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Point of Pines and Riverside Area Coastal Resilience Feasibility Study

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Short Term Resilience Measures– DRAFT

1. Introduction

The Point of Pines/Riverside Area Coastal Resiliency Feasibility Study is an integrated coastal protection initiative for the City of Revere. The study consists of six memorandums aimed to evaluate the flood vulnerability and potential mitigation options for the City. This memorandum is the third of six in the series and provides potential short-term resilience concepts that might be utilized as temporary risk reduction measures. The sections below discuss areas vulnerable to flooding under current day conditions and potential short-term resilience measures that can be considered to reduce risk to these areas. Section 6 of the memorandum describes recommended locations for these measures. Attached to this memorandum in Appendices A and B is a Beach Management Plan for the Point of Pines Beach, as well as a site-specific Emergency Response Plan, which outline additional short-term measures that can be considered for implementation.

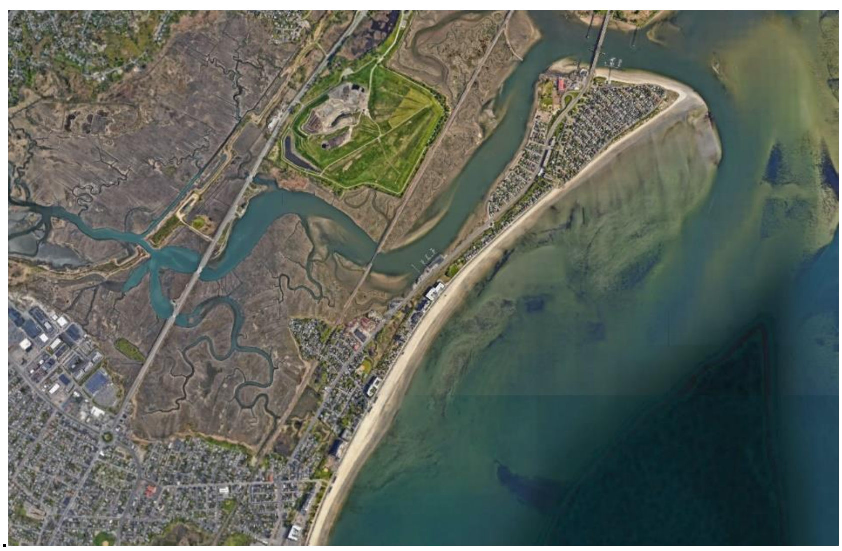


Figure 1-1 – Google Earth Image of Project Site

2. Vulnerability to Flooding

The Point of Pines peninsula is located in the northeast section of the City of Revere. Based on the Massachusetts Coastal Flood Risk Model (MC-FRM) data shown in Figure 2-1 below, the project area is projected to be inundated with up to 10 feet of water in today's 100-year storm conditions.

