DCR PARKWAYS FLOOD RESILIENCE ADAPTATION STRATEGIES

NANTASKET AVENUE, HULL SHORE DRIVE & HULL SHORE DRIVE EXTENSION

SEPTEMBER 2026

EXECUTIVE SUMMARY

The DCR Parkways Flood Resilience Adaptation Strategies Report presents a feasibility-level evaluation of potential approaches to improve coastal flood resilience along Nantasket Avenue, Hull Shore Drive, and Hull Shore Drive Extension within the Nantasket Beach Reservation (the Reservation) in the Town of Hull. The study builds upon the 2025 DCR Parkways Climate Change Vulnerability Assessment (CCVA), which identified these three parkway segments among the most flood-vulnerable in the statewide DCR system under projected conditions for sea level rise, storm surge, wave action, and extreme precipitation through 2070.

Aside from providing multimodal access to Nantasket Beach and the Reservation's abundant recreational amenities, these parkways also serve a critical role as one of the primary coastal access corridors on the Hull peninsula, supporting local neighborhoods, businesses, and transit service.

This report advances beyond vulnerability identification to focus on what types of adaptation strategies could realistically be implemented at this constrained coastal site. Strategies were evaluated at a conceptual level, considering physical space limitations, environmental resources, fragmented land ownership, regulatory requirements, historic context, and operational needs. A key component of this analysis involved testing scenarios that reduce roadway lane capacity and parking supply. These potential adjustments were intentionally explored to demonstrate how reallocating roadway right-of-way can significantly influence the type, scale, and feasibility of flood resilience strategies. In many locations, reductions in vehicular or parking capacity enable the integration of dunes, berms, promenade space, or structural protection measures without expanding beyond existing shoreline limits, improving both environmental and permitting feasibility. Parking and vehicular travel capacity are just one of the types of tradeoffs that DCR and project stakeholders will need to consider in balancing the achievable level of flood resilience.

To reflect the diverse conditions along the corridor, adaptation strategies were organized into four regions, each characterized by unique access needs, shoreline conditions, and land use patterns:

- **Region 1 – Hull Shore Drive Extension**

  This region emphasizes nature-based and hybrid strategies, including beach nourishment, dune enhancement (with and without rock cores), and raised shared-use promenades. Several options test lane reductions or full removal of vehicular access to maximize dune width, improve pedestrian and bicycle amenities, and create flexible flood buffers while maintaining access via the DCR parking lot from Nantasket Avenue.

- **Region 2 – Hull Shore Drive**

  Adaptation strategies in this area focus on structural and hybrid shoreline protection, such as expanded rock revetments, stepped seawalls, vegetated berms, and street-level promenades. Lane narrowing and parking reconfiguration are explored to balance flood protection with continued access to adjacent businesses, while minimizing shoreline encroachment and maintaining economic vitality.

- **Region 3 – Northern Nantasket Avenue**

  This region evaluates larger-scale space reallocation, including roadway realignment, partial roadway removal, elevated promenades, inland berms, and stormwater retention areas. Strategies here illustrate how reducing parking areas and consolidating traffic movement can create new open space and improve resilience while preserving key access functions.

- **Region 4 – Southern Nantasket Avenue and Parking Lots**

  Adaptation strategies in this southernmost region include raising or relocating vulnerable structures, stepped seawalls, elevated promenades, reinforced revetments, and recreational paths. Lane narrowing and selective parking reductions allow for enhanced pedestrian and bicycle circulation while integrating flood protection that respects historic character and high public use.

In general, raising the elevation of roadway sections is not viable due to the direct adjacency of both privately-owned buildings and land and DCR-owned buildings along a majority of the corridor. Doing so would lead to significant access issues throughout. As such, there is limited opportunity for raising the existing stormwater infrastructure to achieve higher discharge elevations. Consideration should be given to implementing backflow preventer flap valves at stormwater discharge pipes that currently have none. Should overtopping of shoreline adaptation measures occur in storm events greater than the design storm, manual or automatic deployable barriers should be considered to allow flood water back into the ocean once tide levels have subsided.

All strategies were qualitatively evaluated using DCR's eight Climate Adaptation Evaluation Criteria, highlighting trade-offs related to flood risk reduction, accessibility, environmental stewardship, cultural resources, transportation, community value, and cost. The list of advantages and disadvantages provided for each option are simply a high-level summary and do not constitute an exhaustive list. After an initial coordination with this report, any preferred strategies will need extensive analysis including an alternatives and feasibility engineering-based study to identify any potential impacts that may result from its implementation. The report concludes that no single solution can address the entire corridor; instead, long-term resilience will require a coordinated, context-sensitive combination of approaches informed by these future efforts.

INTRODUCTION

This report builds directly on the findings of the **Massachusetts Department of Conservation and Recreation (DCR) Parkways Climate Vulnerability Assessment (CCVA)**, completed in 2025, which itself builds on the 2020 **DCR Parkways Master Plan**. Together, these efforts identified the DCR-managed parkways most vulnerable to flooding in the years 2030 and 2070, based on projections for **sea level rise, storm surge, and extreme precipitation**. This report serves as a **feasibility-level evaluation of adaptation strategies** at **Nantasket Beach Reservation**, located in the Town of Hull.

Unlike the CCVA, which documented flood vulnerability and broader community context across DCR's entire 200-mile parkway network, this report focuses solely on **assessing what possible types of flood resilience interventions could be physically, spatially, and operationally viable at this priority site**.

It provides a high-level representation of multiple adaptation strategies – ranging from nature-based solutions to reinforced infrastructure – and qualitatively rates their **alignment with DCR's Climate Adaptation Evaluation Criteria**, alignment with DCR's 2016 Hull Master Plan, potential trade-offs, and spatial fit given real-world constraints. These strategies are intended to be used for informing future discussions with stakeholders, and to help inform future capital planning and project development. It is important to note that while this report includes a wide array of possible shoreline adaptations, inland adjustments, and combinations thereof, there are other potential variations and combinations of these strategies not shown, that may ultimately offer the preferred solution.

The need for this next level of analysis stems from the CCVA's identification of **Nantasket Avenue, Hull Shore Drive and Hull Shore Drive Extension as among the most vulnerable DCR parkways to flooding by 2070**. These three (3) segments serve not only DCR parklands but also provide critical year-round access to and from residential neighborhoods, businesses, hotels, and recreation destinations located on the Hull peninsula. They are also part of a designated evacuation route for isolated neighborhoods, heightening their significance in the face of climate risk.

The CCVA used a structured methodology to assess vulnerability, considering three (3) key indicators:

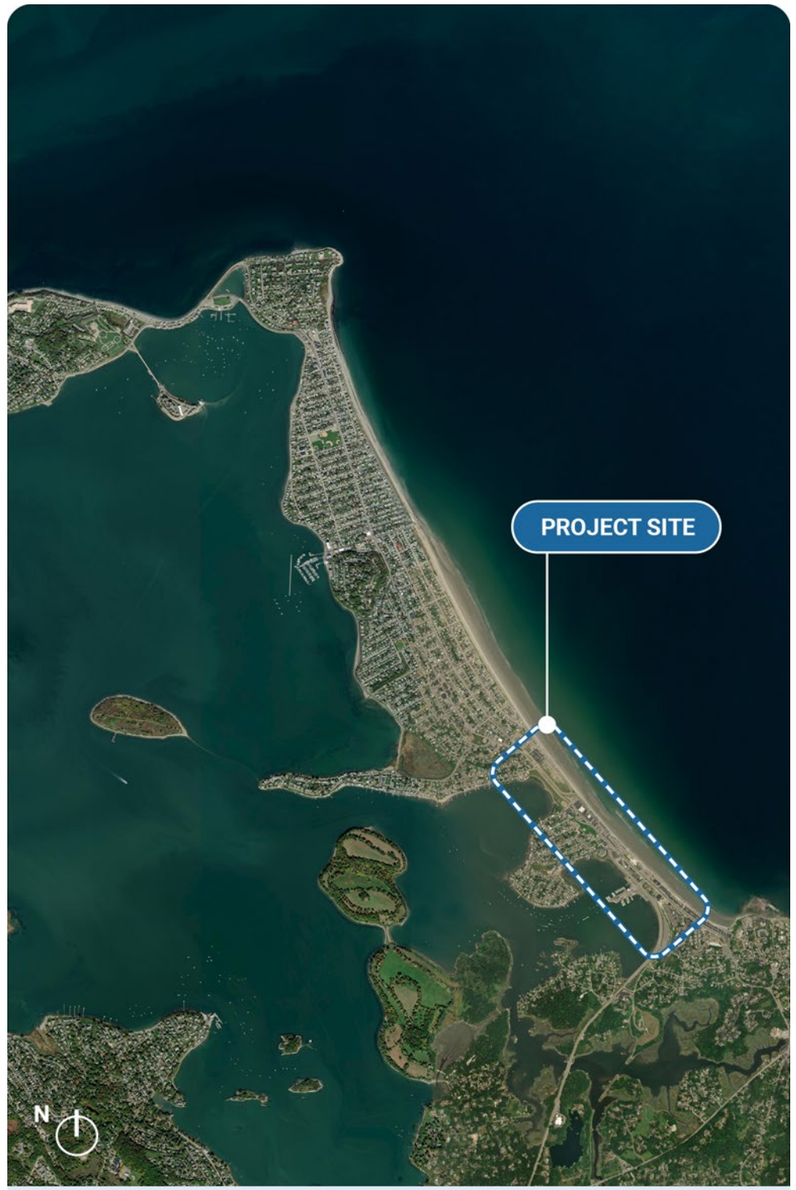
- **Exposure** to coastal and stormwater flooding hazards
- **Sensitivity** based on roadway characteristics (e.g., parking, transit use, flood history)
- **Adaptive capacity**, or the ability to withstand and recover from flood impacts

Each parkway segment received a vulnerability rating – **low, medium, high, or very high** – based on the weighted combination of these factors.

Nantasket Avenue was assigned a very high vulnerability rating due to its frequent exposure to both coastal and stormwater flooding, extensive on-street parking, high bus ridership, and designation as a historic roadway. These elements contribute to high sensitivity and lower adaptive capacity, particularly given the **average replacement cost of $150,000 per 100-foot segment**.

Hull Shore Drive and Hull Shore Drive Extension were also rated as highly exposed to flooding. While their sensitivity is lower due to the absence of transit service and less street-side infrastructure, they still present **medium adaptive capacity**, shaped by moderate traffic volumes (10,000 vehicles/day) and **significant replacement costs ($80,000 per 100-foot segment)**.

Together, these characteristics point to a highly constrained but critical corridor – and the need for comprehensive, context-sensitive adaptation strategies that intend to enhance the flood resilience of the entire Reservation while supporting continued access to its natural resources and operations of its recreational amenities, now and in the future.



Aerial View of Nantasket Avenue, Hull Shore Drive, and Hull Shore Drive Extension Project Limits

PAST, PRESENT, AND FUTURE OF DCR'S PARKWAYS

Boston's parkway system was designed to serve both recreational and transportation needs, with development of the Metropolitan Boston Parkway System in the late 19th century. Many of Boston's parkways were designed by Olmsted landscape architects, integrating into existing park landscapes, delineating park boundaries, and providing unintrusive access to parklands.

As the 20th century progressed, growing pressure to prioritize automobile traffic and access shifted the nature of the parkways, as facilities designed to support pedestrians, cyclists, or carriages were replaced with wider highways. In 1972, Massachusetts voters passed Article 97. This amendment to the Massachusetts Constitution established a right to a clean environment, declared natural resources conservation a public purpose, and instituted a requirement for a two-thirds legislature vote to use Article 97 land for non-conservancy purposes. Many of DCR's parkways are classified as Article 97 land or run adjacent to Article 97 land, providing required access to natural and recreational resources protected under the Massachusetts Constitution. Conversion of more recreational parkways to purely automotive uses was halted by the passage of Article 97, ensuring the continued function of the parkways in the 20th century.

Today, many of DCR's parkways retain features that support non-automotive uses and continue to connect users to recreational spaces, amenities, and natural resources, while others more closely resemble traditional highways, functioning as critical transportation connections and, in some cases, unofficial evacuation routes. Regardless of the primary purpose of each individual parkway, DCR's present day parkway system serves a vital role in providing safe, accessible, multimodal transportation infrastructure throughout the Commonwealth.

Yet the 21st century has brought new challenges to the Parkway System, with coastal and precipitation-based flooding exacerbated by climate change expected to impact the operation and maintenance of many of DCR's facilities. These parkways were not originally designed to accommodate the volume of precipitation expected from the 1% annual chance storm event in 2070, nor were they built above the 2070 design flood elevation. The DCR Parkways Climate Change Vulnerability Assessment (Parkways CCVA) is a comprehensive, data-driven study designed to proactively identify and address current and future flooding risks along Massachusetts's historic parkways. This adaptation strategies report extends the analysis in the Parkways CCVA, identifying specific interventions that could be considered at one of DCR's most vulnerability parkways.

Bird's-Eye View of Nantasket Beach. Source: Adobe Stock

REPORT OBJECTIVES

The objective of this report is to identify a diverse range of initial adaptation strategies to improve the flood resilience of the DCR Parkways, and their associated infrastructure and amenities, along the Nantasket Beach Reservation. The strategies presented here are **preliminary in nature and provide an array of potential approaches** for mitigating flood scenarios for both current and future storm events. They represent a starting point for DCR to begin **the process of developing performance criteria and identifying preferred strategies with input from community stakeholders and other agencies**.

For each strategy presented, **a high-level cross section** illustrates the approximate extent of proposed measures and how they may affect both DCR – and non-DCR-owned land, as well as the pedestrians, cyclists, and vehicles that utilize this parkway corridor. While the focus of these strategies is on DCR Parkways, in some instances, these strategies may provide co-benefits, such as reduced flood risks for surrounding parcels, roadways, or communities. However, these co-benefits should be considered ancillary benefits and are not evaluated in this study. Furthermore, the strategies identified in this report are **not intended to result in changes to FEMA flood maps**. Note that adaptation strategies do not necessarily address the potential for flooding from Hingham Harbor/Hull Bay on the west side of the peninsula, as the infrastructure and roadways directly adjacent to these waters are outside of DCR's jurisdiction.

This report does not represent a comprehensive list of potential strategies; there may be variations or combinations of these strategies that are feasible but not included in this initial study. Once performance criteria and preferred strategies are established, **future phases of investigation, analysis, modeling, and design will be required** to more accurately determine effectiveness, impacts, permitting viability, and cost before strategies can be implemented.

As shown on the strategy page sample to the right, each strategy is summarized on its own page and includes **a description of the strategy scope, an evaluation matrix, and a list of bulleted benefits and trade-offs, to supplement the high-level cross section.**

SAMPLE REPORT PAGE

1 STRATEGY DESCRIPTION

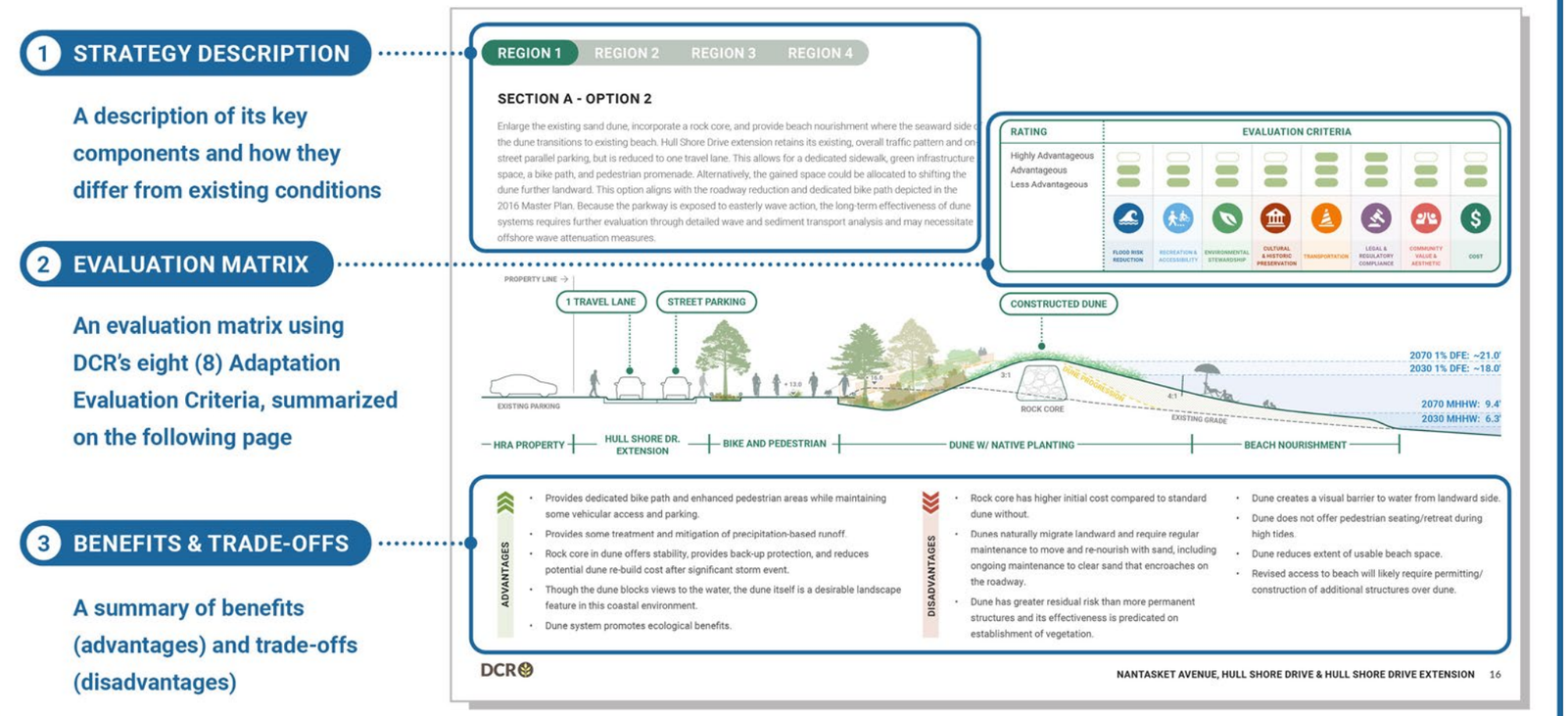
A description of its key components and how they differ from existing conditions

2 EVALUATION MATRIX

An evaluation matrix using DCR's eight (8) Adaptation Evaluation Criteria, summarized on the following page

3 BENEFITS & TRADE-OFFS

A summary of benefits (advantages) and trade-offs (disadvantages)



For each region (refer to Strategies Overview on Page 6), **a representative plan view sketch - or vision plan -** was developed to illustrate how the parkway corridor could be reimagined by implementing one or more adaptation strategies. Similar to the cross sections, these vision plans are also very preliminary and do not reflect actual designs.

Adaptation strategies have been developed to address a preliminary, projected Design Flood Elevation (DFE) of 21.0'. This elevation is based on the vertical datum NAVD88. This DFE accounts for the **2070 1% Annual Exceedance Probability (AEP) storm**, as modeled by FEMA and is consistent with the CCVA time horizon. It also incorporates the Massachusetts Coast Flood Risk Model (MC-FRM), and U.S. Army Corps of Engineers (USACE) guidance for sea level rise planning. This projected DFE should be considered preliminary at this stage and does not represent a conclusive elevation. For the purpose of this report, the DFE offers an initial and consistent way to visualize the overall spatial impacts that may be incurred to implement a particular adaptation strategy, as illustrated in the cross-sectional diagrams. Further analysis and coastal modeling, in conjunction with the development of performance criteria by DCR and stakeholders, will dictate the eventual, agreed upon DFE.

EVALUATION CRITERIA

To provide an initial, qualitative way to compare the wide range of adaptation strategies included in this study, a simple rating system was established based on **eight (8) Adaptation Evaluation Criteria** provided by DCR. The evaluation criteria consists of the following:

- Flood Risk Reduction
- Recreation & Accessibility
- Environmental Stewardship
- Cultural & Historic Preservation
- Transportation
- Legal & Regulatory Compliance
- Community Value & Aesthetic
- Cost

A description for each of the eight (8) criteria is shown in the table to the right.

For each strategy, a bar chart matrix was created to comprehensively rate **how well each strategy meets DCR's criteria**, from "Less Advantageous" to "More Advantageous". Please see an example below.

RATING SYSTEM

- **More Advantageous** (three bars filled)
- **Advantageous** (two bars filled)
- **Less Advantageous** (one bar filled)

EVALUATION CRITERIA

Refer to the table on the right for a listing and description of each adaptation category.

EVALUATION CRITERIA	DESCRIPTION
FLOOD RISK REDUCTION	Reduces the likelihood of parkway flooding due to storm events up to the 2070 1% annual chance flood.
RECREATION & ACCESSIBILITY	Maintains or enhances recreational amenities and universal access (waterfront, etc.) for visitors.
ENVIRONMENTAL STEWARDSHIP	Preserves and restores natural resources, habitat, and water quality.
CULTURAL & HISTORIC PRESERVATION	Preserves and protects cultural and historic assets and archaeological resources.
TRANSPORTATION	Improves transportation network by strengthening transportation alternatives, implementing traffic calming measures, and providing or improving safety for all users.
LEGAL & REGULATORY COMPLIANCE	Considers permissibility, land ownership, and adherence to regulations.
COMMUNITY VALUE & AESTHETIC	Considers alignment with community priorities, resources, and facilities, and preferred aesthetic character, as currently understood by DCR.
COST	Accounts for up-front design, permitting, and construction costs, as well as ongoing maintenance and mitigation costs averaged over the life of the project.

