

# East Boston Waterfront Concept Overview



## Conceptual Solution

The East Boston Waterfront concept is a stormwater outfall consolidation project with proposed pipes and a pump station. The proposed pipes collect excess wet weather flow from Outfalls 26LSDO109, 26LSDO084, 26LSDO108, 25MSDO007, and 25MSDO006, using passive weirs to divert flow into a new conduit for conveyance to a pump station. The pump station utilizes one duty pump and one standby pump. The pump station is underground and utilizes electric submersible pumps to minimize the aboveground footprint of the concept and mitigate noise pollution. The pump station discharges directly into Boston Harbor, with an energy dissipating structure along that section of coastline to prevent erosion.

**Type:** Consolidation and Pumping

**Total Drainage Area:** 43 acres

**Coastal Flood Vulnerable Drainage Area Protected:** 43 acres

## Concept Elements:

- Outfall consolidation
- New conveyance
- Tide gates
- Subsurface Storage Tank
- Subsurface Pump Station

## Outfalls Included in Concept:

- 26LSDO109
- 26LSDO084
- 26LSDO108
- 25MSDO007
- 25MSDO006

Coastal Stormwater Discharge Analysis  
East Boston Waterfront



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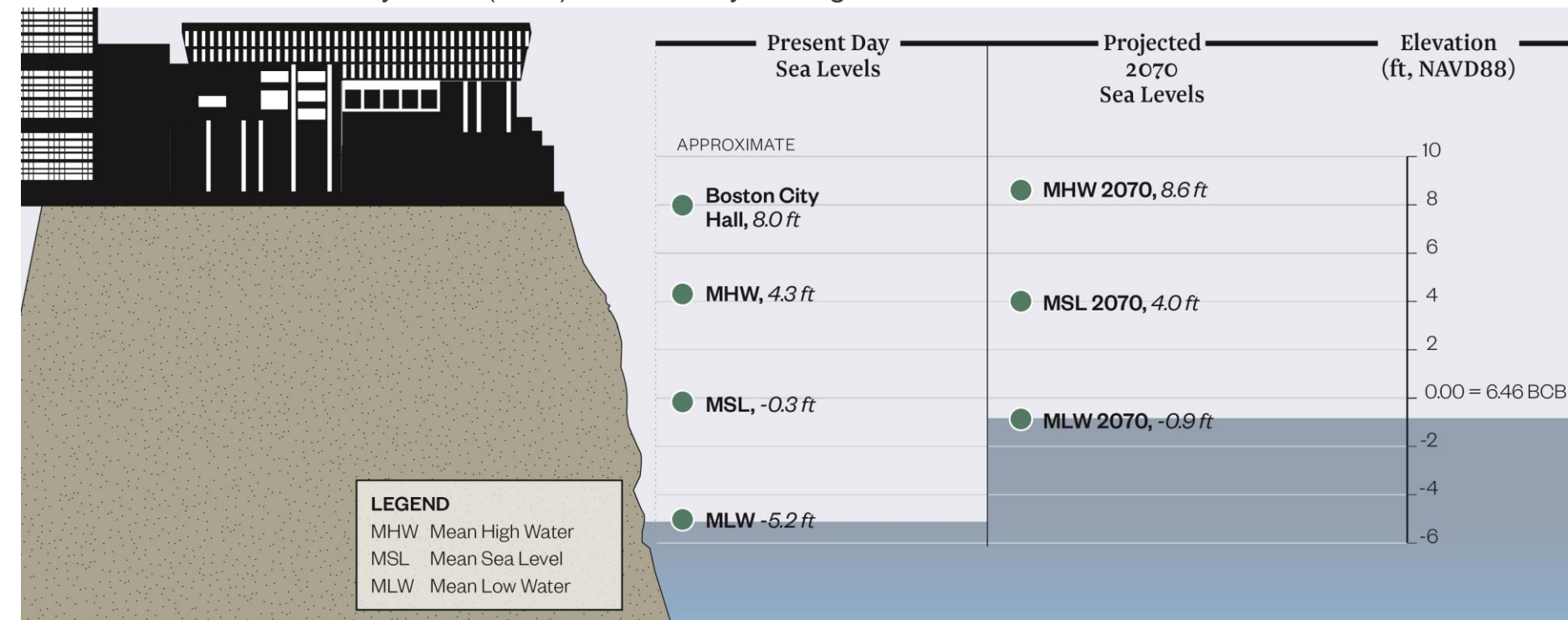
# Assumptions

## Sea Level Rise and Datum

The East Boston Waterfront Pump Station concept was designed for consistency with Climate Ready Boston (CRB) proposed adaptations and analyzed based on sea level rise (SLR) projections in the Massachusetts Coastal Flood Risk Model (MC-FRM). The SLR values applied in MC-FRM are consistent with the standards for the State of Massachusetts developed by Coastal Zone Management. The MC-FRM utilizes a “High” SLR scenario. This scenario is based on the relative SLR projections under Relative Concentration Pathway (RCP) 8.5 (a “worst case scenario” of increasing atmospheric carbon concentrations) and represents elevations that have a 99.5% probability of not being exceeded within the respective timeframes. In 2030, that amounts to an increase of 1.3 feet in Boston from a baseline condition (2008 centered tidal epoch), and in 2070 that amounts to an increase of 4.3 feet.

The concept developed in this project was analyzed using coastal conditions that include 2070 projected SLR and storm surge resulting from a 100-year tropical storm. The peak water surface elevation (WSE) predicted by the MC-FRM during these conditions is approximately 13.8 feet NAVD88 (varies by location). In mid 2022, the Greater Boston Research Advisory Group (BRAG) issued an updated report with new SLR projections. The report acknowledges that long term SLR projections are associated with significant uncertainty, and that updated projections include less SLR by 2100 (compared to earlier projections in the 2015 BRAG Report). According to the report, the likely range of SLR by 2070 under an RCP 8.5 scenario is 1.4 – 2.8 feet. Based on this information, projections from the MC-FRM that were utilized in this project are conservative and appropriate for long term planning purposes.

Unless otherwise noted, all elevations are based on the NAVD88 vertical datum. Elevations given in NAVD88 can be converted to Boston City Base (BCB) elevation by adding 6.46 feet.



# Climate Ready Boston and Shoreline Protection

The East Boston Waterfront Pump Station concept was developed to maintain consistency with possible Climate Ready Boston (CRB) adaptations based on the latest available information at the time they were developed. As the CRB program continues to evolve, it is anticipated that proposed concepts will need to be adapted.

The concept was developed to be consistent with stated neighborhood design flood elevations. In East Boston, where the stated design flood elevation is 16.0 feet, pumps were designed to discharge to a minimum elevation of 16.0 feet.

