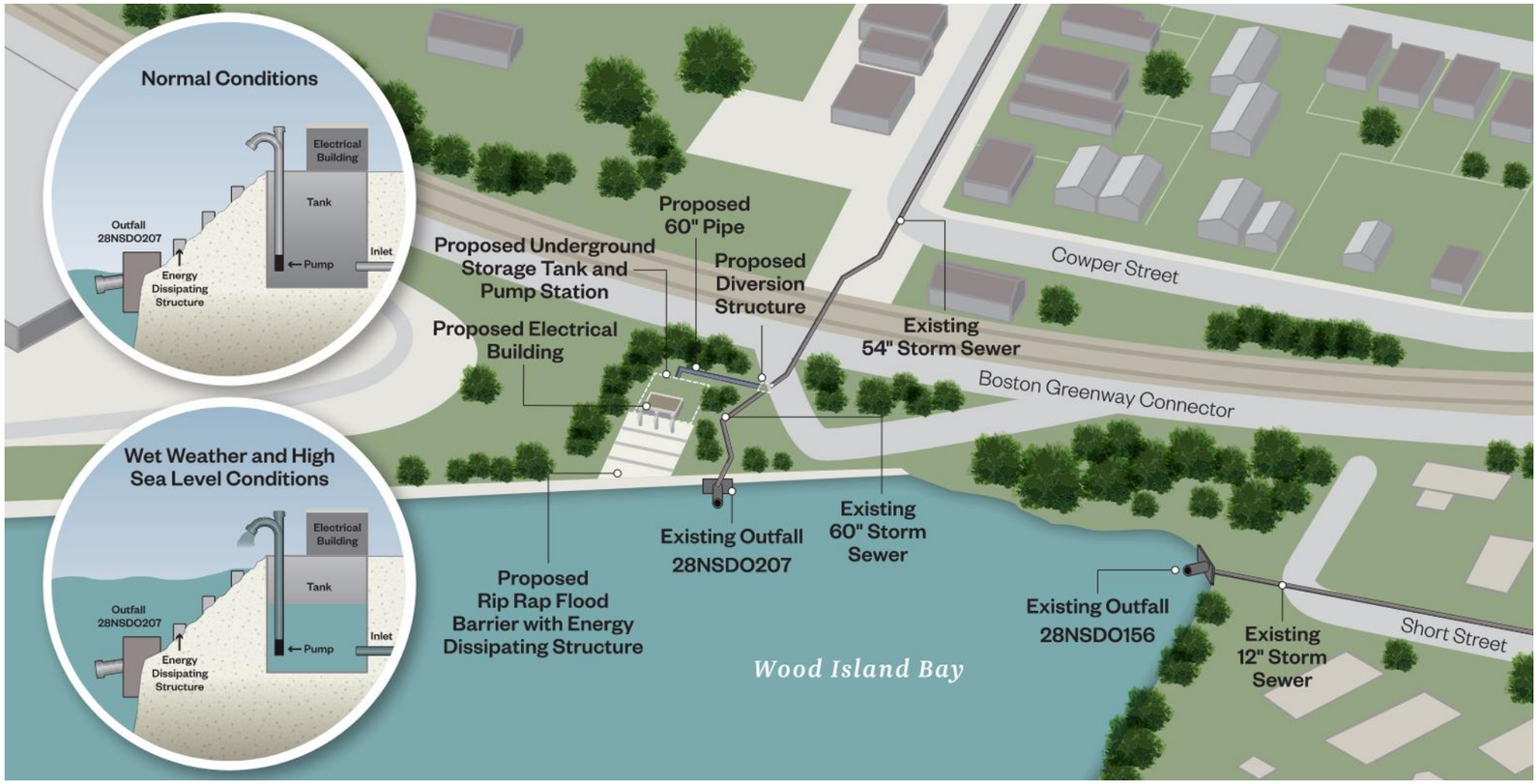
East Boston Greenway *Concept Overview*



Conceptual Solution

The conceptual solution herein includes a small stormwater storage (peak flow shaving) tank and pump station to discharge wet weather flow when tide levels are high. The tank and pump station are located along the East Boston Greenway in close proximity to the Wood Island Bay Edge Park. If a high tide level begins to reduce the ability of existing outfall 28NSDO207 to discharge by gravity the existing storm sewer will begin to surcharge. A diversion structure with a static weir directs excess flow to a small storage tank that is connected directly to the pump station. The pump station utilizes electric submersible pumps to minimize the above ground footprint of the station and mitigate negative visual and auditory impacts from diesel engine driven pumps. During extreme storm conditions a portable generator could be parked along the Greenway to provide a backup power supply in the event of a power outage. Given the high public visibility of this location, this solution could provide educational opportunities about resilient stormwater infrastructure and incorporate nature-based features (such as native plantings) to minimize the impact of new infrastructure.

