WINTER ISLAND PARK

City of Salem, Massachusetts

Site Assessment Memorandum

June 28, 2024

WILKINSON
ECOLOGICAL DESIGN

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INTRODUCTION & PURPOSE

The Winter Island Park Pathway and Bank Restoration Project seeks to address the severe coastal erosion that has impacted much of the Park's shoreline and pathway system in recent years and to address the extensive incursion of invasive plants that comprise much of the vegetative cover in the Park.

The purpose of this memorandum is to document and assess the current state of erosion, ongoing erosion rates and trends, and to identify and document invasive plants growing within the assessment areas.

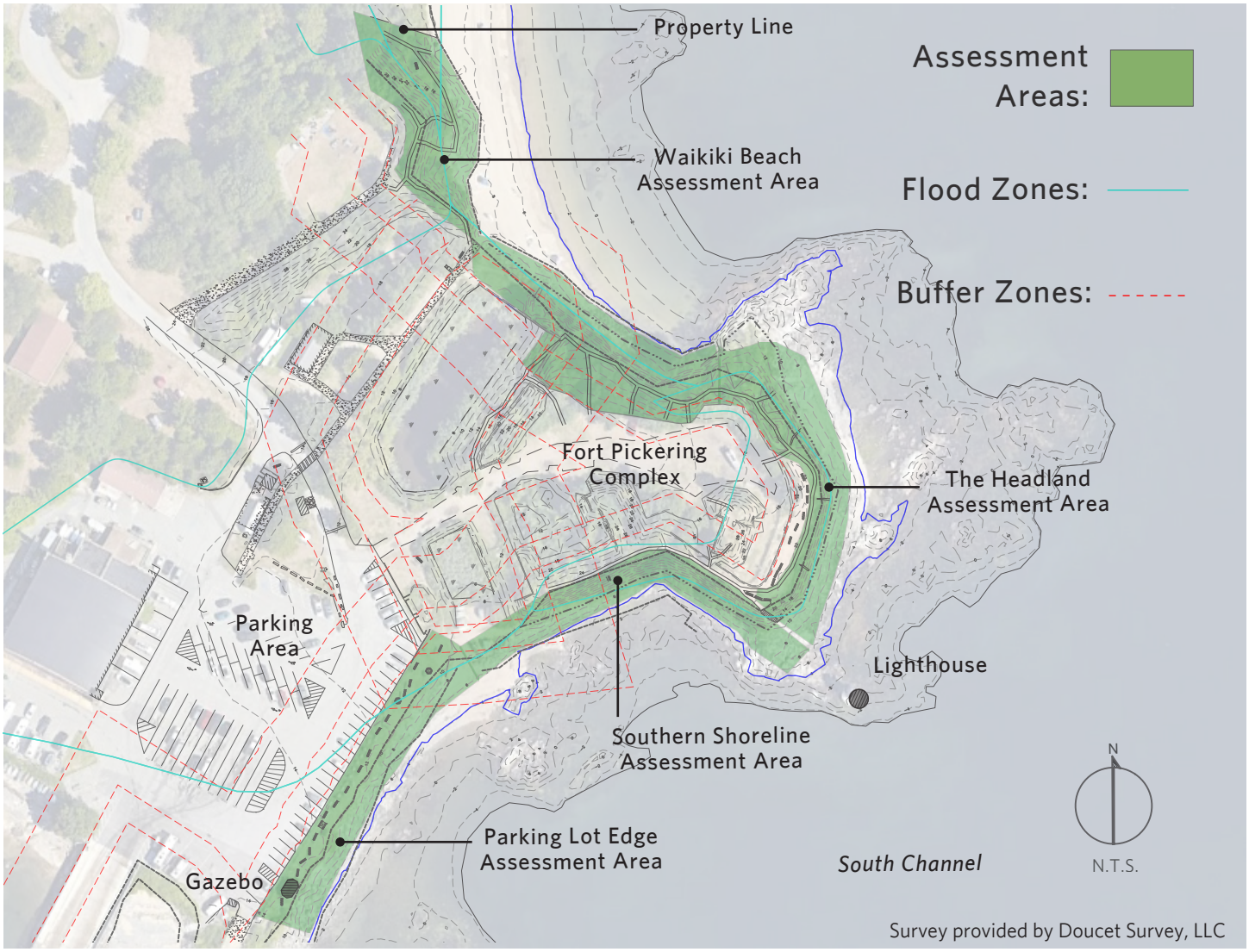
PROJECT SITE & HISTORY

The project site is Winter Island Park, a municipal park located on Winter Island in the City of Salem. The Park is situated off of Salem Neck and is surrounded by several water bodies that comprise the entrance to Salem Harbor including Cat Cove, South Channel, and Juniper Cove.

Fort Pickering forms the central part of the Park that also includes a camping area, a sandy beach, and a boat ramp. Remnants of the Fort can be seen throughout the Park but especially in the central area that contains several stone bunkers and the earthen rampart that follows the shoreline and outlines the Fort perimeter. Footpaths both formal and informal are present throughout the Park and allow the public to access many of the historic features and the shoreline.

Site Locus N.T.S.

PROJECT ASSESSMENT AREAS



Parking Lot Edge

The primary parking area for the Park is located to the southeast of the island. The parking area serves daily visitors to the Park, as well as RV campers during the summer season. An approximate twenty-foot wide mown grass strip extends along the east facing length of the parking lot from the existing gazebo to the headland that comprises the outer wall of Fort Pickering. This grass strip houses underground utilities for campers and contains multiple seating benches and a gazebo at the southern end. The seaward edge of the grass strip has become severely undercut in the winter storms of 2024. The foundation of the gazebo is also becoming undermined.

Southern Shoreline

The southern shore of the headland is a steep, heavily invaded Coastal Bank fronted by a shallow grade revetment that extends seaward from the bottom of the bank. A pathway that once allowed foot traffic access up the bank to the elevated earthen rampart that surrounds the Fort has become severely undermined. There is visual evidence that the low-lying revetment has been overtopped by storm surge and is eroding the Coastal Bank in several locations. This erosion, coupled with a predominantly shallow rooted, non-native plant community, creates a condition where the bank is likely to become more unstable over time.