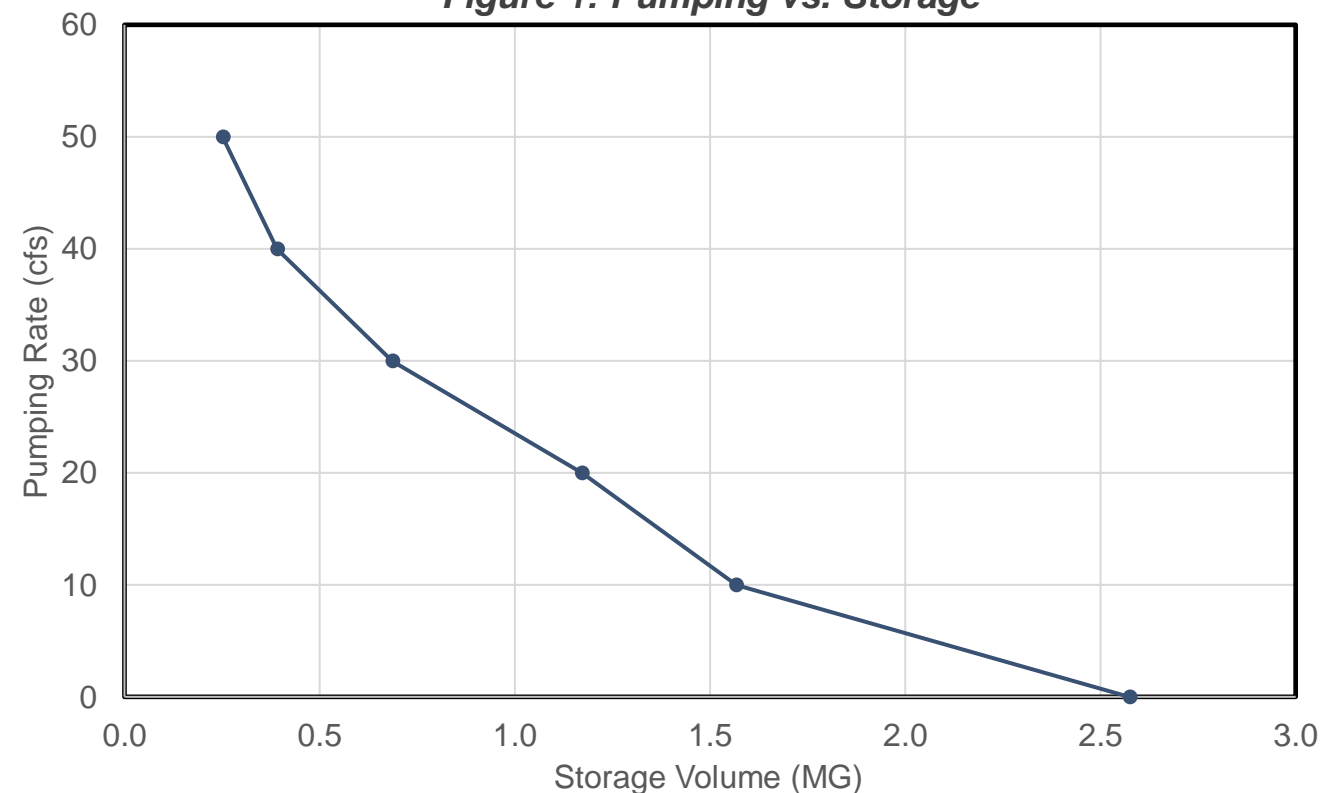
At the time of this project, many CRB concepts were in early planning stages and not fully defined. **In consideration of this, it was assumed the shoreline protection around the City of Boston is 100% effective for all modeling evaluations.** This assumption eliminates overland coastal flooding from model predictions, allowing for isolation of flooding that results only from rainfall and stormwater that cannot be discharged due to high sea levels. It is important to recognize that additional flooding, beyond what is depicted herein, would be expected if 100% effective shoreline protection is not implemented.

# Basis of Design

## Storage and Pumping

Model simulations were conducted to determine the maximum Hydraulic Grade Line (HGL) that occurs at Outfalls 26LSDO109, 26LSDO084, 26LSDO108, 25MSDO007, and 25MSDO006 with the current tide cycle. Analyses were then conducted to determine the acceptable combinations of storage volume and pumping rate required to maintain the existing HGL with 2070 projected sea level rise and 100-year storm surge, as shown in Figure 1. The City of Boston's Parcel database was used to identify publicly owned parcels near the existing outfalls. A suitable location was not available for all outfalls, so an outfall consolidation approach was used. A suitable location on a publicly owned parcel was located for one pump station, and a pipe alignment was designed to transfer flow from all five outfalls to the pump station. An analysis of the pump station was performed to identify a pump rate and physical dimensions that are hydraulically viable. It was found that a significant storage tank is not required, as the proposed pipes needed to divert flow from the outfalls would have sufficient storage when combined with a 40 CFS pump station. The pump station and storage tank occupy an area of 635 ft<sup>2</sup>. The proposed pipes have a storage volume of 0.44 MG. The pump station has one duty pump and one standby pump. Each pump has a separate discharge force main which carries water to the harbor. The pump station is configured with vertical, axial electric submersible pumps in parallel bays.

**Figure 1: Pumping vs. Storage**



## Rainfall and Coastal Conditions

The Commission currently utilizes a 10-year, 24-hour design storm to establish its target level of service. For the purpose of sizing new piping and evaluating storage capacity, a projected 2070 10-year, 24-hour design storm was developed. For consistency with Climate Ready Boston, performance of the DBB storage concept was also evaluated with projected rainfall from a 100-year tropical event (developed during the Commission's Inundation Model Project). The DBB was evaluated using a 100-year return period coastal boundary condition. Data for this condition were obtained from the MC-FRM. For the purpose of evaluating the effectiveness of the concept, it was further assumed that complete shoreline protection was implemented, preventing flow of water between land and the harbor/Neponset River. Table 2 contains a summary of the coastal conditions that were analyzed.

**Table 1: Rainfall Conditions**

Scenario	Purpose	Rainfall Depth (in)	Peak Intensity (in/hr)
Present Day, 10-year, 24-hr design storm	Baseline Conditions	5.15	3.32
Projected 2070, 10-year, 24-hr design storm	Design Conditions	6.18	4.08
100-year Tropical Storm	Damage Analysis	9.58	0.84

**Table 2: Coastal Conditions**

Scenario	Purpose	Peak Water Surface Elevation (ft, NAVD88)	Source
Present Day	Baseline Conditions	3.7	BWSC Existing Model (April 2016 Tide Cycle)
2070, 100-year Tropical Storm	Damage Analysis	13.8	MC-FRM

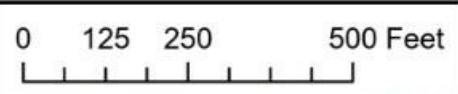
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



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**Legend**

- Proposed Manhole
- Proposed Outfall
- Existing Outfall
- ▶ Proposed Stormwater Pipe
- ▶ Existing Storm Sewer Line



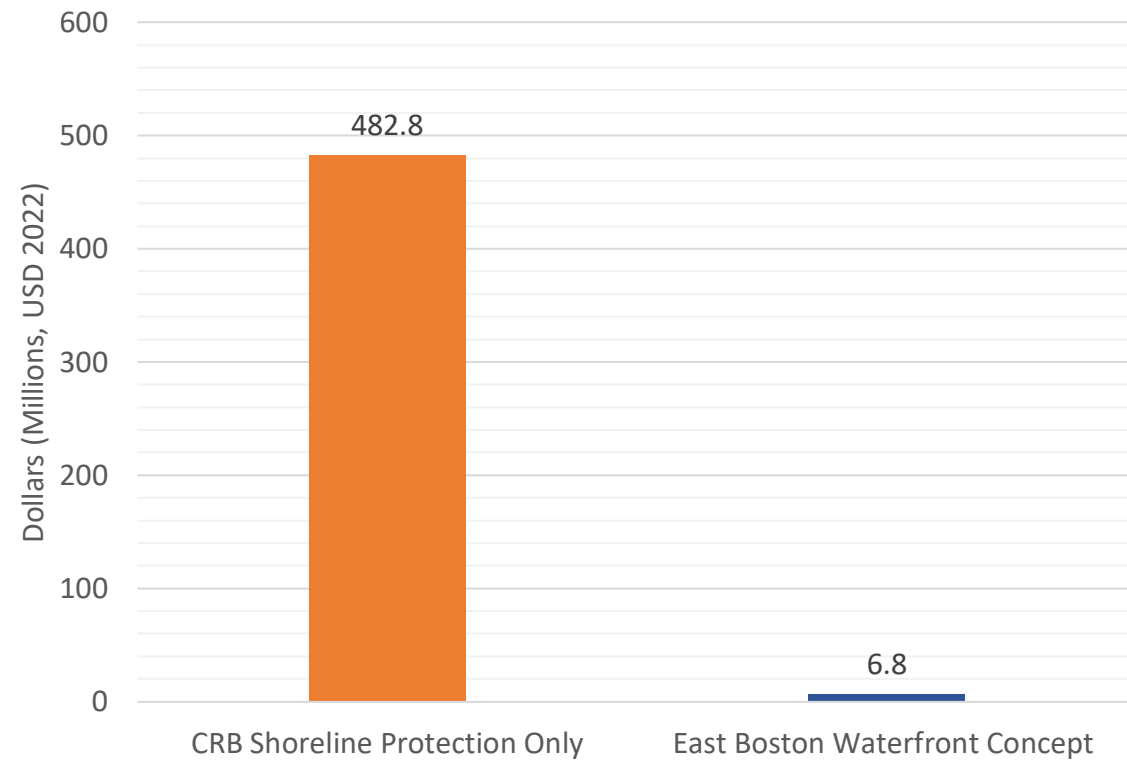
# East Boston Waterfront Outfall Diversion – New Pipeline

