Tighe&Bond

FY20 Municipal Vulnerability Action Grant Executive Office of Energy & Environmental Affairs

COASTAL FLOOD MITIGATION STORM DRAINAGE IMPROVEMENTS: PHASE 1 ENGINEERING & PUBLIC OUTREACH

March 2018 “Storm Riley” Innovyze® InfoWorks Model Validation Storm

JUNE 30, 2020, FINAL REPORT SUBMITTED TO

Quincy Public Works Department

Quincy, MA

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Table of Contents

Figures

Tables

Section 1
Introduction

The City of Quincy ("City") experiences significant impacts to residents, businesses, and municipal operations from both coastal and inland storm events. Since 1990, the City has encountered 18 storm events that have triggered federal or state disaster declarations, in addition to other hurricanes, Nor'easters, blizzards, and high wind and heavy precipitation events. Most of these storms have involved flooding. Damages to property and infrastructure, lost wages, and resulting insurance claims due to severe weather are commonplace. From 1978 to 2003, there were only three years *without* approved flood insurance claims within the City. From 1978 to November 2007, National Flood Insurance Program participants in Quincy received more than $5 million in claims.

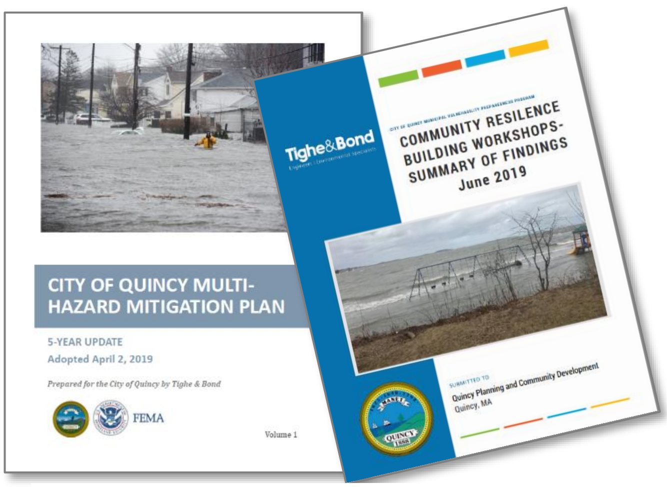


Figure 1-1: City's Recent Planning Reports Related to Hazard Mitigation

The City has been continuously planning for and undertaking both proactive and reactive flood and storm mitigation actions over decades. In recent years, this includes efforts such as upgrading and redirecting drainage in various parts of the City (e.g., Town Brook), designing, permitting, and constructing seawall improvements, initiating a plan to complete a city-wide model of the drainage system, recently completing a new Hazard Mitigation Plan (HMP), and bolstering the HMP with stakeholder engagement under a Municipal Vulnerability and Preparedness (MVP) planning grant that allowed the City to achieve MVP Designation from the Executive Office of Energy and Environmental Affairs (EEA).

1.1 Recent Storms Reinforced the Need for Mitigation

Quincy had been in the process of preparing the updated HMP, including further identifying and prioritizing mitigation actions to address climate resiliency, and proceeding with permitting of improvements to the Adams Shore seawall, when early in 2018, there were three nor'easters that severely impacted the City in January and March[1]. In particular, Winter Storm Riley, which occurred March 2nd and

Figure 1-2: Wave Overtopping Seawall During Winter Storm Riley

[1] January 4, 2018 – Winter Storm Grayson, March 2-3, 2018 - Winter Storm Riley, and March 14-15, 2018 - Winter Storm Skylar

3rd, was a Nor'easter with sustained high winds that coincided with multiple astronomical high tides and soaking rains, therefore resulting in widespread coastal flooding, emergency evacuations, power outages and structural damage. The tide was the 3rd highest ever recorded in Massachusetts. A State of Emergency was declared on March 3rd. FEMA Disaster DR-4372 was declared on June 25, 2018. It is estimated that more than $30 million in damages were sustained by Quincy's seawalls, roadways, tide gates, and water resource areas including beaches, as well as an estimated additional $10-$20 million in damages sustained by property.

Figure 1-3: Sea Street flooded during Winter Storm Riley, rendering it impassable

Sea Street runs almost the entire length of the Houghs Neck peninsula connecting interior sections of the peninsula with major road networks and providing access to emergency services. Under certain storm conditions, low lying sections including Sea Street are flooded by water from the abutting marsh. The outlying eastern parts of Houghs Neck may become stranded until flood waters subside. Evacuation of these flood prone areas becomes mandatory, not only to protect residents from flood waters, but because access to emergency services is cut off. The MWRA sewer line creates a "dike" that hydraulically separates the northern portion of from the southern portion of Houghs Neck. This can be used as an emergency evacuation route for only pedestrians during flooding emergencies. Vehicles are prohibited to protect the over 100-year-old sewer line that carries wastewater from numerous communities to Nut Island and ultimately through the cross-harbor tunnel to Deer Island.

This storm confirmed the vulnerability along Adams Shore and Houghs Neck to coastal storm events coupled with inland flooding due to precipitation that is either intense, long in duration, or both. The State Hazard Mitigation Plan notes that Quincy has the fifth highest number of flood-related repetitive losses in the Commonwealth, and the vast majority are located within in Houghs Neck. According to the Quincy Hazard Mitigation Plan, nearly one-third of all residential and commercial properties in the Houghs Neck area are located within the 100-year flood hazard area with a combined building value over $338 million.

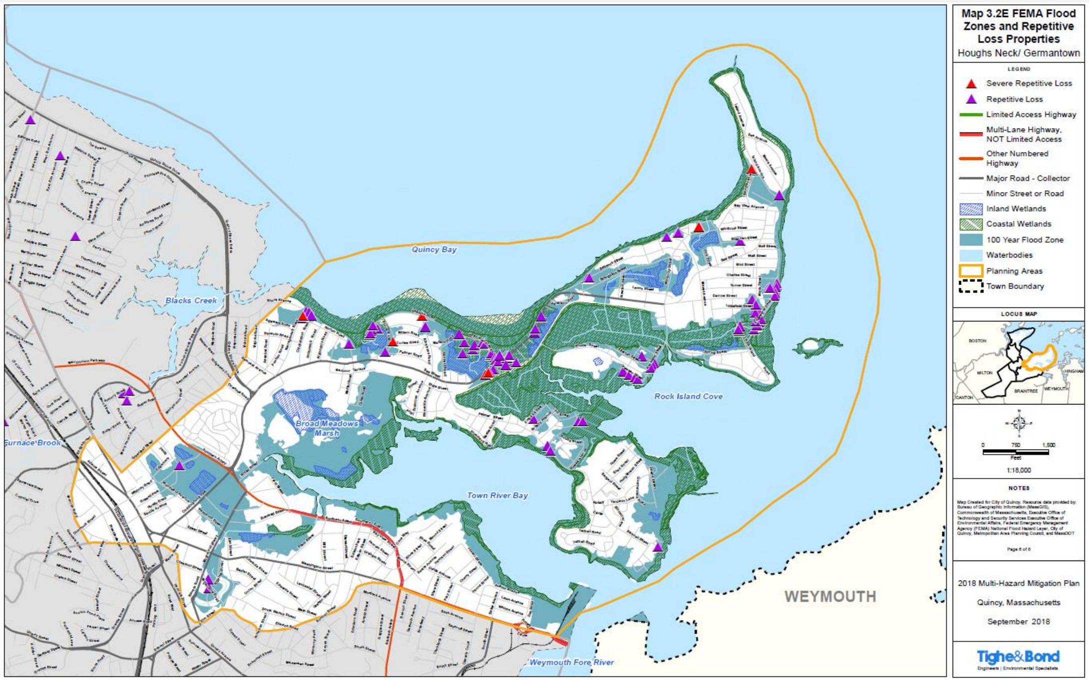


Figure 1-4: FEMA Flood Zones and Repetitive Loss Properties (from Hazard Mitigation Plan)

1.2 Considering Climate Change

While Winter Storm Riley was devastating, future flooding and storm events are likely to be further exacerbated by sea level rise and more frequent and intense storms caused by climate change. The City is proactively utilizing publicly available data to plan for climate change as part completing mitigation projects.

Climate change projections for Quincy were reviewed using multiple sources including the 2017 Quincy Resilient Plan (QRP) and data from the Northeast Climate Science Center (NCSC) at the University of Massachusetts Amherst developed for inclusion in the 2018 State HMP Plan. Researchers from the Northeast Climate Science Center (NCSC) at the University of Massachusetts Amherst developed downscaled projections for changes in temperature, precipitation, and sea level rise for the Commonwealth of Massachusetts. The Executive Office of Energy and Environmental Affairs (EEA) has provided support for these projections to enable municipalities, industry, organizations, state government and other interested parties to utilize a standard, peer-reviewed set of climate change projections that show how the climate is likely to change in Massachusetts through the end of this century. These projections are incorporated into the 2018 State HMP. To ensure consistency with the State HMP, Quincy has adopted data developed for the Boston Harbor region from the State-wide climate change projections (2018, NCSC and EEA). The impacts on coastal and inland flooding due to climate change are discussed extensively in the City's Hazard Mitigation Plan.

1.3 Repairing the Seawall Helped in the Short Term

Emergency repairs sustained during winter Storm Riley were completed at numerous locations along the coastline, including Adams Shore and Houghs Neck. These repairs were necessary to protect public and private property in the areas around the damage. The following photos are representative of these corrective actions in various locations.

Figure 1-5: Examples of damage due to Winter Storm Riley and Emergency Repairs Completed with Federal Funding

1.4 Raising the Seawall and Improving Associated Drainage will Mitigate Impacts from Coastal Storms

To reduce impacts from storm events, the City had been proceeding with full reconstruction and upgrades to the seawall along Adams Shore, inclusive of improvements to drainage infrastructure discharging through that seawall. The limits of this work and the typical seawall repair detail are shown below.

Figure 1-6: Limits of Seawall Improvements Underway

The seawall is being raised from elevation 11 to approximately elevation 13 (NAVD88 datum). Helical anchors are also being installed so the City can add a 2 feet extension in the future, further elevating the seawall structure to elevation 15.

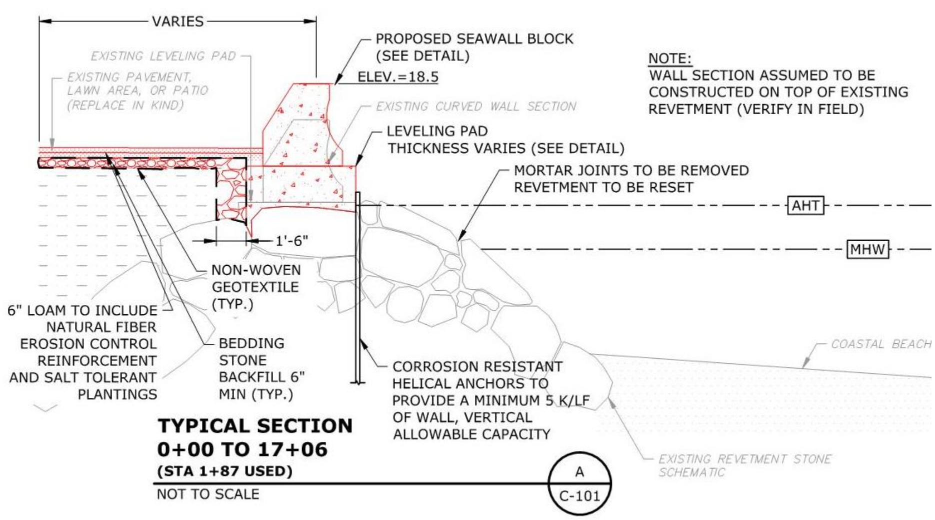


Figure 1-7: Typical Detail for Seawall Repair
Note: NAVD88 elevation 13 = 18.5 MLLW Datum

Certain drainage infrastructure in the vicinity of the seawall, or through the seawall, is being upgraded to improve discharge capacity, and to prevent backflow of ocean water into the drainage system with the addition of rubber check ("flapper") valves.

1.5 Inland Drainage Solutions Require Evaluation

The City recognized that even though many important coastal improvements are in progress, inland areas need further evaluation to better define drainage solutions to further protect residents and minimize damages to personal property and public infrastructure.

The City of Quincy received Fiscal Year (FY20) funding from the MVP program in the form of an Action Grant to complete engineering analysis and public outreach as the first phase to evaluate options for stormwater drainage improvements along the shoreline of Adams Shore and north side of the Houghs Neck neighborhood, as shown in the following figure. This area consists of 420 acres along 2.8 miles of shoreline, over 6.5 miles of drainage infrastructure including 22 outfalls, 525 structures, 12 one-way check valves, and 1 tide gate.

Figure 1-8: MVP Action Grant Study/Modeling Area

Based on the conditions observed during Winter Storm Riley, a number of locations in this study area were targeted as critical locations for tide gate improvements and other drainage modifications or upgrades. The ability of salt marshes and low areas inland in Houghs Neck to adequately drain is currently limited during extreme high tides, especially if there is additional storm surge. The locations including evacuation routes and other roadways, utilities, and properties are particularly vulnerable to coastal and inland flooding.

The grant-funded program includes engineering analysis including hydraulic modeling, to better understand site-specific flood conditions in these vulnerable areas, now and under various storm and climate change scenarios, to help the City refine recommended alternatives for storm mitigation system design. This project was ranked as a top priority to address inland and coastal flooding in Quincy's recently completed Hazard Mitigation Plan and the Municipal Vulnerability Preparedness Summary of Findings Report. This summary report describes the work completed during the grant period, documents public comment received, and provides recommendations for next steps.

Section 2
Adams Shore/Houghs Neck Model Development

The primary component of this MVP Action Grant-funded program is development of a calibrated and validated model of the study area that is used to better understand the following scenarios under a variety of storm events:

1. Existing conditions;
2. Near-term future conditions that reflect the in-progress and soon to be completed raising the seawall by 2 feet and associated drainage improvements;
3. Potential future conditions that reflect raising the seawall by 4 feet; and
4. Drainage system alternatives for up to five potential solutions.

The modeling work also considers impacts of climate change due to sea level rise and extreme precipitation.

Modeling was competing using Innovyze® InfoWorks ICM (Integrated Catchment Management) modeling software. This program allows modeling of complex hydraulic and hydrologic networks and has inputs for both natural (e.g., wetlands, waterbodies, etc.) and constructed elements (e.g., drainage, tide gates, seawalls, pump stations, etc.). The software portrays both one dimensional infrastructure and two-dimensional flows.

2.1 Data Gathering and Coordination

Data was acquired from City, State, regional, and federal sources to provide an accurate representation of the region to support the development of the Adams Shore/Houghs Neck InfoWorks ICM Model. The data collected for the modeling analysis is listed in Table 2-1. A detailed description of each specific dataset and its source is provided in Appendix A.

It is important to note that the modeling built on previous data gathering, including survey, and design efforts of the Adams Shore/Houghs Neck Seawall area, the Manet Seawall area, and portions of Sea Street. This effort also incorporated information from the City's GIS drainage system mapping and referenced available as-builts for drainage in the project area.

A land surveying subcontractor was hired to collect topographic information and existing conditions information of significant drainage structures missing existing mapping or survey information according to the City data. To be consistent with existing City survey and mapping information, the North American Datum of 1983 (NAD 83) horizontal datum and the North American Vertical Datum of 1988 (NAVD 88) vertical datum were used. Information collected included inverts, structure rim/grate elevations, pipe sizes, and material type of pipes entering and exiting the drainage structures.

Data collected during the MVP Action Grant was shared with the City's GIS Coordinator to update the City's drainage system mapping and data management in GIS to reflect actual conditions and providing a consistent datum.

TABLE 2-1
Data Sources for the Adams Shore/Houghs Neck InfoWorks ICM Model

Category	Item	Source/Reference
State & National GIS Data	Elevation Terrain	MassGIS* 2013-2014 LiDAR Dataset
	Hydrologic Soil Type	Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO)
	Land Cover/Land Use	MassGIS* 2016 Land Cover / Land Use Dataset
City of Quincy GIS Data	Building Footprint Data	City of Quincy GIS Geodatabase
Seawall Data	Existing Seawall Geometry	*Adams Shore/Houghs Neck Seawall Survey* - prepared by Corner Post Land Surveying, Inc., dated August 2017. *Manet Avenue Seawall Survey* - prepared by Corner Post Land Surveying, Inc., October 2018.
	Proposed Seawall Geometry	*Adams Shore/Houghs Neck Seawall Repairs & Improvements Design Drawings* - prepared by Tighe & Bond, January 2020. *Manet Avenue Seawall Repairs & Improvements Design Drawings* - prepared by Tighe & Bond, October 2019.
Stormwater Drainage Data	Existing Stormwater Drainage Network	City of Quincy GIS Geodatabase City of Quincy *Plan of Storm Drains* dated 1932 with varying revision dates. *Adams Shore/Houghs Neck Seawall Survey* - prepared by Corner Post Land Surveying, Inc., dated August 2017. *Manet Avenue Seawall Survey* - prepared by Corner Post Land Surveying, Inc., October 2018. The *Adams Shore/Houghs Neck Stormwater Survey*– prepared by Feldman Land Surveyors, April 2020.
	Geometry of Select Drainage Structures	The *Adams Shore/Houghs Neck Stormwater Survey*– prepared by Feldman Land Surveyors, April 2020.
Precipitation Data	Extreme Precipitation Rainfall Depths	Northeast Regional Climate Center (NRCC) Extreme Precipitation Analysis
	Historical Precipitation	National Oceanic and Atmospheric Administration (NOAA) Climate Data - Quality Controlled Hourly Precipitation
Coastal Data	Approximation of Historical Flooding Extents	Federal Emergency Management Agency (FEMA) Repetitive Loss Data
	Coastal Tide Elevations	NOAA Tides & Currents – Extreme Water Levels Station 8443970 - Boston, MA Federal Emergency Management Agency (FEMA) Letter of Map Revision (LOMR) Case No. 15-01-0874P effective August 21, 2015 for the City of Quincy
	Historical Tide & Water Levels	NOAA Tide & Currents – Water Levels Station 8443970 - Boston, MA
	Sea Level Rise	2019 City of Quincy Hazard Mitigation Plan

* MassGIS is the Commonwealth of Massachusetts, Executive Office of Technology Services and Security, Bureau of Geographic Information

2.2 Model Preparation

Appendix B describes the full methodology used to create the Adams Shore/Houghs Neck InfoWorks ICM model. Following is a brief overview of the model development:

- All information included in the model was standardized to the North American Vertical Datum of 1988 (NAVD88) for consistency with the City's overall drainage system mapping goals and with other modeling projects.

- The Two-dimensional (2D) surface model was created. This 2D model uses LiDAR data available from MassGIS as described in Appendix A, checked against City surface elevation data, as well as locations of buildings, roads, outfalls, and considers soils/infiltration and surface roughness to create a "mesh" network (a triangulated simplification of the 2D surface model that is used to facilitate the 2D movement of water).

- Existing conditions and future conditions for the seawall were represented in the model as a Base Linear Structure (2D).

- The storm water network in the study area was included in the model as a 1D feature in the InfoWorks ICM model. The model included all City pipes, catch basins, and manholes that were available from the data sources described in Appendix A. Model inputs (e.g., inverts, rim elevations, pipe materials, pipe lengths, one-way check valves, and the Post Island Road Tide Gate) were acquired based on the most recent available data. The future conditions stormwater network was included based on design plans for the Seawall Repair project described in Appendix A to reflect backflow prevention for each of the 22-outfalls, as compared to existing conditions where 13 of the outfalls currently have backflow prevention with varying age and condition. One-way check valves were used for each of the outfalls other than the outfall at Post Island Road where the tide gate is not anticipated to change. Appendix B provides additional detail on assumptions related to the drainage system in the modeling.
- Design rainfall was included in the model. The extreme precipitation event depths described in Appendix A were transformed into rainfall events using the Northeast Regional Climate Center (NRCC) Type B 24-hour synthetic rainfall distribution. The cumulative rainfall distributions were converted to precipitation hyetographs (i.e., rainfall intensities over time) and were directly input into InfoWorks ICM.
- Design tides and peak tides were determined based on historic data documented in Appendix A and input into InfoWorks ICM.
- Three historic storm events on October 31, 1991; May 24, 2005; and March 3, 2018, were used to calibrate and validate the InfoWorks ICM Model. The calibration/validation was performed by comparing observed flooding during the three evaluated storm events with the model results. For the storm events where repetitive loss data was available (October 1991 and May 2005), the flooding elevations were compared with locations where repetitive losses were document and the number of repetitive loss locations where flooding was observed were counted. Where sill elevations were available the modeled flood elevations were compared with the documented sill elevations. For the March

2018 storm event the roads with major road damage observed were compared with modeled flooding.

- Tighe & Bond compared the 100-year tide levels occurring during a 1-inch storm event with the FEMA Letter of Map Revision (LOMR) Case No. 15-01-0874P effective August 21, 2015 for the City of Quincy. The model results closely matched the FEMA Special Flood Hazard Areas (SFHAs).

Note that the U.S. Army Corps of Engineers (USACE) is preparing to commence a study to support the restoration of the Willows Marsh located to the south of the study area on Houghs Neck. The Willows Marsh is bounded by Sea Street, Kirby Street, State Street, the MWRA high relief sewer dike, and Peterson Road. The marsh currently has low connectivity to the study area (reportedly a 6-inch pipe), and therefore was omitted from the study area because it has a small capacity and the Willows Marsh is outside the study area. Twin 10 ft by 10 ft stone lined culverts now blocked once connected the Willows Marsh to the larger Rock Island Cove Marsh south the MWRA dike.

2.3 Model Scenarios

The model scenarios evaluated:

1. **Existing Conditions** – The Existing Conditions scenario represents existing conditions with the seawalls at their current elevation. The existing conditions model was used for calibration and validation.
2. **Future Conditions** – The Future Conditions scenario represents anticipated near-term future conditions with the seawalls raised two feet to elevation 13 NAVD88.
3. **Potential Future Conditions** – The Potential Future Conditions scenario represents potential future conditions with the existing seawalls raised by 4 feet to elevation 15 NAVD88.
4. **Drainage System Pump Station Alternatives –** This scenario evaluated the potential impact of pump stations at salt marshes adjacent to Post Island Road, Terne Road, and Bayswater Road.
5. **Drainage System Improvements Alternatives –** This scenario evaluated potential drainage improvements (e.g., additional catch basins, redirecting flow, or increasing pipe sizes).

Tighe & Bond created model runs to evaluate existing, future, and potential future conditions for the following:

- The 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storm events occurring during mean higher high tide conditions.
- Joint coastal and upland flooding occurring during 1-year, and 10-year tide occurring simultaneously with 2-, 10-, and 50-year frequency rainfall storm events.
- A moderate rainfall event (1 inch over 24 hours) occurring during a 100-year tide
- Sea Level Rise (SLR) scenarios evaluating a 100-year frequency rainfall event occurring during the three (3) SLR scenarios.

The pump station alterative model runs were evaluated for:

- The 10- and 500-year frequency storm events occurring during mean higher high tide conditions.
- Joint Coastal and upland flooding occurring during a 10-year tide occurring simultaneously with a 10-, and 50-year frequency rainfall storm event.
- Joint Coastal and upland flooding occurring during a 100-year tide occurring simultaneously with 1-inch of rainfall, a 10-year frequency rainfall storm event, and a 100-year frequency rainfall storm event.
- SLR scenario evaluating a 100-year frequency rainfall event occurring with the 2070 SLR Mean Higher High Water (MHHW) conditions.

The drainage system alterative model runs were evaluated for:

- The 10-year frequency storm events occurring during mean higher high tide conditions.
- A SLR scenario evaluating a 10-year frequency rainfall event occurring with the 2070 SLR MHHW conditions.

2.4 Model Results

Appendix C provides the model results, including information on the successful calibration and validation effort, results from existing and future conditions models, and the drainage system alternatives. Section 3 of this report provides additional information on flood mitigation alternatives considered and the results of those modeling exercises.

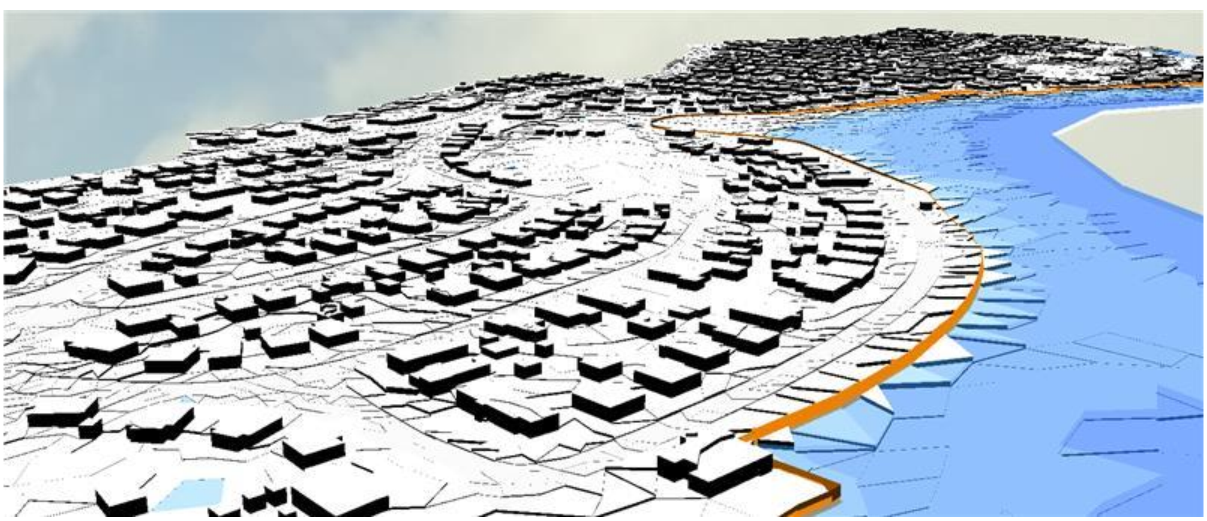


Figure 2-1: Example view of Innovyze® InfoWorks ICM Software

Section 3
Potential Flood Mitigation Alternatives

The MVP Action Grant included identification and evaluation of potential opportunities to reduce flooding in the Adams Shore and Houghs Neck study area. The alternatives included:

1. Planned/underway and potential future seawall improvements.
2. Adding pumping stations to targeted locations.
3. Making improvements to the storm drainage system (e.g., additional catch basins, redirecting flow, or increasing pipe sizes).
4. Consideration for nature-based solutions.
5. Changing City policy related to development and redevelopment in flood zones, including level of protection for private property.

This section discusses these alternatives and the results of the modeling, with consideration for costs and benefits of the proposed solution.

3.1 Seawall Improvements

3.1.1 Improvements Under Way

The ongoing Adams Shore/Hough Neck Seawall Repair & Improvements project currently under construction is anticipated to alter drainage within the study area. To understand the anticipated impact of the changes, the existing and future conditions were evaluated and compared using InfoWorks ICM. The anticipated flooding due to large rainfall events during typical tidal conditions is not anticipated to change substantially as a result of the seawall and drainage improvements. Changes are also not anticipated for the 100-year frequency storm event with SLR for 2050, however slight improvements are anticipated when looking at SLR in 2070 and 2100. The anticipated reduction in flooding due to seawall improvements during extreme tidal events is significant, with the number of anticipated impacted structures reduced by between 30-percent and 60-percent depending on the model scenario.

The March 3, 2018 storm event was also modeled using the dimensions of the seawall project under construction per the request of the City of Quincy, to evaluate what flooding may be expected if a similar event occurred with the improved seawall in place. Based on the modeling, it is anticipated that substantially less flooding would be expected to occur with the improved seawall in place. The inundation area is anticipated to decrease substantially; however, the flooding will occur if waves exceeding the seawall elevation occur for a prolonged period.

The drainback features inserted into the new Seawall include 6-inch diameter pipes with backflow prevention spaced frequently (almost at each seawall block). These drainback pipes, in combination with the street drainage system, have been sized to handle 100% of the predicted wave overtopping from a 100-year tide event inclusive of 5-foot waves. It should be noted however that some of the wave overtopping will not be captured buy these pipes and street drainage system and may flow towards the saltmarshes

3.1.2 Potential Future Improvements

The potential future conditions at the Adams Shore / Houghs Neck seawall consist of a scenario where the seawall is raised an additional 2 feet above the future conditions currently under construction (i.e., a total of 4 feet over the current top of seawall elevation, or equal to elevation 15 NAVD). Inundation areas only vary between future conditions (seawall improvements) and for potential future conditions (seawall improvements + 2-feet) when the seawall is anticipated to overtop, which only occurs during the 100-year extreme tide. The anticipated number of structures with adjacent flooding reduces by 50-percent to 85-percent between future and potential future conditions. Raising the seawall an additional two feet is also anticipated to reduce the average depth of flooding at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) by, on average, 1 foot.

3.2 Potential Pumping Stations

Tighe & Bond evaluated potential pump stations at marsh areas located adjacent to Norton Beach, Post Island Road, and Bayswater Road. The pumping rate was determined assuming the 100-year frequency rainfall event needed to be pumped from each marsh without gravity drainage. A summary of the pump station concepts is provided in Appendix D. The pumps in InfoWorks ICM were assumed to turn on between elevation 3.1 and 3.6 feet NAVD88, and were assumed to turn off between elevations 3 and 3.2 feet NAVD88. The elevation the pumps turned on and off were staggered to improve model stability. The flow rates used for the InfoWorks ICM model and the anticipated elevation where impacts to residences begin are:

- Norton Beach Marsh –7,700 gallons per minute (GPM); anticipated residential impacts at 5.9 feet North American Vertical Datum of 1988 (NAVD88)
- Post Island Road Marsh – 5,750 GPM; anticipated residential impacts at 6.2 feet NAVD88
- Bayswater Road Marsh – 3,525 GPM; anticipated impacts at 6.4 feet NAVD88.

If a stormwater pump station were to be constructed at the Norton Beach Marsh, the Post Island Road Marsh, and the Bayswater Road Marsh, flooding would decrease for adjacent structures. Residences adjacent to the Norton Beach marsh are anticipated to flood for four (4) of the evaluated model scenarios for future conditions (without the pump station) and three (3) scenarios with the pump station. The proposed pump station at the Norton Beach marsh is anticipated to prevent flooding of adjacent properties during a 100-year rainfall event with SLR in 2070. During the extreme storm/tidal events when flooding is expected when the pump station is in place at the Norton Beach marsh the duration of flooding is anticipated to decrease by 35-percent to 50-percent and the number of impacted houses is anticipated to decrease by 40-percent to 50-percent. Residences adjacent to the Post Island Road marsh are anticipated to flood for one (1) of the evaluated model scenarios with the seawall improvements, and for none of the model scenarios with the pump station. The proposed pump station at the Post Island Road marsh is anticipated to prevent flooding of adjacent properties during 100-year tide with 100-year precipitation that would otherwise be expected with the improved seawall constructed. Flooding is not anticipated at properties adjacent to the Bayswater Road Marsh for the evaluated storm events.

The proposed pumps decrease the peak elevations and reduce the duration of flooding. For example, at the Norton Beach marsh for the scenario with a 10-year rainfall event occurring during a 100-year tide, the duration of time that the marsh is above 5.9 feet NAVD88 (critical elevation) decreases from 5 hours to 2.7 hours when the pump is in place.

Model results show that a pump station at Norton Beach marsh would prevent flooding during a 100-year rainfall event with 2070 SLR and reduce both the duration of flooding and the number impacted residences for three additional model scenarios. Results also show that flooding adjacent to the Post Island Road marsh would prevent flooding during a 100-year precipitation event coinciding with a 100-year tide level, and that the marsh generally drains slowly following extreme tidal events. Flooding is not anticipated adjacent to the Bayswater Road marsh for the evaluated model scenarios. Feasibility level Opinion of Probable Costs for this work range significantly and are highly dependent on the level of protection desired by the City. Costs are based on recent bids for similar stormwater pump stations. The level of protection needs to be determined. Construction alone for a practical and protective option (i.e., manage precipitation from a 100 year storm storm event to overcome 2070 MHHW, assumes use of tide gates to limit inflow of ocean pre-storm, wetlands providing temporary storage, etc.) could be approximately $2.7 Million, with additional costs for design, permitting, and construction services. A single rainstorm event was evaluated for each of the model scenarios, and it is possible that multiple rainstorms in series prior to the marshes draining could cause additional flooding. Additionally, extreme wave overtopping could exacerbate flooding. Determining the level of protection is necessary prior to developing further design.

3.3 Storm Drain System Improvements

Tighe & Bond used the existing condition and future conditions model results to identify drainage improvements for:

- Areas with observed flooding during the 10-year storm event;
- Locations where larger pipes flow into smaller pipes;
- Pipes with reverse pitch (e.g., the upstream invert is lower than the downstream invert); and
- Areas where there is a long distance (i.e., over 300 feet) between catch basins.

The identified drainage system modifications that could reduce localized flooding were evaluated within the model during the 10-year frequency storm events and normal tidal conditions, also incorporating SLR for 2070. The 10-year storm event was selected for design because it was assumed that the capacity of the system may be limited by the ability of catch basins to carry larger flows. The methodology for the drainage improvements is further detailed in Appendix B. In general, the anticipated reduction in flooding due to the proposed drainage improvements is expected to be relatively minor. We anticipate the storm drain improvements would provide a greater impact when rainfall occurs during lower tide conditions; however, when the peak rainfall rate coincides with MHHW tidal conditions, significant reductions in flooding are not anticipated until low tide conditions can occur. Feasibility level Opinion of Probable Costs[2] for this work ranges from $1.35 to $2.9 Million. Costs are based on recent bids in the City of Quincy from similar work, MassDOT bid prices, and include general and material contingencies, as well as allowances for police details, survey, engineering design, and construction services.

The City should investigate the potential of reconnecting the ebb & flow that presently goes into the Bayswater saltmarsh to the wetlands area that is surrounded by Manet Avenue, Winthrop Street, Sea Street and Babcock Street. Further study evaluating the impact of peak flows occurring during conditions less than MHHW may show benefits of local improvements to the stormwater network; these conditions were not evaluated as part of this study, but can be undertaken by the City following completion of the MVP Action Grant.

3.4 Nature-Based Solutions

Nature based solutions are one of the core principals of the MVP program. According to EEA, nature based solutions are "projects that restore, protect, and/or manage natural systems and/or mimic natural processes to address hazards like flooding, erosion, drought, and heat islands in ways that are cost-effective, low maintenance, and multi-beneficial for public health, safety, and well-being."

For the Adams Shore/Houghs Neck area of Quincy, nature-based solutions could consist of improving salt marsh habitat through removal of invasive species and promoting native species and habitat. The existing drainage system includes tide gates and one-way check/flapper valves at outlet pipes. These gates and valves are part of the flood control infrastructure but also limit tidal flushing during a typical tidal cycle. Improvements at these points can increase the natural inflow and outflow of coastal waters into salt marshes in the project area. Increased tidal flushing will help keep these marsh systems ecologically healthy by favoring native plant species, avoiding extended periods of marsh flooding and exchanging water to maintain dissolved oxygen and limit temperature increases during stagnant periods. The improvements to marsh conditions will allow the marshes to be the Nature-Based Solution for this project.

Figure 3-1: Wetlands near Heron Beach Tide Gate. Flooding after Winter Storm Reilly, left, and recent photo, right, including the tide gate manhole, right middle.

[2] This is an engineer's Feasibility Level Opinion of Probable Cost (OPC). Tighe & Bond has no control over the cost or availability of labor, equipment or materials, or over market conditions or a Contractor's method of pricing. The OPC is made on the basis of Tighe & Bond's professional judgment and experience. Tighe & Bond makes no guarantee nor warranty, expressed or implied, that the bids or the negotiated cost of the Work will not vary from this OPC.

To obtain environmental permits for the Adams Shore Seawall, the USACE required that the City remove the existing check valve found in the Norton Beach outfall and replace it with a new tide gate that will allow full ebb and flow of the normal tidal cycle into the salt marsh behind the wall. This permitting and design effort is expected to commence soon. In addition as part of the ongoing permitting effort for the Manet Ave Seawall project, the City is considering removing the existing check valve at the Bayswater Road outfall and similar to the Norton Beach check valve, replacing it with a new tide gate to also allow full tidal ebb and flow to the Bayswater Road area saltmarsh.

Addition of "engineered as natural" stormwater infrastructure such as tree-box filters, rain gardens (bioretention), constructed wetlands, swales, etc., may also be considered a nature-based solution. Because our modeling found that detrimental flooding is the result of coastal systems, not just inland conditions, we elected not to include these systems in the modeling. Stormwater infrastructure nature-based solutions in this area of Quincy will help manage smaller storm events by both infiltrating and slowing the discharge of water, along with providing important secondary co-benefits including habitat, reduction of the urban heat island effect, and improved aesthetics in the neighborhood. The City should consider evaluation of these practices during roadway and redevelopment projects as feasible not only to help address flooding and improve water quality, but to address requirements of state and federal Municipal Separate Storm Sewer System (MS4) permits.

Figure 3-2: Bioswale (left), rain garden/bioretention area (middle), planter box (right) (Images from EPA)

3.5 Policy and Regulatory Changes

The City can also consider changes to policy and local code. Potential options for these changes include:

- Encouraging or requiring a downspout disconnection program by residences and businesses. This simple practice reroutes rooftop drainage pipes from draining rainwater into the stormwater system to draining it into rain barrels, cisterns, or permeable areas.
- Allowing rainwater harvesting, which is sometimes prohibited by plumbing code. Rainwater harvesting systems collect and store rainfall for later use. When designed appropriately, they slow and reduce runoff and provide a source of water.

- Preservation of the tree canopy through development of a tree inventory, maintenance, planting, and protection program. Enacting a local ordinance that prohibits removal of private trees.
- Reducing the threshold for new and redevelopment projects to get reviewed for on-site stormwater improvements to mitigate impervious creep. For example, a resident could replace a paved driveway with a permeable pavement system to infiltrate and store runoff.
- Reduce parking requirements associated with non-residential sites to limit overall impervious area. Require non-residential sites to manage stormwater on-site through infiltration, treatment, and generally better site design principles.
- An ordinance that in certain flood prone areas not allowing any occupied living space below a selected elevation.
- Eminent domain action to take or raise critical property to increase the available storage area prior to pumps needing to turn on.
- A City-funded loan or grant program to assist home owners in flood prone areas to lift their homes.
- Modifying the City Tide Gate Management protocols to mandate the Tide Gates are closed at low tide prior to any predicted tide surge and immediately reopened after the surge tides recede.

Section 4
Public Education and Involvement

The City has been extensively engaging and involving the public on these issues over recent years, particularly through the Hazard Mitigation Plan Update, MVP Planning Grant, and the two seawall projects. Quincy's elected officials and municipal staff recognize that including the public in preliminary planning steps is critical to political buy-in by abutters, and this approach promotes overall project success.

Given this, the scope of the City's FY2020 MVP Action Grant included community outreach, education, and engagement, particularly of climate vulnerable populations. The City was planning on utilizing public meetings that overlapped with ongoing seawall improvements to help keep the community informed and maintain project interest at a high level during the first exploratory phase to improve storm drainage and climate resiliency in the Adams Shore/Houghs Neck neighborhoods.

Due to the ongoing COVID-19 emergency, as of mid-March 2018 and through the date of this report preparation, public meetings are currently prohibited in the Commonwealth of Massachusetts. Given this, the City utilized a multimodal approach for public engagement under this MVP Action Grant. Multimodal projects are projects that incorporate multiple methods or "modes" of communicating a message. For example, while traditional papers typically only have one mode (text), a multimodal project would include a combination of text, images, motion, or audio. The multimodal strategy consists of several elements (3 or more) implemented in an integrated way to guide action and provide a clear focus for the implementer.

The goals for the multimodal public engagement strategy for the Quincy MVP action grant included:

- Engage community residents to share common experience with historic flooding, identify future concerns and understand the stormwater modeling project objectives and potential solutions
- Reach a broad audience within the impacted area including those with limited access to computers, language barriers and those unable to travel.
- Comply with the Commonwealth of Massachusetts social distancing requirements
- Provide a variety of communication methods (on-line web site, virtual meeting, direct mailing, audio and video recording)
- Meet MVP action grant project deadlines

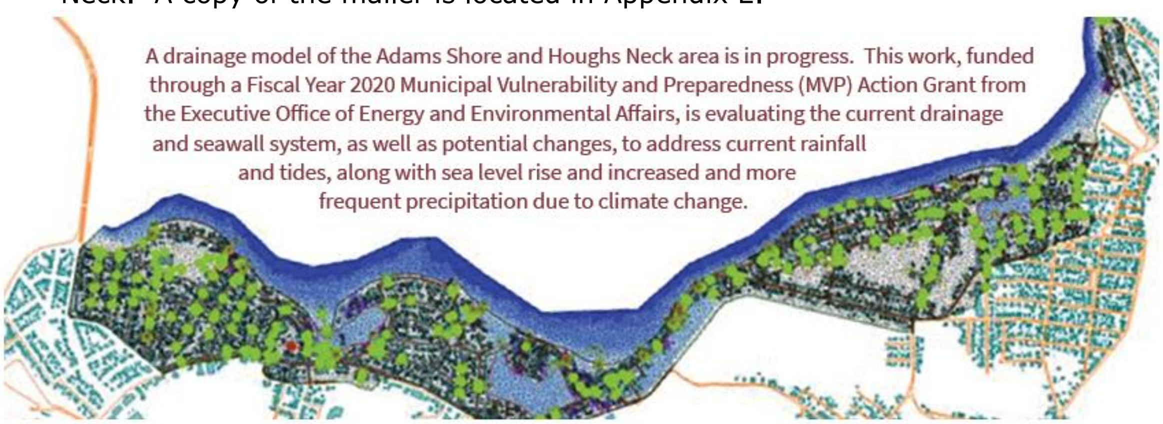
Education and involvement included the following:

- **Online Website:** Establishment of a website on the Department of Public Works website and updated links on the Planning and Community Development site. The page includes the project name, funding source, task descriptions, and other content developed. A copy of the website is included in Appendix E.

- **GIS Based Reporting Website:** Promotion of the previously developed Citizen Input Application for Quincy Flood Mitigation Planning website to solicit input from residents. A copy of the website is included in Appendix E. http://tighebond.maps.arcgis.com/apps/webappviewer/index.html?id=8923af0a70704bfd98047cffecfb3e62
- **PSA:** The Mayor recorded a 3.5-minute public service announcement (PSA) video explaining the modeling project, goals and outcomes. This was distributed via social media, Planning, DPW, and the Mayor's office. A copy of the talking points is included in Appendix E.

- **Virtual Webinars:** A 30-minute presentation was prepared and sponsored by Ward 1 City Councilor David McCarthy. This presentation explained the historic work, the modeling process, and provided attendees with an opportunity for Q&A. Four webinars were scheduled, three were held (no attendees arrived at the 3rd webinar so after 10 minutes, the group canceled the session). The webinars were held on Zoom. A copy of the presentation and the Q&A record is included in Appendix E.

- **Mailer:** A mailer that provided information on both the seawall and MVP Action Grant project was send to 8,900 residents throughout Adams Shore and Houghs Neck. A copy of the mailer is located in Appendix E.



Section 5
Conclusions

At the conclusion of the MVP Action Grant for the *Coastal Flood Mitigation Storm Drainage Improvements: Phase One: Engineering and Public Outreach*, the City of Quincy now has a calibrated and validated model that shows existing conditions under various storm and tidal events, benefits of planned near-term seawall and drainage improvements, and impact of potential solutions including additional increase in seawall height, installation of pump stations, and other drainage improvements.

5.1 Summary

The following summarizes takeaways from the overall project:

- The calibration/validation storm event results show that the InfoWorks ICM model appears to provide a reasonable and acceptable representation of previously observed flooding based on available FEMA repetitive loss data and locations with previously observed flooding.
- The study area is impacted by coastal flooding more than by inland flooding.
- Flooding is anticipated to be greater during extreme tidal events that coincide with small precipitation events, versus larger precipitation events coinciding with more typical tidal conditions because the storm drain system cannot drain during high tides. Although wave overtopping has been addressed in the seawall design through the use of drain back pipes with back flow prevention, it may still have a significant impact on flooding in the study area. It can only be modeled using simplifications in InfoWorks ICM.
- Single rainstorm events were evaluated for each of the model scenarios, and it is possible that multiple rainstorms in series prior to the drainage of the system (e.g., marshes draining) could cause additional flooding.
- Model results show that the Adams Shore/Hough Neck Seawall Repair & Improvements project is anticipated to measurably reduce the likelihood of flooding in the study area during extreme tidal events.
- Localized improvements to the storm drain system are not anticipated to improve flooding that occurs during high tide when the system cannot drain, but will improve localized flooding, and at times during low tide.
- Pump stations may reduce the frequency and duration of flooding, particularly during extreme tidal events when drainage via gravity is not possible. Model results show that a pump station at Norton Beach marsh would prevent flooding during a 100-year rainfall event with 2070 SLR and reduce both the duration of flooding and the number impacted residences for three additional model scenarios. Results also show that flooding adjacent to the Post Island Road marsh would prevent flooding during a 100-year precipitation event coinciding with a 100-year tide level.
- The addition of new tide gates will allow improved ebb and flow to the Bayswater and Norton Beach saltmarshes thereby improving health of these critical

ecosystems. Other nature-based solutions may not provide a reduction in significant flooding, as most of the flooding is strongly influenced by coastal conditions. They will provide mitigation of flooding during smaller precipitation events and will provide co-benefits including reduction in urban heat island effect, creation of habitat, and improved neighborhood aesthetics, while also addressing compliance with federal and state stormwater permit programs.

- A multi-modal public education and engagement program may be more effective than in-person public meetings, as residents were able to access information in a variety of methods including online and print. Information was distributed by the Mayor's office, City Councilor, DPW, and Planning, which reached a broad audience.
- Structural improvements should be coupled with changes to City policy and local code to manage impervious area creep, stormwater runoff from new and redevelopment projects, and increased storage area.

5.2 Next Steps for Quincy

The City can now use the model to vet additional drainage improvements and scenarios, understand the level of protection those improvements provide, and the cost and benefit of the work.

While the development of the Adams Shore/Houghs Neck model was consistent with approaches for other modeling in the City, this final model should be incorporated into the City-wide modeling effort.

Following completion of the seawall construction, the model should be updated to reflect the record plans.

The model can also be integrated with the USACE Willows Marsh restoration study, once complete.

5.3 Lessons Learned & Transferability

For other coastal communities considering using the InfoWorks ICM model, there are lessons learned from this MVP Action Grant that can support more efficient model development. We recommend interested communities review the data utilized as documented in Appendix A to help get started on sources of information for model development. Communities should review the assumptions and details in Appendix B to understand the methodology used, particularly related to the coastal conditions and the seawall. For any community planning to undertake such a modeling exercise, we recommend hiring a Licensed Surveyor to confirm drainage system mapping and fill in data gaps. This is a valuable part of the program, particularly when considering modifications or improvements to the drainage system.

5.4 Acknowledgements & Report Citation

Funding for this work was provided through a Massachusetts Executive Office of Energy and Environmental Affairs (EEA) Municipal Vulnerability and Preparedness Action Grant during Fiscal Year 20.

Many thanks to Department of Public Works Commissioner Alfred Grazioso for serving as the local Project Manager. A special thanks to Paul Costello, City Engineer, and Robert Stevens, Deputy Planning Director, for their ongoing involvement and direction, and to everyone who participated in the public engagement process.

Tighe & Bond (2020). *Coastal Flood Mitigation Storm Drainage Improvements: Phase One: Engineering and Public Outreach Report*, City of Quincy, Massachusetts.

APPENDIX A

Appendix A – Description of Modeling Data Sources

TO: City of Quincy

FROM: Tighe & Bond

DATE: June 30, 2020

This appendix describes the data used to create the Adams Shore/Houghs Neck InfoWorks integrated catchment model (ICM).

The horizontal datum for all spatial data is NAD83; the vertical datum is North American Vertical Datum of 1988 (NAVD88). Elevation values from survey or design drawings in the NOAA 8443970 – Boston, MA Mean Lower Low Water (MLLW) vertical tidal datum were converted to the NAVD88 vertical datum. Spatial data was projected to the Massachusetts State Plane Coordinate System, Mainland Zone (FIPS Zone 2001) and all units are in feet.

Information on the NOAA 8443970 – Boston, MA tidal datums and datum conversions can be accessed at: *https://tidesandcurrents.noaa.gov/datums.html?id=8443970*

1 State & National GIS Data

1.1 Elevation Terrain

The elevation terrain was created using the Light Detection and Ranging (LiDAR) terrain and elevation data from the Bureau of Geographic Information, Commonwealth of Massachusetts (MassGIS), Executive Office of Technology and Security Services using the on-line data viewer, OLIVER.

The project extent included the following LiDAR tiles from the 2013-2014 Sandy Project: *19TCG345815, 19TCG360815, 19TCG375815, 19TCG375815, 19TCG390815, 19TCG345800, 19TCG360800, 19TCG375800*, and *19TCG390800*. The tiles were compiled into a single Digital Elevation Model (DEM) with a raster resolution of approximately 3.128 feet (1 meter).

1.2 Hydrologic Soil Type

Soil data and information was acquired from the United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO) using the on-line data viewer, Web Soil Survey. The project extent is located within the Norfolk and Suffolk Counties, Massachusetts *MA616* survey; survey area version 15, tabular version 12, spatial version 6, dated September 12, 2019. Soil conditions from the MA616 survey were supplemented from the Soil Conservation Service 1989 *Soil Survey of Norfolk and Suffolk Counties, Massachusetts.*

1.3 Land Cover / Land Use

Land cover/land use data was acquired from the MassGIS, Commonwealth of Massachusetts, Executive Office of Technology and Security Services using the on-line data viewer, OLIVER. The project extent included the index tiles *R07C20* and *R08C20* from the 2016 land cover/land use dataset. Impervious areas and select Manning's roughness coefficients (Manning's n values) were determined within the model region using the land use data and available aerial imagery. Manning's n values were estimated based on available literature and values used in the DSS WISE Lite model, which was developed by the National Center for Computational Hydroscience and Engineering (NCCHE) and supported by FEMA. Table A-1 includes the Manning's n values associated with each land use classification.

TABLE A-1
Land Use Classification and associated Manning's roughness coefficients (n values)

Land Use Classification	Manning's roughness coefficient (n value)
Impervious	0.020
Developed Open Space	0.040
Cultivated Land	0.070
Pasture/Hay	0.035
Grassland	0.040
Deciduous Forest	0.100
Evergreen Forest	0.100
Scrub/Shrub	0.040
Palustrine Forested Wetland (C-CAP)	0.150
Palustrine Scrub/Shrub Wetland (C-CAP)	0.050
Palustrine Emergent Wetland (C-CAP)	0.183
Estuarine Forested Wetland (C-CAP)	0.150
Estuarine Scrub/Shrub Wetland (C-CAP)	0.060
Estuarine Emergent Wetland (C-CAP)	0.183
Unconsolidated Shore	0.040
Bare Land	0.011
Open Water	0.033
Palustrine Aquatic Bed (C-CAP)	0.033
Estuarine Aquatic Bed (C-CAP)	0.033

2 City of Quincy GIS Data

2.1 Building Footprint Data

The location of the existing buildings within the study region were acquired from the City of Quincy's GIS Geodatabase. Building footprints were used to augment the elevation terrain developed from the MassGIS LiDAR dataset.

3 Seawall Data

3.1 Existing Seawall Geometry

The existing conditions geometry and elevation information for the existing seawall was determined using survey performed as part of the seawall repairs and improvement project for the Manet Seawall and Adams Shore/Houghs Neck Seawall performed by Tighe & Bond. The prior surveys used to determine the existing seawall geometry are:

- The *Adams Shore/Houghs Neck Seawall Survey* – prepared by Corner Post Land Surveying, Inc., dated August 2017.
- The *Manet Avenue Seawall Survey* - prepared by Corner Post Land Surveying, Inc., dated October 2018.

3.2 Proposed Seawall Geometry

The proposed conditions geometry and elevation information for the proposed seawall was acquired from design drawings completed as part of the seawall repairs and improvement project performed by Tighe & Bond. The design drawings used to determine the proposed seawall geometry are:

- Adams Shore/Houghs Neck Seawall Repairs & Improvements Design Drawings - prepared by Tighe & Bond, dated January 2020.
- Manet Avenue Seawall Repairs & Improvements Design Drawings - prepared by Tighe & Bond, dated October 2019.

4 Stormwater Drainage Data

4.1 Existing Stormwater Drainage Network

The arrangement of the existing stormwater drainage network was acquired from the City of Quincy's GIS Geodatabase. As-built plans available from the City of stormwater structures located within Adams Shore/Houghs Neck area and previous surveys were incorporated into the modeled stormwater drainage network. The surveys used to determine the existing stormwater drainage network were:

- City of Quincy *Plan of Storm Drains* throughout the City dated 1932 with varying revision dates.
- The *Adams Shore/Houghs Neck Seawall Survey* – prepared by Corner Post Land Surveying, Inc., dated August 2017.
- The *Manet Avenue Seawall Survey* - prepared by Corner Post Land Surveying, Inc., dated October 2018.

- The *Adams Shore/Houghs Neck Stormwater Survey*– prepared by Feldman Land Surveyors, dated April 2020.

4.2 Geometry of Select Drainage Structures

A licensed land surveyor was retained to collect topographic information and existing conditions information of select drainage structures (e.g., outfalls, inverts at confluences of pipe networks, pipes greater than 12-inches missing existing mapping or survey according to City data, and three tide gates) within the project area to augment existing City GIS and as-built data. The survey used was:

- The *Adams Shore/Houghs Neck Stormwater Survey*– prepared by Feldman Land Surveyors, dated April 2020

Information collected includes inverts, structure rim/grate elevations, pipe sizes, material type of pipes entering and exiting the drainage structures.

5 Precipitation Data

5.1 Extreme Precipitation Rainfall Depths

Extreme 24-hour precipitation depths were acquired from the Northeast Regional Climate Center (NRCC) Extreme Precipitation Analysis. The NRCC Type B storm distribution curve was used to distribute the precipitation depth across the 24-hour storm duration. Table A-2 provides the precipitation amounts used for the various storms analyzed. The data can be accessed at *http://precip.eas.cornell.edu/.*

TABLE A-2
24-hour Precipitation Values from the NRCC Extreme Precipitation Analysis for Quincy, MA

Storm Return Frequency	24-hour Precipitation Depths from NRCC Analysis (inches)
1-year	2.72
2-year	3.28
5-year	4.11
10-year	4.88
25-year	6.13
50-year	7.29
100-year	8.67
500-year	10.31

5.2 Predicted Changes to Extreme Precipitation Due to Climate Change

According to the Northeast Climate Impacts Assessment report of 2007, annual precipitation levels are expected to increase across New England by as much as fourteen percent (14%) by the end of this century, with an estimated thirty percent (30%) increase in precipitation during winter months. NECSC includes future annual precipitation statistics for the Boston Harbor Basin, increasing from the current 46.1 inches to as much as 50.7 inches per year by the 2030s, and as much as 55.1 inches per year by 2100[1]. To assist the City in planning for climate change, methods to calculate future design storm events for a variety of recurrence intervals were reviewed in the 2019 Hazard Mitigation Plan. Available data included the National Oceanic and Atmosphere Administration (NOAA) Atlas 14, Climate Change and Sea Level Rise Projections for Boston by the Boston Research Advisory Group (BRAG), and the 2017 NECASC state-wide precipitation climate change data.