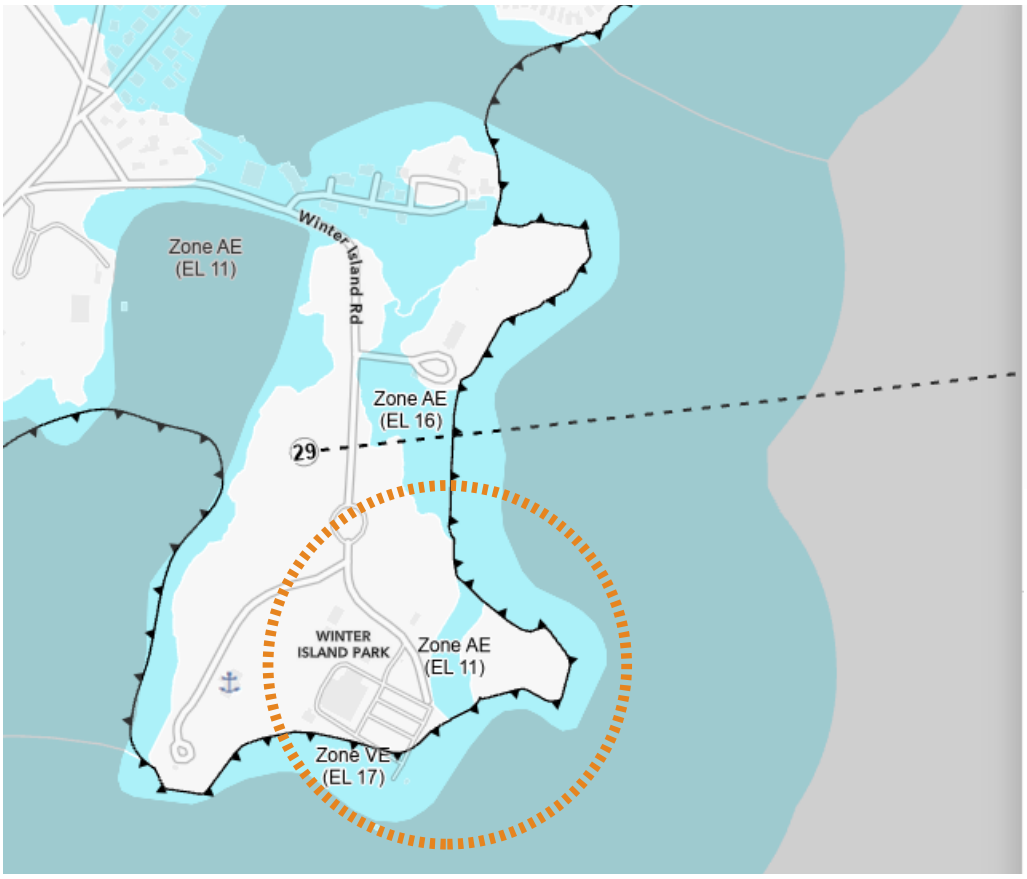
The Headland

The rocky outcrop that forms the point of the headland faces due east/northeast towards the lighthouse. The shallow-grade revetment continues along the shoreline and erosion at the base of the Coastal Bank was also observed in this area. The vegetative matrix on the Coastal Bank in this area is similar to that of the southern shoreline, with a mix of native and non-native plant species. A two-foot wide grass strip extends from the edge of the heavily traversed footpath to the top of the bank. Eroded channels cut down the bank at several points along the headland. The walking path in this area forms the main part of the earthen rampart surrounding the Fort. The Coastal Bank on the northern part of the headland becomes steeper and more undercut with bare, eroding soils readily apparent beneath a dense cover of invasive vines.

Waikiki Beach

The Coastal Bank forms a crescent around Waikiki Beach with bank heights undulating from high to low in a northerly direction. The sandy arc of Waikiki Beach is backed by naturally occurring ledge on the northwestern end and a degraded revetment at the eastern end. There is an approximate 10' gap between these stones and the bottom of the unarmored Coastal Bank, which is filled with sand and small cobbles. The Coastal Bank itself is significantly eroded in several locations and covered with invasive vines and trees. Many informal foot paths cut down the bank to the beach from the more established path at the top of the bank on the earthen rampart. These informal paths have created significant erosion over time.

FLOOD ZONES SEA LEVEL RISE & PROJECTED SHORELINE CHANGE MAPS



FEMA National Flood Hazard Layer

Coastal Flood Zones

1% Annual Chance Flood Hazard

0.2% Annual Chance Flood Hazard

Other FEMA Map Features

Coastal Transects

Limit of Moderate Wave Action

CZM disclaimer:The GIS data, maps, and other information provided should be used only as a screening-level tool for planning and management decisions. This tool should not be used for navigation, permitting, or legal purposes.

FIGURE 1: FEMA Coastal Flood Zones

NOAA Sea Level Rise above Mean Higher High Water (MHHW)

MHHW

MHHW + 1 ft Sea Level Rise

MHHW + 2 ft Sea Level Rise

MHHW + 3 ft Sea Level Rise

MHHW + 4 ft Sea Level Rise

MHHW + 5 ft Sea Level Rise

MHHW + 6 ft Sea Level Rise

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FIGURE 2: Projected Sea Level Rise

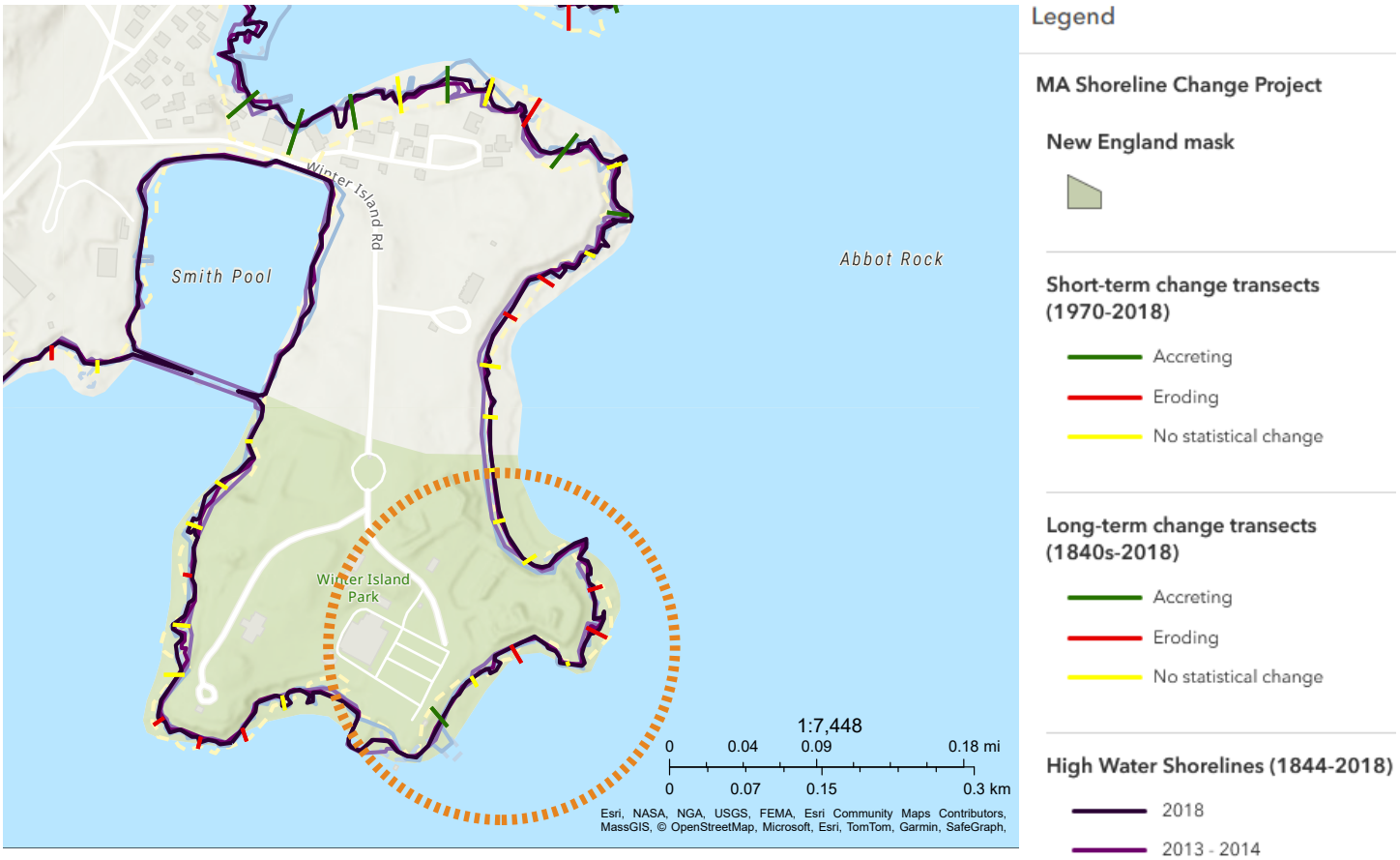

FIGURE 3: WINTER ISLAND SHORELINE CHANGE

SHORELINE CHANGE ANALYSIS & TRENDS

The three maps above and to the left (*Figures 1-3*), were generated by the Sea Level Rise and Coastal Flooding Viewer, and Massachusetts Coastal Erosion Viewer from the Massachusetts Office of Coastal Zone Management (CZM). These maps illustrate the extent to which the shoreline of Winter Island Park is likely to be impacted by coastal storms, flooding and sea level rise.