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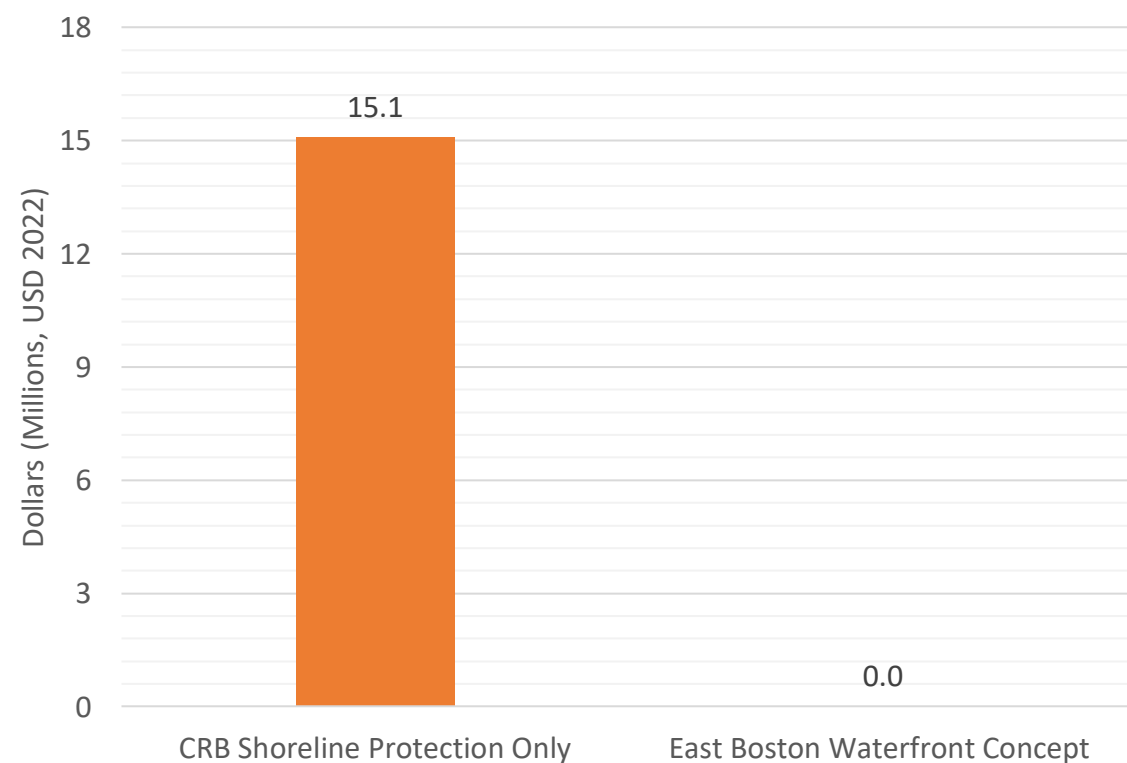


# Flood Modeling and Damage Analysis

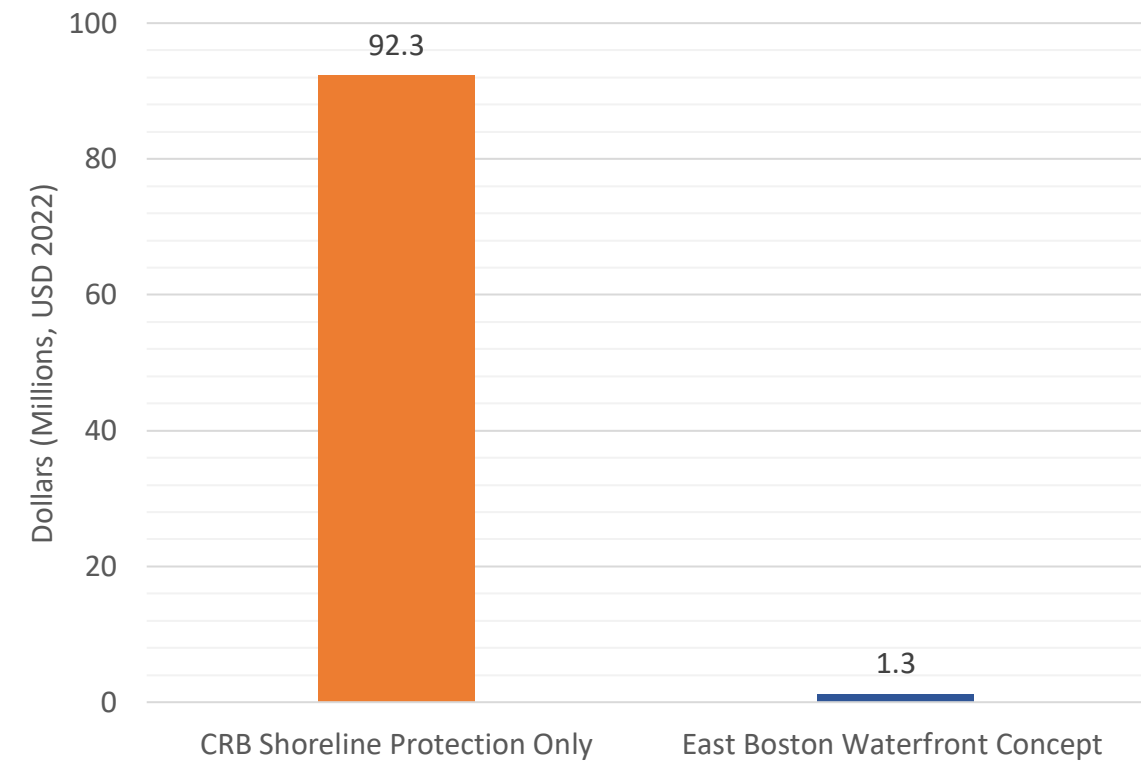
**Figure 2: Estimated Replacement Cost**