COASTAL RESILIENCE VOCABULARY

The strategies proposed for the Quincy Shore Drive draw from a shared coastal resilience vocabulary. While each strategy is tailored to specific conditions, they aim to address the combined effects of sea level rise, storm surge, wave action, and erosion. The following terms provide a foundation understanding the critical climate risks this Parkway faces and the adaptation strategies proposed throughout this report:

SEA-LEVEL RISE (SLR)

The gradual rise of ocean levels caused by climate change. Though the current rate may seem minor (less than one inch per year), projections show a possible rise of more than 3 feet by 2070, leading to more frequent and eventually permanent areas of coastal flooding.

STORM SURGE

A temporary rise in water level during storms caused by wind and low atmospheric pressure. Nor'easters and hurricanes are primary drivers. Surge is measured as the stillwater elevation above normal tides, excluding individual wave heights.

WAVE RUN-UP

The upward rush of water from a wave striking a sloped surface. It can exceed the height of offshore waves, especially on steep or armored coastlines, and must be accounted for in vertical and horizontal design limits.

WAVE OVERTOPPING

When wave run-up exceeds the crest of a dune or wall, sending water – and often debris – over the crest and onto landward shoreline elements. This causes flooding, erosion, and dangerous flow conditions. Designs should aim to limit overtopping rates for public and structural safety.

OVERLAND WAVE ACTION

Occurs when storm generated waves move across inland areas that have been inundated by storm surge, and results in increased flood depth and velocity. These dynamic forces are to be considered in structural design to provide safety and resilience.

MEAN HIGHER HIGH WATER (MHHW)

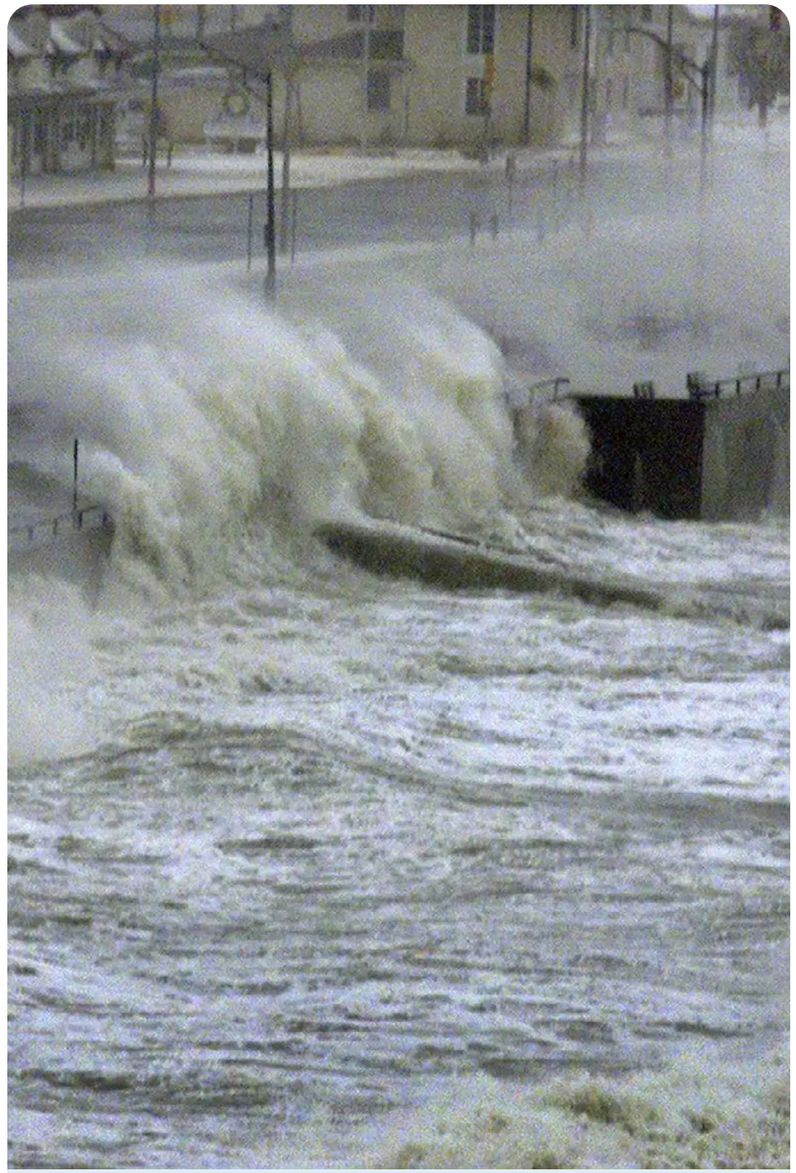
The average daily highest tide, or average of the higher high water height of each tidal day observed over the National Tidal Datum Epoch. Flood inundation typically begins when water levels exceed MHHW (from NOAA).

DESIGN FLOOD ELEVATION (DFE)

The Design Flood Elevation (DFE) represents the flood elevation used to inform the design of adaptation measures and is based on the 1% AEP Significant Wave Crest Elevation projected by the MC-FRM under future sea-level rise conditions. The DFE accounts for sea-level rise, storm surge–driven water surface elevation, and wave action. All elevations referenced in this report are relative to the NAVD88 vertical datum.

EROSION

Coastal erosion is the loss or displacement of sediment due to daily coastal conditions or storm events. Erosion can lead to the loss of embankments, structures, and other forms of infrastructure, and can worsen flooding as storms progress. Adaptation strategies must account for potential erosion and structural failure over time.



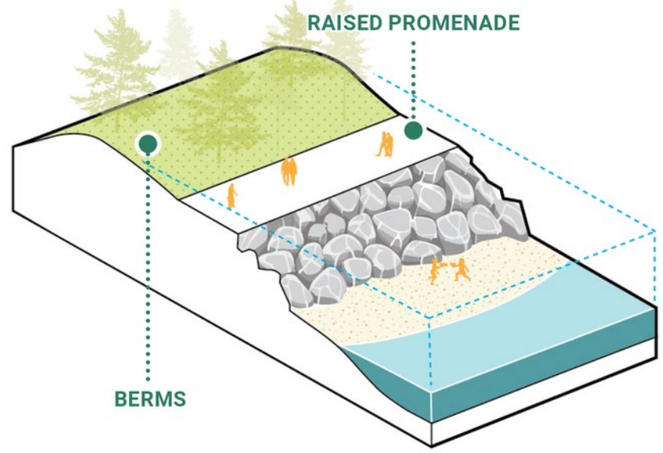
Waves crashed over the sea wall at Hull's Nantasket Beach.
Source: Globe Staff,Tom Herde

TYPES OF ADAPTATION STRATEGIES

The diagrams to the right represent the overarching adaptation strategy categories proposed for the subject parkways. Each type of strategy plays a different role in managing risk, improving resilience to flooding, and balancing infrastructure with natural systems. Understanding these elements helps clarify how different interventions work individually or in combination to build a more resilient shoreline and parkway system.

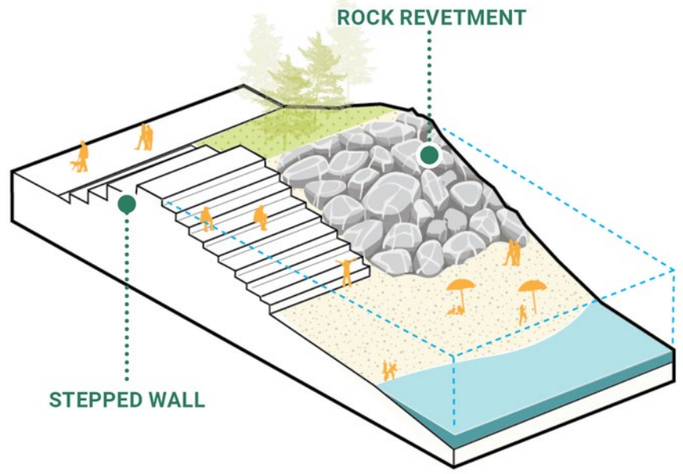
1 RAISED PROMENADES AND BERMS

Raised promenades and inland constructed berms allow for high-value amenity space along the water to also serve as flood protection through landform and coastal planting.



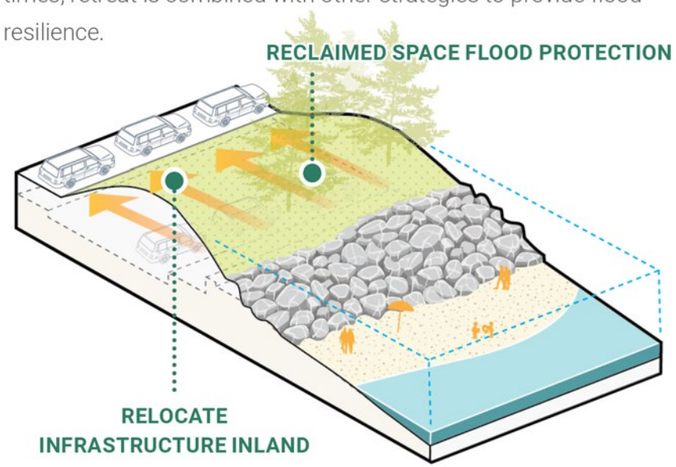
2 STEPPED SEA WALLS AND ROCK REVETMENTS

Structural measures designed to provide flood protection and wave energy dissipation.



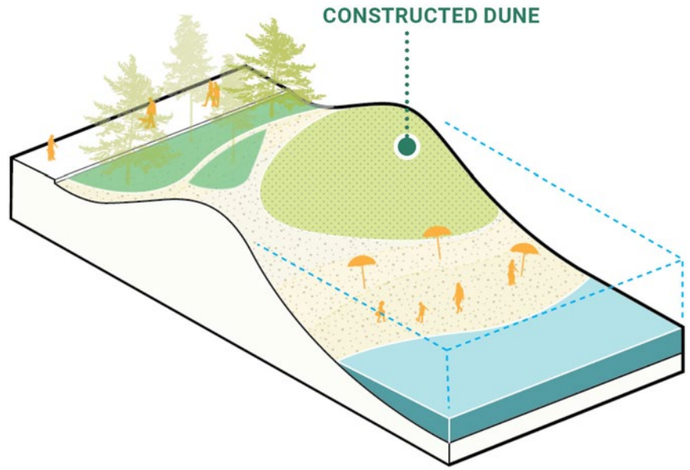
3 STRATEGIC RETREAT

Strategic retreat involves relocating vulnerable infrastructure, development, or amenities away from high-risk coastal areas. Often times, retreat is combined with other strategies to provide flood resilience.



4 BEACH NOURISHMENT AND DUNES

Constructed dunes mimic the natural shoreline, providing flood protection, space for recreation, and habitat.



DCR

PARKWAY CONTEXT

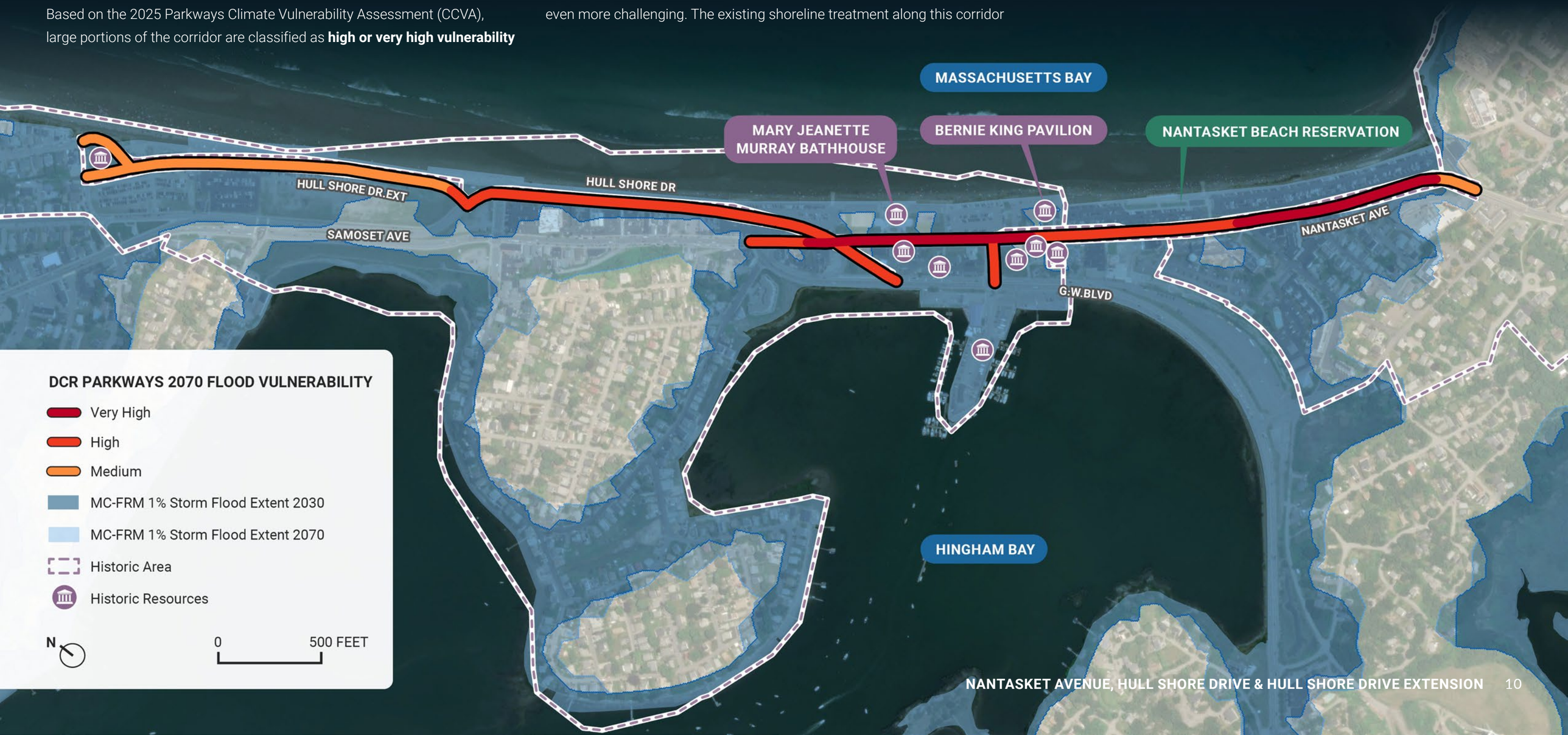
Nantasket Ave, Hull Shore Drive, and Hull Shore Drive Extension provide multimodal access to the Nantasket Beach Reservation, its many recreational amenities, and historic resources, to support the thousands of tourists that come to visit each year. Beyond their importance to the Reservation, these parkways also serve as a vital north-south coastal corridor through the Town of Hull, for community access to businesses and residential neighborhoods on the Hull peninsula. The corridor is heavily utilized, particularly during the warmer months, for walking, jogging, and casual cycling, offering expansive views of the water. These parkways have medium to very high vulnerability scores as a result of their exposure to precipitation-based and coastal flooding, combined with their varying levels of sensitivity to flooding and adaptive capacities for recovering from flood impacts. Situated between Massachusetts Bay to the east, municipal right of ways, private property, and Hingham Bay to the west, the Hull mainland to the south, and the remaining portion of the Hull peninsula to the north, many portions of the parkway currently experience coastal flooding due to wave overtopping, resulting in regular road closures and post-storm cleanup efforts. This flooding is anticipated to become significantly more frequent and severe by the year 2070. While George Washington Boulevard and the Town of Hull's portion of Nantasket Ave also provides access to and from the peninsula, these roads would likely be impassable as well if Nantasket Avenue, Hull Shore Drive, and Hull Shore Drive Extension were closed due to flooding. Enhancing these parkways' resilience to storm surge, sea level rise, and extreme precipitation will better protect the parkway and its infrastructure from recurring damages and failures, enhance the ability to evacuate from the Hull Peninsula, and maintain access to the Nantasket Beach Reservations and its abundant assets.

EXISTING CONDITIONS

DCR's Nantasket Beach Reservation is a dynamic and highly utilized coastal landscape where the parkways – **Nantasket Avenue, Hull Shore Drive, and Hull Shore Drive Extension** – play a vital role in connecting visitors, residents, and local businesses to the shoreline and broader community. However, these parkways are increasingly vulnerable to flooding from **storm surge, sea level rise, and extreme precipitation** events.

Based on the 2025 Parkways Climate Vulnerability Assessment (CCVA), large portions of the corridor are classified as **high or very high vulnerability by 2070**. Flooding already disrupts these routes during storms, with Hull Shore Drive Extension often requiring multi-day closures due to debris and overtopping. The map below includes shading that represents the extent of coastal flood risk expected for a 100-year (1%) storm for both 2030 and 2070.

Under future conditions, maintaining critical access to community members on the peninsula to the north and evacuation routes to the mainland will be even more challenging. The existing shoreline treatment along this corridor includes concrete seawall, seawall with rock revetment, rock revetment, natural stone deposits, and vegetated sand dunes. Beyond the beach and roadways, a sizable portion of the corridor contains a variety of DCR-owned buildings (from bathhouse, pavilions, and amusement facilities to administrative and maintenance facilities), paved parking lot facilities, and hardscape amenities. A majority of the corridor is also categorized as a **Historic Area .**



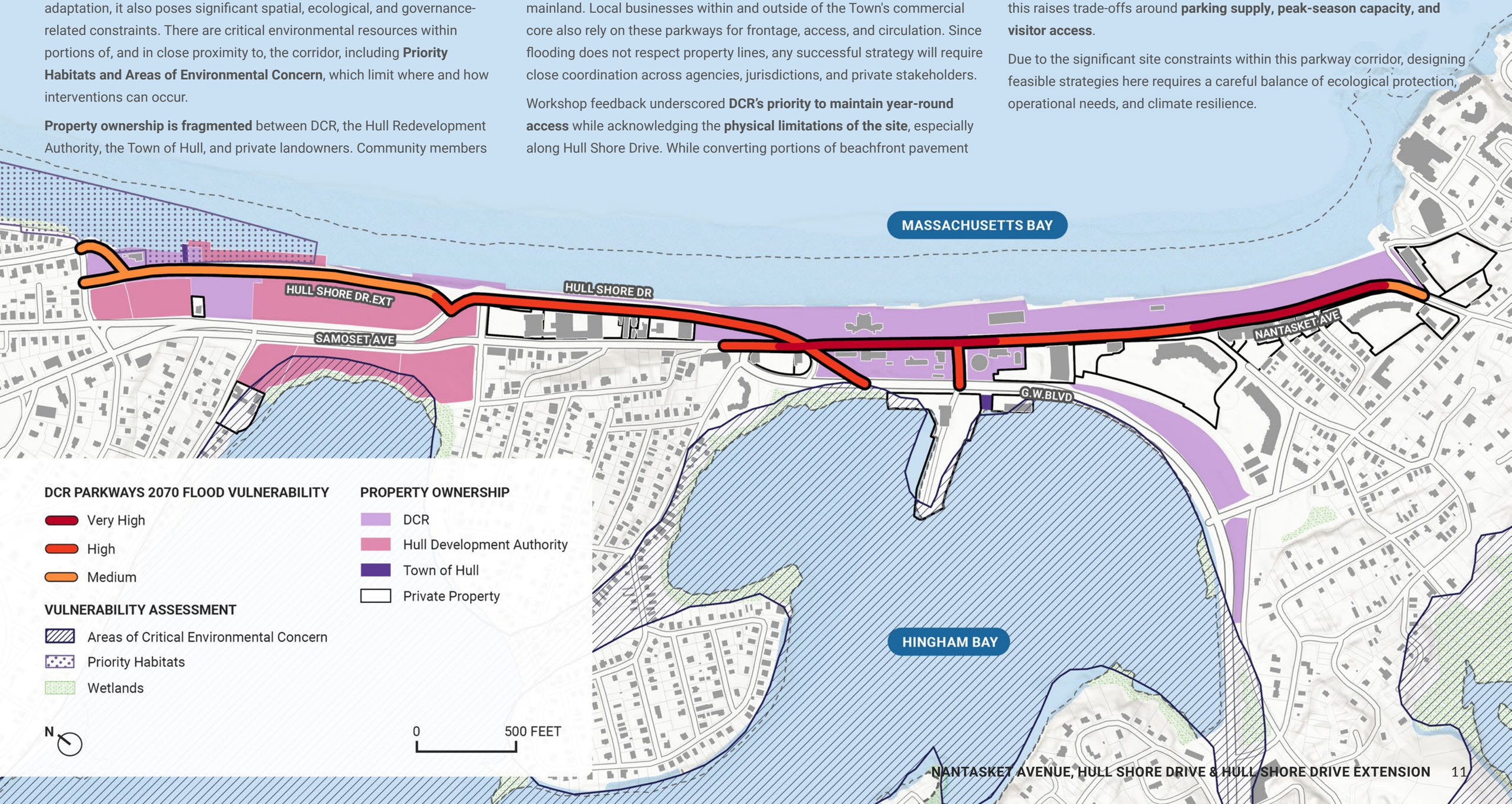
SITE CONSTRAINTS

While the Nantasket Reservation presents clear opportunities for climate adaptation, it also poses significant spatial, ecological, and governance-related constraints. There are critical environmental resources within portions of, and in close proximity to, the corridor, including **Priority Habitats and Areas of Environmental Concern**, which limit where and how interventions can occur.

Property ownership is fragmented between DCR, the Hull Redevelopment Authority, the Town of Hull, and private landowners. Community members to the north rely on the parkways for critical access and evacuation to the mainland. Local businesses within and outside of the Town's commercial core also rely on these parkways for frontage, access, and circulation. Since flooding does not respect property lines, any successful strategy will require close coordination across agencies, jurisdictions, and private stakeholders.

Workshop feedback underscored **DCR's priority to maintain year-round access** while acknowledging the **physical limitations of the site**, especially along Hull Shore Drive. While converting portions of beachfront pavement to coastal resilience infrastructure is necessary to address chronic flooding, this raises trade-offs around **parking supply, peak-season capacity, and visitor access**.

Due to the significant site constraints within this parkway corridor, designing feasible strategies here requires a careful balance of ecological protection, operational needs, and climate resilience.