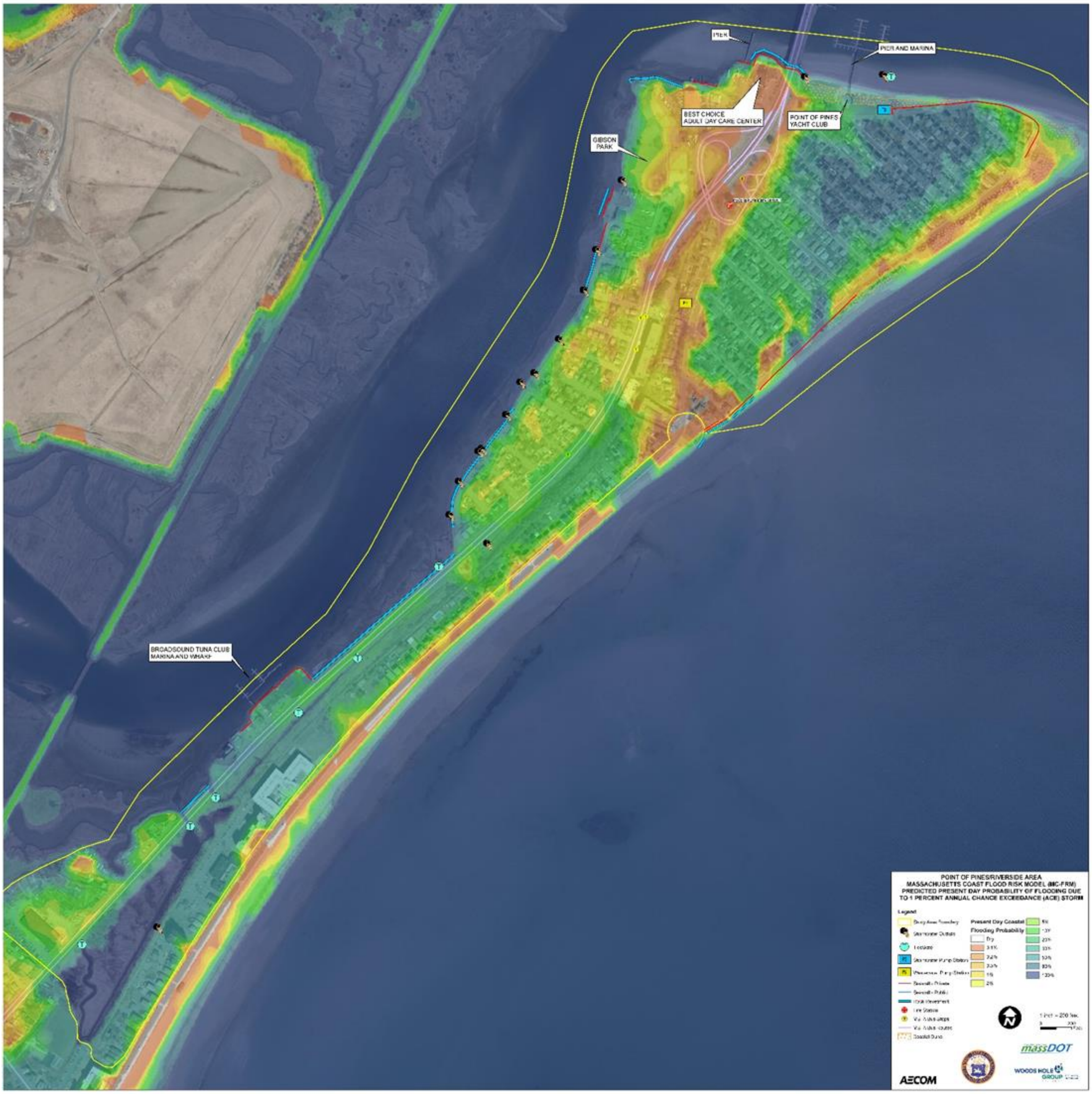
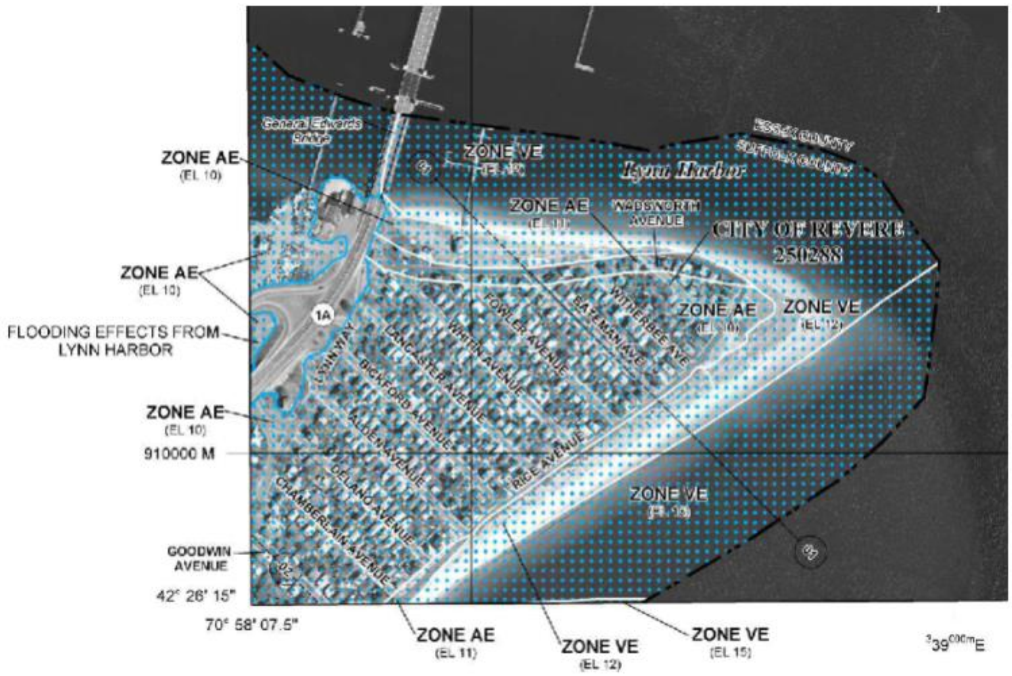


Figure 2-1 – Flooding Probability for a 1% Present Day Coastal Storm

Based on the FEMA firm map shown below in Figure 2-2, the entire peninsula is within the present day 100-year storm flood plain. The eastern side of the peninsula is within the coastal VE zone and the western side is within the coastal AE zone.



