Belle Isle Marsh

Climate Vulnerability Assessment

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Prepared for:
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Executive Summary

Belle Isle Marsh is the largest remaining salt marsh in Boston Harbor, designated as a 359 acres Area of Critical Ecological Concern (ACEC) and supports approximately 266 acres of salt marsh wetland and transitional marsh habitat (Figure 1). The marsh is surrounded by the low-lying, densely developed communities of East Boston, Revere, and Winthrop. Past flooding has damaged both public and private infrastructure, and has impaired critical services, such as public transportation and evacuation routes. All the while, the marsh is suffering increasing environmental stressors, negatively impacting marsh health and longevity. Climate change threatens to exacerbate such risks to both community and marsh. This project emerged from a recognition by stakeholders of the necessity for addressing near-term climate vulnerabilities through regional collaboration.

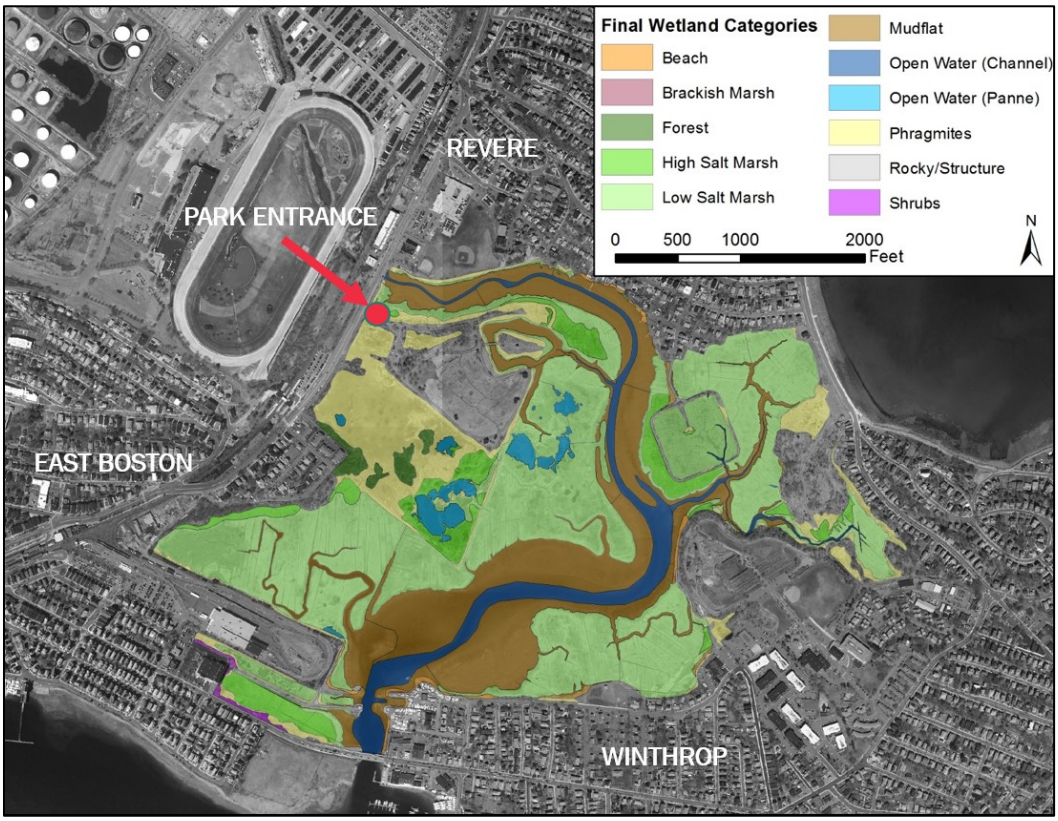

Figure 1. Belle Isle Marsh Climate Vulnerability Assessment – Project Area and Habitat Map.

