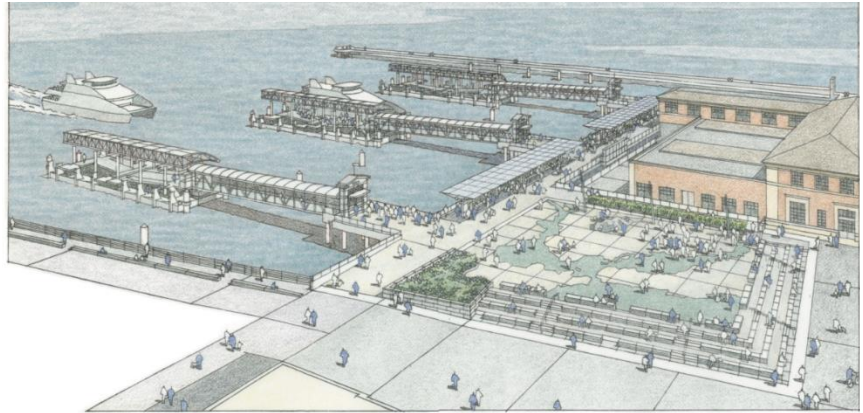
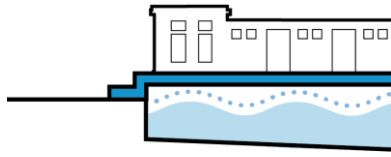


Elevated Pier

Flood Adaptation Measure



PHYSICAL INFRASTRUCTURE



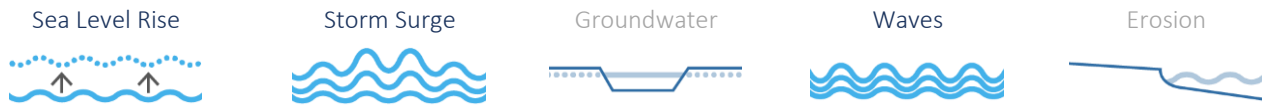
San Francisco Ferry Terminal Expansion Project
 Prepared for the Water Emergency Transportation Authority and the Port of San Francisco by ROMA Design Group and Simpson Gumpertz & Heger
 Elevated Ferry Building Terminal ©Port of San Francisco

SHORELINE LOCATION:



DESIGN LIFE 50+ years	ADAPTABILITY Varies	IMPACT ON THE WATERFRONT Major Intervention	CONSTRUCTION COST TBD
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COASTAL FLOOD HAZARDS MITIGATED:



MEASURES COMPATIBILITY:		ECOSYSTEM SERVICES: Measure may affect these shoreline values			
Flood	Seismic	—	—	—	—
Elevated Wharf, Building Adaptations, New Seawall (in-place)	All	Aquatic Habitat ↓	Terrestrial Habitat	Water Quality	Carbon Storage

DESCRIPTION:

Existing and new piers could be elevated or rebuilt at a high elevation. Elevated piers could be either fixed or floating. This measure would typically be paired with elevated wharves to provide the necessary transitions from street grade.

CONSIDERATIONS:

- Does not protect landside assets.
- Provides ability to protect historic structures.

ADVANTAGES:

- Conventional construction operation.
- Moderate seismic co-benefit, reducing overall seismic risk along the waterfront.
- Good longevity and durability, relative to spot measures or deployable solutions

DISADVANTAGES:

- Does not provide flood protection for the landside assets.
- Potential challenge associated with disassembling/reassembling or moving historic building.

Elevated Pier

Flood Adaptation Measure



<p>CONSTRUCTION IMPACTS TO THE PUBLIC:</p> <ul style="list-style-type: none"> • The most challenging aspect in constructing this measure will be the management (disassemble/reassemble or move) the historic shed building. • Can be readily implemented from marine equipment with disruption only to tenant impacted in the facility under construction. • Very little disruption to Promenade or Embarcadero operations. 	<p>SEA LEVEL RISE ADAPTATION OPPORTUNITIES:</p> <ul style="list-style-type: none"> • Fixed elevation piers could be adapted through the inclusion of perimeter floodwalls, dry-proofing, and wet-proofing. • Floating piers are readily adaptable, and would need to consider future transitions to shoreline and incorporate utility dryproofing in their design. 	<p>CASE STUDIES:</p> <ul style="list-style-type: none"> • Seattle Pier 62 • Norfolk Naval Station double deck piers • Double deck fuel pier NAVFAC Point Loma San Diego
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<p>DESIGN OPPORTUNITIES:</p>		
<p>Ecological Enhancements</p> <ul style="list-style-type: none"> • Raised piers could incorporate ecological enhancements such as ecological concrete and increased light below decks. 	<p>Urban Design</p> <ul style="list-style-type: none"> • Reconstruction of piers provides some opportunity for urban design improvement however needs to be balanced with historic elements of the shed structures. 	<p>Form</p> <ul style="list-style-type: none"> • N/A

DESIGN CONSIDERATIONS:

- Elevation setting should consider maritime function of the piers, with due diligence taken to ensure continued maritime operations are feasible at higher pier deck elevations.
- Being in a relatively high seismic hazard alignment along the waterfront, any new pier would need to accommodate seismic forces, consistent with USACE seismic standards (ER 1110-2-1806 and -1150).
- Note that piers are typically outside of the ground displacement hazard zone, but in some locations the first few pier bents are impacted by this lateral spreading.

SITE-SPECIFIC CONSIDERATIONS:

- Newer facilities, such as Pier 1 or Pier 15 which have been retrofit in the last 20 years may be able to be retrofit, rather than replaced.
- Retrofit could include adding a false floor several feet above the structural slab.

URBAN DESIGN CONSIDERATIONS:

- Reconstruction of piers provides some opportunity for urban design improvement however needs to be balanced with historic elements of the shed structures.

INSTALLATION AND CONSTRUCTABILITY CONSIDERATIONS:

- The most challenging aspect in constructing this measure will be the management (disassemble/reassemble or move) the historic shed building.



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- Can be readily implemented from marine equipment with disruption only to tenant impacted in the facility under construction.
- Very little disruption to Promenade or Embarcadero operations.

ARCHITECTURAL CONSIDERATIONS:

- Maintaining emergency egress pathways and ADA accessibility are two considerations that require particular attention when modifying the existing facility.
- At over 600 feet long with a single connection to the shore, the piers resemble a high-rise building laid on its side, when evaluating egress pathways. Therefore, it is important that a protected corridor is established to safely allow people to evacuate from the end of the pier back to land. The pier apron serves this purpose, therefore must be maintained at a minimum width set a certain distance away from the building envelope.

HISTORICAL RESOURCE CONSIDERATIONS:

- Elevating the piers has the potential to be a large historic resource challenge. While disassembly/reassembly of the shed structure is believed to be feasible it will add expense to the project that needs to be weighed heavily with the remaining life of the historic resource.
- Alternative solutions around staged construction should be explored further to limit the impact to the historic resource while protecting it for future generations.

OPERATION AND MAINTENANCE CONSIDERATIONS:

- Elevating Piers to protect themselves from flooding is a passive solution thus requiring no operational cost for flood events.
- However, there will be maintenance costs associated with overwater structures, but these will be a significant reduction compare the maintenance expense of keeping the existing facilities operational.