**Figure 3: Loss of GDP**





**Figure 4: Physical Damage**

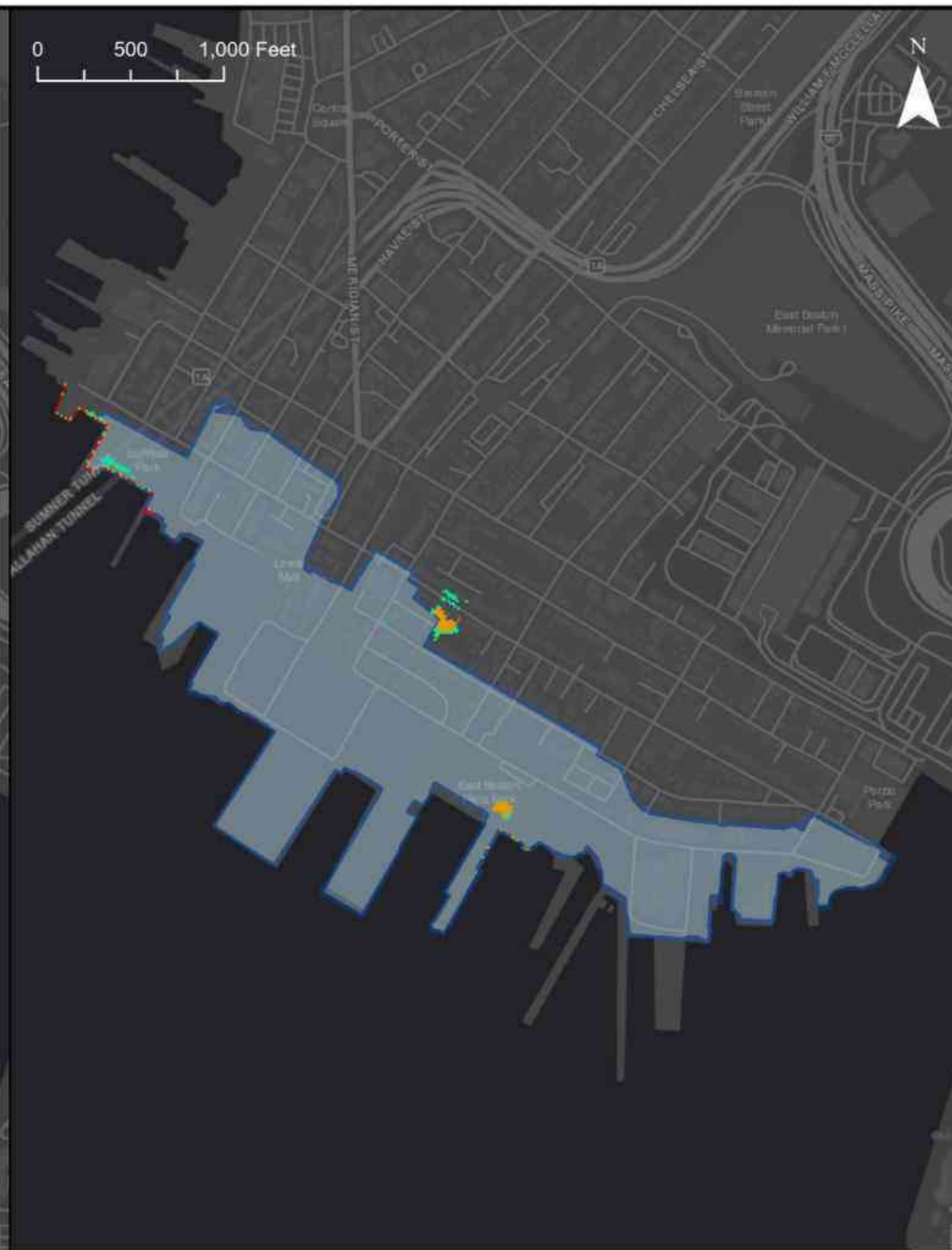
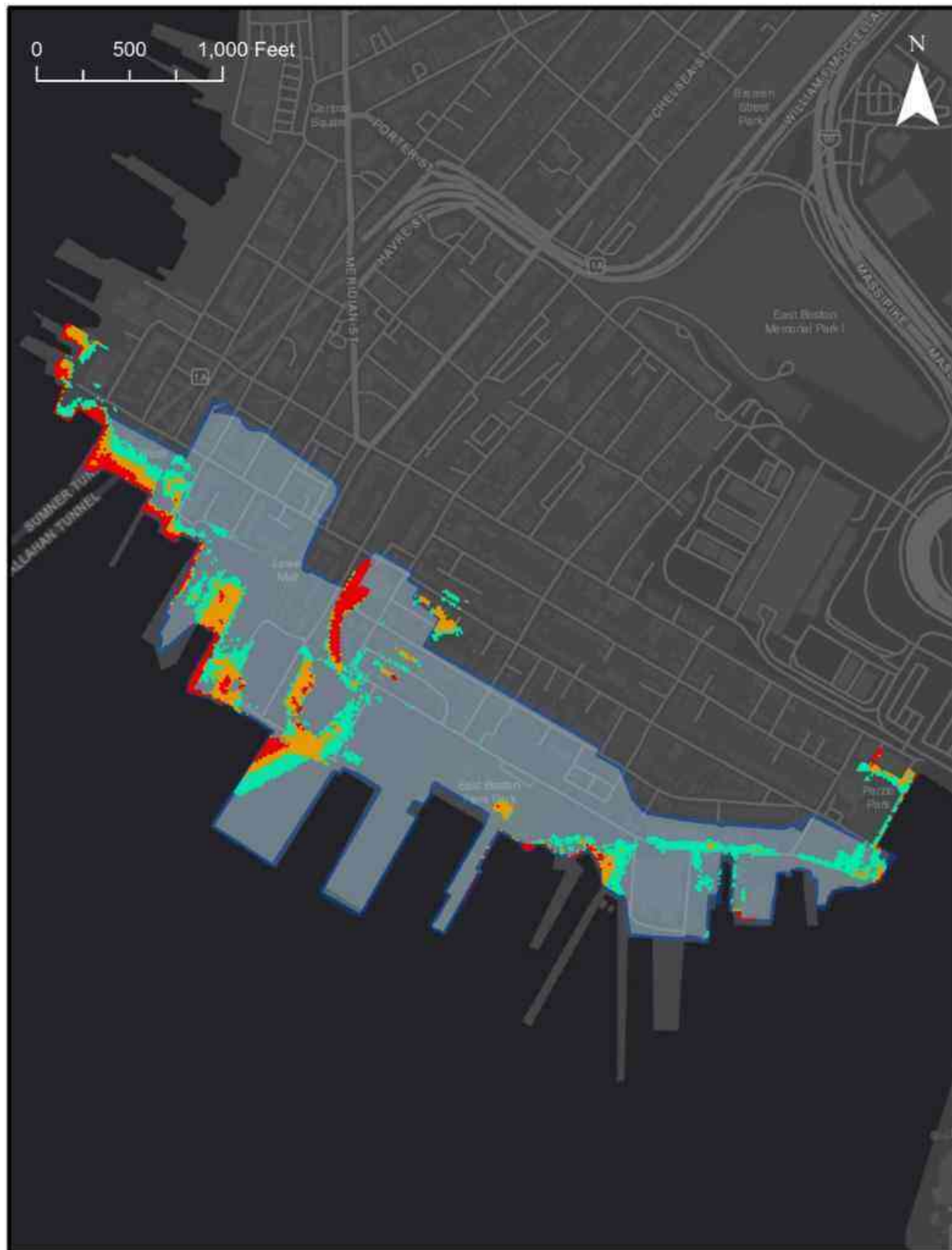


The flood reduction benefits of the East Boston Waterfront concept were evaluated using the Commission’s 2D Inundation Model by simulating a 100-year tropical storm event with 2070 SLR and storm surge. The figures on the following page depict the peak flooding that was predicted in the East Boston Waterfront drainage area with shoreline protection only and with the concept implemented. An analysis of economic losses/physical impacts from flooding under both scenarios was performed by risQ Inc.

Model predictions indicate that **the East Boston Waterfront concept reduces physical damage by \$91 million, avoids \$476 million in rebuilding costs, and mitigates a GDP loss of \$15.1 million** during a 100-year tropical storm event in 2070.

*Note: replacement values include the total value of impacted buildings in flooded areas (e.g., impacted buildings are fully replaced), whereas physical damage includes estimated costs to repair flood damage based on predicted flood depths and building characteristics. The values shown are the average of minimum and maximum calculated losses. Refer to the Project's Final Report for more information.*

Coastal Stormwater Discharge Analysis East Boston Waterfront	
 Boston Water and Sewer Commission	 Hazen
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### Legend

- Flood Depth > 4 in and < 1 ft
- Flood Depth > 1 ft and < 2 ft
- Flood Depth > 2 ft
- Drainage Area Analyzed

### Simulation Parameters

Storm Type	100yr Tropical Storm
Rainfall Depth	9.6 inches
Peak WSE 2070 SLR + 100yr Surge	13.8 feet NAVD88

2070 SLR + 100yr Tropical Storm + Storm Surge  
**Shoreline Protection Only**

2070 SLR + 100yr Tropical Storm + Storm Surge  
**East Boston Waterfront Stormwater Consolidation**

# Cost Estimate and FEMA BRIC Considerations

## Capital Cost Estimate

A construction cost estimate for the East Boston Waterfront concept was developed for planning purposes. Assumptions for the cost estimate include 15-year escalation to the mid-point of construction and the inclusion of a 50% design contingency. Utility hookup costs were not included.

**Table 4: East Boston Waterfront Cost Estimate Subtotals**

Remaining Design Development & Construction Administration (assumed 20% of total less design contingency)	\$3,177,000
Direct Construction Costs	\$6,256,022
Indirect Construction Costs	\$1,251,204
Mark-Up (Including 50% design contingency)	\$16,026,774
<b>Total</b>	<b>\$26,711,000</b>

## Social Vulnerability and FEMA BRIC Funding

FEMA BRIC funding prioritizes disadvantaged communities. Table 4 contains a summary of several indicators for the East Boston Waterfront tributary area that could be used help characterize the community for future FEMA funding applications and prioritization of projects that benefit disadvantaged communities.

**Table 4: East Boston Waterfront Tributary Area Social Vulnerability Indicators**

Low Income & Persistent Poverty	
Per Capita Income	\$39,098
Below Poverty Line	19%
High Housing Cost Burden	
Stressed Renters (>40% rent-to-income)	25%
Households With Food Insecurity	14%
Racial and Ethnic Segregation	
Asian Population	8%
Black Population	5%
Hispanic Population	43%
White Population	69%
Education and Employment	
Adults Age 25+ Without High School (or equivalent) Degree	20%
Unemployment Rate (Age 16+)	6%

Data provided by risQ inc. from the US census and American Community Survey

Coastal Stormwater Discharge Analysis  
East Boston Waterfront



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# Planting Palette

A planting palette was developed for the park area near the proposed pump station along the East Boston Waterfront. After construction, planting of native plant species could provide a public amenity with new green space and environmental benefits associated with native plant species. The palette can also be used to conceal concept utilities such as the pump station and electrical building from the public.