This Climate Vulnerability Assessment investigates marsh and community risk to sea level rise and storm flooding and opportunity for nature-based strategies to prolong the habitat value of Belle Isle Marsh Reservation and minimize coastal flood damage to Winthrop, East Boston, and Revere. Woods Hole Group analyzed habitat and community risk to sea level rise and storms:

Habitat Risk: Belle Isle Marsh supports over 250 bird species (seven listed as threatened or endangered), serves urban development through mitigating the effects of climate change (buffer to storm surge, flood storage capacity, heat island reduction, carbon sequestration), and provides important open and recreational space for the public. Today, human impacts marsh have significantly altered the marsh through urban development, artificial fill, mosquito ditches, stormwater outfalls, and more. Resulting impacts have impaired habitat extent, biodiversity, natural hydrology, sediment delivery, and nutrient loading patterns, leading to the degradation of the marsh and loss of habitat value. In the future, Belle Isle Marsh is at risk of gradually becoming open water and mudflat due to sea level rise, eliminating its habitat, recreational, and coastal protection value. Critical habitat for the saltmarsh sparrow and other wildlife, already experiencing habitat loss, will be squeezed out from between development and the rising ocean if action is not taken.

Community Risk: Today, there is already a threat to the mobility and safety of the communities surrounding the marsh as demonstrated on December 23, 2022, when a nor'easter caused flooding throughout the project area including Bennington Street in East Boston, Fredericks Park, the Beachmont School, Belle Isle Avenue, and Montfern Avenue in Revere, and Morton St in Winthrop. Future sea level rise and storm projections represent a significant flood risk to communities surrounding Belle Isle Marsh. Larger, lower probability storm events are anticipated to occur more frequently with sea level rise. Flood pathways which serve as tipping points for greater flood hazards were identified, in order of exposure, at Banks St and Morton St (Winthrop), Bennington St and Fredericks Park (Boston and Revere), MBTA Orient Heights Railyard and Austin Ave (Boston), Winthrop Parkway at Short Beach (Winthrop), Argyle St and Bayou St (Winthrop), and Saratoga St (Boston). These flood pathways present risks to critical infrastructure such as evacuation routes (Winthrop Parkway, Bennington St, Saratoga St/Main St), public transportation infrastructure (MBTA Blue Line and maintenance railyard), and electrical utilities (Winthrop substation), as well as numerous Environmental Justice communities.

A prioritization matrix (below left) was developed to breakdown the marsh perimeter into thirteen unique reaches and identify the greatest opportunity and need for nature-based adaptation. Key criteria evaluated relative flood protection value, habitat restoration value, community and public access value, permitting feasibility, construction feasibility, design life, and cost magnitude. A second prioritization matrix (below right) supported the development of conceptual strategies for each reach. Climate change adaptation concepts were developed for habitat enhancement and flood risk reduction:

Shoreline Site	Prioritization Score (max 18)
Fredericks Park	15
Bennington St	14
Winthrop Boat Yard / Main St	14
Short Beach	14
Morton St / Marine Ecology Park	13
Rosie's Pond	13
Excel Academy	13
Bayou St / Argyle St	13
MBTA Railyard	12
Lawn Ave	10
Residential Revere	9
Residential North Winthrop	9
Cemetery	5

Adaptation Strategy	Prioritization Score (max 21)
Hybrid Approach	16
Lane Reduction	15
Living Levee	15
Salt Marsh Restoration	14
Beach Nourishment & Dune Restoration	14
Stormwater Management	14
Public Access	13
Monitoring Programs	11
Hard Infrastructure	11
Living Breakwater (Oyster Sill)	10
Engineered Sill	10
Thin Layer Deposition	9
No Action	9

To further guide adaptation development, priorities and values were developed through a combination of literature research, discussions with stakeholders and the public, and outcomes of the Belle Isle Marsh Assessment (WHG, 2022). The intersection of priorities and values with marsh vulnerability and flood risk led to the identification of adaptation goals. Adaptation goals subsequently led to the development of adaptation strategies which could feasibility achieve such goals:

Priorities and Values		Adaptation Goals	Adaptation Strategies
Flood Protection	Storm surge and sea level rise protection	Expand and enhance transitional/upland areas for flood protection and accommodation	No Action
	Wave attenuation	Address marsh erosion	Salt Marsh Restoration for Marsh Resilience
	Intercept flood pathways	Enhance vegetation to maximize wave attenuation	Engineered Sill for Marsh Toe Protection
	Erosion control	Build elevation capital for resilience to sea level rise	Living Breakwater for Marsh Toe Protection
	Stormwater management	Expand high marsh area for saltmarsh sparrow and spring tide flood protection	Thin Layer Deposition (TLD)
	Risk avoidance	Maximize social benefit of Belle Isle Marsh, while minimizing human impact to resources	Living Levee
Habitat Quality and Biodiversity	Habitat diversity and connectivity		Beach Nourishment and Dune Restoration
	Food web support		Stormwater Management
	Biodiversity		Hard Infrastructure (seawall, revetment, raised roadway)
	High marsh habitat		Public Access Trails and Signage
	Transitional and upland habitat		Flood Control Structure
	Water quality		Managed Retreat (e.g., Lane Reduction)
	Carbon storage		Monitoring Program
Community Support and Engagement	Regional approach		Hybrid Approach
	Community outreach		
	Educational and monitoring programs		
	Recreational and open space		

Two priority sites were selected for alternatives development and performance modeling: Bennington St to Fredericks Park (Boston and Revere), and Morton St to Banks St (Winthrop). The preferred adaptation alternative tended to focus on the concept of a living levee (Figure 2). A living levee is a relatively new approach to reducing both riverine and coastal flood risk. The concept involves grading shorelines to be gently sloped or terraced from the lowest elevation habitat (e.g., mudflat/low marsh) up to a critical flood elevation. Living levees facilitate future marsh migration by creating high and transitional marsh and upland open space areas, while simultaneously attaining a critical crest elevation for storm flood protection. As the footprint spans ecotones, a living levee requires planting of appropriate native vegetation for habitat enhancement and wave attenuation. At its crest, the living levee can support public access trails. An engineered impermeable core provides a foundation for trails and inhibits flooding through seepage. Integrated with the living levee, the alternatives may include lane reduction and/or roadway elevation to create space for the levee and address flanking flood pathways where a levee is not feasible.

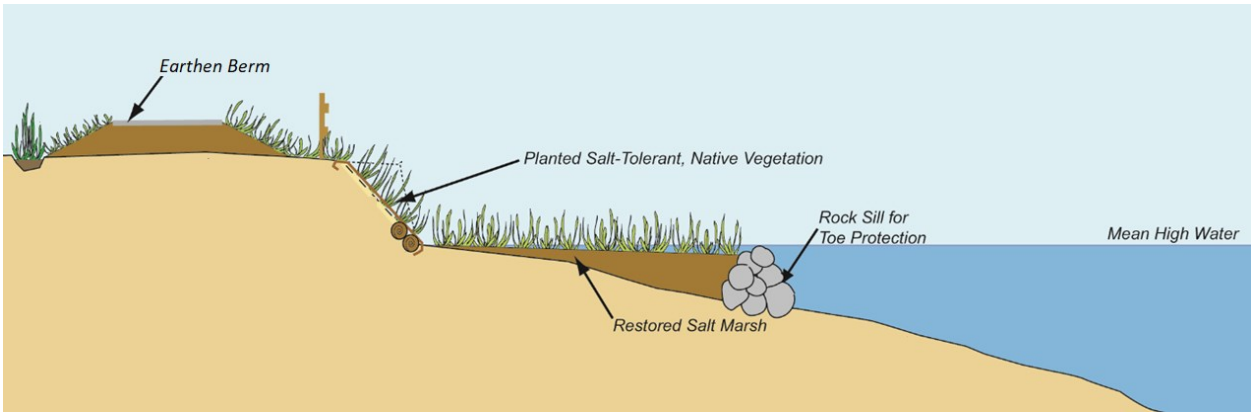

Figure 2. Conceptual diagram of a living levee which builds or restores natural habitat types successively in elevation to achieve a critical flood design level.

