FiDi and Seaport Climate Resilience Plan

Battery Maritime Building Flood Protection Alignments Memo

Financial District and Seaport Climate Resilience Plan

November 2024

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NYC EDC

NYC Mayor's Office of Climate & Environmental Justice

ARCADIS

Executive Summary

This memo provides an overview of the technical and existing conditions studies conducted to understand viable options to, as part of the broader Financial District and Seaport Climate Resilience Plan (FiDi-Seaport Plan), protect the Battery Maritime Building (BMB) from future sea level rise and coastal storms. The preferred alternative, a floodwall located outboard of the BMB, is also described.

The FiDi-Seaport Plan is a comprehensive resilience strategy that is proposing a new multi-level waterfront between the Brooklyn Bridge and the Battery to protect Lower Manhattan from future coastal storms and sea level rise. In addition to the creation of new access pathways and the addition of approximately 8 acres of open space, the Plan also includes drainage infrastructure to manage stormwater behind the flood defense system, ferry terminals and maritime facilities reconstructed to be resilient into the future, and improved multi-modal transportation opportunities that connect the waterfront to the city fabric.

This memo speaks directly to the BMB asset, located in the southern part of the project that is referred to as the Ferry Hub. This area is currently home to the existing Whitehall Ferry Terminal, BMB, and the US Coast Guard site. As of the latest schematic design (fall 2024), the proposal for this area is a combined 6-slip ferry terminal (with integrated flood defense) serving the Staten Island Ferry (SIF), Governors Island Ferry (GIF), and the United States Coast Guard (USCG), an extension of the Battery Park Underpass (BPU) cap, and outboard flood defense to protect the historic BMB.

Introduction

The Financial District and Seaport neighborhoods are a major hub of maritime activity, including ferries, historic ships, sightseeing excursion vessels, recreational services, and other forms of waterborne transportation. Lower Manhattan is at risk of the impacts from climate change-induced sea level rise as well as more frequent, intense storm events and storm surges. In anticipation of the need for coastal protection, the FiDi-Seaport Plan was proposed by New York City Economic Development Corporation (NYCEDC) and the Mayor's Office of Climate & Environmental Justice (MOCEJ) to be designed as part of the overall Lower Manhattan Coastal Resiliency Strategy in coordination with several separate and distinct projects.

The FiDi-Seaport Project aims to provide comprehensive flood defense for the neighborhood and for the assets along the waterfront. While siting flood defense infrastructure, it will also realize opportunities to support emergency evacuations and maintain critical regional transportation connections. The project team studied transportation and maritime infrastructure (TMI), including the vulnerability of TMI assets to future flooding, the criticality of the functions and assets within the study area, and how to adapt TMI assets to withstand future tidal flooding and coastal storms.

TMI was one of many considerations while evaluating design alternatives for flood defense protection.

The BMB is a fundamental asset in the consideration of the flood defense alignment. The BMB is a NYC historic landmark and listed on the National Register of Historic Places and is home to passenger and freight ferry service to Governors Island, which is operated by the Trust for Governors Island. One of the slips is also operated by NYC Department of Transportation (DOT) and provides regional commuter ferry service. The BMB is highly vulnerable to coastal flooding as it is one of the lowest-lying assets in the area, with the lowest level floor elevation that ranges from approximately +5 to +7 feet NAVD88. If no action is taken, the boarding area of the BMB will experience monthly tidal flooding by the 2050s, leading to significant impacts and frequent service closures. Further detail is provided below.