Type: Storage and Pumping

Total Drainage Area: 57 acres

Coastal Flood Vulnerable Drainage Area Protected: 57 acres

Concept Elements:

- Subsurface Pump Station
- Subsurface Storage Tank
- Diversion Structure

Outfalls Included in Concept:

- 28NSDO207
- 28NSDO156

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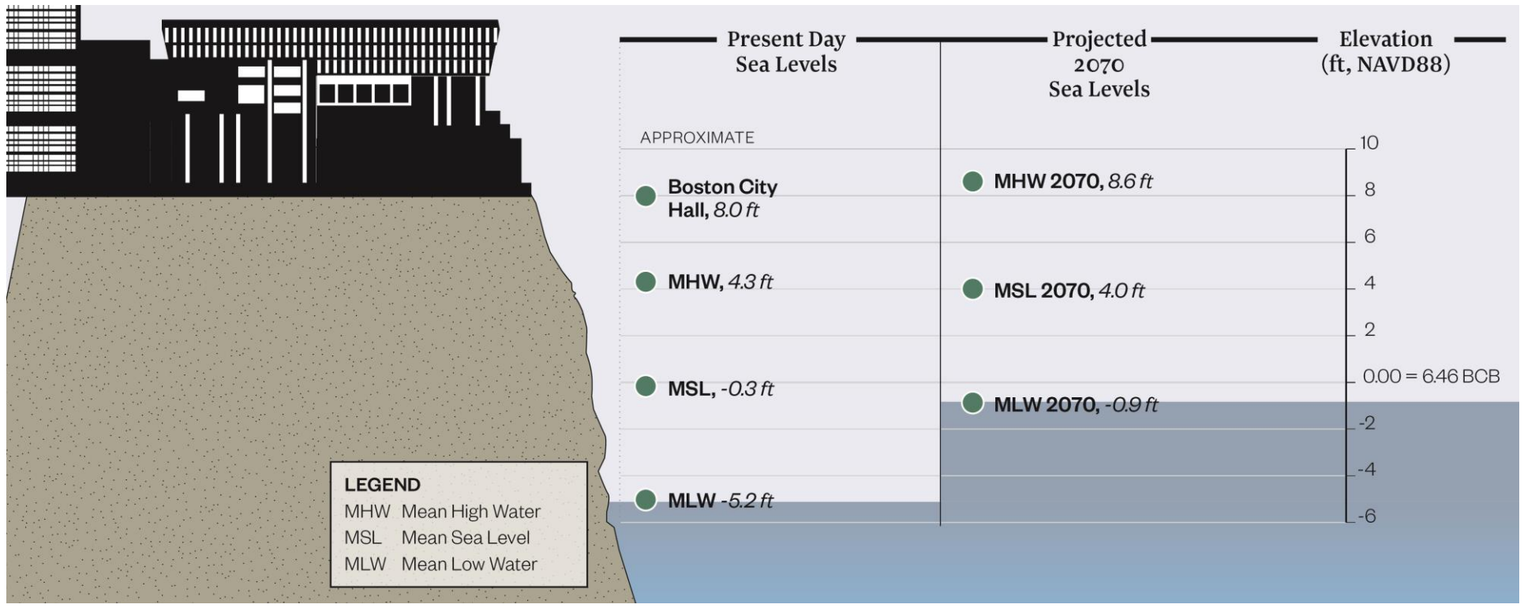
Assumptions

Sea Level Rise and Datum

The East Boston Greenway 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 Greenway 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 Outfall 28NSDO207 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 outfall. 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 0.35 MG storage tank ~26 feet deep could fit within the property with a 130 CFS pump station The pump station and storage tank occupy an area of 2,865 ft^2. The East Boston Greenway pump station utilizes two duty pumps, one standby pump, and two dewatering pumps. The pump station is configured with vertical, axial electric submersible pumps in parallel bays.

Figure 1: Pumping vs. Storage

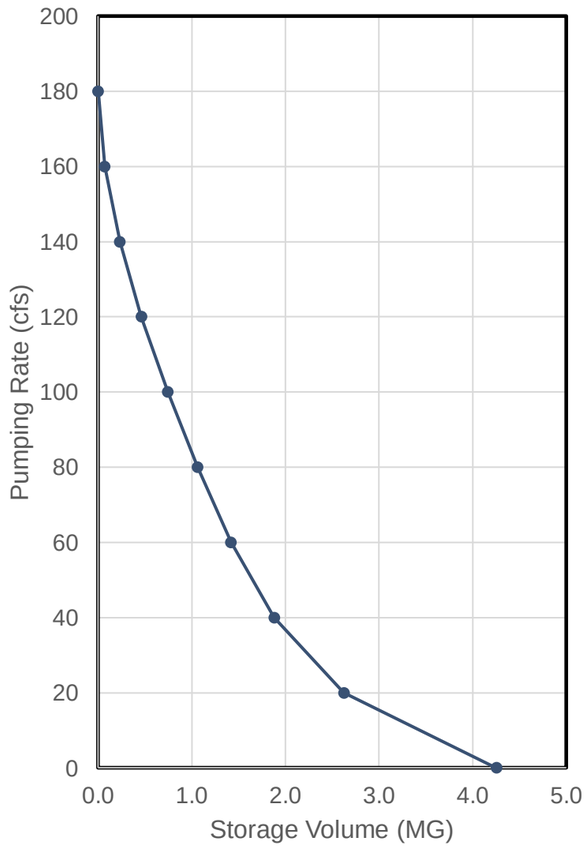


Figure 2: Peak Shaving Tank and Pump Station

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 East Boston pump station concept was also evaluated with projected rainfall from a 100-year tropical event (developed during the Commission's Inundation Model Project. The East Boston pump station 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 the East Boston pump station tributary area and Boston Harbor. 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