Table A-3 summarizes these predictions. Climate change science is evolving rapidly, so these estimates should be updated as future studies are performed. The potential future extreme precipitation values were not used in the InfoWorks ICM modeling; however, Table A-3 can be used with Table A-2 as a basis for comparison. For example, a long-term estimate for the 10-year storm event is similar to a 50-year storm event modeled for existing conditions.

TABLE A-3
Projected 24-hour rainfall depths for Quincy Massachusetts for existing, near term, mid-term, and long-term conditions based on data from Boston Research Advisory Group (2016).

Storm Return Frequency	24 hour Rainfall Depth for Quincy Massachusetts (inch)		
	Near Term Estimate	Mid Term Estimate	Long Term Estimate
2-year	3.6	4.0	4.7
10-year	5.6	6.2	7.4
25-year	6.8	7.5	9.0
50-year	7.8	8.6	10.3
100-year	8.8	9.6	11.6

5.3 Historical Precipitation

Historical precipitation observations were sourced from the National Oceanic and Atmospheric Administration (NOAA) Global Historical Climatology Network Daily (GHCND) for:

- Station USW00014739 (WBAN 14739) at Boston, MA
- Station USW00014790 (WBAN:14790) at Blue Hill Observatory in Milton, MA
- Station USW00014790 (WBAN:14790) at Bridgewater, MA (gage data was not available after May 2005)

Precipitation observations were downloaded for historic storms that did not include snowmelt. Precipitation data was also acquired from the United States Geological Survey (USGS) gage 01105584 (Town Brook at Diversion Tunnel at Quincy, MA) with data available from April 2011 to the present). Data was acquired for historic storms on:

1. October 31, 1991
2. May 24, 2005
3. March 3, 2018

These events were selected because they were large storm events that occurred without impacts from snow melt or snow fall that add a high degree of uncertainty to hydrologic and

[1] Northeast Climate Science Center (NECSC) "Massachusetts Climate Change Projections - Statewide and for Major River Basins" for the Massachusetts Executive Office of Energy and Environmental Affairs, January 2018 (http://www.massclimatechange.org/.)

hydraulic response. The October 31, 1991 storm event (known as the "Perfect Storm") had significant repetitive loss data available, while the May 24, 2005 storm event had some but fewer repetitive loss data. Tighe & Bond did not have repetitive loss data for the March 3, 2018 storm event; however, precipitation data in Quincy was available, and it was a large well-behaved storm event with documented flooding.

6 Coastal Data

6.1 Approximation of Historical Flooding Extents

The flooding extents that resulted from the selected historical precipitation events were developed using Federal Emergency Management Agency (FEMA) Repetitive Loss Data from January 1979 - November 2017. The impacted addresses are not specified in this report for privacy reasons. Sill elevations of impacted properties were estimated using Elevation Certificates available from the City of Quincy. The historical flooding extents were used as the basis for model calibration and validation.

6.2 Coastal Tide Elevations

Coastal tide levels were acquired from the Federal Emergency Management Agency (FEMA) Letter of Map Revision (LOMR) Case No. 15-01-0874P effective August 21, 2015 for the City of Quincy and NOAA Extreme Water Levels: Exceedance Probability Levels and Tidal Datums for Station 8443970 - Boston, MA. Stillwater elevations (e.g., elevations that don't take wave action into account) were acquired for the 10-percent and 1-percent return frequency tidal events (i.e., the 10- and 100-year frequency tide events) from FEMA LOMR 15-01-0874P for Adams Shore to Nut Island. FEMA does not provide tide levels less frequent than the 10-year frequency storm event.

Annual exceedance probabilities (AEP) were assessed by NOAA across the National Tidal Datum Epoch. NOAA defines the National Tidal Datum Epoch (NTDE) as the standardized 19-year period that serves as the National Ocean Service's official time segment over which tide observations are taken and reduced to obtain mean values for tidal datums. The NTDE is actively considered for revision every 20-25 years with the present NTDE extending from 1983 through 2001. Annual exceedance probability tide levels were projected by NOAA in 2018 assuming continuation of the linear historic trend corresponding to the NTDE (1983-2001). The 2018 levels were slightly higher than those computed using data from the to the NTDE.

Table A-4 provides the water level projections used for the various tidal events analyzed.

TABLE A-4
Projected Extreme Tide Water Levels from FEMA LOMR 15-01-0874P and the NOAA Extreme Water Levels for 8443970 - Boston, MA

Tide Return Frequency	Annual Exceedance Probability (AEP) Coastal Flood	Water Level from NOAA Analysis (feet, NAVD88)	Water Level from NOAA Analysis (feet, NAVD88)
1-Year	99-percent AEP Coastal Flood	-	6.8
10-Year	10-percent AEP Coastal Flood	8.7	-
100-Year	1-percent AEP Coastal Flood	10.1	-

A Mean Higher High Tide Water (MHHW) elevation of 4.8 feet NAVD88 was used based upon the current NTDE (1983-2001). The coastal tide elevation data can be accessed at *https://tidesandcurrents.noaa.gov/est/stickdiagram.shtml?stnid=8443970*.

6.3 Historical Tide & Water Levels

Historical tide and water level observations were acquired from the NOAA Tides & Currents for Station 8443970 - Boston, MA. Observations were downloaded across the date range of the selected historical precipitation events. The data can be accessed at *https://tidesandcurrents.noaa.gov/waterlevels.html?id=8443970.*

6.4 Sea Level Rise

Sea level rise was incorporated following the methodology in the 2019 City of Quincy Hazard Mitigation Plan. To ensure consistency with the State HMP, Quincy adopted data developed for the Boston Harbor region from the State-wide climate change projections using the Northeast Climate Science Center (NECSC) dataset[2]. Table A-5 shows the three (3) sea level rise projections used for modeling.

TABLE A-5
Sea Level Rise (SLR) estimates for projecting future flooding risk in Quincy MA[1]

Time Period	Sea Level Rise Projection[2] (feet)
Mid Term (2050)	1.1
Long Term (2070)	1.6
Extended Long Term (2100)	2.3

[1] Scenarios and values are from Table 6 of the NECSC (2018)
[2] Median or 50% percentile estimate for the Medium Emissions Scenario.

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[2] Northeast Climate Science Center (NECSC) "Massachusetts Climate Change Projections - Statewide and for Major River Basins" for the Massachusetts Executive Office of Energy and Environmental Affairs, January 2018. Available from http://www.massclimatechange.org/

Tighe&Bond

APPENDIX B

Appendix B – InfoWorks ICM Modeling Methodology

TO: City of Quincy

FROM: Tighe & Bond

DATE: June 30, 2020

Tighe & Bond performed hydrologic and hydraulic modeling of the Adams Shore/Houghs Neck study area using the InfoWorks Integrated Catchment Modeling (InfoWorks ICM) software by Innovyze, Inc. This appendix describes the methodology used to create the Adams Shore/Houghs Neck InfoWorks model. The data listed in Appendix A were used to develop a physical representation of the combined coastal and stormwater system and to conduct the coastal stormwater analysis.

1 Model Creation

1.1 Vertical and Horizontal Datums

The vertical datum used to develop the Adams Shore/Houghs Neck model was in the North American Vertical Datum of 1988 (NAVD88). Data in the Local Mean Lower Low Water datum from seawall surveys and seawall design, were converted to NAVD88 using the following formula:

NAVD88 = Local Mean Lower Low Water – 5.52 feet.

The datum conversion was computed based on the conversion computed by the Corner Post Land Surveying Inc. using Disc 4525 B 2000 “Nut Island” Quincy Bay, Massachusetts, Station ID 8444525 and Massachusetts DOT Station 807 X, as described in the Adams Shore/Hough Neck Seawall Repair & Improvements project described in Appendix A.

The horizontal projection used for the study is the North American Datum (NAD) 1983 State Plan Massachusetts Mainland FIPS 2001 feet.

1.2 Two-Dimension (2D) Surface Model Development

The Two-dimensional (2D) surface model was developed using LiDAR data available from MassGIS as described in Appendix A, and was checked against City contour data. The extents of the 2D surface model were established along Adams Shore/Houghs Neck based on topography and refined using the 1D stormwater network (i.e., the 2D surface was extended beyond what was suggested by topography where the stormwater network extended beyond the area draining by gravity). The delineated model area is shown in Figure B-1. The 2D surface model includes 22 separate outfalls through the seawall, that can be considered separate drainage areas. The U.S. Army Corps of Engineers (USACE) are currently performing a study to support the restoration of the Willows Marsh located to the south of the study area at Houghs Neck. The marsh currently has low connectivity to the study area (reportedly a 6-inch pipe), which was omitted from the study area because it has a small capacity and the Willows Marsh is outside the study area. Figure B-2 shows surface elevation data from LiDAR over the study area.

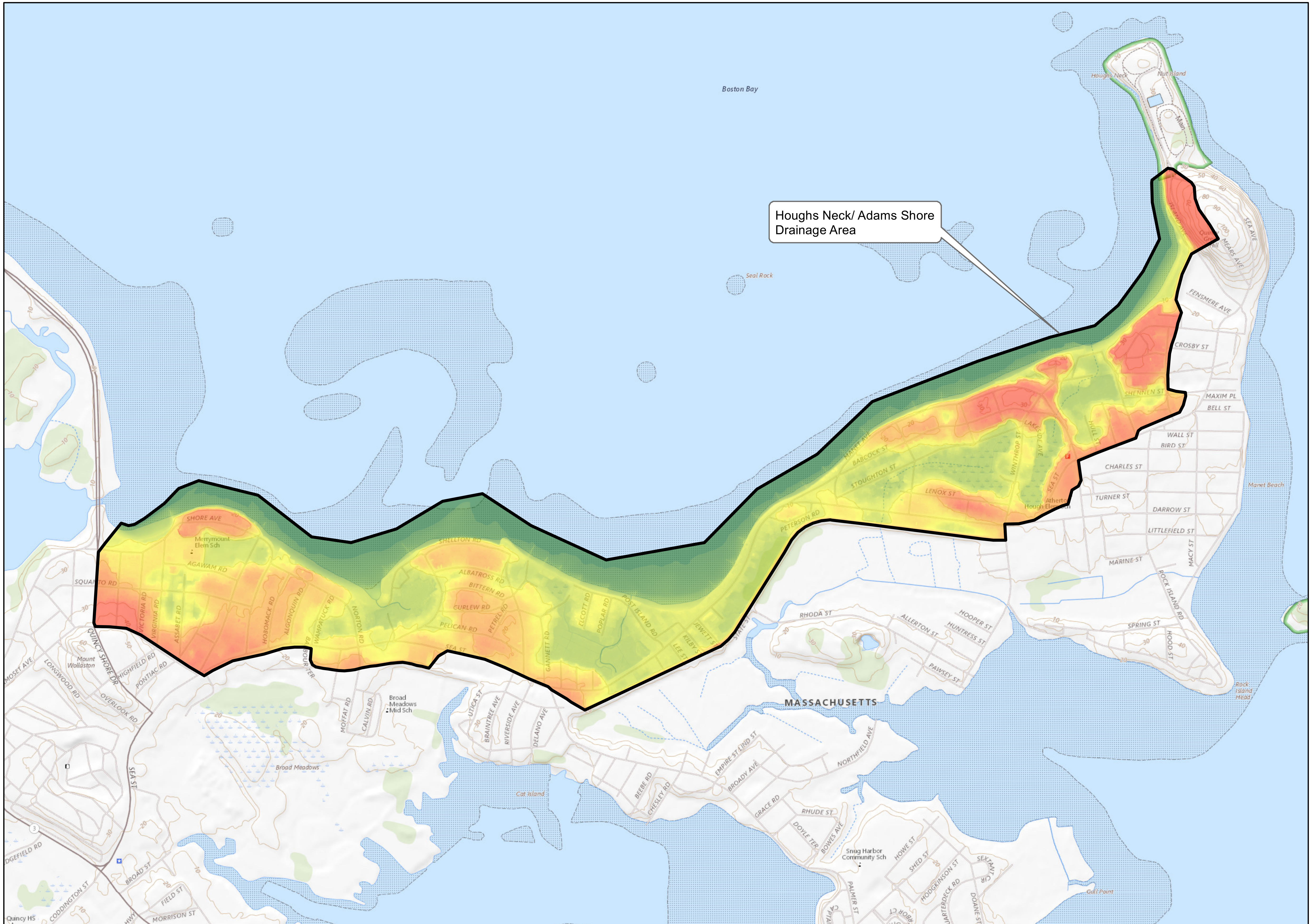

FIGURE 2
LIDAR AND DRAINAGE AREA

LEGEND

LiDAR (ft)

High : 110

Low : -10

Houghs Neck/ Adams Shore Drainage Area

LOCUS MAP

N / E / S / W

0 250 500 1,000

Feet

1:12,000

NOTES

Based on USGS National Topographic Map: National Boundaries Dataset

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

June 2020

Tighe&Bond

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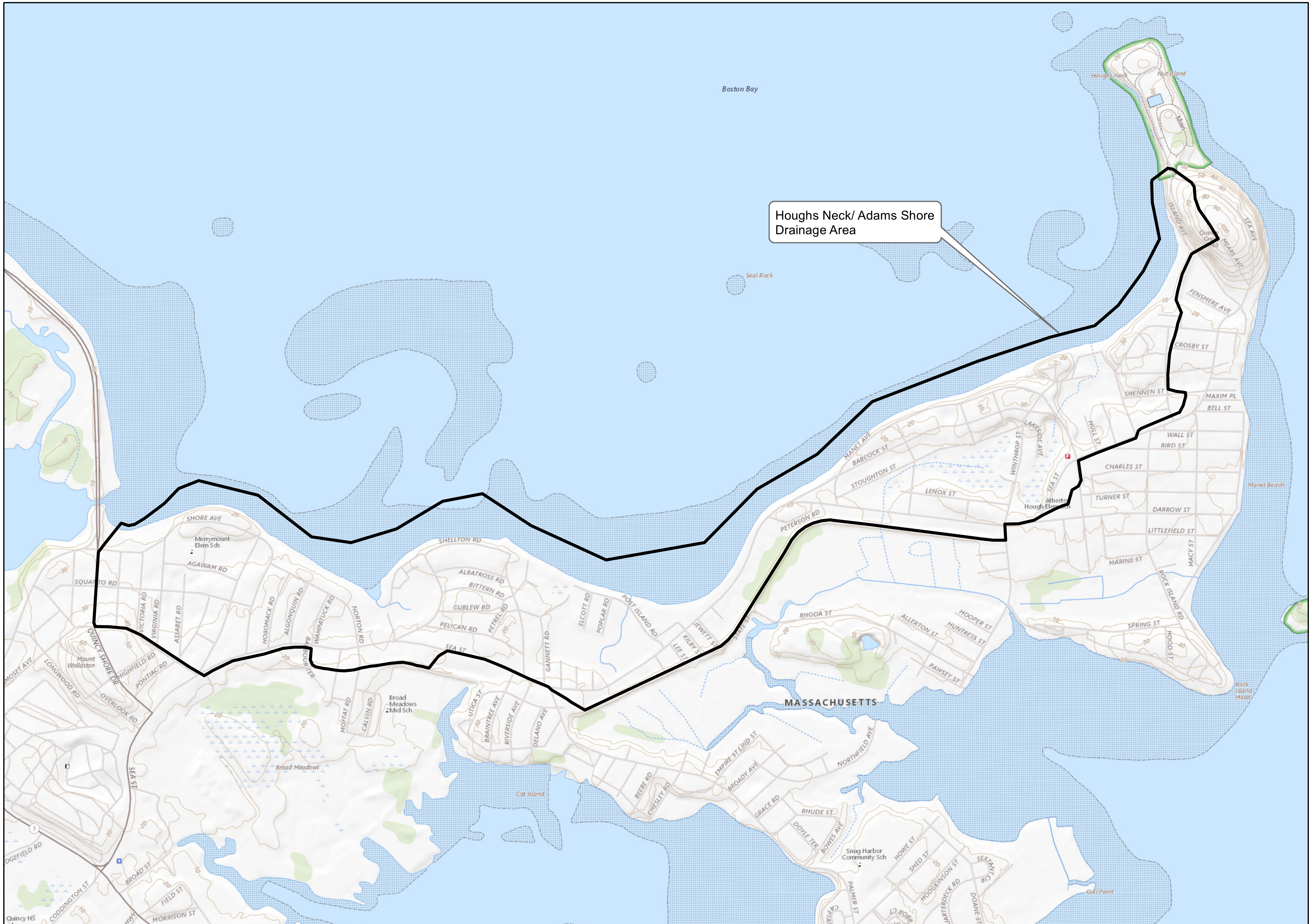

FIGURE B-1
STUDY AREA

LEGEND

Houghs Neck/ Adams Shore Drainage Area

LOCUS MAP

0 250 500 1,000
Feet

1:12,000

NOTES

Based on USGS National Topographic Map: National Boundaries Dataset

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

June 2020

Tighe&Bond

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1.2.1 Mesh Development

A surface model mesh was generated using the 2D surface model. The mesh is a triangulated simplification of the 2D surface model that is used to facilitate the 2D movement of water. The minimum mesh size for the study area was set to 600 square feet, and the maximum was set to 2,000 square feet. A finer mesh was used at roads and buildings (as described in sections below) providing a finer mesh in the urban areas of Adams Shore and Houghs Neck. The study area slopes are generally mild, so terrain sensitive meshing was not used. The 2D mesh has a time varying specified headwater surface elevation boundary condition at the coast, and normal depth boundary conditions around the rest of the boundary. The study area is approximately 420 acres with approximately 2.8 miles of coastline.

1.2.2 Buildings

The location of the existing buildings within the study region were acquired from the City of Quincy's GIS Geodatabase as described in Appendix A. The buildings were defined to extend 10 feet above the existing ground elevation. A roughness coefficient for impervious surfaces was used to represent the building roofs.

1.2.3 Roads

The location of the City roads within the study region were acquired from the City of Quincy's GIS Geodatabase as described in Appendix A. A mesh zone was created for the road (not the right of way) to embed them in ICM with a minimum mesh size of 75 square feet and a maximum mesh size of 175 square feet. The roads were defined to have 0.5-foot elevation drop compared to the ground elevation to account for the approximate height of curbs.

1.2.4 Outfalls

LiDAR data does not measure bathymetry, so ground elevations at submerged outfalls were shown as being higher than the outfall invert. A mesh zone was created for the submerged outfalls to manually lower the mesh elevation to that of the outfall pipe inverts.

1.2.5 Surface Roughness

The surface roughness was modeled using the Manning's roughness coefficient, which represents the amount of friction resistance experience by water when passing over a surface. Land cover/land use data from 2016 was acquired from MassGIS and was used to determine an appropriate Manning's roughness coefficient (as described in Appendix A) for each mesh triangle. The City's GIS building and road data was also incorporated into the land use information.

Figure B-3 shows the land uses within the study area, and Figure B-4 shows the Manning's roughness coefficients used for modeling.

1.2.6 Soils/Infiltration

Infiltration was computed using different methodologies for impervious and pervious areas. The Fixed Coefficient method was used in InfoWorks ICM to define runoff for impervious areas (e.g., roads, buildings, and open water) as 95-percent of rainfall. The Green and Ampt methodology was used to model infiltration for pervious land uses within the study area.

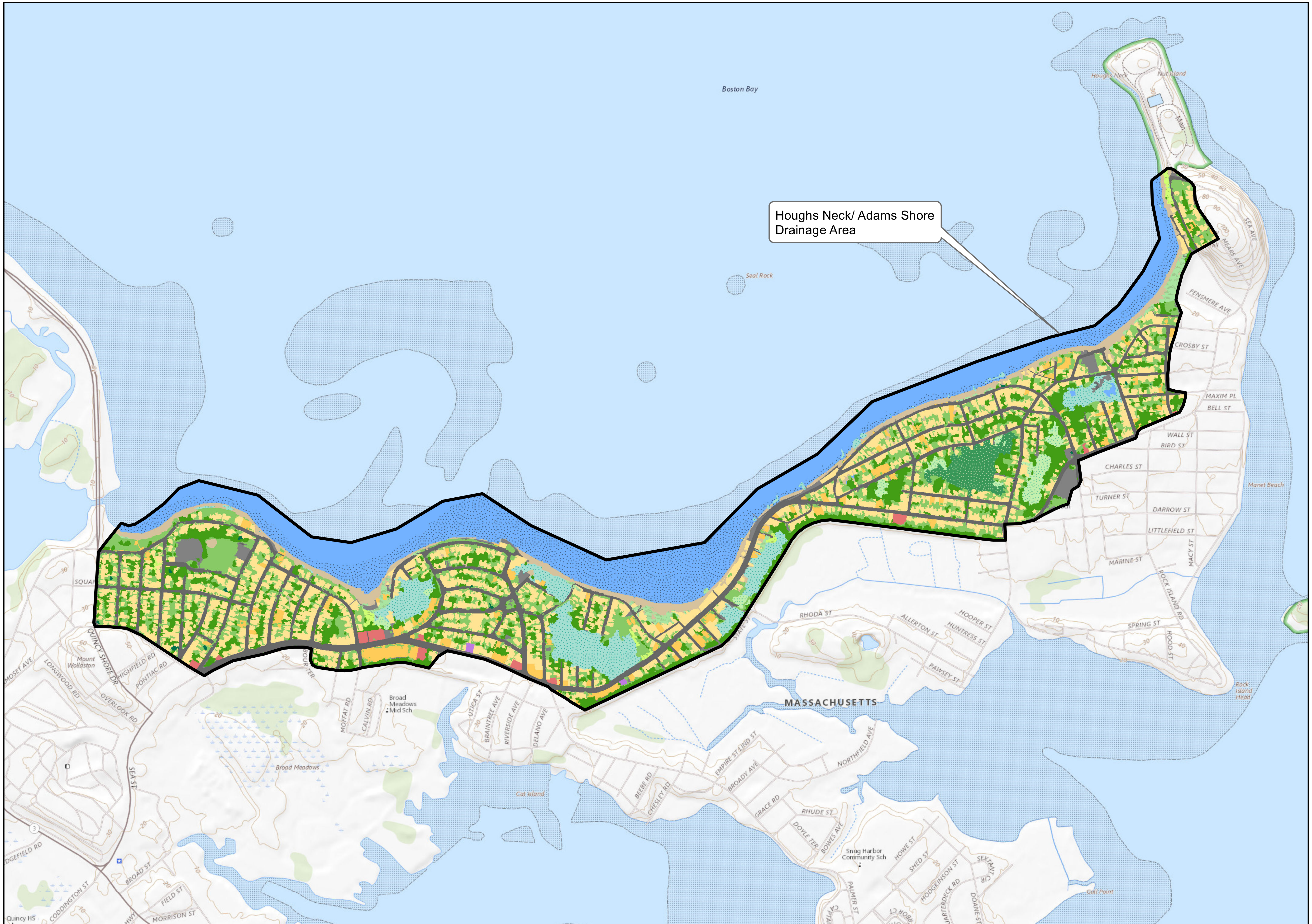
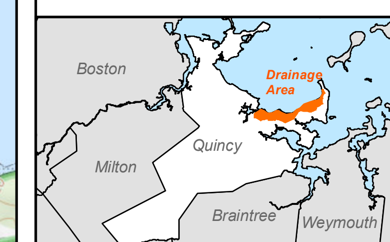


FIGURE 3
LAND USE

LEGEND

- Residential - Single Family
- Residential - Multi-Family
- Commercial
- Industrial
- Mixed Use - Primarily Residential
- Other Impervious
- Right-of-way
- Developed Open Space
- Deciduous Forest
- Evergreen Forest
- Grassland
- Scrub/Shrub
- Bare Land
- Forested Wetland
- Non-forested Wetland
- Saltwater Wetland
- Water
- Unconsolidated Shore

LOCUS MAP



0 250 500 1,000
Feet
1:12,000

NOTES

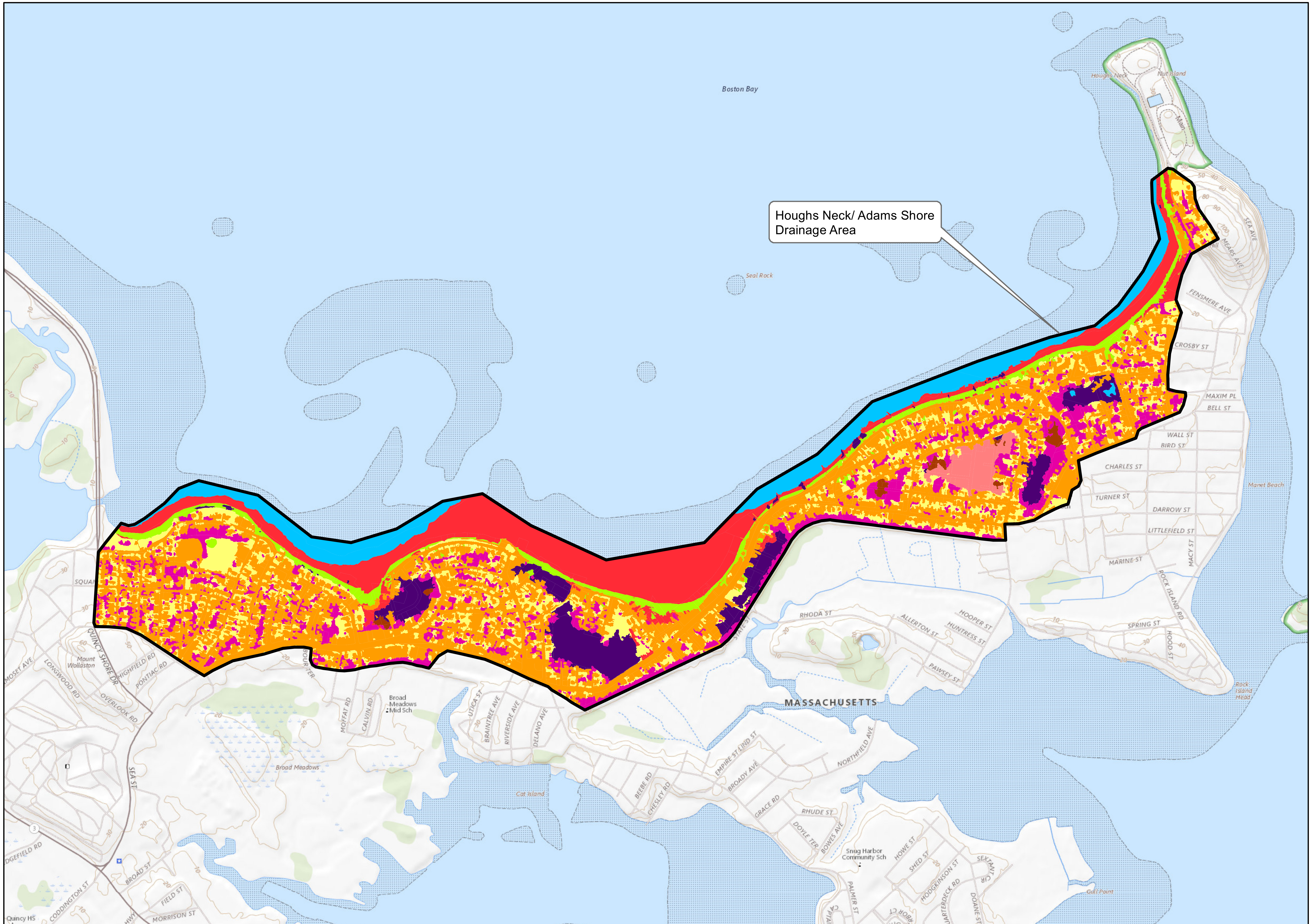
Based on USGS National Topographic Map: National Boundaries Dataset

Adams Shore & Houghs Neck Coastal Flood Modeling
Quincy, Massachusetts

June 2020

Tighe & Bond

FIGURE 4 ROUGHNESS (MANNING'S N)



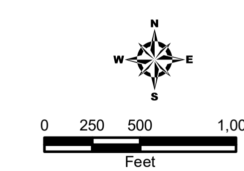
LEGEND

Roughness

Green	0.0113
Orange	0.02
Blue	0.033
Red	0.04
Yellow	0.0404
Brown	0.05
Magenta	0.1
Pink	0.15
Purple	0.1825

Houghs Neck/ Adams Shore Drainage Area

LOCUS MAP



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NOTES

Based on USGS National Topographic Map: National Boundaries Dataset

Adams Shore & Houghs Neck Coastal Flood Modeling
Quincy, Massachusetts

June 2020

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Infiltration in pervious areas was represented using Hydrologic Soil Groups obtained from the U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) Soil Survey Geographic Database (SSURGO), as described in Appendix A. Several areas (primarily in marshes) did not have Hydrologic Soil Groups and were therefore conservatively assumed to be type D. Figure B-5 shows the soil types and impervious areas used for the InfoWorks ICM Model.

The Green and Ampt methodology is a simplification of the Richards Equation for vertical flow through the unsaturated (vadose) zone, and was used to estimate rainfall infiltration losses for this study. The Green and Ampt methodology assumes all rainfall enters the soil column if the rainfall rate is less than the hydraulic conductivity of the soil, with the hydraulic conductivity increasing as the water content approaches the saturated porosity due to a reduction in suction. Runoff occurs when the rainfall rate increases beyond the hydraulic conductivity of the soil and stops when the rainfall falls below the hydraulic conductivity of soil. Data inputs required for each sub-catchment for the Green and Ampt methodology include:

1. Soil hydraulic conductivity (the velocity that water can travel through soil pores)
2. Soil saturated porosity (moisture carrying capacity of soil)
3. Soil residual saturation (initial moisture content of soil, assumed to be 50-percent for design storms)
4. Soil wetting front suction (the suction of soil in the unsaturated zone)

The Green-and-Ampt parameters were defined based on Hydrologic Soil Groups using guidance from Rawls et al. (1982)[1] and the InfoWorks ICM Help Manual, consistent with prior InfoWorks ICM modeling performed at Water Street/Brewers Corner[2]. Table B-1 summarizes the parameters defined for the hydrologic soil groups and their assumed corresponding soil types.

TABLE B-1
Green-and-Ampt parameters used for InfoWorks ICM Modeling*

Hydrologic Soil Group	Porosity	Saturated Hydraulic Conductivity (inch/hour)	Wetting Front Suction (inch)	Initial Moisture Deficit†	Soil Type
A	0.44	3.90	6.17	0.22	Sand to sandy loam
B	0.46	0.52	12.40	0.23	Loam
C	0.45	0.22	16.79	0.22	Sil loam to sandy clay loam
D	0.46	0.05	23.81	0.23	Clay loam to clay

*Values estimated using Rawls et al. (1982), ICM Help Manual, and prior InfoWorks ICM modeling performed at Water Street/Brewers Corner
†The initial moisture deficit was assumed to be 50-percent for design storms

[1] Rawls, Walter J., Donald L. Brakensiek, and K. E. Saxtonn. "Estimation of soil water properties." *Transactions of the ASAE* 25.5 (1982): 1316-1320.
[2] “Water Street/Brewers Corner Area Drainage Study” by Woodard & Curran, dated May 20, 2019.

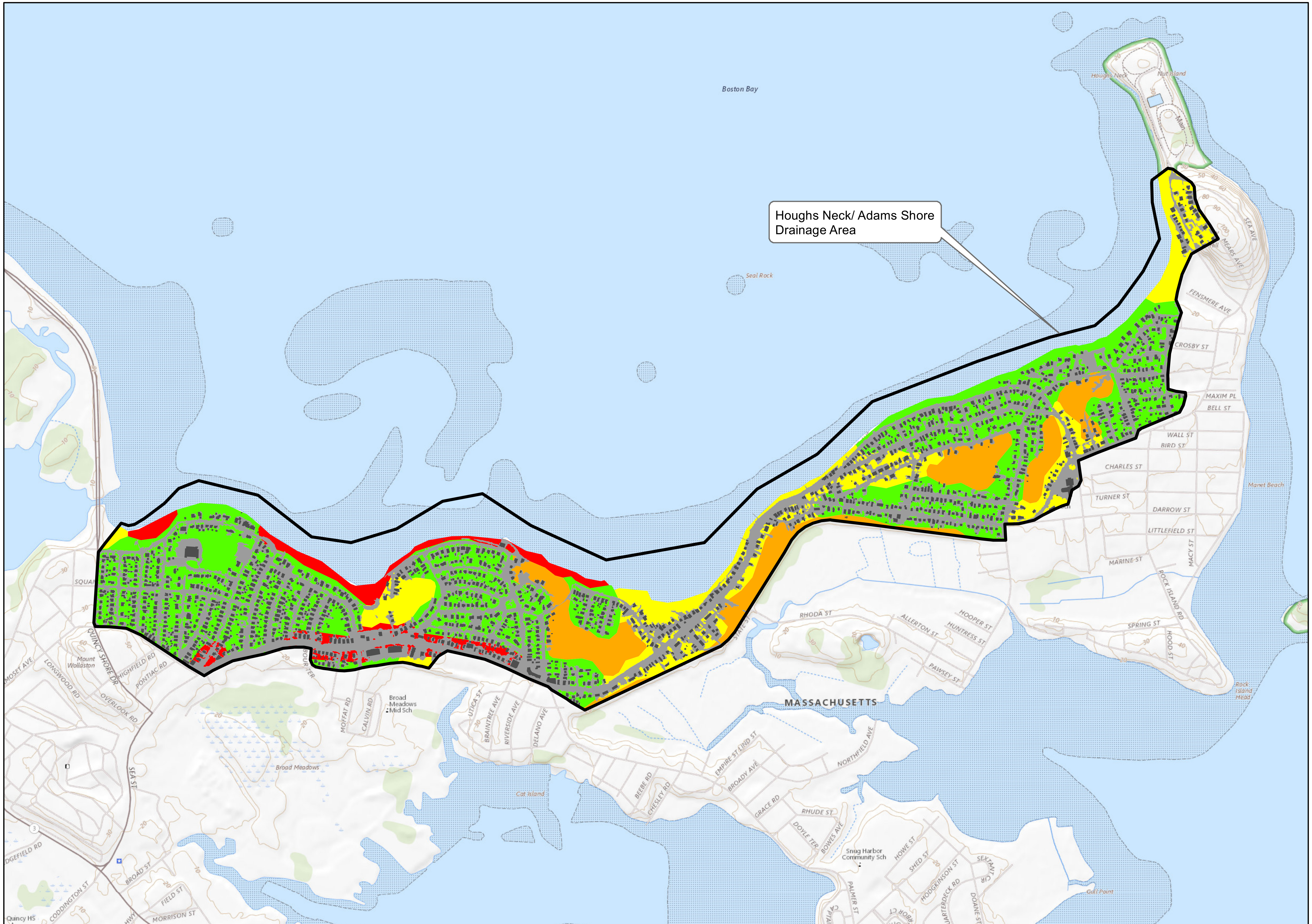

FIGURE 5 INFILTRATION CHARACTERISTICS

LEGEND

Hydrologic Soil Group

- A
- B
- C
- D
- Impervious
- Buildings
- Houghs Neck/ Adams Shore Drainage Area

LOCUS MAP

N W E S

0 250 500 1,000 Feet

1:12,000

NOTES

Based on USGS National Topographic Map: National Boundaries Dataset

Adams Shore & Houghs Neck Coastal Flood Modeling Quincy, Massachusetts

June 2020

Tighe&Bond

G:\GIS\MA\Quincy\avproj\HoughsNeckSW_report_Infiltration.mxd Date Saved: 6/24/2020 User: ABC

Q-0019

1.3 Seawall

1.3.1 Existing Conditions

The Adams Shore/Houghs Neck seawall was represented in the model as a Base Linear Structure (2D). The existing seawall elevations were based on available survey data described in Appendix A.

1.3.2 Future Conditions

Construction is currently underway to raise the seawall elevation along the study area by approximately 2-feet to 13 feet NAVD88. Design plans were used to estimate the future seawall elevations as described in Appendix A. Following completion of construction, we recommend that the seawall geometry (and outfall elevations) be updated based on record drawings provided by the construction contractor. A potential future conditions sea wall was also evaluated where the seawall was raised along the study area by approximately 4-feet above existing conditions to 15 feet NAVD88.

1.4 Storm Drain Infrastructure

1.4.1 Existing Conditions

The storm water network in the Adams Shore / Houghs Neck study area was included in the model as a 1D feature in the InfoWorks ICM model. The model included all City pipes, catch basins, and manholes that were available from the data sources described in Appendix A. Model inputs (e.g., inverts, rim elevations, pipe materials, pipe lengths, one-way check valves, and the Post Island Road Tide Gate) were acquired based on the most recent available data. The data sources are provided below in order of preference (e.g., if #1 wasn't available #2 was used):

1. The April 2020 *Adams Shore/Houghs Neck Stormwater Survey* by Feldman Land Surveyors performed as part of this modeling project.
2. The 2018 *Manet Avenue Seawall Survey* by Corner Post Land Surveying
3. The 2017 *Adams Shore/Houghs Neck Seawall Survey* by Corner Post Land Surveying
4. Available record drawing data.
5. Data available from the City GIS

The 1D stormwater network included 536 nodes, approximately 6.6 miles of pipe, 22 outfalls through the seawall, 12 one-way check valves and one (1) tide gate. One-way check valves and the Post Island Road tide gate were modeled using flap vales in InfoWorks ICM. The check-valve near Bayswater Road is reportedly propped open, and was modeled assuming approximately 25-percent of the pipe capacity was not restricted by the check valve, and 75-percent was restricted for existing conditions. Table B-2 provides a summary of the of the outfalls through the sea wall at Adams Shore/ Houghs Neck.

TABLE B-2
Outfalls through the Sea Wall at Adams Shore/Houghs Neck

Outfall Number	Outfall Designation	Existing Check Valve?
1	OF-01677	Yes
2	Unnamed-1	Yes

Outfall Number	Outfall Designation	Existing Check Valve?
3	OF-10231	-
4	Unnamed-2	-
5	OF-02300	Yes
6	OF-02474	-
7	OF-02506	-
8	OF-02578	-
9	OF-02708	Yes
10	OF-02811	Yes
11	OF-12373	Yes
12	OF-03035	Yes
13	OF-08590*	Yes*
14	OF-02947	-
15	OF-02829	Yes
16	OF-12273	-
17	OF-08564	-
18	OF-08573-1	Yes
19	OF-08573-2	Yes
20	OF-02913	-
21	OF-08549	Yes
22	OF-10028	Yes

*OF-08590 is located at Post Island Road and has a mechanical tide gate, not a one-way check valve.

We performed a multi-step procedure to validate the data input into the 1D stormwater network, as follows (numbers indicate approximate order of the validation procedure):

1. **General Strategy:** The storm drain network geometry was estimated using the most recent available data sources as described above. We used the model's flagging feature to identify what data source was used.
2. **Connectivity:** Connectivity is the connection between model objects, such as the connection between pipes with manholes and outfalls. We checked the network for connectivity to verify that manholes connected correctly to pipes, and that they flowed toward outfalls. The Adams Shore / Houghs Neck storm drainage system is composed of multiple individual networks, so individual connectivity checks were required for the numerous separate systems.
3. **Missing data:** The model requires numerous pieces of information for each pipe, manhole, and outfall included in the study area. Data was not available for all model components, so it was necessary to estimate or infer data where reasonable (e.g., interpolating a missing invert elevation that is missing between two known inverts). We estimated missing data as a last resort, flagging the model input accordingly.
4. **Profile review:** We reviewed profiles of storm drain profiles to visually check that flow entering and flowing through storm drain systems made physical sense based on precipitation and tide levels. This included verifying that one-way check valves operated as anticipated with flow traveling from upstream to downstream direction..

5. **3D Pan of Network:** The model was evaluated using a 3D visualization of the network (i.e., a 3D pan) of the system to visually check the seawall, outfalls, and manholes.
6. **Field Verification:** A site visit was performed in June 2020 to spot check areas identified during modeling as requiring additional information.

The Manning's roughness coefficients for the 1D pipe networks were selected based on the pipe material. Table B-3 provides the Manning's roughness coefficients used for the InfoWorks ICM model. Manhole geometry was determined based on the largest connected pipe to the structure itself. For pipes smaller than 24-inches, manholes were assumed to be 4 feet in diameter (both the shaft and the chamber). For pipes between 30 inches and 42 inches, manholes were assumed to be 5 feet in diameter. Lastly, for pipes larger than 48 inches, a 6-foot diameter manhole was assumed.

TABLE B-3
Manning's Roughness Coefficient Assumed for Storm Drain Pipe Materials

Pipe Material	Manning's Roughness Coefficient
Cast Iron Pipe	0.014
Clay Pipe	0.015
Concrete Pipe	0.013
Corrugated Metal Pipe	0.024
Corrugated Pipe	0.025
Corrugated Plastic Pipe	0.020
Metal Pipe	0.014
PVC Pipe	0.010
Reinforced Concrete Pipe	0.013
Stone Structure	0.025

1.4.2 Future Conditions

The future conditions stormwater network was estimated using design plans for the Seawall Repair project described in Appendix A. The future conditions included backflow prevention for each of the 22-outfalls, as opposed to existing conditions where only 13 of the outfalls have backflow prevention. One-way check valves were used for each of the outfalls other than the outfall at Post Island Road where the tide gate is not anticipated to change. Following completion of construction, we recommend that the outfall elevations used in the model be updated based on record drawings provided by the construction contractor.

1.5 Design Rainfall

The extreme precipitation event depths described in Appendix A were transformed into rainfall events using the Northeast Regional Climate Center (NRCC) Type B 24-hour synthetic rainfall distribution. Figure B-6 shows the cumulative rainfall distributions for the 24-hour precipitation events used for modeling. The cumulative rainfall distributions were converted to precipitation hyetographs (i.e., rainfall intensities over time) and were directly input into InfoWorks ICM. Figure B-7 shows an example precipitation hyetograph for the 100-year frequency storm event.

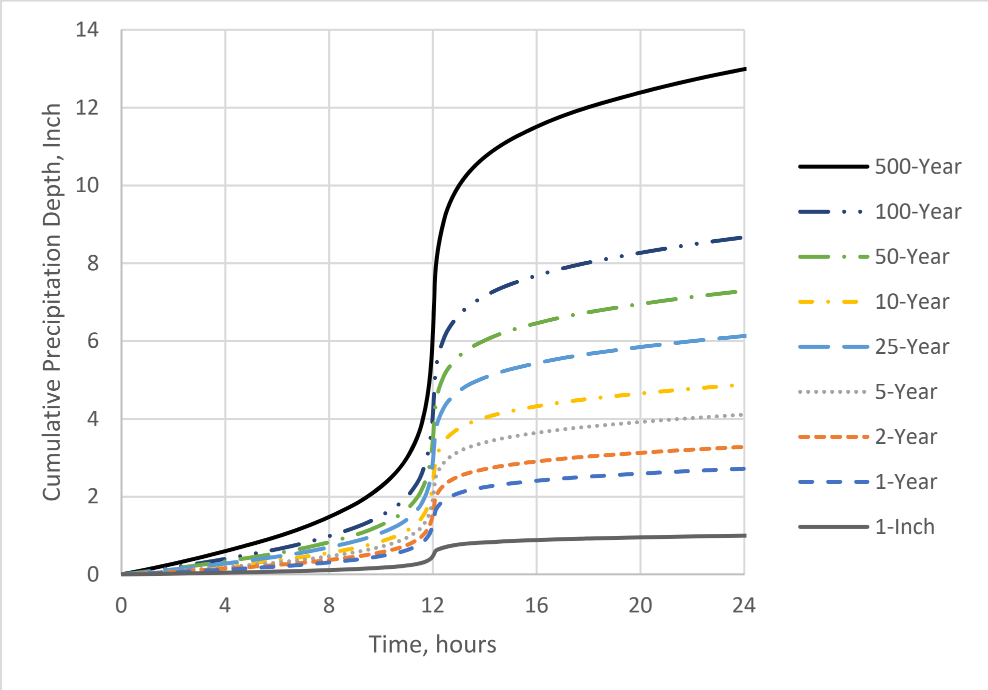

FIGURE B-6
Extreme precipitation cumulative precipitation depth during design 24-hour precipitation event used for InfoWorks ICM modeling

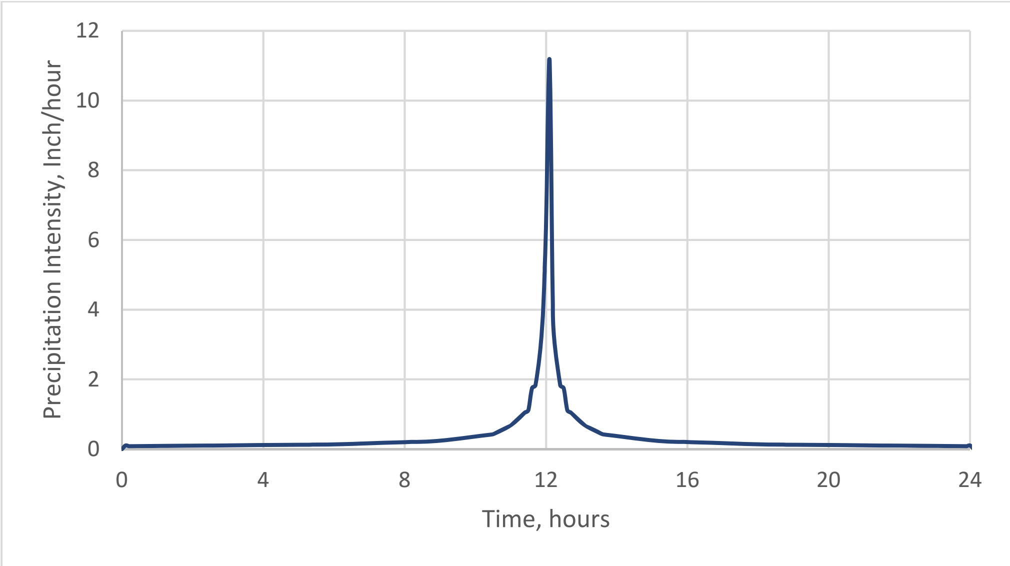

FIGURE B-7
Extreme precipitation 24-hour storm hyetograph for 1-percent annual chance event (100-year) used for InfoWorks ICM modeling

1.6 Design Tides

The "typical" tide was created using the predicted tide on January 16, 2020 that started and ended at approximately the mean higher high water (MHHW) elevation of 4.8 feet NAVD88. The predicted tide was used instead of an observed tide because it is an idealized, smoother curve that is more compatible hydraulic modeling because minor jumps can cause instability. A single period was taken and repeated to create a typical tidal distribution. For the purposes of modeling it was assumed both daily tides were approximately the same. The tidal cycle was assumed to start at the MHHW so that the peak rainfall intensity during the 24-hour rainfall event (at 12 hours) occurred during high tide The Sea Level Rise (SLR) scenarios were evaluated by increasing the unit tide by the sea level rise projections provided in Appendix A. Figure B-8 shows the design typical tide used for modeling as well as the three (3) sea level rise tidal scenarios.

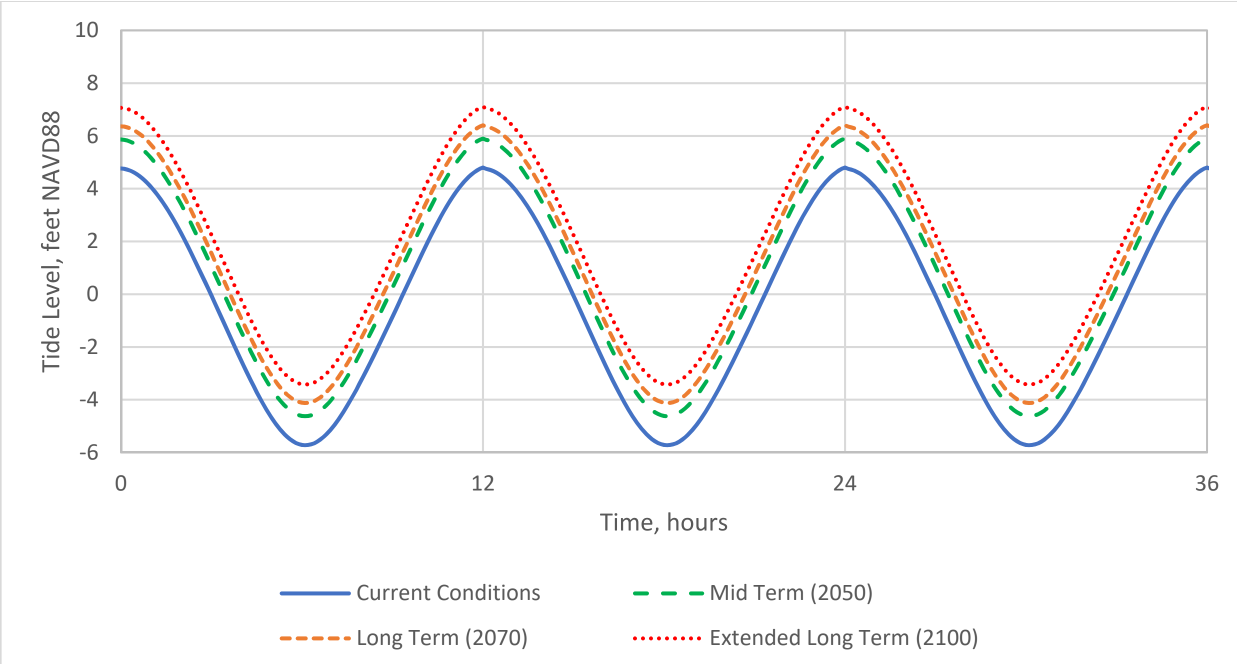

FIGURE B-8

Design typical tide with peak at Mean Higher High Water (MHHW) elevation of 4.8 feet NAVD88 and tides with projected sea level rise used for InfoWorks ICM modeling

Extreme tides were evaluated using data from the Federal Emergency Management Agency (FEMA) for the 10-year and 100-year frequency storm events, and the Annual Exceedance Probabilities (AEPs) from NOAA for the 1-year storm event (as described in Appendix A). The design extreme tides were developed by assuming one high tide was reached at the peak AEP elevation during the peak intensity of a 24-hour design precipitation event (at 12 hours), and that the next high tide was 1/2 way between the typical MHHW and the AEP high tide. The third high tide was assumed to be back at MHHW (e.g., typical tide levels). Transitions were made between low tide and high tide where the increase in tide is approximately linear to provide smooth transitions. Figure B-9 shows the AEP tides used for modeling and the typical MHHW tide for reference. Wave overtopping at seawalls is a complicated phenomenon that is anticipated to significantly impact flooding at Adams Shore/Houghs Neck during extreme tides. InfoWorks ICM does not model wave overtopping so a simplification was developed. A 4-foot rise at the peak tide level at a single 6-minute time step was used to represent wave overtopping based on the historic calibration storm events and the regulatory FEMA flooding extents.

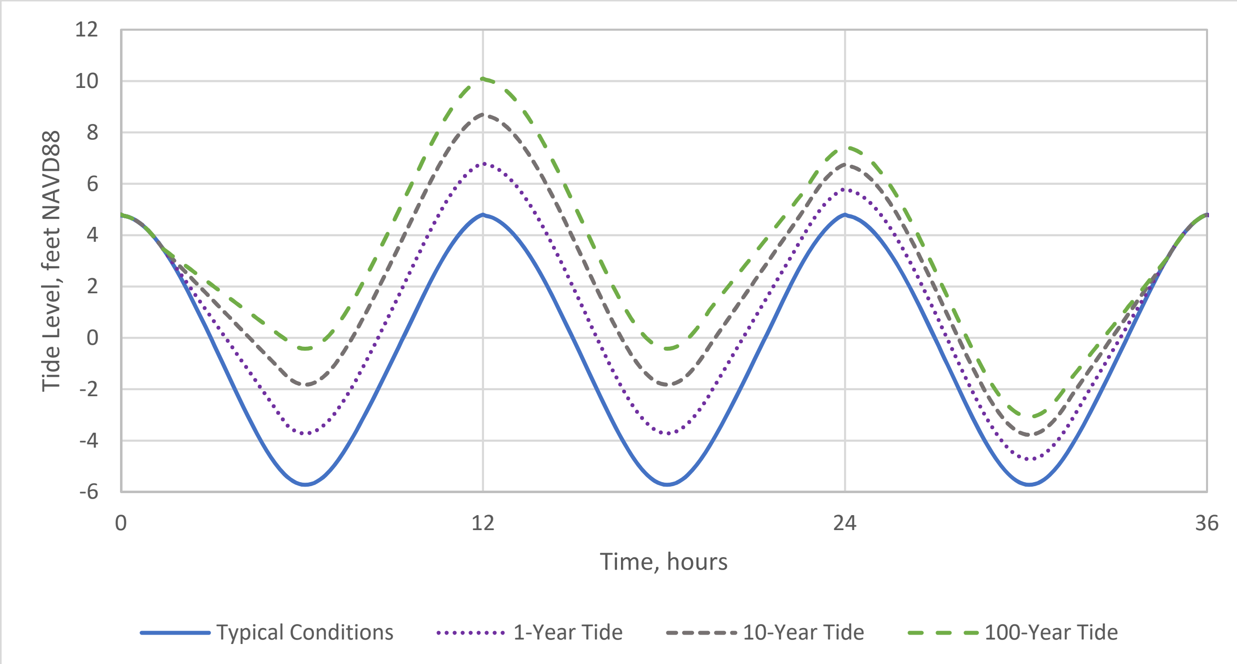

FIGURE B-9
Design Annual Exceedance Probability (AEP) tides used for InfoWorks ICM modeling

1.7 Proposed Conditions

Tighe & Bond evaluated potential opportunities to reduce flooding in the Adams Shore and Houghs Neck study area. The evaluation was performed by adding potential pumps representing pump stations, and evaluating storm drainage improvements (e.g., catch basins, redirecting flow, or increasing pipe sizes). The drainage improvements were evaluated by accessing:

- Areas with observed flooding during the 10-year storm event
- Locations where larger pipes flow into smaller pipes
- Pipes with reverse pitch (e.g., the upstream invert is lower than the downstream invert).
- Areas where there was a long distance between catch basins.

The evaluation of proposed conditions is described in Appendix C.

2 Calibration / Validation

We used historic storm events on October 31, 1991; May 24, 2005; and March 3, 2018 to calibrate/validate the InfoWorks ICM Model.

2.1 Data Inputs

2.1.1 Historic Tide Levels

Historic tide levels for the calibration/validation storm events were taken directly from NOAA Tides & Currents for Station 8443970 – Boston, MA in Local Standard Time (LST). The tide levels do not wave action into account, and slight variations are anticipated between the Boston tide gage and what would be observed at Quincy. Wave overtopping was incorporated into the observed data by assuming a 4-foot rise at the peak tide level at a single 6-minute time step (as described in Section 1.6).

2.1.2 Historic Rainfall Data

Rainfall data for calibration/validation storm events were acquired for each storm event based on best available data. A summary of data for each storm event is provided below

October 1991

Hourly precipitation data from NOAA precipitation gages at Logan International Airport (WBAN 14739), Blue Hills (WBAN 14753), and South Weymouth (14790) were available for the October 1991 storm event. The precipitation distribution from Logan Airport (the nearest gage) was used with the rainfall total depth magnitude adjusted using inverse distance weighting for the three gages. The modeled rainfall depth was approximately 3.3 inches over approximately 2 days.