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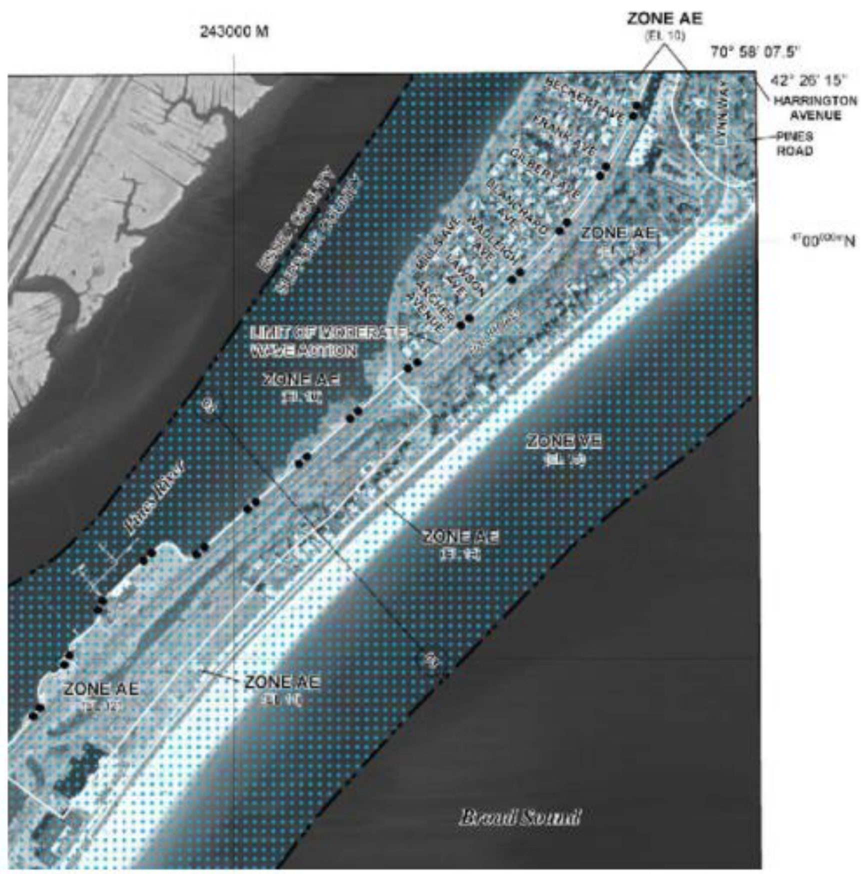

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Figure 2-2 – 2016 FEMA Firm Maps

3. Screening Criteria

To determine the feasibility of each short-term resilience method, the following criteria were considered.

Geometric Constraints – The critical geometric constraint is the maximum height of the flood barrier. The flood barrier systems identified below have flexibility in their lengths as multiple units can be attached together to achieve a desired run.

Coastal Loading – Based on the FEMA firm maps shown in Figure 2-2 above, the western perimeter of the peninsula is within a coastal AE zone, while the eastern side is in a coastal VE zone. Therefore, even a temporary resiliency measure placed there must be capable of withstanding the designated coastal loading.

Structural System – Multiple short-term measures detailed below have structural anchorage requirements. These requirements will have to be designed and constructed to be conducive with the barrier and the surrounding site.

Offsite Storage/Deployment – Deployable measures will require storage, deployment personnel and a detailed deployment plan.

Visual Impact – The aesthetic impact of the temporary measures should be incorporated to best meet community goals.

Cost – The cost implications associated with each measure.

Each of the short-term risk reduction measures are described below in Section 4, which also discusses each of the above criteria. Table 1 in Section 7 summarizes each short-term risk reduction against the criteria listed above.

4. Short-Term Resilience Measures

The following short-term resilience measures were broken into two categories: deployable measures and on-site measures. Deployable measures are stored in an off- site location, brought to site and installed prior to an upcoming storm. They require storage, deployment personnel and a detailed deployment plan. On-site measures are left on site and can help protect against any daily inundation in addition to storm surge. However, they have a significant day to day visual impact on the community.

4.1 Deployable Measures

4.1.1 Aquafence

Aquafence is a deployable flood barrier system that consists of a continuous line of anchored flood panels. The system ranges in height between 30 inches to 9 feet and can be implemented in a coastal AE zone. This system is typically stored offsite and deployed in the event of a storm. A deployment crew anchors the toe of panels into the ground using tie-down anchors. Approximately 500 feet of Aquafence can be installed per day..

Figure 4-1 – Aquafence Empire Stores Brooklyn, NY

Aquafence has been used as flood protection throughout the United States. The image in Figure 4-1 above, showcases a series of 4-7 feet high panels spanning over approximately 1000 feet at Empire Stores in Brooklyn, NY. This system was recently deployed and withstood the forces of Hurricane Isiah.

4.1.2 Tiger Dams (Water Filled Tubes)

Tiger Dams are a temporary flood barrier system that consist of water-filled flexible tubes. The system is stackable as shown in the Figure 4-2 below, and creates a pyramid shape barrier that can reach up to 32 feet in height. Individual tubes can be linked together and set up in any shape to adequately protect vulnerable structures. These tubes can be used in both AE and VE flood zones. When deployed, Tiger Dams are typically filled via a fire hydrant or garden house. When the flooding subsides, the tubes are drained of water, rolled up and stored for future use.

