is a shared dock (at the elbow), the corner is shared with MBTA.

Figures 6-32 and 6-33 (above) Photos of existing conditions along the north side of Central Wharf, between the New England Aquarium main building and the Harborwalk at Old Atlantic Avenue. Note: The concrete wall used to be higher in this location (as seen in bottom photo), but was sawcut and replaced with black metal fencing (right photo, as shown from water side).
Images source: Kleinfelder.

DRAFT

DRAFT

INTEGRATION WITH MARRIOTT HOTEL (NORTH EDGE PLANTER)

Some additional floodproofing elements are required on the north side of the Marriott Hotel to prevent floodwaters from lapping up against the building. A surface planter with a seat wall are proposed as an integrated flood protection measure (see Figures 6-33 and 6-34). As this measure would abut the existing building facade, a 1" expansion joint filled with a neoprene joint filler would be placed between the planter wall and the existing hotel wall with a cap flashing over the joint to prevent water flowing down the building wall from getting into the joint. Aside from the planter, a waterproof coating would be applied to waterproof the hotel wall below the DFE, preventing any accumulated moisture from penetrating the existing hotel wall.

Since the planter is intended to be an integrated flood protection, an engineered structural base or foundation is required to resist wave and overturning forces.

In the case of a coastal flood event, salt water could backup into the planter's drainage system. A backflow preventer would be required as a preventative measure. Any stormwater treated by the planter box system would be an improvement over the existing condition (all impervious), likely providing a net benefit to runoff otherwise entering the Harbor as overland flow.

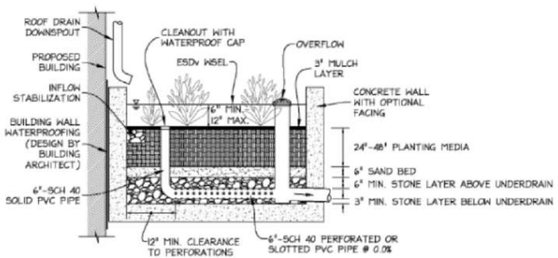


Figure 6-34 - Typical Cross Section - Planter Box Micro-Bioretention

SECTION A

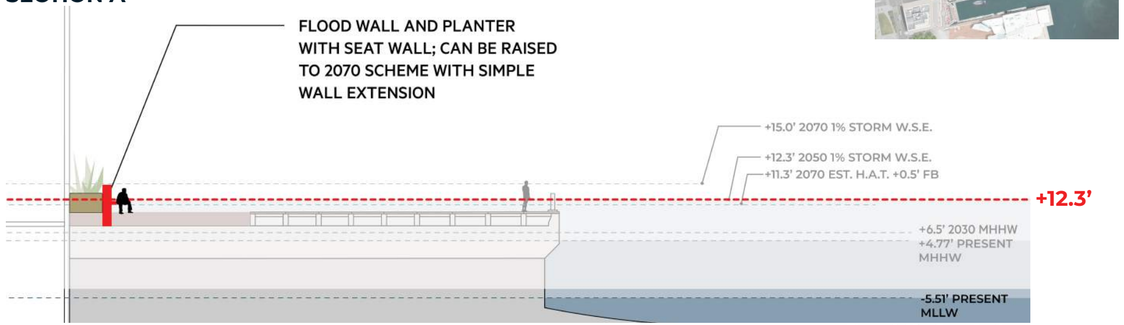


Figure 6-35 - Cross Section A

SECTION B

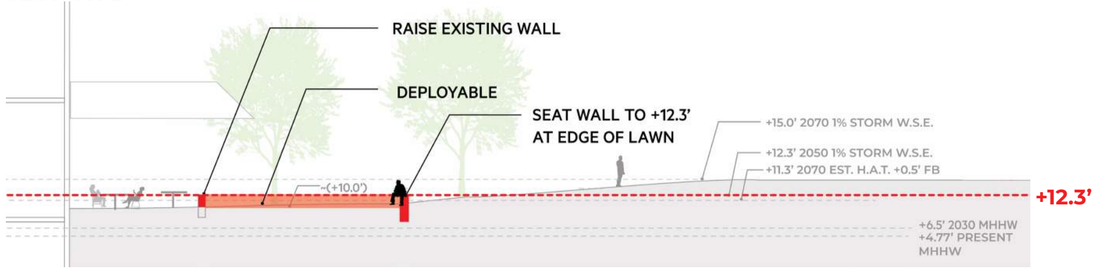


Figure 6-36 - Cross Section B

DRAFT

DRAFT

SEAWALL MODIFICATIONS

ONGOING WORK AND PRIORITIES

The ongoing edge treatment repairs that have been occurring at the south and east edge faces of Long Wharf reflect a combination of historic contract plans, license plans, previous inspection reports, and future long-term plans.

One of the areas where coordination has begun between Boston Planning and Engineering are the foundation and sheet pile toe repairs that are already occurring, or planned over the next few years. As these phased repairs take place, coordination has taken place to ensure completion of 'No Regrets' actions consistent with the long-term seawall and Harborwalk protection plan for Long Wharf, minimizing future demolition and-rebuilding scenarios to achieve higher elevations.

Figure 6-37 - Photos from ongoing construction work at east edge seawall (Image Source: Kleinfelder - taken March 2025).

It should be noted that exploratory test pits were not performed within the scope of this planning and feasibility assessment (or as part of the ongoing east face repair project) to confirm existing seawall thicknesses, for which there were no as-built construction plans to work from.

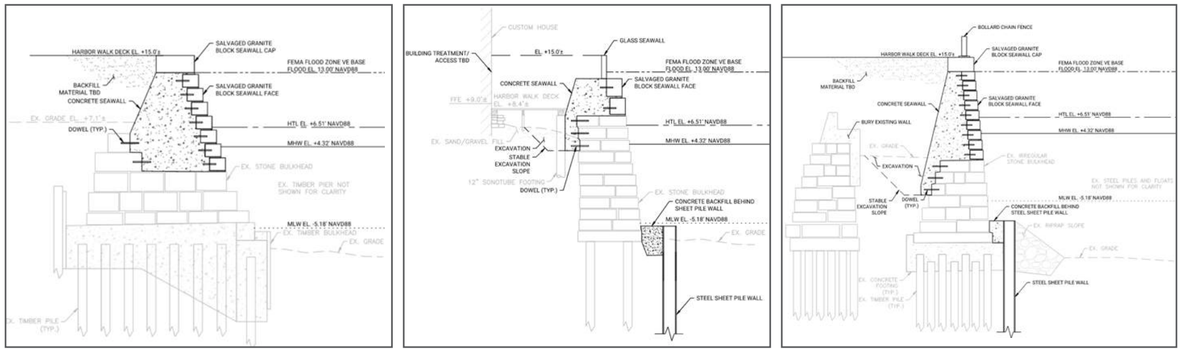
Figure 6-38 - During recent construction of the Southern face bulkhead toe, the existing seawall had to be opened up to repair some misplaced stones, providing some insight into the conditions and historic fill materials behind the seawall. (Image Source: Foth)

In the near term, phased seawall repair work will continue. There is anticipated seawall foundation work at the north-facing middle section of the seawall (behind Waterboat Marina), for which design services have already been procured. The City is currently forecasting that the construction at this location will take place from the Winter 2026- Spring 2027.

DRAFT

FUTURE SEAWALL MODIFICATIONS & CONSIDERATIONS

As part of the current project, future designs for edge conditions and seawall modifications were developed, assuming implementation of the district-scale protection D.F.E. (15.0' NAVD88). Cross sections details were developed at 14 different edge conditions along the perimeter of the wharf (for more detail see Appendix C).
These conditions take into account the varying historic contexts and layering of past wharf construction, identifying locations to salvage granite seawall blocks. In other locations that are particularly space constrained without new in-water fill, it was necessary to consider new pile supported- or cantilevered segments of the Harbor Walk to achieve elevation changes to reach the D.F.E. along the wharf's edge.



Figures 6-39 - Sample proposed conditions, reflecting spatial and context-specific variations at several edge cross-sections, are provided above. The full catalog of cross-section details can be found in Appendix C.

In other areas further west, such as the north-facing segment in front of the existing parking lot, the degraded seawall materials provide historic "layering" context. Specific segments include existing materials that are potentially salvageable or otherwise can be featured, such as in the Acupuncture scheme harbor-facing side of "The Sponge" feature within Acupuncture.

While some segments can be modified to build vertically above existing materials and conditions, there are several locations, such as Segments C and E, where more extensive demolition may be required to rebuild stronger structural foundations while adapting to higher levels of flood protection (see Appendix C).

DRAFT

OPPORTUNITIES FOR EDGE RETREAT, SOFT/NATURE-BASED EDGES

In discussions with the Boston Urban Design team, it was noted from early on that the north side of the wharf has a more calm and "ecological" character, which is therefore more appropriate for nature-based strategies or ecological design interventions.

From the conceptual alternatives stage, multiple ideas for softening edges via the integration of nature-based and ecological features were considered. These ranged from softer edges at Columbus Park (as explored in Coastal Resilience Solutions for Downtown) to a new "urban beach" feature, as well as "floodable blue-green edges", and 'The Sponge' intertidal get-down-to-water features on the north side of the wharf.

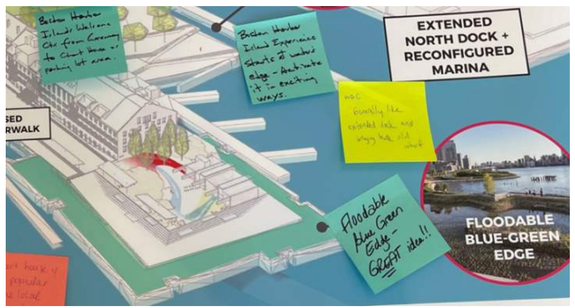


Figure 6-40 - Among other priorities considered for Long Wharf's longer-term design concepts were new opportunities to integrate nature-based solutions or softer edge conditions.

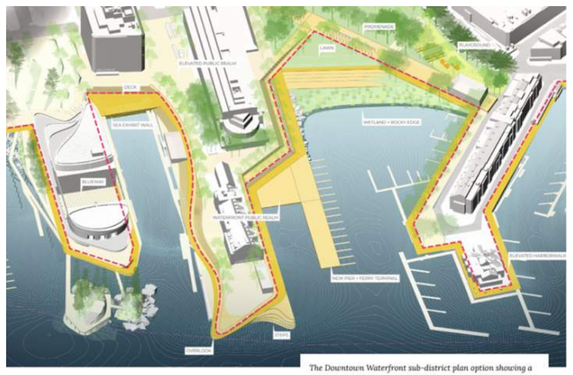
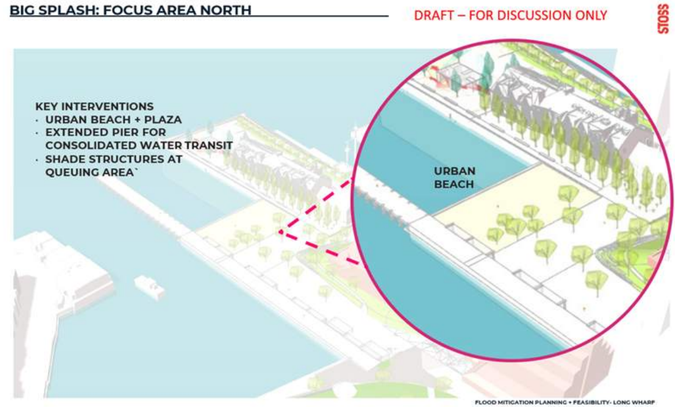


Figure 6-41 - Past planning efforts considered softer edges at adjacent Columbus Park, as well as new island features at Central Wharf.



SUGAR BEACH, TORONTO

PIER 4 BEACH AT BROOKLYN BRIDGE PARK, NEW YORK

Figures 6-42 - Ideas of an urban beach feature - similar to precedents in Toronto and New York - generated early interest in terms of a new types of waterfront experience for the Downtown, but were ultimately deemed unsuitable at Long Wharf's busy harbor front location.

As design ideas evolved at Long Wharf, some ideas – such as the urban beach and wetland and rocky edge at Columbus Park – were deemed infeasible or conflicting with the amounts of marine transportation and marina activity to be relocated or to be further consolidated on the north side of the wharf. Other ideas, such as the floodable edges and "The Sponge" remain in the 2070 alternatives.

DRAFT

DRAFT

Additionally, all concepts also considered the feasibility and best locations for targeted installations of living seawall panels. For example, the area along the section behind the Waterboat Marina is among the segments of the wharf that are most shielded from higher velocities and wave action, making this area more suitable for living seawall installations. Another possible area for a living seawall panels installation is the seawall segment between the ferry dock (Encore Boston ferry) and the Columbus Park seawall, which is also calmer with respect to velocities and wave action.
Each of these areas may be even more visible to the public if larger marine transportation upgrades are made. For instance, any floating dock structure would likely be offset from the seawall, and passengers queuing on the dock's shaded areas would be able to view living seawall panels at various stages of the tide cycle.

Figure 6-43 - Living seawall panels are currently being piloted in East Boston and the Seaport. (Image source: WBUR)

Prior to – or during - any foundation repair mobilizations (such as those tentatively forecasted for Winter 2026-2027) may be a good time to assess the feasibility of installation of 'living seawall' panels near the present day Waterboat Marina. It may be possible to perform any baseline monitoring (such as what Stone Living Lab has done at other locations), or data collection, surface preparations and layout dimensioning to inform design of modular panels.

Lastly, it was also noted during stakeholder coordination meetings with the New England Aquarium that incorporation of any end-of-wharf 'island' features at Central Wharf (such as nature-based features originally depicted in 'The Blue Way' concept) may be particularly helpful in breaking wave energy at the far end of Long Wharf, as prevailing wind and wave directions are typically strongest from the southeast. Such ideas were discussed in tandem with watersheet visioning associated with the City's Harbor Use Design Guidelines, as well as ongoing updates to NEAQ's master plan. The stepped, planted edge at the east end of the Big Splash scheme adds texture, habitat space and helps to attenuate wave action.

DRAFT

SUBSURFACE UTILITIES

To achieve the flood protection elevations in the future 2030 and 2070 designs would require varying degrees of relocating existing subsurface utilities, as well as new utility infrastructure related to interior wharf stormwater drainage and potential future ferry electrification.

Priority considerations for utilities work include making sure that subsurface utilities are located in areas of the project that can be easily accessible in the future for maintenance and that they are not too deep. Construction of utilities also needs to be phased so that services are maintained to existing tenants and the docks during construction.

The depth of future utilities is of particular of importance in the 2070 Big Splash alternatives, where ground surface elevations increase by upwards of six feet in some areas. In such cases, utilities would need to also be elevated to avoid maintenance and equipment maneuverability concerns cited by personnel, as well as the amount of excavation required for future repair and replacement work. Generally, the areas with the highest concentration of existing utilities include: under the east sidewalk at Old Atlantic Avenue in State Street and a network extending north into Columbus Park from just east of the Marriott Hotel's north side entrance. In these areas, the proposed ground surface in 2070 alternatives include between 2-6 feet of fill above present grade.

For the 2030 Scheme, extensive sub-grade utility work is not anticipated on the wharf as the floodproofing elements extended around the Marriott Hotel can be achieved primarily close to the existing ground surface.

As discussed with Eversource and National Grid during stakeholder engagement and focus group sessions, the future implementation of any of the 2070 flood protection infrastructure introduces simultaneous opportunities to upgrade service to substations, as well as add capacity for future uses. It was noted that Eversource has only one subsurface substation that is reaching capacity, and that these stations generate a lot of excess heat. At the same time, future upgrades to the capacity can be concurrently upgraded to provide electric ferry service and supporting infrastructure (e.g., e-ticketing, heated waiting areas, etc.) for Boston Harbor Now and/or MBTA, BHCC, and others. In 2024, an amendment to the MA Economic Development bill included funding for conducting a feasibility study for the infrastructure necessary for an electrified ferry fleet from the Boston Harbor Islands National and State Park area gateways.

Some of the other priorities that are important considerations for subsurface utility work are the potential concentration of like utilities (e.g., MBTA power and signal, building electrical and site lighting) into shared watertight conduit(s), and the potential of raising the elevation of the Chart House, which may create future below-grade space from something new.

DRAFT

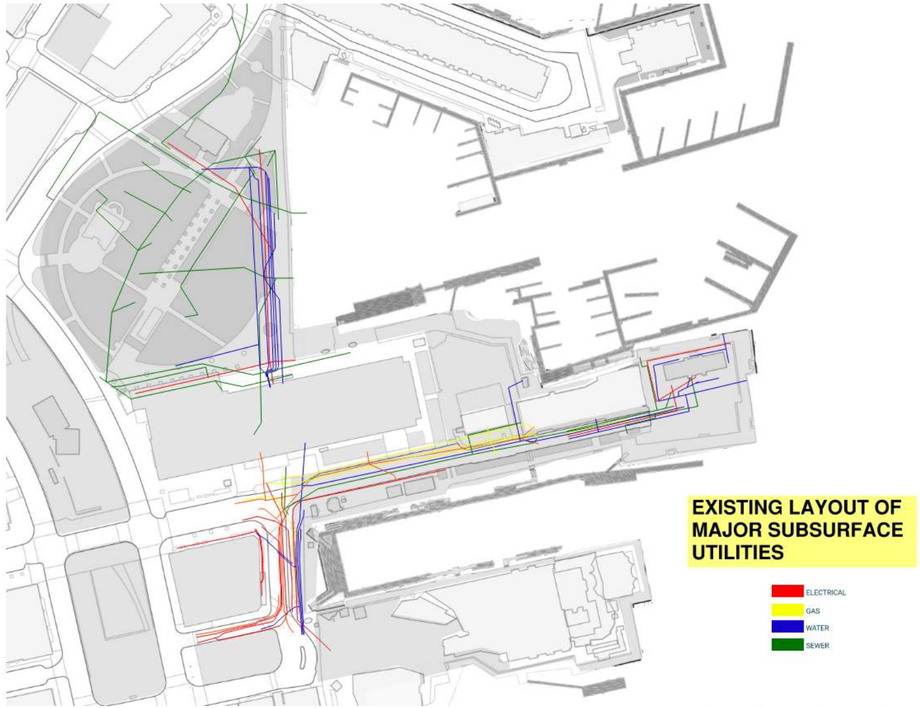


Figure 6-44 - Existing Layout of Major Subsurface Utilities

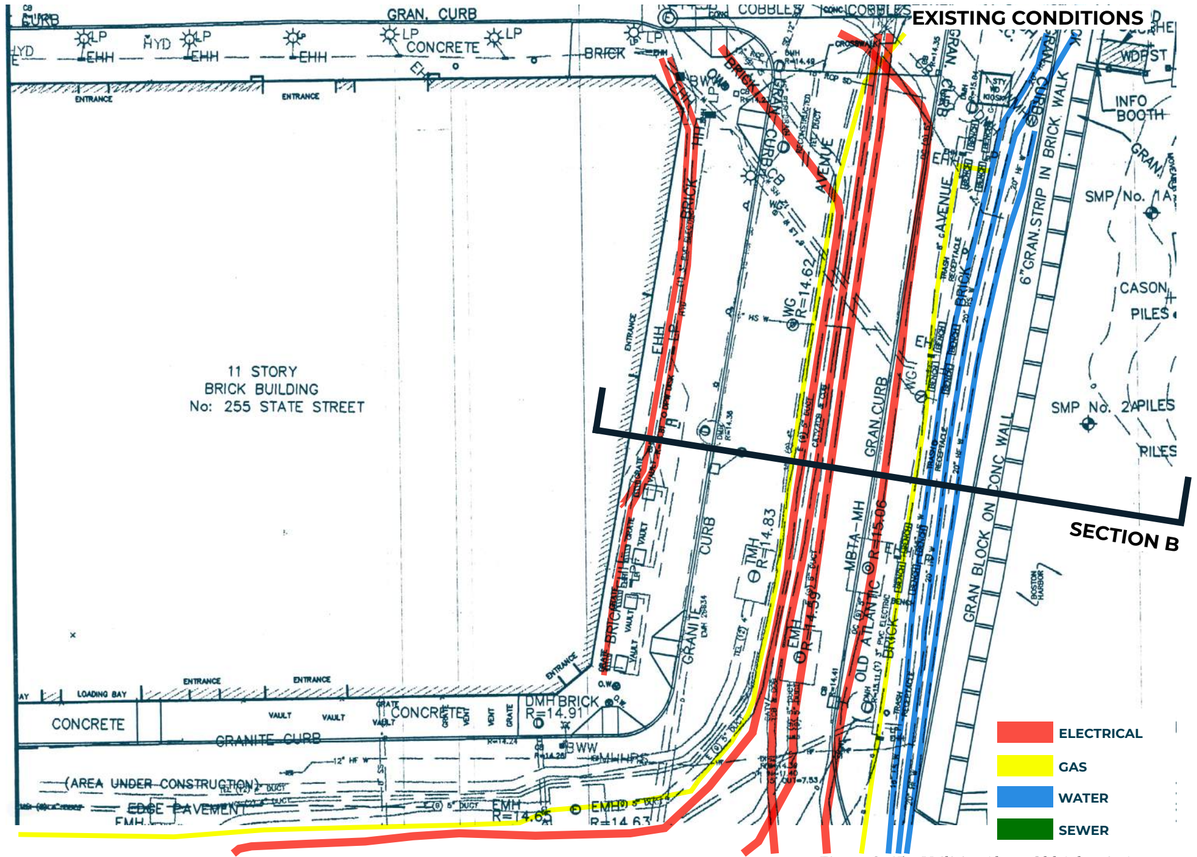


Figure 6-45 - Utilities Along Old Atlantic Avenue

DRAFT

DRAFT

EXISTING CONDITIONS
SECTION B

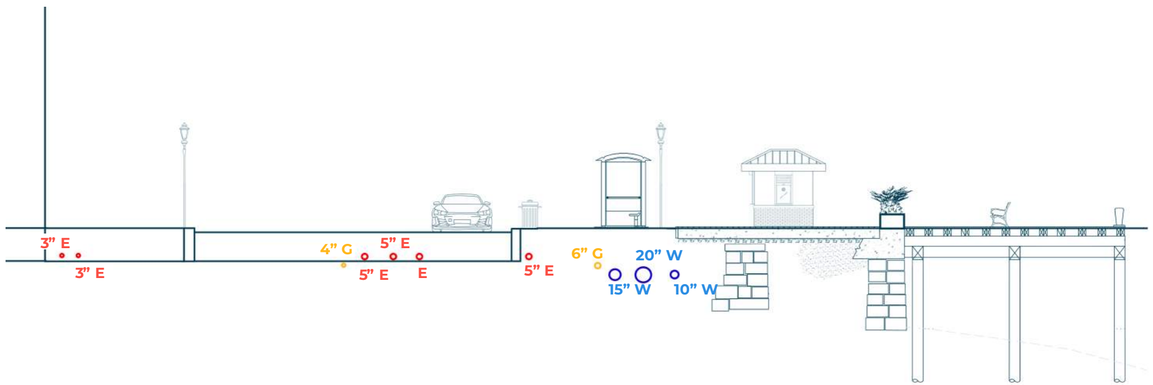


Figure 6-46 - Section B - Utilities Under Old Atlantic Avenue

ACUPUNCTURE
SECTION B

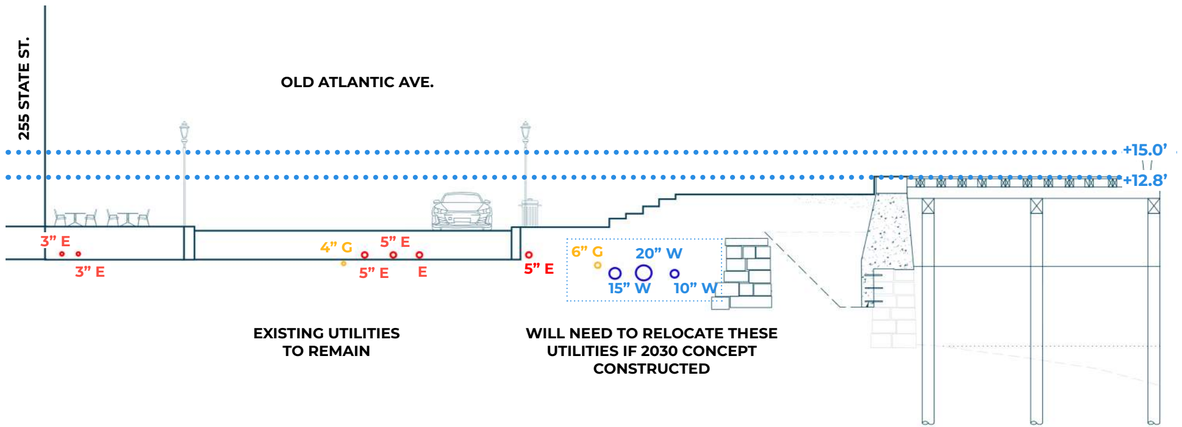


Figure 6-47 - Section B - Utilities Under Old Atlantic Avenue - Acupuncture

DRAFT

DRAFT

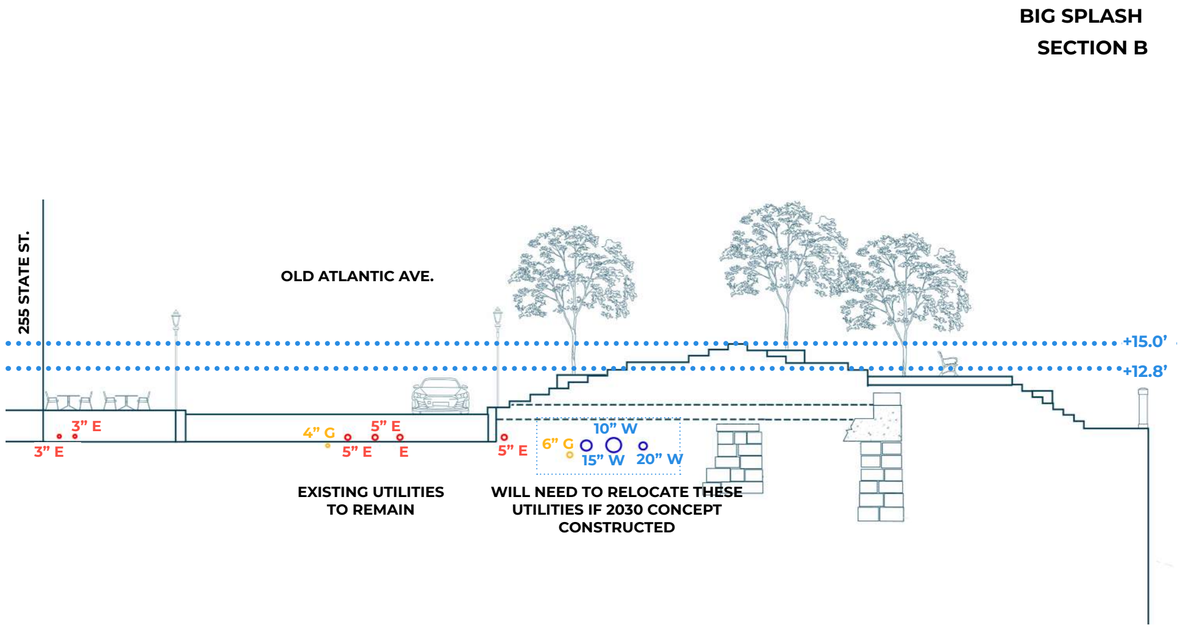


Figure 6-48 - Section B - Utilities Under Old Atlantic Avenue - Big Splash

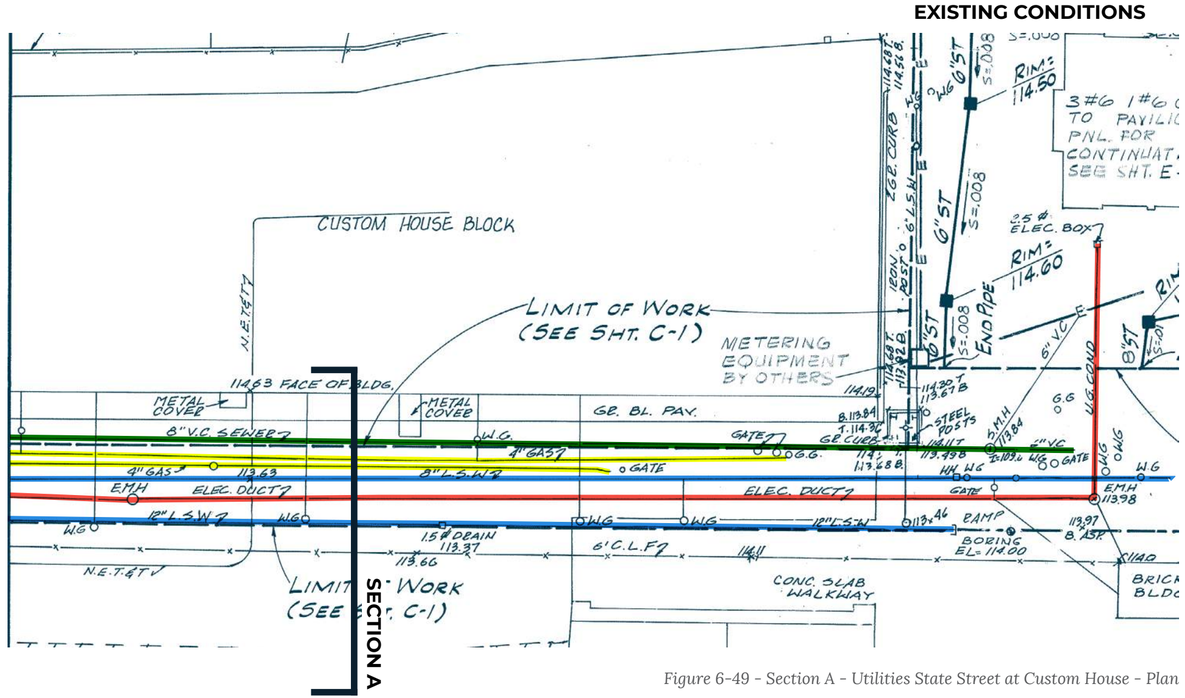


Figure 6-49 - Section A - Utilities State Street at Custom House - Plan

DRAFT

DRAFT

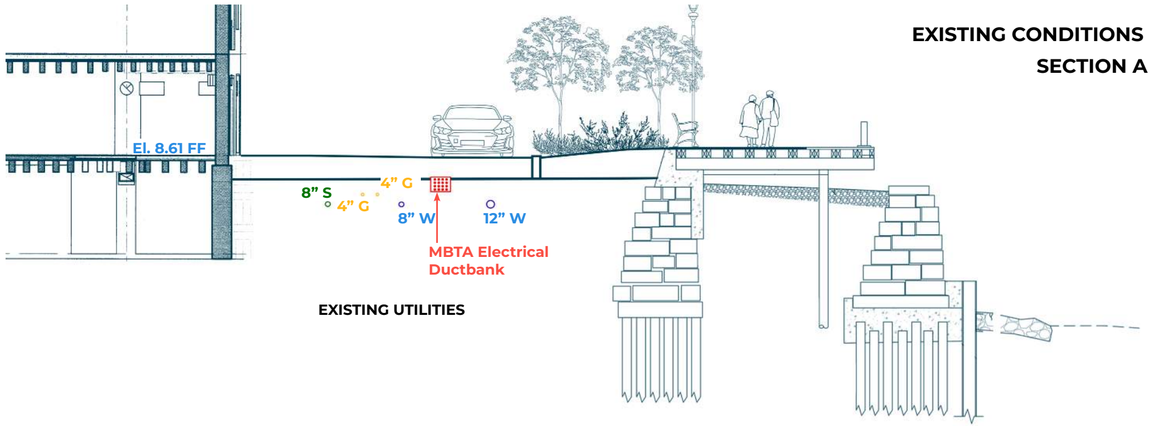


Figure 6-50 - Section A - Utilities State Street at Custom House - Existing Conditions

DRAFT

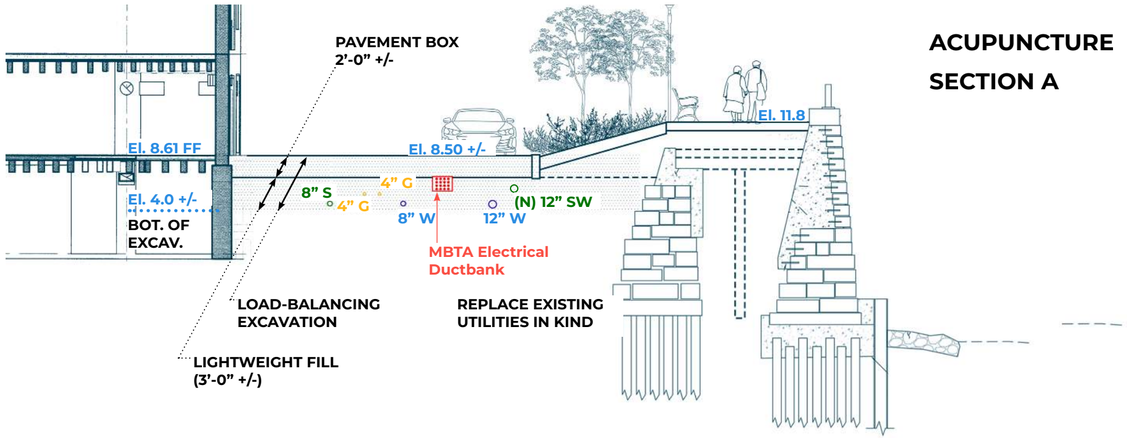
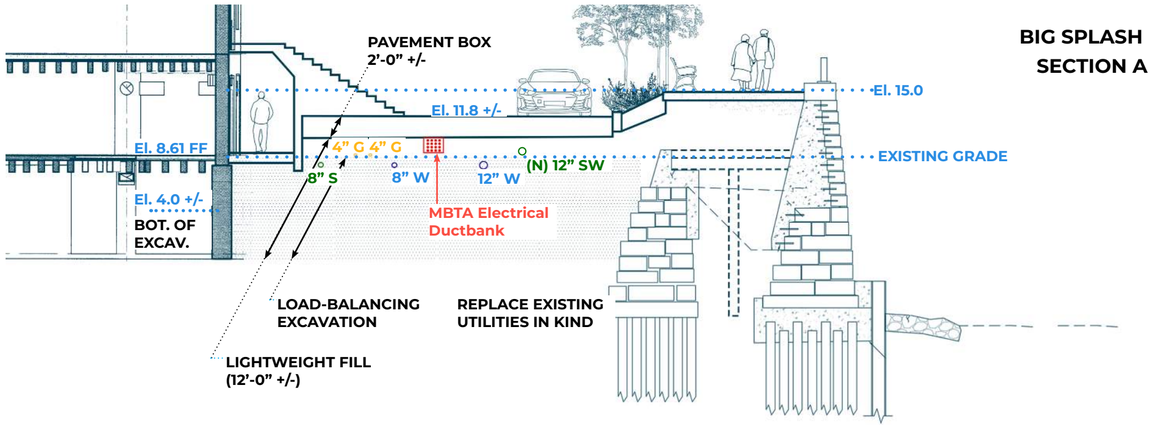


Figure 6-51 - Section A - Utilities State Street at Custom House - Acupuncture

DRAFT



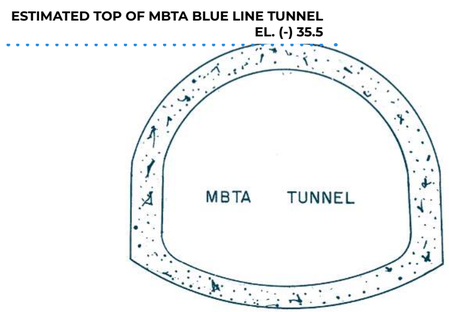


Figure 6-52 - Section A - Utilities State Street at Custom House - Big Splash

DRAFT

REGULATORY CONTEXT

The proposed resiliency improvements for Long Wharf, including the proposed edge treatments, are intended to adapt to the risks associated with rising sea levels and frequency of storm surge events, ensuring the long-term coastal resilience and continued serviceability of Long Wharf as a public space. Regulatory requirements and constraints will have a major influence on the project's design, cost and design and construction schedules.

It is anticipated that the Local, State, and Federal approvals listed below will be required to advance the Project to construction. The approvals are listed in the suggested order of submission to streamline the regulatory review process. Please note that these approvals are focused on the coastal edge of the wharf and are not inclusive of upland permits which may be necessary for the Project.

- Massachusetts Environmental Policy Act - Environmental Impact Report
- Massachusetts Bay Transportation Authority – Access Permit
- Boston Conservation Commission – Notice of Intent
- United States Army Corps of Engineers – General Permit/Individual Permit
- National Parks Service - LWCF Act Section 6(f)(3) Outdoor Public Recreation Use Consistency
- Massachusetts Department of Environmental Protection 401 Water Quality Certificate (Concurrently with USACE General Permit/Individual Permit)
- Massachusetts Department of Environmental Protection Ch. 91 – Ch. 91 License
- Massachusetts Department of Environmental Protection Wetlands Protection Act (WPA) 310 CMR
- Massachusetts Coastal Zone Management Office – Federal Consistency

MassDEP

US Army Corps of Engineers®

CITY of BOSTON
Conservation Commission

Massachusetts Office of Coastal Zone Management

DRAFT

PHASING OF CONSTRUCTION

Regardless of which design option(s) are to be advanced to implementation, one of the key challenges of implementing a coastal resiliency project of this scale is the phasing plan for construction.

Two different phasing plan options were developed as part of this project:

Option 1: A nearer-term implementation path (i.e., a 'quick-build' project path) focused on implementing the 2030 Scheme elements alone, followed later by a second phase of implementation for the long-term 2070 project

Option 2: A singular implementation phase that bypassed the 2030 Scheme altogether and designs for and constructs the larger, long-term project

The consideration of multiple phasing options offers flexibility for the City with respect to the timing of grant funding and/or project financing. It also provides room for taking an adaptive approach, based on findings from follow-on district-scale study, collaboration with the USACE CSRM study/ selected plan, or observed conditions (such as increased storm activity or sea level rise by 2030).

Ultimately, each phasing plan path still includes an extensive construction period, amounting to more than five years of construction work. This extended duration of construction acknowledges the significant length of wharf perimeter work required, and the reasonable limits of what is achievable in each winter season. In this case, wintertime work is necessary to avoid significant negative impacts to water-dependent commercial operations and marine public transit. Both Acupuncture and Big Splash require work along the entire perimeter of the Wharf to raise the Harborwalk above future HAT.

There was broad consensus from relevant stakeholder groups that closing off sizable portions of the wharf (and limiting public Harborwalk access) for extended periods of time is not an option at this central waterfront location and transit hub. Water-dependent business operations also expressed the criticality of construction phasing to avoid their busy season (summer and fringe months), advocating for phasing of in-water work over multiple winter seasons.

Significant site preparation and a staging plan to accommodate boat vessels operations are also required to provide adequate docking berth and swing space for marine operators during construction. This would allow for limited operations (rather than periods of full closure). As the wharf perimeter is built to a higher flood protection elevation, the wharf will take the shape of a bathtub and face exacerbated interior drainage issues. It is thus important that new stormwater drainage systems on the interior of the wharf be added upfront in earlier phases to be operational during the latter phases of construction.

For each of the two Options, the same approach (i.e, order-of-construction) is recommended. As depicted in the Phase-by-Phase graphics on the following pages, there is a summer and winter phase for each construction year.

DRAFT

Timing / phasing of site work was ordered based on the following constraints / objectives:

- Practical staging / phasing for path-critical items, including:
  - staging of new docking/berth space, creating areas to relocate boats during later stages of construction
  - phasing in utilities and interior drainage upgrades (earlier in process)
  - maintaining minimum requirements for emergency and fire lane access
- Minimizing disruption to commercial entities and water-dependent uses (i.e., avoiding edge work during summer and fringe seasons)
- Considering the feasibility of waterfront edge length that can reasonably be accomplished within each winter season (i.e. construction will need to utilize barges and cannot all be performed from land)
- Phasing excavation and earthwork above the Blue Line Tunnel, limiting stockpiling and surcharged loading
- Closing off near-term (2030) coastal flood pathway at Old Atlantic Ave. and State Street as early as possible within the overall construction period
- Minimizing impacts to the publicly-accessible Harborwalk (i.e., taking portions of this offline for phases of construction, rather than restricting access for one extended period of time)
- Utilizing summer or fringe seasons to complete site civil, landscaping, open space furnishings and amenities that are not path-critical
- Minimizing disturbance of newly landscaped areas and amenities with each subsequent season of construction, minimizing re-mobilizations

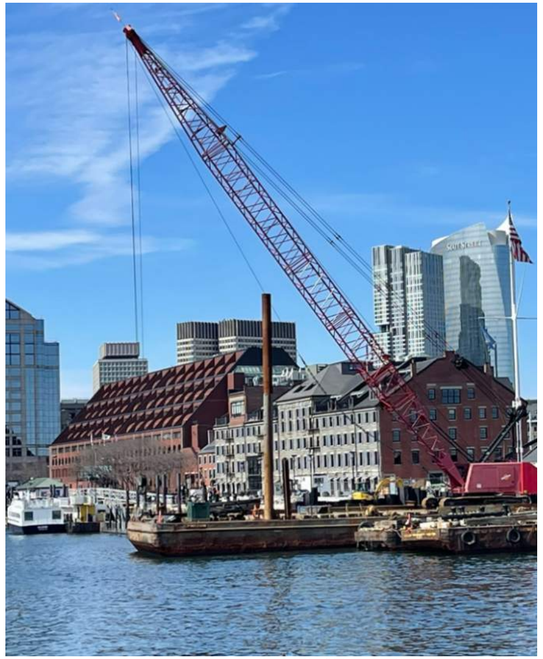
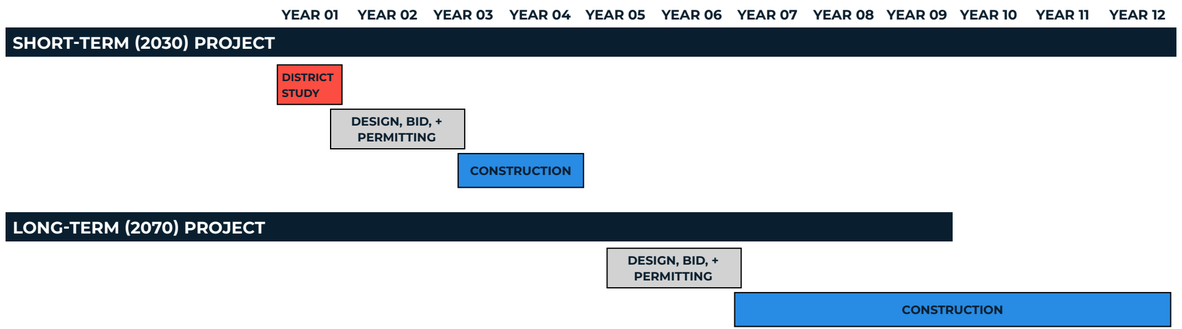


Figure 6-53 (Image Source: Kleinfelder)

DRAFT

OPTION 1: SHORT-TERM FIRST, THEN LONG-TERM PROJECT



OPTION 2: LONG-TERM PROJECT

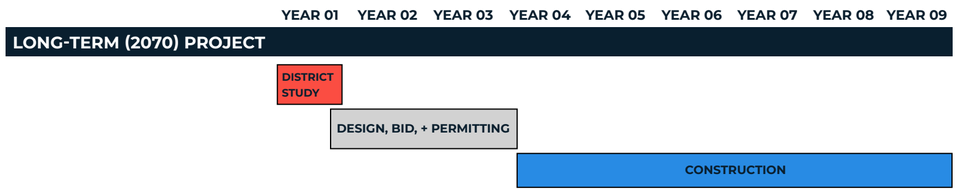


Figure 6-54 -

DRAFT

IMPLEMENTATION TIMELINE

WITH NEAR TERM (2030 PROTECTION), DISTRICT-SCALE FEDERAL GRANT

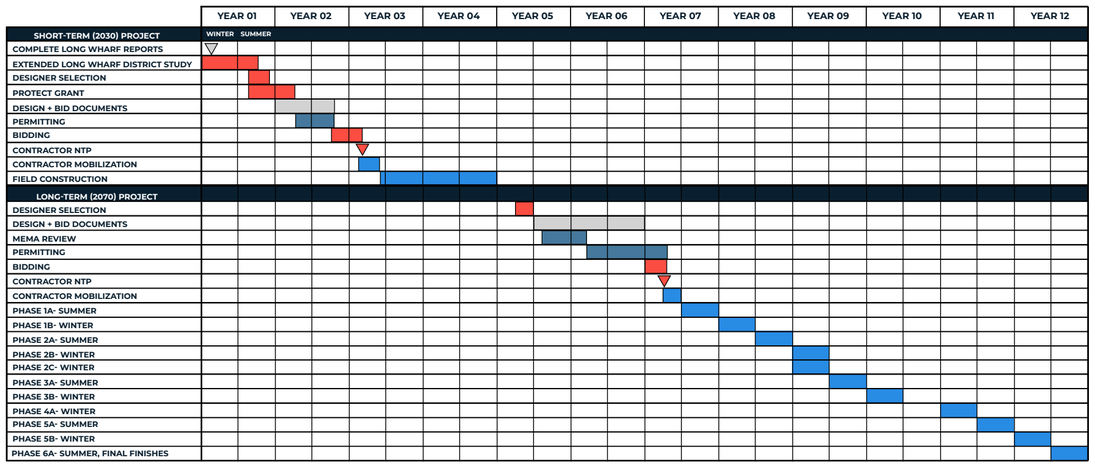


Figure 6-55 -

DRAFT

LONG TERM PROJECT (PROTECT TO 2070)

LONG-TERM (2070) PROJECT	YEAR 01		YEAR 02		YEAR 03		YEAR 04		YEAR 05		YEAR 06		YEAR 07		YEAR 08		YEAR 09	
	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER	WINTER	SUMMER
COMPLETE LONG WHARF REPORTS	▽																	
EXTENDED LONG WHARF DISTRICT STUDY																		
DESIGNER SELECTION																		
DESIGN + BID DOCUMENTS																		
MEMA REVIEW																		
PERMITTING																		
BIDDING																		
CONTRACTOR NTP						▽												
CONTRACTOR MOBILIZATION																		
PHASE 1A- SUMMER																		
PHASE 1B- WINTER																		
PHASE 2A- SUMMER																		
PHASE 2B- WINTER																		
PHASE 2C- WINTER																		
PHASE 3A- SUMMER																		
PHASE 3B- WINTER																		
PHASE 4A- WINTER																		
PHASE 5A- SUMMER																		
PHASE 5B- WINTER																		
PHASE 6A- SUMMER, FINAL FINISHES																		

Figure 6-56 -

PHASE 1, SUMMER YEAR 1: APRIL 16- OCTOBER 14

The primary goal of Phase 1-A (Summer) is demo work at the northern portion of the site (City-leased watersheet), creating swing space and barge access for waterfront edge work in the first winter.

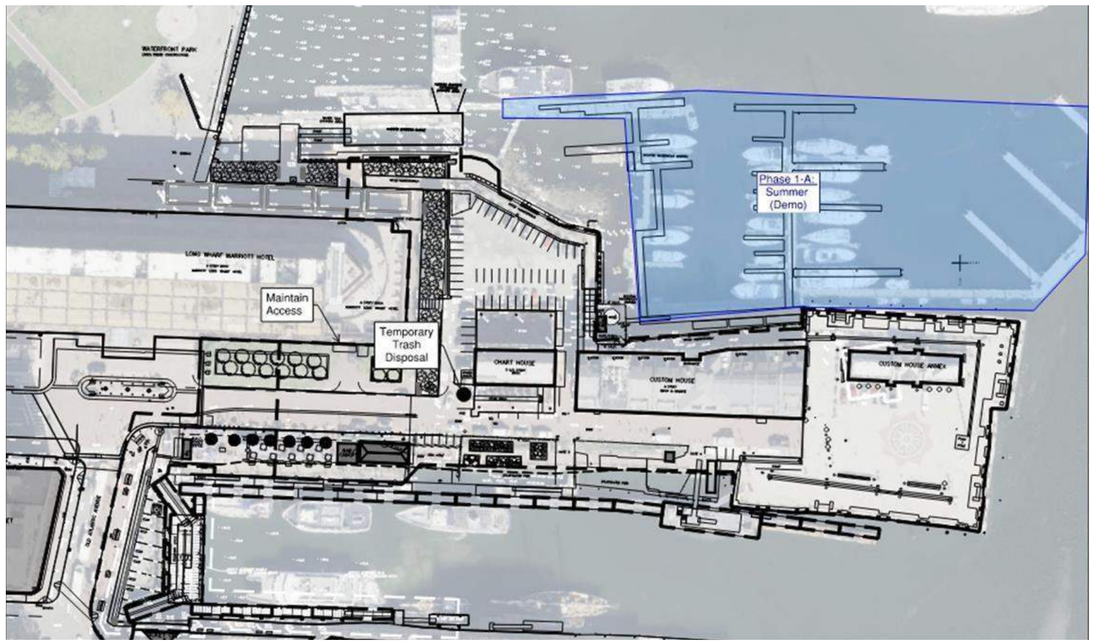


Figure 6-57 - Phase 1, Summer Year 1

DRAFT

DRAFT

PHASE 1, WINTER YEAR 1: OCTOBER 15- APRIL 15

In Phase 1-B (Winter), waterfront edge work begins along the middle segment of the north side of the wharf, which is accessible by barge following the demo work in the summer.

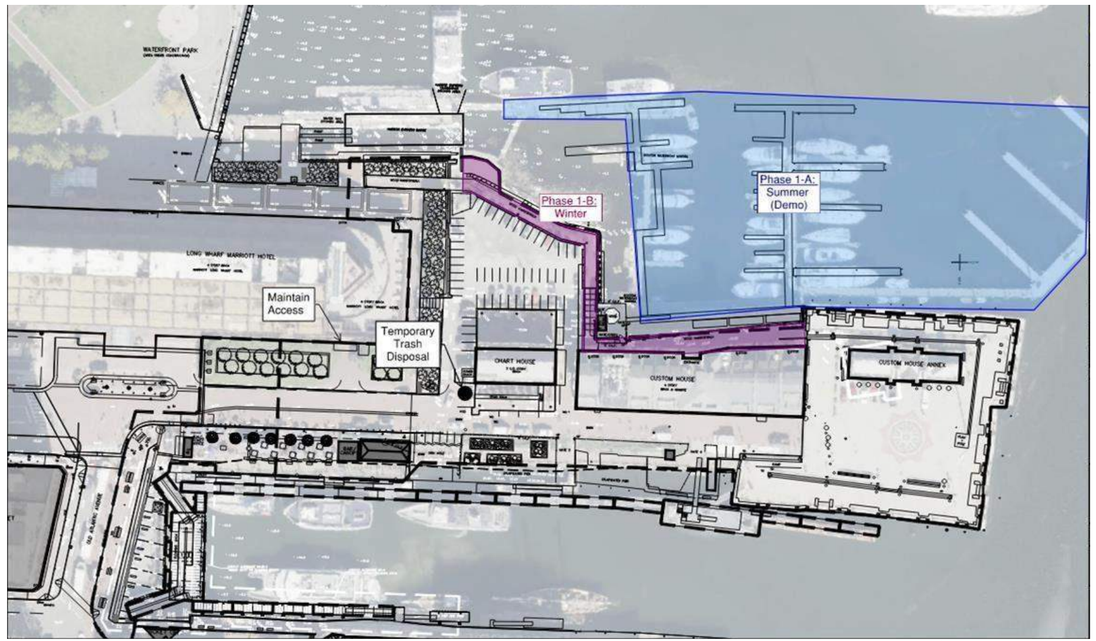


Figure 6-58 - Phase 1, Winter Year 1

PHASE 2, SUMMER YEAR 2: APRIL 16- OCTOBER 14

The primary goal of Phase 2-A (Summer) is to prep the portion of the site that currently serves as the Chart House parking lot. This would include excavation and installation of the east stormwater drainage chamber and conveyance piping, and the enclosure structure for a new heavy-duty flood gate (to be installed in a future phase). North-South pedestrian footpath accessibility would be maintained just east of the Marriott during this phase.

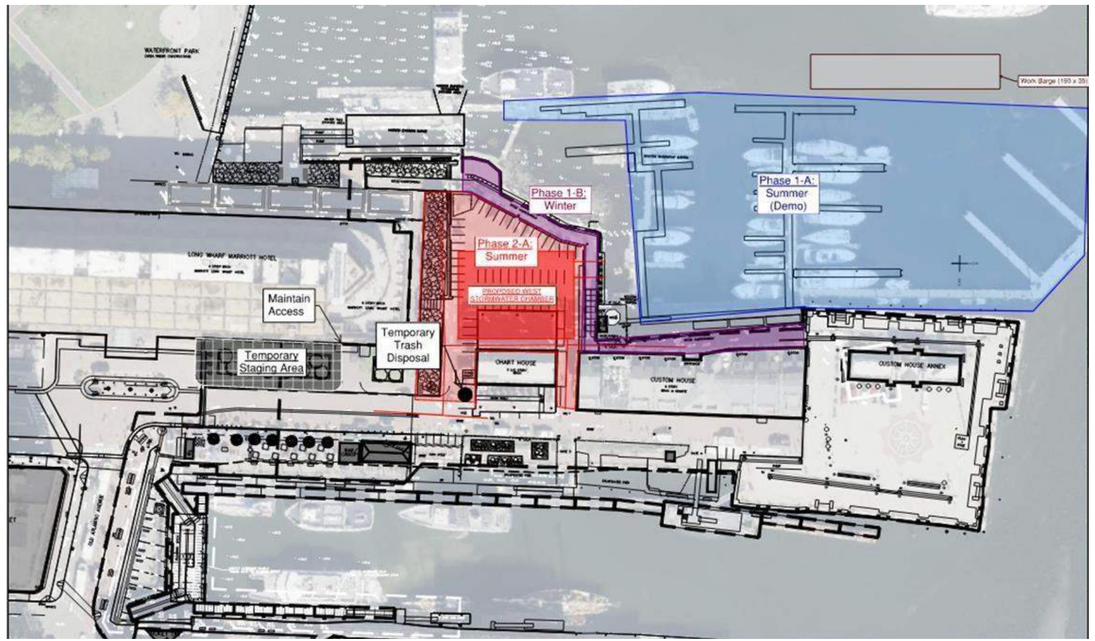


Figure 6-59 - Phase 2, Summer Year 2

DRAFT

DRAFT

PHASE 2, WINTER YEAR 2: OCTOBER 15- APRIL 15

Phase 2-B (Winter) work includes seawall work at the eastern edge of the Wharf, as well as excavation and installation of the west stormwater drainage chamber at the east end plaza. Site prep work for the new open space amenities, including the raised Harbor Walk is completed.

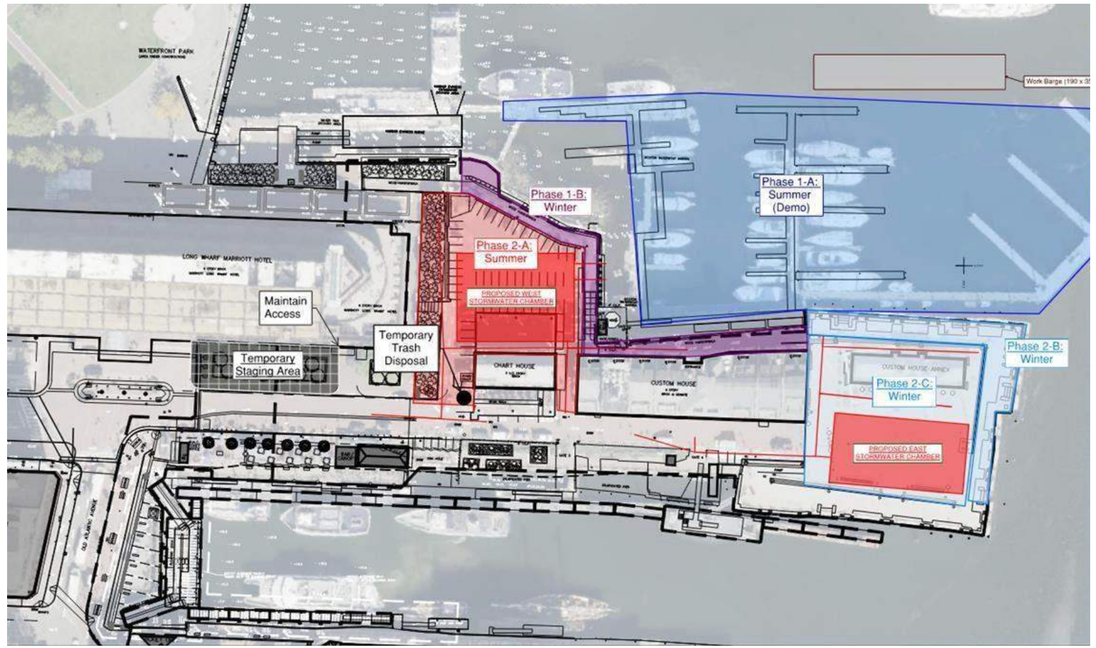


Figure 6-60 - Phase 2, Winter Year 2

DRAFT

PHASE 3, SUMMER YEAR 3: APRIL 16- OCTOBER 14

In Phase 3-A (Summer), the new piers and docking structure are added on the north side of the wharf, proving docking berths for vessels on the south side of the wharf to operate from, or swing to during latter phases of construction.

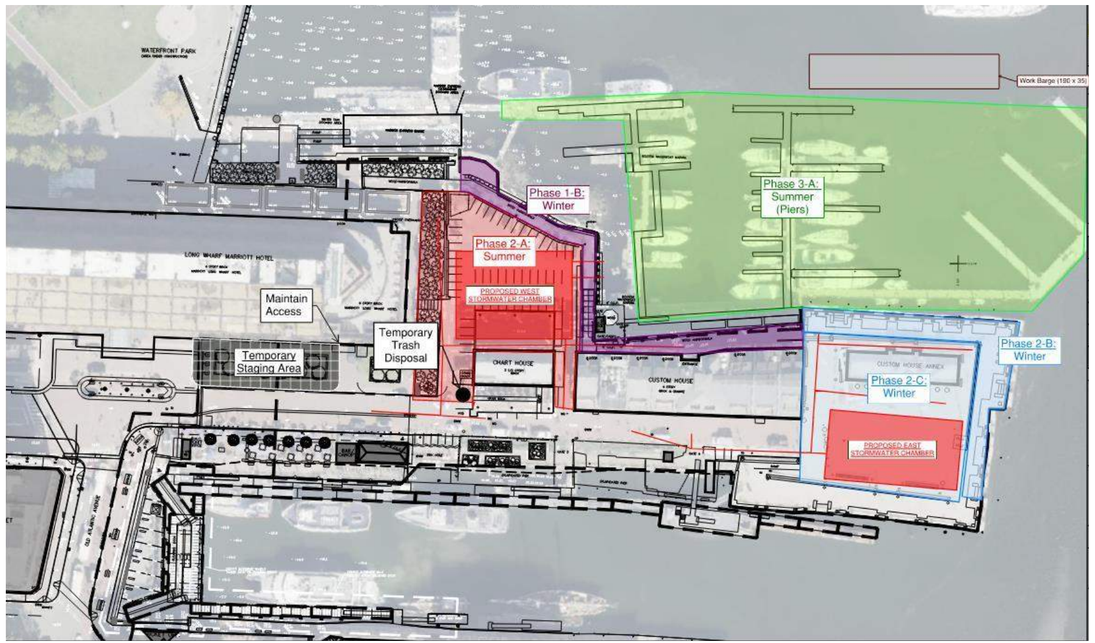


Figure 6-61 - Phase 3, Summer Year 3

DRAFT

PHASE 3, WINTER YEAR 3: OCTOBER 15- APRIL 15

In Phase 3-B (Winter), work begins at the south side interior of the wharf to over-excavate portions above the Blue Line Tunnel, and complete subsurface utility work. This phase requires sub-phasing to maintain emergency vehicle and fire lane access while completing subsurface work. The roadway may be left unpaved (or temporarily paved) given the work still to occur at the southern waterfront edges and elevation of the perimeter Harbor Walk in subsequent phases.

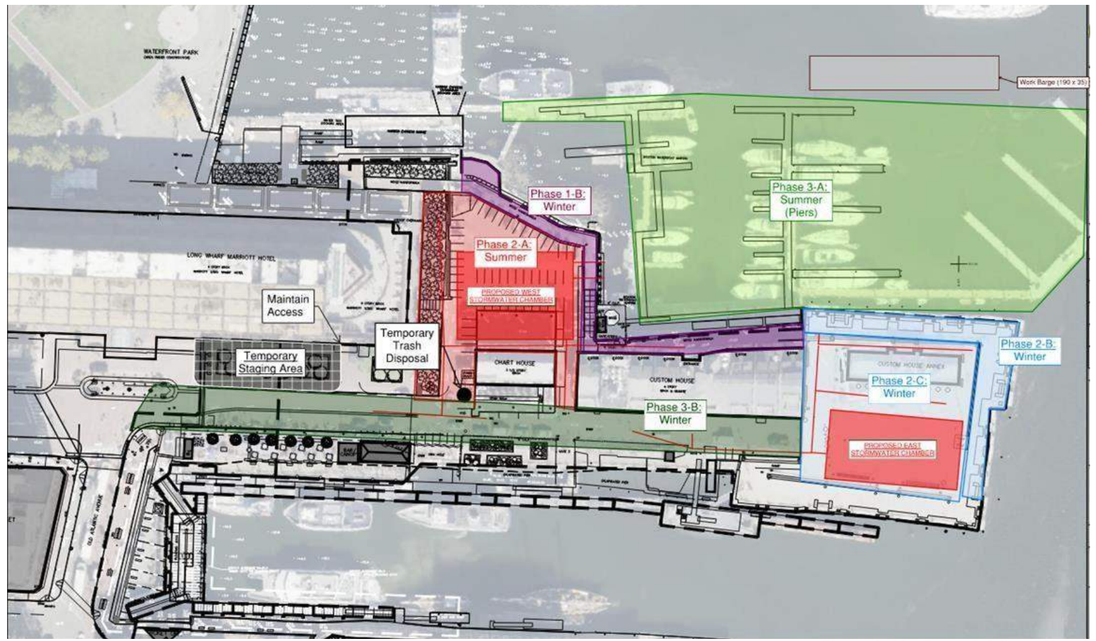


Figure 6-62 - Phase 3, Winter Year 3

PHASE 4, WINTER YEAR 4: OCTOBER 15 - APRIL 15

In Phase 4 (Winter), waterfront edge and public right-of-way work would be performed along Old Atlantic Ave. and perimter Harborwalk areas at the southwest segment along State Street (extended). The heavy-duty flood gate would be installed, effectively eliminating the near-term coastal storm pathway to Downtown. *[Between Phases 3-B and 4 limited site civil work and furnishings can be installed during summer months.]*

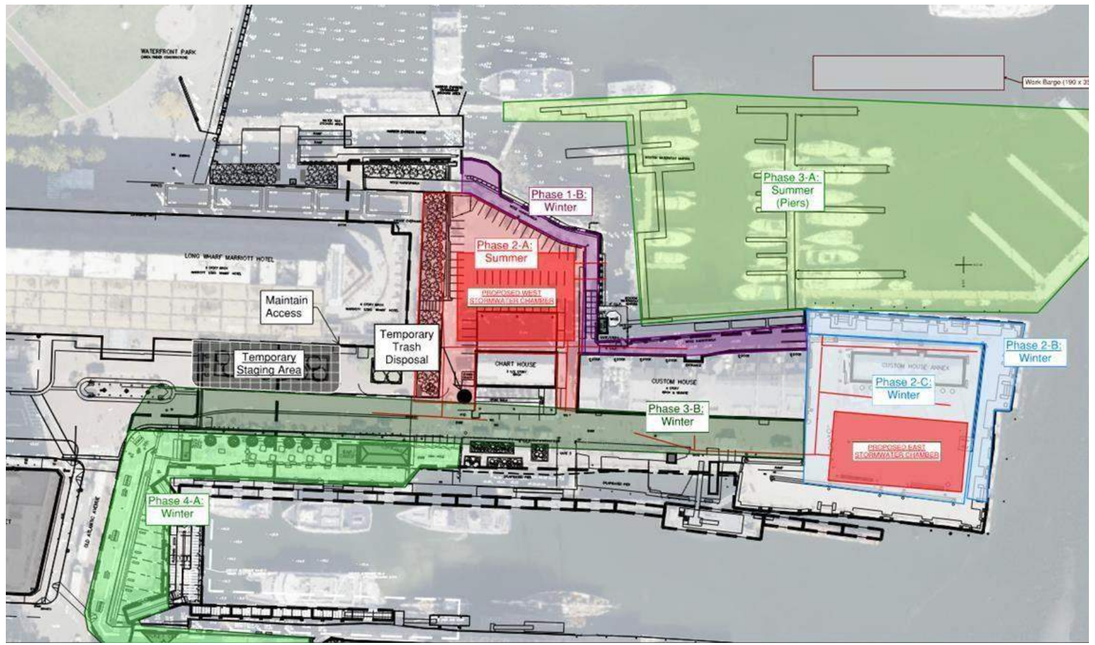


Figure 6-63 - Phase 4, Winter Year 4

DRAFT

DRAFT

PHASE 5, SUMMER YEAR 5: APRIL 16- OCTOBER 14

In Phase 5 (Summer), waterfront edge and public right-of-way work would be performed along the north edge of wharf, including the raised Harborwalk and tie-in to Columbus Park. New planters and/or the raised berm would be implemented along the Marriott hotel. Landscaping and new site amenities (e.g., shade structures, benches, wayfinding, cultural elements) can be added at adjacent new open space (former parking lot area), and at prior phase locations.

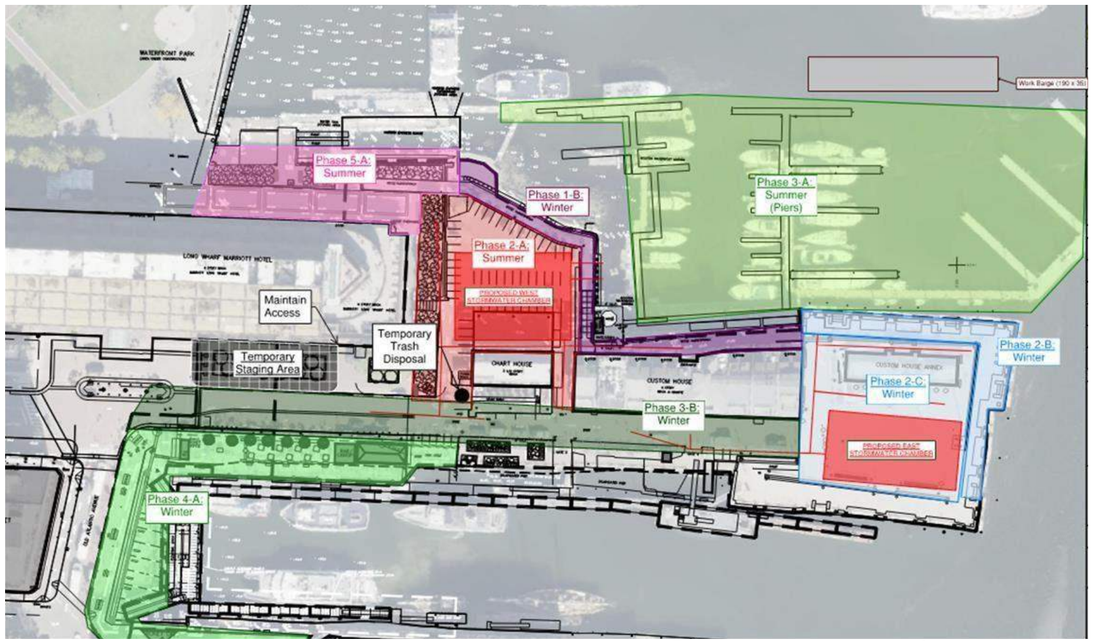


Figure 6-64 - Phase 5, Summer Year 5

DRAFT

PHASE 5, WINTER YEAR 5: OCTOBER 15- APRIL 15

In Phase 5-B (Winter), waterfront edge work would be performed along the remaining southern edges of the wharf, completing the raised seawall and perimeter Harborwalk. Final utility and roadway work are completed.

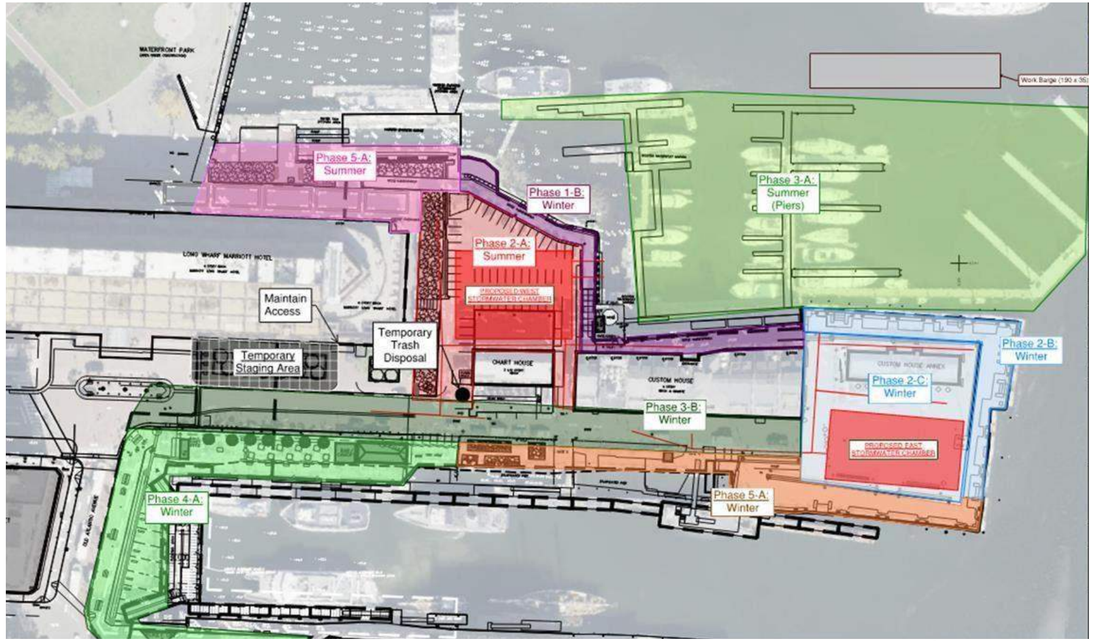


Figure 6-65 - Phase 5, Winter Year 5

DRAFT

7- EVALUATION OF ALTERNATIVES

OVERVIEW OF EVALUATION PROCESS AND OBJECTIVES

As part of the design process, an evaluation of alternatives was performed to compare and highlight the performance (i.e., relative strengths and weaknesses) of the different designs via a simplified (green/yellow/red) scoring system.

The objective of this evaluation was not for the purposes of ultimately selecting one preferred design among the concepts presented in this report. For the purposes of making final decision choices with respect to specific design elements, some flexibility or room for interchangeability is retained. For instance, the near-term 2030 scheme could be implemented independently of any future decisions for the long-term 2070 alternatives presented. Similarly, certain aspects of the 2070 alternatives – such as specific features or public realm amenities (e.g., "The Sponge" from Acupuncture, the stepped "Cove", landscape berm, the elevated Chart House, or split-level entrance at Customs House from Big Splash) could be mixed-and-matched in any final design.

The specific Evaluation Criteria utilized in this analysis were compiled from a combination of sources and user groups, including:

- Core criteria from prior Coastal Resilience Solutions studies (e.g., Effectiveness, Feasibility, Design Life + Adaptability, Social Impact and Equity, Environmental Impact)
- Criteria from the Wharf District Council Conceptual District Protection & Resiliency Plan
- Criteria from the Waterfront Edge Design Guidelines (WEDG) national rating system
- Specific criteria relevant to water-dependent uses and water transit stakeholders (criteria of particular importance as Long Wharf serves as a major water transit hub)

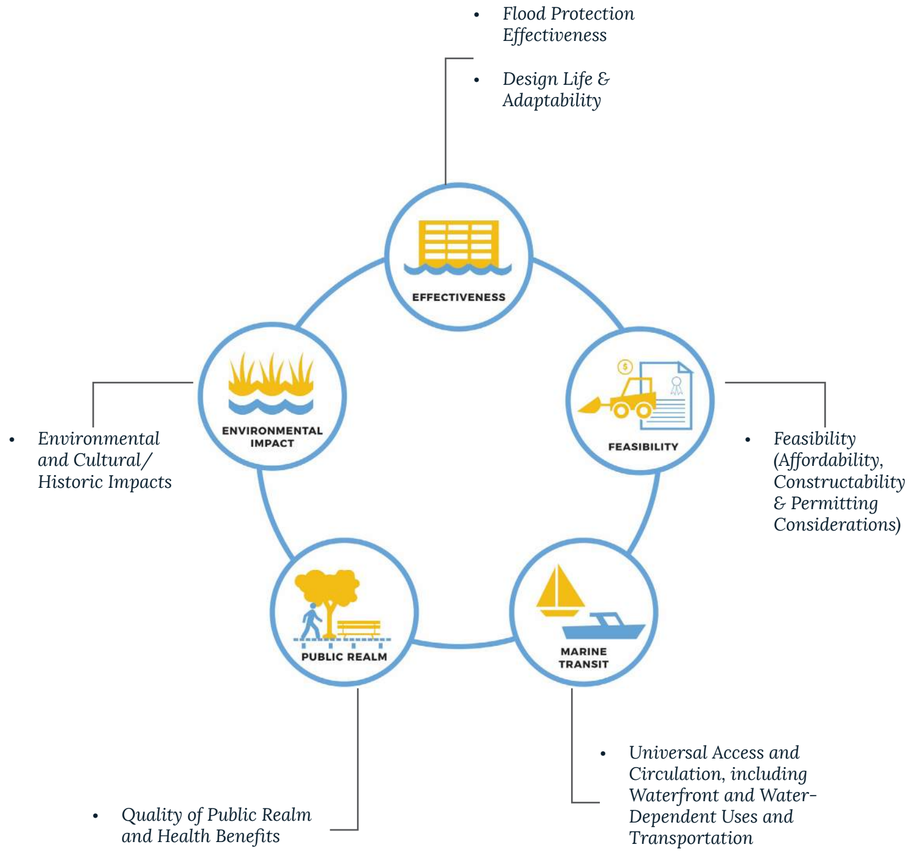
Figure 7-1 - Waterfront Edge Design Guidelines - Desired Outcomes

DRAFT

DRAFT

In order to guide the planning process, a set of evaluation criteria similar to those used in previous Climate Ready Boston and Coastal Resilience Solutions plans were expanded with input from stakeholders.

Stakeholders provided feedback on the categories most important to them, for which specific criteria are provided on the following pages.



OVERVIEW OF EVALUATION CRITERIA

Evaluation Criteria Help Guide and Rank Proposed Climate Resilience Strategies

FLOOD PROTECTION EFFECTIVENESS	*Reduction in flood extent during storms (overall)* *Reduction in flood frequency (post-implementation impacts to right of* *Avoided loss/damages (based on existing built environment)* *Passivity and reliability (magnitude of deployables)*
FEASIBILITY (AFFORDABILITY, CONSTRUCTABILITY & PERMITTING	*Affordability: Cost of Construction* *Affordability: Mid- to Long-Term Operations and Maintenance* *Permitting Complexity / Risk* *Constructability* *Disturbance of Existing Infrastructure (structural decks, seawalls and critical uses during construction)* *Disturbance to Harborwalk, water-dependent uses and commercial activity during construction* *Is Right-of Way available to do the work without redirecting pedestrian vehicular site flow? ?*
DESIGN LIFE AND ADAPTABILITY	*Does scheme reduce redundant protections or future demo (i.e., Phased Implementation with Long Term 2070 Alternatives* *Adaptability/Flexibility (can specific elements be retrofit in-place to an elevation higher than 2030 or 2070 D.F.E.?)* *District-Scale Resiliency Compatibility/Integration with Abutters (i.e., NEAQ, India Row, Columbus Park)* *Compatibility with existing property-specific plans and land use; consistency with Waterfront Use guidelines* *Compatibility with existing property-specific plans and land use; consistency with Waterfront Use guidelines*
QUALITY OF PUBLIC REALM AND PUBLIC HEALTH BENEFITS	*Impacts to Harborwalk and other public spaces* *Overall quality of public realm (materials, social/urban experience), per design team self-evaluation* *Impacts to Views*
UNIVERSAL ACCESS AND CIRCULATION, INCLUDING WATERFRONT AND WATER-DEPENDENT USES	*Impacts to emergency access* *Mid- to long-range impact to water-dependent uses and businesses* *Improved accessibility to water? (i.e., get-downs to water)*
ENVIRONMENTAL + CULTURAL / HISTORIC	*Integration of Green Infrastructure, Nature-Based Solutions* *Improved shade areas, reduction in heat island effects* *Preserves or improves cultural and historic resources*

DRAFT

DRAFT

CONCEPTUAL 2030 SCHEME: EVALUATION OF ALTERNATIVES

EVALUATION OF PROPOSED 2030 ALIGNMENT

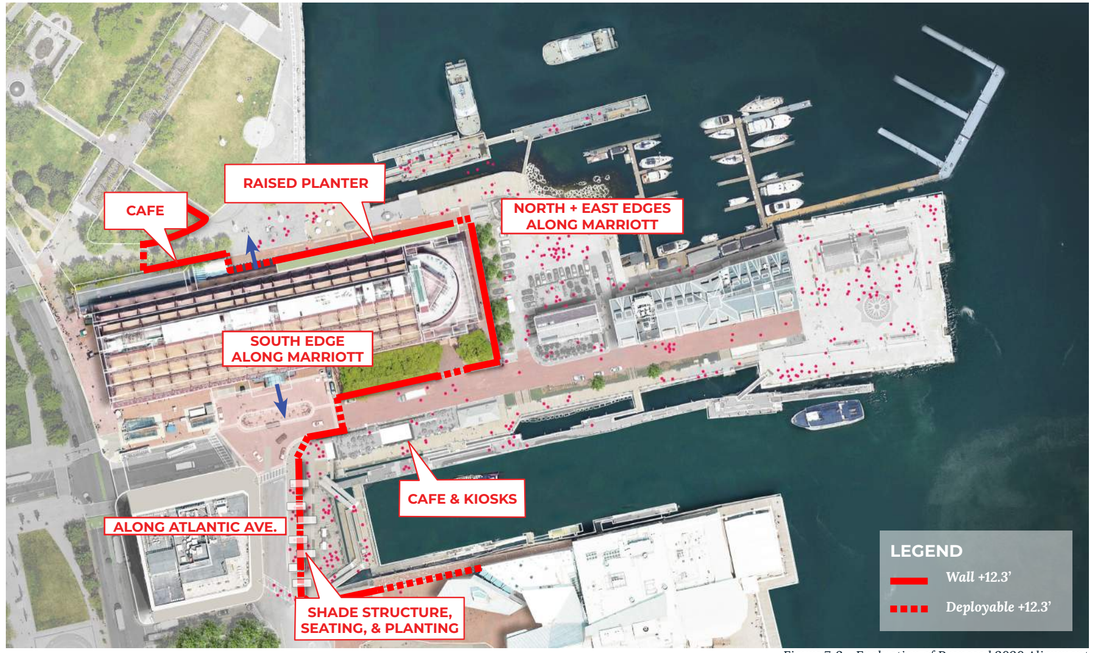


Figure 7-2 - Evaluation of Proposed 2030 Alignment

The 2030 scheme proposes maintaining the existing programmatic uses and maintaining existing grade, materials, and access. This scheme, however, introduces a level of flood protection up to elevation 12.3' NAVD88 by constructing a concrete flood wall as shown in the plan diagram to the right. The solid red line indicates where the wall is intended to be a continuous passive line of defense, with the dashed lines indicating areas that would remain open for service and access but be able to be closed with a deployable flood barrier to a storm event.

The flood wall is proposed to continue to the north side of the wharf and cross the State Street access road adjacent to the Marriott Hotel's loading dock. The existing program elements, including the cafe kiosks, and ticketing booths, are proposed to remain on the exterior of the flood wall and would be subject to flooding during a storm.

Although a wall could provide new flood protection in this configuration, the design team acknowledged that inserting just a wall would not benefit the public realm substantially.

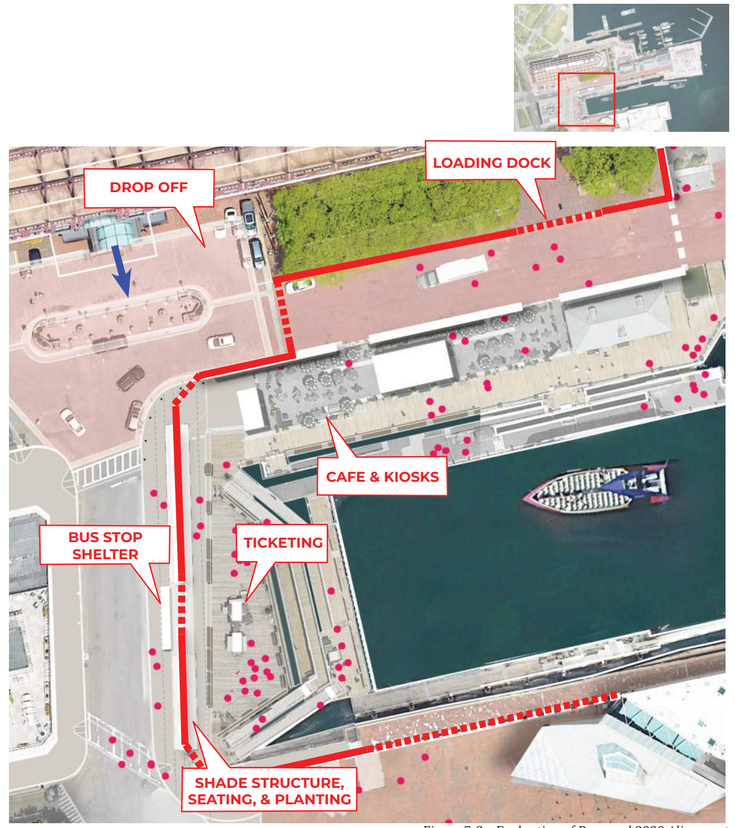


Figure 7-3 - Evaluation of Proposed 2030 Alignment

DRAFT

DRAFT

2030: NEAR-TERM CONCEPTUAL DESIGN

ADVANTAGES & OPPORTUNITIES

- *Wall along Marriott is relatively unintrusive*
- *Opportunity to incorporate public realm benefits such as planting and/or social seating alongside flood protection*
- *Entire alignment is inboard from the existing/historic seawall edge (not directly modifying above any existing shoreline structure)*
- *No flood gate*
- *View down wharf is uninterrupted and accessibility is similar to present condition (access to water-dependent uses not impeded aside from during storms)*
- *Few permitting considerations (all adaptations are inboard of the shoreline)*

LIMITATIONS & TRADEOFFS

- *Only partially contributes to the proposed 2070 schemes*
- *Minimal improvements to the public realm*
- *This scheme includes the most locations for deployables flood barriers that would need to be deployed prior to a storm*
- *Does not provide protection to the Harborwalk-adjacent kiosks and ticketing structures*
- *Provides protection along the Marriott Hotel rather than the public way/Harborwalk*
- *Favors building protection over public realm; Fewer opportunities to address urban heat islands and lack of shade on the wharf*

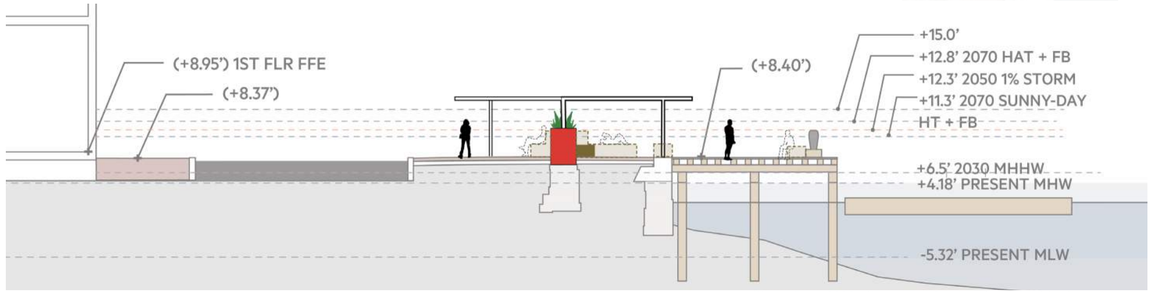


Figure 7-4 - 2030 Alignment - Section through Old Atlantic Avenue

DRAFT

KEY DESIGN INCLUSIONS & CONSIDERATIONS

- *Low wall that can include integrated shade structures, seating and/or planting*
- *Any structural footings/low walls should be designed to be adaptable to raise the height in the future to El. 15.0' NAVD88 with floodproof glass or other devices*

REMAINING CHALLENGES

- *Amount of deployable flood barriers (>400 LF in total) requires labor and trained personnel to deploy*
- *Integration with NEAQ requires elevating a portion of previously-modified low wall (on NEAQ property)*
- *Integration with Columbus Park may be temporary, or revised based on anticipated park redesign project*

DRAFT

2030: NEAR-TERM CONCEPTUAL DESIGN

FLOOD PROTECTION EFFECTIVENESS	ALONG OLD ATLANTIC AVE.	SOUTH EDGE ALONG MARRIOTT	NORTH + EAST EDGE ALONG MARRIOTT
Reduction in flood extent during storms (overall)	Mitigates impacts from storm surge through 2050 1%	Mitigates impacts from storm surge through 2050 1%	Mitigates impacts from storm surge through 2050 1%
Reduction in flood frequency (post-implementation impacts to right of way/Harborwalk)	Deployables may reduce tidal flooding in 2030, but will require more frequent deployments	Mitigation of nuisance / tidal flooding depends on location of street deployables	Mitigation of nuisance / tidal flooding depends on location of street deployables
Avoided loss/damages (based on existing built environment)	Reduces storm surge risks to Old Atlantic Avenue and inland areas	Reduces storm surge impacts to downtown, but not outbuildings	Reduces storm surge impacts to Long Wharf Marriott Hotel
Passivity and reliability (quantity of deployables)	Still utilizes deployables (minimizes # and length)	Still utilizes deployables (minimizes # and length)	Requires a deployable barrier across street

FEASIBILITY (AFFORDABILITY, CONSTRUCTABILITY & PERMITTING CONSIDERATIONS)	ALONG OLD ATLANTIC AVE.	SOUTH EDGE ALONG MARRIOTT	NORTH + EAST EDGE ALONG MARRIOTT
Affordability: Cost of Construction	Relatively low cost intervention	Relatively low cost intervention	Relatively low cost intervention
Affordability: Mid- to Long-Term Operations and Maintenance	Relatively low O&M; deployables require some labor (but not significant)	Some operations required for road barrier (if non-self deploying)	Relatively low O&M; deployables require some labor (but not significant)
Permitting Complexity / Risk	Minimal permitting required	Minimal permitting required	Minimal permitting required
Constructability	Can be constructed relatively quickly compared to other schemes	Can be constructed relatively quickly compared to other schemes	Can be constructed relatively quickly compared to other schemes
Disturbance of Existing Infrastructure (structural decks, seawalls and critical uses during construction)	Minimal disturbance and excavation needed	Minimal disturbance (some demo and replacement of planters)	Minimal disturbance (offset from Long Wharf Marriott Hotel wall)
Disturbance to Harborwalk, water-dependent uses and commercial activity during construction	Minimal disturbance, within public ROW	Minimal construction impact to The Landing / BHCC	Minimal disturbance, within pedestrian cut-through
Is Right-of Way available to do the work without redirecting pedestrian and vehicular site flow? ?	Minimal impacts to pedestrian and vehicular site flow	Minimal impacts to pedestrian and vehicular site flow	Minimal impacts to pedestrian and vehicular site flow

DRAFT

DESIGN LIFE AND ADAPTABILITY	ALONG OLD ATLANTIC AVE.	SOUTH EDGE ALONG MARRIOTT	NORTH + EAST EDGE ALONG MARRIOTT
Does scheme reduce redundant protections or future demo (i.e., Phased Implementation with Long Term 2070 Alternatives	Future adaptations can fill over and bury low walls, as necessary	Future adaptations can fill over and bury low walls, as necessary	North edge planter can get buried under berm; deployable gate and trash enclosure would require demo
Adaptability/Flexibility (can specific elements be retrofit in-place to an elevation higher than 2030 or 2070 D.F.E.?)	Some, but limited ability to adapt much higher without fill	Some, but limited ability to adapt much higher without fill	Deployable across State Street would require something more robust
District-Scale Resiliency Compatibility/Integration with Abutters (i.e., NEAQ, India Row, Columbus Park)	Avoids larger fill in public ROW and longer-term integration with NEAQ	N/A	Easily blended into Columbus Park
Compatibility with existing property-specific plans and land use; consistency with Waterfront Use guidelines	Loses some width and pedestrian dropoff and loading zone to gain height	Opportunity to redesign, consistent with guidelines	Potential improvement in terms of shade + greenery

QUALITY OF PUBLIC REALM AND PUBLIC HEALTH BENEFITS	ALONG OLD ATLANTIC AVE.	SOUTH EDGE ALONG MARRIOTT	NORTH + EAST EDGE ALONG MARRIOTT
Impacts to Harborwalk and other public spaces	New low wall inter-stitched into high foot traffic area and loading zone	New low wall interstitched into The Landing / outbuildings	Minimal width lost along north edge of Marriott Hotel for new planters
Overall quality of public realm (materials, social/urban experience), per design team self-evaluation	Opportunity to add planters and shade structures	Minimal low wall impacts (blends into seating area)	No adverse impact
Impacts to Views	Views from 255 State St marginally impacted	Views from Marriott Hotel south entryway marginally impacted	No adverse impact

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

2030: NEAR-TERM CONCEPTUAL DESIGN

UNIVERSAL ACCESS AND CIRCULATION, INCLUDING WATERFRONT AND WATER-DEPENDENT USES	*ALONG OLD ATLANTIC AVE.*	*SOUTH EDGE ALONG MARRIOTT*	*NORTH + EAST EDGE ALONG MARRIOTT*
Impacts to emergency access	No adverse impact	No adverse impact	No adverse impact
Mid- to long-range impact to water-dependent uses and businesses	No adverse impact	No adverse impact	No adverse impact
Improved accessibility to water? (i.e., get-downs to water)	Not an improvement to access; new low wall has openings, yet marginal impacts to foot traffic to ramp float	Not an improvement to access; new low wall has openings, yet marginal impacts to foot traffic to ramp float	No adverse impact

ENVIRONMENTAL + CULTURAL / HISTORIC	*ALONG OLD ATLANTIC AVE.*	*SOUTH EDGE ALONG MARRIOTT*	*NORTH + EAST EDGE ALONG MARRIOTT*
Integration of Green Infrastructure, Nature-Based Solutions	Possible planters made add some greenery, but likely built shade structures	Potentially need to remove established planters + trees along south edge of Marriott	Potential improvement in terms of shade + greenery
Improved shade areas, reduction in heat island effects	Shade improvement	Planter tree shade may be reduced in near term (planters removed)	Some shade improvement along Marriott Hotel
Preserves or improves cultural and historic resources	No adverse impact; low wall placard may present opp for new signage on historic seawall edges	No adverse impact	No adverse impact

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

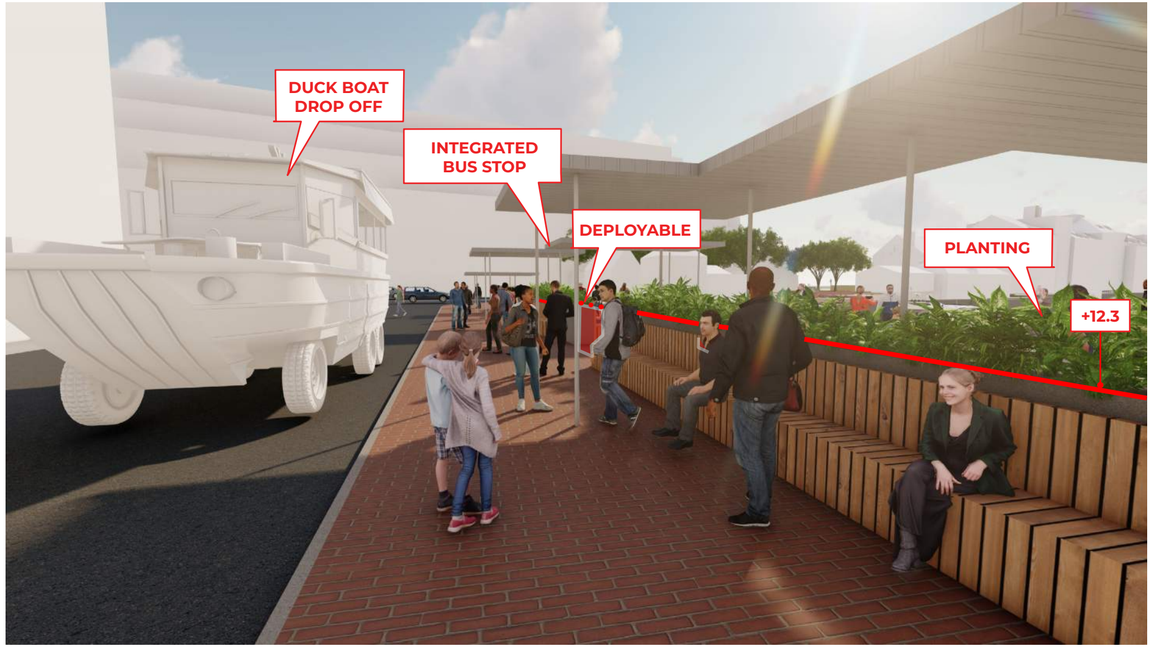


Figure 7-5 - Proposed 2030 South Alignment at Duck Boat Drop Off

DRAFT

DRAFT

CONCEPTUAL 2070 DESIGNS: COMPARATIVE EVALUATION OF ALTERNATIVES

EVALUATION OF LONG-TERM ALTERNATIVE - ACUPUNCTURE

Figure 7-6 -Evaluation of Long-Term Alternative - Acupuncture

The Acupuncture design concept proposes making targeted interventions while building a district-scale protection alignment to elevation 15.0' NAVD88 along Old Atlantic Avenue and the Long Wharf Marriott Hotel building.