The Blue Hills gage was observed to have significantly more precipitation than either the South Weymouth or Logan Airport precipitation gages. Based on the elevation of the Blue Hills Gage (approximately 200 meters above the site) and the location of the gage (on the western face of a regional relative high point) further analysis was required to determine whether this gage was an appropriate representation of rainfall at the site. Daily rainfall data was compared from April 2011 through December 2013 between the Town Brook USGS gage (located in Quincy) with the Blue Hills and Logan precipitation gages. The residuals between the two NOAA gages and Town Brook gage were evaluated over this period, and it was determined that the Blue Hills Gage was more hydrologically distant from Quincy than its physical distance would suggest. The distance weight was modified for the Blue Hills gage to account for differences in elevation and geography between the gage and the study area. The Blue Hills data was not disregarded entirely because the Logan gage was generally found to have less precipitation than the Town Brook gage, so including the gage was considered appropriate.

May 2005

Hourly precipitation data were available from NOAA precipitation gages at Logan International Airport (WBAN 14739) and Blue Hills (WBAN 14753) for the May 2005 storm event. The precipitation distribution from Logan Airport (the nearest gage) was used with the total rainfall depth magnitude adjusted using inverse distance weighting (as described above for the October 1991 storm event) for the two gages. The modeled rainfall depth was approximately 2.8 inches over approximately 3 days.

March 2018

The USGS Town Brook precipitation gage (USGS 01105584) was used with 15-minute time interval. Rainfall data was not available at the Town Brook precipitation gage prior to 2011 so it could not be used for the other calibration/validation storm events. The time was converted from Coordinated Universal Time (UTC) to local standard time. This gage was used on its own because it is located within the City of Quincy and provides a finer time interval than the other nearby gages. The modeled rainfall depth was approximately 4.6 inches over approximately 1 day.

2.1.3 Flooding Data

Tighe & Bond utilized available historic flooding data for the calibration/validation storm events. Tighe & Bond obtained Repetitive Loss information from Federal Emergency Management Agency (FEMA) for the City of Quincy to better understand the impacts of coastal and inland flooding within the City. The Repetitive Loss information was available for the October 1991 and May 2005 storm events, and available residential sill elevations were acquired from the City of Quincy.

The Quincy Repetitive Loss records relating to individuals and individual properties were made available through the FEMA routine use policy for the specific purposes of mitigation planning, research, analysis, and feasibility studies consistent with the NFIP and for uses that further the floodplain management and hazard mitigation goals of the States and FEMA. The information is protected under the Privacy Act of 1974, 5 U.S.C. section 552 (a) and any personal identifiers such as names, addresses, 9 digit zip codes, loss dates or amounts or individual insurance information cannot be disclosed in documents prepared that may be released to the general public or press. The repetitive loss information was used for model calibration/validation but specific information was omitted from this report.

Repetitive loss data could not be acquired for the May 2018 storm event; however, known locations with flooding were available for the City of Quincy. Figure B-10 summarizes Adams Shore/Houghs Neck damages following the March 2018 storm event. The calibration focused on impacted major roads with damages (Bayswater Road, Post Island Road, Terne Road, etc.) and homes noted with first floor damages.

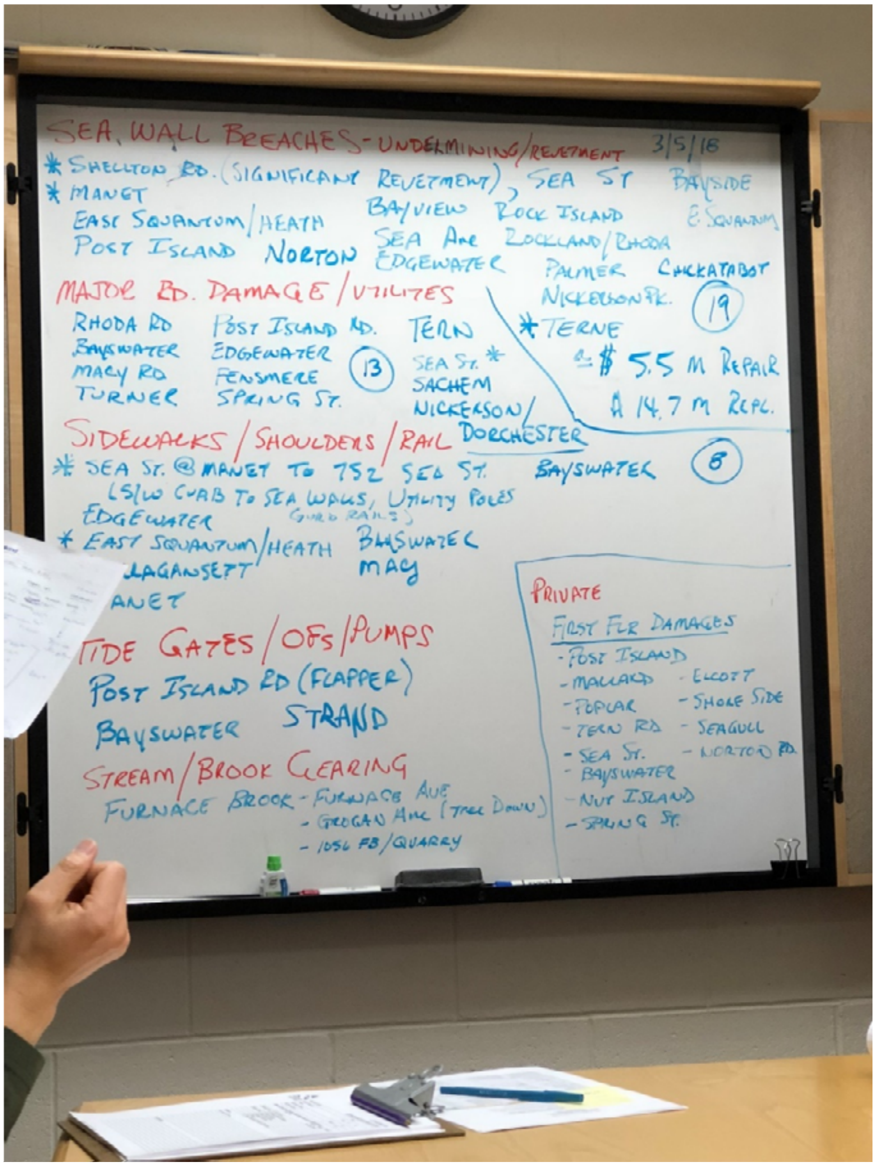

FIGURE B-10

Summary of Adams Shore/Houghs Neck damages following March 2018 storm event

2.1.4 1991 Seawall Geometry

The seawall was modified after the October 1991 storm event. The modeled seawall was modified when performing the October 1991 storm event using design plans titled "Seawalls Rehabilitation Project – Phase III" by East Coast Engineering, dated October 14, 1993. The vertical datum was not clear so the elevations of the pre-1993 floodwall were estimated based on comparisons between the 1993 design plans and recent seawall surveys.

2.2 Calibration/Validation Approach

The calibration/validation was performed by comparing observed flooding during the three evaluated storm events with the model results. For the storm events where repetitive loss data was available (October 1991 and May 2005), the flooding elevations were compared with locations where repetitive losses were document and the number of repetitive loss locations were flooding was observed were counted. Where sill elevations were available the modeled flood elevations were compared with the documented sill elevations. For the March 2018 storm event the roads with major road damage observed were compared with modeled flooding.

2.3 FEMA Special Flood Hazard Area (SFHA)

Tighe & Bond compared the 100-year tide levels occurring during a 1-inch storm event with the FEMA Letter of Map Revision (LOMR) Case No. 15-01-0874P effective August 21, 2015 for the City of Quincy. The model results closely matched the FEMA Special Flood Hazard Areas (SFHAs).

3 Model Scenarios

The Adams Shore/Houghs Neck Model was run four scenarios to evaluate existing, anticipated, and possible future conditions. The model scenarios evaluated:

1. **Existing Conditions** – The Existing Conditions scenario represents existing conditions with the seawalls at their current elevation. The existing conditions model was used for calibration and validation.
2. **Future Conditions** – The Future Conditions scenario represents anticipated near-term future conditions with the seawalls raised two feet to elevation 13 NAVD88.
3. **Potential Future Conditions** – The Potential Future Conditions scenario represents potential future conditions with the seawalls raised by 4 feet to elevation 15 NAVD88.
4. **Drainage System Pump Station Alternatives –** This scenario evaluated potential pump stations at marshes adjacent to Post Island Road, Terne Road, and Bayswater Road.
5. **Drainage System Improvements Alternatives –** This scenario evaluated potential drainage improvements (e.g., catch basins, redirecting flow, or increasing pipe sizes).

Tighe & Bond created model runs to evaluate existing, future, and potential future conditions for the following:

- The 1-, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storm events occurring during mean higher high tide conditions.
- Joint coastal and upland flooding occurring during 1-year, and 10-year tide occurring simultaneously with 2-, 10-, and 50-year frequency rainfall storm events.
- A moderate rainfall event (1 inch over 24 hour) occurring during a 100-year tide
- Sea Level Rise (SLR) scenarios evaluating a 100-year frequency rainfall event occurring during the three (3) Sea Level Rise (SLR) scenarios.

The pump station alterative model runs were evaluated for:

- The 10- and 500-year frequency storm events occurring during mean higher high tide conditions.
- Joint Coastal and upland flooding occurring during a 10-year tide occurring simultaneously with a 10-, and 50-year frequency rainfall storm event.

- Joint Coastal and upland flooding occurring during a 100-year tide occurring simultaneously with 1-inch of rainfall, a 10-year frequency rainfall storm event, and a 100-year frequency rainfall storm event.
- Sea Level Rise (SLR) scenario evaluating a 100-year frequency rainfall event occurring with the 2017 SLR MHHW conditions.

The drainage system alterative model runs were evaluated for:

- The 10-year frequency storm events occurring during mean higher high tide conditions.
- A SLR scenario evaluating a 10-year frequency rainfall event occurring with the 2070 SLR MHHW conditions.

4 Differences from Prior City InfoWorks ICM Modeling

The City of Quincy intends to create InfoWorks ICM models throughout the City that can later be combined into a single comprehensive model. Tighe & Bond attempted to follow similar methodologies (where practical) with prior InfoWorks ICM modeling performed at Water Street/Brewers Corner [3]. Due to differences in the coastal Houghs Neck / Adams Shore area, and the more upland Water Street/Brewers Corner study area, different assumptions were necessary. Tighe & Bond tracked significant changes between the prior InfoWorks ICM modeling performed at Town Brook and the InfoWorks ICM Model developed for the Adams Shore/Houghs Neck study to help develop a framework methodology for coastal versus upland areas within the City.

4.1 Assumptions for Modeling Buildings in 2D Mesh

Tighe & Bond modeled buildings in the Adams Shore/Houghs Neck area as being 10 feet above adjacent grade with an Manning's roughness coefficient approximating impervious cover. (0.02). The reason for this approach was that many of the houses have first floor elevations above grade, and the majority of flow is anticipated to travel around buildings instead of through them. Since InfoWorks does not allow vertically varying Manning's n values (i.e., higher Manning's roughness coefficient at lower elevation representing flow through building and lower Manning's roughness coefficient for roofs representing runoff from rainfall).

The Town Brook Study modeled building as being 0.5 feet above adjacent grade with a high Manning's roughness coefficient value (0.5) to account for potential flow through buildings. The Town Brook study area mostly had larger buildings at grade (e.g., industrial buildings) so accounting for flow through the buildings was assumed to have a greater impact on model results than the reduction in roof runoff volume from using a high Manning's roughness coefficient value. For the Adams Shore/Houghs Neck study area, Tighe & Bond used lower Manning's roughness coefficient with higher buildings to better represent runoff from rainfall, with the assumption that this will have a greater impact on overall volume than flow through the buildings (especially since the first floor elevations of most buildings in the study area are greater than 0.5 feet above adjacent grade).

[3] "Water Street/Brewers Corner Area Drainage Study" by Woodard and Curran, dated May 20, 2019.

4.2 Tidal Data

Prior InfoWorks ICM modeling in the City of Quincy did not include tidal downstream boundaries that changed over time. Adams Shore/Houghs Neck are heavily impacted by tides so detailed tidal boundary conditions were evaluated as described in Section 1.5.

4.3 Surface Roughness

Tighe & Bond utilized the 2016 land cover/land use dataset from MassGIS to estimate surface roughness. This 2016 land cover/land use dataset provides detailed land use that specifically identifies impervious areas so that roughness for developed areas can be split between impervious (e.g., pavement) and pervious (e.g., grass) cover. This approach provides greater detail than making overarching assumptions based on the density of a specific land use type. Tighe & Bond used Manning's roughness coefficients provided by the National Center for Computational Hydroscience and Engineering (NCCHE) for their DSS-WISE 2D modeling software that is supported by FEMA.

The roughness values for the Water Street/Brewers Corner study were estimated using 2005 Land Use data from MassGIS. Roughness value estimated from the Water Street/Brewers Corner study were from the Flo-2D (2017) Reference Manual, which appears to better match the 2005 Land Use data from MassGIS. The difference in approach is primarily due to the Adams Shore/Houghs Neck using a more recent land use dataset released in May 2019.

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APPENDIX C

Appendix C - Results

TO: City of Quincy

FROM: Tighe & Bond

COPY:

DATE: June 30, 2020

Tighe & Bond performed hydrologic and hydraulic modeling of the Adams Shore/Houghs Neck study area using the InfoWorks Integrated Catchment Modeling (InfoWorks ICM) software by Innovyze, Inc. This Appendix summarizes the results from the Adams Shore/Houghs Neck Infoworks Stormwater model. Appendix A summarizes data inputs for the model, and Appendix B summarizes the methodology.

1 Calibration/Validation

1.1 Historical Storm Events

Tighe & Bond used historical storm events to calibrate/validate the InfoWorks ICM Model. Figures C-1, C-2, and C-3 show the model-computed inundation areas for the October 31, 1991, May 24, 2005 and March 3, 2018 storm events, respectively.

October 31, 1991. Following the October 31, 1991 storm event, 33 repetitive loss claims were filed in the study area with the Federal Emergency Management Agency (FEMA), with first floor sill elevations available at nine (9) of the locations. The model showed flooding adjacent to 32 of the 33 repetitive loss locations, equating to a success rate of approximately 97-percent. The repetitive loss location where model inundation was not observed was located approximately 200 feet from the existing seawall, and may have been impacted by localized wave action. Model water surface elevations exceeded the sill elevation at the nine (9) repetitive loss locations with sill data available for this storm event.

May 24, 2005. Following the May 24, 2005 storm event three (3) repetitive loss claims were filed in the study area with FEMA, with first flood sill elevation available at two (2) locations. The model showed flooding at all three repetitive loss locations, and model water surface elevations exceeded the sill elevations at the two (2) repetitive loss locations with sill data available for this storm event.

March 3, 2018. Tighe & Bond was not able to acquire repetitive loss data for the March 3, 2018 storm event; however, the model inundation area was compared with known locations where flood damages occurred. During the storm event major damages to roads and utilities were noted in the study area at Bayswater Road, Post Island Road, Terne Road, and Sea Street. Model results showed greater than 1-foot of flooding at these locations. Damage to the seawall (e.g., breaches or undermining) were noted at the roads with flooding, as well as at Manet Avenue, Bay View Avenue, and Chickatabot Road. Model results showed flooding at all these locations other than Bay View Avenue. Tighe & Bond did not model breaches in the seawall, so it is reasonable that flooding was not observed at all of the locations. Flooding northwest of the Willows Marsh reportedly occurred, and the area drained slowly, while our model results showed this area flooding, and not draining.

There is significant spatial and temporal uncertainty when modeling historic rainfall events in coastal areas. These uncertainties include site precipitation versus gage precipitation, site tides versus gaged tides, and site-specific wave overtopping. Overall, we found that the InfoWorks ICM model provided a good representation of the historical flooding events.

1.2 Federal Emergency Management Agency (FEMA) Special Flood Hazard Area (SFHA)

Tighe & Bond compared a 100-year tide event coinciding with 1-inch of rainfall to the FEMA effective 1-percent-annual-chance Special Flood Hazard Area (SFHA). The purpose of the comparison was to evaluate the assumptions used for wave overtopping (i.e., a 4-foot wave occurring over a single timestep). Figure C-4 compares the modeled inundation area with the FEMA inundation boundary. The InfoWorks ICM model existing condition results closely match the FEMA boundary, further validating the model results.

2 Design Storm Events

The calibrated InfoWorks ICM model was used for modeling design rainfall and tidal events. Tighe & Bond evaluated the model scenarios described in the Appendix B methodology section.

2.1 Existing and Future Conditions

The ongoing Adams Shore/Hough Neck Seawall Repair & Improvements project currently under construction is anticipated to alter drainage within the study area. In order to evaluate the effect of the seawall improvements, both the existing (prior to seawall improvements) and future conditions (after seawall improvements) were evaluated and compared using InfoWorks ICM.

Table C-1 shows a summary of the impacted structures with adjacent flooding greater than 12-inches for existing and proposed conditions. A depth of 12-inches was used instead of 6-inches because most of the houses in Adams Shore / Houghs Neck have first floor elevations at least 0.5 feet above adjacent grade. Sill elevations are not available for all the houses in the study area. The counted impacted structures with adjacent flooding may have first floor elevations above the anticipated flooding levels; however, the counting methodology provides a basis of comparison between the different storm events. The residences in the Willows area were omitted from the count because some drainage is anticipated to occur to the south.

Tables C-2, C-3, C-4, C-5, and C-6 show average flooding depths at Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road, respectively. Table C-7 shows the average flooding over the five locations.

Normal tidal conditions - Normal tidal conditions are defined as the normal tidal cycle peaking at Mean Higher High Water (MHHW). The anticipated number of structures with adjacent flooding due to large rainfall events during typical tidal conditions is not anticipated to change due to the future seawall improvements if the peak rainfall coincides with the peak tide. It is anticipated that the increase in capacity provided for future outfall improvements will improve drainage when peak flows do not coincide with the peak tide elevations since pipe flow would not be limited by tailwater; however, these scenarios were not evaluated as part of this study. Adjacent flooding is anticipated at approximately 10 structures during a 1-year frequency storm event occurring during normal tidal conditions, compared to approximately 120 impacted during a 500-year frequency storm event. The average flooding depths at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) are also anticipated to be approximately the same for existing and future conditions. Figure C-5 shows the modeled inundation area for existing conditions during typical tidal conditions during the 2-, 10-, and 100-year frequency storm events, and Figure C-6 shows the same rainfall and tidal conditions for future conditions. The inundations areas for existing and future conditions during precipitation events during normal tidal conditions are similar.

Extreme Tidal Events – Rainfall events occurring during extreme tides are anticipated to cause substantially more flooding, than similar rainfall events occurring during normal tides. For example, approximately 30 impacted structures with adjacent flooding are anticipated for existing conditions with a 10-year rainfall event during normal tides. The number of impacted structures increases to 50 structures if the rainfall event coincided with a 1-year extreme tide, to 260 structures if the rainfall coincided with a 10-year tide, and 440 structures if the rainfall coincided with a 100-year tide. Similarly, the average depth of flooding at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) is on average 0.8 feet for existing conditions with a 10-year rainfall event during normal tides, and would be anticipated to increase to 1-foot if a 10-year rainfall event coincided with a 1-year tide, 2.8-feet if the rainfall coincided with a 10-year tide, and 4.7-feet if the rainfall coincided with a 100-year tide. The seawall improvements are anticipated to reduce the number of structures with adjacent flooding during extreme tides by between 10-percent and 90-percent depending on the model scenario. For example, if a 10-year rainfall event occurred during a 10-year tide for existing conditions approximately 260 impacts to structures would be anticipated, compared to approximately 40 impacts for future conditions (a reduction of approximately 85-percent). Similarly, if a 10-year rainfall event occurred during a 10-year tide for existing conditions the average depth of flooding at the evaluated roads would be 2.8 feet, compared to approximately 1.0 feet for future conditions (a reduction of over 60-percent). Figure C-7 show the model inundation area for a 10-year tidal conditions occurring during a 10-year frequency rainfall event for existing and proposed conditions, and Figure C-8 shows the model inundation area for a 100-year tidal conditions occurring during a 100-year frequency rainfall event.

Sea Level Rise with 100-Year Storm Event - The model shows that the number of structures with adjacent flooding during the 100-year frequency storm event with Sea Level Rise (SLR) for 2050 and 2070 would be approximately the same for future as existing conditions. However, the seawall improvements will result in a reduction from 120 to 100 impacted structures (a reduction of 15-percent) when accounting for sea level rise in 2100). Sea level rise is anticipated to increase the flooding depths during the 100-year frequency rainfall event at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) by between 0-feet and 0.5 feet compared to the 100-year rainfall event occurring during current tidal conditions. The seawall improvements are anticipated to reduce the flooding depths at the evaluated roads during a 100-year rainfall event with 2100 SLR by 0.1 feet to 0.5 feet, with changes less than 0.1 feet anticipated for the 2050 and 2070 SLR scenarios. The reason that the effects of the seawall improvements are greater for the SLR 2100 conditions compared to 2050 and 2070 may be due to the one-way check valves providing a larger benefit during the higher tide and/or because the reduction in head losses at the proposed larger outfall pipes may allow water to drain with less upstream static head (e.g., a lower water level may be required at the upstream end of the outfall pipes to push water through to the tide). Figure C-9 shows the model inundation areas for the 100-year frequency storm event occurring during the three (3) SLR tidal conditions in 2050, 2070, and 2100.

Table C-1
InfoWorks ICM Model Results Summary for Number of Structures* with Adjacent Flooding Greater than 12-inches

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition†	Potential Future Conditions‡
Normal Tidal Conditions§	1-Year	10	Values approximately the same as for existing conditions during normal tidal conditions	
	2-Year	10		
	5-Year	20		
	10-Year	30		
	25-Year	40		
	50-Year	70		
	100-Year	80		
	500-Year	120		
SLR 2050¶	100-Year	90	90	Values the same for Potential Future and Future Condition
SLR 2070¶		90	90	
SLR 2100¶		120	100	
October 31, 1991		250	-	-
May 24, 2005		180	-	-
March 3, 2018		300	20	-
1-Year Tide	2-Year	30	20	Values the same for Potential Future and Future Condition
	10-Year	50	40	
	50-Year	90	80	
10-Year Tide	2-Year	250	30	Values the same for Potential Future and Future Condition
	10-Year	260	40	
	50-Year	290	80	
100-Year Tide	1-inch	420	140	20
	10-Year	440	170	50
	100-Year	460	230	110

*Buildings from the City of Quincy GIS database adjacent to areas where flooding of 1-foot or more occurred were counted (this assumes most houses are at least 0.5 feet above adjacent grade and are only impacted when ponded water is 0.5 feet or greater). Buildings with areas less than 500 square feet were omitted to remove small sheds included in the database. Inundated properties were counted once even if a residence and a standalone garage (greater than 500 square feet in area) was flooded. Small areas of localized flooding less than 1000 square feet were also omitted. The residences in the Willows area were omitted from the count because some drainage is anticipated to occur to the south.
†Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
‡Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
§Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
¶Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

Table C-2
InfoWorks ICM Model Results Summary for Average Flooding Depth at Chickatabot Road (depth in feet)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	0	Values the same as for existing conditions during normal tidal conditions	
	2-Year	0		
	5-Year	0.5		
	10-Year	0.5		
	25-Year	0.5		
	50-Year	0.6		
	100-Year	0.6		
	500-Year	0.8		
SLR 2050§	100-Year	0.7	0.6	Values the same for Potential Future and Future Condition
SLR 2070§		0.7	0.6	
SLR 2100§		0.8	0.7	
October 31, 1991		1.8	-	-
May 24, 2005		1.6	-	-
March 3, 2018		2.0	1.3	-
1-Year Tide	2-Year	0.7	0.7	Values the same for Potential Future and Future Condition
	10-Year	0.7	0.7	
	50-Year	0.8	0.8	
10-Year Tide	2-Year	1.9	1.1	Values the same for Potential Future and Future Condition
	10-Year	1.8	1.1	
	50-Year	1.7	1.0	
100-Year Tide	1-inch	3.0	2.5	1.5
	10-Year	3.0	2.4	1.5
	100-Year	2.5	2.0	1.3

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

Table C-3
InfoWorks ICM Model Results Summary for Average Flooding Depth at Post Island Area (depth in feet)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	0.7	Values the same as for existing conditions during normal tidal conditions	
	2-Year	0.7		
	5-Year	0.7		
	10-Year	0.8		
	25-Year	0.8		
	50-Year	0.8		
	100-Year	0.8		
	500-Year	0.8		
SLR 2050§	100-Year	0.7	0.7	Values the same for Potential Future and Future Condition
SLR 2070§		0.7	0.7	
SLR 2100§		0.9	0.7	
October 31, 1991		2.5	-	-
May 24, 2005		2.1	-	-
March 3, 2018		3.1	0.7	-
1-Year Tide	2-Year	0.9	0.7	Values the same for Potential Future and Future Condition
	10-Year	0.9	0.8	
	50-Year	0.8	0.8	
10-Year Tide	2-Year	2.6	0.7	Values the same for Potential Future and Future Condition
	10-Year	2.6	0.8	
	50-Year	2.6	0.8	
100-Year Tide	1-inch	4.4	1.7	0.6
	10-Year	4.4	1.7	0.8
	100-Year	4.5	1.7	0.7

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡ Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

Table C-4
InfoWorks ICM Model Results Summary for Average Flooding Depth at Sea Street (depth in feet)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	0.6	Values the same as for existing conditions during normal tidal conditions	
	2-Year	0.6		
	5-Year	0.6		
	10-Year	0.7		
	25-Year	0.7		
	50-Year	0.8		
	100-Year	0.8		
	500-Year	0.8		
SLR 2050§	100-Year	0.8	0.8	Values the same for Potential Future and Future Condition
SLR 2070§		0.8	0.8	
SLR 2100§		0.9	0.8	
October 31, 1991		2.3	-	-
May 24, 2005		1.8	-	-
March 3, 2018		3.3	0.7	-
1-Year Tide	2-Year	0.7	0.7	Values the same for Potential Future and Future Condition
	10-Year	0.8	0.7	
	50-Year	0.8	0.8	
10-Year Tide	2-Year	2.4	0.8	Values the same for Potential Future and Future Condition
	10-Year	2.4	0.8	
	50-Year	2.5	0.8	
100-Year Tide	1-inch	5.3	1.5	0.7
	10-Year	5.4	1.5	0.8
	100-Year	5.4	1.5	0.9

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡ Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

Table C-5
InfoWorks ICM Model Results Summary for Average Flooding Depth at Bayswater Area (depth in feet)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	0.7	Values the same as for existing conditions during normal tidal conditions	
	2-Year	0.7		
	5-Year	0.8		
	10-Year	0.8		
	25-Year	0.8		
	50-Year	0.8		
	100-Year	0.8		
	500-Year	0.8		
SLR 2050§	100-Year	0.9	0.9	Values the same for Potential Future and Future Condition
SLR 2070§		0.9	0.9	
SLR 2100§		1.3	0.8	
October 31, 1991		3.3	-	-
May 24, 2005		1.9	-	-
March 3, 2018		2.6	0.7	-
1-Year Tide	2-Year	0.9	0.7	Values the same for Potential Future and Future Condition
	10-Year	0.9	0.8	
	50-Year	0.8	0.8	
10-Year Tide	2-Year	2.2	0.7	Values the same for Potential Future and Future Condition
	10-Year	2.2	0.8	
	50-Year	2.3	0.8	
100-Year Tide	1-inch	4.0	1.4	NA
	10-Year	4.1	1.4	0.8
	100-Year	4.2	1.4	0.9

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

Table C-6
InfoWorks ICM Model Results Summary for Average Flooding Depth at Terne Road (depth in feet)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	1.1	Values the same as for existing conditions during normal tidal conditions	
	2-Year	1.2		
	5-Year	1.3		
	10-Year	1.5		
	25-Year	1.8		
	50-Year	2.0		
	100-Year	2.3		
	500-Year	3.4		
SLR 2050*	100-Year	2.5	2.5	Values the same for Potential Future and Future Condition
SLR 2070*		2.5	2.5	
SLR 2100*		2.6	2.6	
October 31, 1991		4.7	-	-
May 24, 2005		3.5	-	-
March 3, 2018		6.2	NA	-
1-Year Tide	2-Year	1.3	1.2	Values the same for Potential Future and Future Condition
	10-Year	1.8	1.6	
	50-Year	2.3	2.2	
10-Year Tide	2-Year	5.0	1.2	Values the same for Potential Future and Future Condition
	10-Year	5.1	1.7	
	50-Year	5.3	2.3	
100-Year Tide	1-inch	6.6	2.3	0.5
	10-Year	6.7	2.9	1.7
	100-Year	6.8	3.8	2.8

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

March 3, 2018 Event with Seawall Improvements - The March 3, 2018 storm event was modeled using the "Future conditions" seawall at the request of the City of Quincy to evaluate the extent of flooding that may be expected if a similar event occurred with the improved seawall in place. Figure C-3 compares the March 2018 storm event for the existing seawall (in-place when the storm event occurred in 2018) with conditions if the storm event occurred with the seawall improvements constructed. The model shows that less flooding would be expected to occur for the same storm event if the seawall improvements were constructed. For example, the number of impacted structures with adjacent flooding would be anticipated to reduce from approximately 300 to approximately 20, and the average depth of flooding at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) would be anticipated to reduce from 3.5 feet to 0.9 feet. The model inundation area is anticipated to decrease substantially; however, the simplified wave overtopping is not anticipated to fully match previously observed wave overtopping conditions. It is expected that flooding will occur if waves exceeding the seawall elevation occur for a prolonged period.

Table C-7
InfoWorks ICM Model Results Summary for Average Flooding Depth (depth in feet) at evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road)

Tidal Storm Event	Precipitation Storm Event	Existing Conditions	Future Condition*	Potential Future Conditions†
Normal Tidal Conditions‡	1-Year	0.6	Values the same as for existing conditions during typical tidal conditions	
	2-Year	0.6		
	5-Year	0.8		
	10-Year	0.8		
	25-Year	0.9		
	50-Year	1.0		
	100-Year	1.1		
	500-Year	1.3		
SLR 2050*	100-Year	1.1	1.1	Values the same for Potential Future and Future Condition
SLR 2070*		1.1	1.1	
SLR 2100*		1.3	1.1	
October 31, 1991		2.9	-	-
May 24, 2005		2.2	-	-
March 3, 2018		3.5	0.7	-
1-Year Tide	2-Year	0.9	0.8	Values the same for Potential Future and Future Condition
	10-Year	1.0	0.9	
	50-Year	1.1	1.1	
10-Year Tide	2-Year	2.8	0.9	Values the same for Potential Future and Future Condition
	10-Year	2.8	1.0	
	50-Year	2.9	1.2	
100-Year Tide	1-inch	4.7	1.9	0.7
	10-Year	4.7	2.0	1.1
	100-Year	4.6	2.1	1.3

*Future conditions are conditions where the seawall is raised as part of the Adams Shore/Hough Neck Seawall Repair & Improvements project.
†Potential future conditions are a scenario where the seawall is raised an additional two feet above future conditions.
‡Normal tidal conditions indicate a typical tidal cycle that peaks at Mean Higher High Water (MHHW).
§Normal tidal condition with Sea Level Rise (SLR) estimated based on the City of Quincy Hazard Mitigation Plan.

2.2 Potential Future Conditions

We also evaluated a scenario where the seawall is raised 2 feet above the future conditions currently under construction (referred to as "Potential Future Conditions"). Inundation areas only vary between future conditions (seawall improvements) and for potential future conditions (seawall improvements + 2-feet) when the seawall is anticipated to overtop, which only occurs during the 100-year extreme tide. Table C-1 shows that the anticipated number of structures with adjacent flooding reduces by 50-percent to 85-percent between future and potential future conditions. Table C-2 through C-6 show that raising the seawall an additional two feet is also anticipated to reduce the average depth of flooding at the evaluated roads (Chicatabot Road, the Post Island Area, Sea Street, the Bayswater Area, and Terne Road) by on average 1 foot.

2.3 Drainage System Pump Station Alternatives

Tighe & Bond evaluated potential pump stations at low lying marsh areas located adjacent to Norton Beach, Post Island Road, and Bayswater Road. The pumping rate for each pump station was determined assuming that the 100-year frequency rainfall event would be pumped from each marsh without additional relief from gravity drainage. A summary of the pump station design is provided in Appendix D. The pumps in InfoWorks ICM were assumed to turn on between elevation 3.1 and 3.6 feet NAVD88, and were assumed to turn off between elevations 3 and 3.2 feet NAVD88. The elevation the pumps turned on and off were staggered to improve model stability. Table C-8 provides the pumping rates used for the InfoWorks ICM model and the elevation where impacts to residences are anticipated to begin (i.e., the "critical elevation").

Table C-9
InfoWorks ICM Model Pumping Rates and Approximate Minimum Elevation Anticipated to Cause Residential Impacts

Location	InfoWorks ICM Pumping Rate (gallons per minute)	Critical Elevation* (feet, NAVD88†)
Norton Beach Marsh	7,700	5.9
Post Island Road Marsh	5,750	6.2
Bayswater Road Marsh	3,525	6.4

*The minimum elevation of anticipated residential impact was approximated in the field by estimating the minimum elevation where impacts to adjacent residences would be expected to occur (e.g., the lowest first floor elevation adjacent to the marsh).
†NAVD88 = North American Vertical Datum of 1988

Tables C-9, C-10, and C-11 summarize the reduction in duration of flooding and the number of structures anticipated to be flooded if the pump station was constructed at the Norton Beach Marsh, the Post Island Road Marsh, and the Bayswater Road Marsh, respectively. Residences adjacent to the Norton Beach marsh are anticipated to flood for four (4) of the evaluated model scenarios for future conditions (without the pump station) and three (3) scenarios with the pump station. The proposed pump station at the Norton Beach marsh is anticipated to prevent flooding of adjacent properties during a 100-year rainfall event with SLR in 2070. During the extreme storm/tidal events when flooding is expected when the pump station is in place at the Norton Beach marsh the duration of flooding is anticipated to decrease by 35-percent to 50-percent and the number of impacted houses is anticipated to decrease by 40-percent to 50-percent. Residences adjacent to the Post Island Road marsh are anticipated to flood for one (1) of the evaluated model scenarios with the seawall improvements, and for none of the model scenarios with the pump station. The proposed pump station at the Post Island Road marsh is anticipated to prevent flooding of adjacent properties during 100-year tide with 100-year precipitation that would otherwise be expected with the improved seawall constructed. Flooding is not anticipated at properties adjacent to the Bayswater Road Marsh for the evaluated storm events.

Table C-9
InfoWorks ICM Model Results Comparison of Pump Station Effectiveness in Reducing Structure Impacts under Future Conditions at the Norton Beach Marsh

Tidal Storm Event	Precipitation Storm Event	Duration of Flooding Above Critical Elevation* (hours)			Number of Inundated Structures Along Marsh*†		
		Without Pump	With Pumps	Difference	Without Pump	With Pumps	Difference
Normal Tidal Conditions	10-Year	-	-	-	-	-	-
	500-Year	5.9	3	2.9	16	9	7
SLR 2070	100-Year	1.9	0	1.9	7	0	7
10-Year Tide	10-Year	-	-	-	-	-	-
	50-Year	-	-	-	-	-	-
100-Year Tide	1-inch	-	-	-	-	-	-
	10-Year	5	2.7	2.3	15	8	7
	100-Year	7.4	4.8	2.6	17	10	7

*Results shown are for future conditions (with seawall currently under construction) with and without pump stations. The duration of flooding was estimated based on the minimum elevation of anticipated residential impact (see table C-7). The number of inundated structures was estimated assuming adjacent properties would only be impacted when water surface elevations exceed the minimum anticipated residential impact elevations.

Table C-10
InfoWorks ICM Model Results Comparison of Pump Station Effectiveness in Reducing Structure Impacts under Future Conditions at the Post Island Road Marsh

Tidal Storm Event	Precipitation Storm Event	Duration of Flooding Above Critical Elevation* (hours)			Number of Structures Above Critical Elevation Along Marsh*†		
		Without Pump	With Pumps	Difference	Without Pump	With Pumps	Difference
Normal Tidal Conditions	10-Year	-	-	-	-	-	-
	500-Year	-	-	-	-	-	-
SLR 2070	100-Year	-	-	-	-	-	-
10-Year Tide	10-Year	-	-	-	-	-	-
	50-Year	-	-	-	-	-	-
100-Year Tide	1-inch	-	-	-	-	-	-
	10-Year	-	-	-	-	-	-
	100-Year	3.3	0	3.3	3	0	3

*Results shown are for future conditions (with seawall currently under construction) with and without pump stations. The duration of flooding was estimated based on the minimum elevation of anticipated residential impact (see table C-7). The number of inundated structures was estimated assuming adjacent properties would only be impacted when water surface elevations exceed the minimum anticipated residential impact elevations.

Figure C-10 shows the inundation area during the 50-year rainfall event with 10-year tidal levels for future conditions and future conditions with the proposed pump stations. Figures C-11, C-12, and C-13 show the marsh levels varying over time for future conditions and future conditions with the pump stations at the Norton Beach marsh, the Post Island Road marsh, and the Bayswater Road marsh. The proposed pumps decrease the peak elevations and reduce the duration of flooding. For example, at the Norton Beach marsh for the scenario with a 10-year rainfall event occurring during a 100-year tide, the duration of time that the marsh is above 5.9 feet NAVD88 (critical elevation) decreases from 5 hours to 2.7 hours when the pump is in place.

Table C-11
InfoWorks ICM Model Results Comparison of Pump Station Effectiveness In Reducing Structure Impacts under Future Conditions at the Bayswater Road Marsh

Tidal Storm Event	Precipitation Storm Event	Duration of Flooding Above Critical Elevation* (hours)			Number of Structures Above Critical Elevation Along Marsh*†		
		Without Pump	With Pumps	Difference	Without Pump	With Pumps	Difference
Normal Tidal Conditions	10-Year	-	-	-	-	-	-
	500-Year	-	-	-	-	-	-
SLR 2070	100-Year	-	-	-	-	-	-
10-Year Tide	10-Year	-	-	-	-	-	-
	50-Year	-	-	-	-	-	-
100-Year Tide	1-inch	-	-	-	-	-	-
	10-Year	-	-	-	-	-	-
	100-Year	-	-	-	-	-	-

*Results shown are for future conditions (with seawall currently under construction) with and without pump stations. The duration of flooding was estimated based on the minimum elevation of anticipated residential impact (see table C-7). The number of inundated structures was estimated assuming adjacent properties would only be impacted when water surface elevations exceed the minimum anticipated residential impact elevations.

Model results show that a pump station at Norton Beach marsh would prevent flooding during a 100-year rainfall event with 2070 SLR and reduce both the duration of flooding and the number impacted residences for (3) additional model scenarios. Results also show that flooding adjacent to the Post Island Road marsh would prevent flooding during a 100-year precipitation event coinciding with a 100-year tide level, and that the marsh generally drains slowly following extreme tidal events. Flooding is not anticipated adjacent to the Bayswater Road marsh for the evaluated model scenarios. A single rainstorm event was evaluated for each of the model scenarios, and it is possible that multiple rainstorms in series prior to the marshes draining could cause additional flooding. Additionally, extreme wave overtopping may also exacerbate flooding.

2.4 Drainage System Improvements Alternatives

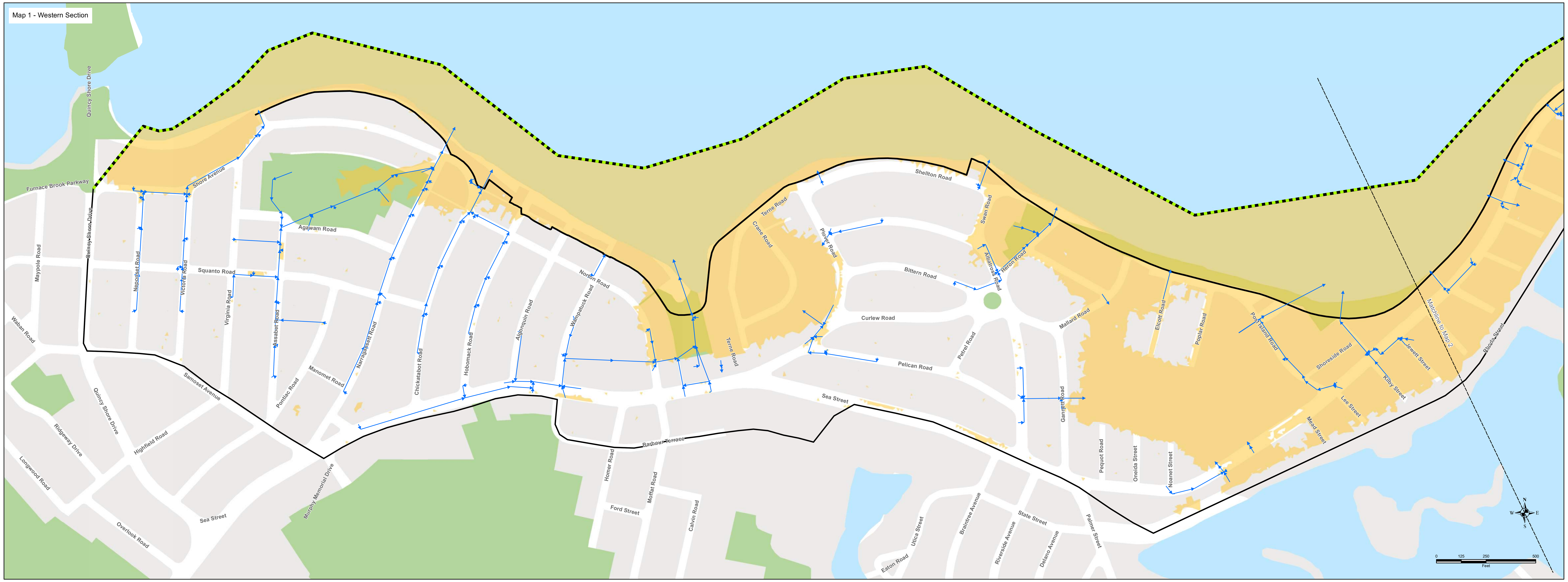
Tighe & Bond evaluated drainage system modifications that could reduce localized flooding during the 10-year frequency storm events during normal tidal conditions, but incorporating SLR for 2070. The 10-year storm event was selected for design because it was assumed that the capacity of the system may be limited by the ability of catch basins to carry larger flows. The methodology for the drainage improvements is discussed in Appendix B. Figure C-15 shows the evaluated drainage system improvements and corresponding InfoWorks ICM model inundation areas for future conditions with and without the evaluated drainage improvements. In general, the anticipated reduction in flooding due to the proposed drainage improvements was relatively minor. We anticipate the storm drain improvements would provide a greater impact when rainfall occurs during lower tide conditions. When the peak rainfall rate coincides with MHHW tidal conditions, significant improvements are not anticipated, because downstream tailwater conditions begin to control. Further study evaluating peak flows occurring during tailwater conditions less than MHHW may show benefits for local improvements to the stormwater network; however, these conditions were beyond the scope of this study.

3 Conclusion

This technical memorandum summarizing the results of the InfoWorks ICM model of Adams Shore / Houghs Neck. Conclusions drawn from the results include:

- The calibration/validation storm event results show that the InfoWorks ICM model appears to provide a reasonable representation of previously observed flooding based on available FEMA repetitive loss data and locations with previously observed flooding.
- Flooding is anticipated to be greater during extreme tidal events that coincide with small precipitation events, versus larger precipitation events coinciding with more typical tidal conditions because the storm drain system cannot drain during high tides. For example, for existing conditions approximately 30 impacted structures with adjacent flooding are anticipated for existing conditions with a 10-year rainfall event during normal tides. The number of impacts increases to 40 structures if the rainfall event coincided with a 1-year extreme tide, to 260 structures if the rainfall coincided with a 10-year tide, and 440 structures if the rainfall coincided with a 100-year tide.
- Wave overtopping is anticipated to have a significant impact on flooding in the study area, and can only be modeled using simplifications in InfoWorks ICM. Extreme wave overtopping may cause flooding greater than the evaluated scenarios.
- Single rainstorm events were evaluated for each of the model scenarios, and it is possible that multiple rainstorms in series prior to the drainage of the system (e.g., marshes draining) could cause additional flooding.
- Model results show that the Adams Shore/Hough Neck Seawall Repair & Improvements project is anticipated to reduce the likelihood of flooding in the study area during extreme tidal events (e.g., the seawall improvements are anticipated to reduce the number of impacted structures with adjacent flooding during extreme tides by between 10-percent and 90-percent depending on the model scenario).
- The seawall improvements are not anticipated to impact flooding due to precipitation events during normal tidal conditions (with peak flows coinciding with the peak tidal elevations). It is anticipated that the increase in capacity provided for future outfall improvements will improve drainage when peak flows do not coincide with the peak tide elevations since pipe flow would not be limited by tailwater; however, these scenarios were not evaluated as part of this study.
- Localized improvements to the storm drain system are not anticipated to improve flooding that occurs during high tide when the system cannot drain, although it may offer relief from routine localized flooding events.
- Pump stations may reduce the frequency and duration of flooding, particularly during extreme tidal events when drainage via gravity is not possible. Model results show that a pump station at Norton Beach marsh would prevent flooding during a 100-year rainfall event with 2070 SLR and reduce both the duration of flooding and the number impacted residences for (3) additional model scenarios. Results also show that flooding adjacent to the Post Island Road marsh would prevent flooding during a 100-year precipitation event coinciding with a 100-year tide level. Flooding is not anticipated adjacent to the Bayswater Road marsh for the evaluated model scenarios.

Figures



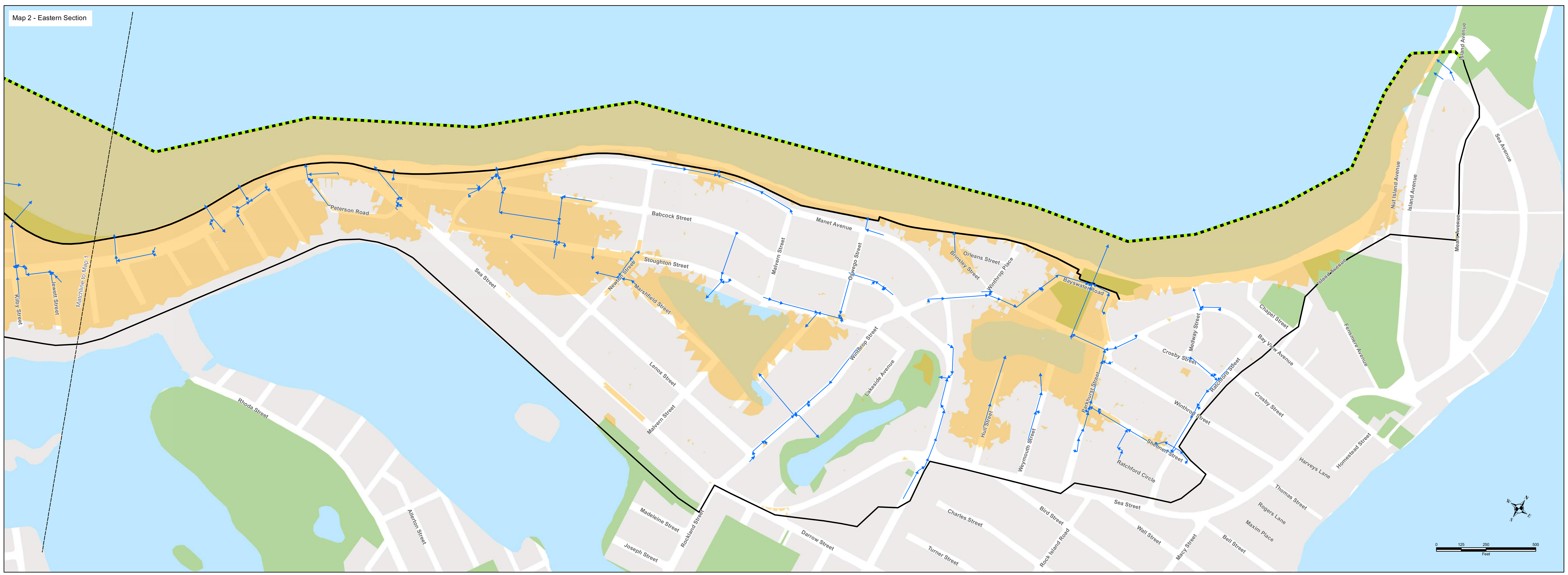
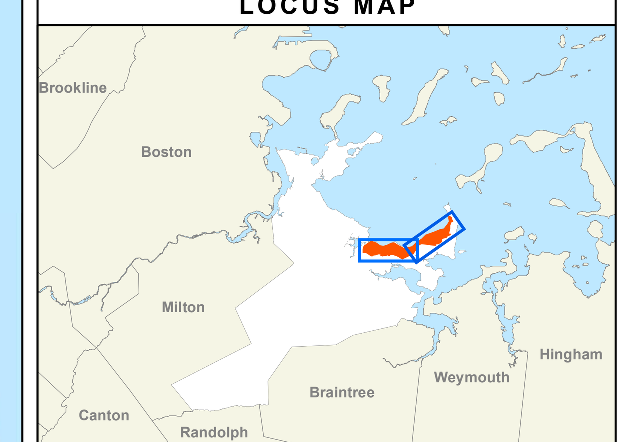


FIGURE C-1
HISTORIC CONDITION
OCT. 21, 1991 STORM EVENT

Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Area Inundated by Storm Event
- Matchline

LOCUS MAP



NOTES

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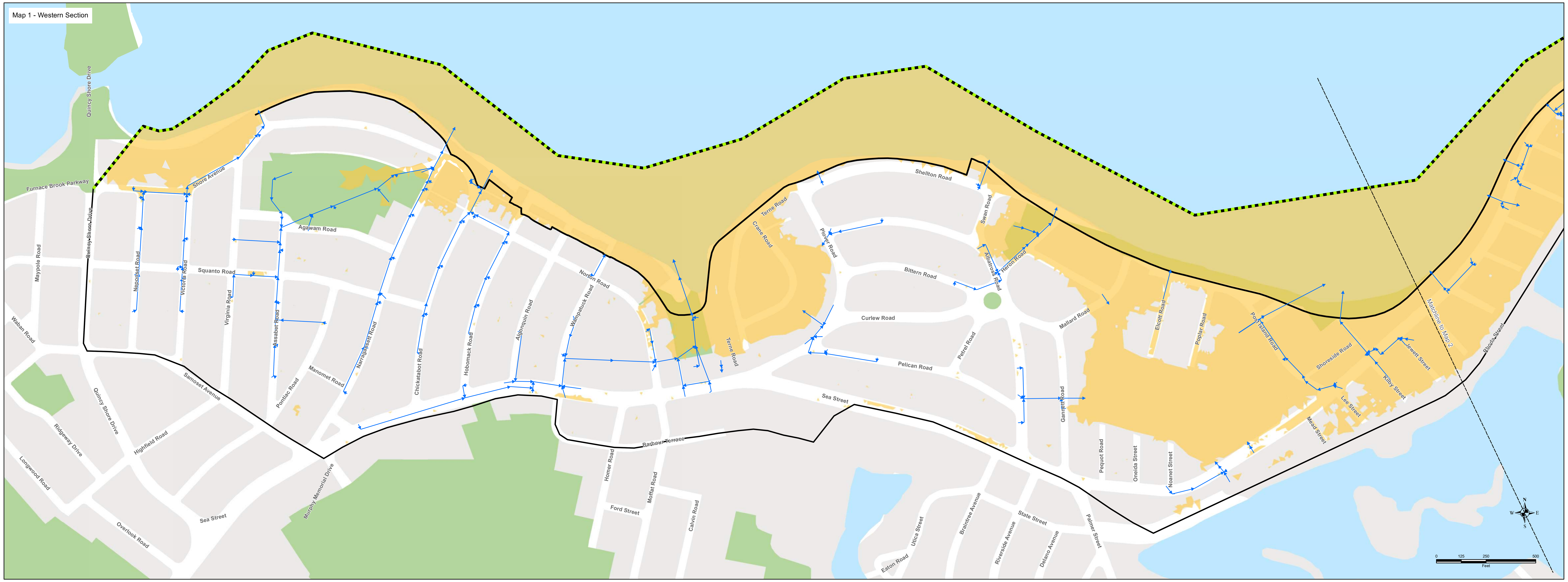
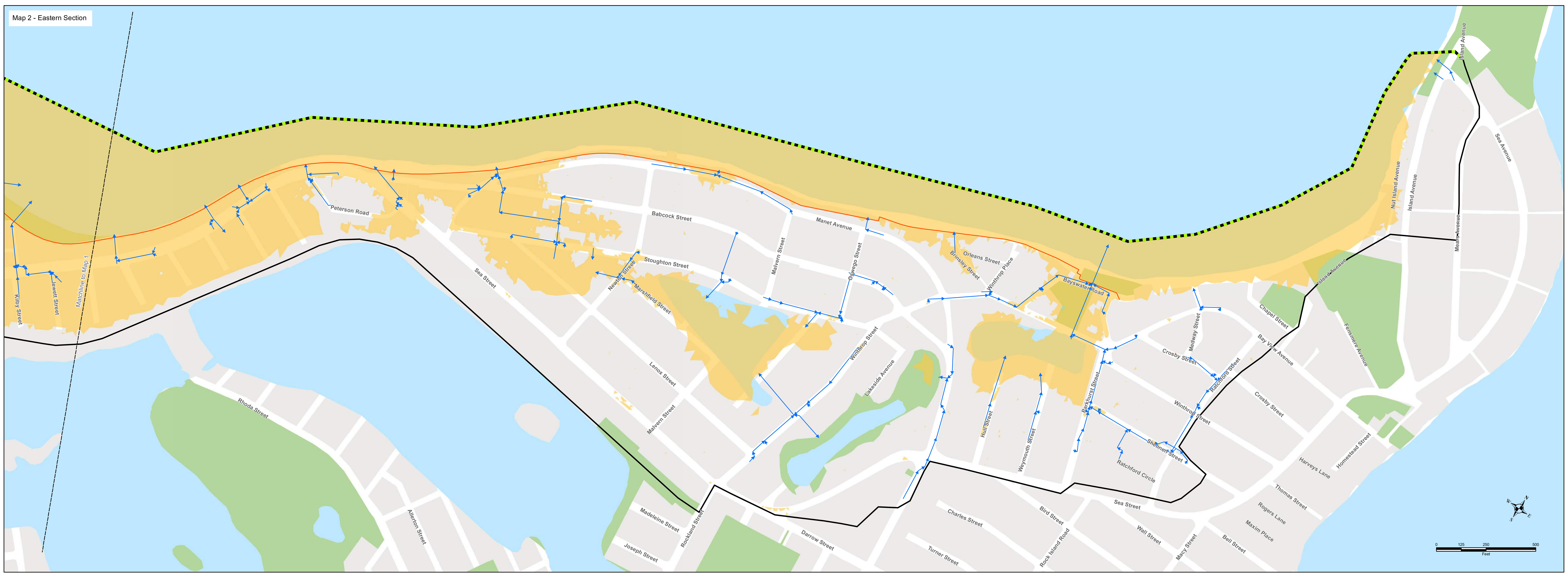
FIGURE C-2
HISTORIC CONDITION
MAY 24, 2005 STORM EVENT