The southwestern and central portions of the Park, and the Waikiki Beach area, in particular, are low-lying and fall within the current FEMA defined 100-year Flood Zone & Velocity Zone VE (EL. 17-feet). The topography in these areas is well below the Velocity Zone limits in most locations. These areas are likely to see continued impacts similar to those observed over the past several winters. When compounded with projected sea level rise, the probability of impacts from flooding and storms increases exponentially across the entire shoreline of the Park, with the likelihood of impacts to inland infrastructure and the higher elevation portions of the site increasing over time.

The shoreline change map above illustrates the extent to which the shoreline of Winter Island Park has been altered by human intervention over time. The high water line has changed in response to the building or removal of structures and fill, particularly along the Parking Lot Edge and the Headland. Short and long term erosion and accretion rates along the transects appear to have remained consistent, with the Headland being the most vulnerable to erosion. Recent storm activity, post 2018, may be altering rates of erosion in relative transect locations that had been stable in previous years. Projected impacts from sea level rise and climate change will likely impact these locations in the future.

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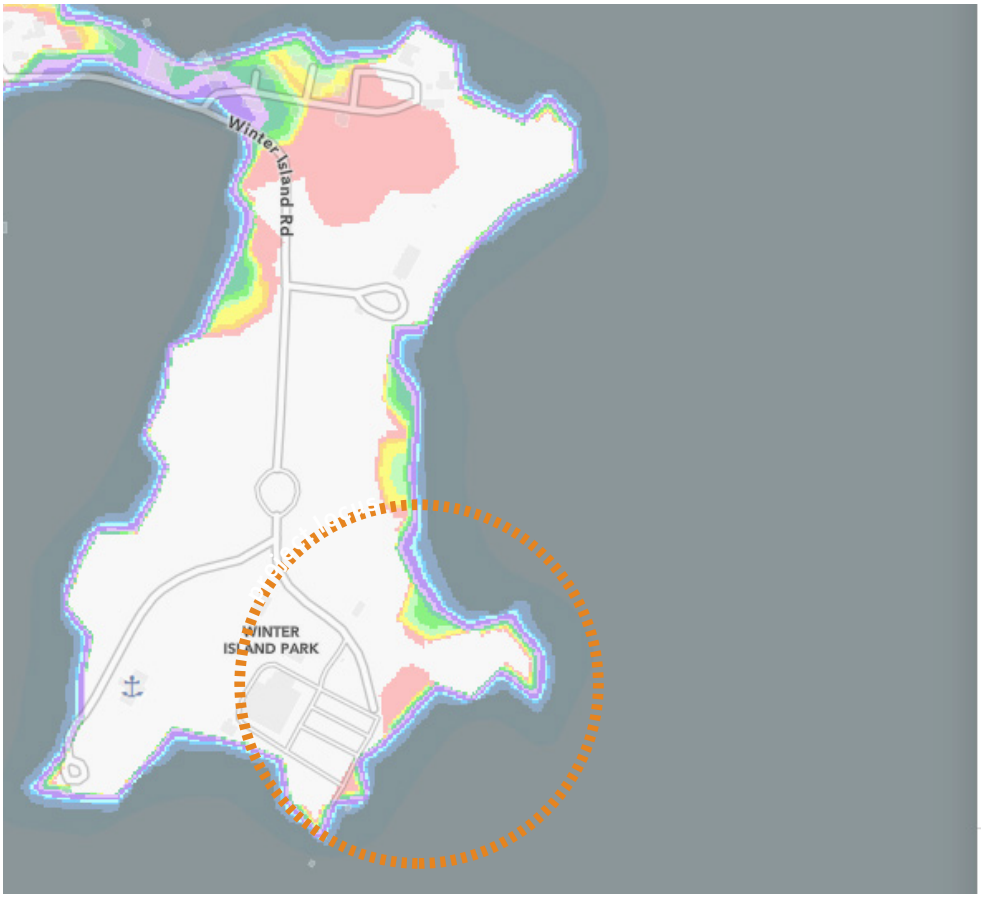
FLOOD ZONES SEA LEVEL RISE & PROJECTED SHORELINE CHANGE MAPS



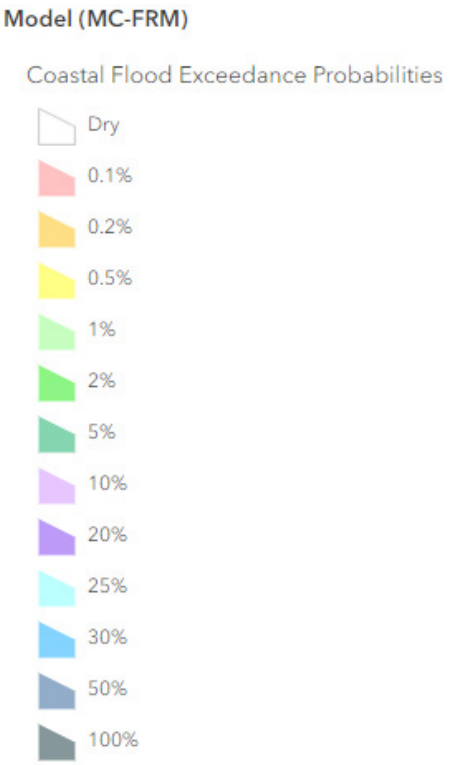


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FIGURE 4: FLOOD EXCEEDANCE PROBABILITIES 2030

The maps above and to the left (*Figures 4-6*), were generated by the Sea Level Rise and Coastal Flooding Viewer from the Massachusetts Office of Coastal Zone Management (CZM). These maps illustrate the projected probability of flooding in Winter Island Park in the near future of 2023, and over the longer term of 2050 and 2070. These scenarios include the presumption of continued sea level rise due to greenhouse gas emissions and storm events.