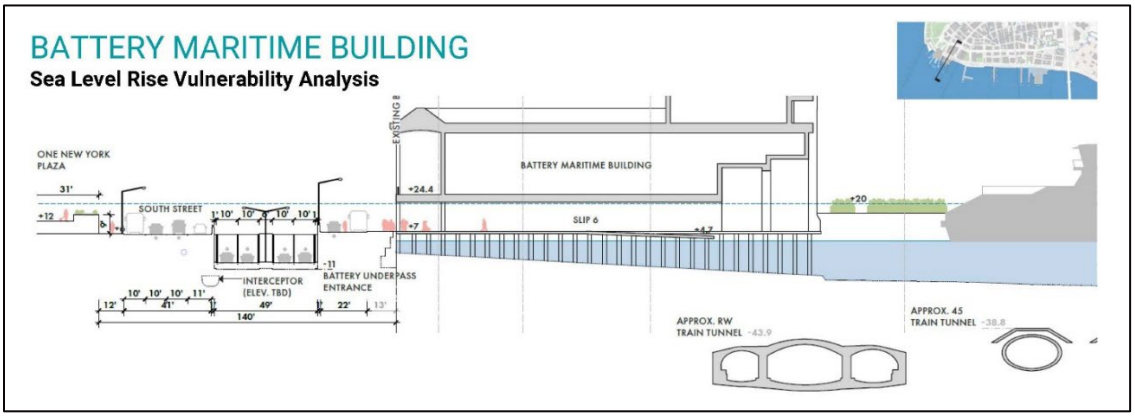

Figure 1. BMB Sea Level Rise Analysis (Elevations in Feet NAVD88)

Anticipated Impacts of Climate Change on the BMB*

**Data from the 2019 New York City Panel on Climate Change (NPCC) high estimate (90th percentile) sea level rise projections for the 2020s through to 2100.*

Anticipated Impacts by the 2050s (+30 inches sea level rise):

- Freeboard of lower-level loading floor reduced to ~2 feet at MHHW.
- Impact of wave action upon seaward-facing structural walls
- Increased vulnerability of Plaza and Terminal Building to high frequency storm surge flooding due to more frequent overtopping of adjoining bulkhead and associated nuisance spray/flooding along promenade and sidewalk.
- Reduced clearance between upper ferry deck and slip roof.
- Non-elevated utilities are affected.
- Lower-level boarding logistics affected—bridge submerged frequently.
    - Possible ADA non-compliance, existing accessibility issues at Slips 5 and 6 worsen.
    - Lower-level exposed to wave action

- More frequent overtopping of adjoining bulkhead and associated nuisance spray/flooding along promenade and sidewalk.

Anticipated Impacts by the 2080s (+58 inches sea level rise):

- No freeboard for lower-level loading level at Mean High High Water (MHHW) (floor is inundated daily at highest tide stage).
- Daily overtopping of adjoining bulkhead and associated Plaza flooding.
- Frequent flooding of the Terminal's lower-level interior spaces.
- Substantial wave forces regularly impact seaward-facing walls of enclosed spaces.
- Non-elevated utilities are infeasible.
- ADA accessibility infeasible at Slips 5 and 6 without modifications. Slip 7 periodically ADA inaccessible.
- Access to second floor affected.
- Regular ferry service becomes infeasible.

Anticipated Impacts by the 2100 (+75 inches sea level rise):

- Lower-level loading floor inundated through approximately 1/3 of every day.
- Terminal is entirely non-functional.

Goals of Study

For the FiDi-Seaport Plan, the team is examining where to site coastal protection infrastructure system from the Battery to the Brooklyn Bridge that provides flood protection to the neighborhood to the future 1-percent annual chance flood event. This will require a floodwall to approximately +23 feet NAVD88. The BMBis a key driver in determining where to construct the flood defense alignment. The project team studied five options for long-term approaches, which are further expanded herein and summarized in Figure 2.

1. **Upland:** Siting the flood protection infrastructure upland of the BMB, with the BMB outboard of the flood protection system
    - Inland of the BPU
    - Along the BPU
2. **Integrated:** Integrating the flood protection into the building
3. **Relocated:** Relocating the building
4. **Elevated:** Elevating the building in place & integrating the flood protection infrastructure into the building
5. **Outboard:** Siting the flood protection infrastructure outboard of the BMB, protecting the facility and relocating ferry services to the newly constructed GIF Terminal within the combined ferry terminal building.

Alternative	Summary	Implications	Maritime Services	Impact to Building	Decision
Inland	Build an independent flood defense structure over the BPU that leaves BMB on the wet side of the alignment	• **Removes 1 lane of traffic** • Complicates emergency access • BMB remains exposed to flooding • BMB would need to be storm-hardened	• Could be maintained at BMB but will not be resilient to storms or future tides • GIF capacity not expanded	Access issues during construction and new traffic flow afterwards	**Removed from further study**
Integrated	Placing flood protection alignment through the BMB, preserving both the cityside and waterside facades.	• Portion of BMB remains exposed to flooding • **Partial building reconstruction required** • Floodwall spans to second floor • Internal gates required • Significant construction logistics	• Could be maintained at BMB but will not be resilient to storms or future tides • Governors Island capacity not expanded	Building likely closed for 1+ years and new internal traffic flow afterwards	**Removed from further study**
Move	Moving the BMB to a new location on the shoreline extension.	• Significant challenges moving old building this size (**feasibility issues**) • Where would it go? • Significant construction logistics	• Could be maintained if the building was moved to a suitable location • GIF service relocated with building • GIF capacity not expanded	**Building closed for 2+ years and internal repairs likely**	**Removed from further study**
Elevate & Integrate	Raise the BMB so first floor is +11' passive elevation and put alignment under and through building	• Significant challenges related to elevating a historic building over water (**feasibility issues**) • Internal gates required	• Could be maintained at BMB • Would require many more actively deployed gates	**Building closed for 2+ years and internal repairs likely**	**Removed from further study**

