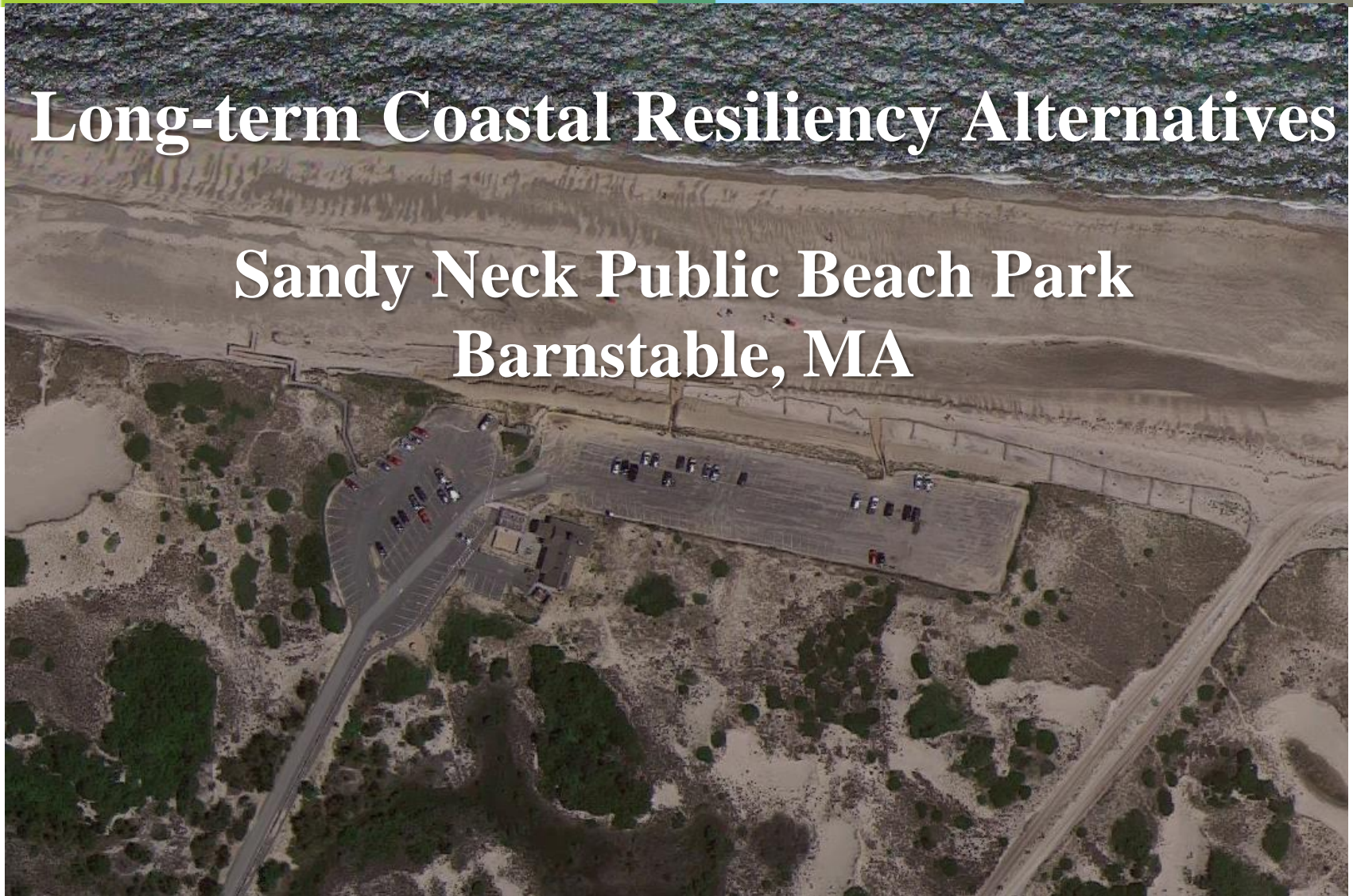


Long-term Coastal Resiliency Alternatives

Sandy Neck Public Beach Park Barnstable, MA



PROJECT GOALS & OBJECTIVES:

To explore various conceptual long-term alternatives that will continue to support current on-site access and address the severe erosion and primary dune loss that has occurred at the Sandy Neck Public Beach.



“LONG-TERM COASTAL RESILIENCY”

Defined as an alternative that is demonstrated to be:

- ✓ Sustainable for a minimum of 50 years
- ✓ Economically viable
- ✓ Permittable under current environmental regulations
- ✓ Supports current parking capacity & public access

WHY IS ACHIEVING LONG-TERM COASTAL RESILIENCY AT SANDY NECK PUBLIC BEACH FACILITY SO IMPORTANT?

- Revenues generated from the Public Beach Facility greatly impact the Town's future ability to continue with providing the high quality management of natural resources, wildlife, endangered species and recreational opportunities at Sandy Neck Beach Park.
- Annual Public Beach Revenue ~ \$250,000 from beach parking stickers, parking fees, concessions and permit fees.

FAILURE TO ACHIEVE LONG-TERM COASTAL RESILIENCY



- LOSS OF INFRASTRUCTURE

- DECREASE IN REVENUES

- REDUCED ABILITY TO PROTECT/ MANAGE
NATURAL RESOURCES/HABITATS

- DECREASE IN RECREATIONAL
OPPORTUNITIES & PUBLIC ACCESS

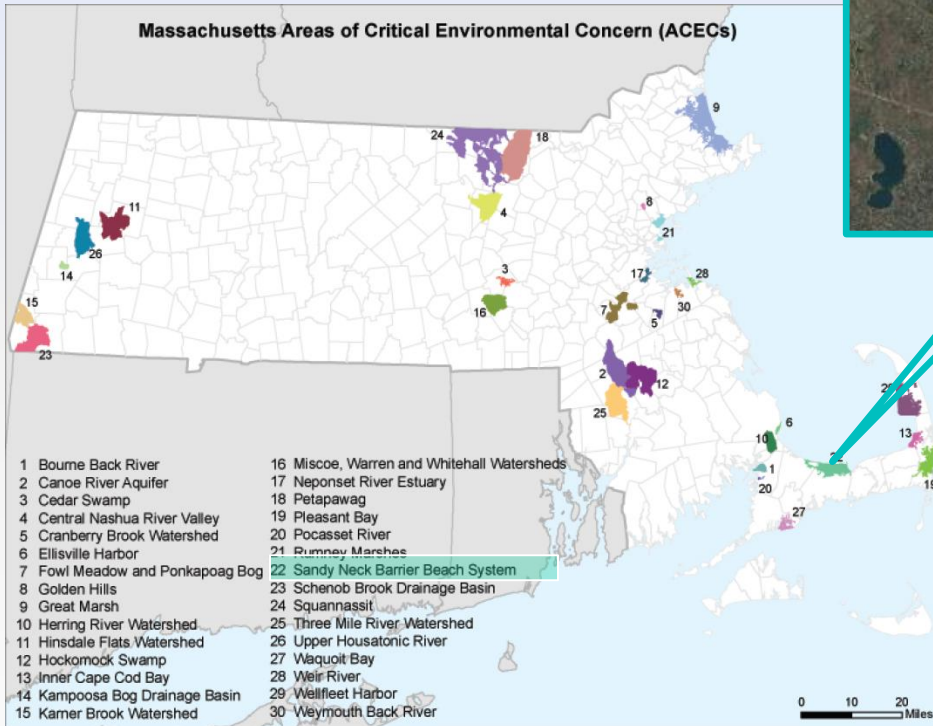
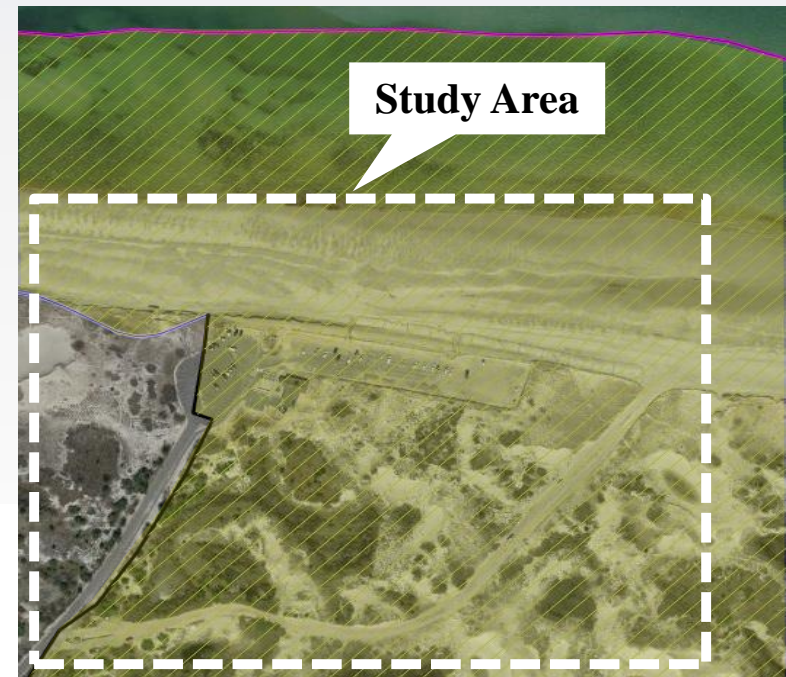
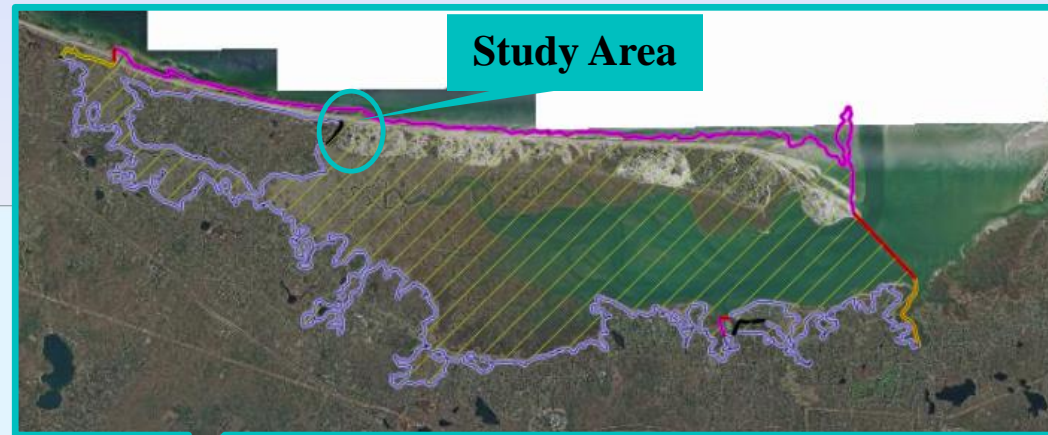
Long-term Coastal Resiliency must be achieved within the current regulatory framework that is established by the Sandy Neck Barrier Beach System Area of Critical Environmental Concern (ACEC) Designation, MA Wetland Protection Act (WPA), Code of the Town of Barnstable, Chapter 237 & MA Endangered Species Act (MESA).

SANDY NECK BARRIER BEACH SYSTEM AREA OF CRITICAL ENVIRONMENTAL CONCERN (ACEC)

Designation: 1978

Size: 9,130 acres

Towns: Barnstable & Sandwich



(ACECs) are places in MA that receive special recognition because of the quality, uniqueness and significance of their natural and cultural resources.

SANDY NECK ACEC DESIGNATION

- ❑ Largest barrier beach system in MA outside of the Cape Cod National Seashore;**
- ❑ Recognizes the importance of the natural resource features of Sandy Neck and how each perform a specific and important function; Cites that inappropriate use(s) or alteration(s) of any feature(s) have the potential to impair the ability for the resource/resources to function;**
- ❑ Recognizes the natural tendency of a barrier beach to migrate landward and that the construction of groins/jetties and stabilization efforts will “alter natural movements of the beach and reduce its ability to absorb storm impacts”;**
- ❑ Recognizes/protects the high quality, productivity and uniqueness of the area (water quality, salt marsh, wildlife and shellfish habitat, endangered species, etc.); and**
- ❑ Recognizes economic benefits to Towns of Barnstable & Sandwich.**

MA Wetland Protection Act (WPA) Regulations

310 CMR 10.28 Coastal Dunes

Coastal Dune means any natural hill, mound or ridge of sediment landward of a coastal beach deposited by wind action or storm overwash. Coastal dune also means sediment deposited by artificial means and serving the purpose of storm damage prevention or flood control.