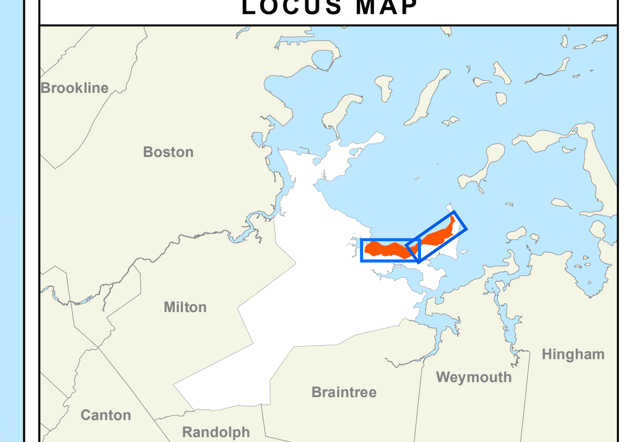




Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Area Inundated by Storm Event

LOCUS MAP



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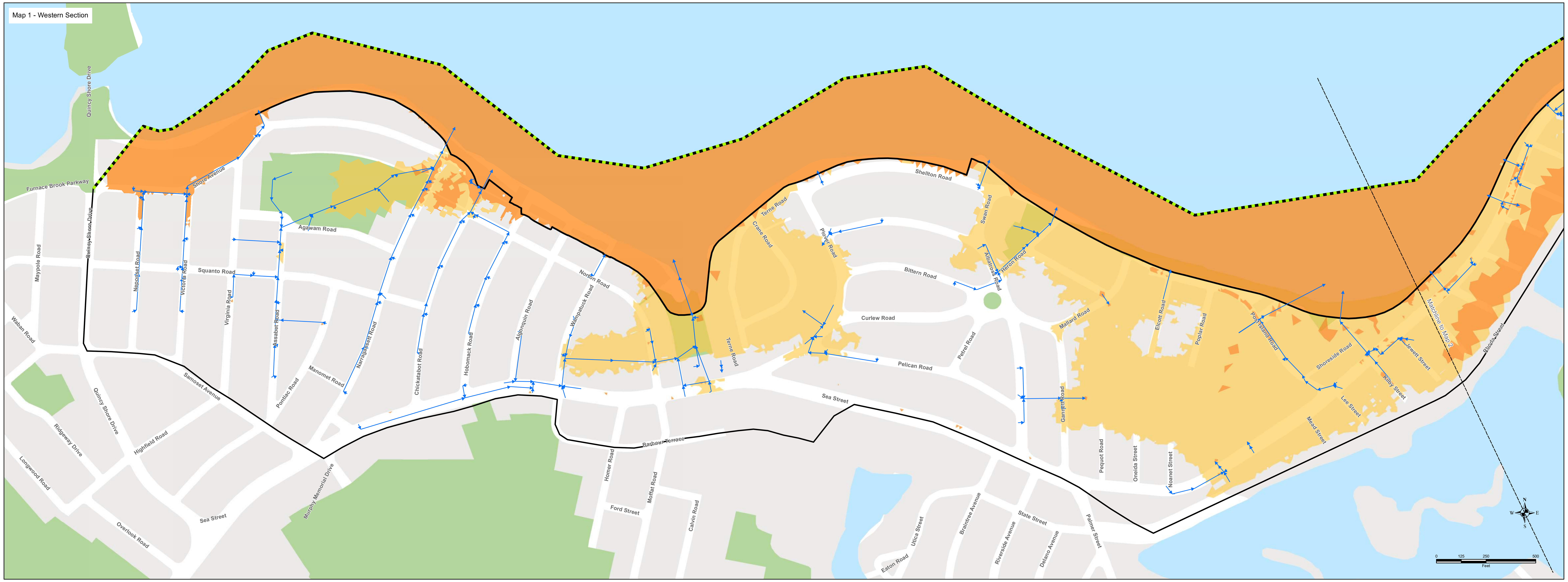
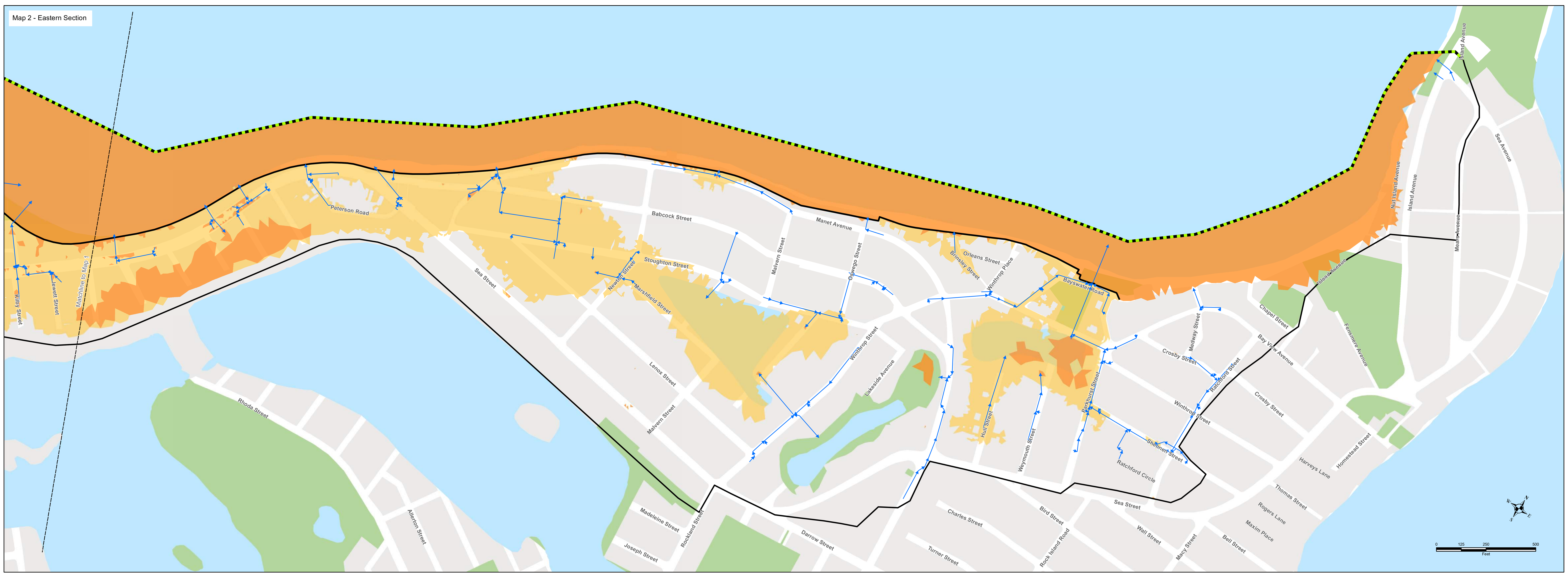
Q-0019

FIGURE C-3
HISTORIC CONDITION
MARCH 3, 2018 STORM EVENT

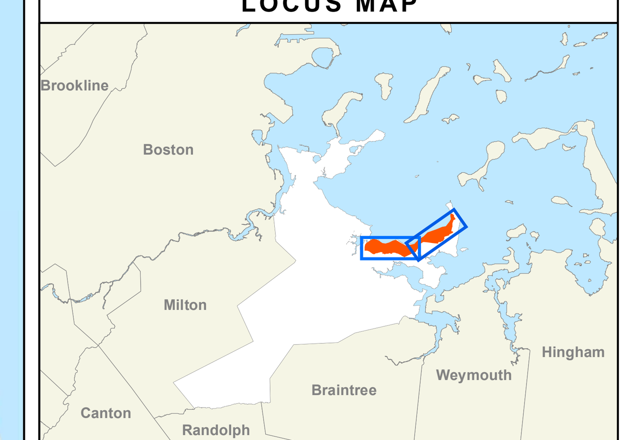
Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- 2018 Future Conditions
- 2018 Historic Conditions





LOCUS MAP



NOTES

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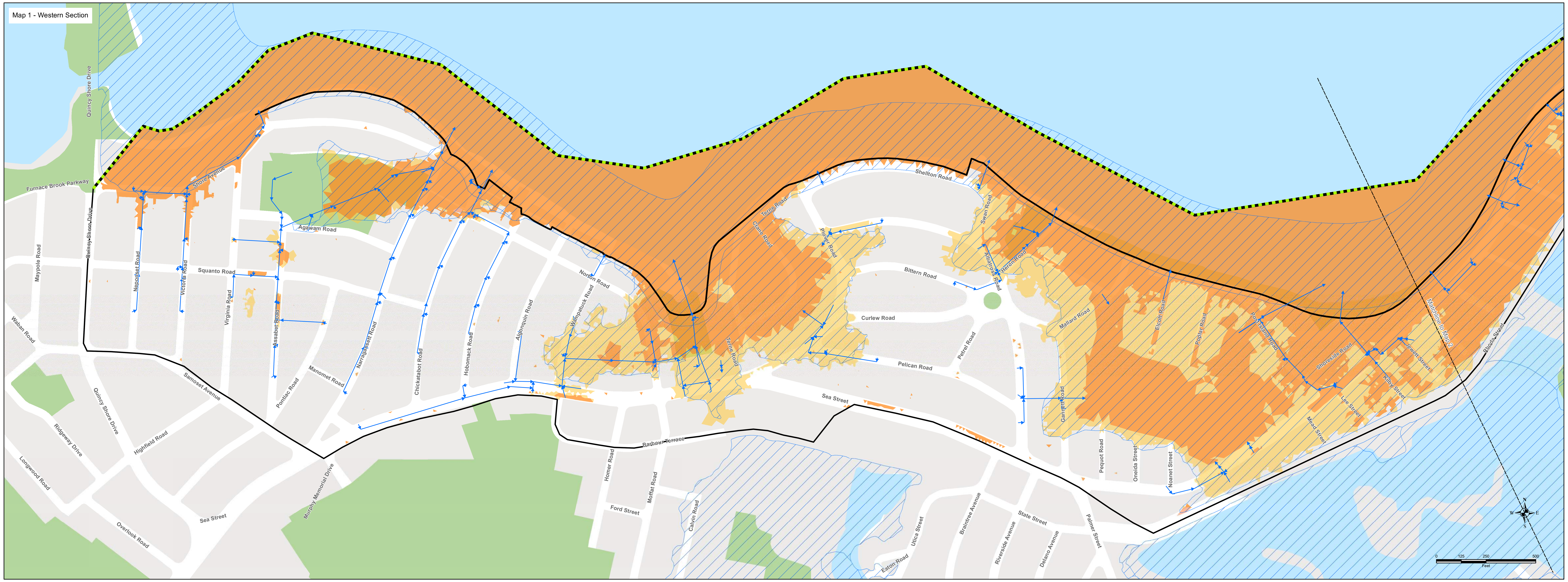
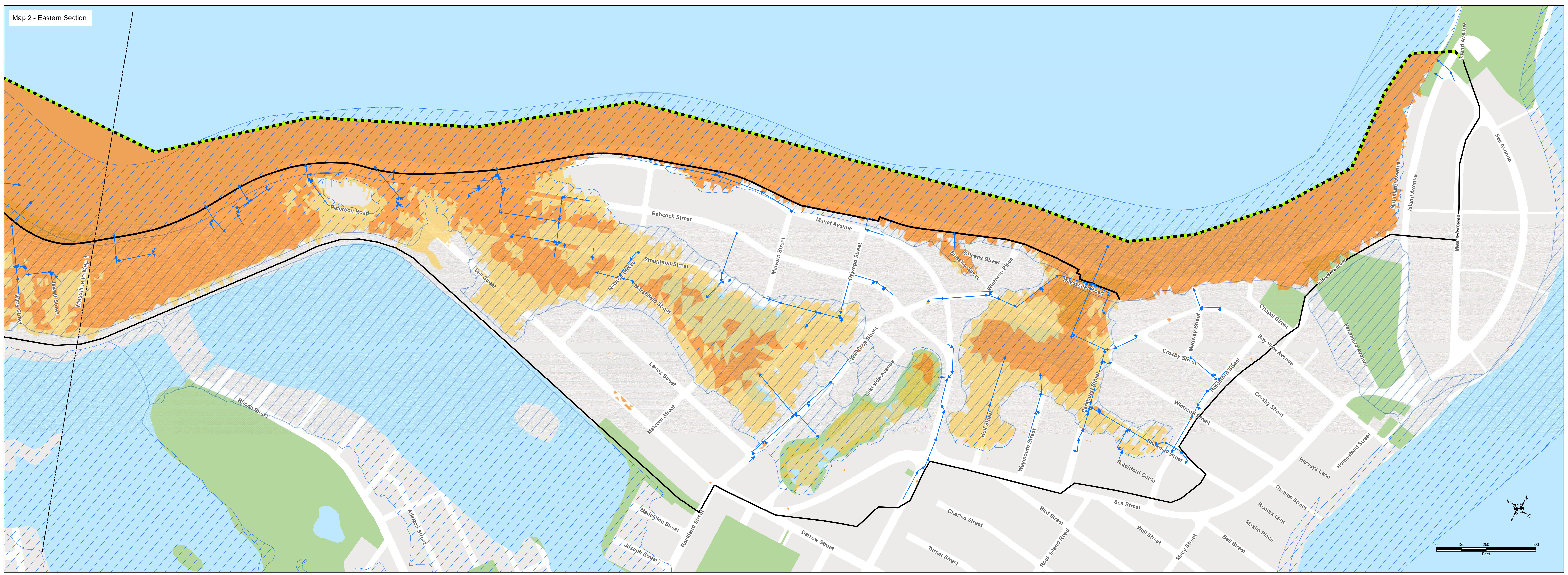
Q-0019

FIGURE C-4
100-YEAR TIDE
1-INCH RAINFALL

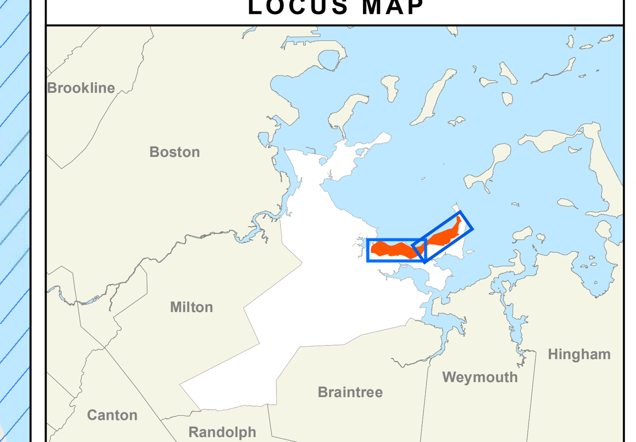




Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Future Conditions
- Existing Conditions
- FEMA AE & VE Zone
- Matchline

LOCUS MAP



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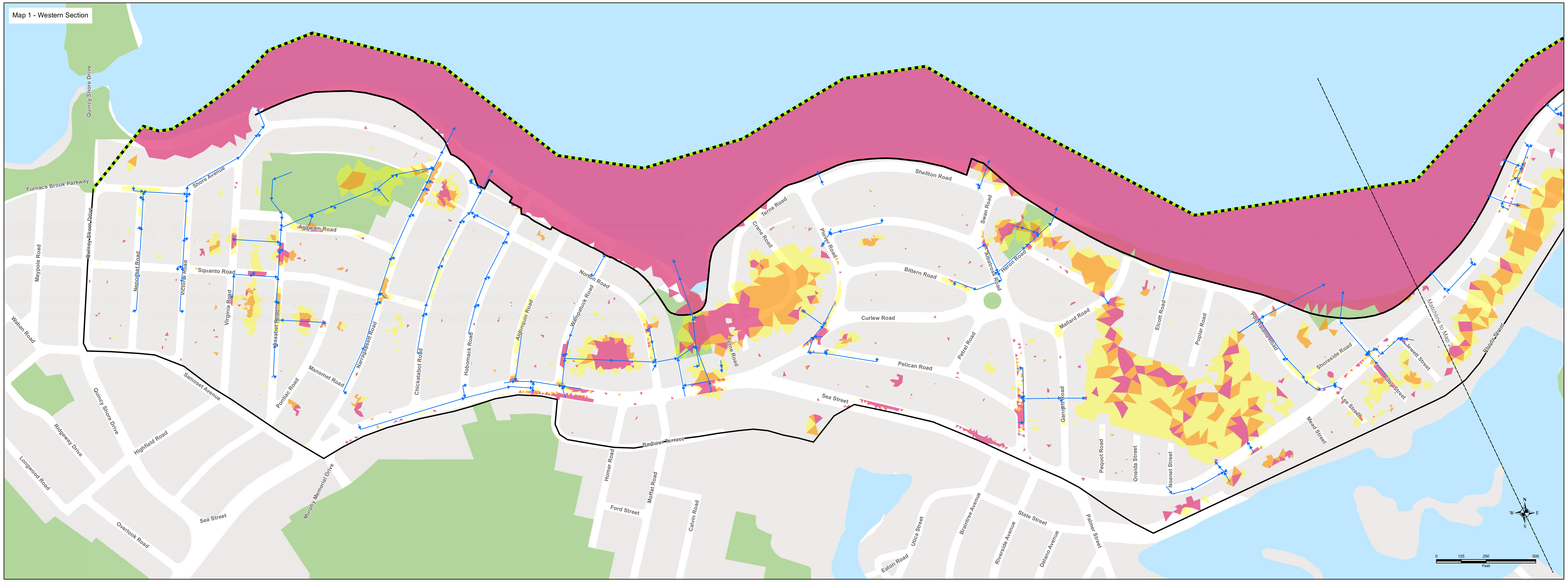

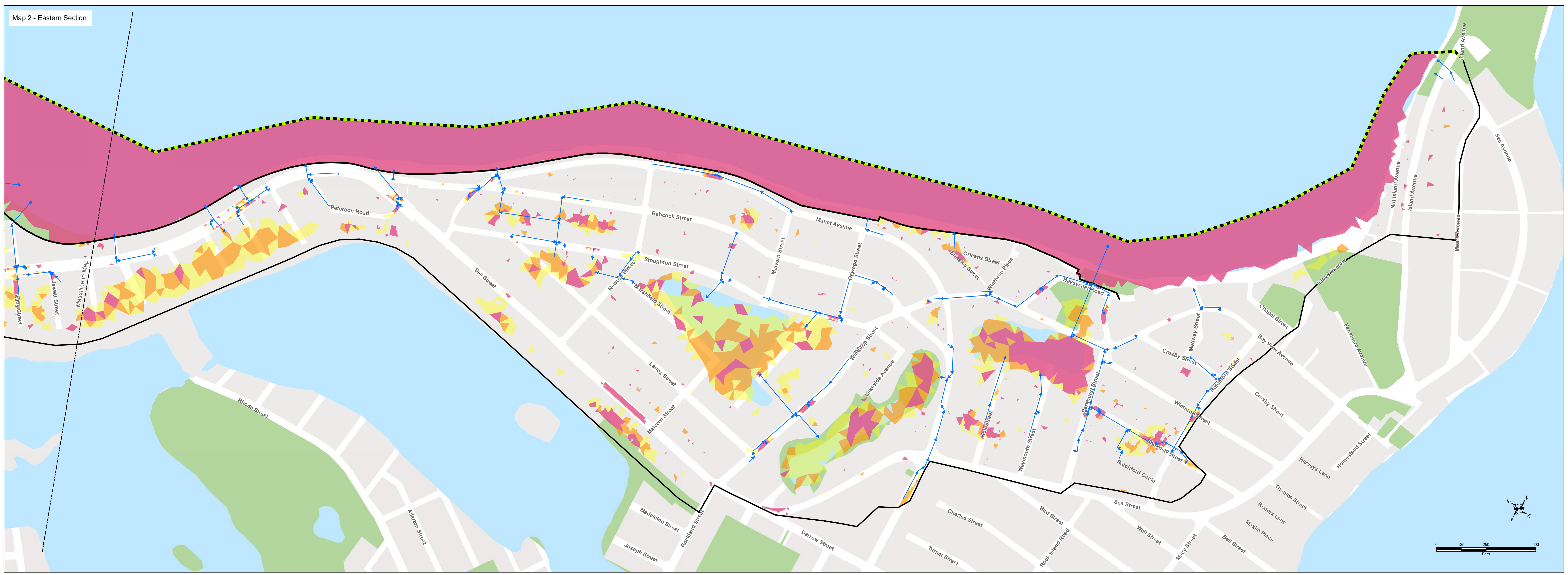

FIGURE C-5
EXISTING CONDITIONS
NORMAL TIDE

Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- 2 Year Rainfall
- 10 Year Rainfall
- 100 Year Rainfall
- Matchline

LOCUS MAP

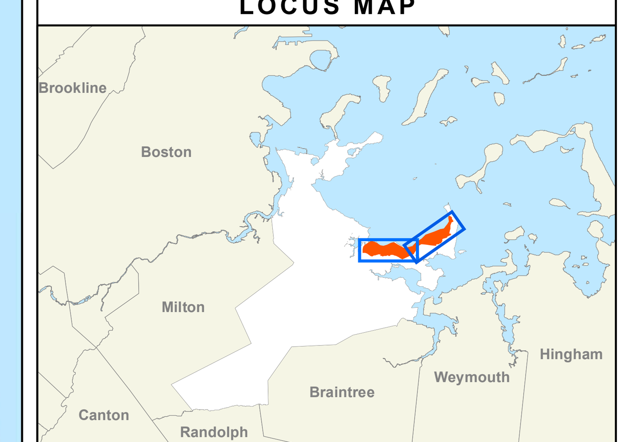

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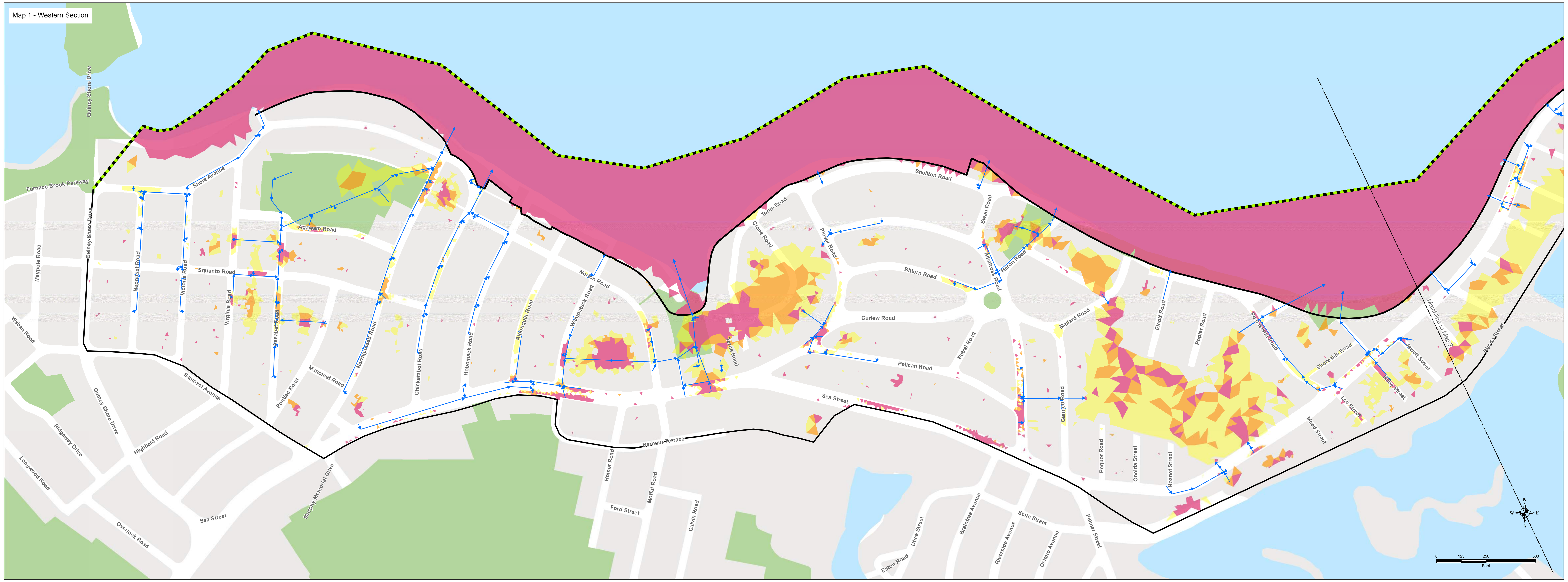
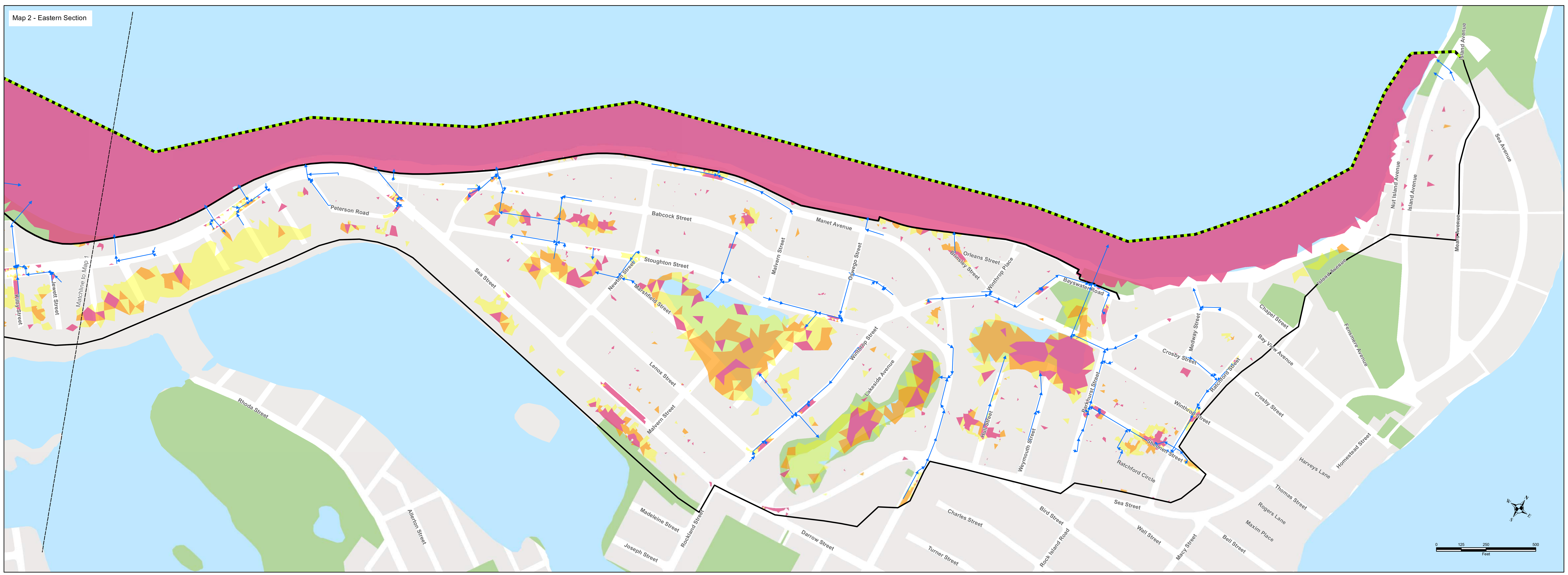
FIGURE C-6
FUTURE CONDITIONS
NORMAL TIDE





Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- 2 Year Rainfall
- 10 Year Rainfall
- 100 Year Rainfall
- Matchline

LOCUS MAP

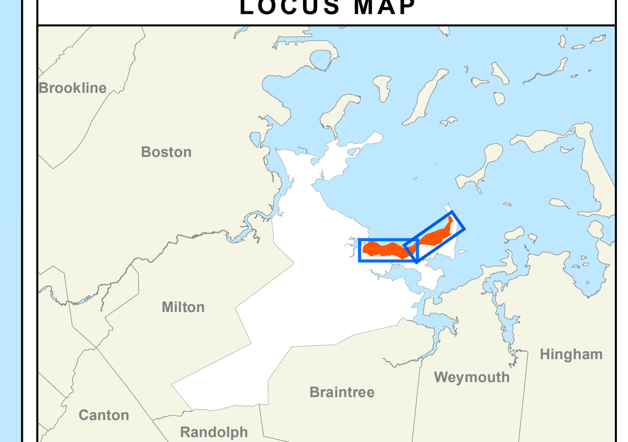


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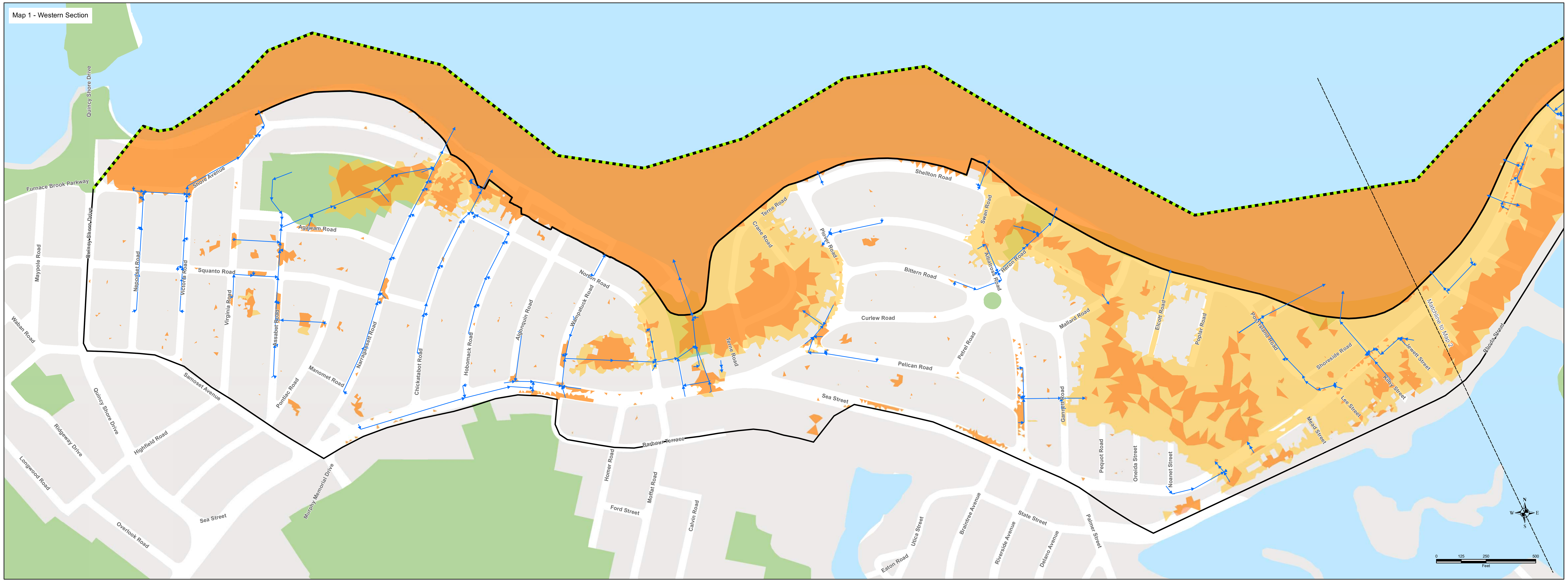
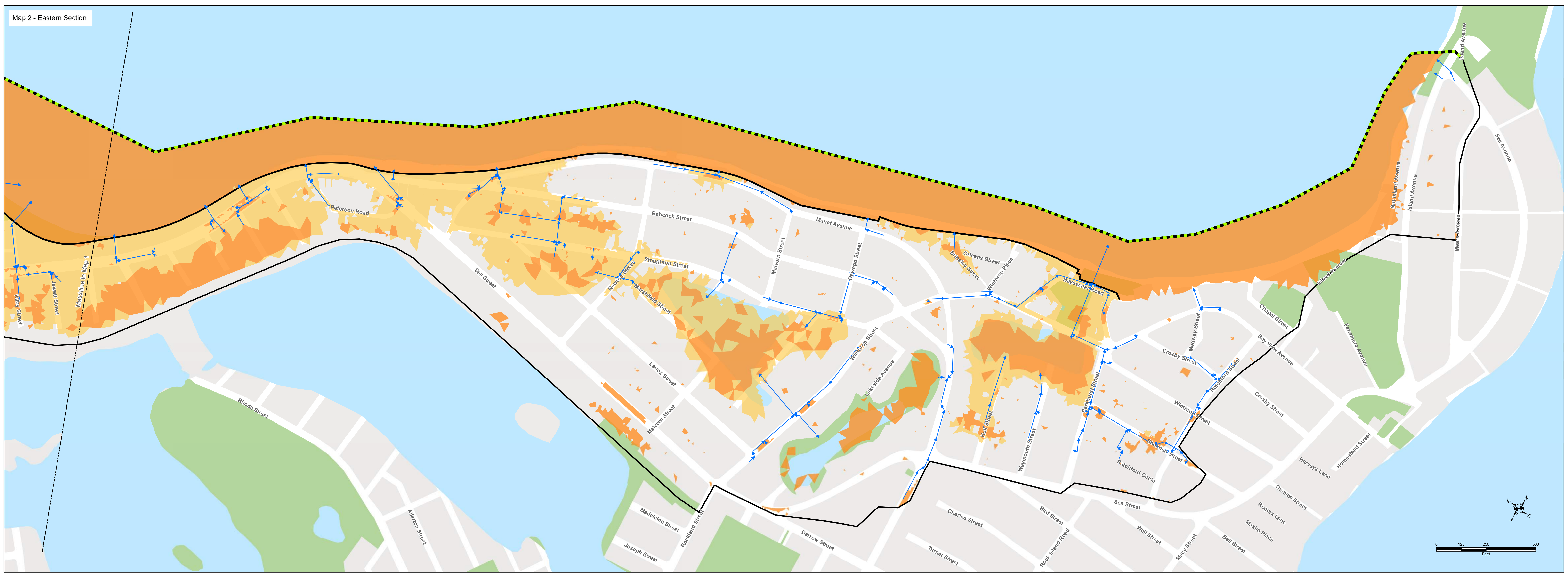
FIGURE C-7
10-YEAR TIDE
10-YEAR RAINFALL

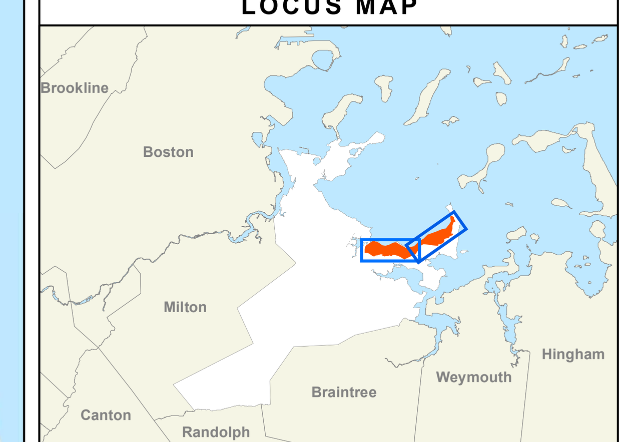




Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Future Conditions
- Existing Conditions

LOCUS MAP



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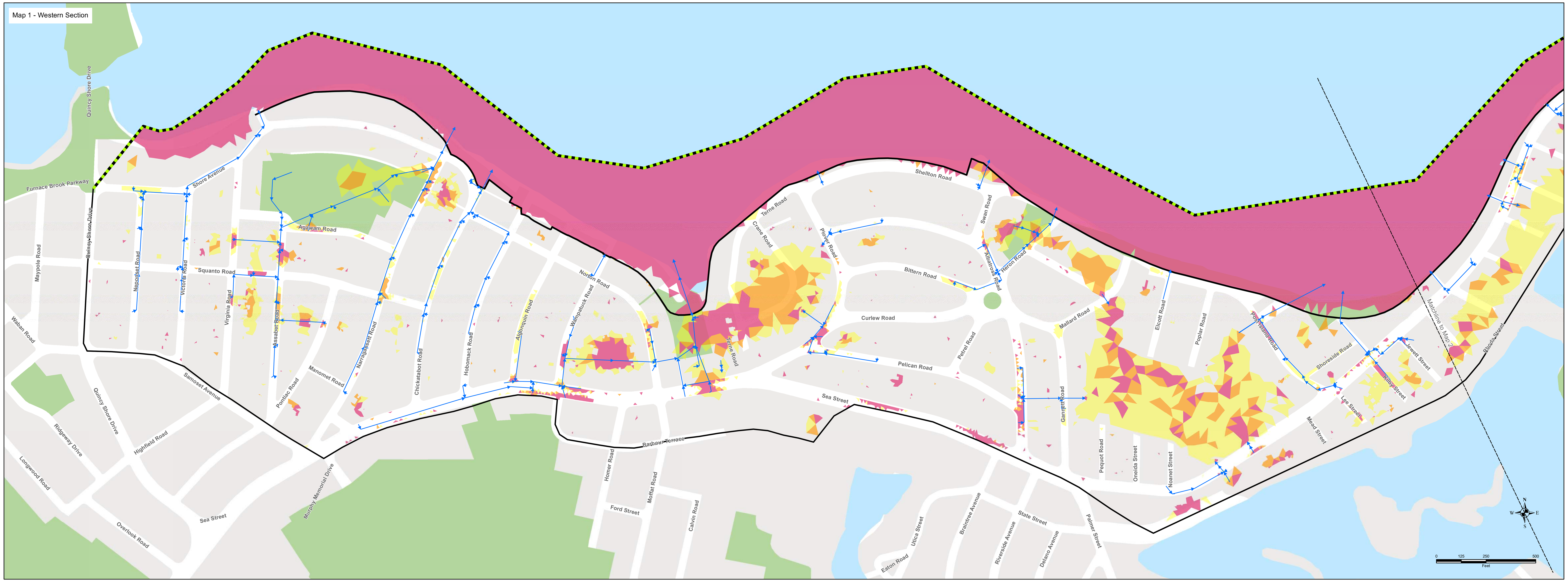


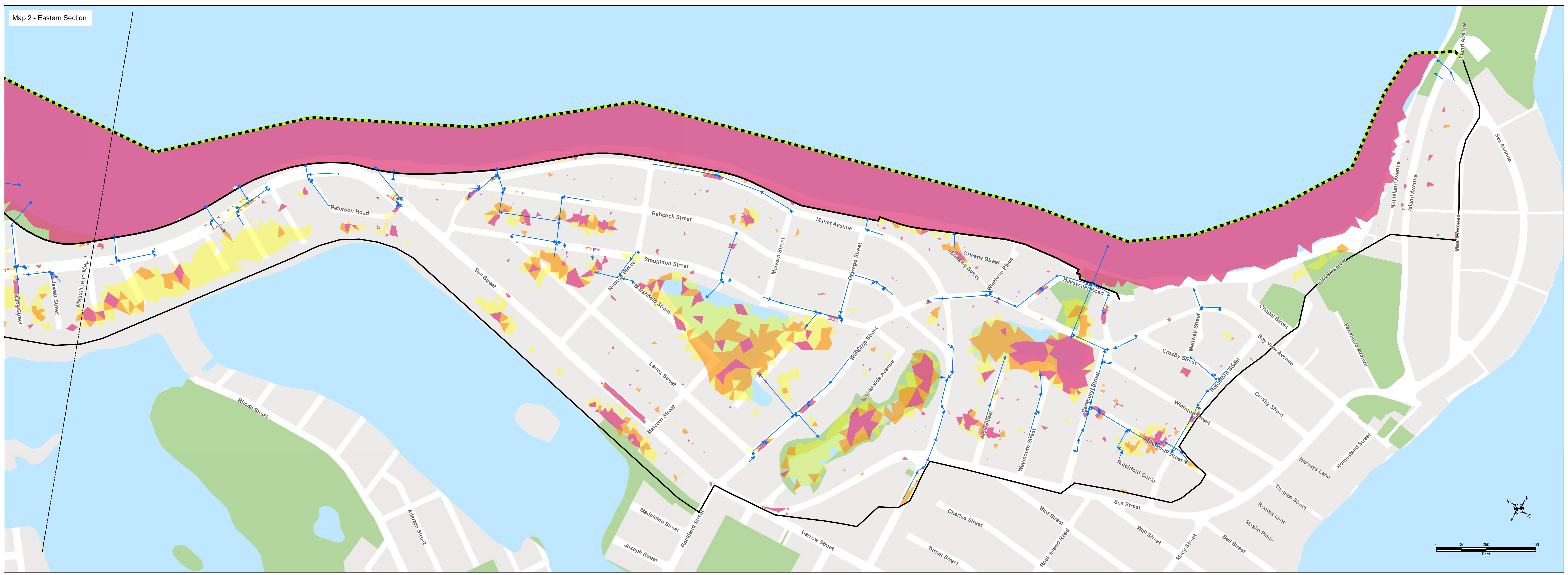
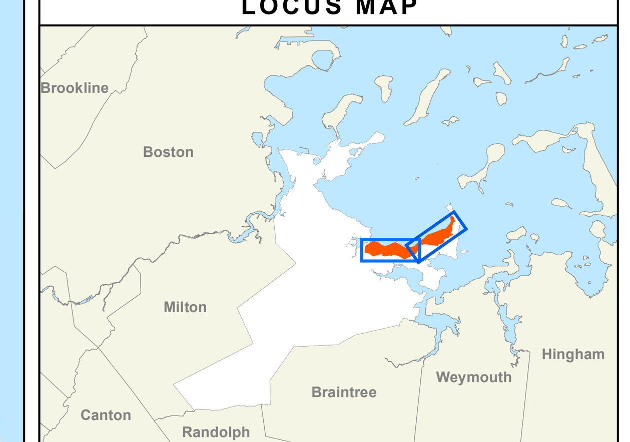


FIGURE C-6
FUTURE CONDITIONS
NORMAL TIDE

Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- 2 Year Rainfall
- 10 Year Rainfall
- 100 Year Rainfall
- Matchline

LOCUS MAP



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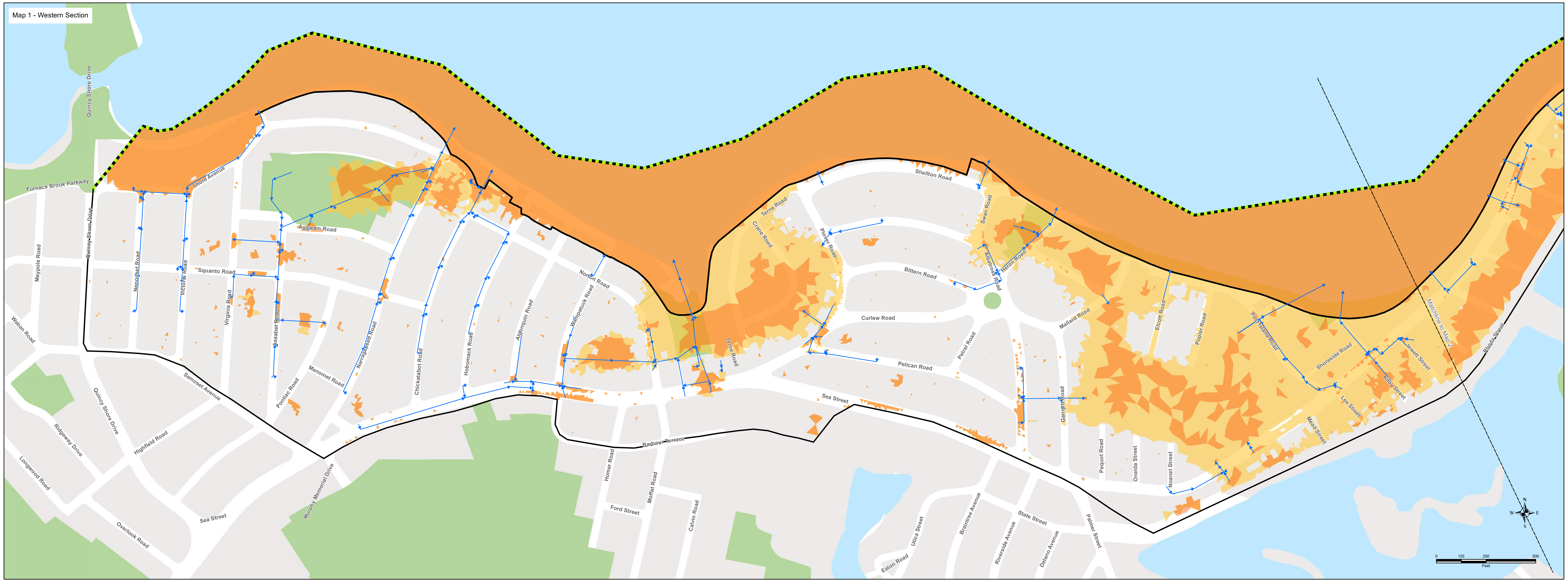


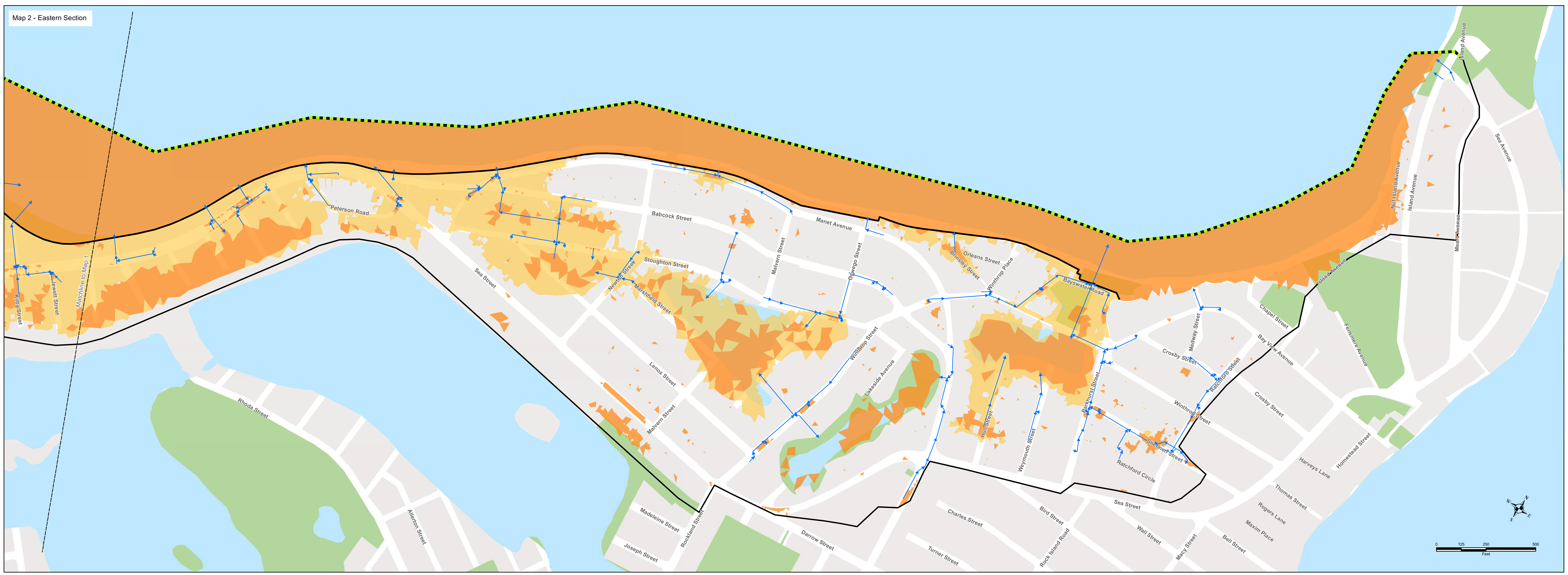
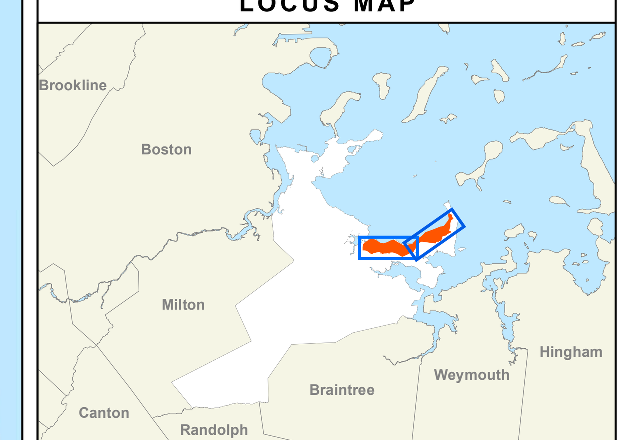


FIGURE C-7
10-YEAR TIDE
10-YEAR RAINFALL

Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Future Conditions
- Existing Conditions

LOCUS MAP



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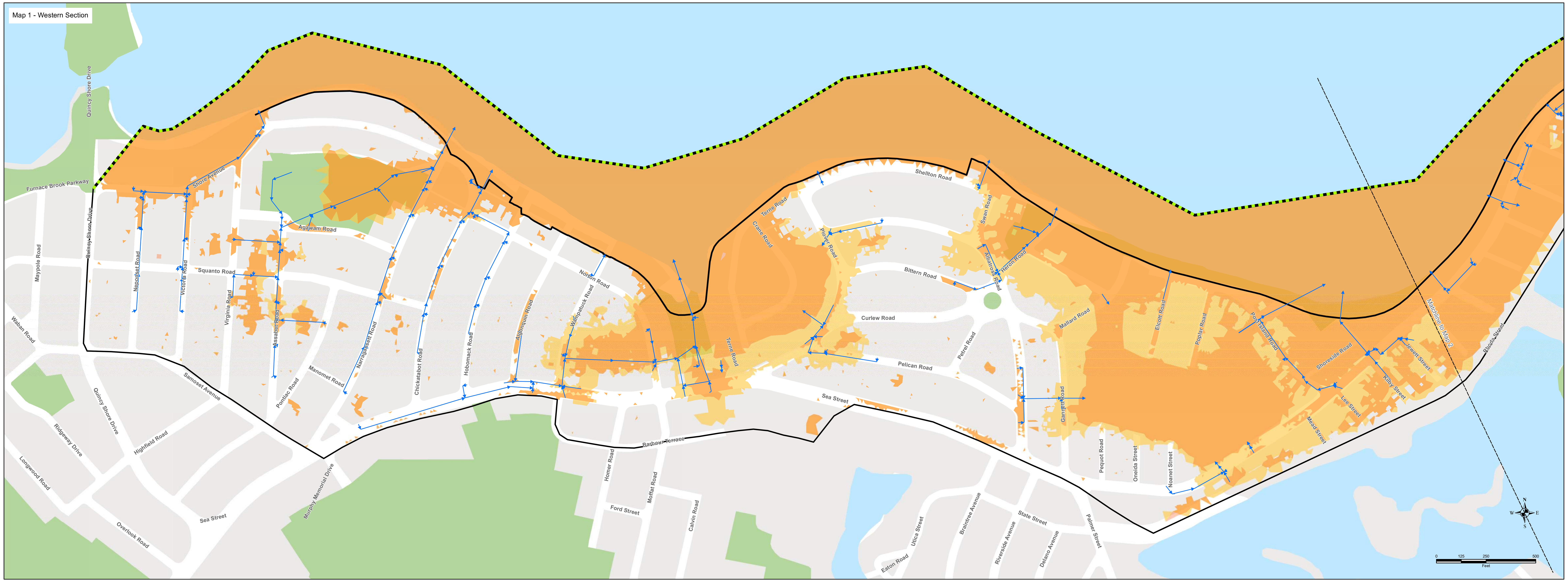


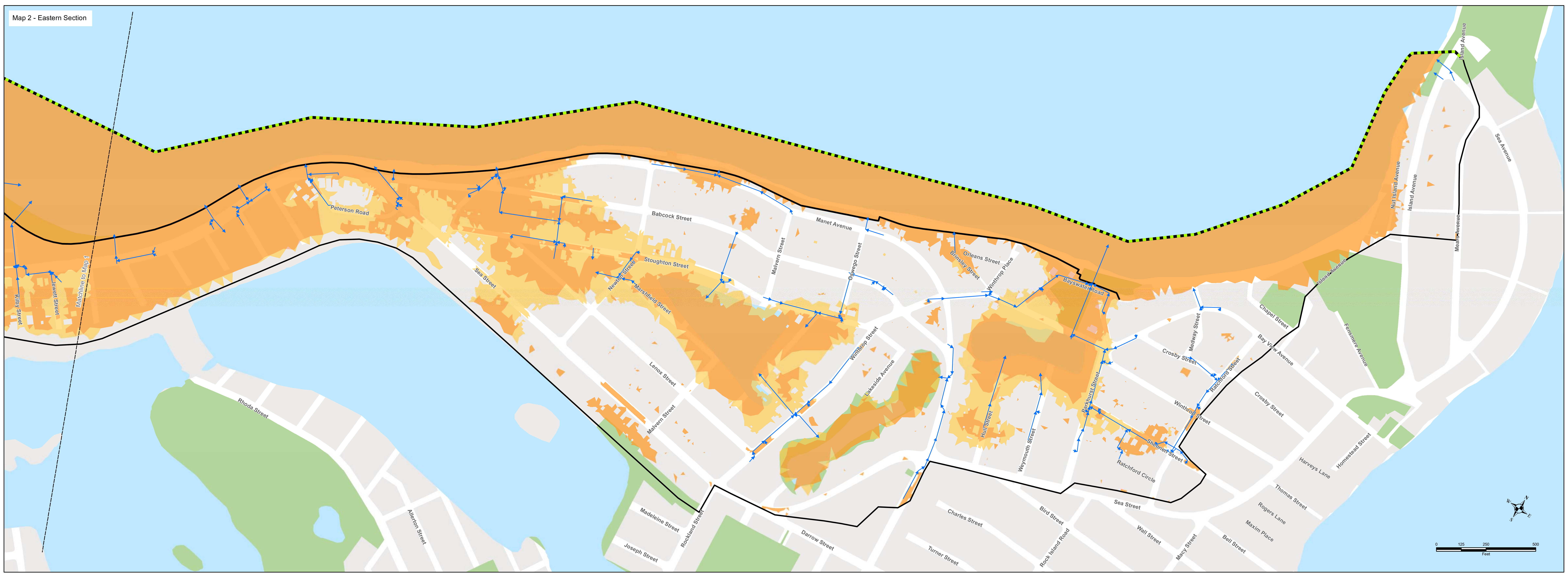
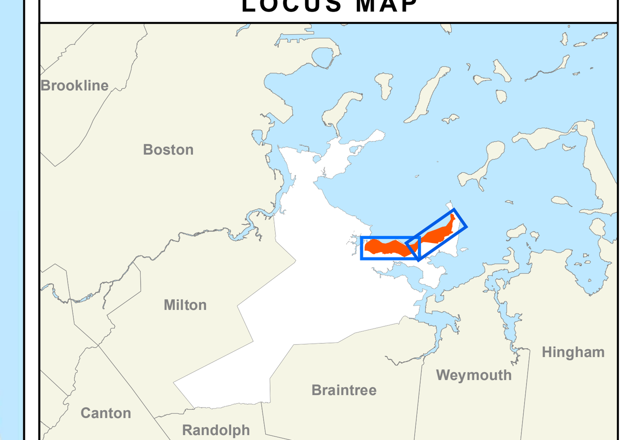


FIGURE C-8
100-YEAR TIDE
100-YEAR RAINFALL

Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Future Conditions
- Existing Conditions