Utilizing the Massachusetts Coast Flood Risk Model (MC-FRM), Woods Hole Group evaluated the potential successes and drawbacks of alternative alignments for flood protection. The results of the modeling effort indicate the following:

- The Bennington Street/Frederick's Park alignment features independent benefits in eliminating flooding during storm events smaller than the 1% storm in present day, or the 25% storm in 2030 (equivalent water levels) but fails to eliminate flooding in larger events due to other flood pathways stemming from Chelsea Creek and Roughan's Point.
- The Bennington Street/Frederick's Park alignment features independent benefits of depth reduction in storms that are larger than the 1% storm in present day, or the 25% storm in 2030.
- The Morton Street project could provide protection to the community under a 1% storm in 2070. The alignment that features a living levee along the marsh edge protects an additional 1 commercial and 8 residential properties when compared to an alignment that raises Banks Street.
- There is no increase in water surface elevation, and therefore no increased flooding, to properties surrounding the alignments when the design is in place for both priority sites with all alignments considered.

At the end of this project, the team learned that effective near-term adaptation requires mitigating flood pathways across jurisdictional boundaries, as well as integrating flood protection into existing natural resources and infrastructure. Ultimately, enhancing the balance between society and nature is the intention of adaptation at these sensitive sites.

The adaptation strategies developed for each reach prioritize green infrastructure, living shorelines, and natural and nature-based features to the maximum extent practicable. Where necessary due to flood risk or existing conditions (e.g., available space), hard infrastructure is proposed. The preferred strategy at both Bennington St/Fredericks Park and the Morton St reaches incorporate adaptation strategies including living levee, lane reduction, salt marsh restoration, stormwater management, and public access.

Filling and conversion of wetland resource areas is proposed in certain instances to facilitate sea level rise resiliency, though it is recognized that permitting of such work will be difficult. As a preferred alternative is carried forward to design and permitting in later phases, it may be necessary to build mitigation into a design, and/or identify mitigation opportunities elsewhere within Belle Isle Marsh. Pre-application permitting discussions with local, state, and federal agencies will be important for identifying feasible permitting pathways, and further refining design.

Furthermore, determining a target storm and sea level rise scenario for protection will allow alternative design to progress. Owners and stakeholders should aim to strike a balance between flood protection, habitat enhancement, and natural resource impacts, all the while addressing public access. Extensive community outreach and regulatory coordination will be required to determine a preferred approach. Difficult conversations are anticipated regarding project design elevations and alignments, as this will result in varying degrees of flood mitigation to communities. However, no action is the worst possible outcome, as existing flood risk and habitat vulnerability is only projected to worsen in the near future.

Looking ahead, the regional group agrees that more work is necessary. Winthrop, Boston, and Revere have submitted MVP FY24 applications to facilitate further regional stakeholder and community engagement, and conduct alternatives analysis, preliminary engineering, and permit applications in support of resilience projects to mitigate flooding.

To find details and follow the succession of work prepared leading to future phases, the following appendices are included representing the technical work of this Climate Vulnerability Assessment:

Appendix A: Belle Isle Marsh Climate Vulnerability Assessment – Task 2.2 Flood Risk

Appendix B: Belle Isle Marsh Climate Vulnerability Assessment – Task 2.3 Future Conditions

Appendix C: Belle Isle Marsh Climate Vulnerability Assessment – Task 2.4 Strategy Identification

Appendix D: Belle Isle Marsh Climate Vulnerability Assessment – Task 2.5 High-resolution modeling of storm wave height and energy attenuation at Belle Isle Marsh under different restoration and climate scenarios

Appendix E: Belle Isle Marsh Climate Vulnerability Assessment – Task 6.1 Alternatives Analysis and Selection

Appendix F: Belle Isle Marsh Climate Vulnerability Assessment – Task 6.2 Cumulative Impact Modeling and Analysis

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