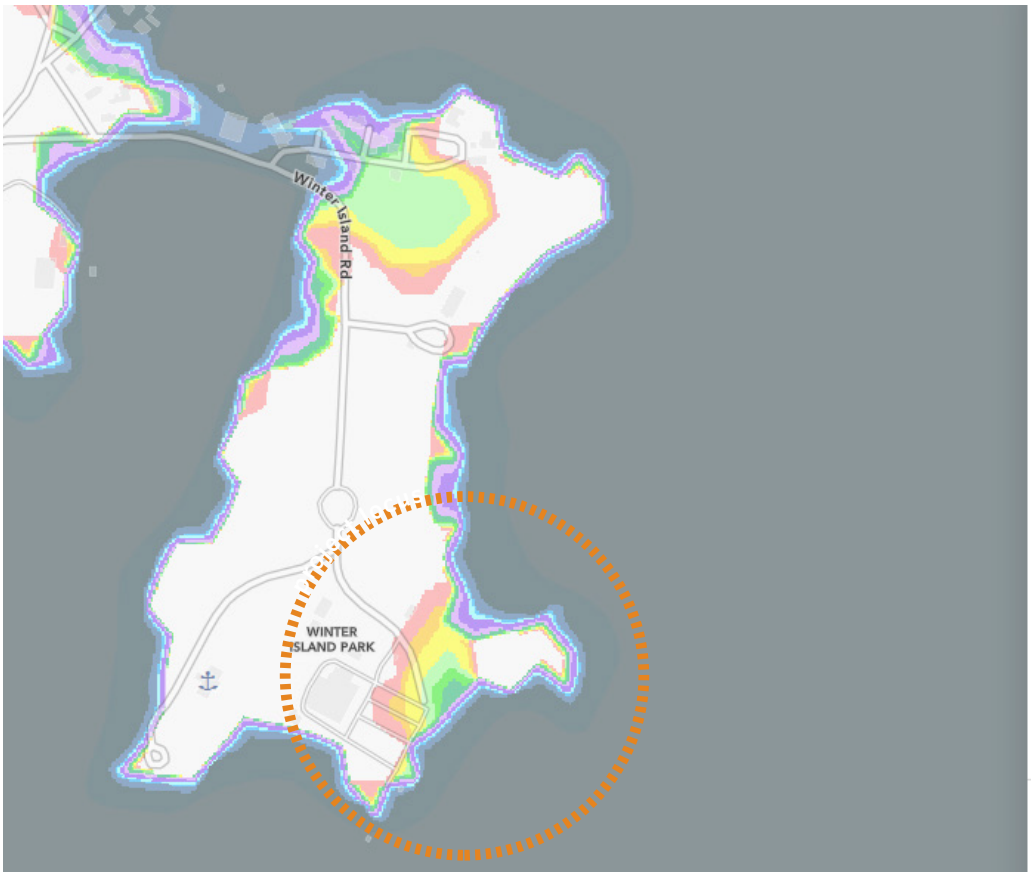

FIGURE 5: FLOOD EXCEEDANCE PROBABILITIES 2050

2050 Massachusetts Coast Flood Risk Model (MC-FRM)

Coastal Flood Exceedance Probabilities

- Dry
- 0.1%
- 0.2%
- 0.5%
- 1%
- 2%
- 5%
- 10%
- 20%
- 25%
- 30%
- 50%
- 100%

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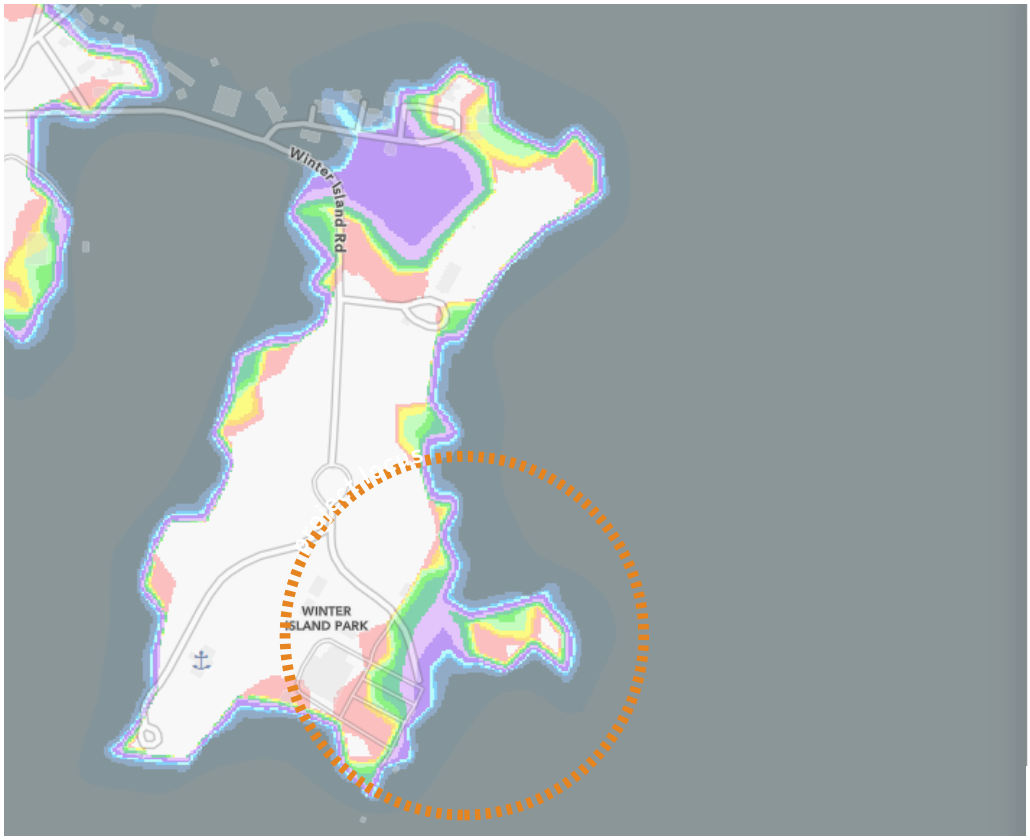


FIGURE 6: FLOOD EXCEEDANCE PROBABILITIES 2070

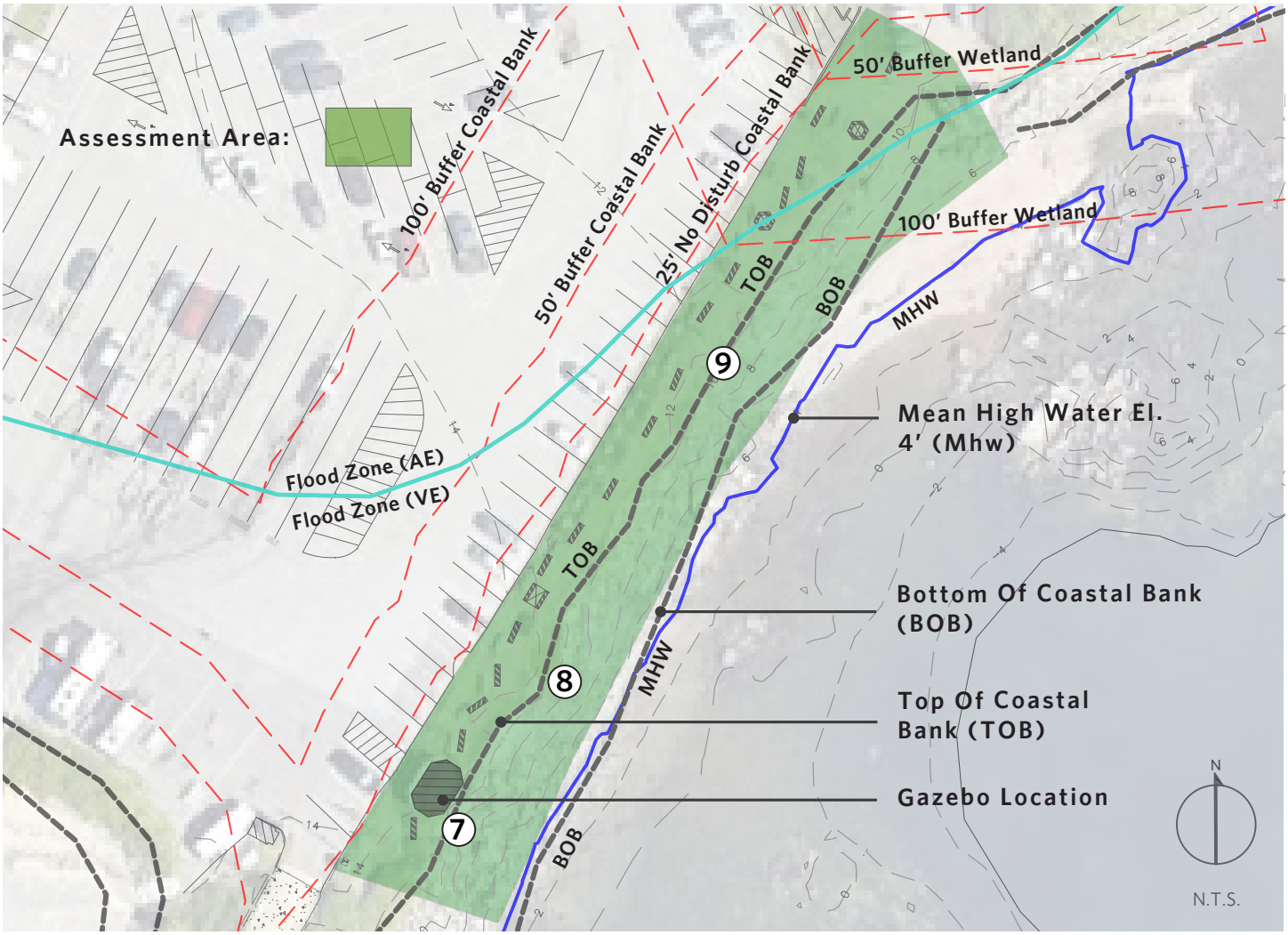
2070 Massachusetts Coast Flood Risk Model (MC-FRM)