WHEN A COASTAL DUNE IS DETERMINED TO BE SIGNIFICANT TO STORM DAMAGE PREVENTION, FLOOD CONTROL OR THE PROTECTION OF WILDLIFE HABITAT, 310 10.28(3) THROUGH (6) SHALL APPLY:

- (3) Any alteration of, or structure on, a coastal dune or within 100 feet of a coastal dune shall not have an adverse effect on the coastal dune by:
- (a) affecting the ability of waves to remove sand from the dune;
 - (b) disturbing the vegetative cover so as to destabilize the dune;
 - (c) causing any modification of the dune form that would increase the potential for storm or flood damage;
 - (d) interfering with the landward or lateral movement of the dune;
 - (e) causing removal of sand from the dune artificially; or
 - (f) interfering with mapped or otherwise identified bird nesting habitat.

MA Wetland Protection Act (WPA) Regulations

310 CMR 10.29 Barrier Beaches

10.29: Barrier Beaches

(1) Preamble. Barrier beaches are significant to storm damage prevention and flood control and are likely to be significant to the protection of marine fisheries and wildlife habitat and, where there are shellfish, the protection of land containing shellfish.³

(2) Definition.

Barrier Beach means a narrow low-lying strip of land generally consisting of coastal beaches and coastal dunes extending roughly parallel to the trend of the coast. It is separated from the mainland by a narrow body of fresh, brackish or saline water or a marsh system. A barrier beach may be joined to the mainland at one or both ends.

(3) When a Barrier Beach Is Determined to Be Significant to Storm Damage Prevention, Flood Control, Marine Fisheries or Protection of Wildlife Habitat. 310 CMR 10.27(3) through (6) (coastal beaches) and 10.28(3) through (5) (coastal dunes) shall apply to the coastal beaches and to all coastal dunes which make up a barrier beach.

(4) Notwithstanding the provisions of 310 CMR 10.29(3), no project may be permitted which will have any adverse effect on specified habitat sites of rare vertebrate or invertebrate species, as identified by procedures established under 310 CMR 10.37.

The MA Endangered Species Act (MESA) protects rare species and their habitats by prohibiting the “Take” of any plant or animal species listed as Endangered, Threatened or Special Concern by the MA Division of Fisheries & Wildlife.

A “TAKE” is not solely defined as “killing” of a species....

ANIMALS - harass, harm, pursue, hunt, shoot, hound, kill, trap, capture, collect, process, disrupt the nesting, breeding, feeding or migratory activity or attempt to engage in any such conduct, or to assist such conduct

PLANTS - collect, pick, kill, transplant, cut or process or attempt to engage or to assist in any such conduct. Disruption of nesting, breeding, feeding or migratory activity may result from, but is not limited to, the modification, degradation or destruction of Habitat."

SANDY NECK PUBLIC BEACH PARK STUDY AREA MA LISTED ENDANGERED SPECIES OF CONCERN

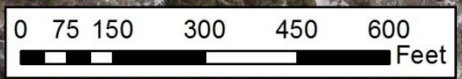
Piping Plover



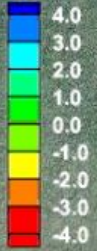
Spade Foot Toad



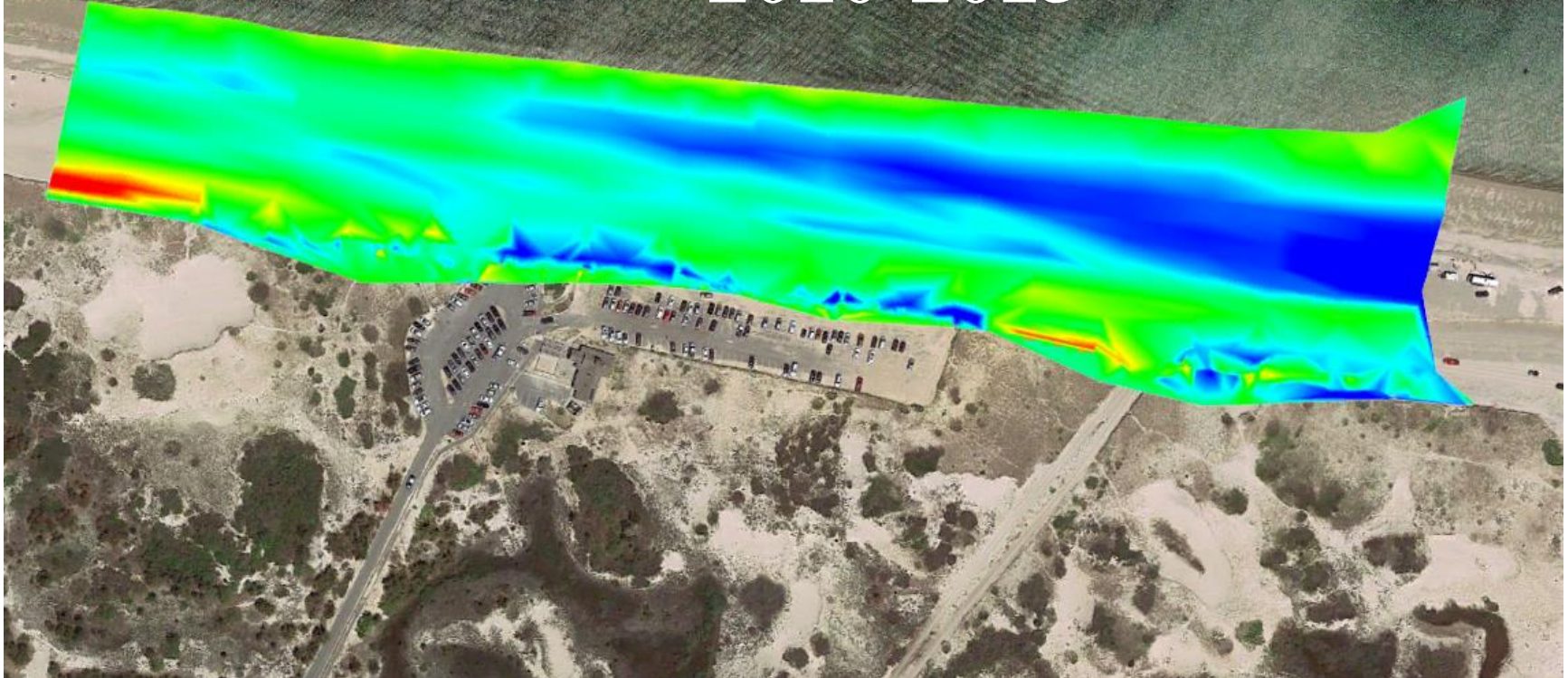
“The Conundrum” Historical Shoreline Change



Elev. Change (feet)