It integrates some level of storm protection and dry Harborwalk conditions up to the 2070 Highest Astronomical Tide (HAT) on the wharf, but does not protect the entire perimeter of the wharf from significant coastal storms and surge events.

Unlike the 2030 scheme, the outbuildings and cafe would need to be removed and rebuilt, with the 2070 district-scale flood protection alignment integrated into the new structures.

The Acupuncture scheme retains the floating ADA-compliant ferry ramp on the south side of the wharf following raised Harborwalk upgrades.

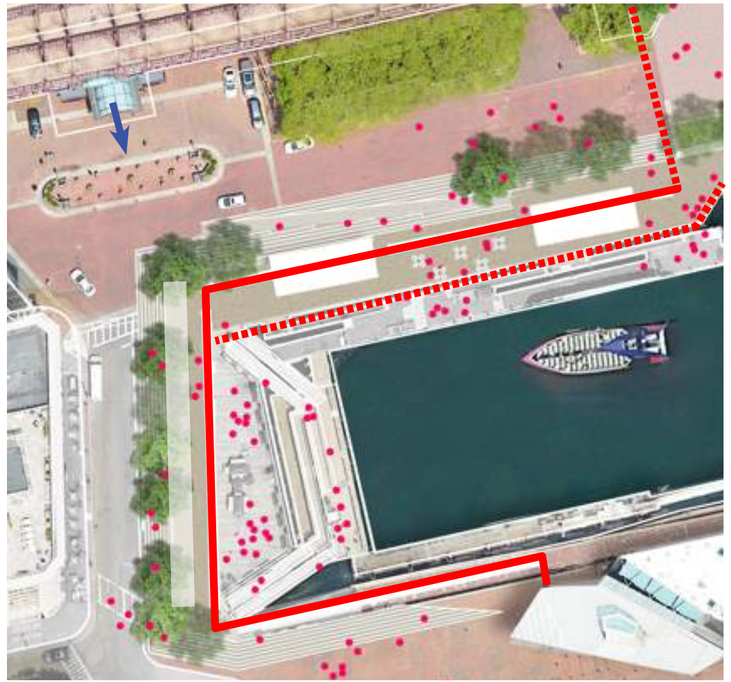


Figure 7-7 -Evaluation of Long-Term Alternative - Acupuncture

DRAFT

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

SECTION A - ALONG OLD ATLANTIC AVENUE

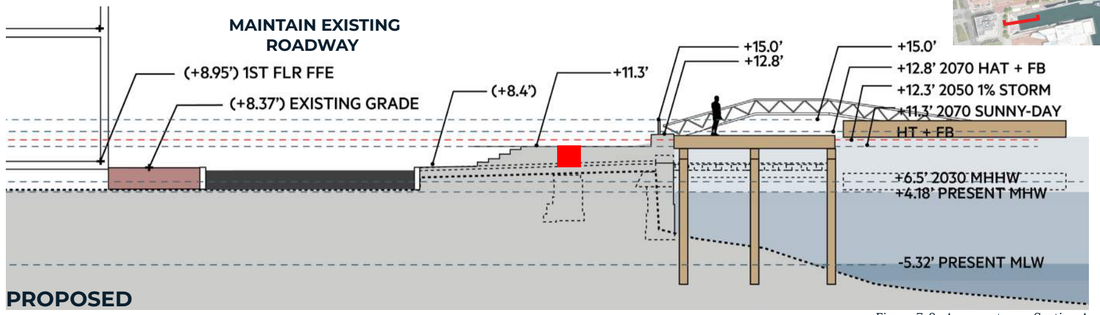


Figure 7-8 -Acupuncture - Section A

SECTION B - ALONG MARRIOTT HOTEL (SOUTH EDGE)

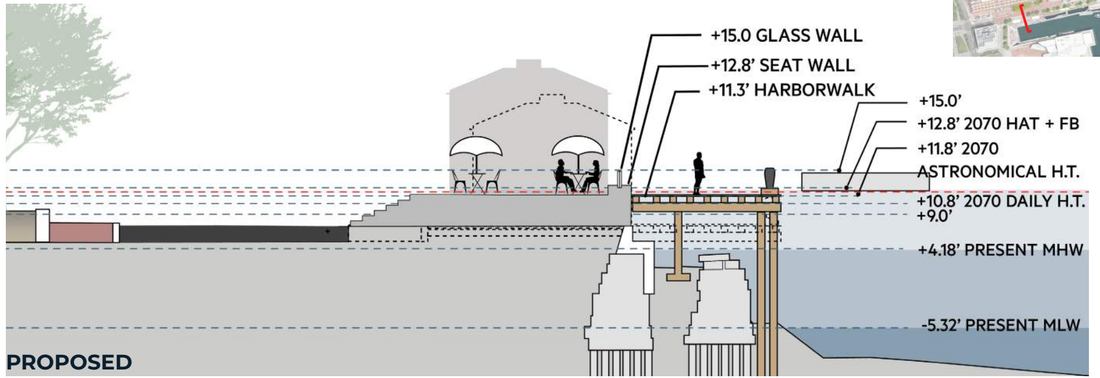


Figure 7-9 -Acupuncture - Section B

DRAFT

ADVANTAGES & OPPORTUNITIES

- *Careful insertion of flood protection into existing conditions*
- *Raise harborwalk above 2070 H.A.T.*
- *More robust planting for shade*
- *Reimagined MBTA egress pavilion at east end*
- *Stepped social edge at west end of wharf*
- *Incorporation of a heavy-duty floodgate across State Street*
- *Chart House parking lot converted to open space*

LIMITATIONS & TRADEOFFS

- *Improves conditions with respect to nuisance flooding from high tides and small storms in the near term, but does not protect Chart House and Customs House from significant coastal storm events; buildings will need to be retrofitted/ adapted to periodic flooding (i.e., "living with water")*
- *The narrow width on the north side of the Custom House Block makes it challenging to be consistent with goals in the Harbor Use Design Guidelines*
- *Water views are lost at first level of buildings on the wharf, particularly on north side of Customs House Block*
- *Waterboat Marina would be removed or relocated for north side marine transit consolidation*

VIEW FROM STATE STREET TO EAST

Figure 7-10 -Acupuncture - View from State Street to East

DRAFT

SECTION D - NORTH OF CUSTOM HOUSE

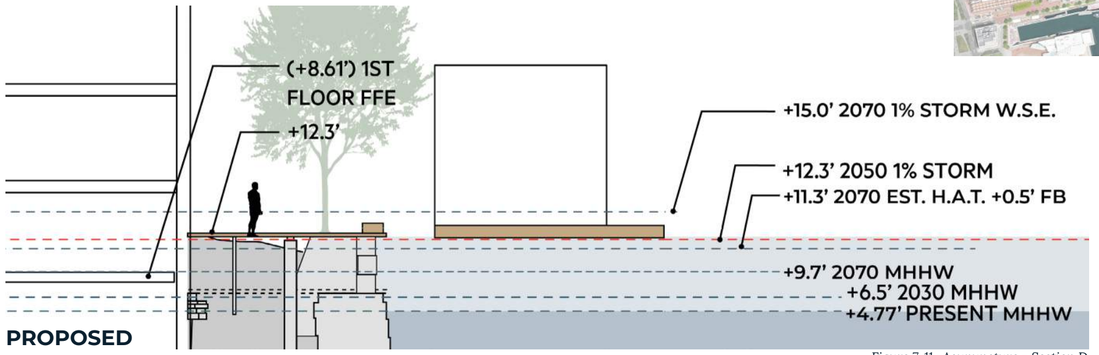


Figure 7-11 -Acupuncture - Section D

SECTION E - NORTH OF CHART HOUSE

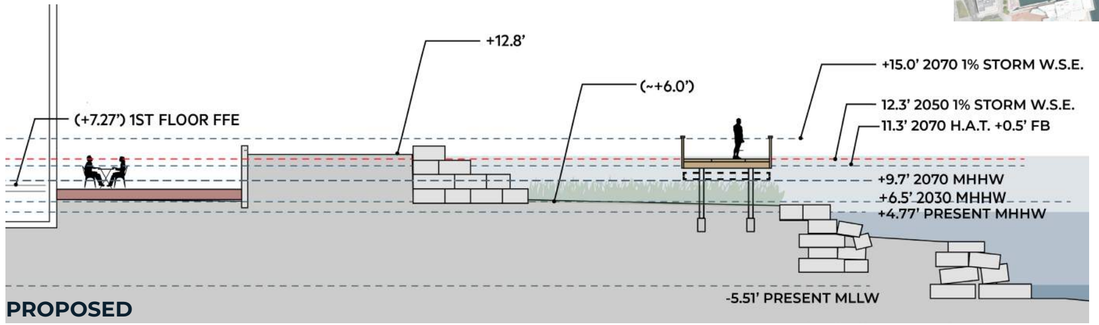


Figure 7-12 -Acupuncture - Section E

DRAFT

KEY DESIGN INCLUSIONS AND CONSIDERATIONS

- *Some narrowing of the roadway (~10-12') is required; design would need to ensure truck turns at Marriott Loading Dock are not impeded*
- *Heavy-duty deployable floodgate needs further design and loading analysis; tie-in not yet integrated on south side of street*
- *Glass seawall feature adds new maintenance considerations*
- *Interior stormwater drainage systems required, even if not building edge higher*
- *Significant phasing of construction, as edge conditions are modified along entire wharf perimeter*
- *If elements are included within Army Corps CSRM program, a flood berm design cannot include trees (USACE policy)*
- *Growing vegetation on north side of Wharf has previously been a challenge (maintenance intensive)*

REMAINING CHALLENGES

- *Modifications in the area with The Sponge feature must consider delineated resource area protections for Rocky Intertidal and Coastal Bank wetland area*
- *North side of Custom House is very narrow Harbor Walk; may be worth looking at concept of extending bulkhead into the harbor to provide more room for the Harborwalk if marine transportation improvment design advances*

VIEW AT NORTH SIDE OF WHARF LOOKING EAST

Figure 7-13 -Acupuncture - View at North Side of Wharf Looking East

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

FLOOD PROTECTION EFFECTIVENESS	ALONG OLD ATLANTIC AVE.	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Reduction in flood extent during storms (overall)	Robust flood protection for storm surge flooding to 2070	Robust on south side of wharf; DFE tie-in to Columbus Park still needs coordination. Exist high point in park is below 2070 1% DFE of El. 15.0 NAVD88	Some flood protection for storm surge but limited beyond 2050	Some flood protection for storm surge but limited beyond 2050
Reduction in flood frequency (post-implementation impacts to right of way/ Harborwalk)	Robust flood protection for tidal flooding to 2070 HAT	Robust flood protection for tidal flooding to 2070 HAT	Robust flood protection for tidal flooding to 2070 HAT	Robust flood protection for tidal flooding to 2070 HAT
Avoided loss/damages (based on existing built environment)	Mitigates key flood pathways to Downtown	Mitigates key flood pathway on south side; rebuilds outbuildings to higher elevation; Columbus Park long-term DFE tie to be coordinated	Reduces but does not elminate risk of coastal storm damages to Chart and Custom House Block	Reduces but does not eliminate risk of coastal storm damages to Chart and Custom House Block
Passivity and reliability (quantity of deployables)	Fully passive protection to 2070 1% event	Large flood gate across State Street	Chart and Custom House still have to self-protect beyond 12.3' NAVD88	Chart and Custom House still have to self-protect beyond 12.3' NAVD88

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

FEASIBILITY (AFFORDABILITY, CONSTRUCTABILITY, & PERMITTING CONSIDERATIONS)	ALONG OLD ATLANTIC AVE.	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Affordability: Cost of Construction	Reconstruction of public ROW can mostly be done from land side	Significant wharf edge work and flood gate and flood berm	East SW tank; considerable excavation / fill; extensive perimeter edge work	West SW tank; considerable excavation / fill; extensive perimeter edge work
Affordability: Mid- to Long-Term Operations and Maintenance	Glass seawall component may require regular maintenance and cleaning	Large flood gate requires manpower / specialized O&M	Chart and Custom House may still rely on active (deployable) floodproofing	Chart and Custom House may still rely on active (deployable) floodproofing
Permitting Complexity / Risk	Work in public ROW	Any pilings above water; modification of curb lines (City GI policy), flood berm; some FEMA VE zone considerations on South	WPA Resource Areas (rocky intertidal / coastal bank)	Waterfront permitting required, MBTA ZOI
Constructability	Significant work, but not overly-complex	Significant seawall edge work, possibly some new pilings	Very tight north of Custom (need to access via water side)	Significant seawall edge work, some above tunnel/ZOI
Disturbance of Existing Infrastructure (structural decks, seawalls and critical uses during construction)	Some seawall edge work, but not outboard into water	Seawall edges near Columbus Park to be rebuilt	Modifying Harbor Walk area north of Custom House; tight against building	Entire wharf perimeter edge would be rebuilt
Disturbance to Harborwalk, water-dependent uses and commercial activity during construction	Construction will disturb Harbor Walk, but major impacts to water-dependent uses may be avoided	Rebuilding edge will require closure or relocation of The Landing cafe / restaurant and outbuildings	Waterboat Marina / watersheet and Haborwalk north of Custom House heavily impacted	Rebuilding edge will require relocation of water-dependent uses (phasing plan)
Is Right-of Way available to do the work without redirecting pedestrian or vehicular site flow??	Would remove access to entire public ROW to east of Old Atlantic during construction	Work can be performed with minimal disturbance to roadway	Harborwalk foot traffic must be diverted from area north of Custom House	No adverse impacts in this area, work is mostly along edges with space on interior

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

2070: CONCEPT OPTION 1- ACUPUNCTURE

DESIGN LIFE + ADAPTABILITY	ALONG OLD ATLANTIC AVE.	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Adaptability/Flexibility (can specific elements be retrofit in-place to an elevation higher than 2030 or 2070 D.F.E.?)	Modular elements could go higher in future, or additional elevation via fill	May require re-design to get to higher levels of flood protection; flanking possible via Columbus Park above 12.3' NAVD88	Modular elements could go higher in future, or additional elevation via fill	Modular elements could go higher in future along edges (some limitations)
District-Scale Resiliency Compatibility/ Integration with Abutters (i.e., NEAQ, India Row, Columbus Park)	Can be adapted to integrate with NEAQ Master Plan and India Row flood pathway mitigation	Opportunity for integration with Columbus Park and North End flood pathway mitigation	N/A	N/A
Compatibility with existing property-specific plans and land use; consistency with Waterfront Use guidelines	Provides opportunity for more consistent material transitions to NEAQ	Provides opportunity for more consistent material transitions to Columbus Park and State Street	Still very narrow for Harbor Walk	

QUALITY OF PUBLIC REALM AND PUBLIC HEALTH BENEFITS	ALONG OLD ATLANTIC AVE.	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Impacts to Harborwalk and other public spaces	Elevated Harbor Walk requires steps reducing overall width	New berm and Harborwalk upgrades	New boardwalk, maintains perimeter Harbor Walk	Raised perimeter edge creates a small enclosed plaza
Overall quality of public realm (materials, social/urban experience), per design team self-evaluation	Requires steps in high foot traffic area	Raised roadway and improved Harborwalk	New amenity 'The Sponge" / seating	No major adverse impacts
Impacts to Views	Views from 255 State St marginally impacted	Views marginally impacted from Marriott Hotel south entrance	Views marginally impacted on north side of Custom House first floor	No adverse impact

DRAFT

UNIVERSAL ACCESS AND CIRCULATION, INCLUDING WATERFRONT AND WATER-DEPENDENT USES	ALONG OLD ATLANTIC AVE	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Impacts to emergency access	No adverse impact	No adverse impact	No adverse impact	No adverse impact
Mid- to long-range impact to water-dependent uses and businesses	No adverse impact	Sustains or improves water-adjacent commercial interests	Improved outcomes possible for water-dependent uses compared to current conditions	No adverse impact
Improved accessibility to water? (i.e., get-downs to water)	Floating ADA ramp to ferry would move from this location; with rebuilt edge / glass floodwall no 'get-down' to water on this side	Built up edge to 12.3' NAVD88 may make water feel further, especially in near-term	New feature, "The Sponge", allows more direct access to get down to water	Similar to present condition, but not as interactive as Blue-Green edge

ENVIRONMENTAL AND CULTURAL / HISTORIC	ALONG OLD ATLANTIC AVE	INBOARD EDGES ALONG MARRIOTT	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Integration of Green Infrastructure, Nature-Based Solutions	Space limited for opportunities for new trees; edge not suitable for living seawall	Space limited for new trees; possible suitable for living seawalls (north)	New feature, "The Sponge", and opportunities for living seawalls	Similar to present condition, hardened edge; edges not suitable for living seawalls
Improved shade areas, reduction in heat island effects	Some opportunities for shade structures	Some tree removal likely required for large flood gate enclosure	Some opportunities for shade structures	More space for new trees or shade structures
Preserves or improves cultural and historic resources	No major adverse impacts; historic seawall already not visible today	Seawall "layering" requires design considerations / tradeoffs	Custom House split-level entry and basement modifications	Chart House requires additional storm floodproofing or raised structure

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

EVALUATION OF LONG-TERM ALTERNATIVE - BIG SPLASH

Figure 7-14 -Big Splash - Plan

The Big Splash concept design is a bolder re-imagining of Long Wharf, including more diverse public experiences, new open space amenities, and viewsheds.

The proposed terraced cove on the south side of the wharf would replace the floating ADA ferry ramp structure, accompanying a consolidation of maritime transit operations to the north side. A new terraced park, landscaped berm and plaza take the place of the Chart House parking lot.

This concept extends the El. 15.0' NAVD88 longer-term flood protection solid red line along the entire perimeter of the wharf, effectively floodproofing the wharf against all but the most extreme coastal surge events by 2070. This effort is vastly more complex in terms of cost, engineering design, and constructability, requiring more load-balancing above the Blue Line tunnel.

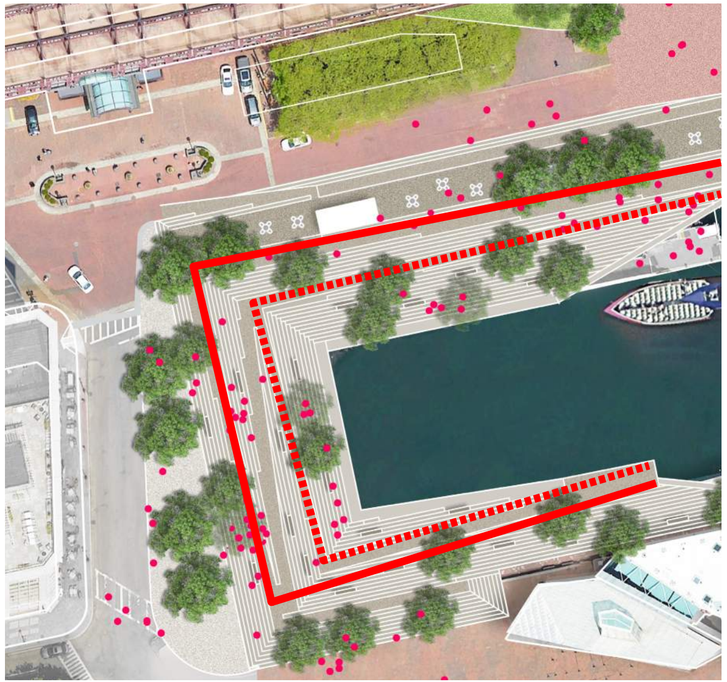


Figure 7-15 -Big Splash - South Area Detail

DRAFT

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

SECTION A - ALONG OLD ATLANTIC AVE.

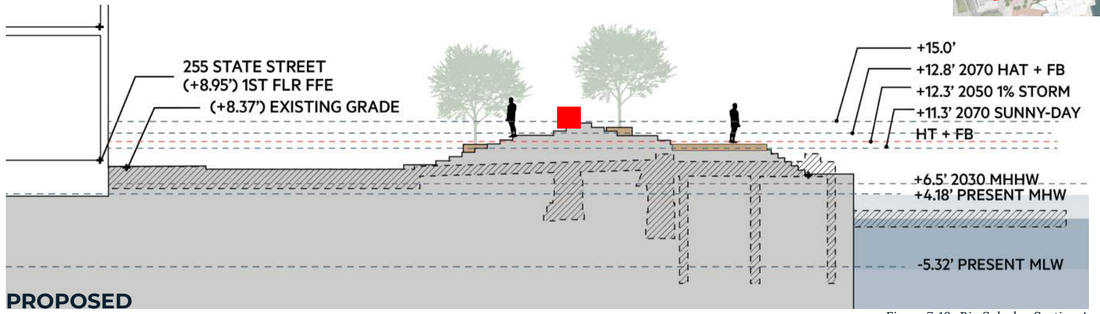


Figure 7-16 -Big Splash - Section A

SECTION B - ALONG MARRIOTT HOTEL (SOUTH EDGE)

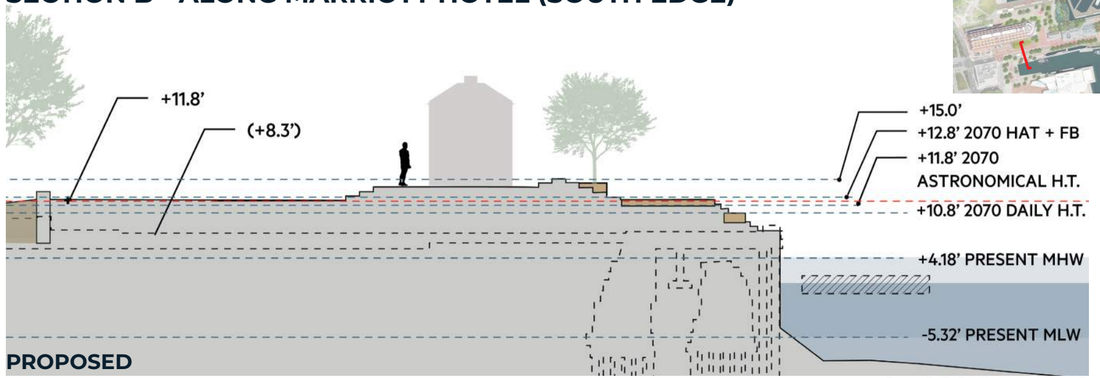


Figure 7-17 -Big Splash - Section B

DRAFT

ADVANTAGES AND OPPORTUNITIES

- *Long-term focus, upgrading all utilities, maritime transportation infrastructure and public realm and social experience*
- *Raise entire perimeter of wharf and adjacent property tie-in's to El. 15.0' NAVD88*
- *New terraced plazas on both north and south sides invite people to the water*
- *Split-level entry on south side of Custom House has opportunities for greater activation and commercial use*
- *Elevate Chart House and possibly changes use for public ticketing / restroom facility*

LIMITATIONS & TRADEOFFS

- *More extensive geotechnical and structural engineering effort*
- *Bolder interventions have tradeoffs for historic layering, aesthetics*
- *Segments further towards the end of wharf may be elevated far above water, especially at low tide*
- *Significant construction phasing duration, with portions of wharf and Harborwalk inaccessible on a rotating basis*
- *Waterboat Marina would be removed or relocated for north side marine transit consolidation*
- *Water views are lost at first level of buildings on the wharf, particularly on north side of Custom House Block; consider glass panels so lower floors get light*

VIEW FROM OLD ATLANTIC AVENUE LOOKING EAST

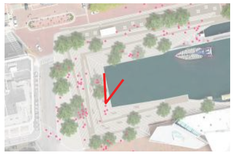


Figure 7-18 -Big Splash - View from Old Atlantic Avenue to the East

DRAFT

SECTION C - SOUTH OF CUSTOM HOUSE

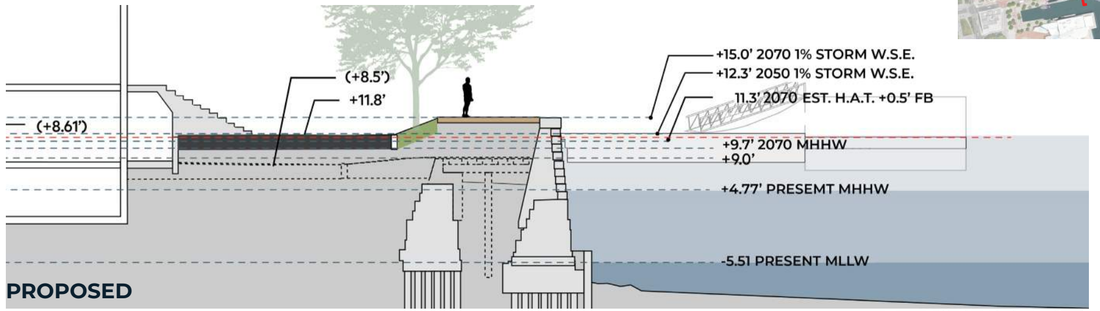


Figure 7-19 -Big Splash - Section C

SECTION D - NORTH OF CUSTOM HOUSE

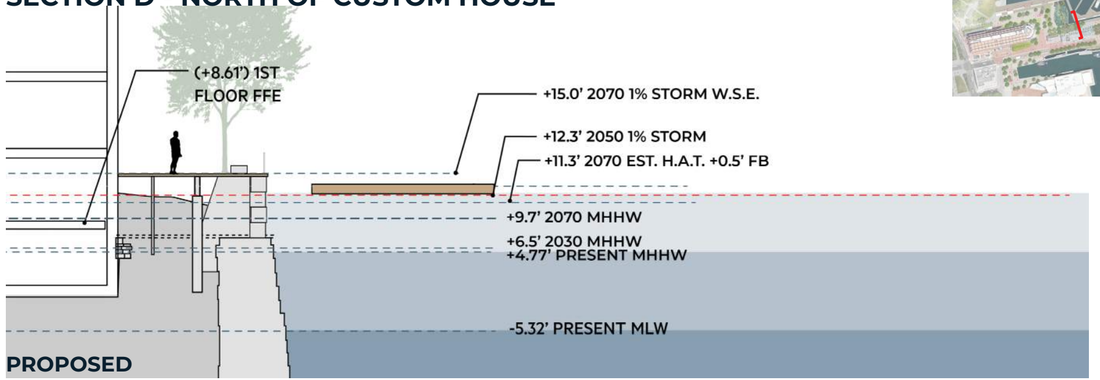


Figure 7-20 -Big Splash - Section D

DRAFT

SECTION E - NORTH OF CHART HOUSE (TOWARDS LONG WHARF MARRIOTT)

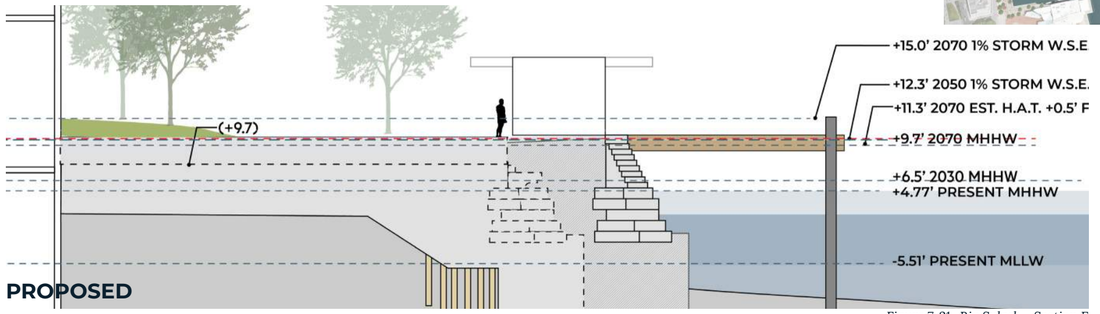


Figure 7-21 -Big Splash - Section E

KEY DESIGN INCLUSIONS & CONSIDERATIONS

- *ADA accessible / vehicular drop off point for access to new consolidate maritime transit hub*
- *Blue-Green Edge at east end of wharf and living seawalls increase visibility of nature-based and ecological design in highly active waterfront environment and provide wave attenuation*
- *Reimagined MBTA egress pavilion*
- *New ferry docking and queuing areas at North Side to replace Waterboat Marina providing ADA-compliant access and shade*
- *Existing Chart House restaurant use is a significant to local residential community stakeholders*
- *The ratio of space needs (between BHCC, Eversource, vehicular dropoff, trash and storage) should be revisited*

REMAINING CHALLENGES

- *Space constraints at Old Atlantic Avenue while retaining vehicle flow (even if converted to one way street)*
- *Tie-in to Columbus Park requires coordination with Boston Parks, as the district-scale DFE 15.0' NAVD88 is above the existing high point within the park*
- *Modifications north of Chart House must consider delineated resource area protections for Rocky Intertidal and Coastal Bank wetland area*
- *Some narrowing of the roadway (~10-12') is required; design would need to ensure truck turns at Marriott Loading Dock are not impeded*

DRAFT

FLOOD PROTECTION EFFECTIVENESS	ALONG OLD ATLANTIC AVE. + TERRACED COVE	INBOARD EDGES ALONG MARRIOTT AND STATE ST.	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Reduction in flood extent during storms (overall)	Robust flood protection for storm surge flooding to 2070	Robust on south side of wharf; DFE tie-in to Columbus Park still needs coordination. Exist high point in park is below 2070 1% DFE 15.0' NAVD88	Robust flood protection for storm surge flooding to 2070	Robust flood protection for storm surge flooding to 2070; some wave overwash possible in 2070 1% event
Reduction in flood frequency (post-implementation impacts to right of way/ Harborwalk)	Robust flood protection for tidal flooding to 2070 HAT	Robust flood protection for tidal flooding to 2070 HAT	Robust flood protection for tidal flooding to 2070 HAT	Adds protection; maintains floodable lower plaza area (similar to today's King Tide educational programming)
Avoided loss/damages (based on existing built environment)	Mitigates key flood pathways to Downtown	Mitigates key flood pathway on south side; rebuilds outbuildings to higher elevation; Columbus Park long-term DFE tie to be coordinated	Reduces risk of coastal storm damages to Chart House and Custom House Block	Reduces risk of coastal storm damages to Chart House and Custom House Block
Passivity and reliability (magnitude of deployables)	Fully passive protection to 2070 1% event	No deployables on south; tie-in to Columbus can potentially be achieved w/o deployables	Fully passive protection to 2070 1% event	Fully passive protection to 2070 1% event

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

FEASIBILITY (AFFORDABILITY, CONSTRUCTABILITY & PERMITTING CONSIDERATIONS)	ALONG OLD ATLANTIC AVE. + TERRACED COVE	INBOARD EDGES ALONG MARRIOTT AND STATE ST.	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Affordability: Cost of Construction	Fill above existing grade; Harborwalk upgrades	Large amount of excavation / fill	East SW tank; large amount of excavation / fill; extensive perimeter edge work	West SW tank; large amount of excavation / fill; extensive perimeter edge work
Affordability: Mid- to Long-Term Operations and Maintenance	A new public realm amenity that may require higher maintenance/cleaning frequency (such as glass seawalls)	No active (deployable) flood measures; but new public realm amenities may require higher maintenance/cleaning frequency	No active (deployable) flood measures; more tree maintenance	No active (deployable) flood measures; more tree maintenance
Permitting Complexity / Risk	Any outboard expansion into water is more significant permitting effort	Any pilings above water; some FEMA VE zone considerations on South	WPA Resource Areas (rocky intertidal / coastal bank)	Waterfront permitting required, MBTA ZOI
Constructability	Large reconstruction of waterfront; can mostly be done from land side	Large reconstruction of waterfront; edges, accessible without major demo	Very challenging to raise grade without outboard expansion	Large reconstruction of waterfront; edges, accessible without major demo
Disturbance of Existing Infrastructure (structural decks, seawalls and critical uses during construction)	Entire waterfront edge would be rebuilt	Seawall edges near Columbus Park to be rebuilt	Modifying Harbor Walk area north of Custom House; tight against building	Entire wharf perimeter edge would be rebuilt
Disturbance to Harborwalk, water-dependent uses and commercial activity during construction	Phasing required to stage ferries to north side; commercial uses may have to relocate for a season	Work can be phased so that portions of Harbor Walk can be closed as work is completed	Waterboat Marina removed Harborwalk north of Custom House Block heavily impacted	Work can be phased so that portions of Harborwalk can be closed as work is completed
Is Right-of Way available to do the work without redirecting pedestrian or vehicular site flow?	Would remove access to entire public ROW to east of Old Atlantic Avenue during construction	Roadway work on south would require phasing	Harborwalk foot traffic must be diverted from area north of Custom House	Roadway work south of Chart House and Custom House Block would require phasing

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

DESIGN LIFE + ADAPTABILITY	ALONG OLD ATLANTIC AVE. + TERRACED COVE	INBOARD EDGES ALONG MARRIOTT AND STATE ST.	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Adaptability/Flexibility (can specific elements be retrofit in-place to an elevation higher than 2030 or 2070 D.F.E.?)	Modular elements could go higher in future	Potentially with modular/deployable or lightweight additions; additional fill /roadway raising may present challenges	Modular elements could go higher in future	Possible at edges; additional fill / plaza raising may present challenges
District-Scale Resiliency Compatibility/ Integration with Abutters (i.e., NEAQ, India Row, Columbus Park)	Can be adapted to integrate with NEAQ Master Plan and India Row flood pathway mitigation	Opportunity for integration with Columbus Park and North End flood pathway mitigation	N/A	N/A
Compatibility with existing property-specific plans and land use; consistency with Waterfront Use guidelines	Large investment, but more consistent with adjacent area	Provides opportunity for more consistent material transitions to Columbus Park and State Street	Still very narrow for Harborwalk	Potential for further activation with split-level entry to Custom House Block

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

QUALITY OF PUBLIC REALM AND PUBLIC HEALTH BENEFITS	ALONG OLD ATLANTIC AVE. + TERRACED COVE	INBOARD EDGES ALONG MARRIOTT AND STATE ST.	NORTH SIDE OF WHARF AND NEW PUBLIC SPACE	SOUTH SIDE OF WHARF + END OF WHARF PLAZA
Impacts to Harborwalk and other public spaces	Upgraded Harborwalk; more space without ferry ADA floating ramp	Upgraded, elevated Harborwalk	Upgraded Harborwalk; new public open space	Raised perimeter edge creates a larger 'enclosed' plaza
Overall quality of public realm (materials, social/urban experience), per design team self-evaluation	Wholly new social edge experience with terraced cove	Berm along Marriott Hotel north edge; opportunities for more consistent Harborwalk design	New, terraced park elevated above district-scale DFE	Elevated edge Harborwalk with new views of plaza and back toward Old State House
Impacts to Views	Grade would be raised much higher; no water view from Legal Seafoods	No adverse impact	Larger impacts to Custom House Block views (i.e., buried first level)	Negative impacts to Custom House Block; but new views of plaza and back toward Old State House

No adverse impact, or improvement upon existing condition

Some impact, or complexities/ tradeoffs, compared to existing condition

Adverse impact(s) or use constraints compared to existing condition

DRAFT

2070: CONCEPT OPTION 2- BIG SPLASH

UNIVERSAL ACCESS AND CIRCULATION, INCLUDING WATERFRONT AND WATER-DEPENDENT USES	*ALONG OLD ATLANTIC AVE. + TERRACED COVE*	*INBOARD EDGES ALONG MARRIOTT AND STATE ST.*	*NORTH SIDE OF WHARF AND NEW PUBLIC SPACE*	*SOUTH SIDE OF WHARF + END OF WHARF PLAZA*
Impacts to emergency access	No adverse impact	No adverse impact	No adverse impact	No adverse impact, as long as construction phased appropriately
Mid- to long-range impact to water-dependent uses and businesses	Possible new watersheet use(s)	Sustains or improves water-adjacent commercial interests	Improved outcomes possible for water-dependent uses compared to current conditions	Potential for further activation with split-level entry to Custom House Block
Improved accessibility to water? (i.e., get-downs to water)	New terraced cove amenity allows better direct access to water at Old Atlantic Avenue	Built up edge to 15.0' NAVD88 may make water feel further, especially at low tide	Easier to get down to the water than present day condition with marina	New feature, Blue-Green edge creates new interactions with water and wave attenuation

ENVIRONMENTAL AND CULTURAL / HISTORIC	*ALONG OLD ATLANTIC AVE. + TERRACED COVE*	*INBOARD EDGES ALONG MARRIOTT AND STATE ST..*	*NORTH SIDE OF WHARF AND NEW PUBLIC SPACE*	*SOUTH SIDE OF WHARF + END OF WHARF PLAZA*
Integration of Green Infrastructure, Nature-Based Solutions	New terraced cove is mostly new paving; area less suitable for living seawall panels	New planted berm; possible suitable locations for living seawalls	Significant new green space, lawn; area potentially suitable for living seawalls	Blue-Green edge concept
Improved shade areas, reduction in heat island effects	Potential for trees within terraced steps	Potential for trees within landscape berm	New tree canopy along new open space; opportunities for new shade structures north of Custom House Block	Some opportunity for new tree canopy at part of South raised edge
Preserves or improves cultural and historic resources	No major adverse impacts; historic seawall already not visible today	Seawall "layering" requires design considerations / tradeoffs	Custom House split-level entry and basement modifications	Chart House is elevated; end of wharf heavily modified in appearance

DRAFT

COST ESTIMATION

ORDER-OF-MAGNITUDE COST ESTIMATES

OVERVIEW

Order-of magnitude project cost estimates were developed for the 2030 Short-Term Scheme and the 2070 Acupuncture and Big Splash Schemes. Although It is difficult to develop accurate construction costs at such an early stage in the design process because there are so many design elements and timing issues that have not been finalized, it is important to develop costs with the best information available so that the Boston Planning Department can apply for grants develop future Capital Improvement Plan requests to fund the project.

COST BREAKDOWNS

Cost estimates are based on the following parameters:

- Construction costs are based on 2025 dollars. For budgeting purposes, construction costs need to be projected to the actual year that the project is anticipated to start construction taking into account market trends and projections occurring at the time the escalation is being calculated. The project costs do take into account phasing over the assumed 5-year construction period for this project by escalating the 2025 base costs to the year in the construction cycle at which they are anticipated to be actually performed. The escalation rate used in these estimates is 5%/year. The costs for construction of the 2030 Short-Term Scheme are assumed to occur within one construction year and are therefore not escalated.
- Construction costs are the costs that a contractor would bid the job for. The base construction costs shown represent the cost that a contractor would typically incur to perform the work. The Total Construction Costs shown, in 2025 dollars, include a 25% design contingency to cover work that could not be estimated at this time as well as a 20% mark-up for contractor overhead, profit, insurance and bid bonds.
- Total Project Costs are the total cost that the City of Boston will incur to design, permit, construct and manage the project. The Total Project Cost includes the Total Construction Cost described above plus 30% for Project “Soft” Costs and 10% for City of Boston project contingencies. Project ”Soft” Costs includes consultant design, permitting and construction administration fees, City of Boston costs for project management, legal services, permitting costs, bidding, testing during construction, resident engineering, grant application, etc.
- A detailed breakdown of the construction cost estimates for the 2030 Short-Term Scheme and the Acupuncture are included in Appendix C. The costs for the Big Splash Scheme were not estimated in detail at this time. Instead, the Acupuncture costs were escalated by 22%, which represents the percent increase in DFE protection levels of El. 15.0 NAVD88 for the Big Splash scheme versus El. 12.3 NAVD88 for the Acupuncture scheme (15.0/12.3 = 1.22). Although this approach is not 100% accurate, it is assumed to be suitable for estimating pruposes at this stage of conceptual design. The costs of replacing the Waterboat Marina with new ferry transit docks on the north side are not escalated because the work is essentially the same for both schemes. Also, the cost for raising the Chart House is only included in the Big Splash scheme, so it is not escalated.
- A 20% cost range is included in the cost summary tables below to reflect the uncertainty of construction costs at this stage in the design process.

DRAFT

PROJECT COST SUMMARIES

2030 Short-Term Scheme

Table 7-1 shows the order-of-magnitude construction and project costs for the 2030 Short-Term scheme. Costs on the north side are broken down into costs related to the Marriott Hotel area and costs associated with work in Columbus Park. We understand that the Boston Parks Department is undertaking a design project to make Columbus Park more resilient to flooding. The can included in their project the passive flood walls and drop-in deployable flood barriers shown in the is scheme.

	2030 SHORT-TERM SCHEME (RANGE)		
Construction Costs	Low	**Average**	High
Old Atlantic Avenue Area	$ 4,138,000	**$ 4,598,000**	$ 5,058,000
South Side	$ 6,204,000	**$ 6,893,000**	$ 7,582,000
North Side			
Marriott Hotel Related	$ 1,256,000	**$ 1,396,000**	$ 1,536,000
Columbus Park Related	$ 674,000	**$ 749,000**	$ 824,000
CONSTRUCTION COSTS	**$ 12,272,000**	**$ 13,636,000**	**$ 15,000,000**
Project "Soft" Costs (30%)	$ 3,682,000	**$ 4,091,000**	$ 4,500,000
BPDA Contingency (10%)	$ 1,228,000	**$ 1,364,000**	$ 1,500,000
TOTAL PROJECT COST	**$ 17,182,000**	**$ 19,091,000**	**$ 21,000,000**

Table 7-1 -Summary of Construction and Project Costs for 2030 Short-Term Scheme

2070 Long-Term Acupuncture and Big Splash Schemes

Table 7-2 shows the order-of-magnitude construction and project costs for the 2070 Long-Term Acupuncture and Big Splash Schemes.

	2070 ACUPUNTURE (RANGE)			2070 BIG SPLASH (RANGE)		
Construction Costs	Low	**Average**	High	Low	**Average**	High
- North Marina Transit Work	$ 12,382,000	**$ 13,758,000**	$ 15,134,000	$ 12,382,000	**$ 13,758,000**	$ 15,134,000
- Resiliency Work	$ 79,184,000	**$ 87,982,000**	$ 96,780,000	$ 99,359,000	**$ 110,399,000**	$ 121,439,000
CONSTRUCTION COSTS	**$ 91,566,000**	**$ 101,740,000**	**$ 111,914,000**	**$ 111,741,000**	**$ 124,157,000**	**$ 136,573,000**
Project "Soft" Costs (30%)	$ 27,470,000	**$ 30,523,000**	$ 33,575,000	$ 33,522,000	**$ 37,247,000**	$ 40,972,000
BPDA Contingency (10%)	$ 9,157,000	**$ 10,174,000**	$ 11,191,000	$ 11,174,000	**$ 12,416,000**	$ 13,658,000
TOTAL PROJECT COST	**$ 128,193,000**	**$ 142,437,000**	**$ 156,680,000**	**$ 156,437,000**	**$ 173,820,000**	**$ 191,203,000**

Table 7-2 - Summary of Construction and Project Costs for 2030 Short-Term Scheme

DRAFT

8- ADAPTATION DESIGN GUIDELINES

ADAPTATION DESIGN GUIDELINES

The City of Boston has prepared Flood Adaptation Guidelines for the Long Wharf area to advise property owners of potential measures to reduce risk of flood damage, encourage proactive safety precautions, encourage safeguarding their properties and interests against potential disruptions, and proactively implement resiliency measures ahead of future flood events. These guidelines are informed by the site's flood vulnerability assessment and are intended to support near- and long-term decision-making.

BACKGROUND

Conceptual strategies have been developed to address potential coastal flooding vulnerabilities at Long Wharf for the 2030 and 2070 time frames as part of the Flood Resilience Mitigation and Feasibility Study for Long Wharf project. Some of the privately-owned infrastructure on Long Wharf, including the Custom House Block, Chart House and various ancillary ticket booth facilities, are not fully protected from flooding under the 2030 and Acupuncture conceptual flood protection strategies.

The intent of this document is to provide a resource for the owners of privately-owned infrastructure to be able to construct flood adaptation measures to protect their properties against coastal flooding events.

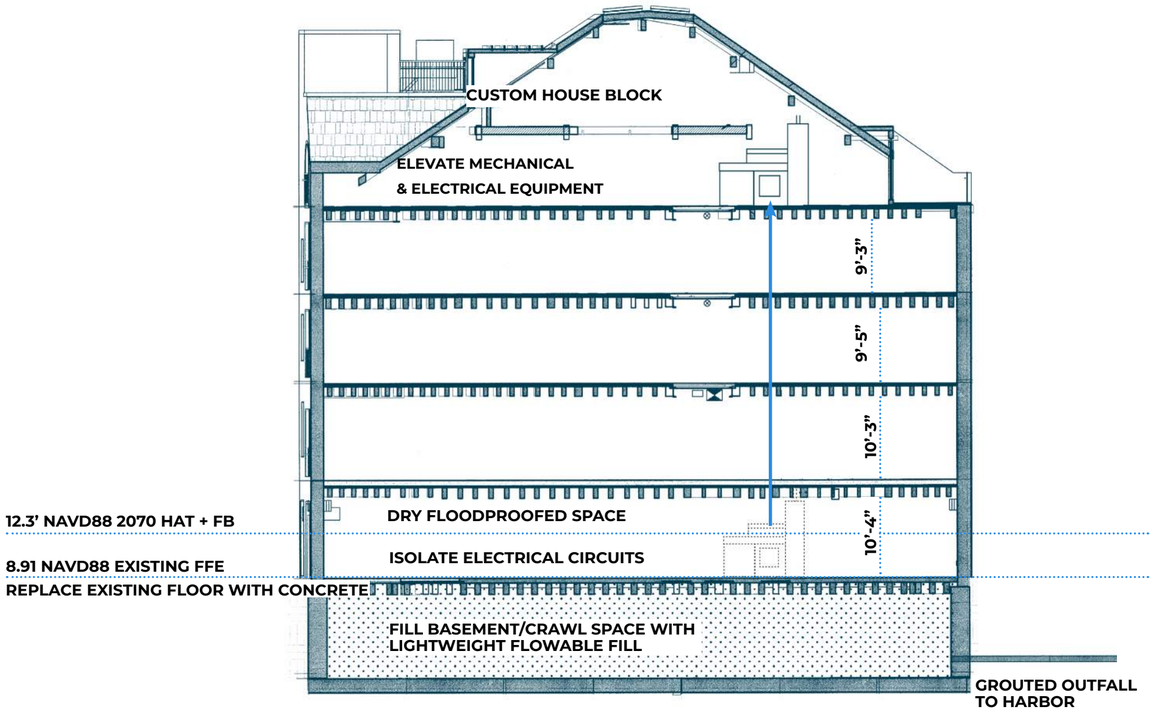
CONSIDERATIONS FOR APPLICATION OF FLOOD ADAPTATION TREATMENTS

For any flood adaptation treatment, a property owner should consider the following attributes when evaluating, installing, or deploying a flood adaptation treatment(s).

- Safety and accessibility
- Effects on historic character
- Affordability and economic costs
- Technical and design limitations
- Efficacy and sustainability
- Operations, maintenance, and logistics
- Storage
- Service life
- Resilience benefits
- Building and site characteristics
- Flood characteristics
- Alignment with neighborhood, City, and State goals and regulations

A more detailed analysis of potential adaptation measures is provided in Appendix D.

Appendix D contains general recommendations for flood adaptation treatments, flood adaptation guidelines specific to the Custom House Block building, flood adaptation guidelines specific to the Chart House, and flood adaptation guidelines specific to smaller ancillary exterior infrastructure such as ticket booths.



DRAFT

DRAFT

9- PROJECT RECOMMENDATIONS

NEXT STEPS

The Long Wharf Flood Resilience Mitigation Planning & Feasibility Study studied and has now advanced multiple potential design options, focused on 2030- and 2070-time horizons for potential implementation. As the project evolved, a decision was made not to select a preferred option for final design at this juncture, reflecting the need for additional analysis of future phasing and funding considerations as well as more stakeholder input.

One particularly important finding of the current project was that a near-term project, focused on 2030 implementation and fully-contained within the defined project area, would not itself be independently effective at mitigating coastal flooding at a district scale beyond a 20-year event due to other flood pathways north and south of the project area.

Another key finding was the length of construction time required to implement either of the 2070 long-term Acupuncture or Big Splash schemes. It is important to consider how a project of this magnitude can feasibly be constructed without completely shutting down operations at the wharf, putting tenants out of business or greatly impacting ferry transit services. Either of the long-term schemes will require a minimum of 5-years of phased winter and summer construction to complete construction due to the amount of seawall restoration/raising that can realistically be achieved within a winter season.

While the 2030 Short-Term Scheme is not an independently cost-effective long-term strategy to provide district-wide flood protection for Downtown Boston and the Wharf District, it would afford significant flood protection beyond current conditions, effectively floodproofing this area up to the past storm-of-record (9.66' NAVD88), which saw floodwaters entering the Blue Line Aquarium Station. **It is recommended that the 2030 Short-Term Scheme be considered as a component piece of a larger district-scale project.** Such a project would include mitigating flooding from the North End waterfront and East India Row to a similar 2030 D.F.E. Taken together, such actions would mitigate the most impactful flooding – including interior flood pathways to the Central Artery Tunnel and protect a significant amount of critical transportation infrastructure and City, commercial, and institutional property. **It is recommended that a follow-on district-scale study of the Downtown, Wharf District, and North End coastal flood pathways be performed, extending the prior project north up to Sargent's Wharf in the North End and south to East India Row (just south of Central Wharf).**

It is also recommended that the 'Acupuncture' and 'Big Splash' 2070 Long-Term alternatives for Long Wharf be presented to the U.S. Army Corps of Engineers for discussion and possible inclusion into the Boston Coastal Storm Risk Management Study (CSRM) partnership with the City. Specifically, the 2070-focused 'Acupuncture' and 'Big Splash' schemes may be best qualify as a "Locally Preferred Project (LPP)" within the study's Tentatively Selected Plan (TSP). Based on the current timeline for the Boston CSRM study, some of the key decision-making for inclusion of LPP's will occur by February 2026.

NEXT STEPS FOR DISTRICT-SCALE STUDY

Building upon the flood risk analysis in Section 3 and the order-of-magnitude cost estimate for the 2030 Short-Term Scheme in Section 7, it is recommended that the following actions be undertaken as part of a follow-on district-scale study:

- Apply the same design approach as the 2030 Scheme for Long Wharf - develop similar conceptual design strategies for the North End waterfront and East India Row are, targeting a district-scale D.F.E. of 12.3' NAVD88.

- Study the quantitative and qualitative benefits associated with the 2030 Scheme (cumulatively, and at each waterfront segment), including:
  - A refined estimate of avoided damages to buildings and/or avoided losses to businesses
  - The consequences of roadway inundation for surface transportation – not just from event-based
  - impacts from large storms - but also the cumulative impacts of more frequent high-tide flooding impacting Atlantic Avenue., Old Atlantic Avenue, State Street and East India Row, which may experience monthly high tide
  - Flooding by 2050 or sooner.
  - A calculation of the monetary benefits at the largest coastal flood event
  - for which the design is effective (for instance, sub-modeling indicates this is the 2030 25-year event at Long Wharf)
  - a "distributed benefits" analysis that considers how the benefits of the strategies are distributed across different groups of people, as well as the general public versus private stakeholders (if each segment were completed as a stand- alone project)
  - As part of district-scale study, conduct additional outreach with entities critical to funding adaptation concepts at each segment. Given the flood risks to the Wharf District and Downtown communities' private stakeholders and commercial enterprises, it is important to consider blended funding strategies beyond City funds and local/state/ federal grants. It is recommended that this study explore the feasibility of a Shoreline Protection District, or other means of neighborhood-specific or district-scale financing (e.g., Betterments or Business Improvements Districts (B.I.D.), Tax Increment Financing (TIF) assessment approaches).

DRAFT

DRAFT

NEXT STEPS FOR SITE DESIGN AT LONG WHARF

The following items are recommended to further the localized flood adaptation design at Long Wharf. These next steps may be conducted at various scales depending on the timing and scope of the design development process for priority projects. Specific items may be advanced independently, or included within the district-scale follow-on study outlined above.

Floating Dock Design for Consolidated Marine Transit Hub

Should the City elect to proceed with developing a new Marine Transit hub on the north side of Long Wharf in place of the existing Waterboat Marina, the next phase of design will require a naval architect to advance a floating dock design that takes into account the range of tidal, wind and wave conditions. Also, further consultation with the MBTA and Boston Harbor Cruises, the operators of the ferries and recreational boats, will be required to develop a more detailed program, especially considering vessel types and operations (existing and potential future vessels), landside operations such as trash collection, queuing of passengers and ticketing operations, taking into account possible new technologies to possibly eliminate or reduce the need for landside buildings.

Conduct Additional Geotechnical & Structural Analysis

To inform the next phase of development, a more robust subsurface exploration program will need to be performed to inform the viability and details of load-balancing approaches above the MBTA Blue Line tunnel for the long-term conceptual designs. More advanced geotechnical analysis - such as finite element analysis and analyses of groundwater and subsurface water balance factoring in future conditions - should be conducted as the design progresses.

Perform Additional Subsurface Utilities Mark-outs

Given the prevalence of unmapped and abandoned utilities in this area, further mark-out of subsurface utilities by ground penetrating radar or other means is recommended.

Select Appropriate Heavy-Duty Floodgate, Design Enclosure Structure and Foundation

All conceptual designs – including the 2030 Scheme – incorporate a deployable flood barrier east of the Long Wharf Marriott to close off the State Street flood pathway. Such a system can be designed as a hinged or rolling gate system or an in-ground panelized system that manually or self-deploys with rising waters. The designs will need to account for the significant weight of these systems, potential impacts to subsurface utilities and potential loading above the Blue Line tunnel. The tie-in point on the south side of State Street was not designed as part of this project and needs further integration with either of the long-term schemes.

Advance Interior Stormwater Drainage Design

During the next phase of design, further study and engineering of the stormwater collection systems will need to be performed to address issues such as underground tank buoyancy, water quality treatment, outfalls, backflow prevention and pumping operations for higher-intensity precipitation events.

Revisit Options at Key Space-Constrained Sections

Several space-constrained segments, including the narrow Harborw Walk area north of the Customs House Block and the roadside drop-off zone at Old Atlantic Avenue. may warrant further study prior to final design based on stakeholder feedback and operational concernsdevelopment and alternatives analysis prior to final design. Meetings with the Boston Fire Department and Boston Police should also be conducted to review the concepts and obtain feedback related to safety and emergency services to Long Wharf.

Additional Outreach + Engagement

As the recommended alternative is further developed through subsequent phases of planning and design, continued stakeholder engagement of the public and relevant agencies will play a key role in ensuring public support for the project. Additional public outreach will ensure that design refinement aligns with community priorities and operational capacities before advancing to final design and construction. Further engagement should include the following stakeholder groups:

- Boston Harbor City Cruises
- Boston Harbor Now
- Boston Water and Sewer Commission
- Capital Properties
- City of Boston Parks and Recreation Department
- Eversource
- Friends of Christopher Columbus Park
- The Rose Kennedy Greenway Conservancy
- Harbor Towers
- Massachusetts Department of
- Environmental Protection
- Massachusetts Historical Society
- National Grid
- National Parks Service
- New England Aquarium
- North End Waterfront Neighborhood Council
- Massachusetts Bay Transportation Authority
- Stone Living Lab
- Sunstone Management Partners / Long Wharf Marriott
- U.S. Army Corps of Engineers
- Wharf District Council
- Boston Fire Department
- Boston Police Department

Design Development

Based on continued engagement and technical assessments, a preferred design alternative will be advanced to the next phase of design. Keep in mind a preferred design will likely include elements from each of the concepts studied in this report as well as new ideas. After reaching consensus on the concept design, the preferred alternative will proceed to preliminary design which translates the high-level concepts into preliminary engineering drawings and technical specifications.

DRAFT

DRAFT

FUNDING OPPORTUNITIES

Developing a funding strategy is a key next step in implementation of any adaptation scheme. The funding strategy should consider different funding sources including grants and loans to supplement funding available through the City of Boston and other municipal sources. This section provides a high-level overview of potentially relevant funding sources for implementation including U.S. Army Corps of Engineers' Coastal Storm Risk Management, the Promoting Resilient Operations for Transformative, Efficient and Cost-saving Transportation (PROTECT) Program, and FEMA's Building Resilient Infrastructure and Communities (BRIC) Program. As each grant has different eligibility requirements, funding caps and timelines, funding availability and strategy development should be considered in the determination of next-steps.

The following list outlines a range of grant funding opportunities relevant to projects that align with six key themes: resilience, marine transit, community, nature-based solutions, recreation/open space, and historic preservation/restoration. Each listing includes the lead agency, a summary of the program's purpose, potential opportunities, key considerations, applicability to various project types, relevant dates, and a link to the program's website for further details. For more comprehensive information on each program, including potential challenges, please refer to Appendix F.

- Seaport Economic Council Grant Program – Massachusetts Executive Office of Economic Development
- Coastal Zone Management (CZM) Coastal Resilience Grants - CZM
- Promoting Resilient Operations for Transformative Efficient and Cost-Saving Transportation (PROTECT) Program – Federal Highway Administration (FHWA)
- Building Resilient Infrastructure and Communities (BRIC) Program – Federal Emergency Management Agency (FEMA)
- Coastal Storm Risk Management – U.S. Army Corps of Engineers
- Pre-Disaster Mitigation (PDM) Grant Program – Federal Emergency Management Agency (FEMA)
- Corps Water infrastructure Financing Program - U.S. Army Corps of Engineers
- Municipal Vulnerability Preparedness (MVP) Program, Action Grant – Massachusetts Executive Office of Energy and Environmental Affairs (EEA)
- Dam and Seawall Repair or Removal Program - Massachusetts Executive Office of Energy and Environmental Affairs (EEA)
- Passenger Ferry Grant Program – Federal Transit Administration (FTA)
- Historical/Preservation Funding Sources – Commonwealth of Massachusetts and City of Boston
- Boating Infrastructure Grant (GIB) Awards – Tier 2 Competitive Program Awards – U.S. Fish and Wildlife Service
- Federal Land and Water Conservation Fund – Department of the Interior (DOI) /National Park Service (NPS)
- Rebuilding American Infrastructure with Sustainability and Equity (RAISE) – U.S. Department of Transportation (USDOT)
- Transportation Improvement Program (TIP) – Boston Metropolitan Planning Organization (MPO)
- Other USDOT or FTA Grants – USDOT, FTA
- National Coastal Resilience Fund - National Fish and Wildlife Foundation (NFWF) and National Oceanic and Atmospheric Administration (NOAA)
- Transformational Habitat Restoration and Coastal Resilience Grants - National Oceanic and Atmospheric Administration (NOAA)
- Hazard Mitigation Grant Program (HMGP) – Post Disaster Funds - Federal Emergency Management Agency (FEMA)

DRAFT

ADDITIONAL SOURCES & LEVERAGING PRIVATE FUNDS

Given the high price tag associated with capital infrastructure projects, and acknowledging the recent headwinds with federal funding programs for climate and coastal resilience infrastructure, future funding approaches for Boston's coastal adaptation projects – including for Long Wharf – should consider blended funding and finance approaches.

In February 2025, the New York City Department of Environmental Protection (along with the Mayor's Office and DEC) published a new report, Securing a Resilient New York City: Funding and Financing Shoreline Protection. The report considers multiple strategies to blend revenue streams, explore new debt instruments, and further unlock private capital, such as by:

- Implementing 'Shoreline Protection Districts', where local property owners contribute to maintenance in high-risk zones.
- Partnering with the insurance community, leveraging actions from insurers and insureds with the most to lose from inaction.
- Blending revenue streams that diversify beyond federal and state funding using targeted local taxes or fees.
- Public-private capital strategies that open the door to long-term investment in resilience.

The report specifically notes that these strategies are being considered as New York City has historically financed its non-federal portion of coastal resilience capital costs primarily through General Obligation bonds; however, budget realities have increased competition for limited capital funds.

Specific to Boston, the Green Ribbon Commission and Arcadis in 2020 published Expanding Boston's Capacity to Build Coastal Resilience Infrastructure Lessons from the Seaport District report. This report, funded by The Barr Foundation, also stressed the need for "[new] or evolved governance, funding, and regulatory approaches will need to be developed over the next three to four years to advance project delivery and district-scale coordination to stay on the desired implementation schedule for South Boston projects planned beyond 2025." While the report focuses on South Boston, this conclusion applies to the city's overall efforts.

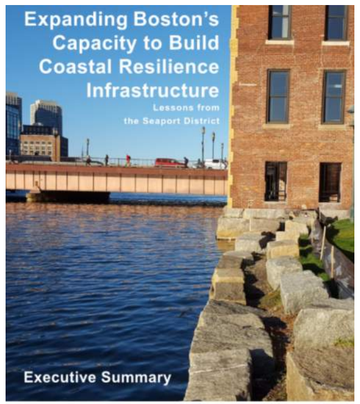


Figure 9-1 - Expanding Boston's Capacity to Build Coastal Resilience Infrastructure

DRAFT

DISTRICT-SCALE FINANCING APPROACHES

Given the profile of flood risk to the Wharf District and Downtown communities, private stakeholders and commercial enterprises, it is important to consider blended funding strategies (beyond City funds, and local/state/federal grants). Among these are the development and implementation of Business Improvements Districts (B.I.D.), Tax Increment Financing (TIF), Assessment(s), or Betterments District approaches.

From a land use perspective, such approaches may be particularly relevant for the Downtown and Wharf District areas, as these areas are characterized by mostly commercial, mixed-use, and institutional, with limited residential uses. This District also contains fewer economically-disadvantaged residents, as compared to other focused Coastal Resilience Solutions plans and neighborhoods in USACE's City of Boston CSRM study. Combined with the higher concentration of public waterfront and transportation infrastructure at Long Wharf with the active bottom-up resilience planning efforts of the Wharf District Council, this particular area may be more favorable to a B.I.D., or similar approach, particularly when compared with other near-term coastal flood pathways in Boston neighborhoods containing higher volumes of residential- and other zoned uses, and potentially fewer near-term opportunities for value capture from otherwise necessary public infrastructure improvements (such as public water transit, harbor walk, and open space upgrades at Long Wharf and Columbus Park).

In Massachusetts, to set up a B.I.D., at least 75% of the land has to be zoned commercial, retail or industrial. This effort must have support of 60% of the property owners, representing 51% of the assessed value, and also go through a public process including a public hearing.

The City of Norfolk, Virginia adopted a policy in 2019 authorizing the creation of Special Service Districts (SSD) to support implementation of flood mitigation, dredging, water quality improvements, and coastal protection projects. To initiate a project, residents must work with the city to determine feasibility, boundary, and cost and develop a plan including engineering, costs, and a timeline. To initiate further study of a project, 30 percent of parcel owners in the area to benefit from the project must sign a petition supporting development of an SSD plan. To approve construction, at least 75 percent of parcel owners representing at least 50 percent of the property value of the benefited area must agree to the SSD plan and the tax to support implementation.

LEVERAGING LOCAL USER FEES FOR OPERATIONS AND MAINTENANCE COSTS OF COASTAL RESILIENCE INFRASTRUCTURE

Without a dedicated source of funding, operations and maintenance costs may be overlooked or deprioritized. In New York City, for instance, the State Comptroller recently found deficiencies with the Metropolitan Transit Authority's (MTA) maintenance and inspections of resiliency equipment and found that the City's operations and maintenance needs for resilience are already in the low millions of dollars per year. A citywide system may require closer to $500 million per year (based on a conservative estimate of 1% of capital cost).

Among the recommendations of NYCDEP's Securing a Resilient New York City: Funding and Financing Shoreline Protection report (2025), was the note that operations and maintenance costs are well-suited to being funded by local user fees. If implemented, a Shoreline Protection District (or similar district-scale entity) user fee could fund all or a portion of the operations and maintenance costs associated with its coastal resilience infrastructure by implementing a fee-for-service.

Under certain conditions, the City can authorize and enact a fee-for-service itself through local legislation. Such a funding model could align costs with risk exposure, so those benefiting directly from resilience measures contribute proportionately. For example, New York City's B.I.D.s already use a similar model for non-resiliency applications, raising funds for cleaning and safety operations through assessments on properties within their boundaries.

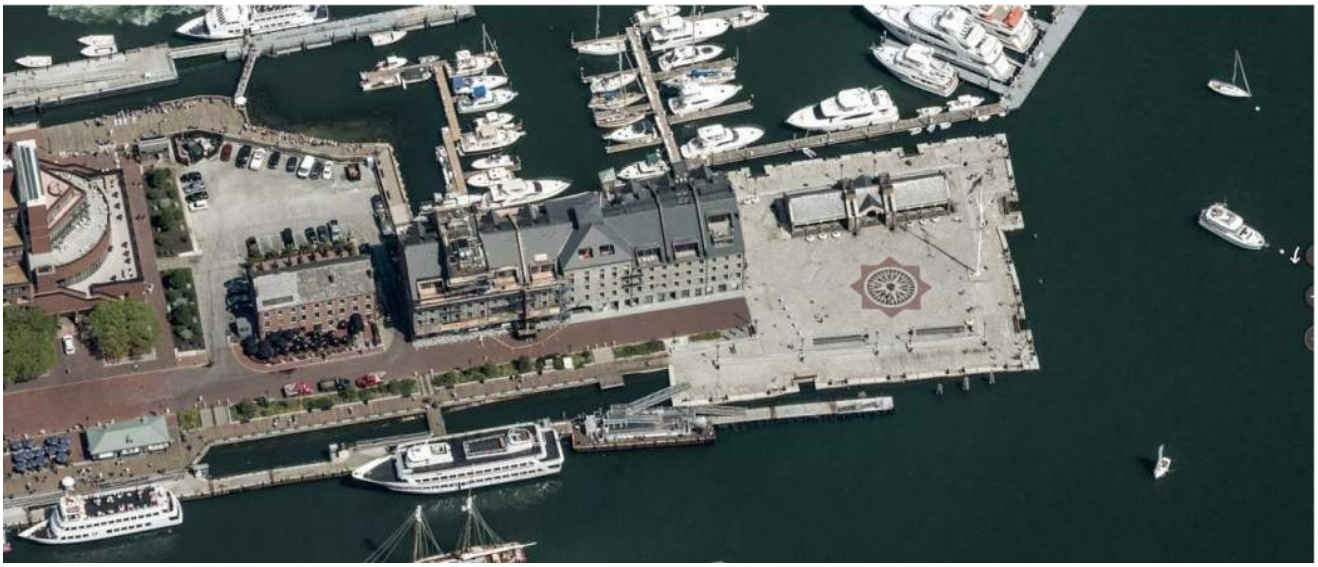
DRAFT

DRAFT

APPENDIX A - EXISTING CONDITIONS & VULNERABILITY ASSESSMENT BASIS FOR CONCEPTUAL ALTERNATIVES REPORT

FLOOD MITIGATION PLANNING LONG WHARF
BPDA PROJECT NO. 5124

TASK 2 – BASIS FOR CONCEPTUAL ALTERNATIVES INTERIM REPORT



KLEINFELDER NORTHEAST, INC.
One Beacon Street/Suite 8100
Boston, MA 02128
Phone: 617.497.7800

August 11, 2023
Kleinfelder Project No: **20235500.001A**

KLEINFELDER
Bright People. Right Solutions.

Table of Contents

1 INTRODUCTION 1

1.1 PURPOSE 1

1.2 SITE CONTEXT 1

1.3 SITE HISTORY 8

1.4 PRESENT DAY WHARF 11

1.5 HIERARCHY OF LONG WHARF ASSETS 12

2 EXISTING CONDITIONS AND VULNERABILITY ASSESSMENT 14

2.1 HARBORWALK NORTH 14

2.2 CHRISTOPHER COLUMBUS PARK 19

2.3 PAVILION 24

2.4 HARBORWALK SOUTH 27

2.5 AQUARIUM STATION (MBTA) 32

2.5.1 MBTA BLUE LINE AQUARIUM STATION EAST HEADHOUSE 32

2.6 OLD ATLANTIC AVENUE 35

2.7 BOSTON HARBOR CRUISES 35

2.8 CUSTOM HOUSE BLOCK 38

2.9 CHART HOUSE 40

2.10 WATERBOAT MARINA 42

2.11 SEAWALL CONDITIONS 42

2.11.1 LONG WHARF NORTH SEAWALL 44

2.11.2 LONG WHARF SOUTH SEAWALL 44

2.11.3 LONG WHARF EAST SEAWALL 46

2.12 ABUTTING PROPERTIES 51

2.12.1 MARRIOTT HOTEL AND GARAGE 51

2.12.2 NEW ENGLAND AQUARIUM 52

2.12.3 255 STATE STREET 52

3 GEOTECHNICAL INVESTIGATIONS 54

4 UTILITY INFORMATION 58

4.1 DRAINAGE INFRASTRUCTURE 58

4.2 ELECTRIC 64

4.3 NATURAL GAS 65

4.4 WATER INFRASTRUCTURE 67
4.5 SANITARY 67
4.6 OTHER 68
4.6.1 MBTA 68
4.6.2 TELECOM 68
4.6.3 DOCKAGE SERVICES 68
5 PUBLIC REALM AND SITE ACCESS 69
5.1 SITE ACCESS AND CONNECTIVITY 69
5.2 VEHICULAR TRANSPORTATION 73
5.3 WATER TRANSIT & TRANSPORTATION 75
5.4 SITE PROGRAMMING AND USE 79
5.5 SURFACE MATERIALS AND CONDITIONS 83
6 REFERENCE LIST 87
6.1 ABUTTER DOCUMENTS AND PLANS 87
6.2 PHYSICAL ASSET PLANS (BY LOCATION) 88
6.3 CITYWIDE PLANS 89
7 WORKS CITED 90

APPENDICIES

APPENDIX A – DESIGN FLOOD ELEVATION MEMO
APPENDIX B – IDENTIFIED STAKEHOLDERS AND ABUTTERS
APPENDIX C – SITE VISIT REPORT FROM CUSTOM HOUSE BLOCK AND CHART HOUSE
APPENDIX D – GEOTECHNICAL INFORMATION SUMMARY

1 INTRODUCTION

1.1 PURPOSE

This report summarizes the site assessment findings associated with Task 1 of the Long Wharf Flood Resilience and Feasibility Planning Study (BPDA Project No. 5124) and identifies vulnerabilities to flooding. Under this Task, the Kleinfelder team collected and evaluated available data related to Long Wharf to understand the Wharf's vulnerability to flooding today and in the future. The findings of this report will be updated in subsequent tasks as the project develops.

1.2 SITE CONTEXT

Long Wharf is in a key location both along Boston's waterfront and within Boston's downtown at the end of State Street between Central Wharf and Commercial Wharf. Immediately to the south of the site is the property at 255 State Street and immediately to the north is Christopher Columbus Park. The Rose Kennedy Greenway and Atlantic Avenue provide the western edge of the project site, while the eastern edge is open to the inner harbor, with East Boston across the water. The project study area is roughly 13 acres encompassing Long Wharf proper, and the adjacent properties and water-supported infrastructure as shown in the image below.

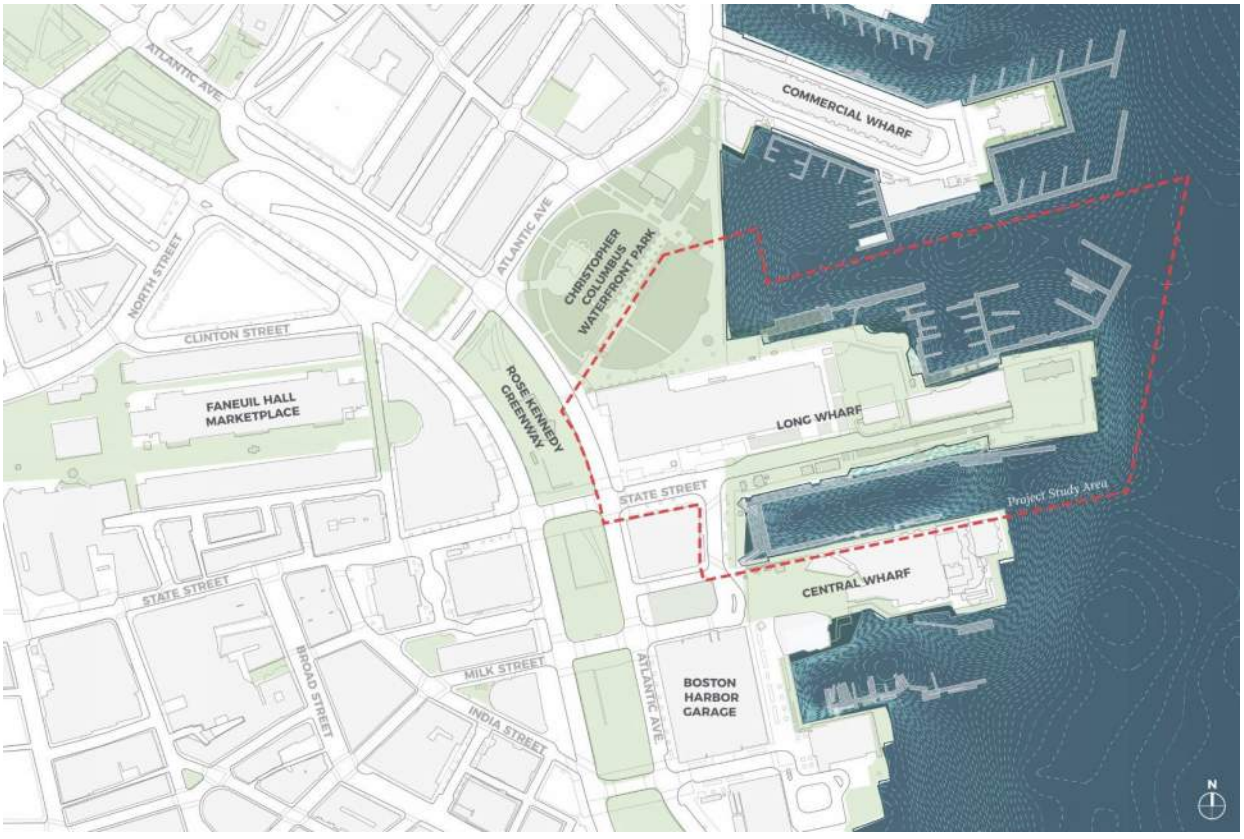


Image above: Project Study Area and Context

Long Wharf is part of Boston's Harborpark: North End Waterfront zoning district and the Downtown Waterfront Subdistrict. The site is also subject to several zoning overlays per the BPDA Zoning Viewer and the State of Massachusetts MassMapper, including the Greenway Overlay District, the Groundwater Conservation Overlay District, Restricted Parking District, area of Open Space protection, and the Coastal Flood Resilience Overlay District, and the Massachusetts Coastal Zone.[1]

Image above: Boston Zoning Jurisdictional Overlays; shapefile layers sourced from the City of Boston's Analyze Boston database

According to Article 49A of the Boston Redevelopment Authority, the Greenway Overlay District includes:

> "...guidelines and design controls for parcels adjacent to the Rose Kennedy Greenway that will: (1) activate the broader public realm in and surround the Greenway parks by identifying and strategically locating desired uses, particularly at the ground level, that will contribute positively to the Greenway; (2) preserve the character of the Greenway parks (environmentally, aesthetically, and economically) by setting design standards and guidelines for Proposed Projects, to ensure that they are planned and designed in a manner that is compatible with the recreational activities and horticultural life within the parks; and (3) ensure the long-term value of the public's investment in creating the Greenway parks by setting standards for he review of Proposed Project impacts, to maximize the quality of the parks and extend their publicly beneficial effects into adjacent districts and neighborhoods."[2]

Relevant aspects of this Section include the regulation of signage and outdoor cafes, among others, specifically as related to Priority Greenway Frontages. In addition, Section 49A-7 stipulates that any proposed project which amends any existing structure or proposes a new one will be subject to a design review and adherence to the Design Guidelines, primary elements of which include suitable massing and proportions to match the

surrounding historic and architectural character of the existing built environment and the enhancement of the pedestrian environment.

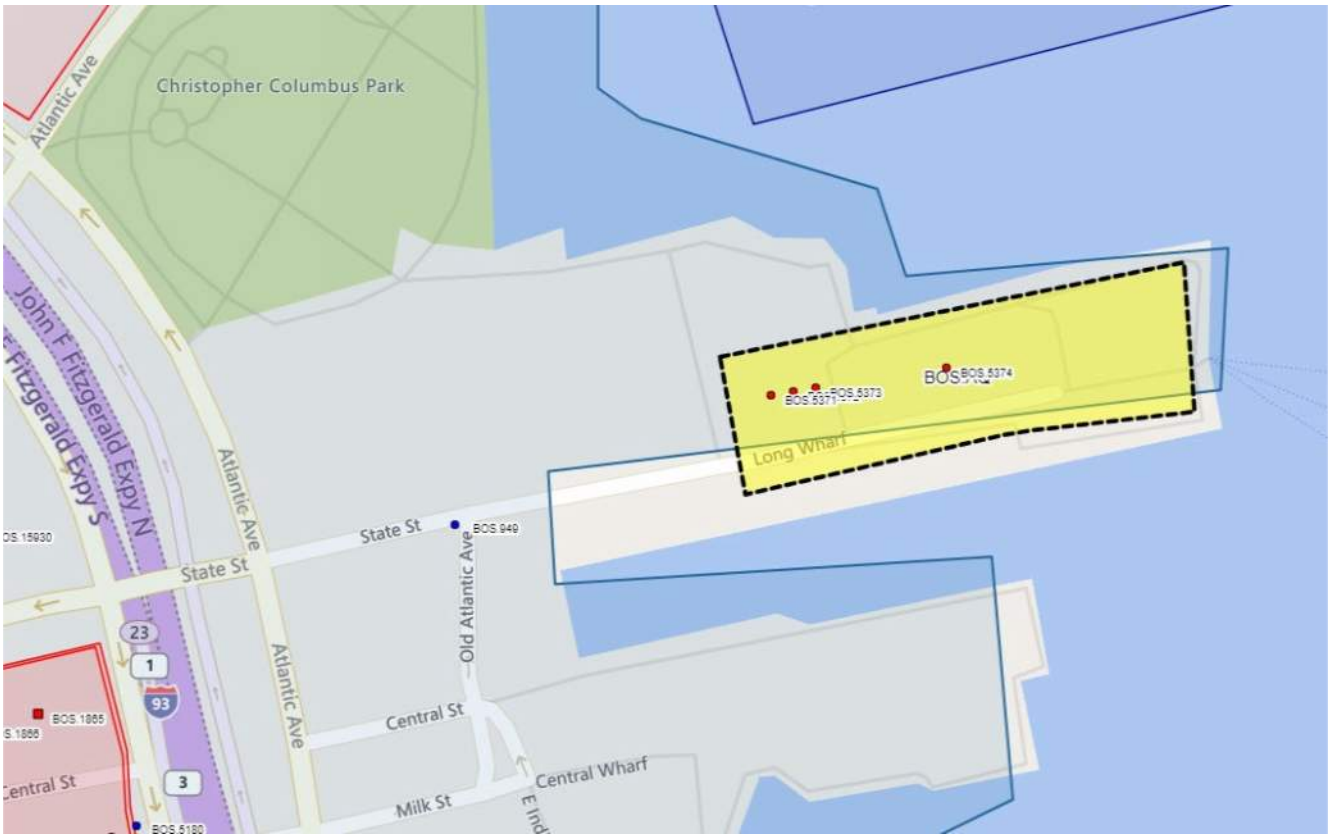
The site at Long Wharf is also subject to Article 32 of the City of Boston zoning and the Groundwater Conservation Overlay District (GCOD), which is supported by maps provided by the Boston Water and Sewer Commission (BWSC). Per this article:

> "Any applicant seeking a building permit for a proposed project within the GCOD shall be subject to the requirements of this article where such Applicant seeks:
>
> - The erection or extension of any structure, where such new structure or extension will occupy more than fifty (50) square feet of lot area
> - The erection or extension of any structure designed or used for human occupancy or access, mechanical equipment, or laundry or storage facilities, including garage space, if such construction involves the excavation below grade to a depth equal to or below eight (8) feet above Boston City Base (other than where such excavation is necessary for, and to the extent limited to, compliance within the requirements of this article)
> - To Substantially Rehabilitate any structure
> - Any paving or other surfacing of lot area"[3]

Subsequent action required for work requiring a permit at Long Wharf will include the design and installation of a groundwater recharge system capable of capturing 1" of precipitation over the impervious area of the lot and approval from the BWSC per their site plan requirements[4].

Long Wharf is also subject to the Boston Proper zone of the Boston Parking Freeze Requirements which seeks to maintain air quality by limiting commercial parking spaces. This freeze, which was established in 1973, requires owners and operators to obtain a Parking Freeze Permit or an Exemption Certification from the Boston Parking Freeze Commission prior to initiating any construction or modifications to a place where commercial vehicles are parked.[5]

In addition, the Massachusetts Cultural Resource Information System (MACRIS) maps which depicts properties identified as significant to the Massachusetts Historical Commission identifies the eastern end of Long Wharf and the Custom House Block as historic and has indicated the designation of National Historic Landmark in 1966 and the National Register of Historic Places, also in 1966 per the below image. These designations are administered by the state on behalf of the National Park Service.