Coastal Flood Exceedance Probabilities

- Dry
- 0.1%
- 0.2%
- 0.5%
- 1%
- 2%
- 5%
- 10%
- 20%
- 25%
- 30%
- 50%
- 100%

CZM disclaimer:The GIS data, maps, and other information provided should be used only as a screening-level tool for planning and management decisions. This tool should not be used for navigation, permitting, or legal purposes.

Parking Lot Edge Assessment Area



Survey provided by Doucet Survey, LLC

FIGURE 7: SOUTHWEST CORNER OF THE GAZEBO HAS BECOME UNDERMINED

FIGURE 8: ASIATIC BITTERSWEET GROWING AT THE EDGE OF THE COASTAL BANK

EXISTING EROSION

The Coastal Bank that runs the east facing length of the parking lot is undercut at an almost vertical angle. The root systems of the existing turf grass that grows at the top of the bank, and extends to the parking lot edge, are exposed at the seaward edge with sections of the bank having slumped or been completely eroded away (*Figure 9*).

The existing stones that comprise the lower bank have been subject to storm surge and extreme high tides during the winter and spring storms of 2023 & 2024 and will likely offer little protection to the existing parking lot and undermined gazebo foundation (*Figure 7*) in the near future. The undulating 20′ wide grass strip extends from the top of the bank to the edge of the parking lot is also heavily compacted by foot traffic, reducing the likelihood that existing vegetation can withstand the impacts of extreme tidal conditions.

This entire assessment area is within the 100-year flood zone as, defined by FEMA, which extends well into the low-lying parking area and gazebo location. The southeastern corner of the gazebo and parking area is entirely within the FEMA defined Velocity Zone (VE), which identifies areas where wave heights can reach 3′ during storm events (refer to Figure 1 on page 6).

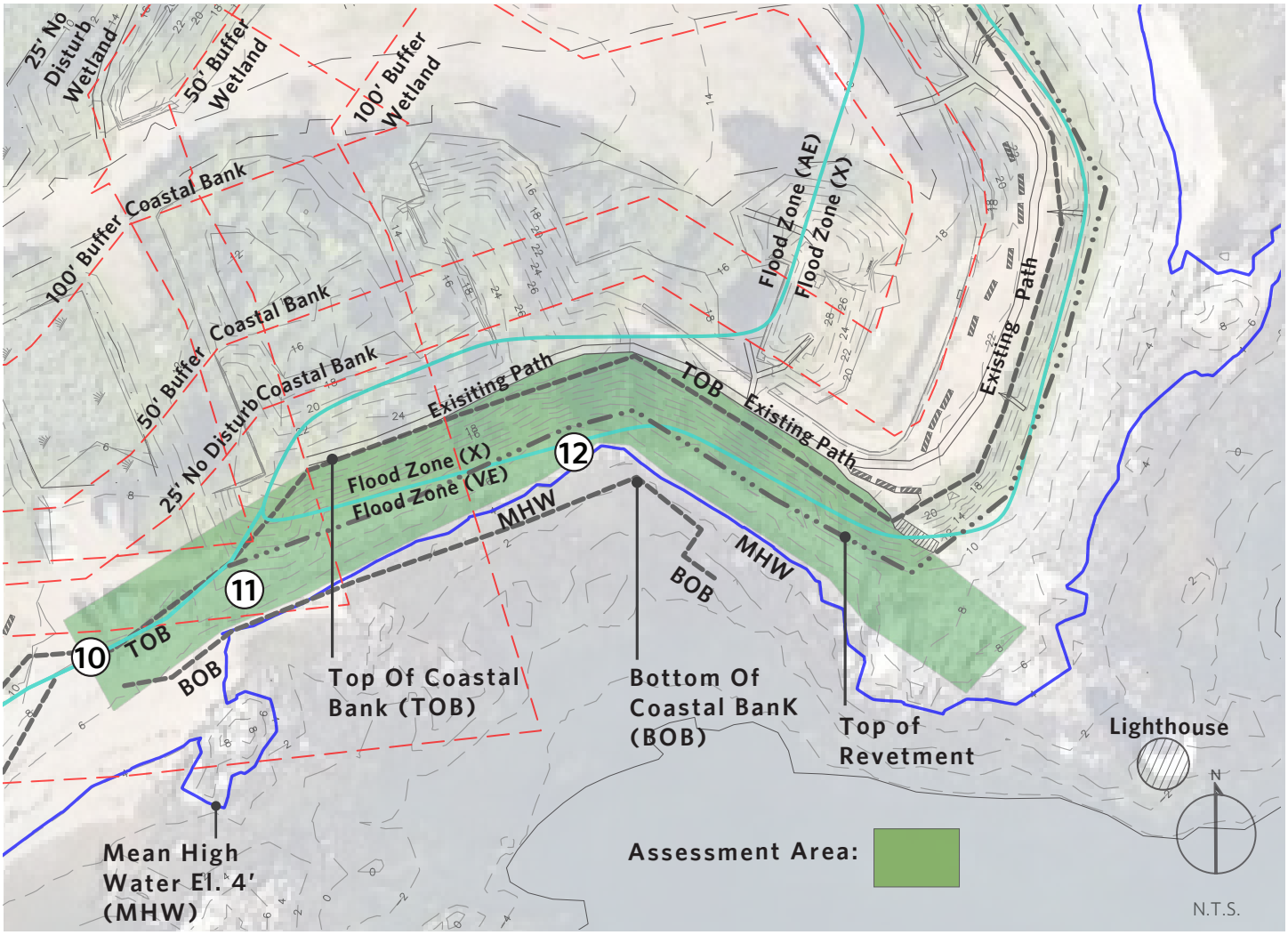
EXISTING VEGETATION & MANAGEMENT RECOMMENDATIONS

There is a limited amount of Asiatic bittersweet (*Celastrus orbiculatus*) growing at the eroded edge of the mown grass strip adjacent to the parking lot and between the revetment stones (*Figure 8*). It is recommended that Asiatic bittersweet in this area be treated and removed prior to implementing any erosion control strategy so that this invasive plant does not take root in any future erosion control solutions or planting.

The grass species that comprise the mown strip along the parking lot are likely a mix of non-native turf grass and self seeded native grasses. Management recommendations included establishing a no-mow buffer of deep-rooted and salt tolerant native grasses that can hold soils more effectively than shallow-rooted grasses and are more resilient to salt water over-wash. Though this area is well utilized by the public, WED recommends that foot traffic be restricted from as much of this area as possible, while native grasses are establishing. This could be accomplished with the installation of symbolic fencing, or other systems similar to what is used at the nearby Collins Cove salt marsh restoration. Shoreline stabilization measures, other than planting, will likely be required to stabilize and retain the Coastal Bank in this area and to protect the parking lot from future flooding. Planting should be performed in conjunctions with other shoreline stabilization methods that will retain soils until the root systems of the plantings become established.