Flood Modeling and Damage Analysis

Figure 3: Estimated Replacement Cost

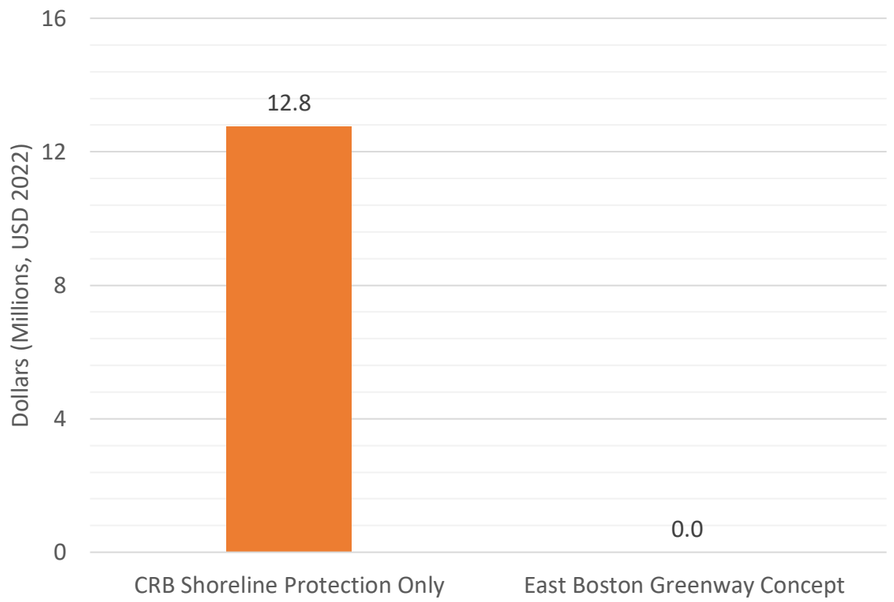


Figure 4: Loss of GDP

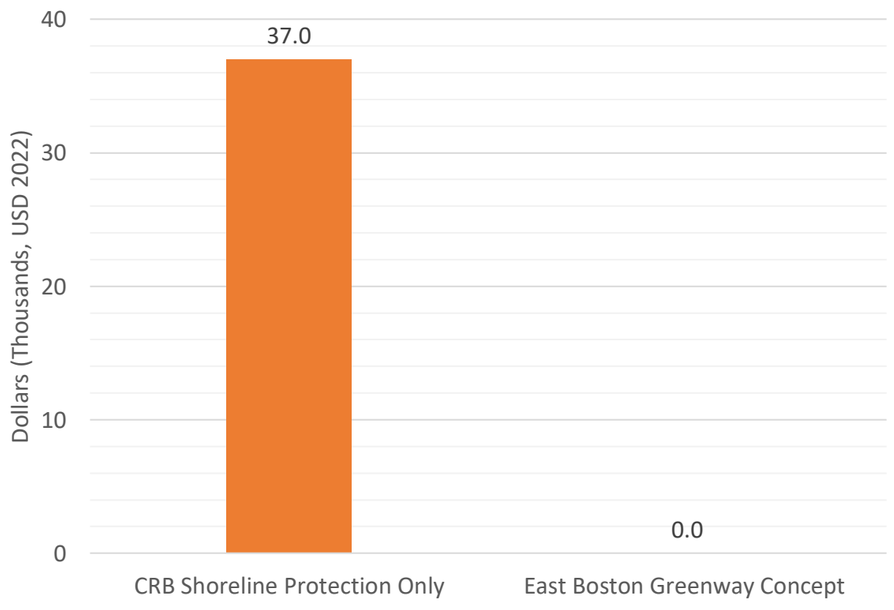
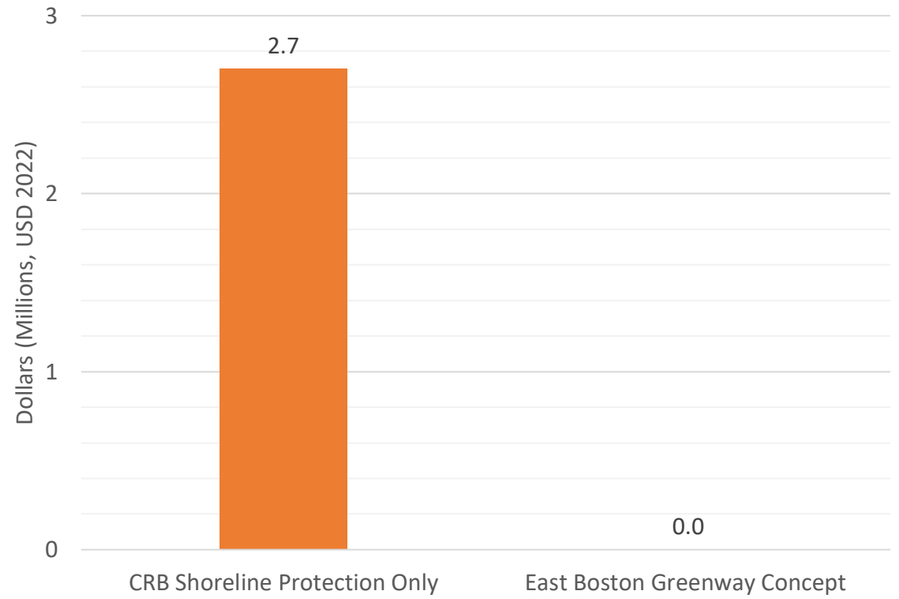