Long Wharf Points and Areas Designated as National Historic Landmarks and locations on the National Register of Historic Places. Accessed via Massachusetts Cultural Resource Information System (MACRIS) online, 07/10/2023.

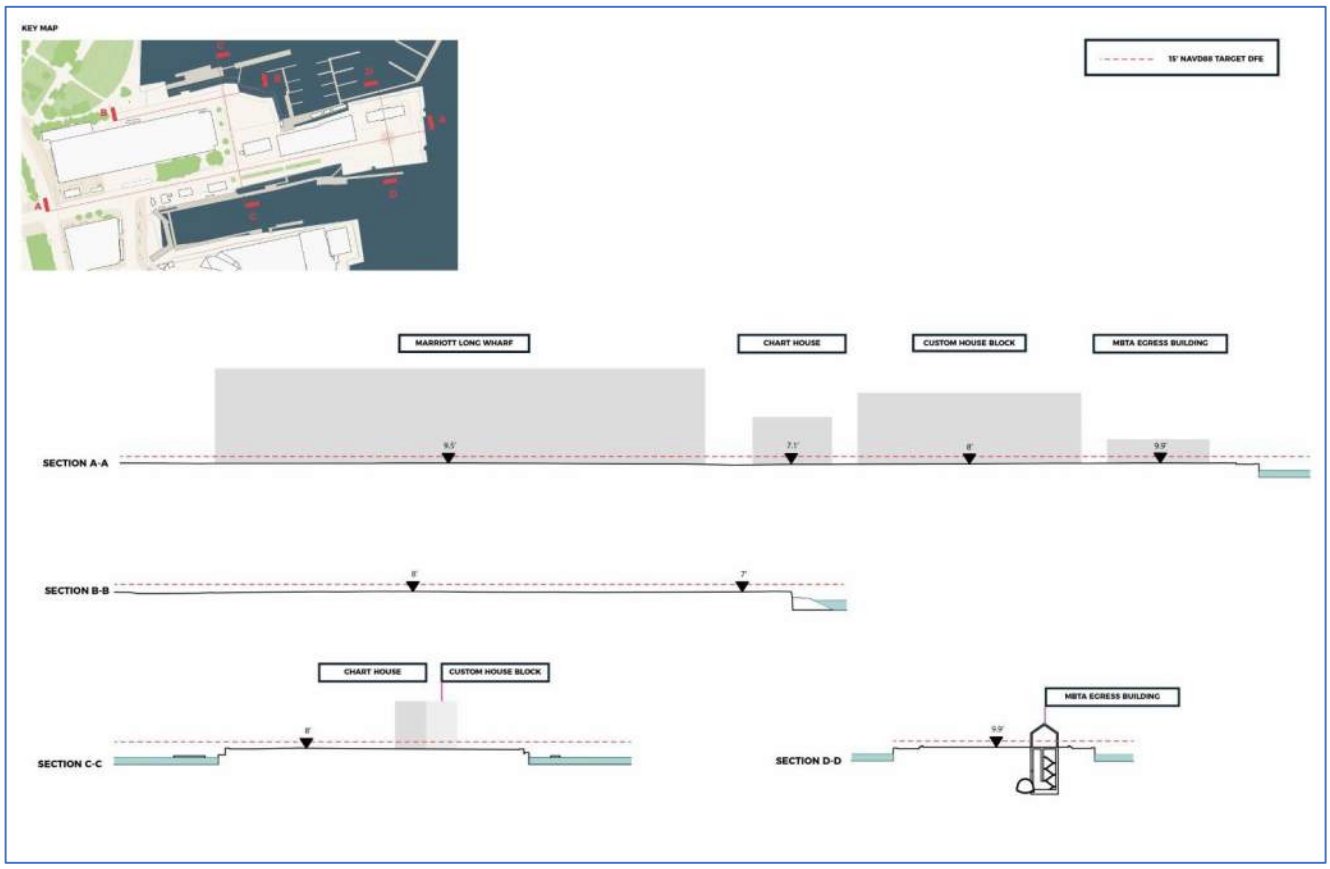
From a zoning review perspective, the BPDA zoning viewer also notes the need for a Parks Design Review by the City of Boston Parks Department. It is also significant that Long Wharf previously received funding from the Land and Water Conservation Fund through the Department of the Interior.

Because of its coastal location, there are several flood and resiliency related overlays associated with the site. These include the FEMA Flood Hazard Area as well as the aforementioned Coastal Flood Resilience Overlay District (CFROD). The CFROD has implemented Article 25A, which regulates proposed projects of various kinds. For the purposes of the Long Wharf site, it is key to note that properties subject to the CFROD include the addition of 10,000 square feet or more within the Harborpark or the change of use or substantial rehabilitation of structures having more than one hundred thousand square feet in gross floor area[6]. Pertinent regulations include dimensional requirements as well as the development of a Design Flood Elevation (DFE), among other design considerations for a more sustainable site. The base flood elevation designated for Long Wharf is 13.0 ft NAVD88 (19.5ft BCB), and Article 25A denotes an additional two feet is required for the minimum DFE on properties within the FEMA A, E, or VE zone. FEMA's National Flood Hazard Layer viewer hosts online maps with flood risk boundaries, and Long Wharf is shown as being subject to both the "VE" and "AE" zones (see image below), thus subjecting the Long Wharf site to a minimum DFE of 15.0 ft. NAVD88 (21.5ft BCB).

Areas of Long Wharf Subject to Coastal Flood Risk; Accessed via FEMA National Flood Hazard Layer viewer, online, 07/07/2023

For an expanded review of flood risks and projected flood levels, please refer to the Coastal Resilience Solutions for Downtown and the North End published as part of the continued efforts established by Climate Ready Boston.[7]

There is little variation in topography over the length of the wharf, with a clear and accessible public way provided throughout the project area. Several elevations are provided in the following diagrammatic section cuts to demonstrate the gentle transition in grade across the site. The minimum DFE can be seen as a datum for reference. The low point of the site is noted as adjacent to the Chart House at an approximate elevation of approximately 7.1 ft NAVD88 (13.6 ft BCB), and higher points recorded at the east end of the Marriott at approximately 9.5 ft NAVD88 (16 ft BCB) and the MBTA Emergency Egress Pavilion finished floor elevation at 9.9 ft NAVD88 (16.4 ft BCB). This elevation information has also been recorded in the Wharf District Council's report studying the Long Wharf project area.[8]



Diagrammatic Sections through Existing Conditions at Long Wharf

When reviewing other significant resilience studies such as the Urban Heat Island Intensity (UHII) Index CRB Heat Resilience Study conducted by the City with Sasaki in 2021, it is evident that Long Wharf, while subject to the effects of urban heat, is a space with relatively cooler temperatures, especially concentrated at the wharf's eastern end closest to the water. Similar results are shown in the Daytime Air Temperature and Nighttime Air Temperature layers provided in the CRB Heat Resilience Study.[9] The Climate Ready Boston Map Explorer also denotes that Long Wharf and the sites immediately bounding it are designated as socially vulnerable due to the present elderly population.[10] This information is sourced from the 2008-2012 American Community Survey 5-Year Estimates and is detailed on the City's Analyze Boston website.[11]

The Long Wharf site is subject to Chapter 91 of the Massachusetts Department of Environmental Protection and is within the Tidelands Jurisdiction zone per the Massachusetts Ocean Resource Information System (MORIS) hosted by the Coastal Zone Management (CZM).[12] [13] Per Chapter 91, several activities require authorization from the State:

" Including both new and existing... activities...as follows:

- Structures - Placement or construction of any structure, regardless of size, whether permanent or seasonal. Examples of typical structures include, but are not limited to: piers, wharves, dams, seawalls, weirs, booms, breakwaters, bulkheads, ripraps, revetments, jetties, piles, lines, groins, roads, culverts, bridges, buildings, parking lots, cables, pipes, conduits, tunnels, wires, floats, etc.
- Filling - Placement of any unconsolidated materials that are confined or expected to remain in place in a waterway, except for material placed by natural processes. Such placement includes

material placed for the purposes of shoreline protection, beach nourishment, or subaqueous disposal of dredged spoils.

- Dredging - Removal of materials, including but not limited to rocks, bottom sediments, debris, sand, refuse, plant or animal matter, in any excavating, cleaning, deepening, widening, or lengthening of any waters in the Commonwealth. The Department must also know the location where the removed material will be disposed.
- Change in Use - Any use of the authorized premises or structures for a purpose unrelated to the authorized use, whether express or implied. An example of such a change in use would be the conversion of a commercial fishing establishment to an office building.
- Structural Alteration - Any change in the dimensions of a structure or fill from the specifications contained in the existing authorization.
- Demolition/Removal of Structures - Approval is required for removal of any unauthorized structure or fill that was previously not authorized or for which there is not a current and valid grant or license."

Present on Long Wharf as a series of structures, including the Marriott Long Wharf Hotel and its garage, the Chart House restaurant, the Custom House Block building, and the MBTA egress building (referred to as the 'Pavilion'), among other supporting structures for tourism and infrastructure. Depicted in the figure below are the uses present currently on Long Wharf. Most of the open spaces along Long Wharf are owned and operated by the BPDA and feature elements such as the Harborwalk and a public plaza at the water's edge. For more information on these various structures and spaces, please refer to Section 1.4 - Present Day Wharf and the supporting sections of this report.

Image above: Parcel Use at Long Wharf, GIS data obtained from the City of Boston's Analyze Boston Geospatial Database, online, July 05, 2023.

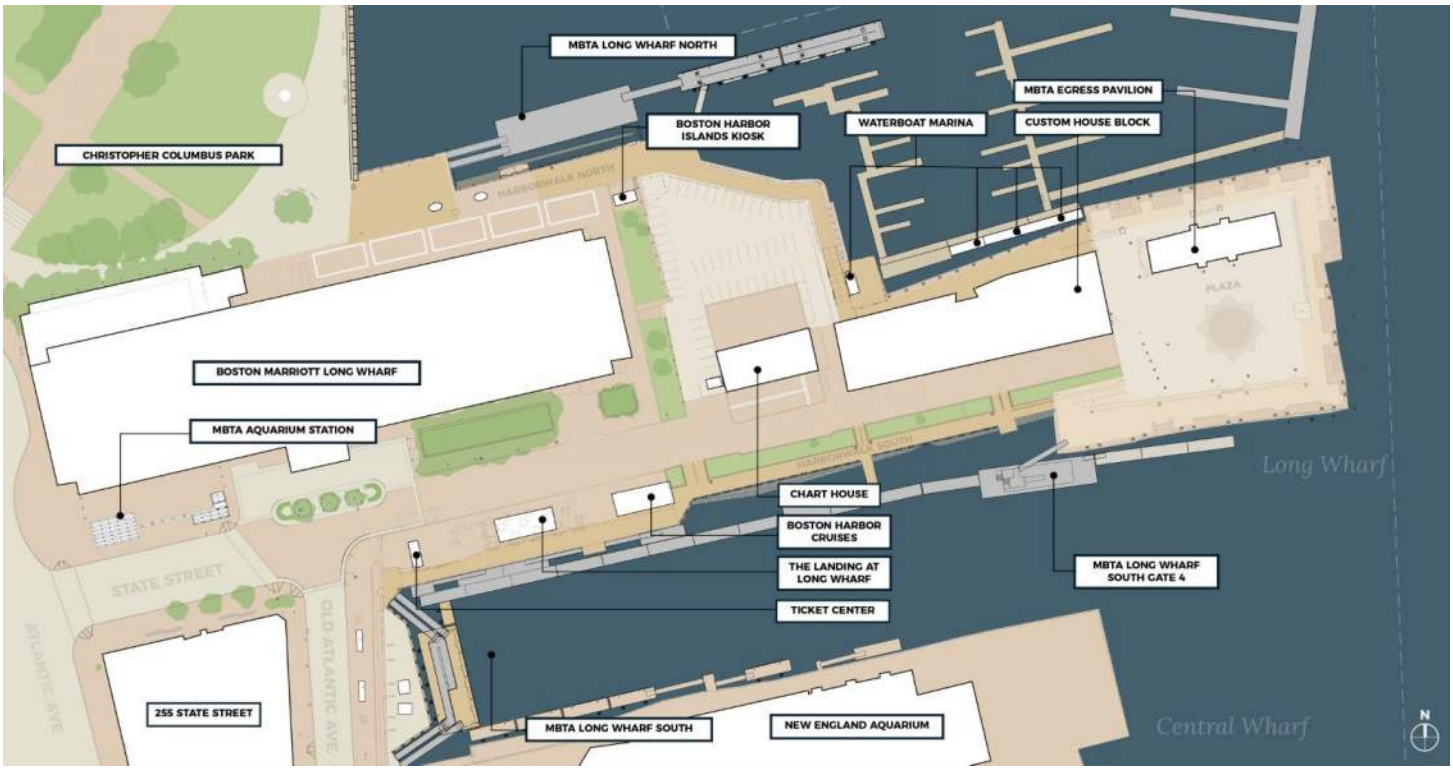


Image above: Existing Conditions at Long Wharf

1.3 SITE HISTORY

Long Wharf's rich history is integrally tied to the evolution of Boston not only through its role in stimulating economic, cultural, and military movements within the city, but by also playing a key role in defining the city's relationship to the waterfront and the larger Boston Harbor. A review of historic materials depicting Long Wharf, particularly mappings, photographs, and drawings, aid in understanding Long Wharf's prominence at various moments in time. For example, several maps from the early 1700s depict Long Wharf as the sole protrusion from the then-smaller peninsula that served as a home for early settlers, and a few drawings depict Long Wharf as part of the "Barricado," an early defensive measure built prior to Long Wharf's construction.1 The wharf features prominently in the early Boston skyline—playing a role almost equal to the various civic buildings and churches seen at a distance from the harbor. The various structures and buildings along the wharf are also visible in several historic sources, notably photographs from the advent of the medium, which depict various merchants and services such as cocoa, coffee, and tea importers, the Boston Fruit Company, and Boston's immigration station.[2]

Not only does Long Wharf reveal itself through maps and photographs, but its cultural significance can be traced through artifacts such as newspapers and plaques as well. Because Long Wharf served commercial and passenger boat traffic throughout its history, it served as a point of entry to Boston or to America in general. Not only did an immigration station occupy a portion of the wharf which served to process incoming citizens, but it also served as a point of access for the slave trade in the 1700s. Boston's role and complicity in the slave

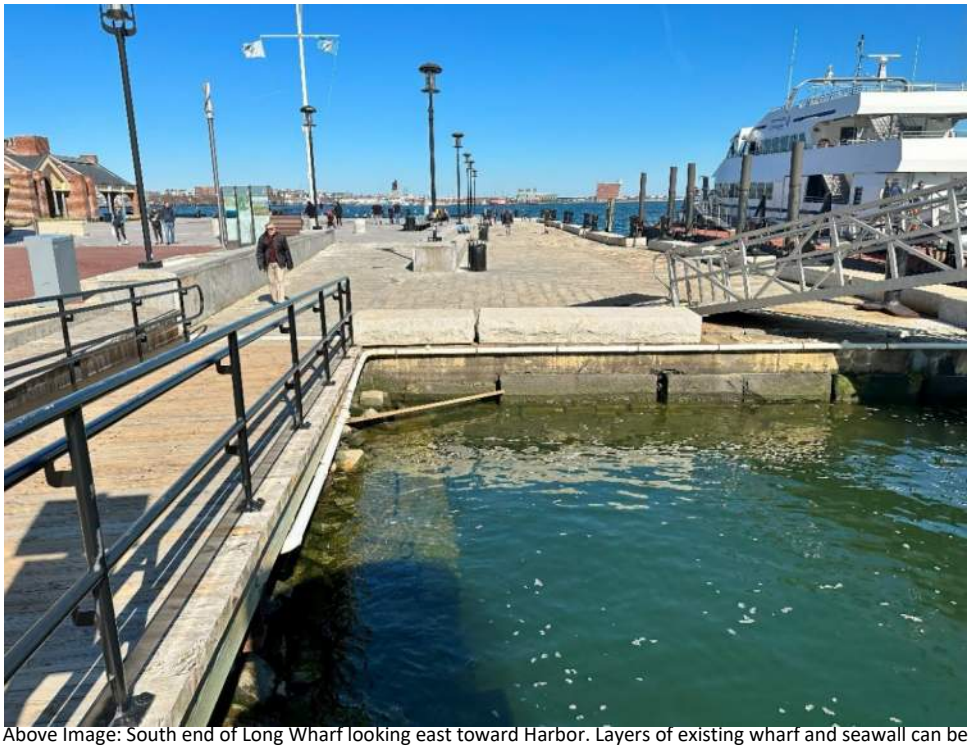
[1] (National Parks Service)
[2] (Kilcrease)

trade is one of the stories embedded in its history including the rendition of Anthony Burns. A National Parks monument is now installed near the end of the wharf to mark its significance as a docking point for ships carrying enslaved Africans through the Middle Passage.[3]

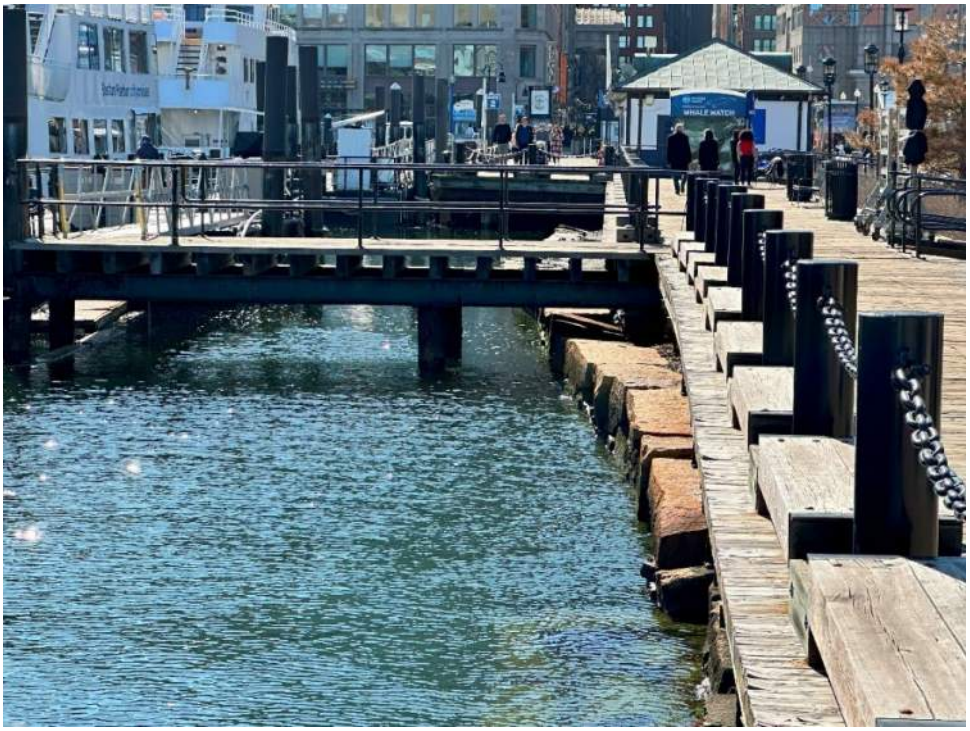
Through a study of these representative materials, one can also observe the growth of Long Wharf in relation to the surrounding shoreline and other maritime structures, particularly its relationship to T-Wharf and eventually to the present condition adjacent to Christopher Columbus Park and the New England Aquarium. The growth of the wharf can also be traced through documentation of its present condition, which displays an amalgamation of materials in various layers. For instance, a walk along the wharf reveals the stratified history of Long Wharf as seen in the images below:

Above Image: Western-most edge of Long Wharf alongside New England Aquarium. Layers of granite block, fill, brick paving, boardwalks, and raised grades can be seen.

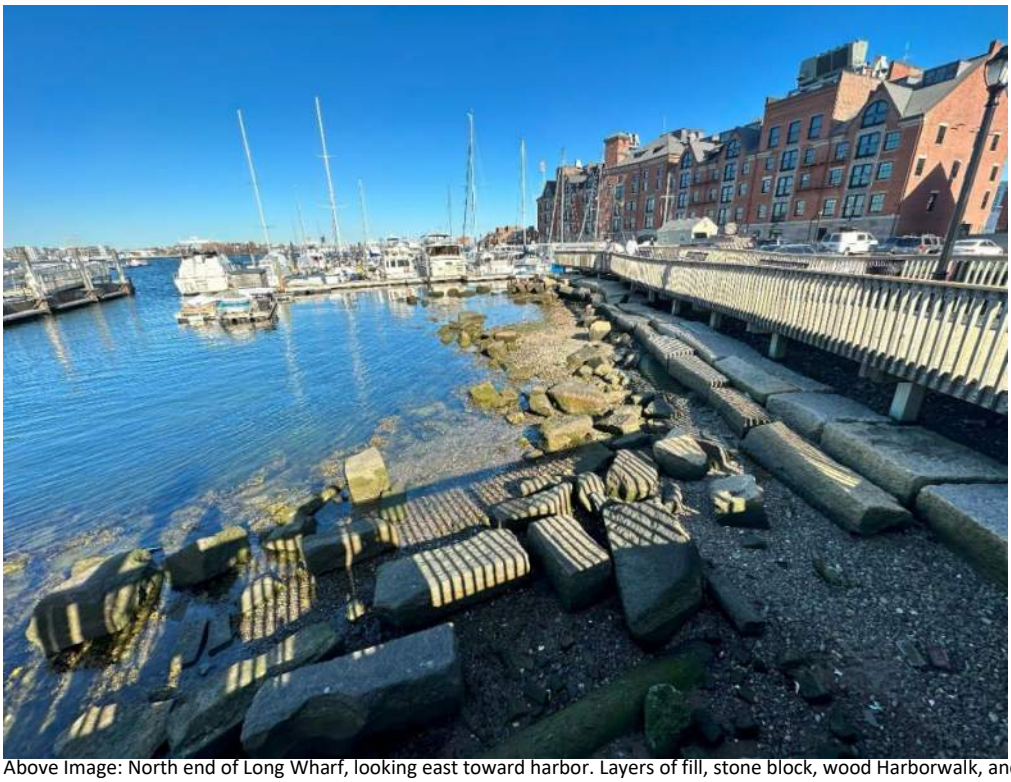
[3] (Boston Middle Passage Project)



Above Image: South end of Long Wharf looking east toward Harbor. Layers of existing wharf and seawall can be seen with programmatic site furnishings that support maritime functioning and access including boardwalks, gangplanks, seating areas, etc.



Above Image: South end of Long Wharf looking west inland. Various layered materials of stone, paving, wood, and steel construction can be seen that support maritime functioning and access.



Above Image: North end of Long Wharf, looking east toward harbor. Layers of fill, stone block, wood Harborwalk, and maritime infrastructure meet at this location. A rough deposit of stone and sand creates a small natural beach abutting the large granite blocks.

1.4 PRESENT DAY WHARF

The following text details the contemporary constructed nature of Long Wharf as provided in *"Downtown Waterfront District Municipal Harbor Plan & Public Realm Activation Plan" (BPDA, 04/2018).*

"Long Wharf – The oldest continually operated wharf in the country. Long Wharf accommodates a number of public and private uses and serves as one of the City's primary water transportation hubs. The Marriott Hotel and garage were opened in 1982 as part of the redevelopment and transformation of the wharf from a blighted property to the modern, service-oriented uses and public open space we currently associate with the Downtown Waterfront District. The eight-story, 277,000 square-foot brick building with peaked, upper-story massing and bowed harbor-side wall reflects the profile of a cruise ship. The interior lobby is open to the public and connects Christopher Columbus (Waterfront) Park to Central Wharf and Old Atlantic Avenue. In 2012, the Marriott (Sunstone Hotel Investors, Inc.) completed a four-year, $30 million renovation of the hotel including upgrades to the lobby, the new Waterline restaurant and Harbor View Ballroom, room and suite upgrades, and new public restrooms at the hotel's north entrance. As with many buildings constructed adjacent to the elevated Central Artery, the ground plane facing the Greenway does not include many openings other than service and loading entrances. Currently, Tia's Restaurant operates on the northern side of the building and various trolley tour companies have ticketing kiosks on the Greenway end of the structure. The Marriott and Long Wharf are also bounded to the north by Christopher Columbus Park. One of the City's first waterfront parks, it was opened in 1976, updated in 2003, and provides numerous public amenities, including active lawn

areas, a play lot, a spray fountain, the Rose Kennedy rose garden, a wisteria trellis, and programming throughout the year.

Additional structures on Long Wharf include the three-story Gardiner Building, which houses the Chart House restaurant, and the brick and granite Custom House Block building, currently owned by Capital Properties. This former warehouse, constructed in 1848, consists of five stories and now serves as office space. Office and headquarters for Boston Harbor Cruises, a water-dependent use and provider of water transportation services for the MBTA and Boston Harbor Islands, is also located in this building and benefits from proximity to the water transportation terminals at Long and Central Wharves. Both the Gardiner Building and the Custom House Block are on the National Register of Historic Places. The BPDA owns many of the wharf's public ways and open spaces, including the popular plaza at the end of Long Wharf. Both the north and south sides of the wharf provide water transportation terminals that service the Inner Harbor, Harbor Islands and coastal communities including Winthrop, Salem, and Provincetown. The terminals service over one million visitors and commuters a year. The BPDA has administered over $8 million in waterside and landside upgrades over the past 15 years, including new water transportation terminals on the north and south side of Long Wharf, new and improved sections of Harborwalk, and seawall stabilization, as well as public amenities, such as benches and wayfinding signage. Boston Waterboat Marina, a long-standing tenant of the BPDA, is also located on the north side of the wharf, serving as Boston's oldest continually operating marina facility, which provides transient dockage for about 40 to 50 boats.[4]"

1.5 HIERARCHY OF LONG WHARF ASSETS

Asset Name	Primary Ownership Type
Long Wharf North area (inc. marine structures)	Public & Private
Harborwalk North	Public- State
Christopher Columbus Park [abutting property]	Public- City of Boston
Long Wharf North (MBTA)	Public- MBTA; Private- BPDA tenant
Pavilion	Public- MBTA + NPS; BPDA tenant
Long Wharf South area (inc. marine structures)	Public & Private
Harborwalk South	Public- State
Long Wharf South (MBTA)	Public- MBTA; Private- BPDA tenant
Aquarium Station (MBTA)	Public- MBTA
Old Atlantic Avenue	Public & Private
Boston Harbor Cruises (Horizontal + Vertical Infrastructure)	Public & Private; BPDA tenant

[4] BPDA, "Downtown Waterfront District Municipal Harbor Plan & Public Realm Activation Plan," 2017.

Waterboat Marina	Private; BPDA tenant, privately operated and maintained (5-year with option to renew yearly
Custom House Block	Private; BPDA tenant
Chart House	Private; BPDA tenant
Chart House Parking Lot	Private; BPDA tenant (yearly lease)
Abutting properties (for site context purposes only): Marriott Hotel and Garage, New England Aquarium, 255 State Street	Private

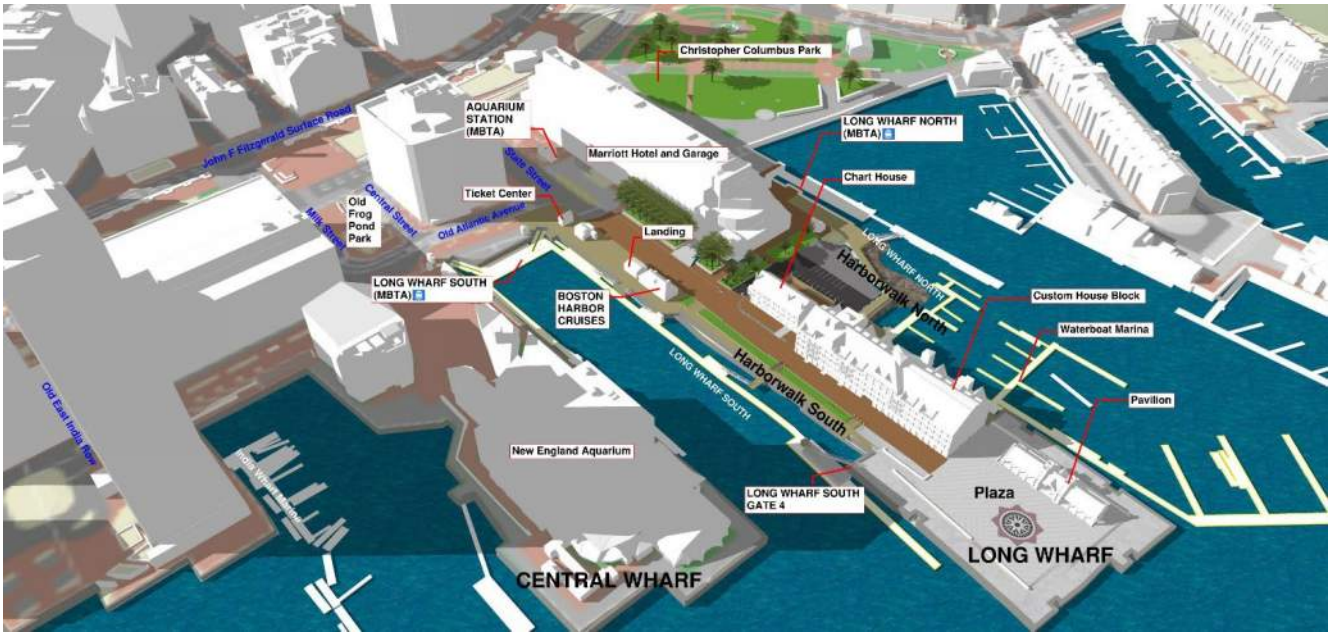


Image above: Long Wharf Master Plan view (asset naming conventions in this report are shown)

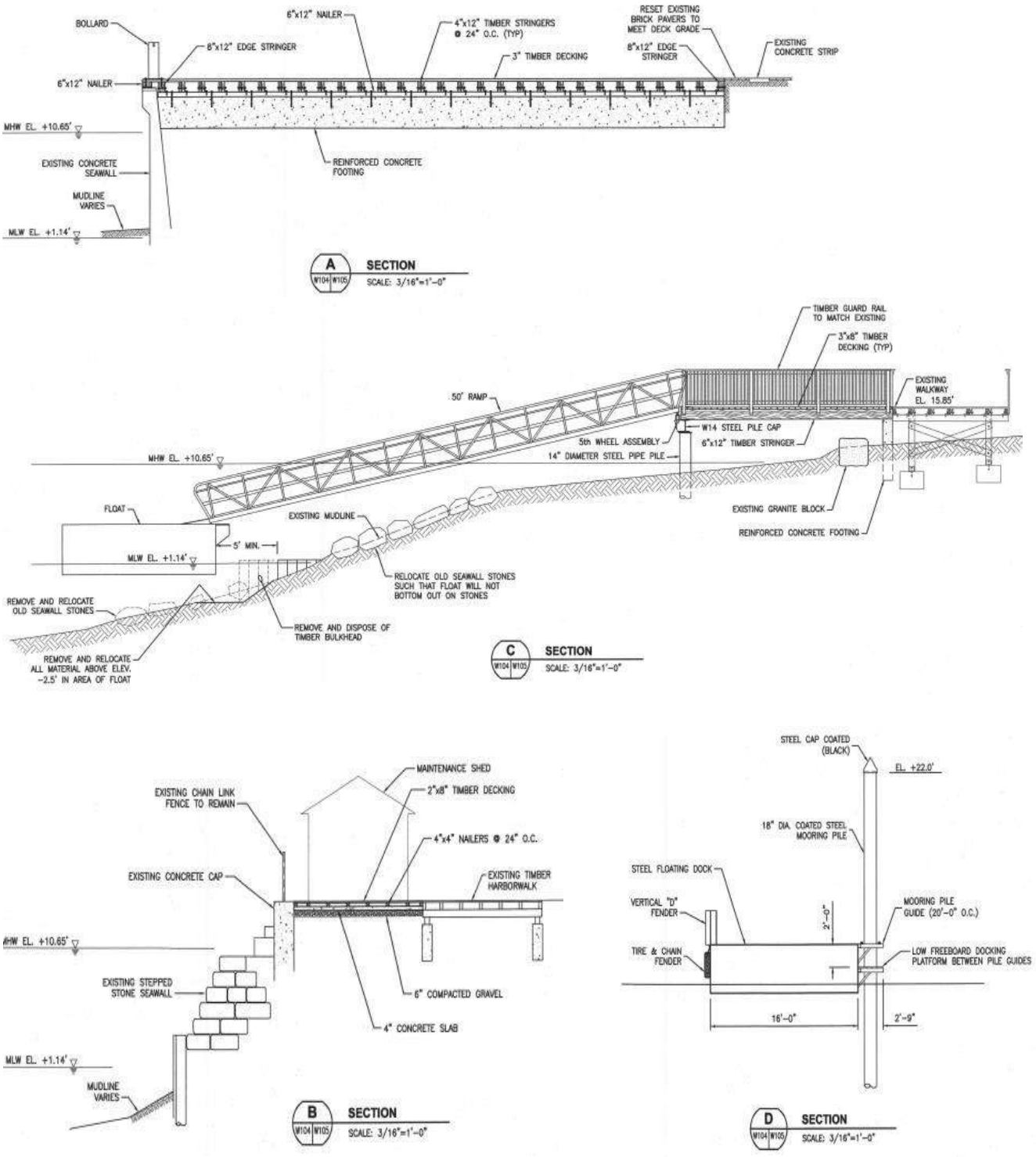
2 EXISTING CONDITIONS AND VULNERABILITY ASSESSMENT

2.1 HARBORWALK NORTH

Harborwalk North, where the MBTA ferry's Long Wharf North dock is located, provides ferry service between Logan Airport-Hull, MA- Hingham, MA, East Boston Lewis Mall and free ferry service to the Encore Casino. In 2007, BPDA conducted its Long Wharf North Site Improvements project.

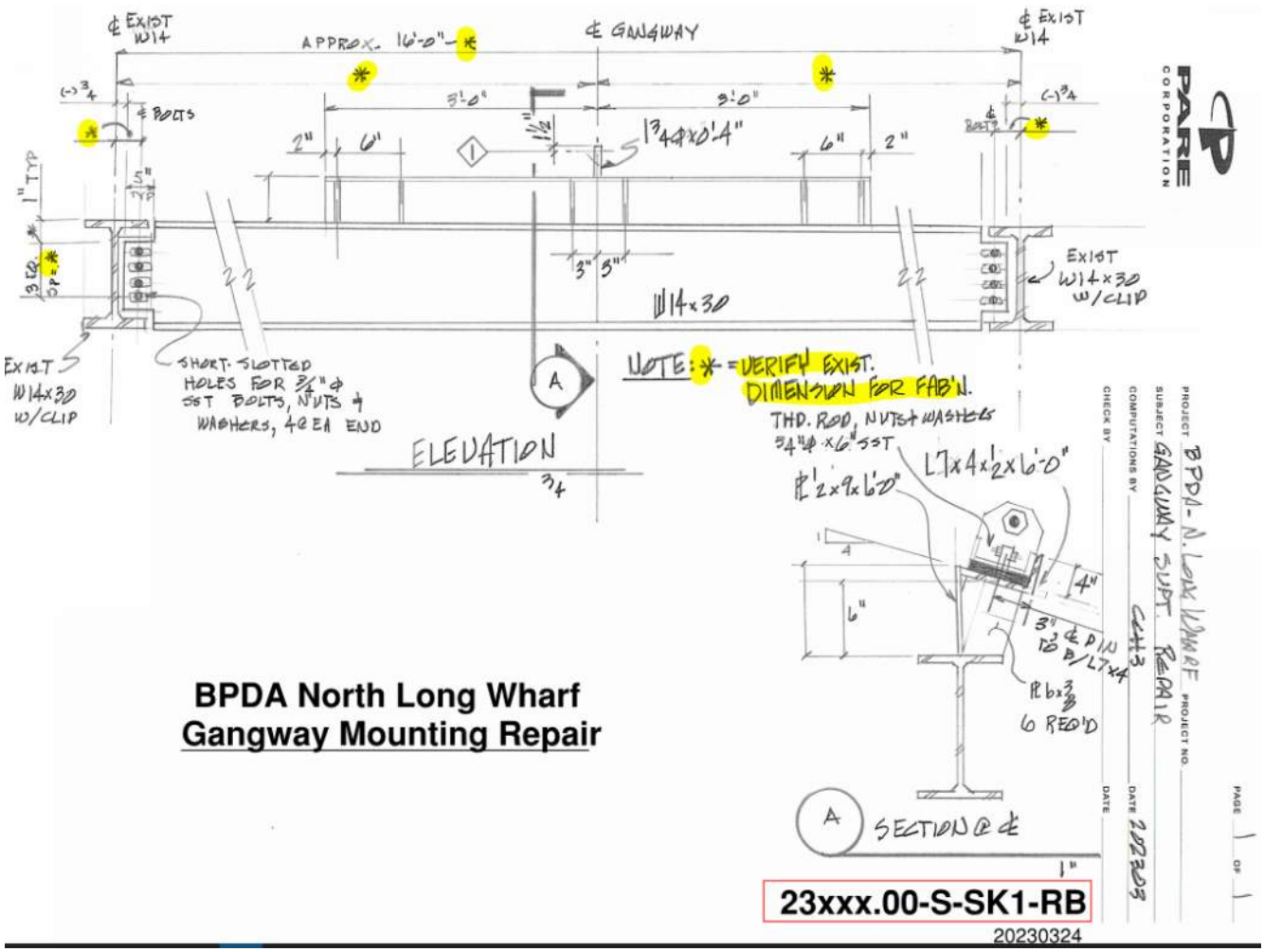
- The timber decking and timber stringers were constructed above reinforced concrete footings.
- The decking was set to align with the existing walkway at EL +9.35' NAVD88.
- The top of the steel mooring pile is at EL +15.5' NAVD88.

Image above: Long Wharf North MBTA Ferry Gate Entry Platform looking east



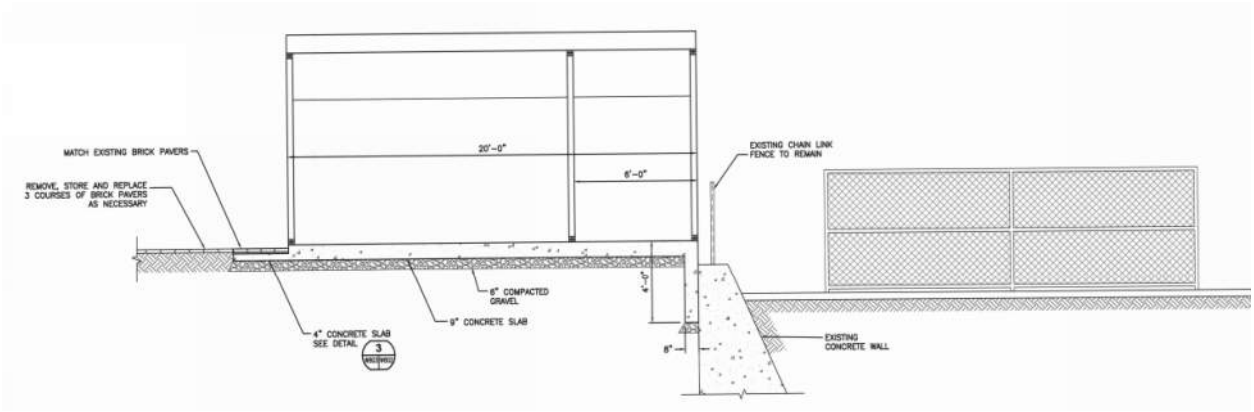
** The section background reference _ Long Wharf North Site Improvement _01/2007 (BPDA/Childs)*

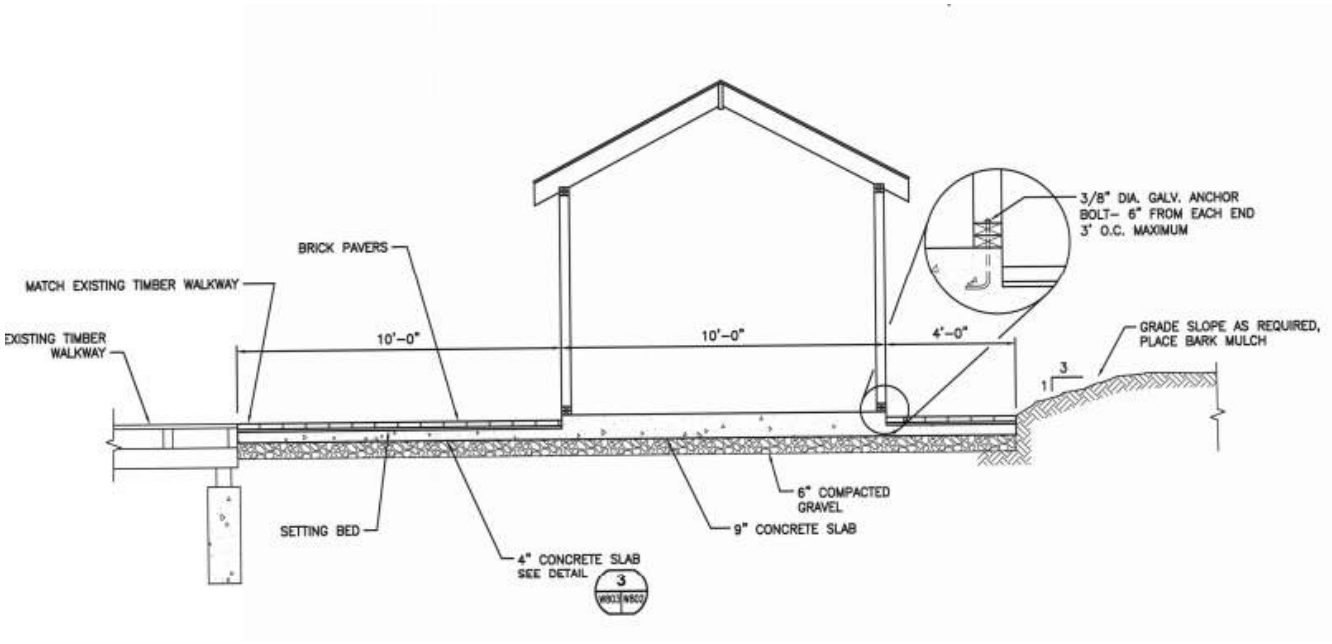
A new steel gangway connector was designed to reduce issues associated with slope inversion with the floating ramp.



** Structural fabrication detail of gangway mounting repair at Long Wharf North (Pare Corporation_2023).*

The Ferry Center/ Ticket Booth on the site is a 10'X20' wood structure on concrete slab.





** The section background reference _ Long Wharf North Site Improvement _01/2007 (BPDA/Childs)*

Present Day (Existing) Flood Vulnerabilities:

- No major past damage or existing operational issues noted.
- The 50' ramp to the MBTA/Encore ferry float can be inverted (negative slope) when coastal storm raises total water levels above ~9.35' NAVD88 (the elevation of existing walkway and timber decking).

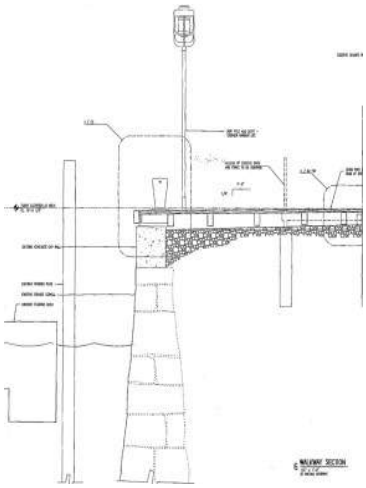
Near-term Flood Vulnerabilities (to 2050):

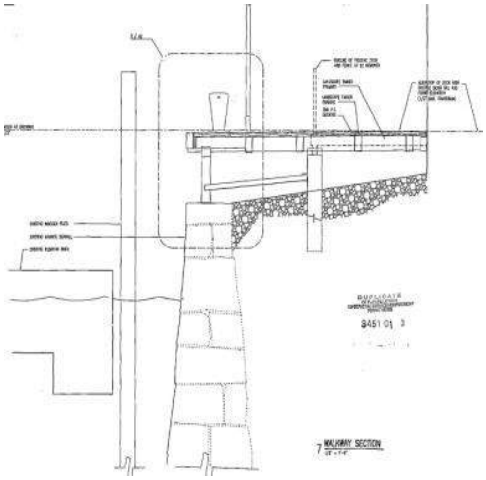
- Pilings currently extend to 15.5' NAVD88, which is only six inches higher than the near-term target design flood elevation of 15.0 NAVD88. By 2050 there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.
- Increased risk of damage or displacement of the wood ticket booth during a coastal storm event. By 2050, the ferry center / maintenance shed could experience flooding damages from king tide events, absent a major coastal storm. The wood structure cannot resist any flood forces and would leak and be likely destroyed with any wave action.

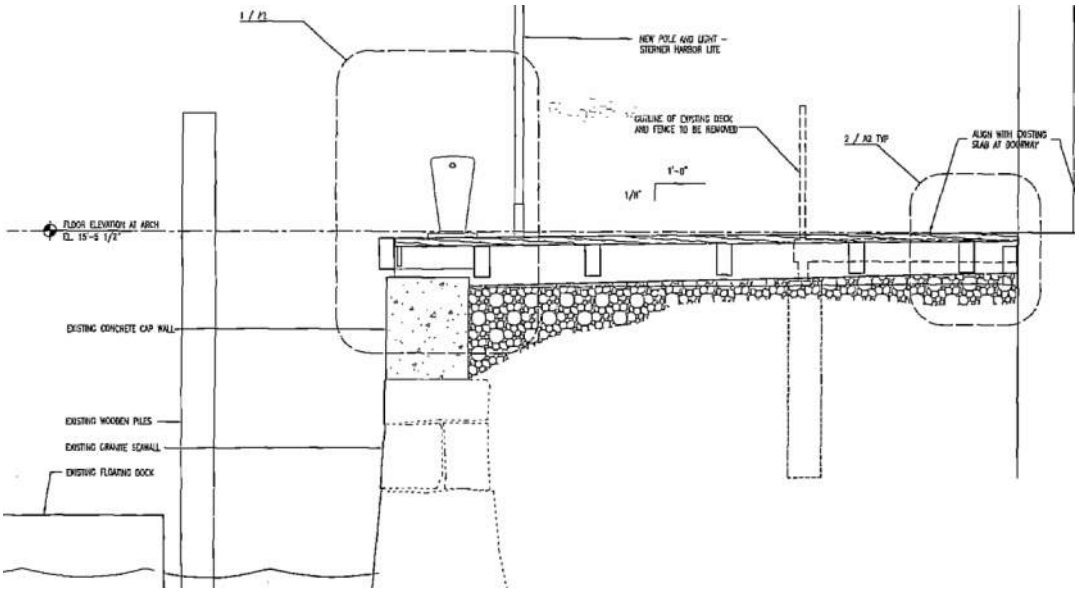
Long-term Flood Vulnerabilities (2070 and beyond):

- By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.
- By 2070, the wooden ticket booth would experience regular flooding (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)).
- Decking could be inundated twice a day at high tide.

Harborwalk North was extended towards the harbor during the year 2000 construction/renovation. The old chain-link fence, timber deck, ramp, and stairs were removed, and a new timber boardwalk was constructed and extended towards the harbor. This walkway was considered an interim condition anticipating later improvements to the area and parking site. The timber decking and timber stringers were constructed above the existing granite seawall with steel bracing braced back to the existing fence footing. The top of the Harborwalk North was indicated at EL. 8.96 NAVD88 (15.46 BCB).







** The section background reference _ Long Wharf Harborwalk Renovation (North Side)_ 09/29/2000 (ELV/ArrowStreet)*

Present Day (Existing) Flood Vulnerabilities

- Existing seawall not watertight.

Near-term Flood Vulnerabilities (to 2050)

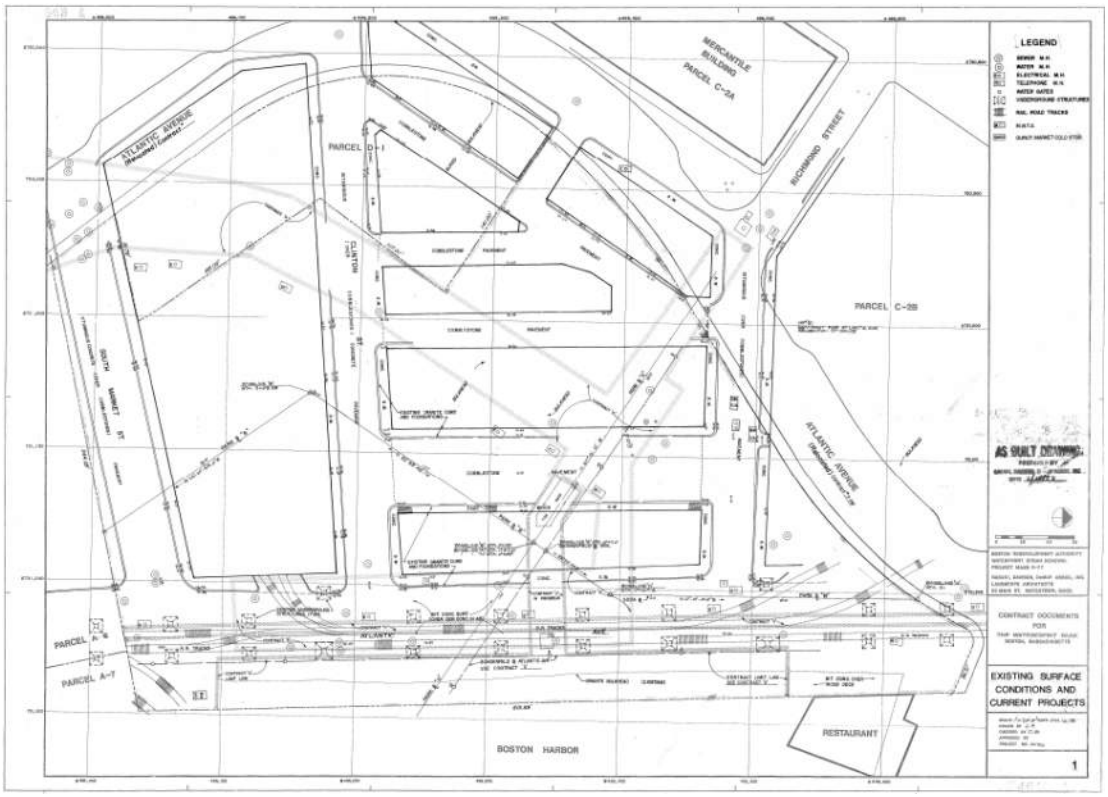
- The top of Harborwalk North would be more regularly inundated during moderate surge (i.e., 1-2' surge events) and King Tides.

Long-term Flood Vulnerabilities (2070 and beyond)

- The top of Harborwalk North could be inundated twice a day at high tide.

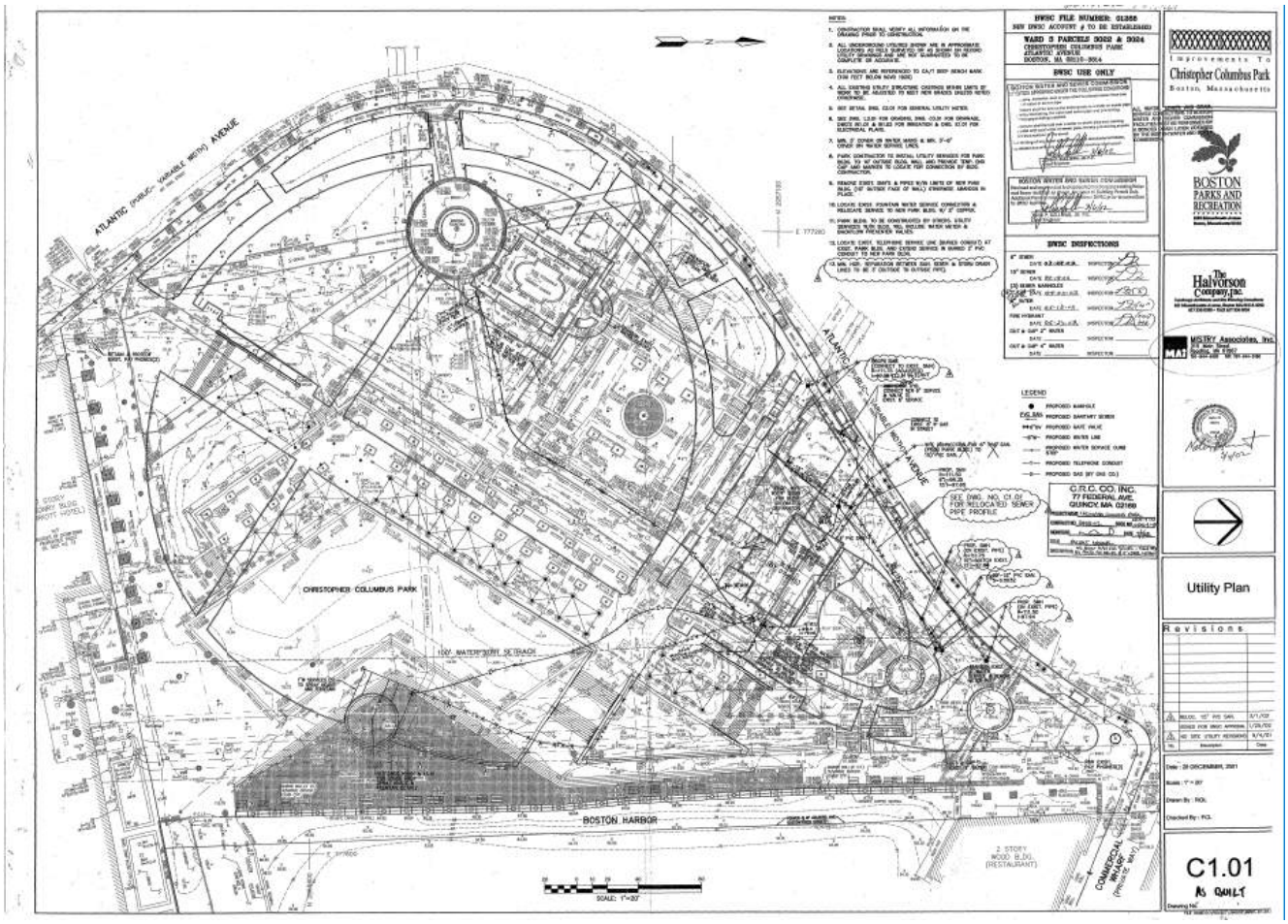
2.2 CHRISTOPHER COLUMBUS PARK

Located between Boston's Commercial Wharf and Long Wharf, this site was once populated by industrial buildings serving the city's shipping industry.



** The plan background reference _ Existing Surface Conditions and Current Projects _ 7/28/1977 (BRA Waterfront Urban Renewal / Sasaki,Dawson, Demay Associates, Inc.)*

In the 1960s, as a part of urban renewal planning, the Boston Redevelopment Authority (now d/b/a the BPDA) Waterfront Urban Renewal program envisioned a concept for a "Walk to the Sea" from Government Center to Quincy Market to the waterfront. In 1974, the landscape architecture firm Sasaki, Dawson & DeMay created a waterfront park on filled land that became the harbor's public access point.



Plan background reference - Improvements to Christopher Columbus Park - 12/20/2001 (City of Boston Parks and Recreation Department)

In 1999 a new design by the landscape architecture firm Halvorson Company produced a new performance area and additional lawn space with expanded views of Boston Harbor. Framed by Atlantic Avenue, Christopher Columbus Park is screened from traffic by generous landscaping, including numerous trees. A central lawn is bordered by a paved walkway connecting the park's central features, including Rose Kennedy Garden and an open promenade framed by a shade structure draped in wisteria vines. A circular fountain marks the park's southwest entrance, while, along the northerly edge, a linear brick path leading from the street to the harbor separates the playground and the Massachusetts Beirut Memorial (1992) from the lawn. A statue honoring the park's namesake was moved to storage in 2020 after protests and vandalism surrounding Columbus' legacy.

- The park high point is along the walkway with trellis above at EL. 14'+/- NAVD 88. The low point is at water edge ranging from EL. 7'+/- NAVD 88 to EL. 8' +/- NAVD 88.

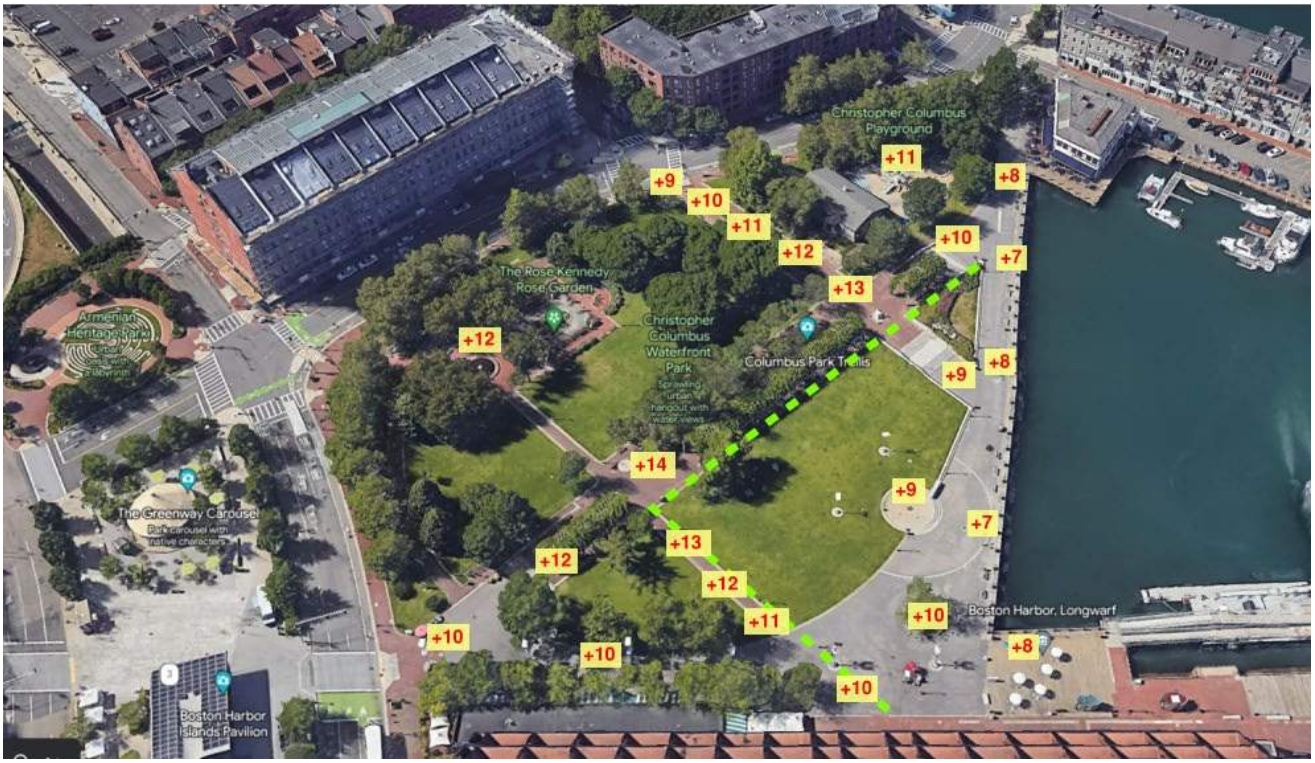
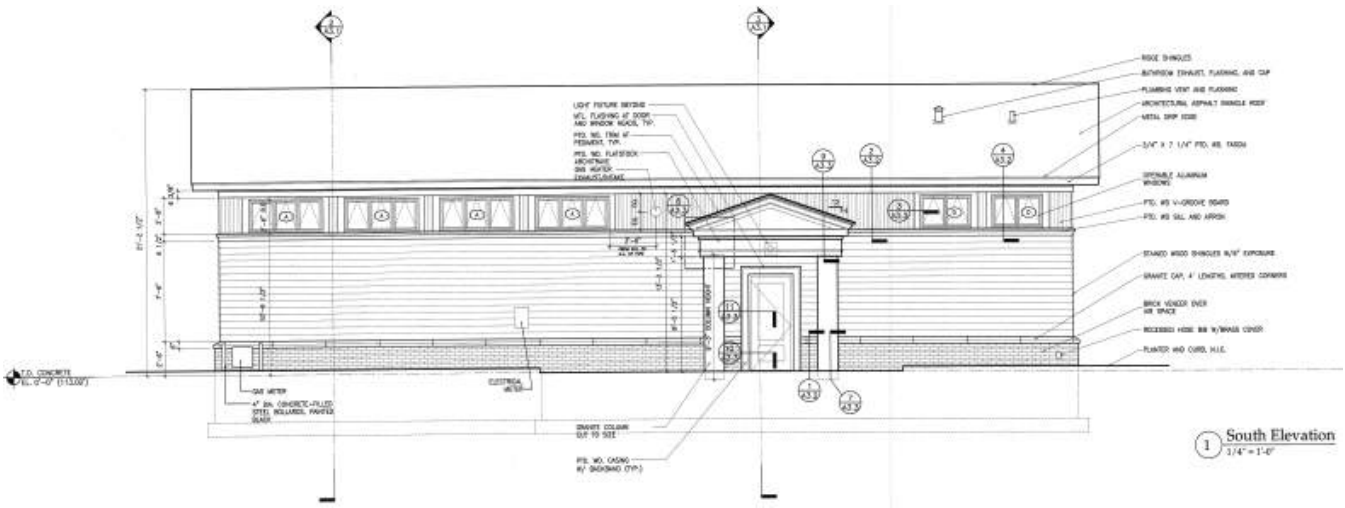
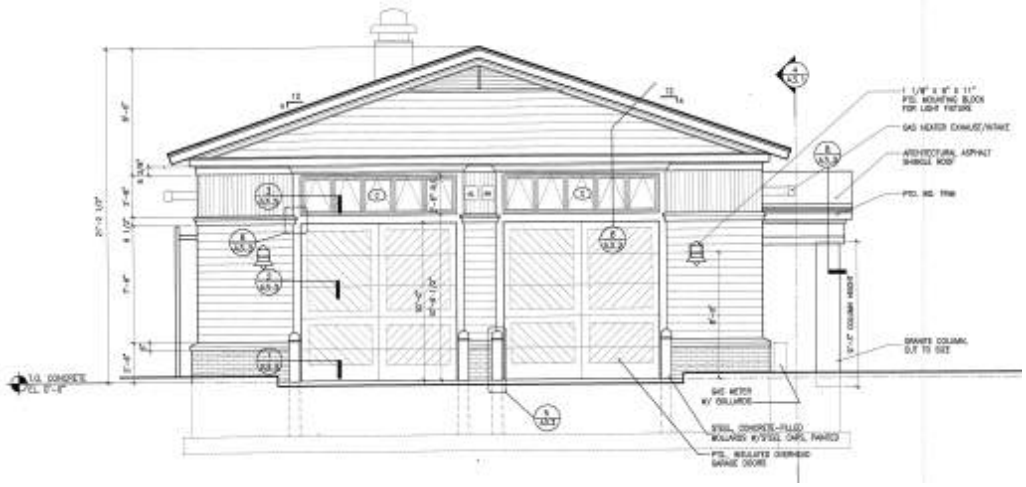


Image above: Christopher Columbus Park Elevation Diagram (all elevations shown relative to NAVD88 datum)

Image above: Christopher Columbus Park Pier Edge (all elevations shown relative to NAVD88 datum)

The Columbus Park Building was constructed around the year 2003. The building includes a garage, staff room Meter room, electrical room and two unisex toilet rooms.





Elevation and section background reference _ Christopher Columbus Park Building _ 05/28/2002 (Boston Parks and Recreation/ The Halvorson Company, Inc./ Carlone Dick LaFleche)

The building envelope is not designed to resist flooding. Details for this structure include:

- Stained wood shingles with 6" exposure over building paper and ¾" plywood.
- Granite cap over brick veneer as the building base
- The top of the slab EL. is at 12.18' +/- AVD 88)

Present Day (Existing) Flood Vulnerabilities:

- Overtopping of the existing seawall has occurred along the paved Harborwalk pathway.
- No major past damage or existing operational issues noted for the building; no floodproofing elements noted at this time.

Near-term Flood Vulnerabilities (to 2050):

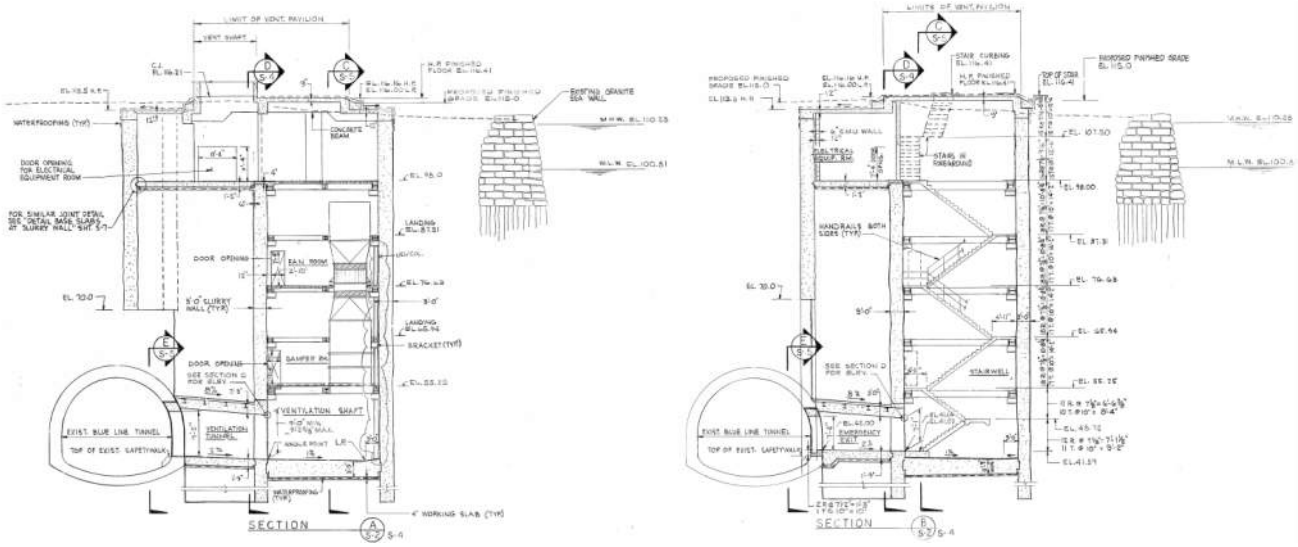
- By 2070, there is risk interior flooding (beyond the paved Harborwalk section of the park), with propagated flooding from the drainage system accompanying coastal storms with significant precipitation.
- The building will be subject to flood damage at the proposed DFE of El. 15.0 NAVD88.

Long-term Flood Vulnerabilities (2070 and beyond):

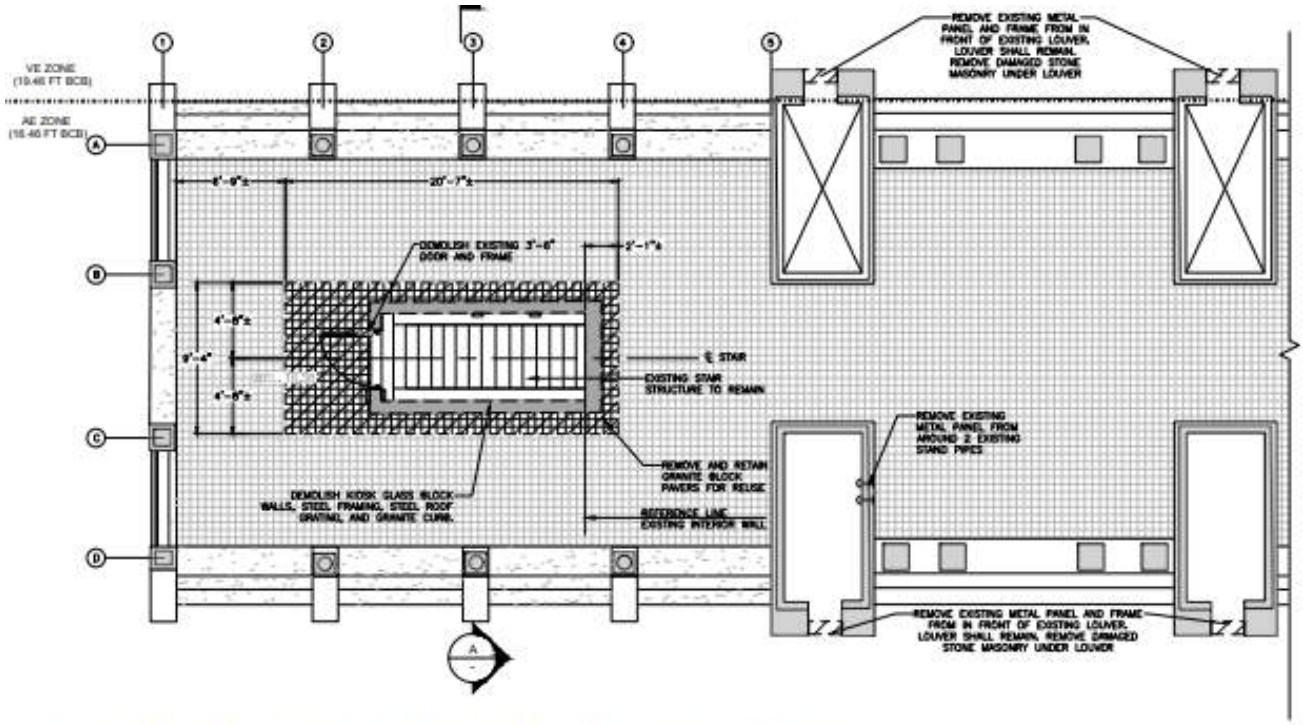
- By 2070, the park would experience regular flooding (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)), with inundation of the paved Harborwalk section of the park twice a day at high tide.
- Water levels during a major coastal flood event would reach the Park building via coastal flanking from the north along Atlantic Ave.

2.3 PAVILION

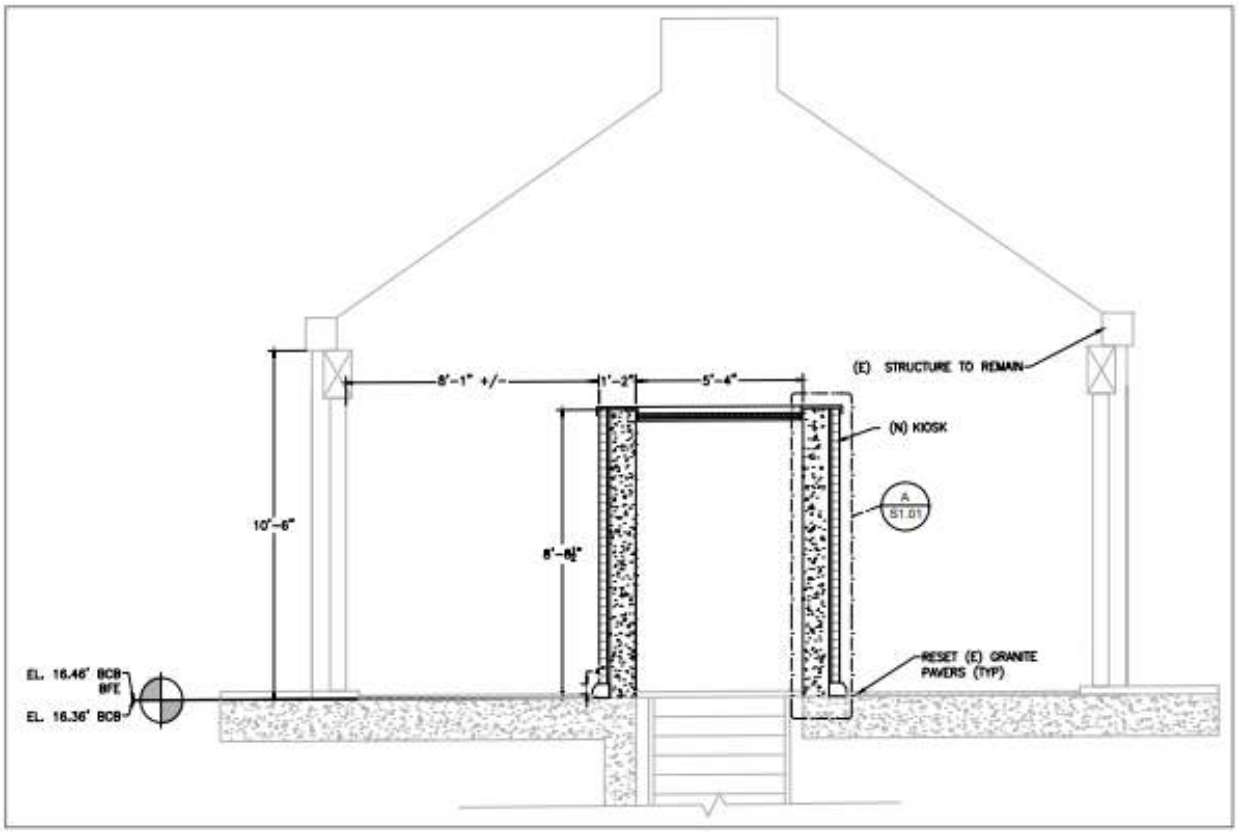
The Long Wharf Pavilion building was built in 1983 to serve as an MBTA vent building and Blue Line tunnel emergency exit. The construction documents indicated the M.H.W. EL. 110.23 (MBTA datum), and the finished grade elevation was at EL.115.0 (MBTA datum). The waterproofing was applied at the top of the structural slab and extended roughly 3' along the cast-in-place concrete structural wall below the grade. In 2018, Kleinfelder prepared engineering and design documents for the demolition and architectural design, structural design, and electrical design for a new floodproof headhouse and retrofitted ventilation structure openings. The project replaced a glass-block headhouse with a floodproof reinforced concrete headhouse with a flood-proof door. Permanent flood protection panels were installed at four emergency ventilation shaft openings including anchorage to prevent flood waters from entering the louvered vent shafts. The ground floor elevation of the egress door is EL. 9.86' NAVD88. The structure was designed to protect up to a design flood elevation (DFE) incorporating 4 feet of freeboard above the MassDOT Boston Harbor Flood Risk Model 1% annual chance flood elevation in 2030.



** The section background reference _ MBTA Subway Ventilation Improvements 1983*



ENLARGED DEMOLITION PLAN - LONG WHARF BLUE LINE EMERGENCY TUNNEL EGRESS KIOSK
SCALE: 1" =50'



Plan and section background reference for MBTA Blue Line Aquarium Station Floodproofing Improvements - 10/23/2019 (MBTA/Kleinfelder)

Present Day (Existing) Flood Vulnerabilities:

- The structure is not vulnerable to coastal flooding in the near term:
  - The Pavilion structure – which serves as an MBTA emergency egress from the Blue Line Tunnel – can become unusable as tunnel egress during major coastal storms, as floodwaters overtopping Long Wharf can result in inundation of the stairwell door, making it impossible to evacuate. But flood waters will not enter into the tunnel through the egress structure.
  - The Pavilion structure was previously retrofit in 2020-2021 to add coastal dry floodproofing measures, including the installation of a flood door (watertight door), replacement of glass walls with brick stairwell walls, and floodproofing of the exterior structure vent louvres (metal sheeting added) up to an elevation of 14.1' NAVD88.
- Present Day vulnerabilities are limited to underground leakage through the egress shaft walls and utility conduits (not necessarily storm-related risk):
  - The subsurface structure is not watertight. The MBTA is currently investigating ways to control underground leakage, but this is not within the scope of this project. The MBTA did note that much of the earth fill material on Long Wharf is very porous due to the nature of the fill material (old debris typically is in the fill). The porosity of the fill makes it

easier for tidal waters and storm surges to migrate quickly through the fill to the subsurface structures.

Near-term Flood Vulnerabilities (to 2050):

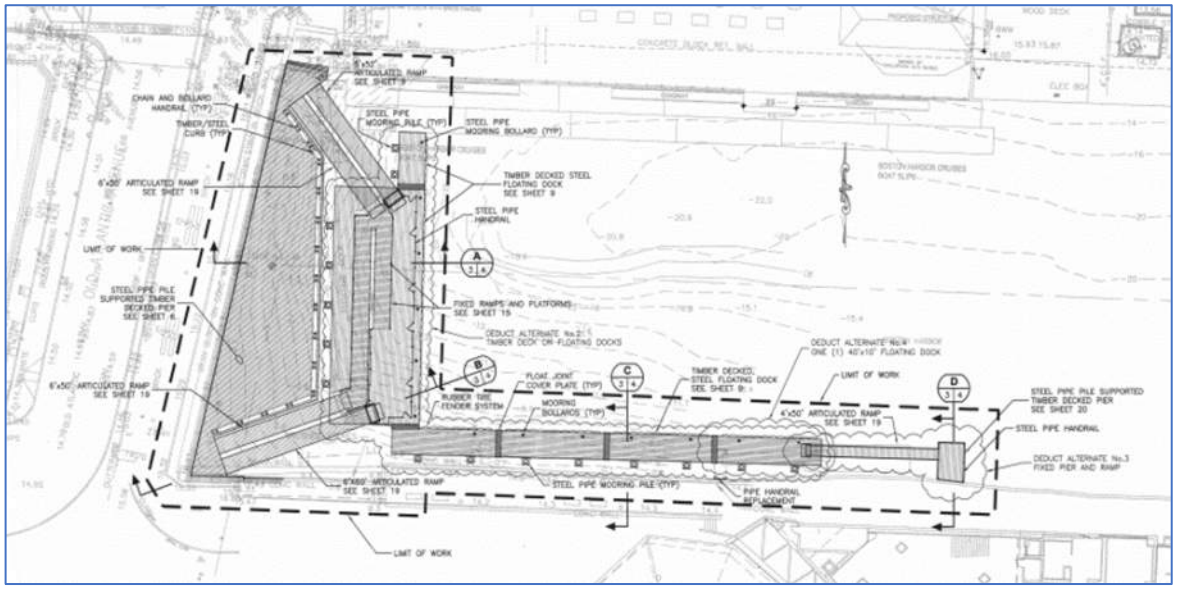
- By 2050, the frequency at which the Blue Line Tunnel egress is impeded at this location could increase. At the DFE of 15.0 NAVD88, the water levels would exceed the height of the flood panels on the ventilation louvers and would flood the Blue Tunnel below.

Long-term Flood Vulnerabilities (2070 and beyond):

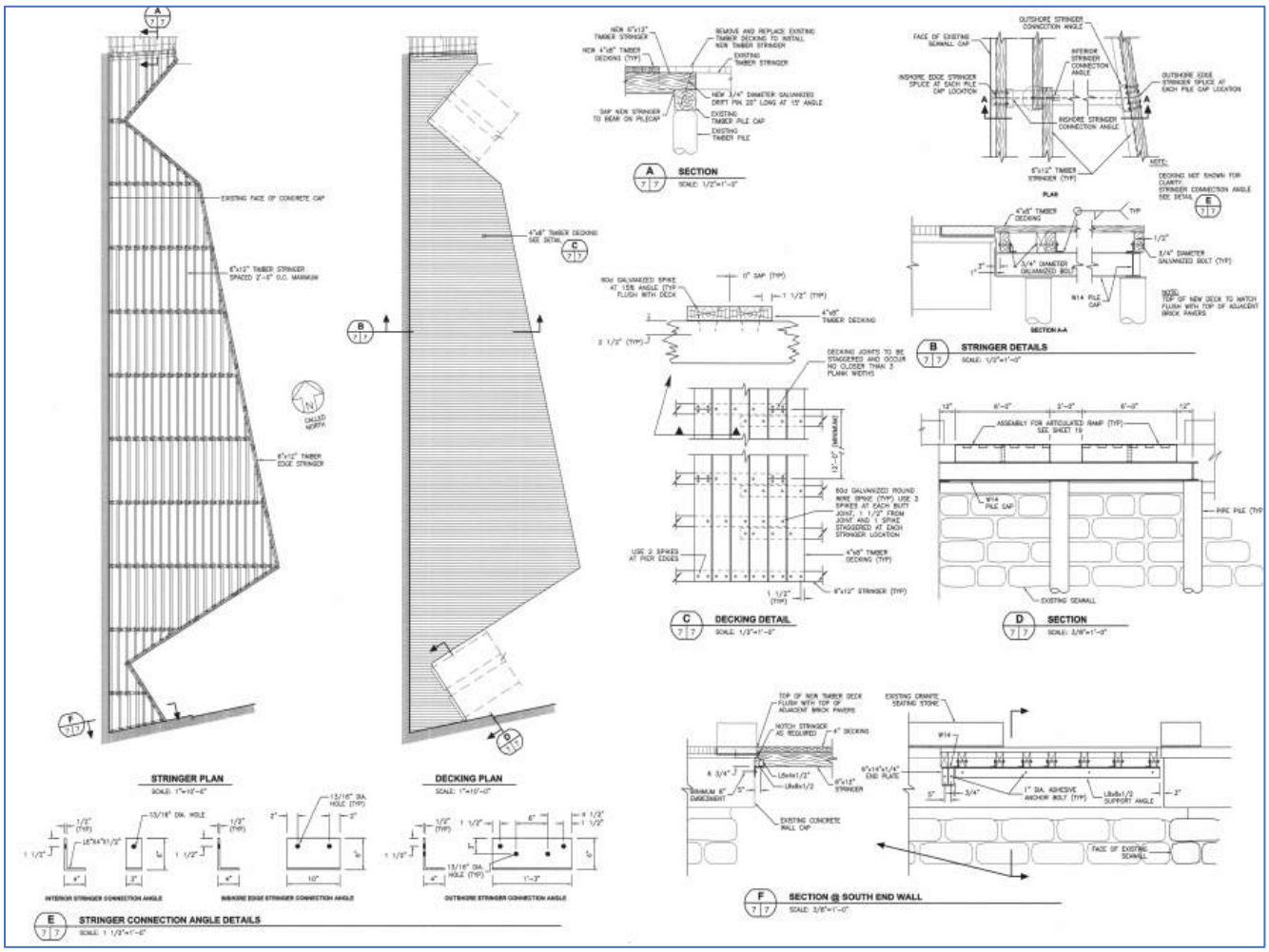
- By 2070, the Pavilion structure would experience regular flooding during elevated tide events, even absent a storm (modeled 2070 MHHW is ~9.7' NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)).
- By 2070, a major coastal flood event could overtop the maximum height of dry floodproofing at the exterior structure vent louvres (~14.1' NAVD88).

2.4 HARBORWALK SOUTH

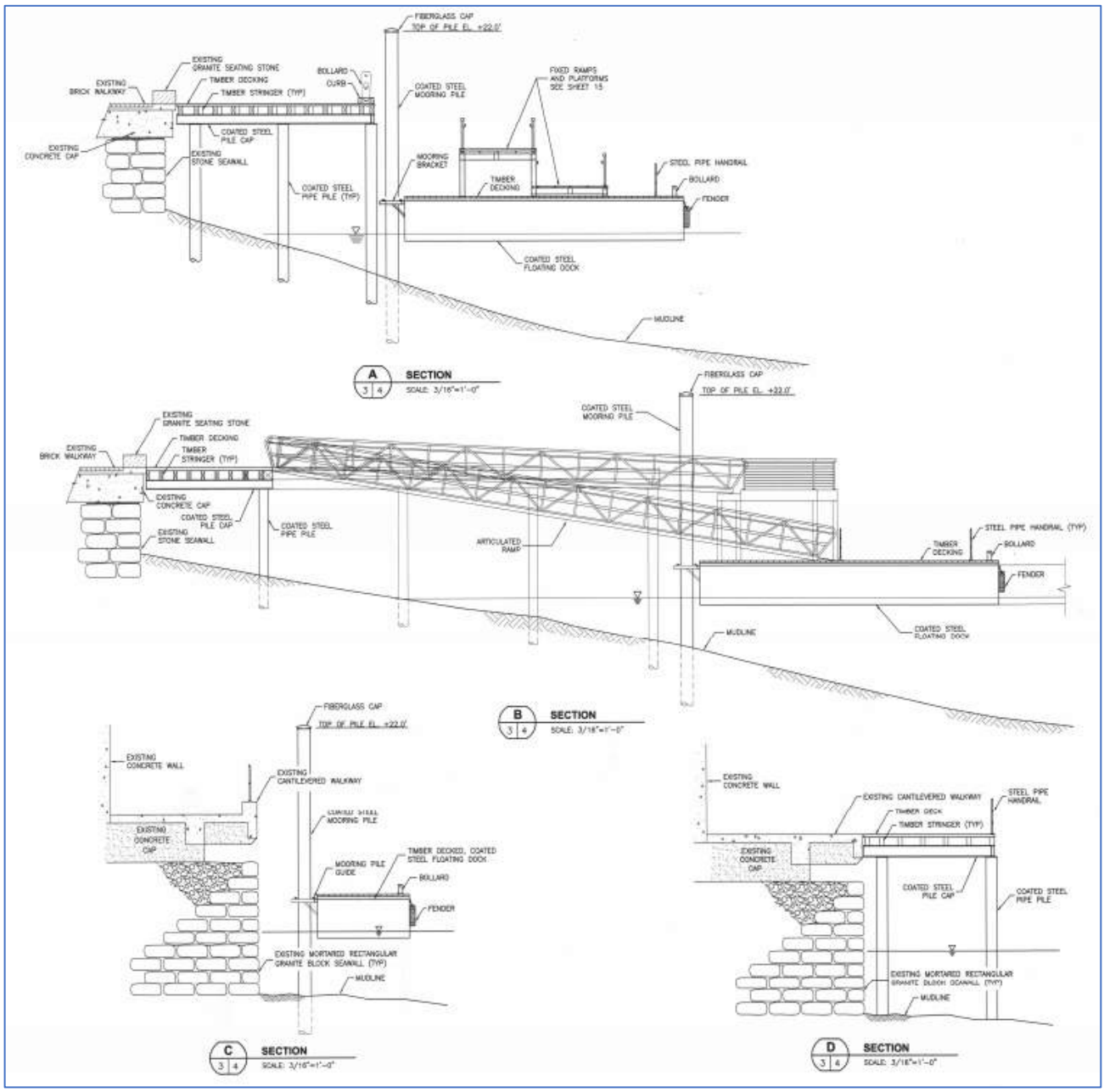
Harborwalk South is where the MBTA Ferry's Long Wharf South dock is located. The MBTA operates three year-round water commuter services through contracts with Boston Harbor City Cruises (BHCC) from this location. Public ferries to six of the Boston Harbor Islands leave from gateways at Long Wharf South. Two main MBTA service lines at Long Wharf South include ferries to Charlestown and Long Wharf South to Lynn.