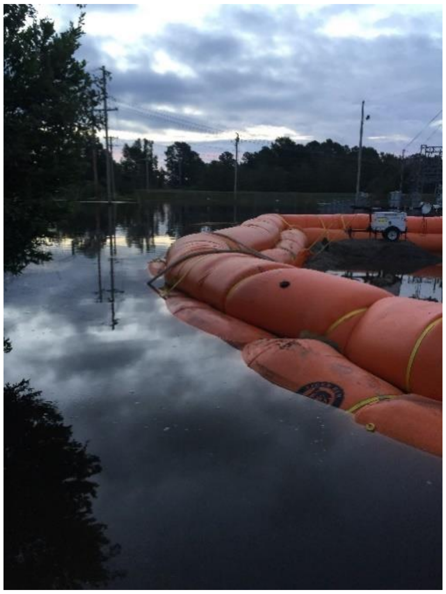

Figure 4-2 – Tiger Dams Lumberton, NC

The Tiger Dam system was used in Lumberton, NC to protect the substations of an energy company from Hurricane Florence. The dams were 42-inch diameter and stacked in a 2/1 configuration to achieve a final height of 7 feet. Sump pumps were used to pump out any rainwater and seepage that accumulated on the protected side.

4.1.3 Tubewall (Air Filled Tubes)

The Tubewall flood barrier system is similar to the Tiger Dam system, but instead of using water, the tubes are inflated by air. The Tubewall is available in heights ranging from 20-40 inches and can be deployed in both coastal AE and VE zones. The Tubewall's anchorage system consists of a skirt which lies on the flood side of the barrier. When flood water covers the skirt, the hydrostatic load seals the barrier to the ground. To deploy the system, the tubes are rolled out, inflated with air using a handheld blower, and then zipper together to form the desired shape.

Figure 4-3 – Tubewall Sheffield, England

The Tubewall shown in Figure 4-3 above, highlights a recent 40-inch-high system. This Tubewall extends for 1500 feet and was deployed in Sheffield, England.

4.1.4 Stop Logs

Stop logs are removal flood barriers made of steel or aluminum demountable beams that are inserted into intermediate posts. Spans can reach up to 10 feet in width and 14 feet in height and the system can be utilized in both AE and VE coastal zones. The beams and intermediate posts are both deployable, but the system requires a foundation with on-site anchors for the posts to be secured to. The cost varies based on the height of the barrier.

Figure 4-4 – Stop Logs Aquarium Station Boston, MA

The stoplog system shown in Figure 4-4 above was designed to protect the Aquarium subway station in Boston, Massachusetts. This system consisted of 500 feet of 4-foot-high stop logs.

4.1.5 NOAQ Boxwall

NOAQ Boxwall is a freestanding temporary flood barrier made of light box sections that are snapped together and anchored by the weight of the flood water. The Boxwall is a deployable system that has a maximum height of 40 inches. However, this system is not designed to withstand any impact loading (vessel or significant debris impacts) and would not be suitable in a coastal environment.

Figure 4-5: Boxwall in London, England

The Boxwall system shown above in Figure 4-5 was used by the London Fire Service. This system was 1500 feet long and was comprised of 3-foot-units that were 20 inches high.

4.1.6 INERO Flood Panel

The INERO Flood Panel is deployable flood barrier system made from marine-grade aluminum. The system can be built up to a maximum height of 5 ft 8 inches and is designed to provide riverside protection. Although this system can take some impact loading, it is not designed to stop waves in a coastal environment. When deployed, consecutive sections interlock to form a continuous, flexible barrier.

Figure 4-6: INERO in England

The INERO flood panel system shown in Figure 4-6 above was procured by England's Environmental Agency for national flood protection. This image shows a segment of over 10 miles of INERO flood barrier. This system varies in height up to 5 feet 8 inches.

4.2 On-Site Measures

4.2.1 Hesco Barriers

HESCO Floodline barriers are steel wire crates that are lined with a plastic canvas and then filled with dirt. Each crate is approximately 4 feet tall by 3 feet wide. Multiple crates can be stacked together to heights up to 20 feet. The plastic in the canvas is felted instead of woven and is therefore much stronger than typical construction tarp. The Floodline barriers can withstand coastal loading but are not recommended to be installed on the sand due to potential undercutting.

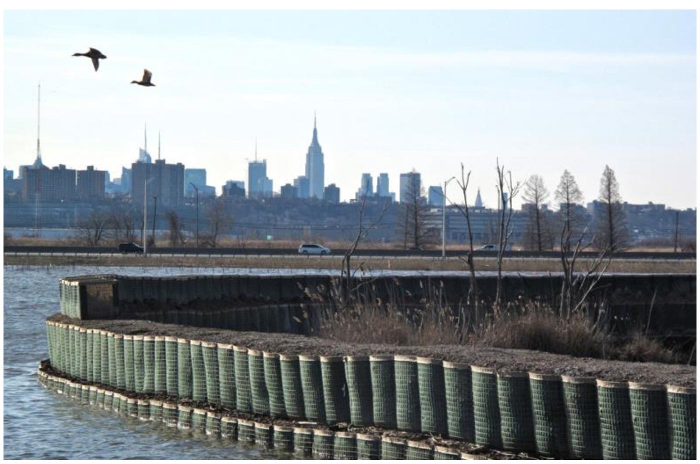

Figure 4-7 – Kane Berm in Hackensack, NJ

The HESCO system shown in Figure 4-7 above showcases the Kane Berm which was built in New Jersey to create a buffer around a wetlands development area. The units were stacked up to 12 feet high.