Figure 5: Physical Damage



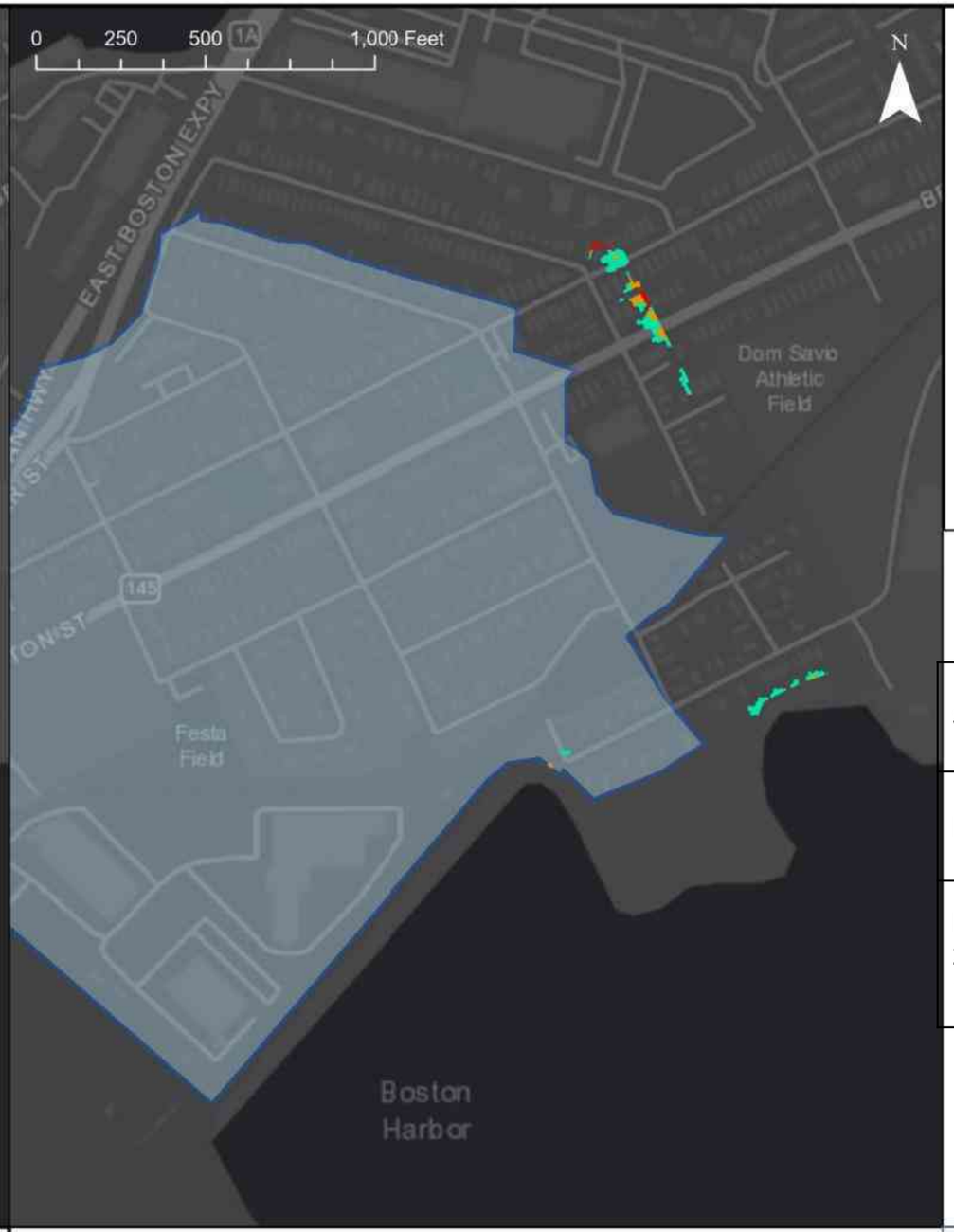
The flood reduction benefits of the East Boston Greenway pump station were evaluated using the Commission's 2D Inundation Model by simulating a 100-year tropical storm event with 2070 SLR and storm surge. The figures on the following page depict the peak flooding that was predicted in the drainage area tributary to the East Boston Greenway pump station with shoreline protection only and with the pump station 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 pump station reduces physical damage by **$2.7 million**, avoids **$12.8 million** in rebuilding costs, and mitigates a GPD loss of **$37 thousand** 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.