Alternative	Summary	Implications	Maritime Services	Impact to Building	Decision
		• Significant construction logistics	• Governors Island capacity not expanded		
Outboard - Passive	Alignment on the waterside, fill or sluice gates, and new ferry terminal building	• Fully passive • **Maritime services would require relocation**	• Not maintained at BMB – requires new ferry terminal for GIF • Fully passive measure • Opportunity for GIF capacity expansion at newly constructed combined ferry terminal	Visual and noise impacts during construction, more 1st floor space afterwards	**Preferred alternative in FiDi-Seaport Plan**

Figure 2. Summary of Options Evaluated

Additional near-term approaches were also studied early in the design process but were not further pursued as they do not provide long-term, resilient flood protection.

Short-term approaches studied, but not further pursued, included:

- **Raise the slip deck and limit traffic to pedestrian only; re-route truck traffic elsewhere**. This option leaves the structure vulnerable to storm surge events and creates concern for potential wave uplift on the deck during storm conditions. Wave impacts could also potentially impact the structural integrity of the outer walls.
- **Reconfigure the building so that the second floor can be used for loading and unloading, and wet floodproof the first floor.** Like the previous option, this option leaves the structure vulnerable to storm surge events and creates concern for potential wave uplift on the deck during storm conditions. Wave impacts could also potentially impact the structural integrity of the outer walls. Regular tidal flooding would also significantly impact the first floor due to its increased frequency, even if significant damages were avoided through the wet floodproofing effort.
- **Complete a level of floodproofing around the perimeter of the building and connect it to an internal, independent, deployable structure where the line of protection crosses the slips.** Regular tidal flooding would still significantly impact the first floor due to its

increased frequency. The frequency at which the deployable structures would need to be used would also become unsustainable as sea levels rise.

1. Inland Alignments

1.1 Inland of the BPU

Figure 3: On-land alignment options between the southern tie-in and the BMB

(Background source: Google Earth)

An option inland of the BPU would aim to avoid direct impacts to both the Whitehall Ferry Terminal and the BMB. To achieve this, the coastal defense system would have to be integrated with adjacent building podiums north of South Street and across through Peter Minuit Plaza. With several subway tunnels (4/5 train, R/W train), the South Ferry Loop, and subway station (Whitehall Station) underneath the plaza, this option would encounter significant technical obstacles underground. An overview of the subsurface infrastructure in this area is shown in Figure 4.

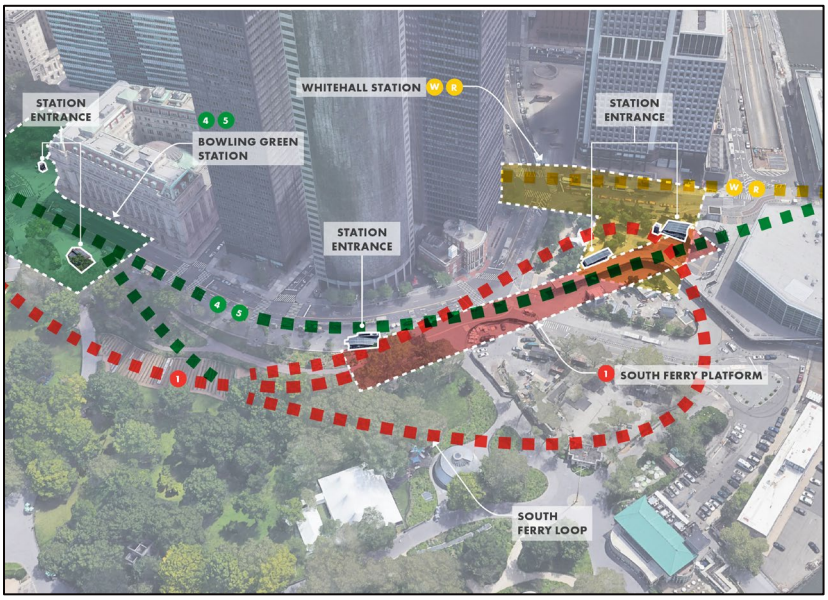

Figure 4: Overview of key subsurface infrastructure in the southern portion of the study area