4.2.2 DefenCell

DefenCell is a flood protection barrier made from polypropylene geotextile. Depending on the site conditions, the geotextile cells can be filled with earth, sand, gravel, or aggregate. This system is lightweight and stackable and can be used in coastal AE and VE zones. By layering rows of cells in a pyramidal shape, it is possible to achieve a barrier height of 15 feet. DefenCell walls can remain in place for up to three years or be removed when the threat has passed. Since these barriers remain in place, there will be some visual impacts; however, by backfilling or planting around the barriers, the system can blend into the landscape well.

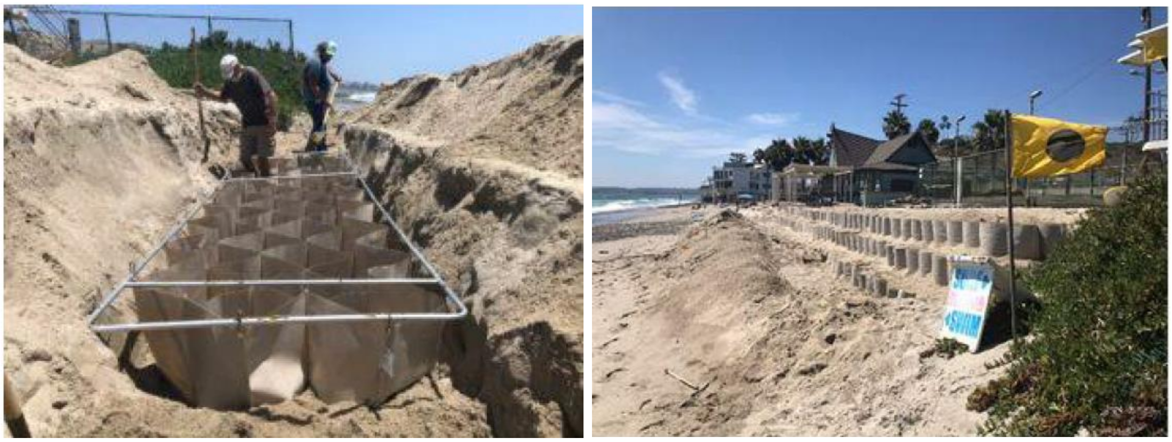

Figure 4-8 – DefenCell non-metallic barriers in Southern California

The above figures show the DefenCell non-metallic barriers installed in 2019 to mitigate coastal flooding and erosion in Southern California. The left image shows the cells being placed and filled with sand. The right image shows the barriers in their 3-layer stairstep configuration. The barriers were then backfilled with sand and vegetation was planted so the barriers would blend into the surrounding landscape.

4.2.3 Geocell Systems Rapid Deployment Flood Wall (RDFW)

The RDFW system is a grid of lightweight internal structure reinforcement filled with sand. Each individual square grid has a footprint of about 48 x 48 inches and is approximately 12 inches tall. This system can be used in coastal zones and up to 9 layers of interlocking cells can be stacked to achieve a maximum barrier height of 72 inches. After it has been deconstructed RDFW can be repackaged and re-used.

Figure 4-9 – Emergency Deployment in Jamestown, ND

The images in Figure 4-9 above are from 2009 during an emergency flood incident in Jamestown, ND. In the image to the left, the RDFW is assembled in a confined area. In the right image, a skid loader fills and traverses over RDFW. The above structure consists of 4 rows of interlocking cells, which equates to a barrier of approximately 48 inches in height.

4.2.4 TrapBags

TrapBags are pentagon-shaped bags made of woven polyethylene that are filled with earth, sand, or aggregate to produce a sturdy wall. The bags have double fabric front that is resistant to UV damage and provides strength. The cells can be stacked in a pyramid shape up to 42 feet high and can be used in both coastal AE and VE zones. While TrapBags are not reusable, they can last up to 10 years in place.

Figure 4-10 – TrapBags on the beach in Sarasota, FL

This TrapBag system was deployed in Sarasota, FL to withstand coastal flooding. Several rows of TrapBag cells were stacked up to a height of 8 feet. The cells shown in the figure above were filled with sand.

4.2.5 Sandbag Wall

A sandbag wall is a common flood mitigation technique. It consists of a built-up stack of burlap or woven polypropylene sacks filled with sand. Sandbags are typically 14x26 inches, inexpensive, and easy to obtain. Sandbags walls can be used in both coastal AE and VE zones and can be stacked in pyramid shape up to 42 ft tall. Sandbags walls do not require specialized laborers to construct. However, building a sandbag wall can be very labor-intensive depending on the size.