2070 SLR + 100yr Tropical Storm + Storm Surge

Shoreline Protection Only



2070 SLR + 100yr Tropical Storm + Storm Surge

East Boston Greenway Pump Station and Tide Gates

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

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Damage Analysis

Capital Cost Estimate

A construction cost estimate for the East Boston Greenway Pump Station concept was developed for planning purposes. Assumptions made for the Davenport Creek Stormwater Park cost estimate include 15-year escalation to the mid-point of construction and the inclusion of a 50% design contingency. Hookup costs to existing electrical services were not included in this estimate.

Table 3: East Boston Greenway Cost Estimate Subtotals

Remaining Design Development & Construction Administration (assumed 20% of total less design contingency)	$1,491,000
Direct Construction Costs	$2,936,938
Indirect Construction Costs	$587,388
Mark-Up *(Including 50% design contingency)*	$7,517,674
Total	**$12,533,000**

Social Vulnerability and FEMA BRIC Funding

FEMA BRIC funding prioritizes disadvantaged communities. Table 4 contains a summary of several indicators for the East Boston Greenway 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 Greenway Tributary Area Social Vulnerability Indicators

Low Income & Persistent Poverty	
Per Capita Income	$37,917
Below Poverty Line	16%
High Housing Cost Burden	
Stressed Renters (>40% rent-to-income)	33%
Households With Food Insecurity	14%
Racial and Ethnic Segregation	
Asian Population	5%
Black Population	4%
Latino Population	46%
White Population	61%
Education and Employment	
Adults Age 25+ Without High School (or equivalent) Degree	14%
Unemployment (Age 16+)	5%

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

Planting Palette

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

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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Conceptual Design – Not for Construction

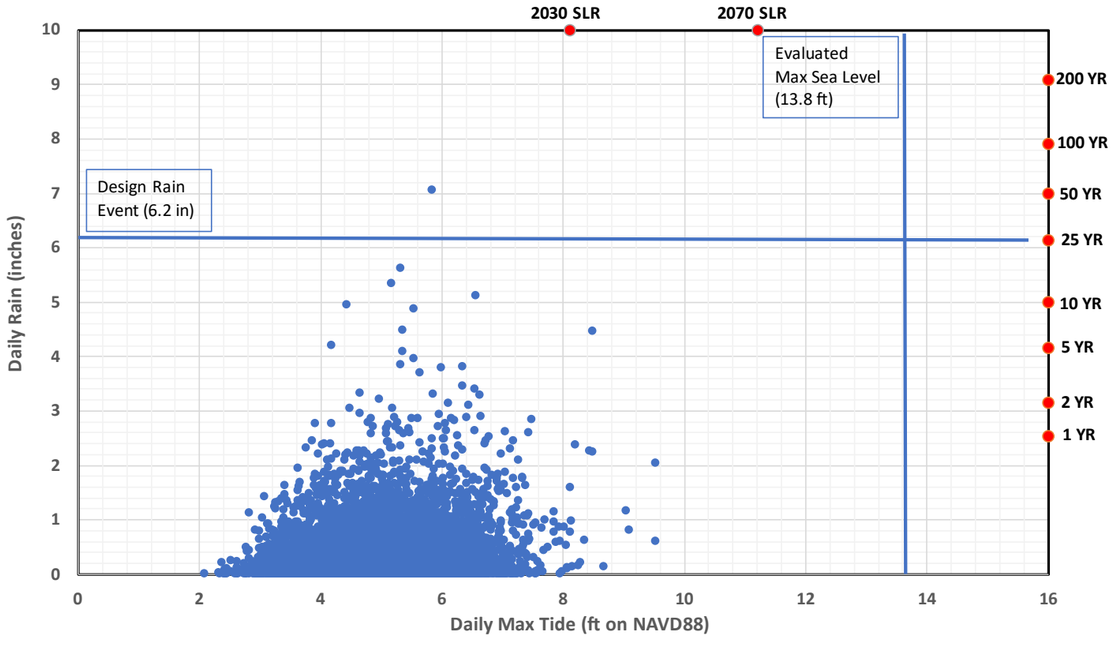
Adaptability and Implementation

Adaptability

Figure 6 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 Greenway 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 peak shaving tank
- Consider construction of a larger storage and pump facility at the large privately owned vacant parcel between Short Street and Byron Street.
- Flow from Outfall 28NSDO206 could be redirected to the pump station if it is found that the existing outfall is a source of flooding. The East Boston greenway pump station concept is designed to accommodate this additional flow.