## Trees



*Amelanchier arborea*  
common serviceberry



*Juniperus virginiana*  
eastern red cedar



*Magnolia virginiana*  
sweet bay magnolia



*Quercus rubra*  
northern red oak

## Shrubs



*Rosa carolina*  
pasture rose



*Rhus copallinum*  
winged sumac



*Aronia melanocarpa*  
black chokeberry



*Morella pensylvanica*  
bayberry

## Herbaceous and Grasses



*Panicum virgatum*  
switchgrass



*Schizacharium scoparium*  
little bluestem



*Eutrochium purpureum*  
Joe-Pye-Weed



*Solidago sempervirens*  
seaside goldenrod

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# Adaptability and Implementation

## Adaptability

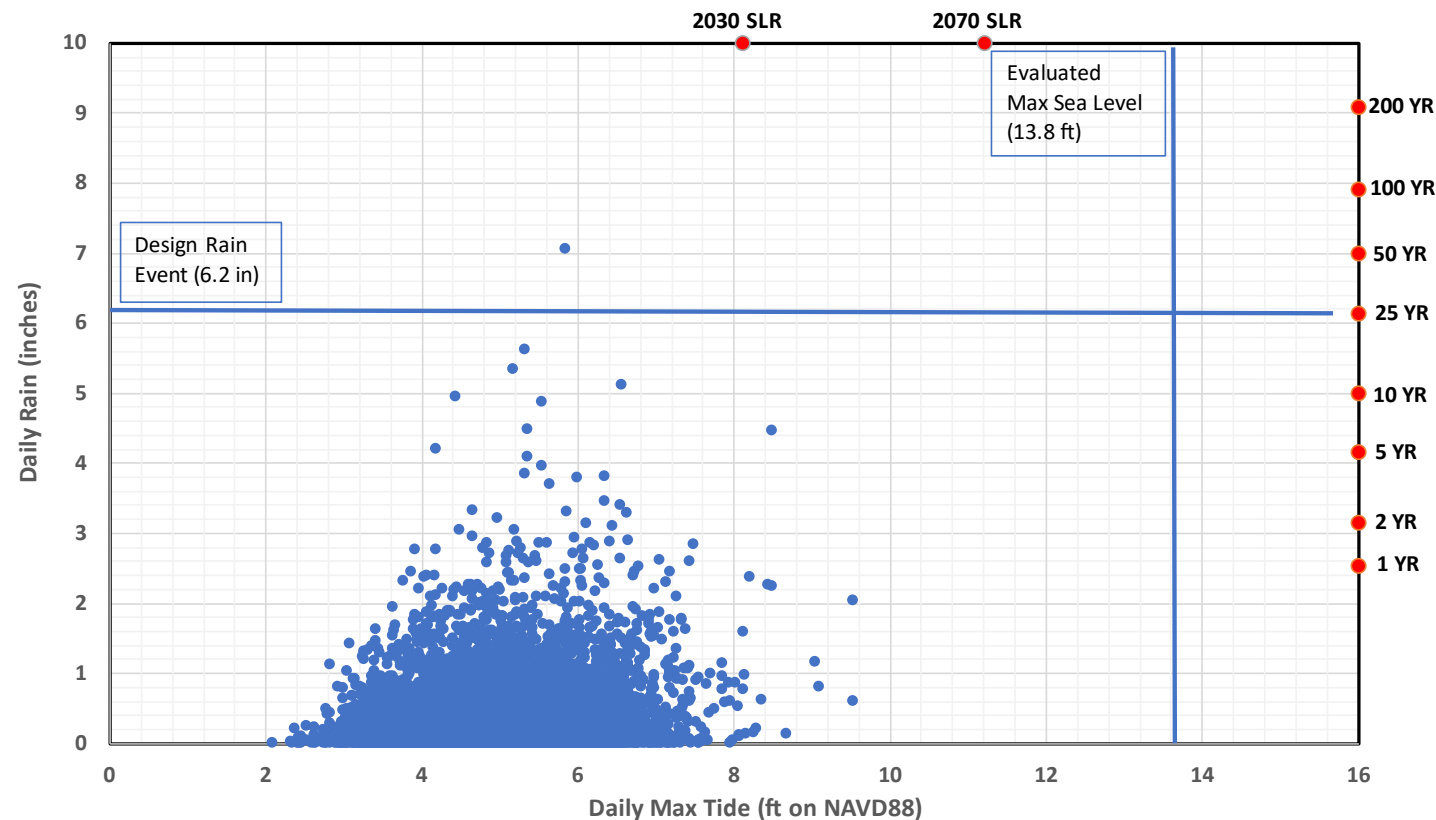
Figure 5 below depicts historical daily rainfall totals and tide levels. As shown in this figure, the conditions that were used to design and analyze the East Boston Waterfront pump station are conservative and represent more extreme conditions than have occurred historically. Regardless, the following measures could be implemented to adapt the concept to more severe conditions (additional SLR, more intense rainfall, etc.) in the future:

- Increase the size of installed electric submersible pumps
- Utilize the standby pump as a duty pump during extreme conditions
- Increase the size of the pump station to increase pumping capacity
- Increase the size of the pump station to add more peak-shaving storage volume
- Divert additional flow into the new consolidation conduit

## Implementation Considerations

- Coordination with CRB (and other relevant stakeholders) to construct adequate shoreline protection around the East Boston Waterfront is essential for successful implementation of this concept. To function as designed, the region must be fully isolated from high sea levels; as such, careful coordination with CRB is essential at this location.
- The portions of existing pipelines downstream from the proposed diversion structures are designed to surcharge to allow flow to back up enough to be diverted at the diversion structures. As such, under design conditions, it is important that manhole covers along those portions of the existing pipelines are watertight and securely bolted or fastened in place to prevent flooding.
- Regional stormwater pipes should not be directly connected to the diversion pipeline, as there is currently no way for flow within the pipeline to be discharged without the pump station; therefore, the diversion pipeline should only be configured to accept flow from stormwater outfall pipes that are surcharging, unless a large pump station is provided.
- A careful analysis of constructability, and design efforts to minimize disruptions from large diameter pipe construction, should be completed.
- Tide gates could be added on the included outfalls a near term measure to prevent backflow during higher tide conditions.

**Figure 5: Design and Analysis Conditions vs. Historical Tide and Rainfall**



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East Boston Waterfront

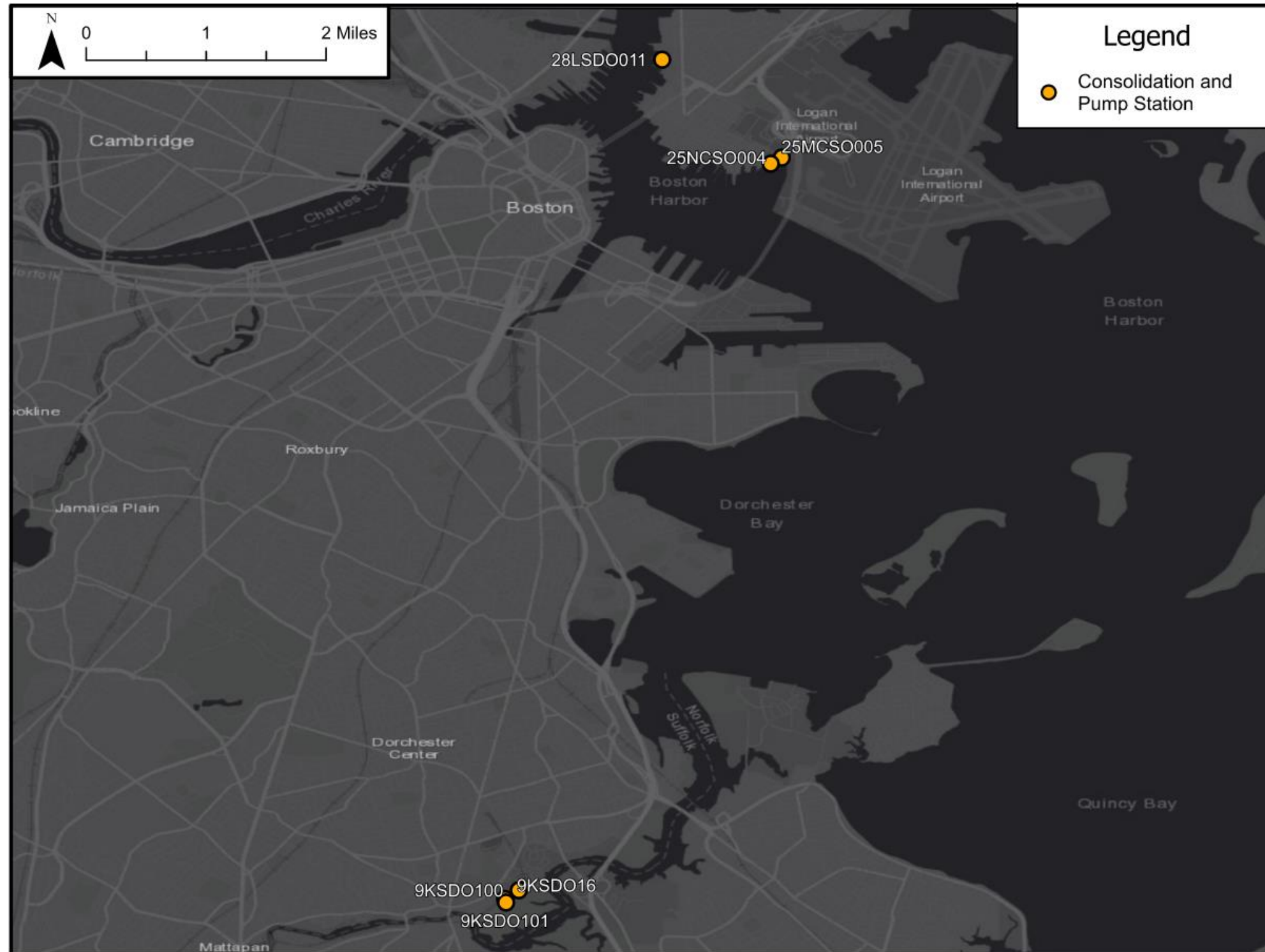


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# Replicability and Implementation Timeline



## Summary of Similar Concepts

**Number of Sites:** 6

**Vulnerable Area:** 41 acres

The map on this sheet depicts other vulnerable outfalls that could be consolidated with a new conduit that conveys flow to a single pump station.