FIGURE 9: THE STEEPLY ERODED EDGE OF THE COASTAL BANK

Southern Shoreline Assessment Area



Survey provided by Doucet Survey, LLC

FIGURE 10: BASE OF ERODED PATHWAY

FIGURE 11: SLUMPED SECTION OF COASTAL BANK

EXISTING EROSION

The southwestern corner of the assessment area, just beyond the seasonal kayak rack and existing pathway, is the most heavily eroded portion of this area. The lower half of the pathway and bank has been stripped to bare soils with the exposed roots of Asiatic bitterweet and staghorn sumac trailing onto the lower bank (*Figure 10*). The eroded entrance to the pathway is likely due to a combination of soil compaction from foot traffic and the flooding conditions present during storm events. Portions of the lower bank adjacent to the pathway have begun to slump onto the flat area just above the revetment (*Figure 11*).

As the shoreline extends to the east towards the lighthouse, the Coastal Bank becomes much steeper and taller. Portions of the bank are undercut along the extent of this area. The shallow angle of the existing revetment coupled with extreme tidal events allows stormwater to be directed and run-up to the toe of the bank. There is also an elevation drop between the top of the revetment to the bottom of the Coastal Bank, which could have a funnel-like effect on incoming stormwater compounding the effects of wave action. Bare soils at the ground level, over the majority of the assessment area, offer no protection from potential overland flow from the compacted footpath that follows the earthen rampart at the top of the bank. If the toe of the bank becomes further undermined, sections of the mid and upper bank, which supports many mature Sycamore maple trees may become destabilized. The 100-year flood zone (VE), extends approximately half way up the Coastal Bank, level with the top of the revetment or above.

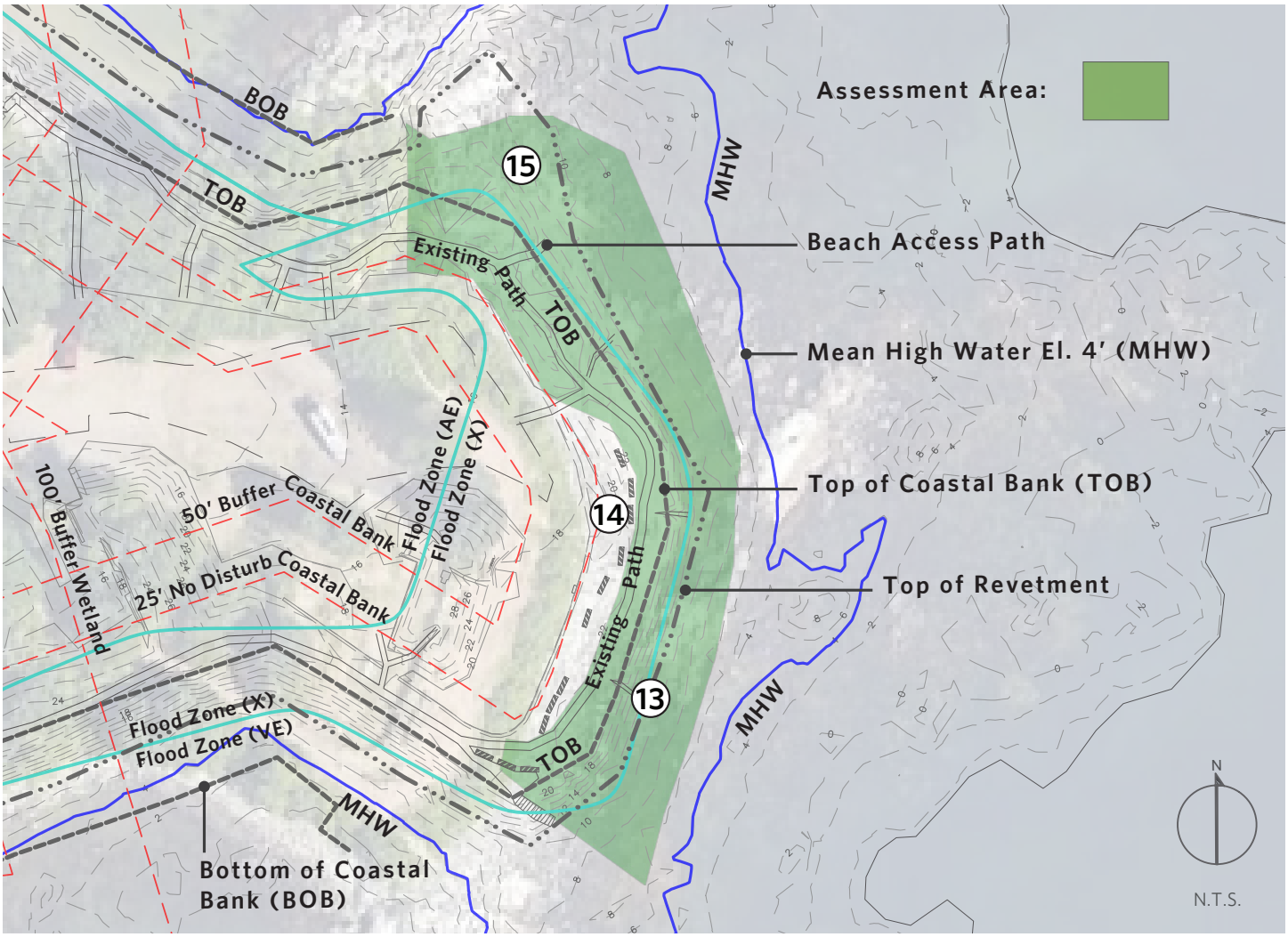
EXISTING VEGETATION & MANAGEMENT RECOMMENDATIONS

The entire southern shoreline, is heavily invaded with Asiatic bittersweet (*Celastrus orbiculatus)* and sycamore maple (*Acer pseudoplatanus*). Crabapple trees and saplings are present throughout this area but are particularly dense on the western end of the assessment area. Moderate clusters of native staghorn sumac are present near the eroding path from the parking lot and towards the lighthouse point. A ground layer of soil retaining grasses was observed where the sumac is most concentrated and appears almost entirely absent where there is a high density of Asiatic bittersweet and sycamore maple.

Vegetation management recommendations include the treatment and removal of Asiatic bittersweet from the entire area. Consideration should also be given to the selective removal of Sycamore maple trees (*Figure 12*). Sycamore maple is a significant invasive tree species observed throughout Massachusetts. This species' dense foliage and growth habit can significantly impact native forest understory stratification. Sycamore maple trees spread rapidly at maturity because of the large volume of seeds produced. In addition, Sycamore maple also exudes allelopathic chemicals that inhibit the growth of surrounding vegetation. In addition, large trees on steep banks can destabilize large portions of the bank if they topple. After invasive plant management is complete, planting of appropriate native grasses and shrubs on the bank is critical to establishing the deeply rooted biomass that will help retain bank soils during storm events, and to discourage the re-colonization of invasive and unwanted plants by limiting the resources available to such plants (i.e. sunlight, nutrients, and growing space).