LOCUS MAP



NOTES

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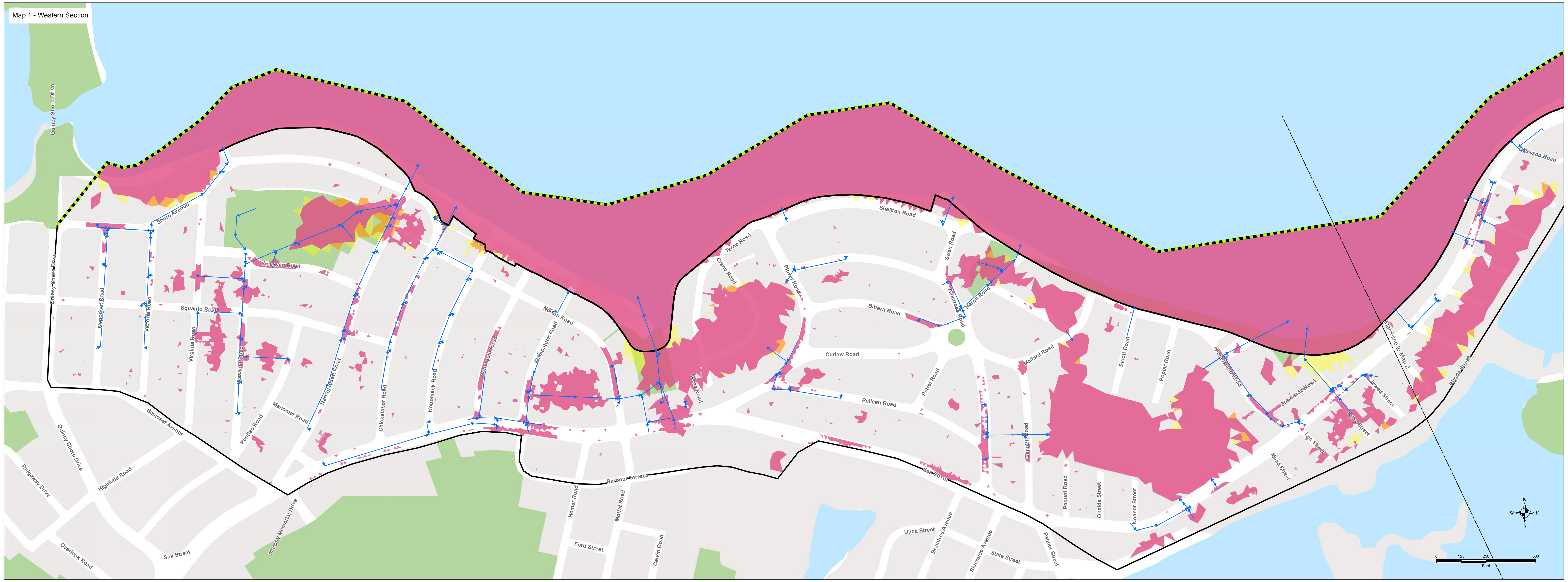
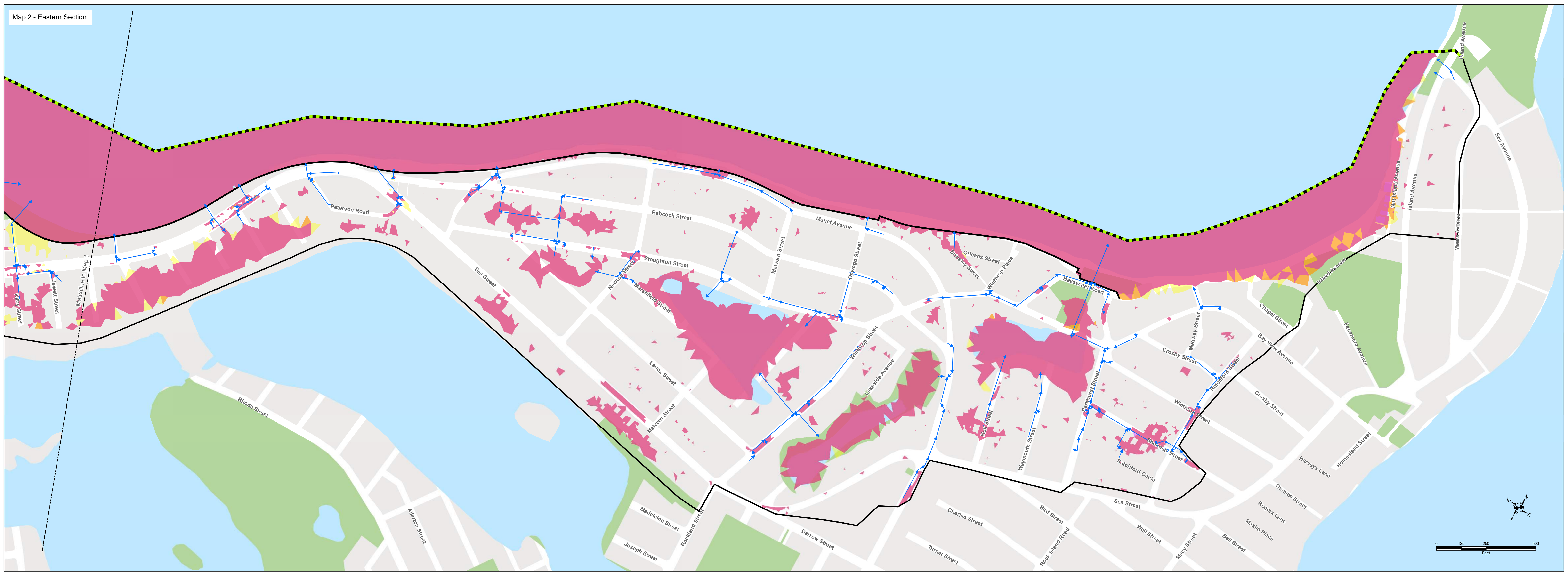
FIGURE C-9
FUTURE CONDITIONS
SEA LEVEL RISE
100-YEAR RAINFALL





Legend

- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- 2050 SLR
- 2070 SLR
- 2100 SLR
- Matchline

LOCUS MAP

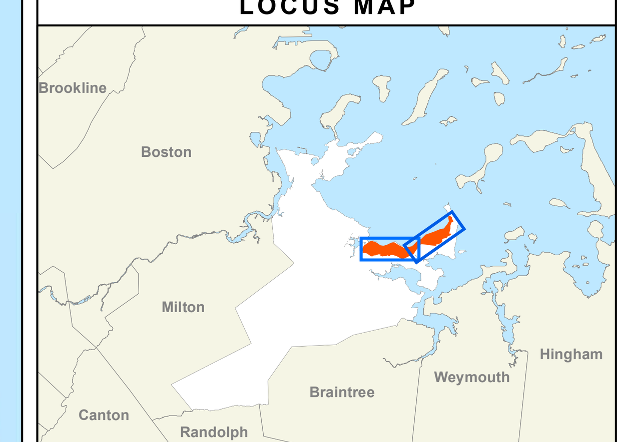


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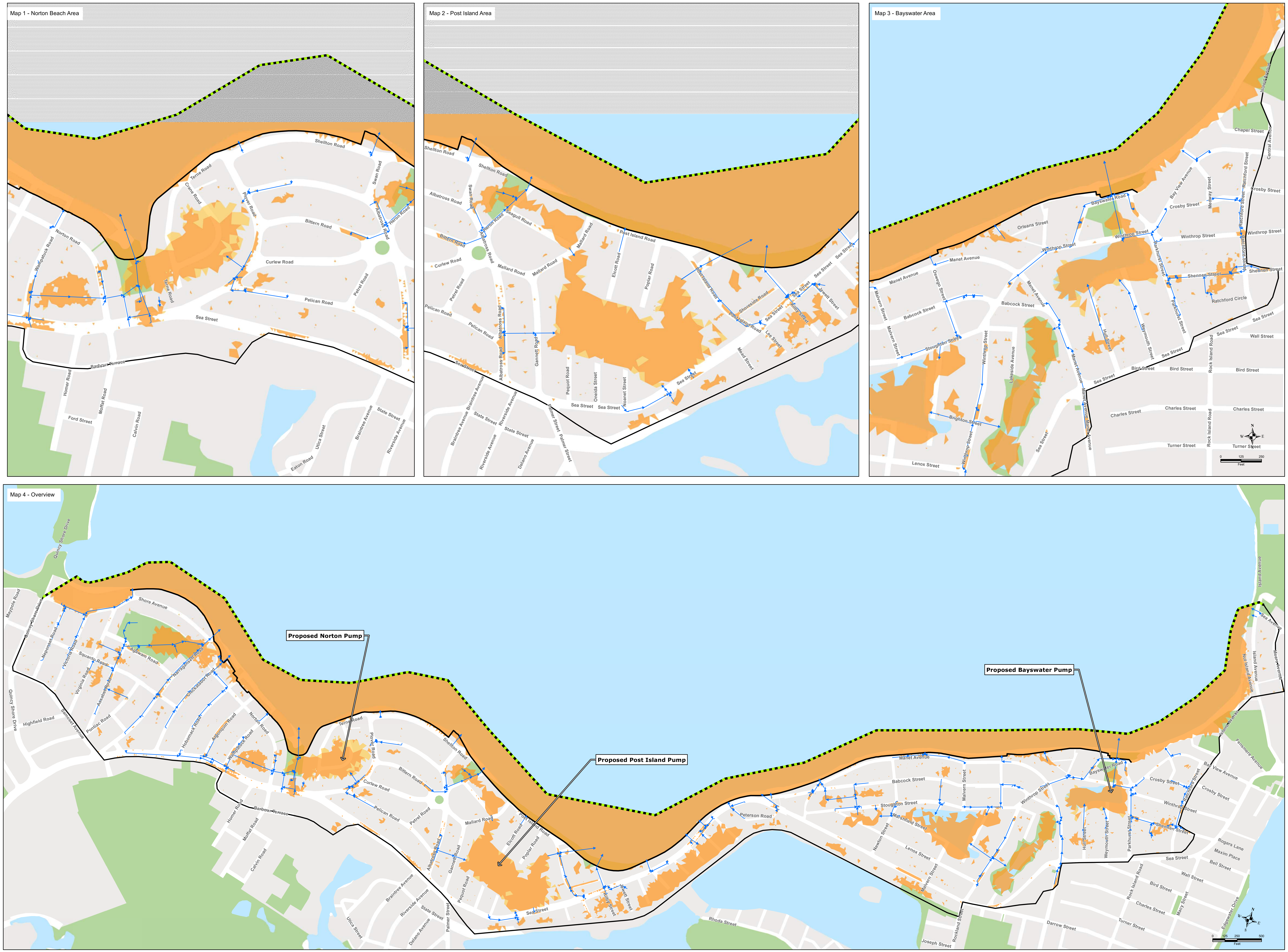
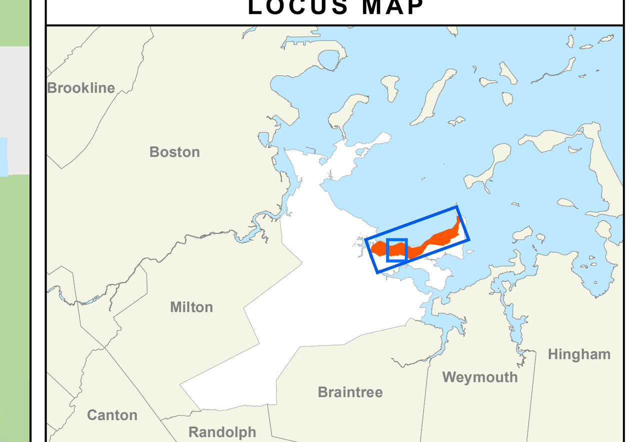
FIGURE C-10
10-YEAR TIDE
50-YEAR RAINFALL
PROPOSED PUMPS



Legend

- Matchline
- Stormwater Network
- Seawall
- Tidal Boundary Condition
- 2D Mesh Area
- Proposed Conditions
- Future Conditions

LOCUS MAP



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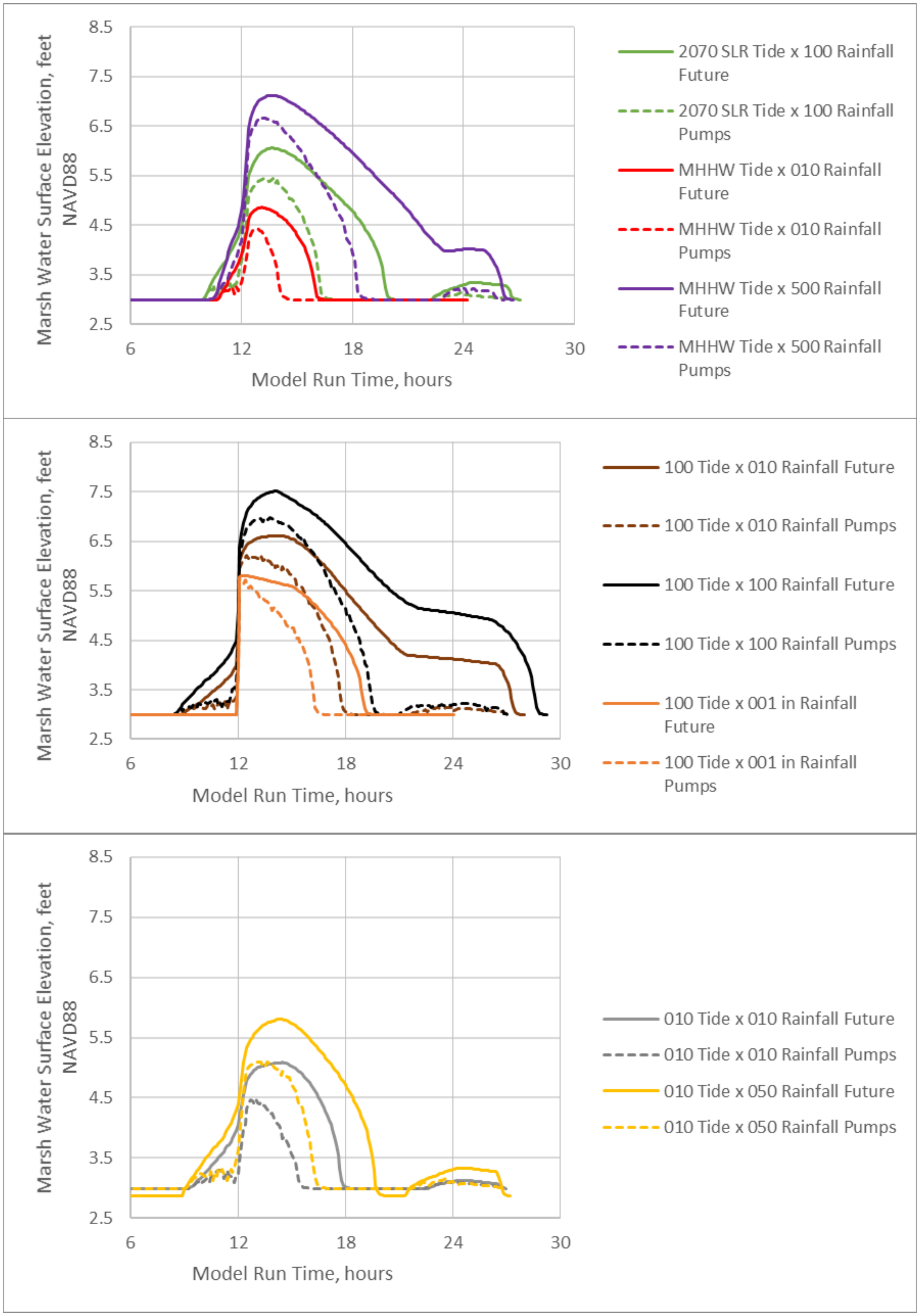


FIGURE C-11

Norton Beach Marsh Water Surface Elevation Versus Time for Future Conditions and Future Conditions with Proposed Pumps *(impacts to adjacent homes anticipated at approximately 5.9 feet NAVD88)*

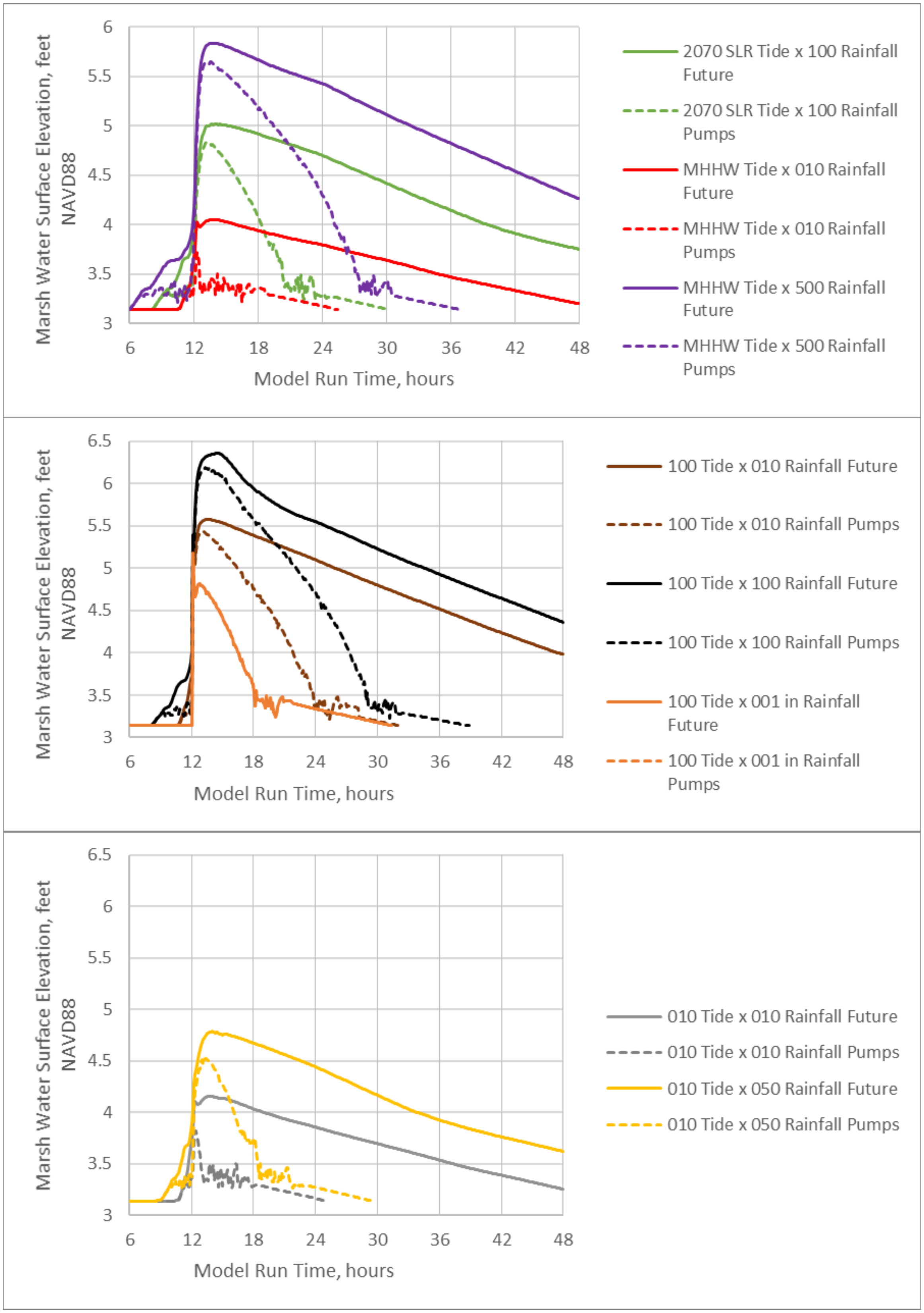


FIGURE C-12

Post Island Road Marsh Water Surface Elevation Versus Time for Future Conditions and Future Conditions with Proposed Pumps *(impacts to adjacent homes anticipated at approximately 6.2 feet NAVD88)*

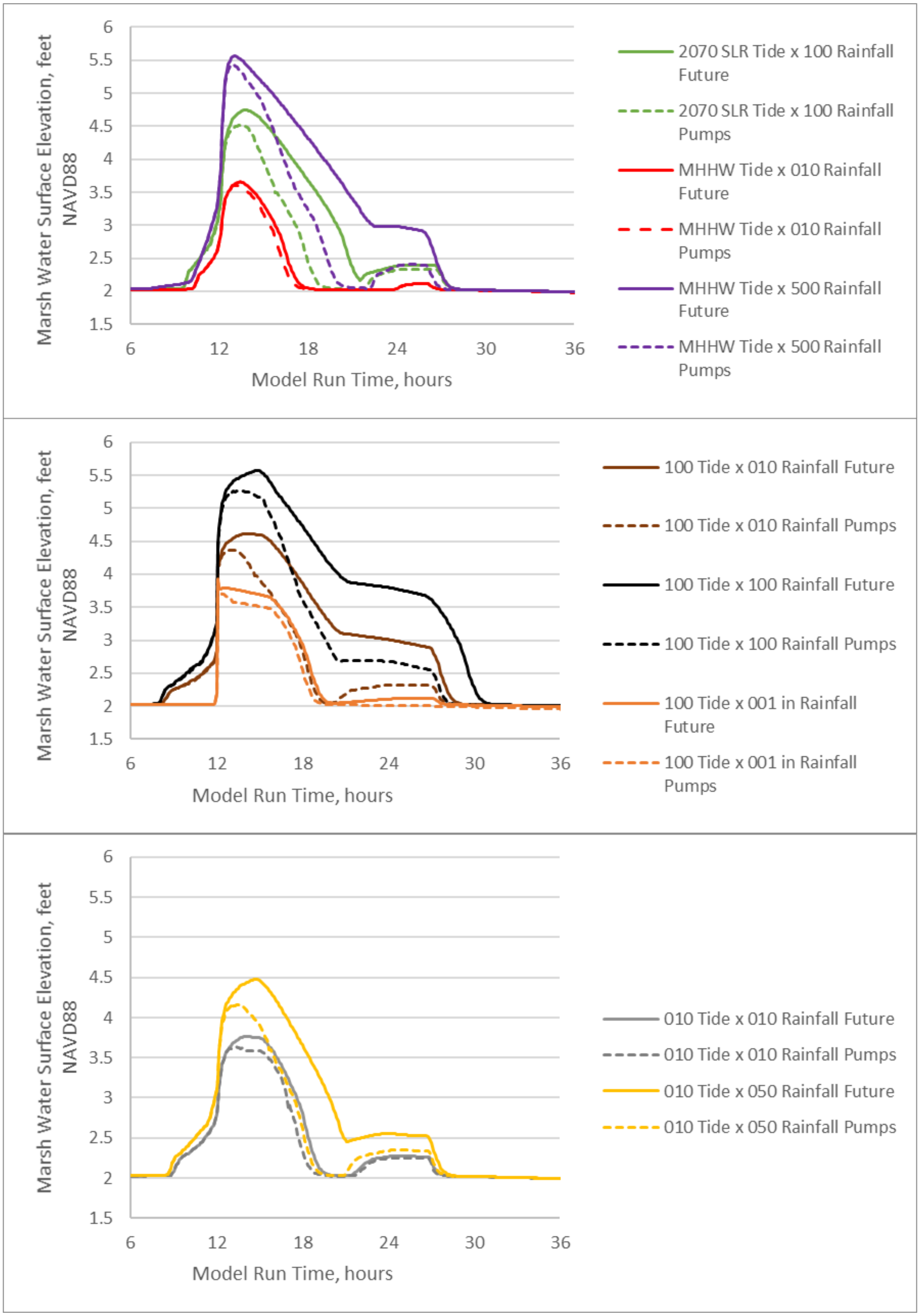
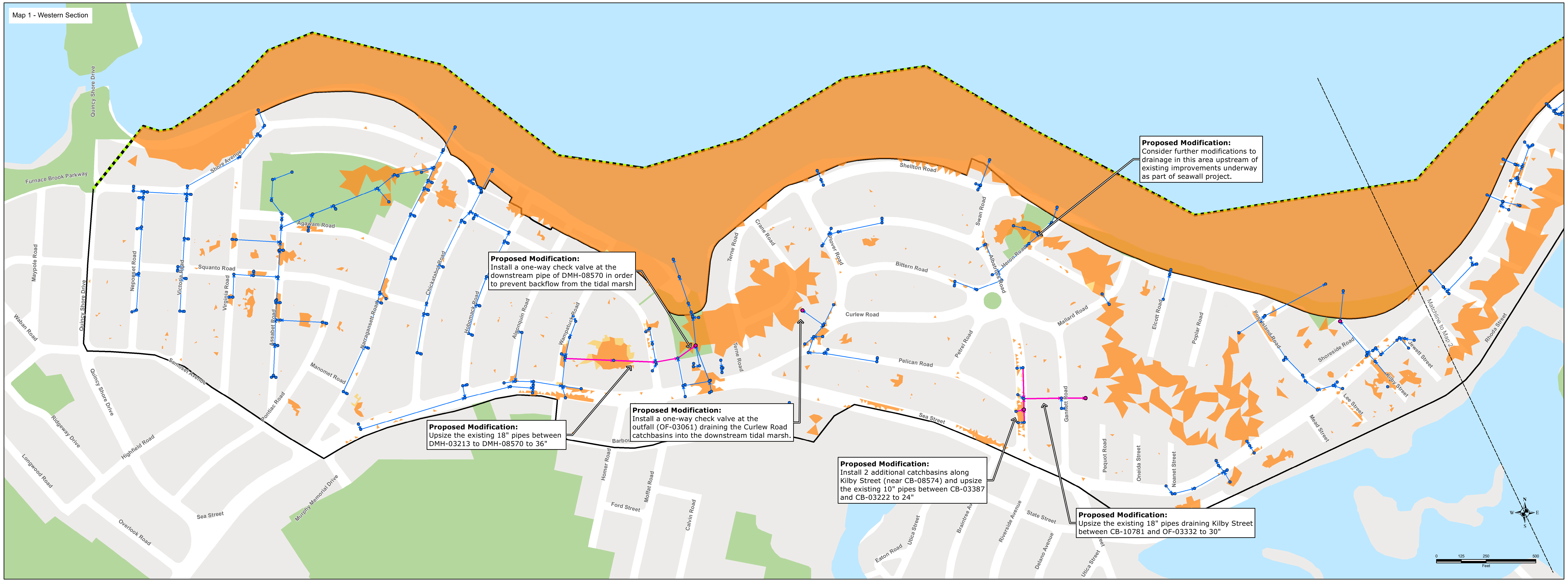
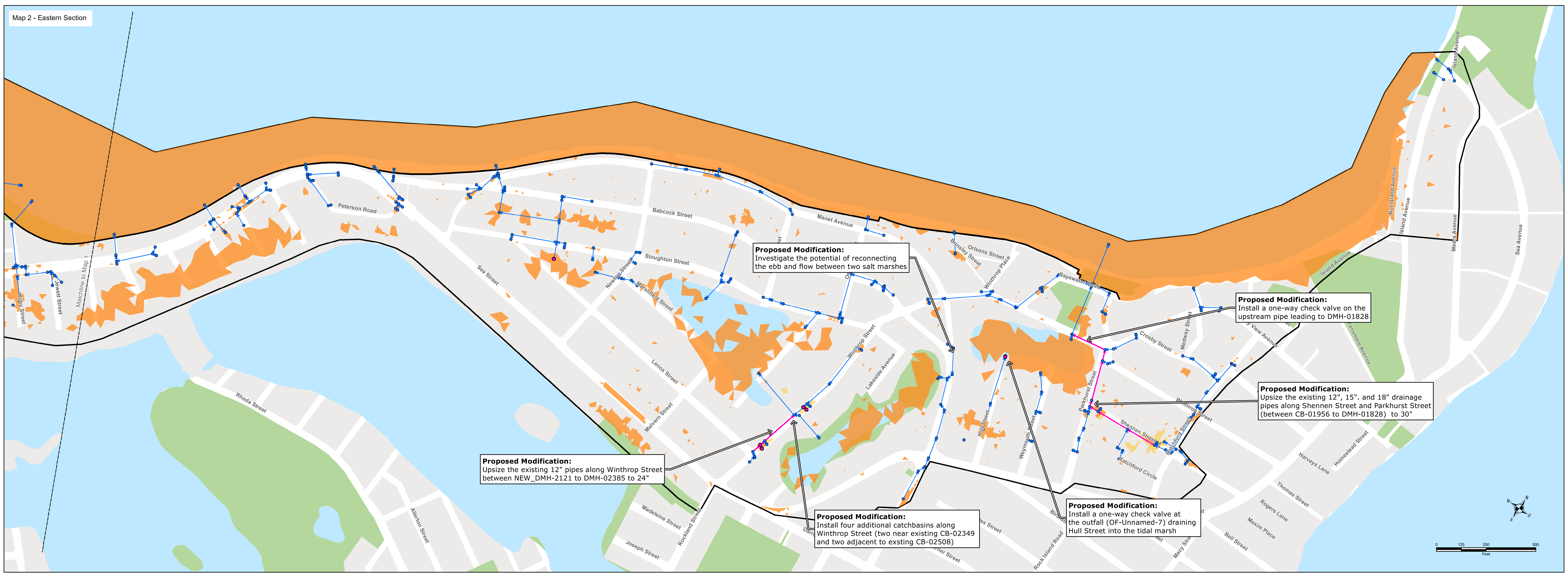


FIGURE C-13

Bayswater Road Marsh Water Surface Elevation Versus Time for Future Conditions and Future Conditions with Proposed Pumps *(impacts to adjacent homes anticipated at approximately 6.4 feet NAVD88)*

FIGURE C-14
PROPOSED DRAINAGE MODIFICATIONS

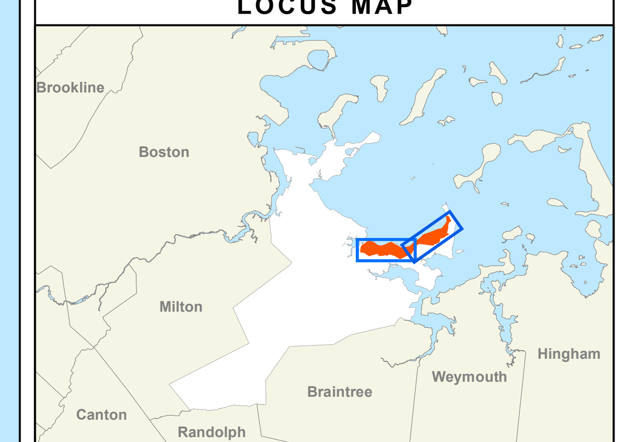




Legend

- Modified Node
- Stormwater Node
- Modified Network
- Stormwater Network
- Proposed Drainage Modifications
- 2070 Sea Level Rise MHHW x 10 Year Rainfall selection
- Future Conditions 2070 Sea Level Rise MHHW x 10 Year Rainfall
- Seawall
- Tidal Boundary Condition
- 2D Mesh

LOCUS MAP



NOTES

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August 2020

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APPENDIX D

Appendix D – Potential Stormwater Pumping Stations (Norton Beach, Island Pond, Bayswater Areas) Conceptual Deisgn

TO: City of Quincy

FROM: Tighe & Bond

DATE: June 30, 2020

Purpose

The purpose of this memorandum is to present information related to conceptual design of stormwater pump stations to mitigate flooding in the Norton Beach, Bayswater Road, and Post Island Road wetlands and developed areas. This memorandum provides a brief description of stormwater pump station concepts and the assumptions made to provide practicable limits to each concept. Figure D-1 shows the potential locations of these pumping stations.

Stormwater Pump Station Scenarios

Pump stations were sized to manage a 100-year precipitation event (see Appendix A of overall report) and be able to pump to overcome the elevation of the 2070 Mean Higher High Water (MHHW) tidal condition (i.e., sea level rise of 2 feet). The following scenarios were then considered:

1. Creating available stormwater in the abutting wetlands area by using a tide gate system to close the wetlands off at low tide, prior to start of the storm event
2. Leaving the tide gate open prior to the storm event
3. Considering these options combined with wave overtopping of the new seawall currently and planned to be under construction as of the date of this memorandum.

Table D-1 shows a summary of the pump station options with relative pumping needs. As flow needed to be pumped increases, so does the associated pump station size, including space needs and costs, along with impacts to abutters and increasing hurdles to environmental permitting. The most practical alternative given lily land available, that still provides protection, is to assume a new or updated tide gate system can be constructed in conjunction with a pump station and storage tank that will allow the abutting wetlands area to mostly empty prior to a storm event. This is scenario number 1 listed above and shown in italics below.

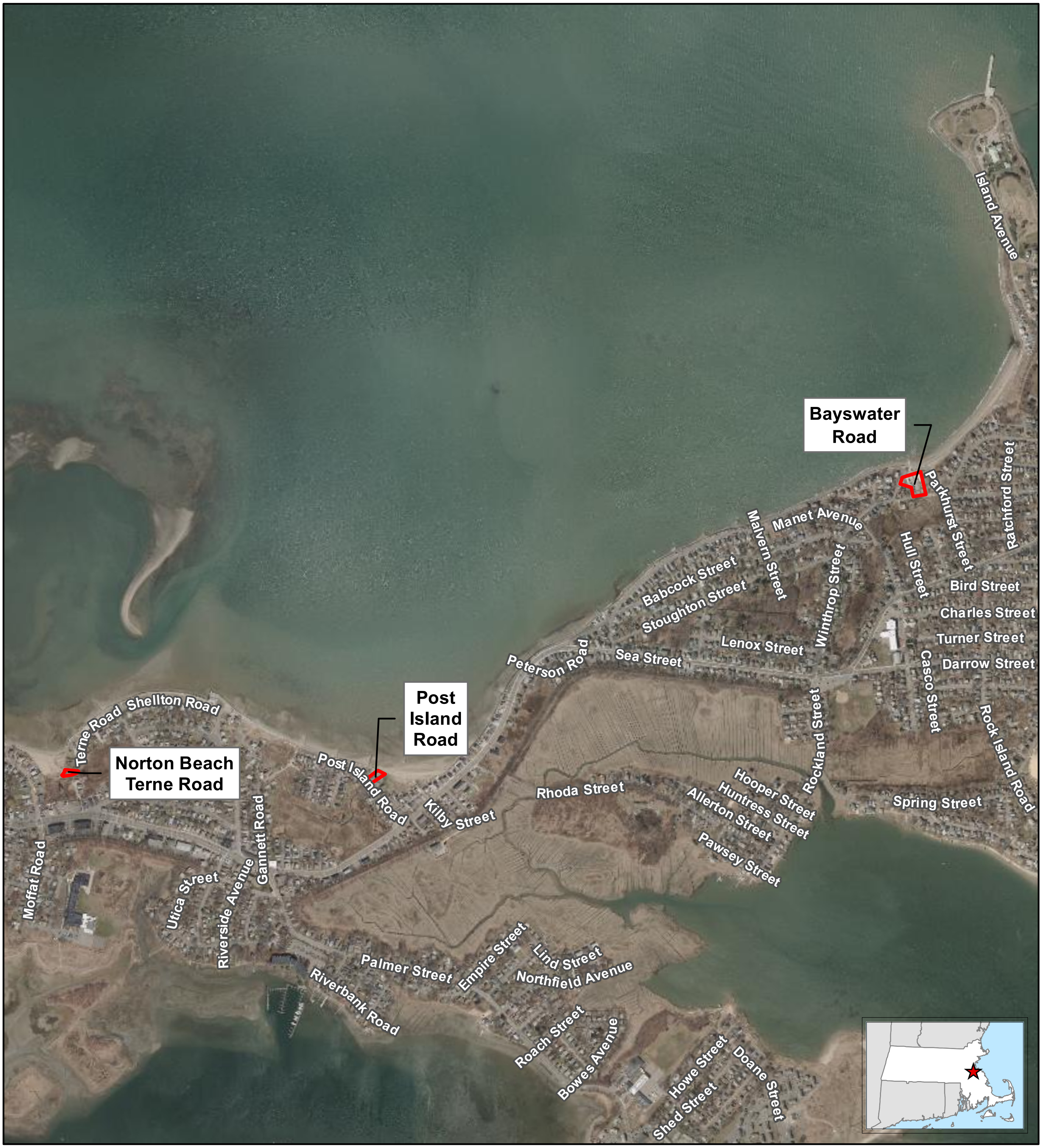
Table D-1: Summary of Pump Station Concepts

Scenario Description	Design Max. Storage Elev. (Flood Elev. NAVD 88)	Tide Gate Shut Elev. (NAVD 88)	Available Storage Volume	Required PS Flow (gpm)	Required PS Flow (gpm) with Assumed Wave Overtopping
Norton Beach Area (See Figure D-2)					
Gate Closed When Low Prior to Storm	El 5.88	El 1.6	8.76 acre-ft (~2.85 MG)	*7,700*	23,800 (overtop makes up about 68% of the total flow)
Gate Left Open Prior to Storm	El 5.88	El 4.8	~4.9 acre-ft (~1.6 MG)	13,500	

Scenario Description	Design Max. Storage Elev. (Flood Elev. NAVD 88)	Tide Gate Shut Elev. (NAVD 88)	Available Storage Volume	Required PS Flow (gpm)	Required PS Flow (gpm) with Assumed Wave Overtopping
Island Pond Area (see Figure D-3)					
Gate Closed When Low Prior to Storm	El 6.18	El 0.82	24.24 acre-ft (~8.22 MG)	5,750	17,950 (overtop makes up about 68% of the total flow)
Gate Left Open Prior to Storm	El 6.18	El 4.8	~14.42 acre-ft	8,750	
Bayswater Area (see Figure D-4)					
Gate Closed When Low Prior to Storm	El 6.38	El 0.34	14.85 acre-ft (~4.84 MG)	3,525	12,425 (overtop makes up about 72% of the total flow)
Gate Left Open Prior to Storm	El 6.38	El 4.8	~6.14 acre-ft	4,500	

Table notes:

1. The minimum shut level of the gates used are based on the design of the existing tide gates and their apparent possible minimum level due to the existing invert elevations.
2. When the tide gate is not closed in advance of a storm by the operations personnel, it is assumed that the shut elevation is based on normal operations. Assumes that under normal operation the tide gate closes at Mean Higher High Water (MHHW) El 4.8 feet NAVD88.
3. The Required Pump Station Flow is calculated based on available storage volume, rain and catchment (contributing) Hydrology, graphs provided below. (It is assumed that some localized flooding will be allowable within the area in a 100-year storm event.)
4. The wave overtopping calculations are based on a 100-yr storm event with a still water elevation of 9.5 ft NAVD 88 with overtopping only occurring for approximately 2.5 hours during the peak of the tidal cycle between El 7.4 ft and El 9.4. Estimates assume 11.1 gpm/lf of elevation 13 seawall. Note that 6-inch diameter return flow pipes with check valves are being cast into the base of the new elevation 13 seawall to handle the predicted wave overtopping volume. It is probable that some of the wave overtop flow will drain into the City catch basin system and a portion of the flow will enter the salt marsh areas associated with each site, so this should be considered for future discussions.
5. Assumes that the stormwater pump station discharge can be release to a local head tank which will be connected directly to the offshore outfall, downstream of the tide gate.
6. Check valves, which will allow flow out of the storage area by gravity, are being installed throughout this area to allow drainage when tide is low, when the tide gate is shut in anticipation of or during a storm, and should be integrated into the final design assumptions.
7. Assumes all scenarios discharge into the existing outfall downstream of existing tide gate/check valve.
8. The majority of the drainage areas around each site falls within the FEMA defined Special Flood Hazard Area subject to inundation by the 1% annual chance flood. The proposed project sites are located in and will impact VE and AE Zones. The FEMA (AE Zone) have a Base Flood Elevations of El. 12.0 NAVD 88.



Legend

Potential Pump Station Location

Parcel Boundary

1:14,400

0 600 1,200 Feet

Tighe&Bond

Based on MassGIS Color Orthophotography (2019).

MAP D-1
POTENTIAL STORMWATER PUMP STATION LOCATIONS

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

July 2020

Legend

- Potential Pump Station Location
- Parcel Boundary

1:1,200

0 50 100 Feet

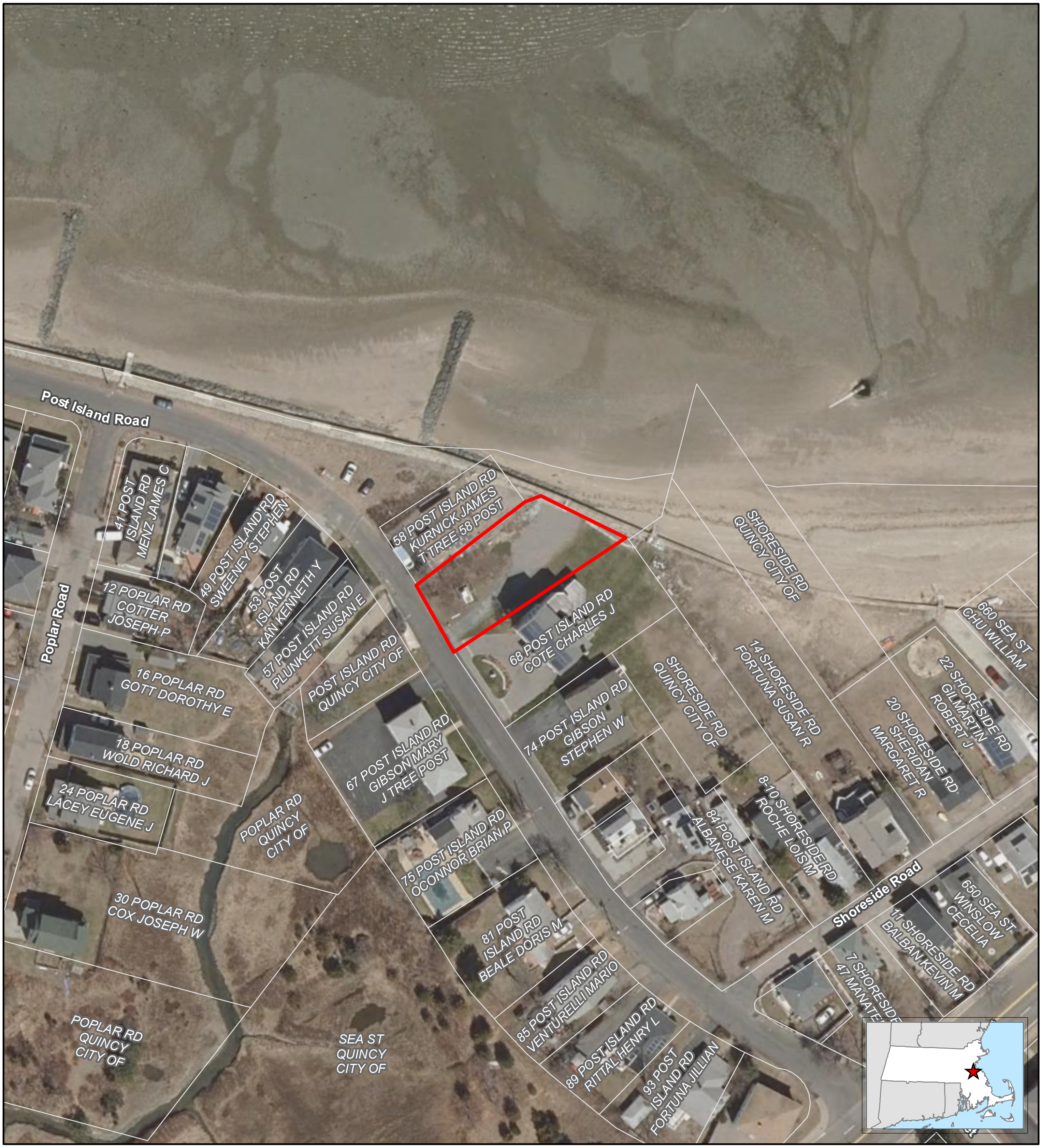
Tighe&Bond

Based on MassGIS Color Orthophotography (2019).

MAP D-2
NORTON BEACH/TERNE ROAD POTENTIAL PUMP STATION SITE

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

July 2020



Legend

- Potential Pump Station Location
- Parcel Boundary

1:1,200

0 50 100 Feet

N

Tighe&Bond

Based on MassGIS Color Orthophotography (2019).

MAP D-3
POST ISLAND ROAD
POTENTIAL STORMWATER PUMP STATION SITE

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

July 2020

Legend

Potential Pump Station Location

Parcel Boundary

1:1,200

0 50 100 Feet

N

Tighe&Bond

Based on MassGIS Color Orthophotography (2019).

MAP D-4
BAYSWATER ROAD
POTENTIAL STORMWATER
PUMP STATION SITE

Adams Shore & Houghs Neck
Coastal Flood Modeling
Quincy, Massachusetts

July 2020

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Q-0019

The conceptual basis of design for the pump stations is described in the following sections. Each site was evaluated with Innovyze® InfoWorks ICM software as discussed in Appendix A, B, and C. Hydrographs and stage storage evaluations were developed. Figure D-5 explains the hydrographs used. The blue line in the hydrograph depicts the inflow due to rainfall during the storm, while the orange line depicts the pump capacity of the proposed pump station.

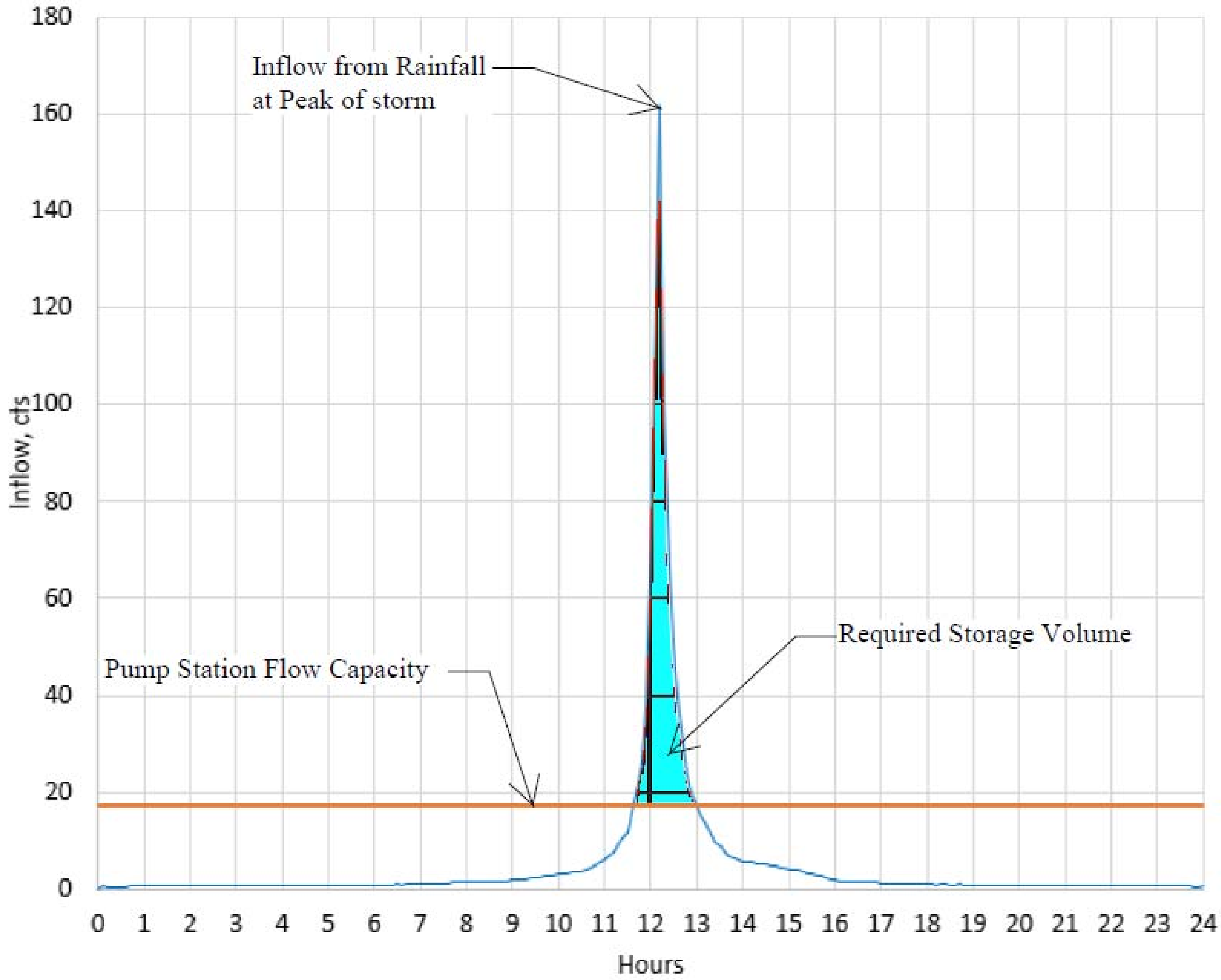


Figure D-5: Example Hydrograph

Norton Beach Site

The potential pump station site could be located just outside the seawall to the southeast. Figure D-2 shows the location. The area is bounded by the wall to the northwest, a private residence to the north, City owned wetlands to the west and southwest and private land/wetland south. The existing tide gate structure is southwest of the potential site. The potential pump station site might be located on parts of various properties:

- Norton Road, Quincy, MA 02169 (City Owned)
- Terne Rd, ROW (City Owned)
- 22 Terne Rd., Quincy, MA 02169 (Owned by Peter B. Fifield) (Largest Portion)
- 32 Terne Rd., Quincy, MA 02169 (Owned by Rita C. Fuller) (Boarder)

Based on field work, 39 Terne Rd (basement water entry point) (Elev 5.88 ft in NAVD88), is the location with the lowest elevation in the area, or first to likely be impacted by flooding. This elevation was used as the upper boundary of the acceptable flood level at his juncture in planning.

During a 100-year precipitation event, it is anticipated that the inflow to the watershed served by the Norton Road stormwater outfall will receive approximately 161.6 cfs (72,551 gpm) of rainfall, at its peak.

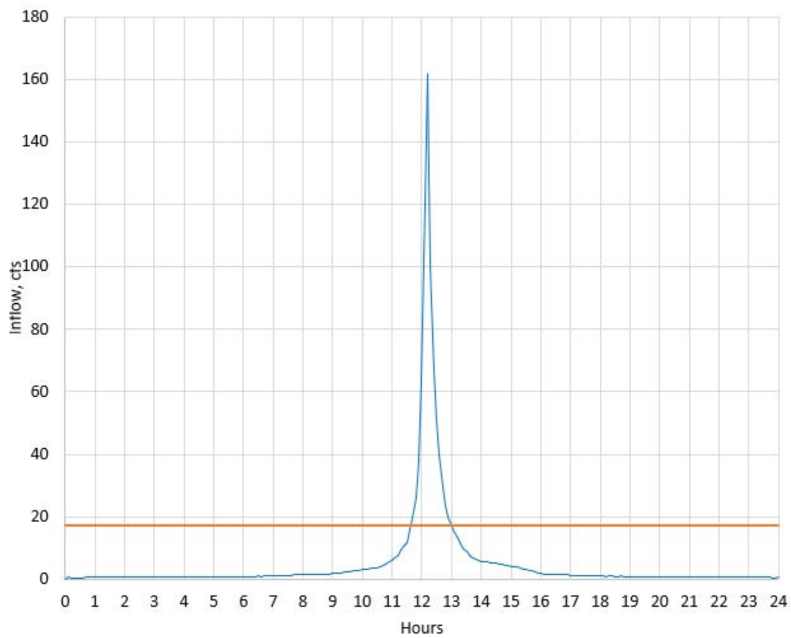


Figure D-6: Inflow into Norton Beach Wetlands Area

Existing Tide Gates and Required Upgrades: The existing "tide gate" at Norton Beach is a check valve setup. The check valve orientation is towards the bay, allowing discharge through the outfall pipe under low tide conditions and restricting backflow through the outfall pipe under high tide conditions. This check valve orientation restricts the natural tidal flow from the bay to the associated saltmarsh.

It would be preferred both environmentally and for the purpose of flood mitigation in this area to have a combination tide gate/check valve system. The check valve would be set up as it is now, blocking backflow into the saltmarsh during higher tides, and allowing it to drain flows both stormwater flows and tidal flows, when the tide was lower than the saltmarsh level or with the ebbing tide. Under normal operation the tide gate would remain open and only be closed when the tide reached a level that threatens to flood the community. This setup allows for the natural filling and draining of the adjacent saltmarsh with the normal rising and fall of the tides when the tide gate is open.

Below discusses how this tide gate / check valve system could also be used, alone or in conjunction with a pump station, in anticipation of major storms, to provide stormwater storage in the saltmarshes.

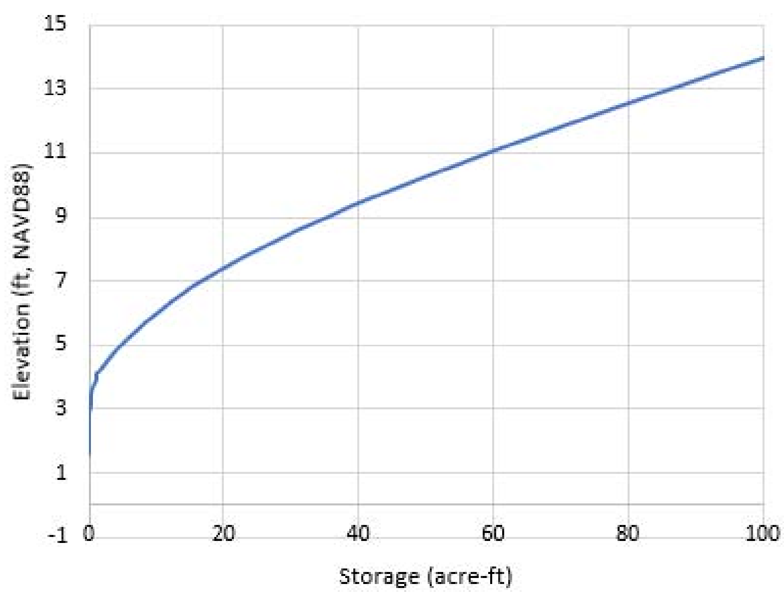


Figure D-7: Stage-Storage Relationship for Norton Beach Area

Gate Closed During Low Tide in Anticipation of a Storm: It is assumed that the tide gates can be operated in anticipation of a major storm (closed below El. 1.6 NAVD 88 to maintain storage capacity, top of storage El. 5.88 NAVD 88) and therefore approximately 8.76 acre-feet of on-site storage can be provided in a 100-year storm event.

> Tide Gate/Check Valve System: The benefit would be restricted to storage and head to overcome the tide. Based on the elevations noted above, the combination tide gate/check valve system could provide approximately 8.76 acre-feet (2.85 million gallons) of storage. In a severe storm, that is not much storage, but the storage also translated into a rise in water level. The storage water surface elevation when higher

than the tide elevation will force flow out through the check valve portion of the system.

New Tide Gate/Check Valve with Stormwater Pump Station System: Based on the above noted elevations and resulting storage, a pump station providing 7,700 gpm could be used to protect against the impacts of flooding from the 100-year storm event. A single precast wet well with a suitably sized pump station structure might be restricted to approximately 12 feet in diameter.

It appears that at a head elevation of 9.01 ft NAVD 88, the Norton Outfall, (a 302 ft long, 30" CMP pipe), can discharge 32.40 cfs (14,542 gpm). Thus, if the required discharge flow of 17.16 cfs (7,700 gpm) can be lifted to that same elevation (9.01 ft NAVD 88), or greater, this discharge can be via the same outfall pipe.

The Tide Gate/Check Valve Setup benefits both the natural environmental cycle and provides some level of flood protection for the community when used alone.

Gate Left Open Prior to Storm: It is assumed that the level is limited to the MHHW Elevation, or 4.8 NAVD 88 (top of storage El. 5.88 NAVD 88), and therefore approximately 4.9 acre-feet of on-site storage (approximately 1.6 million gallons) can be provided in a 100-year storm event. Because the storage has been reduced, the pump station needs to be increased to manage approximately 13,500 gpm to provide sufficient flow.