STRATEGIES OVERVIEW

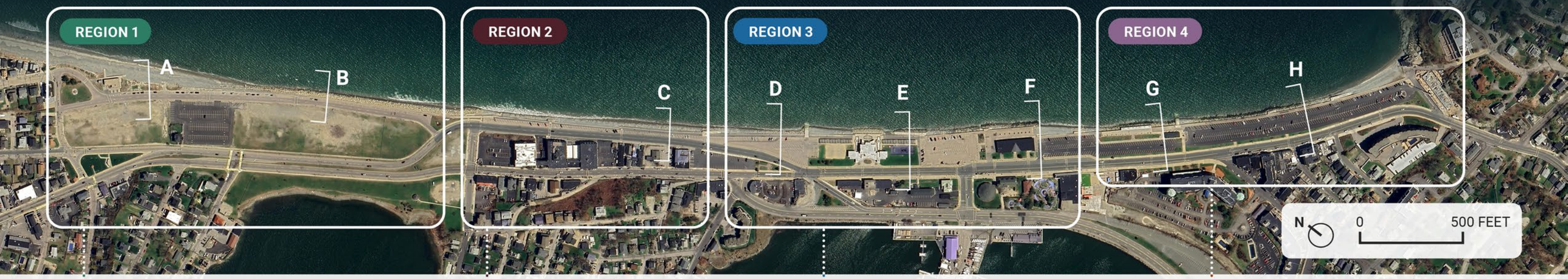
To address the complex conditions of the Nantasket Beach Reservation, adaptation strategies have been organized into **four distinct regions**, each with its own characteristics such as access, flood risk profile, and physical constraints. This approach allows for **custom, context-sensitive solutions** while considering that the overall vision remains **cohesive and site-wide in its resilience goals**.

Each region's strategy responds to its adjacencies and the character of existing uses, including seasonal tourism, neighborhood access, property ownership, historic resources, and sensitive natural areas.

This methodology also reflects our observations from site walks, engagement with DCR staff, and review of previous plans and studies – including **DCR's 2016 Nantasket Beach Reservation Master Plan and DCR's 2020 Parkways Master Plan.** Where feasible, ideas from these Master Plans were incorporated into the adaptation strategies to depict where and to what extent they be viable, so as to build upon, rather than replace, earlier efforts. General adherence to Master Plan elements is noted, where applicable, in each strategy's description. Based on this information gathering, several themes emerged to help shape the adaptation strategy goals:

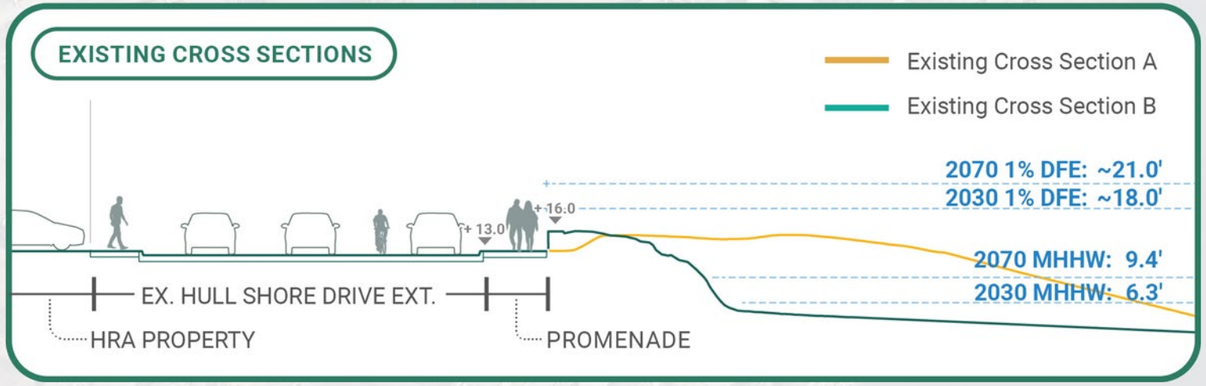
- The need to maintain critical year-round access along the corridor
- The importance of preserving views and the character of the historic beachscape
- The opportunity to address aging infrastructure while planning for future climate conditions
- Embracing a universal design mindset that considers accessibility and equality for public access into each strategy, without compromising on the effectiveness of flood resilience.

These themes ground the strategies explored in the following pages. Each region is examined through **plan view and cross-sectional diagrams**, illustrating a high-level vision of the proposed range of treatments. Each strategy is rated using **DCR's eight (8) Evaluation Criteria** for parkways to provide a consistent lens for understanding **trade-offs, performance, and alignment** with long-term resilience objectives.



EXISTING CONDITION PLAN

EXISTING CROSS SECTIONS



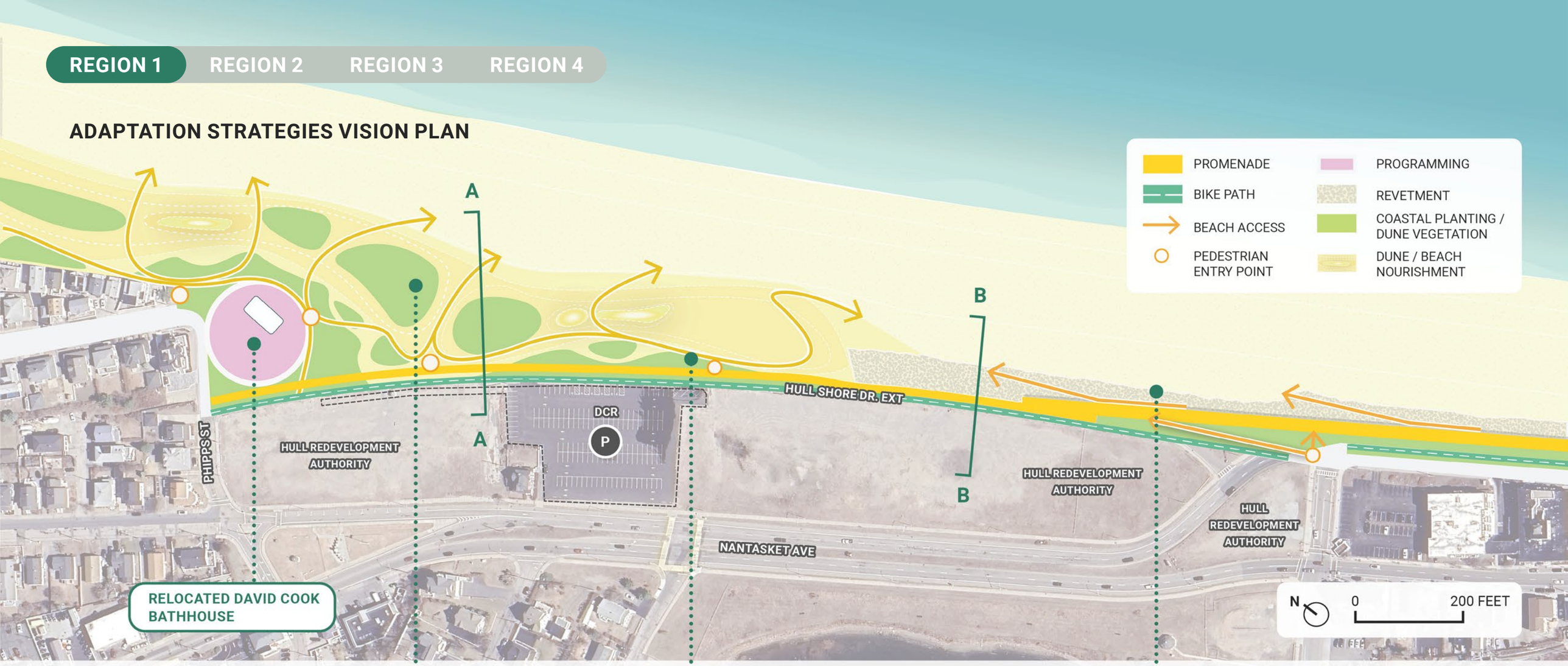
EXISTING CONDITION

Photo at the beach looking West

EXISTING CONDITION

Photo at the beach looking East

ADAPTATION STRATEGIES VISION PLAN



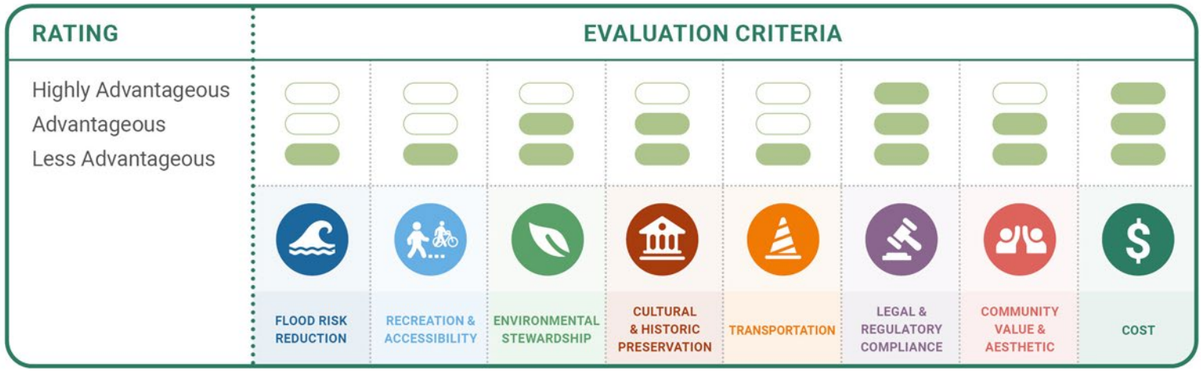
Precedent Image (Source: FUN 107)

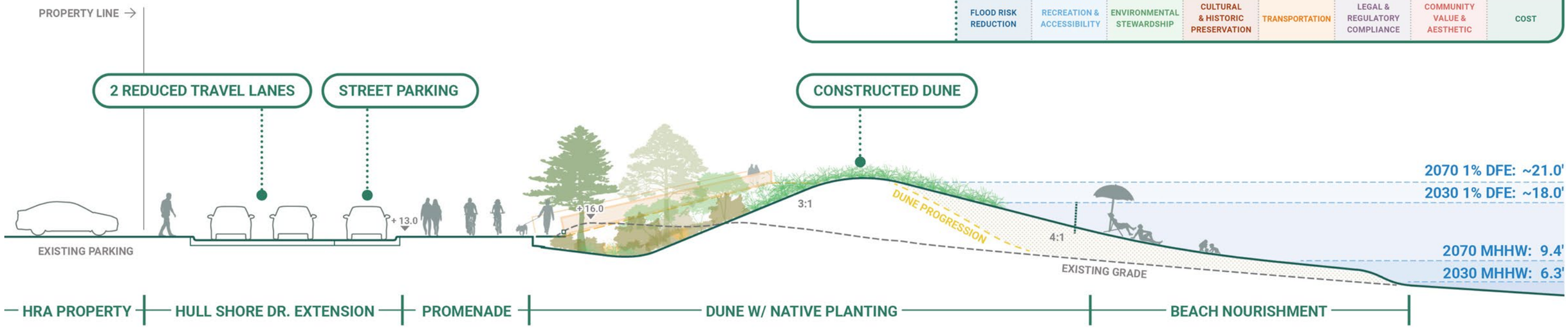
Precedent Image (Source: Kurt Lischka)

Precedent Image (Source: Urban by Design Online)

SECTION A - OPTION 1

Enlarge and enhance the existing sand dune and provide beach nourishment where the seaward side of the dune transitions to existing beach. Hull Shore Drive extension retains its existing traffic pattern, lane configuration, and on-street parallel parking, but with narrower lanes to optimize the space for combined pedestrian and bicycle use on the landward side of the dune. This option does not align with the 2016 Master Plan vision of a lane reduction on Hull Shore Dr. extension and dedicated bike path. Because the parkway is exposed to easterly wave action, the long-term effectiveness of dune systems requires further evaluation through detailed wave and sediment transport analysis and may necessitate offshore wave attenuation measures.





ADVANTAGES

- Provides wider and improved pedestrian and bicycle amenities.
- Dune system promotes ecological benefits.
- Though the dune blocks views to the water, the dune itself is a desirable landscape feature in this coastal environment.
- Provides some treatment and mitigation of precipitation-based runoff.

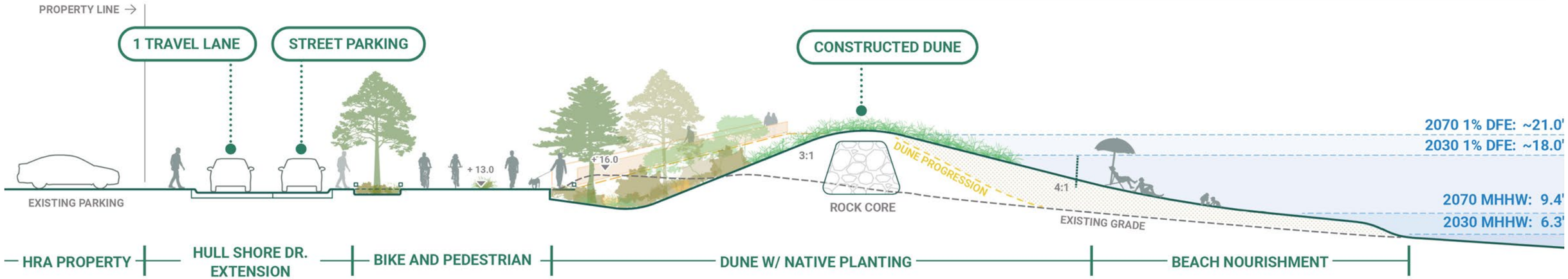
DISADVANTAGES

- Dunes naturally migrate landward and require regular maintenance to move and re-nourish with sand, including ongoing maintenance to clear sand that encroaches on the roadway.
- Dune has greater residual risk than more permanent structures and its effectiveness is predicated on establishment of vegetation.
- Dune creates a visual barrier to water from landward side.
- Dune does not offer pedestrian seating/retreat during high tides.
- Dune reduces extent of usable beach space.
- Revised access to beach will likely require permitting/ construction of additional structures over dune.

SECTION A - OPTION 2

Enlarge the existing sand dune, incorporate a rock core, and provide beach nourishment where the seaward side of the dune transitions to existing beach. Hull Shore Drive extension retains its existing, overall traffic pattern and on-street parallel parking, but is reduced to one travel lane. This allows for a dedicated sidewalk, green infrastructure space, a bike path, and pedestrian promenade. Alternatively, the gained space could be allocated to shifting the dune further landward. This option aligns with the roadway reduction and dedicated bike path depicted in the 2016 Master Plan. Because the parkway is exposed to easterly wave action, the long-term effectiveness of dune systems requires further evaluation through detailed wave and sediment transport analysis and may necessitate offshore wave attenuation measures.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

- Provides dedicated bike path and enhanced pedestrian areas while maintaining some vehicular access and parking.
- Provides some treatment and mitigation of precipitation-based runoff.
- Rock core in dune offers stability, provides back-up protection, and reduces potential dune re-build cost after significant storm event.
- Though the dune blocks views to the water, the dune itself is a desirable landscape feature in this coastal environment.
- Dune system promotes ecological benefits.

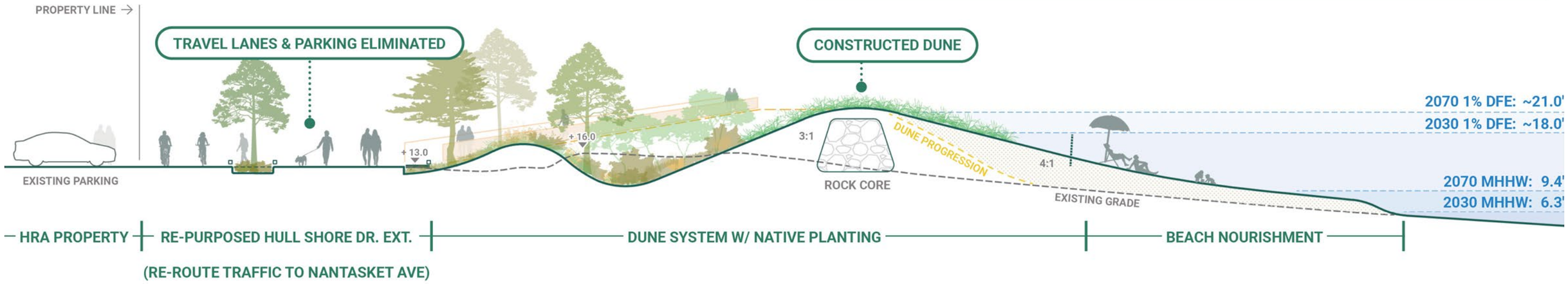
DISADVANTAGES

- Rock core has higher initial cost compared to standard dune without.
- Dunes naturally migrate landward and require regular maintenance to move and re-nourish with sand, including ongoing maintenance to clear sand that encroaches on the roadway.
- Dune has greater residual risk than more permanent structures and its effectiveness is predicated on establishment of vegetation.
- Dune creates a visual barrier to water from landward side.
- Dune does not offer pedestrian seating/retreat during high tides.
- Dune reduces extent of usable beach space.
- Revised access to beach will likely require permitting/ construction of additional structures over dune.

SECTION A - OPTION 3

Enlarge the existing sand dune, incorporate a rock core, and provide beach nourishment where the seaward side of the dune transitions to existing beach. Vehicular circulation and parking on Hull Shore Drive Extension is eliminated and the area is re-purposed as a dedicated bicycle path and a pedestrian promenade. While this option provides space for a secondary dune, increased green space, or for shifting the dune landward to optimize usable beach space, it does require modifications to existing traffic patterns and eliminates on-street parking capacity. The layout does not fully align with the 2016 Master Plan, as there is a dedicated bike path but vehicular capacity on Hull Shore Drive Extension is eliminated. Because the parkway is exposed to easterly wave action, the long-term effectiveness of dune systems requires further evaluation through detailed wave and sediment transport analysis and may necessitate offshore wave attenuation measures.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

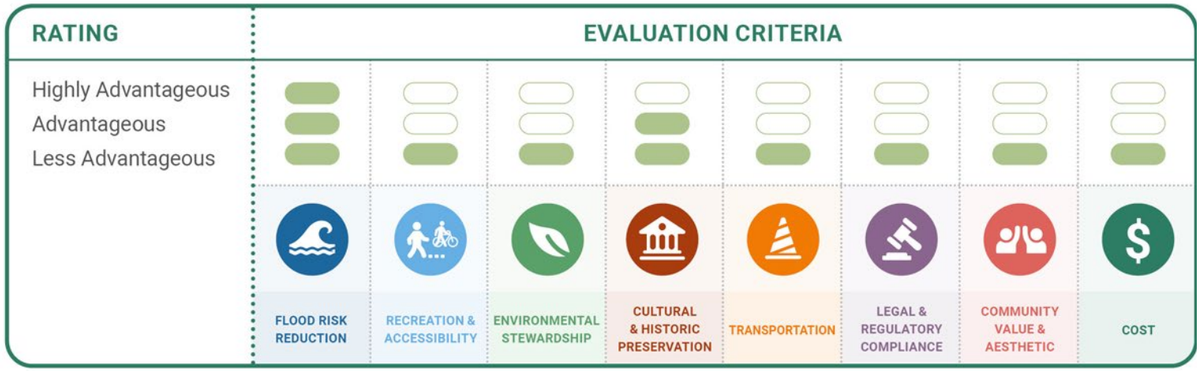
- Optimizes dune and usable beach space.
- Creates a less vehicle-centric park space and opens up the area to enhance pedestrian and bicycle amenities.
- Reduces pavement, enhances treatment, and mitigates precipitation-based runoff.
- Rock core in dune offers greater stability than standard dune and reduces potential dune re-build cost after significant storm event.
- Though the dune blocks views to the water, the dune itself is a desirable landscape feature in this coastal environment.
- Dune system promotes ecological benefits.

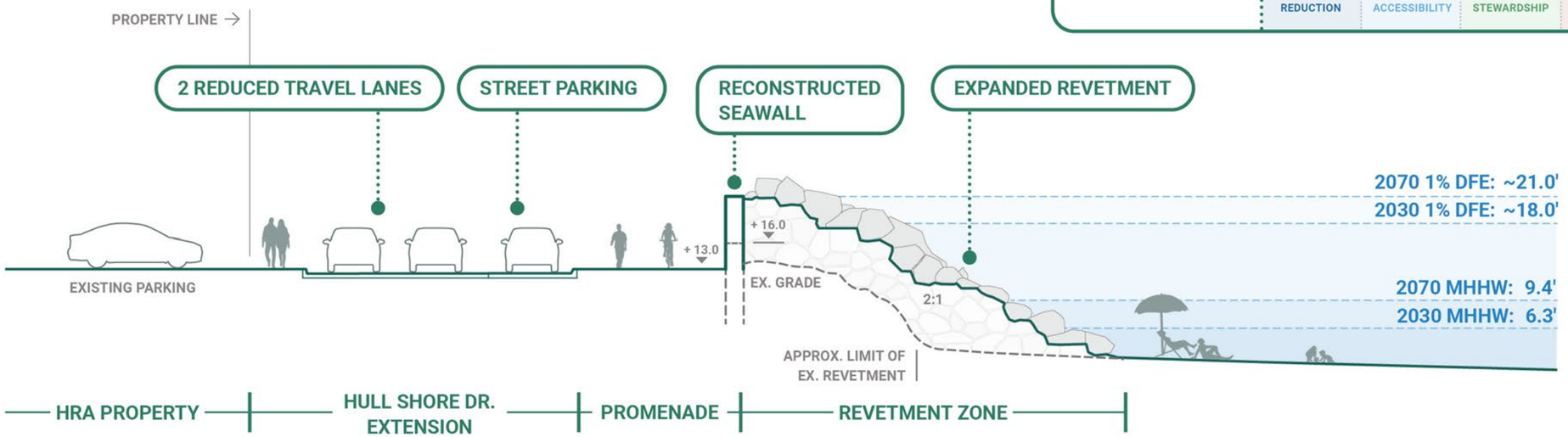
DISADVANTAGES

- Rock core has higher initial cost compared to standard dune without.
- Dunes naturally migrate landward and require regular maintenance to move and re-nourish with sand, including ongoing maintenance to clear sand that encroaches on the roadway.
- Dune has greater residual risk than more permanent structures and its effectiveness is predicated on establishment of vegetation.
- Dune creates a visual barrier to water from landward side.
- Dune does not offer pedestrian seating/retreat during high tides.
- Dune reduces extent of usable beach space.
- Revised access to beach will likely require permitting/construction of additional structures over dune.