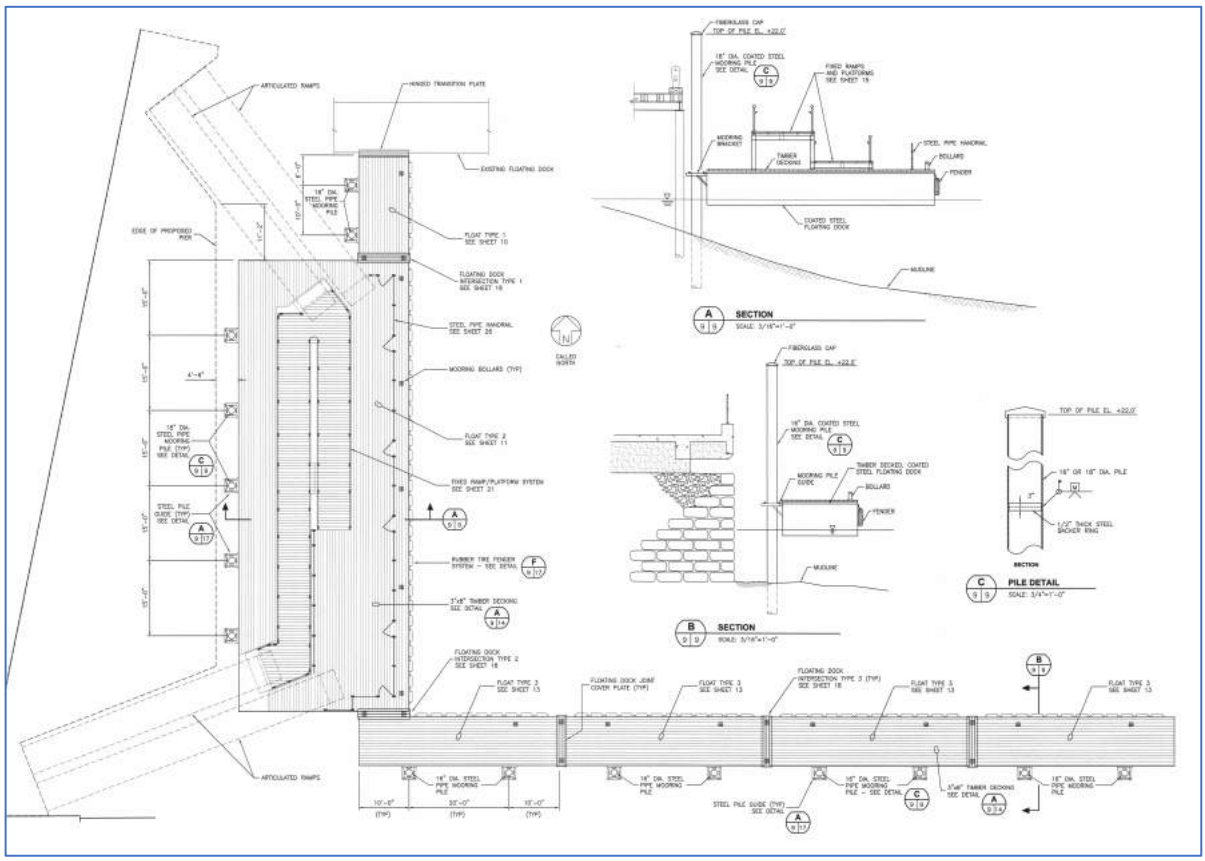
Plan background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)



Plan and section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)



Section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)



Plan and section background reference - Fixed piers, Floating Docks and Ramp System - 08/23/2000 (BPDA/Childs Engineering Corporation)

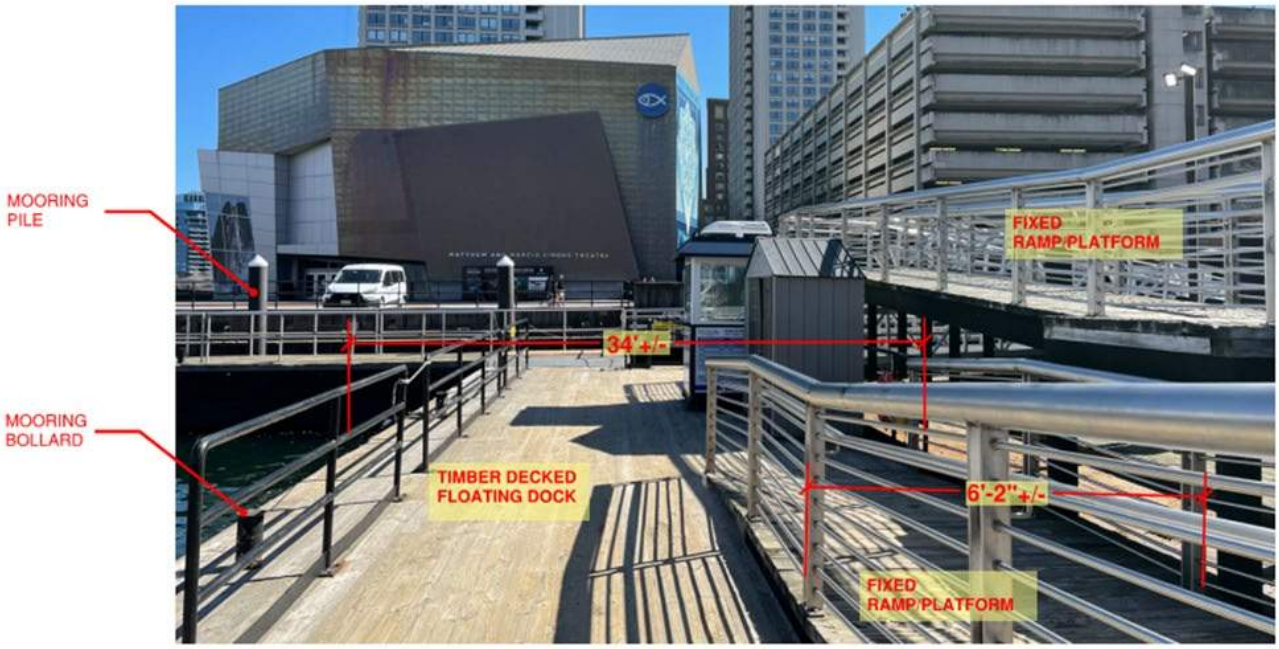


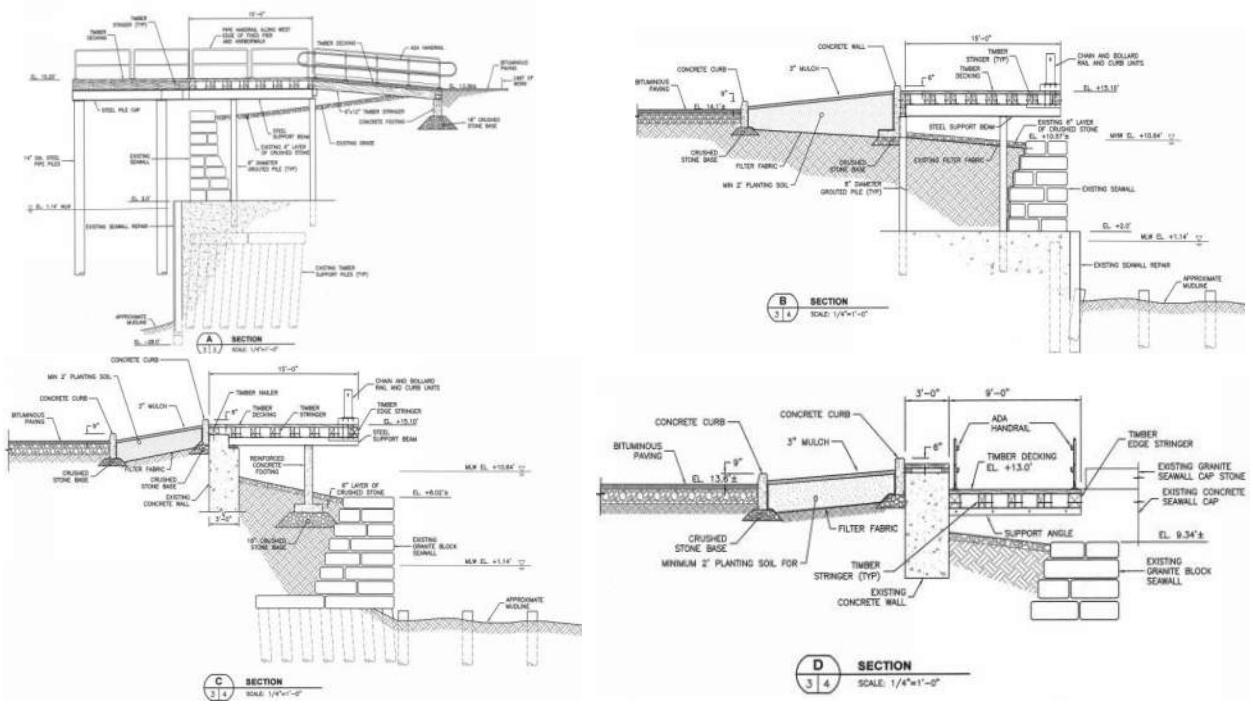
Image Above: ADA Ramp above The Float Platform at Long Wharf South

The BPDA's Long Wharf and Central Wharf Marine Transportation Facilities, Old Atlantic Avenue Berth, project took place in the year 2000. The project included ADA-applied decking, railing, platforms, ramps, float updates, etc. The project provided upgraded decking and float arrangement layout. The majority of the 3"x8" timber

decking was constructed on 6”x12” timber stringers. The timber deck is flush with the top of the adjacent brick pavers. Details at this section include:

- Existing concrete cap at the edge of old Atlantic Avenue is at 8.75’ +/- NAVD88
- A 6-foot-wide ADA ramp
- 16” diameter steel pipe mooring piles, top of piles are at EL. +15.5’ NAVD88

Reconstruction at Harborwalk South was one of the BPDA’s 2006 projects. Harborwalk timber decking and timber stringers were constructed above the piles and steel beams and cantilevered over the existing granite seawall. The existing seawall was also repaired and stabilized during the Harborwalk reconstruction. Elevations at the top of the existing seawall vary, ranging from EL +8.02’ to +10.57’ NAVD88, and the top of the Harborwalk decking is at an average EL +15.10’ NAVD88.



Section background reference - Harborwalk Reconstruction at Long Wharf South - 01/11/2006 (BPDA/Childs)

Present Day (Existing) Flood Vulnerabilities:

The existing Harborwalk structures are relatively immune to flood issues in the present day.

Near-term Flood Vulnerabilities (to 2050):

- Pilings currently extend to 15.5’ NAVD88, which is only six inches higher than the near-term target DFE of 15.0 NAVD88. By 2050 there is increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.

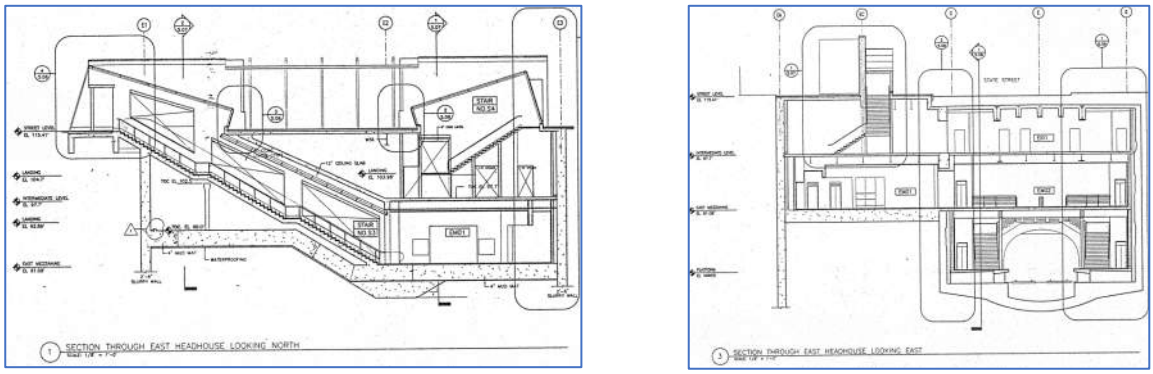
Long-term Flood Vulnerabilities (2070 and beyond):

- By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the steel pipe mooring pile) during a major coastal storm.
- By 2070, the existing seawall would be overtopped more regularly (modeled 2070 MHHW is ~9.7’ NAVD88 per the Massachusetts Coast Flood Risk Model (MC-FRM)), with inundation twice a day at high tide.

2.5 AQUARIUM STATION (MBTA)

2.5.1 MBTA BLUE LINE AQUARIUM STATION EAST HEADHOUSE

The MBTA Blue Line Aquarium Station modernization project took place in 1996. It is located under State Street at Atlantic Avenue on the eastern edge of Boston's Financial District, near Boston Harbor and adjacent to Long Wharf. The east mezzanine is located on the west end of Long Wharf, near the New England Aquarium. Two glass headhouses—one with escalators and stairs, the other with an elevator—provide access from the surface.



Section background reference - MBTA Aquarium Station Blue Line Station Modernization Project - 07/10/95 (MBTA/Ellenzweig Associates)

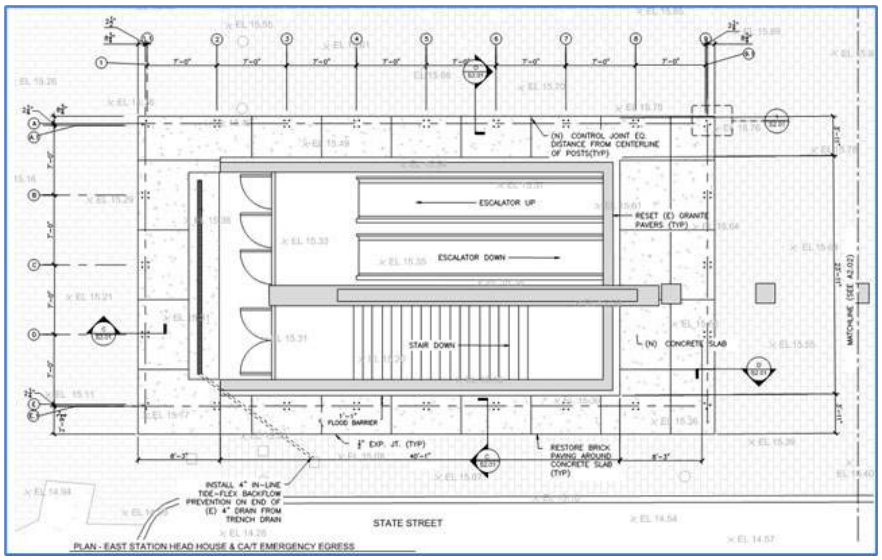
The 1995 construction documents indicate the street level at EL: 115.41’+/- (MBTA datum). Since the 1996–2003 reconstruction, the Aquarium Blue Line station has experienced repeated underground water leakage issues. The location of the east headhouse near Boston Harbor has resulted in additional coastal flooding during storm surge events. On January 4, 2018, the station was flooded by ocean water, which reached a record level of 9.66 NAVD88. A nor'easter, two months later in March 2018, which was the third highest flood of record after the Blizzard of ’78, also caused flooding that again briefly closed the station.

In 2020, Kleinfelder designed a temporary deployable flood barrier system to protect the Blue Line Aquarium Station headhouses located at Long Wharf and on State Street across the Greenway. At the East Station headhouse on the corner of Atlantic Avenue and State Street, flood proofing measures included:

- Removal of existing brick pavements and replacement with cast-in-place concrete slabs and foundations.
- Restoration of existing brick pavers to meet new concrete pavement.
- Installation of anchors in cast-in-place concrete foundations.
- Deployment, flood testing, and storage of deployable drop-in-panel flood barriers and intermediate removable support posts.
- Installation of waterproofing.
- Installation of an in-line backflow preventer on an existing trench drain line to prevent water from backing up in the drain line under the flood barrier system.

The Aquarium Station East Headhouse structure also includes MassDOT tunnel egress door TE-434, immediately adjacent to the East Headhouse elevator. This tunnel egress door leads directly to the Tip O'Neill Tunnel below. The deployable flood barrier also helps to prevent flood water from flooding the Tip O'Neill tunnel.

Image Above (Left) - Deployable drop-in-panel Flood Barriers at Blue Line Aquarium Station East Headhouse Entrances
Image Above (Right) – Tench Drain at the East Headhouse Entrance



Plan background reference - Blue Line Aquarium Station Floodproofing Improvements - 10/23/2019 (MBTA/Kleinfelder)

Present Day (Existing) Flood Vulnerabilities:

- The Blue Line Aquarium Station East Headhouse at Long Wharf is vulnerable to present day flooding as evidenced by previous flood damage at the station in 2018.
- Since 2021, the MBTA uses a temporary deployable drop-in flood barrier system to provide flood protection up to approximately EL. 13.0 NAVD88.
- Present Day vulnerabilities also include significant underground leakage through the underground structure and utility conduits (not necessarily storm-related risk). The subsurface structure is not watertight. The MBTA is currently investigating ways to control underground leakage, but this is not within the scope of this project.

Near-term Flood Vulnerabilities (to 2050):

- By 2050, the frequency at which flood waters will affect the Blue Line Aquarium Station East Headhouse will increase.
- The proposed project DFE of 15.0 NAVD88 will exceed the height of the temporary flood barrier, resulting in flooding of Aquarium Station below. This elevation would also cause flooding across Atlantic Avenue into the Blue Line Aquarium Station West Headhouse on State Street.

Long-term Flood Vulnerabilities (2070 and beyond):

- By 2070, high tides will flood the East Station headhouse twice a day, which will essentially require shutting down the East Headhouse.

2.6 OLD ATLANTIC AVENUE

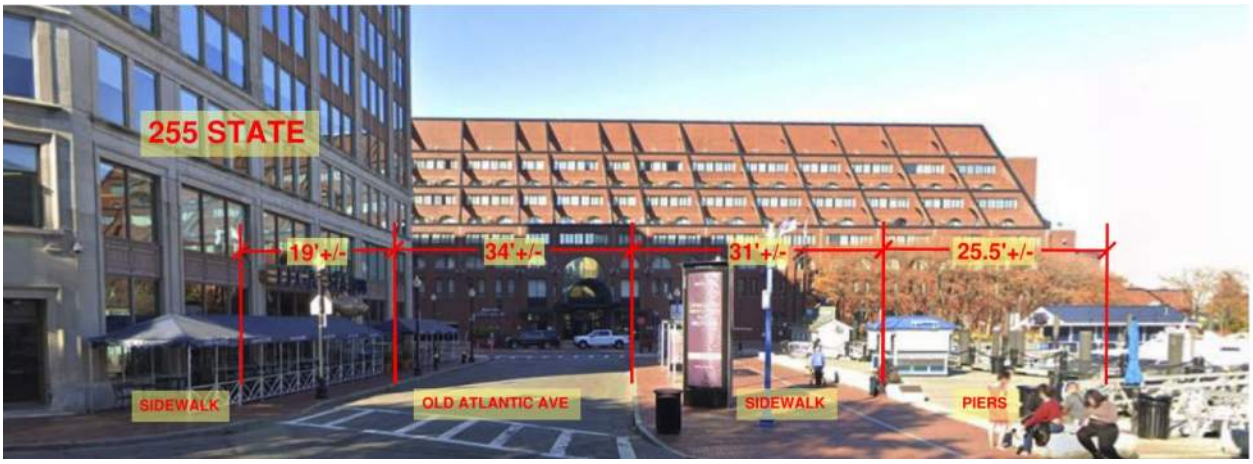


Image Above: View from Old Atlantic Avenue looking north towards Long Wharf

Old Atlantic Avenue connects State Street, Central Street and Milk Street in a north south direction. It is bounded by the 255 State Street Building and Central Wharf Plaza on the west side and the New England Aquarium and Boston Harbor on the east. It is a two-lane paved road with no markings. Tourist buses, including the Duck Boat Tours, embark and disembark passengers on the east side. There is also a drop area on the east side for the New England Aquarium.

Present Day (Existing) Flood Vulnerabilities:

- Old Atlantic Avenue is vulnerable to flooding today. It has flooded in past major coastal storms, including the January 4, 2018 flood-of-record nor'easter. The road can become impassable, but otherwise does not sustain major damage once the water recedes.

Near-term Flood Vulnerabilities (to 2050):

- Flooding of the roadway will likely increase in the future. At the DFE of 15.0 NAVD88, the road will be substantially flooded.

Long-term Flood Vulnerabilities (2070 and beyond):

- Old Atlantic Avenue will be subject to extensive tidal flooding events in the long-term.

2.7 BOSTON HARBOR CRUISES FACILITIES

There are three structures in the southwest of the Long Wharf area that Boston Harbor Cruises (BHC) use for various operations, including ticket sales for the various excursion boats and other ferries operating from Long Wharf, as well as the sale of food, souvenirs, and other merchandise. BHC operate a number of different boats, including New England Aquarium Whale Watch, the Provincetown Fast Ferry, the Godzilla thrill-ride

boat, private charters, the Salem Fast Ferry, Sunset Cruises, sightseeing cruises, Harbor Islands cruises, among others. The three structures include a ticket booth, the Landing bar and a Marine Operations building.

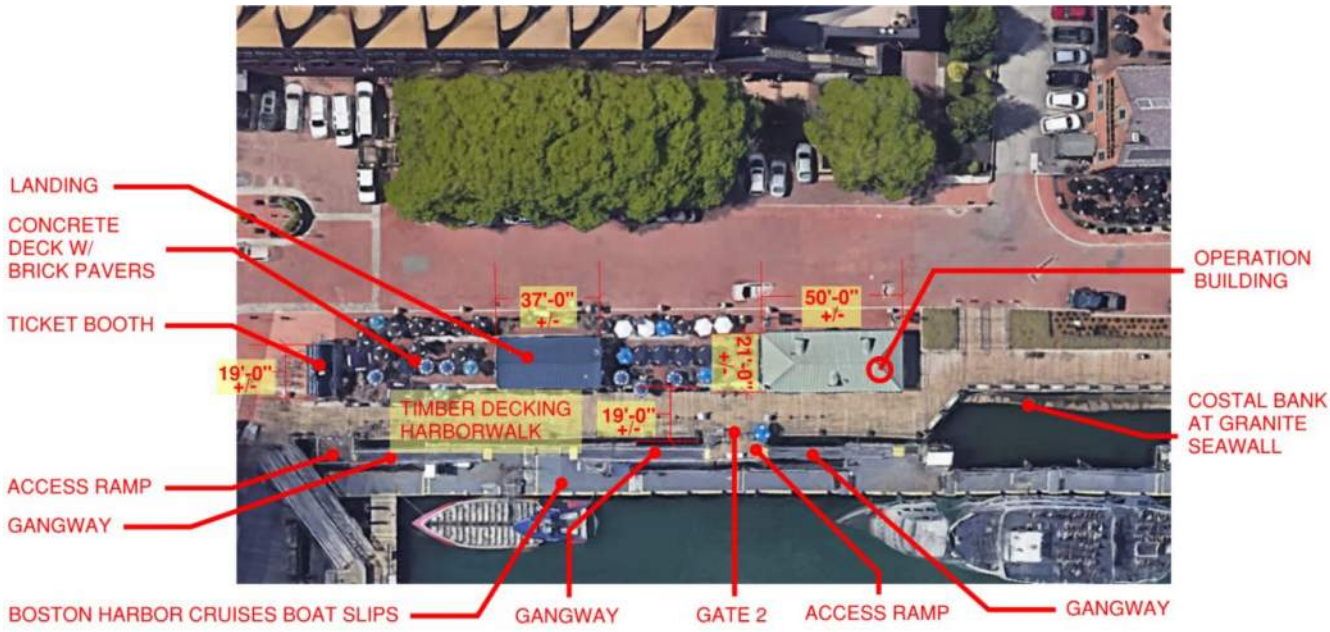
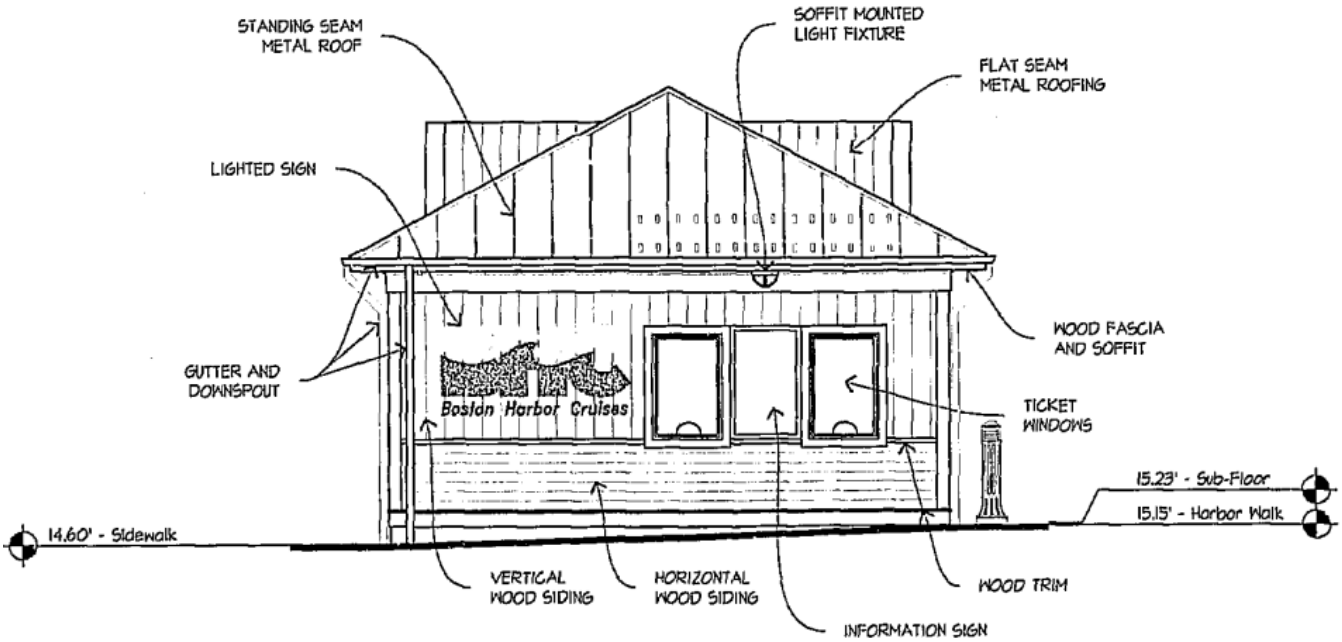
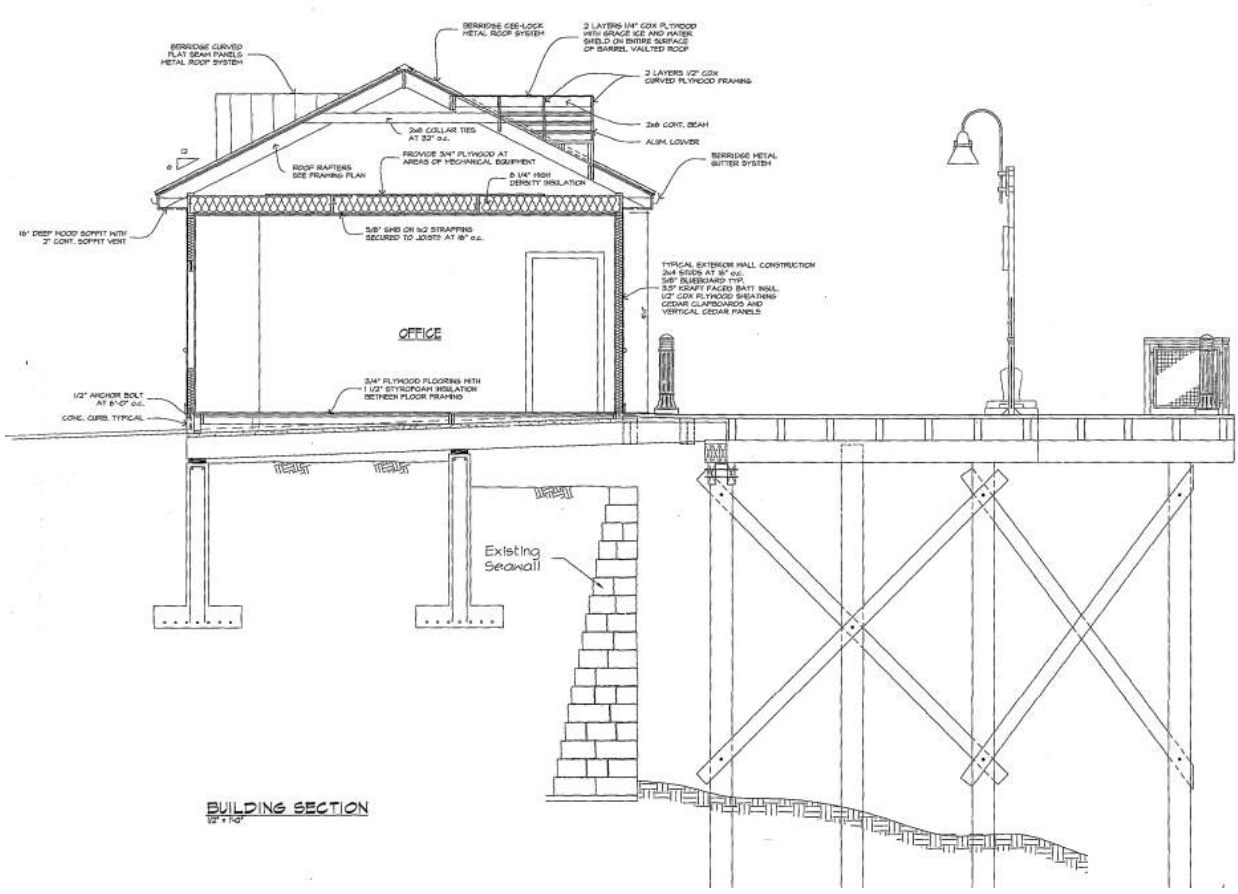


Image Above: Existing Condition Plan of some of BHC facilities on Long Wharf

Image Above: Existing timber Harborwalk along the south side of Long Wharf with BHC docking facilities on the right





BHC Marine Operations Building - Section background reference - BHC at Long Wharf- 04/28/2000 (BPDA, BHC, Modern Continental Architect)

Boston Harbor Cruises' operation office was constructed around the year 2000. The construction included a BHC operation office and a wood timber harbor walk. The nearby ticket booth and Landing bar structure were constructed in a similar fashion.

- Floor deck: ¾" plywood flooring with 1-½" Styrofoam insulation between 4x12 joists floor framing. Top of the subfloor structure EL. +8.73+/- NAVD88
- Exterior cladding: 2x4 studs w/ ½" plywood sheathing and wood siding
- Harborwalk: Wood decking with wood frame. Top of the Harborwalk wood deck EL. +8.65' +/- NAVD88
- Mooring Pile: 16" dia. steel pipe mooring pile, top of the extended Pile EL. +15.5'+/- NAVD88

Present Day (Existing) Flood Vulnerabilities:

- The existing buildings are all subject to flooding under present day conditions. The EL. 9.66' NAVD88 flood-of-record during the January 4, 2018 nor'easter was above the first floor of all of the buildings. The method of structure tie-down is unknown. The buildings are all wood-framed construction, which cannot hold back any flood water.

Near-term Flood Vulnerabilities (to 2050):

- At the proposed DFE of 15.0 NAVD88, the structures will likely be very damaged and could possibly float away. If the wood-framed structures were subject to any wave action, the structures would likely break apart.
- Dock pilings currently extend to 15.5' NAVD88, which is only six inches higher than the near-term target DFE of 15.0' NAVD88. By 2050 there is an increased risk of the docking structure becoming unmoored (floating off the top of the mooring pile cap) during a major coastal storm.

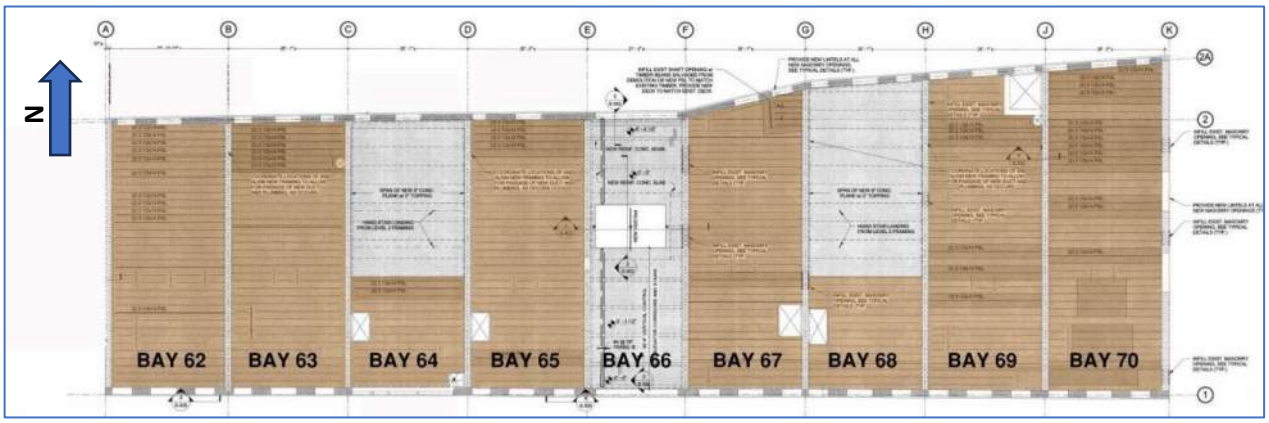
Long-term Flood Vulnerabilities (2070 and beyond):

- At water depths above the DFE of 15.0 NAVD88, the wood framed structures would likely completely fail or float away.
- By 2070, there is increased risk of the docking structure becoming unmoored (floating off the top of the steel pipe mooring pile) during a major coastal storm.

2.8 CUSTOM HOUSE BLOCK

The Custom House Block is a five-story brick and granite masonry building located on Long Wharf. The building is believed to be constructed in or about 1848. The interior floor of the building consists of wood framing supported on the masonry structure. The Custom House Clock originally served as a warehouse along Long Wharf and today is used as commercial office space. The ground level floor is at about EL. 8.91 +/- NAVD88 and the basement level floor is at EL. 0.0 +/- NAVD88. The foundation system is believed to be stacked granite blocks supported on wood pilings. The wood pilings are anticipated to be deriving their load-carrying capacity

from the marine clay deposits located below the organic silt and fill layers at depths estimated to be 35-40 ft. below the existing ground surface. The MBTA Blue Line tunnel passes under the southeast corner of the building. The basement of the building floods tidally and has flooded since at least the early 1940s. Originally, the basement was kept dry by a below-grade clay dam on the exterior of the building. The flooding is believed to be associated with the clay dam being compromised when trenches were excavated and backfilled with more porous materials to bring below-grade utilities to the building (refer to pictures in the site visit report). There is also evidence of passages on the north side that connect the basement with the harbor.



The plan background reference - Capital Properties 2017 Redevelopment

During Capital Properties 2017 Redevelopment, a part of the ground floor structure timber beams and wood plank decks were renovated. Construction was coordinated around ocean tides, with the basement level flooding twice a day. The timber flooring in three of the ground floor bays was replaced with 8" precast concrete planks with a 2" concrete topping slab (Bays 64, 66, and 68). Although the drawings show the timber flooring in Bay 64 being replaced with concrete, it appears that it was actually done in Bay 65. These floor replacements were part of a waterproofing strategy for these bays to prevent water from coming up through the floor. At Bay 65, the north electrical room, a full structural slab was constructed from masonry wall to masonry wall, along with a 42" high concrete perimeter curb flood protection on the ground floor, with a surface-mounted jamb frame and floodgate (refer to pictures in the site visit report). The top of the interior flood wall is at approximately El. 12.41' NAVD88. The transformer room is located in Bay 66. Additional information is needed for the transformers, such as platform elevation and whether the transformer units are self-waterproofed.

Present Day (Existing) Flood Vulnerabilities:

- The ground floor of the Custom House Block is subject to flooding under present day conditions. The EL. 9.66' NAVD88 flood-of-record during the January 4, 2018 nor'easter was above the first

floor of all of the units. Building management has on hand some deployable barriers that they can deploy at doorways to help slow the movement of water into the building.

- The main electrical room located in Bay 65 is fairly well protected to El. 12.41 NAVD88 under present day conditions against flooding by the concrete floor and interior perimeter flood wall.
- We are still waiting for information from Eversource on the vulnerability of the transformer to flooding under temporary conditions.

Near-term Flood Vulnerabilities (to 2050):

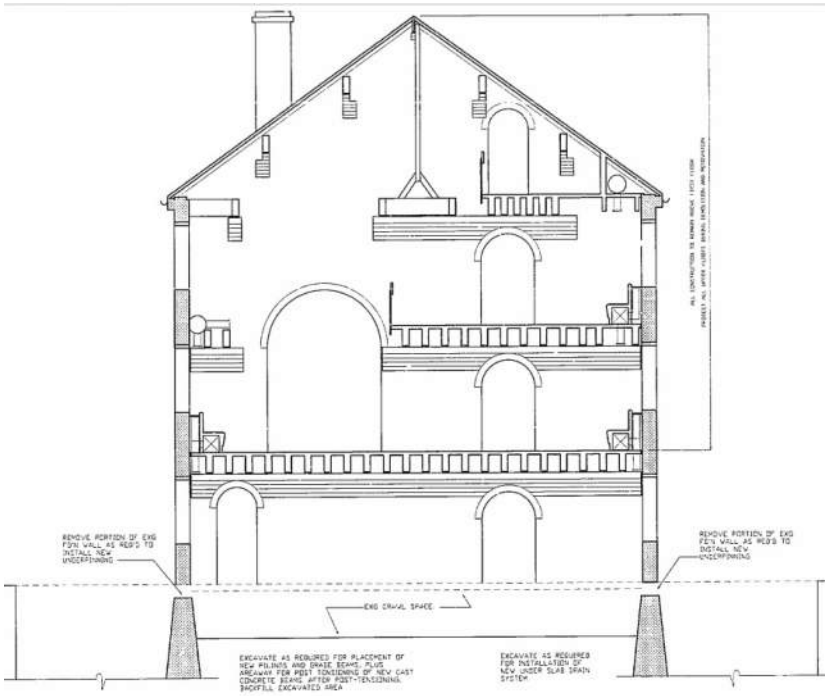
- At the near term DFE of 15.0' NAVD88, the first floors of the building will be completely inundated. In addition, the main electrical room in Bay 65 will also flood because the water will be higher than the interior concrete perimeter flood wall.
- It is likely that the glass storefront windows and doors would also be damaged at a DFE of 15.0' NAVD88. The masonry walls can likely withstand the water pressure at this depth of water, with some leakage through cracks in the masonry. Areas with timber floor would also flood through the timber flooring from the basement below.

Long-term Flood Vulnerabilities (2070 and beyond):

- At water depths greater than the near term DFE of 15.0' NAVD88, the flood damage to the building would only increase.

2.9 CHART HOUSE

The Chart House is a four-story brick masonry building located on Long Wharf. The four-story Gardiner Building, which now houses the Chart House, was built around 1763 and served as an office to Thomas Hancock and, subsequently, his nephew John Hancock. Often referred to as "Hancock's Counting House," it is the oldest building on Long Wharf. The Boston Chart House restaurant, which opened in July 1973, continues to maintain this ideal. Guests will note many original fixtures such as Hancock's safe, broad wooden beams, floors, staircase, and red brick walls. The latest records show the building underwent a major renovation in 1999. The renovation included foundation, façade, and interior repairs. The record drawings indicate below-grade excavation was done for the placement of piles and grade beams, plus excavation for an areaway for post-tensioning of new cast concrete beams. The space then was backfilled after post-tensioning. There is no indication of any special waterproofing having been installed, except a layer of "vapor barrier". The Gound floor elevation is approximately EL. 7.2' NAVD88.



Plan background reference - Chart House Restaurant - Structural Stabilization and Selective Restoration of the Chart House - 13 January 1999 (Platt Anderson Freeman)

Present Day (Existing) Flood Vulnerabilities:

- The Chart House is vulnerable to flooding under present day conditions. The EL. 9.66' NAVD88 flood-of-record during the January 4, 2018 nor'easter flooded the ground floor of the restaurant. The restaurant has also flooded been flooded several times under lesser events. Based on discussions with the restaurant staff, the previously experienced water levels have not caused significant damage to the electrical system.

Near-term Flood Vulnerabilities (to 2050):

- The near term DFE of EL. 15.0' NAVD88 will cause significantly more flood damage on the ground floor of the restaurant, including to the building's electrical system.

Long-term Flood Vulnerabilities (2070 and beyond):

- For flood events higher than the near term DFE of 15.0' NAVD88, the flooding damage will only get worse.

2.10 WATERBOAT MARINA

The Waterboat Marina, located on the north side of Long Wharf, is owned and operated by a private tenant of the BPDA. The business started in the 1800's supplying casks of water to ships. This operation lasted in 1960. The marina began operation in about 1965. The tenant owns and maintains all of the docking facilities.

The inner docks accommodate boats up to 42 ft. in length The outer docks can accommodate much larger yachts. The owner says that they do not have issues with ferry traffic going to Long Wharf North. There is a sewage pump-out service but no fueling facilities. There are bathroom facilities in the Marina for marina guests only (not for general public).

The oldest docks were installed in 2007. Docks float on 66' piles that extend approximately 20 ft. into the mud. The marina has experience storm damage from various storms, the most significant being in 2022 and later due to wave action. The landing at the top of the ramp was reconstructed in 2016. The marina has an upcoming project to replace the outer docks with deeper, wave attenuating docks.

Present Day (Existing) Flood Vulnerabilities:

- The Waterboat Marina is potentially vulnerable to flooding and storm events under present day conditions. The most significant vulnerability is more due to wave damage than it is from flooding. The docks float up and down with tide on piles. In 2018 and 2022, the docks floated up so high that the ramp was damaged and they lost access to the docks until the ramp could be repaired.

Near-term Flood Vulnerabilities (to 2050):

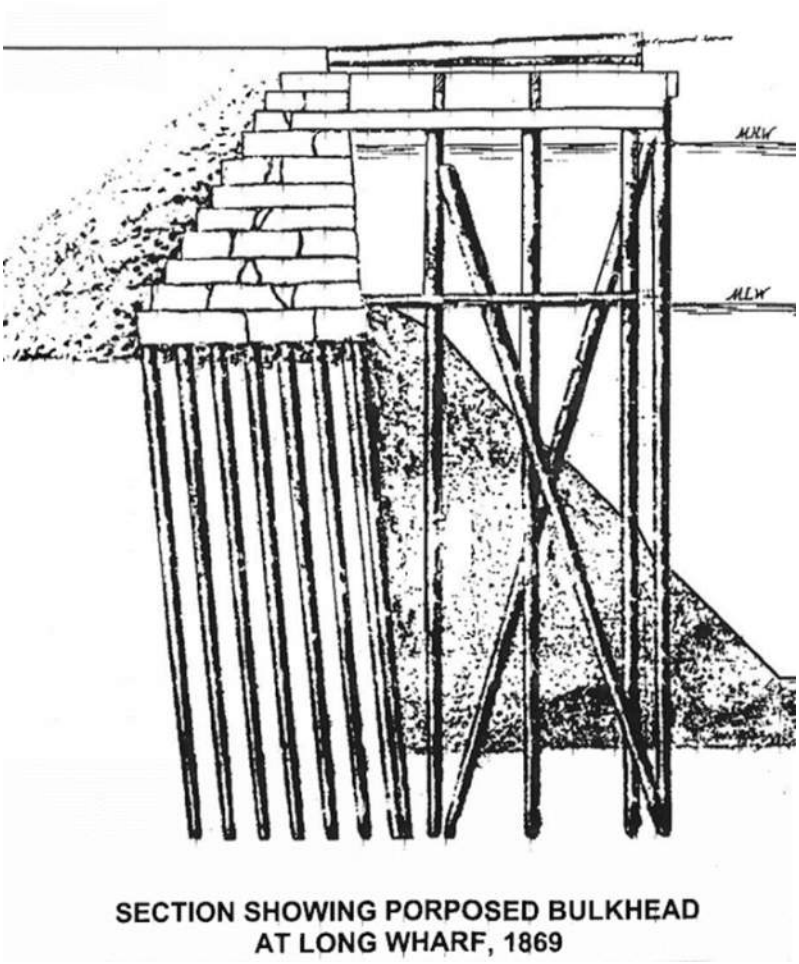
- The marina's ramp, landing area and electrical system will be very vulnerable to the near term DFE of EL. 15.0' NAVD88. In addition, the tops of pilings may not be high enough to prevent the docks from floating off the piles at El. 15.0' NAVD88. Frequency of damage to the ramp and electrical facilities will increase dramatically.

Long-term Flood Vulnerabilities (2070 and beyond):

- For flood events higher than the near term DFE of 15.0' NAVD88, the flooding damage will only get worse. In 2070 the high tide cycles will likely be too high for the existing ramp configuration to operate properly.

2.11 SEAWALL CONDITIONS

The Long Wharf site contains various granite walls of varying construction dates. The image below was taken from the "*Restoration of Long Wharf's 18th and 19th Century Bulkheads*" by Maurice Freeman, March 1984. The granite gravity walls are founded on timber piles which were designed to be completely buried by several feet.



SECTION SHOWING PORPOSED BULKHEAD
AT LONG WHARF, 1869

All of the granite walls are gravity structures and portions are supplemented with steel toe protection (either through AZ-steel sheeting or road plates). The previous repair along the South face of the wall extends to the Southeast corner of the East face (STA 6+72). Additionally, historic plans indicate that the granite blocks along the Northeast portion of the wall were restacked during the installation of the MBTA Blue Line ventilation shaft.

The Long Wharf East Face intersects the MBTA Blue Line tunnel. Based on historic plans, the center of the tunnel is located directly below STA 5+00, approximately 42’ below the top of the seawall. The tunnel is shown as approximately 30’ in diameter and a *Zone of Influence* extends for 30’ on either side of the tunnel. The approximate location of the tunnel and the 30’ *Zone of Influence* are shown in a figure below.

The entire site is located within an AE10 FEMA flood zone indicating a storm surge is likely to rise to that elevation during the 100-year storm interval event. Given that the site is predominantly at EL 7.0’ NAVD88 the seawalls are overtopped at events at lower storm intervals and during significant King Tide events.

Granite gravity walls are considered to be some of the most resilient coastal infrastructure that historically exists in urban settings. The pyramidal structures are able to be raised slightly without significant modifications to the foundations and typically were designed for higher live vertical load conditions than currently exist.

2.11.1 LONG WHARF NORTH SEAWALL

The granite seawall along the north side of Long Wharf is immediately adjacent to an intertidal area. The gravity wall structure in this area is very limited to wave exposure compared to the south and east sides of Long Wharf. The smaller blocks in this area experience the same observed voids and shifted courses however no significant structural issues or concerns have been documented.

2.11.2 LONG WHARF SOUTH SEAWALL

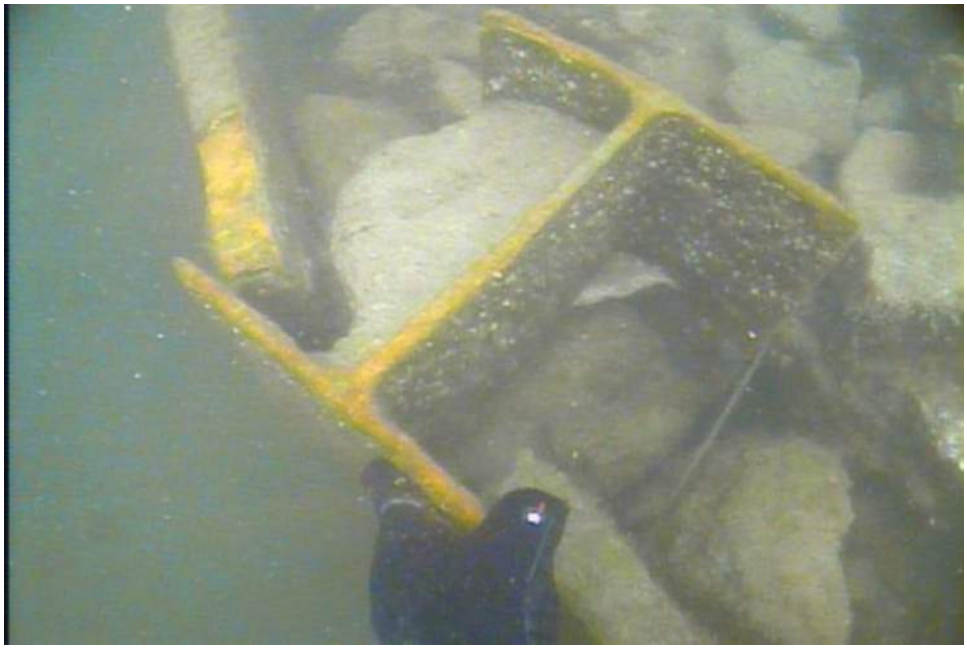
The conditions observed during the 2018 underwater inspection indicate that the granite wall from STA 6+75 to 8+50 (approximately) was exhibiting signs of global failure due to either subsidence or through deterioration of the original timber foundation piles. Scour in this area is likely due to the large vessel traffic and associated propellor wash immediately adjacent to seawalls. Aerial imagery clearly shows high velocity propellor wash directly impacting and reflecting off the granite seawall in the area of most concern. As a result, BPDA undertook a Long Wharf South Seawall Stabilization project in 2020.

A sheet pile toe-protection bulkhead was constructed adjacent to the seaward face of the existing seawall near the east end. The area between the bulkhead and the existing seawall was backfilled with flowable fill. The top elevation of the sheet pile bulkhead and fill material was -5.51' NAVD88, which is the elevation of Mean Lower Low Water (MLLW). The repairs originally included installing a geotextile fabric behind the existing seawall however plans showing existing fabric were located and this element was removed from the project scope. In addition to the toe protection, an existing granite staircase was closed.

The repairs constructed in 2020 at the east end were the third such over-sheeting repair detail along the toe of the South Seawall. Previous repairs in the 1990's were constructed of AZ steel sheet piles (see Photo 3 below) and steel road plates (see Photo 2 below). Inspections in 2018 determined that these repairs remain intact.

Methodologies involving placing grout bags along the base of the seawall have been used along the structure (see Photo 1 below), however these have not provided significant service life and are now found to be completely absent.

Photograph 1: Grout Bag Toe Repair



Photograph 2: H-Beam/Road Plate Toe Repair

Photograph 3: AZ-Sheet Pile Toe Repair STA 10+50 to 12+50

2.11.3 LONG WHARF EAST SEAWALL

Constructed identically to the south face, the east face of Long Wharf consists of granite blocks founded on timber pile foundations. The 2018 inspection noted irregular courses and significant undermining of the south half of the east seawall. The east face, is the 228 linear foot portion of the wall which extends furthest from the shoreline. The topside of this area consists of granite block pavers and cobblestones set and jointed with mortar.

The perimeter of the wharf is topped with approximately 16” high granite coping blocks of varying lengths. In areas where there are spaces between the coping blocks, bollards are mounted to the blocks and a chain is hung between bollards to create a barrier. There are two (2) historic stair access points along the East face, referred to as “steps to the sea.” The gap between granite copings on either side of these steps is spanned by a steel pipe rail. There is one jog in the seawall, at approximately STA 5+30.

The first course of the wall along the east face of Long Wharf consists of either a concrete slab, or granite block slab. The granite block slabs are approximately 14” thick and the concrete slab varies in thickness along the east face. The remainder of the courses below the top course are made up of granite blocks. Historic plans show that the bottom course of granite blocks is supported by timber piles.

East Fascia of the Long Wharf Seawall

Typical observations noted during the inspection of the granite block seawall from STA 4+44 to 5+31 included miscellaneous debris scattered along the toe of the seawall, small gaps (2" to 3") between adjacent blocks in the upper four (4) courses, weathering and cracking of granite blocks, and minor spalling along the bottom of the concrete slabs on the upper course.

The wall was observed to be relatively plumb overall and courses were generally parallel, with the exception of a small portion of the wall in the northeast corner, where stones in the second course from the top appear to be of slightly different size than typical.

Typical observations noted during the inspection of the granite block seawall from STA 5+31 to 6+72 included voids of an unknown origin, spanning up to 48" wide along the bottom course of the wall. These voids were observed to be rectangular in cross section, having a block above and below them, and on both sides. Ten (10) of these voids were observed along the bottom of the seawall, with the width varying among them and depths of at least 60", with several voids extending an unknown distance back.

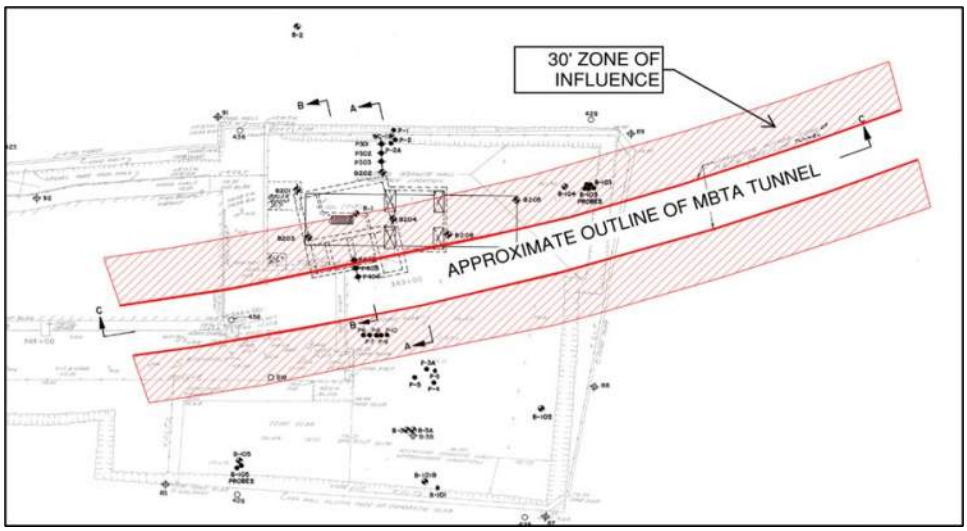
Additional observations noted for this section of the wall included scattered debris along the toe of the seawall, some of which were observed to be stones of a similar size to the typical seawall blocks, several gaps between adjacent blocks ranging from between 3" to 6" both horizontally and vertically, loose blocks at the toe, and several timbers along the toe of the wall which were cut at the mudline. The top course of concrete blocks were observed to have several areas of spalling with exposed steel reinforcement, typically within the bottom half of the block.

The previous repair at approximately STA 6+57, consisting of steel bracing to support wall stones, was observed to still be in place, however stones in this area of the wall were displaced and courses are no longer

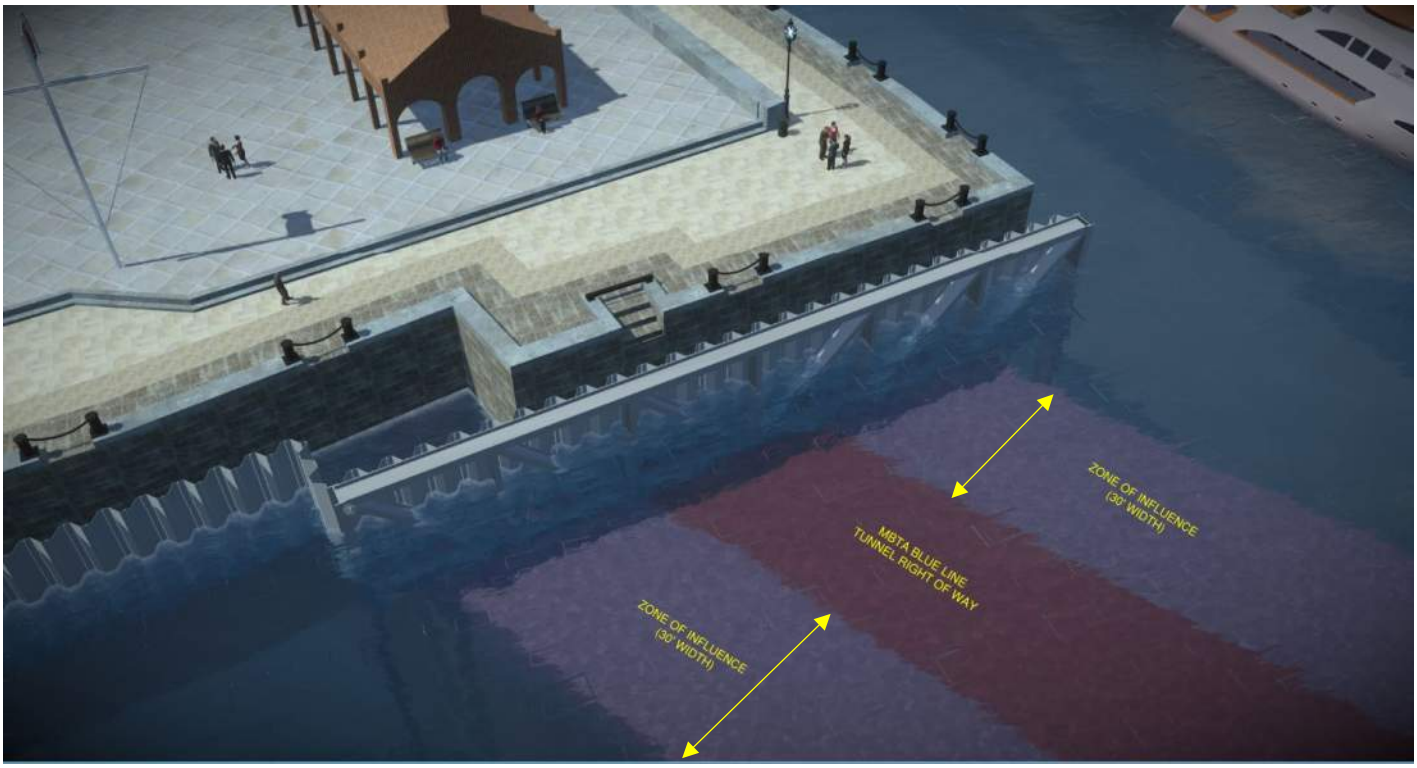
parallel along the southeast corner from STA 6+07 to STA 6+72. All stones were observed to have larger than typical voids between adjacent stones in this area.

The east face of Long Wharf is the most susceptible to coastal damage given the long south easterly fetch length and the vertical face of the granite seawall. Potential improvements to address wave and surge impacts will be complicated by the presence of the MBTA Blue Line Tunnel and the associated Zone of Influence limitations. Currently any loading within the 30' Zone of Influence will require coordination and approval of the MBTA. Foth has previously proposed a solution to bridge this area using a steel bridge beam and driven piles as shown in Figure below.

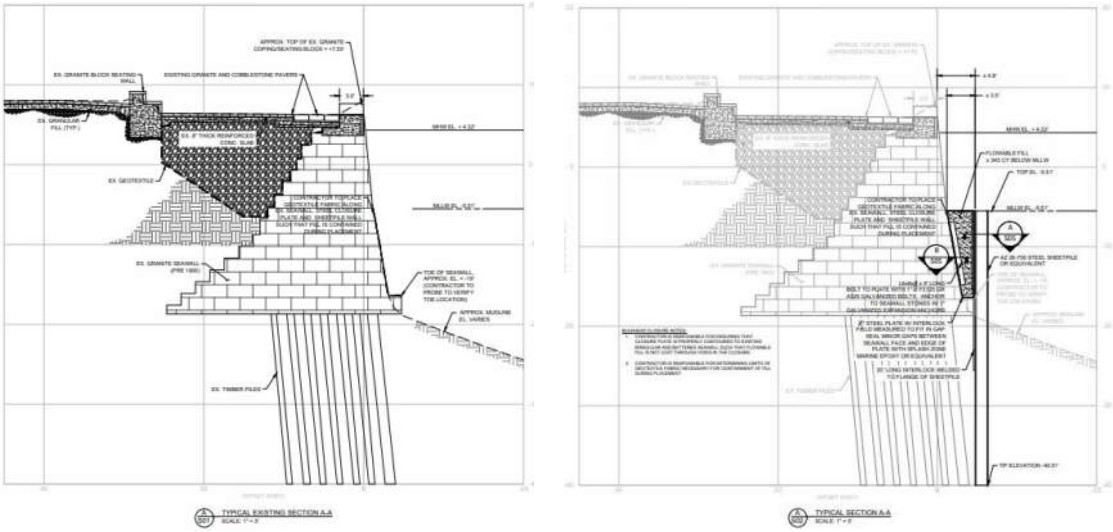
Photograph 4: Dislocated corner at the intersection of the south and east sides



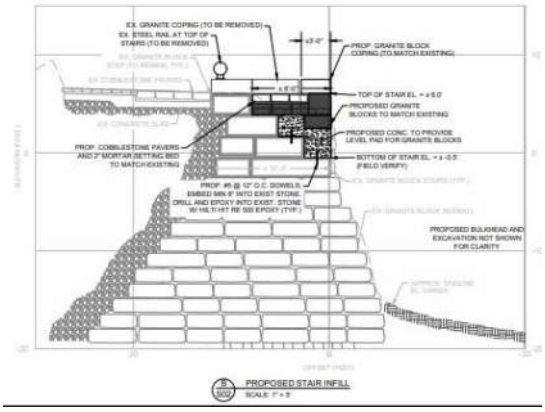
MBTA Zone of Influence



MBTA Zone of Influence



Typical Sections through Long Wharf Seawalls



Plan and section background reference - BPDA Long Wharf Seawall Stabilization - 01/24/2020 (BPDA/Foth)

Present Day (Existing) Flood Vulnerabilities:

- The existing Long Wharf granite seawalls along the south and east sides are frequently overtopped by storm surge and King Tide events under present day conditions.
- There is evidence of existing structural damage to the south and east walls that needs to be addressed to preserve the long-term functionality of the these walls.

Near-term Flood Vulnerabilities (to 2050):

- The near term DFE of 15.0’ NAVD88 will likely cause more ongoing damage to the existing seawalls if additional structural repairs are not performed to help stabilize the walls, primarily due ot increase wave action on the south and east facing walls.
-

Long-term Flood Vulnerabilities (2070 and beyond):

- As water depths increase above the near term DFE of 15.0’ NAVD88, the overtopping of the walls will only increase with more chance of wave-induced damage.

2.12 ABUTTING PROPERTIES:

2.12.1 MARRIOTT HOTEL AND GARAGE

Sunstone Realty owns the Marriott Hotel property, which they acquired in 2007. There are four main flood path entries into the Hotel building:

- The main lobby entries on the ground floor with entrances on the north and south sides of the building. The doors are glass storefront systems that are not water-tight.
- The garage entry portal on the south side of the building. There are no doors on this entry.
- The loading dock on the south side of the building.
- Tia's Restaurant on the north side of the building.

The hotel currently has some deployable flood barriers that can be deployed at the lobby entries to help to minimize water intrusion into the building for very low-level flood events. It is our understanding that there are no deployable flood barriers for the garage entry, the loading dock or Tia's restaurant. Hotel management said that at this time there are no plans to develop long-term flood barriers for the entire building.

Present Day (Existing) Flood Vulnerabilities:

- The Long Wharf Marriott is vulnerable to flooding and storm events under present day conditions. For example, during the January 4, 2018 flood-of-record storm, water did flow into the ground floor lobbies. The flood level during that storm was apparently not high enough to cause flood of the lower levels of the garage or through the loading dock. Flood from the 2018 storm did not affect electrical equipment or the elevators.

Near-term Flood Vulnerabilities (to 2050):

- Without significant flood adaptation measures, the Long Wharf Marriott will be highly vulnerable to coastal flooding at the proposed near term DFE of 15.0 NAVD88. It is out understanding that there is some electrical equipment on the ground floor that would be susceptible to flooding damage as well as elevators and the ground floor public bathrooms.

Long-term Flood Vulnerabilities (2070 and beyond):

- For flood events higher than the near term DFE of 15.0' NAVD88, the Long Wharf Marriott will experience significant flood damage without significant flood adaptation measures. In addition, in 2070 the high tide cycles will likely high enough to be causing nuisance flooding on a daily or monthly basis.

2.12.2 NEW ENGLAND AQUARIUM

The New England Aquarium (NEA) is a major tourist draw to the Long Wharf area. The NEA is in the process of developing their own 50-year Master Plan, which will include major flood resiliency adaptation improvements. The extent of their flood resiliency adaptation measures is not known at this time.

Present Day (Existing) Flood Vulnerabilities:

- The NEA is vulnerable to flooding and storm events under present day conditions. For example, during the January 4, 2018 flood-of-record storm, the facility had to be closed due to flooding and they sustained over $1.0 million in damage.

Near-term Flood Vulnerabilities (to 2050):

- Without significant flood adaptation measures, the NEA will be highly vulnerable to coastal flooding at the proposed near term DFE of 15.0 NAVD88.

Long-term Flood Vulnerabilities (2070 and beyond):

- For flood events higher than the near term DFE of 15.0' NAVD88, the NEA will experience significant flood damage without significant flood adaptation measures. In addition, in 2070 the high tide cycles will likely high enough to be causing nuisance flooding on a daily or monthly basis.

2.12.3 255 STATE STREET

255 State Street is located on the west side of old Atlantic Avenue, across from the New England Aquarium. Atlantic Avenue and the Rose Kennedy Greenway are located to the west of the building. The 12-story 1913 warehouse building was transformed into a boutique office community in a 1998 redevelopment by Pembroke Real Estate. The building has a 42" +/- active deployable flood plank system at all of the building's entrances and windows. The estimated top of the plank is at EL: 12.25' NAVD88.

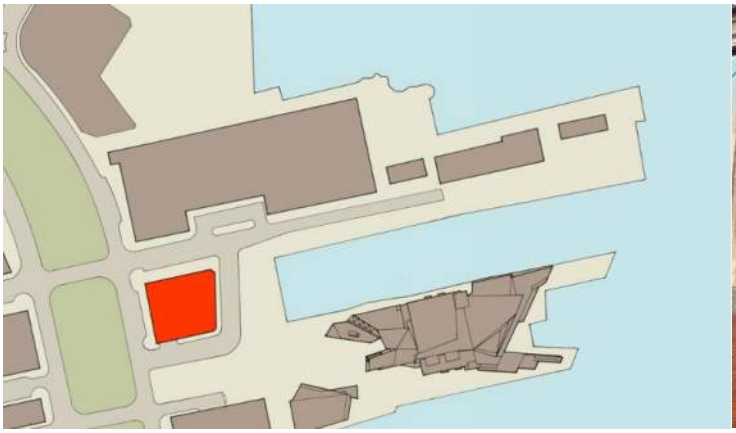


Image Above (Left): Existing Harborwalk along the Pier
Image Above (Right): 255 State Street Entrance Active/Deployable Flood Plank System

Present Day (Existing) Flood Vulnerabilities:

- With deployment of temporary flood barriers, 255 State Street appears to protected against present day flooding events up to an estimated EL 12.25 NAVD88.

Near-term Flood Vulnerabilities (to 2050):

- The existing deployable flood barriers at 255 State Street would be overtopped at the proposed near term DFE of 15.0 NAVD88, causing significant damage to the building.

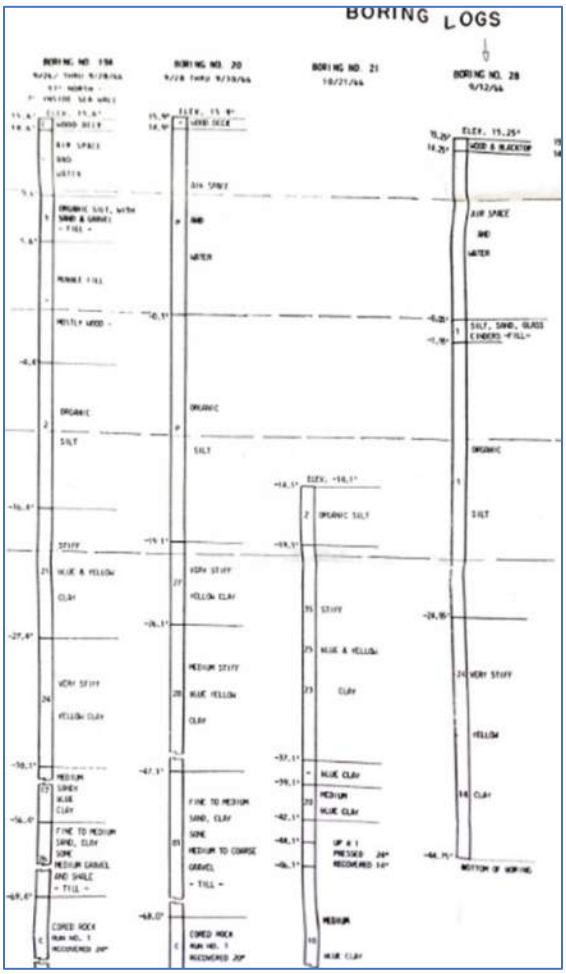
Long-term Flood Vulnerabilities (2070 and beyond):

- For flood events higher than the near term DFE of 15.0' NAVD88, 255 State Street will experience significant flood damage without significant flood adaptation measures. In addition, in 2070 the high tide cycles will likely high enough to be causing nuisance flooding on a daily or monthly basis.

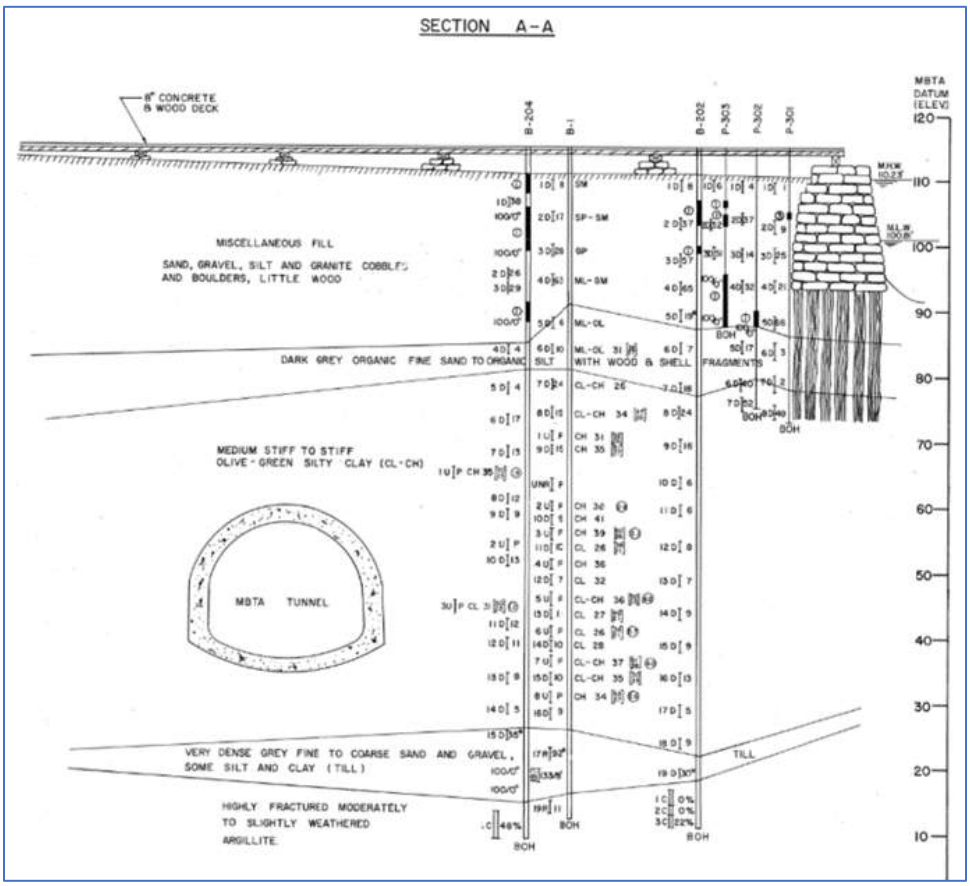
3 GEOTECHNICAL INVESTIGATIONS

Existing geotechnical conditions within the footprint of Long Wharf and the adjacent water sheet have been investigated and documented since at least the early 20th century. The earliest currently available information is from 1906, and the latest is from 2018. In total, there are 96 locations where geotechnical investigations have been performed and documented within the project area. Plans showing the approximate locations of previously performed geotechnical investigations along with the findings of the investigations are provided in APPENDIX C – GEOTECHNICAL INFORMATION SUMMARY.

Review of the boring logs indicates that the existing fill and in-situ soil stratification at Long Wharf is fairly consistent throughout the project area. Within the footprint of the wharf, the top 20’ reflects the finished wharf deck of brick and granite constructed on a layer of historic fill comprised of wood, concrete, glass, brick, asphalt, silt, sand, and gravel. Directly below the fill, approximately at the mudline elevation of the adjacent water sheet, is a loose layer of silt approximately 5-10’ deep with a thin peat layer indicated on some boring logs towards the western/landward area of the wharf. Below the silt/peat is approximately 60’ of in-situ clay material of varying degrees of stiffness and composition, and below that is a layer of boulders/shale/rock of undetermined thickness. Layer depths and material characteristics vary throughout the project site, but the description provided is generally representative of the geotechnical stratification likely to be present at any given location.



Example soil boring log from MBTA project in 1966



Soil boring log showing the MBTA Blue Line Tunnel

Plan showing historic geotechnical investigations locations at Long Wharf (see appendix)

A sufficient amount of existing geotechnical information is available via historic records to make reasonable global assessments regarding the sediment characteristics at Long Wharf. However, additional geotechnical investigations are recommended to be performed and coupled with modern laboratory testing programs to ascertain the location-specific soil parameters and information necessary to support proper engineering design depending on the nature of the work proposed. Modern recommended testing programs yield location-specific results for Direct Shear, Atterberg Limits, Soil Classifications, Soil Density, and Moisture Content.

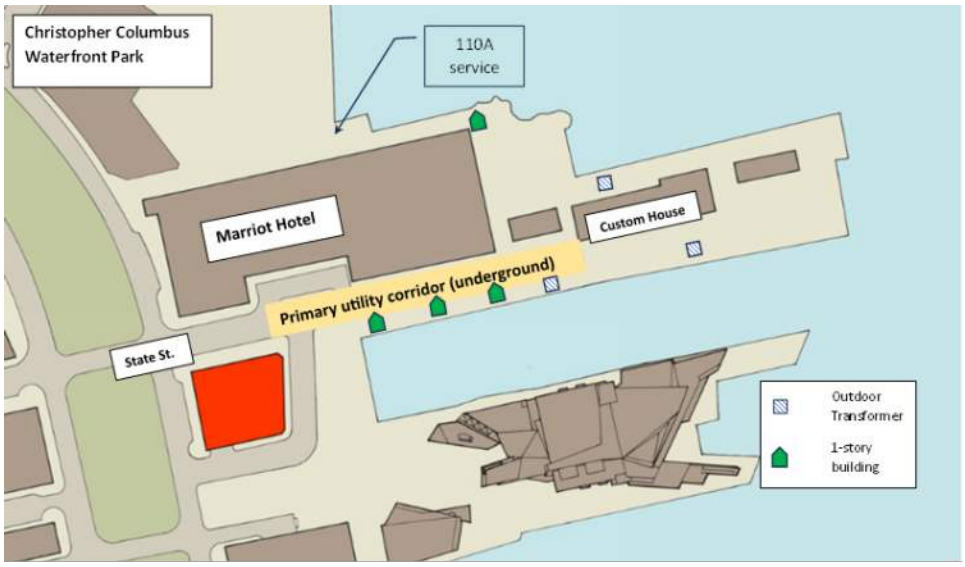
4 UTILITY INFORMATION

Utility lines and services are shown in the brick paved areas to the south of the main structures along Long Wharf. These lines connect to the main system networks via State Street. Drain, sanitary sewer, and electrical systems are of concern due to below grade voids and access points. Gas and drinking water distribution lines are also shown on plans, but these pressurized networks are not believed to have any below grade openings, such as meter or valve pits.

The MBTA Blue Line tunnel crosses below utility line elevations along the south side of the site.

The gas and drinking water distribution pressure systems are considered to be at a lower risk to inundation than gravity flow and electrical networks. No large subgrade structures such as valve pits are known for water or gas in the project area. Telecom may also be low risk.

Much of the underground utility system was relocated, replaced or upgraded within the last 30 years, especially along the western edge of Long Wharf, as part of the Central Arter Tunnel project.



Overview of Outdoor Utilities

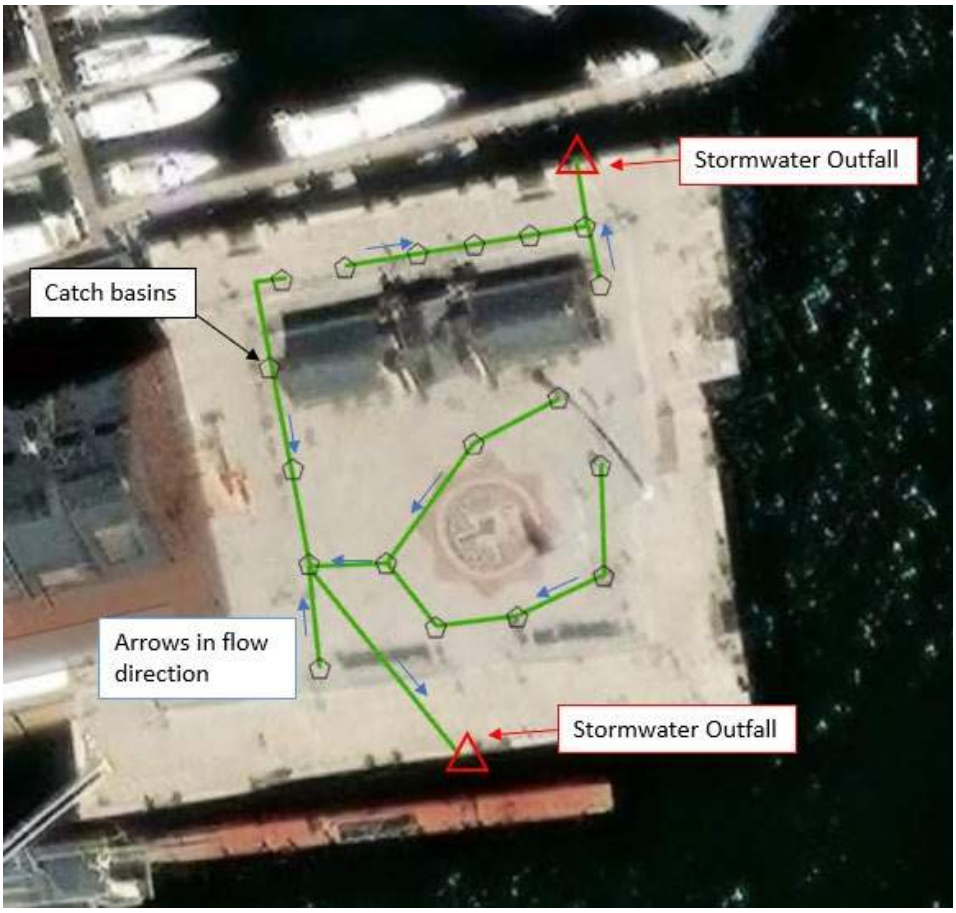
4.1 DRAINAGE INFRASTRUCTURE

Existing drainage infrastructure on Long Wharf was assessed to understand flood vulnerabilities from extreme precipitation and potential flood pathways from high coastal water levels. Data was collected from Boston Water and Sewer Commission's (BWSC) GIS database as well as record plans for the wharf and abutting properties to understand existing infrastructure on the wharf. Results indicate that three stormwater outfalls on the wharf are currently unprotected from tidal backflow, while an additional two outfalls tie into drainage

systems that include a tide gate. An overview of the drainage infrastructure on the project site as documented in BWSC's GIS database and record drawings are shown in maps 1.0 and 2.0 respectively.

Three small drainage networks on Long Wharf currently lack tide gate protection and present potential flood pathways onto the wharf during extreme high tides. On the eastern side of the wharf, flow is collected in a

series of catch basins and split via 12-inch drain lines to two outfalls sitting on the northern and southern sides of the wharf. An overview of the flow paths from these two drainage networks are shown in the figure below. All drainage pipes are relatively shallow and are believed to be above other utilities on the wharf with no shared manholes or interconnections.

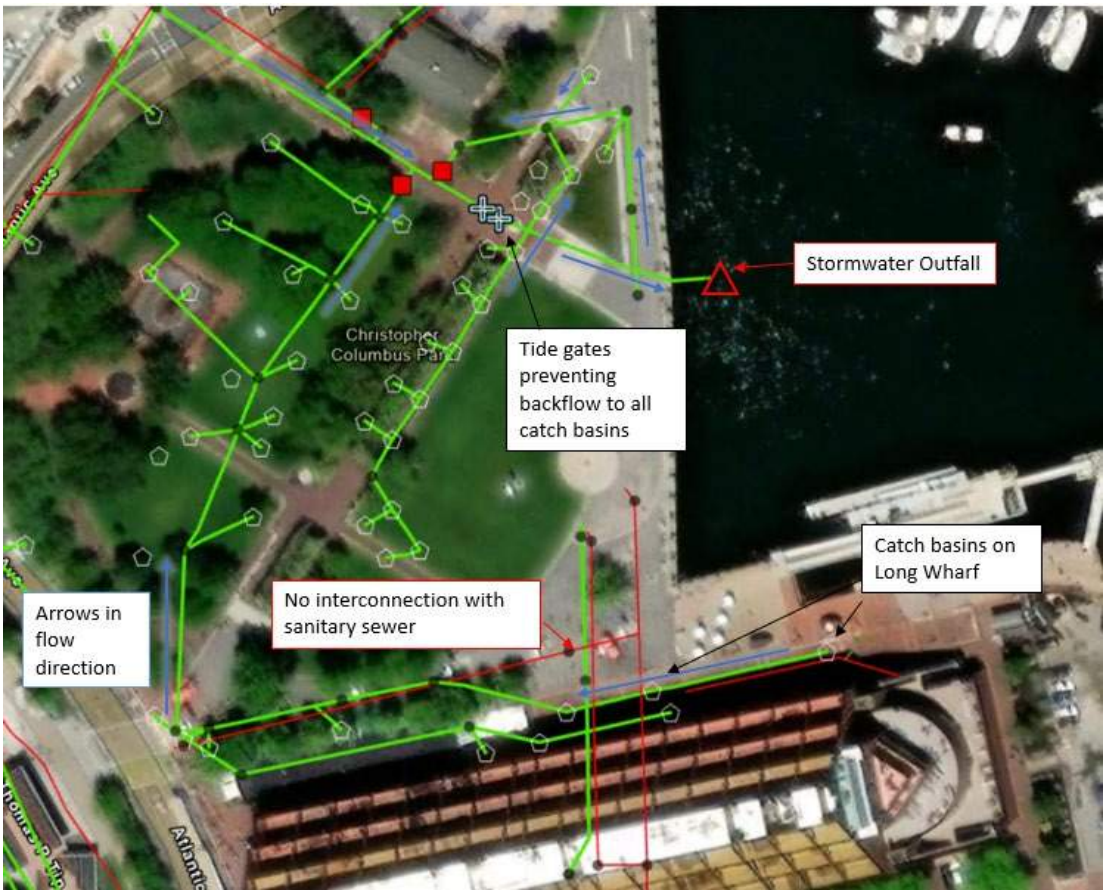


Drainage Network in Plaza at Eastern End of Long Wharf

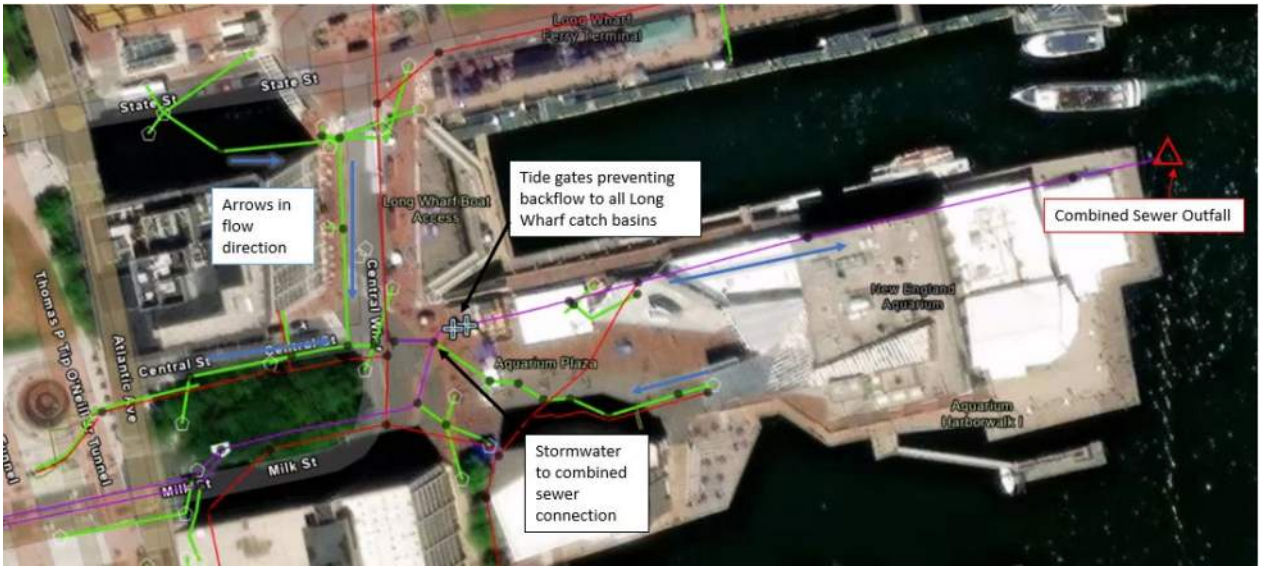
The remaining unprotected stormwater outfall sits to the southeast of the Long Wharf Marriot and collects stormwater runoff from a single catch basin that sits between the Marriot and the Chart House restaurant. The drain line was included in both BWSC's GIS database as well as multiple record plans obtained for the wharf and is conveyed through a single 12-inch PVC drain line. The drainage pipe crosses over the path of a sanitary sewer pipe running from the east end of the wharf, however, has no direct connection with the sanitary line. The remaining unprotected drain line is shown in the figure below.

Drainage Network for Catch Basin Between Marriot and Chart House

All remaining catch basins located on the wharf are routed to larger drainage networks that include runoff from parcels outside of the scope of the Long Wharf flood study. Flow is routed either north to a stormwater outfall in Christopher Columbus Park, or south where it joins Boston's combined sewer system with a combined sewer outfall located at the end of the New England Aquarium's Central Wharf. The following figures show flow paths from Long Wharf's remaining catch basins to their respective outfalls.



Long Wharf Drainage to Christopher Columbus Park



Long Wharf Drainage to New England Aquarium

- The existing drainage pipe and catch basin located between the Long Wharf Marriott and Chart House restaurant is vulnerable to coastal flooding under present day conditions. As the outlet for this pipe does not have a tide gate, water is often observed backing out of the catch basin during extreme high tides or coastal flood events. The catch basins at the east end of Long Wharf, which have drainage outlets without tide gates, are high enough on the upper plaza not to be vulnerable under present day conditions.

Near-term Flood Vulnerabilities (to 2050):

- At the proposed near-term DFE of EL. 15.0, the existing catch basins on Long Wharf, which have three outlets without tide gates, will all be vulnerable to backflow through the outlet pipes on the plaza if a perimeter flood proofing system is constructed. Tide gates would need to be installed to prevent backflow under the perimeter flood barrier system.
- Although a hydraulic precipitation model has not been performed for this project, it is safe to say that if a perimeter flood barrier is constructed, precipitation falling over Long Wharf will need to be collected and temporarily stored until it can be discharged when the tides at are lower stage. Without on-site storage, there is a chance that mild flooding could occur behind a perimeter flood barrier system from precipitation during extreme precipitation events

Long-term Flood Vulnerabilities (2070 and beyond):

- The same vulnerabilities identified in the 2050 near-term flood scenarios described above would only increase by 2070 with higher predicted extreme precipitation events.

4.2 ELECTRIC POWER

2000 Plan of Taking, Bryant Associates

Electrical power assets are shown in paved brick and cobble areas along the south side of the Custom House Block, Chart House and Long Wharf Marriott. Electrical Man Holes (EMH) access the lines serving the buildings and infrastructure along the wharf, and hand holes (EHH) are shown along the street lighting between the Long wharf Marriot and Harbor Walk.