Figure 4-11 – Sandbag wall in Cape Girardeau, MO

Sandbag walls are a common flood protection system throughout the United States. Figure 4-11 showcases a stack of sandbags in Cape Girardeau, MO in March 2008. This sandbag wall was built up to withstand Mississippi river flooding in Cape Girardeau County.

5. Permitting

As discussed above, the two categories of short-term resiliency measures presented include deployable and on-site measures. The types of permitting and agency reviews associated with these measures will be dependent on the specific location, anchoring type as applicable (permanent versus temporary), size of the structure's temporary and/or permanent component footprints, duration of deployment, and storage location (onsite vs. offsite), among other factors. Since this memo introduces measures that could be implemented rather than specific project designs for each proposed measure, the following text describes general permitting considerations. The discussion below assumes that any temporary flood control structures deployed would be located outside of wetlands or waterways.

5.1 MA Wetlands Protection Act/Revere Wetlands Protection Ordinance

The Revere Conservation commission administers the Massachusetts Wetlands Protection Act (WPA; MGL Ch. 131 s. 40), its implementing regulations (310 CMR 10.00), and Title 16 Environment Chapter 16.04 Wetlands Protection of the Revere City Ordinances.

The purpose of the City of Revere's Chapter 16.04 ordinance (Wetlands Protection) is to protect the wetlands of the city by controlling the activities deemed to have a significant effect upon wetland values, including but not limited to the following: public or private water supply, groundwater, flood control, erosion control, storm damage prevention, water pollution, fisheries, shellfish, wildlife, recreation and aesthetics (collectively, the "interest protected by this chapter").

Jurisdiction of the Revere Conservation Commission includes any activity within a resource area, or within 100 feet of a resource area, that will remove, fill, dredge, build upon, degrade, or otherwise alter an area subject to protection under the bylaw. Such activities require must be authorized via an Order of Conditions issued by the Conservation Commission. In addition to regulations regarding work within the 100-foot Buffer Zone (Rice Avenue and other non-wetland or water locations), the coastal portion of the WPA regulations within 310 CMR 10.00 includes jurisdiction over work within Coastal Bank, Coastal Dune, Coastal Beach, and Land Subject to Coastal Storm Flowage. Work within these areas for the installation of flood control measures (both temporary and permanent) may require the filing of a Notice of Intent simultaneously with the Revere Conservation Commission and MassDEP The Massachusetts Wetlands Protection Act regulations accommodate emergency actions, as detailed in 10.06. It is likely that the temporary deployment of flood control structures would be allowed as an emergency certification. It is recommended that consultation with the Revere Conservation Commission occur to determine whether implementation of these temporary measures would be approved when needed as an emergency certification, or if issuance of a blanket Order of Conditions is preferred to allows for the deployment of flood control measures on an as needed basis prior to predicted storm events.

5.2 Massachusetts Division of Fisheries and Wildlife

The Massachusetts Endangered Species Act (MESA; 321 CMR 10.00) requires agency review for any non-exempt activity within sites mapped by the Massachusetts Natural Heritage and Endangered Species Program (NHESP) as Estimated Habitats of Rare Wildlife (for projects under the Massachusetts WPA) and/or Priority Habitats of Rare Species (for projects under MESA). Mapped habitat, including both Estimated and Priority Habitat, exists along the beach from the Route 1A bridge area eastward and then southward along the beach throughout the study area (see Beach Management Plan in Attachment A for further detail). Activities within Estimated Habitat would typically be reviewed by MassDFW as part of a submittal of a Notice of Intent under the MA WPA. A formal request for MESA review, via the submission of a MESA Project Review Checklist package, would be needed for any non-exempt activity within Priority Habitat. MassDFW review under MESA would be required for all of the flood control options described above if any potion of them lies within Priority

Habitat. As depicted below, it should be feasible to implement short-term risk reduction measures in locations outside of mapped Estimated/Priority Habitat boundaries, thus avoiding the need for MESA review and permitting.

5.3 Massachusetts Environmental Policy Act (MEPA)

The Massachusetts Executive Office of Energy and Environmental Affairs (EEA) implements the Massachusetts Environmental Policy Act (MEPA; 301 CMR 11). MEPA review is required for projects exceeding certain thresholds that are undertaken by a state agency, require a permit issued by a state agency, or involve financial assistance by a state agency. When a project meets or exceeds review thresholds established in 301 CMR 11.03, the project proponent is required to submit an Environmental Notification Form (ENF) as part of the MEPA review process. Depending on the thresholds met or exceeded beyond the requirements for an ENF, project proponents may also need to prepare and submit a Draft and possibly Final Environmental Impact Report (EIR).