SECTION B - OPTION 1

Increase the height of the rock revetment in conjunction with increasing the height of the seawall (with either a full re-build or adding to top of existing). Hull Shore Drive retains its existing traffic pattern, lane configuration, and on-street parallel parking, but with narrower lanes to optimize the width of the shared-use bicycle and pedestrian promenade. On average, the top of wall would need to be raised between 5'- 6' higher than existing. This option does not align with the 2016 Master Plan vision of a lane reduction on Hull Shore Dr. extension and a dedicated bike path. Applicable to all revetment options in this report - there are various types of eco-revetment materials and systems available that could potentially be utilized in lieu of standard rock revetment to enhance ecological value while offering similar levels of flood resilience.





ADVANTAGES

- Provides modest improvement to width of pedestrian/bicycle promenade.
- New rock revetment can be installed over the existing revetment.
- Rock revetment requires less maintenance than dunes and stepped walls.

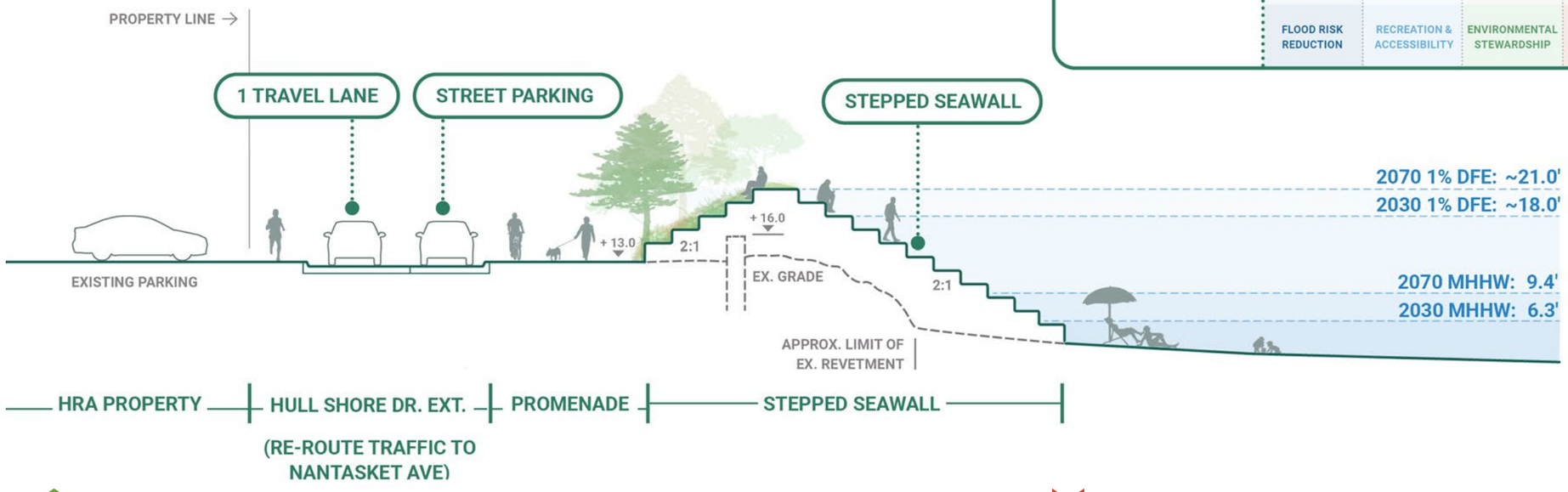
DISADVANTAGES

- To provide promenade, expanded revetment extends beyond existing revetment toe of slope. Viability of permitting this encroachment is low based on current environmental regulations.
- Increasing wall height creates a visual barrier from the landward side and reduces visual appeal of corridor for parkway users.
- Beyond flood protection, the rock revetment does not serve as an amenity feature for parkway users.
- Pedestrian and bicycle circulation is at street level, below flood resilience measures.
- Expanded revetment reduces usable sand beach area.
- Does not reduce pavement or mitigate precipitation-based runoff.
- Rock revetment provides less ecological benefit than dunes.

SECTION B - OPTION 2

Construct a stepped seawall to replace the existing vertical seawall and rock revetment. The existing wall can be buried in place or cut down to an appropriate elevation, but it does not necessarily need to be fully removed. Hull Shore Drive Extension retains its existing, overall traffic pattern and on-street parallel parking, but is reduced to one travel lane. The recovered space is converted to a wider, share-used path and a 2-sided, stepped seawall that is intended to extend only to the limits of existing rock revetment. The lane reduction in this option aligns with the 2016 Master Plan, however, offering a dedicated bike path and pedestrian promenade would require the stepped seawall to shift even further seaward.

RATING	EVALUATION CRITERIA							
Highly Advantageous								
Advantageous								
Less Advantageous								
	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

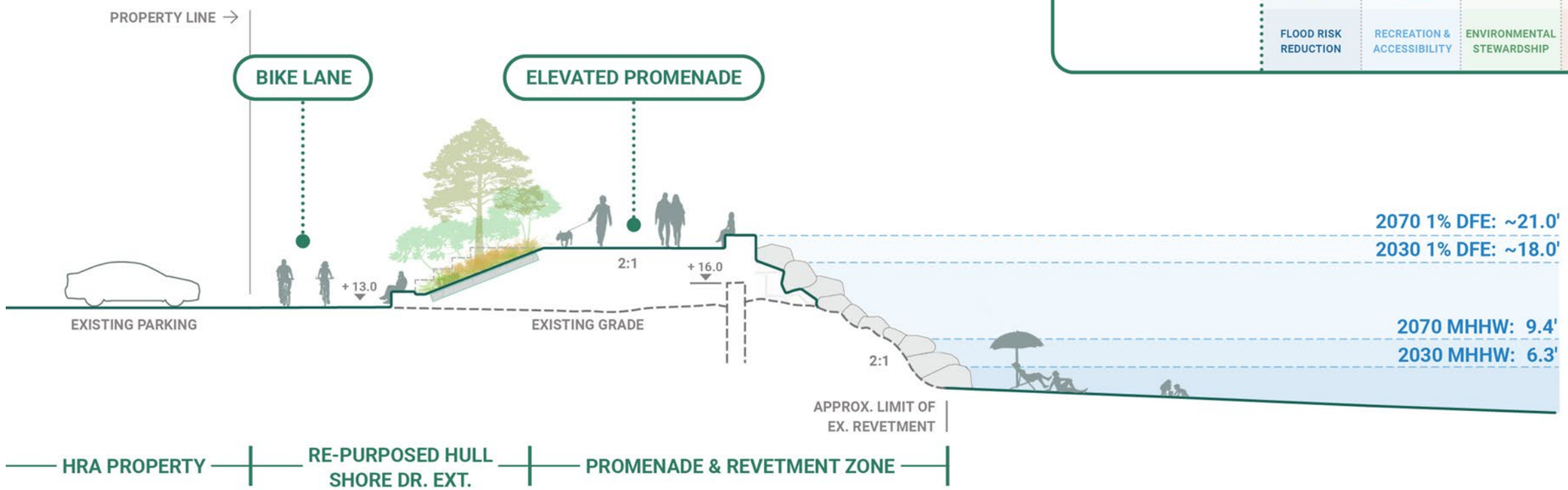
- Steps allow for seating on both sides of the wall, with the noteworthy benefit of offering retreat amenity space for beach goers during periods of high tide.
- Landward side can alternate between areas of stepped wall and areas of vegetated slope with trees to add visual interest and provide shade zones.
- Though not an accessible feature, the stepped wall provides a more approachable barrier that can be climbed by able-bodied users to access the beach or water directly from the promenade.
- Stepped wall requires less maintenance than sand dune.

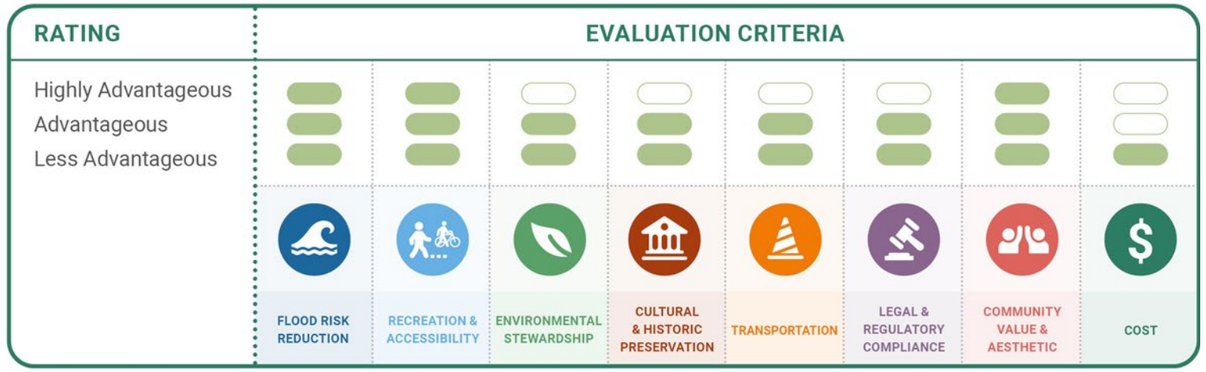
DISADVANTAGES

- Stepped wall creates a visual barrier to water from landward side.
- To provide promenade, new stepped seawall extends beyond existing revetment toe of slope. Viability of permitting this encroachment is low based on current environmental regulations.
- Extent of stepped seawall reduces usable sand beach area.
- Pedestrian and bicycle circulation is at street level, below flood resilience measures.
- Stepped wall on seaward side has less ecological benefit than dune and may require more maintenance than revetment.
- Does not reduce pavement and mitigate precipitation-based runoff, except in areas where stepped wall alternates to vegetated slope.

SECTION B - OPTION 3

Expand the rock revetment and create a planted, earthen berm with an elevated promenade atop the berm, behind the revetment. Vehicular circulation and parking on Hull Shore Drive Extension is eliminated and the area is re-purposed as a bicycle path. While this option optimizes recreational space within the corridor, it does require modifications to existing traffic patterns and reduces on-street parking capacity. The layout does not fully align with the 2016 Master Plan, as there is a dedicated bike path but vehicular capacity on Hull Shore Drive Extension is eliminated versus reduced.





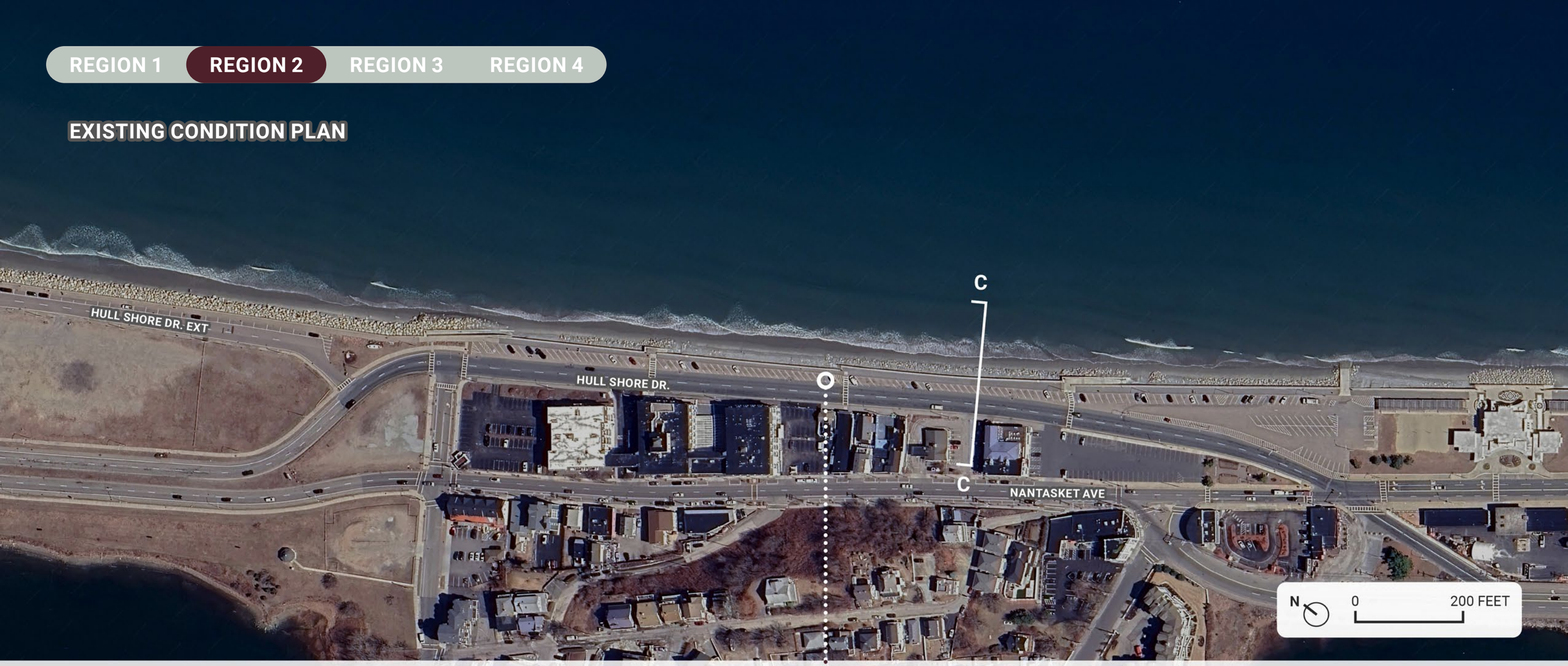
ADVANTAGES

- Creates a less vehicle-centric park space and optimizes pedestrian and bicycle space.
- Pedestrian promenade is elevated and provides unobstructed views of water and beach.
- Rock revetment requires less maintenance than dunes and stepped walls.
- Landward side can alternate between areas of stepped wall and areas of vegetated slope with trees to add visual interest and provide shade zones.
- Lane reduction in Hull Shore Drive allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Reduces pavement and mitigates precipitation-based runoff.

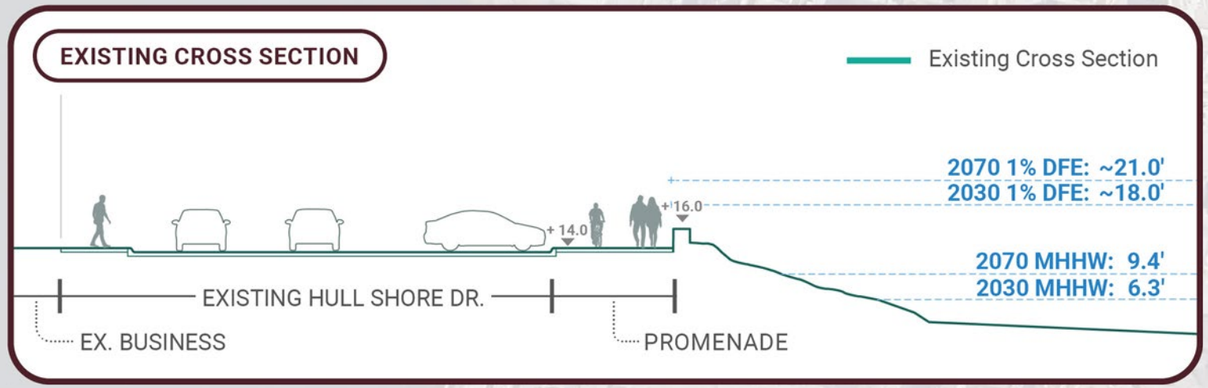
DISADVANTAGES

- Rock revetment does not serve as an amenity feature for parkway users.
- Berm and elevated promenade creates a visual barrier to water from landward side.
- Rock revetment provides less ecological benefit than dunes.

EXISTING CONDITION PLAN



EXISTING CROSS SECTION



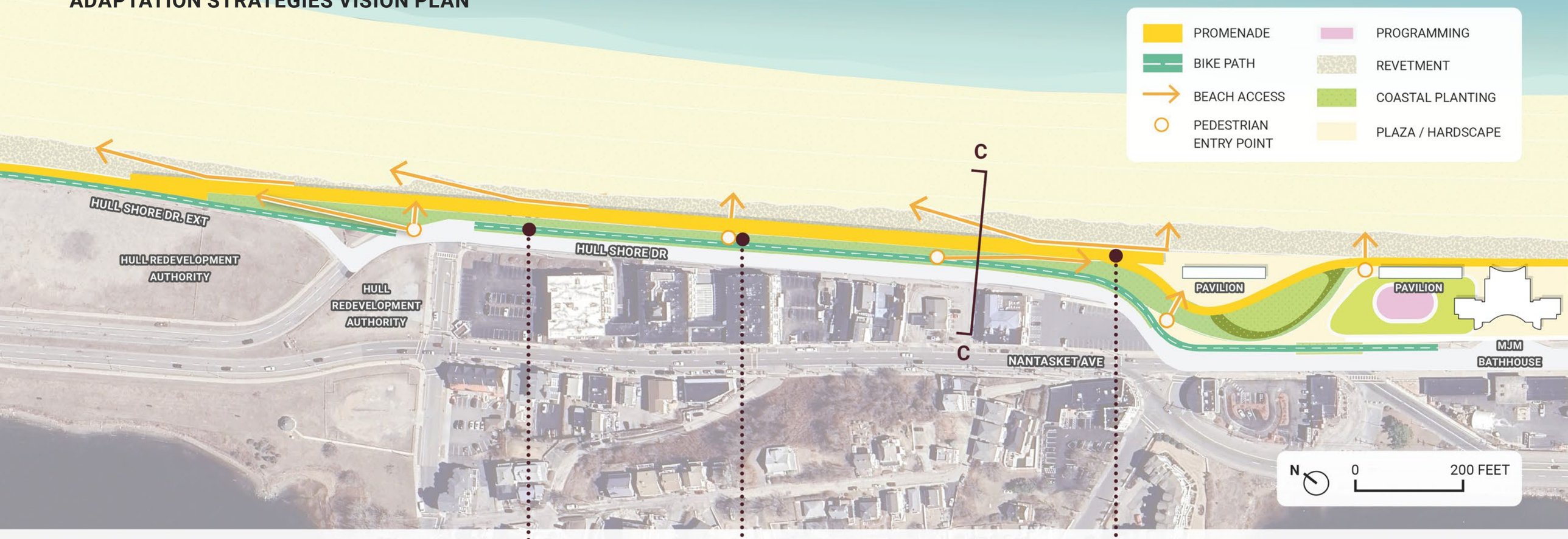
EXISTING CONDITION

Photo at the existing Hull Shore Drive looking west

EXISTING CONDITION

Aerial photo of project site

ADAPTATION STRATEGIES VISION PLAN



Precedent Image (Source: SWA / David Lloyd)

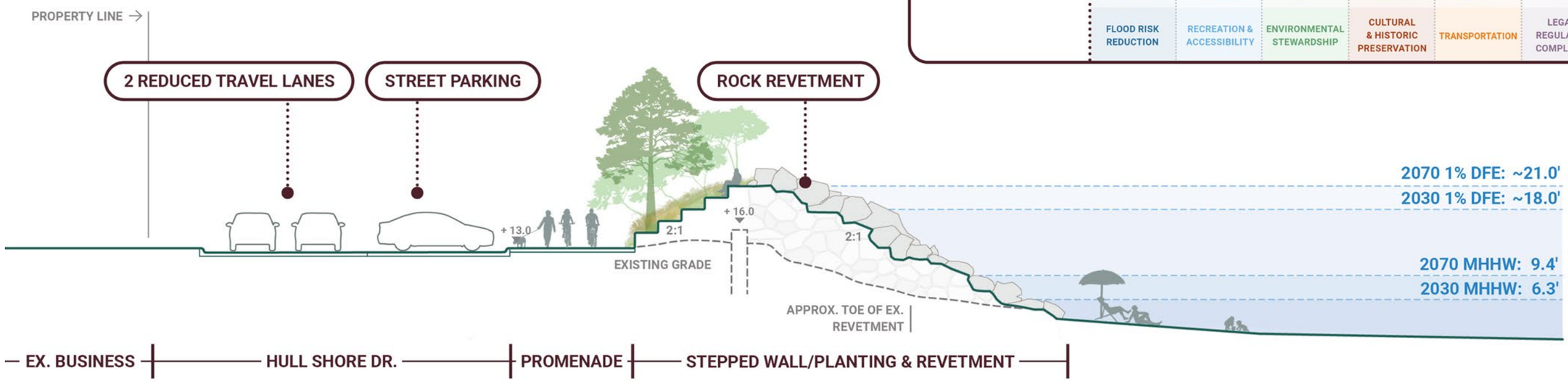
Precedent Image (Source: HMWHITE)

Precedent Image (Source: creativecommons.org)

SECTION C - OPTION 1

Increase height of rock revetment on seaward side of existing wall and create a combination of stepped concrete seating and vegetated berm on landward side of the wall. Existing wall can remain in place, beneath new measures. Hull Shore Drive retains its existing traffic pattern, lane configuration, and on-street angled parking, but with narrowed lanes, to optimize space for combined pedestrian and bicycle traffic on a street-level promenade. This option does not align with the 2016 Master Plan vision of providing parallel parking on Hull Shore Dr. and providing a dedicated bike path..