Additional detail about these outfalls can be found in the Commission's Coastal Stormwater Discharge Analysis Implementation Timeline.

Coastal Stormwater Discharge Analysis  
East Boston Waterfront



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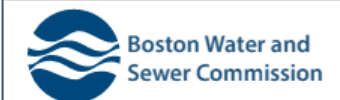
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ATTACHMENT A  
EAST BOSTON WATERFRONT PUMP STATION CONCEPTUAL DESIGN DRAWINGS

A-1: Overview Plan and Pump Station Plan

A-2: Pump Station Section View

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East Boston Waterfront



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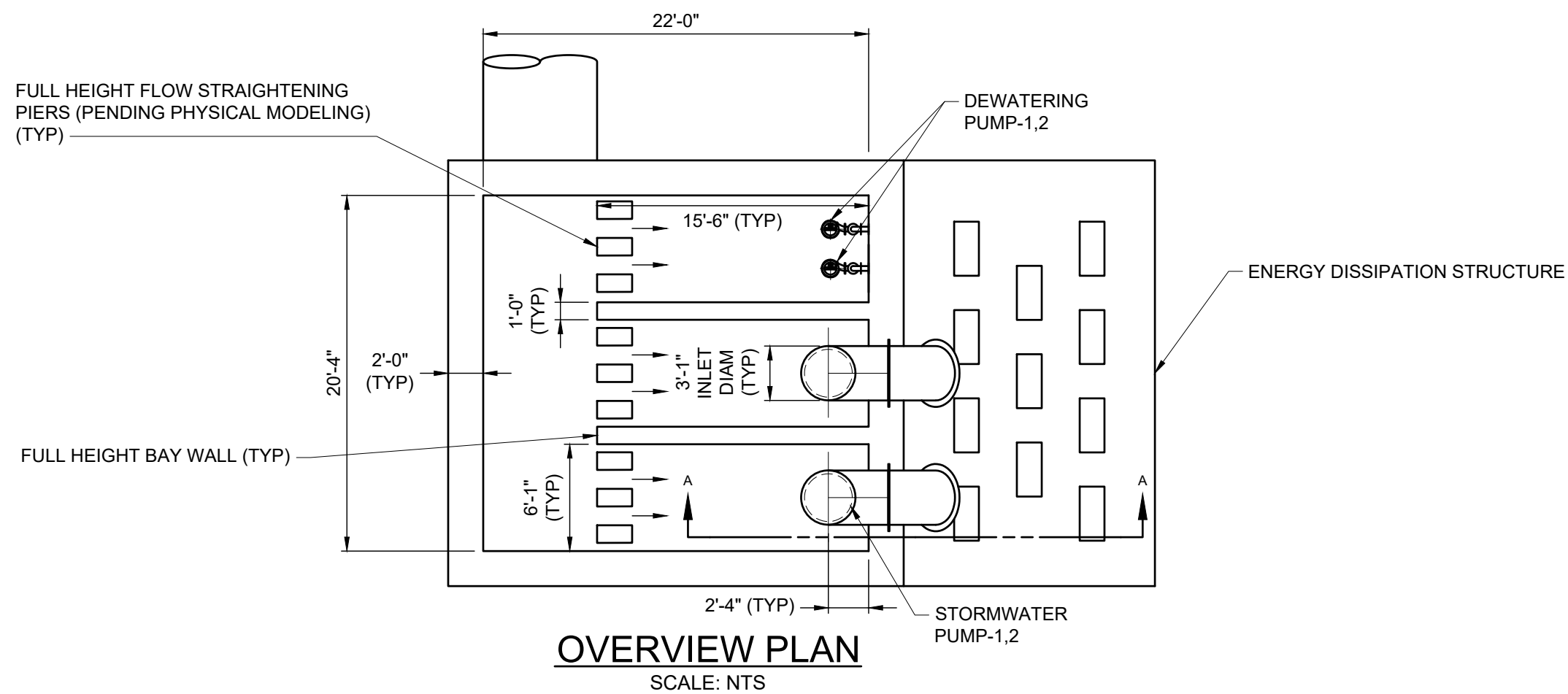
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# East Boston Waterfront Stormwater Pump Station



## NOTES

1. FOR WATER SURFACE ELEVATIONS REFER TO OPERATIONAL TABLE.
2. ALL ELEVATIONS USE THE NAVD88 VERTICAL DATUM UNLESS OTHERWISE STATED.
3. CONCEPTUAL DRAWING, NOT FOR CONSTRUCTION.



STORMWATER PUMP-1,2 OPERATIONAL PARAMETERS	
FLOW RATE, CFS	40
STATIC HEAD RANGE, FT	13.8 - 19.8
DESIGN FLOOD ELEVATION, FT	16.0

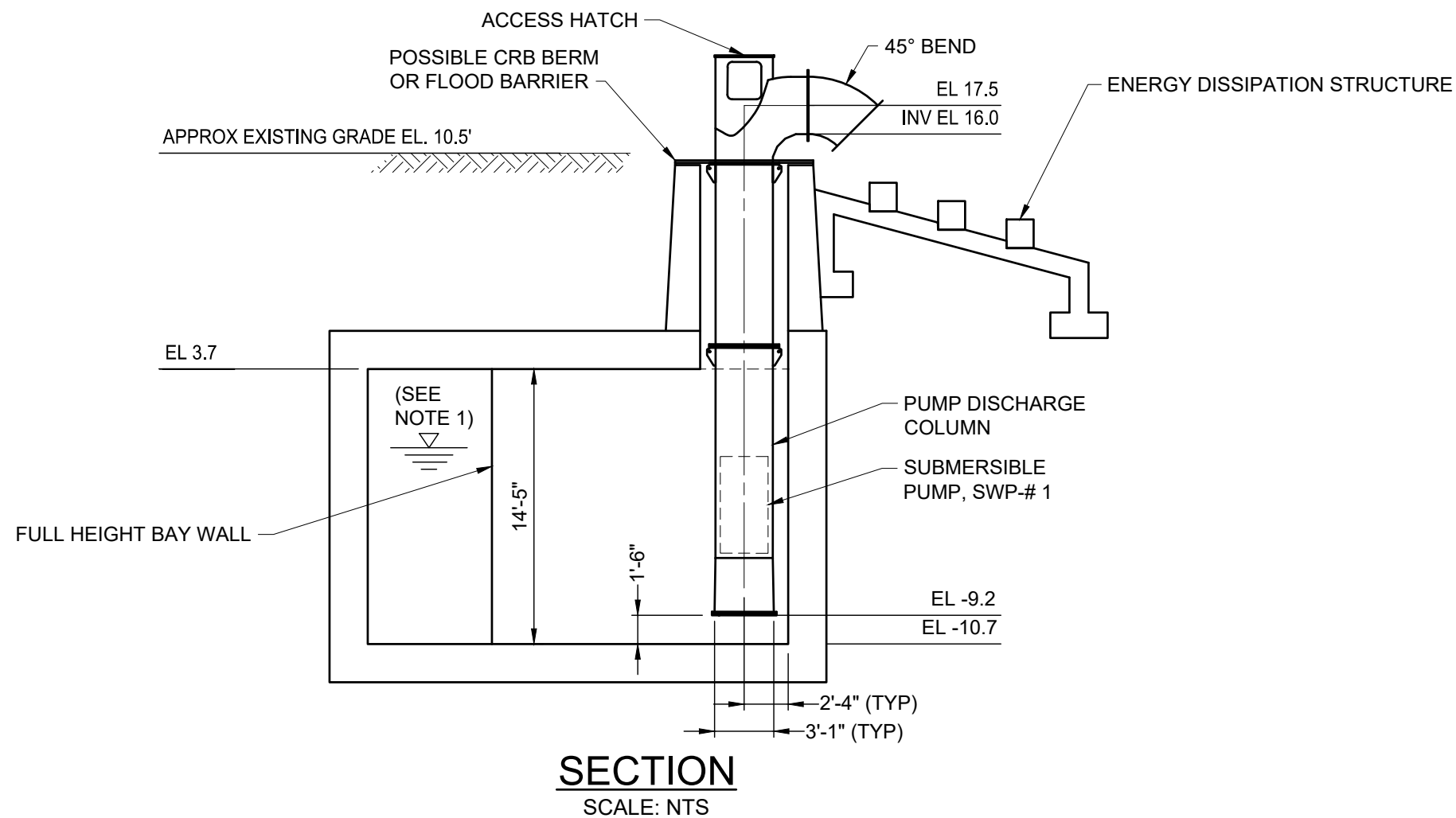
STORMWATER PUMP-1,2 OPERATIONAL WSE TABLE		
NOTE	OPERATION	ELEVATION, FT
A	HIGH LEVEL ALARM	2.7
B	LAG PUMP ON	1.7
C	LEAD PUMP ON	0.7
D	LEAD PUMP OFF	-0.3
E	LOW LOW ALARM	-1.3
G	MIN PUMP SUBMERGENCE	-2.3