2007 *Long Wharf North Site Improvements*

The existing 100A service owned by City of Boston for street lighting is located at deck elevation on the North side of Long Wharf. This service also supplies power to the two proposed Wood structures: Maintenance Shed and Ticket Booth with floor elevation approximately four feet above MHW (both floors EL. 8.0 +/- NAVD88). One 60A service is shown for each structure, with PP, EUH, electric baseboard heater, receptacles, lighting, and outdoor receptacles on bollards. Conduits for these systems are shown to be run on the underside of decking in this area.

Numerous electrical service meter cabinets are known to be located on the lower floor of the Custom House Block.

The 2015 *Existing Conditions Plan of Land* by Feldman Land Surveyors shows transformers located close to the wharf edge to the North and South of the Custom House Block. These are presumed to be at grade, no size or cabinet rating details are known.

Present Day (Existing) Flood Vulnerabilities:

- The existing electrical room located in the north side of Custom House Block Bay 65 is protected from present day flooding by an interior concrete perimeter flood wall and a concrete floor up to a water elevation of approximately 12.41 NAVD88.
- We are still waiting for information from Eversource on the vulnerability of the transformer, located in Bay 66, to flooding under present day and future flood conditions.
- We are still waiting for information from Eversource on the vulnerability of the two underground switches located in a vault just east of the Chart House to present day and future flooding.

Near-term Flood Vulnerabilities (to 2050):

- At the proposed near-term DFE of EL. 15.0, the existing electrical room located in the north side of Custom House Block Bay 65 would be flooded from overtopping of the interior concrete perimeter flood wall. All of the electrical equipment in this room would be subject to damage.

Long-term Flood Vulnerabilities (2070 and beyond):

- Flood levels above the near-term DFE of 15.0 NAVD88 would likely cause significant damage to electrical equipment associated with all of infrastructure on site.

4.3 NATURAL GAS

Assets shown in paved areas brick and cobble along south side of buildings. Gas branch line size shown as 3-inch on the 2015 *Existing Conditions Plan of Land* by Feldman Land Surveyors, one 2-inch service line to the Marriott hotel and 1-1/4- inch line to the Chart House Restaurant. There is at least one gas service to the Chart House Block (size unknown).

National Grid confirmed that they recently replaced the gas service mains on Long Wharf with a high-pressure system that is more resistant to intrusion of water from flooding.

Present Day (Existing) Flood Vulnerabilities:

- National Grid confirmed that there are no underground vaults that would be susceptible to flooding within the project area. National Grid said that the only part of the gas transmission system that would be vulnerable to flooding are small vent pipes at gas meters. Typically, the meter vents to the atmosphere using a small pipe. If the pipe is underwater that would be a

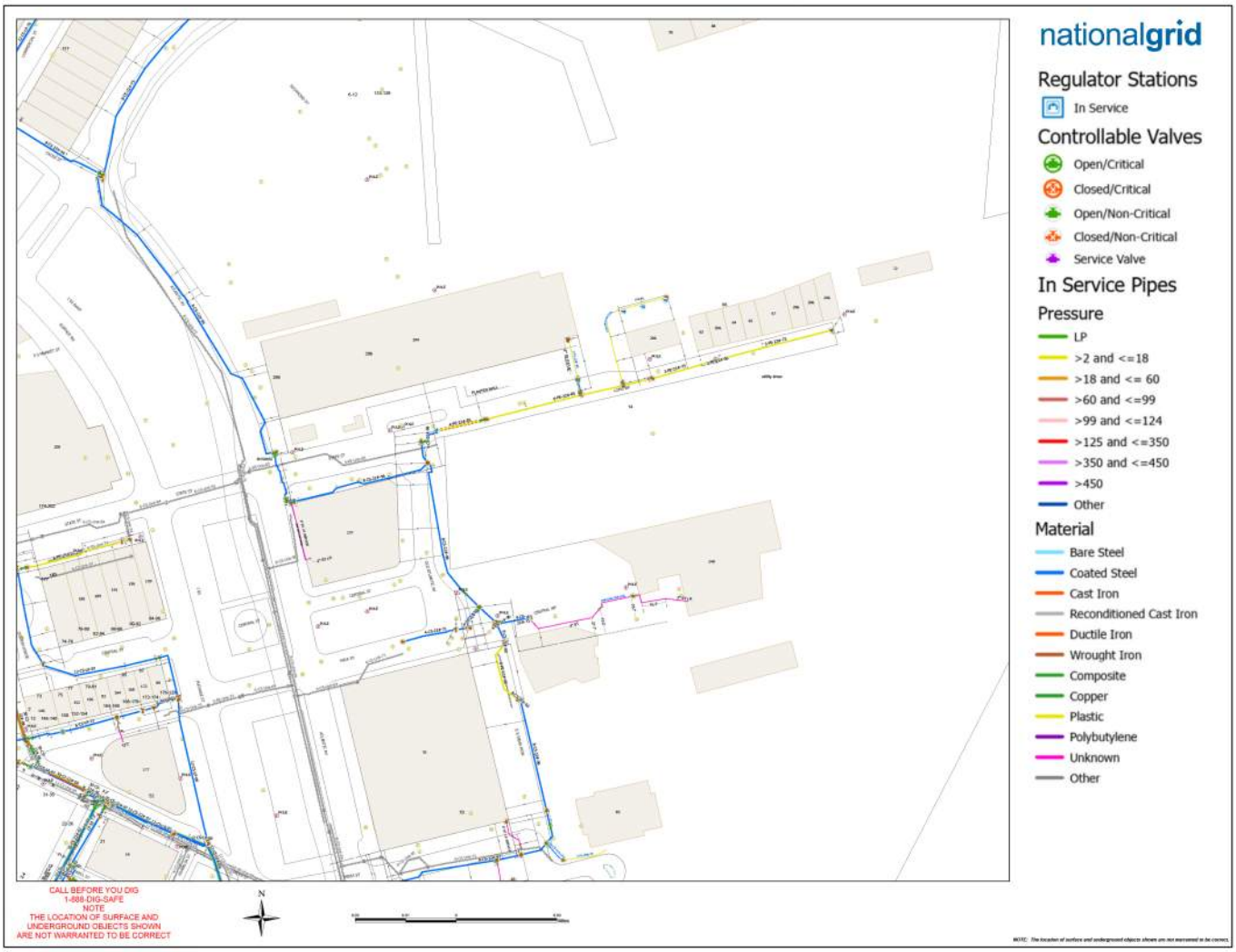
problem. It does not appear that any of the gas meter vents are susceptible to present day flooding.

Near-term Flood Vulnerabilities (to 2050):

- Gas meter vents would be vulnerable to flooding at the proposed near-term DFE of 15.0 NAVD88. The vent pipes can be extended relatively easily to above the DFE. Some gas infrastructure piping may have to be relocated to allow construction of any larger flood barrier systems as part of a near-term solution.

Long-term Flood Vulnerabilities (2070 and beyond):

- Aside from the gas vents, the underground gas infrastructure has relatively little vulnerability to flooding above the near-term DFE of 15.0 NAVD88.



National Grid Gas Distribution System for Long Wharf and Central Wharf area – Source National Grid

4.4 WATER INFRASTRUCTURE

The 2015 *Chart House and Custom House Block* figure by DGT shows a 12-Inch water branch line approximately along the Long Wharf brick paved area south of the multi-story buildings. The existing piping is not vulnerable to flooding damage as it is buried and already under water much of the time. Some water infrastructure piping may have to be relocated to allow construction of any larger perimeter flood barrier systems as part of a near- or long-term solution.

4.5 SANITARY

The main branch of the sanitary sewer collection system is along the South side of multi-story buildings on Long Warf. This is a is a 12-inch diameter line from the connection with mains on State Street that reduces first to 10-inch South of the Long Wharf Marriot, then to 6-inch at the upstream end at the pavilion on the east end of Long Wharf. Line inverts are shown to range from the shallowest of 3.5 ft. NAVD88 at the pavilion to below 0.0 ft. NAVD88 at the southeast corner of the Long Wharf Marriot on the 2015 *Existing Conditions Plan of Land*

by Feldman Land Surveyors. At the time of writing, it is not known if these manhole access points have water tight or gasketed bolt-down covers.

4.6 OTHER

Numerous temporary and single story structures exist along the North and South sides of Long Wharf. These include concessions, storage, ticketing, and maintenance facilities.

4.6.1 MBTA

MBTA Blue line tunnel alignment follows Long Wharf to the South of the multi-story buildings. The Bryant Associates' 2000 *Plan of Taking* shows an MBTA manhole access off the southeast corner of the four-story Custom House block building.

4.6.2 TELECOM

Telecom lines are believed to be buried along the south side of Long Wharf. These lines are all assumed not to be water-tight.

4.6.3 DOCKAGE SERVICES

The transportation docking facilities on the north and south sides of Long Wharf and the Waterboat marina on the north side have electrical service for boat shore power as well as site lighting and miscellaneous receptacles. The Boston Harbor Cruise docks on the south side of Long Wharf and the Waterboat Marina on the north side have sewage pump-out facilities to service the boats. We understand that the Boston Harbor Cruises pump out station connects directly to the sanitary sewer pipe on Long Wharf.

5 PUBLIC REALM AND SITE ACCESS

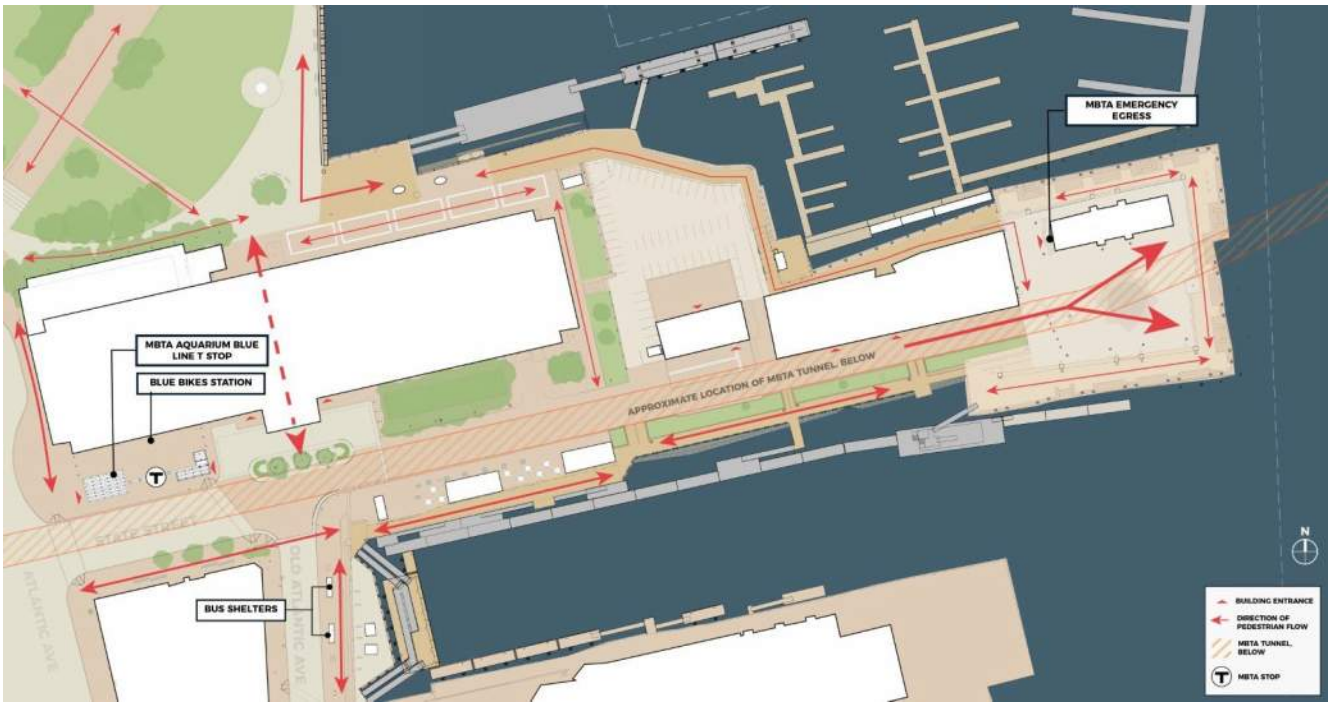
5.1 SITE ACCESS AND CONNECTIVITY

Because of Long Wharf's location, the site affords ample connections to other key landmarks and transportation nodes. Sections 5.2 and 5.3 following provide further detail regarding transportation.

Long Wharf can be accessed by both pedestrian and vehicular traffic, with pedestrian traffic extending to the far end of the wharf to the water's edge and along all edges of the site via the Boston Harborwalk. The Harborwalk connects 43 miles of shoreline[14] throughout Boston and also provides access to several inland parks including the Rose Kennedy Greenway. The Harborwalk 's linear park system occurs throughout the North End and the Wharf District, with a continuous connected path around the entirety of Long Wharf that then provides access and connection to Commercial Wharf to the north and Central Wharf to the south.

Primary pedestrian access occurs along State Street and continues along the wharf to its terminus. The MBTA Blue Line Aquarium stop is located at the intersection of Atlantic Avenue and State Street, making it a key transit stop for access to both Long Wharf and the New England Aquarium. Because of the vehicular traffic lane along the center of the wharf, pedestrian travel space is consolidated along the Harborwalk adjacent to the water on the south side of Long Wharf. This is one of the narrower spaces along the wharf and can become congested with people both utilizing the space for circulation and for queuing for water transportation. Once past the Custom House Block, though, pedestrian access is made freer, and visitors can utilize additional space at the open plaza at the eastern end of the wharf. The Harborwalk continues along the northern edge of the site behind the Chart House's parking area and alongside the north face of the Marriott. This portion of the Harborwalk, like that to the south, is also quite narrow behind the MBTA egress pavilion and along the shoreline adjacent to the parking lot. Pedestrian access again becomes more generous as the public way meets Christopher Columbus Park and Atlantic Avenue.

At the northwest end of the site Long Wharf abuts Christopher Columbus Park, a public park featuring several open lawn areas and a raised promenade along the Harborwalk. A large expanse of open plaza space connects the park to Long Wharf with views of the water and the Waterboat Marina. This area can support larger crowds and is a main thoroughfare for pedestrians accessing the Marriott Hotel.



Main Pedestrian Points of Access along Long Wharf

The team has observed on site a general preference by pedestrians to utilize the south side of Long Wharf for access as opposed to the less narrower north side which connects to Columbus Park. This may be attributed to a number of factors, including signage, sightlines, and/or a concentration of programming as many of the transportation nodes and tourist-oriented services are grouped along the southern edge of the wharf. See photos below for further detail.

Following are a series of photos capturing key elements of water transit at Long Wharf. Each photo has been labeled with observations and is keyed to the plan below.

Above: Harborwalk South showing available width for pedestrian circulation adjacent to marine infrastructure directly to the west of ferry Gate 2. Photo by Chelsea Kilburn

Above: View from Vehicular Lane to the Southwest, photo by Chelsea Kilburn

Above: Pedestrian Access along Harborwalk North, photo by Chelsea Kilburn

Above: Grade-Mediating Ramp at East End of Long Wharf, photo by Chris Reed

Pedestrian access largely occurs on grade along the length of the wharf. With the exception of a few steps that have been mitigated with various ramps and sloped surfaces toward the eastern end of the wharf, the site is accessible and free of major changes in grade. Descriptions of surface materials are elaborated upon in the following section 5.5.

Above: Pedestrian Occupation of Eastern Edges of Long Wharf, photo by Jake Deluca

5.2 VEHICULAR TRANSPORTATION

The site is accessed by vehicles along State Street via Atlantic and Old Atlantic Avenues. State Street runs parallel into the wharf and allows access to the Marriott for parking, service, loading/deliveries, and passenger drop off. The entrance to the Marriott subterranean parking garage is located adjacent to the MBTA Blue Line Aquarium stop which occupies the corner of State Street and Atlantic Avenue. To the east of the parking garage entrance is a drop off area for the hotel that is utilized by vehicles and rideshare services. The team has observed Marriott service and maintenance vehicles parked perpendicular to the Marriott in the area immediately north of the drop off area adjacent to the Marriott's main entrance. Service and loading for the hotel are accessed via the far eastern end of the building where there are three loading bays and a series of at-grade doors.

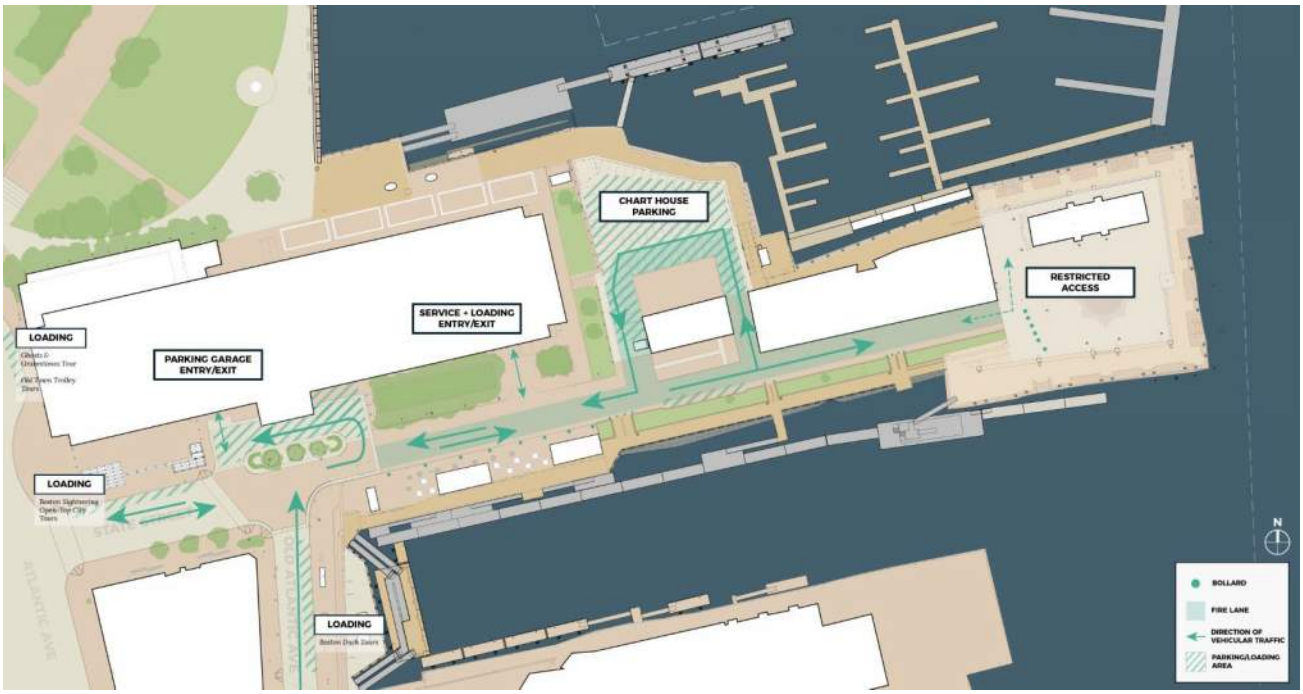
Vehicular access extends along the wharf to the end of the Custom House Block where it is then impeded by a series of bollards. Service access for maintenance vehicles has been observed passing through the bollards and was confirmed as a point of access in a meeting with MBTA who has noted an upcoming stair replacement project at the Blue Line tunnel egress pavilion. Per the existing document review, emergency vehicle access is provided along the length of the wharf with a turnaround provided around the Chart House via the parking area. The team has made note that keeping this area free and clear of obstruction or providing a similar means of access will be key for the next iterations of design.

View from vehicular drive area west toward Atlantic Ave

Parking is provided in a lot behind the Chart House. This lot is owned by the BPDA but leased and operated by others with an annual lease. Several businesses utilize space in this lot for their employee parking. 55 parking spaces have been observed in this area as documented on existing conditions plans. Additional parking spaces are provided directly to the south of the Chart House at a pull off area adjacent to the planter separating the drive lane from the Harborwalk. This area contains signage noting that parking is not allowed and that it is a tow zone. Exempt from this enforcement are commercial vehicles.

Loading to several tourist and recreation services are located around Long Wharf, including Boston Sightseeing Open Top City Tours, Boston Duck Tours, and the Old Town Trolley Tours. These companies utilize loading primarily along Atlantic Avenue.

Stone bollards provide a layer of protection between traffic areas and those used by pedestrians although users tend to mix across the drive lane.



Main Vehicular Access along Long Wharf

5.3 WATER TRANSIT & TRANSPORTATION

Long Wharf is a key hub in Boston's water transit infrastructure, as it serves the MBTA ferry (Long Wharf North and Long Wharf South), the Boston Harbor Islands ferry, Boston Harbor City Cruises, the Waterboat Marina, the Encore Casino ferry, and the water taxi, among other water-based services. Long Wharf is also an important location within greater Boston due to its position as the gateway to the Boston Harbor Islands National and State Park.

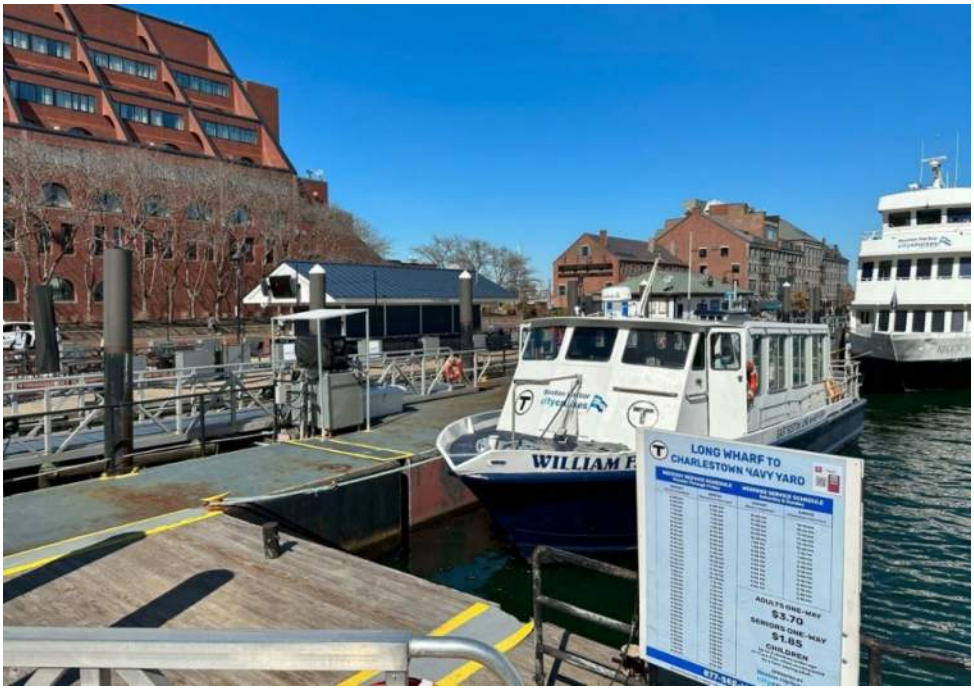
At the project site, a large area of the wharf is utilized for queuing for the various water transit services. This is accommodated along a series of boardwalks and docks extending from the wharf proper that feature ramps and gangways. Various kiosks and auxiliary structures support the functioning of marine transportation, some of which are situated on the docks, such as the office, showers/restrooms, and laundry/workshop buildings supporting the Waterboat Marina on the north side of the wharf, and others which are located on the wharf, such as the Boston Harbor City Cruises information and ticket kiosk.

Above, left: View from Harborwalk southeast toward the Customs House Block. Above, right: View from Harborwalk southeast toward ferry gates 2 and 3.

Above, left: View from Harborwalk southwest toward Atlantic Ave. Above, right: View from Harborwalk south to the waterfront with queuing crowd.

The MBTA operates two ferry terminals at Long Wharf: Long Wharf North, which presently services East Boston via Lewis Mall Wharf and Hingham/Hull which services Georges Island, Logan Airport, and Rowes Wharf in addition to Hingham and Hull; and Long Wharf South, which services Charlestown via the Charlestown Navy

Yard. It is significant to note that at the time of this study, the MBTA is providing additional service via the ferries due to the closure of the Sumner Tunnel for maintenance.



MBTA Long Wharf South Ferry Dock looking northeast

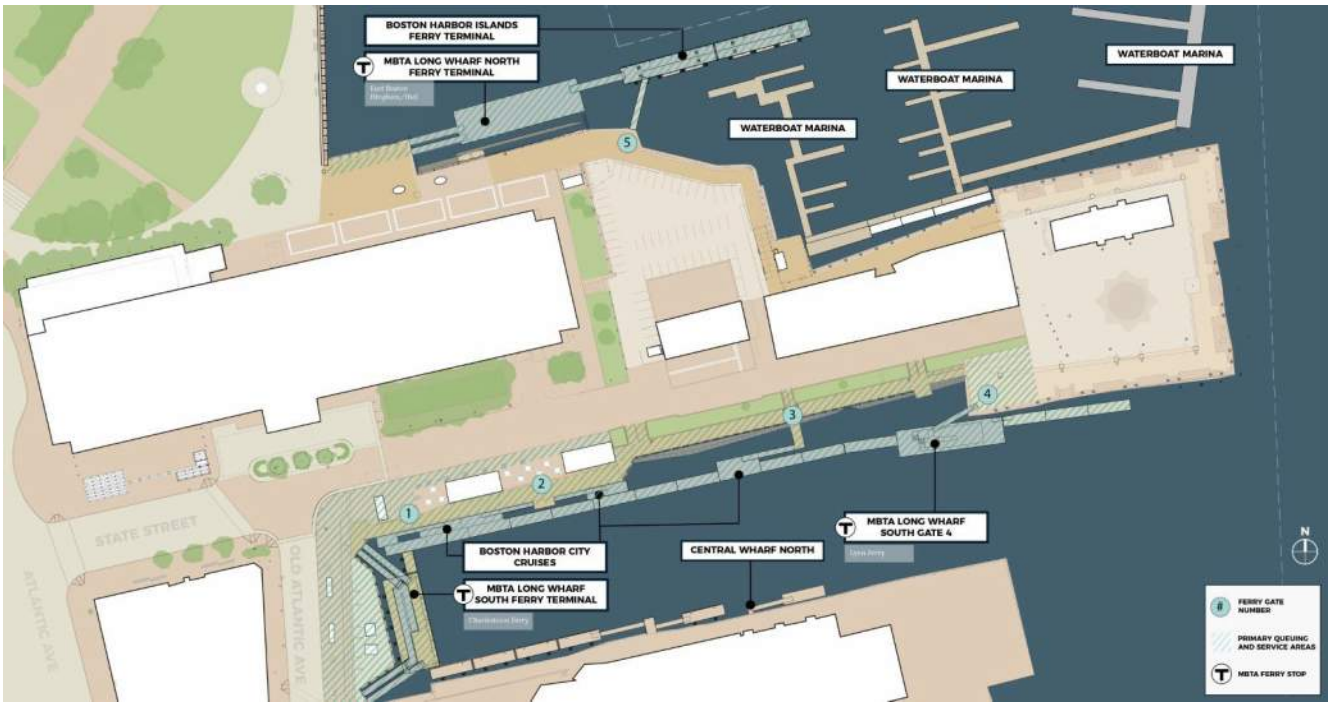
MBTA Long Wharf South Ferry Dock looking east

MBTA Long Wharf North Ferry Dock looking east

Presently patrons utilizing the ferry terminal gates queue along the boardwalks that service the ferries, but the influence of water-based transit extends beyond the docks to the surrounding widened sidewalk and Harborwalk.

Per MassDOT, additional ferries not operated by the MBTA provide service to other locations. Service is provided to Quincy-Hull-Logan Airport year-round and to the Harbor Islands in the summer via operator Harbor Express. Service is provided to Provincetown in the summer via operator Boston Harbor City Cruises, and service to Salem is provided in the summer by operator Water Transportation Alternatives.[15]

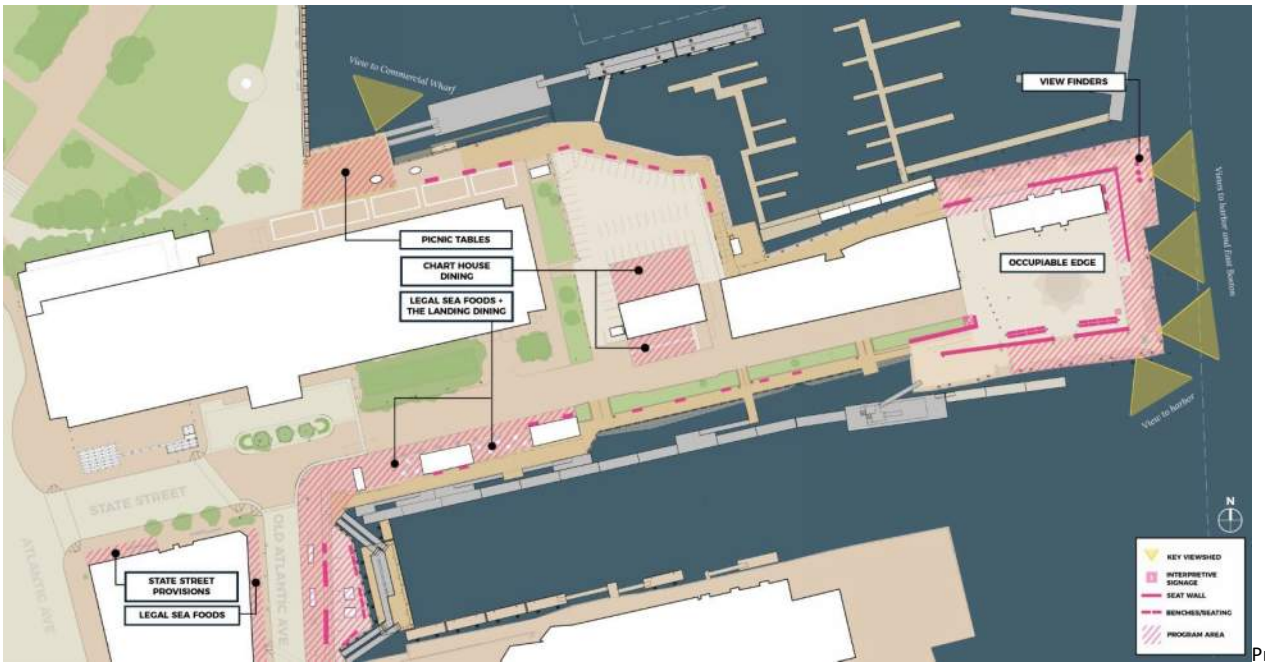
Further, other leisure boats and services are provided along Long Wharf. These include a ferry service offered by the Encore Casino in Everett and leisure rides provided by Boston Harbor City Cruises. These services range from nature-oriented experiences like whale watching to dining-focused cruises to thrill rides like Codzilla.[16] The various docks and loading platforms that service the ferries and boats have been updated and replaced throughout the history of the wharf; please reference Section 2 of this report for further analysis of the existing conditions of these structures.



Water Transit at Long Wharf

5.4 SITE PROGRAMMING AND USE

As mentioned previously, Long Wharf is a key open space within the City of Boston as it is the gateway to the Harbor Islands and greater Boston Harbor, it is a primary water transit hub, and it is an area of cultural and historic significance. Long Wharf is also one of the main publicly accessible larger open spaces at the water's edge, and its proximity to other local attractions such as the New England Aquarium and Christopher Columbus Park allow it to be part of a larger waterfront feature area.



Program Areas at Long Wharf

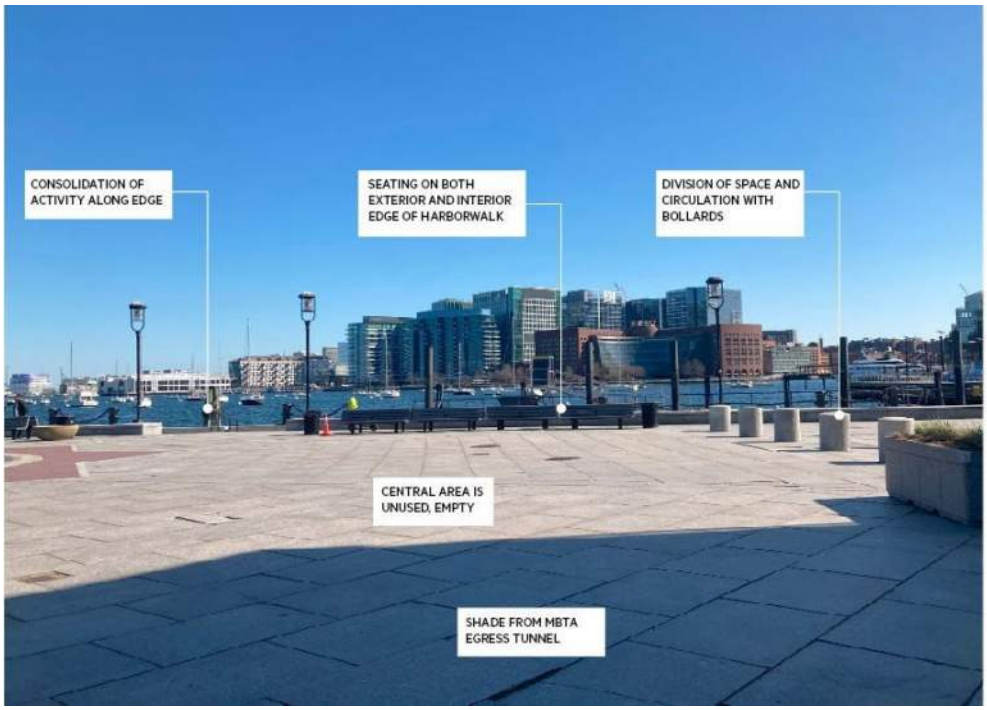
The primary use associated with Long Wharf is public open space although a variety of other uses can be found along the length of the site. As noted in the above sections, there are several means of public transit that provide access to the site, thus activating all edges of the wharf. A number of leisure and recreation-oriented kiosks can be found along the southwest of the wharf that sell tickets for the various nearby attractions such as whale watching tours, harbor cruises, etc. Several popular restaurants are located within the vicinity of the wharf for food and beverage. These include Legal Sea Foods at the ground level of 255 State Street which has outdoor seating facing Old Atlantic Avenue, Tia's Restaurant on north side of the Long Wharf Marriott hotel and the Chart House Restaurant located on Long Wharf. The Landing at Long Wharf is a seasonal bar that shares space with additional Legal Sea Foods service. Exterior seating is provided at this location along Harborwalk south directly adjacent to Gate #1. Outdoor seating extends along the Harborwalk, filling the space between the Landing and the space to the east operated by Boston Harbor City Cruises. This end of the wharf can be characterized as quite urban as it carries the energy and activity found within the downtown area of the city in spaces such as Faneuil Hall and the Greenway out towards the waterfront. The activity at the southwest corner of Long Wharf is complemented by the activity created by patrons of the Marriott Hotel at the northwest of the site. The Marriott serves as a main north-south thoroughfare for pedestrians, with amenities such as public restrooms, ticket sales, and several cafes and restaurants supporting the area. Although the west end of the wharf is quite active and directly adjacent to the water, there are not many moments in which the water itself is directly visible. Several layers of marine-related infrastructure including boats, signage, docks, and gangways can create a physical barrier to the wider view and connection to Boston Harbor.

Continuing along the wharf towards the water is the Chart House, which occupies the middle of the wharf at its lowest point. The Chart House restaurant is open year-round and offers seasonal outdoor seating both at the north and south sides of the restaurant. The south edge faces out onto the vehicular lane on Long Wharf south, and the north outdoor dining area is situated adjacent to the parking lot.

As users pass the Customs House Block, the view to the harbor is greatly expanded and the plaza provides access to the water's edge. A series of three free-standing interpretive signs along the southern edge of the vehicular drive aisle provides background and context for Long Wharf. These double-sided signs offer information on the 'Walk to the Sea', showcasing various maps and images that highlight the changing shoreline on and around Long Wharf. Further information regarding proposed plans for the interpretive signage along Long Wharf can be accessed via the State Street and Long Wharf Interpretive Plan prepared by the BRA and Roll Barresi & Associates from 2007. An additional interpretive sign installed at the southeast corner of the wharf describes Long Wharf's connection to the transatlantic slave trade and provides maps and images to provide context for this information.

Above, left: View from the western end of plaza east toward harbor. Above, right: Historic placard on the western façade of Customs House Block.

The easternmost end of Long Wharf can also be quite active, particularly when the weather is clear as this space offers clear views across the inner harbor to East Boston on the other side. The end of the wharf features several areas for seating, including benches along the south edge and a seat-height wall along the north edge. Additional benches can be found along the east edge of the MBTA pavilion. Many users of the site also enjoy lounging and sitting on the edge of the wharf itself or along the steps that create the raised platform of the plaza. Users of the wharf have also been observed sitting along the steps that lead into the water along the edges of the wharf although they are barricaded off with large bollards and chains.



View from plaza south to the Federal Courthouse and the Seaport District

View from plaza southwest to MBTA egress pavilion and downtown

Several other features also distinguish the public realm at this end of Long Wharf, including the tall flag mast featuring the national, state, and city flags and a large compass composed in the granite block paving. These features further express the nautical character of the wharf and designate the space as significant although activity and energy is observed to be consolidated at the edges of the wharf rather than in this space at the center of the plaza.

The MBTA egress pavilion provides the only shade at the end of the wharf, and users are often seen utilizing this space for comfort, especially in the summer months. The structure provides shade via its roof and overhangs but also from its shadow. There is no seating under the pavilion roof. Unhoused occupants also have been observed utilizing the pavilion for shelter.

At the northwest corner of the wharf are a series of viewfinders that have been observed to be a popular attraction with visitors. The viewfinders provide enhanced vantages across the water to East Boston and Logan Airport.

The north side of Long Wharf is significantly less active that the southern side and the eastern plaza, probably due to its narrowness and somewhat poorly maintained condition. Moving from the east end of the wharf back towards Atlantic Avenue, users are presented with views to Commercial Wharf and the Waterboat Marina. As the site widens, there are more seating opportunities made available, creating an enjoyable space along the Harborwalk to the north of the Chart House parking lot. The water's edge of this area is quite rocky and presents several layers of materials that highlight the various states of the wharf throughout history. Due to its shallower depth, this area is often calm and ducks and geese can be seen swimming in the water. Before the Harborwalk meets Christopher Columbus Park, there is a small informal seating area featuring outdoor furnishings arranged on the boardwalk adjacent to the Long Wharf North ferry terminal. In the summer this area has been observed to be arranged with picnic tables and umbrellas. To the west of this area the public way once again joins traffic from Atlantic Avenue and the park and activity is consolidated around the Marriott and the Harborwalk.

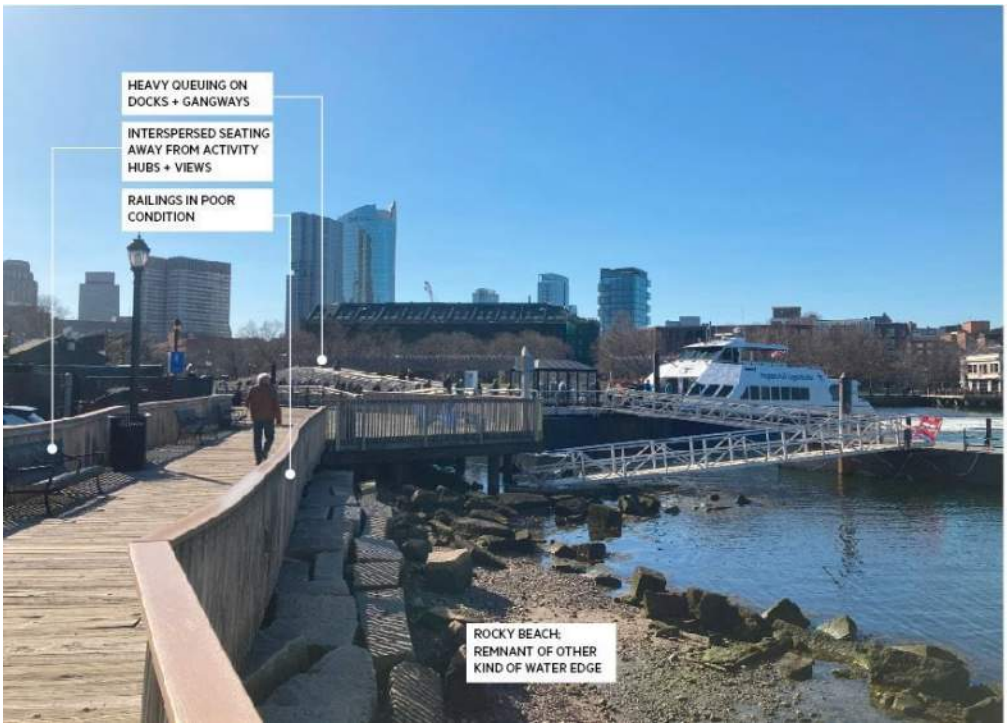
5.5 SURFACE MATERIALS AND CONDITIONS

Long Wharf is a largely hardscaped area, with brick and granite paving serving as the main materials. The Harborwalk which wraps the wharf is largely timber boardwalk along its length until transitioning into the open plaza. Several planters appear throughout the length of the site, with two large raised curbed planters along the eastern side of the Marriott's south façade containing mature trees. Two additional linear planters featuring a mix of shrubs and smaller trees follow the eastern façade of the Marriott adjacent to the parking lot. These plantings near the Marriott offer limited shade for the vehicular access lane. A series of linear planters abut Harborwalk south and contain a few small coniferous trees and lower shrubs.

Existing Topography and Grade Transitions at Long Wharf

The edges of Long Wharf reveal several layers of materials, the result of a continually changing condition. The area between the docks and the constructed edge between gates 2 and 4 on the south edge of the wharf feature large-scale granite blocks and several layers of decking structure, and the area to the north of the parking lot similarly reveals layers of granite block and remnants of previously structures. This space presents itself as a natural rocky beach, with water and materials flowing beneath the raised wood boardwalk into the parking lot.

Harborwalk South looking east toward Chart House and Customs House Block with layered material in the foreground.



Harborwalk North looking west to MBTA Long Wharf North ferry terminal

There is a slight gradient along the length of the wharf, with the low point located between the Marriott and the Chart House. Sloped paths mitigate the grade change between the brick paved drive aisle and the elevated timber Harborwalk surface at the various ferry gates. At the open plaza, a slightly raised level meets the water's edge through steps and seat walls along the plaza edge. Due to a lack of accessible paths built into the

steps, a minimal ramp has been added to the central set of steps at the easternmost end of the wharf to provide clear access.

6 REFERENCE LIST

6.1 ABUTTER DOCUMENTS AND PLANS

Chart House and Custom House Block

Chart House Restaurant _ Structural Stabilization and Selective Restoration of the Chart House _ *13 January 1999 (**Platt Anderson Freeman**)*

Chart House Foundation _ Foundation Work for the Structural Stabilization of the Chart House _ *5 November 1999 (**Platt Anderson Freeman**)*

Custom House Block Existing Conditions Plan of Land _ *04/17/2015 (**Feldman Land Surveyors**)* Chart House and Custom House Block ALTA/ACSM Land Title Survey _ *January 2015 (**Haley & Aldrich**)*

Long Wharf Custom House Block 62-70 Redevelopment _ *06/30/2017 (**Capital Properties/Stantec**)*

Proposed Fire Lane _ *06/28/2020 (**Bryant**)*

Boston Harbor Cruises

BWSC Drainage and Sewerage Works Improvements _ *1994 (*Sanitary Serwer Pipe Replacement; Proposed 10 PVC Storm Drain and Outfall) (**BWSC**)*

Boston Harbor Cruises at Long Wharf _ *04/28/2000 (**Modern Continental**)*

Boston Harbor Cruises One Long Wharf Underpinning/Repairs _ *03/03/2003 (**Modern Continental**)*

Boston Harbor Cruises Sales Office Underpinning/Repairs _ *05/12/2005 (**Childs**)*

Boston Harbor Cruises As-Built Plan _ *05/10/2021 (**Modern Continental**)*

Marriott Long Wharf

Marriott Boston Long Wharf Lounge Reno - *11/17/1994*

Marriott Long Wharf Hotel Parking Garage - *02/1997*

Marriott Boston Long Wharf Rooms and Suites Renovations - *08/28/2000*

Marriott Boston Long Wharf Lounge Reno - *11/30/2001*

Marriott Starbucks Coffee - *03 31 2003*

Marriott Maintenance Shed and Ticket Booth - *01/18/2007*

Marriott Boston Long Wharf Guestroom Rono - *08/13/2007*

Marriott Boston Long Wharf Guestroom Reno 2 - *08/13/2007*

Marriott Boston Long Wharf Rooms Corridors Suites Renovation - *08/29/2007*

Marriott Long Wharf Interior Reno Phase 2 - *01/31/2011*

Marriott Concierge to Guestroom Conversions - *10/20/2017*

MBTA Aquarium Station

MBTA Aquarium Blue Line Station Modernization Project - 07/10/1995 (***MBTA***)

MBTA Blue Line Aquarium Station Floodproofing Improvements - *10/23/2019* (***MBTA/Kleinfelder***)

New England Aquarium

Existing Condition Plan - *10/15/1999 (**New England Aquarium Imax Theater**)*

South Pier Expansion - *12/14/2001 (**New England Aquarium Imax Theater**)*

Chapter 91 Plans - *05/21/2022*
Certificate - *08/2022*

Boston Water and Sewer Commission (BWSC)
Columbus Park Pump Station Concept Overview - (***BWSC***)
Coastal Stormwater Discharge Analysis - 01/20/2023 (***BWSC/Hazen & Sawyer***)

National Park Service
NPS Flood Adaptation Guidelines - *2021* (***US Department of Interior National Park Service Technical Preservation Services***)

Christopher Columbus Park
Existing Surface Conditions and Current Projects - 01/16/1976 (***Boston Redevelopment Authority Waterfront Urban Renewal/Sasaki, Dawson, DeMay Associates Inc.***)
Improvements to Christopher Columbus Park - 08/13/2001 (***City of Boston parks and Recreation Department/The Halvorson Company, Inc./Mistry Associates, Inc.***)
Christopher Columbus Park Building - 05/28/2002 (***City of Boston Parks and Recreation Department/Carlone Dick Lafleche***)

6.2 PHYSICAL ASSET PLANS (BY LOCATION)

Site and Harborwalk
Waterfront Park to Boston Waterboat Marina Raise Walkway and Ramp Layout - *05/20/1998* (***BPDA/Bryant***)
Site Survey Plan - 01/02/2000 (***Bryant***)
Long Wharf Harborwalk Renovation (North Side) - *09/29/2000 (**ELV/ArrowStreet**)*
Conduit Installation - *04/09/2001 (**VHB**)*
Existing Site Utility Plan - *02/13/2001(**Childs**)*
Long Wharf Emergency Stabilization - *10/21/2002 (**BPDA/Childs**)*
Long Wharf Harborwalk South Side - 02/17/2003 (***Childs***)
Harborwalk Reconstruction at Long Wharf South - 01/11/2006 (***BPDA/Childs***)
Emergency Seawall Rehabilitation South Side Long Wharf - 04 01 2003 (***BPDA/Childs***)
South Long Wharf Ramp Connection and Modifications - 04/02/2003 (***Childs***)
Long Wharf North Configuration - 09/15/2006 (***Childs***)
Long Wharf North Configuration - 12/05/2006 (***Childs***)
Long Wharf North Site Improvement - 01/2007 (***BPDA/Childs***)
Float Sketch - *01/03/2007*
Float - *04/30/2007 (**Rockland Marine Corp.**)*
Survey - *07/06/2007* (***Bryant***)
Pier Repairs Boston Waterboat Marina - *04 10 2009 (**Childs**)*
Long Wharf North Waterboat Marina Pier and Office Float Replacement - 02 19 2013 (***Childs***)
LW-GLP10 (AutoCAD) Long and Central Wharf Downtown Waterfront Plan - *01/2019* (***BPDA***)
LW-COODPL (AutoCAD) Long Wharf and Central Wharf Existing Condition Plan - *08/06/2020 (**BPDA**)*

Long and Central Wharf Old Atlantic Ave Berth

Long and Central Wharf Marine Facilities Old Atlantic Avenue Area - 08/23/2000 (***Childs***)
Deck Structural - *Not Dated*
Fixed Piers Floating Docks and Ramp System - *08/23/2000 (**BPDA/Childs**)*
High Mast Pole Site Plan - 03/02/2001 (***Childs***)
Proposed Float Modification - 03/29/2001 (***Childs***)
Revised Power and Lighting Plan - 05/09/2001 (***Childs***)

Long Wharf Plaza

BPDA Long Wharf Seawall Stabilization - *01/24/2020 (**BPDA/Foth**)*
Long Wharf Plaza Repair Plan and Sections - *12/19/2005 (**Childs**)*

Pavilion at East End of Long Wharf

Subway Ventilation Improvements MBTA B-6 Long Wharf - *04/1983* (***MBTA***)

6.3 CITYWIDE PLANS

Downtown Waterfront District Municipal Harbor Plan & Public Realm Activation Plan - *04/2018* (***BPDA***)
DRAFT Materials / Stakeholder Feedback from Downtown Waterfront Design and Use Guidelines - *03/2021* (***BPDA***)
Coastal Resilience Solutions for Downtown Boston and North End (Final Report) - 09/2020 (***Boston***)
Structural Condition Assessment Long Wharf - (***BPDA/Foth***)
Climate Resilient Design Standards for Protection of Public Rights-of-Way - 10/2018 (***Boston PWD/Weston & Sampson***)
Appendix-A - Downtown Waterfront Public Realm and Watersheet Activation Plan - *01/2017* (***BPDA/COB***)
BHN Water Trans Report Inner Harbor - (***Boston Harbor NOW, MassDOT, Massport***)
Future of Long Wharf Report - *08/09/2019* (***Boston Harbor NOW***)
State Street and Long Wharf Interpretive Plan - *10/15/2017* (***BPDA***)
Long Wharf Master Plan COB Mayor White 1980s - *(**Boston/Sasaki**)*
Resilient Historic Design Guide - *08/2018* (***Boston Environment Department***)

7 WORKS CITED

Boston Middle Passage Project. *The Port Marker*. n.d. https://bostonmiddlepassage.org/the-port-marker/. 11 May 2023.

Kilcrease, Kelly. *Boston's Long Wharf: A Path to the Sea*. Charleston: The History Press, 2021. Book.

National Parks Service. *Long Wharf and Custom House Block*. n.d. https://www.nps.gov/nr/travel/maritime/lon.htm. 11 May 2023. <https://www.nps.gov/nr/travel/maritime/lon.htm>.

TECHNICAL MEMORANDUM

TO: Boston Planning and Development Agency (BPDA)

FROM: Andre Martecchini, PE [Kleinfelder]

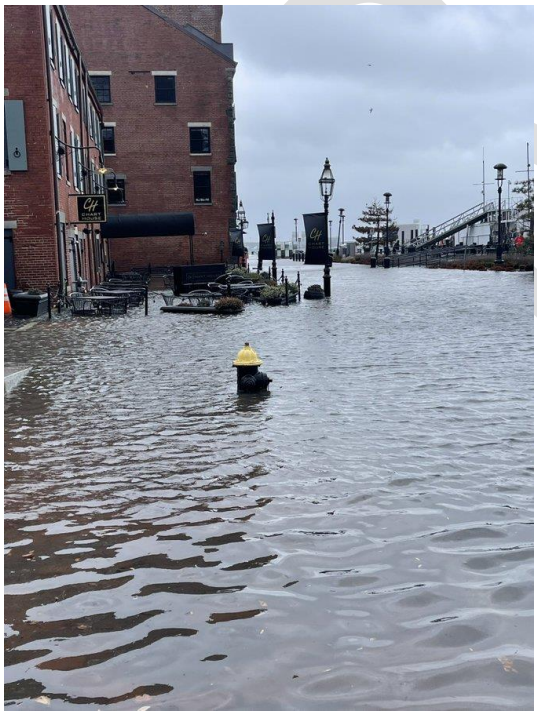
DATE : June 20, 2023

SUBJECT: Long Wharf Design Flood Elevation (D.F.E.) Technical Memorandum

CC: Caitlin Spence PhD, Kyle Johnson, Seth Bryant [Kleinfelder]

1 INTRODUCTION / BACKGROUND

This technical memorandum describes the recommended Design Flood Elevations (D.F.E.'s) which will best protect the Long Wharf area in the intermediate (2050) and long term (2070 - beyond). This memorandum summarizes key data sources, D.F.E.'s from other projects in Boston, as well as the project team's approach in developing the recommended D.F.E.'s for Long Wharf.



This memo begins by reviewing the current and future flood risk and potential for impacts at Long Wharf, then review the considerable prior efforts to develop base and design flood elevations at Long Wharf and surrounding areas by entities such as Boston Water & Sewer Commission (BWSC), the Wharf District Council (WDC), Massachusetts Bay Transportation Authority (MBTA), and BPDA itself. This memo then describes the assumptions which contribute to each D.F.E. and the project design team recommendations.

Figure 1: Flooding at Long Wharf on December 23, 2022 [Credit: WBZ Media]

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

1.1 LONG WHARF PRESENT AND FUTURE FLOOD RISKS

Long Wharf is a key cultural and historic resource in downtown Boston which provides and supports significant economic, recreational, and functional services – including significant marine transportation and tourism infrastructure. The wharf area is already prone to inundation during coastal high water and king tide flooding events (see Figure 1), and the frequency of such events is expected to increase in the future as sea level rises. As the wharf may serve as a critical pathway by which coastal high waters could reach key inland infrastructure such as the MBTA Aquarium station and the Rose Fitzgerald Kennedy Greenway, as well as cultural landmarks including Quincy Market, Faneuil Hall, and others.

The recommended design flood elevation anticipates future increased risk of coastal flooding, and coordinates with other recommended D.F.E.'s in the area so that recommended near-term project D.F.E. will provide robust protection through 2050, with a long-term D.F.E. that is shared as a cohesive 'barrier' to coastal storm flooding that interfaces seamlessly with adjacent flood protection structures within a coordinated district-scale floodproofing strategy.

For the purposes of this project in setting target D.F.E.'s, it is anticipated the Long Wharf flood mitigation design will have an anticipated useful life of fifty (50) years. Therefore, the project team recommend the D.F.E. correspond to 2070 projected sea level and coastal flood conditions at the site. Due to the expanding uncertainty in future sea level with each future decade, the project team recommend 2050 as an intermediate planning target for which immediate steps should be taken to prepare. Designs that prioritize near-term protection (i.e., to protect to projected 2050 sea level and coastal storms) rather than projected 2070 conditions must consider adaptability so that future adaptation(s) to projected 2070 sea levels and coastal storms are simple and efficient.

1.2 EXISTING KEY ELEVATIONS

1.2.1 NOAA Tidal Datums

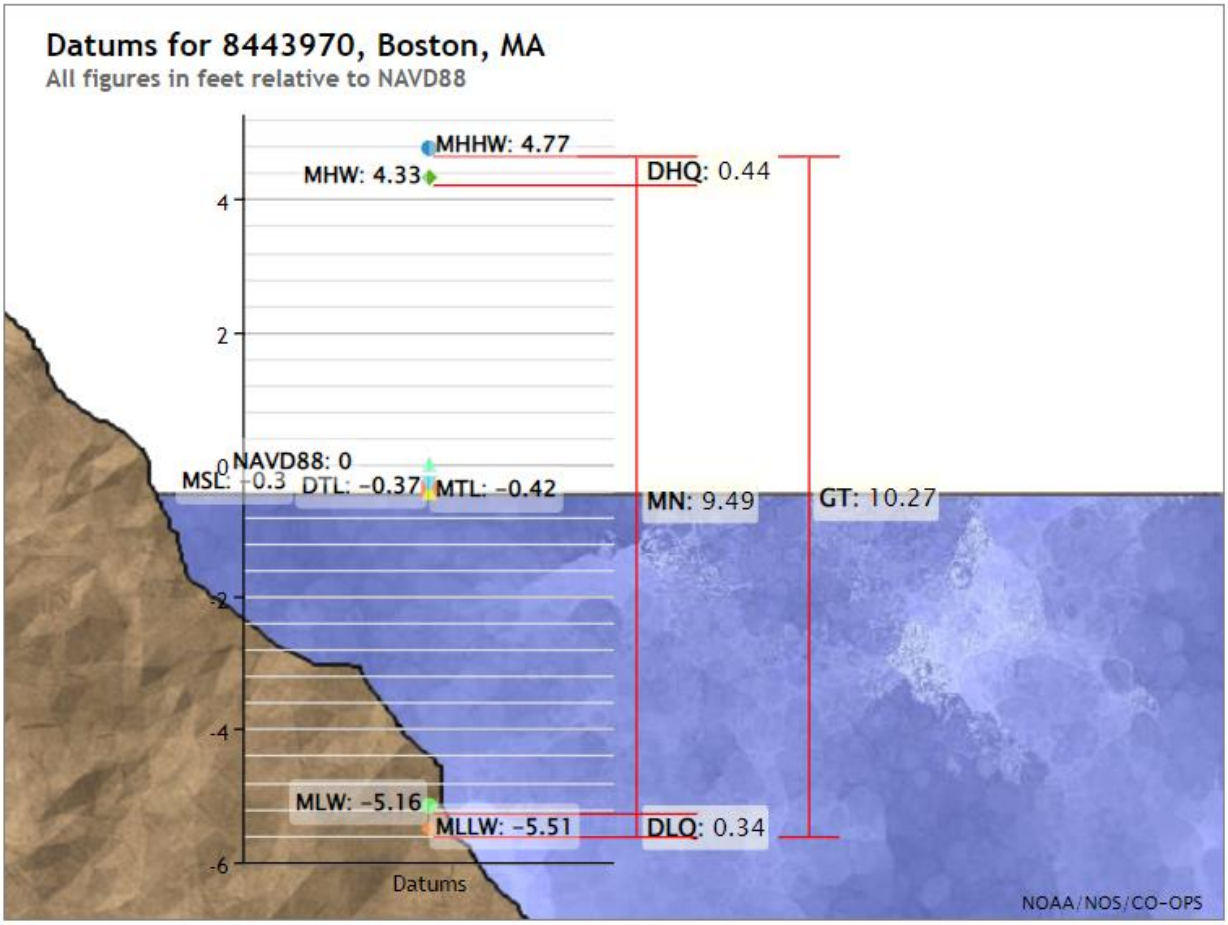
The variability of coastal water levels outside storms is important to coastal resilience design. The National Oceanographic and Atmospheric Administration (NOAA) maintains estimates of key water levels and tidal elevations based on detailed historic records. These records at Boston Harbor Tide Gauge (NOAA Station 8443970[1]) based on the 1983 – 2001 tidal epoch indicate a mean sea level (MSL) of -0.3 ft NAVD88 (6.16 BCB),

[1] NOAA. Tides and Currents - *Datums for Station 8443970, Boston MA.* https://tidesandcurrents.noaa.gov/datums.html?id=8443970

© 2023 Kleinfelder www.kleinfelder.com
KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

Mean Higher High Water (MHHW) of 4.77 NAVD88 (11.23 BCB), and 6.82 ft NAVD88 (13.28 BCB) Highest Astronomical Tide.

Notably, in this historic period the MHHW was 5.07 ft higher than MSL while the Highest Astronomical Tide (HAT) was 7.12 ft higher than MSL.



1.2.2 FEMA Base Flood Elevation

The latest effective FEMA Flood Insurance Study (FIS) was revised in 2016. The study designates the borders of Long Wharf as a Zone VE with Base Flood Elevation 13 feet NAVD88 (19.46 ft BCB) and the interior of Long Wharf as a Zone AE with B.F.E. 10 feet NAVD88 (16.46 ft BCB) (Figure 2). FEMA Base flood elevations in both coastal zone AE and zone VE include wave effects; however FEMA zone VE includes high-velocity waves. These are 13.3 ft and 10.3 ft higher than the most recent estimate of local MSL, respectively.

© 2023 Kleinfelder

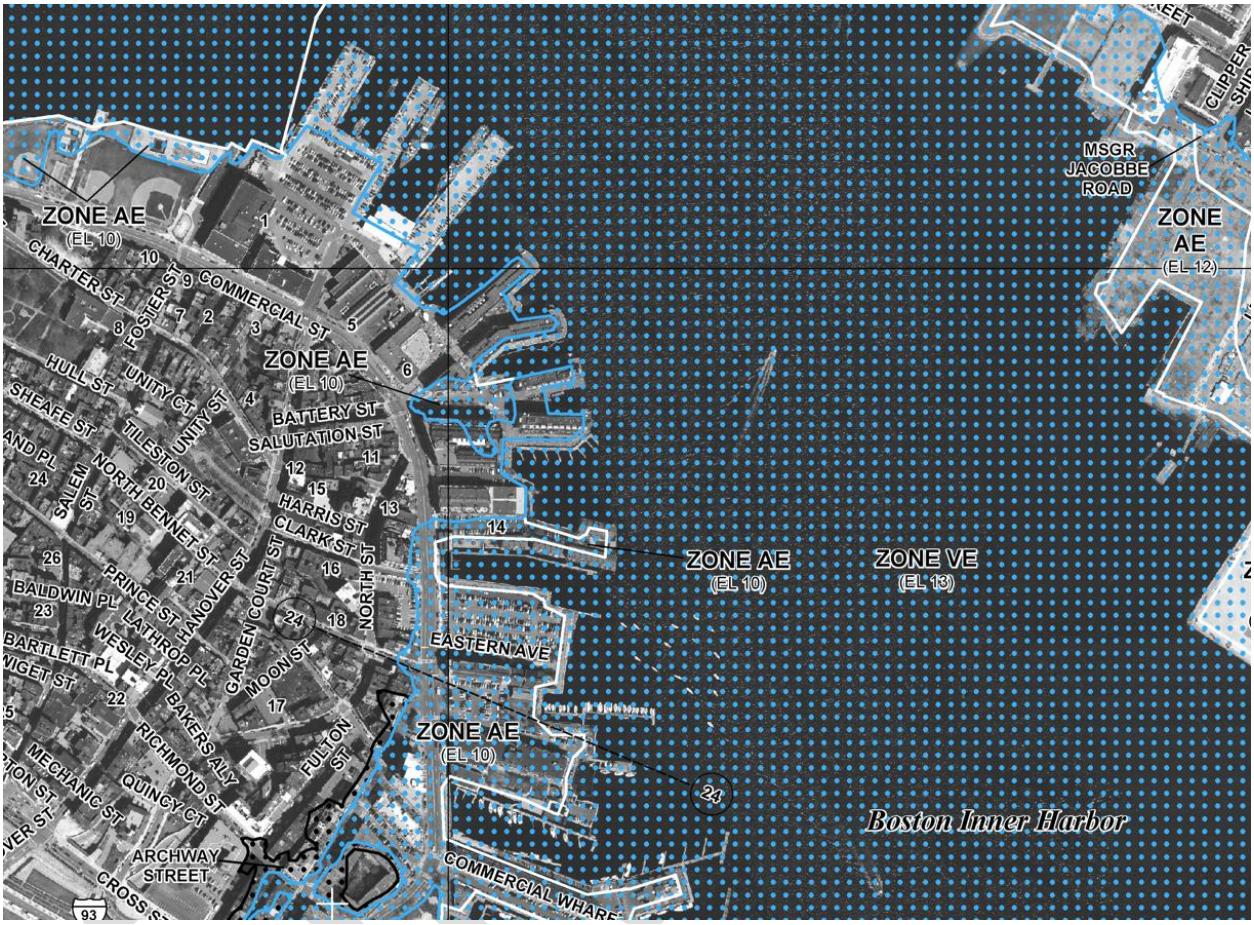


Figure 2: FEMA Flood Insurance Study map; FEMA National Flood Hazard layer GIS viewer.

The FEMA FIS does not account for future increases in sea level or future changes in coastal storms.

1.2.3 Massachusetts Climate Change Projections

The Northeast Climate Adaptation Science Center (NECASC) produced detailed sea level rise projections as part of the 2016 Massachusetts Climate Change Projections.[2] The projections represent present, 2030, 2050, 2070, and 2100 conditions and are based on the National Climate Assessment global sea level scenarios adjusted to reflect

[2] Northeast Climate Adaptation Science Center (NeCASC) (2016). *"Massachusetts Climate Change Projections."* https://necasc.umass.edu/projects/massachusetts-climate-change-projections

© 2023 Kleinfelder www.kleinfelder.com
KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

localized sea level factors probabilistically represented in the Northeast Climate Adaptation Science Center (NECASC) modelling study.

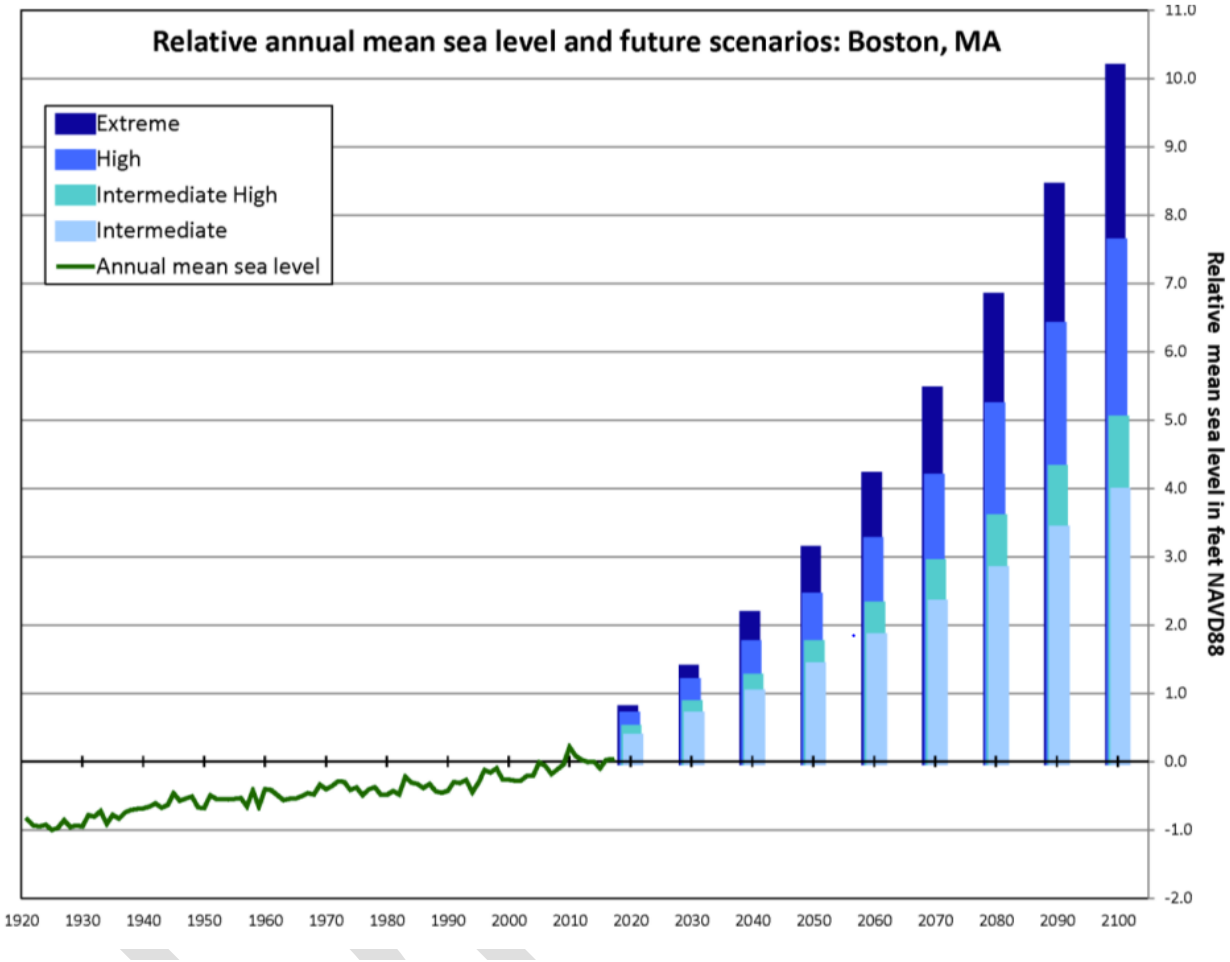


Figure 3: Relative MSL projections for Boston, MA tide station.

The sea levels used under each time horizon scenario reflect the “High” National Climate Assessment scenario, which the study estimated has an 0.5% probability of being exceeded by the specified time horizon under RCP 8.5 and a 17% chance of being exceeded under RCP 8.5 when accounting for possible higher than expected contributions from ice sheets to future sea level increases. Under this scenario, the 2050 relative mean sea level (MSL) at Long Wharf would be 2.4 ft NAVD88 (8.86 BCB) and the 2070 relative MSL would be 4.2 ft NAVD88 (10.66 ft BCB). Under the “Intermediate” sea level rise scenario or lowest shown on Figure 3, MSL would be 2.3 ft NAVD88 (8.76 BCB) in 2070.

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

1.2.4 MBTA Flood Resiliency Design Directive

The MBTA Flood Resiliency Design Directive[3] provides a simple method to select a future coastal flood design flood elevation:

$$DFE = BFE_{FEMA} + SLR + Freeboard$$

The future D.F.E. is the sum of the most recent FEMA Flood Insurance Study (FIS) Base Flood Elevation (B.F.E.) at the location of interest, projected sea level rise (SLR) between present and the design year, and freeboard of either one or two feet depending on the asset or location's criticality.

At Long Wharf, the B.F.E. given in the current effective FEMA FIS[4] is 13 feet NAVD88 in zone VE (19.46 BCB); 10 feet NAVD88 (16.46 ft BCB) in zone AE. Note that this corresponds to a 1% annual chance (100-year) flood. Based on the MBTA Flood Resiliency Design Directive, the projected 2070 sea level rise with a 1% chance of exceedance according to the MBTA Flood Resiliency Design Directive is 3.6 feet. Because the Long Wharf provides an MBTA ferry access point, it is considered a critical asset which requires two (2) feet of freeboard.

Therefore, the appropriate D.F.E. under this methodology would be 18.6 feet NAVD88 (25.06 BCB) in zone VE and 15.6 feet NAVD88 (22.06 ft BCB) in zone AE. The FEMA B.F.E. corresponds to a 1% annual chance flood.

1.2.5 Resilient MA Action Team (RMAT) Climate-Resilient Design Standards Tool

The Massachusetts Climate-Resilient Design Standards tool (version 1.2)[5] is a resource for providing climate-informed planning horizon and design values based on proposed project type, assets protected, criticality, and social impact potential. The tool, commissioned by Massachusetts Executive Office of Energy and Environmental Affairs (MA EOEEA), integrates data from the Massachusetts Coast Flood Risk Model (MC-

[3] MBTA (2019). *Flood Resiliency Design Directive.* https://cdn.mbta.com/sites/default/files/2019-12/2019-11-18-flood-resiliency-directive-accessible.pdf

[4] FEMA (2016). *Suffolk County Flood Insurance Study.* https://map1.msc.fema.gov/data/25/S/PDF/25025CV000B.pdf?LOC=82be63c2cf6fe1ef86b925b569ea5381

[5] Resilient MA and State of Massachusetts (2023*). "Climate Resilience Design Standards & Guidance: Climate Resilience Design Standards Tool."* https://resilientma.mass.gov/rmat_home/designstandards/

© 2023 Kleinfelder www.kleinfelder.com
KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

FRM) modeling study[6], and produces recommendations for site design criteria that are dynamic based on asset location, criticality, and useful life.

Based on user inputs, the tool identifies target design standards for 2070 or 2090 (i.e., long term) and 2050 or 2030 (i.e., intermediate) time horizons. The tool also maps hazard exposure at the proposed project site (Figure 4) as well as design parameters (Figure 5). Similar to the NECASC study described in Section 1.2.3., the MC-FRM model utilizes the "High" National Climate Assessment scenario[7]:

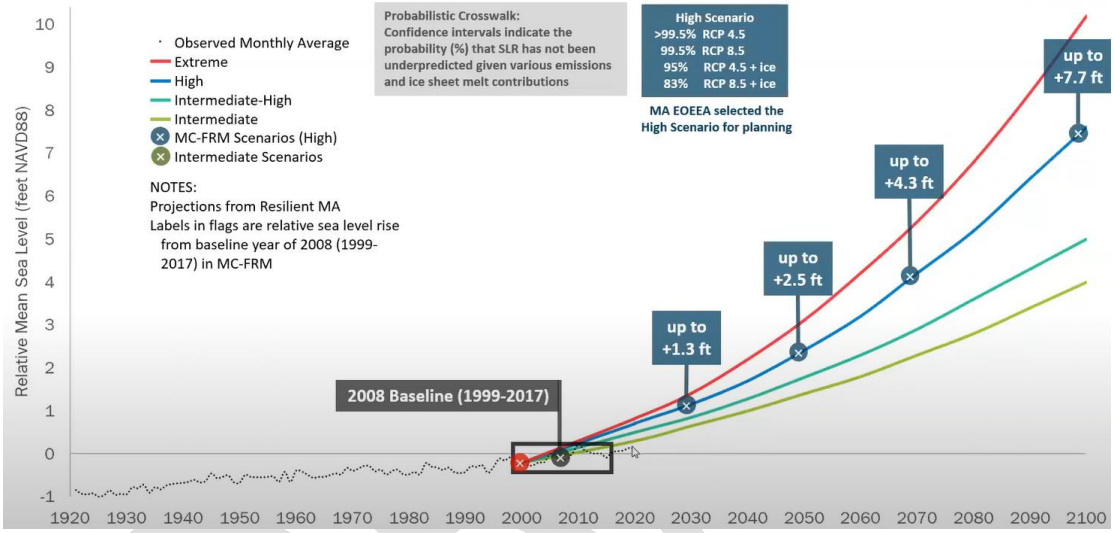
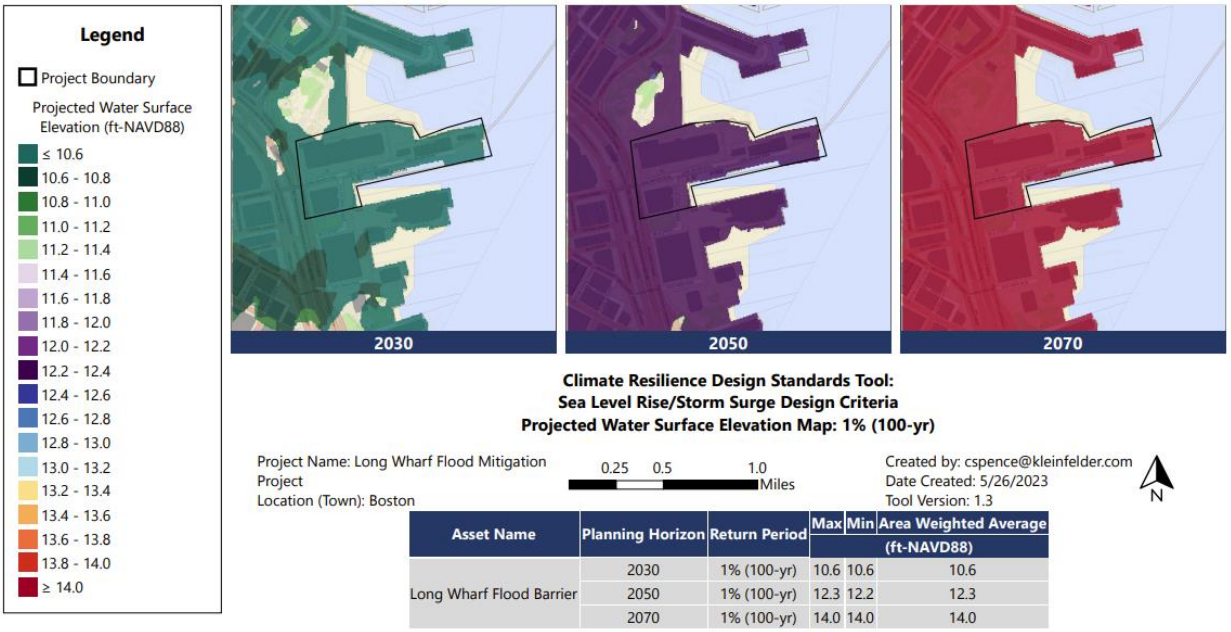


Figure 4: Sea level rise scenarios (MA EOEEA and Woods Hole Group, May 2023)

[6] Bosma, K., E. Douglas, P. Kirshen, K. McArthur, S. Miller and C. Watson (2021)."*Assessing the vulnerability of MassDOT's coastal transportation systems to future sea level rise and coastal storms, and developing conceptual adaptation strategies."*

[7] MA EOEEA and Woods Hole Group (2023). *MC-FRM Training #2: MC-FRM Level 2 Data, Application, and Usage.* https://youtu.be/gjgzTHaGsKA

© 2023 Kleinfelder



Asset Name	Planning Horizon	Return Period	Max	Min	Area Weighted Average (ft-NAVD88)
Long Wharf Flood Barrier	2030	1% (100-yr)	10.6	10.6	10.6
	2050	1% (100-yr)	12.3	12.2	12.3
	2070	1% (100-yr)	14.0	14.0	14.0

Figure 5 Projected water surface elevation of 1% annual chance flood at Long Wharf under 2030, 2050, and 2070 sea level as estimated through the MC-FRM study.

The Massachusetts Coast Flood Risk Model (MC-FRM) dataset is a product of a detailed coastal inundation modelling study using the MC-FRM. The MC-FRM was used to simulate a large ensemble of coastal storms under present and future sea level scenarios; with the ensemble of coastal storms used in distant simulations enhanced to reflect the potential changes in frequency and severity of coastal storms impacting the Massachusetts coast. The MC-FRM dataset includes several products in this study, including maps showing annual inundation exceedance probability at each location in the study, the depth of inundation simulated to occur under specified return periods, and more advanced study products such as flood water level elevations. The sea level scenarios included in the MC-FRM study are based on the Massachusetts Climate Change Projections produced by the Northeast Climate Adaptation Science Center (see section 1.2.3).

The Climate-Resilient Design Standards Tool provides projected tidal datums, water surface elevations, and wave action elevations for 2050. While the public-facing tool does not provide projected Highest Astronomical Tide (HAT), the projected MHHW is 5.5 ft higher than MSL in 2070 and 5.4 ft higher than MSL in 2050. For comparison, the difference between MHHW and MSL when both statistics are calculated over the 1983 – 2001 period is 5.07 ft.

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

Based on the project design team inputs, the Climate-Resilient Design Standards Tool assesses the Long Wharf project location as highly exposed to future sea level rise and coastal flooding. These inputs included preliminary estimates of project costs through construction and impacts in the case of failure.

The outputs of the Climate-Resilient Design Standards Tool (see Figure 6) recommend the design should protect against an 1% annual chance of exceedance (100-year) coastal flood under the 2050 sea level scenario as an intermediate target and a 2070 sea level as a long-term target. This water level is 12.3 ft NAVD88 (18.76 BCB) in 2050 and 14.0 ft NAVD99 (20.46 BCB) in 2070 without wave action. With wave action, the elevation is 18.6 ft NAVD88 (25.06 BCB) in 2050 and 20.4 ft NAVD88 (26.46 BCB) in 2070.

1.2.6 BPDA Coastal Flood Resilience Design Guidelines

Applicable Design Criteria

Projected Tidal Datums: APPLICABLE

Planning Horizon	MHHW	MHW	MTL	MLW	MLLW
	(ft-NAVD88)				
2050	7.8	7.4	2.5	-2.4	-2.7
2070	9.7	9.3	4.3	-0.7	-1.0

Projected Water Surface Elevation: APPLICABLE

Asset Name	Recommended Planning Horizon	Recommended Return Period	Max	Min	Area Weighted Average
			(ft - NAVD88)		
Long Wharf Flood Barrier	2050	1% (100-Year)	12.3	12.2	12.3
	2070		14.0	14.0	14.0

Projected Wave Action Water Elevation: APPLICABLE

Asset Name	Recommended Planning Horizon	Recommended Return Period	Max	Min	Area Weighted Average
			(ft - NAVD88)		
Long Wharf Flood Barrier	2050	1% (100-Year)	18.6	12.7	14.6
	2070		20.4	15.1	16.7

Projected Wave Heights: APPLICABLE

Asset Name	Recommended Planning Horizon	Recommended Return Period	Max	Min	Area Weighted Average
			(Feet)		
Long Wharf Flood Barrier	2050	1% (100-Year)	9.0	0.5	3.5
	2070		9.0	1.5	3.9

Figure 6: Outputs from the RMAT Climate Resilient Design Standards tool for a Long Wharf flood mitigation project.

BPDA's *Coastal Flood Design Guidelines*[8] recommend the use of a B.F.E. and D.F.E. based on the 2070 1% water level as simulated by the Boston Harbor Flood Risk Model

[8] BPDA (2019). *"Coastal Flood Design Guidelines."* http://www.bostonplans.org/getattachment/d1114318-1b95-487c-bc36-682f8594e8b2

© 2023 Kleinfelder

(BH-FRM), the predecessor detailed coastal model upon which the MC-FRM was improved and expanded in spatial scale. The sea level scenarios used in the BH-FRM study use 3.41 feet of sea level rise between 2013 and 2070 (approximately one foot lower than the MC-FRM 2070 sea level scenario).

The BPDA Coastal Flood Resilience Design Guidelines' B.F.E. at Long Wharf is 13.04 ft NAVD88 (19.5 ft BCB). One (1) foot of freeboard may be added to produce the D.F.E.; two (2) feet must be added to produce D.F.E. if the use is residential or involves critical infrastructure or emergency response. As Long Wharf includes an MBTA ferry launch point, the D.F.E. is 15.04 ft NAVD88 (21.5 ft BCB).

1.2.7 Massport Floodproofing Design Guide

The Massport Floodproofing Design Guide[9] specifies a D.F.E. "defined by the maximum water elevation with a 0.2% annual probability of exceedance in 2030 (modeled by BH-FRM) plus 3 ft. of freeboard" for existing facilities. This nearer-term 500-year flood with freeboard corresponds to 13.7 ft NAVD88 (20.16 BCB) at Long Wharf. For new facilities, the D.F.E. is also based on an 0.2% annual chance flood and 3 feet of freeboard at 2070 sea level as estimated from the BH-FRM study. At Long Wharf, this is 17.0 ft NAVD88 (23.46 ft BCB).

1.2.8 Coastal Resilience Solutions for Downtown Boston and North End

The Coastal Resilience Solutions for Downtown Boston and North End report[10] includes recommended near-, mid- and long-term design elevations for the area between Fort Point Channel to Callahan Tunnel which includes Long Wharf. The Target D.F.E. for this area is 15.0 ft NAVD88 (21.46 BCB), while the "Modular" long-term D.F.E. is 16.5 ft NAVD88 (22.96 BCB).

These are based on the elevation of the 1% annual chance/100-year flood with freeboard and between 9-21 inches of sea level rise (BH-FRM 2030s – 2050s) and 21 inches of sea level rise (2050s and 2060s) respectively.

---

[9] Massport (2018). *"Floodproofing Design Guide."* https://www.massport.com/media/2xacmacm/massport-floodproofing-design-guide-revised-november-2018.pdf

[10] City of Boston (2020). *"Coastal Resilience Solutions for Downtown Boston and North End."* https://www.boston.gov/sites/default/files/file/2020/10/Final_North%20End%20Downtown%20Final_EMBARGO_0.pdf and https://www.boston.gov/sites/default/files/file/2020/10/Final_North%20End%20Downtown%20Final_EMBARGO_0.pdf

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

1.2.9 Wharf District Council Coastal Resilience Plan

In 2022, the Wharf District Council (WDC) contracted a consultant team led by Arup to study District-wide coastal flood vulnerabilities and prepare a conceptual *Wharf District Council Coastal Resilience Plan.*[11]

The *Wharf District Council Coastal Resilience Plan* design team (led by Arup and Woods Hole Group) recommended a set of "Strategic D.F.E.s" for varying locations and location criticality within Boston's Wharf District as summarized below in Figure 7.

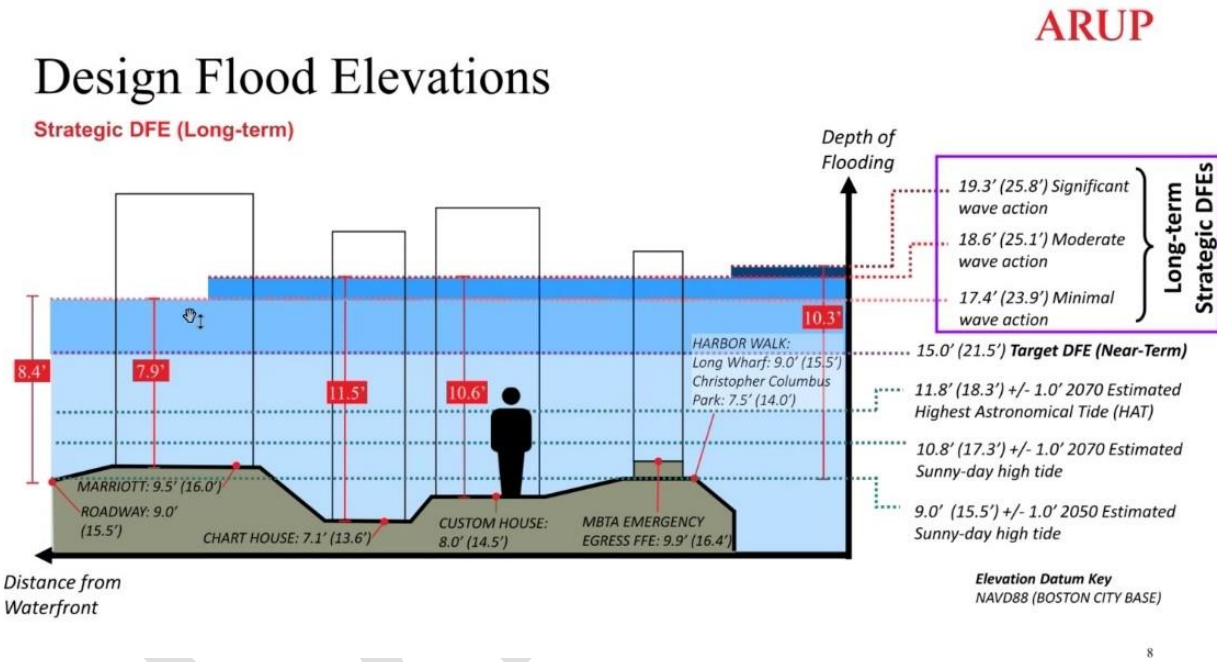


Figure 7 Wharf District Council Coastal Resilience Plan D.F.E. recommendations (under development, Arup)

The WDC study recommended a "Long-term Strategic D.F.E." of up to 19.3 ft NAVD88 (25.8 ft BCB) in areas of significant wave action, and a "Long-term Strategic D.F.E." of 17.4 ft NAVD88 (23.9 ft BCB) in areas of minimal wave action.

In the interim, the WDC study recommended a Near-Term Target D.F.E. of 15.0 ft NAVD88 (21.46 BCB).

[11] Wharf District Council (2023). *Wharf District Council Coastal Resilience Plan.* https://www.wharfdistrictcouncil.org/climate-resiliency

© 2023 Kleinfelder

2 RECOMMENDATIONS

2.1 APPROACH

Due to the increasing uncertainty in future sea level with each coming decade (see Figure 3), the project design team recommends that flood mitigation at Long Wharf may be implemented in phases with agreed upon points in the future at which the decision whether to provide a higher degree of protection based on knowledge of sea level rise trajectory at that time. The project design team therefore provides two Design Flood Elevations which may be used in a phased mitigation strategy for Long Wharf: (1) a near-term D.F.E. which the initial flood mitigation design should protect to and, (2) a long-term D.F.E. which the initial flood mitigation design should allow to be constructed with minimal additional effort. For example, the initial design may provide a foundation which could support protection to the higher, long-term level, but only build to the lower, near-term level.