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

- Provides wider and improved pedestrian and bicycle amenities.
- Stepped wall facing Hull Shore Drive offers terraced seating for patrons of food and retail establishment with interspersed with soft, vegetated berms that can offer areas of shade for the corridor.
- Rock revetment requires less maintenance than dunes and stepped walls.
- Maintains existing parking capacity for local business corridor, and offers some flood resilience to businesses as a co-benefit.

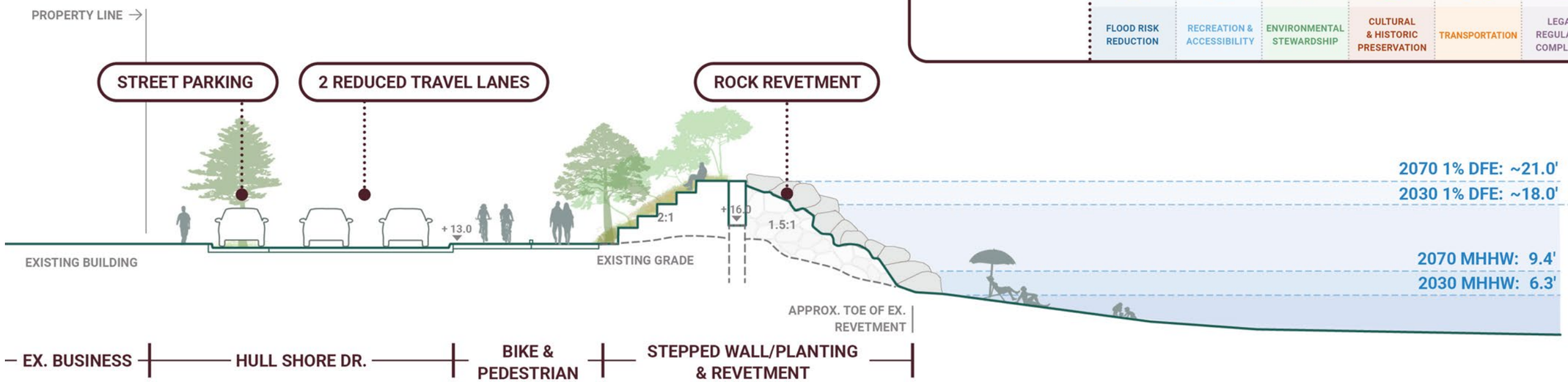
DISADVANTAGES

- Revetment and stepped wall create a visual barrier to water from parkway and local business corridor.
- Pedestrian and bicycle circulation is at street-level, below flood resilience measures.
- To achieve targeted flood mitigation and provide adequate width for shared use promenade, flood resilience measures extend beyond existing revetment toe of slope. Viability of permitting this encroachment is low based on current environmental regulations.
- Rock revetment on seaward side does not serve as an amenity feature for parkway users.
- Does not reduce pavement and mitigate precipitation-based runoff, except in areas where stepped wall alternates to vegetated slope.
- Expanded rock revetment reduces usable sand beach area.
- Rock revetment provides less ecological benefit than dunes.
- Maintaining existing street parking reduces space for pedestrian and bicycle circulation.

SECTION C - OPTION 2

Increase height of rock revetment on seaward side of existing wall and create a combination of stepped concrete seating and vegetated berm on landward side of the wall. Existing wall can remain in place, beneath new measures. Hull Shore Drive retains its existing traffic pattern and lane configuration, but narrowed, and angled street parking is replaced by parallel parking to optimize space for combined pedestrian and bicycle traffic on a street-level promenade. This option generally aligns with the 2016 Master Plan vision of providing parallel parking on Hull Shore Dr. and providing a dedicated bike path, though parallel parking is on the landward side in this option.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

- Provides enough space for a dedicated bicycle path and pedestrian promenade, which could benefit the adjacent business corridor due to increased foot traffic.
- Stepped wall facing Hull Shore Drive offers terraced seating for patrons of food and retail establishment, interspersed with soft, vegetated berms that can offer areas of shade for the corridor.
- Rock revetment on seaward side requires less maintenance than stepped walls or dune.
- Reduced lane widths and conversion of angled parking to parallel allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Shifts parking closer to adjacent business corridor, and offers some flood resilience to businesses as a co-benefit.

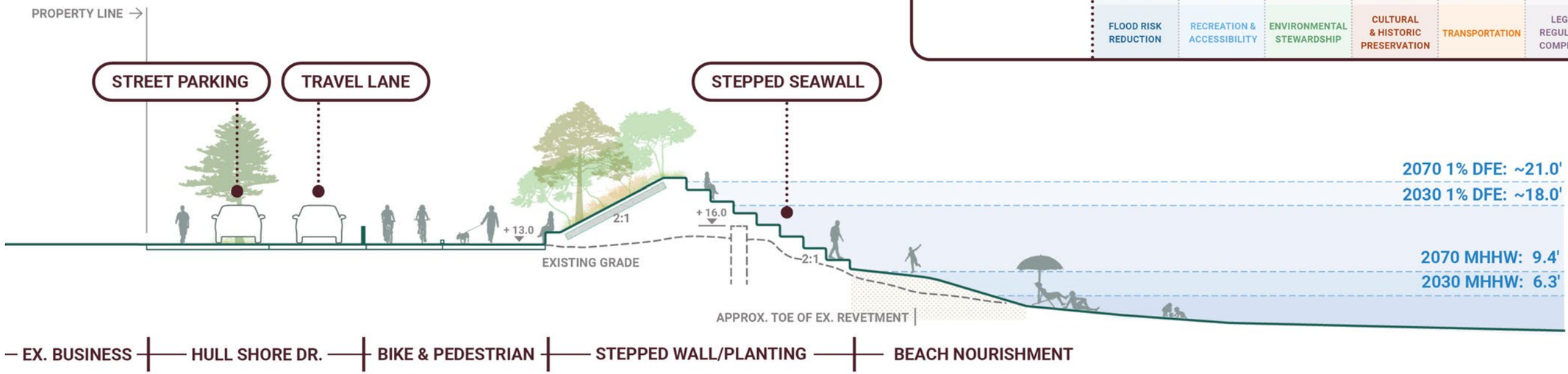
DISADVANTAGES

- Stepped wall creates a visual barrier to water from parkway and local business corridor.
- Pedestrian and bicycle circulation is at street level, below flood resilience measures.
- Rock revetment on seaward side does not serve as an amenity feature for parkway users.
- Does not reduce pavement and mitigate precipitation-based runoff, except in areas where stepped wall alternates to vegetated slope.
- Rock revetment provides less ecological benefit than dunes.
- Reduces existing street parking capacity for adjacent, local business corridor.

SECTION C - OPTION 3

Replace rock revetment with a stepped concrete wall that transitions to beach nourishment, and create a vegetated berm with a bottom seat wall on the landward side of the stepped wall. Existing wall can be cut down to appropriate elevation beneath new measures. Hull Shore Drive retains its existing, overall traffic pattern but is reduced to one travel lane, with angled street parking being replaced by parallel parking along the landward side of the parkway. This parkway configuration reduces vehicular capacity, but allows for the shoreline protection to be shifted landward, and provides enough space for a dedicated bicycle path and pedestrian promenade. This option does not align with the 2016 Master Plan in that it reduces the number of travel lanes from two to one.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

- Provides enough space for a dedicated bike path and pedestrian promenade, which could benefit the adjacent business corridor due to increased foot traffic.
- Vegetated berm with bottom seat wall facing Hull Shore Drive creates more green space, enhances shading for corridor, and offers passive seating.
- Though not an accessible feature, the stepped wall facing seaward offers amenity spaces for beach goers during high tide and serves as a more approachable barrier that can be climbed by able-bodied users.
- Lane reduction in Hull Shore Drive allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Reduces pavement and mitigates precipitation-based runoff.
- Stepped wall requires less maintenance than sand dune.
- Shifts parking closer to adjacent business corridor, and offers some flood resilience to businesses as a co-benefit.

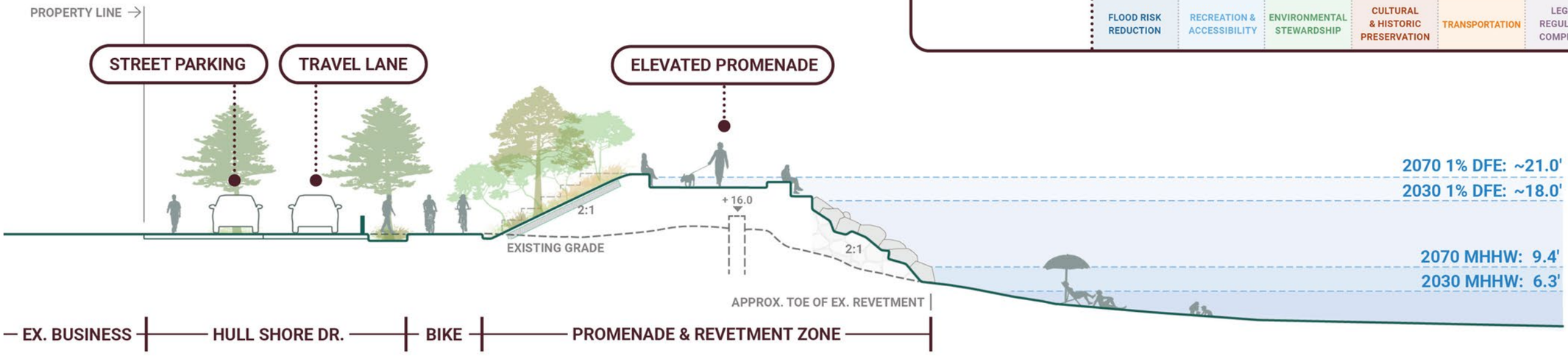
DISADVANTAGES

- Berm creates a visual barrier to water from parkway and adjacent business corridor.
- Pedestrian and bicycle circulation is at street level, below flood resilience measures.
- Stepped wall on seaward side has less ecological benefit than dune and may require more maintenance than revetment.
- Reduces existing street parking capacity and vehicular circulation capacity for adjacent, local business corridor.

SECTION C - OPTION 4

Increase height of rock revetment and create an elevated promenade at the crest of the revetment with a seat wall that also increases flood resiliency. Landward of the elevated promenade and seat wall is a vegetated and reinforced berm. Hull Shore Drive retains its existing, overall traffic pattern but is reduced to one travel lane, with angled street parking being replaced by parallel parking along the landward side of the parkway. This parkway configuration reduces vehicular and parking capacity, but allows for the shoreline protection to be shifted landward, and provides enough space for a dedicated bicycle path and elevated pedestrian promenade. This option does not align with the 2016 Master Plan in that it reduces the number of travel lanes from two to one.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

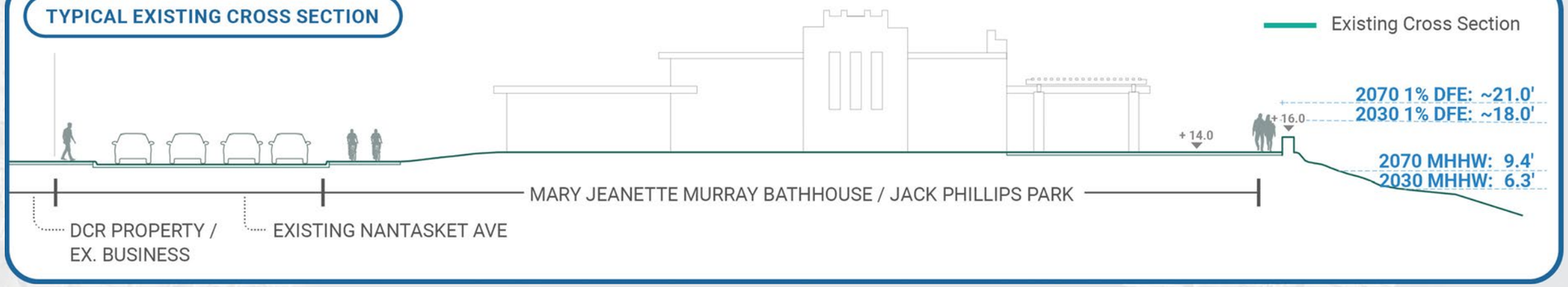
- Provides enough space for a street-level dedicated bicycle path and elevated promenade, which could benefit the adjacent business corridor due to increased foot traffic.
- Vegetated berm facing Hull Shore Drive creates more green space, enhances shading for corridor, and could be interspersed with stepped wall seating.
- Pedestrian promenade is elevated and provides unobstructed views of water and beach.
- Reduces pavement and mitigates precipitation-based runoff.
- Rock revetment on seaward side requires less maintenance than stepped walls or dune.
- Lane reduction in Hull Shore Drive allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Shifts parking closer to adjacent business corridor, and offers some flood resilience to businesses as a co-benefit.

DISADVANTAGES

- Berm creates a visual barrier to water from parkway and adjacent business corridor.
- Rock revetment on seaward side does not serve as an amenity feature for parkway users.
- Rock revetment provides less ecological benefit than dunes.
- Reduces existing street parking capacity and vehicular circulation capacity for adjacent, local business corridor.

EXISTING CONDITION PLAN

TYPICAL EXISTING CROSS SECTION



EXISTING CONDITION

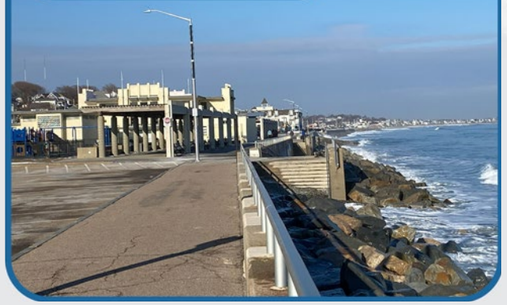
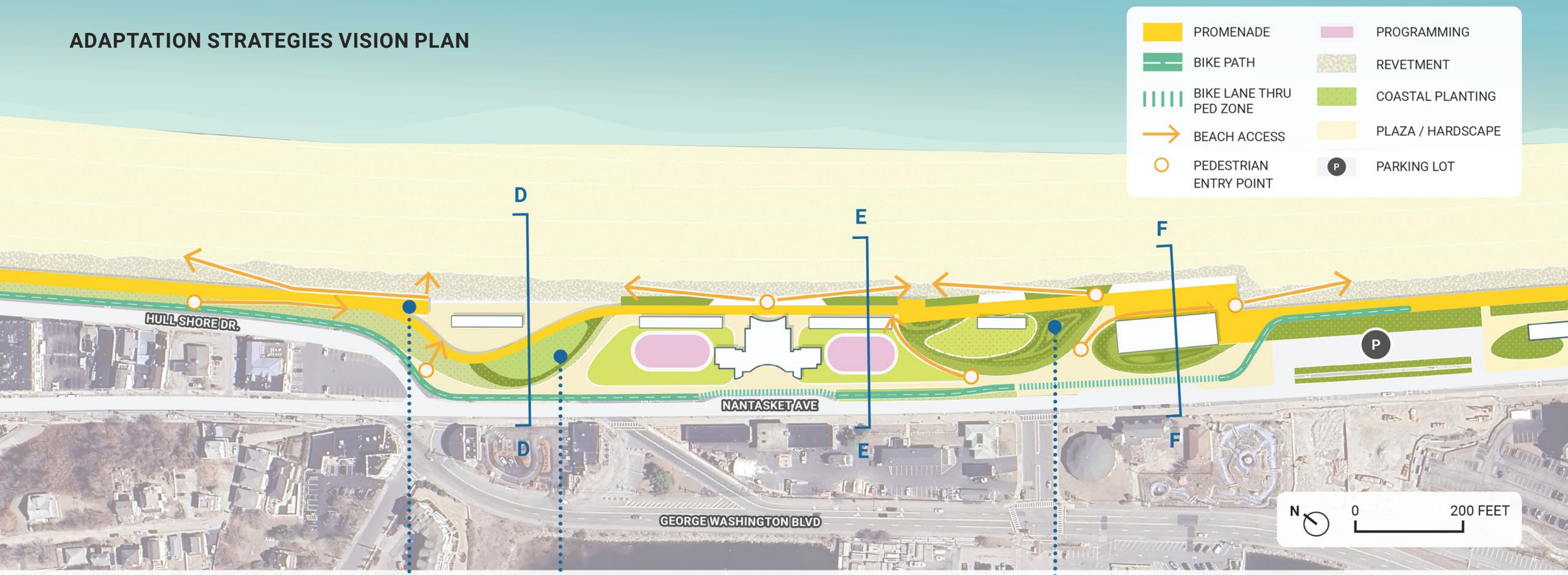


Photo at the parking lot looking West

ADAPTATION STRATEGIES VISION PLAN



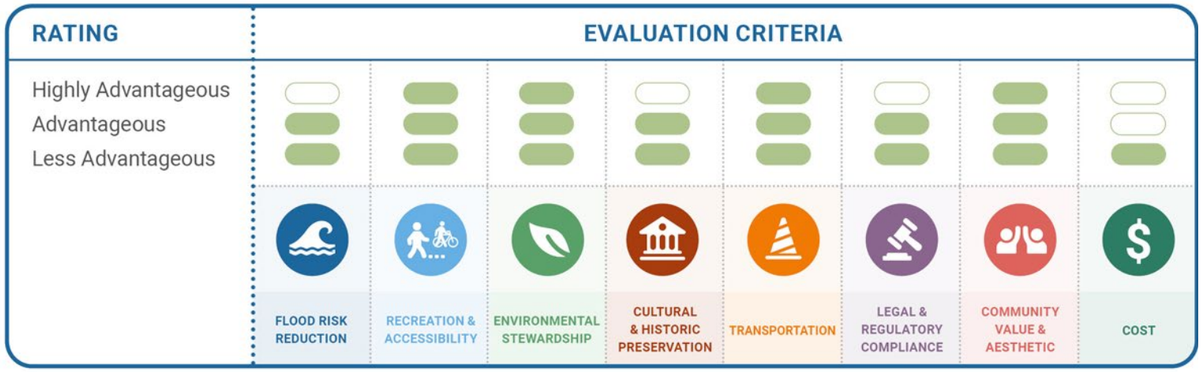
Precedent Image (Source: PWPLA)

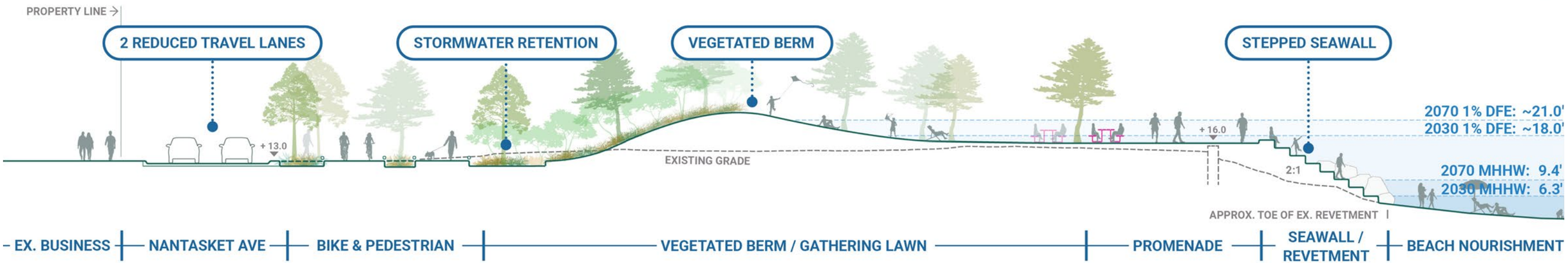
Precedent Image (Source: Inhabitat)

Precedent Image (Source: SWA)

SECTION D - OPTION 1

Replace rock revetment with a stepped concrete wall that transitions to beach nourishment at the bottom, and create an elevated, vegetated berm further inland to increase flood resiliency. Immediately adjacent to the top of stepped wall is a pedestrian promenade followed by open green space that leads up to the reinforced, vegetated berm. The southernmost portion of Hull Shore Drive is eliminated and the two-way access on Nantasket Avenue is extended to the intersection of George Washington Blvd, which optimizes the open spaces, creates some stormwater retention area, and still maintains street-level pedestrian and bicycle traffic. Parking capacity is reduced with the elimination of off-street parking area. This option aligns with the roadway realignment and dedicated bike path depicted in the 2016 Master Plan.





ADVANTAGES

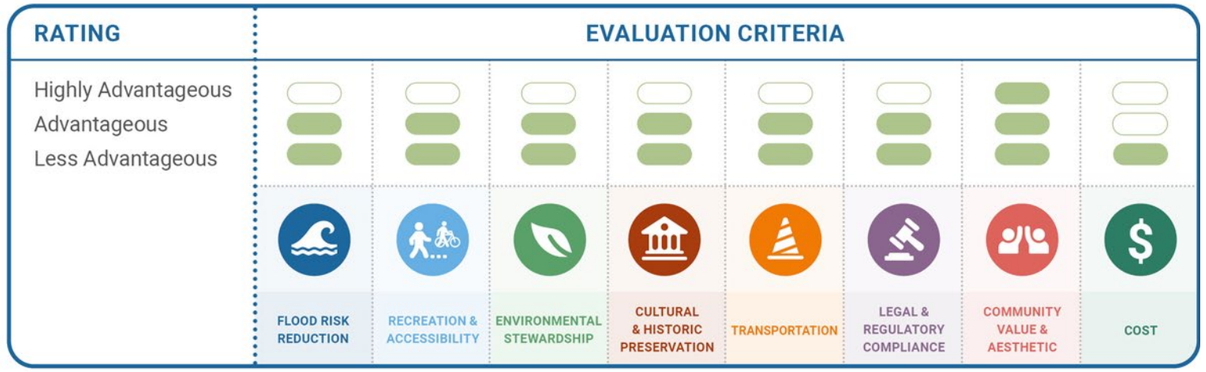
- Large expanse of usable green space is created (by eliminating parking lot), and use of inland vegetated berm reduces height of hardened structure at shoreline and brings users closer to the water
- Creates enough space for a street-level dedicated bicycle path and pedestrian sidewalk, in addition to the elevated promenade that provides unobstructed views of water and beach.
- Though not an accessible feature, the stepped wall facing seaward offers amenity spaces for beach goers during high tide and serves as a more approachable barrier that can be climbed by able-bodied users.
- Pavement reduction mitigates precipitation-based runoff and the reconfiguration of spaces allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Stepped wall requires less maintenance than sand dune.