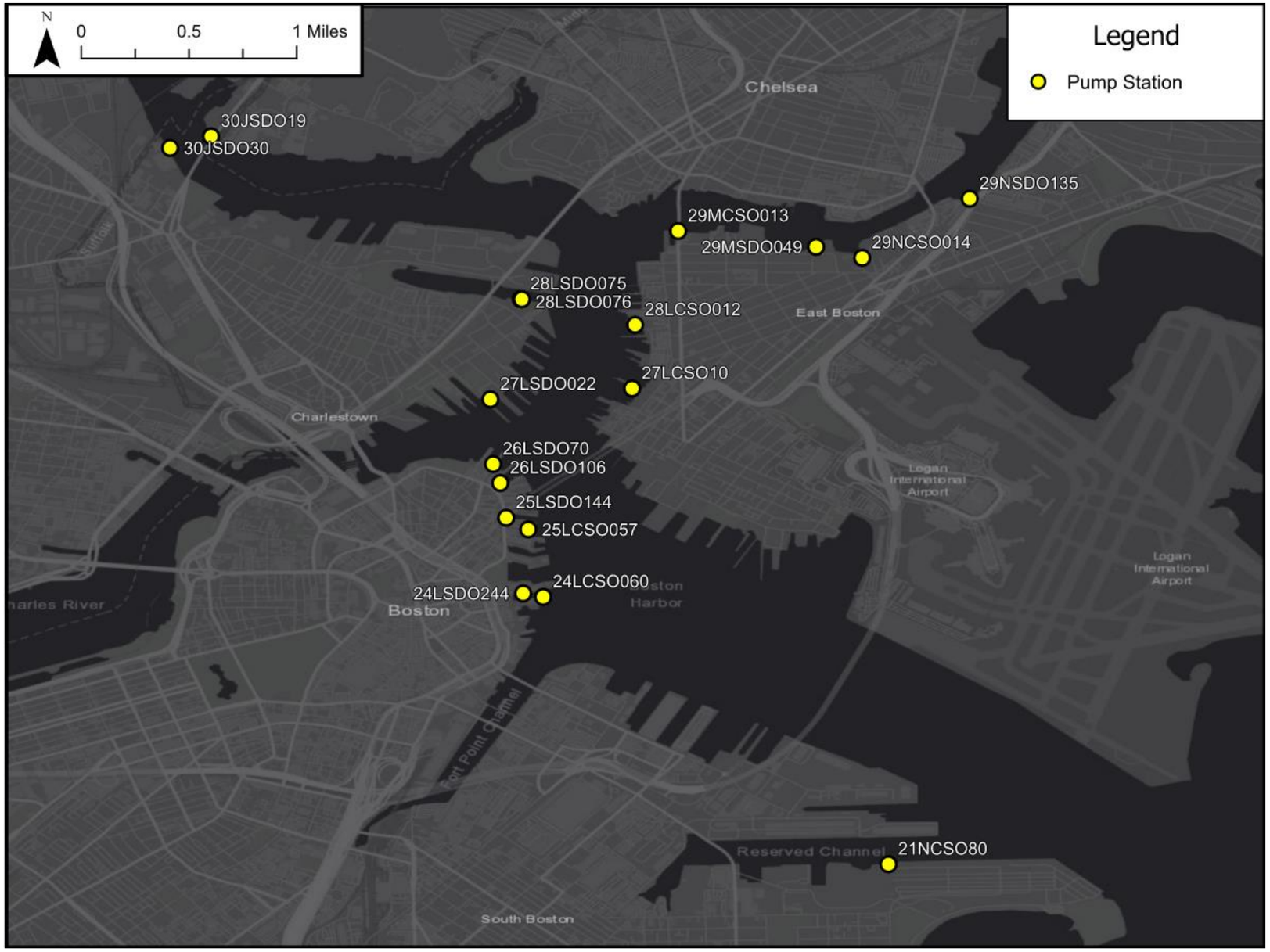
Figure 6: Design and Analysis Conditions vs. Historical Tide and Rainfall



Implementation Considerations

- Compared to other coastal stormwater concepts, the East Boston Greenway Pump station is smaller in size and cost. This project could provide a “pilot” opportunity to implement a coastal stormwater project and shoreline adaptation in parallel.
- Coordination with CRB is necessary to implement shoreline protection. The pump station should not be implemented without shoreline protection to prevent coastal flooding within the area tributary to it.
- Planting of native plant species and other green features will provide an improved public amenity and preserve the “look and feel” of the greenway.
- Community engagement with stakeholders may help build project support by illustrating the flood control benefits of the pump station.
- A comprehensive permitting evaluation should be conducted to evaluate possible impacts from construction and operation of the pump station to the receiving water (marsh area).
- Constructability of the currently proposed concept should be analyzed in greater detail to determine possible impacts to the Greenway. If necessary, the design could be modified to mitigate potential impacts to Greenway users.