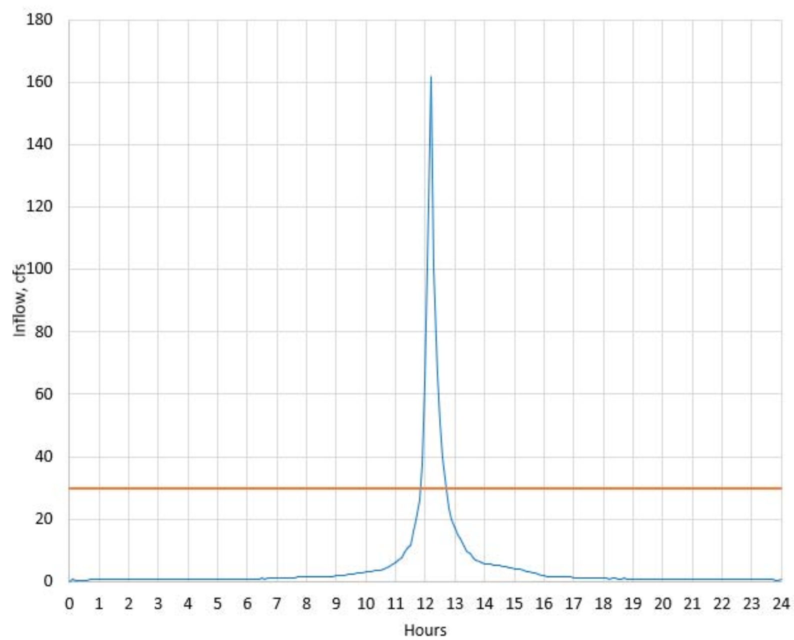


Figure D-8: Inflow into Norton Beach Wetlands Area

Post Island Road Site

The potential pump station site is located outside the seawall to the south and southwest. The pump station is recommended to be located on the same property as the existing tide gate. Figure D-3 shows the location. The area is bounded by the wall to the northeast, private residence to the east, west, and the southeast. Post Island Road and City owned properties, wetlands to the south and southwest. The existing tide gate structure is southwest of the potential site. There appears to be sufficient City owned land and ROW, to place a reasonable sized stormwater pump station. The abutters to the potential site are as follow:

- 57 Post Island Rd., Quincy, MA 02169 (Owned by Susan E. Plunkett)
- 58 Post Island Rd., Quincy, MA 02169 (Owned by James T Kurnick)
- 67 Post Island Rd., Quincy, MA 02169 (Owned by Mary J. Gibson)
- 68 Post Island Rd., Quincy, MA 02169 (Owned by Charles J Cote)

Based on field work, 30 Poplar Road's garage slab (elev 6.18 ft in NAVD88), is the location with the lowest elevation in the area, or first to likely be impacted by flooding. This elevation was used as the upper boundary of the acceptable flood level at his juncture in planning.

During a 100-year precipitation event, it is anticipated that the inflow to the watershed served by the Post Island Road stormwater outfall will receive approximately 217 cfs (97,410 gpm) of rainfall, at its peak.

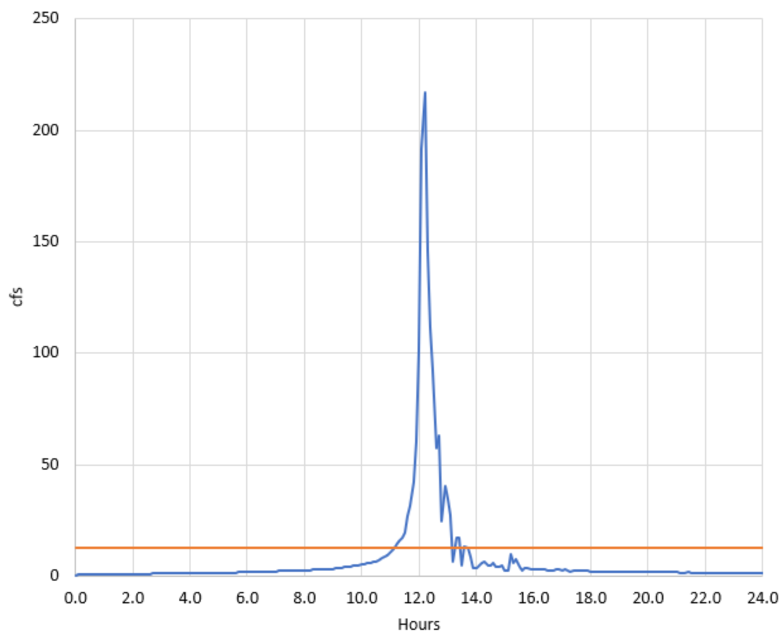


Figure D-9: Inflow into Post Island Road Wetlands Area

Existing Tide Gates and Required Upgrades: The tide gate at Island Pond is a true two-way tide gate. The tide gate allows flow in both directions through the outfall pipe. Under low tide conditions flow goes out, and as the tide rises flow can return to the saltmarsh. When open, this tide gate setup somewhat mimics natural tidal flow to the associated saltmarsh that would occur in a natural waterway. The only restrictions are the losses in the piping.

An unrestricted connection between the bay and the marsh provides natural flows between both but provides the community less protection from higher tides and major storms. For this reason, the tide gate is installed, which allows the community to close the tide gate when a particularly high tide is anticipated to minimize flooding potential.

Though the existing tide gate setup at the Island Pond site is better than a simplistic check valve system, it requires that the gate? be manipulated based on tide levels and it does not consider the potential for buildup of water on the saltmarsh side of the gate. This buildup during a storm can exceed the tide level, without a means of discharge, thus creating flooding that the tide gate was intended to protect against. Similar to the other sites, a combination tide gate/check valve system would be preferred, to provide protection against this stormwater flooding on the land side of the gate. The check valve would be set up to block backflow into the saltmarsh during higher tides and allow both stormwater and tidal flows to discharge from behind the tide gate when the tide was lower than the saltmarsh level or with the ebbing tide. Under normal operation the tide gate would remain open and only be closed when the tide reached a level that threatens to flood the community. This setup allows for the natural filling and draining of the adjacent saltmarsh with the normal tide cycle while providing the City the ability to close the gate and prevent flooding caused by a high tide or excessive stormwater flooding.

Below discusses how this tide gate/check valve system could also be used, alone or in conjunction with a pump station, in anticipation of major storms, to provide stormwater storage in the saltmarshes.

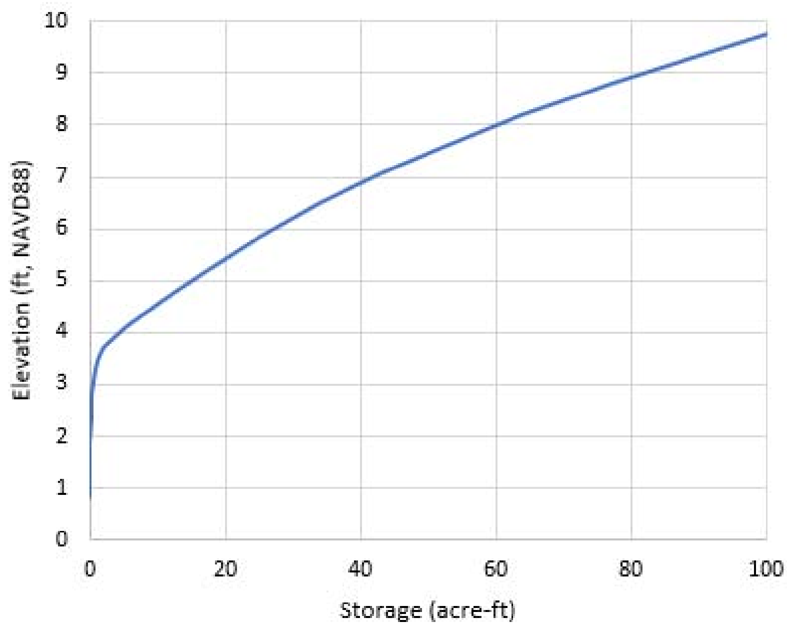


Figure D-10: Stage-Storage Relationship for Post Island Road Area

Gate Closed During Low Tide in Anticipation of a Storm: It is assumed that the tide gates can be operated in anticipation of a major storm (closed below El. 0.82 NAVD 88 to maintain storage capacity, top of storage El. 6.18 NAVD 88) and therefore approximately 24.24 acre-feet of on-site storage can be provided in a 100-year precipitation event.

> <u>New Tide Gate/Check Valve System)</u>: The benefit would be limited to storage and head to overcome the tide. Based on the elevations noted above, the combination tide gate/check valve system could provide approximately 24.24 acre-feet (8.22 million gallons) of storage. In a severe storm, that is not much storage, but the storage also translated into a rise in water level. The storage water surface elevation when higher than the tide elevation will force flow out through the check valve portion of the system.
>
> <u>New Tide Gate/Check Valve with Stormwater Pump Station System</u>: Based on the above noted elevations and resulting storage, a pump station providing 5,750 gpm could be used to protect against the impacts of flooding from the 100-year storm event. A single precast wet well with a suitably sized pump station structure might be restricted to approximately 12 feet in diameter due to site conditions.
>
> It appears that an elevation of 8.52 ft NAVD 88, the Post Island outfall, (a 345 ft long, 36" HDPE pipe), can discharge 43.40 cfs (19,479 gpm). Thus, if the required discharge flow of 12.81 cfs (5,750 gpm) can be lifted to that same 8.52 ft NAVD 88 or greater, the discharge can be accommodated via the same outfall pipe.
>
> Note: The above flow assumes a single storm and not multiple days of peak storm weather. If the City would like a design to protect against multiple days for 100-year storm weather, the draining or pumping out of the storage volume during the peak events must be further considered.

Gate Left Open Prior to Storm: It is assumed that the level is limited to the MHHW Elevation, or 4.8 NAVD 88 (top of storage El. 6.18 NAVD 88), and therefore approximately 14.42 acre-feet of on-site storage (approximately 4.7 million gallons) can be provided in a 100-year precipitation event. Because the storage has been reduced, the pump station to be increased to manage approximately 8,750 gpm to provide sufficient discharge.

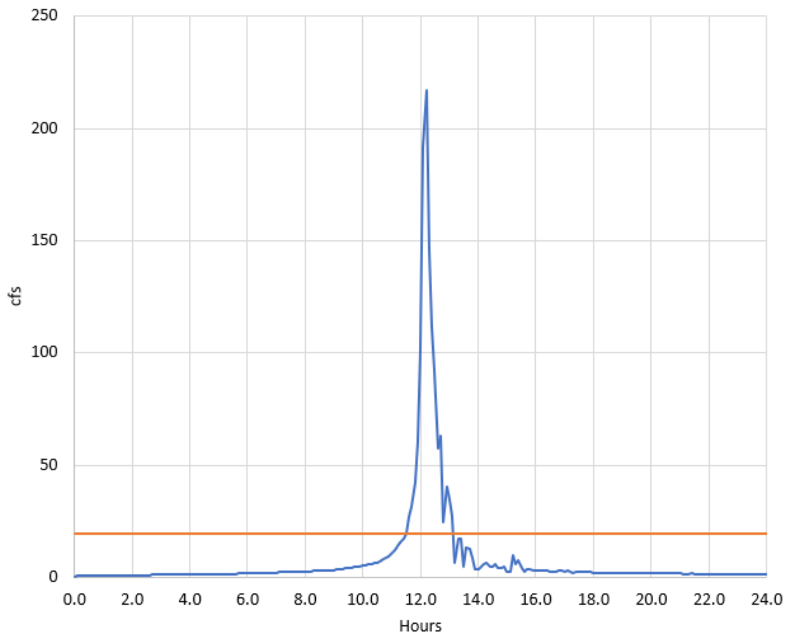


Figure D-11: Inflow into Post Island Road Wetlands Area

Bayswater Road Site

The potential pump station site is located outside the seawall and across Bayswater Rd to the south. Currently the site is used for boat storage and has a community playground located on a portion of it. Figure D-4 shows the location. The area is bounded by the seawall and Bayswater Road to the north and northwest, private residence to the east, west. Winthrop Street and City owned property and wetlands/marshland to the south and southeast. The existing tide gate structure is north of the potential site, on Bayswater Road. There appears to be sufficient City owned land and ROW, to place a stormwater pump station at this location.

The abutters to the potential site are as follow:

- 13 Bayswater Rd., Quincy, MA 02169 (Owned by Dawna Creighton)
- 162 Winthrop St., Quincy, MA 02169 (Owned by Erin Kelley)
- 167 Winthrop St., Quincy, MA 02169 (Owned by Margaret Mary Hickey)
- 5 Parkhurst St., Quincy, MA 02169 (Owned by Helen E Mina)
- 15 Parkhurst St., Quincy, MA 02169 (Owned by Meredeth Johnston)

Based on field work, 13 Bayswater Road (basement slab) (Elev 6.36 ft in NAVD88), is the location with the lowest elevation in the area, or first to likely be impacted by flooding. This elevation was used as the upper boundary of the acceptable flood level at his juncture in planning.

During a 100-year precipitation event, it is anticipated that the inflow to the watershed served by the Bayswater Road storm sewer outfall will receive approximately 128.3 cfs (57,600 gpm) of rainfall, at its peak.

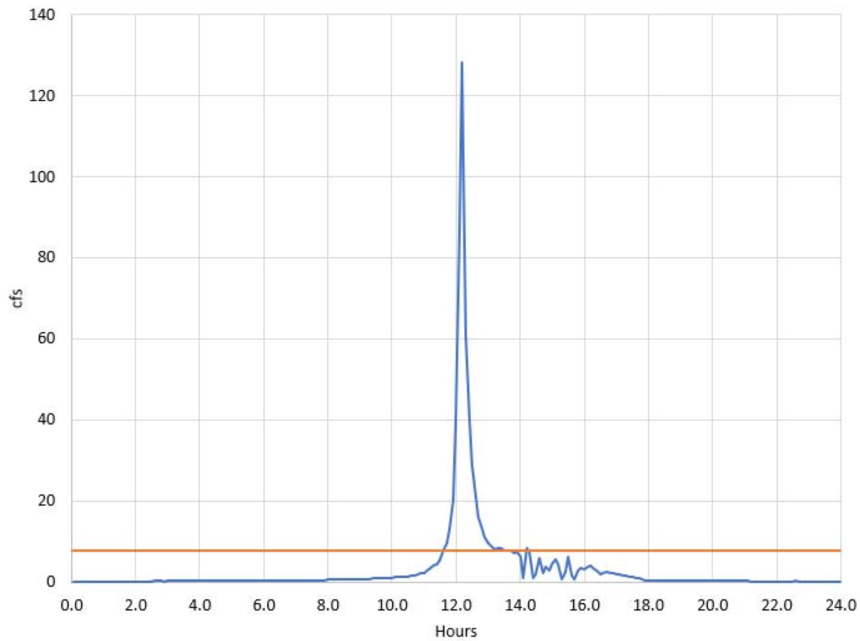


Figure D-12: Inflow into Bayswater Road Wetlands Area

Existing Tide Gates and Required Upgrades: The existing "tide gate" at Bayswater, similar to the one at Norton, is a check valve setup. The check valve orientation is to the bay allowing discharge through the outfall pipe under low tide conditions, but restricts backflow in through the outfall pipe, under high tide conditions. This check valve orientation restricts the natural tidal flow to the associated saltmarsh.

It would be preferred both environmentally and for the purpose of flood mitigation in this area to have a combination tide gate/check valve system. The check valve would be set up as it is now, blocking backflow into the saltmarsh during higher tides, and allowing it to drain flows both stormwater flows and tidal flows, when the tide was lower than the saltmarsh level or with the ebbing tide. Under normal operation the tide gate would remain open and only be closed when the tide reached a level that threatens to flood the community. This setup allows for the natural filling and draining of the adjacent saltmarsh with the normal rising and fall of the tides when the tide gate is open.

Below discusses how this tide gate/check valve system could also be used, alone or in conjunction with a pump station, in anticipation of major storms, to provide stormwater storage in the saltmarshes.

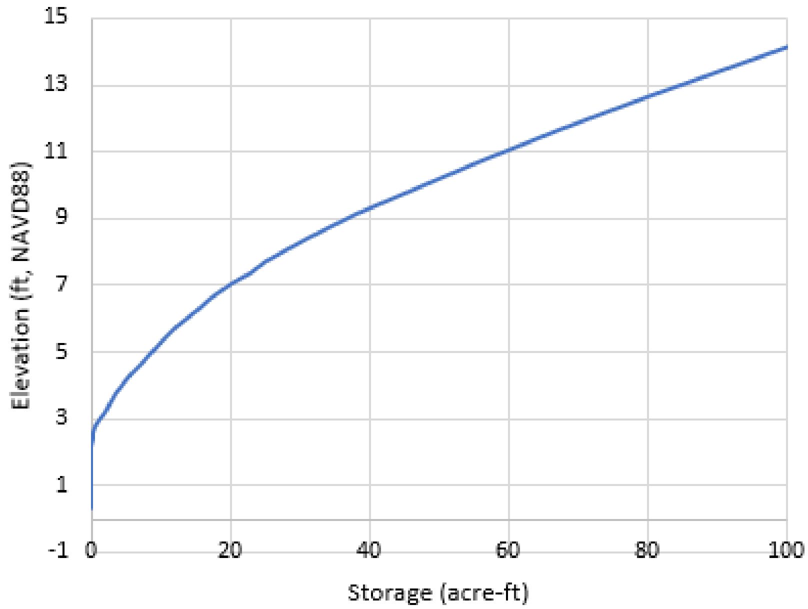


Figure D-13: Stage-Storage Relationship for Bayswater Road Area

Gate Closed During Low Tide in Anticipation of a Storm: It is assumed that the tide gates can be operated in anticipation of a major storm (closed below El. 0.34 NAVD 88 to maintain storage capacity, top of storage El. 6.38 NAVD 88) and therefore approximately 14.85 acre-feet of on-site storage can be provided in a 100-year precipitation event.

<u>Without a Stormwater Pump Station (With a Tide Gate/Check Valve Setup)</u>: The benefit would be restricted to storage and head to overcome the tide. Based on the elevations noted above, the combination tide gate/check valve system could provide approximately 14.85 acre-feet (4.84 million gallons) of storage. In a severe storm, that is not much storage, but the storage also translated into a rise in water level. The storage water surface elevation when higher than the tide elevation will force flow out through the check valve portion of the system.

<u>With a Stormwater Pump Station (With a Tide Gate/Check Valve Setup)</u>: Based on the above noted elevations and resulting storage, a pump station providing 3,525 gpm could be used to protect against the impacts of flooding from the 100-year storm event. A single precast wet well with a suitably sized pump station structure might be restricted to approximately 12 feet in diameter.

It appears that an elevation of 7.10 ft NAVD 88, the Bayswater Outfall, (a 222 ft long, 36" RCP pipe), can discharge 54.0 cfs (24,237 gpm). Thus, if the required stormwater discharge flow of 7.85 cfs (3,525 gpm) can be lifted to that same 7.10 ft NAVD 88, or greater, this stormwater will flow to the outfall discharge via the same outfall pipe.

Note: The above flow assumes a single storm and not multiple days of peak storm weather. If the City would like a design to protect against multiple days for 100-year precipitation events, the draining or pumping down of the storage during the peak events must be further considered.

Gate Left Open Prior to Storm: It is assumed that the level is limited to the MHHW Elevation, so 4.8 NAVD 88 (top of storage El. 6.38 NAVD 88). Based on preliminary data this memo assumes that approximately 6.14 acre-feet of on-site storage (approximately 2.0 million gallons) can be provided in a 100-year storm event. Because the storage has been reduced, the flow needs to be increased to approximately 4,500 gpm to provide sufficient flow.

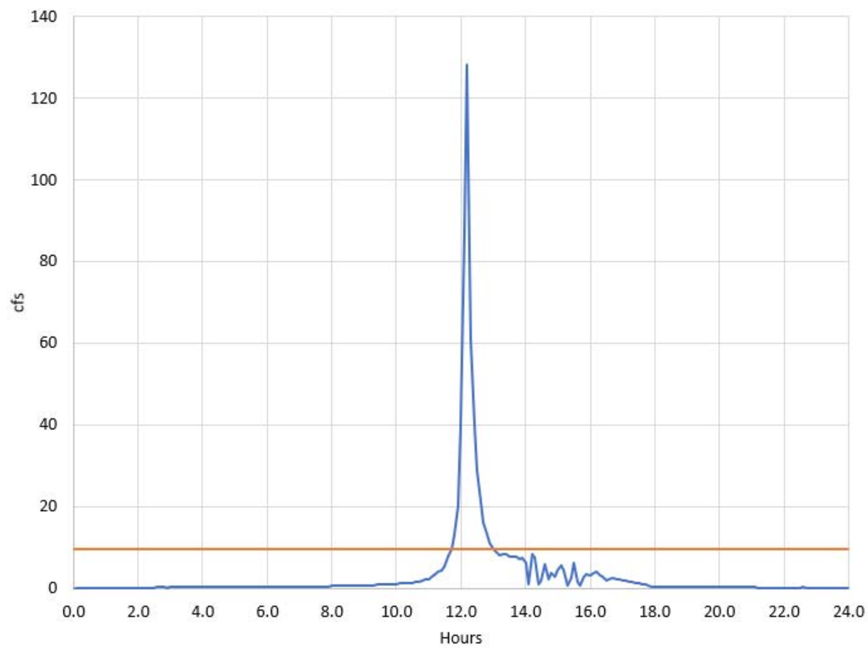


Figure D-14: Inflow into Bayswater Road Wetlands Area

Stormwater Pump Station Considerations

As noted above, for all three sites, a pump station in combination with a tide gate/ check valve setup can provide added flood protection security to public infrastructure and private property. The following should be considered in making a decision regarding the level of protection and redundancy that the City is looking for from such a flood mitigation system:

Pump Station Size

The design size of a pump station is critical when considering the level of flood protection.

If the stormwater pumps at each station were to be sized to handle the peak flow from the 100-year storms, the stations would be required to be very large, to handle a short period of the storm. Another method would be to provide a storage structure within the pump station of enough size to store the peaks. This require a very large and expensive storage structure. Allowing for limited flooding to provide storage in the marsh and on surrounding property, in leu of a large physical structure permits the reduction in pump station size.

Wetlands and marshes have throughout time been natural means to absorb storm and tidal flows and reduce the impacts of flooding. With development, some of these natural flood protections have been eliminated. The proposed stormwater pump stations would utilize this land storage concept to reduce the size of the required stations while also reducing the impacts of the coastal flooding caused by rainstorms. The concept is to reduce the size of the stormwater pump stations by using capacity in their watersheds to provide temporary storage to handle peaks in flow. By taking advantage of the topography around the pump station sites to provide this storage, it is possible to cut the peak to a more manageable flow and the size of the pump stations significantly, to allow footprints more appropriate for the limited space available at each site.

Pump Station Type

There are two common pump station types which include submersible and self-priming. Both types have pros and cons and are described in more detail below.

Submersible Pump Station

A submersible pump has a sealed motor close-coupled to the pump body. It is designed as a tightly contained unit, with watertight gaskets and seals that keep the liquid out of the housing and internal components. The whole assembly can be submerged in the fluid to be pumped. This design ensures that the pump do not leak or short out electrically when submerged, so no issues in a flooded environment.

Submersible pumps push fluid to the surface in contrast with self-priming pumps, which create a vacuum and rely upon atmospheric pressure. Pushing the fluid is more efficient than suction methods.

The placement of the pumps has an added advantage because they are located inside the fluid. This helps keep them cool, pump out the fluid more efficiently, it reduces the chance of pump cavitation. Cavitation is problem associated with a high elevation difference between the pump. While not a problem with submersible pumps cavitation can be an issue with self-priming pumps.

There are some disadvantages to submersible pumps when compared to self-priming and other types of pump:

- One potential problem would occur if a gasket were to rupture or lose its integrity. This would cause the pump to leak, eventually corroding the internal components and causing it to fail. A gasket failure may be difficult to notice because it is submerged inside water. With regular and proper maintenance and testing these types of issues can be identified, before they become a problem.

- Non-submersible pumps of comparable flow and pressure cost less than submersible pumps. The issue is that one either needs a watertight drywell to place the other pump type in, or one needs an elevated platform above the flood level to place the self-priming pump on and a larger pump to overcome the head requirements.

Self -Priming Pump Station

A self-priming pump is a pump which can draw water from below the physical pump. This type of pump can pump fluid drawn from a wet well while situated out of the pit. These pumps will clear the suction piping of air and draw liquid up into the pump without outside assistance.

Self-prime pumps often require larger volute to assist with self-priming. As the suction line of a self-priming pump is always below the atmospheric pressure, some air leakage might occur, and the pumps may need time to re-prime before they can pump.

Generally, self-priming pumps are less efficient than submersible pumps and require larger horsepower motors to pump at a similar rate. Because of the higher horsepower required, the electrical usage can be more expensive to install and operate than the submersible pumps. While self-priming pumps can be run on a diesel power station, this is an advantage as well as a disadvantage. If powered by diesel one needs to be able to get fuel to the units and provide secondary containment.

It is sensible to place the pump as close as possible to the suction source. As noted above, cavitation can be an issue with self-priming pumps. Sensible design dictates that the suction pipe length be held to a minimum to promote longer pump life by reducing the priming time to a minimum. Every lineal foot of suction piping equates to a volume of air that must be removed when the pump starts. This means the pump will be close to the area of potential flooding, and these pumps will be susceptible to failure if the water reaches the units.

The conceptual design of the stations recommends a submersible pump design.

Redundancy

Redundancy is a component of protection planning that should be considered, but it should be recognized that it is not a requirement and rather a backup to a stormwater protection system, which is already a backup to the natural systems.

These pump stations are likely to be run infrequently and the service when they run is not difficult. The key issue for ensuring that these pumps run when you need them to run is regular maintenance. This will include flushing them with fresh water after they have run, running them with fresh water on a regular basis and storing them in fresh water.

In order to fit the stations on the sites the method of providing redundancy if requested, will need to be carefully considered. It may be prudent to design with multiple pumps for a larger peak flow (the overtopping flow), but not design for redundancy at that larger flow. This will provide a modicum of redundancy at the design flow, but not at the higher peak flow.

Access (Regular for Maintenance; During Storm Events)

Access to stormwater protection system is important for regular inspection, maintenance, testing and repair of the stations and the equipment. Vehicle access must be secured and maintained.

Access during a storm event is a consideration. The stormwater pump station is on the proverbial front line in a storm emergency and should be designed to operate when needed, without much interaction from personnel, who will likely be busy with other matters. The goal should be to avoid the need for access during storm events by providing a system that will be protected from the storm and run when needed.

Electrical Power and Backup Power

Location of electric equipment and control panels needs to be confirmed, and the need for and location of backup power should be determined.

Permitting

The permitting required will depend upon the pump station locations and impacts of a new outfall over the seawall near the stations or needed to tie the pump stations into existing outfalls. This will not be known until the design is developed. For the purposes of this the conceptual design, the following assumptions with regards to the pump station locations and potential resource area impacts were made as identified below:

- The work at all sites will be within Land Subject to Coastal Storm Flowage (LSCSF)
- The pump stations discharge will be to a head tank with discharge tie into the existing outfall pipes downstream of the tide gate. Depending on the impacts at each site, permit modifications may be required.
- Portions of the work area are within a Barrier Beach.
- No dredging is currently intended for any of the options.
- It is important to recognize that there is salt marsh in the area of all three proposed pump station site locations. The intent should be to limit any impact to salt marshes to less than 1000 sf per project. The size and scope of the work will depend on the requirements and decisions of the City. Salt marsh may be a limiting factor in those decisions.
- There are no mapped endangered species habitat within the currently proposed project areas.
- The Bayswater Boatyard is not subject to protection as open space under Article 97 of the Amendments to the Massachusetts Constitution. (The Bayswater Boatyard site is identified on MassGIS as protected open space and is identified in the City of Quincy's 2012-2018 Open Space and Recreation Plan as having limited protection. For the purposes of this conceptual review, it is assumed the site is not protected under Article 97. This will require confirmation by the City of Quincy. Additional effort including a detailed alternatives analysis, MEPA ENF review, identification of a replacement parcel of land for protection, and local and state legislative approval would be required if the land is protected by Article 97.)

Summary of Design Assumptions

1. The minimum shut level of the gates used are based on the design of the existing tide gates and their apparent minimum level due to the existing invert elevations.
2. The required pump station flow is calculated based on available storage volume, rain and catchment (contributing) Hydrology. (It is assumed that some localized flooding will be allowable within the area in a 100-year storm event.)
3. Wetlands and marshes are used for a portion of the storage volume.
4. The design of the seawalls in the area include some drainage to manage wave overtopping. The concepts assume no contribution from wave overtopping.
5. Assumes that the stormwater pump station discharge will first be managed by a storage tank, allowing discharge via gravity connected directly to the existing offshore outfall. Outfall flow can be achieved by gravity, based on different headwater elevation condition based on 2070 MHHW.
6. Check valves, which will allow flow out of the storage area, by gravity, are used at the tide gates, to allow drainage when tide is low and the tide gate is shut.
7. The conceptual design of the stations is based on a submersible pump design, with budgets costs based on Sulzer/ABS pumps from similar sized projects.

8. Redundancy has not been incorporated in the budgetary costs.
9. Assumes sufficient electrical power is available at the site. No costs for bringing in utility power transformers or backup power have been incorporated in the costs.
10. No improvements to allow pump station site location access for maintenance or during storm conditions have been included.
11. No contaminated or unsuitable soil materials and no rock in the construction area are assumed.
12. A number has been assumed for dewatering within the feasibility level opinion of probable cost (OPC), however a detailed evaluation would be necessary as part of the preliminary efforts to fully understand and quantify the impacts of ground water and tidal flow on the station design and the construction efforts.
13. The required dimensions and depth of the station structures and the head tank height cannot be determined at this point. Twelve-foot diameter precast structures have been assumed for the purpose of the feasibility level OPC.
14. Siting of the pump stations has not been determined. The feasibility level OPC assumes that the proposed pump station equipment can fit and be constructed at the proposed sites within the available space.
15. As noted above, for all three sites, a pump station in combination with a tide gate/ check valve setup, can provide added flood protection security to the community. Part of the decision-making process for the City, will be determination of goals and how they are weighted by the stakeholders. Each of the City's goals will have an impact on the cost of any pump station and the associated components. Examples of goals to be considered include Life Safety/ Access Houghs Neck and Adams Shore neighborhoods, Property Protection, Environmental factors, Visual Impacts, among others.

APPENDIX E

Houghs Neck and Adams Shore Coastal Flood Mitigation Storm Drainage Improvements

Executive Office of Energy & Environmental Affairs (EEA) MVP Action Grant

The City of Quincy received a grant through EEA's Municipal Vulnerability and Preparedness (MVP) program. The City became an **official MVP Community in 2019**, which allowed this funding to happen.

As we're all too familiar, Quincy has experienced significant impacts from coastal storms and heavy rainfall. The funding for this project covers an engineering analysis and public outreach process as a necessary first phase to identify cost-effective improvements to storm drainage systems in Houghs Neck and along Adams Shore.

Project Details

The Quincy Coastal Flood Mitigation Storm Drainage Improvements (Phase One) consists of:

- Updating drainage system mapping in the project area
- Completing modeling of the watershed, under present and anticipated future climate change conditions, related to precipitation and ocean levels
- Identifying natural resource areas in tandem with traditional storm drainage approaches to address flooding
- Engage vulnerable populations throughout the planning process
- Providing conceptual engineering designs to retrofit and/or redesign undersized stormwater infrastructure, add pump stations, adjust tide gates, and improve wetland function.

Related Information

The work being undertaken is related to the **previous resiliency planning** and the **Adams Shore Seawall improvements**. More information on flooding in Quincy can be found on the DPW website by clicking **here**.

Public Engagement

Due to the ongoing COVID-19 emergency, an initial public meeting cannot be held at this time. Community input is vital in the successful competition of this project; therefore, the City of Quincy has established a multimodal approach for this public engagement project. The goal of the multimodal public engagement strategy is to engage a broad audience while still complying with the Commonwealth of Massachusetts social distancing requirements.

How Do I Get Involved?

- Report Historic Flooding - Utilize the previously developed **GIS-Based Reporting Website** to give your input to the City and their consultant.

- Engage with the City and Tighe & Bond - Attend one of four live 30-minute presentations with moderated Q&A that will be held on Monday June 29, 2020 and Tuesday June 30, 2020. One session will be held from 10:00 AM to 10:30 AM and one will be from 6:00 PM to 6:30 PM each day. If you cannot attend one of these four meetings, a recording will be posted on QATV. The City will receive additional comments online following the webinar. The Q&A from the webinar will be posted to this website after the virtual meeting has concluded and all comments have been collected. The presentation can be found by clicking **here**.

  To join one of the sessions, use the password "Quincy" and the appropriate link for the time you want to watch:

  Jun 29, 2020 6:00 PM Eastern Time (US and Canada) Zoom Meeting
  https://us02web.zoom.us/j/82269146439?pwd=WHpMVk5iRk43YkJ0WHR0YkJDWjdkQT09

  Jun 30, 2020 10:00 AM Eastern Time (US and Canada) Zoom Meeting
  https://us02web.zoom.us/j/82606648808?pwd=U3ROQXJLK1YzVnRhSVg2Z0p2WFdSUT09

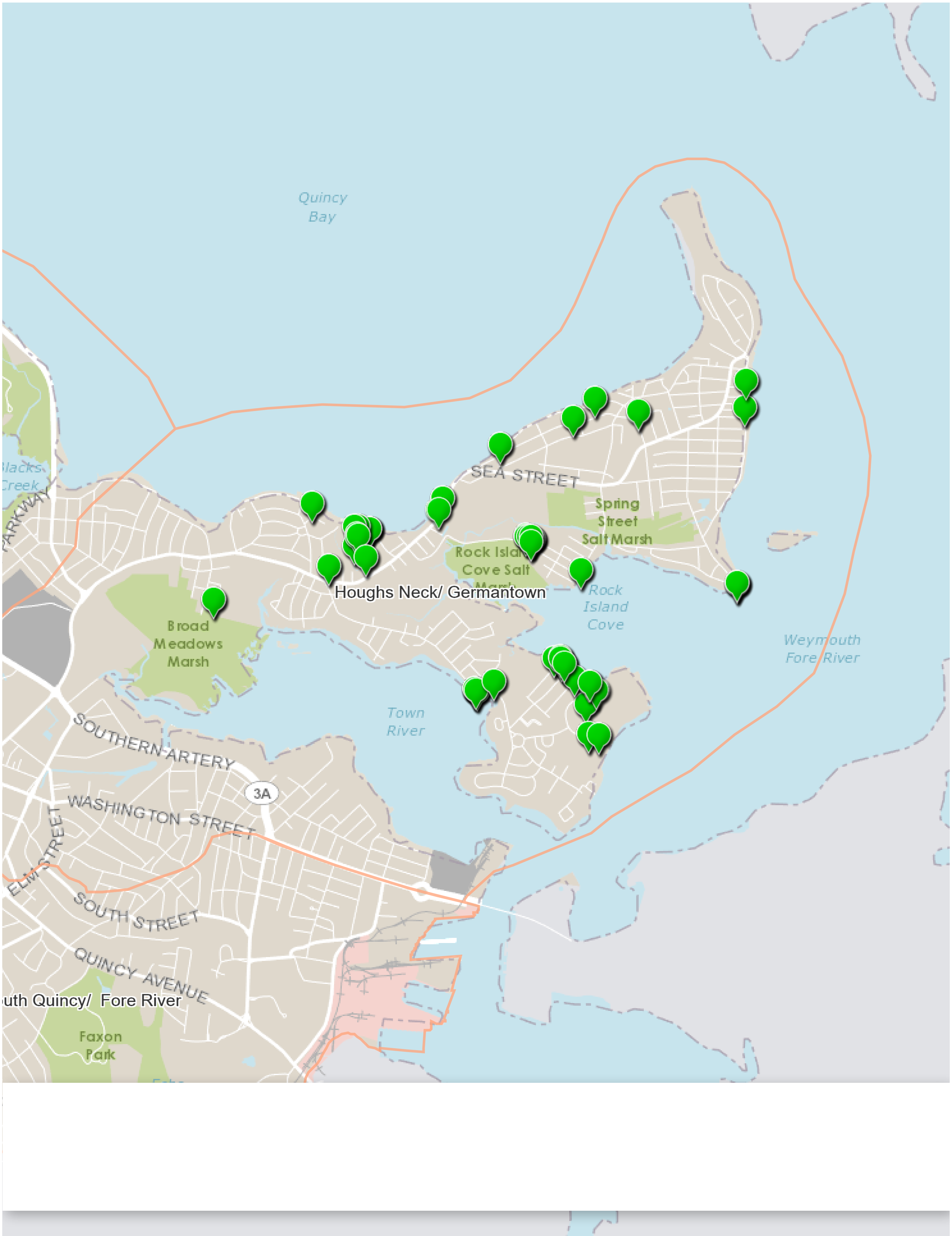
  Jun 30, 2020 6:00 PM Eastern Time (US and Canada) Zoom Meeting
  https://us02web.zoom.us/j/86990342287?pwd=OWhzMTdYUlR5akpKWjFhY3BqbXlvQT09

Welcome to the Citizen Input Application for Quincy Flood Mitigation Planning

This application is designed to solicit comments and provide photos of damage to both coastal and non-coastal, private and public infrastructure that may have resulted from not only recent but also past coastal and inland flooding events.

Do not show this splash screen again.

OK


Quincy
Bay
SEA STREET
Spring
Street
Salt Marsh
Rock Island
Cove Salt
Houghs Neck/ Germantown
Rock
Island
Cove
Broad
Meadows
Marsh
Weymouth
Fore River
Town
River
SOUTHERN ARTERY
3A
WASHINGTON STREET
SOUTH STREET
QUINCY AVENUE
uth Quincy/ Fore River
Faxon
Park

June 22, 2020

Talking points for Public Service Announcement to Support Coastal Flood Mitigation Storm Drainage Improvements – Phase 1: Engineering & Public Outreach

Today we want to talk about the great progress we are making along our coastline:

- The 8,000 ft stretch of new $13M seawall from Shore Ave to Babcock St is under construction.
- The abutting 4,000 ft stretch of new seawall along Manet Ave is near fully designed and is in permitting
- All of our stormwater outfalls along this north facing 2.5 mile stretch of coastline are being replaced and upsized, with new check valves to keep the ocean out
- We have completed our 5-year Hazard Mitigation Plan update with MEMA and FEMA
- We have become a Municipal Vulnerability and Preparedness (known as MVP) Designated Community by the Commonwealth
- Through initiatives led by our Public Works Department, we are modeling our City's stormwater system area by area. **Of note, we are completing a detailed hydraulic stormwater model of Hough's Neck through a MVP grant funded by the Executive Office of Energy and Environmental Affairs and matched by City funds and staff time.**

In cooperation with the Governor's office, our City Council, the neighborhood groups, and our DPW led by Commissioner Grazioso, we are making great progress, but I am no fool, much coastal resiliency work remains to be done.

Stepping back to when I was elected…One of my administration's 1st priorities was to address the 27 miles of Coastline in our City

- In 2011 we studied and independently ranked every seawall and through a detailed engineering process, and selected the highest priority seawalls to focus on. You may recall our first coastal project was the Edgewater Drive Seawall rebuild and outfall in 2012.
- We followed that by a rebuild of all our City seawall stairs across the City in 2013 and 2014 together with emergency spot repairs.
- We kept moving
- By 2016 we started the difficult and arduous permitting process with the state and federal agencies initially proposing breakwaters offshore, like the 5 sisters in Winthrop, to dissipate the wave energy, then followed by the design we have today, of the Adams shore and Manet Ave seawalls.

Governor Baker's Office awarded us two large design and permitting grants for the 2.5 miles of public seawall from Shore Ave to Baywater Rd.

As permitting progressed, along came the Winter of 2018, and the storms hit the City hard, and as we can all recall, the Adams Shore area was hit severely and suffered significant loss due to flooding.

The City responded in force, and within days we had dozens of construction crews performing emergency work including:

- Tide gate repairs;
- Pumping in Flooded areas;
- School and Kennedy center boiler rooms;

- Seawall and slope repairs;
- Evacuation Boardwalk repairs;
- Road and sidewalk repairs;
- etc

The storm served a very positive purpose of engaging many of our coastal and flood prone residents that have become part of our coastal team.

Together with Councilor McCarthy we have worked tirelessly to listen to, engage, and respond to the concerns of our residents related to:

- Height of seawalls
- Access to public stairs
- Rebuilding of private stairs
- Functioning of our saltmarshes and our tide gates
- Repairing of private property along the wall during construction
- Sea Level Rise and ability to build the seawall higher

One of the most important concerns we heard was **about the City's ability to manage stormwater and wave overtopping to prevent future flooding**. This is the very reason we are engaged right now in a detailed hydraulic stormwater modeling exercise, funded by the State, that will allow us to simulate different storm events and coastal conditions to predict how our existing and in progress drainage and seawall improvements will function with respect to current and predicted storms due to climate change.

But more importantly, it will help us determine:

- what additional drainage improvements are needed
- how we can increase our stormwater storage areas
- if stormwater pump stations are required and, if yes, how many and how large these pump stations will need to be

I am committed to never seeing a repeat of the flooding that occurred in March of 2018. As I have said together with Councilor McCarthy, if we need stormwater pumping stations, we will install them. In September of 2019 our City Council already approved $2.7M for this work.

Over the next few months as work on the seawalls continues, we will be working with our City Councilor McCarthy and our engineering team to evaluate the hydraulic modeling results and begin to implement the necessary improvements

Finally, I can report to you that the City has successfully received:

- $165,000 State MVP grant funding to conduct this hydraulic modeling (thank you Governor), matched with $56,000 of City funds and staff time
- $3.0M State seawall grant to help with construction costs and
- $$3.1M FEMA Seawall repair reimbursement monies from the March 2018 storms (thank you Congressman Lynch)

We have a great City and one that needs to be protected from existing and future storms. Thank you for listening, as we built a resilient City for our future generations

PSA

City of Quincy Facebook page: https://www.facebook.com/CityofQuincy

Vimeo: https://vimeo.com/440408831?fbclid=IwAR1HYg7LneHZ58Ma-cnuZ_uptVkAq3Wy_shoMULm3bj2IVdckYXzh2FMHRI

COASTAL FLOOD MITIGATION STORM DRAINAGE IMPROVEMENTS

Public Outreach Meetings
June 29, 2020 10 AM and 6 PM
June 30, 2020 10 AM and 6 PM

Dave McCarthy, City Councilor Ward 1
David Murphy, PE, Vice President, Tighe & Bond
Janet Moonan, PE, Project Manager, Tighe & Bond

Tighe&Bond

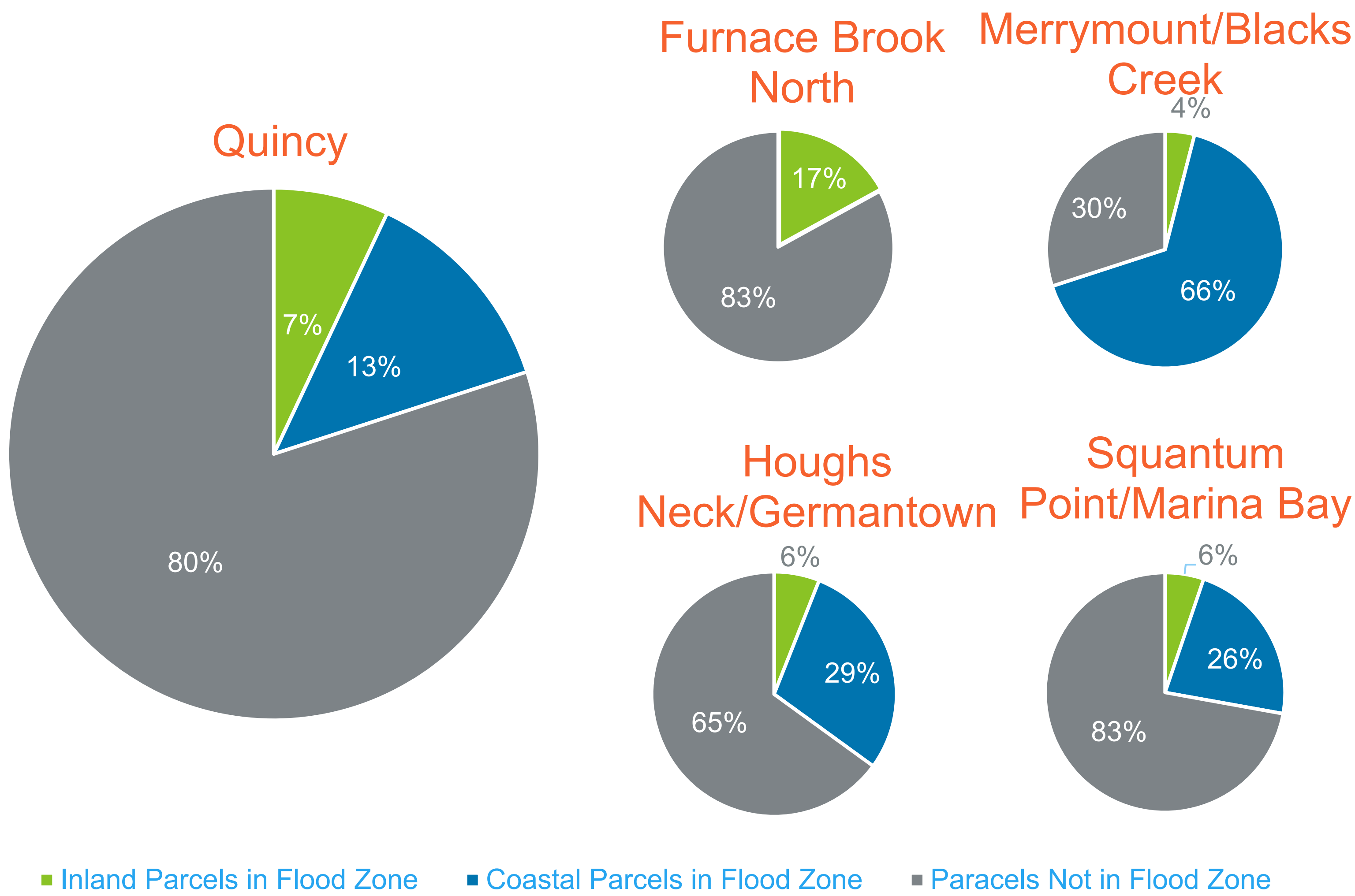
WELCOME

- **5 minutes:** **Our City's Unique Flooding Challenges:** Councilor McCarthy
- **5 minutes:** **Planning for Risk:** David Murphy, PE, Principal, Tighe & Bond
- **10 minutes:** **Preliminary Engineering for Solutions in Houghs Neck/Adams Shore:** Jennie Moonan, PE, Project Manager, Tighe & Bond
- **10 minutes:** **Questions & Answers:** Attendees

CITY OF QUINCY

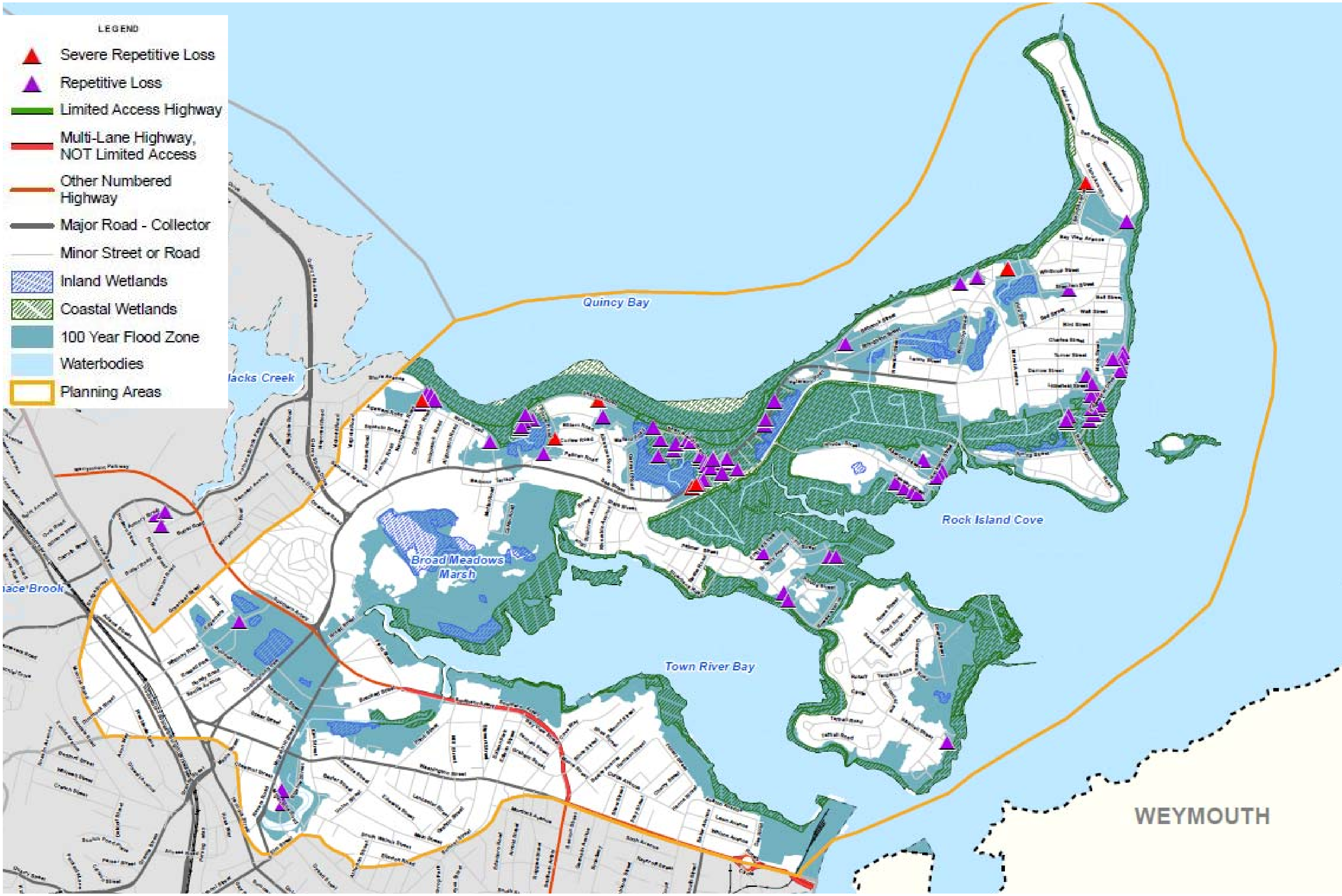
- 27 miles of coastline
- Over 20% of buildings vulnerable to flooding
- 5th most repetitive loss claims in Massachusetts

SUMMARY OF EXISTING FLOOD RISK



Tighe&Bond

REPETITIVE LOSS PROPERTIES IN HOUGHS NECK GERMANTOWN

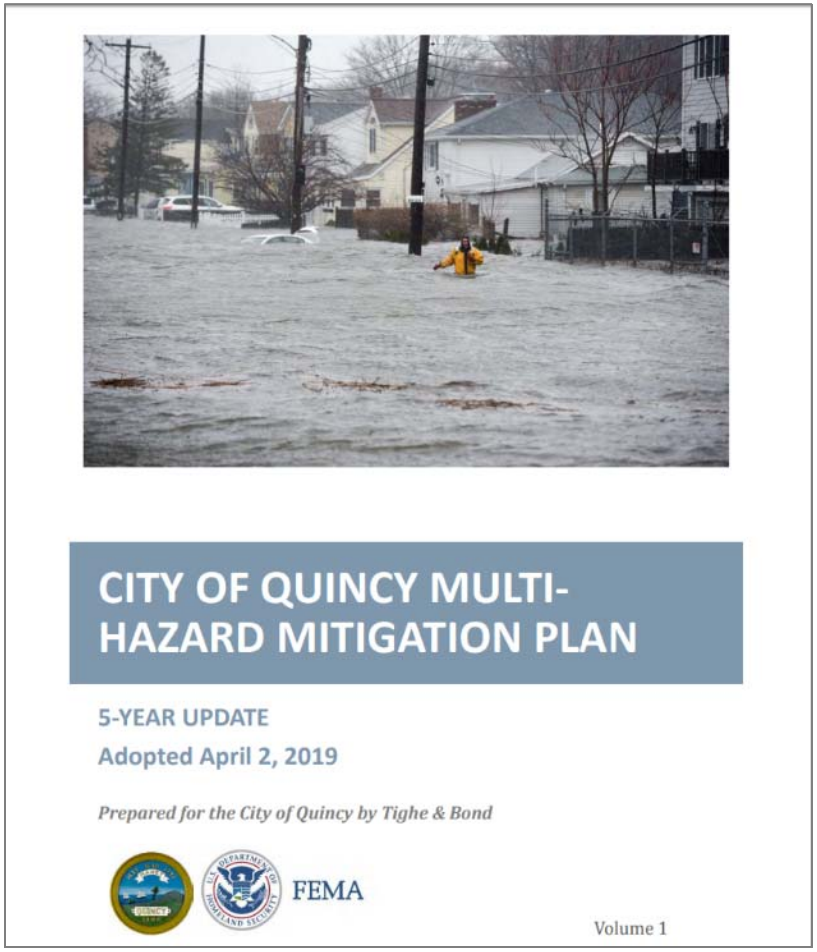


UNDERSTANDING AND PLANNING FOR AREAS MOST AT RISK

2012 SEAWALL ASSESSMENT

THE CITY RECENTLY UPDATED PROACTIVE PLANNING

- **From late 2017 through end of 2018, Quincy worked to update the City's local Hazard Mitigation Plan**
  - Website: https://www.quincyma.gov/residents/multi_hazard_mitigation_plan.htm