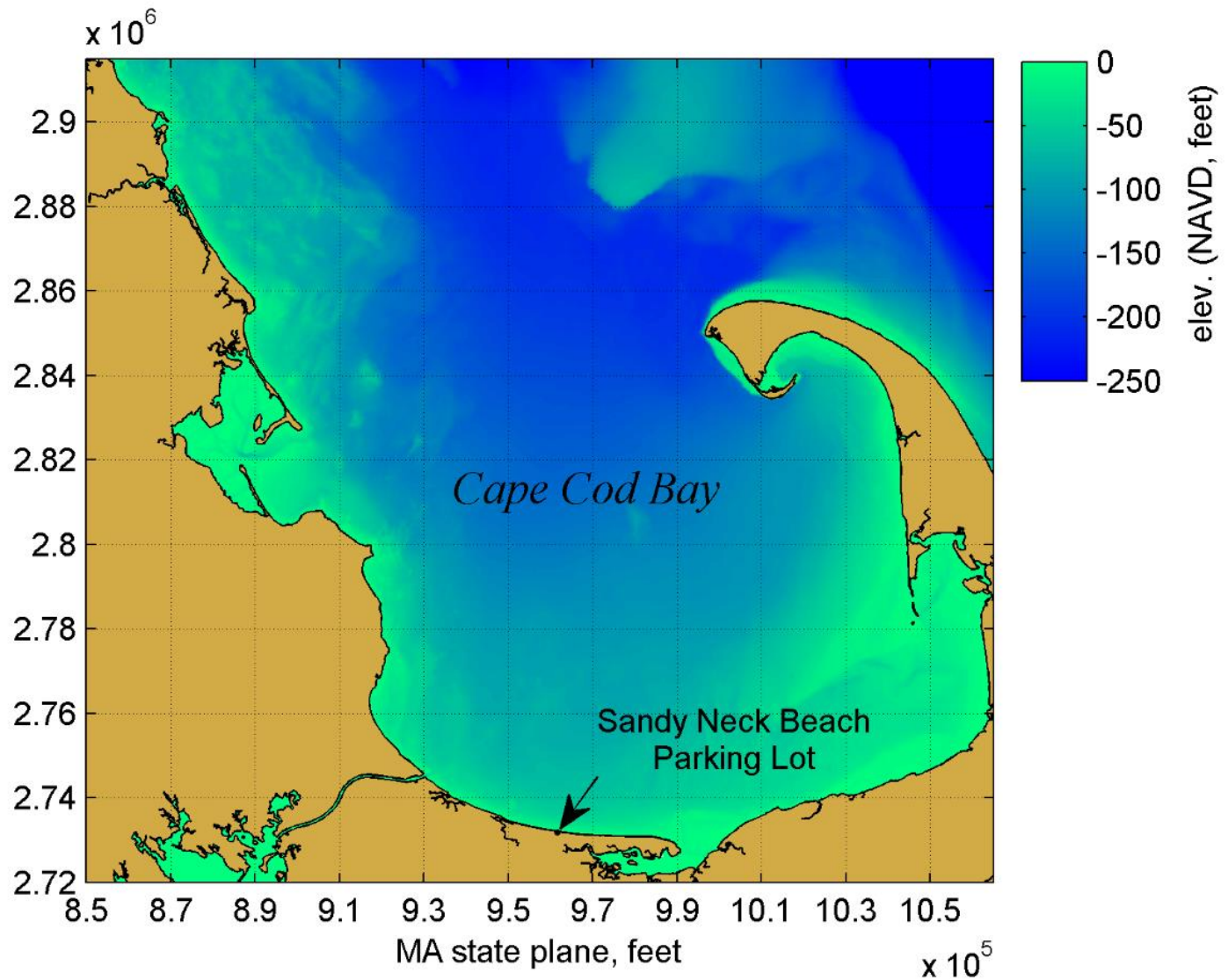


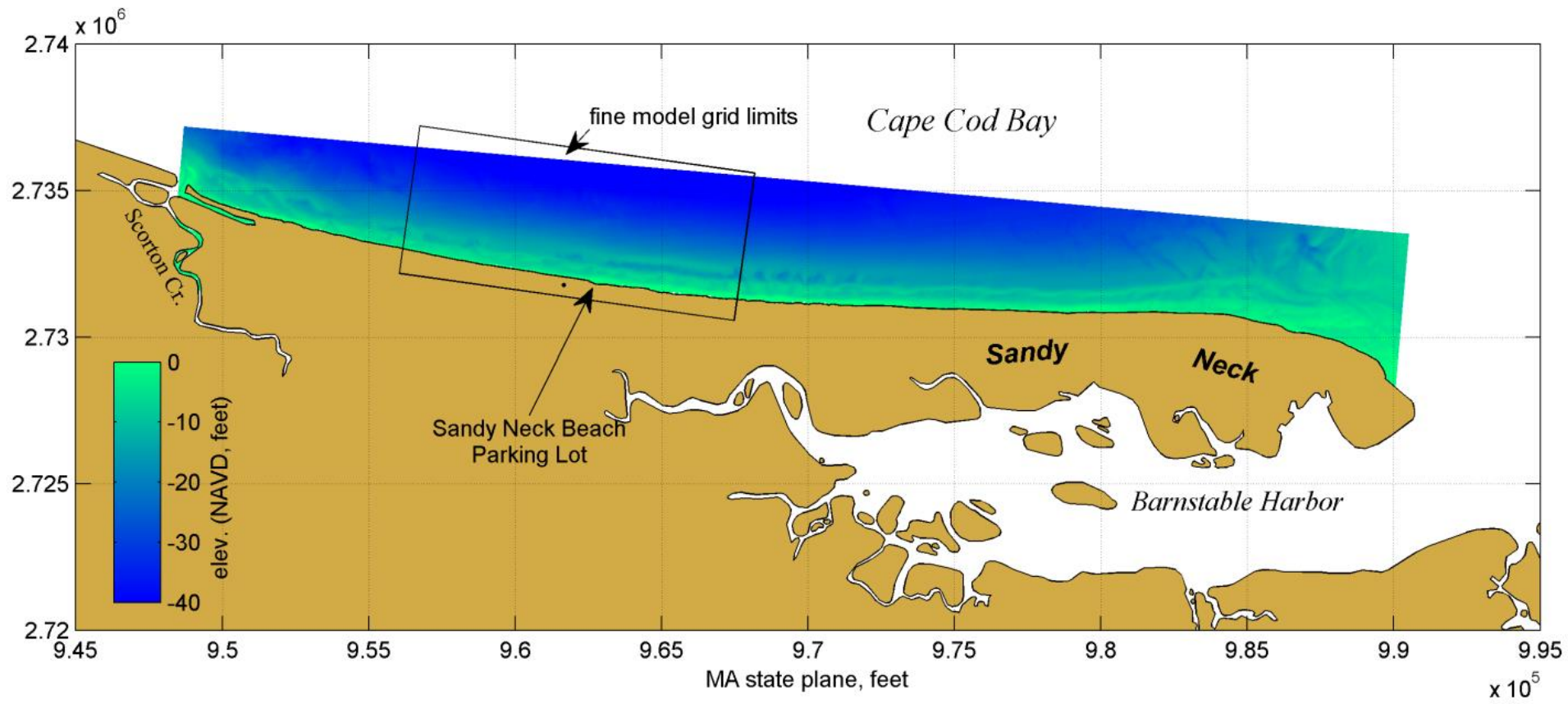
2010-2015

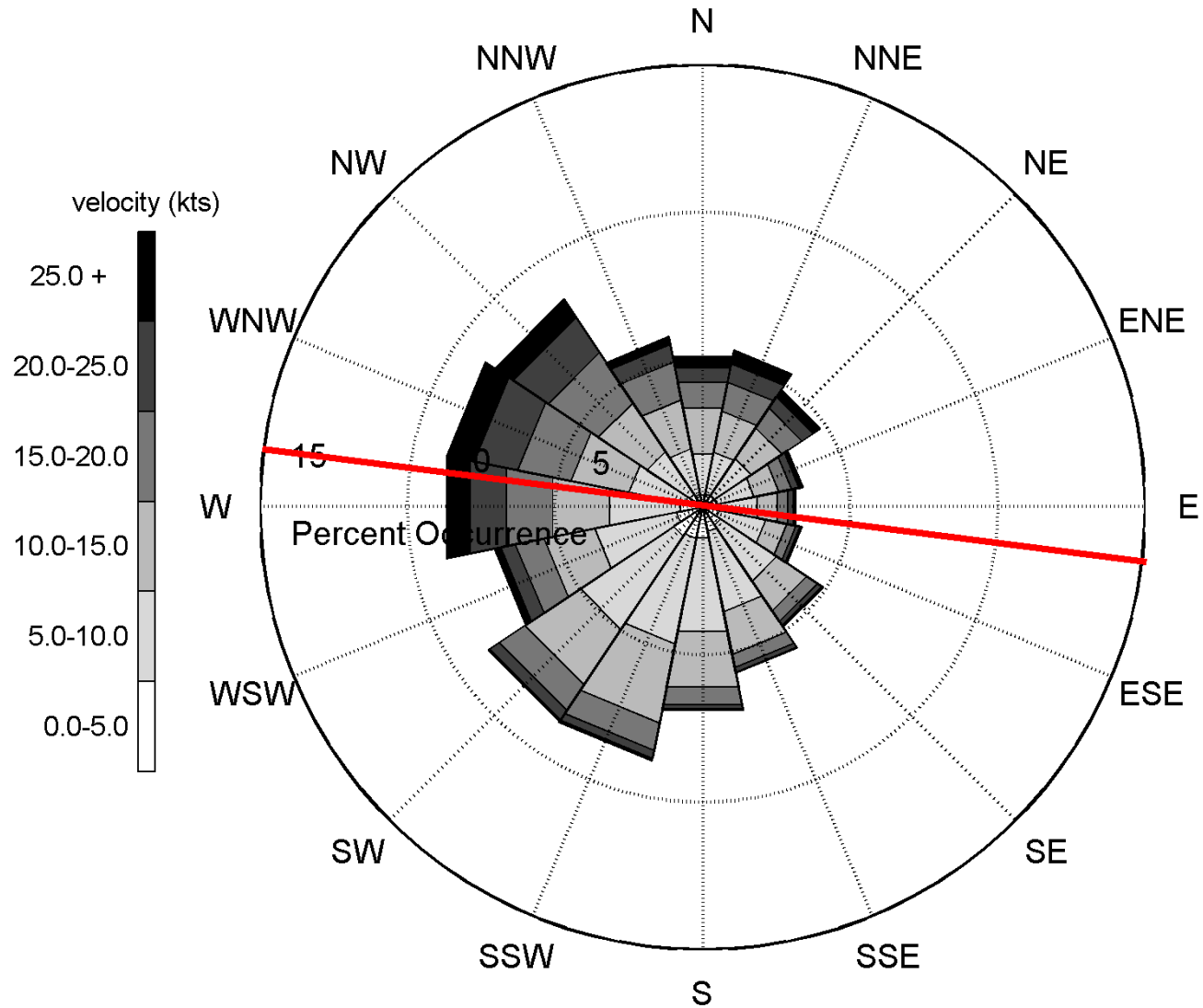


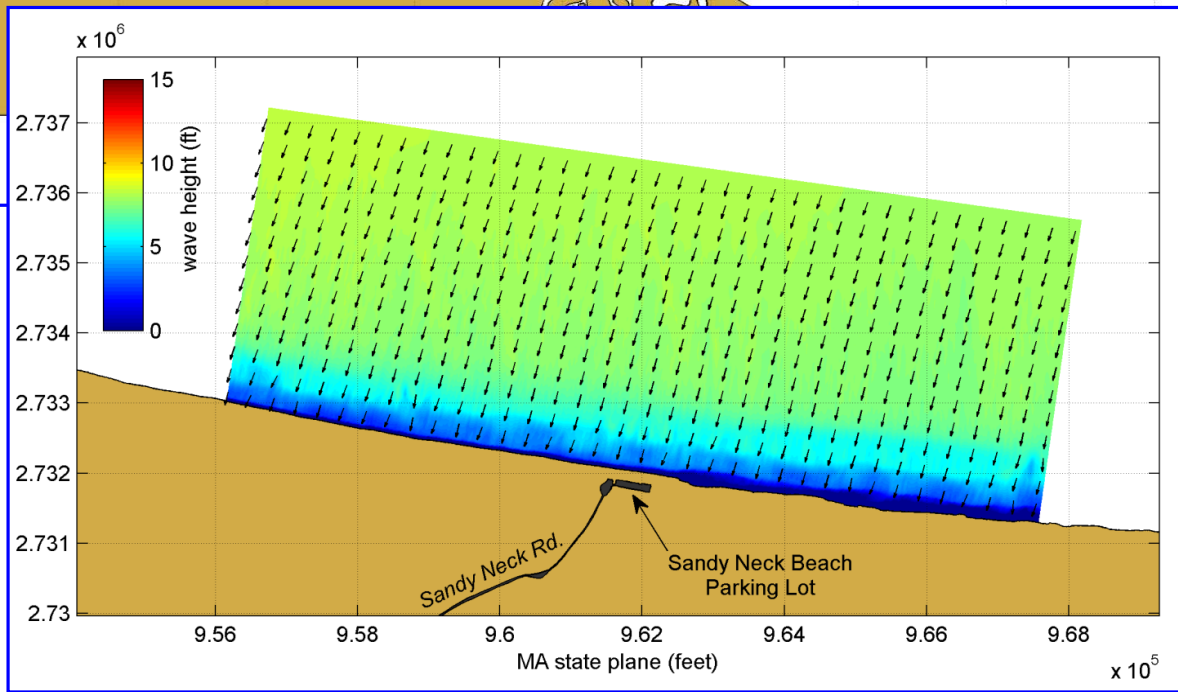
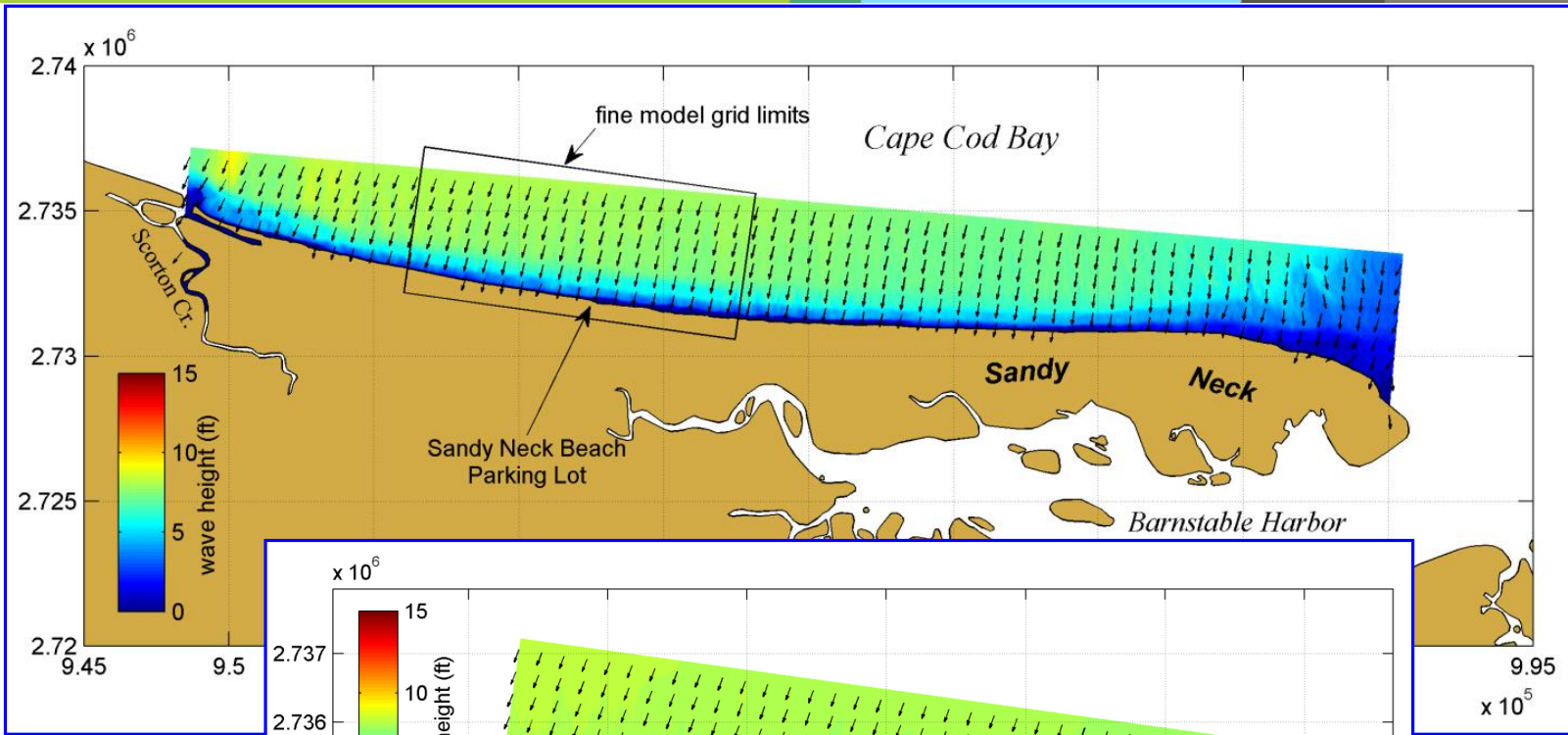
cleengineering