In addition, an estimate of future Highest Astronomical Tide (HAT) elevation is also provided for the further-term sea level scenario. The estimated future HAT elevation is provided to inform the design of features which accommodate sunny-day high water conditions which may occur more than once per year. This condition is particularly important for interior drainage considerations.

Based on the critical resources within the proposed protected area on Long Wharf, project design team *at a minimum* recommends the flood mitigation strategy at Long Wharf be designed to protect from inundation at the water surface level of a conservative estimate of 2070 sea level, i.e., a 1% annual chance coastal flood event plus two (2) feet of freeboard based on the most recent and rigorous study of these values (i.e., 14.0 ft. NAVD88 + 2 ft freeboard = 16.0 ft. NAVD88). The project design team recommends that any flood barrier be designed to prevent inundation at this coastal water level without accounting explicitly for wave action beyond freeboard, though the any flood barriers should be designed to withstand wave forces over the course of the design life.

Note: Based on the latest MC-FRM data provided in the *Wharf District Council Coastal Resilience Plan,* Kleinfelder recommends further coordination with Woods Hole Group and MA EEOEA to better understand the newer MC-FRM Maximum Wave Crest Elevation and Wave Action Water Elevation data that explicitly model wave crests.

© 2023 Kleinfelder

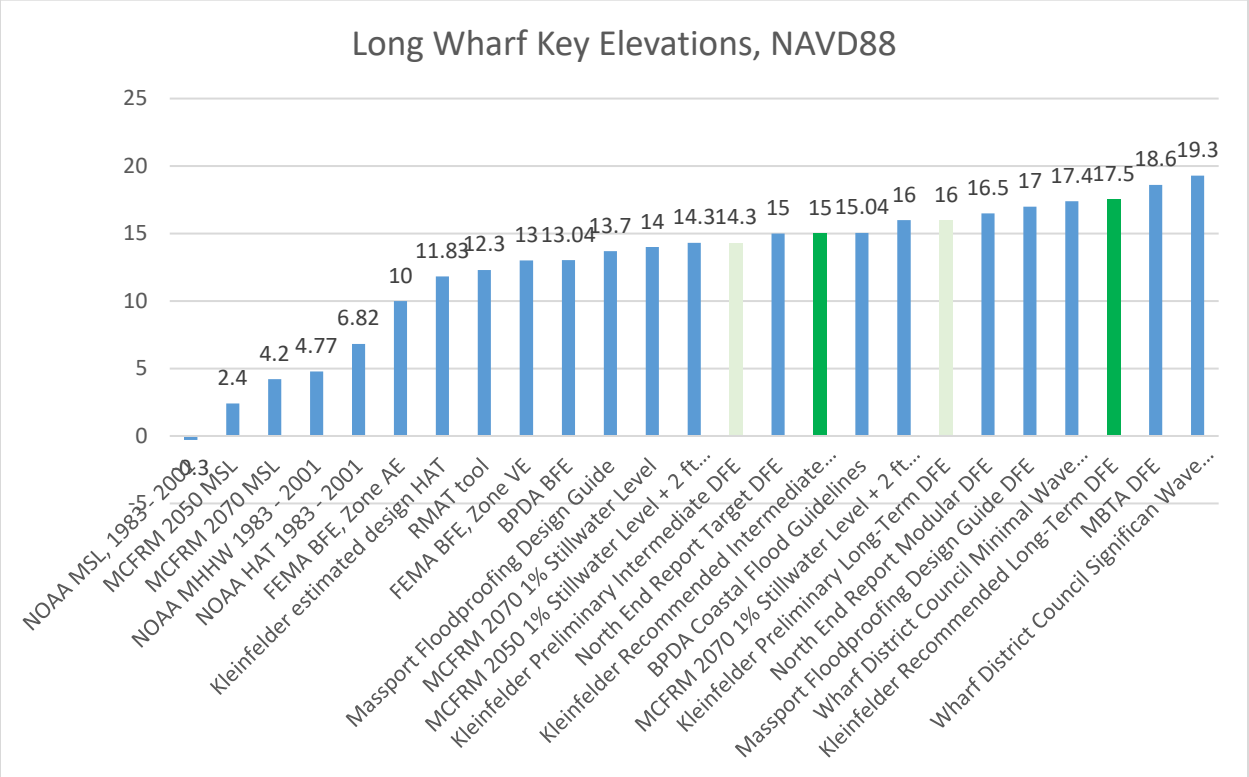


Figure 8: Long Wharf Critical Coastal Elevations, relative to NAVD88 vertical datum

2.2 RECOMMENDATIONS

The RMAT Design Tool (referencing the MC-FRM data) and approach described above yield the following design elevations (highlighted in lighter green on Figure 8):

- Near-term D.F.E.: 14.3 ft NAVD88 (20.76 ft BCB)
- Long-term D.F.E.: 16.0 ft NAVD88 (22.46 ft BCB)

As described in section 2.1, the near-term D.F.E. is based on the 2050 1% stillwater level wave elevation as simulated in the MC-FRM modelling study with two feet of freeboard added. The 2050 MSL used in the MC-FRM modelling study is based on the “High” MA Climate Change Projections’ sea level scenario (see Figure 3). However, the “Intermediate” MA Climate Change Projections’ sea level scenario indicates MSL would reach the same elevation in 2070 rather than 2050. Therefore, the near-term D.F.E. may be interpreted as hedging against the eventuality that sea level does not rise as rapidly as the “High” scenario would indicate.

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

The two feet of freeboard used in this method are typically included with the justification that freeboard accounts for variable and uncertain factors such as, in the case of coastal flooding, wave action effect. However, the MC-FRM modelling study provides explicit values for wave elevations which may be used for design. At Long Wharf, the wave elevation ranges between 12.7 ft NAVD88 and18.6 ft NAVD88 (19.16 ft BCB – 25.06 ft BCB; 2050) and 15.1 ft NAVD88 and 20.4 ft NAVD88 (21.56 ft BCB – 26.86 ft BCB; 2070). Given this large variation in potential wave heights at Long Wharf and assuming some degree of wave overtopping at the flood barrier is acceptable provided an appropriate drainage system is provided, the project team recommends the following near-term/target and long-term/modular design flood elevations which lie between each range of wave elevations (highlighted in dark green, Figure 8):

- **Near-term/Target D.F.E.: 15.0 ft NAVD88 (21.46 BCB)**
- **Long-term/Modular D.F.E.: 17.5 ft NAVD88 (23.96 BCB)**

Though the Climate Ready Boston D.F.E.s are based on sea level projections and coastal modelling which have since been superseded by the MA Climate Change Projections and the MC-FRM study, increasing the Long Wharf D.F.E.s by less than one foot to match the Climate-Ready Boston D.F.E.s will bring the flood mitigation design in line with other climate-informed infrastructure while minimizing additional cost. The recommended Near-term/Target D.F.E. is consistent with the WDC's design team recommendation as well.

For the **Long-term/Modular D.F.E.**, the project design team recommends a modular target of **17.5 ft NAVD88**, for areas of minimal wave action. Building future adaptation(s) to this elevation standard would essentially protect the majority of the wharf (less the end of the wharf in the higher wave action zone) and all inland areas to a condition that protects against a 2070 1% coastal flood/storm surge event, plus some additional wave action. It is also the project design team's view that it is also not efficient (i.e., cost effective or offering significantly more flood protection) for later modular adaptation(s) to increase the design flood elevation by less than 2.5 feet above the Near-term/Target D.F.E.

While some coastal elevations included in this review are higher than the Climate Ready Boston D.F.E. (see Figure 8), these higher design recommendations were formulated for different contexts than the Long Wharf flood mitigation case. For example, the Massport and MBTA D.F.E. methodology were both designed with critical point infrastructure and/or routes which could serve evacuation purposes in mind, and consequently design to prevent inundation during even lower-probability coastal storm events (Massport) and add freeboard on top of the FEMA B.F.E. which already accounts for wave action (MBTA). Similarly, the WDC's recommended long-term D.F.E.s include freeboard on top of the effects of wave action under a future sea level and coastal storm scenario. Therefore, Kleinfelder recommends the Long Wharf flood mitigation approach design to the Climate-Ready Boston recommended D.F.E. which is close in elevation to the D.F.E. which would

© 2023 Kleinfelder

otherwise be recommended based on the most up-to-date modelling and approach described in section 2.1.

- Future estimated HAT: 11.82 ft NAVD88 (18.28 ft BCB)

With respect to the **future elevated tide levels,** the sea level scenarios recommended by the NECASC Massachusetts Climate Change Projections are currently the most recent, widely used, and locally-tailored resource, whereas the MC-FRM modelling study is the most current, detailed, and localized study available. While future projections of HAT are not a Level 1 or 2 MC-FRM product made publicly available, a 2070 HAT elevation is estimated here based on the difference between the current estimated HAT and MSL applied to the MA Climate Change Projections “High” scenario 2070 MSL at Boston Harbor. This elevation is adjusted upwards by six inches to reflect the increased difference between MSL and MHHW observed in MC-FRM modelling study outputs (see sections 1.2.1 and 1.2.5).

DRAFT

© 2023 Kleinfelder

KLEINFELDER One Beacon Street, Suite 8100, Boston, MA 02108 p | 617.497.7800 f | 617.498.4630

APPENDIX B - IDENTIFIED STAKEHOLDERS AND ABUTTERS

The project team developed a comprehensive list of stakeholders and abutters on the Long Wharf project site. These entities may be engaged as part of the project depending on overall project goals and needs.

Public-Private/City/State/Federal Agencies

Public/private agencies

- Boston Planning and Development Agency (BPDA)

City

- City of Boston Departments and Commissions:
    - Environment Department
    - Parks and Recreation Department (BPRD)
    - Transportation Department (BTD)
    - Public Works Department (State Street and Old Atlantic Avenue)
    - Public Improvements Commission (PIC)
    - Boston Disabilities Commission
    - Boston Landmarks Commission
- Boston Water and Sewer Commission (BWSC)
- Boston Green Ribbon Commission

State

- Massachusetts Bay Transportation Authority (MBTA)
- Massachusetts Department of Transportation (MassDOT)
- Massachusetts Executive Office of Housing and Economic Development
- Massachusetts Emergency Management Agency (MEMA)
- Massachusetts Executive Office of Energy and Environmental Affairs (EEA)
- Massachusetts Office of Coastal Zone Management (CZM)
- Seaport Economic Council

Federal

- National Park Service (NPS)
- US Coast Guard
- Department of Defense
- FEMA
- US Army Corps of Engineers

Utilities

- Eversource
- National Grid

Tenants (on-site)

- Custom House (Capital Properties, tenant)
- Chart House (Capital Properties, tenant)
- Boston Waterboat Marina (tenant)
- Boston Harbor City Cruises (tenant)
- MBTA ferry and water shuttle services (tenant)
- Encore Casino Water Taxi operators (tenant)

Abutters

- New England Aquarium
- Long Wharf Marriott (Sunstone Hotels)
- Harbor Garage (Chiofaro Company)
- Harbor Towers
- 255 State Street and ground-floor tenants (i.e., Legal Seafood)
- Rose Kennedy Greenway Conservancy

Public Realm [Harborwalk, Neighborhood-, Historic-, and Waterfront Groups]

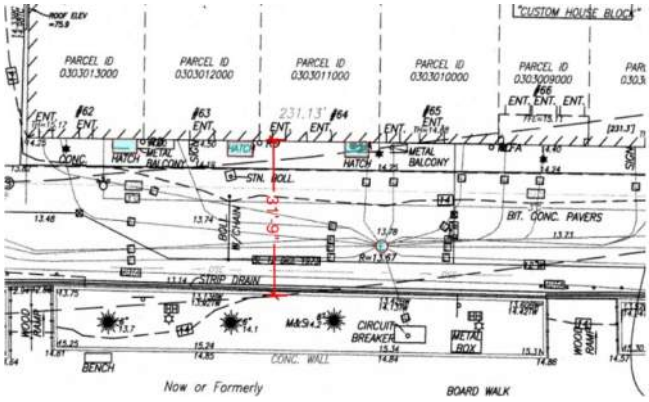
- Boston Harbor Now (BHN)
- Friends of the Harborwalk
- Stone Living Lab
- Boston Waterfront Partners / Harborfront Neighborhood Alliance
- Wharf District Council
- Friends of Christopher Columbus Park
- North End Waterfront Residents Association (NEWRA)
- North End Waterfront Neighborhood Council (NEWNC)
- A Better City

APPENDIX C - SITE VISIT REPORT FROM CUSTOM HOUSE BLOCK AND CHART HOUSE

The utility information described in this section is informed by a site visit that took place Tuesday, April 18, 2023, 1:30 PM-3:00 PM. Attendees included Dolores Fazio (BPDA), Ksenia Acquaviva (BPDA), Andre Martecchini (Kleinfelder), Keng Liu (Kleinfelder), and Capital Properties facility manager.

Custom House Block Building

- From Custom House Block building exterior wall to landscape curb @ Bay 63: 31’-9”
- Paving material: stamped asphalt
- 6” planting curb
- 16” trench drain
- 160” wide planting beds (outside curb to curb)



- Bay 63 South elevation @ grid 1 exterior windowsill height 6” average
- Electrical connection sleeve is embedded in the asphalt paving
- The building is owned in its entirety by Capital Properties.

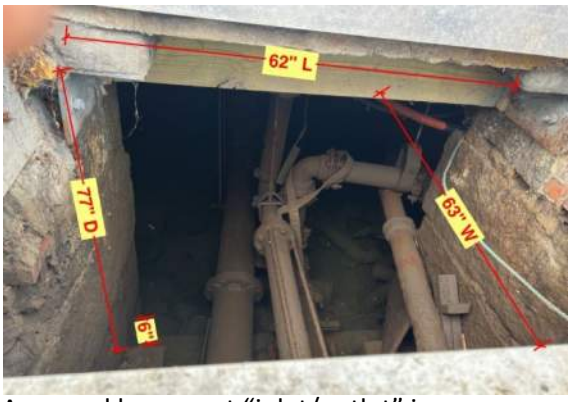
Custom House Block Bay 63 & 69:

- Bay 63 along Grid C and Bay 69 along Grid J: Exhaust air louver with insulated plenum and motorized damper connected to 16” duct down to the basement. The shaft is enclosed with drywall

Custom House Block Bay 64:

- Electrical manhole is at the offset position from the utility connection hatch

- Basement access panel @ bay 64 south near Gid1D: 62” L X 63” W X 77” D
- Below-grade utility pipes/sleeves connected to the building. The lines at the lower elevation are constantly submerged in the water
- PVC plumbing P trap from the building hangs just above the water line
- No backflow preventer is visually discovered at this location



- Assumed basement “inlet/outlet” is discovered at Bay 64 North between Grid C and Grid D
- Several similar “inlets/outlets” are found along the Long Wharf north seawall w/ granite lentils support

Custom House Block Bay 65 North Main Electrical Room:

- Full structural slab from masonry wall to wall
- 42” high concrete resiliency curb
- Surface-mounted jamb frame and floodgate
- Liquid-applied waterproofing (yellowish Ploy) outside of the electrical room
- Single access door to the transformer room @ grid E

Custom House Block Bay 66 North Transformer Room/Vault

- Exterior granite sill height 6”
- Transformer room layout, pads and equipment elevations need to be verified

Custom House Block Bay 69:

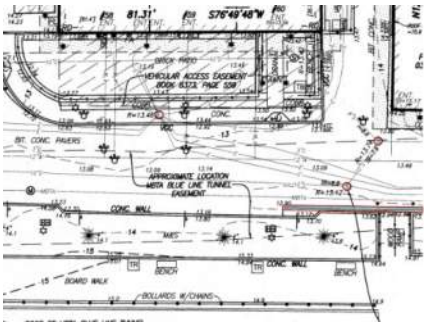
- Masonry infill at the granite opening behind the exterior shutters
- FP testing connection and hose bibb penetrate through the exterior wood shutter

Custom House Block Bay 70:

- Exterior wall: Full-depth granite block around the exterior openings w/ masonry infill at the interior side
- East elevation @ grid 2K new window unit: interior sill height at 32” AFF
- East elevation @ grid K door interior sill height at 4” AFF
- West Elevation @ grid 1 window interior sill height at 3” AFF
- The interior is sloped from east to west following the slope of the exterior Harborwalk
- Masonry infill at the granite opening behind the exterior shutters

Chart House

- BWSC and Electrical manhole locations match the 2015 survey plan
- Trench Drain ends across the street from the Chart House’s front entrance



- Fire Department connection and gong, sprinkler center line 24” above the grade.

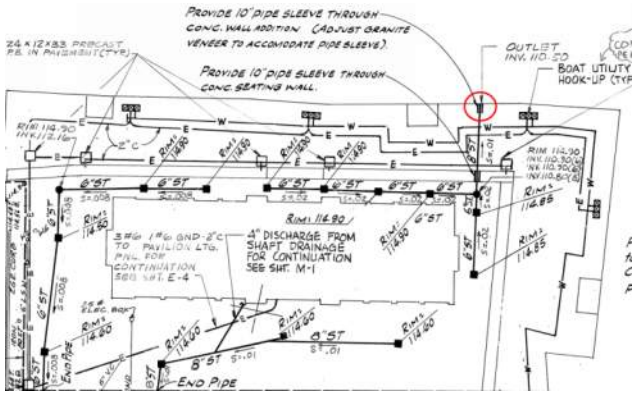
- The electrical service cabinet sits about 3’ to 3 ½” above the finished floor (per BPDA email, electrical service has not been impacted by the flooding to date)

- The outdoor seating areas at the Chart House are on leased property.
- The building is owned in its entirety by Capital Properties.

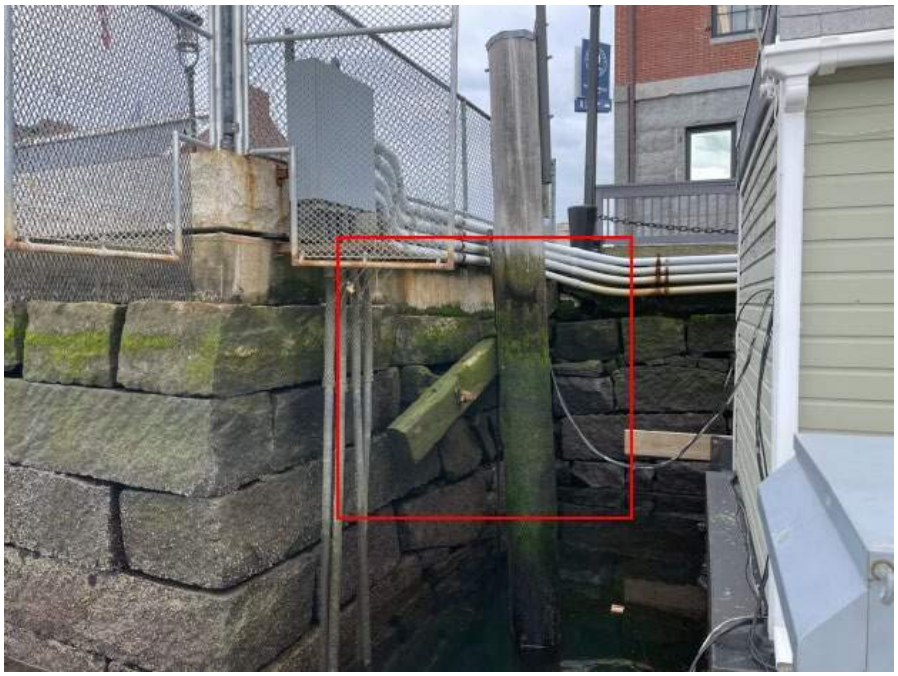
Seawall

- 10” +/- outlet pipe sleeve through the seawall

- Granite block was partially removed to accommodate the pipe sleeve



- Northwest corner of the pavilion seawall has a temporary stabilization waler beam below the concrete slab



APPENDIX D – GEOTECHNICAL INFORMATION SUMMARY

GEOTECHNICAL INFORMATION INDEX

PLAN ID	ORIGINAL ID	SOURCE
B1	B0	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B2	B0-A	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B3	B0-B	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B4	B0e-e3	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B5	434	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B6	B1	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B7	452	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B8	B2	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B9	457	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B10	B3	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B11	A17b	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B12	427	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B13	B4	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970 / BORINGS
B14	B5	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970 / BORINGS
B15	A26	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B16	B-105	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-102/ OCTOBER 1981 / BORINGS
B17	B-B9	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970 / BORINGS
B18	B-3	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B19	B-3A	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B20	B-104B	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-102/ OCTOBER 1981 / BORINGS
B21	A23	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B22	B7	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970/ BORINGS
B23	B-102	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-102/ OCTOBER 1981 / BORINGS
B24	B6	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970 / BORINGS
B25	A58	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B26	EC53	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B27	B-1	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / BORINGS
B28	D2W	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B29	B2W	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B30	D2W5	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B31	B-103	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B32	B8	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970/ BORINGS
B33	B2B	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B34	B-2	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / BORINGS
B35	B2SC	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B36	D2E1	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1982 / BORINGS
B37	B2B	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B38	B1	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970/ BORINGS
B39	106	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B40	103	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B41	B2	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / JUNE 1970 / BORINGS
B42	A29	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / DECEMBER 1906 / BORINGS
B43	104	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B44	95	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B45	103	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B46	102	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B47	98	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B48	12	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B49	97	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B50	96	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B51	107	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B52	94	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B53	101	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B54	92	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B55	91S-11S	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B56	424	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B57	5	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B58	4	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B59	3	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B60	434	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B61	7	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B62	11	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B63	99	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B64	10	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B65	100	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B66	6	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B67	2	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B68	940-117	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B69	433	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B70	1	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B71	5	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B72	9	DOWNTOWN WATERFRONT FANEUIL HALL PROJECT / MAY 1976 / BORINGS
B73	B1-2018	LONG WHARF SEAWALL STABILIZATION / DECEMBER 2018 / BORINGS
B74	B2-2018	LONG WHARF SEAWALL STABILIZATION / DECEMBER 2018 / BORINGS
T1	B-105 PROBES	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-102/ OCTOBER 1981 / PROBES
T2	B-102	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-102/ OCTOBER 1981 / PROBES
T3	P-4	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T4	P-3	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T5	P-5	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T6	P-3A	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T7	P-1B	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T8	P-6	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T9	P-8	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T10	P-9	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T11	P-7	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T12	P404	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T13	P403	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T14	P402	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T15	P303	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T16	P302	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T17	P301	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T18	P-2A	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T19	P-2	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T20	WC-1	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / WALL CORE
T21	P-1	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES
T22	B-103 PROBES	SUBWAY VENTILATION IMPROVEMENTS CONTRACT NO.103-103/ OCTOBER 1981 / PROBES

Foth

BOSTON PLANNING & DEVELOPMENT AGENCY

FLOOD MITIGATION PLANNING & FEASIBILITY STUDY

NO.	BY	DATE	DESCRIPTION
1			
2			
3			
4			
5			
6			

DATE OF PREPARATION

	BY	DATE
SUBMITTED		
DRAWN	MAB	
DESIGNED		
CHECKED	JMP	

SHEET TITLE

GEOTECHNICAL INFORMATION SUMMARY

STATUS: FOR INFORMATIONAL PURPOSES

PROJECT NO. 23K004.00

SHEET NUMBER 1

Wednesday, July 26, 2023 8:33:01 AM
DWG Filename: bra_long wharf_boring plan.dwg Layout: b101
DWG Folder Location: per\Data per\Boring data\data per\Documents\Client\Projects\2023\BRA\LONG\CAD\Drawings\Geotechnical Info drawing\BRA_Long Wharf_Boring Plan

APPENDIX B - SUMMARY OF STAKEHOLDER ENGAGEMENT + TAKEAWAYS

INTRODUCTION

In an effort to establish an equitable design process, the team has deliberately communicated with and learned from a wide variety of stakeholders througout the duration of the project. By utilizing the lived knowledge and cumulative expertise of Long Wharf, the team was able to develop and iterate upon conceptual designs that hopefully respond to a shared future vision for this prominent waterfront space.

Because of the complexity of the project site, the team required in-depth conversation with many different agencies, tenants, abutters, marine transit operators, and regulators through each step of the process. This project also sought to build upon the existing documentation of the site area and feedback provided by stakeholders as part of the various planning efforts, both past and ongoing.

HOW ENGAGEMENT INFORMS THIS STEP

A LISTENING TOUR INVOLVING KEY STAKEHOLDERS PROVIDED CONTEXT THROUGH WHICH TO FRAME OPPORTUNITIES AND EXISTING CHALLENGES

FACT-CHECKING FINDINGS WITH STAKEHOLDERS TO MAKE SURE WE CAPTURE KEY PROJECT ELEMENTS

TEAM DELIBERATELY INCORPORATING FEEDBACK INTO PROPOSALS AND ITERATING ON CONCEPTUAL SCHEMES

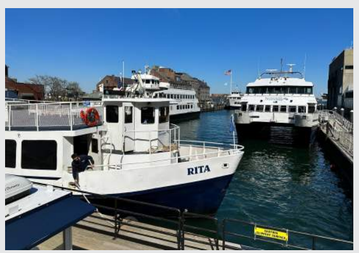
ALLOWING FOR ITERATION AND REFINEMENT BASED ON EVOLVING FEEDBACK FROM STAKEHOLDERS

PRESENTATION OF FINDINGS AND ENGAGEMENT EFFORTS AS A WAY TO SET UP A FRAMEWORK FOR CONTINUED EQUITABLE DESIGN AND COMMUNICATION IN THE SUBSEQUENT PHASES OF THE PROJECT

Community and Stakeholder Input

The following groups generously provided feedback via stakeholder interviews, in-depth conversations, and focus group meetings on the conceptual designs that are captured in this report. It is with their guidance and collaboration that the project team was able to better understand opportunities and challenges as related to the urban realm, infrastructure, utilities, and tenant concerns in this complex waterfront area.

- *Boston Harbor Cruises*
- *Boston Harbor Now*
- *Boston Water and Sewer Commission*
- *Capital Properties*
- *City of Boston Parks and Recreation Department*
- *Eversource*
- *Friends of Christopher Columbus Park*
- *The Rose Kennedy Greenway Conservancy*
- *Harbor Towers*
- *National Grid*
- *New England Aquarium*
- *North End Waterfront Neighborhood Council*
- *Massachusetts Bay Transportation Authority*
- *Sunstone Management Partners*
- *Wharf District Council*



DRAFT

DRAFT

ENGAGEMENT APPROACH

The project team relied on an approach to engagement that utilized various formats in order to receive meaningful feedback from stakeholders. These approaches included virtual meetings, presentations, and interviews via Zoom, in-person focus group meetings and workshops, and on-site walking tours. During the public virtual meeting held in January 2024, the team also incorporated the use of MentiMeter, an online voting platform which allowed participants to use their phone or browser to provide feedback in real time.

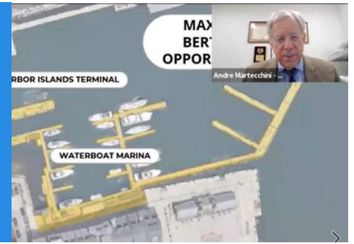
These various formats and activities were held throughout the duration of the project so that the public would be informed of the project process and key objectives. Key stakeholders played an active and ongoing role by being repeatedly engaged as the designs and findings were iteratively advanced.

HOW WE ARE INCORPORATING FEEDBACK

Following each interaction with stakeholders, the team recorded comments and questions, which were then addressed through continued conversation and reflection in the design. Because this process relies on the development of implementable and feasible concepts, when the team encountered trouble incorporating feedback, it was brought to the stakeholders attention with reasons for why there might be future difficulties. Additionally, feedback specific to each of the focus groups was reflected back in subsequent conversations so participants could clearly see how their comments were incorporated into design updates.

VIRTUAL MEETINGS

- *Zoom online meetings with various stakeholders, both private and public*
- *Public meeting presentation*

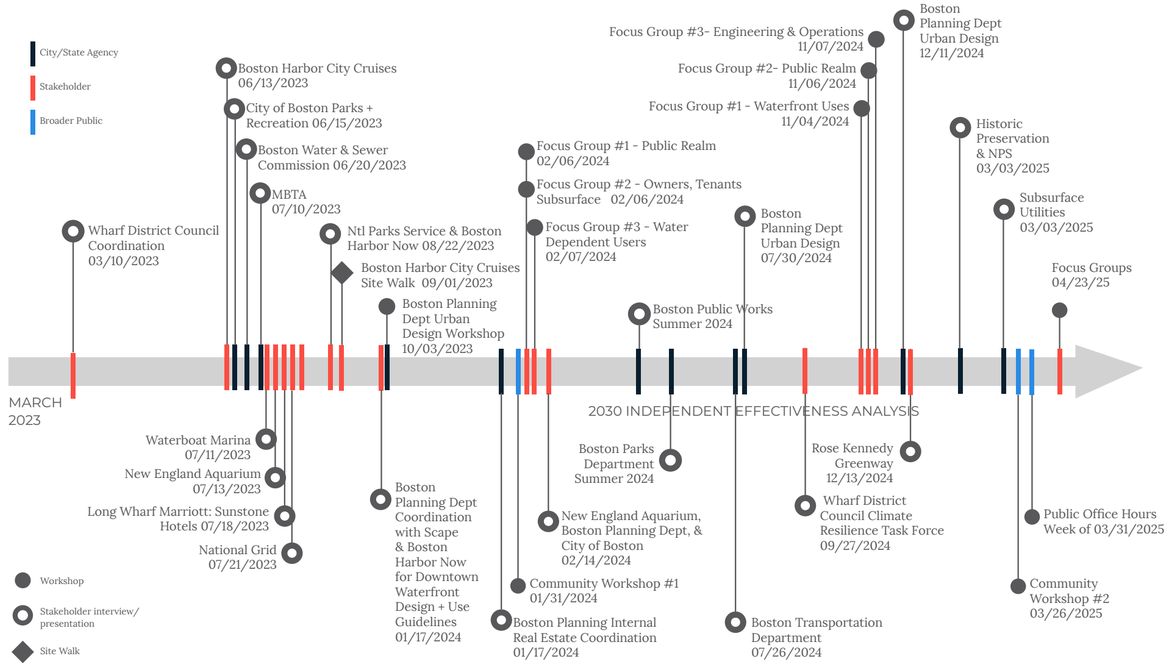


FOCUS GROUPS

- *Dedicated and interactive conversations, activities, and design feedback opportunities with key stakeholders, abutters, and tenants*

SITE VISITS

- *Review of existing conditions with team members*



DRAFT

DRAFT

WHAT WE HAVE HEARD

FOCUS GROUPS- TENANTS + ABUTTERS

The tenants and abutters focus group was comprised mainly of representatives from the Waterboat Marina, the Boston Marriott Long Wharf (Sunstone Management Partners), Pembroke Properties, and the New England Aquarium. Feedback from this group included concerns around access to and from the various existing buildings, primarily as it related to Old Atlantic Avenue, as well as concerns around maintenance activities, including trash removal and the upkeep of salt-tolerant plant species. Additionally, folks expressed interest in consolidation of water transporation and the movement of people along the Wharf, which were proposed to be remedied through improved wayfinding and opportunities for outdoor comfort through shade structures and tree planting.

FOCUS GROUPS- INFRASTRUCTURE + UTILTIES

The infrastructure and utilities focus group overlapped with several members from the tenants and abutters focus group and included additional stakeholders such as the MBTA, BWSC, Eversource, and National Grid. Primarily, this group's feedback focused on technical issues, including subsurface conditions, access, and maintainance. Comments from the MBTA were centered around the relationship of the Blue Line Aquarium transit stop to the proposed flood barriers as well as the potential impact of loading on the tunnel below the wharf. BWSC shared concerns about stormwater detention and storage locations and capacities.

WHO MAINTAINS THE DEPLOTABLE FLOOD BARRIERS? WHO DEPLOYS

CONCERNED WITH CLOSING OFF OLD ATLANTIC AVE TO VEHICLES BECAUSE IT IS USED DURING HOTEL EVENTS FOR ACCESS TO THE GARAGE

ARE THERE ANY RESTRICTIONS CONCERNING LOADING ON OR AROUND THE MBTA BLUE LINE TUNNEL?

WASTE MANAGEMENT IS A HUGE CONCERN-- THE CURRENT SYSTEM IS INADEQUATE, UGLY, +

THE CHART HOUSE IS VERY POPULAR WITH THE LOCAL COMMUNITY

CLOSING OLD ATLANTIC AVE TO TRAFFIC WOULD BE A PROBLEM AT DROP OFF/PICK UP AREAS FOR THE BUSES + DUCK BOATS

THERE WILL NEED TO BE A VEHICULAR / EMERGENCY ACCESS PATHWAY MAINTAINED TO THE MBTA EGRESS PAVILION

WILL PHASING DISRUPT TOURISM + BUSINESS ON THE WHARF? WOULD HATE TO SEE A 12-YEAR CONSTRUCTION PROJECT!

DRAFT

FOCUS GROUPS- MARINE TRANSIT

The marine transit group focused on the public transporation infrastructure provided by the MBTA ferry service as well as private tourist and excursion boats. This group's main points of feedback were centered on opportunities to consolidate and better structure ferry service, primarily at the north end of the wharf. The group expressed the need to consider user expereince and outdoor comfort as well, and feedback included a desire to think through queuing space needs, shade and seating opportunities, ticketing operations, and boat loading requirements. In addition, this group discussed the need for safety, accessibility, and redundancy in the marine transit operations for proper functioning and usability.

FOCUS GROUPS- PUBLIC REALM

The public realm focus group was composed of stakeholders from various agencies, including Boston Parks and Recreation, City of Boston Urban Design, the National Parks Service, the Wharf District Council, and Boston Harbor Now. Comments from this group addressed the critical need to create an accessible and safe waterfront with an elevated Harbor Walk. Stakeholders also shared concerns for maintaining key views to the water from all sides of the wharf. Signage and wayfinding comments were also elevated by several members of this focus group, an overlapping comment among other groups. Also, this group emphasized the need to respect and work with historic elements of the wharf, including the existing seawalls and structures.

THE IDEA OF A CENTRALIZED TICKETING/ INFORMATION BUILDING IS WELL-RECEIVED

THE TEAM SHOULD CONSIDER THE LANDSIDE SPACE NEEDED FOR FERRIES + THE FUTURE INFRASTRUCTURE NEEDS FOR ELECTRIFICATION OF VESSELS

PEOPLE WANT SHADE ALONG THE HARBORWALK, NOT JUST WHILE THEY WAIT FOR THE FERRIES

DOES A PARRIER AT ELEVATION +15.0' CREATE A BARRIER BETWEEN THE WATER'S EDGE AND FOLKS VISITNG THE SITE?

THERE NEEDS TO BE MROE STORAGE SPACE FOR MARINE TRANSIT FOOD + BEVERAGE SERVICES

CONCERN WITH CONSOLIDATING MARINE TRANSIT-- REDUNDANCY NEEDS TO BE BUILT IN

BETTER SIGNAGE IS NEEDED; WAYFINDING IS AN ONGOING PROBLEM

ENSURE THERE ARE NO TRIPPING HAZARDS + THAT THERE IS ADEQUATE WATER EDGE PROTECTION IN THE DESIGNS

HOW CAN PEOPLE EASILY ACCESS THE WATER'S EDGE?

DRAFT

OVERALL FEEDBACK

THERE IS NO EASY PATH TO THE WATERFRONT, AND THERE IS NO HANGOUT SPACE. WE NEED TO CREATE A COMMUNAL OPEN SPACE.

NEW ENGLAND AQUARIUM

WAYFINDING

OPEN SPACE + ACCESS TO THE WATER

ENSURE THAT THE PARK'S PROGRAMMING IS RETAINED, AS THE COMMUNITY VALUES THE OPEN, FLEXIBLE SPACE AND DOES NOT WANT TO LOSE IT DUE TO FLOODING OR CHANGES IN THE RELATIONSHIP TO WATER.

BOSTON PARKS DEPARTMENT

DRAFT

FOR PASSENGERS ARRIVING EARLY, THERE ARE FEW PLACES TO ESCAPE THE SUN OR RAIN, SO ADDITIONAL WAITING AREAS WOULD BE WELCOME.

NEW ENGLAND AQUARIUM

OUTDOOR COMFORT + SHADE

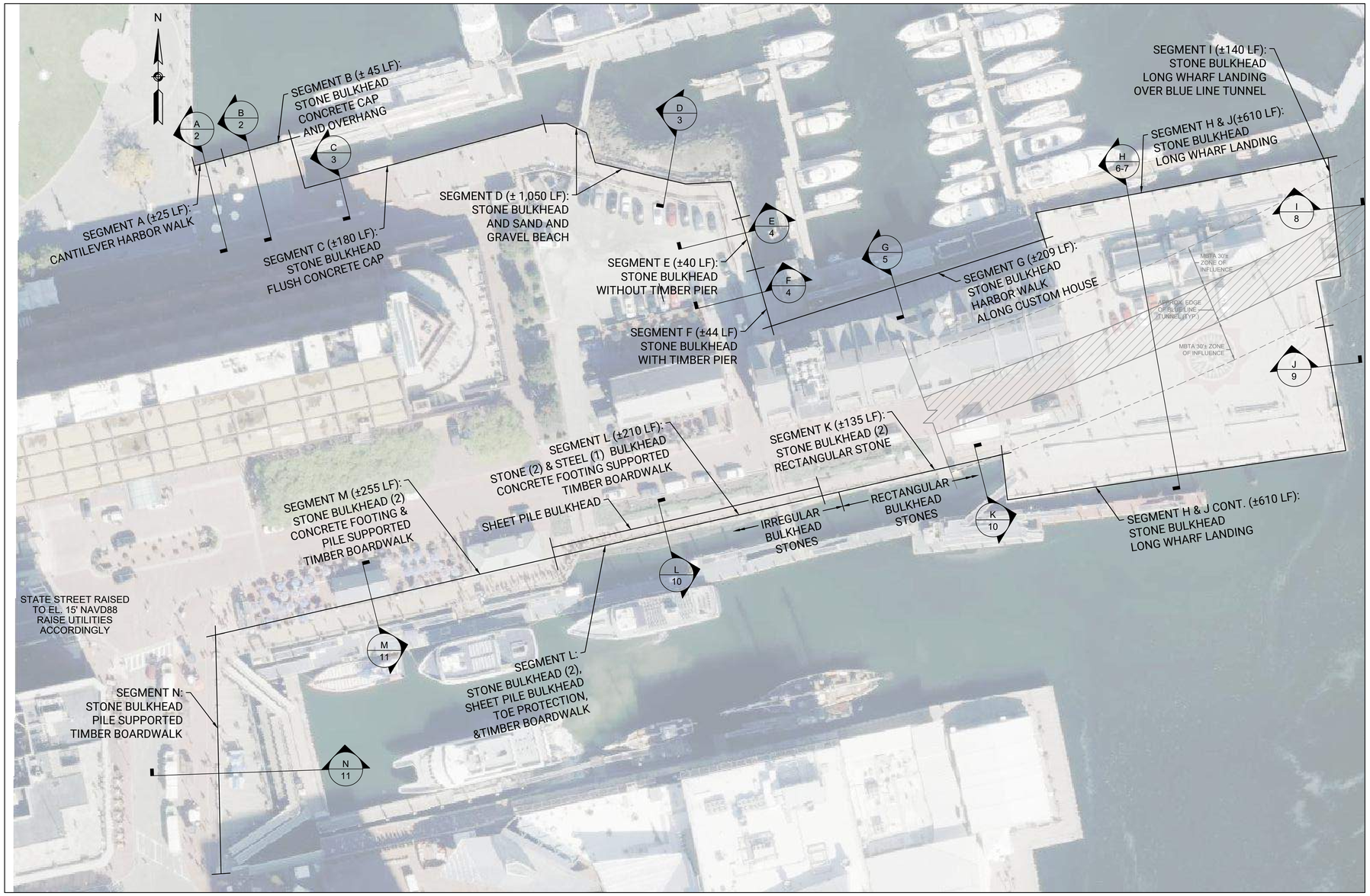
HISTORY + PLACEMAKING

LONG WHARF IS A SIGNIFICANT SITE IN THE REVOLUTIONARY WAR, PROVIDING A GREAT OPPORTUNITY TO INCORPORATE HISTORY THROUGH LANDSCAPE AND ART.

NPS + BHN

DRAFT

APPENDIX C - WHARF EDGE CONDITIONS



NOTES:

1. PROJECT INFORMATION SHOWN HEREIN IS FOR CONCEPTUAL AND PLANNING PURPOSES ONLY, PLANS ARE NOT FOR PERMITTING, DESIGN, OR CONSTRUCTION.
2. TIDAL DATUM INFORMATION IS TAKEN FROM BENCHMARK SHEET FOR STATION ID 8443970, BOSTON HARBOR, MASSACHUSETTS, 12/12/2023, PUBLISHED BY THE U.S. DEPARTMENT OF COMMERCE, NATIONAL OCEAN SERVICE (NOS). ELEVATIONS REFERENCE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).

TIDAL STAGE	MLLW DATUM	NAVD88 DATUM
HTL	12.02	6.51
MHHW	10.28	4.77
MHW	9.84	4.33
NAVD88	5.51	0.00
MLW	0.35	-5.16
MLLW	0.00	-5.51

3. TIDAL DATA IS PER NOAA AVERAGES BASED ON THE 1983-2001 TIDAL EPOCH AND NOT GUARANTEED TO REPRESENT CONDITIONS WHICH MAY OCCUR DURING CONSTRUCTION. ACTUAL WATER LEVELS WILL VARY FROM LEVELS INDICATED.
4. FEMA FLOODPLAIN LINES, APPROXIMATE PROPERTY LINES, AND PROPERTY INFORMATION SHOWN PROVIDED VIA MOST RECENTLY AVAILABLE MAGIS DATA.
5. FEMA FLOODPLAIN LINES REFERENCE FEMA PANEL 250525C0081J EFFECTIVE 3/16/2016.
6. THE TOPOGRAPHIC AND BATHYMETRIC DATA SHOWN ON THIS PLAN WAS GATHERED ON APRIL 4, 2018 AND SEPTEMBER 8, 2022.
7. SECTION INFORMATION COLLECTED FROM THE BOSTON REDEVELOPMENT AUTHORITY REPORT "CENTRAL AND LONG WHARVES CONDITIONS REPORT", DATED JULY 2000, SUBMITTED BY CHILDS ENGINEERING CORPORATION.
8. THE INFORMATION DEPICTED ON THIS PLAN REPRESENTS THE RESULTS OF SURVEYS MADE ON THE DATES SHOWN, AND CAN ONLY BE CONSIDERED AS INDICATING THE GENERAL CONDITIONS AT THAT TIME. INTERPOLATED INFORMATION FROM BETWEEN SOUNDING RUNS IS NOT GUARANTEED. SHOALS, OBSTRUCTIONS OR OTHER DIFFERING CONDITIONS MAY EXIST BETWEEN THESE RUNS. CONSULT WITH FOTH FOR MORE DETAILED INFORMATION.

GRAPHIC SCALE

0 20 40 80

(IN FEET)
1 INCH = 40FEET

KLEINFELDER
Bright People. Right Solutions.
STOSS
Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO.	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SITE LOCUS

ISSUANCE:

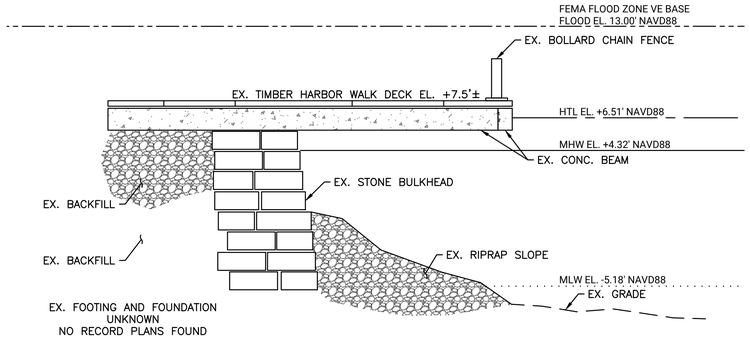
CONCEPTUAL

PROJECT NO: 23K004

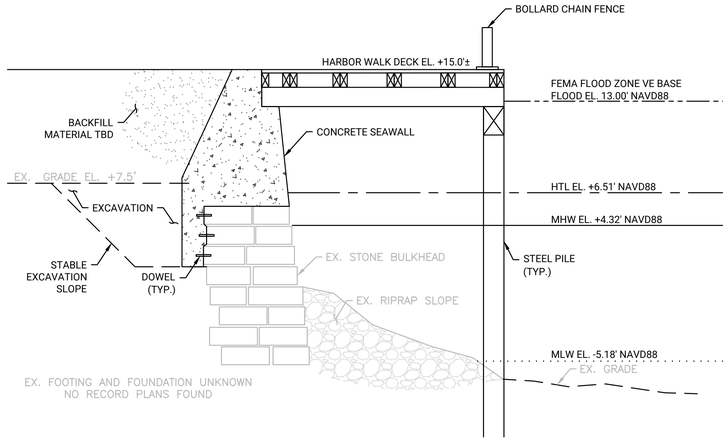
SHEET NUMBER

1

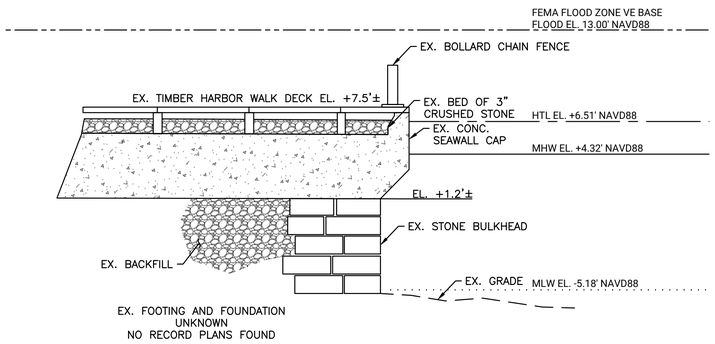
Wednesday, April 3, 2024 3:38:59 PM
DWG Filename: Kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: site overview
DWG Folder Location:



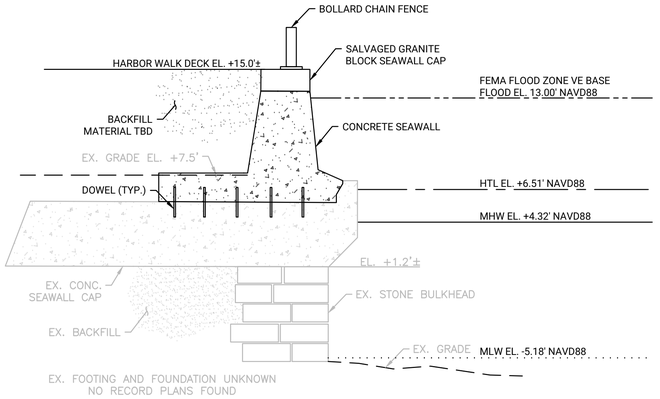
A1 SEGMENT A: EXISTING CONDITIONS
SCALE: 1" = 5'



A2 SEGMENT A2: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'



B1 SEGMENT B: EXISTING CONDITIONS
SCALE: 1" = 5'



B2 SEGMENT B: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

KLEINFELDER Bright People. Right Solutions.
STOSS
Foth
BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT A & B

ISSUANCE:

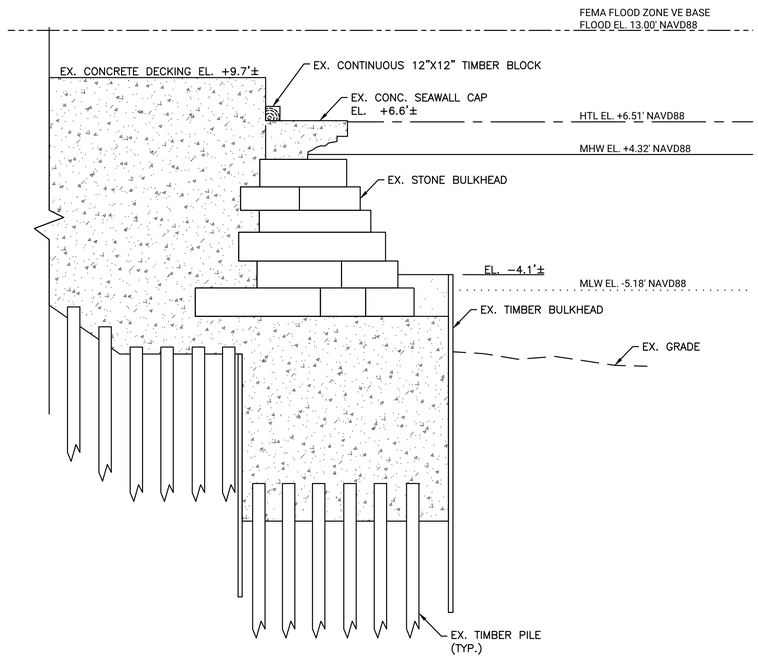
CONCEPTUAL

PROJECT NO: 23K004

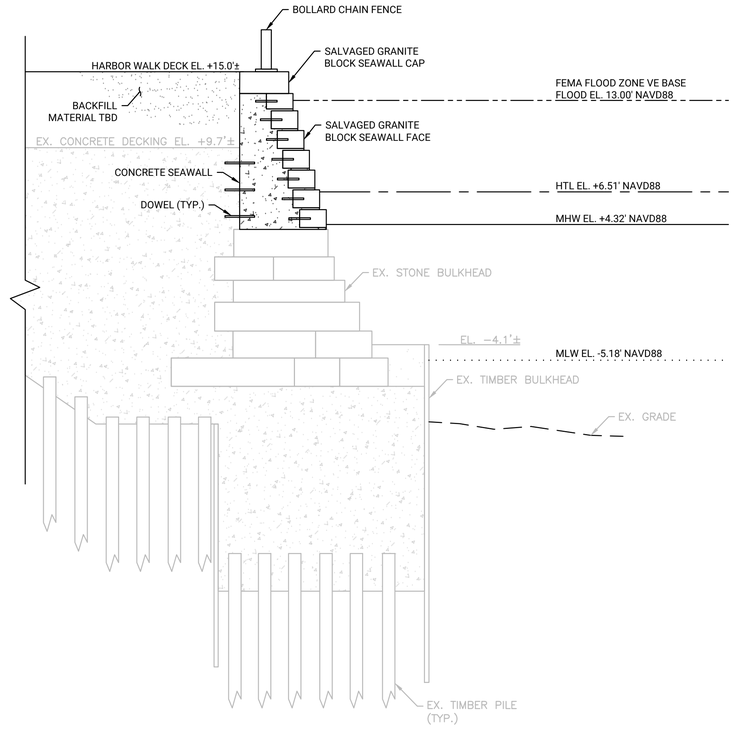
SHEET NUMBER

2

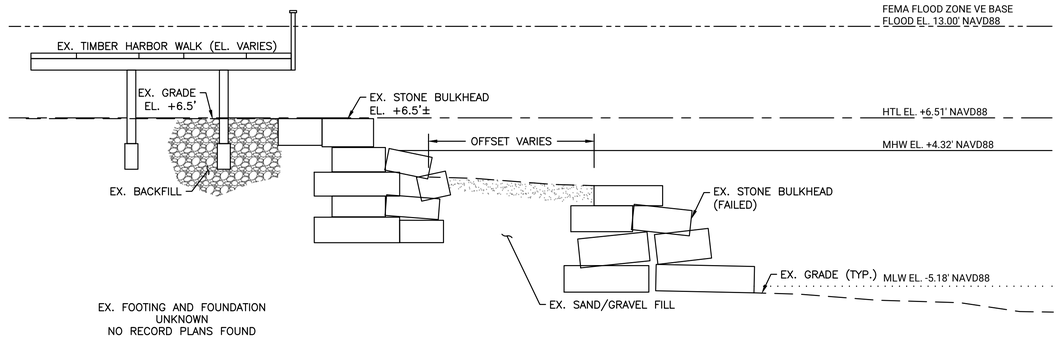
Wednesday, April 3, 2024 3:39:08 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment a and b
DWG Folder Location:



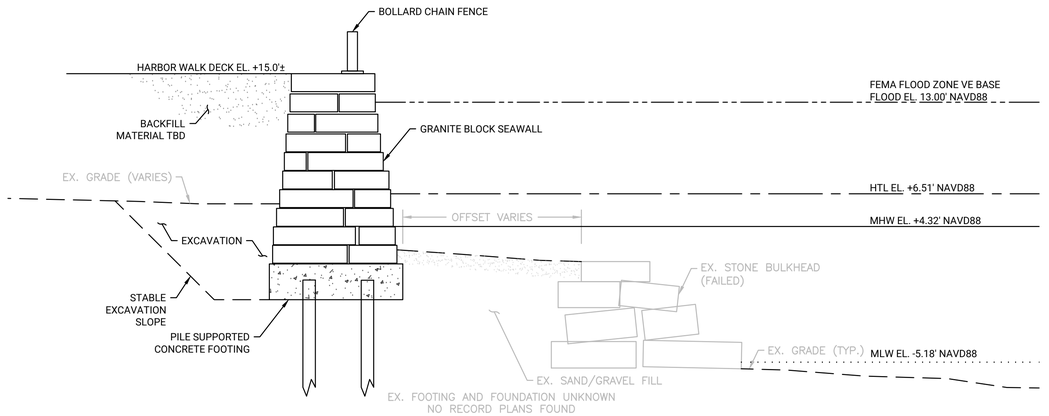
C1 SEGMENT C: EXISTING CONDITIONS
SCALE: 1" = 5'



C2 SEGMENT C: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'



D1 SEGMENT D: EXISTING CONDITIONS
SCALE: 1" = 5'



D2 SEGMENT D: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

STOSS
KLEINFELDER
Bright People. Right Solutions.
Foth
BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO.	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT C & D

ISSUANCE:

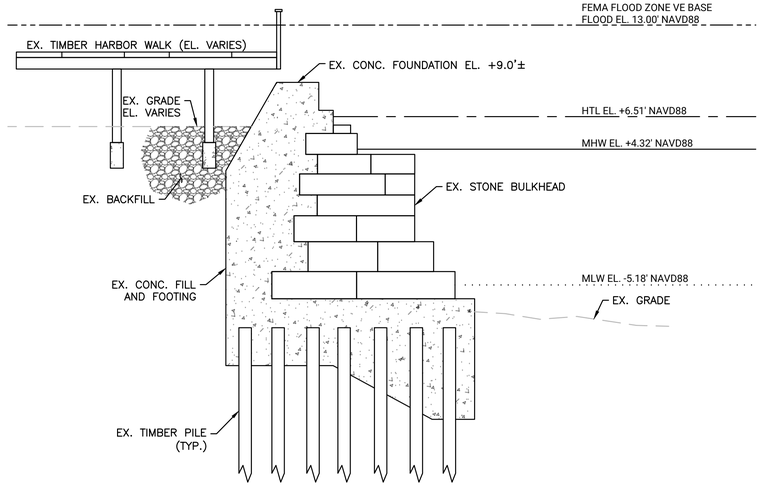
CONCEPTUAL

PROJECT NO: 23K004

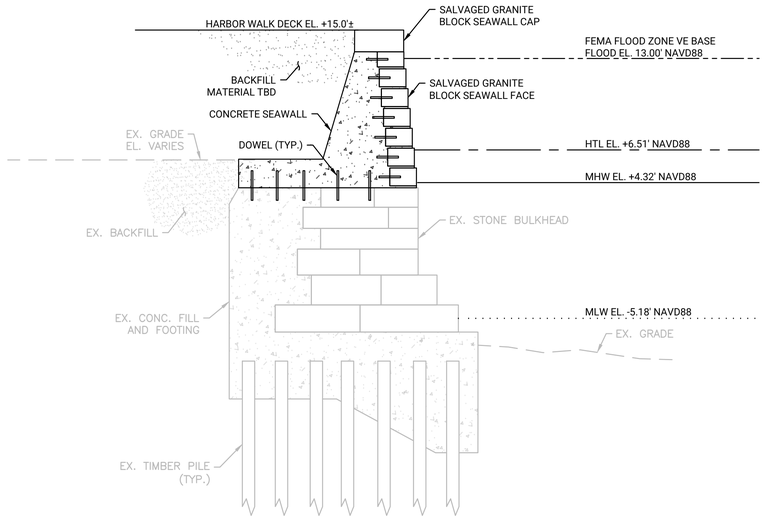
SHEET NUMBER

3

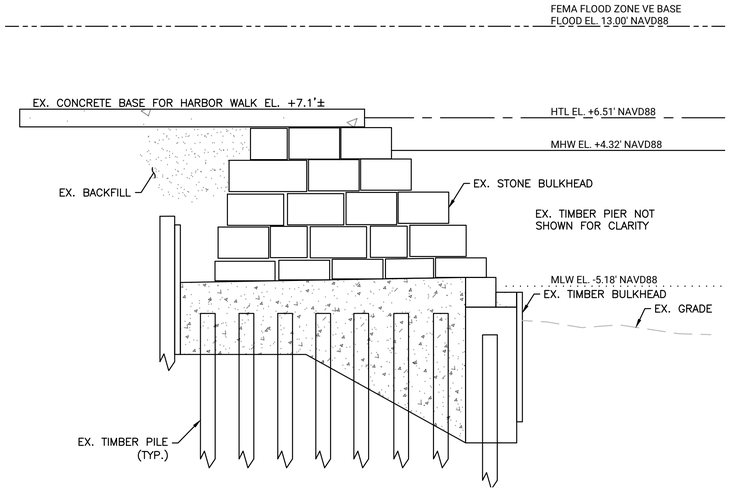
Wednesday, April 3, 2024 3:39:19 PM
DWG Filename: Kleinfelder_long wharf resiliency_conceptual drawings.dwg Layout: segment c and d
DWG Folder Location:



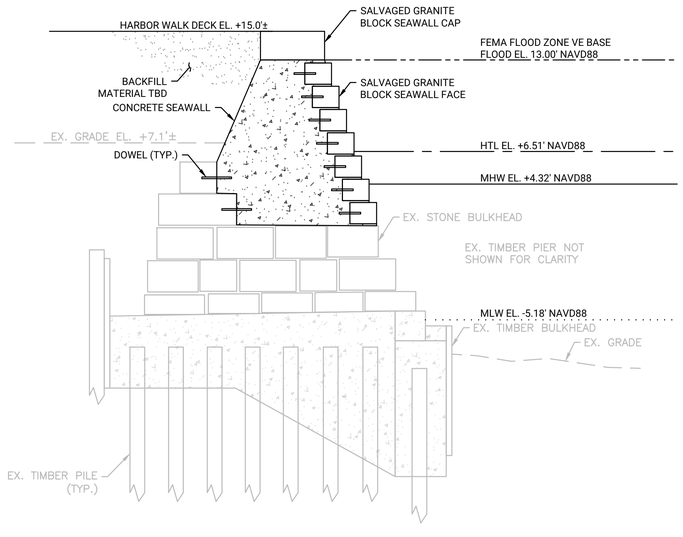
E1 SEGMENT E: EXISTING CONDITIONS
SCALE: 1" = 5'



E2 SEGMENT E: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'



F1 SEGMENT F: EXISTING CONDITIONS
SCALE: 1" = 5'



F2 SEGMENT F: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

KLEINFELDER
Bright People. Right Solutions.
SIGNOSS
Foth
BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	DESCRIPTION	DATE	BY
1			
2			
3			
4			
5			

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT E & F

ISSUANCE:

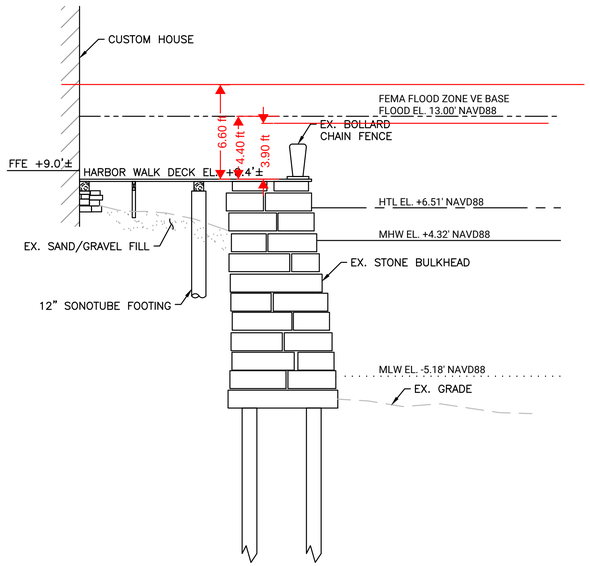
CONCEPTUAL

PROJECT NO: 23K004

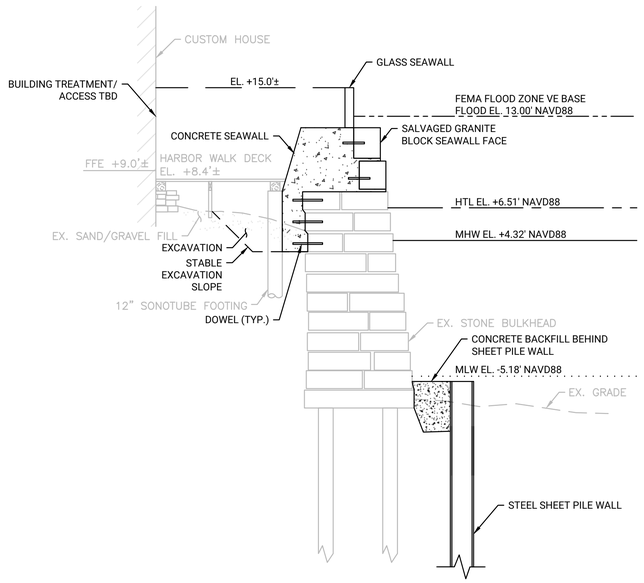
SHEET NUMBER

4

Wednesday, April 3, 2024 3:39:29 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment e and f
DWG Folder Location:



G1 SEGMENT G: EXISTING CONDITIONS
SCALE: 1" = 5'



G2 SEGMENT G: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

KLEINFELDER Bright People. Right Solutions.
STOSS
Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT G

ISSUANCE:

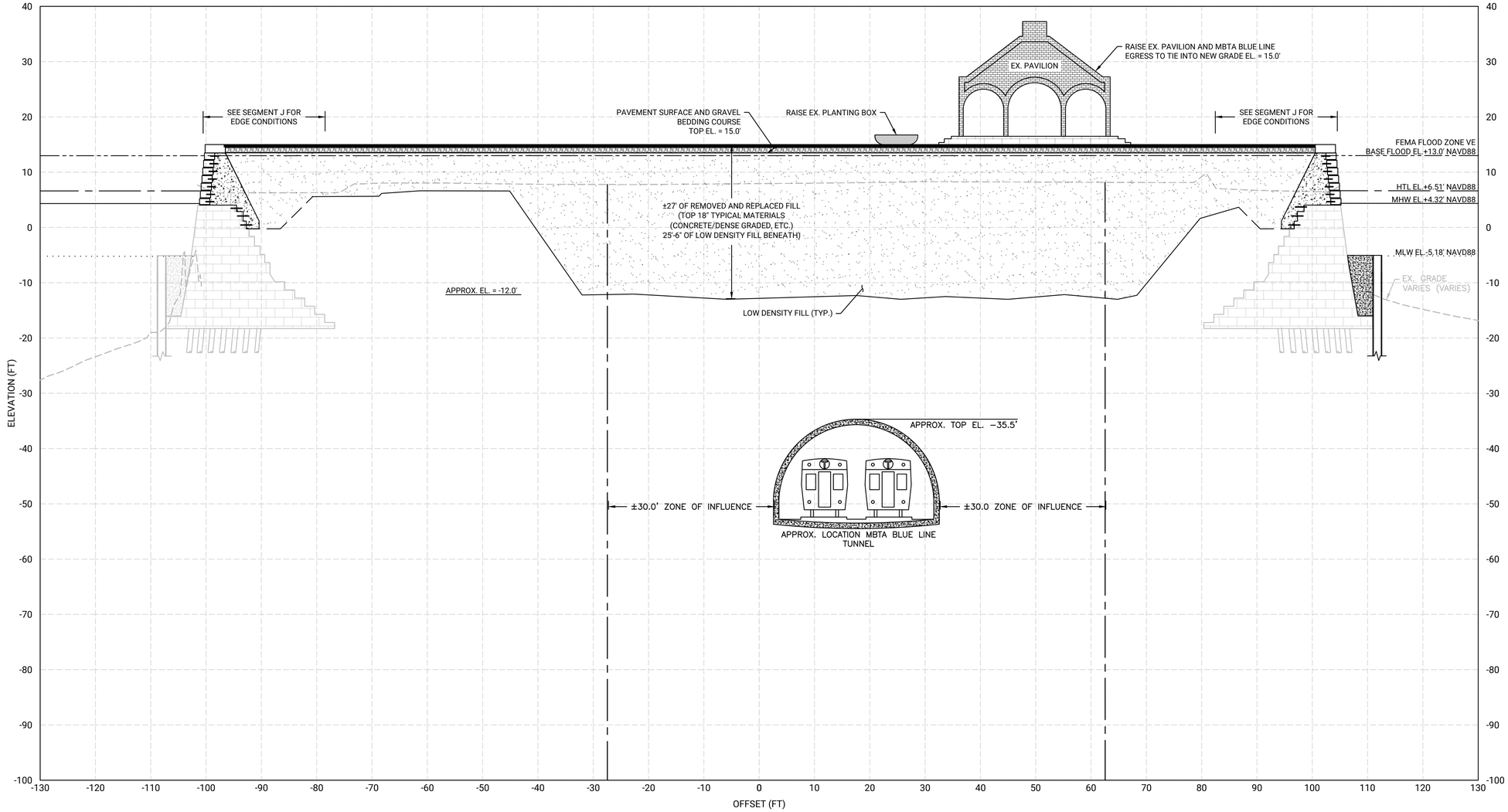
CONCEPTUAL

PROJECT NO: 23K004

SHEET NUMBER

5

Wednesday, April 3, 2024 3:39:35 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment g
DWG Folder Location:



H1 SEGMENT H & J: PROPOSED CONDITION - WHARF ELEVATION RAISED TO 15.0' W/ LOW DENSITY FILL
SCALE: 1" = 10'

NOTES:

1. LOCATION OF MBTA BLUE LINE TUNNEL AND VENTILATION SHAFT SHOWN ON PLANS IS APPROXIMATE AND BASED ON MBTA PLAN NO. 80480 TITLED, "SUBWAY VENTILATION IMPROVEMENTS. CONTRACT NO. 103-103" PREPARED BY BRYANT ASSOCIATES, INC. AND DATED APRIL 1983.
2. LOW DENSITY FILL BETWEEN 65 AND 105 PCF TO ACHIEVE MASS BALANCE AND PREVENT BUOYANCY.

GRAPHIC SCALE
0 5 10 20
(IN FEET)
1 INCH = 10FEET

KLEINFELDER Bright People. Right Solutions. STOSS Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO.	BY	DATE	DESCRIPTION
1			
2			
3			
4			
5			

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT H & J
(1 OF 2)

ISSUANCE:

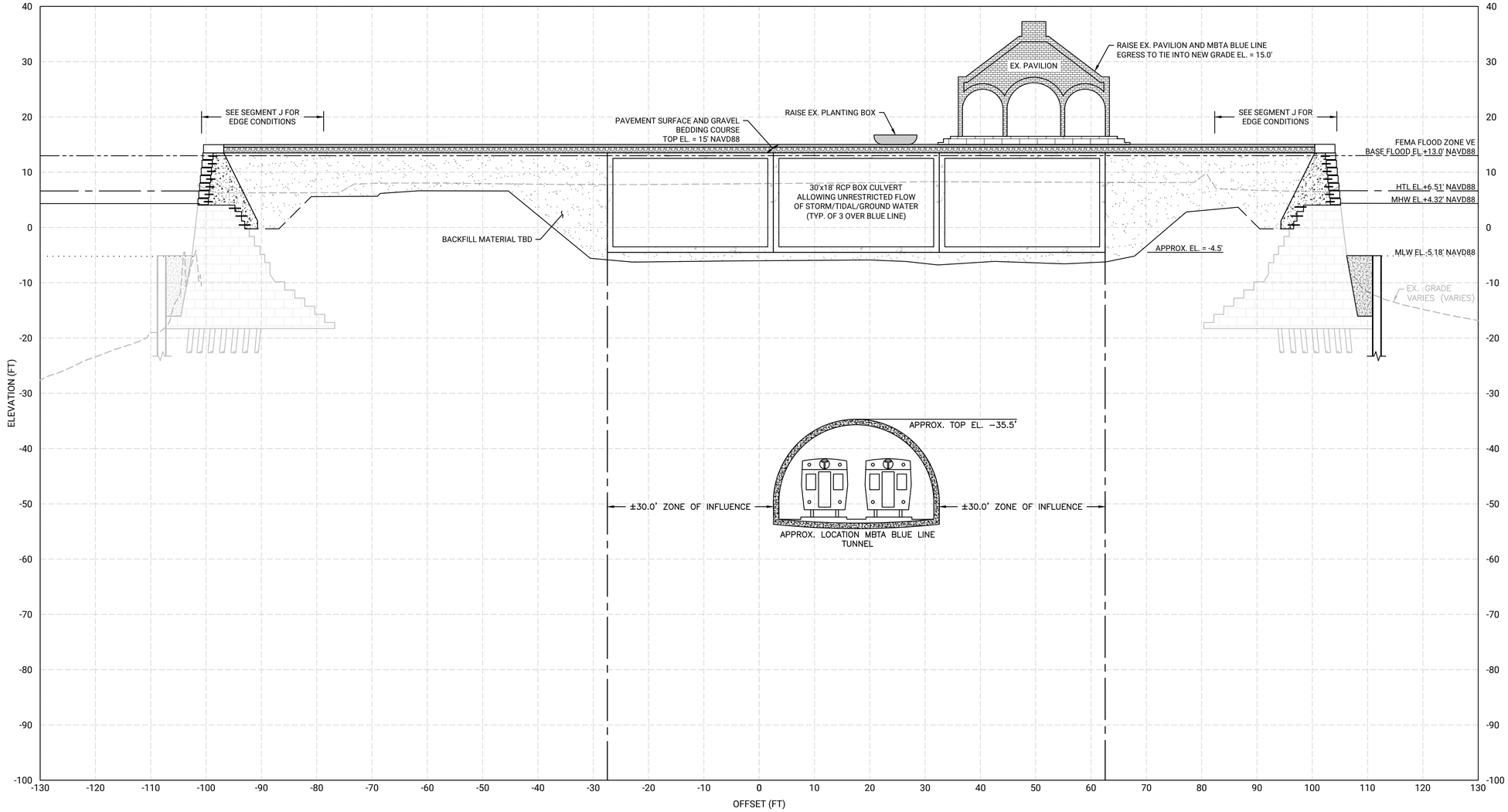
CONCEPTUAL

PROJECT NO: 23K004

SHEET NUMBER

6

Wednesday, April 3, 2024 3:39:38 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment h.1
DWG Folder Location:



H2 SEGMENT H & J: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0' W/ 30' X 18' BOX CULVERTS
SCALE: 1" = 10'

NOTES:

1. LOCATION OF MBTA BLUE LINE TUNNEL AND VENTILATION SHAFT SHOWN ON PLANS IS APPROXIMATE AND BASED ON MBTA PLAN NO. 80480 TITLED, "SUBWAY VENTILATION IMPROVEMENTS. CONTRACT NO. 103-103" PREPARED BY BRYANT ASSOCIATES, INC. AND DATED APRIL 1983.

GRAPHIC SCALE
0 5 10 20
(IN FEET)
1 INCH = 10FEET

KLEINFELDER Bright People. Right Solutions.
STOSS
Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO.	BY	DATE	DESCRIPTION
1			
2			
3			
4			
5			

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT H & J
(2 OF 2)

ISSUANCE:

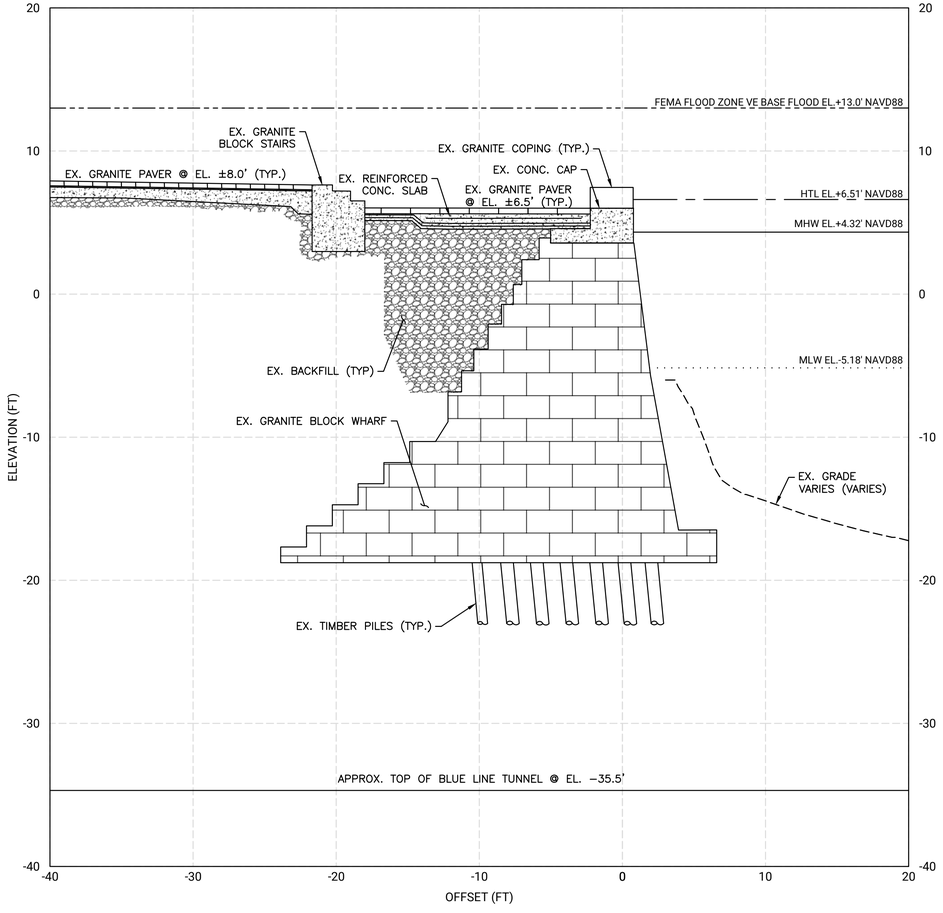
CONCEPTUAL

PROJECT NO: 23K004

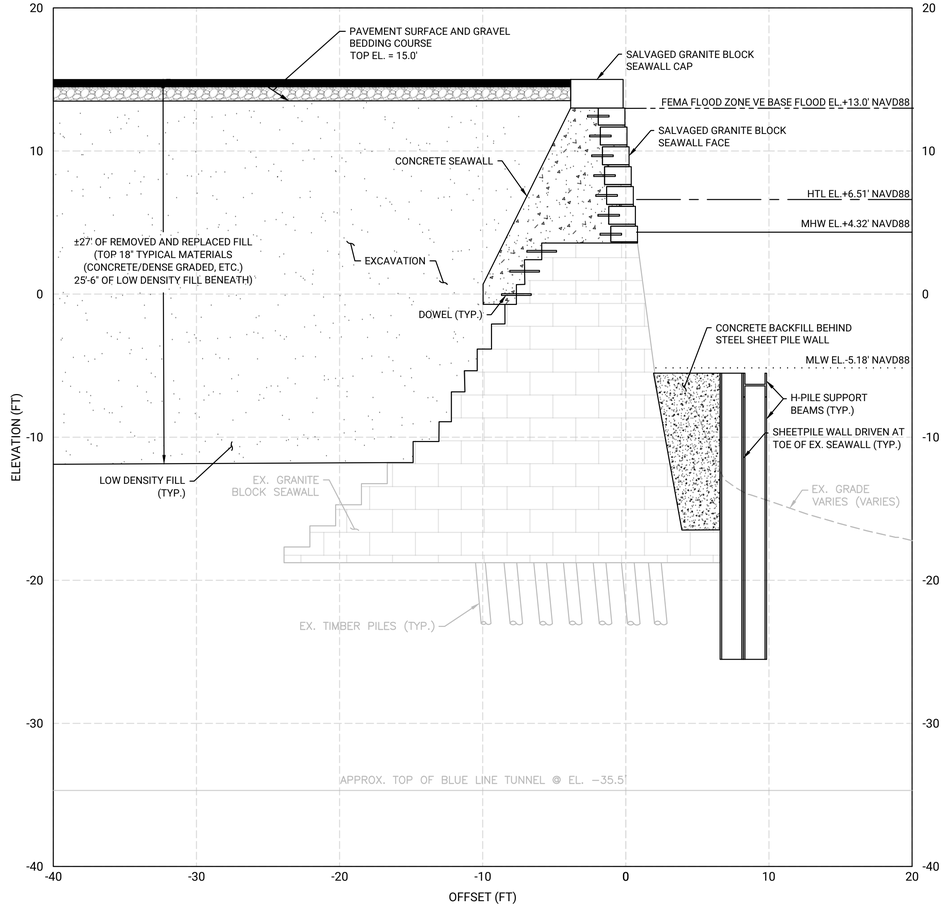
SHEET NUMBER

7

Wednesday, April 3, 2024 3:39:41 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment h.2
DWG Folder Location:



I1 SEGMENT I: EXISTING CONDITIONS
SCALE: 1" = 5'



I2 SEGMENT I: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO ELEVATION 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

KLEINFELDER Bright People. Right Solutions.
STOSS
Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT I

ISSUANCE:

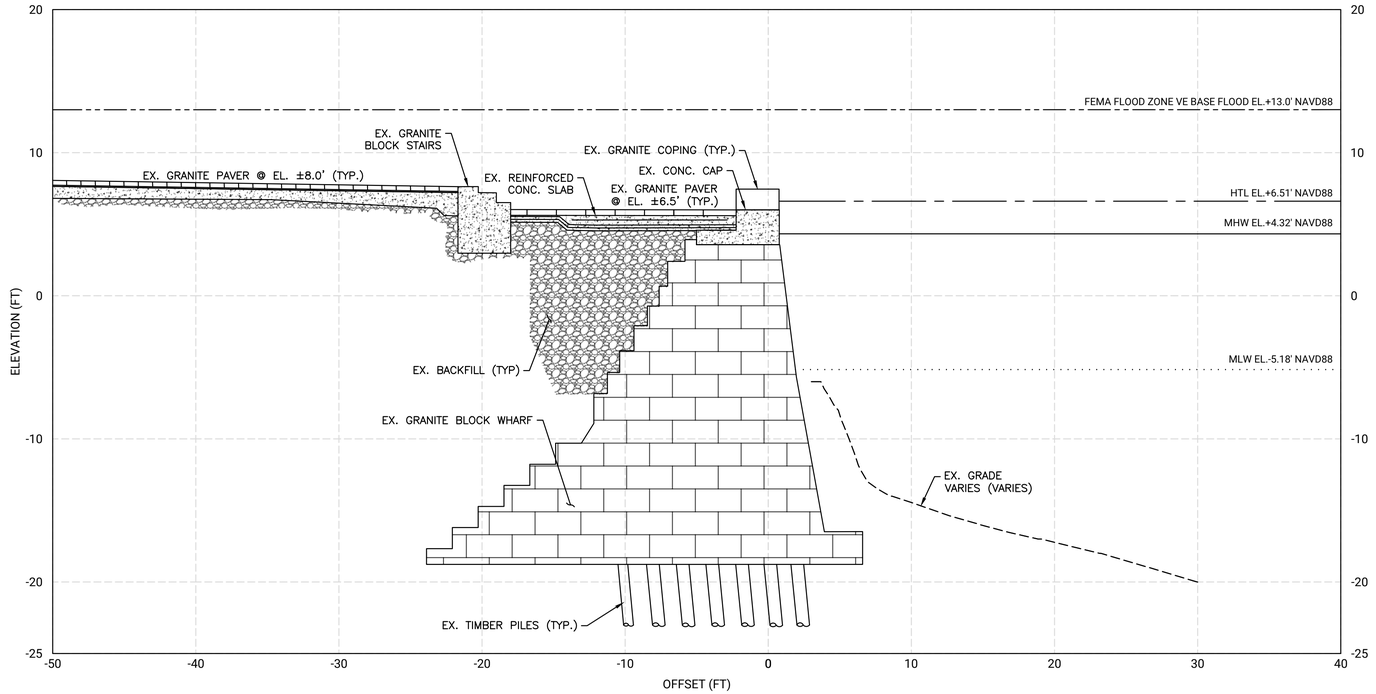
CONCEPTUAL

PROJECT NO: 23K004

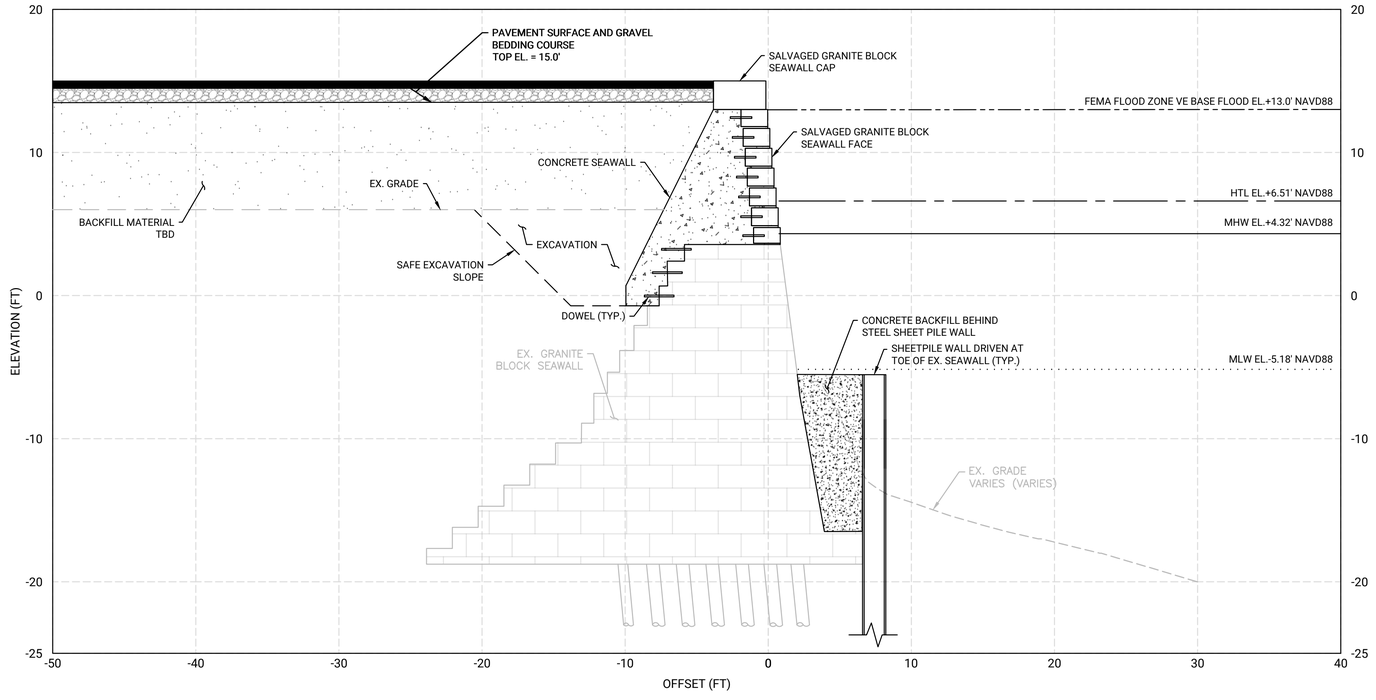
SHEET NUMBER

8

Wednesday, April 3, 2024 3:39:46 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment i
DWG Folder Location:



J1 SEGMENT J: EXISTING CONDITIONS
SCALE: 1" = 5'



J2 SEGMENT J: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

KLEINFELDER Bright People. Right Solutions.
STOSS
Foth
BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT J

ISSUANCE:

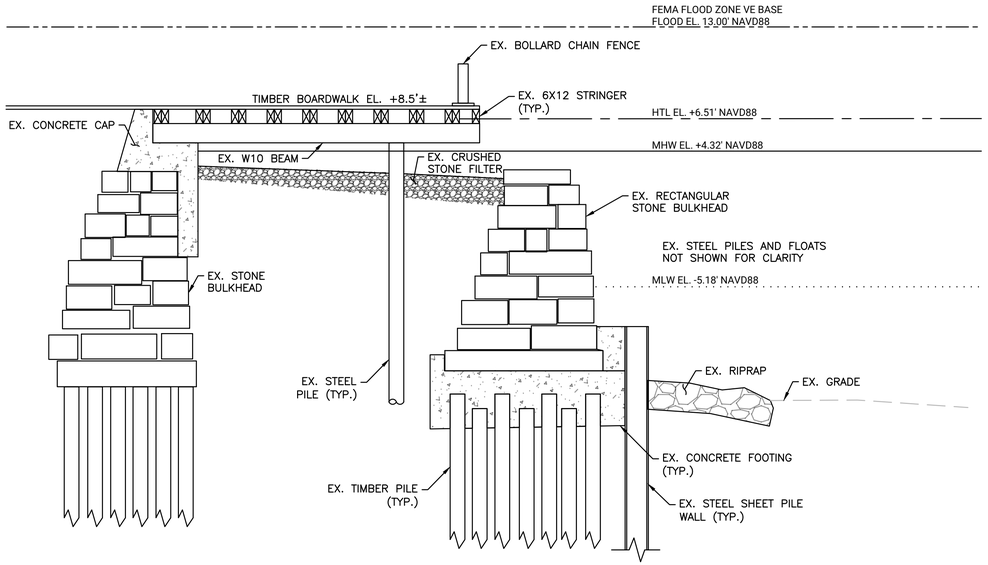
CONCEPTUAL

PROJECT NO: 23K004

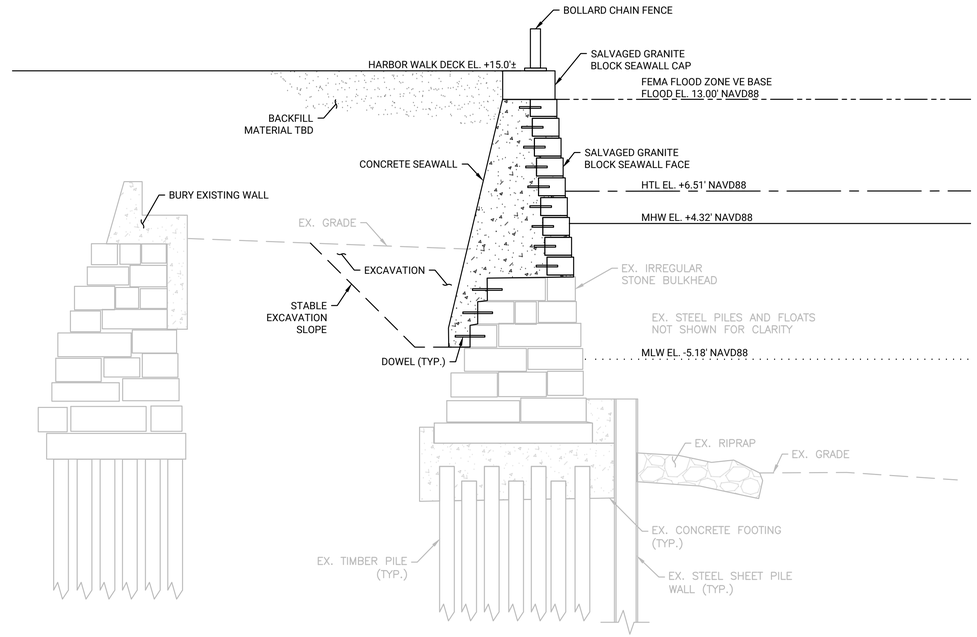
SHEET NUMBER

9

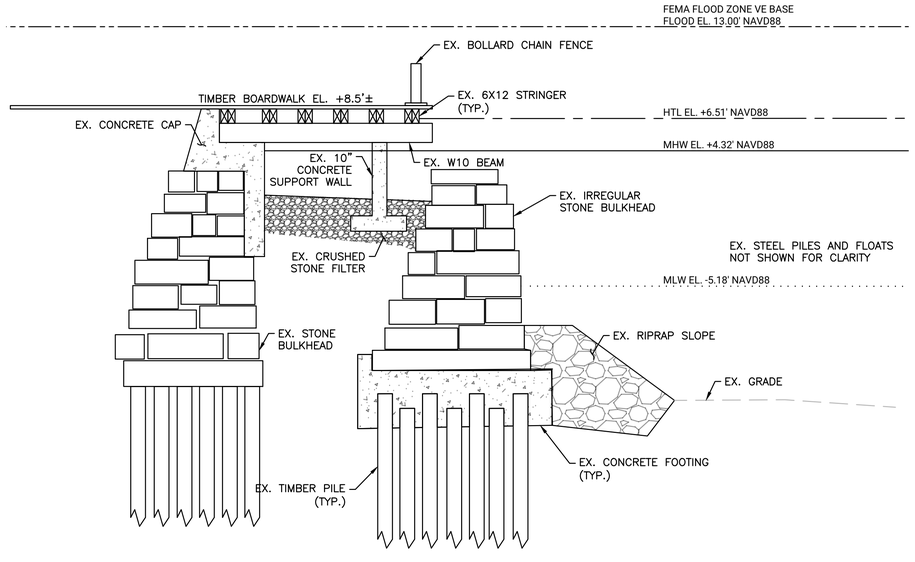
Wednesday, April 3, 2024 3:39:52 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment h (section j)
DWG Folder Location:



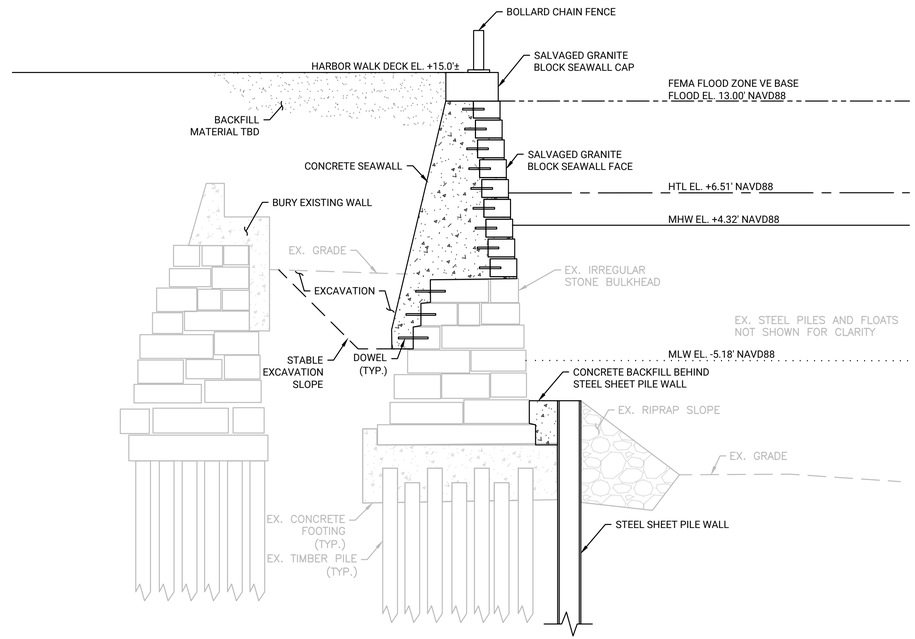
K1 SEGMENT K: EXISTING CONDITIONS
SCALE: 1" = 5'



K2 SEGMENT K: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'



L1 SEGMENT L: EXISTING CONDITIONS
SCALE: 1" = 5'



L2 SEGMENT L: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

NOTES:

1. SEGMENT K, L, & M REFERENCE RECORD DEP LICENCE 609 FOR FOUNDATIONS AND FIELD OBSERVATIONS FOR UPDATED TOPSIDE ELEMENTS

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

SIGNATURE
KLEINFELDER
Bright People. Right Solutions.
SIGNATURE
Foth

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT K & L

ISSUANCE:

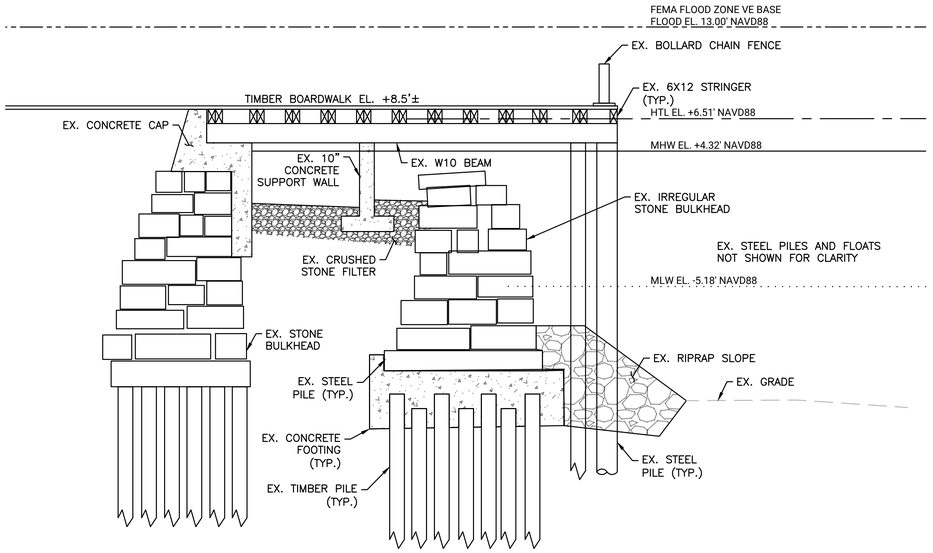
CONCEPTUAL

PROJECT NO: 23K004

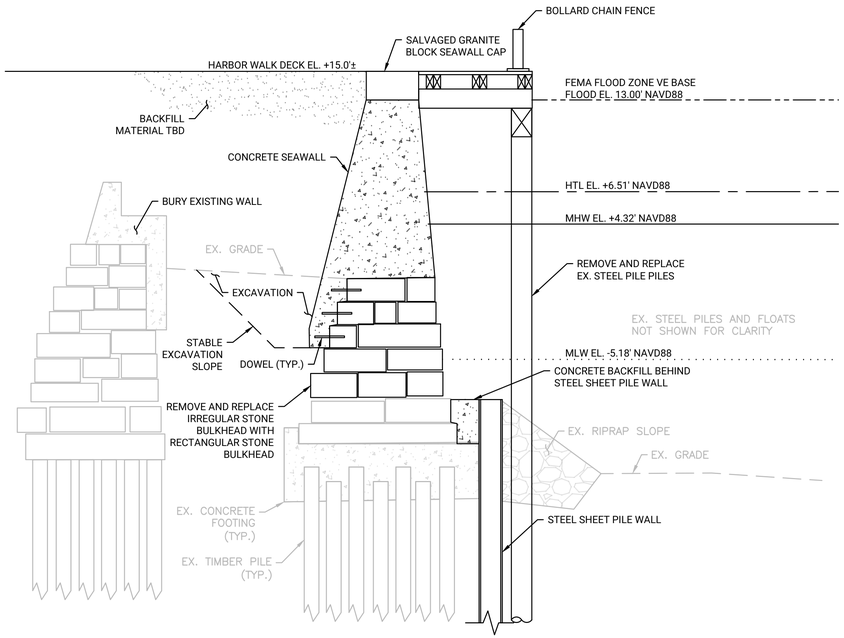
SHEET NUMBER

10

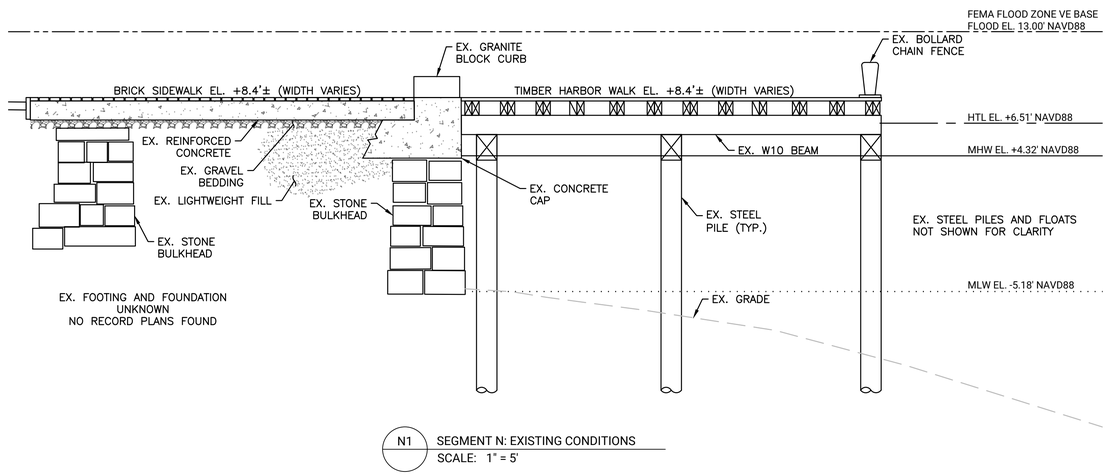
Wednesday, April 3, 2024 3:40:02 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment k & l
DWG Folder Location:



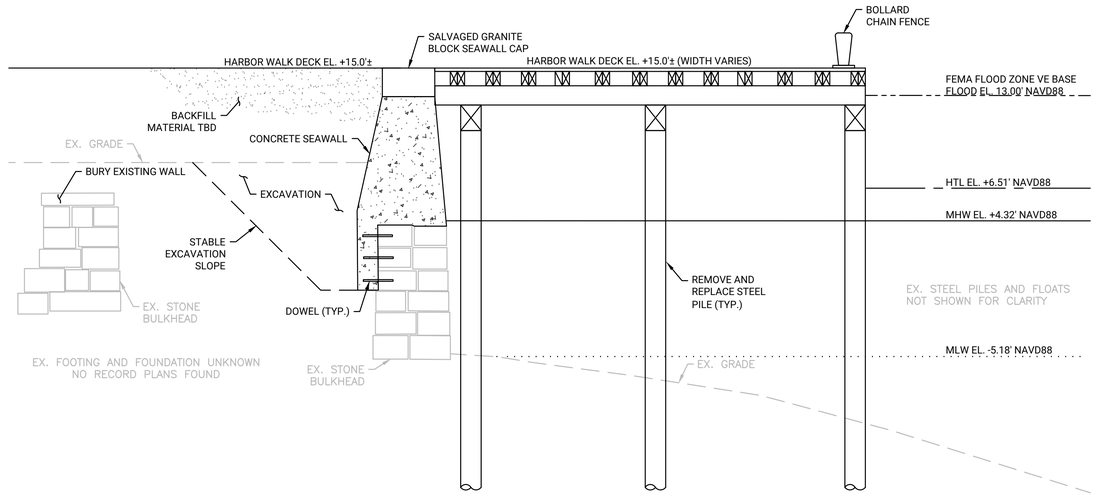
M1 SEGMENT M: EXISTING CONDITIONS
SCALE: 1" = 5'



M2 SEGMENT M: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'



N1 SEGMENT N: EXISTING CONDITIONS
SCALE: 1" = 5'



N2 SEGMENT N: PROPOSED CONDITIONS - WHARF ELEVATION RAISED TO 15.0'
SCALE: 1" = 5'

NOTES:

1. SEGMENT K, L, & M REFERENCE RECORD DEP LICENCE 609 FOR FOUNDATIONS AND FIELD OBSERVATIONS FOR UPDATED TOPSIDE ELEMENTS

GRAPHIC SCALE
0 2.5 5 10
(IN FEET)
1 INCH = 5 FEET

STOSS
KLEINFELDER
Bright People. Right Solutions.
Foth
BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #9, BOSTON, MA 02201

LONG WHARF RESILIENCY
LONG WHARF, BOSTON, MA

REVISIONS

NO	BY	DATE	DESCRIPTION

DATE OF PREPARATION

	BY	DATE
SURVEYED	AS NOTED	AS NOTED
DRAWN	BPF	MARCH 2024
DESIGNED		
CHECKED	JMP	MARCH 2024

SHEET TITLE:

SEGMENT M

ISSUANCE:

CONCEPTUAL

PROJECT NO: 23K004

SHEET NUMBER

11

Wednesday, April 3, 2024 3:40:11 PM
DWG Filename: kleinfelder_long wharf resiliency_conceptial drawings.dwg Layout: segment m & n
DWG Folder Location:

APPENDIX D - DETAILED ADAPTATION DESIGN GUIDELINES (FOR BUILDINGS)

ADAPTATION GUIDELINES - DESIGN AND BASIC OPERATIONS RECOMMENDATIONS

The City of Boston has prepared Flood Adaptation Guidelines for the Long Wharf area to advise property owners of potential measures to reduce risk of flood damage, encourage proactive safety precautions, encourage safeguarding their property and interests against potential disruptions, and proactively implement resiliency measures ahead of future flood events.

Section 1 contains general recommendations for flood adaptation treatments.
Section 2 provides flood adaptation guidelines specific to the Custom House Block building complete with diagrams, installation and deployment guidance, and implementation considerations.
Section 3 provides flood adaptation guidelines specific to the Chart House complete with diagrams, installation and deployment guidance, and implementation considerations.
Section 4 provides flood adaptation guidelines specific to smaller ancillary exterior infrastructure such as ticket booths.

BACKGROUND

Conceptual strategies have been developed to address potential coastal flooding vulnerabilities at Long Wharf for the 2030 and 2070 time frames as part of the Flood Resilience Mitigation and Feasibility Study for Long Wharf project. Some of the privately-owned infrastructure on Long Wharf, including the Custom House Block, Chart House and various ancillary ticket booth facilities, are not fully protected from flooding under the 2030 and Acupuncture conceptual flood protection strategies.

The intent of this document is to provide a resource for the owners of the privately-owned infrastructure to be able to construct flood adaptation measures to protect their properties against coastal flooding events.

CONSIDERATIONS FOR APPLICATION OF FLOOD ADAPTATION TREATMENTS

For any flood adaptation treatment, a property owner should consider the following attributes when evaluating, installing, or deploying a flood adaptation treatment(s).

- Safety and accessibility
- Effects on historic character
- Affordability and economic costs
- Technical and design limitations
- Efficacy and sustainability
- Operations, maintenance, and logistics
- Service life
- Resilience benefits
- Building and site characteristics
- Flood characteristics
- Alignment with neighborhood, City, and State goals and regulations

STANDARDS FOR ADAPTATION GUIDELINES

The Adaptation Guidelines recommend to floodproof existing structures to an elevation of 12.3 NAVD88. Although the height for built engineering concepts is 15 ft. NAVD88, the recommended height for proposed adaptation strategies is 12.3 ft. NAVD88 for the following reasons:

1. Minimize changes to the building's distinctive features and historic character
2. Maintain building aesthetic by avoiding building of unnecessarily tall structures
3. Minimize construction costs
4. Cognizant of economic and technical feasibility
5. Reduce flood impacts while making the building more resilient

The property owner can elect to design floodproofing measures to a higher level of flood protection.

SECTION 1: GENERAL RECOMMENDATIONS

Section 1 includes information on general flood adaptation recommendations, with considerations for installation and deployment, examples, and select diagrams.

Concurrent Actions
For any flood adaptation treatment, it is recommended that property owners take the following steps concurrently:

- Conduct regular maintenance for drainage systems and flood control structures.
- Improve on-site stormwater drainage system capacity (i.e., right-size downspouts and gutters to handle increasing precipitation loads).
- Develop an operations and maintenance plan for adaptation treatments.
- Stay informed of changes to building codes, regulations, incentives and permitting.
- Coordinate with City officials, utility operators and adjacent properties.
- Provide for emergency egress.
- Secure or store objects that can be swept away or damaged by floodwaters (e.g., secure garbage bins and dumpsters, outside furniture and awnings) in advance of a coastal flood event.
- Know the established flood risk level.
- Ensure utilities are always protected.
-
- There are two basic approaches to floodproofing a building:
- Dry floodproofing
- Wet Floodproofing

DRY FLOODPROOFING

Dry floodproofing involves designing or modifying a building, enclosure, or area to render it substantially impermeable to the entrance of floodwaters, thereby lowering the potential for flood damage. Substantially impermeable is defined as resulting in a maximum accumulation of 4 in. of water depth in a dry floodproofed space during a 24-hour period.

Dry floodproofed areas of a building shall:

- Be designed and constructed so that any area below the designated DFE, together with attendant utilities and sanitary facilities, is flood resistant with walls or temporary flood barriers that are substantially impermeable to the passage of water.
- Have walls, floors, flood shields and other temporary flood barriers designed and constructed to resist hydrostatic, hydrodynamic, and other flood related loads, including the effects of buoyancy resulting from the DFE.
- Have any soil or fill adjacent to the structure compacted and protected against erosion and scour.
- Have at least one door satisfying building code requirements for an exit door or primary means of escape, above the designated DFE, and capable of providing human ingress and egress during

DRAFT
DRAFT

- the design flood. This requirement of ASCE/SEI 24 is interpreted to apply to buildings that are normally occupied. For buildings or facilities that are not normally occupied, provisions shall be made to remotely monitor water levels within the dry floodproofed area and to remove water from such areas as required to maintain water levels below that which will cause damage to critical equipment.
- Have sump pumps (permanent or temporary) to remove water accumulation due to any seepage of water during the flooding event. Sump pumps shall not be relied upon as a means of dry floodproofing, but rather only to control water levels below critical levels to prevent damage to critical equipment. Sump pumps shall be powered by independent emergency electrical systems raised above the DFE to ensure performance during power outages.
- Be evaluated by a structural engineer to verify that the foundation, exterior wall and floor systems can resist the forces generated by the design flood event.

The existing walls of the Custom House Block and the Chart House are substantial solid masonry walls. It was beyond the scope of this project to perform a structural analysis of the building foundation, wall and floor systems to ensure that they can resist the forces generated by the design flood event. These structural systems should be evaluated by a professional structural engineer as part of the design of any floodproofing program. At minimum, consideration should be given to applying a waterproofing sealer to the outside of exposed masonry walls to minimize the passage of water through minor cracks in the walls. Further study will be required to develop an exterior waterproofing system that is compatible with the historic nature of the buildings.

The smaller ancillary buildings, such as the ticket booths, Harbor Cruises building and café are wood-framed structures that are not capable of withstanding pressures from flood water and cannot be sealed. These structures cannot be dry floodproofed.

WET FLOODPROOFING

Wet floodproofing involves designing or modifying a building, enclosure, or area to accommodate the entrance of floodwaters while minimizing the potential for flood damage to critical infrastructure and equipment.

Wet floodproofing involves the following:

- Using flood damage-resistant materials below the DFE throughout the building.
- Raising utilities, life-safety systems, important contents and other critical infrastructure above the DFE.
- Installing and configuring electrical, telecommunications, mechanical, and other systems to allow for easy isolation of system components located below the DFE, facilitate repairs, and minimize disruptions due to flood damage.
- Installing flood openings or using other methods to equalize the hydrostatic pressure exerted by floodwaters to prevent structural damage to walls and floors.
- Providing pumps (permanent or temporary) to gradually remove floodwater from basements and non-draining areas.
- Designing tie-down systems for fuel or other storage tanks below the DFE to resist buoyant forces caused by submersion.

At Long Wharf, wet floodproofing could be concepts adopted for the Custom House Block and the Chart House. For this to happen, flood water would be allowed to enter the first floor of either building, which would render these spaces as non-habitable, effectively non-usable spaces. The building entries and elevators would need to be reconfigured to access the upper floors.

DRAFT

DRAFT

PROTECT UTILITIES

Building utilities include mechanical, electrical, gas, plumbing, or fire suppression systems. There are several utility operators in the Long Wharf area who coordinate with property owners.

Elevate Interior and Exterior Utilities
Elevate or relocate utilities, to the maximum extent feasible, above elevation 15.0 NAVD88. Usually, utility systems are in the building's lowest level (typically a basement). Therefore, property owners should strive to relocate them to higher floors, the roof, or other spaces out of flood risk.

Isolate Electrical Circuits
For wet-proofed flood protection, where flood water could potentially enter a building, it is recommended to isolate any electrical circuits for receptacles and light switches within the flood risk zone with separate circuits back to the electrical panel that can quickly be shut off prior to a flood. The electrical panel should be relocated to an elevation above the flood zone.

Considerations for historic buildings:
- Install an electrical disconnect switch well above the established flood risk level in an easy to access location. This should be separate from the utility panel.
- Eliminate electrical service, to the maximum extent feasible, from areas within the flood zone.

Seal off Utilities
A key element of flood protection is to seal off non-pressure pipes passing through the building foundations and envelope walls within the flood zone to prevent flood water from entering the building through the pipes. Such pipes include electrical conduits, drain and sewer pipes Some of the many sealing systems and devices that can be used include:

- Foam duct sealant for electrical conduits
- Rubber-insulated end caps sealing electrical conduits
- In-line duckbill check valves for drain and sewer pipes

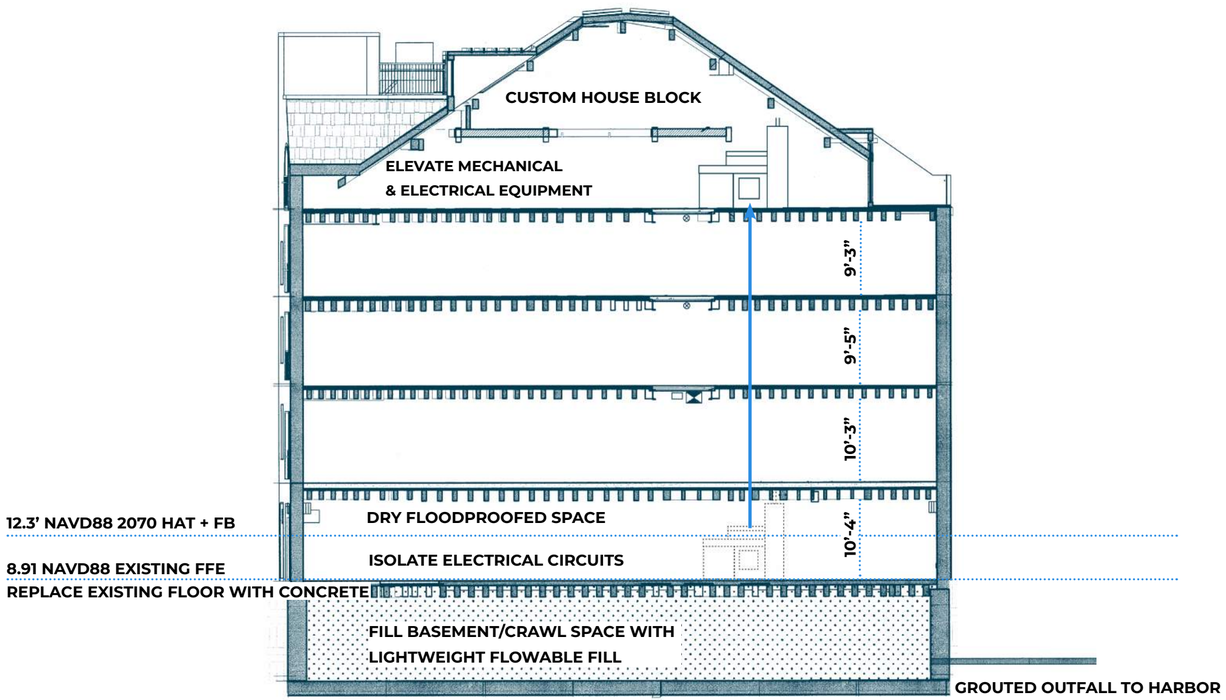
Foam Duct Sealant | Rubber-Insulated End Caps | In-line Rubber Check Valve

Figure 1- Examples of Products to Seal Utilities

FILL THE CUSTOM HOUSE BASEMENT/ CRAWL SPACE

There is a tidal connection between the basement/crawl space and the adjacent harbor such that water levels fluctuate with the tide in the basement/crawl space below the Custom House Block first floor. Most of the floors in the Custom House Block consist of timber joists with timber decking. Floors in two blocks of the building, where the new electrical substation and transformer are located, were replaced with concrete floors during a recent building renovation.

If any floodproofing is done to the Custom House Block to prevent water from entering the building above the first floor, then all of the remaining timber first floor structures need to be replaced with a waterproof concrete floor to prevent flood waters from rising and passing through the floors. To make the floor system more resistant to leakage from below, it is recommended to fill the basement/crawl space and the connections to the harbor with a lightweight flowable fill. This will solidify the under-floor area and remove the tidally-connected water under the floor.



There are a number of utilities that enter the building underground through the basement/crawl space. All such utilities should be replaced with new connections that are accessible for future maintenance/replacement. Communications wiring that may be located under the first floor should be relocated above the design flood elevation prior to filling the basement/crawl space.

ACTIVE VERSUS PASSIVE FLOOD BARRIERS

Flood barriers are used around a building or to protect specific vulnerable elements of a building to protect it from flooding. Flood barriers can be categorized as either active or passive devices.

Active flood barriers need human intervention to be deployed in advance of a flood event. There needs to be adequate notice and time before a flood event to notify, mobilize and deploy active flood barriers. Active flood barriers are generally not suitable for flash flood events. Examples of active flood barriers include drop-in flood barriers, sand bags, flood gates and flood panels. The benefits of active systems is that they can have much less permanent physical impact to historic structures and they can be lower cost solutions. The drawbacks to active flood barriers are that they need sufficient time to deploy, require human intervention to deploy and typically require on-site or off-site storage areas.

Passive flood barriers operate automatically or do not require any human intervention or power source to deploy in advance of a flood event. Examples of passive flood barriers include berms, levees, aquarium glass walls, flood walls, flood doors and flood barriers that deploy automatically without human intervention. The benefit of passive flood barriers is that no human intervention is required, which saves on time and the labor costs associated with deployment.

FLOOD DAMAGE-RESISTANT MATERIALS

Use of flood damage-resistant materials is recommended in any areas that have the possibility of being inundated by floodwaters, whether in dry- or wet-proofed systems. For the Custom House Block and the Chart House, flood damage-resistant materials would be recommended for the interior first floor floors and walls. Examples of flood damage-resistant materials include concrete, stone, masonry block, ceramic and clay tile, pressure-treated and naturally decay-resistant lumber, epoxy-based paints, and metal.

RAISE THE BUILDING

One potential flood protection measure is to raise the structure so that the first floor is above the design flood elevation. This is certainly a feasible option for the smaller wood-framed ancillary structures on Long Wharf. This would involve raising the existing building or reconstructing the building on new elevated foundations. The historic Chart House could be raised onto a new higher foundation system. It is technically feasible but would be very costly to do. Due to its size and proximity to the seawall along its north side, raising the Custom House Block is probably not a feasible option to consider.

MONITORING FLOOD FORECASTS

The National Oceanic and Atmospheric Administration (NOAA) maintains a tide monitoring station, known as the Boston Harbor Tide Gauge (NOAA Station ID: 8443970) located on the nearby Evelyn Moakley Bridge. Total predicted water levels at this tide gauge can be used to estimate flood potential at Long Wharf. Flood forecasts at the NOAA Boston Tide Gauge are typically available 3-4 days before a major flood event. The accuracy of flood predictions improves the closer it is to the flood event. If any active flood barrier systems are used, the property owner will need to monitor flood forecasts in advance of a flood event and make a determination whether or not to deploy flood barriers with sufficient time to allow for mobilization and installation of the barriers.

DRAFT

DRAFT

SECTION 2: CUSTOM HOUSE

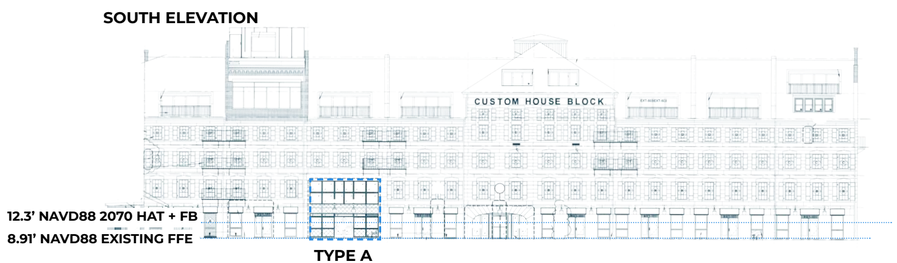
Below are nine adaptation measures specific to the Custom House Block. These adaptation techniques can be applied to other properties in the Long Wharf area as well.

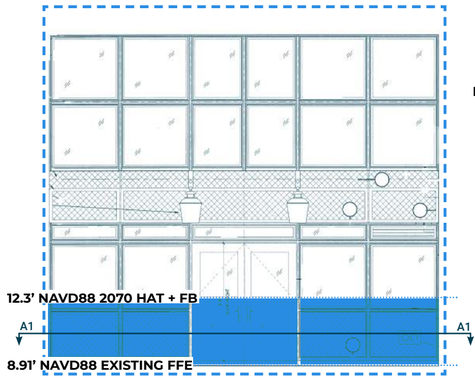
Type A: Drop-in Panels at Storefront Double Doors
Type B: Drop-in Panels at Revolving Doors
Type C: Drop-in Panels at Regular Doors
Type D: Replacement Windows (Aquarium Glass)
Type E: Seal Coal Bins with Masonry
Type F: Vertical Lift Passive Flood Barrier Source
Type G: Hydrostatic Flood Barrier Source
Type H: Deployable Modular Flood Barriers (AquaFence) Source

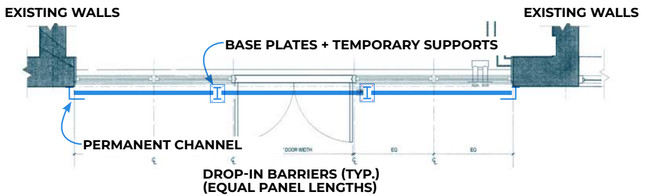
TYPE A: DROP-IN PANELS AT STOREFRONT ENTRANCE

The Custom House Block storefront entrance is a large opening that is vulnerable to the impacts of rising tides and floodwaters. The Type A system is an active deployable temporary measure using drop-in panels that block water from entering above grade.

PRO	CON
• Drop-in panels should have uniform dimensions to make storage and deployment simpler. • Center drop-in panel can be installed at the last minute to maintain access to the building for as long as possible. • Temporary supports can be installed prior to deployment of barrier panels. • Channels can be installed permanently to minimize deployment time. • When not in use, the panels are removed and stored, preserving the building's historic character	• As an active system, requires manual deployment and sufficient notice to deploy. • Requires storage area. • Requires channels mounted to the building. These channels can be deployed with the rest of the system to minimize architectural impacts, but deployment time will increase. • Panels and seals require periodic inspection and maintenance.







INSTALLATION

The system includes "C" channel support posts, end channels and drop-in hollow aluminum planks that anchor the flood barrier system. These planks stack on edge with each other with a tongue and groove connection and gaskets. The end support channels that attach to the building structure can be permanently installed or installed as part of the deployment.

DEPLOYMENT

The panels are lowered or "dropped" into place and clamped down, to create a watertight barrier against rising floodwaters.

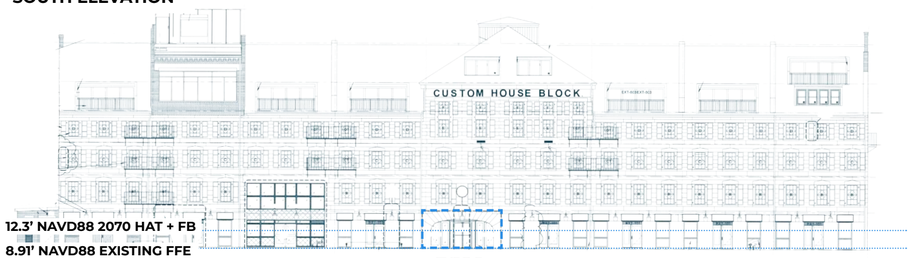
DRAFT
DRAFT

TYPE B: DROP-IN PANELS AT REVOLVING DOOR

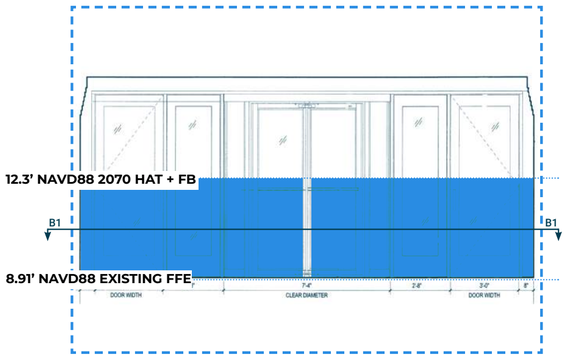
The Custom House Block main entrance is a large set-back opening that is vulnerable to the impacts of rising tides and floodwaters. Type B system is an active deployable temporary measure using drop-in panels that block water from entering above grade.

PRO	CON
• Drop-in panels should have uniform dimensions to make storage and deployment simpler. • One set of panels on either side can be installed at the last minute to maintain access to the building for as long as possible. • Temporary support can be installed prior to deployment of barrier panels. • End channels can be installed permanently to minimize deployment time. • When not in use, the panels are removed and stored, preserving the building's historic character	• As an active system, requires manual deployment and sufficient notice to deploy. • Requires storage area. • Requires channels mounted to the building. These channels can be deployed with the rest of the system to minimize architectural impacts, but deployment time will increase. • Panels and seals require periodic inspection and maintenance.

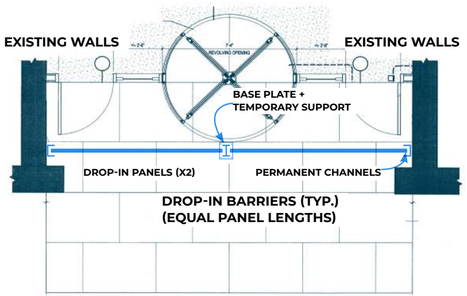
SOUTH ELEVATION



TYPE B



ELEVATION TYPE B



SECTION B1

Installation
The system includes a "C" channel support post, end channels and drop-in hollow aluminum planks that anchor the flood barrier system. These planks stack on edge with each other with a tongue and groove connection and gaskets. The end support channels that attach to the building structure can be permanently installed or installed as part of the deployment.

Deployment
The panels are lowered or "dropped" into place and clamped down, to create a watertight barrier against rising floodwaters.

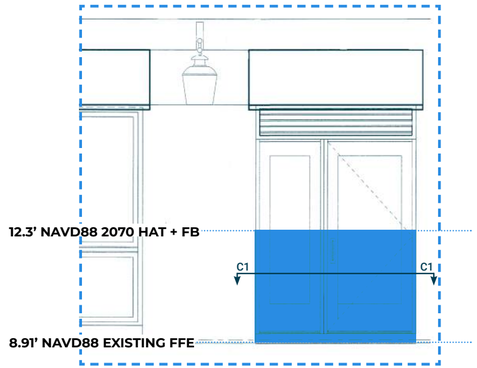
DRAFT

DRAFT

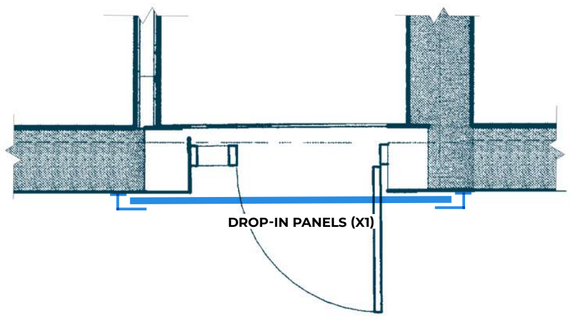
TYPE C: DROP-IN PANELS AT REGULAR DOORS

The Custom House Block regular doors are vulnerable to the impacts of rising tides and floodwaters. Type C system is an active deployable temporary measure using drop-in panels that block water from entering above grade.

PRO	CON
• End channels can be installed permanently to minimize deployment time. • When not in use, the panels are removed and stored, preserving the building's historic character.	• As an active system, requires manual deployment and sufficient notice to deploy. • Requires storage area. • Requires channels mounted to the building. These channels can be deployed with the rest of the system to minimize architectural impacts, but deployment time will increase. • Panels and seals require periodic inspection and maintenance.

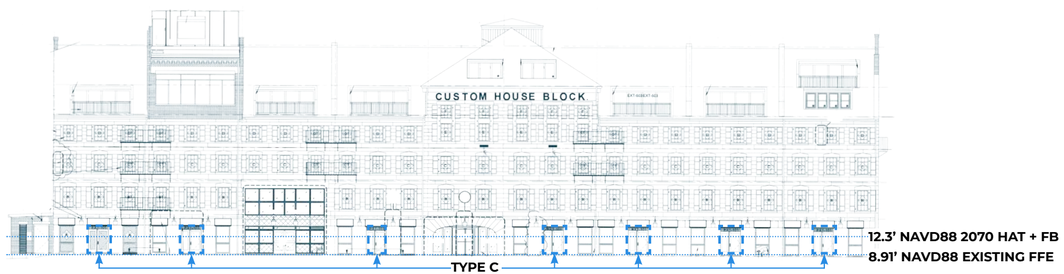


ELEVATION TYPE C



SECTION C1

SOUTH ELEVATION



INSTALLATION

The system includes end channels and drop-in hollow aluminum planks that anchor the flood barrier system. These planks stack on edge with each other with a tongue and groove connection and gaskets. The end support channels that attach to the building structure can be permanently installed or installed as part of the deployment.

DEPLOYMENT

The panels are lowered or "dropped" into place and clamped down, to create a watertight barrier against rising floodwaters.

DRAFT

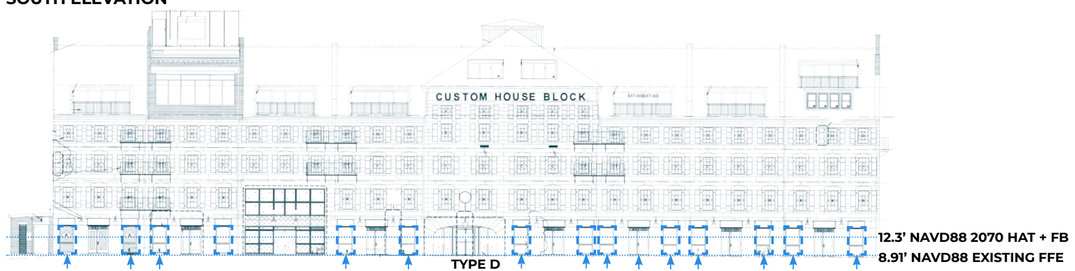
DRAFT

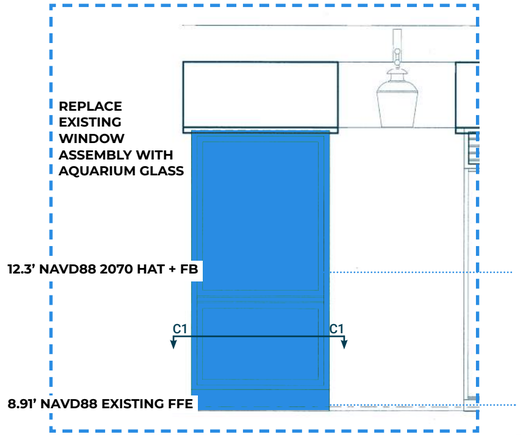
TYPE D: REPLACE EXISTING GLAZING WITH AQUARIUM GLASS

The Type D strategy replaces the Custom House Block first-floor windows with flood-proof aquarium glass to enhance the resilience of the building to the impacts of flooding. The Type D strategy is a passive strategy that does not require any human intervention to deploy. Aquarium glass, known for its durability and ability to withstand high water pressure, can serve as a barrier against floodwaters while maintaining visibility and natural light. For the historic structure, this approach preserves the aesthetic integrity by customizing glass to match the existing window styles. The use of flood-proof glass also provides long-term cost savings by minimizing damage from water intrusion and reducing the need for temporary flood protection methods.

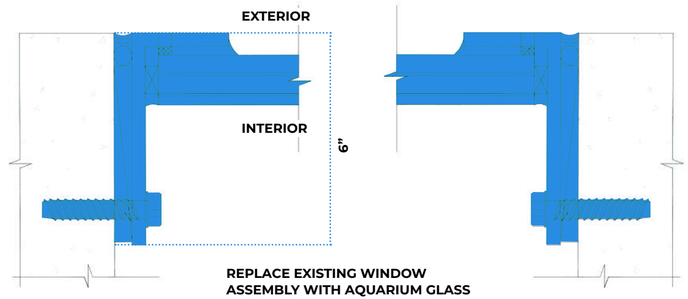
PRO	CON
• Durability: highly resistant to cracking, impact, and water intrusion. • Preserves architectural integrity. • Preserves of natural light. • Low maintenance. .	• High initial cost. • Technical challenges: Need to work with manufacturer to provide new window frames that fit historical context. • Thermal efficiency: Aquarium glass may have lower insulation performance compared to modern windows unless specially treated.

SOUTH ELEVATION





ELEVATION TYPE D



SECTION D1 - WINDOW JAMB DETAIL

INSTALLATION

Due to the weight and thickness of aquarium glass, existing window frames must be replaced to ensure structural integrity.

DEPLOYMENT

A permanent solution - No deployment required.

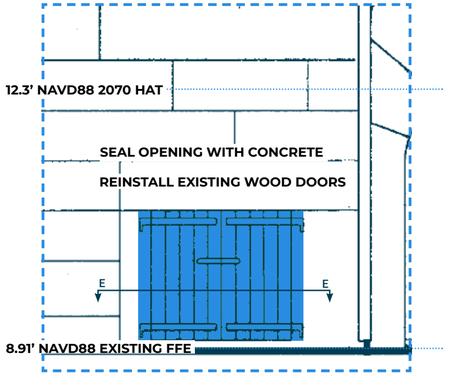
DRAFT

DRAFT

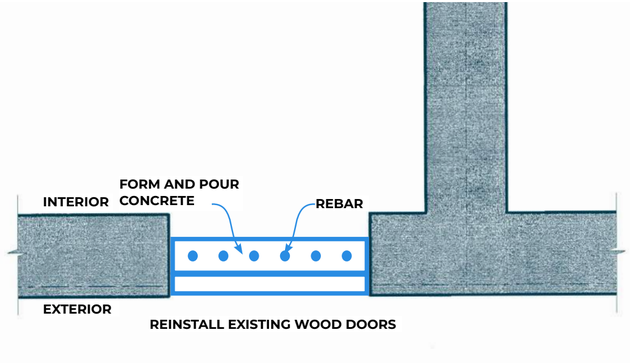
TYPE E: SEAL COAL BINS WITH MASONRY

The Type E strategy seals off existing coal chute openings that penetrate the building envelope within the flood zone. Sealing will be done with form-and -pour concrete anchored to the existing stone masonry wall. The closure concrete can be set back from the outside face to allow the existing wood doors to be reinstalled, thus preserving the historic character of the building.

PRO	CON
• Strategy is a passive solution, requiring no human intervention to deploy. • Reinstalling existing wood doors will preserve historic character.	• Loose use of openings if they are being used today.



ELEVATION TYPE E



SECTION E1

NORTH ELEVATION

INSTALLATION

Openings will be sealed with a form-and-pour concrete technique with steel reinforcing anchoring the closure pour to the existing masonry walls.

DEPLOYMENT

A permanent solution - No deployment required.

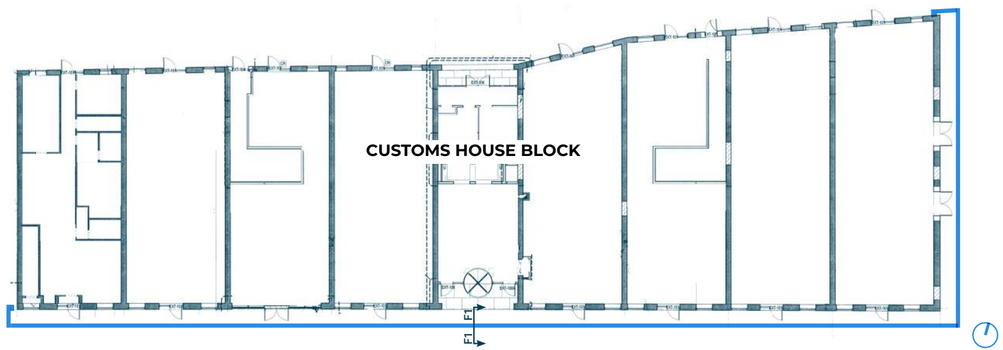
DRAFT

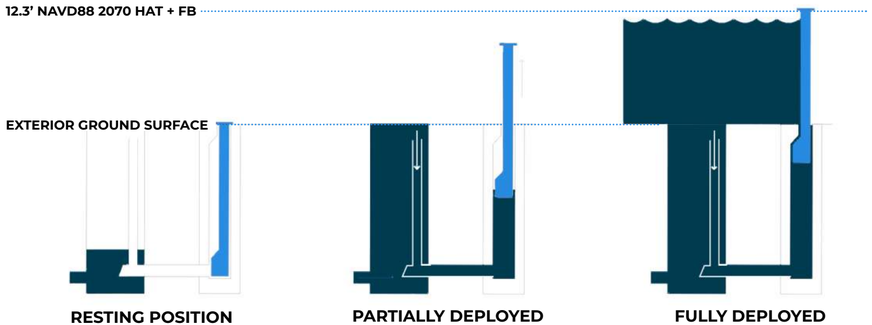
DRAFT

TYPE F: VERTICAL LIFT PASSIVE FLOOD BARRIER

This system uses approaching floodwater to automatically deploy the barrier without the need for external power or human intervention. These barriers are typically installed flush with the ground and remain hidden during normal conditions. When floodwaters reach a threshold, the buoyancy of the barrier causes it to rise vertically, forming a barrier that protects the Custom House Block from water intrusion. The floating panels are composed of PUR foam core with a fiberglass outer layer, with long-lasting gaskets that create a watertight connection inside the basin and guiderails.

PRO	CON
• Automatic Activation: Operates without human intervention • Requires no electricity: Can be used even in the event of a power outage • Custom built to match protection requirements • On-site storage: The system is stored in the ground at its point of use, and eliminates the need for off-site storage and transportation costs	• High Initial Installation Cost: May require a higher upfront investment for installation, including excavation and structural modifications • May impact existing underground utilities • May impact emergency vehicle access or parking • Requires periodic testing





SECTION F1

INSTALLATION

Installation of vertical lift flood barrier requires excavating and constructing an underground concrete pocket to house the system. The depth of excavation, which will be at least one foot greater than the retained water height, will likely require utility services to the buildings to pass under the barriers.

DEPLOYMENT

Fully passive versions of a vertical lift flood barrier would not require any human intervention for the barriers to deploy. Deployment occurs automatically with rising water levels.

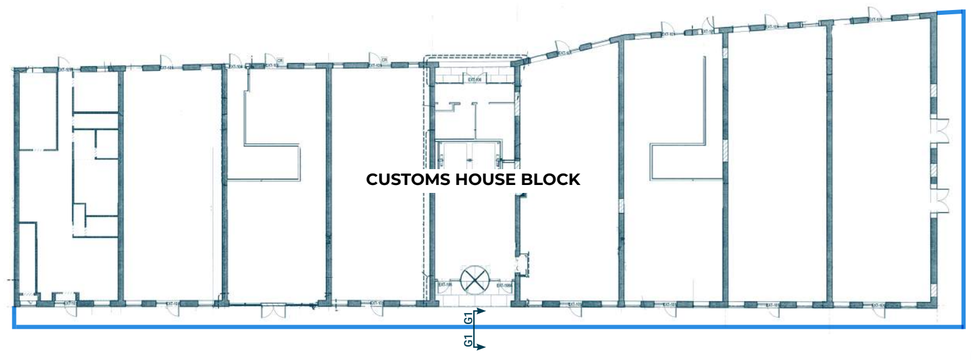
DRAFT

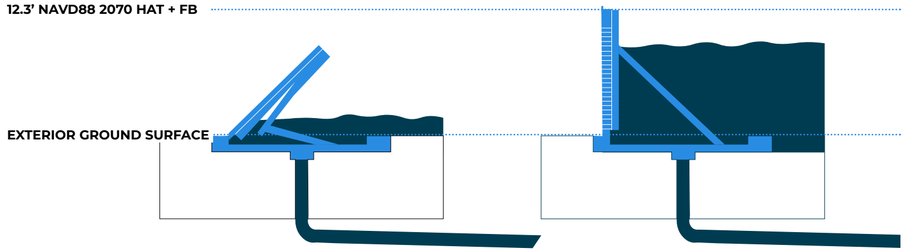
DRAFT

TYPE G: HYDROSTATIC PASSIVE FLOOD BARRIER

This passive system uses hydrostatic water pressure to automatically deploy the barrier without the need for external power or human intervention. These barriers are typically installed flush with the ground and remain hidden during normal conditions. When floodwaters reach a threshold, the buoyancy of the barrier causes it to rise vertically, forming a barrier that protects the Custom House Block from water intrusion. The floating panels are composed of PUR foam core with a fiberglass outer layer, with long-lasting gaskets that create a watertight connection inside the basin and guiderails.

PRO	CON
• Automatic Activation: Operates without human intervention. • Requires no electricity: Can be used even in the event of a power outage. • Custom built to match protection requirements. • On-site storage: The system is stored in the ground at its point of use, and eliminates the need for off-site storage and transportation costs.	• High Initial Installation Cost. May require a higher upfront investment for installation, including excavation and structural modifications. • Will likely affect underground utilities services to buildings. • Deployment would be compromised if vehicles parked on top or if there are mounds of snow. • The system requires periodic testing, inspection and maintenance.





SECTION G1

INSTALLATION

Installation of vertical lift flood barrier requires excavating and constructing an underground concrete pocket to house the system. The depth of excavation, which will be at least one foot greater than the retained water height, will likely require utility services to the buildings to pass under the barriers.

DEPLOYMENT

The hydrostatic pressure of rising floodwater causes the barriers to tilt-up into place. No human intervention is required to deploy.

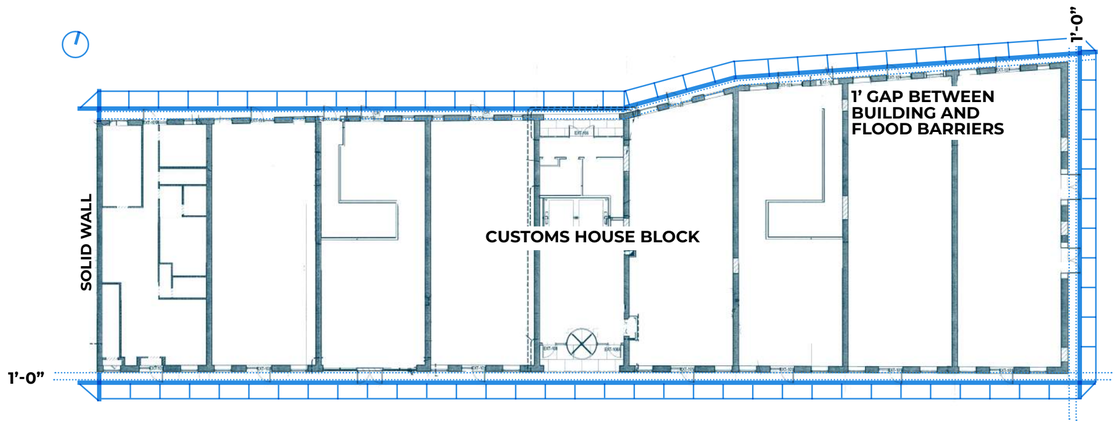
DRAFT

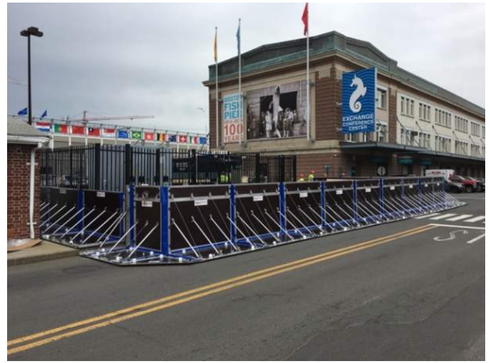
DRAFT

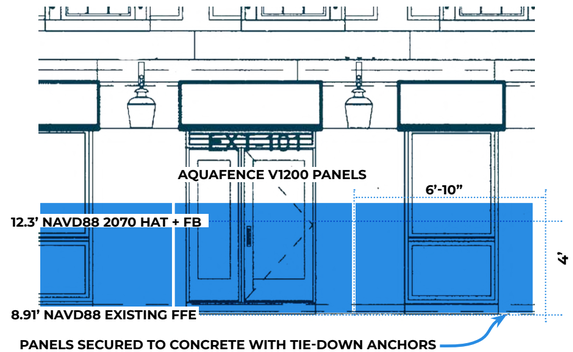
TYPE H: DEPLOYABLE MODULAR FLOOD BARRIERS

The AquaFence Flood Barrier is a modular panelized system where multiple interconnected panels are used to form a flood wall around a structure. Each panel is self-stabilized by the weight of the water on the system, creating a barrier that is highly resistant to a variety of flood loads with minimal anchoring and pre-installation site work.

PRO	CON
• Reusable: The system can be reused and only requires a fresh water rinse after each use. • Relatively inexpensive to procure. • Highly customizable to account for unique site parameters, such as sidewalks and drainage systems. • The panels are relatively lightweight and portable.	• Labor-intensive installation: The installation process requires manual labor and can take time, especially for large-scale installations. • Storage space: The panels need to be flat-packed and stored when not in use, which can require significant space. • Vulnerable to extreme wind if not tied down.







ELEVATION TYPE H

INSTALLATION

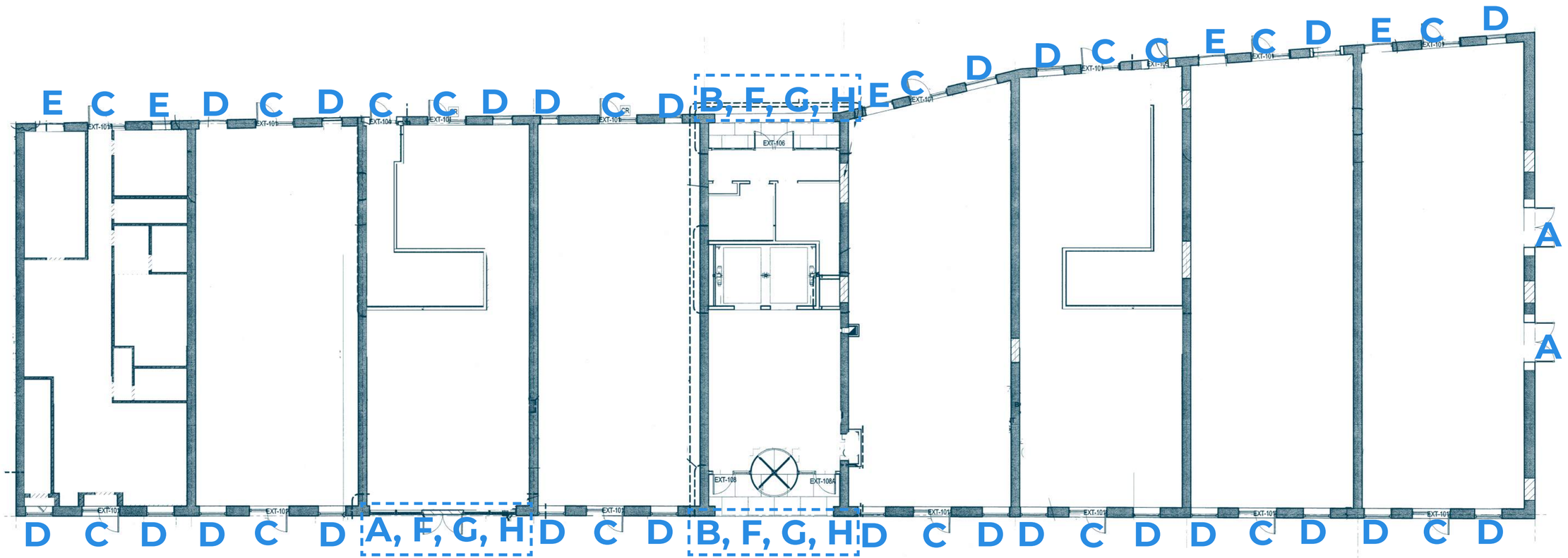
Pre-set ½" dia. drop-in anchors are typically used to fasten down the panels against wind. These anchors are capped when not in use. Flexible gaskets are attached between panels to make the water-tight seal.

DEPLOYMENT

Sufficient notice is required to take the panels out of storage and deploy them, especially for large installations. The modularity of the system allows egress points to be created by leaving single panels out of the barrier. With egress in and out, the area at risk can stay open until the last minute before flooding occurs, at which point the remaining panels are installed to complete the barrier.

DRAFT

DRAFT


E C E D C D C C D D C D B, F, G, H E C D D C C E C D E C D
A
A
D C D D C D A, F, G, H D C D B, F, G, H D C D D C D D C D D C D
EXT-101
EXT-104
EXT-105
EXT-106
EXT-108
EXT-108A
CR

DRAFT DRAFT

SECTION 3: CHART HOUSE

Below are three adaptation measures specific to the Chart House. However, these adaptation techniques may be applied to other properties in the Long Wharf area as well.

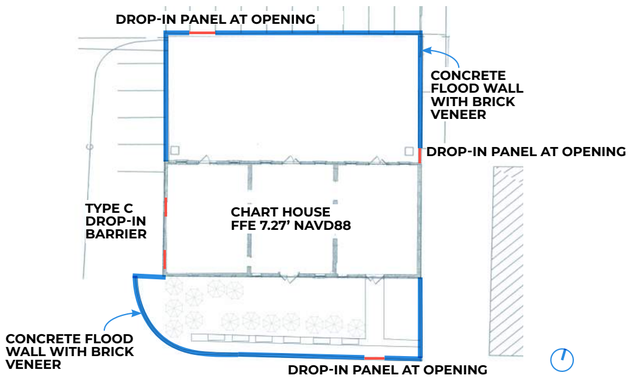
Type J: Permanent Concrete Flood Wall with Brick Veneer

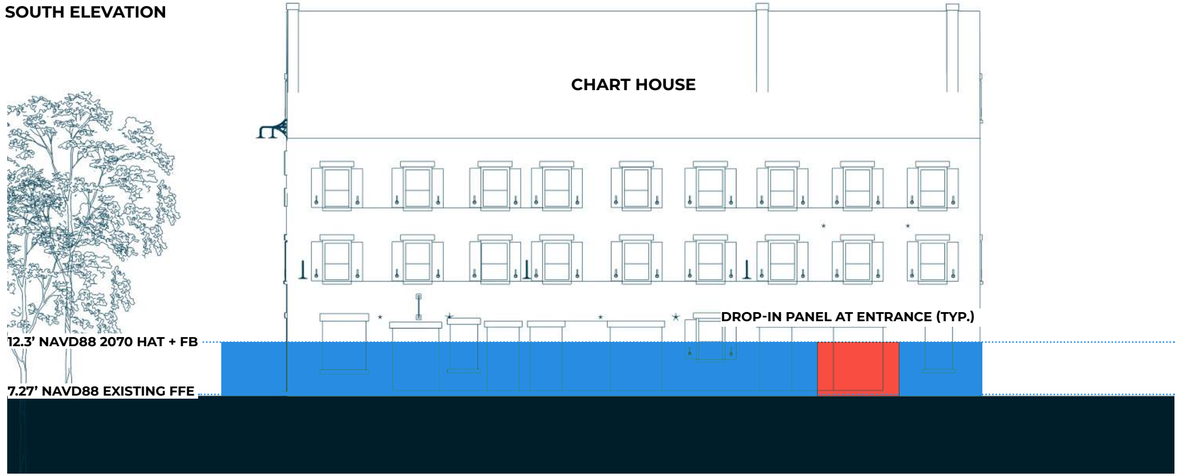
Type K: Wing Walls + Drop-in Panels

TYPE J: PERMANENT FLOOD BARRIER MASONRY WALL

This strategy involves constructing a permanent concrete flood wall with brick veneer faces around the existing Chart House seating areas with openings for building access that would be sealed off with drop-in flood barriers, similar to Type C flood barriers. The exterior of the barriers can be designed to accommodate seating or planters.

PRO	CON
• A passive system requiring minimal human intervention to deploy at openings. • Relatively more expensive to install. • Will create more secluded seating areas with some wind break.	• The relatively high wall will block harbor views from the seating areas.





INSTALLATION

The permanent wall will require excavation and construction of a concrete footing. Brick veneer on both sides with a stone cap will be more compatible with the historic brick-faced Chart House building.

DEPLOYMENT

The majority of the flood wall will be permanently installed. Only the three access penetrations through the wall and two doors on the west face of the Chart House will require deployment of drop-in-flood panels.

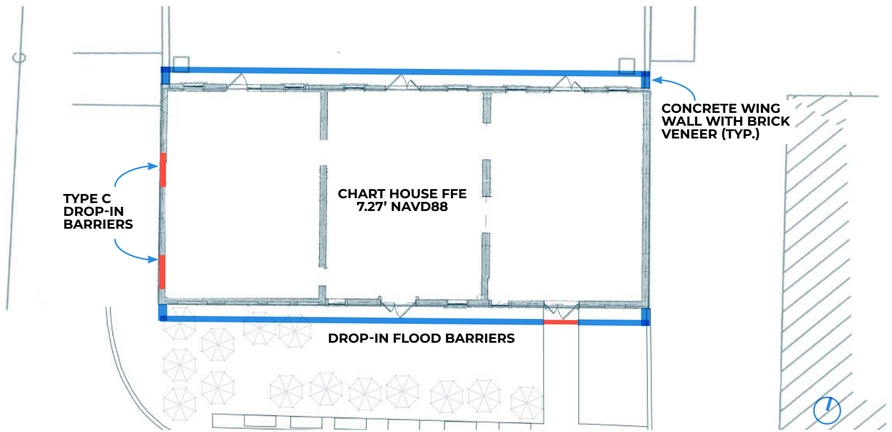
DRAFT

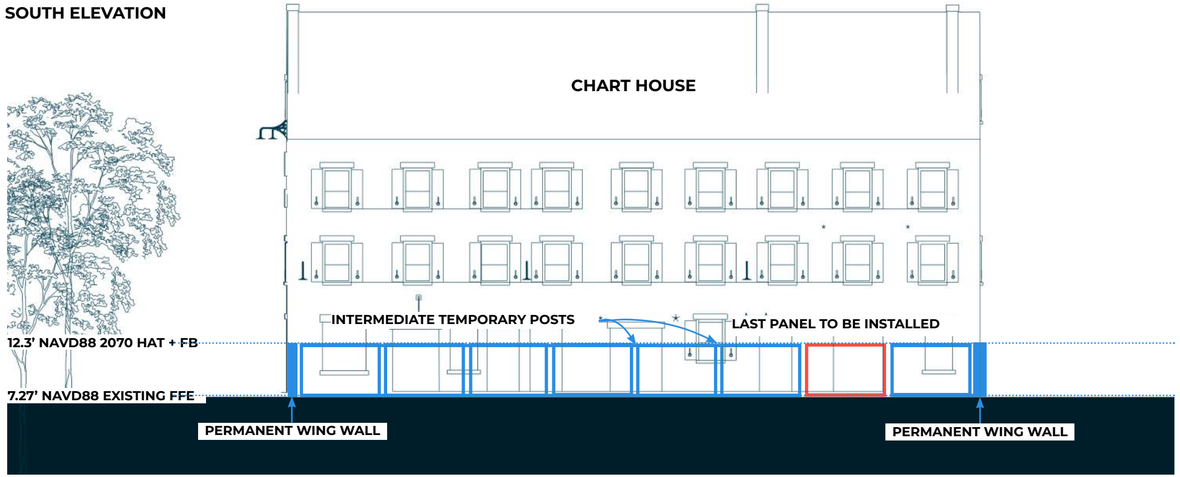
DRAFT

TYPE K: WING WALLS + DROP-IN PANELS

This strategy involves constructing short concrete wingwall at the building corners and then spanning between the wingwalls with drop-in deployable flood panels. In addition, two Type C barriers would be installed at the two existing doors on the west face.

PRO	CON
• When not in use, the panels are removed and stored, preserving the building's historic character. • Relatively low procurement cost.	• As an active system, requires manual deployment and sufficient notice to deploy. • Requires storage area. • Panels and seals require periodic inspection and maintenance.





INSTALLATION

Concrete wingwalls and intermediate posts for drop-in panels will require excavation and a concrete footing. There will need to be a concrete slab along the foot of the flood panels to provide a smooth surface for the panels to seal against. Pre-inserted bolt connections will be installed in the concrete post support bases for easy bolting of posts during deployment.

DEPLOYMENT

Panel intermediate support posts will need to be deployed first. Then drop-in panels are lowered or "dropped" into place and clamped down, to create a watertight barrier against rising floodwaters. Panels at doors can be left out until the last moment before flooding to allow access to the building.

DRAFT

DRAFT

SECTION 4: ANCILLARY STRUCTURES

There are a number of smaller ancillary wood-framed structures that are within the flood zone that cannot be floodproofed due to the walls not being able to withstand the design flood pressures. These structures include the following:

- Ticket booth on the south side of the wharf.
- Landing Café on the south side of the wharf.
- Boston Harbor Cruises gift shop on the south side of the wharf
- Ticket booth on the north side of the wharf.

These structures are already vulnerable to flooding today. The 2018 flood of record at 9.66 ft. NAVD88 was very close to the floor elevations of these buildings. Certainly, by the mid-2030s, the probability of being inundated with flood waters will be very high.

There are several possible strategies to address the vulnerability of these structures to flooding in the short term, before any of the long-term solutions are constructed. Some of these structures might also be subject to flooding under the Acupuncture scheme. For example, under the Acupuncture scheme, the wharf perimeter, including the Harborwalk, is protected to elevation 12.3 ft. NAVD88. The western end of the wharf is protected to elevation 15.0 ft. NAVD88. If these structures are located in the area subject to flooding below elevation 15.0 ft. NAVD88, then they would need to be floodproofed for full protection.

OPTION 1

Raise the existing wood-framed structures so that the floor elevation is above the Design Flood Elevation (DFE). This will require construction of new building foundations and new approaches to the building for ADA-compliant access.

OPTION 2

Demolish and reconstruct the structures using flood resistant construction with a floor elevation below the DFE. Walls and floors would most likely be constructed in concrete with windowsills set above the DFE. Door openings within the flood zone would be sealed off using drop-in flood barriers, similar to the Type C strategy described above for the Custom House Block. All interior utilities such as HVAC units, electrical panels and electrical receptacles would be located above the DFE.

OPTION 3

For the two ticket booths on the south and north side of the wharf, perimeter flood barriers could be constructed around the structures. Perimeter systems could be a drop-in panel system, similar to what is being used to protect Aquarium Station to the south of the Marriot Hotel, or AquaFence panels. In their existing conditions, the Landing Café and the BHC Gift Shop cannot easily be protected with perimeter flood proofing because the south side of each of these structures is the elevated timber boardwalk, which cannot retain water.

OPTION 4

Demolish the existing structures and replace them with portable trailer-type facilities that can be unhooked from their utilities and moved off-site in advance of a major flood event and then brought back on site after the flood has passed. Portable facilities can also be moved off-site for the winter, when the probability of flood is higher due to winter nor-easter storms.

DRAFT

DRAFT

REFERENCES

Eggleston, J., Parker, J., & Wellock, J. (2021). Guidelines On Flood Adaptation For Rehabilitating Historic Buildings. U.S. Department of the Interior, National Park Service (NPS), Washington, DC. Retrieved from https://www.nps.gov/orgs/1739/upload/flood-adaptation-guidelines-2021.pdf

Federal Emergency Management Agency (FEMA). (2013). Mitigation Ideas: A Resource for Reducing Risk to Natural Hazards. U.S. Department of Homeland Security. Retrieved from https://www.fema.gov/sites/default/files/2020-06/fema-mitigation-ideas_02-13-2013.pdf

Federal Emergency Management Agency (FEMA). (2014). Homeowner's Guide to Retrofitting: Six Ways to Protect Your Home From Flooding. U.S. Department of Homeland Security. Retrieved from https://www.fema.gov/sites/default/files/2020-07/fema_nfip_homeowners-guide-retrofitting_2014.pdf

Federal Emergency Management Agency (FEMA). (2023). Building Community Resilience With Nature-Based Solutions. U.S. Department of Homeland Security. Retrieved from https://www.fema.gov/sites/default/files/documents/fema_nature-based-solutions-guide-2-strategies-success_2023.pdf

Federal Emergency Management Agency (FEMA). (2024). Climate Adaptation Planning: Guidance for Emergency Managers. U.S. Department of Homeland Security. Retrieved from https://www.fema.gov/sites/default/files/documents/fema_climate-adaptation-planning-guide_2024.pdf

Purdy, B. (2018). Resilient, Historic Buildings Design Guide. Boston Environment Department. Boston: City of Boston. Retrieved from https://www.boston.gov/sites/default/files/embed/file/2018-10/resilient_historic_design_guide_updated.pdf

US Army Corps of Engineers. (1993). Flood proofing: How to evaluate your options: Decision tree. US Army Corps of Engineers. Retrieved from https://usace.contentdm.oclc.org/digital/collection/p16021coll11/id/356/

APPENDIX E - DETAILED CONSTRUCTION COST ESTIMATES

2030 SHORT-TERM SCHEME

CONSTRUCTION COST ESTIMATE

Long Wharf 2030 Scheme - Order of Magnitude Cost Estimate Summary
9/1/2025

Section 1 - Old Atlantic	$	4,598,000
Section 2 - South Side	$	6,893,000
Section 3 - North Side		
Marriott Hotel Related	$	1,396,000
Columbus Park Related	$	749,000
	$	2,145,000
TOTAL CONSTRUCTON COST IN 2025	**$**	**13,636,000**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**
2030 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE
SECTION 1 - OLD ATLANTIC AVENUE

Item	Unit	Quantity	Unit Price	Total
Erosion Controls	AL	1	$ 29,000.00	$ 29,000
Termporary Construction Fence	LF	592	$ 29.00	$ 17,168
Demo Existing Sidewalk	SF	3620	$ 17.00	$ 61,540
Utility Relocation/Support	AL	1	$ 171,000.00	$ 171,000
Excavation Support	LF	362	$ 290.00	$ 104,980
Concrete Footing	CY	107	$ 1,274.00	$ 136,318
Concrete Stem	CY	70	$ 1,500.00	$ 105,000
Steel Reinforcing	LB	14480	$ 2.90	$ 41,992
Mob/Demob Pile Driver	LS	1	$ 58,000.00	$ 58,000
Piles	LF	3720	$ 232.00	$ 863,040
Crushed Stone	CY	80	$ 75.00	$ 6,000
Excavation	CY	402	$ 116.00	$ 46,632
Soil Disposal	TON	651	$ 87.00	$ 56,637
Gravel Borrow Backfill	CY	89	$ 75.00	$ 6,675
Sidewalk Subbase	CY	124	$ 174.00	$ 21,576
6" Concrete Slab	SF	3350	$ 29.00	$ 97,150
Remove old railing at NEAQ	LF	125	$ 23.00	$ 2,875
Concrete wall on top of NEAQ wall	CY	15	$ 1,735.00	$ 26,025
Rebar for NEAQ wall extension	LB	2125	$ 2.90	$ 6,163
Concrete slab under drop-in panels	SF	250	$ 116.00	$ 29,000
Drop-in Flood Barriers	SF	200	$ 405.00	$ 81,000
Remove granite curb @ Old Atlantic	LF	160	$ 29.00	$ 4,640
Fill for bleacher seating	CY	533	$ 75.00	$ 39,975
Granite for bleacher seating	AL	1	$ 579,000.00	$ 579,000
Top Pavement subbase	CY	133	$ 174.00	$ 23,142
Top Pavement	SF	3600	$ 41.00	$ 147,600
Reset Granite curb along Old Atlantic	LF	160	$ 87.00	$ 13,920
Railing along top of wall	LF	120	$ 575.00	$ 69,000
End walls at drop-in openings	CY	77	$ 1,735.00	$ 133,595
Landscaping allowance	AL	1	$ 29,000.00	$ 29,000
Lighting allowance	AL	1	$ 58,000.00	$ 58,000
			SubTotal	**$ 3,065,643**
			25% Design Contingency	$ 766,411
			Subtotal	$ 3,832,053
			Contractor Mark-ups (20%)	$ 766,411
			TOTAL CONSTRUCTON COST IN 2025	**$ 4,598,464**
			SAY	**$ 4,598,000**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**
2030 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE
SECTION 2 - SOUTH SIDE

Item	Unit	Quantity	Unit Price	Total
Erosion Controls	AL	1	$ 29,000.00	$ 29,000
Temporary Construction Fence	LF	940	$ 29.00	$ 27,260
Temporarily Relocate 2 Exist Buildings	AL	1	$ 58,000.00	$ 58,000
Demo Existing Sidewalk	SF	10000	$ 17.00	$ 170,000
Utility Relocation/Support	AL	1	$ 232,000.00	$ 232,000
Excavation Support	LF	674	$ 289.00	$ 194,786
Concrete Footing (wall at Marriott)	CY	112	$ 1,275.00	$ 142,800
Concrete Stem (wall at Marriott)	CY	82	$ 1,500.00	$ 123,000
Steel Reinforcing (Wall at Marriott)	LB	15120	$ 2.90	$ 43,848
Mob/Demob Pile Driver	LS	1	$ 58,000.00	$ 58,000
Piles (Wall at Marriot)	LF	2880	$ 232.00	$ 668,160
Crushed Stone Wall at Marriott)	CY	84	$ 75.00	$ 6,300
Excavation (wall at Marriott)	CY	420	$ 116.00	$ 48,720
Soil Disposal (wall at Marriott)	TON	680	$ 89.00	$ 60,520
Gravel Borrow Backfill (wall at Marriott)	CY	93	$ 75.00	$ 6,975
Sidewalk Subbase (at Marriott)	CY	130	$ 174.00	$ 22,620
6" Concrete Slab (at Marriott)	SF	3497	$ 29.00	$ 101,413
Excavation at Bulkhead	CY	1316	$ 116.00	$ 152,656
Soil Disposal at Bulkhead	TON	2132	$ 87.00	$ 185,484
Demolish Top of Concrete Bulkhead	CY	45	$ 1,735.00	$ 78,075
Concrete Footing at Bulkhead	CY	263	$ 1,390.00	$ 365,570
Concrete Stem at Bulkhead	CY	28	$ 1,500.00	$ 42,000
Lightweight Flow Fill Backfill at Bulkhead	CY	346	$ 463.00	$ 160,198
Sidewalk Subbase at Bulkhead	CY	143	$ 174.00	$ 24,882
Restore Sidewalk at Bulkhead	SF	3848	$ 29.00	$ 111,592
Concrete slab under drop-in panels	SF	285	$ 116.00	$ 33,060
Drop-in Flood Barriers	SF	720	$ 405.00	$ 291,600
Single 42' wide Sliding Gate	LS	1	$ 1,011,700.00	$ 1,011,700
Landscaping Allowance	AL	1	$ 29,000.00	$ 29,000
Lighting Allowance	AL	1	$ 58,000.00	$ 58,000
Reinstall 2 Exisitng Buildings	AL	1	$ 58,000.00	$ 58,000
			SubTotal	**$ 4,595,219**
			25% Design Contingency	$ 1,148,805
			Subtotal	$ 5,744,024
			Contractor Mark-ups (20%)	$ 1,148,805
			TOTAL CONSTRUCTON COST IN 2025	**$ 6,892,829**
			SAY	**$ 6,893,000**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**
2030 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE
SECTION 3 - NORTH SIDE - MARRIOTT HOTEL RELATED

Item	Unit	Quantity	Unit Price	Total
Erosion Controls	AL	1	$ 10,000.00	$ 10,000
Temporary Construction Fence	LF	230	$ 29.00	$ 6,670
Demo Existing Sidewalk	SF	2733	$ 15.00	$ 40,995
Utility Relocation/Support	AL	1	$ 67,500.00	$ 67,500
Excavation Support	LF	160	$ 289.00	$ 46,240
Excavation (planter)	CY	370	$ 93.00	$ 34,410
Soil Disposal (planter)	TON	599	$ 98.00	$ 58,702
Crushed Stone (planter)	CY	148	$ 75.00	$ 11,100
Concrete Footing (planter)	CY	231	$ 1,275.00	$ 294,525
Steel Reinforcing for Footing (planter)	LB	18750	$ 2.90	$ 54,375
Concrete Stems (planters)	CY	65	$ 1,500.00	$ 97,500
Steel Reinforcing for Stems (planter)	LB	1760	$ 2.90	$ 5,104
Loam for Planter	CY	213	$ 73.00	$ 15,549
Gravel Borrow Backfill (planter)	CY	56	$ 75.00	$ 4,200
Excavation (walls)	CY	0	$ 93.00	$ -
Soil Disposal (walls)	TON	0	$ 98.00	$ -
Crushed Stone (walls)	CY	0	$ 75.00	$ -
Concrete Footing (walls)	CY	0	$ 1,275.00	$ -
Concrete Stems (walls)	CY	0	$ 1,504.00	$ -
Steel Reinforcing (walls)	LB	0	$ 2.90	$ -
Gravel Borrow Backfill (walls)	CY	0	$ 75.00	$ -
Sidewalk Subbase	CY	15	$ 174.00	$ 2,610
Sidewalk Pavement	SF	795	$ 30.00	$ 23,850
Concrete slab under drop-in panels	SF	333	$ 116.00	$ 38,628
Drop-in Flood Barriers	SF	199	$ 405.00	$ 80,595
Landscaping Allowance	AL	1	$ 20,000.00	$ 20,000
Lighting Allowance	AL	1	$ 18,000.00	$ 18,000
			SubTotal	**$ 930,553**
			25% Design Contingency	$ 232,638
			Subtotal	$ 1,163,191
			Contractor Mark-ups (20%)	$ 232,638
			TOTAL CONSTRUCTON COST IN 2025	**$ 1,395,830**
			SAY	**$ 1,396,000**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**
2030 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE
SECTION 3 - NORTH SIDE - COLUMBUS PARK RELATED

Item	Unit	Quantity	Unit Price	Total
Erosion Controls	AL	1	$ 15,000.00	$ 15,000
Temporary Construction Fence	LF	230	$ 29.00	$ 6,670
Demo Existing Sidewalk	SF	2732	$ 15.00	$ 40,980
Utility Relocation/Support	AL	1	$ 67,500.00	$ 67,500
Excavation Support	LF	0	$ 289.00	$ -
Excavation (planter)	CY	0	$ 93.00	$ -
Soil Disposal (planter)	TON	0	$ 98.00	$ -
Crushed Stone (planter)	CY	0	$ 75.00	$ -
Concrete Footing (planter)	CY	0	$ 1,275.00	$ -
Steel Reinforcing for Footing (planter)	LB	0	$ 2.90	$ -
Concrete Stems (planters)	CY	0	$ 1,500.00	$ -
Steel Reinforcing for Stems (planter)	LB	0	$ 2.90	$ -
Loam for Planter	CY	0	$ 73.00	$ -
Gravel Borrow Backfill (planter)	CY	0	$ 75.00	$ -
Excavation (walls)	CY	178	$ 93.00	$ 16,554
Soil Disposal (walls)	TON	288	$ 98.00	$ 28,224
Crushed Stone (walls)	CY	36	$ 75.00	$ 2,700
Concrete Footing (walls)	CY	47	$ 1,275.00	$ 59,925
Concrete Stems (walls)	CY	22	$ 1,504.00	$ 33,088
Steel Reinforcing (walls)	LB	6400	$ 2.90	$ 18,560
Gravel Borrow Backfill (walls)	CY	80	$ 75.00	$ 6,000
Sidewalk Subbase	CY	16	$ 174.00	$ 2,784
Sidewalk Pavement	SF	795	$ 30.00	$ 23,850
Concrete slab under drop-in panels	SF	332	$ 116.00	$ 38,512
Drop-in Flood Barriers	SF	200	$ 405.00	$ 81,000
Landscaping Allowance	AL	1	$ 20,000.00	$ 20,000
Lighting Allowance	AL	1	$ 38,000.00	$ 38,000
			SubTotal	**$ 499,347**
			25% Design Contingency	$ 124,837
			Subtotal	$ 624,184
			Contractor Mark-ups (20%)	$ 124,837
			TOTAL CONSTRUCTON COST IN 2025	**$ 749,021**
			SAY	**$ 749,000**

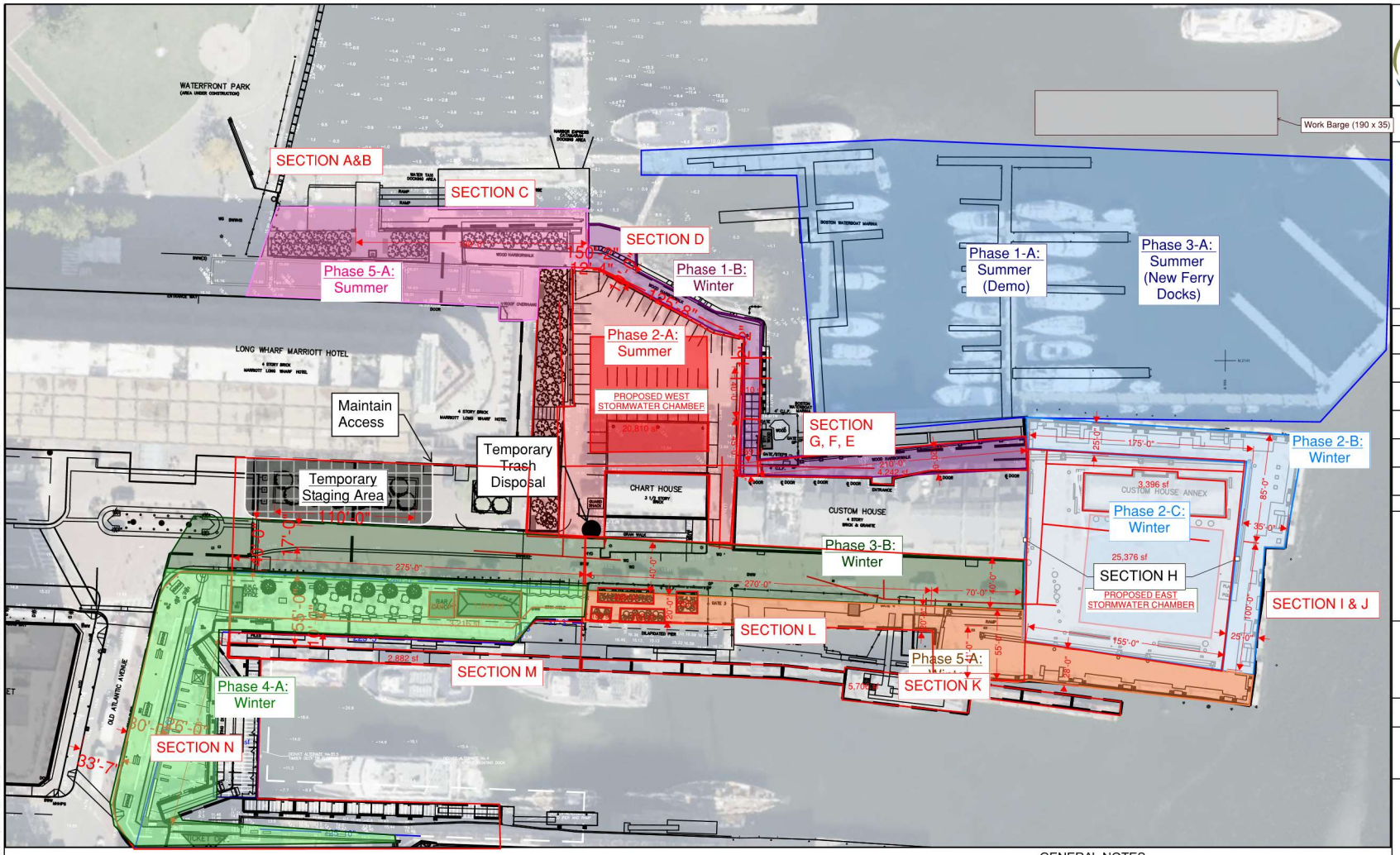
2070 LONG-TERM ‘ACUPUNCTURE’ SCHEME

CONSTRUCTION COST ESTIMATE

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING
2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME
SUMMARY

Phase	Sections	Construction Year	Base Cost (2025)	Escalation Factor (5%/ Year)	Escalated Costs
1A (Summer)	Demo Marina	1	$ 1,149,000	1.0000	1,149,000
1B (Winter)	D	1	$ 2,985,938	1.0000	2,985,938
1B (Winter)	E	1	$ 707,291	1.0000	707,291
1B (Winter)	F	1	$ 703,994	1.0000	703,994
1B (Winter)	G	1	$ 2,892,658	1.0000	2,892,658
2A (Summer)	W. Drainage	2	$ 5,023,177	1.0500	5,274,335
2B (Winter)	I & J	2	$ 5,830,483	1.0500	6,122,007
2B (Winter)	H (2B)	2	$ 4,818,780	1.0500	5,059,719
2C (Winter)	E. Drainage	2	$ 1,778,822	1.0500	1,867,763
3A (Summer)	New Ferry Docks	3	$ 8,406,000	1.1025	9,267,615
3B (Winter)	Utilities	3	$ 3,293,300	1.1025	3,630,863
4A (Winter)	N	4	$ 4,102,307	1.1576	4,748,830
4A (Winter)	M	4	$ 5,892,966	1.1576	6,821,697
5A (Summer)	A & B	5	$ 1,542,996	1.2155	1,875,511
5A (Summer)	C	5	$ 2,704,270	1.2155	3,287,040
5A (Winter)	L	5	$ 5,805,069	1.2155	7,056,061
5A (Winter)	K	5	$ 1,734,525	1.2155	2,108,315
5A (Winter)	H(5B)	5	$ 1,866,103	1.2155	2,268,249
		Subtotal	$ 61,237,675	**Subtotal**	$ 67,826,885
				Design Contingency (25%)	16,956,721
				Subtotal	$ 84,783,606
				Contractor Mark-Ups (20%)	$ 16,956,721
				TOTAL CONSTRUCTION COST (2025 $)	**$ 101,740,327**
				Project Soft Costs (30%)	$ 30,522,098
				BPD Internal Contingency (10%)	$ 10,174,033
				TOTAL PROJECT COST (2025 $)	**$ 142,436,458**
				SAY	**$142,437,000**

CONCEPT: ACUPUNCTURE:



LEGEND

- PHASE(S)
- PROPOSED STORMWATER COLLECTION SYSTEM
- STAGING AREA
- PROJECT LIMITS

GENERAL NOTES

1. PROJECT INFORMATION SHOWN HEREIN IS FOR CONCEPTUAL AND PLANNING PURPOSES ONLY, PLANS ARE NOT FOR PERMITTING, DESIGN, OR CONSTRUCTION.
2. TIDAL DATUM INFORMATION IS TAKEN FROM BENCHMARK SHEET FOR STATION ID 8443970, BOSTON HARBOR, MASSACHUSETTS, 12/12/2023, PUBLISHED BY THE U.S. DEPARTMENT OF COMMERCE, NATIONAL OCEAN SERVICE (NOS).
3. ELEVATIONS REFERENCE NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88).
4. TIDAL DATA IS PER NOAA AVERAGES BASED ON THE 1983-2001 TIDAL EPOCH AND NOT GUARANTEED TO REPRESENT CONDITIONS WHICH MAY OCCUR DURING CONSTRUCTION. ACTUAL WATER LEVELS WILL VARY FROM LEVELS INDICATED.
5. FEMA FLOODPLAIN LINES, APPROXIMATE PROPERTY LINES, AND PROPERTY INFORMATION SHOWN PROVIDED VIA MOST RECENTLY AVAILABLE MAGIS DATA. FEMA FLOODPLAIN LINES REFERENCE FEMA PANEL 25052SC0081J EFFECTIVE 3/16/2016.
6. CONCEPT ASSUMES NOT NORTH SIDE ACCESS FROM THE PARK

KLEINFELDER
Bright People. Right Solutions.
One Beacon St.
Suite 8100 Boston, MA 02108

REVISIONS

		DSN	CHK	
0	CONSTRUCTION PHASING	DWN	APP	10/09/2024

GRAPHIC SCALES
CHECK GRAPHIC SCALES BEFORE USING
0 40 80 FT
1"=80'-0"

LONG WHARF RESILIENCY

BOSTON PLANNING & DEVELOPMENT AGENCY
1 CITY HALL SQUARE #, BOSTON, MA 02201

CONSTRUCTION PHASING

PROJECT NO. 20235500.001A	
ISSUE DATE 10/09/2024	
CURRENT REVISION 0	CONCEPT
DESIGNED BY	
DRAWN BY GSVR	
CHECKED BY	
APPROVED BY	SHEET 1 of 1

PLOT DATE=10/9/2024 12:52:52 PM USER=GEORGES VALCOUR
FILENAME=G:_clients\Boston MA\20235500.001A-Flood Mitigation Planning_Long Wharf\Documents\Shoreline Edge Conditions\Constructability_Phasing\ACAD-PHASING-Model.dwg

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION A & B

Item	Unit	Quantity	Unit Price	Total
Demo - Section A & B (Phase 5A)				
Demo Concrete Foundation and Dispose	CY	4250	$ 50.00	$ 212,500
Remove Existing Granite Blocks	TON	18	$ 100.00	$ 1,800
Demo Piers, Staging Platforms & Disposal (Fixed Platform)	SF	3850	$ 49.83	$ 191,846
Marine Infrastructure - Section A & B (Phase 5A)				
Bollard Install	EA	7	$ 3,500.00	$ 24,500
Remove, Stockpile, Reset Pavers	SF	630	$ 50.00	$ 31,500
Salvage and Repurpose Granite Blocks	TON	36	$ 350.00	$ 12,600
Concrete Seawall	CY	78	$ 350.00	$ 27,300
Temporary Formwork	SF	770	$ 1.00	$ 770
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	420	$ 90.00	$ 37,800
Furnish and Install Geotextile	SY	78	$ 8.00	$ 624
Furnish and Place Backfill	CY	52	$ 70.00	$ 3,640
Elevated Pedestrian Walkway - Section A & B (Phase 5A)				
Excavation Support	LF	400	$ 250.00	$ 100,000
Excavation	CY	52	$ 100.00	$ 5,200
Top Pavement Subbase	CY	2626	$ 150.00	$ 393,900
Top Pavement - Pavers and Sealers	SF	3920	$ 11.00	$ 43,120
Roadway Subgrade (Aggregate Base Course), Compacted	CY	1960	$ 70.00	$ 137,200
Slab-On-Grade Aggregate Subbase, 1 ft	CY	3220	$ 70.00	$ 225,400
Concrete Footing	CY	3	$ 1,100.00	$ 3,300
Concrete Stem Wall	CY	3	$ 1,300.00	$ 3,900
Topsoil Depth on Grade	CY	32	$ 180.00	$ 5,760
Plant Trees	EA	10	$ 3,000.00	$ 30,000
Drip Irrigation	SF	210	$ 1.60	$ 336
Miscellaneous Site Amenities	AL	1	$ 50,000.00	$ 50,000
			TOTAL	**$ 1,542,996**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION C

Item	Unit	Quantity	Unit Price	Total
Demo - Section C (Phase 5A)				
Demo Concrete Foundation and Dispose	CY	700	$ 50.00	$ 35,000
Demo Timber Blocking	LF	900	$ 5.00	$ 4,500
Remove Existing Granite Blocks	TON	45	$ 100.00	$ 4,500
Marine Infrastructure - Section C (Phase 5A)				
Bollard Install	EA	18	$ 3,500.00	$ 63,000
Remove, Stockpile, Reset Pavers	SF	1620	$ 50.00	$ 81,000
Salvage and Repurpose Granite Blocks	TON	90	$ 350.00	$ 31,500
Concrete Seawall	CY	200	$ 350.00	$ 70,000
Temporary Formwork	SF	1980	$ 1.00	$ 1,980
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	1080	$ 90.00	$ 97,200
Furnish and Install Geotextile	SY	200	$ 8.00	$ 1,600
Furnish and Place Backfill	CY	133	$ 70.00	$ 9,310
Elevated Pedestrian Walkway - Section C (Phase 5A)				
Excavation Support	LF	840	$ 250.00	$ 210,000
Excavation	CY	133	$ 100.00	$ 13,300
Top Pavement Subbase	CY	6754	$ 150.00	$ 1,013,100
Top Pavement - Pavers and Sealers	SF	10080	$ 11.00	$ 110,880
Roadway Subgrade (Aggregate Base Course), Compacted	CY	5040	$ 70.00	$ 352,800
Slab-On-Grade Aggregate Subbase, 1 ft	CY	8280	$ 70.00	$ 579,600
Miscellaneous Site Amenities	AL	1	$ 25,000.00	$ 25,000
			TOTAL	**$ 2,704,270**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION D

Item	Unit	Quantity	Unit Price	Total
Demo - Section D (Phase 1B)				
Demo Piers, Staging Platforms & Disposal (Fixed Platform)	SF	1500	$ 49.83	$ 74,745
Demo Concrete Foundation and Dispose	CY	44	$ 50.00	$ 2,200
Mob/Demob Pile Driver	LS	1	$ 25,000.00	$ 25,000
Temporary Construction Fence	LF	190	$ 50.00	$ 9,500
Remove Existing Granite Blocks	TON	380	$ 100.00	$ 38,000
Timber Pile and Decking Demo	AL	1	$ 20,000.00	$ 20,000
Marine Infrastructure - Section D (Phase 1B)				
Bollard Install	EA	15	$ 3,500.00	$ 52,500
Concrete Footing	CY	139	$ 1,100.00	$ 152,900
Steel Reinforcing for Concrete Walls	LB	13889	$ 2.50	$ 34,723
Timber Piles	LF	1200	$ 200.00	$ 240,000
Remove, Clean and Reset Granite Blocks	TON	1254	$ 250.00	$ 313,500
Concrete Seawall	CY	228	$ 350.00	$ 79,800
Temporary Formwork	SF	1650	$ 1.00	$ 1,650
Furnish and Install Concrete Stabilization Mat	CY	33	$ 350.00	$ 11,550
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	400	$ 90.00	$ 36,000
Furnish and Install Geotextile	SY	250	$ 8.00	$ 2,000
Furnish and Place Backfill	CY	361	$ 70.00	$ 25,270
Pile Cap Connection at Pile-Supporting Footing	EA	15	$ 2,500.00	$ 37,500
Pile Footing Formwork	SF	1500	$ 100.00	$ 150,000
Elevated Pedestrian Walkway - Section D (Phase 1B)				
Excavation Support	LF	600	$ 250.00	$ 150,000
Excavation	CY	361	$ 100.00	$ 36,100
Temporary Formwork	SF	750	$ 1.00	$ 750
Top Pavement Subbase	CY	750	$ 150.00	$ 112,500
Top Pavement - Pavers and Sealers	SF	1500	$ 11.00	$ 16,500
Roadway Subgrade (Aggregate Base Course), Compacted	CY	750	$ 70.00	$ 52,500
Concrete Footing (Slab-on-Grade) , 8 Inches	CY	1005	$ 900.00	$ 904,500
Steel Reinforcing for Slab-on-Grade	LB	100500	$ 2.50	$ 251,250
Slab-On-Grade Aggregate Subbase, 1 ft	CY	1500	$ 70.00	$ 105,000
Miscellaneous Site Amenities	AL	1	$ 50,000.00	$ 50,000
			TOTAL	**$ 2,985,938**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION E

Item	Unit	Quantity	Unit Price	Total
Demo - Section E (Phase 1B)				
Demo Harborwalk Decking	SF	610	$ 12.46	$ 7,601
Demo Concrete Foundation and Dispose	CY	44	$ 50.00	$ 2,200
Temporary Construction Fence	LF	60	$ 50.00	$ 3,000
Remove Existing Granite Blocks	TON	20	$ 100.00	$ 2,000
Additional Timber Pile Demo and Decking Demo	AL	1	$ 20,000.00	$ 20,000
				$ -
Marine Infrastructure - Section E (Phase 1B)				$ -
Remove, Clean and Reset Existing Granite Blocks	TON	110	$ 250.00	$ 27,500
Remove, Stockpile, Reset Pavers	SF	240	$ 50.00	$ 12,000
Salvage and Repurpose Granite Blocks	TON	80	$ 350.00	$ 28,000
Concrete Seawall	CY	61	$ 350.00	$ 21,350
Temporary Formwork	SF	440	$ 1.00	$ 440
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	320	$ 90.00	$ 28,800
Furnish and Install Geotextile	SY	75	$ 8.00	$ 600
Furnish Fill (Structural) Lightweight	CY	50	$ 350.00	$ 17,500
Elevated Pedestrian Walkway - Section E (Phase 1B)				
Excavation Support	LF	480	$ 250.00	$ 120,000
Excavation	CY	37	$ 100.00	$ 3,700
Soil Disposal	TON	60	$ 50.00	$ 3,000
Top Pavement Subbase	CY	200	$ 150.00	$ 30,000
Top Pavement - Pavers and Sealers	SF	400	$ 11.00	$ 4,400
Roadway Subgrade (Aggregate Base Course), Compacted	CY	200	$ 70.00	$ 14,000
Concrete Footing (Slab-on-Grade) , 8 Inches	CY	268	$ 900.00	$ 241,200
Steel Reinforcing for Slab-on-Grade	LB	26800	$ 2.50	$ 67,000
Slab-On-Grade Aggregate Subbase, 1 ft	CY	400	$ 70.00	$ 28,000
Miscellaneous Site Amenities	AL	1	$ 25,000.00	$ 25,000
			TOTAL	**$ 707,291**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION F

Item	Unit	Quantity	Unit Price	Total
Demo - Section F (Phase 1B)				
Demo Harborwalk Base Slab	SF	650	$ 30.00	$ 19,500
Temporary Construction Fence	LF	50	$ 50.00	$ 2,500
Remove Existing Granite Blocks	TON	24	$ 100.00	$ 2,400
				$ -
Marine Infrastructure - Section F (Phase 1B)				$ -
Bollard Install	EA	4	$ 3,500.00	$ 14,000
Remove, Clean and Reset Existing Granite Blocks	TON	132	$ 250.00	$ 33,000
Remove, Stockpile, Reset Pavers	SF	270	$ 50.00	$ 13,500
Salvage and Repurpose Granite Blocks	TON	24	$ 350.00	$ 8,400
Concrete Seawall	CY	125	$ 350.00	$ 43,750
Temporary Formwork	SF	594	$ 1.00	$ 594
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	270	$ 90.00	$ 24,300
Furnish and Install Geotextile	SY	100	$ 8.00	$ 800
Furnish Fill (Structural) Lightweight	CY	50	$ 350.00	$ 17,500
Elevated Pedestrian Walkway - Section F (Phase 1B)				
Excavation Support	LF	540	$ 250.00	$ 135,000
Excavation	CY	33	$ 100.00	$ 3,300
Soil Disposal	TON	54	$ 50.00	$ 2,700
Top Pavement Subbase	CY	225	$ 150.00	$ 33,750
Top Pavement - Pavers and Sealers	SF	450	$ 11.00	$ 4,950
Roadway Subgrade (Aggregate Base Course), Compacted	CY	225	$ 70.00	$ 15,750
Concrete Footing (Slab-on-Grade) , 8 Inches	CY	302	$ 900.00	$ 271,800
Slab-On-Grade Aggregate Subbase, 1 ft	CY	450	$ 70.00	$ 31,500
Miscellaneous Site Amenities	AL	1	$ 25,000.00	$ 25,000
			TOTAL	**$ 703,994**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION G

Item	Unit	Quantity	Unit Price	Total
Demo - Section G (Phase 1B)				
Demo Harborwalk Decking	SF	4250	$ 12.46	$ 52,955
Temporary Construction Fence	LF	50	$ 50.00	$ 2,500
Mob/Demob Pile Driver	LS	1	$ 25,000.00	$ 25,000
Remove Existing Granite Blocks	TON	52	$ 100.00	$ 5,200
Excavation Material-Hauling, Loading onto Barge & Disposal	CY	194	$ 25.00	$ 4,850
Mechanical Dredging with Upland Disposal	CY	194	$ 300.00	$ 58,200
Remove Bollards	EA	21	$ 50.00	$ 1,050
				$ -
Marine Infrastructure - Section G (Phase 1B)				$ -
Bollard Install	EA	21	$ 3,500.00	$ 73,500
Remove, Stockpile, Reset Pavers	SF	1260	$ 50.00	$ 63,000
Salvage and Repurpose Granite Blocks	TON	416	$ 350.00	$ 145,600
Concrete Seawall	CY	210	$ 350.00	$ 73,500
Temporary Formwork	SF	1848	$ 1.00	$ 1,848
Furnish Miscellaneous Hardware (Dowels, Etc.)	EA	700	$ 90.00	$ 63,000
Furnish and Install Geotextile	SY	117	$ 8.00	$ 936
Furnish, Install and Coat Sheet Piles	LB	189603	$ 3.75	$ 711,011
Furnish and Install Clousre Plate	LB	408	$ 3.75	$ 1,530
Furnish, Install and Coat Connectors	LB	170	$ 3.75	$ 638
Furnish Fill (Structural) Lightweight	CY	257	$ 350.00	$ 89,950
Elevated Pedestrian Walkway - Section G (Phase 1B)				
Excavation Support	LF	2520	$ 250.00	$ 630,000
Reconstruct Pile-Supported Pier	SF	4250	$ 150.00	$ 637,500
Furnish and Place Backfill	CY	257	$ 70.00	$ 17,990
Glass Wall Installation	SF	462	$ 450.00	$ 207,900
Miscellaneous Site Amenities	AL	1	$ 25,000.00	$ 25,000
			TOTAL	**$ 2,892,658**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION H (PHASE 2B)

Item	Unit	Quantity	Unit Price	Total
Demo - Section H (Phase 2B)				
Demo Existing Sidewalk	SF	22600	$ 15.00	$ 339,000
Temporary Construction Fence	LF	388	$ 50.00	$ 19,400
Demo Structure	SF	3400	$ 42.25	$ 143,650
Miscellaneous Other Features Removal	AL	1	$ 100,000.00	$ 100,000
Elevated Walkway - Section H And Deep Excavation for Stormwater Drainage (Phase 2B)				
Excavation Support	LF	640	$ 250.00	$ 160,000
Excavation	CY	17825	$ 100.00	$ 1,782,500
Soil Disposal	TON	24064	$ 50.00	$ 1,203,200
Low Density Fill	CY	12986	$ 30.00	$ 389,580
Fill Material - Procure	CY	3760	$ 35.00	$ 131,600
Sidewalk Subbase	CY	1256	$ 150.00	$ 188,400
Top Pavement Subbase	CY	419	$ 150.00	$ 62,850
Top Pavement - Pavers and Sealers	SF	22600	$ 11.00	$ 248,600
Miscellaneous Site Accessories (Benches, Trash Cans, Etc)	AL	1	$ 50,000.00	$ 50,000
			TOTAL	**$ 4,818,780**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION H (PHASE 5B)

Item	Unit	Quantity	Unit Price	Total
155 Ft. Southern Portion of the Pier Elevated Way (Section H South Portion, Phase 5B)				
Sidewalk Subbase	CY	40	$ 150.00	$ 6,000
Top Pavement Subbase	CY	13	$ 150.00	$ 1,950
Top Pavement - Pavers and Sealers	SF	720	$ 11.00	$ 7,920
Roadway Subgrade (Aggregate Base Course), Compacted	CY	133	$ 70.00	$ 9,310
Concrete Footing (Slab-on-Grade), 8"	CY	60	$ 900.00	$ 54,000
Exterior Stair System	SF	720	$ 137.00	$ 98,640
Steel Reinforcing for Slab-on-Grade	LB	5985	$ 2.50	$ 14,963
Slab-on-Grade Aggregate Subbase (1 ft)	CY	89	$ 70.00	$ 6,230
155 Ft. Southern Portion of the Pier Marine (Section H South Portion, Phase 5B)				
Marine Infrastructure - Section H - Southern Portion				
Bollard Install	EA	18	$ 3,500.00	$ 63,000
Remove, Stockpile, Reset Pavers	SF	540	$ 50.00	$ 27,000
Salvage and Repurpose Granite Blocks	TON	45	$ 350.00	$ 15,750
Concrete Seawall	CY	367	$ 350.00	$ 128,450
Remove, Clean and Reset Existing Granite Blocks	TON	315	$ 250.00	$ 78,750
Temporary Formwork	SF	2178	$ 1.00	$ 2,178
Furnish and Place Backfill	CY	1597	$ 70.00	$ 111,790
Furnish and Install Concrete Stabilization Mat	CY	40	$ 350.00	$ 14,000
Furnish and Place Concrete Fill Behind Sheet Piles	CY	267	$ 350.00	$ 93,450
Crushed Stone	CY	159	$ 65.00	$ 10,335
Gravel Borrow Backfill	CY	93	$ 65.00	$ 6,045
Dowels (Hilti Quick Bolts)	EA	810	$ 90.00	$ 72,900
Diver Installation	DAY	4	$ 7,475.00	$ 29,900
Furnish and Install Geotextile	SY	300	$ 8.00	$ 2,400
H-Pile Installation (Furnish and Coat)	LB	64260	$ 3.75	$ 240,975
Waler (Struct Installation), Including Splice	LF	180	$ 25.00	$ 4,500
Anchors for Closure Plate and Hardware	EA	18	$ 2,000.00	$ 36,000
Furnish, Install and Coat Sheet Piles	LB	189603	$ 3.75	$ 711,011
Furnish and Install Clousre Plate	LB	918	$ 3.75	$ 3,443
Furnish, Install and Coat Connectors	LB	680	$ 3.75	$ 2,550
Rip Rap - 4.5 SF Depth	CY	200	$ 63.32	$ 12,664
			TOTAL	**$ 1,866,103**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION I & J

Item	Unit	Quantity	Unit Price	Total
Demo - Section I & J (Phase 2B)				
Demo Existing Sidewalk	SF	9850	$ 15.00	$ 147,750
Temporary Construction Fence	LF	495	$ 50.00	$ 24,750
Mob/Demob Pile Driver	LS	1	$ 25,000.00	$ 25,000
Remove Existing Granite Blocks	TON	98	$ 100.00	$ 9,800
Remove Existing Granite Blocks Below Grade	TON	196	$ 100.00	$ 19,600
Salvage and Repurpose Granite Blocks	TON	98	$ 350.00	$ 34,300
Miscellaneous Bollards and Other Features	AL	1	$ 50,000.00	$ 50,000
Marine Infrastructure - Section I & J (Phase 2B)				
Bollard Install	EA	40	$ 3,500.00	$ 140,000
Remove, Stockpile, Reset Pavers	SF	1185	$ 50.00	$ 59,250
Salvage and Repurpose Granite Blocks	TON	98	$ 350.00	$ 34,300
Concrete Seawall	CY	805	$ 350.00	$ 281,750
Furnish and Place Concrete Fill Behind Sheet Piles	CY	585	$ 350.00	$ 204,750
Remove, Clean and Reset Existing Granite Blocks	TON	686	$ 250.00	$ 171,500
Temporary Formwork	SF	4780	$ 1.00	$ 4,780
Furnish and Place Backfill	CY	4375	$ 70.00	$ 306,250
Furnish and Install Concrete Stabilization Mat	CY	88	$ 350.00	$ 30,800
Crushed Stone	CY	275	$ 65.00	$ 17,875
Gravel Borrow Backfill	CY	150	$ 65.00	$ 9,750
Dowels (Hilti Quick Bolts)	EA	1778	$ 90.00	$ 160,020
Diver Installation	DAY	3	$ 7,475.00	$ 22,425
Furnish and Install Geotextile	SY	658	$ 8.00	$ 5,264
H-Pile Installation (Furnish and Coat)	LB	141015	$ 3.75	$ 528,806
Waler (Struct Installation), Including Splice	LF	395	$ 25.00	$ 9,875
Anchors for Closure Plate and Hardware	EA	40	$ 2,000.00	$ 80,000
Furnish, Install and Coat Sheet Piles	LB	416074	$ 3.75	$ 1,560,278
Furnish and Install Clousre Plate	LB	918	$ 3.75	$ 3,443
Furnish, Install and Coat Connectors	LB	680	$ 3.75	$ 2,550
Rip Rap - 4.5 SF Depth	CY	439	$ 63.32	$ 27,797
Furnish Misc. Hardware (Dowels)	LS	1	$ 100.00	$ 100
Elevated Pedestrian Walkway - Section I & J (Phase 2B)				
Excavation Support	LF	1780	$ 250.00	$ 445,000
Excavation	CY	4375	$ 100.00	$ 437,500
Soil Disposal	TON	4738	$ 50.00	$ 236,900
Sidewalk Subbase	CY	88	$ 150.00	$ 13,200
Top Pavement Subbase	CY	29	$ 150.00	$ 4,350
Top Pavement - Pavers and Sealers	SF	1580	$ 11.00	$ 17,380
Roadway Subgrade (Aggregate Base Course), Compacted	CY	249	$ 70.00	$ 17,430
Concrete Footing (Slab-on-Grade), 8"	CY	112	$ 900.00	$ 100,800
Exterior Stair System	SF	2880	$ 137.00	$ 394,560
Steel Reinforcing for Slab-on-Grade	LB	11164	$ 2.50	$ 27,910
Slab-on-Grade Aggregate Subbase (1 ft)	CY	167	$ 70.00	$ 11,690
Concrete Wall Stem	CY	27	$ 1,300.00	$ 35,100
Concrete Footing	CY	24	$ 1,100.00	$ 26,400
Steel Reinforcing for Concrete Walls	LB	15800	$ 2.50	$ 39,500
Miscellaneous Accessories	AL	1	$ 50,000.00	$ 50,000
			TOTAL	**$ 5,830,483**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION K

Item	Unit	Quantity	Unit Price	Total
Demo - Section K				
Demo Existing Sidewalk	SF	350	$ 15.00	$ 5,250
Demo Roadway	SF	2450	$ 30.00	$ 73,500
Temporary Construction Fence	LF	200	$ 50.00	$ 10,000
Demo Piers, Staging Platforms & Disposal (Fixed Platform)	SF	3850	$ 49.83	$ 191,846
Remove Existing Granite Blocks	TON	26	$ 100.00	$ 2,600
Marine Infrastructure - Section K				
Bollard Install	EA	7	$ 3,500.00	$ 24,500
Gangway	EA	1	$ 18,000.00	$ 18,000
Remove, Stockpile, Reset Pavers	SF	420	$ 50.00	$ 21,000
Salvage and Repurpose Granite Blocks	TON	126	$ 250.00	$ 31,500
Concrete Seawall	CY	150	$ 350.00	$ 52,500
Steel Reinforcing for Concrete Walls	LB	7000	$ 2.50	$ 17,500
Fill Material	CY	739	$ 35.00	$ 25,865
Furnish and Place Backfill	CY	856	$ 70.00	$ 59,920
Temporary Formwork	SF	700	$ 1.00	$ 700
Crushed Stone	CY	132	$ 65.00	$ 8,580
Gravel Borrow Backfill	CY	79	$ 65.00	$ 5,135
Furnish Misc. Hardware (Dowels)	LS	560	$ 90.00	$ 50,400
Furnish and Install Geotextile	SY	156	$ 8.00	$ 1,248
Furnish, Install and Coat Sheet Piles	LB	73735	$ 3.75	$ 276,506
Furnish and Install Clousre Plate	LB	918	$ 3.75	$ 3,443
Furnish, Install and Coat Connectors	LB	340	$ 3.75	$ 1,275
Concrete Fill (Structural) Lightweight	CY	13	$ 350.00	$ 4,550
Rip Rap - 4.5 SF Depth	CY	52	$ 63.32	$ 3,293
Elevated Pedestrian Walkway - Section K				
Excavation Support	LF	400	$ 250.00	$ 100,000
Excavation	CY	117	$ 100.00	$ 11,700
Soil Disposal	TON	190	$ 50.00	$ 9,500
Sidewalk Subbase	CY	39	$ 150.00	$ 5,850
Top Pavement Subbase	CY	52	$ 150.00	$ 7,800
Top Pavement - Pavers and Sealers	SF	2800	$ 11.00	$ 30,800
Roadway Subgrade (Aggregate Base Course), Compacted	CY	104	$ 70.00	$ 7,280
Concrete Footing (Slab-on-Grade), 8"	CY	71	$ 900.00	$ 63,900
Slab-on-Grade Aggregate Subbase (1 ft)	CY	106	$ 70.00	$ 7,420
Steel Reinforcing for Slab-on-Grade	LB	7122	$ 2.50	$ 17,805
Exterior Stair System	SF	280	$ 137.00	$ 38,360
Concrete Wall Stem	CY	230	$ 1,300.00	$ 299,000
Concrete Footing	CY	80	$ 1,100.00	$ 88,000
Steel Reinforcing for Concrete Walls	LB	43200	$ 2.50	$ 108,000
Miscellaneous Accessories	AL	1	$ 50,000.00	$ 50,000
			TOTAL	**$ 1,734,525**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION L

Item	Unit	Quantity	Unit Price	Total
Demo - Section L				
Demo Existing Sidewalk	SF	1350	$ 15.00	$ 20,250
Demo Roadway	SF	8100	$ 30.00	$ 243,000
Temporary Construction Fence	LF	350	$ 50.00	$ 17,500
Mob/Demob Pile Driver	LS	1	$ 25,000.00	$ 25,000
Demo Piers, Staging Platforms & Disposal (Fixed Platform)	SF	4050	$ 49.83	$ 201,812
Remove Existing Granite Blocks	TON	67	$ 100.00	$ 6,700
Remove Existing Floating Dock	SF	6000	$ 50.00	$ 300,000
Demo Planters Haul and Disposal	SF	1350	$ 8.00	$ 10,800
Marine Infrastructure - Section L				
Piles	LF	3240	$ 200.00	$ 648,000
Bollard Install	EA	27	$ 3,500.00	$ 94,500
Remove, Stockpile, Reset Pavers	SF	1620	$ 50.00	$ 81,000
Salvage and Repurpose Granite Blocks	TON	603	$ 350.00	$ 211,050
Concrete Seawall	CY	550	$ 350.00	$ 192,500
Temporary Formwork	SF	2970	$ 1.00	$ 2,970
Furnish and Place Backfill	CY	1450	$ 70.00	$ 101,500
Crushed Stone	CY	160	$ 65.00	$ 10,400
Gravel Borrow Backfill	CY	80	$ 65.00	$ 5,200
Furnish Misc. Hardware (Dowels)	LS	2160	$ 90.00	$ 194,400
Diver Installation	DAY	5	$ 7,475.00	$ 37,375
Furnish and Install Geotextile	SY	540	$ 8.00	$ 4,320
Furnish, Install and Coat Sheet Piles	LB	284405	$ 3.75	$ 1,066,519
Furnish and Install Clousre Plate	LB	918	$ 3.75	$ 3,443
Furnish, Install and Coat Connectors	LB	340	$ 3.75	$ 1,275
Concrete Fill (Structural) Lightweight	CY	50	$ 350.00	$ 17,500
Rip Rap - 4.5 SF Depth	CY	300	$ 63.32	$ 18,996
Reinstall Floating Docks	SF	6000	$ 150.00	$ 900,000
Elevated Pedestrian Walkway - Section L				
Excavation Support	LF	1080	$ 250.00	$ 270,000
Excavation	CY	1450	$ 100.00	$ 145,000
Soil Disposal	TON	2349	$ 50.00	$ 117,450
Sidewalk Subbase	CY	75	$ 150.00	$ 11,250
Top Pavement Subbase	CY	25	$ 150.00	$ 3,750
Top Pavement - Pavers and Sealers	SF	1350	$ 11.00	$ 14,850
Roadway Subgrade (Aggregate Base Course), Compacted	CY	350	$ 70.00	$ 24,500
Concrete Footing (Slab-on-Grade), 8"	CY	107	$ 900.00	$ 96,300
Steel Reinforcing for Slab-on-Grade	LB	10720	$ 2.50	$ 26,800
Slab-on-Grade Aggregate Subbase (1 ft)	CY	160	$ 70.00	$ 11,200
Exterior Stair System	SF	1080	$ 137.00	$ 147,960
Concrete Wall Stem	CY	230	$ 1,300.00	$ 299,000
Concrete Footing	CY	80	$ 1,100.00	$ 88,000
Steel Reinforcing for Concrete Walls	LB	43200	$ 2.50	$ 108,000
Miscellaneous Accessories	AL	1	$ 25,000.00	$ 25,000
			TOTAL	**$ 5,805,069**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION M

Item	Unit	Quantity	Unit Price	Total
Demo - Section M (Phase 4A)				
Demo Existing Sidewalk	SF	10200	$ 15.00	$ 153,000
Demo Harborwalk Decking	SF	14025	$ 12.46	$ 174,752
Temporary Construction Fence	LF	295	$ 50.00	$ 14,750
Remove Existing Granite Blocks	TON	70	$ 100.00	$ 7,000
Remove Granite Curb	LF	255	$ 25.00	$ 6,375
Demo Structure	SF	1500	$ 42.25	$ 63,375
Remove and Store Existing Floating Docks	SF	2520	$ 75.00	$ 189,000
Demo Concrete Support Wall	EA	1	$ 25,000.00	$ 25,000
Marine Infrastructure - Section M (Phase 4A)				
Piles	LF	1530	$ 200.00	$ 306,000
Bollard Install	EA	29	$ 3,500.00	$ 101,500
Reconstruct Pile Supported Pier	SF	4125	$ 150.00	$ 618,750
Gangway	EA	2	$ 18,000.00	$ 36,000
Remove, Stockpile, Reset Pavers	SF	1710	$ 45.00	$ 76,950
Furnish and Install Concrete Stabilization Mat	CY	126	$ 350.00	$ 44,100
Concrete Seawall	CY	866	$ 350.00	$ 303,100
Temporary Formwork	SF	6270	$ 1.00	$ 6,270
Furnish and Place Backfill	CY	1794	$ 70.00	$ 125,580
Furnish and Install Geotextile	SY	697	$ 8.00	$ 5,576
Furnish, Install and Coat Sheet Piles	LB	257319	$ 3.75	$ 964,946
Furnish and Install Clousre Plate	LB	918	$ 3.75	$ 3,443
Furnish, Install and Coat Connectors	LB	340	$ 3.75	$ 1,275
Furnish and Place Backfill	CY	53	$ 70.00	$ 3,710
Furnish and Install Miscellaneous Hardware (Dowels)	LS	285	$ 90.00	$ 25,650
Diver installation	DAY	6	$ 7,475.00	$ 44,850
Elevated Pedestrian Walkway - Section M (Phase 4A)				
Excavation Support	LF	1080	$ 250.00	$ 270,000
Excavation	CY	4475	$ 100.00	$ 447,500
Soil Disposal	TON	7250	$ 50.00	$ 362,500
Sidewalk Subbase	CY	75	$ 150.00	$ 11,250
Top Pavement - Pavers and Sealers	SF	9450	$ 11.00	$ 103,950
Top Pavement Subbase	CY	175	$ 150.00	$ 26,250
Roadway Subgrade (Aggregate Base Course), Compacted	CY	350	$ 70.00	$ 24,500
Concrete Footing (Slab-on-Grade), 8"	CY	250	$ 900.00	$ 225,000
Crushed Stone	CY	399	$ 65.00	$ 25,935
Gravel Borrow Backfill	CY	213	$ 65.00	$ 13,845
Steel Reinforcing for Slab-on-Grade	LB	25013	$ 2.50	$ 62,533
Exterior Stair System	SF	1080	$ 137.00	$ 147,960
Concrete Wall Stem	CY	100	$ 1,300.00	$ 130,000
Concrete Footing	CY	30	$ 1,100.00	$ 33,000
Steel Reinforcing for Concrete Walls	LB	26800	$ 2.50	$ 67,000
Glass Wall Installation	SF	594	$ 450.00	$ 267,300
Topsoil	CY	359	$ 180.00	$ 64,620
Plant Trees	EA	10	$ 3,000.00	$ 30,000
Drip Irrigation	SF	2420	$ 1.60	$ 3,872
Miscellaneous Accessories	AL	1	$ 25,000.00	$ 25,000
Trash Building (36' x 20')	AL	1	$ 250,000.00	$ 250,000
			TOTAL	**$ 5,892,966**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

SECTION N

Item	Unit	Quantity	Unit Price	Total
Demo - Section N (Phase 4A)				
Demo Existing Sidewalk	SF	3000	$ 15.00	$ 45,000
Demo Roadway	SF	5250	$ 30.00	$ 157,500
Temporary Construction Fence	LF	560	$ 50.00	$ 28,000
Site Access Gate	EA	1	$ 9,000.00	$ 9,000
Mob/Demob/Pile Driver	LS	1	$ 25,000.00	$ 25,000
Demo Piers, Staging Platforms & Disposal (Fixed Platform)	SF	4500	$ 49.83	$ 224,235
Remove Existing Granite Blocks	TON	38	$ 100.00	$ 3,800
Remove Granite Curb at Old Atlantic	LF	150	$ 25.00	$ 3,750
Marine Infrastructure - Section N (Phase 4A)				
Piles	LF	4500	$ 200.00	$ 900,000
500 psf Floating Dock - Restore	SF	4680	$ 180.00	$ 842,400
Reconstruct Pile Supported Pier	SF	3000	$ 150.00	$ 450,000
Gangway	EA	2	$ 18,000.00	$ 36,000
Bollard Install	EA	30	$ 3,500.00	$ 105,000
Concrete Seawall	CY	250	$ 350.00	$ 87,500
Temporary Formwork	SF	1777	$ 1.00	$ 1,777
Furnish and place Backfill	CY	533	$ 70.00	$ 37,310
Crushed Stone at Base of Concrete Wall	CY	22	$ 65.00	$ 1,430
Crushed Stone at Below Slab on Grade (1 ft)	CY	222	$ 65.00	$ 14,430
Gravel Borrow Backfill	CY	111	$ 65.00	$ 7,215
Furnish and Install Concrete Stabilization Mat	CY	28	$ 350.00	$ 9,800
Furnish and Install Geotextile	SY	233	$ 8.00	$ 1,864
Dowels (Hilti Quick Bolts)	EA	300	$ 90.00	$ 27,000
Elevated Pedestrian Walkway - Section N (Phase 4A)				
Excavation Support	LF	760	$ 250.00	$ 190,000
Excavation	CY	1241	$ 100.00	$ 124,100
Soil Disposal	TON	2010	$ 50.00	$ 100,500
Sidewalk Subbase	CY	53	$ 150.00	$ 7,950
Asphalt Paving Restoration	SF	3256	$ 18.00	$ 58,608
Top Pavement Subbase	CY	123	$ 150.00	$ 18,450
Top Pavement - Pavers and Sealers	SF	3990	$ 11.00	$ 43,890
Roadway Subgrade (Aggregate Base Course), Compacted	CY	246	$ 70.00	$ 17,220
Concrete Footing (Slab-on-Grade), 8"	CY	78	$ 900.00	$ 70,200
Exterior Stair System	SF	760	$ 137.00	$ 104,120
Steel Reinforcing for Slab-on-Grade	LB	9333	$ 2.50	$ 23,333
Concrete Wall Stem	CY	67	$ 1,300.00	$ 87,100
Concrete Footing	CY	47	$ 1,100.00	$ 51,700
Steel Reinforcing for Concrete Walls	LB	25200	$ 2.50	$ 63,000
Remove Old Railing at NEAQ	LF	125	$ 20.00	$ 2,500
Concrete Wall on Top of NEAQ Wall	CY	22	$ 1,500.00	$ 33,000
Steel Reinforcing for NEAQ Wall Extension	LB	2250	$ 2.50	$ 5,625
Reset Granite Curb Along Old Atlantic	LF	160	$ 50.00	$ 8,000
Railing Edge of Waterfront	LF	150	$ 500.00	$ 75,000
			TOTAL	**$ 4,102,307**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

REBUILD NORTH DOCKS

Item	Unit	Quantity	Unit Price	Total
Demo - Waterboat Marina (Phase 1A)				
Demolish Existing Marina	SF	25000	$ 41.00	$ 1,025,000
Turbidity Curtain	LF	900	$ 110.00	$ 99,000
Disconnect Utilities	AL	1	$ 25,000.00	$ 25,000
			Subtotal	**$ 1,149,000**
Construct New Ferry Docks (Phase 3A)				
Concrete Floats	SF	25000	$ 262.00	$ 6,550,000
18" Steel Pipe Piles	LF	10000	$ 150.00	$ 1,500,000
18" Steel Pipe Piles Installation Cost	LF	10000	$ 20.00	$ 200,000
Structural Steel	AL	1	$ 20,000.00	$ 20,000
Gangway Ramps	EA	2	$ 18,000.00	$ 36,000
Utilities and Lighting	AL	1	$ 100,000.00	$ 100,000
			Subtotal	**$ 8,406,000**
			TOTAL	**$ 9,555,000**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

WEST DRAINAGE SYSTEM (PHASE 2A)

Item	Unit	Quantity	Unit Price	Total
West Drainage System (Phase 2A)				
Water Main Installation, 12" Pipe	LF	738	$ 257.00	$ 189,666
Trench Box Installation	LF	738	$ 15.00	$ 11,070
Stormwater Outfall	EA	2	$ 7,000.00	$ 14,000
Rip Rap - 4.5 SF Depth	CY	100	$ 63.32	$ 6,332
Catch Basin	EA	6	$ 7,250.00	$ 43,500
Stormwater Pump	EA	1	$ 50,000.00	$ 50,000
Temporary Sheet Pile Installation	SF	18690	$ 40.00	$ 747,600
Foundation Gravel	TON	504	$ 50.00	$ 25,200
Gravel Base	TON	546	$ 50.00	$ 27,300
Stormwater Sewer Chimney	LS	1	$ 5,800.00	$ 5,800
Manhole, 4 ft. Diameter	EA	6	$ 12,000.00	$ 72,000
Formwork	SF	3271	$ 3.50	$ 11,449
Miscellaneous Temporary Support of Excavation	AL	1	$ 5,000.00	$ 5,000
Concrete Footing	CY	415	$ 800.00	$ 332,000
Concrete Wall - Stormwater Tank	CY	55	$ 1,000.00	$ 55,000
Steel Reinforcing for Stormwater Tank	LB	41481	$ 2.50	$ 103,703
Stormwater Treatment Device	EA	1	$ 19,000.00	$ 19,000
Additional West Area Improvements (Phase 2A)				
Concrete Footing	CY	111	$ 1,100.00	$ 122,100
Concrete Wall Stem	CY	111	$ 1,300.00	$ 144,300
Manually Operated Gate (8 ft. Tall x 50 wide)	EA	1	$ 850,000.00	$ 850,000
Topsoil Depth on Grade	CY	445	$ 180.00	$ 80,100
Plant Trees	EA	30	$ 3,000.00	$ 90,000
Drip Irrigation	SF	3000	$ 1.60	$ 4,800
Miscellaneous Site Amenities	AL	1	$ 50,000.00	$ 50,000
Surface Improvements West Drainage Installation (Phase 2A)				
Excavaton Support	LF	2440	$ 250.00	$ 610,000
Excavation	CY	4889	$ 100.00	$ 488,900
Soil Disposal	TON	6600	$ 50.00	$ 330,000
Low Density Fill	CY	1344	$ 30.00	$ 40,320
Fill Material - Procure	CY	6722	$ 35.00	$ 235,270
Sidewalk Subbase	CY	278	$ 150.00	$ 41,700
Top Pavement Subbase	CY	93	$ 150.00	$ 13,950
Top Pavement - Pavers and Sealant	SF	5000	$ 11.00	$ 55,000
Roadway Subgrade (Aggregate Base Course), Compacted	CY	519	$ 70.00	$ 36,330
Concrete Footing (Slab-on-Grade), 8 Inches	CY	50	$ 900.00	$ 45,000
Steel Reinforcing for Slab-on-Grade	LB	4963	$ 2.50	$ 12,408
Slab On Grade Agg. Subbase, 1 ft	CY	74	$ 70.00	$ 5,180
Concrete Wall Stem	CY	17	$ 1,300.00	$ 22,100
Concrete Footing	CY	11	$ 1,100.00	$ 12,100
Steel Reinforcing for Concrete Walls	LB	6000	$ 2.50	$ 15,000
			TOTAL	**$ 5,023,177**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

EAST DRAINAGE SYSTEM (PHASE 2C)

Item	Unit	Quantity	Unit Price	Total
East Drainage System (Phase 2C)				
Water Main Installation, 12" Pipe	LF	738	$ 257.00	$ 189,666
Trench Box Installation	LF	738	$ 15.00	$ 11,070
Stormwater Outfall	EA	2	$ 7,000.00	$ 14,000
Rip Rap - 4.5 SF Depth	CY	100	$ 63.32	$ 6,332
Catch Basin	EA	6	$ 7,250.00	$ 43,500
Stormwater Pump	EA	1	$ 50,000.00	$ 50,000
Temporary Sheet Pile Installation	SF	19530	$ 40.00	$ 781,200
Foundation Gravel	TON	528	$ 50.00	$ 26,400
Gravel Base	TON	572	$ 50.00	$ 28,600
Stormwater Sewer Chimney	LS	1	$ 5,800.00	$ 5,800
Manhole, 4 ft. Diameter	EA	6	$ 12,000.00	$ 72,000
Formwork	SF	3971	$ 3.50	$ 13,899
Miscellaneous Temporary Support of Excavation	AL	1	$ 5,000.00	$ 5,000
Concrete Footing	CY	435	$ 800.00	$ 348,000
Concrete Wall - Stormwater Tank	CY	56	$ 1,000.00	$ 56,000
Steel Reinforcing for Stormwater Tank	LB	43342	$ 2.50	$ 108,355
Stormwater Treatment Device	EA	1	$ 19,000.00	$ 19,000
			TOTAL	**$ 1,778,822**

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING **9/1/2025**

2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - ACUPUNCTURE SCHEME - BASE CONSTRUCTION COSTS

UTILTIES (PHASE 3B)

Item	Unit	Quantity	Unit Price	Total
Site Utilities and Water Infrastructure (Phase 3B)				
Water Main (8")	LF	605	$ 400.00	$ 242,000
Sewer Line (12")	LF	605	$ 500.00	$ 302,500
Utility Main Line	LF	720	$ 290.00	$ 208,800
General Utility Installations (Transformer, Fire Water, etc.)	AL	1	$ 2,000,000.00	$ 2,000,000
Site Survey (Connection Survey)	AL	1	$ 100,000.00	$ 100,000
Trench Drain	LF	2200	$ 200.00	$ 440,000
			TOTAL	**$ 3,293,300**

2070 LONG-TERM ‘BIG SPLASH’ SCHEME

CONSTRUCTION COST ESTIMATE

LONG WHARF FLOOD RESILIENCE & FEASIBILITY PLANNING
2070 ORDER-OF-MAGNITUDE CONSTRUCTION COST ESTIMATE - BIG SPLASH SCHEME
SUMMARY

Phase	Sections	Construction Year	Base Cost (2025)	Escalation Factor (5%/ Year)	Escalated Costs
1A (Summer)	Demo Marina	1	$ 1,149,000	1.0000	1,149,000
1B (Winter)	D	1	$ 3,643,000	1.0000	3,643,000
1B (Winter)	E	1	$ 863,000	1.0000	863,000
1B (Winter)	F	1	$ 859,000	1.0000	859,000
1B (Winter)	G	1	$ 3,529,000	1.0000	3,529,000
2A (Summer)	W. Drainage	2	$ 6,128,000	1.0500	6,434,400
2B (Winter)	I & J	2	$ 7,113,000	1.0500	7,468,650
2B (Winter)	H (2B)	2	$ 5,879,000	1.0500	6,172,950
2C (Winter)	E. Drainage	2	$ 2,170,000	1.0500	2,278,500
3A (Summer)	New Ferry Docks	3	$ 8,406,000	1.1025	9,267,615
3B (Winter)	Utilities	3	$ 4,018,000	1.1025	4,429,845
4A (Winter)	N	4	$ 5,005,000	1.1576	5,793,788
4A (Winter)	M	4	$ 7,189,000	1.1576	8,321,986
4A (Winter)	Raise Chart House	4	$ 2,000,000	1.1576	2,315,200
5A (Summer)	A & B	5	$ 1,882,000	1.2155	2,287,571
5A (Summer)	C	5	$ 3,299,000	1.2155	4,009,935
5A (Winter)	L	5	$ 7,082,000	1.2155	8,608,171
5A (Winter)	K	5	$ 2,116,000	1.2155	2,571,998
5A (Winter)	H(5B)	5	$ 2,277,000	1.2155	2,767,694
		Subtotal	$ 74,607,000	**Subtotal**	$ 82,771,302
				Design Contingency (25%)	20,692,826
				Subtotal	$ 103,464,128
				Contractor Mark-Ups (20%)	$ 20,692,826
				TOTAL CONSTRUCTION COST (2025 $)	**$ 124,156,954**
				Project Soft Costs (30%)	$ 37,247,086
				BPD Internal Contingency (10%)	$ 12,415,695
				TOTAL PROJECT COST (2025 $)	**$ 173,819,735**
				SAY	**$ 173,820,000**

APPENDIX F - FUNDING OPPORTUNITIES

Coastal Storm Risk Management (U.S. Army Corps of Engineers)

LEAD AGENCY	*U.S. Army Corps of Engineers* *The U.S. Army Corps of Engineers (USACE) seeks to safeguard coastal communities from the harmful impacts of flooding and coastal storms by reducing vulnerabilities, enhancing resilience, and protecting lives, property, and natural resources through its coastal storm risk management (CSRM) work. USACE CSRM implementation activities – if approved and authorized funds by the federal Congress - involve building and maintaining structures like levees and sea walls, as well as implementing more natural and nature-based approaches.*
OPPORTUNITIES	*The objective of the City of Boston CSRM Feasibility Study is to manage risk associated with coastal storms and coastal hazards over a 50-year period for economic analysis, but adaptable over 100-years. The Corps is looking to out towards 2090 as its Long Term horizon, and also considering 38" or more of sea level change. Given both the coastal storm and sea level rise vulnerabilities at Long Wharf, the long-term strategy (beyond addressing short-term coastal flood pathways with any 2030-oriented scheme) align well with the Corps' study objectives.*
CONSIDERATIONS	• *Depending on the benefit: cost implications of any proposed actions at Long Wharf by the Corps, it is worth considering avenues available for other scope inclusions as part of a 'Locally Preferred Project' approach under CSRM.* • *For example, if USACE determines that a project that floodproofs to the end of the Marriott (and not the full perimeter of Long Wharf) is more cost-effective, and the City/stakeholders want a whole wharf solution, a 65-35 (federal: non-federal) cost share can still apply. However, the rest of the costs must come from the non-federal sponsor.* • *The USACE will be evaluating several categories of benefits, including socioeconomic and environmental benefits.* • *The National Environmental Policy Act (NEPA process) is required as part of the Feasibility Study analysis.*
APPLICABILITY	*The City of Boston CSRM Feasibility Study is already underway, and includes the Downtown/North End as one of five neighborhoods being assessed.*
RELEVANT DATES	*The USACE Headquarters formally approved an updated timeline due to the size and complex scope of the City of Boston CSRM Feasibility Study. The Study is scheduled for completion in 2028. Upon its completion, additional State and Agency reviews would take place of the final recommendation, prior to the Corps finalizing necessary NEPA documentation, and the USACE Chief of Engineers' recommendation submittal to Congress. Any Congressional authorization and appropriated funding would come after 2028.*
WEBSITE(S)	*https://www.usace.army.mil/Missions/Civil-Works/Infrastructure/Revolutionize/CWIFP/cwif_prog_eligibility/ https://www.nae.usace.army.mil/Missions/Projects-Topics/City-of-Boston-Coastal-Storm-Risk-Management-Project/*

DRAFT

Pre-Disaster Mitigation (PDM) Grant Program

LEAD AGENCY	*Federal Emergency Management Agency (FEMA)* *FEMA's PDM grant program provides federal funding to plan for and implement sustainable cost-effective measures that are "designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters."*
OPPORTUNITIES	*In 2024, this funding source was used for the City of Boston's Climate Resilience & Equity in Downtown Boston for a Resilient Christopher Columbus Park & Long Wharf project (award: $1,150,000).*

CONSIDERATIONS	• *PDM projects are essentially Congressionally Directed Spending (CDS) (i.e., federal "earmarks"), requiring coordination with federal congressmembers. The PDM program was originally intended to be phased out as the FEMA BRIC program was phased in, but it is still used for CDS projects.*
	• *The cost share for the PDM program is 75% federal and 25% non-federal.*
	• *Eligible projects include:*
	  • *Capability and Capacity-Building activities – activities that enhance the knowledge, skills, and expertise of the current workforce to expand or improve the administration of mitigation assistance. This includes activities in the following sub-categories: project scoping, hazard mitigation planning and planning-related activities, and other activities;*
	  • *Hazard Mitigation Projects – cost-effective projects designed to increase resilience and public safety; reduce injuries and loss of life; and reduce damage and destruction to property, critical services, facilities, and infrastructure (including natural systems) from a multitude of natural hazards, including drought, wildfire, earthquakes, extreme heat, and the effects of climate change;*
	  • *Management Costs – financial assistance to reimburse the recipient and subrecipient for eligible and reasonable indirect costs, direct administrative costs, and other administrative expenses associated with a specific mitigation measure or project.*

APPLICABILITY	*Given the new FY 2024 award through this program, any additional application would have to be for separate scope and management costs.*
RELEVANT DATES	*No future dates have been announced; The FT24 round opened in May 2024, and closed at the end of June 2024.*
WEBSITE(S)	*https://www.fema.gov/es/node/677444*

DRAFT

Promoting Resilient Operations for Transformative, Efficient, and Cost-saving Transportation (PROTECT) Program

LEAD AGENCY	*Federal Highway Administration (FHWA), US Department of Transportation* *The PROTECT program helps make surface transportation more resilient to natural hazards through support of planning activities, resilience improvements, community resilience and evacuation routes, and at-risk costal infrastructure. The program has two components: (1) formula-based funding issued to State DOTs, and (2) Discretionary Grants.* *For the PROTECT Formula program, FHWA apportions funding as a lump sum for each State who then divide that total among apportioned programs, whereas the PROTECT Discretionary Grant Program provides grants on a competitive basis (and is open to other transportation entities).* *ructures like levees and sea walls, as well as implementing more natural and nature-based approaches.*
OPPORTUNITIES	*Under the Competitive Grants component, PROTECT has four categories of project types (e.g., Planning, At-Risk Coastal Infrastructure, Resilience Improvement, Community Resilience and Evacuation Route Evacuation Route).*

CONSIDERATIONS	• *This program is highly competitive and has a fairly complex application process.*
	• *The four categories cover different activities.*
	  • *Resilience Improvement Grant and the At-Risk Coastal Infrastructure Grant, which fund development phase activities (e.g., feasibility analysis, preliminary engineering and design work, other preconstruction activities), construction phase, and other supporting activities (e.g., environmental mitigation, construction contingencies, acquisition of equipment, operational improvements). Both have minimum award $500,000 with no maximum amount.*
	  • *Planning Grants can only cover development phase activities.*
	• *Benefit-Cost Analysis (BCA) requirements vary by category, and – when applicable - must follow FHWA's requirements for BCA (as opposed to FEMA's):*
	  • *No BCA is required for Planning projects.*
	  • *At-Risk Coastal Infrastructure Grants do not need a formal, quantitative BCA, however projects must demonstrate how long-term infrastructure cost are reduced (i.e., avoided larger future maintenance or rebuilding costs).*
	  • *Resilience Improvement Grant projects require a BCA, unless the project is in an applicable Resilience Improvement Plan (RIP).*
	  • *All Community Resilience and Evacuation Route projects require a BCA.*
	  • *Atlantic Ave. is an OEM-designated Evacuation Route*
	• *Cost-Sharing Requirement incentives may apply for having a qualifying Resilience Improvement Plan (from a State agency or MPO);*

DRAFT

CONSIDERATIONS **CONT.**	• • *Funding obligation deadlines (FY2026 funds must be obligated by September 2029);* • *This is primarily a surface transportation-focused grant that may limited project scoping to elements that directly protect transportation infrastructure. Note: Boston's Planning Department is likely not most favorable lead department, and would benefit from coordinating with the Transportation Department.*
APPLICABILITY	*Future phases of Long Wharf implementation (or a district-scale 'Long Wharf Extended' Planning project) fit strongly with several categories. Most relevant are the Resilience Improvement Grant and the At-Risk Coastal Infrastructure Grant, which fund development phase activities (e.g., feasibility analysis, preliminary engineering and design work, other preconstruction activities), construction phase, and other supporting activities (e.g., environmental mitigation, construction contingencies, acquisition of equipment, operational improvements). Both have minimum award $500,000 with no maximum amount. Planning Grants can only cover development phase activities.* *Overall, the Long Wharf project aligns well with some other project awarded in the initial round, including a $1 million District of Columbia DOT project to conduct an engineering study and develop an implementation plan to improve flood resilience of a critical access route. Several other implementation projects by Florida DOT and City of Virginia Beach have similar objectives, raising infrastructure, upsizing drainage infrastructure and public rights-of-way as Resiliency Improvements. The largest single funding awards in the initial round (FY24) were $56M and $60M, respectively. However the majority of funded projects in the At Risk Coastal Infrastructure and Resilience Improvement categories were in the $14M to $17M range. In terms of awarded projects, the majority (62 of 80 total projects) were in the Resilience Improvement and Planning grant categories. Only 8 total awards were made in the At Risk Coastal Infrastructure category, with two projects going to New England states ($11M to City of Newport, RI – Newport Cliff Walk Restoration; $20M to New Hampshire DOT Route 1A Revetment Reconstruction Phase 1 in North Hampton and Rye).*
RELEVANT DATES	*FY 2024-2025 Opened October 25, 2024 with a due date of February 24, 2025. See update .* *Per original scheduling (prior to the current round being paused), the FY 2026 round of PROTECT is projected to open October 27, 2025 and close February 24, 2026*
WEBSITE(S)	*https://www.fhwa.dot.gov/environment/protect/discretionary/* *https://www.fhwa.dot.gov/infrastructure-investment-and-jobs-act/protect_fact_sheet.cfm*

DRAFT

Building Resilient Infrastructure and Communities (BRIC) Program

LEAD AGENCY	*Federal Emergency Management Agency (FEMA)* *The BRIC grant program makes federal funds available to states, U.S. territories, federally recognized Tribal nations, and local governments for hazard mitigation activities. Its guiding principles include supporting communities through capability and capacity building; encouraging and enabling innovation, including multi-hazard resilience or nature-based solutions including the use of native plants; promoting partnerships; enabling large, systems-based projects; maintaining flexibility; and providing consistency.* *There are multiple types of projects (Community Capacity Building (CCB) and Project Scoping, Implementation, Phased Projects)*
OPPORTUNITIES	*This funding source most closely aligns with future phases of Long Wharf. Especially for a district-scale approach that encompasses protections from India Row to Sargent's Wharf.* *Up to $50 million allowed per application. Nationally competitive program where local governments can apply directly to FEMA.* *Long Wharf projects align with BRIC priorities for public infrastructure projects, projects that mitigate risk to one or more lifelines, and projects that incorporate nature-based solutions.*
CONSIDERATIONS	• *Benefit-Cost Analysis Requirements* • *Federal cost share requirements: The percentage of federal and nonfederal share varies by project type (25% local match is typical). Allows cash and/or in-kind services to contribute toward non-federal cost share.* • *Complex and lengthy two-part application process that takes ~2 years (i.e., local applicant applies to MEMA and MEMA applies to FEMA).* • *Application process. Eligible states, territories and federally recognized Tribal Nations submit applications on behalf of sub-applicants for BRIC funding. Sub-applicants cannot submit directly to FEMA and instead must submit their sub-applications to their applicant for review and submission.* • *Specific and strict eligibility criteria (every year many sub-applicants' applications are deemed ineligible for "not satisfying HMA requirements")* • *Highly competitive (especially if targeting funding under the National Competition and not the state's Set-Aside)* • *Specific requirements and incentives tend to change year-to-year for this program.*

DRAFT

APPLICABILITY	*This program is a good overall fit for projects of this nature, however the independent effectiveness of flood mitigation measures is critical to the Benefit-Cost Analysis, and may prove challenging if measures at Long Wharf alone are to progress ahead of other coastal flood pathways that influence the Downtown area.* *A 'Phased Project' may be worth further discussion with MEMA/FEMA. I.e., A multi-phase project, starting with a Project Scoping project that extends the project area, alternatives analysis, and BCA to cover a larger district-scale area (i.e., the 'Long Wharf Extended' proposed project area) may be advantageous for a project with a known lengthy implementation timeline. However, one potential drawback is locking into a rigid timeline with FEMA, potentially limiting flexibility to act more nimbly (say if other funding sources arise in interim).* *Whether or not a 'Phased Project' approach makes sense, the Implementation phase (i.e., future construction) of Long Wharf coastal flood protections (i.e., the core flood protective elements of Acupuncture or Big Splash concepts) will likely align very well with this program in combination with select near-term measures in the North End and at India Row. However, applying for such a stand-alone project will require a very tight scope and BCA, showing independent effectiveness of proposed measures and itemizing non-flood protective elements (e.g., urban realm upgrades and other public amenities), showing that these are to be covered by other pay-for's.*
RELEVANT DATES	*The 2024-25 round of funding for BRIC opened January 2025, with a close date in April 2025. This round's start date was delayed a bit from prior rounds, for which the N.O.F.O. is typically released in the late months of the prior calendar year. See update .*
WEBSITE(S)	*https://www.fema.gov/grants/mitigation/learn/building-resilient-infrastructure-communities*

DRAFT

National Coastal Resilience Fund (NCRF)

LEAD AGENCY	*National Fish and Wildlife Foundation (NFWF) + National Oceanic and Atmospheric Administration (NOAA)* *The National Coastal Resilience Fund (NCRF) invests in nature-based solutions that protect coastal communities while enhancing habitats for fish and wildlife. The focus for these projects is on restoring, increasing, and strengthening natural infrastructure to protect communities while also enhancing habitats for fish and wildlife.* *NFWF makes investments to restore and strengthen natural systems so they can protect coastal communities from the impacts of storms, floods, and other natural hazards and enable them to recover more quickly, and enhance habitats for fish and wildlife. This funding program pre-dates the IIJA/ Bipartisan Infrastructure Law (BIL), but received significant funding boosts from this law ($93+ million in each of the 2022-2024 rounds), as well as $44+ million the Inflation Reduction Act (IRA) in 2023* *FEMA's PDM grant program provides federal funding to plan for and implement sustainable cost-effective measures that are "designed to reduce the risk to individuals and property from future natural hazards, while also reducing reliance on federal funding from future disasters."*
OPPORTUNITIES	*Tying Long Wharf supporting infrastructure to other efforts by National Parks Service, Stone Living Lab, and others related to Boston Harbor Islands' long-term natural infrastructure protection strategy (i.e., Long Wharf is critical as the 'gateway to BHI').*
CONSIDERATIONS	• *This program is strongly focused on natural infrastructure, habitat and ecosystem restoration, and nature-based approaches. Living seawall components or the "Sponge" concept on North side of wharf can be integrated into final design.*
APPLICABILITY	*This is not a highly promising funding opportunity for future, built infrastructure-heavy phases of the Long Wharf project. Most awards go to conservation organizations, non-profits, or coastal communities with less developed shorelines and projects with a significant natural infrastructure and focus on habitat co-benefits. Relatively few awards have gone to municipal entities, and fewer to large cities and urban harbor waterfronts.*
RELEVANT DATES	*The Notice for Funding Opportunity is typically posted in the spring (~March), with a limited pre-proposal due shortly thereafter (~April-May). After an initial review, invited applicants must submit a full proposal submissions in summer (~July).*
WEBSITE(S)	*https://www.nfwf.org/programs/national-coastal-resilience-fund* *https://coast.noaa.gov/funding/bil/ncrf/overview.html*

DRAFT

Transformational Habitat Restoration and Coastal Resilience Grants (NOAA)

LEAD AGENCY	*NOAA (Fisheries)* *Similar to the NFWF+NOAA National Coastal Resilience Fund, this program (established and funded via IIJA/BIL) provides investments focused on habitat-based resilience approaches that strengthen both ecosystem and community resilience.*
OPPORTUNITIES	*Tying Long Wharf supporting infrastructure to other efforts by National Parks Service, Stone Living Lab, and others related to Boston Harbor Islands' long-term natural infrastructure protection strategy (i.e., Long Wharf is critical as the 'gateway to BHI'). Projects can include measures supporting water industries, including tourism.*
CONSIDERATIONS	*Given this program is run by NOAA's Fisheries division, projects must be strongly focused on natural infrastructure, and habitat- and ecosystem restoration. Living seawall components or the "Sponge" concept on North side of wharf can be integrated into final design. The program accepts proposals between $750,000 and $10 million for the entire award, with typical funding anticipated to range from $4 million to $6 million.*
APPLICABILITY	*Based on prior awards made the initial two funding rounds under this program, this is not a highly promising funding opportunity for future, built infrastructure-heavy phases of the Long Wharf project. Relatively few awards have gone to municipal entities, and fewer to large cities and urban harbor waterfronts. The most similar project setting with an award was the South Baltimore Gateway Community Impact District Management ($1 million in first year; up to $4 million total over 3 years). That project is part of a larger community-led initiative to reconnect South Baltimore residents to the nearby river. The project aims to restore marsh habitat in an urban ecosystem in Baltimore City, increase public access to the river, and reduce erosion and flooding.*
RELEVANT DATES	*The Notice for Funding Opportunity is typically posted in December, with the deadline for proposal submissions in April.*
WEBSITE(S)	*https://www.fisheries.noaa.gov/grant/transformational-habitat-restoration-and-coastal-resilience-grants*

DRAFT

Corps Water Infrastructure Financing Program (U.S. Army Corps of Engineers)

LEAD AGENCY	*U.S. Army Corps of Engineers* *The Corps Water Infrastructure Financing Program (CWIFP) program is administered as low-cost loans that accelerate investment in non-federal levee (or dam safety) infrastructure projects focused on resilience, economic development, and improving environmental quality.*
OPPORTUNITIES	*CWIFP is a new federal financing program to provide low-cost, long-term, flexible loans for safety projects to maintain, upgrade, and repair non-federal dams or levees. A non-federal flood levee project that may otherwise classify as a 'Locally Preferred Project' via the City's Coastal Storm Risk Management (CSRM) program may be worthy of consideration for CWIFP.*

CONSIDERATIONS	• *It may be worth considering how this program can supplement (or otherwise been seen as duplicative with) the City of Boston CSRM study and project program. Depending on the potential timeline of any proposed/ recommended implementation action item(s) for the Long Wharf area following the end of the ongoing CSRM study (set to conclude in 2028), it may be worth understanding the federal: local (and/or federal: public-private partnership) cost share implications, as compared to advancing similar action(s) via the CSRM program as a 'Locally Preferred Project'.*
	• *To be eligible for CWIFP credit assistance, a prospective borrower must be either a Local, State or Tribal Government, a Private Corporation, or a State Revolving Fund Program. Additionally multiple entities may apply for a single project under a joint application. Projects must be publicly supported, if undertaken by a private entity.*
	• *Funds up to 49% of project costs for groups of projects over $20 million. However, the program requires identification of a dedicated source of repayment (taxes, user fees, etc.).*
	• *Eligible costs include costs associated with:*
	  • *Development-phase activities*
	  • *Construction, reconstruction, rehab, and replacement activities.*
	  • *Acquisition of property used to mitigate environmental impacts of eligible projects.*
	  • *Capitalized interest, reserve funds, issuance costs, and other project carrying costs during construction.*
	  • *"Development-phase" or related work completed prior to CWIFP application is eligible and can be included in the total project costs. CWIFP can provide credit assistance of up to 49% of the total project costs and up to 80% of project costs in some cases.*
	• *CWIFP focuses on projects that are not federally authorized. Non-federal projects that have received federal appropriations may be eligible under certain circumstances.*

DRAFT

CONSIDERATIONS CONT.	• *To qualify under 'Coastal or inland harbor navigation improvement, or inland and intracoastal waterways navigation improvement' category, the project must demonstrate improvements to navigation features connected or integral to a dam safety project. Navigation system includes channels, harbors, and waterways to provide safe, reliable, and efficient waterborne transportation systems.*
	  • *Example 'dam safety' projects that meet this eligibility include channel improvements related to the safe operation of a dam, dam surfaces for lock systems, and/or jetties or breakwaters that protect a dam.*
	  • *Dredge material disposal and sediment basins which support safe operations of a dam may also be eligible.*

APPLICABILITY	*Applicability of any project at Long Wharf may depends on the Corps' definition of qualifying 'levee' projects, as dam safety is the primary focus of the program.* *The CWIFP does have a focus on "dam safety" projects, such as those including channel improvements related to the safe operation of a dam, dam surfaces for lock systems, and/or jetties or breakwaters that protect a dam. For this reason, it may be a more applicable consideration for the area near the New Charles River Dam and adjacent areas at Paul Revere Park and Lovejoy Wharf.*
RELEVANT DATES	*The Office of the Assistant Secretary of the Army for Civil Works and the U.S. Army Corps of Engineers announced the first set of proposals being invited to apply for loans under the new Corps Water Infrastructure Financing Program (CWIFP) on September 9, 2024.*
WEBSITE(S)	*https://www.usace.army.mil/Missions/Civil-Works/Infrastructure/Revolutionize/CWIFP/cwif_prog_eligibility/*

DRAFT

Hazard Mitigation Grant Program (HMGP) --- post-disaster funds

LEAD AGENCY	*Federal Emergency Management Agency (FEMA)* *The HMGP provides funds to state, local, tribal and territorial governments, after a disaster, to reduce or eliminate future risk to lives and property from natural hazards. The intent for funding of hazard mitigation plans and projects is to reduce the need for the reliance on taxpayer-funded federal assistance for disaster recovery. This grant funding is available after a presidentially declared disaster.*
OPPORTUNITIES	*State and local governments, tribal organizations, and certain private non-profits may be eligible to apply for funding to cover projects including stormwater upgrades; drainage and culvert improvements; property acquisition; slope stabilization; infrastructure protection; seismic and wind retrofits, and structure elevations.*
CONSIDERATIONS	• *This is a post-disaster funding program; funding is only available after a major federal disaster declaration.* • *Application process. Eligible entities [Massachusetts Emergency Management Agency (MEMA)] submit funding applications on behalf of sub-applicants (i.e., State agencies, federally recognized Tribal organizations and local governments). Sub-applicants cannot submit directly to FEMA and instead must submit their sub-applications to their applicant (Massachusetts Emergency Management Agency (MEMA)) for review and submission.* • *FEMA's hazard mitigation grant programs are not intended to fund repair, replacement, or deferred maintenance activities.* • *Federal cost share requirements.* • *HMGP funds are available based on a percentage of the total Public Assistance and Individual Assistance programs.*
RELEVANT DATES	*Post-disaster funding rounds are not recurring; timing depends upon presidential disaster declaration(s).*
WEBSITE(S)	*https://www.mass.gov/info-details/hazard-mitigation-grant-program-hmgp*

DRAFT

DRAFT

Seaport Economic Council Grant Program

LEAD AGENCY	*Executive Office of Economic Development, Commonwealth of Massachusetts* *Seaport Economic Council grants help the economic growth of coastal communities, create jobs and build resilience to the impacts of climate change. The purpose of this state-funded program is to cultivate job and economic growth in the maritime sector. The program prioritizes use of best available science and information regarding potential threats to coastal communities from sea level rise and extreme weather events.*
OPPORTUNITIES	*This is a promising funding opportunity for future phases of the Long Wharf project. Grant funds are to be used for capital expenses. Preference will be given to those applications that demonstrate collaboration and joint applications are encouraged from entities with a proven track record in maritime sector strategy, maritime economic development, and the development of economically supportive and resilient coastal assets in a sustainable fashion.* *There are five types of grants, including Innovation, Local Maritime Economic Development Planning, Public Education Institutions, Supportive Coastal Infrastructure, and Dredging & Permitting.*
CONSIDERATIONS	• *Matching funds required (20% of the total project cost); maximum awards of about $1 million but most will be smaller.* • *Grant funds are to be used for capital expenses.* • *The purpose of this program is to cultivate job and economic growth in the maritime sector.. Preference will be given to those applications that demonstrate collaboration and joint applications are encouraged from entities with a proven track record in maritime sector strategy, maritime economic development, and the development of economically supportive and resilient coastal assets in a sustainable fashion.*
APPLICABILITY	*This funding opportunity aligns very well for Maritime Infrastructure and supporting water-dependent commercial uses (e.g., excursions) at Long Wharf, and may be a good opportunity for collaboration with water-dependent commercial entities, such as BHCC, Boston Harbor Now, NPS and other ferry and marina users.* *The Supportive Coastal Infrastructure grant type is particularly well-aligned, as it recognized that in order to fulfill the job or economic growth potential within a coastal community, investments may need to be made in coastal infrastructure to achieve these aims. If future design considerations incorporate any dredging (such as on the north side of the wharf) to accommodate docking or marina infrastructure, this program's Dredging & Permitting grants may also be of interest.*
APPLICABILITY	*It is likely this program will see increased allocations as a result of the MA Economic Development Bill, which funded this program at $100 million until 2029. Given the sizable amount of funding for this program over the next 4 years, it may make sense to prioritize this program for near-term upgrades that can interface with near-term (2030) flood protections without significant later disruption considering long-term construction phasing.*
RELEVANT DATES	*FY26 opens on June 1, 2025, with applications due June 30, 2025.*
WEBSITE(S)	*https://www.mass.gov/info-details/learn-more-about-the-seaport-economic-council-grant-program*

DRAFT

DRAFT

CZM Coastal Resilience Grants

LEAD AGENCY	*Office of Coastal Zone Management, Massachusetts Executive Office of Energy and Environmental Affairs (EEA)* *Coastal Zone Management (CZM) provides financial and technical support for local efforts to increase awareness and understanding of climate impacts, identify and map vulnerabilities, conduct adaptation planning, redesign vulnerable public facilities and infrastructure, and implement non-structural (or green infrastructure) approaches that enhance natural resources and provide storm damage protection.*
CONSIDERATIONS	• *Eligible projects must fall under one (or more) of the following five categories: detailed vulnerability and risk assessment; public education and communication; local bylaws, adaptation plans, and other management measures; redesigns and retrofits; nature-based storm-damage protection techniques.* • *Unlike EEA's Municipal Vulnerability Preparedness program, this program is only open to coastal communities in Massachusetts.* • *Individual grant awards are not (on average) very large, and mostly support design and permitting stage projects. Awarded projects are mostly under $350,000. The largest grant award in FY25 was just under $2 million, which is the maximum award.* • *While funding and awards are managed by the state, funding for MA CZM's programs comes through federal sources via NOAA (Department of Commerce).*
APPLICABILITY	*The CZM Coastal Resiliency grant program is a very popular state program. In FY25, the program was oversubscribed , with 40 total applications requesting a total of $24M and ~20% of the applications were awarded funding.* *Boston has been successful in recent years with some coastal resiliency projects, including Technical Analysis and Resilient Schematic Design Options for Dorchester's Waterfront at Tenean Beach and Conley Street (FY23; $300,000 award), Technical Analysis and Resilient Design Development Options for East Boston's Waterfront from Carlton Wharf to Lewis Mall (FY2`; $300,000 award), Priority Flood Mitigation in East Boston and Charlestown (FY17; $227,000 award), and the Boston Climate Preparedness Planning Initiative (FY16; $350,000 award).*
RELEVANT DATES	*The FY26 round will open in late spring 2025, with optional Expression of Interest forms accepted by March 14.*
WEBSITE(S)	*https://www.mass.gov/service-details/coastal-resilience-grant-program*

DRAFT

Municipal Vulnerability Preparedness (MVP) Program, Action Grant

LEAD AGENCY	*Massachusetts Executive Office of Energy and Environmental Affairs (EEA)* *The MVP Action Grant offers financial resources to communities that are seeking to advance priority climate adaptation actions to address climate change impacts resulting from extreme weather, sea level rise, inland and coastal flooding, severe heat, and other climate impacts. All projects must incorporate future climate change projections.*
CONSIDERATIONS	• *This program does fund project at Design and Permitting stage, or Construction and On-the-Ground Implementation stage (once necessary permits & permissions have been secured).* • *To maintain eligibility for Action grant awards, municipalities must have completed – or applied for – a MVP2.0 planning project. [The City of Boston has been awarded funding for FY26 and is progressing its project between 2025-2027.]* • *A 10% match (via financial or on-kind contribution) is required of all applicants (with some exceptions for Rural and Small Towns, or other communities prioritized in a given funding round).* • *This is a reimbursement-based program, based on task-specific milestones.* • *Projects can be 1- or 2-year projects (aligned with state fiscal year ending in June each year), with a maximum grant award of $3 million for projects submitted by a single municipality.* • *The application process is moderately complex, but does take time – often several weeks to compile.* • *There is a strong emphasis on meaningful community involvement and engagement, with scoring criteria specifically weighted toward more robust "Community Engagement and Capacity Building" approaches.* • *Scoring also prioritizes projects with Nature-Based Solutions, as well as those benefitting Environmental Justice & Priority Populations.*
APPLICABILITY	*The MVP program is a very popular state program, and demand for funding far outpaces funding awarded each year. In FY25, the program was oversubscribed >2:1 ($108 million was requested; $52.3 million awarded), and the average grant size was ~$738,000.* *Boston has been successful in recent years with some coastal resiliency projects, including Resilient Bennington Street & Fredericks Park – Phase II (FY25; $456,500 award), Regional Climate Resilience and Recreation in Boston, Revere, and Belle Isle Marsh (FY24; $330,500 award), and Moakley Park - Resilience Preliminary Design, Technical Analysis, and Pre-Permitting (FY19; $1, 500,000 award).*
RELEVANT DATES	*The FY26 round for MVP Action Grants opened February 24th, 2024 and closed April 4th, 2025.*
WEBSITE(S)	*https://www.mass.gov/info-details/mvp-action-grant*

DRAFT

Dam and Seawall Repair or Removal Program

LEAD AGENCY	*Massachusetts Executive Office of Energy and Environmental Affairs (EEA)* *The Dam and Seawall Repair or Removal Program offers financial resources to qualified applicants for projects that share our mission to enhance, preserve, and protect the natural resources and the scenic, historic and aesthetic qualities of the Commonwealth of Massachusetts.* *The program has three different parts; The first is a grant program to support the completion of designs and permit applications to repair or remove dams, seawalls and other coastal infrastructure, and levees. Municipalities and nonprofit organizations are eligible to apply. The second is a grant program to support the construction phase of repair or removal of dams, seawalls and other coastal infrastructure, and levees. Municipalities and nonprofit organizations are eligible to apply. The third is a loan program to support the construction phase of repair or removal of dams, seawalls and other coastal infrastructure, and levees.*

CONSIDERATIONS	• *This program consists of two sub-programs, based on project stage:*
	  • *"Design and Permit" projects to repair or remove dams, seawalls and other coastal infrastructure, and levees.*
	  • *"Construction" projects to repair or remove dams, seawalls and other coastal infrastructure, and levees.*
	• *Per the enabling legislation, at least 50% of funds must go to dam projects, and in practice an even larger percentage of past funding within this program has gone to dam-related projects.*
	• *Across all categories, the program gives preference to projects owned by cities, towns, and tax-exempt charitable organizations, as well as projects that USACE has identified in writing as requiring imminent infrastructure improvement.*
	• *Further, all coastal project applications fall within the category of "Seawalls, coastal flood and/or foreshore protection" (Category 2) with a maximum funding amount of $3,000,000. Under Category 2:*
	  • *Structures owned by state agencies or private owners are not eligible.*
	  • *Preference given to projects that also improve natural resources, remove unneeded infrastructure implement nature-based solutions to increase flood resilience.*
	• *A minimum match of 25%, cash or in-kind time, was also required in prior funding rounds.*

DRAFT

APPLICABILITY	*This program would be a good potential consideration for repairs and seawall upgrades (i.e., raised elevation and Harborwalk) along waterfront edges as part of long-term adaptation of the Wharf.* *Over the past several funding rounds, there have been five awards for coastal shoreline projects (two for design, three for construction), and phased projects (i.e., splitting design and construction phases across multiple funding rounds) are popular.* *Living Seawall components, the Blue-Green wharf edge, or other nature-based approaches may be more competitive, particularly if part of a leveraged funding strategy that layers other grants and financing.*
RELEVANT DATES	*The Request for Proposals for this program typically opens in February or March, wit proposals to be submitted by early to late April. Award announcements are typically in early June.*
WEBSITE(S)	*https://www.mass.gov/info-details/dam-and-seawall-repair-or-removal-program-grants-and-funds*

DRAFT

Passenger Ferry Grant Program

LEAD AGENCY	*Federal Transit Administration (FTA)*
OPPORTUNITIES	*Consider this funding opportunity for Maritime Infrastructure at Long Wharf. Funds can be used to repair and modernize ferry terminals, and related facilities and equipment.*
WEBSITE(S)	*https://www.transportation.gov/rural/grant-toolkit/passenger-ferry-grant-program* *https://www.transit.dot.gov/grants/fta-ferry-programs*

Historical/Preservation Funding Sources

LEAD AGENCY	*Commonwealth of Massachusetts, City of Boston*
OPPORTUNITIES	• *Consider these funding opportunities for the Chart House and Wharf itself (particularly new open space park use), as both are as National Historic Landmarks.* • *Examples of relevant funding programs include* • *Massachusetts Historical Commission's (MHC) Massachusetts Preservation Projects Fund (MPPF) - a state-funded, 50% reimbursable matching grant program supporting preservation of properties, landscapes, and sites (cultural resources) listed in the State Register of Historic Places. Applicants must be a municipality or nonprofit organization. Eligible project types range from feasibility studies to development (specific allowable costs), and acquisition of threatened properties.* • *Community Preservation Act (CPA) funds that have four allowable uses, including Historic Preservation and Open Space. The City of Boston has funded over 150 projects (cumulatively over $45 million) under the 'Historic' use category and over 25 projects (cumulatively over $8.5 million) under the Open Space category.* • *Federal Cultural Resources Grants - a variety of grants at the federal level to support planning, development, documentation, repair, and research at historic sites, including State Historic Preservation Office (SHPO) formula-funded grants, the Maritime Heritage Program (NPS/DOT), Save America's Treasures Grants (NPS) preservation projects category (for properties as a National Historic Landmark), and post-Disaster Recovery Grants (via Historic Preservation Fund).*
WEBSITE(S)	*https://www.sec.state.ma.us/divisions/mhc/grants/grants-overview.htm* *https://www.nps.gov/history/offices-and-programs.htm*

DRAFT

Boating Infrastructure Grant (BIG) Awards -- Tier 2 Competitive Program awards

LEAD AGENCY	*U.S. Fish & Wildlife Service*
OPPORTUNITIES	*Tier II funding is for larger projects that create new boater facilities or grow existing facilities. The maximum award size in the FY25 round of funding was $1,500,000, with a recommended local match of 25 percent. Funded projects under the Tier 2 category were mostly marina and dockage infrastructure projects, including a large-scale project at Fisherman's Wharf Marina in Virginia Beach, Virginia. This program has a focus on tie-up facilities and support facilities for transient vessels greater than 26 feet in length for stays of up to 15 days, which may make it a good fit for relocation and/or replacement of marina assets on the north side of Long Wharf.*
WEBSITE(S)	*https://www.fws.gov/media/fy-2024-big-tier-2-funded-application-summaries* *https://www.fws.gov/program/boating-infrastructure*

Federal Land & Water Conservation Fund (LWCF)

LEAD AGENCY	*Department of Interior (D.O.I.) / National Parks Service (NPS)*
OPPORTUNITIES	*This funding opportunity, administered at the state level by the Massachusetts Executive Office of Energy and Environmental Affairs' (EEA) Division of Conservation Services, helps fund the acquisition of parkland and creation of new parks. Eligible applicants include municipalities that have an up-to-date Open Space and Recreation Plan.* *Consider this funding opportunity – in tandem with EEA's PARC Program (Parkland Acquisitions and Renovations for Communities) - for the conversion of the Chart House parking lot to an accessible open space with public realm amenities and landscape and/or flood berm.*
WEBSITE(S)	*https://www.mass.gov/info-details/massachusetts-land-and-water-conservation-fund-grant-program*

DRAFT

DOT - RAISE - Rebuilding American Infrastructure with Sustainability and Equity

LEAD AGENCY	*US Department of Transportation*
OPPORTUNITIES	*Under the Bipartisan Infrastructure Law (BIL), the Rebuilding American Infrastructure with Sustainability and Equity (or RAISE) program provides funding for capital investments in surface transportation that will have a significant local or regional impact. The RAISE program, formerly known as the Better Utilizing Investments to Leverage Development (BUILD) and Transportation Investment Generating Economic Recovery (TIGER) discretionary grants, was created under the American Recovery and Reinvestment Act of 2009 and continued through annual appropriations until it was officially authorized by the Bipartisan Infrastructure Law (BIL) in November 2021.* *There are some similarities with this program and the USDOT/FHWA PROTECT Discretionary Grants Program. However, the PROTECT program is more explicitly linked to coastal resiliency and at-risk coastal infrastructure. A RAISE grant may be more appropriate for elevating key surface transportation infrastructure, such as raised bike lanes or public rights-of-way at Commercial/Atlantic Ave. and/or India Row that can have multi-modal tie-ins to Long Wharf water transit infrastructure. (Note: The 2013 "North End Cycle Track/Connect Historic Boston" bike lane project at Commercial Ave./Atlantic Ave. in the North End was funded via the predecessor BUILD grant program).* *Note: A FWHA-compliant benefit-cost analysis (BCA) is required for projects applying to this grant program.*
WEBSITE(S)	*https://www.transportation.gov/rural/grant-toolkit/better-utilizing-investments-leverage-development-build-grants*

DRAFT

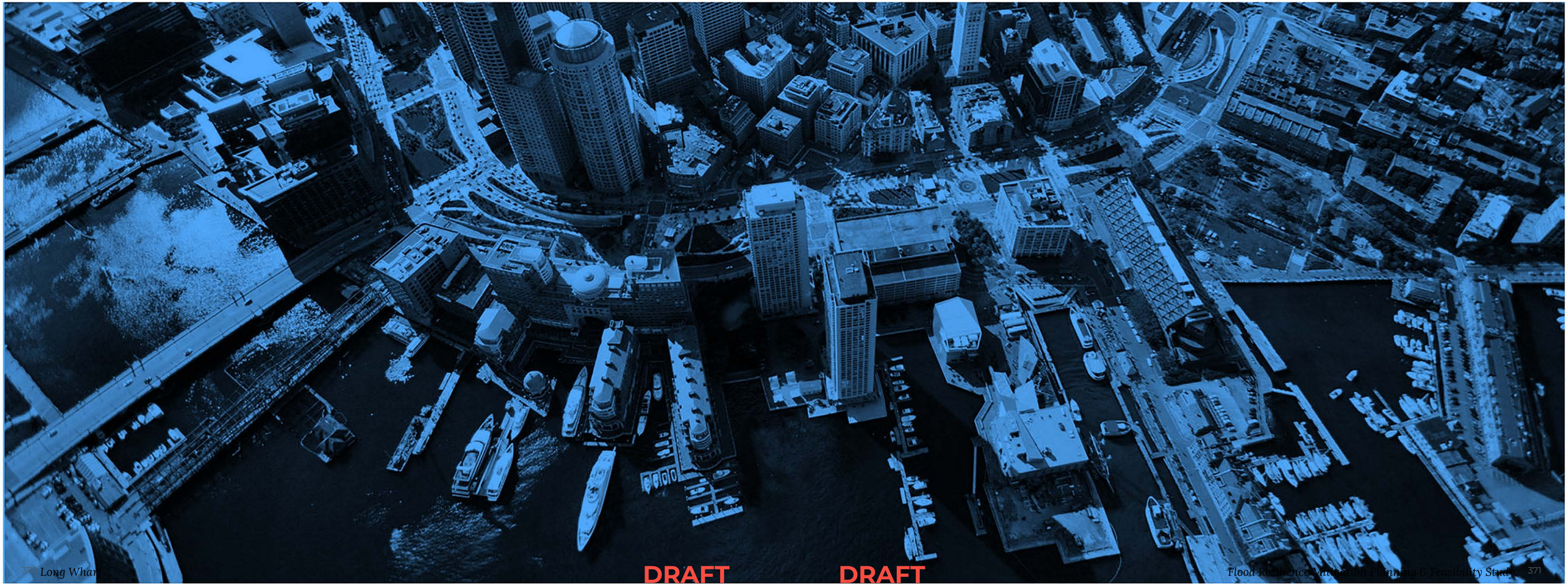
Transportation Improvement Program (TIP)

LEAD AGENCY	*Boston Metropolitan Planning Organization (MPO)*
OPPORTUNITIES	*The Transportation Improvement Program (TIP) is the five-year rolling capital plan for the 97 cities and towns in the Boston Region MPO's planning area. The TIP documents all transportation projects (all modes) that will receive federal funding in the region over the next five years. The TIP prioritizes investments that preserve the current transportation system in a state of good repair, provide safe transportation for all modes, enhance livability, promote equity and sustainability, and improve mobility throughout the region.* *Consider this funding opportunity for maritime transit infrastructure at Long Wharf, or raised bike lane/pedestrian connectors or other multimodal transportation infrastructure as part of district-scale protections.*
WEBSITE(S)	*https://www.bostonmpo.org/tip*

Other USDOT or Federal Transit Administration (FTA) Grants

LEAD AGENCY	*USDOT, FTA*
OPPORTUNITIES	*Consider additional funding opportunities via USDOT, including the Public Transportation Emergency Relief Program – 5324 (post-disaster) or Transit Infrastructure Grants for Community Project Funding (CPF; also referred to as Congressionally Directed Spending, CDS).* *Consider this funding opportunity for Maritime Infrastructure at Long Wharf. Funds can be used to repair and modernize ferry terminals, and related facilities and equipment.*
WEBSITE(S)	*https://www.transit.dot.gov/grants*

DRAFT



DRAFT DRAFT