COASTAL STORMWATER DISCHARGE ANALYSIS	
	
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# East Boston Waterfront Stormwater Pump Station

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### COASTAL STORMWATER DISCHARGE ANALYSIS



ATTACHMENT B  
EAST BOSTON WATERFRONT CONSOLIDATION CONDUIT ALIGNMENT DRAWINGS

B-1: Pipe Alignment Drawings

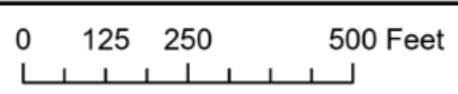
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East Boston Waterfront



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**Legend**

- Proposed Manhole
- Proposed Outfall
- Existing Outfall
- ▶ Proposed Stormwater Pipe
- ▶ Existing Storm Sewer Line



# East Boston Waterfront

## Outfall Diversion – New Pipeline

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East Boston Waterfront



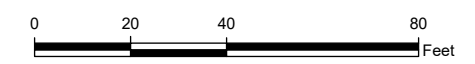
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# PROP-PIPE-73



Plan  
1" = 20'





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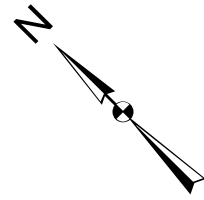
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Coastal Stormwater Discharge Analysis  
East Boston Waterfront

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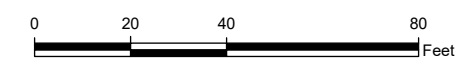




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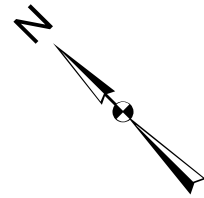
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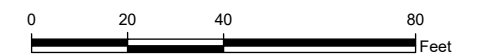
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# PROP-PIPE-75



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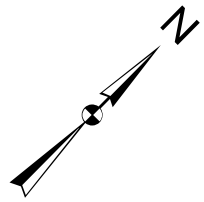
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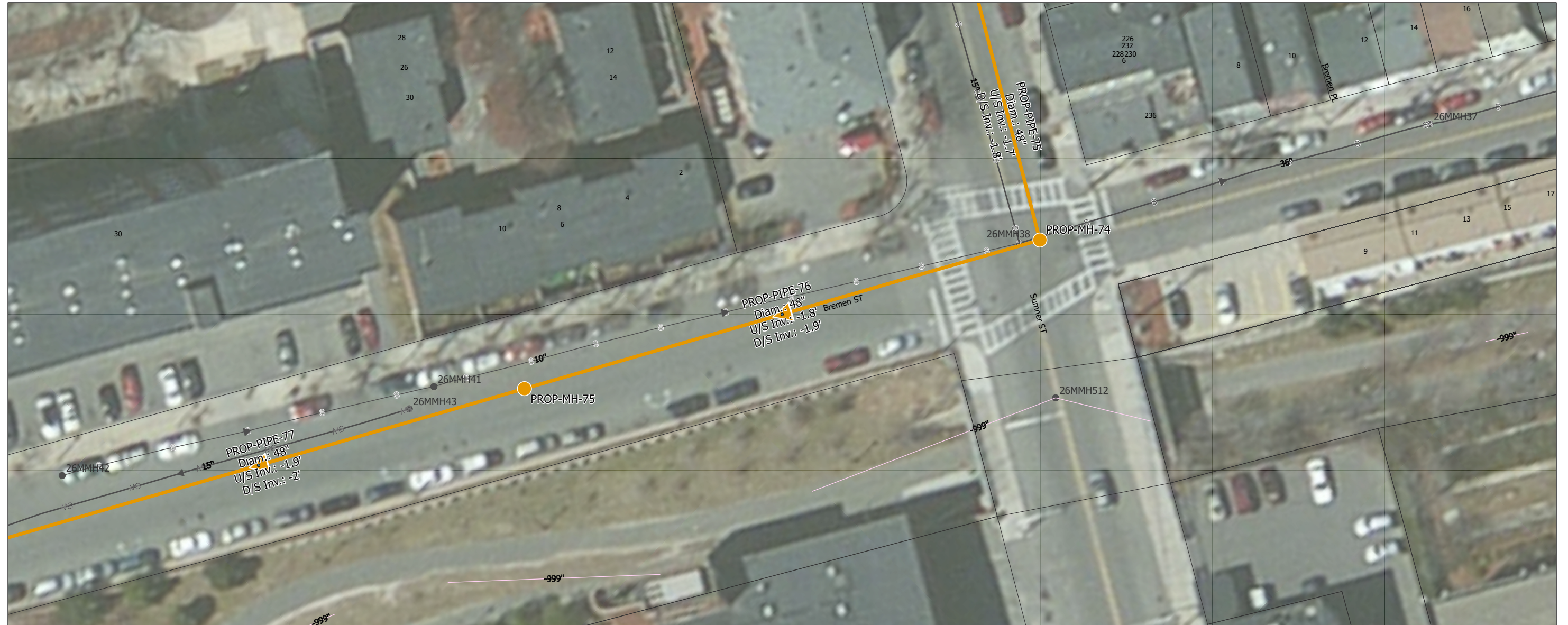
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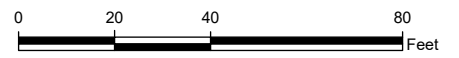
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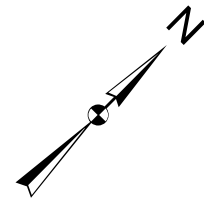
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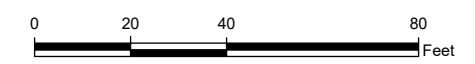
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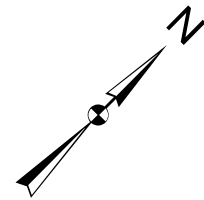
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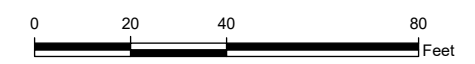
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# PROP-PIPE-78





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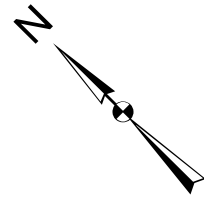
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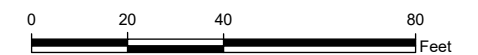
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 -PROPOSED PIPE AND MANHOLE ALIGNMENTS ARE PRELIMINARY AND CONCEPTUAL  
 -DETAILED SURVEY AND AN EVALUATION FOR SUBSURFACE CONFLICTS SHOULD BE PERFORMED BEFORE ADVANCEMENT OF THESE CONCEPTS

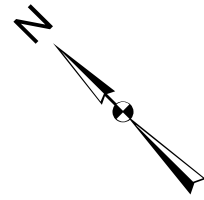
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

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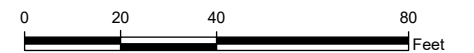
November 2022



# PROP-PIPE-80



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

**ASSUMPTIONS, DEFINITIONS, AND DISCLAIMERS**  
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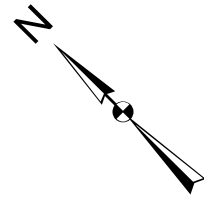
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