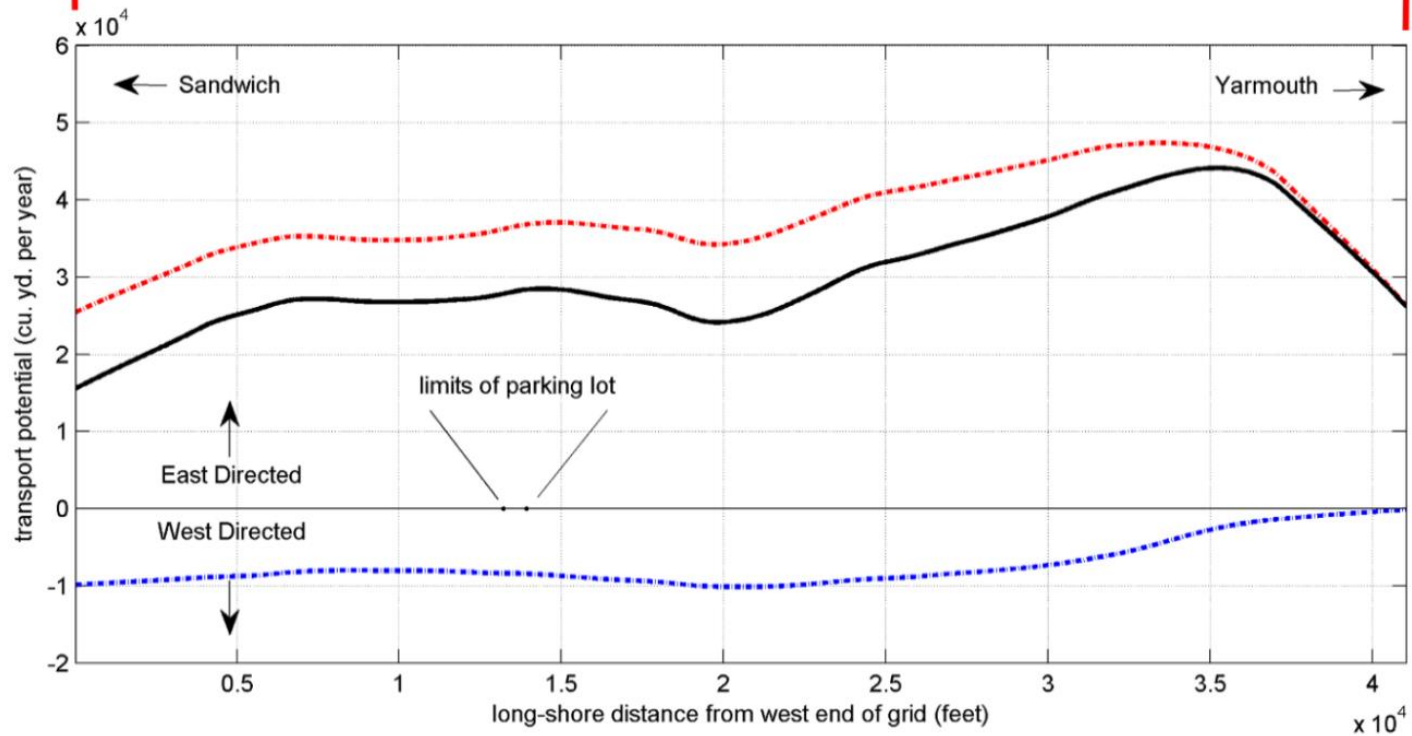


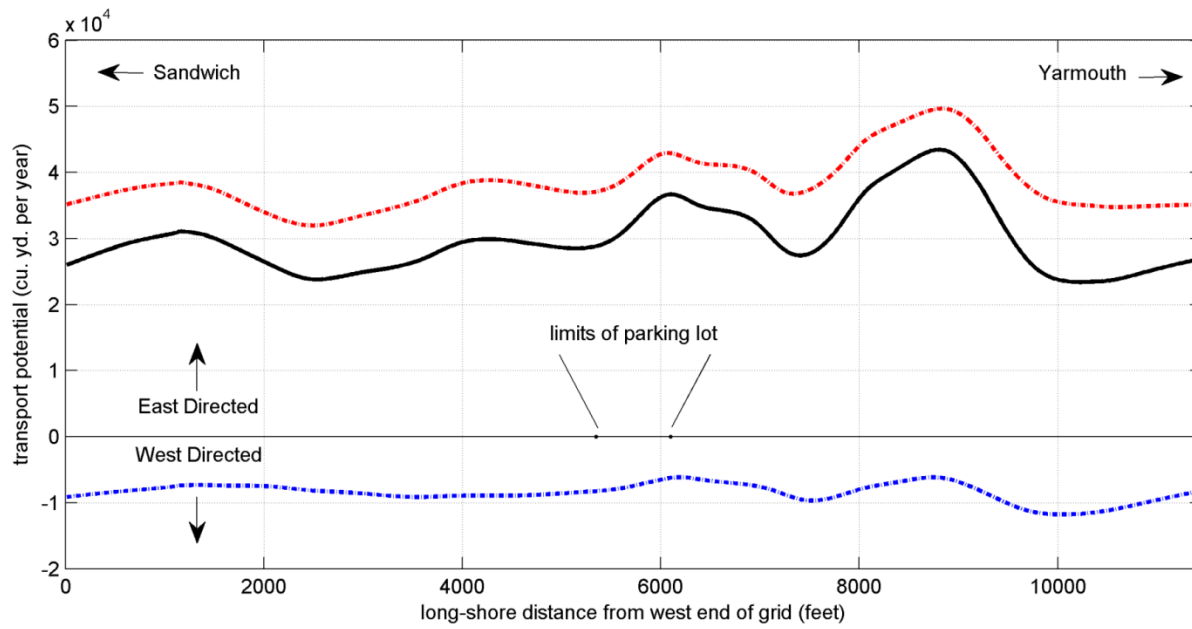




Sediment Transport Modeling







COASTAL PROCESSES ANALYSIS FINDINGS

- No clear erosion pattern, where shoreline shows periodic variation (on order of ~30 feet)
- Importance of shore-attached bar system
- Sediment transport directed to the east (~30,000 cubic yards per year)
- Important to stabilize dune fronting parking lot to ensure longevity
- Relocation of vulnerable infrastructure approximately 50 to 60 feet likely will be sufficient for foreseeable future ; i.e. 50 year planning horizon with 1.5 ft anticipated sea-level rise
- Beach nourishment alternatives were evaluated

SANDY NECK BEACH PARK TIMELINE

BLIZZARD OF 1978



Storm impacts resulted in significant damage to the primary dune system at the Sandy Neck Beach Park Facility resulting in the permanent loss of parking (40 spaces) in 1978.

SANDY NECK BEACH PARK TIMELINE

POST-BLIZZARD OF 1978 TO 2012

- ❑ **Stable Primary Dune**
- ❑ **Annual dune stabilization efforts performed by Park Staff & Volunteers**
 - ✓ **Sand fencing**
 - ✓ **Beach grass planting**



SANDY NECK BEACH PARK TIMELINE

2013 TO PRESENT

- Since 2013, the Town has addressed primary dune loss at the Sandy Neck Beach Park through “Reactive Management”. Emergency stabilization performed on 3 occasions:

<u>Month/Year</u>	<u>Cost</u>	<u>Vol. Sand Placed</u>
December 2013	\$119,250	± 5,500 cy
December 2014	\$ 90,000	± 4,300 cy
February 2015	\$ 50,000	± 2,600 cy
Total	\$259,250	±12,400 cy



Primary dune looking east 1 month prior to 2nd emergency sand placement in December 2014.



Primary dune looking east post-January 2015 (“Juno”).

SANDY NECK BEACH PARK TIMELINE

2013 TO PRESENT

“REACTIVE MANAGEMENT”

- ❑ Efforts performed by the Town since 2013 = “Band-Aid” approach which is **NOT SUSTAINABLE**.
- ❑ “Reactive Management” in this manner will eventually result in the progressive loss of parking and revenue over time.
- ❑ As with the loss of parking following the Blizzard of 1978, it is assumed that permits are unlikely to be issued for reclaiming loss of existing parking (at current locations) within the primary dune system.
- ❑ Considering the above, this has prompted the Town to be **PROACTIVE** and move forward with evaluating long-term coastal resiliency alternatives.

CRITERIA USED TO EVALUATE LONG-TERM RESILIENCY ALTERNATIVES “TOTAL RATING VALUE”

Parameters Considered	Definition
Benefit/Cost Ratio (B/C)	[Annual Revenue = \$250k] / [Total Costs = Capital + Maint. with 3% inflation rate applied over 50 year life expectancy]
Permitability Rating Value	No = 0; Yes = 1
Protection Rating Value	Low = 0; High = 1
Enhance Coastal Wetland Resources Rating Value	No = 0; Limited = 0.5; Yes = 1
Enhance Wildlife Habitat Rating Value	No = 0; Yes = 1

TOTAL RATING VALUE = B/C + Permit + Protection + Enhance Coastal Wetland Resources + Enhance Wildlife Habitat

☐ LONG-TERM RESILIENCY ALTERNATIVES CONSIDERED:

➤ **Conventional (Hard) Shoreline Protection**

Alternative 1: Cantilever Bulkhead

Alternative 2: Stone Revetment

➤ **Engineered (Soft) Shoreline Protection**

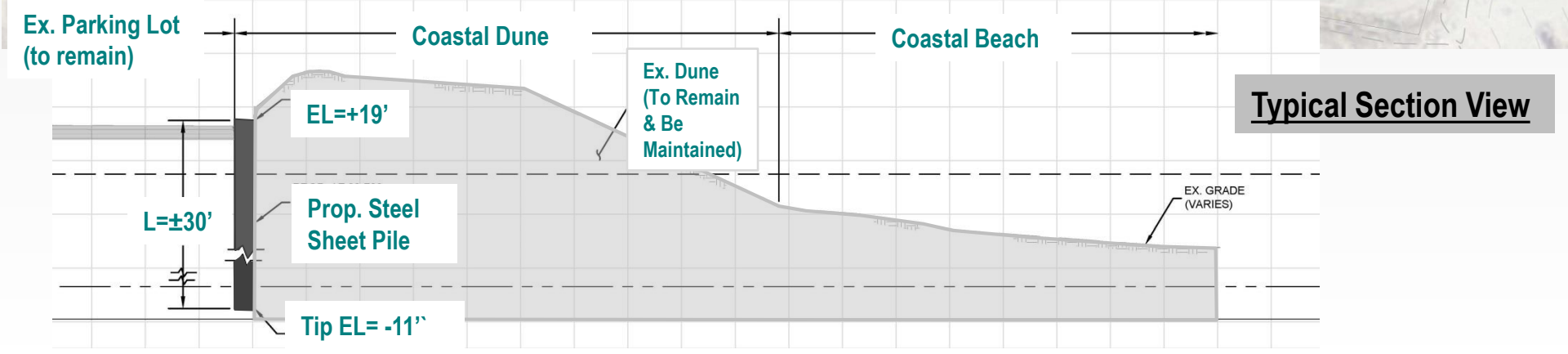
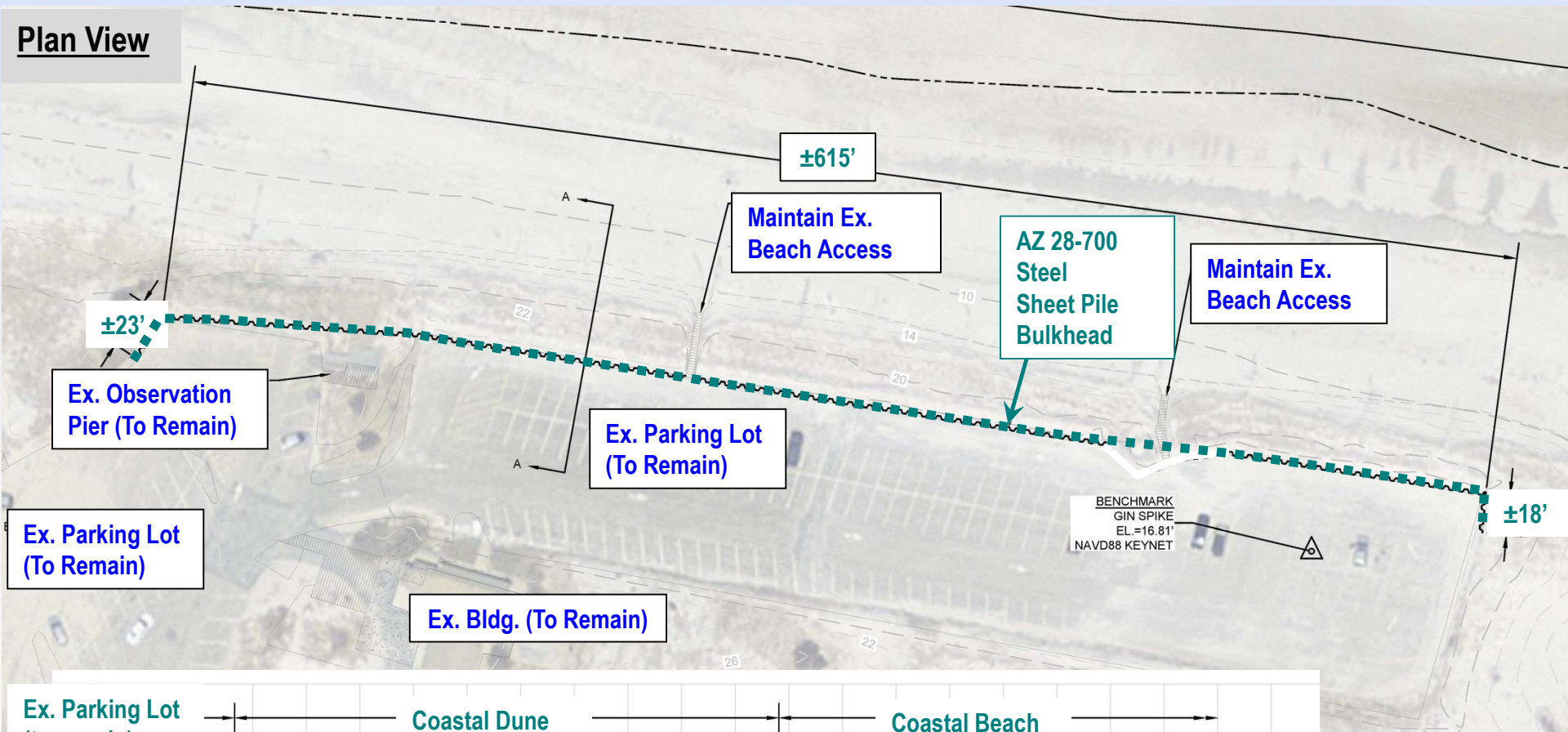
Alternative 3: Sand-filled Coir Bags

Alternative 4: Beach Nourishment (4 options)

➤ **Managed Site Reconfiguration**

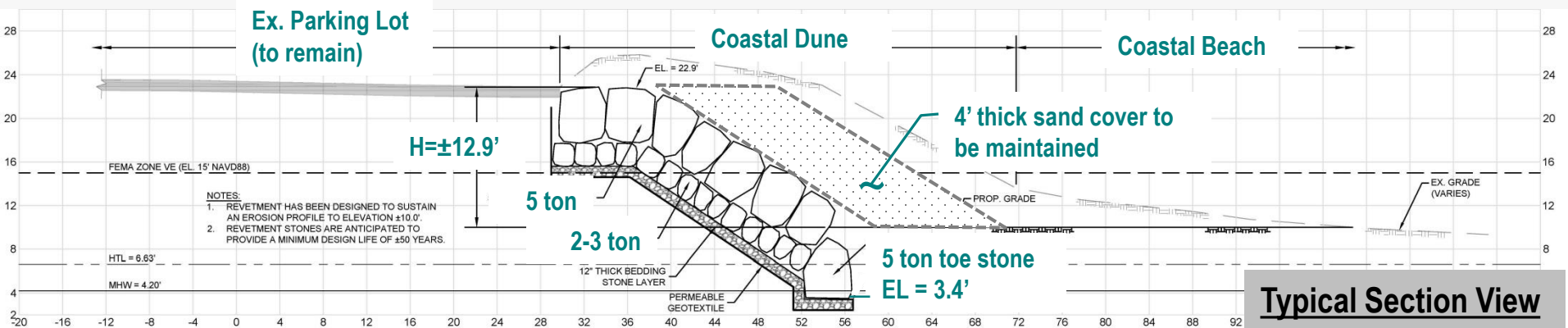
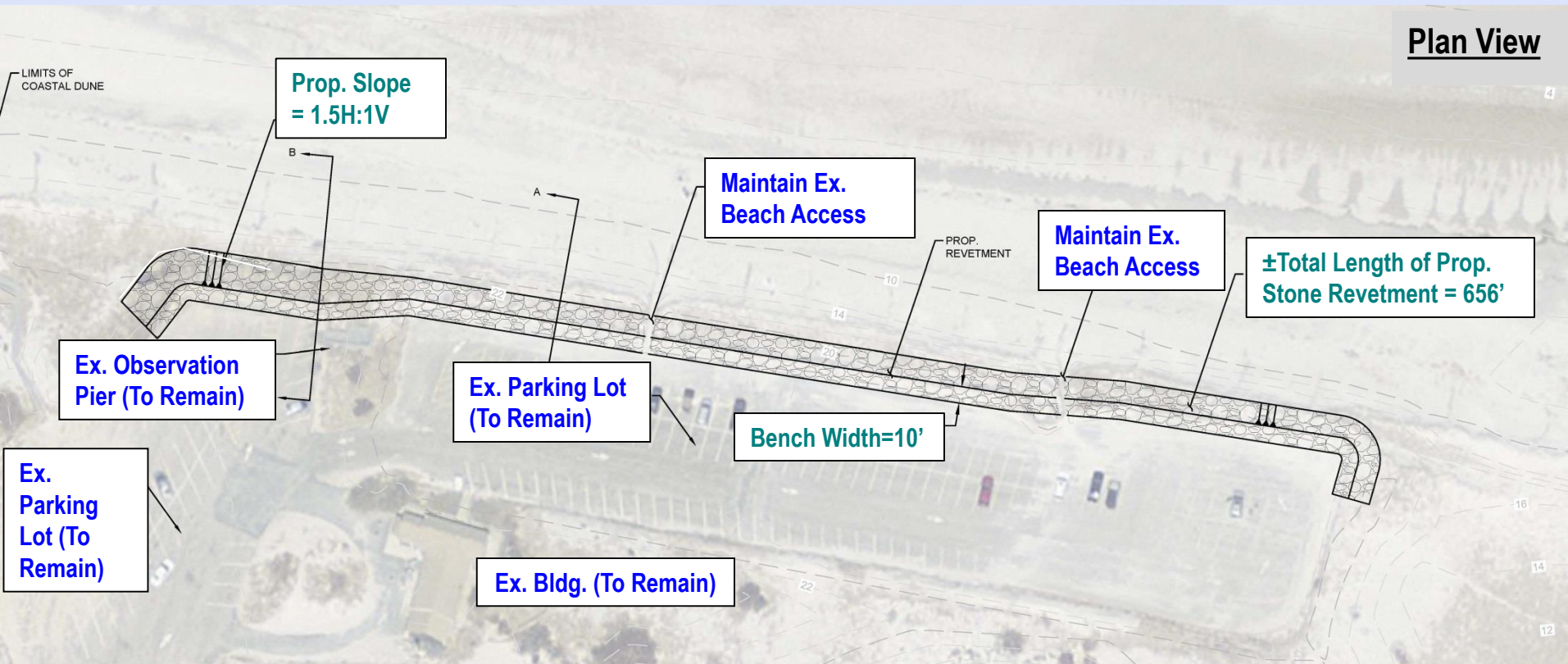
Alternative 5: Relocation/Reconfiguration of Existing Infrastructure (4 options)

Conceptual Alternative 1 : Cantilever Bulkhead



Conceptual Alternative 2: Stone Revetment

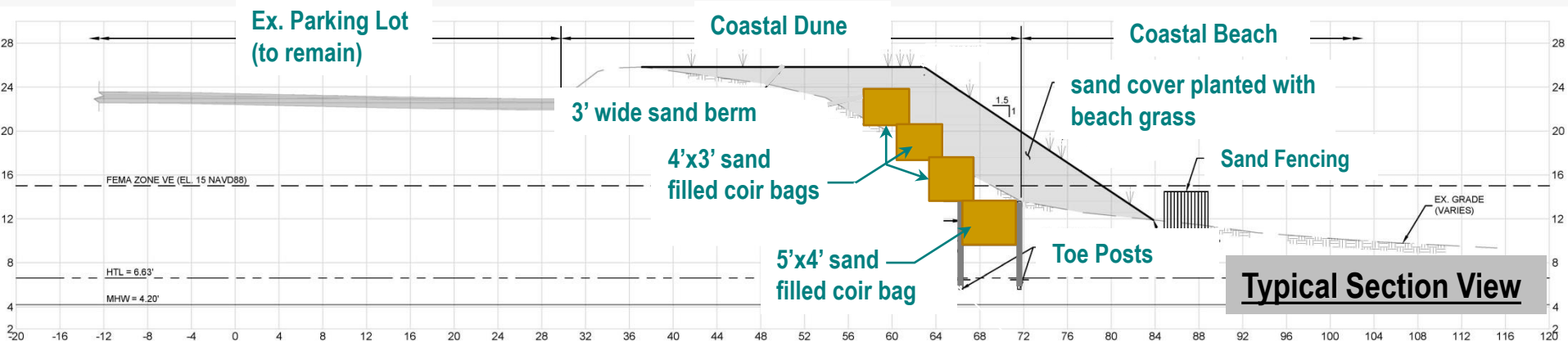
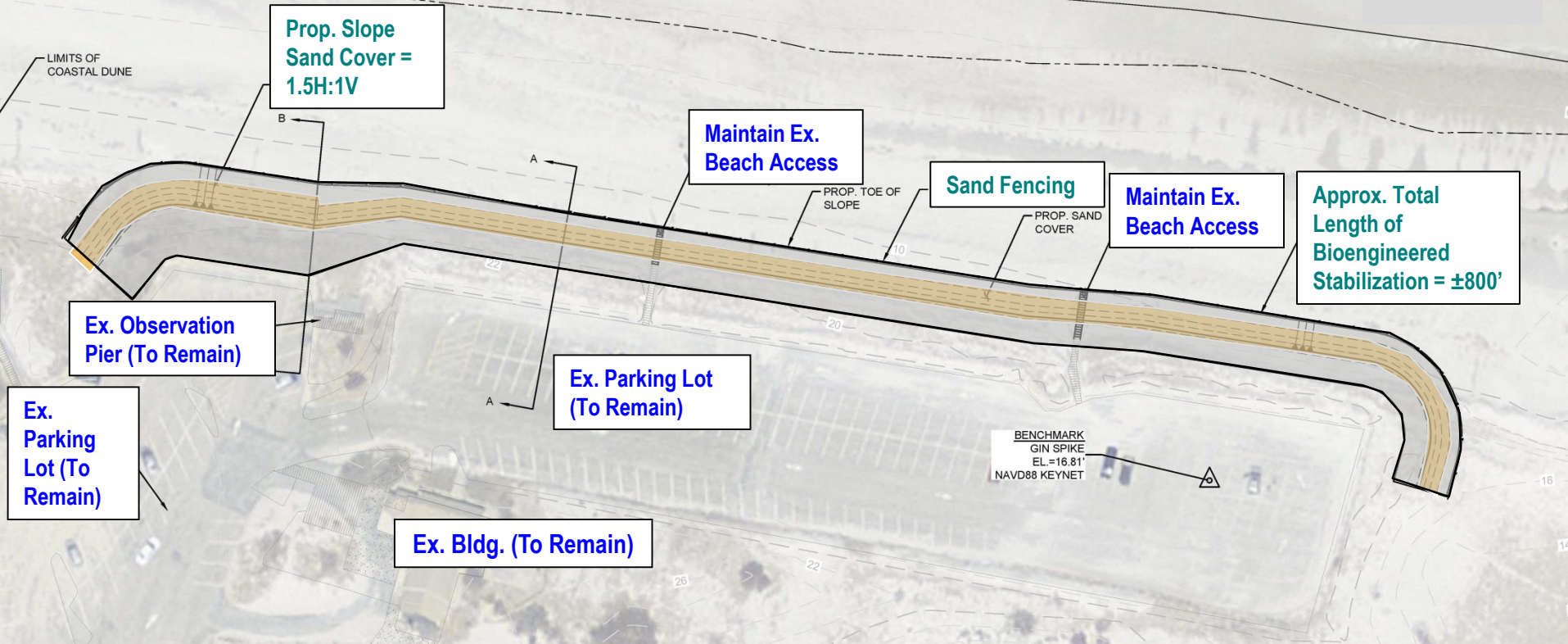
Plan View