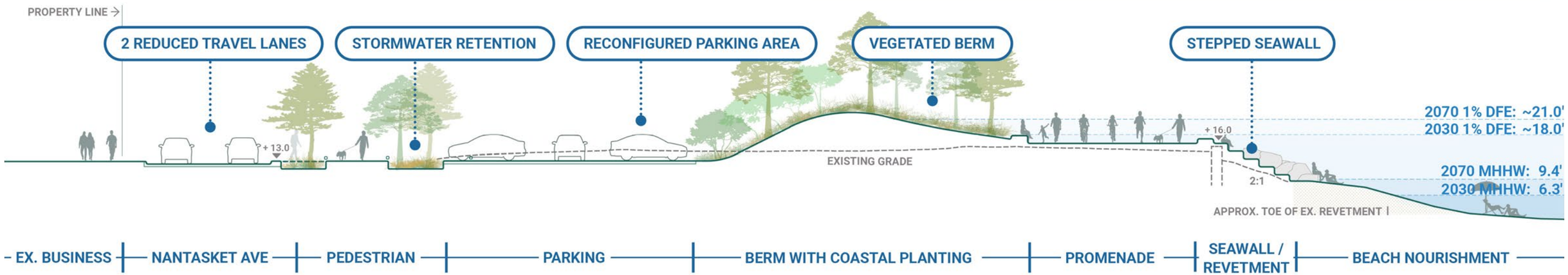
DISADVANTAGES

- Berm creates a visual barrier to water from landward side.
- Stepped wall on seaward side has less ecological benefit than dune and may require more maintenance than revetment.
- Elevated promenade next to shoreline is more prone to flooding than Nantasket Ave due to highest flood measure being landward of promenade.
- Maintaining landscape quality of gathering lawn in area exposed to flooding.
- Eliminates dedicated parking area.

SECTION D - OPTION 2

Replace rock revetment with a combination of stepped concrete wall and higher rock revetment, and create an elevated, vegetated berm further inland to increase flood resiliency. Immediately adjacent to the stepped wall is pedestrian promenade followed by the reinforced, vegetated berm. A reconfigured one-way parking area is located at the bottom, landward side of the berm. The southernmost portion of Hull Shore Drive is eliminated and the two-way access on Nantasket Avenue is extended to the intersection of George Washington Blvd, which increases the open space, and allows for a tree-line pedestrian path. This option aligns with the roadway realignment depicted in the 2016 Master Plan but does not include a dedicated bike path adjacent to the roadway.





ADVANTAGES

- Use of inland vegetated berm reduces height of hardened structure at shoreline and brings users closer to the water
- Creates enough space for a tree-lined pedestrian corridor along Nantasket Ave and a shared-use promenade that provides unobstructed views of water and beach.
- Though not an accessible feature, the stepped wall facing seaward offers amenity spaces for beach goers during high tide and serves as a more approachable barrier that can be climbed by able-bodied users.
- Pavement reduction mitigates precipitation-based runoff and the reconfiguration of spaces allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Still offers some dedicated parking area.
- Stepped wall requires less maintenance than sand dune.

DISADVANTAGES

- Berm creates a visual barrier to water from landward side.
- Stepped wall on seaward side has less ecological benefit than dune and may require more maintenance than revetment.
- Elevated promenade adjacent to shoreline is more prone to flooding than Nantasket Ave due to highest flood resilience measure being landward of the promenade.
- Vegetated berm has reduced recreational value and accessibility.
- Parking area reduces available lawn space for recreation.

SECTION E

Replace rock revetment with a combination of stepped concrete wall and higher rock revetment, with the stepped wall extending back down to grade in front of the Mary Jeanette Murray Bathhouse (MJMBH) on the landward side. Nantasket Ave retains its existing, overall traffic pattern, but is reduced from two travel lanes in each direction to one travel lane in each direction, which allows for a dedicated bike path and pedestrian promenade adjacent to the MJMBH. This option generally aligns with the layout depicted in the 2016 Master Plan.

While not depicted in this section, the relocation of MJMBH further landward and elevating it to improve its flood resilience, should be considered. Though designated as a historic resource, replacing it with a new, smaller, and more efficient facility could be more cost effective and result in additional, programmable, open space.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST

ADVANTAGES

- Creates enough space for a street-level dedicated bicycle path and pedestrian promenade.
- Stepped wall facing bathhouse offers terraced seating for beach goers and users of bathhouse amenities, including the playground.
- Though not an accessible feature, the stepped wall facing seaward offers amenity spaces for beach goers during high tide and serves as a more approachable barrier that can be climbed by able-bodied users from either side.
- Stepped wall requires less maintenance than sand dune.
- Reduces pavement and mitigates precipitation-based runoff.

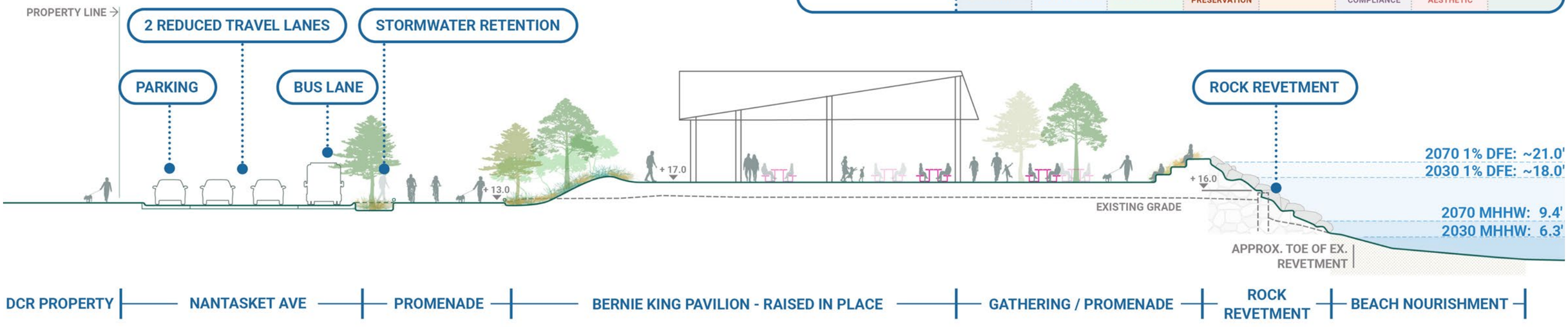
DISADVANTAGES

- Stepped wall creates a visual barrier to water from landward side.
- Dedicated bicycle path is at street level, below flood resilience measures.
- To achieve targeted flood mitigation and provide adequate width for shared use promenade, flood resilience measures may extend just beyond the existing revetment toe of slope. Viability of permitting this encroachment is low based on current environmental regulations.
- Stepped wall on seaward side has less ecological benefit than dune, and may require more maintenance than revetment.

SECTION F

Increase height of rock revetment and raise the Bernie King Pavilion to approximately elevation 17', along with the associated promenade and plaza. Above elevation 17', transition the revetment to stepped seat wall up to the DFE and then back down to the elevated promenade. Landward of the raised pavilion is a wider, shared use bike and pedestrian promenade, offset from Nantasket Ave. Nantasket Ave retains its existing, overall traffic pattern, but with narrower lanes to optimize space for streetscaping and the shared use promenade. Though the shared use promenade offers cycling access, it does not align with the 2016 Master Plan of providing a dedicate bike path.

RATING	EVALUATION CRITERIA							
Highly Advantageous								
Advantageous								
Less Advantageous								
	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



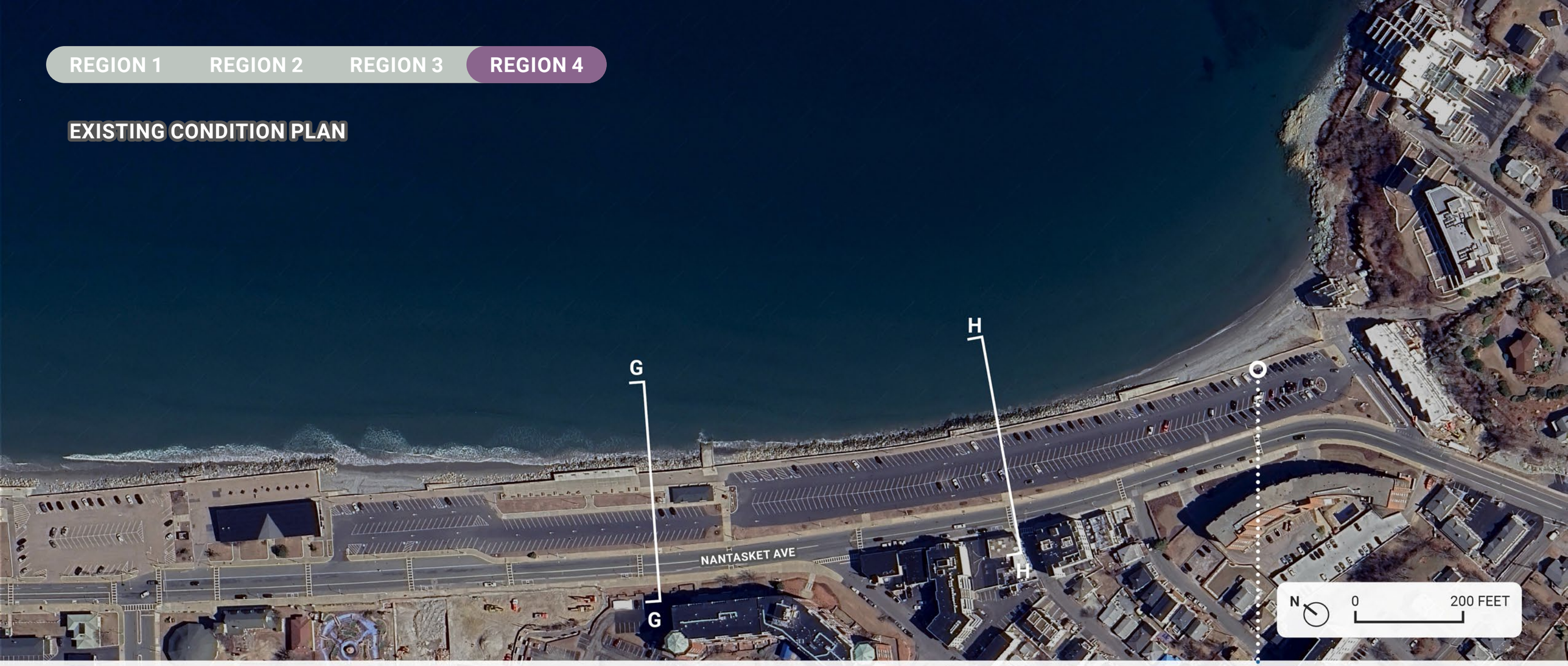
ADVANTAGES

- Provides wider and improved pedestrian and bicycle amenities, with vegetated buffer along Nantasket Ave.
- Stepped wall facing pavilion offers terraced seating for beach goers and users of the pavilion.
- Raising of the pavilion creates more usable space closer to the shoreline, reduces the height of the stepped wall, and allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Rock revetment requires less maintenance than dune or stepped wall.

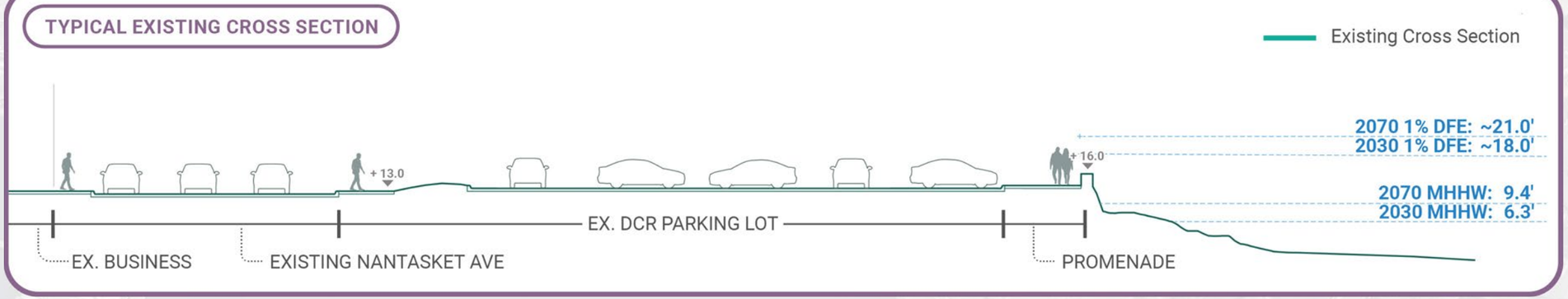
DISADVANTAGES

- Stepped wall creates a visual barrier to water from landward side.
- Revetment and stepped wall have less ecological benefit than dune.
- Does not reduce pavement and mitigate precipitation-based runoff.

EXISTING CONDITION PLAN



TYPICAL EXISTING CROSS SECTION



EXISTING CONDITION

Photo at the promenade looking West

ADAPTATION STRATEGIES VISION PLAN

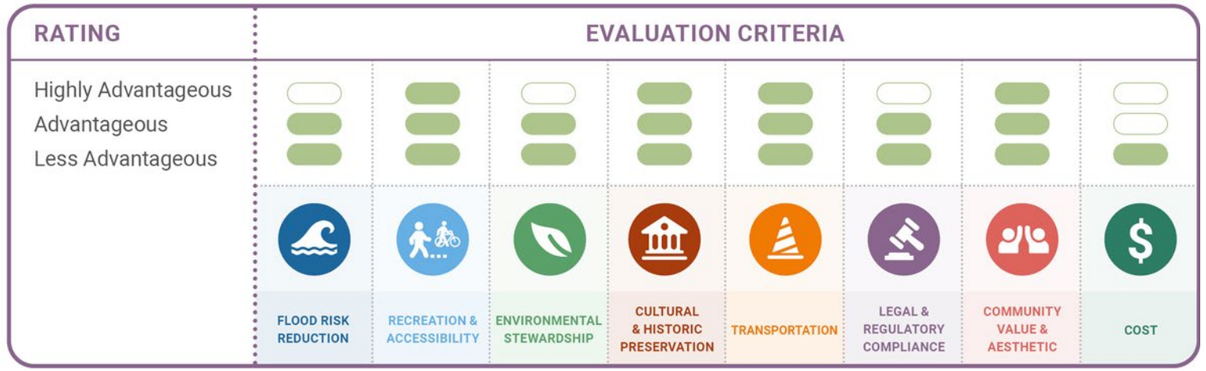
Precedent Image (Source: STANTEC)

Precedent Image (Source: PWPLA)

Precedent Image (Source: BBP.org)

SECTION G

Increase height of rock revetment. Create an elevated pedestrian promenade landward of the revetment, followed by a seat wall that increases flood resilience. The Tivoli Bathhouse is relocated further landward, and elevated. Relocating the bathhouse allows for the creation of a elevated bike path, adjacent to the promenade and separated by landscape buffers. The bathhouse is separated from both the elevated promenade and Nantasket Ave by vegetated berms and seat walls. Nantasket Ave retains its current configuration, but with narrowed lanes, while the parking is modified to make room for the relocated bathhouse. The previously connected parking areas will be divided by green space at this area, and new curb cuts will be created on Nantasket Ave. This option generally aligns with the 2016 Master Plan of creating a dedicated bike path on the seaward side of the relocated Tivoli Bathhouse.



ADVANTAGES

- Provides vegetated buffer along street-level pedestrian promenade and creates elevated tiers of shared use access around the relocated bathhouse and at the shoreline.
- Seat walls offer passive seating and help to transition grade changes between tiered uses.
- Relocating and raising of the bathhouse creates more usable space closer to the shoreline, reduces the height of berm between the bathhouse area and the elevated shoreline promenade, and allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Rock revetment on seaward side requires less maintenance than stepped walls or dune.
- Reduces pavement and mitigates precipitation-based runoff.

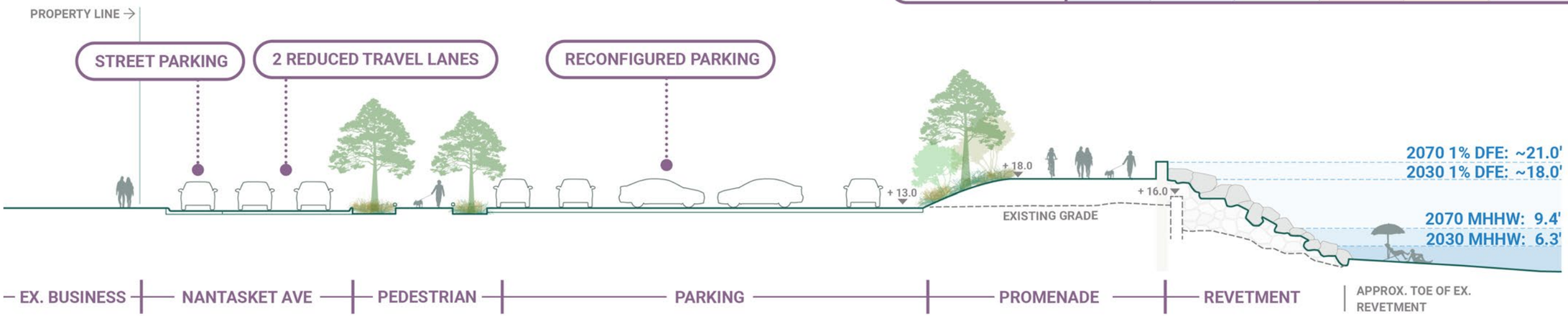
DISADVANTAGES

- Eliminating parking area directly adjacent to relocated bathhouse reduces off-street parking capacity.
- Vegetated berms create a visual barrier to water from landward side.
- Rock revetment on seaward side does not serve as an amenity feature for parkway users.
- Elevated promenade adjacent to shoreline is more prone to flooding than bathhouse and Nantasket Ave due to highest flood resilience measure being landward of promenade.
- Rock revetment provides less ecological benefit than dunes.

SECTION H - OPTION 1

Increase height of wall by modifying or replacing the existing wall and extend rock revetment up to the top of wall. An elevated, shared use bicycle and pedestrian promenade is landward of the wall, separated from the lower parking area by a vegetated berm. Nantasket Ave retains its current configuration, but with narrowed lanes, while the parking lot reflects the replacement of outer lane angled parking with parallel parking. These adjustments aim to optimize pockets of open space and the shared use promenade. This option does not align with the 2016 Master Plan vision of creating a dedicated bike path on the seaward side of the parking lot. Instead, maximization of the parking area with an adequate vegetated buffer from the elevated promenade is prioritized.

RATING	EVALUATION CRITERIA							
Highly Advantageous Advantageous Less Advantageous	FLOOD RISK REDUCTION	RECREATION & ACCESSIBILITY	ENVIRONMENTAL STEWARDSHIP	CULTURAL & HISTORIC PRESERVATION	TRANSPORTATION	LEGAL & REGULATORY COMPLIANCE	COMMUNITY VALUE & AESTHETIC	COST



ADVANTAGES

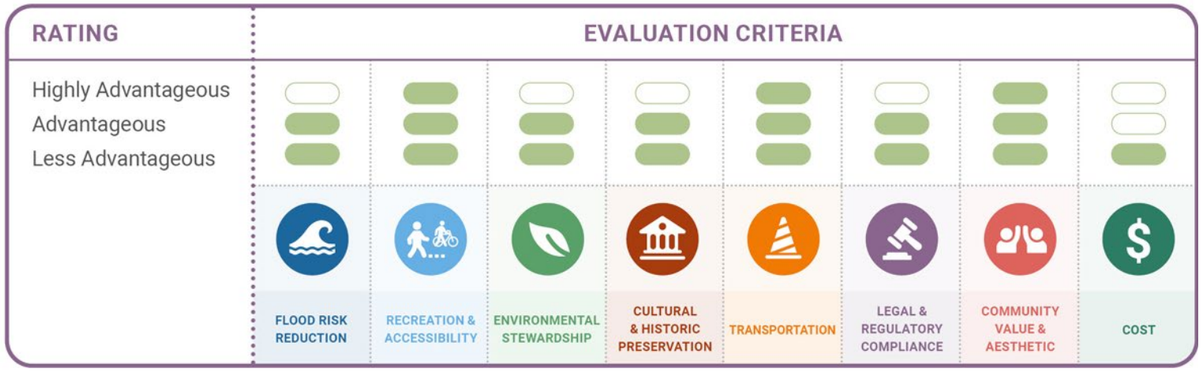
- Provides vegetated buffer along street-level pedestrian promenade and uses a vegetated berm to elevate the shared use promenade at the shoreline while providing buffer to the parking lot.
- Rock revetment on seaward side requires less maintenance than stepped walls or dune.
- Reducing size of off-street parking lot allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability).
- Reduces pavement and mitigates precipitation-based runoff.