Replicability and Implementation Timeline



Summary of Similar Concepts

Number of Sites: 18

Vulnerable Area: 422 acres

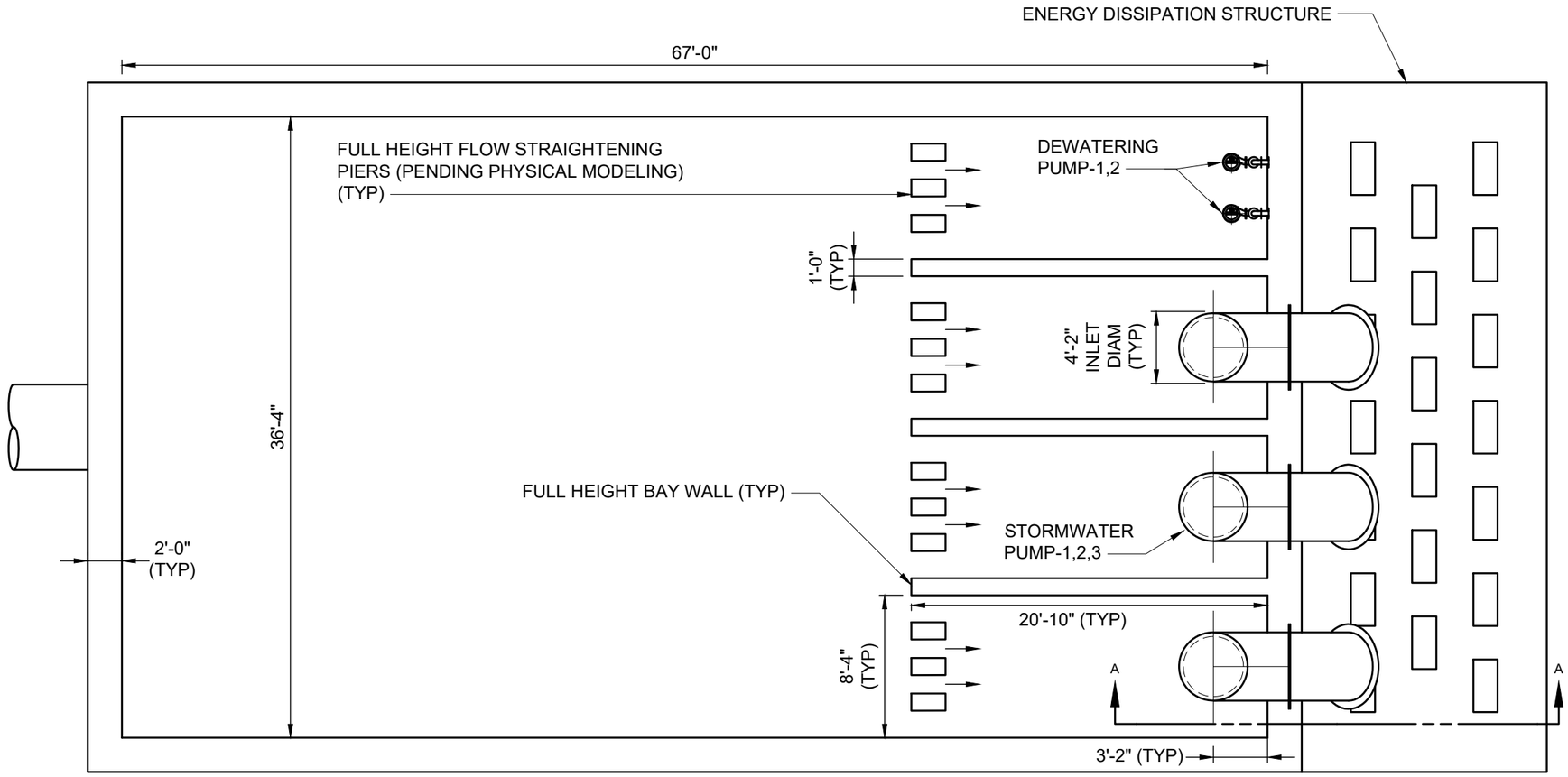
The map on this sheet depicts other vulnerable outfalls that could be adapted with electric submersible pump stations. In some locations, several outfalls could be consolidated with a new conduit that conveys flow to a single pump station.