Typical Section View

Conceptual Alternative 3: Bioengineered Slope Stabilization (Sand Bags)

Plan View



Typical Section View

ENGINEERED (SOFT) SHORELINE PROTECTION

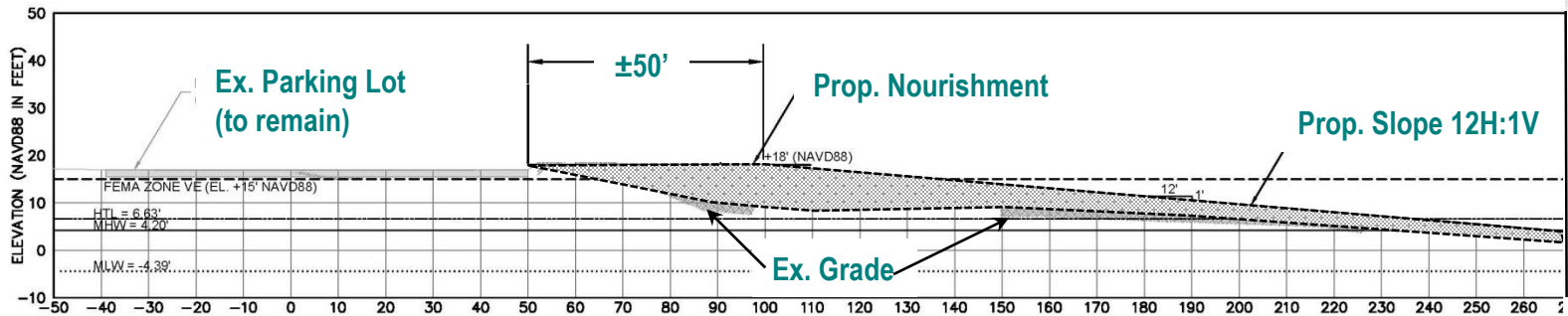
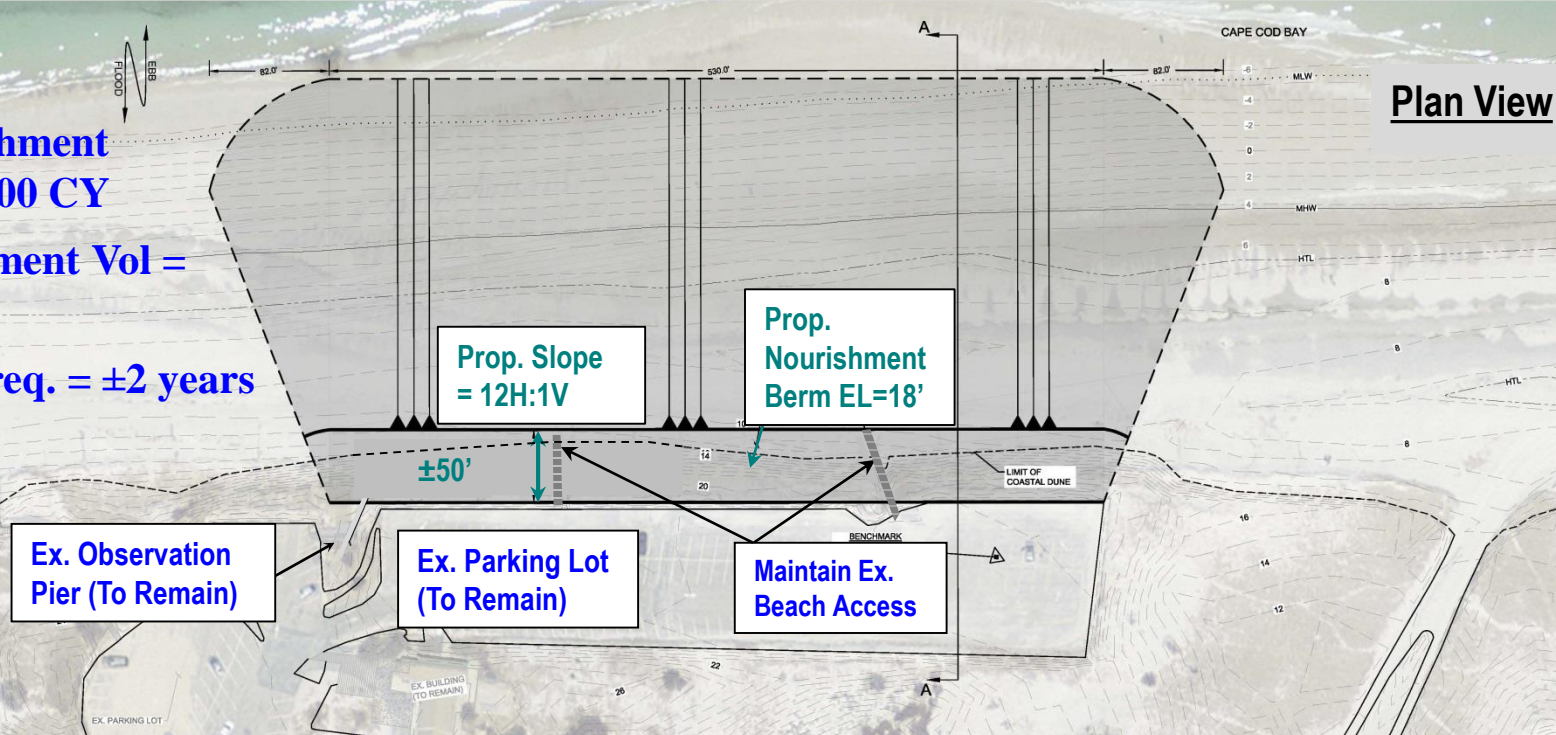
Beach Nourishment Alternatives

Alternative	Length of Nourishment	Est. Nourishment Volume
A	530 LF	±35,600 CY
B	750 LF	±47,780 CY
C	1,000 LF	±61,830 CY
D	1,500 LF	±90,880 CY

- ❑ All alternatives consist of a 50-ft wide berm at El. 18 NAVD with 12H:1V slope to MLW/slightly below;
- ❑ Sand source assumed to be compatible off-site material;
- ❑ One-line Shoreline Model developed by ACRE used to evaluate the longevity/performance of 4 nourishment alternatives; and
- ❑ Each nourishment template is considered depleted at the point in time where the percent fill remaining >30% of the original fill volume.

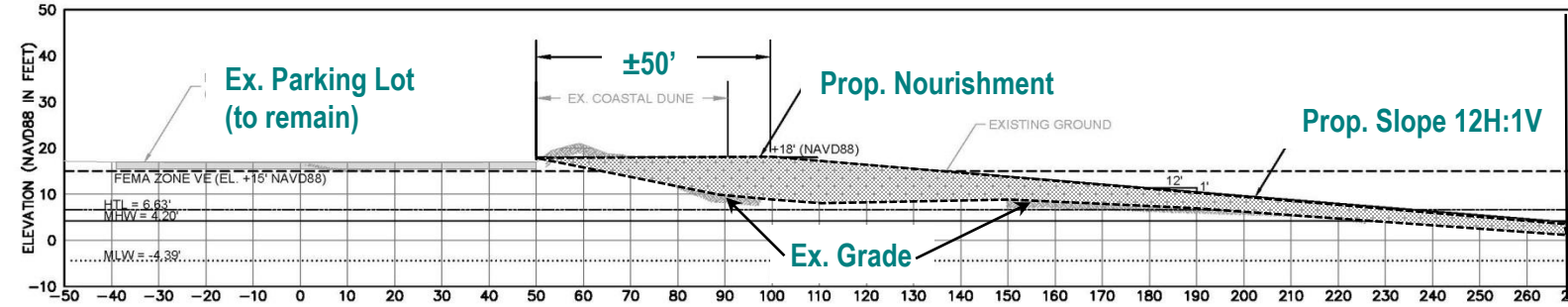
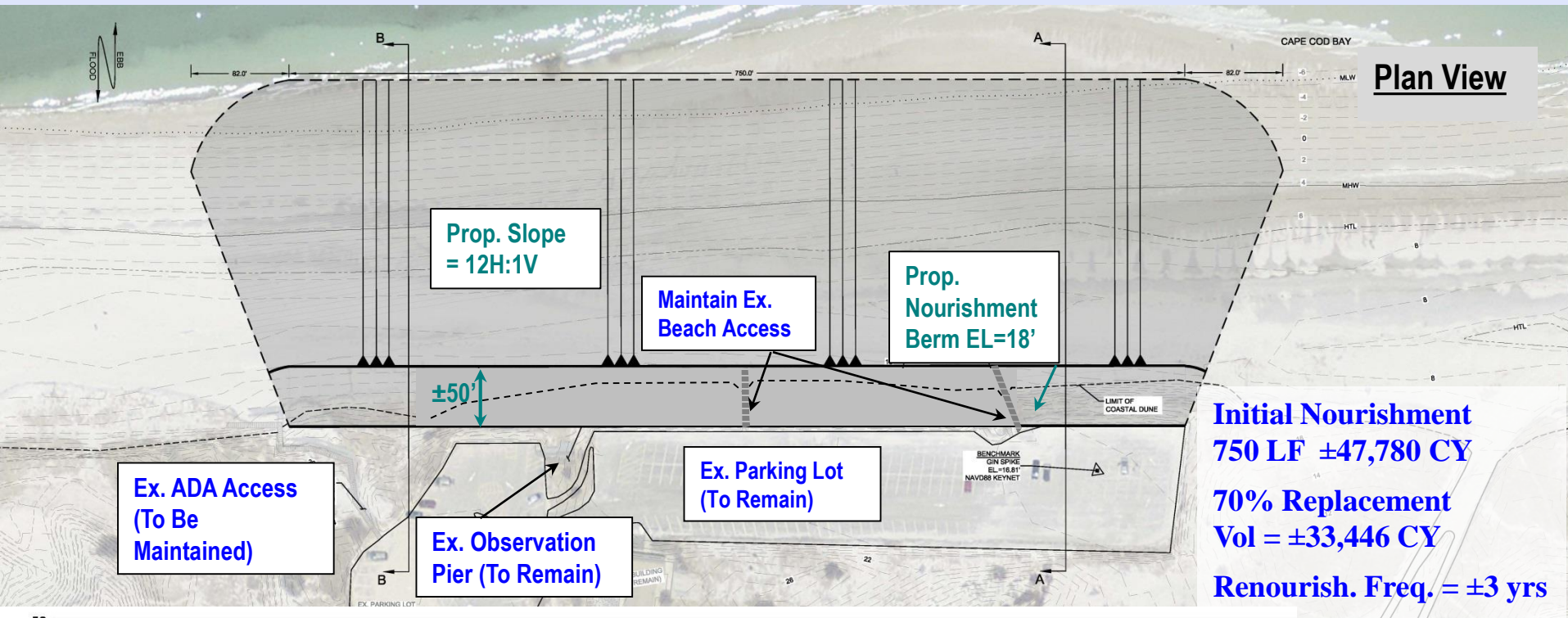
Conceptual Alternative 4A: Beach Nourishment