This alignment option also precludes achieving the target design flood elevation for regular tidal flooding. The BPU, subway stations, and critical maritime infrastructure would remain vulnerable under this approach. Tidal flooding will also create issues with high deployment frequency of gates or other deployable measures. Every deployable system requires resources to plan and execute each deployment, rendering frequent deployment challenging.

Additional technical challenges that preclude this alignment are described in further detail below:

South Ferry Loop: Per discussions with MTA, the South Ferry Loop is used regularly and cannot be decommissioned or moved. The South Ferry Loop presents several challenges. First, it is preferable from a structural standpoint to cross the tunnel at 90-degree angle, which given the South Ferry configuration would require multiple crossings or long spans of bridging structure. Moreover, the South Ferry Loop is less than 5 feet from the surface in some locations, presumably above the groundwater table. If any portion of the tunnel is located on the water side (floodable side) of the coastal defense system, it would require extensive floodproofing, structural retrofitting, or reconstruction to meet performance standards and to prevent it from becoming a flood pathway into the protected area by other means. These modifications would likely require taking the tunnel out of service for an extended period. Overall, any alignment that impacts the South Ferry Loop would impact MTA operations, have significant feasibility concerns, and add significant costs to the project beyond the core resilience work. For these reasons, it would be highly preferable to site the line of defense seaward of the tunnel.

Whitehall and South Ferry Subway Stations: The Whitehall and South Ferry subway stations cannot be moved without significant costs and operational impacts. Like the South Ferry Loop, the Whitehall and South Ferry subway stations present several challenges. They are located very close

to the surface and their sizes and configurations would require long, expensive spans of bridging structures. While the stations have previously undergone floodproofing, they were not designed to resist forces associated with being an integral component of an areawide flood defense system. For these reasons, as well as to maintain access, the project aims to protect the subway stations. If any portion of the stations were to be located on the water side of the coastal defense system, it would require extensive structural retrofitting or reconstruction to meet performance standards and to prevent it from becoming a flood pathway into the protected area by other means. These modifications would require taking the stations out of service for an extended period or otherwise disrupt normal operations.

Crossing the BPU: Placing a flood alignment inland of the BPU also requires crossing the BPU in this location. While crossing the BPU is technically feasible and likely necessary to complete a tie-in to higher ground at the southern end of the alignment, it remains challenging. Shallow depth of the tunnel and any crossing angle that is not perpendicular adds complexity to this crossing. Crossing the underpass at 90 degrees is most preferred and most feasible. This crossing is recommended to occur at another location closer to The Battery, rather than near the BMB.

Location of the BPU with relation to the line of defense: If the tunnel is on the flood side of the line of defense, the flood pathway through the tunnel *to* the West side would still need to be addressed. With the BPU on the dry side of the alignment, the flood pathway through the tunnel *from* the West side still needs to be addressed; the timing of this mitigation will depend on BPCA resiliency projects and could prove a challenge to the independent utility of the alignment. Additional coordination will also be needed with NYC Department of Transportation flood protection plans to ensure that the underpass does not serve as a flood pathway in either direction.

Building Level Adaptation and Deployable Measures: This option would also rely heavily on use of deployable gates as well as selective building-level flood protection measures to maintain access to streets and buildings. Building-level measures in this area are constrained by the sheer height of the target design flood elevation and the lack of necessary foundation space due to the dense urban fabric of the area. Key considerations of building level adaptation and deployable measures are further described in the Challenges to Constructing an On-Land Alignment document.

1.2 Along the BPU

As mentioned above, the project team evaluated whether the flood defense system could be sited on-land, upland of the BMB, and run along the BPU. While this option minimizes fill in the East River and minimizes interference with multiple utilities, it would remove one lane of traffic from the BPU. It also complicates and potentially reduces the ability for emergency and other services to access the first floor of the building, requiring modifications for elevated street access to the second floor

of the building. Further, the BMB would remain exposed to flooding and would require building-level flood defense including structural reinforcement for future storm wave impacts. Given the BMB is a landmarked building, adapting the structure for future coastal storms and sea level rise would be challenging. Ultimately, this option was not recommended as part of the FiDi-Seaport Plan because of the expected impacts to the BPU, such as losing a lane of traffic, impacts to building access, and the additional necessary independent hardening of the BMB.