Short-term deployable measures such as those described above are unlikely to trigger the need for ENF or EIR review, with the exception of placement of structures in the beach classified as Priority Habitat as discussed above. Greater than two acres of disturbance of designated priority habitat, as defined in 321 CMR 10.02, that results in a take of a state-listed endangered or threatened species or species of special concern triggers the need for submittal of an ENF and subsequent MEPA review. Although not expected to trigger MEPA review, the flood control option(s) ultimately chosen should be reviewed against the MEPA review thresholds to determine if the proposed action is subject to MEPA review.

5.4 Coastal Zone Management Act

The Massachusetts Office of Coastal Zone Management (MassCZM) implements the federal Coastal Zone Management Act in Massachusetts. Projects requiring federal funding or federal permitting that also exceed certain MEPA thresholds must obtain a Coastal Zone Management Federal Consistency Certification and demonstrate that the project is consistent with the policies of MassCZM. As indicated above, it is assumed that any temporary flood control measures would be deployed outside of wetlands and waterways, and therefore a federal permit is not anticipated to trigger the need for MassCZM review. If federal funding were used for the chosen flood control method, a CZM Federal Consistency Review may be required.

5.5 Massachusetts Department of Environmental Protection (MassDEP) Waterways Program

Massachusetts Waterways Regulations at 310 CMR 9.00 indicate that a Chapter 91 License or Permit application would need to be submitted for work within all waterways, including all flowed or filled tidelands. Activities requiring a License Application include any construction, placement, excavation, addition, improvement, maintenance, repair, replacement, reconstruction, demolition or removal of any fill or structures, not previously authorized, or for which a previous grant or license is not presently valid. Similar to the MA Wetlands Protection Act regulations, the Chapter 91 regulations allow emergency actions to proceed without obtaining a License (310 CMR 9.03), although either written or verbal notice to MassDEP is required. Consultation with MassDEP is recommended to verify that a Chapter 91 license would not be required for the emergency, temporary implementation of the flood control options described above.

6. Critical Assets

There are multiple critical assets in the study area, six of which have significant flood vulnerability as shown in Figure 6-1 **Error! Reference source not found.**below. These assets were evaluated based on their vulnerability to a 100-year storm in present day conditions. The recommended temporary resilience measures are detailed in the section below.