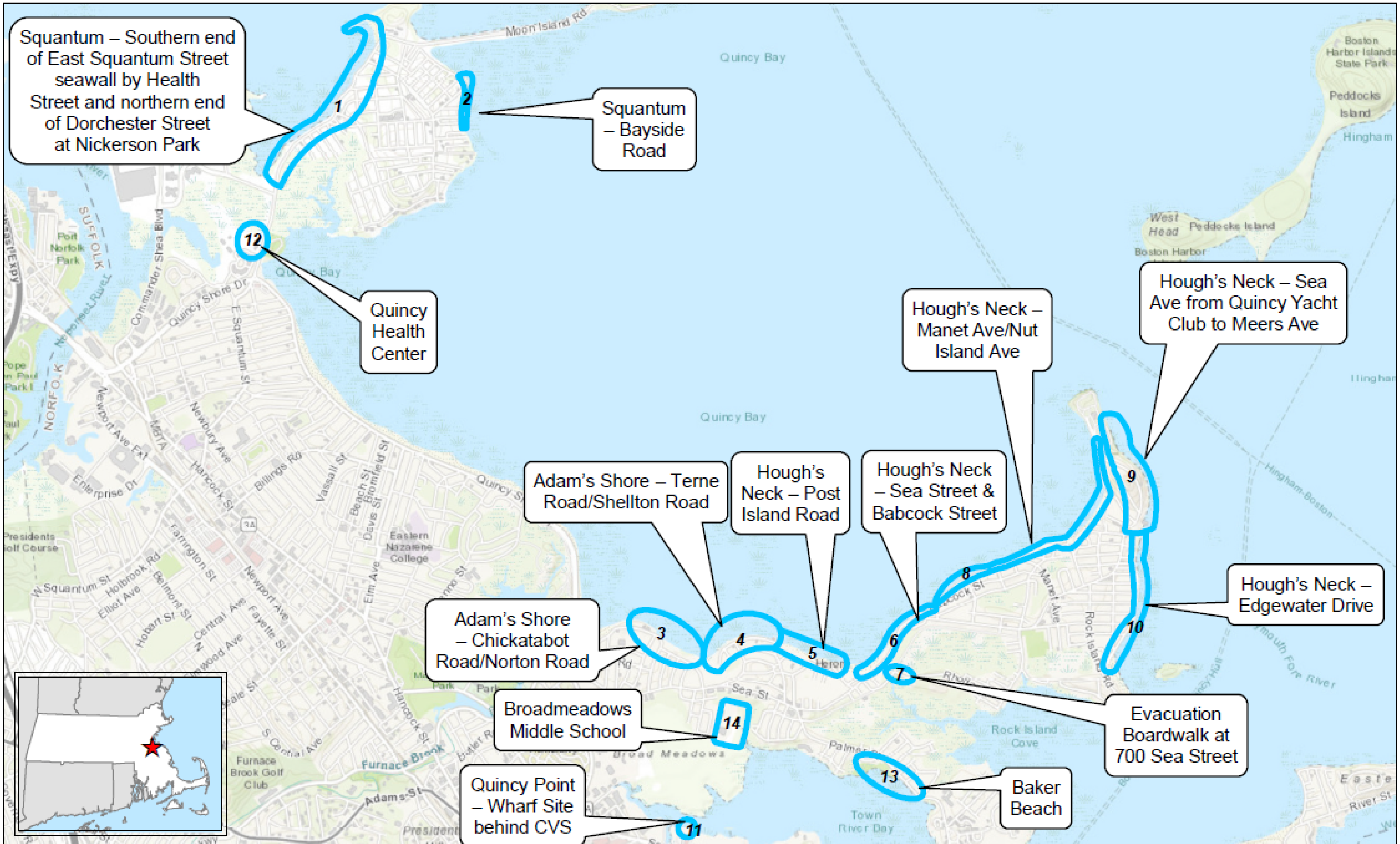


2018 WINTER STORM RILEY

y firefighters rescue a mother and child by boat after their residence was flooded along Post Island Road in the Houghs Neck section of Quincy, Mass., Friday, March 2, 2018. (John Tlumacki/The

2018 WINTER STORM RILEY

EMERGENCY REPAIR AREAS



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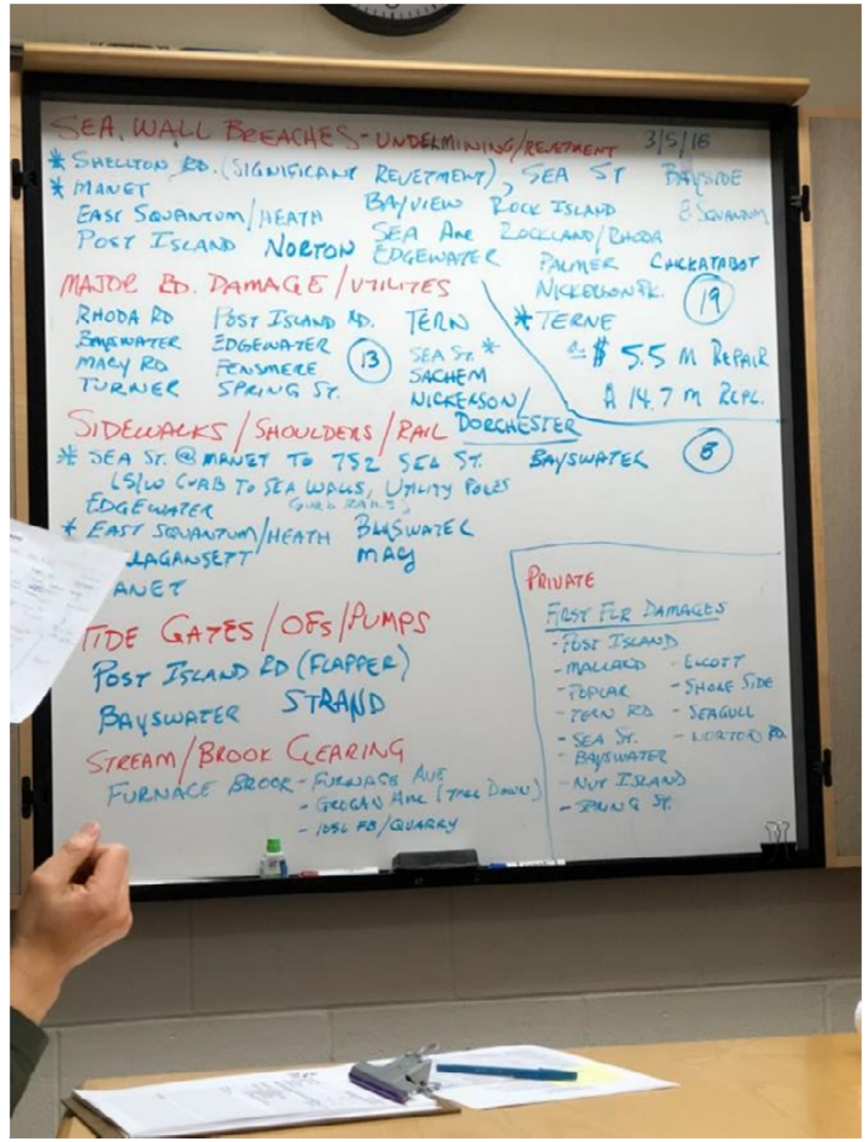
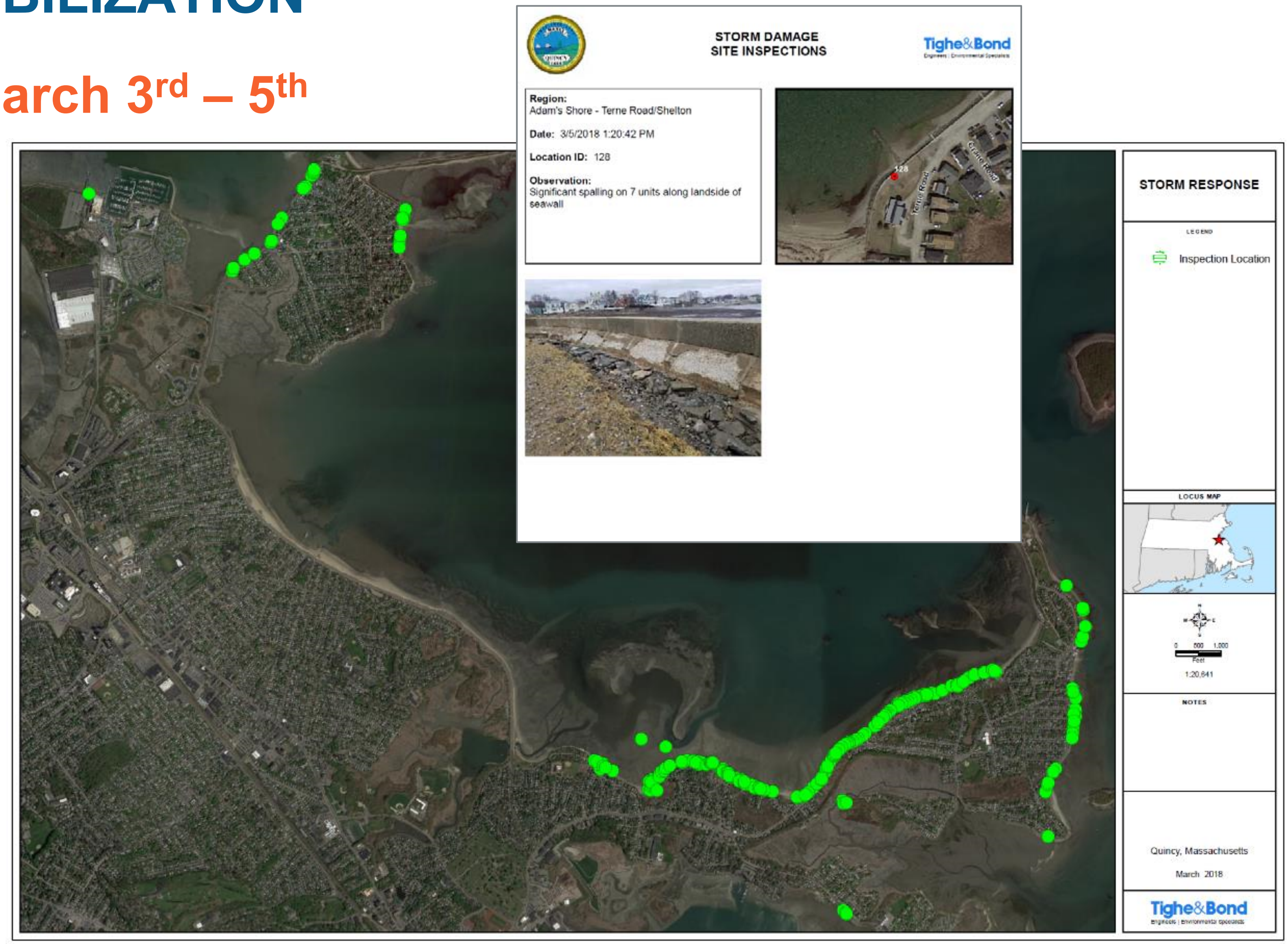
QUINCY: EMERGENCY RESPONSE

- **Damages following Winter Storm Reilly**
  - $5.5 M Seawall repairs
  - $25 M estimate to design to withstand climate change
  - $5 M for road, utility and tide gate damages and stream clearing



POST STORM EMERGENCY ASSESSMENT – MOBILIZATION

- **March 3rd – 5th**

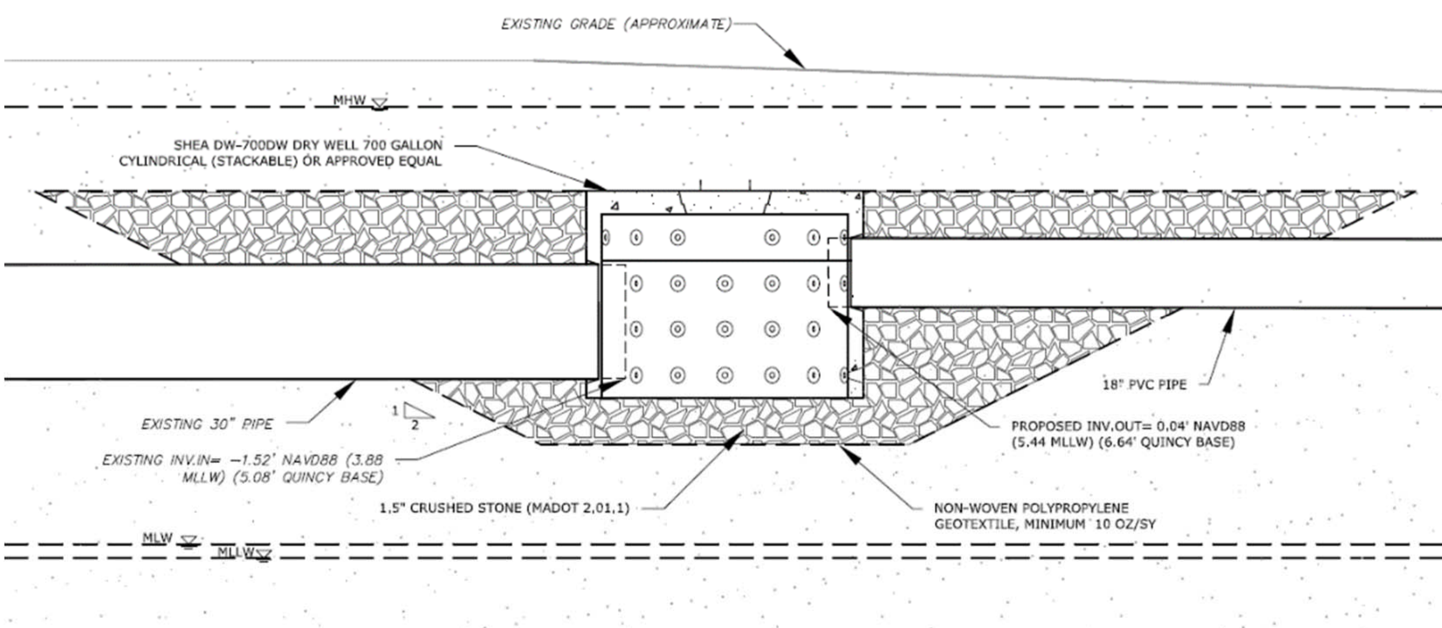


Tighe&Bond

EMERGENCY RESPONSE: TERNE RD. / SHELTON RD.

Leveling slab repaired at seawall along Shelton Rd.

EMERGENCY RESPONSE: NORTON BEACH OUTFALL



Tighe&Bond

EMERGENCY RESPONSE: MULTIPLE LOCATIONS

Leveling slab repaired at pre-cast seawall

FOLLOWING THE STORM…

- In Spring 2019, the City continued the resiliency engagement process to reflect the serious impacts of Storm Riley

- City designated by Commonwealth's Executive Office of Energy and Environment as an Municipal Vulnerability Preparedness (MVP) Community in mid-2019

PRIORITY ACTIONS FROM HMP/MVP

High Priority	Moderate Priority	Lower Priority
- Emergency Communications System	- Drainage Improvements	- Coastal Buffer Maintenance
- Emergency Power Generators	- Tree Removal Equipment	- Salt Marsh Restoration
- Stormwater Pumping Stations	- Slope Protection and Infrastructure Hardening	- Seismic Impact Evaluation and Gas Utility Study
- Seawall Construction	- Sewer System Modernizations	- O'Rourke Field Conversion
- Building Inspection Records System	- Sewer System Interceptor Relief	
- Tide Gate Construction and Management Plan	- Hurricane Barrier Evaluation	
- Public Education and Post Disaster Support		

RESILIENCY ACTIONS UNDER CONSTRUCTION

- **Adams Shore/Houghs Neck Seawall Repair & Improvements Project**

PLANNING FOR A RESILIENT QUINCY

- EOEEA awarded MVP action Grant in 2020

- This effort built on City's approved FEMA Hazard Mitigation Plan and the MVP Summary of Findings Report

DRAINAGE IMPROVEMENTS ENGINEERING

2020 MVP Action Grant

Tighe&Bond

WHAT IS THE MVP PROGRAM?

Executive Order 569 - 2016

- Comprehensive approach to reduce GHG emissions to combat climate change and prepare for the impacts of climate change
  - State Adaptation Plan
  - Climate Coordinators
  - Agency Vulnerability Assessments
  - Municipal Support

Environmental Bond - 2018

- $2.4 billion bond bill with focus on climate change resiliency
- Over $200 million authorized for climate change adaptation
- Codifies EO 569, including the MVP Program

THE CLIMATE IS CHANGING

By end of century:

RISING TEMPERATURES

- 10.8°F increase in avg annual temp.
- Up to 64 fewer days/year with min. temperatures < 32° F
- Up to 64 more > 90°F days/year

CHANGES IN PRECIPITATION

- 18% increase in consecutive dry days
- 57% increase in days with > 1 in. rainfall
- 7.3 inches additional annual rainfall

SEA-LEVEL RISE

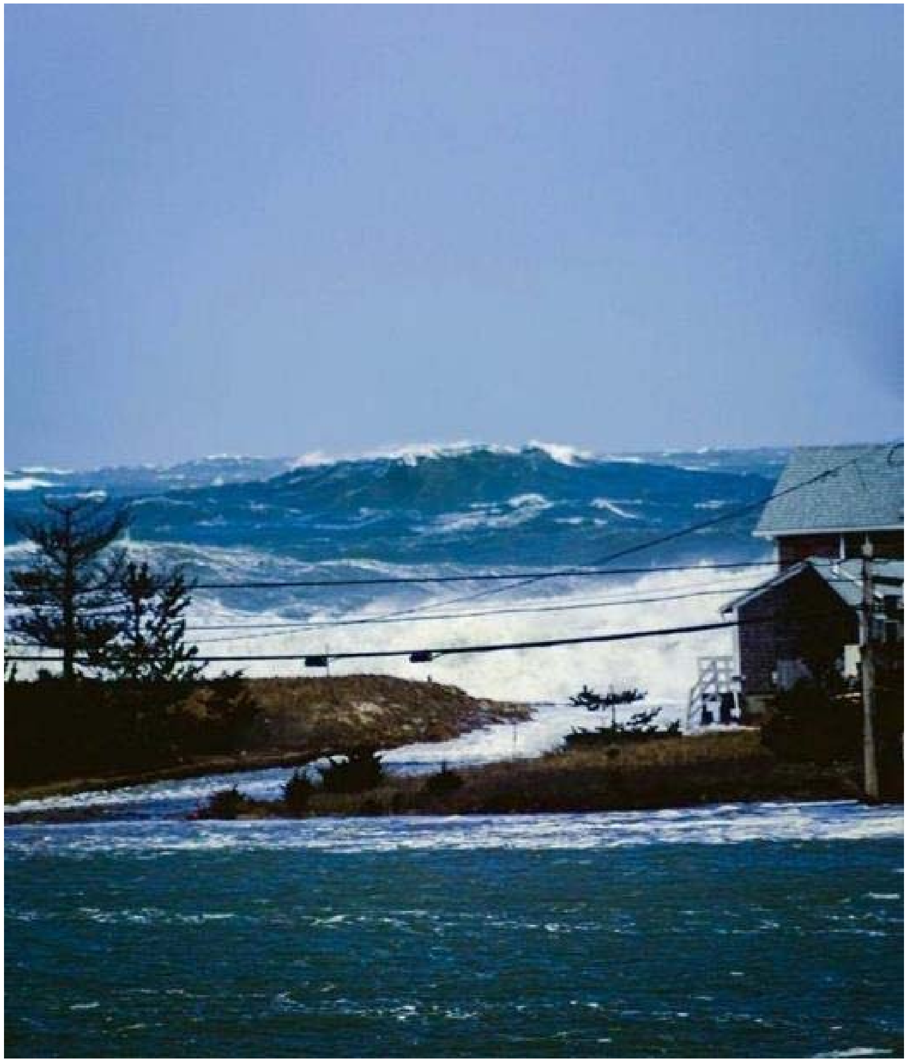
- 4- to 10.5-feet along the MA coast

EXTREME WEATHER

- Increase in frequency and magnitude

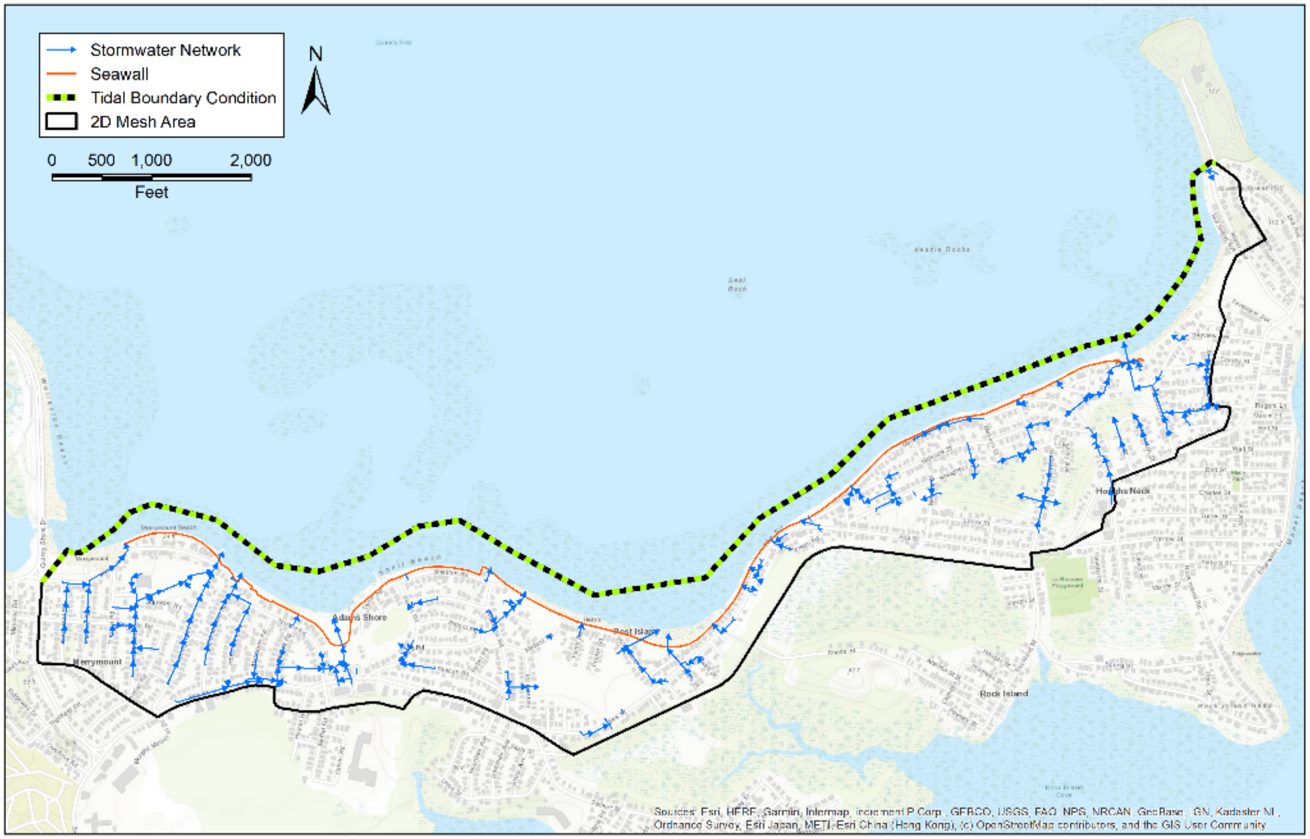
DRAINAGE IMPROVEMENTS ENGINEERING TASKS

- **Data Gathering**
  - -Survey drainage structures
- **Watershed Modeling**
  - Set up the Model
- **Model Runs**
  - Existing Conditions
  - Future Conditions
  - Potential Future Conditions with SLR
    - Pump Stations
    - Drainage Improvements
    - Nature –based solutions
- **Report on Results**
- **Public Engagement**



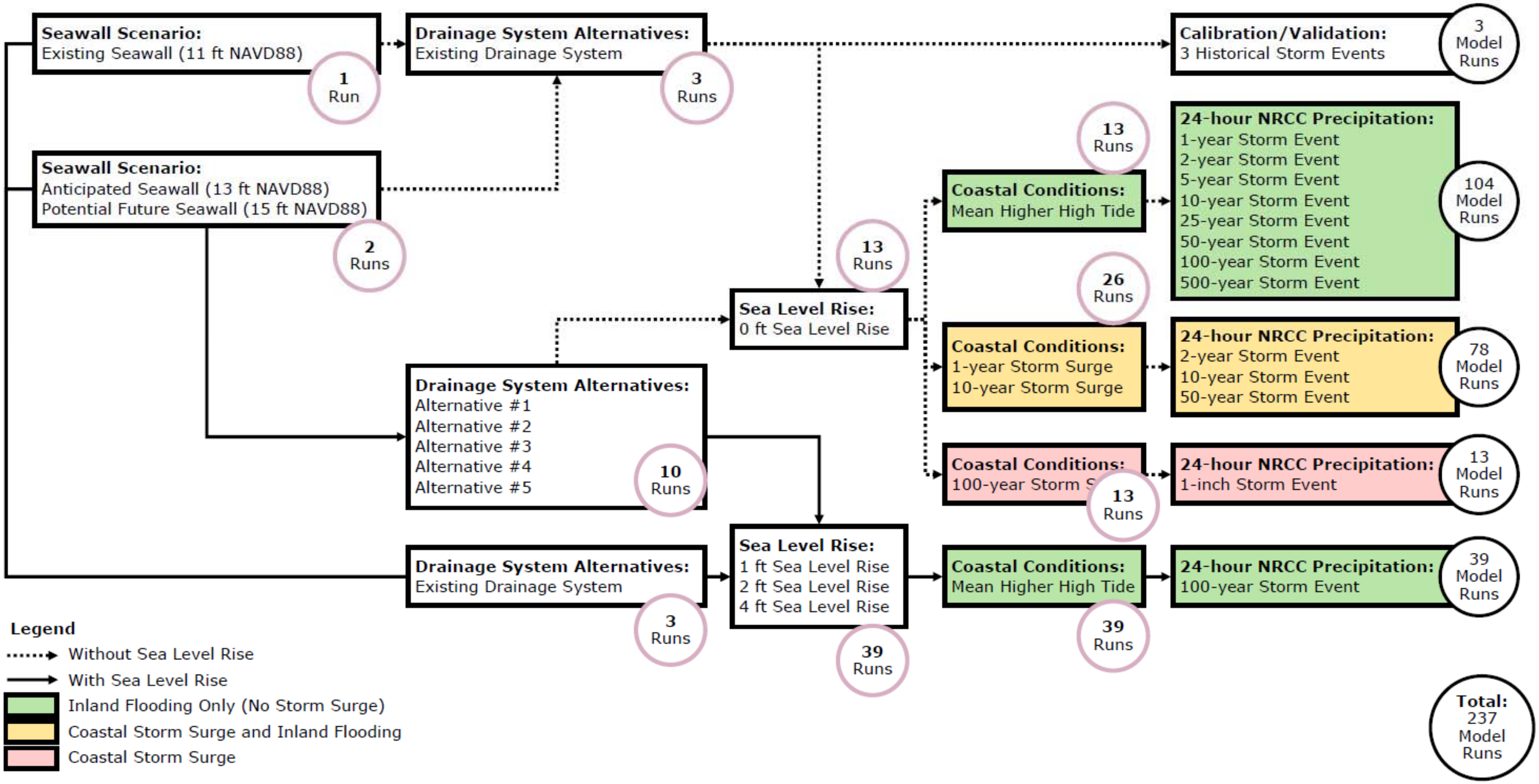
Adams Shore / Houghs Neck Statistics

- 22 Outfall Pipes
- 420 Acres
- 6.6 Miles of Pipe
- 526 Structures
- 12 one-way Check Valves
- 1 Tide Gate
- 2.8 Miles of Shoreline



STORMATER MODELING ENVIRONMENTAL CONDITIONS & ALTERNATIVE SOLUTIONS

Coastal Flood Mitigation Storm Drainage Improvements - Phase 1: Engineering & Public Outreach
Quincy Adams Shore / Houghs Neck Watershed Modeling Scenarios



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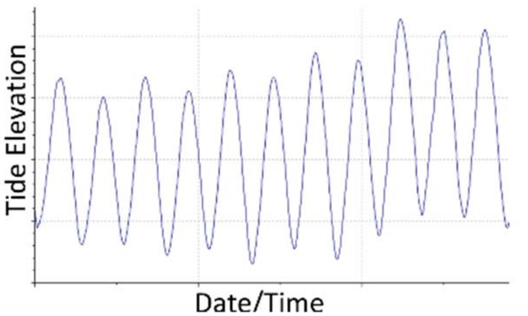
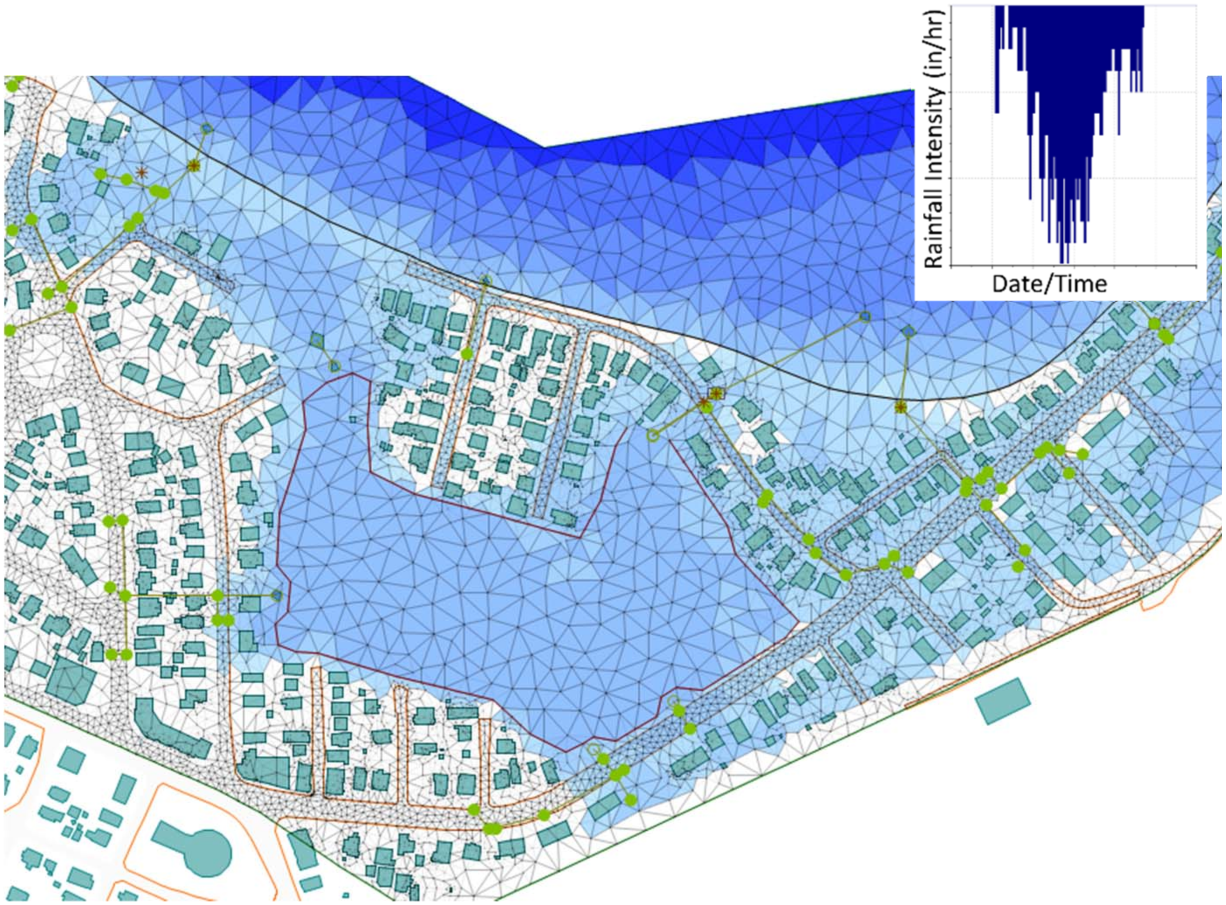
Adams Shore / Houghs Neck Modeling

- **Calibration/Validation Completed for:**
  - October 1991
  - May 2005
  - March 2018
- **Existing Conditions Completed**
- **Proposed/Future Conditions Ongoing**





March 2018 Storm Riley Model Validation Storm

DRAINAGE IMPROVEMENTS PRELIMINARY FINDINGS

Tighe&Bond

NATURE-BASED SOLUTIONS

What are Nature Based Solutions (NBS)?

Projects that **restore**, **protect**, and/or **manage** natural systems and/or mimic natural processes to address hazards like flooding, erosion, drought, and heat islands in ways that are **cost-effective**, **low maintenance**, and **multi-beneficial** for public health, safety, and well-being.

From - **Conserving Land -**
to - **Restoration** and **green stormwater management -**
And anything in between!

QUESTIONS

Tighe&Bond

Houghs Neck/Adams Shore Flood Mitigation Storm Drainage Improvements Modeling
Public Meetings

Clarifications, Questions & Answers

Rob Stevens, City of Quincy Planning Department

- We were updating the Hazard Mitigation Plan right after Winter Storm Riley hit in March 2018. We put a pause on our planning effort, and Tighe & Bond redirected some of their manpower to document real world flooding experienced. A lot of times in a planning exercise, all we can do is computer modeling. While we feel good that those data are very helpful, however, whenever you get the chance to verify on the ground what has actually happened, there is even more benefit. This work is a continuation of those needs we identified with planning efforts completed during the last couple years, while being able to add the real-world experiences to the modeling. I think this really helps the City's understanding in the Hough's Neck peninsula so I just wanted to add that level of detail for those on the call.

Jennie Moonan, Tighe & Bond

- Thank you, Rob, those are really good points.

Q: *Resident*

- A couple of quick questions. In the watershed slide where you showed all the drainage that you were looking at, it looked like you included Merrymount. Is Merrymount part of this or not?

A: *Jennie Moonan, Tighe & Bond*

- No Merrymount is not part of this, so we are stopping right before we get to Merrymount.

Q: *Resident*

- Okay, so even though you're modeling that whole watershed, Merrymount is not going to be part of the drainage improvements?

A: *Jennie Moonan, Tighe & Bond*

- Not for this phase. The City has other ongoing projects in the Merrymount area.

Q: *Resident*

- But it is going to cover all the way down Manet Ave and all the way to Nut Island Treatment Plant. Is that correct?

A: *Jennie Moonan, Tighe & Bond*

- Yes, that's correct. The black boundary (in the slides) is the approximate extent of the drainage study area.

Q: *Resident*

- Will a copy of these slides be posted on the DPW website?

A: *Jennie Moonan, Tighe & Bond*

- Yes, we'll work with Quincy IT coordinator to get these up today so they're available. They are part of grant funding so they are publicly available as part of that program so we'll get them up.

Q: *Resident*

- Okay as far the Army Corps project and the culverts that go underneath the sewer dike, how is this complimenting that effort or is it mutually exclusive--two different efforts or are they combined? How does that all fit in?

A: *Dave Murphy, Tighe & Bond*

- The Army Corps study is progress. We're working with the assigned engineer responsible for the execution of the study. The City is funding half of the work. We have supplied to the Corps all the survey information we've obtained all around the boundaries of their study. Our hydraulic model goes right up to the edge of the Willows area. The plan is that, once the Corp completes its work, it will literally fit almost like a in a glove the larger study. So the interconnection of the two watersheds will be worked on. Clearly the two 10x10 box culverts are critical to that work and they'll be looking at all the alternatives for possibly installing a slip pipe through those that would control the maximum height of water that goes in the wetlands as well the ability for the tides to go in and out on a daily basis.

A: *Paul Costello, City of Quincy City Engineering Department*

- The model is a big component for future drainage improvements. The selected improvements have not been finalized. Tighe & Bond has done a good job with the northern part of Houghs Neck. We realize the southern part of Houghs Neck where the Corp of Engineers is doing their study weighs in on the flows for stormwater that border Sea street.

Q: *Resident*

- Paul, when you say south of Sea Street are you talking about on the other side of the sewer dike?

A: *Paul Costello, City of Quincy City Engineering Department*

- Yes, the dike area and the flow that comes through the dike and impacts Sea Street and that whole area. The Corps of Engineers should have been well along by now but they had some personnel issues and with the virus they've pretty much stopped.

A: *Rob Stevens, City of Quincy Planning Department*

- One of our big goals coming out of updating the hazard mitigation plan is not only to account for sea level rise but the water that's coming from the sky. Planning is supporting Paul in the Engineering Department in advancing modeling for the entire City. One of the first areas we chose was the whole Town Brook watershed. That was largely because we did the big relocation project about ten years ago so we had a lot of good current engineering data. After becoming an MVP Designated Community, this was our first grant and we awarded it to Tighe & Bond for modeling Houghs Neck area. Most recently, development mitigation efforts from the Quincy Hospital redevelopment helped to fund our peer-reviewed consultant to do the modeling of the watershed and hospital hill area. My department also assisted Woodard & Curran to submit a new MVP action grant that will look at Wollaston up through North Quincy. Planning, Engineering. We're looking to advance the modeling covering the whole City in a two- to five- year window.. This will set up justification for the next generation of hazard mitigation, whether it's seawall or drainage. The Planning website has links on these mitigation efforts. The front page has a residential tab and below that is the hazard mitigation and the MVP planning. I know DPW has their own correspondence as well on mitigation projects.

A: *David McCarthy, City of Quincy City Council*

- I want to thank everyone. This has been a long and positive process. It's been positive after day one when we got involved after the storms. It stayed on track. Tighe & Bond has done a nice job. The community has had great input. Paul and Al and Jim and Rob have been a huge help.

A: *Paul Costello, City of Quincy City Engineering Department*

- To add briefly on the modeling. The City has 22 subwatersheds and to have any one consultant to do all 22 would take forever. So we're looking at the City like it's a jigsaw puzzle and Woodard & Curran completed their model of the Town Brook and will be making recommendations in future months on lower Town Brook. We saw the opportunity for the seawall project to have Tighe & Bond do the pieces of the puzzle along Adams Shore and work with the Corps of Engineers on much of Houghs Neck. Woodard & Curran is also collecting existing conditions of the Furnace Brook area. They'll be doing the Furnace Brook model which flows down to the Merrymount area. Tighe & Bond is working with Woodard & Curran on modelling Blacks Creek which has a lot of roadway projects that are ongoing along Blacks Creek. The pieces will come together. We're trying to get an MVP action grant similar to this for the Neponset River and Sagamore Creek in North Quincy. We're using state funding, grants, the City sewer drain rehab fund and FEMA and MEMA money from Adams Shore. We're piecing it together so that in a couple years, the City will have one inundation hydraulic model for the whole City.

Q: *Resident*

- Is this information your are providing at this time to inform the public that this grant has been given and how the money is being spent?

A: *Dave Murphy, Tighe & Bond*

- That's correct.

Q: *Resident*

- Are we going to get feedback on the drainage, pump stations, etc.? Is there a time frame on that?

A: *Jennie Moonan, Tighe & Bond*

- The City has been vetting the recommendations on what is ready for the public to weigh in because there's still some last decisions they want to make sure they feel comfortable with. My understanding is the dialogue with Public Works will continue to be ongoing about overall work in the area.

A: *Dave Murphy, Tighe & Bond*

- The amount of work that's gone into survey every catch basin, drain structure, outlet, to look at the pipe network and input that into the system to make hydraulic model runs under numerous scenarios (i.e. some scenarios are under a rain event that occurs every 2-years or 25 or 50 or 100-years) and then tide events that occur (i.e. normal high tide, annual high tide or moon tide, or high tides that occur every 100-years similar to what we saw in 2018) and then combinations of those storms to see how the drainage system reacts and then to add improvements in the drain system and pump stations has been extensive. City officials need time to digest the information, plan funding, and make decisions on what elevations to place pump stations. One the things we're finding is that under extreme rain events the system works quite fine even at a normal high tide but it's when we have extreme high tides we can't release the water, no matter how much water is in there. The City has a lot to process. Paul Costello, the City Engineer, leads the charge. He is a very educated man in this area. We'll expect to see some more information come out over the summer from Public Works.

Q: *Resident*

- Incredibly detailed, thank you for your work. Hopefully it's going to happen concurrently as you're working on the seawall project?

A: *Dave Murphy, Tighe & Bond*

- I'll let Councilor McCarthy respond to that.

A: *David McCarthy, City of Quincy City Council*

- From the talks that I have with DPW, yes, we're trying to keep it on the same track as the seawall so we don't come back two or three other times and instead be efficient.

A: *Resident*

- Okay, very good, thank you.

A: *Jennie Moonan, Tighe & Bond*

- We've been really pleased with the modelling. It's been giving the City a really good tool in this area and it's going to coordinate with work being done by other consultants. DPW's vision is to get the City a calibrated, validated model that works under all these different storm events and really helps vet that cost-effectiveness of the solutions. We proposed preliminary solutions and have worked with City on input on those but more will be coming out.

A: *David McCarthy, City of Quincy City Council*

- It's been a real positive project. Great community input up and down the shoreline. Talking to the residents about things we might have seen that were an issue and might have been corrected a little bit because they've been there so long. In particular places they see what happens and Paul Costello came along at the right time and Tighe & Bond has been really good and the mayor has been tremendously supportive to take care of this. We'll hopefully get through this and be in better shape, then head to Phase 2 and go the other way toward Bayswater toward Houghs Neck. Thank you.

A: *David McCarthy, City of Quincy City Council*

- There's a newsletter we put together, myself, the Mayor's office, and Tighe & Bond, with a lot of facts going out to everyone in the Ward in the next week. It talks about the schedule, all of the licenses we had to get, timeframe, costs, a little about the Army Corp project, and includes all the general information that might prompt someone to give us a call and ask a question. It's a nice newsletter, it covers everything, and you should have it this week.

Q: *Resident*

- What's the timeline for this project?

A: *Dave Murphy, Tighe & Bond*

- The grant is wrapping up June 30th. Over the course of the months of July and early August the City will be further evaluating next steps, identifying funding sources, and be able to present the results of all the runs.

Q: *Resident*

- You have a sense of the recommendations you're going to make already, is that correct?

A: *Dave Murphy, Tighe & Bond*

- As Jennie was saying earlier, there's a whole series of model runs. What that means is we're looking at your areas when there's a high tide, a normal high tide with a 2-year rain event or a 50 or 100-year rain event. And we're looking at the highest high tide of the year with those rain events and then a storm surge that takes that high tide up to the extreme tides with those rain events. Under existing conditions, we have the seawall improvements that are going in right now and the drainage pipes so all of those results or runs are being completed as part of the scope.

Q: *Resident*

- The mitigation you're doing with the drainage pipes and the seawall right now, can you tell if that significantly impacts the data you're getting from the modeling?

A: *Dave Murphy, Tighe & Bond*

- The model results are verifying the fact that the seawall improvements are creating significant improvements, yes. We kind of knew that but the part that's most important is to see how the system reacts under all of the varying storm scenarios we put together. The decision has to be made, what level of protection does the City invest in—is it a combination of the worst rain event ever and the worst tide event ever and pay for the monster-type of results or do we try to balance somewhere in between for a more frequent level of storm. What it's really coming down to is what type of additional catch basins, pipes if necessary, possible pump stations, any increased storage area for that water—those are all on the table for discussion.

Q: *Resident*

- As a resident that's being impacted, what can we do to ensure that the project is a success?

A: *Dave Murphy, Tighe & Bond*

- When the City begins to roll out the results, we really would encourage your participation.

Q: *Resident*

- Are you recording this and making it available?

A: *Jennie Moonan, Tighe & Bond*

- Yes, we've recorded all of the meetings because the funding requirement do require documentation of all the public outreach so those will get updated and distributed on the websites—I believe Planning has been working on a website and there's one as well on the Public Works. There's a link right on the Public Works home site right on the left at the very bottom under where the seawall link is for those of you that are familiar with that, it's right there and it has a copy of this presentation currently and we'll be getting the recording up as well.

Q: *Resident*

- What is the website? Can you tell us what it is?

A: *Dave Murphy, Tighe & Bond*

- Rob Stevens is on the line from Planning.

A: *Rob Stevens, City of Quincy Planning Department*

- Right on Quincyma.gov, the City's front page. There's a couple of suggestions up top and there's one called residents. When you select residents, there's a drop-down list and in there, we have the multi-hazard mitigation plan. That's how you access all the work that we've done with the hazard mitigation plan and the MVP. Our requirement to hold a public meeting where we had a chance to see all of you and make this presentation in person, but obviously this not possible with Covid-19. This is the fourth iteration of it, so I believe there's some repetitiveness to it. The presentation is already posted on the DPW website, but we will work to post the recording.

A: *Jennie Moonan, Tighe & Bond*

- Rob, that's a really good point. EEA has asked for us to take all of the questions we've received for all of these and put together a Q&A, so we will have that posted as well. There will be a presentation that's recorded without the Q&A and then the copy of the Q&A that we'll document all four meetings.

A: *Rob Stevens, City of Quincy Planning Department*

- That seems fair to transcribe all of the questions and answers from the four meetings and then we'll post one of the presentations.
- I appreciate the folks that come out these Zoom meetings. I appreciate the chance to kind of show off what we do. I'm really proud of our Department. We've had a real shining moment with Covid-19. We were able to provide Cares Act assistance through our community development block grant to over 330 businesses to give them some temporary relief during this emergency and a lot of those checks just went out. We're really happy to get on the front lines with that and we're always really happy to help these efforts. We saw the damage from the storms. We have a need, it's here now and it's a big need. We need all the help—private sector, government sector, and residential sector—to all be working together toward this goal. I really appreciate the participation, thank you.

A: *Dave Murphy, Tighe & Bond*

- Thank you all. Tighe & Bond loves the collaboration we have with the City and with the other consultants in the City and we look forward to being able to roll out the results that come out the discussions with the Departments later summer. Thank you.

Q: *Rob Stevens, City of Quincy Planning Department*

- Yes, and we will post that report as part of this effort and it will be released publicly, correct Dave?

A: *Dave Murphy, Tighe & Bond*

- Correct.

City of Quincy, Massachusetts
Department of Public Works
55 Sea Street
Quincy, MA 02169
Phone: 617-376-1957
Or see us on the web at QuincyMA.gov

City of Quincy DPW

SEAWALL PROJECT
WARD 1 InfoLetter
SUMMER 2020

POSTAL CUSTOMER

PREPAREDNESS MEETS OPPORTUNITY InfoLetter SUMMER 2020

City of Quincy DPW

Dear Ward 1 Residents,

Greetings from Mayor Koch and myself hoping that your summer is going well. Hopefully we are moving forward likewise in a positive direction for the rest of 2020. The Ward 1 Seawall Project is moving forward at a very good pace. This newsletter is to help all residents get a clear picture of the progress that has been and will be made over the coming months including the new seawall structure from the Willows to the Chickatabot Beach area, the larger outfall pipes for better drainage, the Willows culvert work with Army Corp of Engineers, a complete Hydraulic Study of the area/Pump-House project. Thank you to each of you for your involvement and communication. If you have any questions, please don't hesitate to contact me at 617 376-1351 or email me at dmccarthy@quincyma.gov.

Thank You,

David McCarthy, Ward One Councillor

For More Information About this Project Please Contact

Councillor David F. McCarthy
City of Quincy, Ward 1
dmccarthy@quincyma.gov
617.376.1351

Ian Mead, PE, BCEE
Tighe & Bond
IMead@tighebond.com
508.572.5214

SUMMER 2020

SEAWALL PROJECT WARD 1 InfoLetter

City of Quincy DPW

SEAWALL PROJECT LIMITS

In May, necessary rehabilitation began on the Ward 1 seawall. Work is being conducted by MIG Corporation, Inc. based in Acton, MA. The project will increase the seawall height by an average of 2' to a final elevation of 13' (based on NAVD88, vertical datum). Additional work includes new drainage structures and larger outfall piping along the entire wall. Work will typically be completed between the hours of 7am and 5pm, but due to the nature of the work and tidal influences, some work will likely occur outside of those typical hours.

Additional work is being conducted by the city, including hydraulic analysis of the area, that will result in future stormwater improvements.

More information, including project plans and regular updates are available on the City's website, linked below:

Quincy Department of Public Works:
Seawall Improvement Project
https://www.quincyma.gov/govt/depts/pwd/seawall_improvement_project/default.htm

FUNDING FOR AREA PROJECTS HAS BEEN APPROVED AS FOLLOWS

$14.9M	Phase 1 Adams Shore Seawall
$2.8M	Hydraulic Analysis & Drainage Improvements
$120k	City Funding Towards USACOE Willows Culvert Study
$17.8M	TOTAL

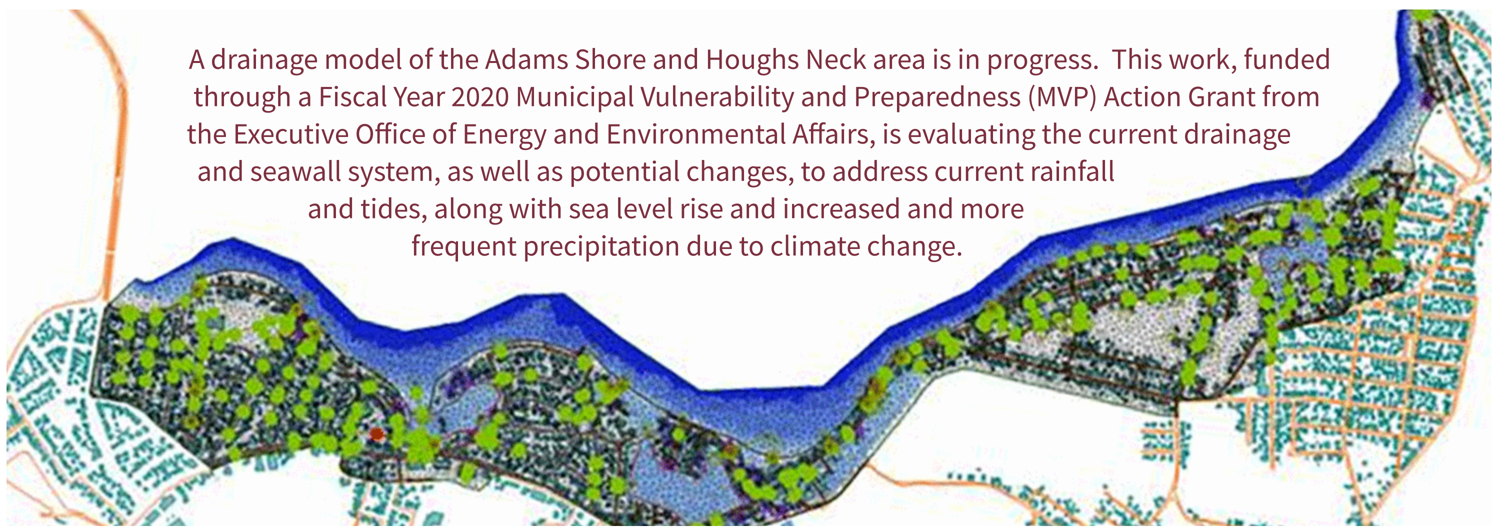
Visit QuincyMA.gov for more details.

ADDITIONAL WORK

A study of the Willows Area culverts by the Army Corps of Engineers will be completed.

THE SEAWALL IMPROVEMENT PROJECT REQUIRED EXTENSIVE PERMITTING AND APPROVALS

Quincy Conservation Commission
MassDEP Chapter 91
MassDEP Water Quality Certificate
MEPA Certificate
USACOE 404 Permit
USEPA Concurrence
MassCZM Concurrence
USF&W Concurrence
MassDMF Concurrence
MassBUAR Concurrence
MWRA Concurrence



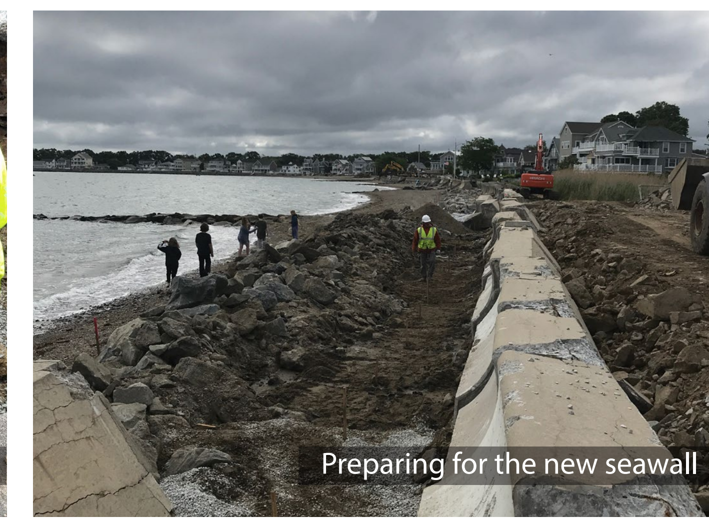
A drainage model of the Adams Shore and Houghs Neck area is in progress. This work, funded through a Fiscal Year 2020 Municipal Vulnerability and Preparedness (MVP) Action Grant from the Executive Office of Energy and Environmental Affairs, is evaluating the current drainage and seawall system, as well as potential changes, to address current rainfall and tides, along with sea level rise and increased and more frequent precipitation due to climate change.

CONSTRUCTION SCHEDULE **As of June 15, 2020**

	Plan Sheets	Project Stationing	Start of Work Area	End of Work Area	Notes of Buried Pipe Installation
May through July	C-101 to C-103	0+00 to 8+00	Babcock Street	#752 Sea Street	Pipe work to be done in June
July through September	C-104 to C-109	8+00 to 22+50	Sea Street	#68 Post Island Road	Pipe work to be done in July
June into September	C-109 to C-116	22+50 to 41+00	#68 Post Island Road	#72 Shellton Road	Pipe work to be completed in June
July into October	C-116 to C-122	41+00 to 57+00	#72 Shellton Road	32 Terne Road	Pipe work to be done in June
September into November	C-122 to C-124	57+00 to 63+91	#32 Terne Road	#68 Norton Road	Pipe work to be done in July and August
November	C-127	71+08 to 73+32	#10 Norton Road	#18 Chickatabot	No pipe work this section
October to November	C-128 to C-129	73+32 to 75+60	#18 Chickatabot	#144 Shore Ave	Pipe work to be done in September

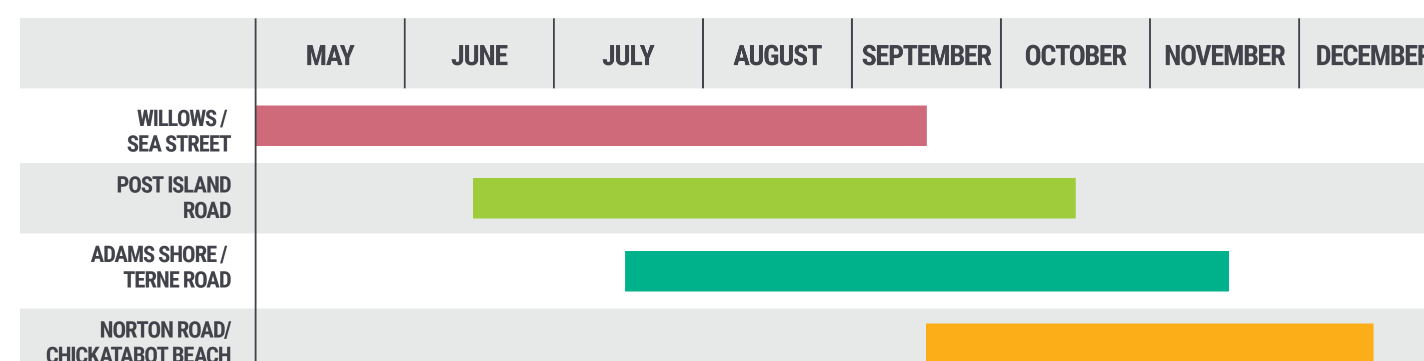
March 2018 Storm Conditions

Ongoing pipe work



Preparing for the new seawall

WHEN WILL WE BE IN YOUR NEIGHBORHOOD?



Tighe&Bond

APPENDIX F

Coastal Flood Mitigation Storm Drainage Improvements - Phase 1: Engineering & Public Outreach

Quincy, MA

ATTENDEES: *See sign in sheet*
Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
Robert Stevens (City of Quincy)
Carolyn Meklenburg (EEA)
David Murphy, Tighe & Bond
Janet Moonan, Tighe & Bond
Joseph Canas, Tighe & Bond
Gabrielle Belfit, Tighe & Bond (via phone)
David Azinheira, Tighe & Bond (via phone)

LOCATION: 55 Sea Street, DPW Conference Room

MEETING DATE: February 21, 2020

TIME: 10 AM to 11 AM

I. Introductions

II. Scope & Schedule

A. Survey

1. Tighe & Bond has reached out to Feldman and they should be ready to begin the survey soon. It will likely take about 2 weeks to perform the survey and another 1.5 to 3 weeks to get the data. Tighe & Bond will be coordinating with survey to obtain data throughout process.