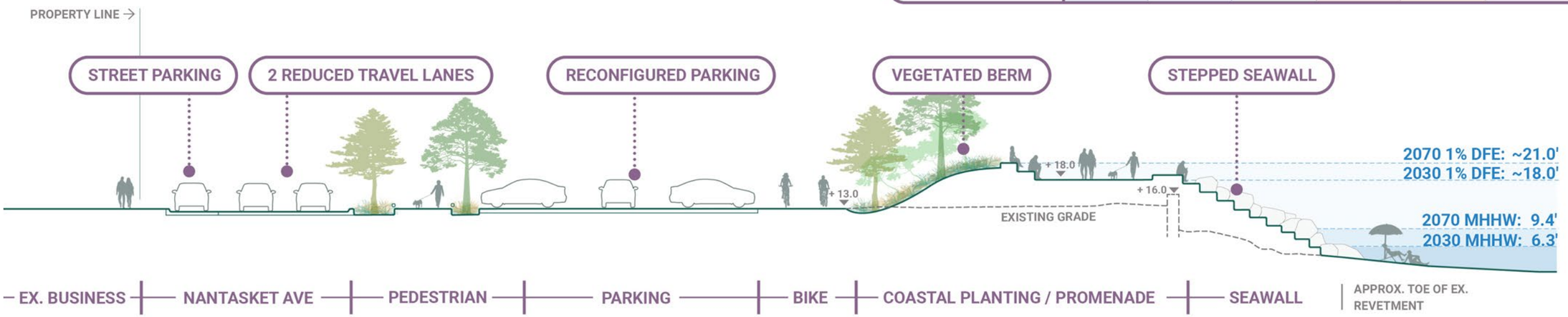
DISADVANTAGES

- Reduces off-street parking capacity.
- Vegetated berm creates a visual barrier to water from landward side.
- Rock revetment on seaward side does not serve as an amenity feature for parkway users.
- Rock revetment provides less ecological benefit than dunes.

SECTION H - OPTION 2

Replace rock revetment and vertical wall with stepped concrete wall that transitions to beach nourishment on the seaward side. An elevated promenade is landward of a stepped wall, followed by a smaller, two-tier seat wall that increases flood resilience. These measures are separated from the lower parking area by a vegetated berm. Nantasket Ave retains its current configuration, but with narrowed lanes, while the parking lot reflects a more efficient layout, but with reduced parking capacity. These adjustments allow for the creation of a bike path on the landward side of the vegetated berm and keeps the enhanced flood resilience measures from extending beyond the existing seaward limits. This option generally aligns with the 2016 Master Plan of creating a dedicated bike path on the seaward side of the parking lot.





ADVANTAGES

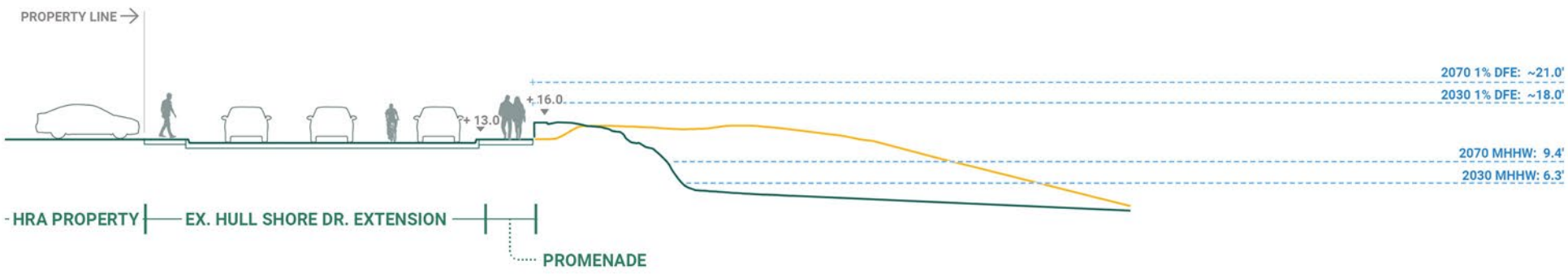
- Provides vegetated buffer along street-level pedestrian promenade and uses a vegetated berm to elevate the promenade at the shoreline while providing buffer to the parking lot.
- Seat wall at top of berm offers passive seating and helps to transition grade change between parking lot and elevated promenade.
- Though not an accessible feature, the stepped wall facing seaward offers amenity space for beach goers during high tide and serves as a more approachable barrier that can be climbed by able-bodied users.
- Reducing size of off-street parking lot allows for installation of flood resilience measures without extending beyond existing limits of revetment (improves permitting viability), and creation of a bike path.
- Reduces pavement and mitigates precipitation-based runoff.
- Stepped wall requires less maintenance than sand dune.

DISADVANTAGES

- Further reduces off-street parking capacity.
- Vegetated berm and seat wall create a visual barrier to water from landward side.
- Stepped wall on seaward side has less ecological benefit than dune and may require more maintenance than revetment.

SECTION A

EXISTING



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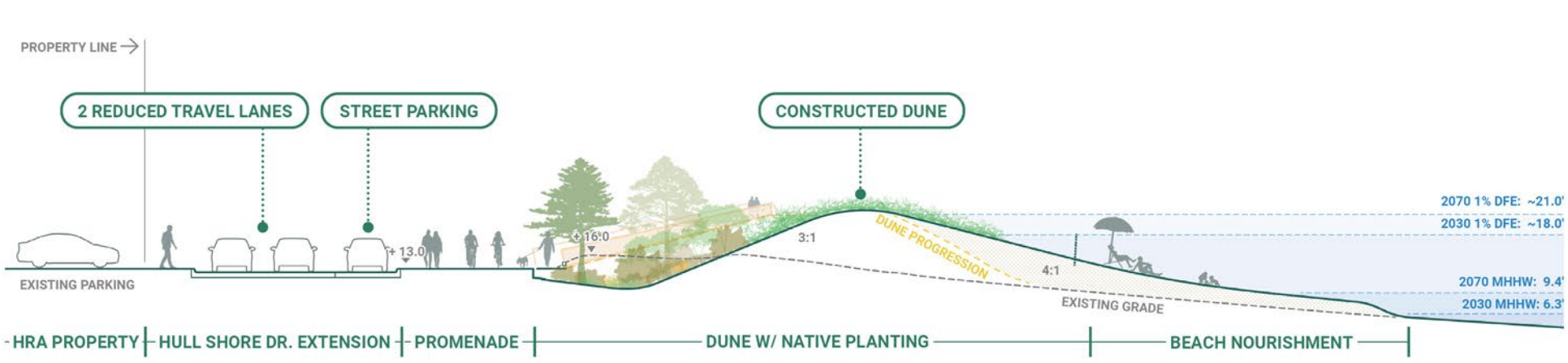

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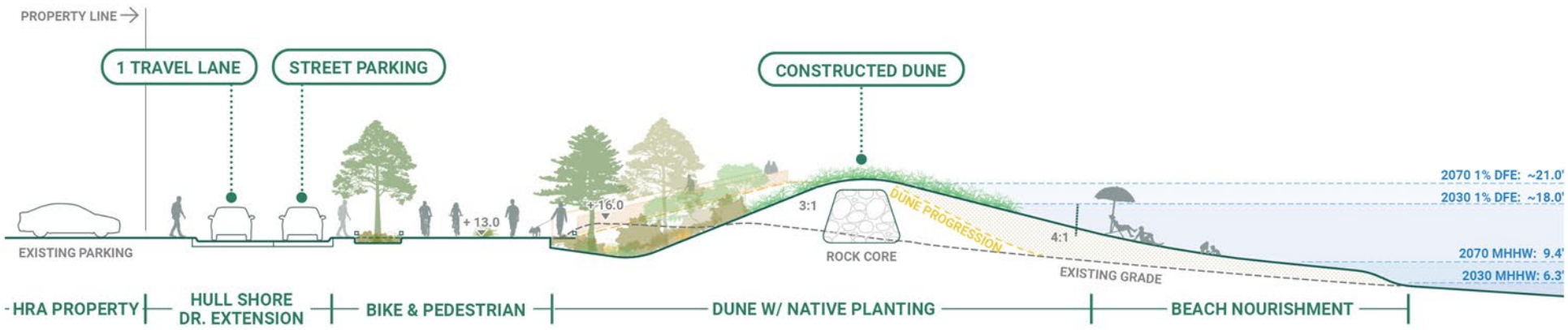

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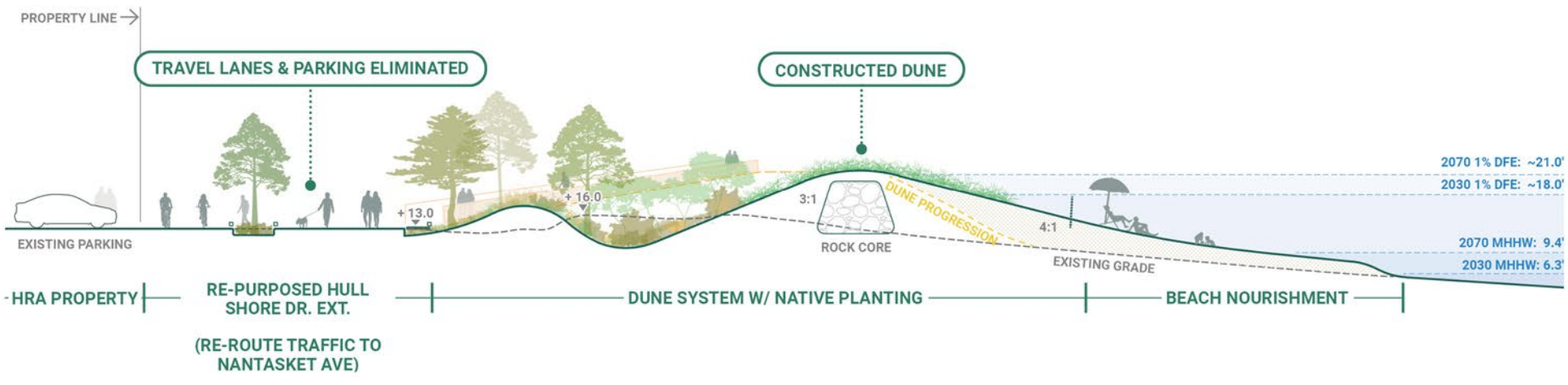

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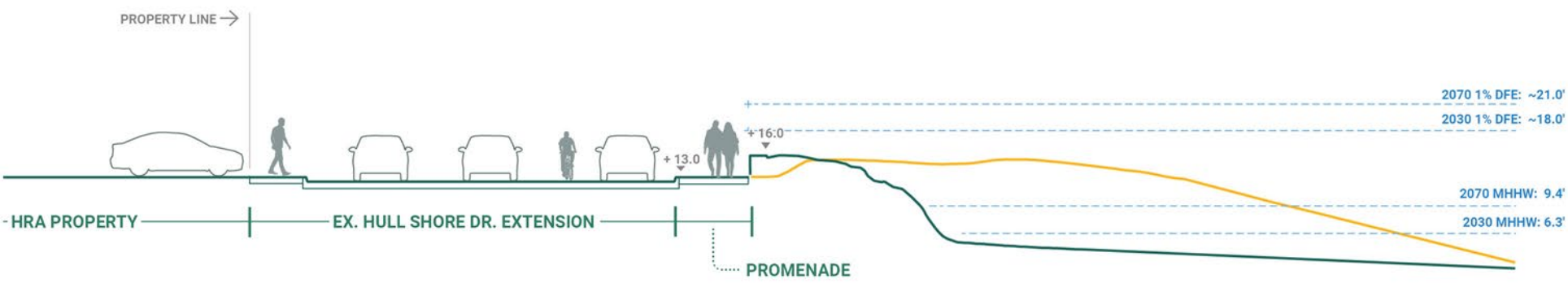

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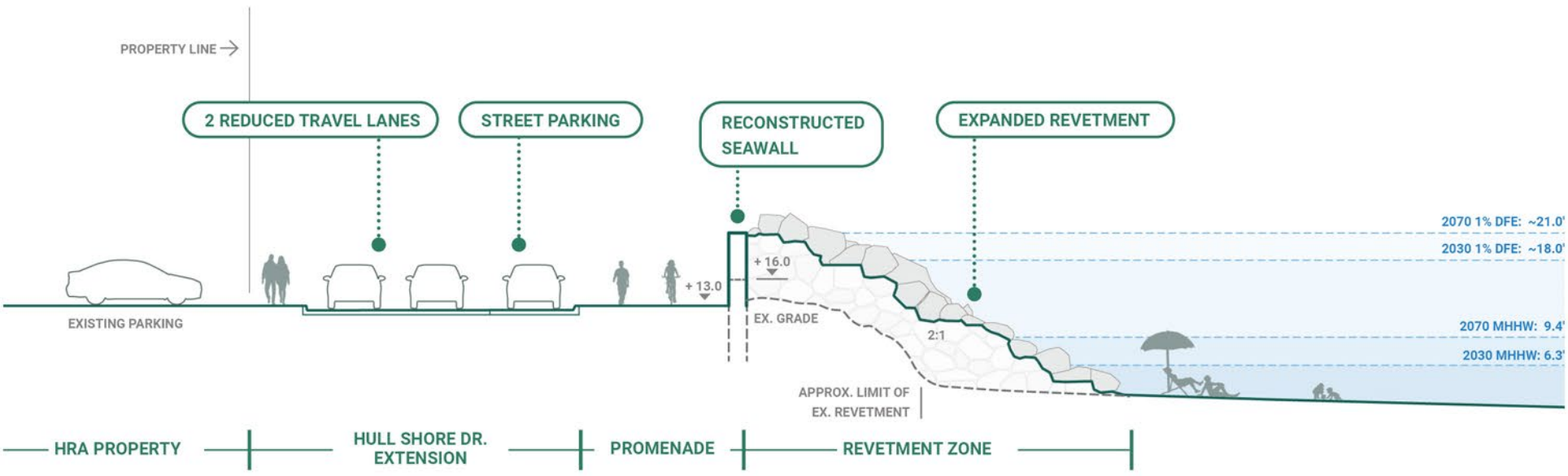

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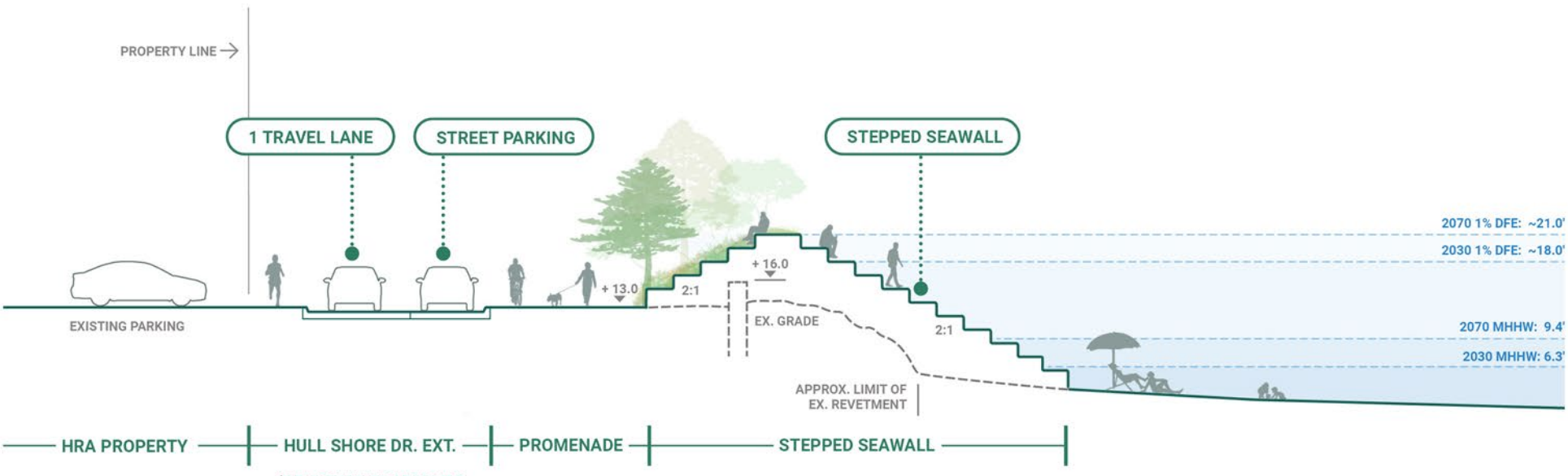

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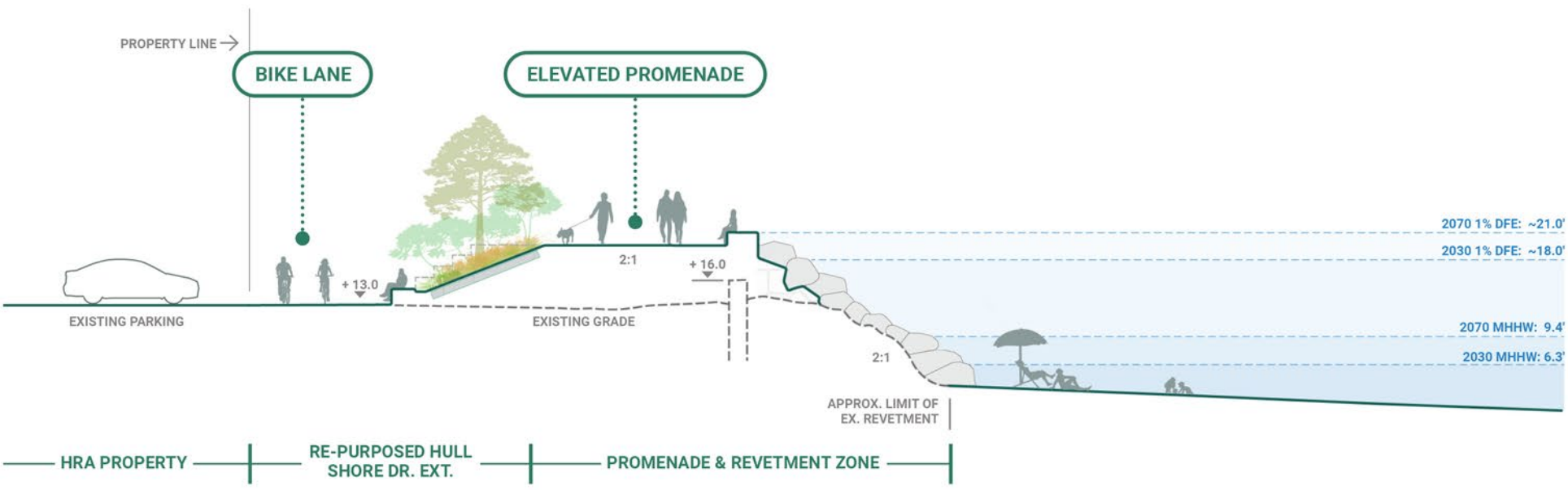

SECTION C

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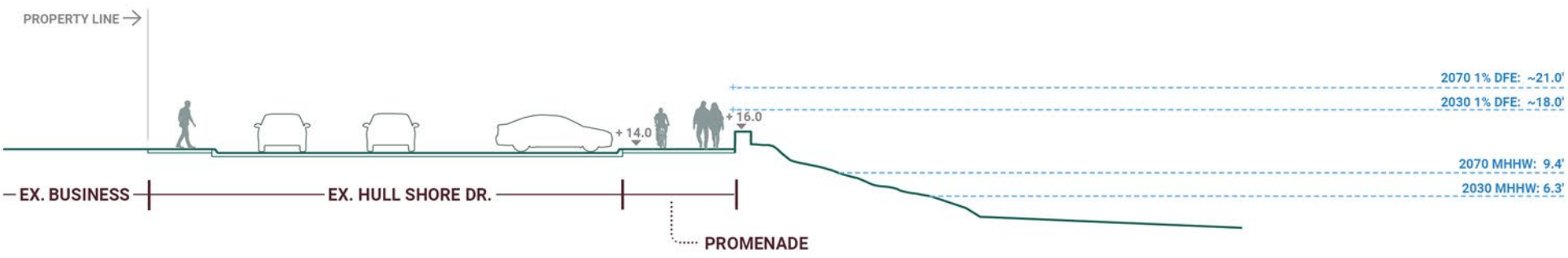

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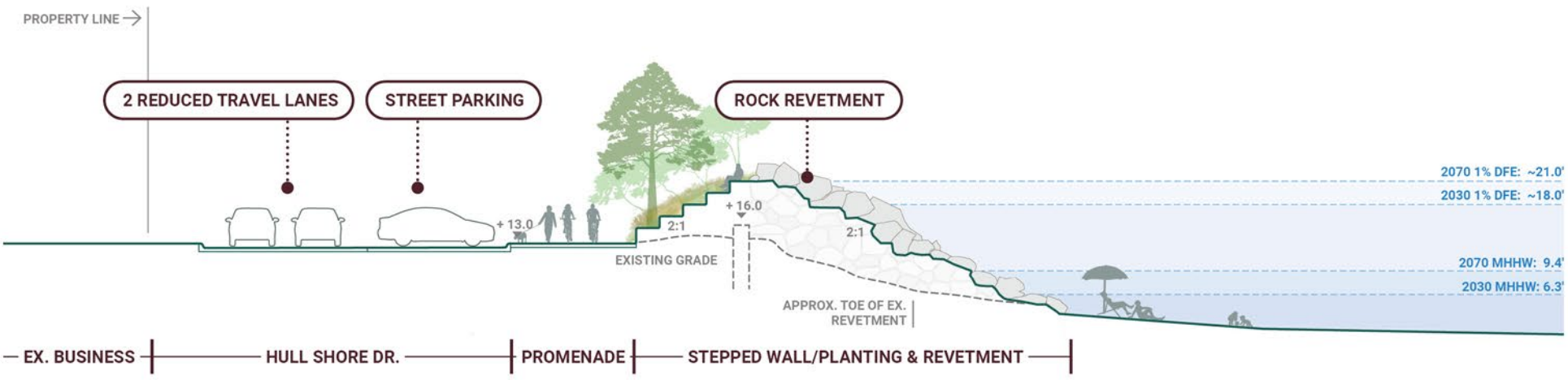