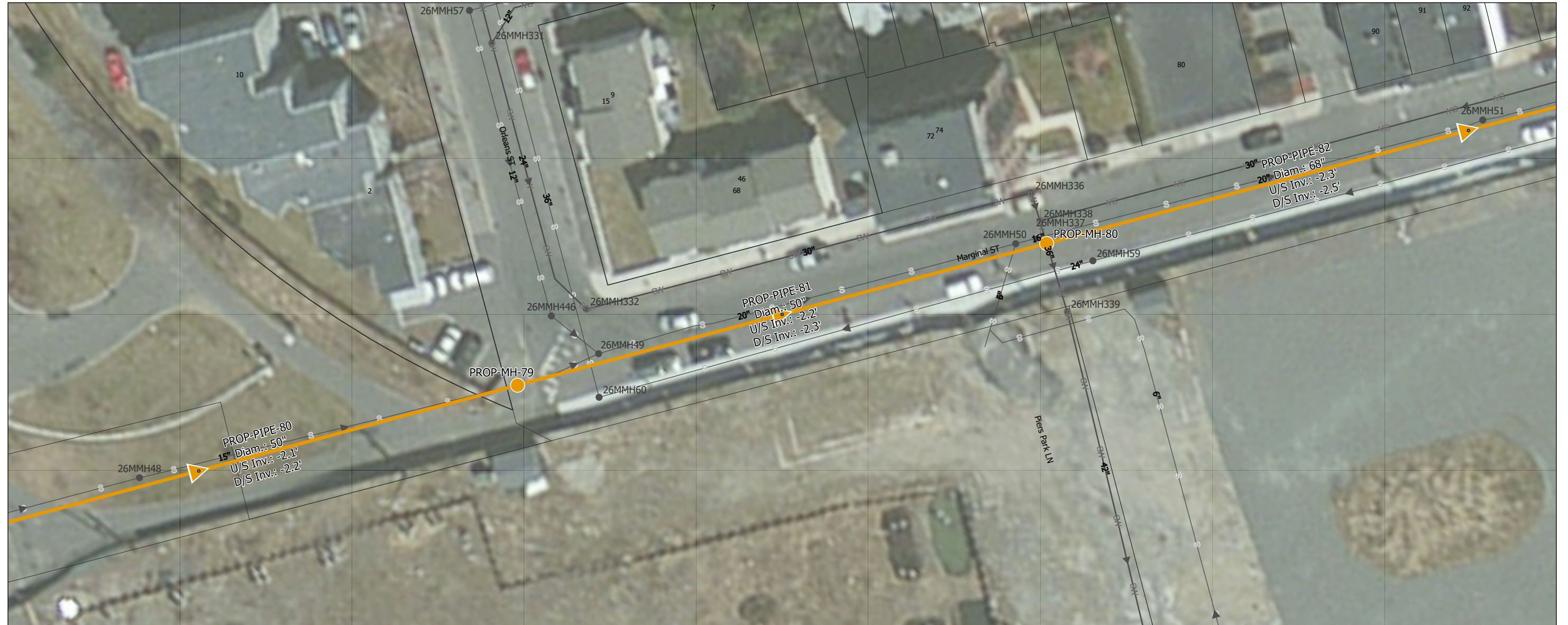
**Hazen**

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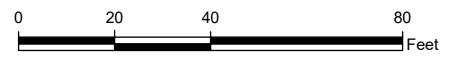
November 2022



# PROP-PIPE-81



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

ASSUMPTIONS, DEFINITIONS, AND DISCLAIMERS  
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Coastal Stormwater Discharge Analysis  
East Boston Waterfront

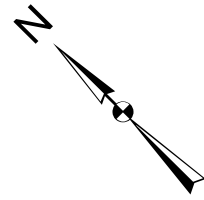


**Hazen**

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November 2022





# PROP-PIPE-82



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

ASSUMPTIONS, DEFINITIONS, AND DISCLAIMERS  
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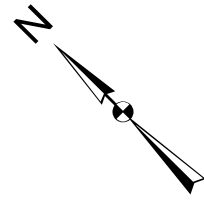
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



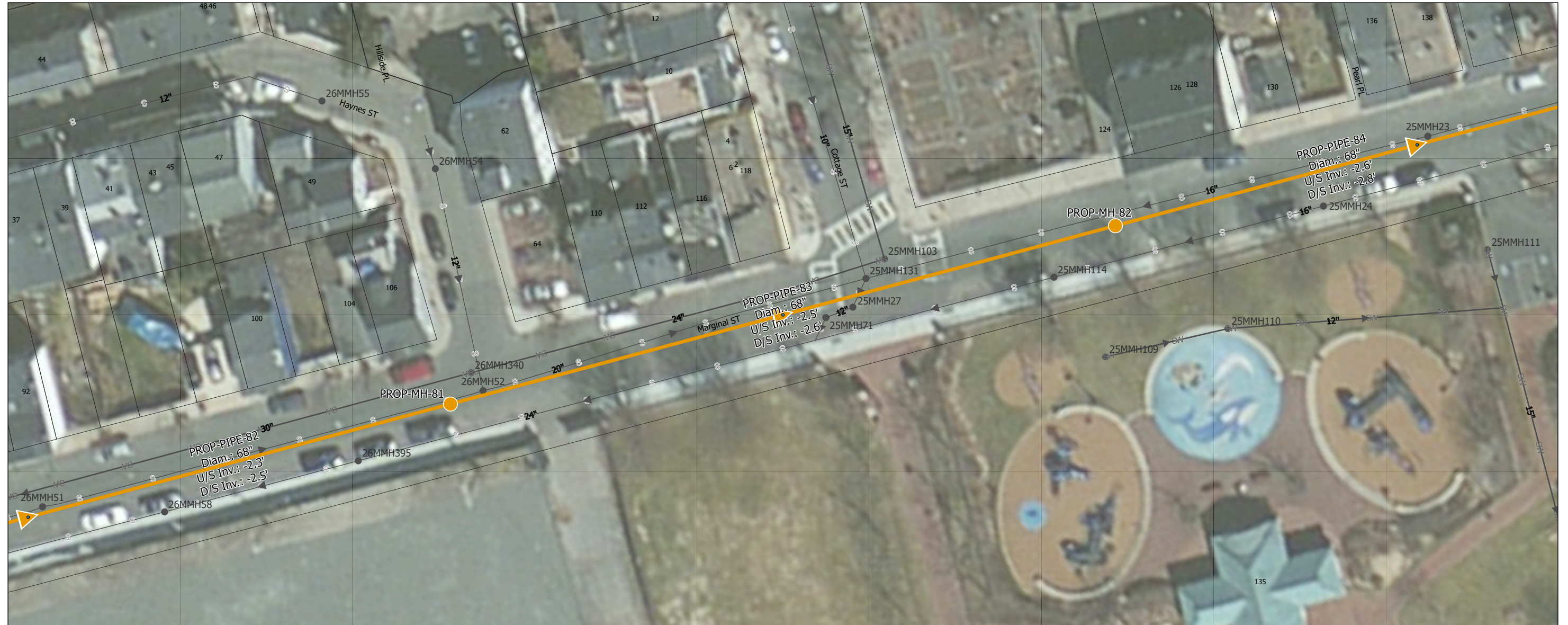
**Hazen**

B-11

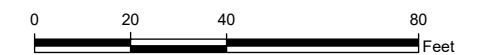
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# PROP-PIPE-83



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

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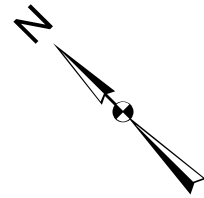
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

B-12

November 2022



# PROP-PIPE-84



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

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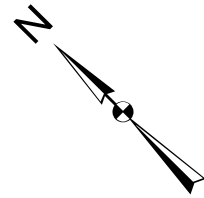
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

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November 2022



# PROP-PIPE-85



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

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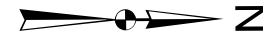
Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

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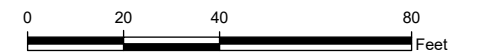
November 2022



# PROP-PIPE-86



Plan  
1" = 20'



**PRELIMINARY  
DO NOT USE FOR  
CONSTRUCTION**

ASSUMPTIONS, DEFINITIONS, AND DISCLAIMERS  
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Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

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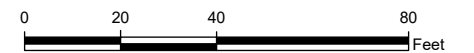
November 2022



# PROP-PIPE-87



Plan  
1" = 20'



**PRELIMINARY  
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CONSTRUCTION**

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Coastal Stormwater Discharge Analysis  
East Boston Waterfront



**Hazen**

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November 2022