FIGURE 12: SOUTHERN COASTAL BANK WITH LARGE SYCAMORE MAPLES TREES

The Headland Assessment Area



Survey provided by Doucet Survey, LLC

FIGURE 13: ERODED CHANNEL ON THE COASTAL BANK

FIGURE 14: COMPACTED FOOTPATH & GRASS EDGE

EXISTING EROSION

The shallow revetment continues from the southern shoreline around the point. The Coastal Bank facing the lighthouse is moderately steep with a series of deep, eroded channels extending from the top of the bank to the top of the revetment (*Figure 13*). These channels likely funnel stormwater down the bank during storm events. Soils at the top of the bank are heavily compacted and devoid of vegetation due to intensive foot traffic through this vista point, though the top 1 to 2 feet at the crest of the bank is vegetated with predominantly non-native grasses which likely limits foot traffic in this area (*Figure 14*).

As the shoreline wraps around to the point to the north, the Coastal Bank becomes steeper (*Figure 15*). Bare soils under a dense thicket of invasive vines are present across the whole northern bank, with scarping present at several points across the bank. The wrack line is present just above the revetment at the base of the unarmored bank. A well-worn pathway cuts from the top of the bank to the beach below and a limited amount of herbaceous vegetation was observed to be stabilizing soils at the bottom of the pathway.

The 100-year flood zone (VE), extends to the lower third of the Coastal Bank, just above or at the top of the revetment. The approximate toe of the unarmored Coastal Bank is likely within the (VE) zone and is vulnerable to wave action from storm events.

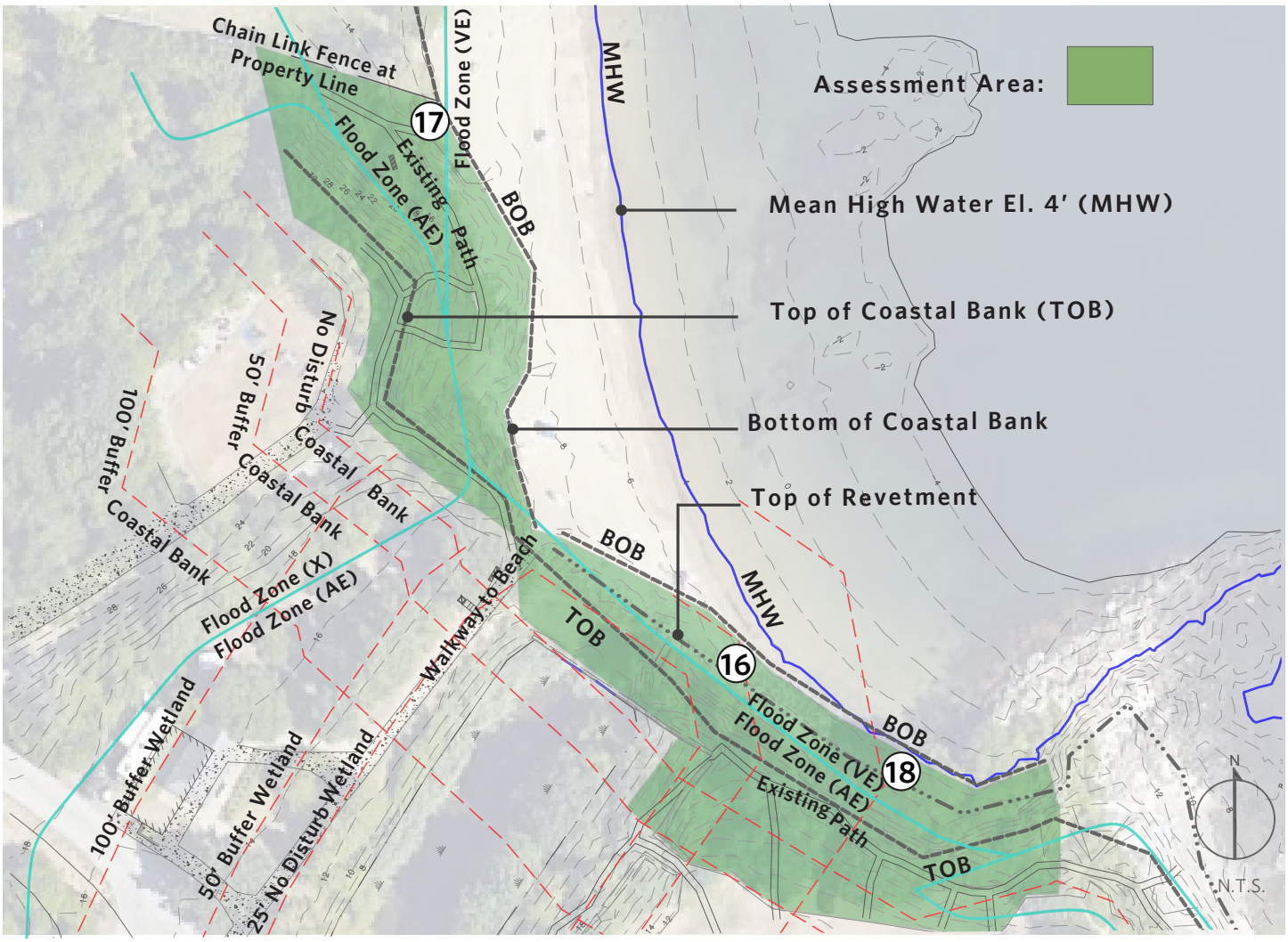
EXISTING VEGETATION & MANAGEMENT RECOMMENDATIONS

The Coastal Bank at the point and along the northern shoreline of the headland is also severely impacted by invasive vegetation. The bank facing the lighthouse is predominantly covered with Asiatic bittersweet, crabapple saplings and small trees, and staghorn sumac. As the bank turns north, vegetation becomes almost exclusively Asiatic bittersweet. Occasional native black cherry trees and saplings are present in the northwesternmost portion of the assessment area. The groundlayer of the bank across most of the assesement area is devoid of vegetation.

Vegetation management recommendations include the treatment and removal of Asiatic bittersweet from the entire area. Staghorn sumac, while native and a good bank stabilizer, may be a candidate for minimal management if views are to be considered. Management could consist of limited treatment and removal and/or selective pruning of height in key locations. At a minimum, crab apple sapling should be replaced with vegetation that will more effectively hold bank soils in place, like deeply rooted native grasses and salt tolerant shrubs. Pathway edges near the top of the bank should be revegetated to the extent feasible while still leaving adequate room to walk, and pathways that veer too close to eroded areas at the top of the bank, should be pulled landward where there is space to do so.

FIGURE 15: NORTH FACING COASTAL BANK COVERED WITH INVASIVE VINES

Waikiki Beach Assessment Area



Survey provided by Doucet Survey, LLC

FIGURE 16: ERODED CHANNEL ON THE COASTAL BANK

FIGURE 17: COMPACTED FOOTPATH & GRASS EDGE

EXISTING EROSION

The Coastal Bank forms a crescent around Waikiki Beach with bank heights undulating from high to low in a northerly direction. The bank furthest to the south of the assessment area is fronted by a rubble revetment with a gap of 10-20 feet between the top of the revetment and the toe of the bank. (*Figure 18)* Wrack and other storm debris is present within this gap. As the bank extends north towards the primary pedestrian entrance to the beach, the bank becomes less steep and is protected by natural ledge-like rock formations that jut onto the beach.

Bank soils on the southern end are highly compacted, vertical, and devoid of vegetation on the unarmored bank. It is apparent that bank sediment has been washing away over time due to the brick, metal and other artifacts that protrude from the bank or are lying on the beach (*Figure 16*). Overall the bank in this area is highly vulnerable to erosion from storm events.

Erosion on the northern end of the bank is mostly limited to locations where there is heavy foot traffic on the formal and informal pathways (*Figure 17*). Erosion in these areas is exacerbated by the density of invasive and non-native plants that cover the majority of the bank and do little to hold soils in place.

The AE Flood Zone surges well inland along the primary walkway to the beach and beyond, and may account for the scarps near the terminus to the walkway at the beach.