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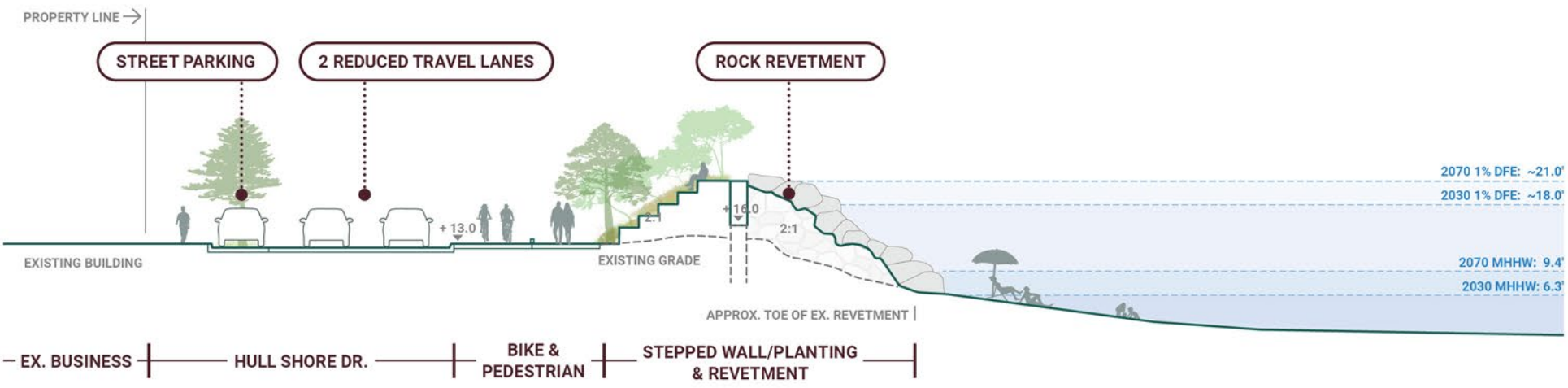

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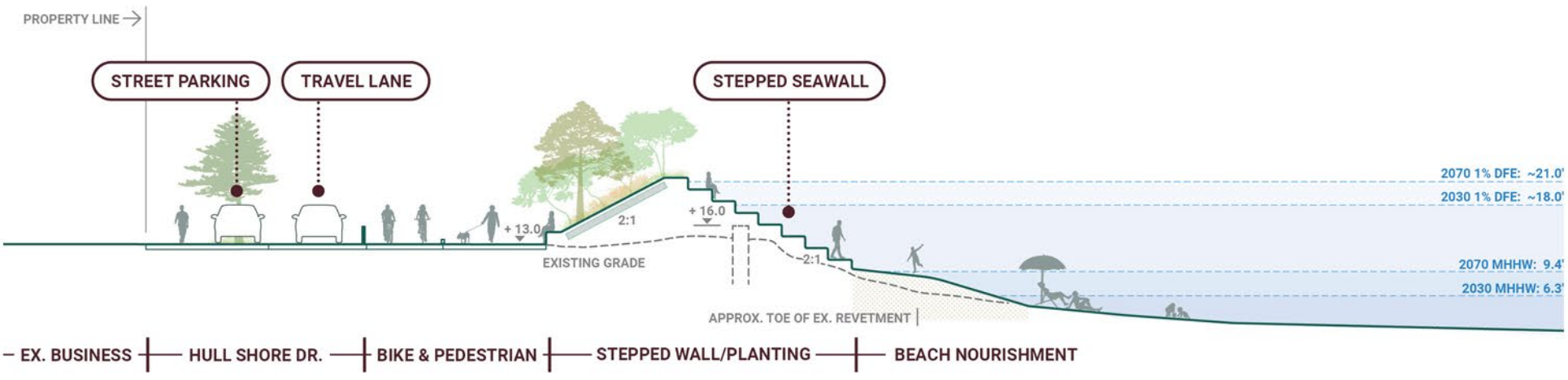

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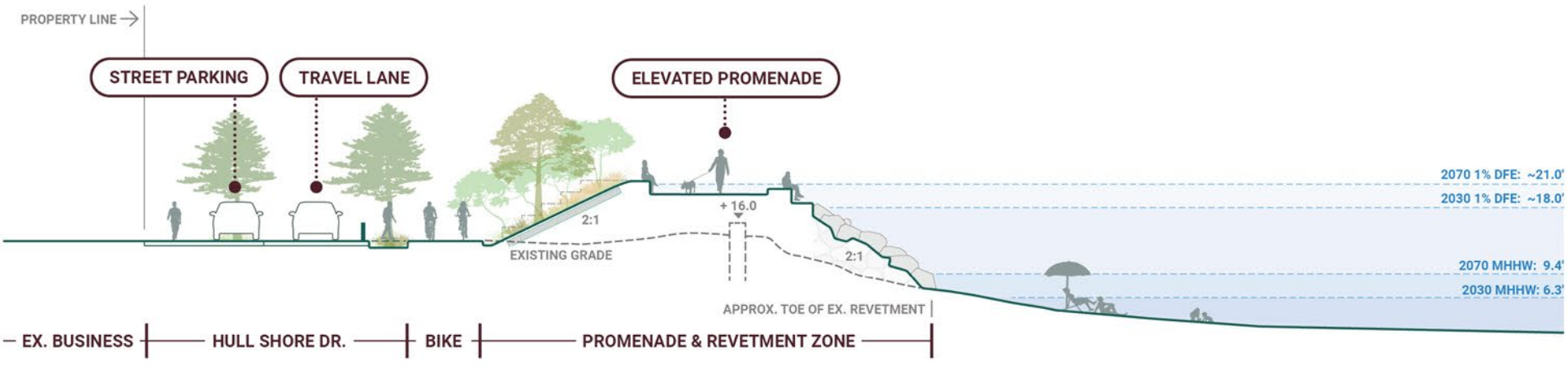
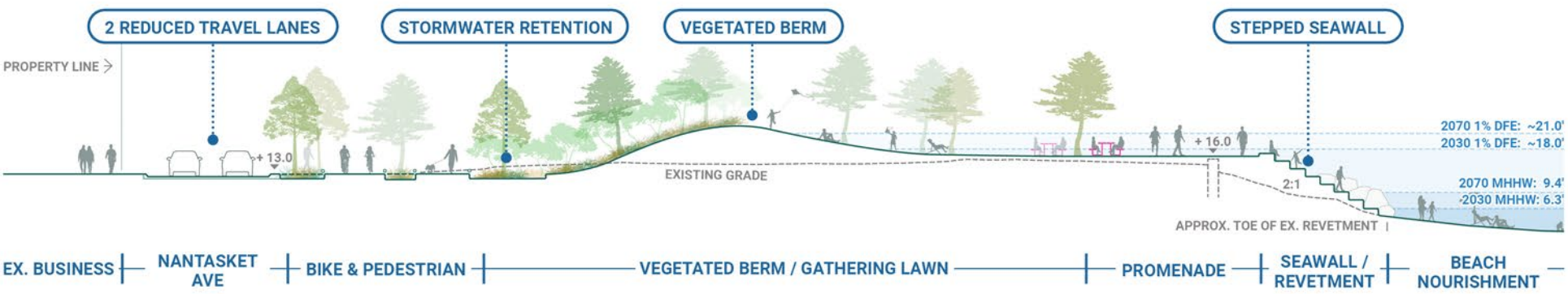
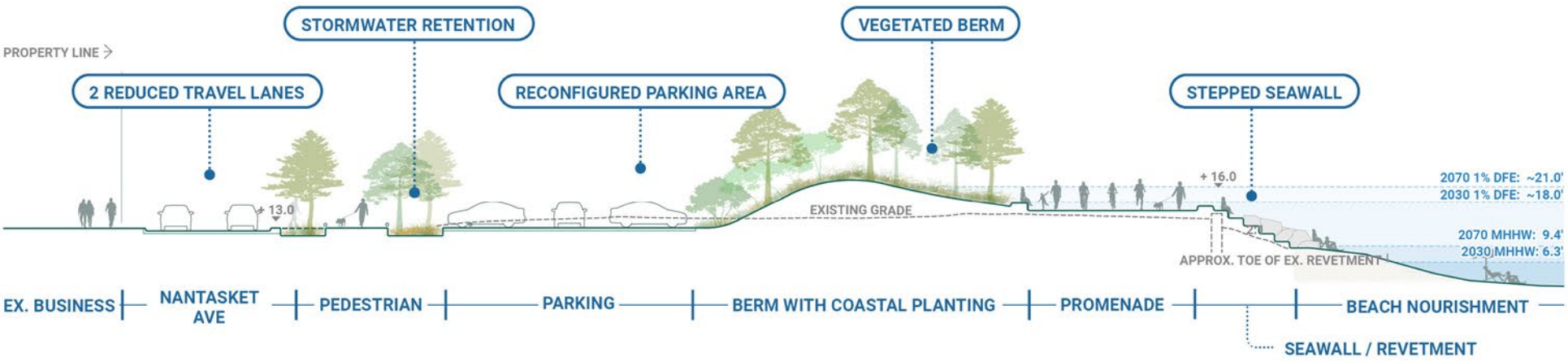


TYPICAL EXISTING CROSS SECTION

SECTION D OPTION 1



SECTION D OPTION 2



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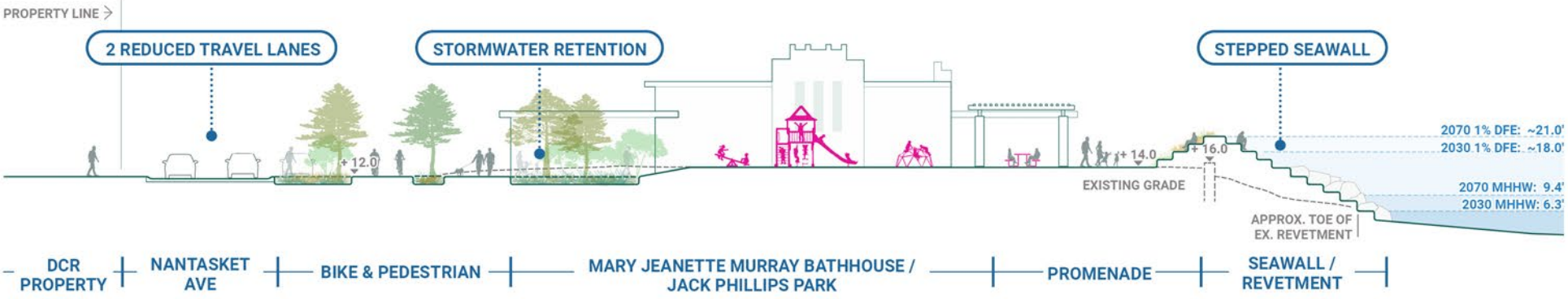

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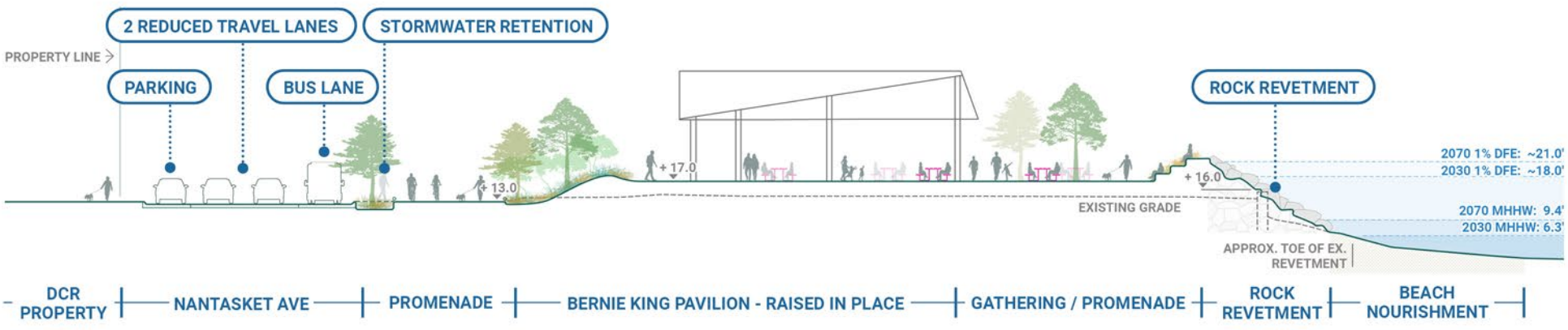

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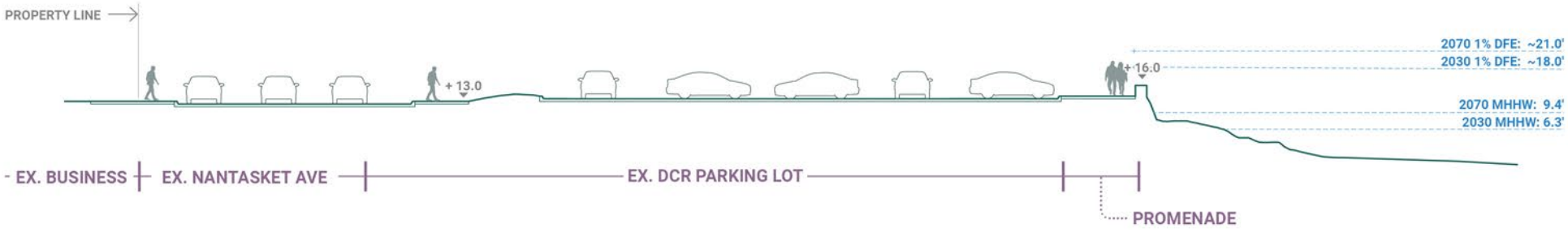

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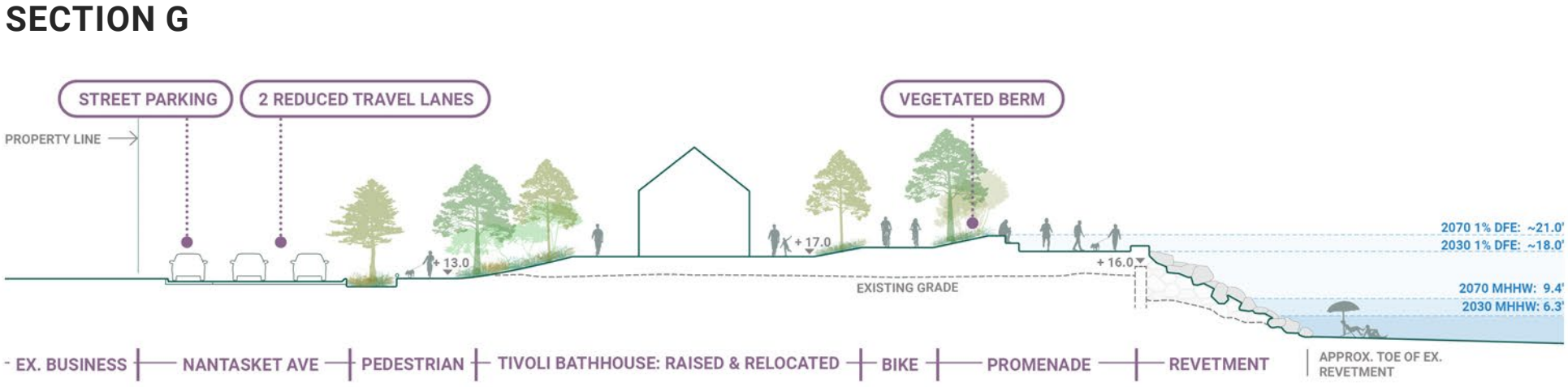
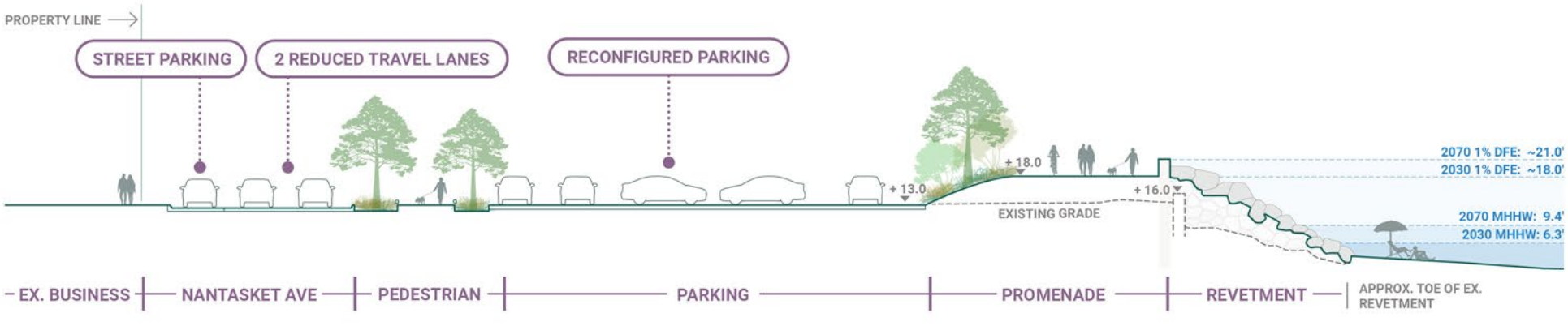


SECTION H

OPTION 1



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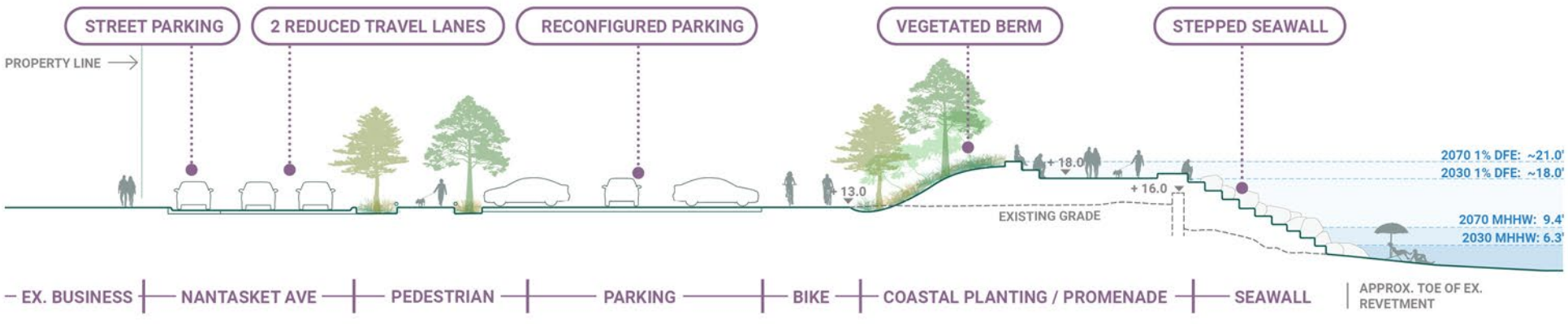

CONCLUSIONS & NEXT STEPS

This report identifies and illustrates a menu of potential adaptation strategies aimed at improving the resilience of DCR parkways at Nantasket Beach Reservation to coastal and extreme precipitation-based flooding associated with the 1% storm event projected for 2070. The plan view and cross-section diagrams are based on publicly available LiDAR topography, aerial imagery, supporting map datasets, and site-specific field observations. These illustrations are intended to convey approximate spatial relationships and physical constraints that influence the feasibility of each strategy.

The high-level evaluation of advantages and disadvantages, paired with qualitative ratings across DCR's Climate Adaptation Framework categories, is intended to support relative comparisons between options. Together, these materials are meant to guide DCR in identifying preferred strategies for advancement into the next stages of analysis and design.

Importantly, this study affirms that there is no single solution that addresses the entire corridor. The region-based approach reflects the diverse physical and operational conditions along the Parkway, and the strategies presented are tailored to that complexity. While each region presents unique challenges, the report offers a clear starting point for site-specific resilience planning that remains cohesive across the corridor.

To progress this effort, DCR may consider the following next steps:

- **Identify funding programs that align with near-term next steps** – such as conceptual design advancement, modeling, and/or stakeholder engagement. Positioning the project for competitive funding can help support phased implementation over time.
- **Conduct a benefit-cost analysis (BCA)** of preferred adaptation strategies to help prioritize investments based on cost-effectiveness, risk reduction, and multi-benefit potential.
- **Develop a consolidated land use map and supplemental community context layer** to better understand how adjacent uses – public and private – will be affected by or could support future interventions. This will also assist in coordination with non-DCR landowners and agencies.
- **Perform site-specific wave, sediment transport, and hydrodynamic modeling to evaluate the effectiveness of each proposed strategy.** Outputs from the Massachusetts Coastal Flood Risk Model (MC-FRM) can be used to inform boundary conditions. High-resolution wave models, such as XBeach or FUNWAVE, are recommended for simulating wave processes, while hydrodynamic models such as Delft3D Flexible Mesh or SFINCS should be applied to assess circulation, and flooding.
- **Conduct a cultural resources reconnaissance survey, including an archaeological sensitivity assessment, for the anticipated project impact areas** to help refine design alternatives, identify potential mitigation measures, support historic preservation requirements during environmental permitting, and inform outreach with stakeholders such as Tribal Nations, Descendent Communities, and Municipal Historical Commissions
- **Perform a traffic operations and parking analysis** to determine the feasibility of considered lane reductions and on-street parking reductions, and to evaluate potential impacts to vehicular capacity and level of service.
- **Refine and advance selected strategies into preliminary conceptual designs**, incorporating additional technical input on engineering feasibility, public realm impacts and enhancement, constructability, permitting, and maintenance.
- **Initiate targeted public outreach and engagement**, focused on local stakeholders, property owners, and Town leadership. This step is critical for gathering early input on design priorities, understanding community trade-offs, and building support for future implementation.
- **Begin reviewing the permitting and regulatory requirements associated with the selected adaptation strategies, including coordination with local agencies**, MassDEP Wetlands & Waterways Program, CZM, and federal agencies such as the Army Corps of Engineers. Early identification of likely constraints and opportunities will facilitate discussion, inform decisions, and streamline future design and approval processes.

Taken together, these next steps will allow DCR to move forward with a grounded, adaptable, and informed approach – one that strengthens the long-term resilience of this critical coastal corridor while remaining responsive to both the physical site and the needs of the community it serves.

Bird's-Eye View of Project Site, February 2025.

DCR Stantec