2. Tighe & Bond will provide a GIS geodatabase and AutoCAD survey data to the City once received/approved.

3. The goal to have survey completed in mid-March, although the end of March is likely a more reasonable date.

B. Watershed Model

1. Modeling will be performed using Infoworks ICM using two dimensional (2D) hydraulic modeling with dynamic rain on grid hydrology. The model will incorporate overland flooding, pipe flooding, and coastal flooding (using boundary conditions).

2. The model scenarios were discussed as shown in the handout titled “Quincy Adams Shore / Houghs Neck Watershed Modeling Scenarios” (attached).

3. The City has a vision for a comprehensive stormwater model for the entire City that can be used as a decision-making tool. The modeling for Adams Shore / Houghs Neck will be a piece of creating the comprehensive stormwater model.

C. Public Engagement

1. Homeowners near the floodwalls have been told about this study for several years, and there is substantial interest in part due to 186 houses being damaged during a recent storm event.

2. Seawall construction is anticipated to start in March, with several public meetings. The City of Quincy proposed combining status update meetings for the model with the sea wall progress meetings where many community members are anticipated to be in attendance.

3. The Executive Office of Energy and Environmental Affairs (EEA) requested that they be kept up to date regarding scheduling of public engagement. Group agreed that communication will be frequent and ongoing.

4. EEA takes no issue with public updates for this project being part of the seawall meetings assuming they are well attended.

III. Review of Progress and Approach

A. Infoworks ICM Modeling Approach

1. The first step of modeling will be to set up an existing conditions model that will be used for calibration/validation. Tighe & Bond plans to use repetitive loss data to calibrate model and will coordinate with the City to acquire elevation certificates. The goal of calibration/validation will be to make sure the existing conditions model results are realistic prior to performing the other model runs.

2. Tighe & Bond noted that InfoWorks does not account for wind effects.

3. This modeling effort will be part of the City effort to create a City-wide rainfall model. The City noted that in Quincy they need to consider coastal and stormwater flooding. Woodard & Curran and BETA are working on different pieces of this City model.

4. Rainfall data from NRCC precipitation data will be used to be consistent with prior studies in the City (precip.net)

5. The City indicated that they are concerned about frequent storms (e.g., large thunderstorms) that cause nuisance flooding frequently to residents, as well coastal storm surge events.

6. Tighe & Bond has reached out to David White at Woodard & Curran to discuss modeling approach (they already modeled an upland part of the City using InfoWorks ICM).

7. As part of Quincy seawall project, outfalls were designed to pass the 100-year frequency storm event and will be upgraded during construction.

B. Site Walk

1. Following model calibration Tighe & Bond staff will perform a site walk to perform a cursory verification that the model results are realistic. This is anticipated to occur in late March/early April. If needed, Tighe & Bond can stay on roadways and not go onto private property. In the event that access to private property not covered under the seawall access agreement is necessary, Tighe & Bond would coordinate access through the City.

C. Conceptual Improvements

1. Tighe & Bond will evaluate potential alternatives to improve areas with flooding concerns (e.g., by constructing pump stations).

2. The conceptual improvements will include estimates of Capital Costs for the potential upgrades.

3. Tighe & Bond and the City noted that one big question will be what size storm event or tidal level to design pump stations to. Currently there are no State-mandated design standards, although EEA noted that the Commonwealth is working this.

D. Meetings

1. A meeting will be held with the City after preliminary modeling to discuss conceptual solutions.

2. A meeting will be held with the City after conceptual models are developed.

3. A final meeting will be held to discuss the completed report and recommendations.

IV. Data Needs

A. Group discussed available data for calibration and validation including photos from March 2018 storm and website that gathered citizen input.

B. Following meeting, discussed DEM/elevation data with Paul. Tighe & Bond to coordinate with Woodard & Curran and City's GIS Coordinator.

V. Schedule

A. See draft schedule (attached)

1. Group discussed schedule adjustments. Interim deliverables can be extended but this needs to be communicated to EEA.

2. Final deadline of June 30, 2020, is not negotiable.

B. Progress updates

1. Tighe & Bond will include updates during bi-weekly DPW progress update meetings with the City and will provide weekly communication through ongoing status meetings.

2. EEA noted that the MVP Grant requires monthly updates, using form provided. First update covers February 2020.

VI. MVP Grant

A. For reimbursement, typically work is completed by June 30th, then municipalities can submit paperwork by late July / early August.

B. Tighe & Bond indicated that they can get final bill to the City prior to June 30th. EEA confirmed that invoices are acceptable, and proof of payment will not be required. Tighe & Bond will assist the City with meeting the MVP grant requirements.

C. The next round of Planning and Action MVP grants are anticipated to be released in late April/early May. The City hopes to include more InfoWorks modeling as part of another MVP grant application. The City wants to perform stormwater improvements using a "bottom up" approach due to the coastal backwater. It is anticipated that there would be closer to a full fiscal year to perform the next round of work. There is $10 million total available state-wide as part of the MVP grant program. The median grant awarded over the last 5 years has been approximately

$123,000. During the last application period, $30 million in grants were requested with $10 million awarded.

D. EEA will provide feedback on ways the City application could have been improved (for future reference). Jennie, Rob, and Gab to coordinate this with Carolyn.

E. The grants need to be awarded to municipalities; however, partnering with DCR (including a letter of support) may help future applications related to areas on or adjacent to DCR property.

VII. Miscellaneous

A. The scope of work for the U.S. Army Corps of Engineers Study of the Willows is anticipated to be provide soon.

B. Quincy and Tighe & Bond have been discussing the possibility for designing breakwaters to help reduce wave action. Potential for more organic solutions in the marsh, but may not be strong enough for the coastal side. U.S. Army Corps guidance has indicated that 1 to 2 feet wave can use green solutions, but greater than 2 feet will need to be a mix of green and grey.

VIII. Action Items:

A. Tighe & Bond to provide recommended schedule update to City and then EEA, meeting materials, and confirm survey schedule and communicate back. Tighe & Bond to continue ongoing coordination with Woodard & Curran.

B. Rob Stevens and Tighe & Bond to schedule time in March to review grant application with EEA and obtain feedback.

IX. Attachments:

A. Handouts

1. Agenda
2. Scope, Schedule and Budget from MVP Action Grant Application
3. Modeling Scenarios
4. Proposed Schedule

B. Completed Sign-in Sheet

J:\Q\Q0019 Quincy, MA Consultant Review Services\Q0019-032 Stormwater Modeling\Project Management\Meetings\2020.02.21 Kickoff With City and EEA\2020.02.21_DRAFT_Quincy Adams Shore and Houghs Neck Kick-off_Meeting_Notes.doc

City of Quincy FY20 MVP Action Grant
Coastal Flood Mitigation Storm Drainage Improvements - Phase 1: Engineering & Public Outreach

Kickoff Meeting Agenda

ATTENDEES: See sign in sheet

LOCATION: 55 Sea Street, DPW Basement Conference Room

DATE: February 21, 2020

TIME: 10 AM to 11 AM

10:00 AM Introductions

- Please sign in

10:05 AM Scope & Schedule

- See handout: Copy of grant Scope of Work
- See handout: Proposed schedule
- Survey
- Public engagement

10:25 AM Review of Progress and Modeling Approach

- See handout: Adams Shore/Houghs Neck Watershed Modeling Scenarios

10:45 AM Data Needs

- See reverse side of agenda

10:50 AM Open Discussion

11:00 AM Conclude

Data We are Using

Historical Precipitation data will be sourced from USGS gauge 01105585 (Town Brook at Quincy, MA) and NOAA gauge USW00014739 (Logan Airport - Boston, MA). Wind data can also be sourced from the Logan Airport Gauge; however, InfoWorksICM does not handle wind.

Historical Tide Levels will be sourced from NOAA Tide Gauge 8443970 - Boston, MA.
This data record will be used to develop the Mean Higher High Tide and 1-year storm surge.
FEMA Mapping will be used to develop the 10-year storm surge and 100-year storm surge.

Historical Storm Events and Flooding Extents will be developed from precipitation and tide records as well as the Repetitive Loss Claims and the respective sill elevations of relevant properties from flood insurance certificates.

24-hour Design Storm events will be sourced from the Northeast Regional Climate Center (NRCC) Extreme Precipitation Analysis Webtool.

Drainage Network Data from:

- Survey file for Merrymount Parkway that includes bridge at Blacks Creek and into the intersection of Furnace Brook Parkway.
- Survey from Adams Shore, Manet, and Sea Street

Data We Need From City (As Available)

Resolve elevation data source – Quincy or State data to be used

The sill elevations for Repetitive Loss Properties (from Flood Certificates)

City of Quincy, MA
Sign-in Sheet

Date: February 21, 2020 **Time:** 10:00 AM

Location: 55 Sea Street - DPW Basement Conference Room

RE: MVP Action Grant

Attendees:

Name	Title/Department	Signature
Al Grazioso	Public Works Commissioner	
Paul Costello	City Engineer	
David Murphy	Tighe & Bond	
Joe Canas	Tighe & Bond	
Jennie Moonan	Tighe & Bond	
Carolyn Meklenburg	MVP Greater Boston Regional Coordinator, EEA	
Rob Stevens	Planning Director	

Section 8 Scope, Schedule, and Budget

8.1 Project Scope

TASK 1: DATA GATHERING AND COORDINATION

Subtask 1.1 Site Survey: A land surveying subcontractor shall be retained to collect topographic information and existing conditions information of significant drainage structures (e.g., outfalls, inverts at confluences of pipe networks, pipes greater than 12-inches missing existing mapping or survey according to City data, and three tide gates) within the project area. The survey datums will be on NAD 83 horizontal and NAVD 88 vertical datums. Information collected will include inverts, structure rim/grate elevations, pipe sizes, material type of all pipes entering and exiting the drainage structures.

Subtask 1.2 Data Collection & Review: Gather and review the available as-built plans of stormwater structures located within Adams Shore/Houghs Neck area. High-resolution LiDAR data, available from MassGIS, shall be acquired and processed to supplement the survey for the remainder of the project extent. Data from MassGIS will be used to determine the location of resource areas.

Subtask 1.3 Geodatabase Coordination: The geospatial information collected during survey shall be confirmed with the City's GIS Coordinator. Ensure that the collected geospatial survey during survey is consistent with the City of Quincy's objectives and goals for data management and organization.

Task 1 Deliverables:

- GIS geodatabase updates

TASK 2: WATERSHED MODELING

The proposed model will include the areas draining north through the floodwall along Adams Shore/Houghs Neck. This area is bounded from the West by Quincy Shore Drive and bounded to the north/east by the Boston Harbor Island National Recreation Area. The proposed model will exclude areas draining to the salt marsh located south of Hough's Neck. The drainage area of this study area is approximately 40 acres, and it includes approximately 35 outfalls identified from the City GIS.

Subtask 2.1 Model Development: The collected information and data will be utilized to develop a model of the Adams Shore/Hough's Neck areas using the Innovyze® InfoWorks Integrated Catchment Modelling (ICM) software. Infoworks ICM allows modeling of complex hydraulic and hydrologic networks for both above ground and below ground systems and includes both 1-dimensional (1D) and 2-dimensional (2D) model components. The software can be used to establish a robust model of the study area system that integrates coastal and inland natural systems and built infrastructure, including the existing and proposed floodwalls.

A modeling using similar methods as the recent modeling performed by other consultants in the City shall be performed. An elevation mesh will be developed using data available from the City and MassGIS. The hydrology will be developed using a 2D rain-on-grid hydrology method that uses the elevation mesh, land use data, and soils data.

1D stormwater networks are modeled using junctions (manholes), links (pipes), and outfalls. The 1D stormwater components are data intensive requiring information on manhole inverts, manhole elevations, pipe inverts, pipe sizes, pipe materials, and outfall boundary conditions. Attempts to include 12-inches and larger pipes within the proposed study areas into the model shall be considered depending on available data. The storm drain structure geometry will be developed using the data described in Subtask 1.2 of this proposal. Data that is missing will be interpolated or estimated based on best available data and will be marked as "estimated". The 1D nodes will be connected to the 2D mesh at manholes. Model boundary conditions will be established using available tidal data.

Three (3) observed/historical storm events shall be modeled to calibrate/validate the existing conditions model. Information from the City regarding areas with known flooding during these historical storm events shall be considered and used.

24-hour design storm events with rainfall depths; established using the Northeast Regional Climate Center (NRCC) precipitation; shall be modeled. Typically, the updated National Oceanic and Atmospheric Administration (NOAA) Atlas 14 would be used; however, prior studies completed in the City by other consultants used the NRCC precipitation depths so they shall be used to be consistent. Modelling efforts shall include the 1, 2-, 5-, 10-, 25-, 50-, 100-, and 500-year frequency storm events occurring during mean higher high tide conditions. Joint coastal and upland flooding occurring during 1-year, and 10-year coastal storm surge events occurring simultaneously with 2-, 10-, and 50-year frequency rainfall storm events shall also be evaluated. A moderate rainfall event (1-inch over 24 hour) occurring during a 100-year storm surge shall also be evaluated.

As the model is developed, meeting with the City shall be conducted to review progress and findings as further described under Task 3.2.

Subtask 2.2 Model Scenarios: The Adams Shore/Hough's Neck Model will be run three scenarios to evaluate existing, anticipated, and potential future conditions. The model scenarios will evaluate the storm events described in Task 2.1. and will include:

1. **Existing Conditions** – The Existing Conditions scenario represents existing conditions with the seawalls at their current elevation. The existing conditions model will be used for calibration and validation.
2. **Future Conditions** – The Future Conditions scenario represents anticipated near-term future conditions with the seawalls raised two feet to elevation 13 NAVD88.
3. **Potential Future Conditions** – The Potential Future Conditions scenario represents potential future conditions with the seawalls raised by 2 feet to elevation 13 NAVD88 in most areas and raised by 4 feet to elevation 15 NAVD88 in select areas where the City is considering providing additional wall height.

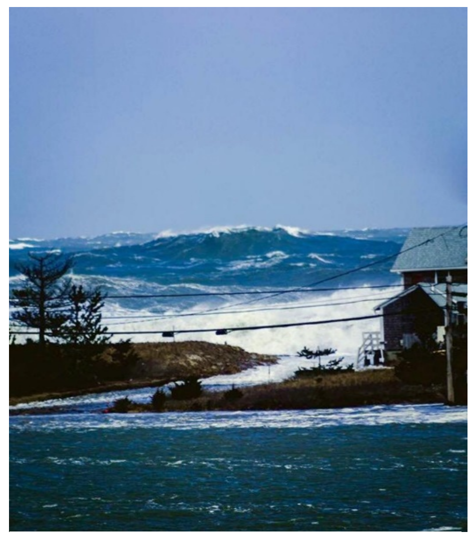


Photo 8: 20-foot waves breaking during Winter Storm Reilly

Each of the above three model scenarios will also be run to evaluate "sea level rise" based on the recent Quincy Hazard Mitigation Plan (HMP). The "sea level rise" conditions will evaluate the 100-year frequency rainfall event occurring during mean higher high tide with 1, 2, and 4 feet of sea level rise corresponding with the sea level rise evaluated in the HMP.

Drainage system alternatives will be considered and evaluated for in both the future and potential future scenarios shall be evaluated in both future and Potential future conditions as follows: Evaluate up to five (5) potential drainage improvements within each of the future and the potential future scenarios, including pump stations, to manage the marshes adjacent to Post Island Road, Tern Road, and Bayswater Road.

Subtask 2.3 Report Development: The results of the Adams Shore/Hough's Neck modeling will be used to evaluate existing conditions flooding, and potential improvements resulting from raising the existing floodwall by 2 feet, as well as potential future conditions of raising select additional areas an additional 2 feet. We will also evaluate the potential for implementing pump stations and related drainage improvements at the three locations described above (Post Island Road, Tern Road, and Bayswater Road).

A report shall be prepared; summarizing the methods, assumptions, and results of the analysis including summary tables and inundation maps for the various flooding scenarios and conditions. The report will also include an anticipated five (5) planning level drainage improvement alternatives, including an opinion of probable construction cost, that can be used as a starting point for potential future pump station designs.

A draft report shall be submitted to the City for review and comment. Meet with the City to review the report and incorporate comments they may have shall be conducted. After receiving and discussing comments from the City the model and report will be updated, and the final report and the model will be provided to the City.

Task 2 Deliverables:

- Draft Report to the city for review includes:
  - Modelling efforts, including modelling approach, model set up, input data, modelling scenarios, modelling matrix for storm events, alternatives, and modelling output
  - Opinion of Probable Cost (OPC) for each scenario including drainage system alternatives.
- Final Report

TASK 3: MEETINGS

Subtask 3.1 Public Engagement

Up to two (2) meetings shall be performed with the public and/or selected stakeholders to support this project in the Adams Shore/Houghs Neck Area. These meetings include soliciting public input on existing conditions and reviewing modeling results and potential solutions. The City's consultants will work with City staff to determine the messaging and timing of these meetings. The City's consultant will prepare a PowerPoint presentation and provide a sign in sheet and appropriate handouts to facilitate these meetings. The City will provide meeting space, coordinate invitations, and provide refreshments as appropriate.

Subtask 3.2 Meetings with City Staff

Up to four (4) meetings shall be budgeted for with the City of Quincy's project team for discussions regarding the watershed model and alternatives evaluation. The following meetings are anticipated and will be held under the Scope of Work:

1. Project Kick Off Site Visits: After reviewing all collected data and information, an initial site visit will be performed to visually verify information and to familiarize the project team with the site. The City will be invited to attend so that the site visit may serve as a kick-off meeting to discuss the project background, collected data, modeling approach, and the basis of model scenarios.
2. Preliminary Modeling Results Meeting: A meeting will be conducted with the City staff to review results of preliminary existing and future conditions modeling to discuss initial results, findings, and next steps.
3. Meeting to Discuss Conceptual Solutions: A meeting will be conducted with City staff to review conceptual solutions and associated modeling results.
4. Review of Draft Deliverables: After the City has had time to review the draft deliverables, a meeting will be conducted with City staff to solicit input.

Task 3 Deliverables:

- Sign-in Sheet
- Meeting minutes document
- PowerPoint presentation

TASK 4: REPORTING

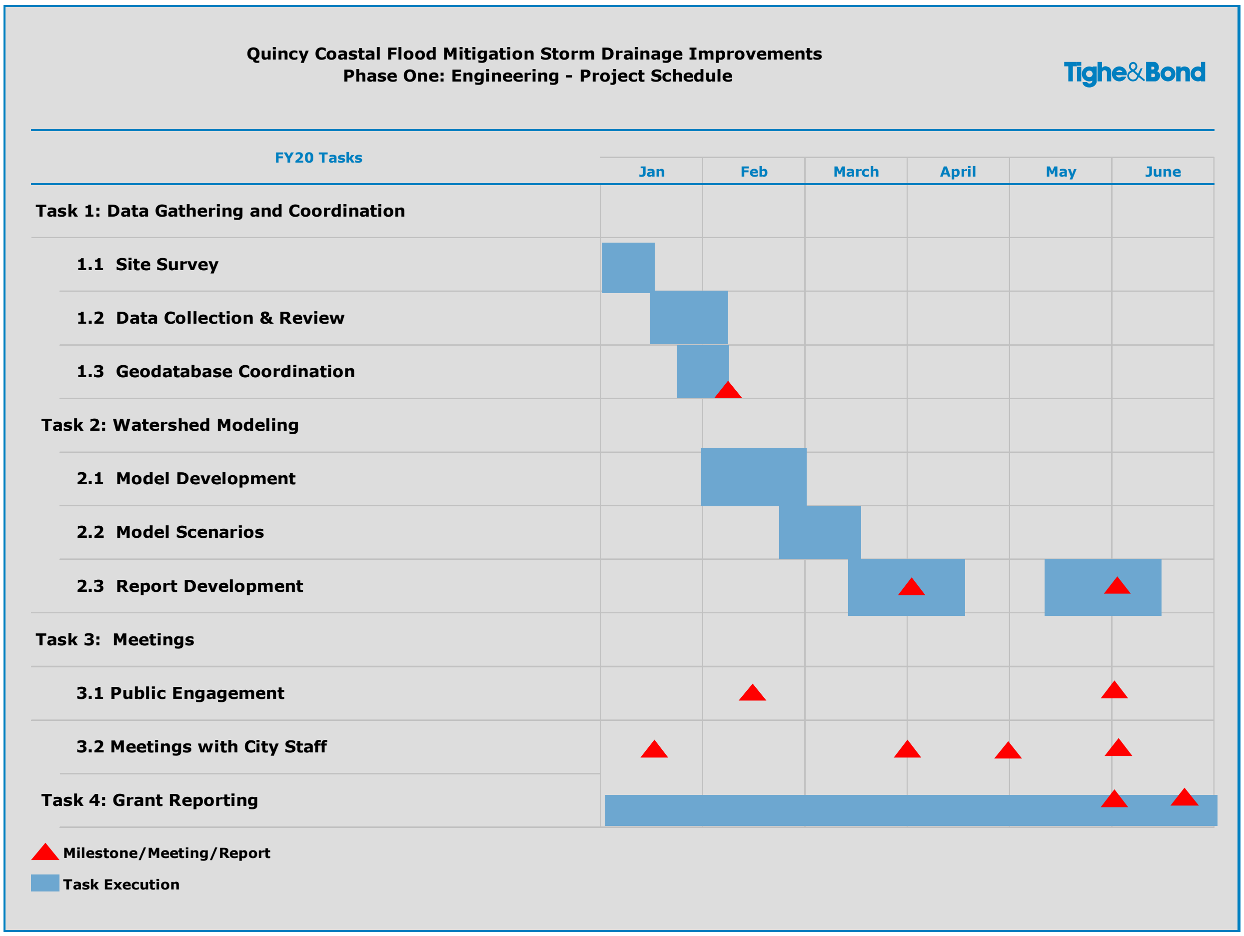
This task includes grant administration, quarterly progress reports and a final report (FY20) describing the results of the project and MVP executive summary. The final report will include a summary of project deliverables, meetings and any technical support provided by project partners under the grant.

Task 4 Deliverables:

- quarterly progress reports, draft and final report, and MVP executive summary.

8.2 Timeline

Quincy anticipates a project duration of 6-months to complete all phases of this project by June 30, 2020. The table below presents a project schedule. The work will commence in January 2020.

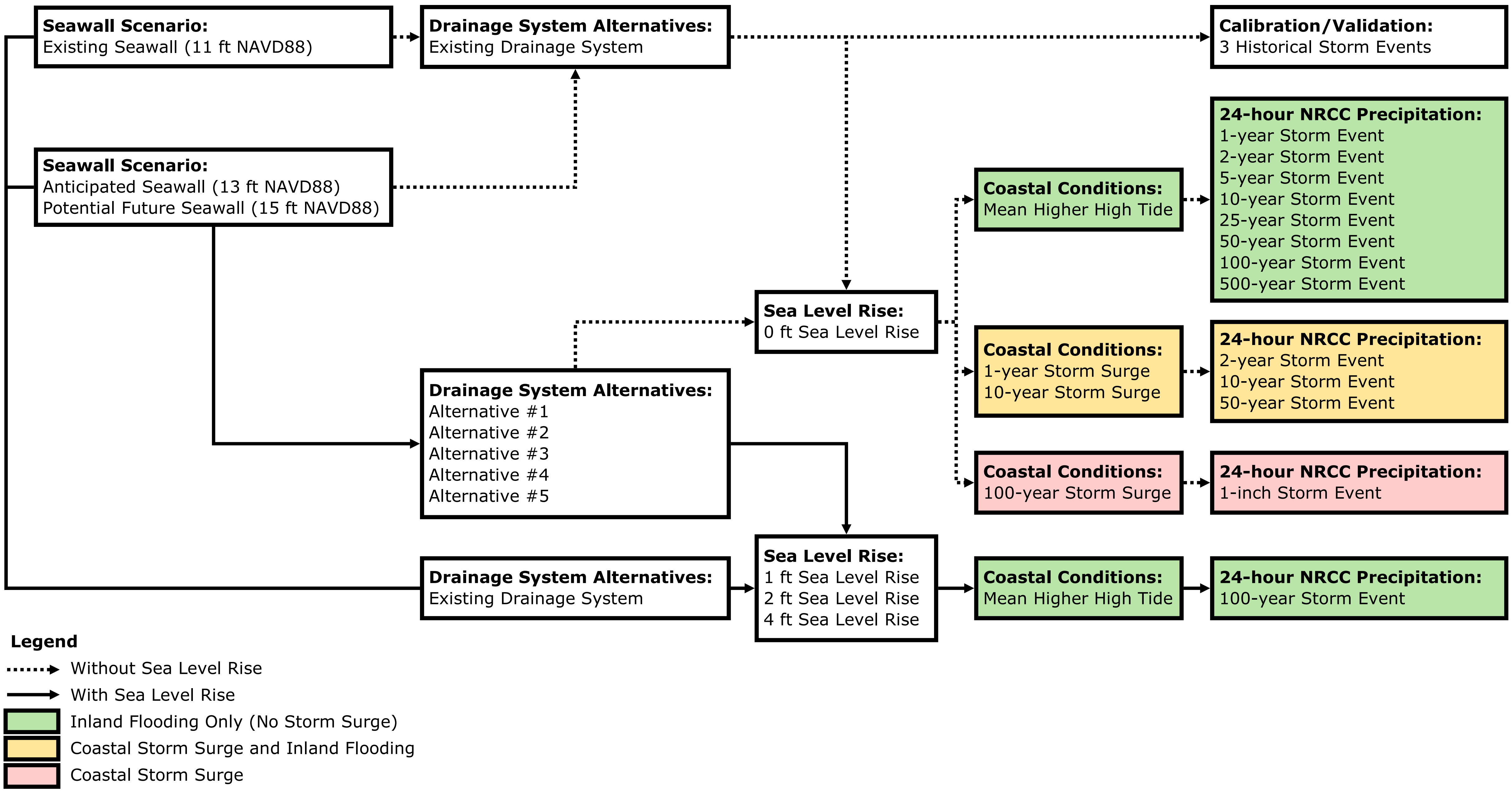


8.3 Project Budget

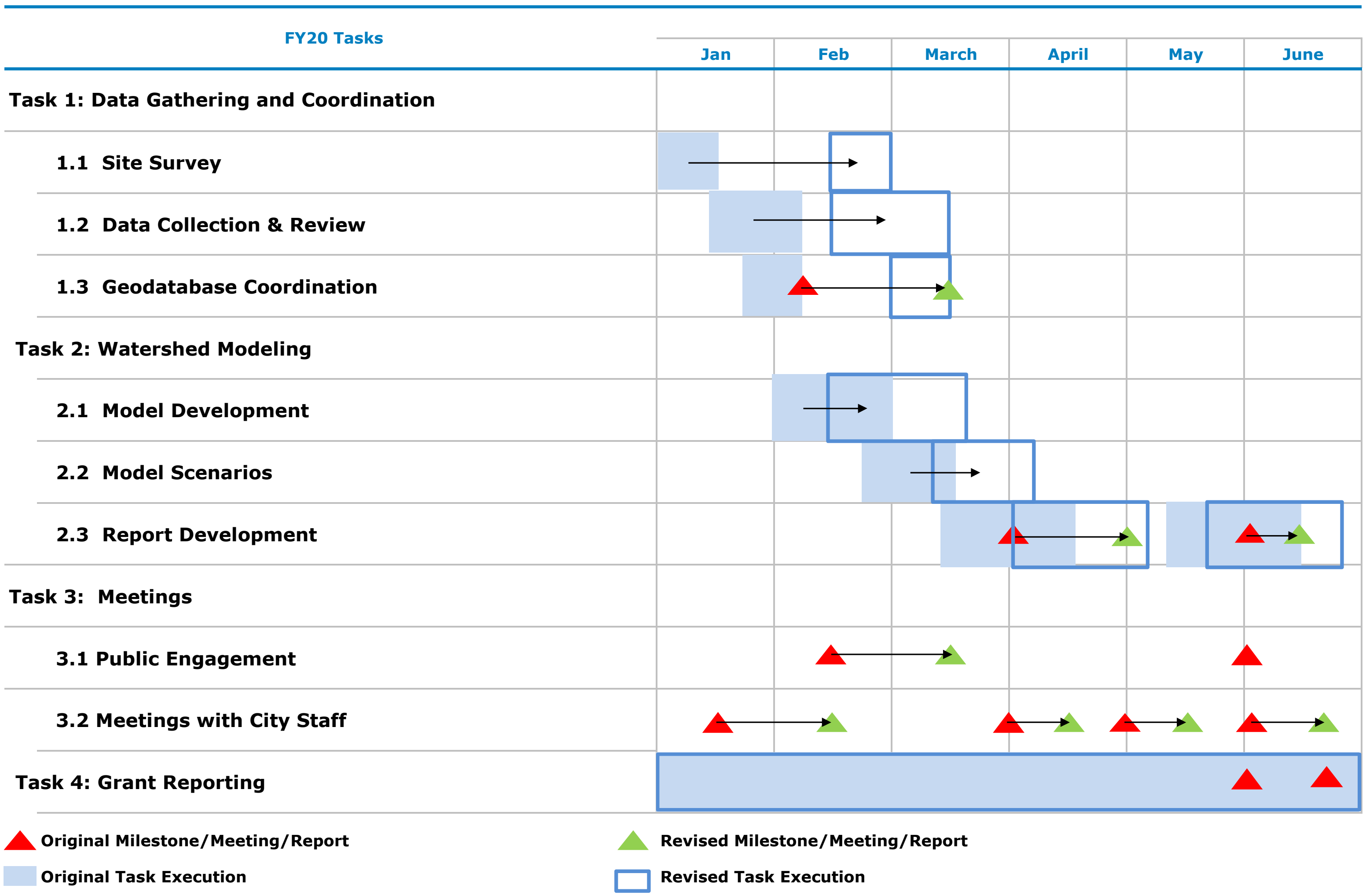
Funding from the MVP action grant is vital to developing solutions for coastal flood mitigation for one of the most vulnerable areas of the City. Appendix B provides a detailed budget, broken down by grant funds and matching funds for the components of each project task. The project provides a cash match available from the City Capital Improvement funds. The total match exceeds the required 25% of total project cost. The match provided for this grant is from approved Quincy Capital Improvement Funding, as stipulated in the cover letter from the Department of Public Works Commissioner.

Coastal Flood Mitigation Storm Drainage Improvements - Phase 1: Engineering & Public Outreach

Quincy Adams Shore / Houghs Neck Watershed Modeling Scenarios



Quincy Coastal Flood Mitigation Storm Drainage Improvements
Phase One: Engineering - Orignal & Revised Project Schedule



DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: February 26, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19 032	AGREEMENT DATE: 2/26/2020

TIGHE & BOND STAFF CONTACT:
Janet Moonan, PE, Project Manager
781.708.9826 JSMoonan@TigheBond.com

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Kickoff meeting with City and MVP Regional Coordinator held on 2/21/2020 and meeting notes/action items distributed
- Collected, organized, and reviewed data for model input
- Prepared memorandum documenting data gathering
- Initiated watershed modeling, including pre-processing of data for model inputs
- Prepared outline of final report

WORK TO BE COMPLETED NEXT PERIOD

- Waiting on MVP Grant contract to be executed with City
- Data gathering and compilation
- Ongoing model setup

KEY OPEN ISSUES

- None

ITEMS REQUIRED FROM CITY

- None

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted based on City staff input.

J:\Q\Q0019 Quincy, MA Consultant Review Services\Q0019-032 Stormwater Modeling\Project Management\Meetings\2020.02.26 Meeting Agenda.docx

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: March 11, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19 032	AGREEMENT DATE: 2/26/2020
TIGHE & BOND STAFF CONTACT: Janet Moonan, PE, Project Manager 781.708.9826 JSMoonan@TigheBond.com		

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Preliminary Model set up in progress
- Ongoing coordination with Woodard & Curran for consistency
- Survey sub under contract
- MVP Grant contract executed with City

WORK TO BE COMPLETED NEXT PERIOD

- Data gathering and compilation
- Ongoing model setup
- Survey beginning week of March 16, 2020
- Survey coordination with GIS team
- Looking ahead to public meeting, credit from Manet Ave alternatives meeting

KEY OPEN ISSUES

- None

ITEMS REQUIRED FROM CITY

- Input on proposed schedule update submitted to City on 3/6/2020, in order to finalize and submit to EEA.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted based on City staff input.

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: March 25, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19 032	AGREEMENT DATE: 2/26/2020

TIGHE & BOND STAFF CONTACT:
Janet Moonan, PE, Project Manager
781.708.9826 JSMoonan@TigheBond.com

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Data gathering and compilation, including Flood Elevation Certificates (thank you to DPW and Building)
- Ongoing model setup
- Survey coordination with GIS team
- Survey began March 18, 2020
- Call with EEA on Friday March 20, 2020

WORK TO BE COMPLETED NEXT PERIOD

- Complete data gathering and compilation
- Coordination with Woodard & Curran
- Further model development
- Anticipate surveyor will begin delivery of data

KEY OPEN ISSUES

- Public engagement process that previously consisted of two public meetings needs to be revised due to social distancing. May need to hold virtual public meeting, complete mailing/emailing program, etc. for first, if not second meeting. Will coordinate with City in the coming month.

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time, however, waiting for updates from EEA on contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

J:\Q\Q0019 Quincy, MA Consultant Review Services\Q0019-032 Stormwater Modeling\Project Management\Meetings\2020.02.26 Meeting Agenda.docx

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: April 8, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
    - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19 032	AGREEMENT DATE: 2/26/2020
TIGHE & BOND STAFF CONTACT: Janet Moonan, PE, Project Manager 781.708.9826 JSMoonan@TigheBond.com		

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Ongoing model setup
- Have a preliminary working existing model, including 2-D mesh (roughness, infiltration, etc.), existing conditions seawall, precipitation for calibration and design storms, tidal elevations for calibration events, etc.
- Receiving periodic survey results
- Ongoing coordination with Woodard & Curran
- Ongoing survey coordination with GIS team
- Data gathering and compilation

WORK TO BE COMPLETED NEXT PERIOD

- Coordination with Woodard & Curran
- Further model development and calibration/validation
- Anticipate surveyor complete delivery of data
- Begin public engagement process
- Coordination with Manet team on drainage impacts

KEY OPEN ISSUES

- Public engagement process that previously consisted of two public meetings needs to be revised due to social distancing. May need to hold virtual public meeting, complete mailing/emailing program, etc. for first, if not second meeting. See memorandum describing approach.

ITEMS REQUIRED FROM CITY

- Input on alternative public engagement process.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: April 22, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19-032	AGREEMENT DATE: 2/26/2020

TIGHE & BOND STAFF CONTACT:
Janet Moonan, PE, Project Manager
781.708.9826 JSMoonan@TigheBond.com

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Ongoing model setup
- Review of historic seawall elevations for calibration of storm events
- Receiving periodic survey results
- Ongoing coordination with Woodard & Curran
- Ongoing survey coordination with GIS team
- Data gathering and compilation
- Report development including methodology section

WORK TO BE COMPLETED NEXT PERIOD

- Ongoing coordination with Woodard & Curran
- Anticipate surveyor complete delivery of data
- Assuming survey is completed, model information should be updated to reflect drainage and calibration/validation can be initiated
- Begin public engagement process
- Coordination with Manet team on drainage impacts

KEY OPEN ISSUES

- Public engagement process that previously consisted of two public meetings needs to be revised due to social distancing. May need to hold virtual public meeting, complete mailing/emailing program, etc. for first, if not second meeting. See memorandum describing approach.

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: May 6, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19-032	AGREEMENT DATE: 2/26/2020
TIGHE & BOND STAFF CONTACT: Janet Moonan, PE, Project Manager 781.708.9826 JSMoonan@TigheBond.com		

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Ongoing model setup
- Survey results near complete
- Ongoing coordination with Woodard & Curran
- Ongoing survey coordination with GIS team
- Report development including methodology section
- Validation and calibration underway

WORK TO BE COMPLETED NEXT PERIOD

- Ongoing coordination with Woodard & Curran
- Surveyor delivery of data
- Model information should be updated to reflect drainage and calibration/validation can be finalized
- Continue public engagement process
- Coordination with Manet team on drainage impacts

KEY OPEN ISSUES

- Coordinate with Mayor's office on public education

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

J:\Q\Q0019 Quincy, MA Consultant Review Services\Q0019-032 Stormwater Modeling\Project Management\Meetings\2020.02.26 Meeting Agenda.docx

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: May 20, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19-032	AGREEMENT DATE: 2/26/2020
TIGHE & BOND STAFF CONTACT: Janet Moonan, PE, Project Manager 781.708.9826 JSMoonan@TigheBond.com		

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Obtained final survey
- Finished all data collection and review
- Prepared geodatabase for delivery, will provide once City hires new GIS coordinator
- Incorporated final survey into model
- Continued to prepare report
- Ongoing coordination with Woodard & Curran

WORK TO BE COMPLETED NEXT PERIOD

- Ongoing coordination with Woodard & Curran
- Anticipate surveyor complete delivery of data
- Assuming survey is completed, model information should be updated to reflect drainage and calibration/validation can be initiated
- Begin public engagement process
- Coordination with Manet team on drainage impacts

KEY OPEN ISSUES

- Coordinate with Mayor's office for public education.

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: June 3, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
    - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19-032	AGREEMENT DATE: 2/26/2020

TIGHE & BOND STAFF CONTACT:
Janet Moonan, PE, Project Manager
781.708.9826 JSMoonan@TigheBond.com

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Ongoing coordination with Woodard & Curran
- Continued watershed modeling, including proposed conditions modeling and alternatives analysis
- Prepared draft report, consisting of background, methodology, results, conclusions, recommendations, and associated costs of alternatives
- Coordinated with other ongoing City modeling efforts for consistency
- Initiated public engagement, including website

WORK TO BE COMPLETED NEXT PERIOD

- Finalize model runs and review with City
- Finish public engagement process
- Ongoing coordination with Woodard & Curran

KEY OPEN ISSUES

- None at this time.

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

DPW Check in Meeting

ATTENDEES: Paul Costello (City of Quincy)
Alfred Grazioso (City of Quincy)
David Murphy, Tighe & Bond
Ian Mead, Tighe & Bond
Joe Shea, Woodard & Curran

LOCATION: 55 Sea Street, DPW Conference Room

DATE: June 17, 2020

TIME: 10 AM to 12 PM

Current Projects

- Tighe & Bond
  - Post Island Road Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (MVP Action Grant)
- Woodard & Curran

Underway – Awaiting Signed Contract from City

- Tighe & Bond
- Woodard & Curran

Proposals Submitted or Under Development

- Tighe & Bond
- Woodard & Curran

Note: All other projects redacted for purposes of FY20 MVP Action Grant Reporting

PROJECT NAME:	**Post Island Rd Stormwater Improvements / Adams Shore/Houghs Neck Stormwater Modeling (EEA MVP Action Grant)**	
CITY DEPARTMENT: **DPW**		
PO#: 20005320-00	T&B PROJECT #: Q19-032	AGREEMENT DATE: 2/26/2020
TIGHE & BOND STAFF CONTACT: Janet Moonan, PE, Project Manager 781.708.9826 JSMoonan@TigheBond.com		

PROJECT STATUS

WORK COMPLETED THIS PERIOD

- Finalized model runs
- Internal QA/QC process commenced
- Ongoing coordination with Woodard & Curran
- Further edits to report
- Preparation for modeling summit with City
- Developed PSA
- Prepared for public meetings with City Councilor

WORK TO BE COMPLETED NEXT PERIOD

- Ongoing coordination with Woodard & Curran
- Final spot checks re survey data to be completed
- Updates to model runs as needed
- Complete public engagement process
- Delivery of final draft report

KEY OPEN ISSUES

- Public engagement process inclusive of 4 virtual meetings, newsletter and a PSA all in motion. See memorandum describing approach.

ITEMS REQUIRED FROM CITY

- None at this time.

RISKS TO SCHEDULE, BUDGET, LEGAL, ETC.

- None at this time. EEA has not extended contract end date. Assuming it is still June 30, 2020.

SCHEDULE

Work must be completed by June 30, 2020. Interim deliverables will be adjusted following EEA approval of schedule change.

980 Washington Street | Suite 325
Dedham, Massachusetts 02026
www.woodardcurran.com

T 800.426.4262
T 781.251.0200
F 781.251.0847

MEETING AGENDA - Inundation Model Meeting

MEETING DATE: June 25, 2020

TIME: 10:00 AM to Noon
LOCATION: Quincy DPW – Upper Conference Room
Proper Covid-19 PPE Required

Invited Attendees

Name	Organization	Telephone/email	Attendance
Paul Costello	Quincy DPW	pcostello@quincyma.gov	IP
Al Grazioso	Quincy DPW	agraziosp@quincyma.gov	IP
Joe Casserly	Quincy DPW	jcasserly@quincyma.gov	IP
Mark Kintigos	Quincy DPW	mkintigos@qunicyma.gov	IP
Steve Washburn	Quincy DPW	swashburn@quincyma.gov	IP
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V – Virtual

IP – In-person

Meeting Objectives

1. Provide an update on the status of on-going stormwater planning, design, and construction projects.
2. Review of key coordination elements across Consultants for City to receive cohesive deliverables.
3. Identify Potential planning, design, and construction project for consideration of SRF PEF Applications due in August.

Agenda

1. Introductions (PC) (5 mins)
2. Meeting Objectives (PC) (5 mins)
    a. Progress Update
    b. Coordination of deliverables and data
    c. Future funding opportunities
    d. other
3. City- wide Modeling Program (W&C)
    a. Town Brook Modeling (W&C) (10 mins)
    b. Hospital Hill Modeling (Beta) (10 mins)
    c. Adams Shore Modeling (T&B) (10 mins)
    d. Wollaston Center Modeling (W&C) (5 mins)
    e. Broad Street Outfall Modeling (W&C) (5 mins)
    f. Furnace Brook/Black's Creek Modeling (W&C) (5 mins)
4. Integration of Models (15 mins) (Team)
5. GIS Data Deliverables (15 mins) (Team)
6. Project Funding - Potential planning, design, and construction projects for consideration (JS) (25 mins)
    a. SRF PEFs
    b. FY 21 MVP Grant
    c. FY 21 MassWorks
    d. FEMA BRIC
    e. Other

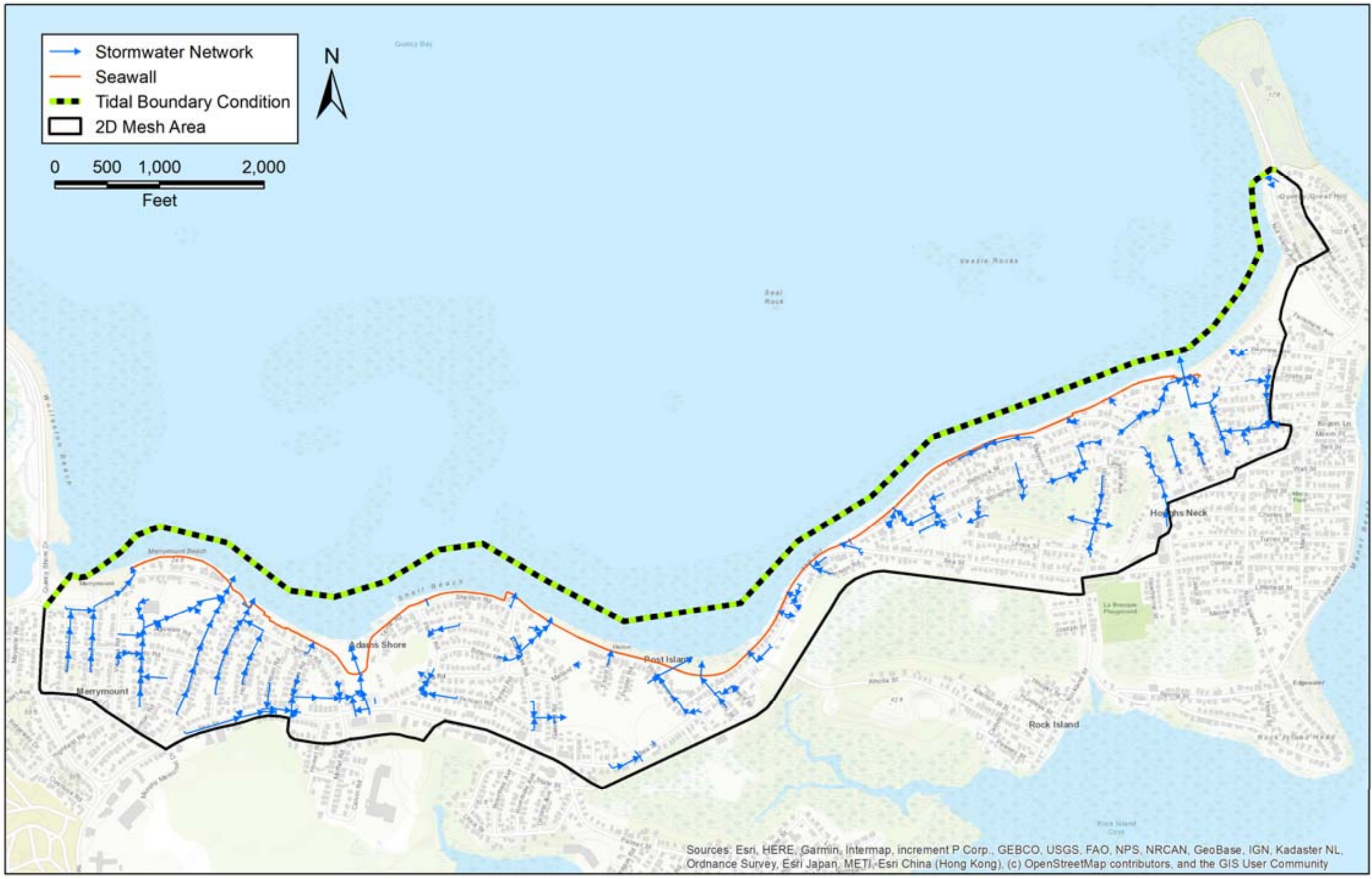
Deadline for Potential Projects

1. SRF PEF: List by 7/1/20. Applications due 8/15/20 +/-
2. FY 21 MVP Grant: Project Selected. Application due 6/11/20.
3. FY 21 MassWorks Grant: List by 7/1/20. Applications due 8/28/20.

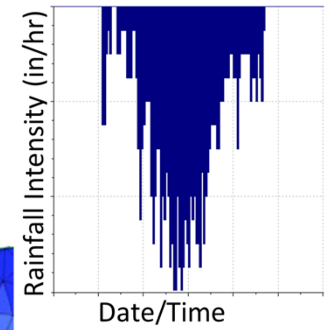
Tighe & Bond Slides – City of Quincy Modeling Roundtable

Adams Shore / Houghs Neck Statistics

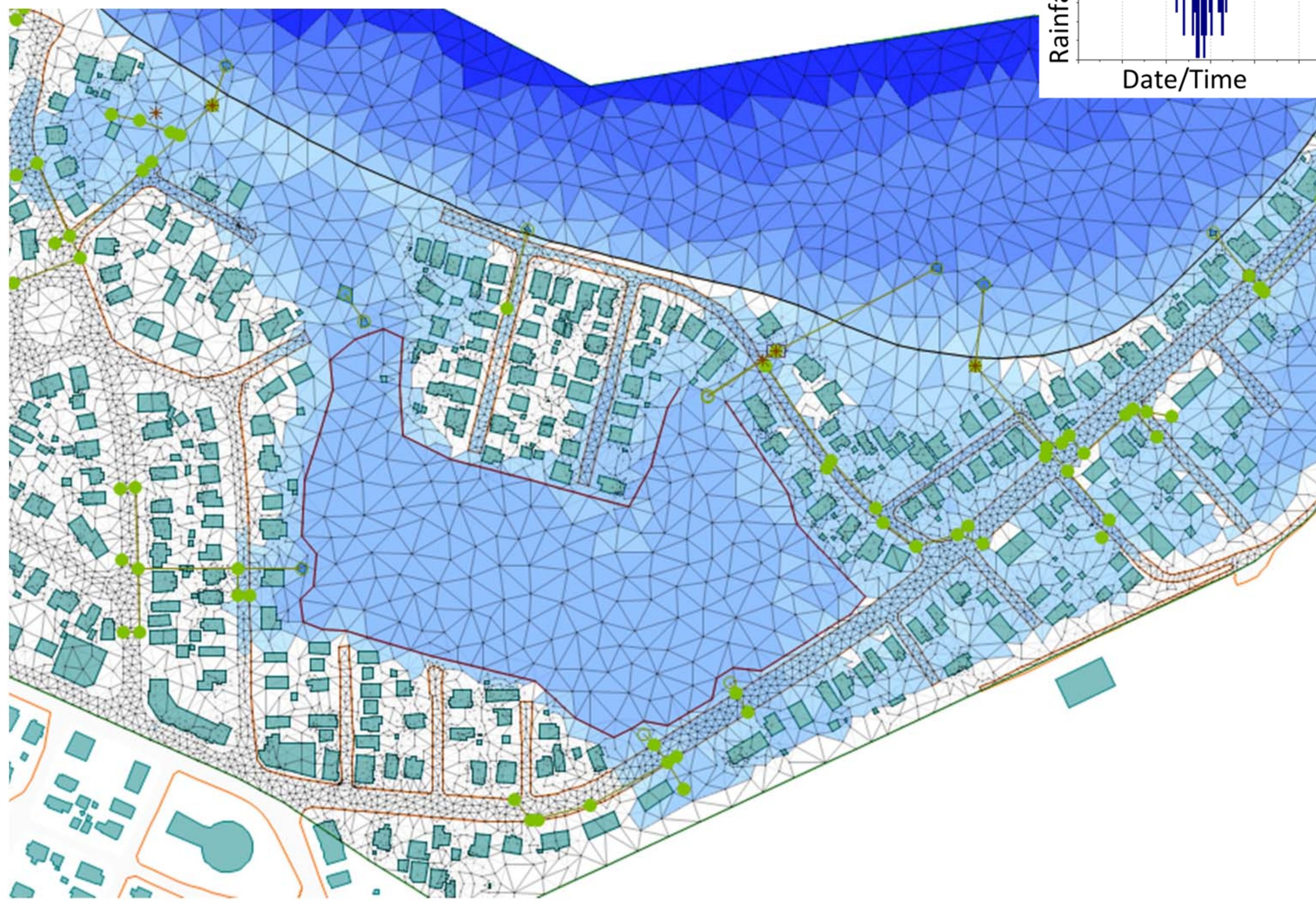
- 22 Outfall Pipes
- 420 Acres
- 6.6 Miles of Pipe
- 526 Structures
- 12 one-way Check Valves
- 1 Tide Gate
- 2.8 Miles of Shoreline

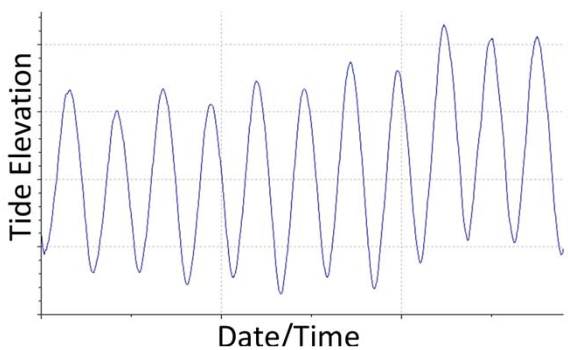


Adams Shore / Houghs Neck Status



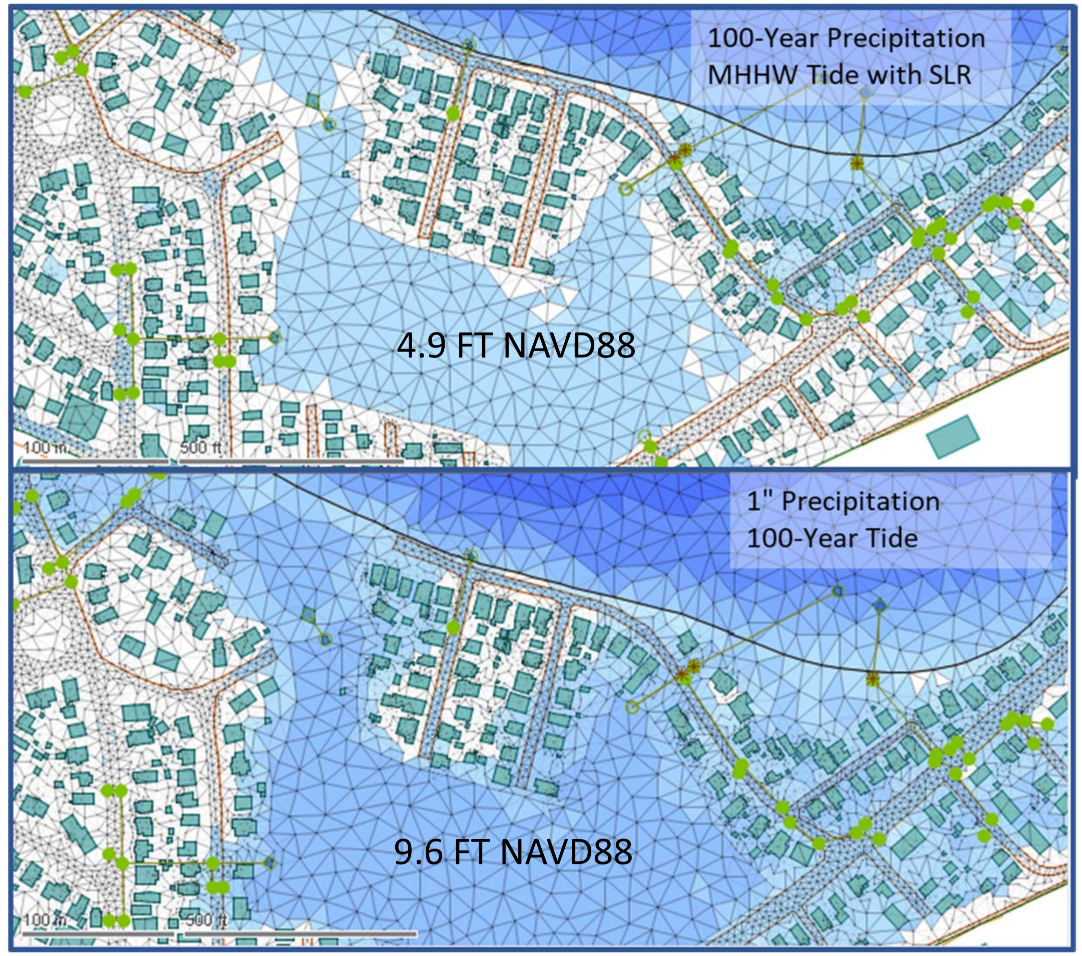
- Calibration/Validation Completed for:
  - October 1991
  - May 2005
  - March 2018
- Existing and Proposed Conditions Completed





Adams Shore / Houghs Neck Preliminary Results

- Storms During "Normal" Tides
  - Anticipate to cause relatively little flooding
  - i.e. 100-year and 500-year storm events
- Minor Rainfall During "Extreme" Tides
  - Substantial flooding anticipated
  - i.e., 1-inch storm event during 1% Annual Exceedance Probability (AEP) tide (100-year)
- Pump Stations Provide Opportunity for Drainage During Extreme Tides



Adams Shore / Houghs Neck Next Steps

- Finalize Future/Proposed Conditions model runs
  - Pump stations
  - Other drainage improvements (e.g., tide gates, upsizing and new catch basins, property and building options)
  - Consider: nature-based solutions
- Public Engagement Final Meetings
- Submit MVP Action Grant Report
- Advance pump station preliminary designs
- MA SRF PEF Eligible