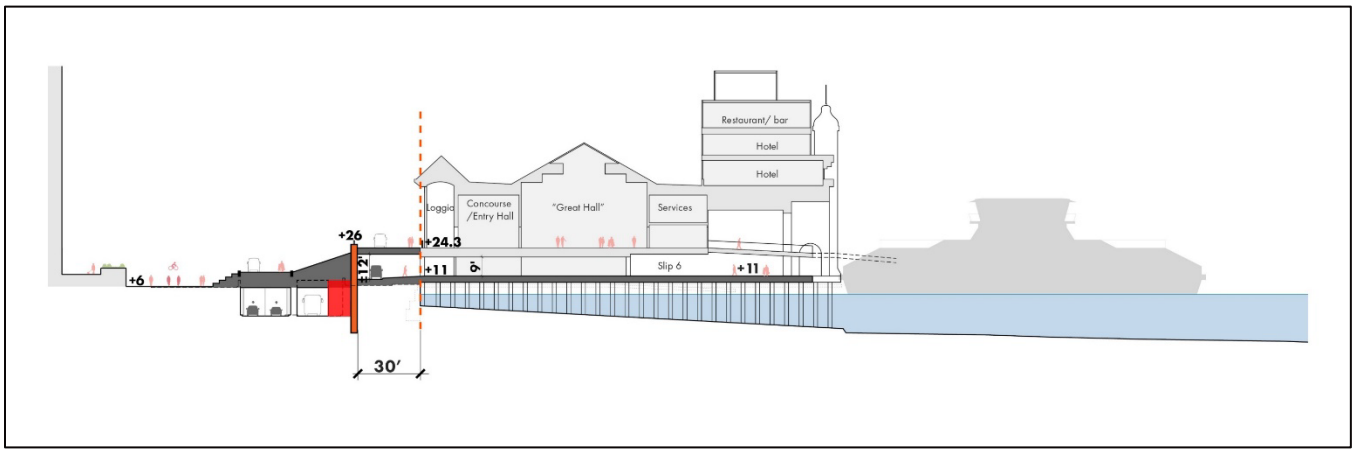

Figure 5: Flood defense alignment through the BPU (draft)

Incorporating the BPU into the line of defense, such as placing a floodwall above or along the centerline of the underpass, may be possible but would require some level of demolition and reconstruction with likely significant service disruptions to traffic. Repurposing the structure itself, such as relying on the existing outer wall or center divider, to be part of the flood alignment would require significant structural modifications or reconstruction. These modifications or reconstruction would likely include new foundation support, structural reinforcement of the tunnel, and waterproofing; these measures would be very expensive and result in significant service interruptions to traffic, to above ground uses, and to adjacent uses. The current thought process is to build an independent flood defense structure "around" the BPU, utilizing the BPU alignment as a convenient pathway for the line of defense. This would still require some structural modification to the tunnel and would likely result in the loss of one lane of traffic, as well as traffic disruptions during construction.

For the segment of the flood protection along the BMB, following the BPU would allow impacts to the historic structure to be greatly minimized. It would leave the BMB on the water side of the coastal protection system, requiring additional building-level measures to protect the structure. In addition, the coastal defense system would obscure views of and reconfigure access and connections to the first floor of the BMB South Street façade.

2. Integrated into the Building

The project team studied whether the flood defense system could pass through and be integrated into the BMB. This option avoids impacts to the BPU, maintains vehicle access to maritime uses, preserves public waterfront access, and preserves the BMB façade. However, a portion of the BMB would remain exposed to flooding while other portions will require a degree of reconstruction. Due to the required height of the flood defense, modifications to the first floor would be required. Substantial portions of the outboard portion of the building would require hardening including structural reinforcement for future storm wave impacts for both the ground and second floors. The BMB is located over several subway tunnels and an alignment through the building would require long bridging spans over the tunnels with large piles at either end (see Figure 7). Constructing these piles inside the existing building envelope would be a substantial constructability challenge. Additionally, some in-water fill would be required. Ultimately, this option was not recommended as part of the FiDi-Seaport Plan due to the complexity of constructing flood defense through this historic landmarked building and effectively hardening the water side of the building.