Initial Nourishment
530 LF ±35,600 CY
70% Replacement Vol =
±24,920 CY
Renourish. Freq. = ±2 years



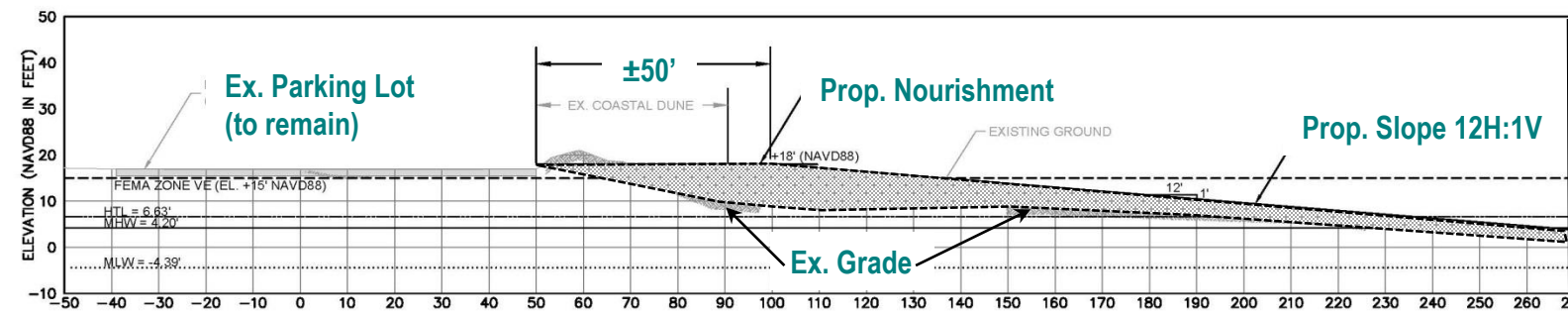
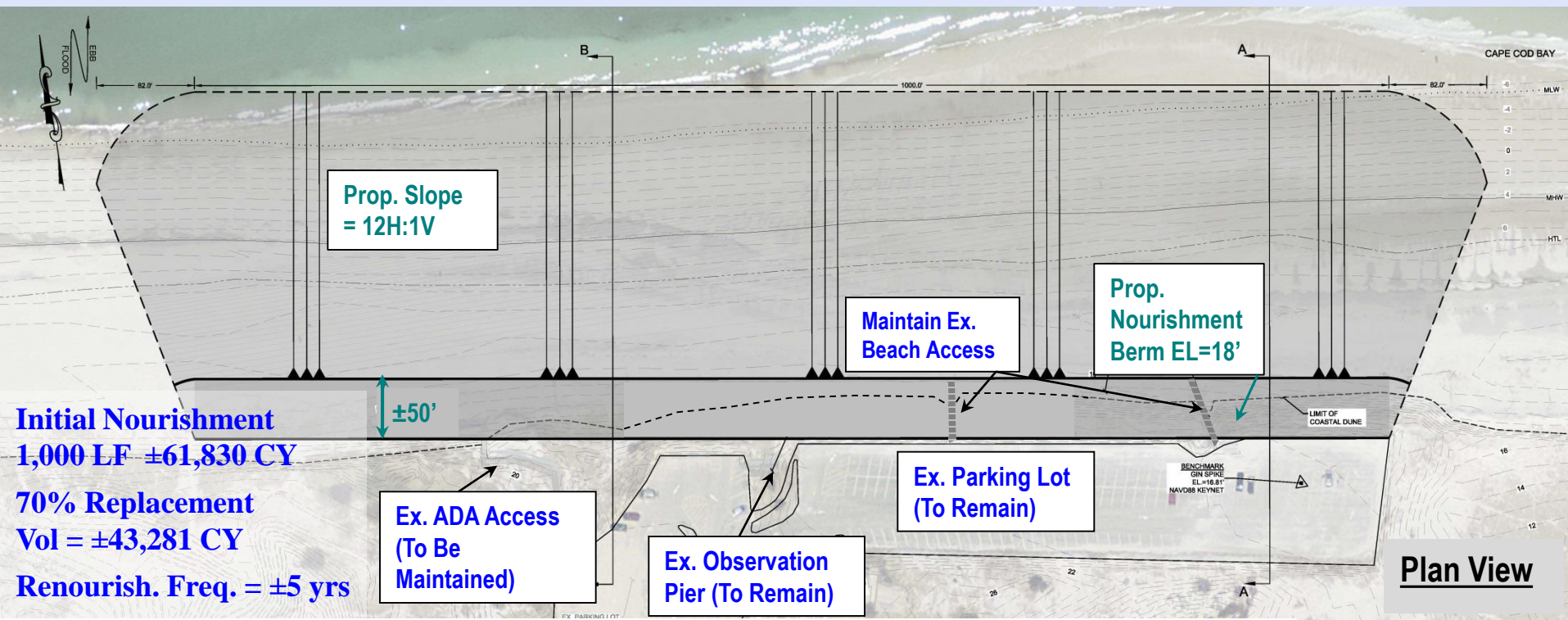
Typical Section View

Conceptual Alternative 4B: Beach Nourishment



Typical Section View

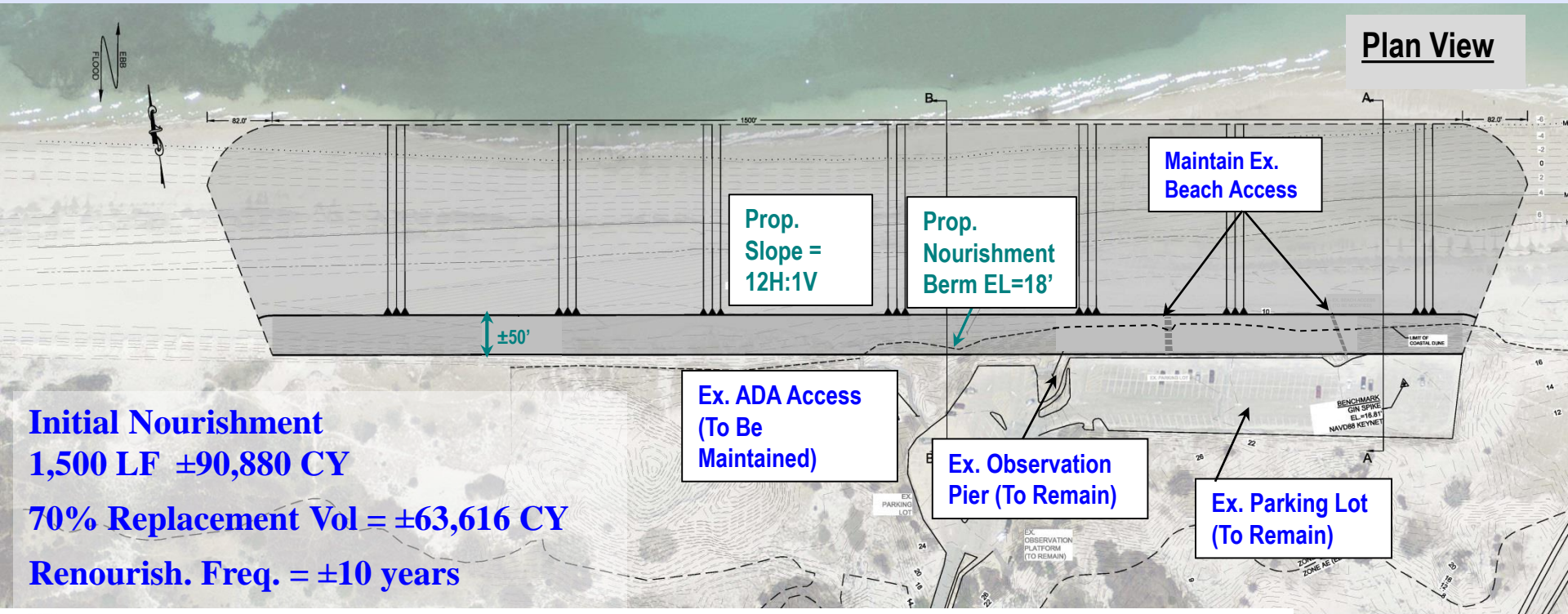
Conceptual Alternative 4C: Beach Nourishment