EXISTING VEGETATION & MANAGEMENT RECOMMENDATIONS

The Coastal Bank landward of Waikiki Beach hosts the greatest diversity of trees, shrubs and ground layer vegetation within the combined shoreline area. Invasive Asiatic bittersweet (*Celastrus orbiculatus*) and sycamore maple (*Acer pseudoplatanus*) are still well represented, but an expanded range of invasive plants also includes black locust, shrub honeysuckle, common buckthorn, multiflora rose, and garlic mustard, represented in moderate to heavy distribution. The ground layer is more heavily vegetated to the northern extent of the assessment area where the toe of the bank is protected by ledge and becomes less steep. Native oaks become more common towards the northern upland of the assessment area.

Vegetation management recommendations include the treatment and removal of all non-native invasive plants where feasible. Including the selective removal of large sycamore maple and black locust where they are growing on or adjacent to the eroding Coastal Bank. Invasive plant management should be followed by soil stabilizing planting of native grasses and salt tolerant shrubs.

FIGURE 18: NORTH FACING COASTAL BANK COVERED WITH INVASIVE VINES

SUMMARY OF FINDINGS

EXISTING EROSION

The shoreline of the Winter Island Park has been evolving for decades based on human usage, both current and historical, and climate and coastal processes. Shoreline change data collected by the State Massachusetts Shoreline Change Project between 1970 and 2018 shows erosion rates vary within the assessment areas ranging from 0.1 to 0.4 feet/year, particularly in the Southern Shoreline and Headland assessment areas. Though the shoreline change maps express that portions of the Parking Lot Edge and Waikiki Assessment Areas show no statistical change or even accretion (*Figure 3, page 7*), in the years since 2018, visual evidence of continued erosion impacts from more frequent storm events is present throughout the assessment areas in the form of visible wrack located at the toe of the Coastal Bank, and slumping and scarping occurring on all assessment areas.

Storm events coupled with the high volume of pedestrian traffic that moves through the Park on the existing and informal pathways serves to exacerbate erosion in some locations, particularly in the Parking Lot Edge, Waikiki Beach, and Headland Assessment areas. The existing revetments and revetment-like stone structures appear to be offering minimal protection to the Coastal Bank in the face of increased, intense storm events, and may even exacerbate impacts to the stability of the Coastal Bank. With the projected changes in sea level rise and revised flood zones, it is likely that erosion of the Coastal Bank will continue to happen in many locations in the near and long-term future.

Potential interventions to stabilize the shoreline could include both plant based "soft solutions", hybrid solutions, enhancement of hard structures, and realignment of pedestrian access. Further study is needed to determine the appropriate intervention for each of the assessment areas.

EXISTING VEGETATION & MANAGEMENT RECOMMENDATIONS

In summary, all assessment areas with the exception of the Parking Lot Edge, are heavily invaded with invasive and non-native plants across the Coastal Bank resource area, within the buffer zones to the bank, and further inland within the interior of the Fort Pickering complex. Invasive and non-native plants species observed in the assessment area represent approximately 85% percent of all vegetative cover. The invasive plant species that were observed in the greatest quantity are Asiatic Bittersweet and Sycamore maple. These two plants were present in all assessment areas except the Parking Lot edge, where only Asiatic bittersweet was observed. This is followed closely by non-native crab apple and native staghorn sumac which are both widely represented in both the Southern Shoreline and Headland assessment areas. Other observed invasive plants include black locust, multiflora rose, shrub and vine honeysuckle, common buckthorn, tree of heaven, and garlic mustard which grow in localized patches in the Southern Shoreline, Headland, and Waikiki Beach assessment areas. We believe the observed invasive and non-native plants represent the greatest threat to the ecological integrity of the Park, as they threaten biodiversity, contribute to soil destabilization and displace native plants, and recommend they be managed to the extent feasible.

Recommended management methods include targeted herbicide application and/or mechanical removal. Successful invasive plant management depends upon using the most effective treatment method for the individual plant species, implemented at the correct time of the year. The use of herbicide to treat State-listed invasive plant species should be carried out using best management practices. These practices take into account: the plant species phenology and herbicide efficacy, site conditions such as topography, and application methods that reduce herbicide volume and that minimize or omit over spray. Best management practices are designed to be environmentally sensitive, targeted, and effective. Mechanical removal techniques reduce herbicide use and are often used when site conditions allow. In general, mechanical removal methods can be effective for annual and biannual herbaceous species, and shallow-rooted woody species. Removals should be undertaken before a plant has set seed in the case of herbaceous, annual and biannual species, while woody species can be manually removed at any time. Mechanical removal methods include cutting, mowing, and hand pulling. Care should be taken to limit soil disturbance during mechanical removal. Follow-up invasive plant treatment is recommended for at least one growing season after initial management efforts have taken place and ideally over a longer period of targeted and well-timed follow up treatments.

Restoring native plants to areas where invasive plants have been removed is an important component of restoration success. After invasive plant removal has taken place, establishing native plant communities discourages the re-colonization of invasive and unwanted plants by limiting the resources available to such plants (i.e. sunlight, nutrients, and growing space). Deeply rooted native plants will also serve to better stabilize bank soils and provide enhanced habitat for local and migrant wildlife.

Invasive plant management on the steeper sections of the coastal bank should only be undertaken in conjunction with permitted coastal stabilization and/or repair of the existing revetments. Steep slopes, as exist in all assessment areas with the exception of the Parking Lot Edge, need careful consideration when undertaking a project which will disturb existing plants and soils, even on a temporary basis. Stabilizing steep slopes on the Coastal Bank will likely require a combination of interventions that include alternations to existing structures,and/or alternate solutions in combination with invasive plant removal and native planting.

PLANT INVENTORY & TREATMENT RECOMMENDATIONS

Best Management Practices (BPMs) for treating invasive plants maximize treatment effectiveness and minimize disturbance to natural resources. Individual life cycles, growing seasons, and infestation levels all inform which BMPs practitioners use for each target species. Treatment techniques may include mechanical removal, hand removal, and/or selective herbicide application.

Individuals performing invasive plant management must have field expertise in plant identification and knowledge of plant life cycles to execute the correct treatment method at the appropriate time of the year to effectively treat the targeted species without negatively impacting desirable native plants or natural resource areas.

The plant species listed below are predominately non-native, invasive species that have been identified in the assessment area. These plants threaten existing natural plant communities, soil stability, and resource areas The Massachusetts Invasive Plant Advisory Group (MIPAG) is responsible for classifying plants as invasive in Massachusetts. The plant species listed below include their invasive status as defined by MIPAG.

PLANT INVENTORY FOR WINTER ISLAND PARK ASSESSMENT AREAS

Non-native & Invasive Plant Species Observed :

Asiatic Bittersweet*	*Celastrus orbiculatus*
Crab Apple	*Malus sp*
Garlic Mustard*	*Alliaria petiolata*
Common Buckthorn*	*Rhamnus cathartica*
Black Locust*	*Robinia pseudoacacia*
Multiflora Rose*	*Rosa multiflora*
Sycamore Maple*	*Acer pseudoplatanus*
Shrub Honeysuckle*	*Lonicera morrowii*
Vine Honeysuckle*	*Lonincera japonica*
Tree of Heaven*	*Ailanthus altissima*
Rugosa Rose	*Rosa Rugosa*
Common Buckthorn *	*Rhamnus cathartica*

*MIPAG State-listed invasive plant

Native species Observed:

Staghorn Sumac	*Rhus typhina*
Oak Species	*Quercus sp.*
Black Cherry	*Prunus serotina*
Birch species	*Betula sp.*