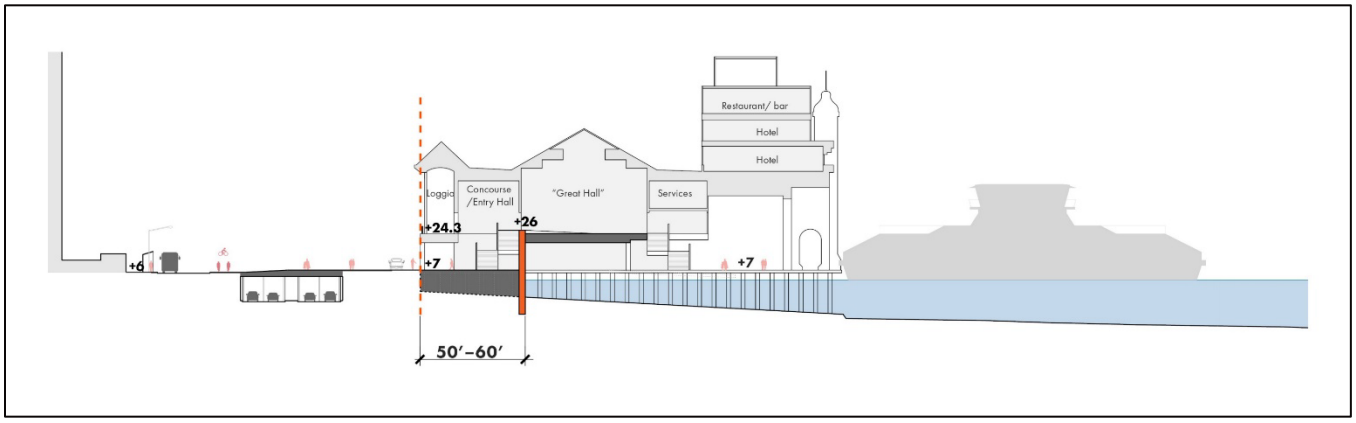

Figure 6: Flood defense alignment through the BMB (draft)

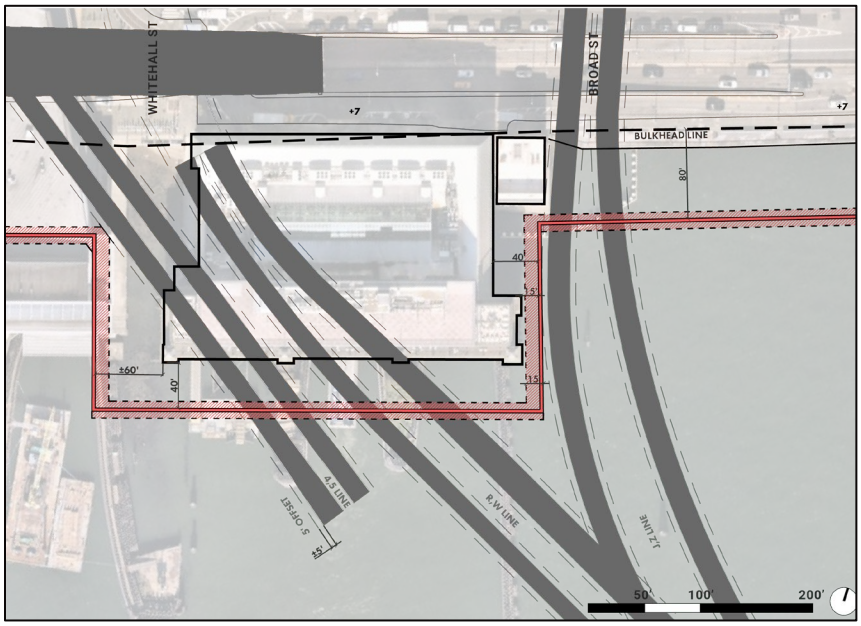

Figure 7: Subway Tunnels beneath the BMB

3. Move the Building

The project team explored moving the BMB to a new location on the shoreline extension; however, there are numerous technical challenges associated with this option. First, there are feasibility concerns with moving a historic building of this size. The building's condition – whether the building is structurally sound and able to withstand the stresses of being moved – would need to be evaluated, and the size and weight of the building would play a significant role in the ability to relocate the facility. To date, there is no precedent in NYC of a historic building this large that has been moved laterally over open water. There are also significant construction logistics that would need to be considered, such as route planning to relocate the facility, access to the building, and other permits and regulations. Most importantly, the team was unable to identify an appropriate receiving site if the building would be moved

With this option, maritime services could be maintained if the building was moved to a suitable location, allowing the GIF services to be relocated with the building. However, the GIF capacity could not be expanded. The building would be closed for at least two years, and internal repairs would be needed after the relocation of the structure. Due to the feasibility issues presented by this option as well as the current tenants and uses, this option was removed from further study.