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

ATTACHMENT A
EAST BOSTON GREENWAY CONCEPTUAL DESIGN DRAWINGS

A-1: Pump Station Overview Plan
A-2: Pump Station Section View

East Boston Stormwater Pump Station



OVERVIEW PLAN

SCALE: NTS

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-1,2,3 OPERATIONAL PARAMETERS	
FLOW RATE, CFS	67
STATIC HEAD RANGE, FT	14.8 - 23.8
DESIGN FLOOD ELEVATION, FT	16.0

STORMWATER PUMP-1,2,3 OPERATIONAL WSE TABLE

NOTE	OPERATION	ELEVATION, FT
A	HIGH LEVEL ALARM	2.7
B	LAG PUMP ON	1.7
C	LEAD PUMP ON	-2.3
D	LEAD PUMP OFF	-3.3
E	LOW LOW ALARM	-4.3
G	MIN PUMP SUBMERGENCE	-5.3

COASTAL STORMWATER DISCHARGE ANALYSIS

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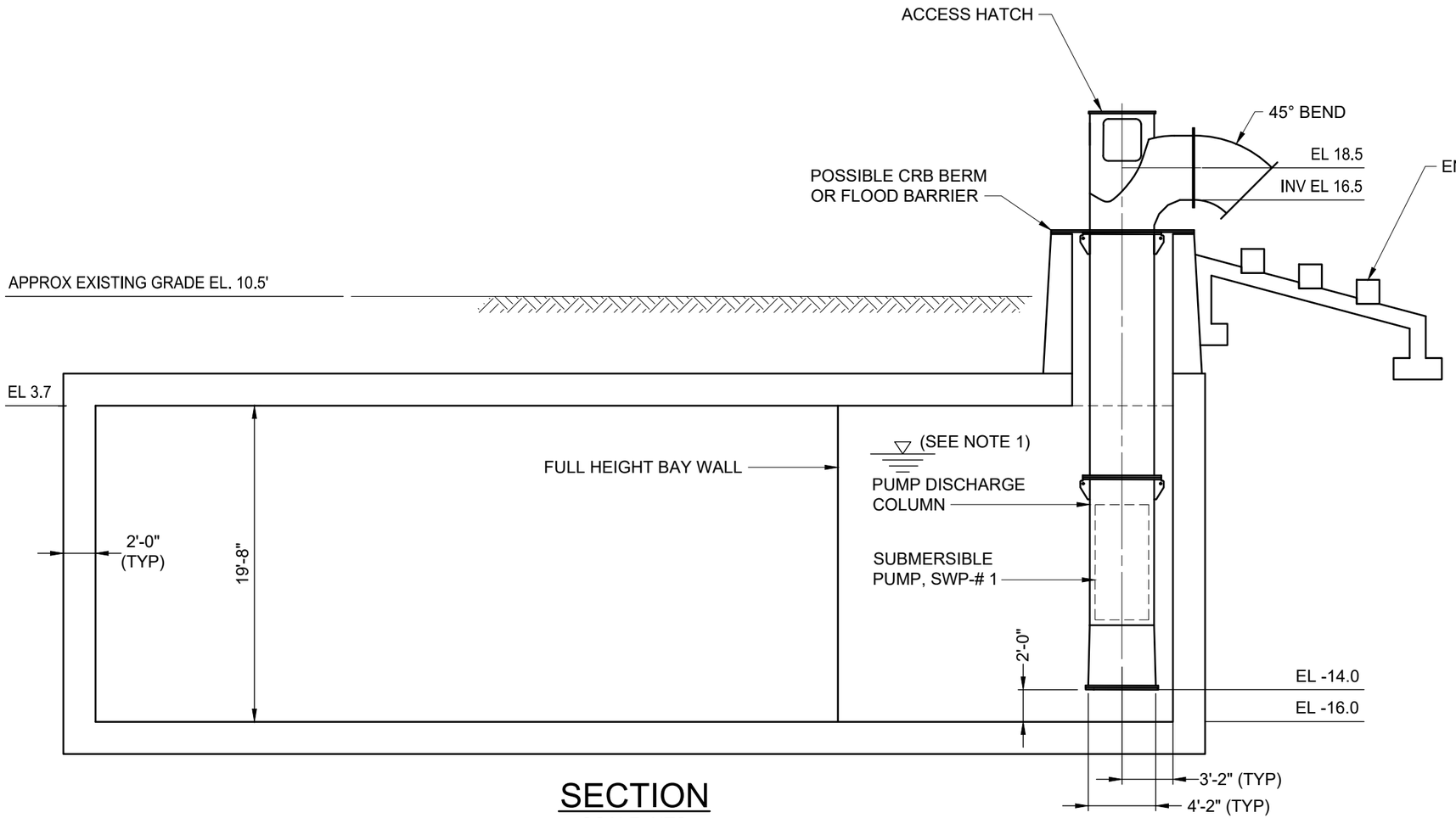
East Boston Stormwater Pump Station



SECTION
SCALE: NTS

NOTES

1. FOR WATER SURFACE ELEVATIONS REFER TO OPERATIONAL TABLE.
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E	LOW LOW ALARM	-4.3
G	MIN PUMP SUBMERGENCE	-5.3

COASTAL STORMWATER
DISCHARGE ANALYSIS

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ATTACHMENT B
EAST BOSTON GREENWAY DIVERSION PIPELINE ALIGNMENT DRAWINGS

B-1: Pipe Alignment Drawings

East Boston Greenway

Flow from existing outfalls 28NSDO207 and 28NSDO156 is diverted to the East Boston Greenway concept.

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