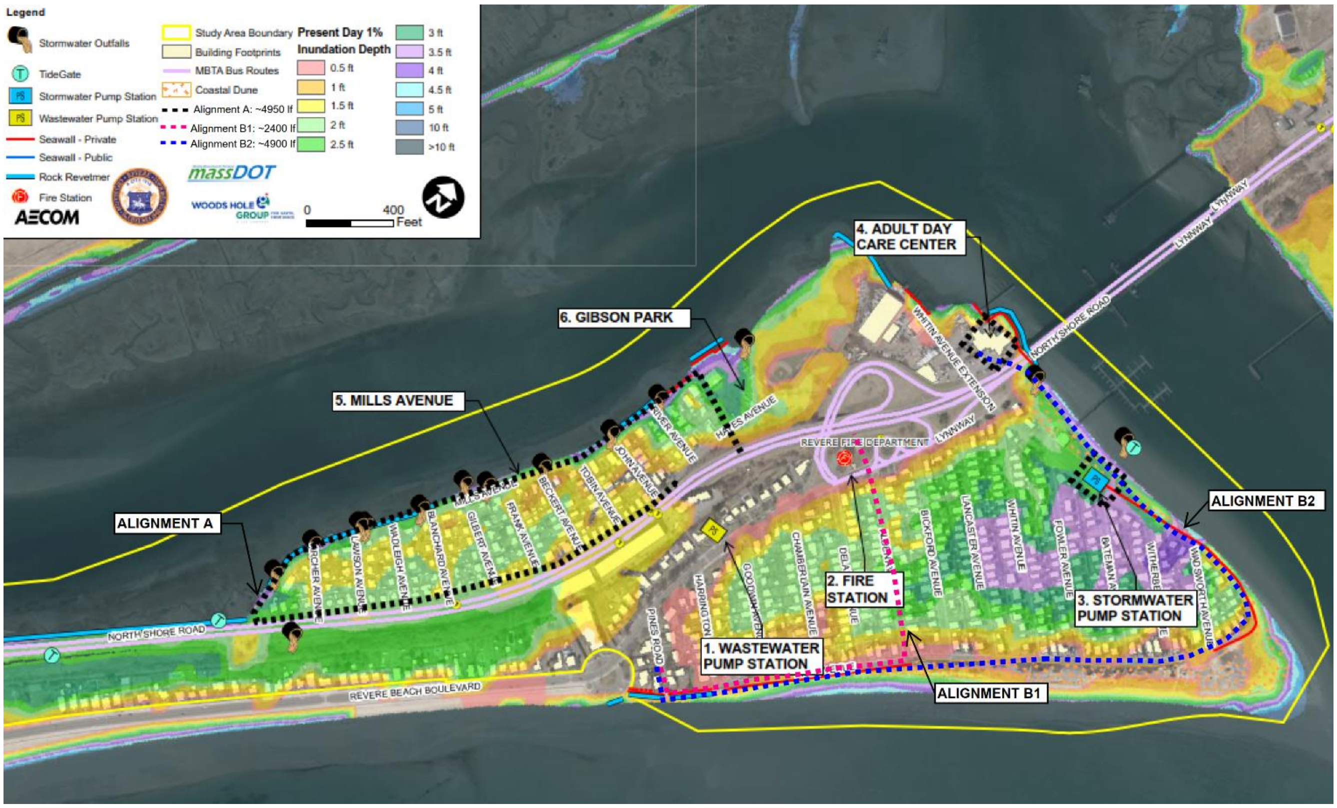

Figure 6-1: MC-FRM Predicted Present Day Water Depths Due to 1 Percent ACE Storm

Based on present day conditions, the wastewater pump station and the fire station are outside of the 100-year storm floodplain and would not require any flood risk reduction measures. The stormwater pump station and the adult day care center are within the 100-year storm floodplain and require temporary flood risk reduction measures. A combination of the deployable measures detailed in section 4.1 may be used to help protect and secure these buildings. In comparison to on-site measures, deployable options are preferable in these locations since they allow for daily access and egress to be maintained.

Mills Avenue is projected to be subject to up to four feet of flooding during a present day 100-year storm and currently experiences regular tidal inundation. To provide risk reduction in this area it is recommended that an alignment of temporary flood measures be placed along the black dashed line (Alignment A) shown in Figure 6-1 above. There is flexibility in the shape and location of this alignment as long as both ends tie back into high ground outside of the floodplain. Due to the length and location of this alignment, it is recommended to utilize a combination of on-site and deployable measures. The on-site measures can help protect against tidal inundation and the deployable measures can be utilized at roadways or other areas that need to remain open. Gibson Park is a low-lying area of the peninsula and may be designated to withstand flooding in the short-term.

Figure 6-2: MC-FRM Predicted Present Day Probability Due to 1 Percent ACE Storm

Additionally, under present day 100-year storm conditions, there is coastal flood pathway along Rice Avenue in the southern part of the Point of Pines between Goodwin and Alden Avenue, which is denoted by the red circle in Figure 6-2. To protect the homes in this area, two alternative alignments of temporary flood protection measures are proposed above. The shorter alignment (Alignment B1) is shown as a pink dashed line in Figure 6-1, while the longer alignment option (Alignment B2) is shown as a blue dashed line in Figure 6-1. There is flexibility in the shape and location of this alignment as long as both ends tie back into high ground outside of the floodplain. Due to the length and location of this alignment, it is recommended to utilize a combination of on-site and deployable measures. Alignment B2 would protect approximately three times as many properties in the Point of Pines Area, but is about 2,500 feet longer, and therefore is anticipated to be roughly twice as expensive as Alignment B1.

Further investigation of each asset is required to determine factors critical to the feasibility of implementing the temporary flood risk reduction measures. Specifically, drainage, seepage and structural analysis will have to be performed and existing topography and borings may need to be collected.

7. Conclusion

The research detailed in this report is summarized in Table 1 below.

Table 1: Summary Short-Term Resilience Measures

Resiliency Measure	Max Height	Coastal Loading	Anchor System Required	Storage/ Deployment Required	Visual Impact	Material Cost per LF
Aquafence	9 ft	✓[1]	✓	✓	Low	$$$
Tiger Dams	32 ft	✓	✓	✓	Low	$
Tubewall	40 in	✓	X	✓	Low	$$
Stoplogs	14 ft	✓	✓	✓	Low	$$$
Boxwall	20 in	X	X	✓	Low	$
INERO Flood Panel	5 ft	X	X	✓	Low	$$$
DefenCell	15 ft	✓	X	X	Medium	$
Geocell RDFW	72 in	✓	X	X	Medium	$$
Hesco Barriers	20 ft	✓	X	X	High	$
Trap Bags	42 ft	✓	X	X	High	$
Sandbag Wall	42 ft	✓	X	X	High	$

Total costs will vary based on height of the barrier, specific location, labor, installation, and storage. The costs provided in the table above are for materials only and are grouped into three categories. These costs do not include any drainage, seepage or structural work that may also need to be done.

I. $ = $0-100

II. $$ = $100-300

III. $$$ = $300+

Based on these findings, Aquafence, Tiger Dams, Tubewall and Stoplogs would be the best deployable measures for the Point of Pines Peninsula since they can all withstand coastal loading. All of the on-site measures listed above can also withstand coastal loading and would be viable options for the project site. These short-term resilience measures can be implemented as temporary protection while longer-term resilience interventions are being developed.

[1] AE only

8. Acronyms

Ac.	Acres
Ft. or ft	Feet
In. or in	Inches
MC-FRM	Massachusetts Coastal Flood Risk Model
MLW	Mean Low Water
MPO	Metropolitan Planning Organization
NYRCR	New York Rising Community Reconstruction
NGVD	National Geodetic Vertical Datum
PoP	Point of Pines
USACE	United States Army Corps of Engineers

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