4. Elevate the Building & Integrate

The team investigated the possibility of first elevating the BMB and then integrating flood protection within the building. Elevating the building to the passive design flood elevation of the project (+11

feet NAVD88) would protect the first floor from future regular tidal flooding events. It would also allow the alignment to run through the building without protruding onto the second floor. Maritime uses could be maintained at the same location, removing the need for a new GIF building. The South Street and Harbor side historic facades would be preserved. However, this option would require multiple gates within the building to maintain the maritime uses; the system would no longer be passive, and more O&M would be required. Since there are MTA structures under the BMB, multiple bridging structures would be needed, requiring drilling within the building, and significantly increasing costs. Furthermore, buildings are typically renovated after lifting; the whole process would likely close the building for over two years and require significant internal repairs. The ability to accommodate additional ferry capacity would also be limited. Note, specialized services would need to be engaged to verify the feasibility of lifting the building. Due to the significant complications of this option, including the multiple internal gates, and high costs, this option was removed from further study.

5. Outboard Alignment

The project team studied whether the flood defense system could be outboard of the BMB, providing flood defense for the entire building. A floodwall would be located outboard of the building, with an offset of approximately 40 feet from the BMB to respect the landmarked façades (all façades excluding the west façade) and provide access to an elevated waterfront esplanade. The space between the existing BMB and the floodwall would be decked over, leaving open water beneath the platform. The covered water would be open to the East River in normal conditions but would be cut off during a surge event by a sluice gate to prevent flooding behind the floodwall. This option would not impact the BPU and could facilitate a continuous waterfront esplanade throughout the study area. Additionally, the BPU cap would be extended to address access, congestion, safety, and open space connectivity (See Figure 10). The building would no longer function as a ferry terminal and the maritime services would need to be relocated. The façade closest to Whitehall Ferry Terminal would be preserved, and the inland facing façade would be preserved with visual impacts. Existing street level access to the building would also be preserved.

Ultimately, the FiDi-Seaport Plan proposes this option because it protects the historic BMB and avoids conflicts with other infrastructure assets, such as the BPU and subway stations. As noted at the beginning of this memo, the facility is extremely vulnerable to impacts by sea level rise. Placing the alignment outboard of the building protects it from both sea level rise and storm surge impacts. The facility itself can be adapted for complementary public uses, such as an extended waiting hall or community space. GIF and other services will be relocated to the newly constructed combined ferry terminal. Combining the ferry terminals into a 6-slip terminal serving GIF, SIF, and the USCG and placing the flood alignment outboard of the BMB creates a large span of publicly accessible spaces along the outboard and northern side of the BMB. These new public spaces serve as an

esplanade with higher accessibility and multiple opportunities for public use as shown in Figure 9. This option also allows the subway tunnels to be crossed with shorter spans and better access, improving constructability. As the FiDi-Seaport Plan advances towards implementation, historic impacts will be evaluated and coordinated with relevant agencies. Note that the design of outboard floodwall and how it interacts with the building's seaward façade is still under development, in addition to the waterside esplanade and platforms.

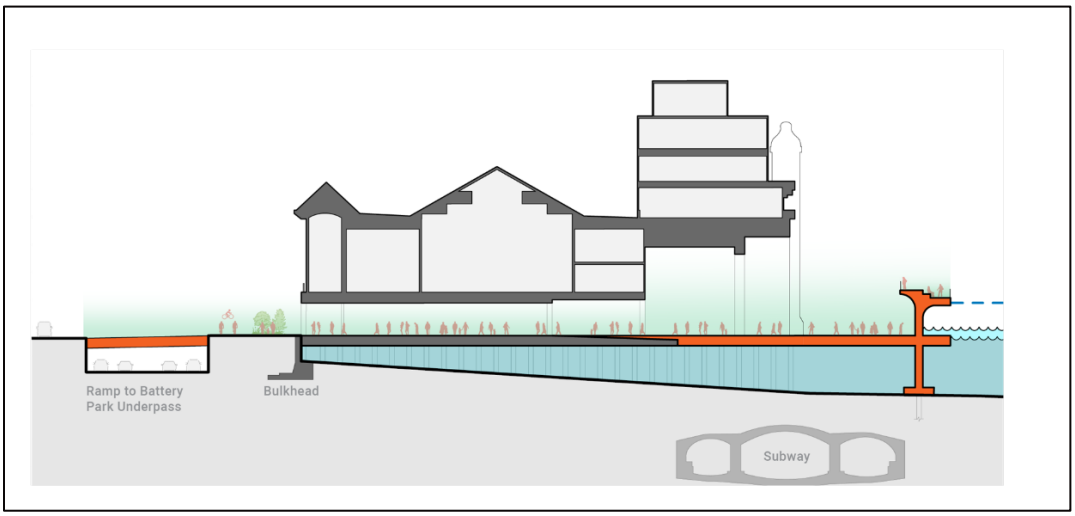

Figure 8: Flood defense alignment outboard of the BMB (with sluice gates) and Ramp to BPU (draft)

Figure 9: Flood defense alignment and esplanade outboard of the BMB (draft)

Figure 10: Streetview of the BMB (draft)

Overall Design

The latest design of the FiDi-Seaport waterfront including the updated Ferry Hub design, the outboard BMB flood defense, and the BPU cap extension, prioritizes resilience, security, user experience, upgrades to current operations and addresses access, congestion, safety, and open space connectivity.

The design has undergone optimization to make the project more implementable. The construction timeline has been expedited and employs phasing that accounts for maintaining an open and functional waterfront. Planning assumptions were revisited by evaluating maritime facility size and function to avoid overbuilding. Waterfront uses were optimized by identifying opportunities to consolidate maritime uses. Lastly, the design identified ways to minimize carbon footprint by exploring opportunities to retrofit existing facilities.

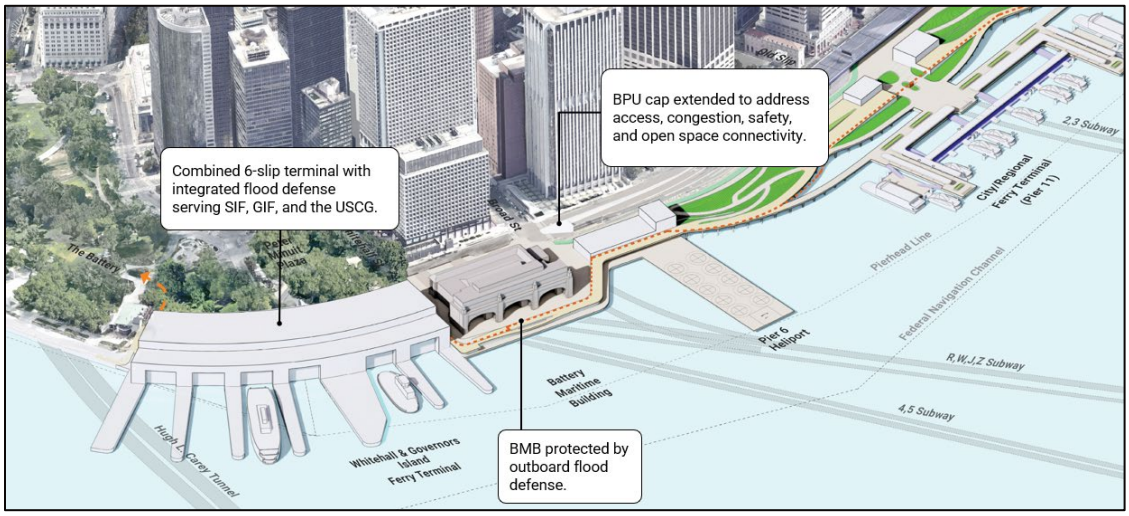

Figure 11: Fall 2024 draft design for southern part of FiDi-Seaport Climate Resilience Plan

Conclusion

Based on this analysis, the outboard alignment was selected as the most feasible and preferable alignment. This alignment avoids the complications of building the flood defense along the BPU or through the BMB, and it protects the historic asset from flooding and sea level rise. Additionally, given the complications and likely costs of elevating or relocating the structure, the outboard alignment was selected as the preferred alignment for the FiDi-Seaport Plan. As the team proceeds into the next phases of the project, the design of the outboard structure, including the space created between the floodwall and the waterside-facing façade, as well as opportunities for extending the publicly accessible esplanade, will continue to be explored.