Typical Section View

Conceptual Alternative 4D: Beach Nourishment

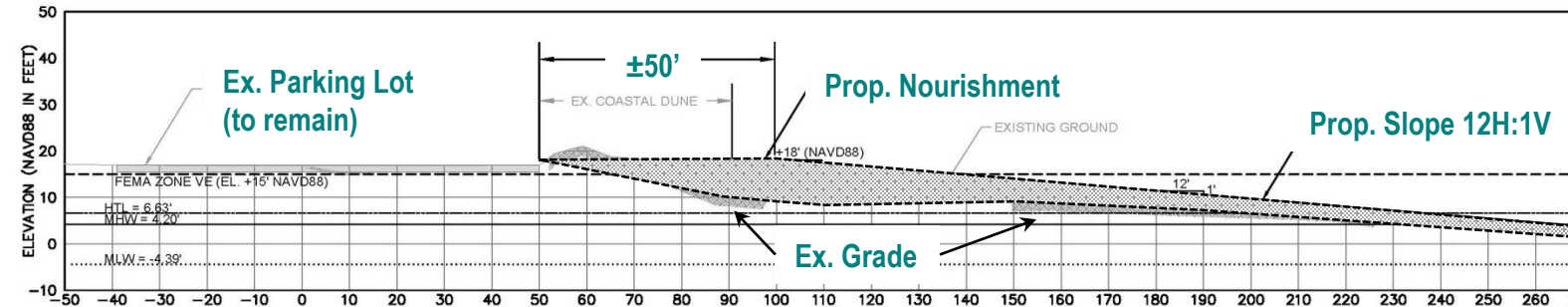
Plan View



Initial Nourishment
1,500 LF ±90,880 CY

70% Replacement Vol = ±63,616 CY

Renourish. Freq. = ±10 years



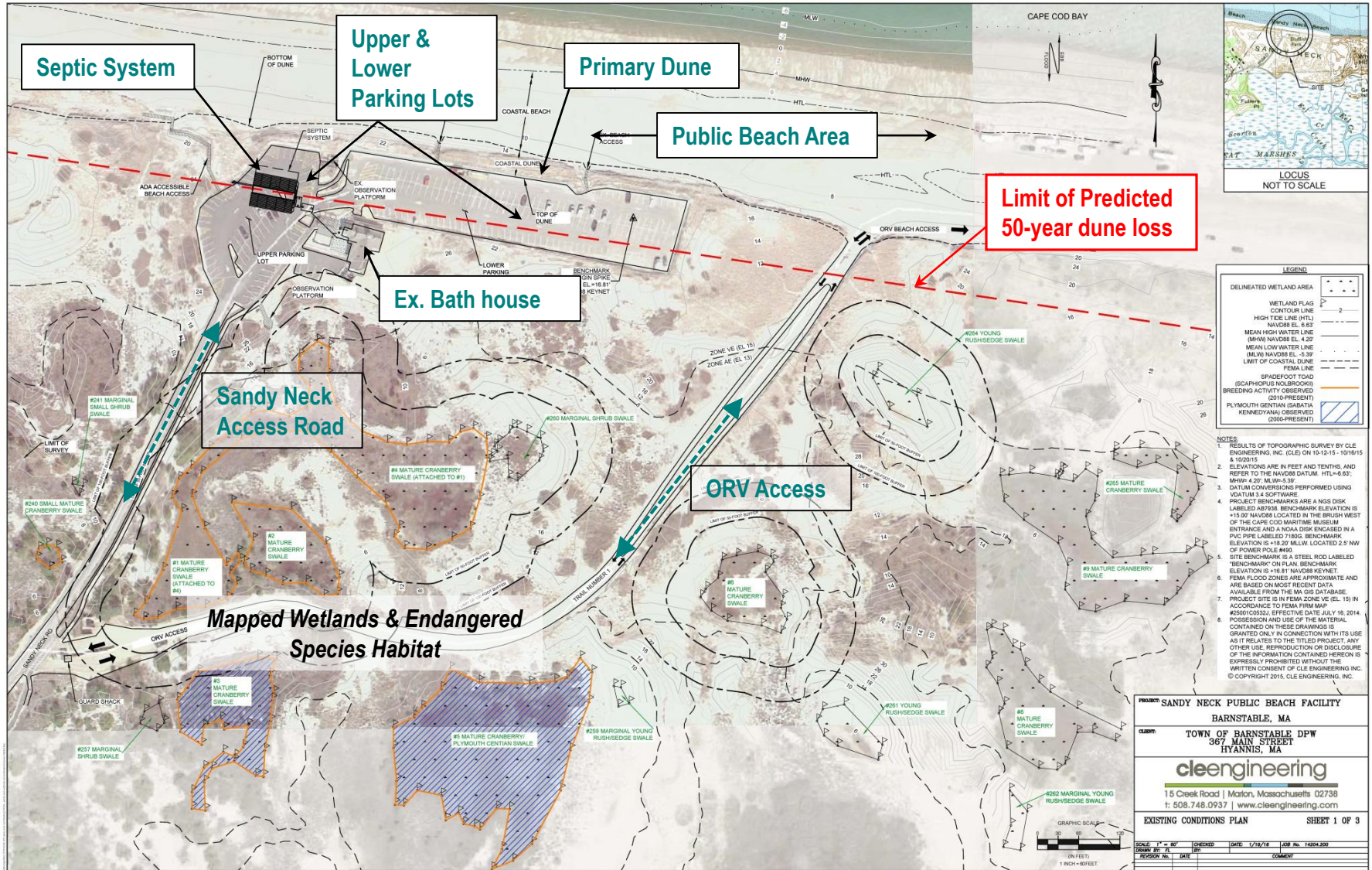
Typical Section View

MANAGED SITE RECONFIGURATION

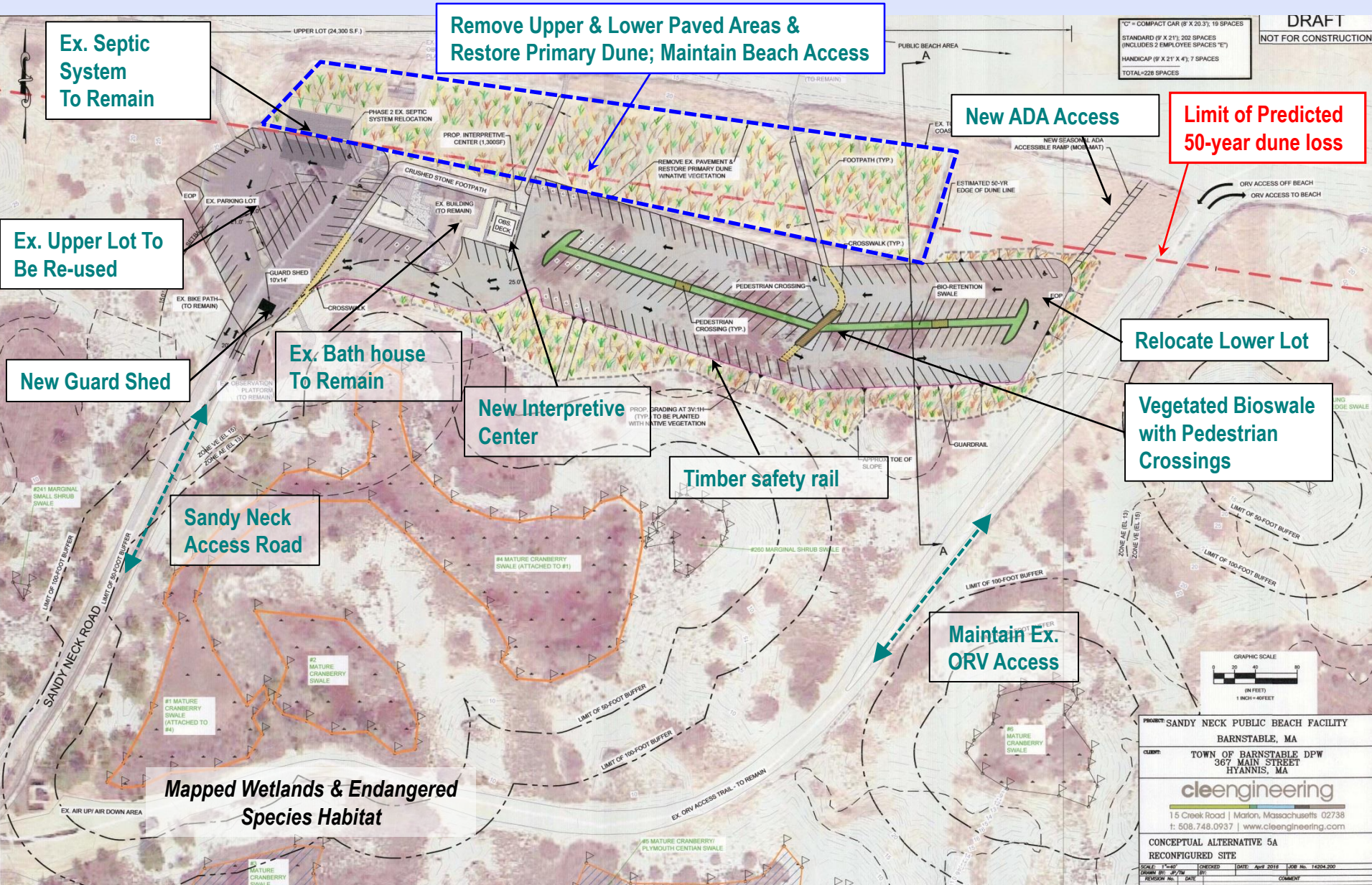
- ACRE Shoreline Assessment determined shoreline loss over 50 years due to erosion including 1.5 feet of loss due to sea level rise to identify vulnerable infrastructure.**
- Existing vegetative wetland/habitat areas were delineated to identify constraints of reconfiguring existing infrastructure.**
- No loss in parking capacity (total = 228 spaces including ADA and employee parking).**
- ADA accessibility maintained/improved.**

MANAGED SITE RECONFIGURATION

EXISTING CONDITIONS PLAN SANDY NECK BEACH PARK



Conceptual Alternative 5A: Parking Lot Relocation & Reconfiguration

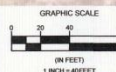


'C' = COMPACT CAR (8' X 20.3'), 19 SPACES
 STANDARD (9' X 21'), 202 SPACES (INCLUDES 2 EMPLOYEE SPACES 'E')
 HANDICAP (9' X 21' X 4'), 7 SPACES
 TOTAL=228 SPACES

DRAFT
NOT FOR CONSTRUCTION

Relocate Lower Lot

Vegetated Bioswale with Pedestrian Crossings

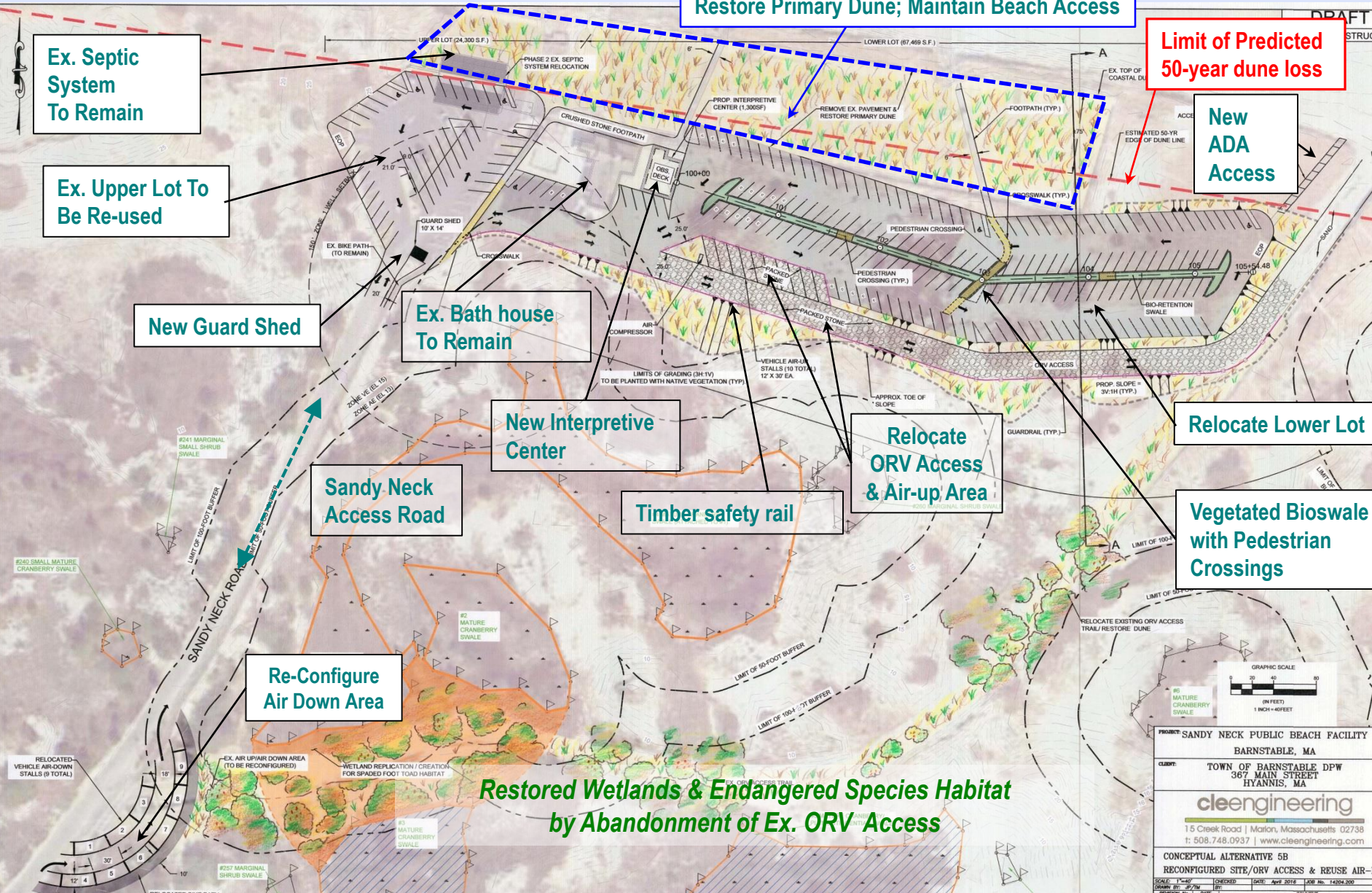


PROJECT: SANDY NECK PUBLIC BEACH FACILITY
 BARNSTABLE, MA
 CLIENT: TOWN OF BARNSTABLE DPW
 367 MAIN STREET
 HYANNIS, MA

cleengineering
 15 Creek Road | Marion, Massachusetts 02738
 t: 508.748.0937 | www.cleengineering.com

CONCEPTUAL ALTERNATIVE 5A
 RECONFIGURED SITE
 SCALE: 1"=40'
 DRAWN BY: JF/ML
 CHECKED BY: JF/ML
 DATE: April 2018
 JOB NO.: 14204-200
 REVISION NO. DATE COMMENT

Conceptual Alternative 5B: Parking Lot & ORV Access Relocation with Re-use of Existing Air-Down Area



Limit of Predicted 50-year dune loss

New ADA Access

Ex. Septic System To Remain

Ex. Upper Lot To Be Re-used

New Guard Shed

Ex. Bath house To Remain

New Interpretive Center

Relocate ORV Access & Air-up Area

Relocate Lower Lot

Vegetated Bioswale with Pedestrian Crossings

Sandy Neck Access Road

Timber safety rail

Re-Configure Air Down Area

Restored Wetlands & Endangered Species Habitat by Abandonment of Ex. ORV Access



PROJECT: SANDY NECK PUBLIC BEACH FACILITY
BARNSTABLE, MA

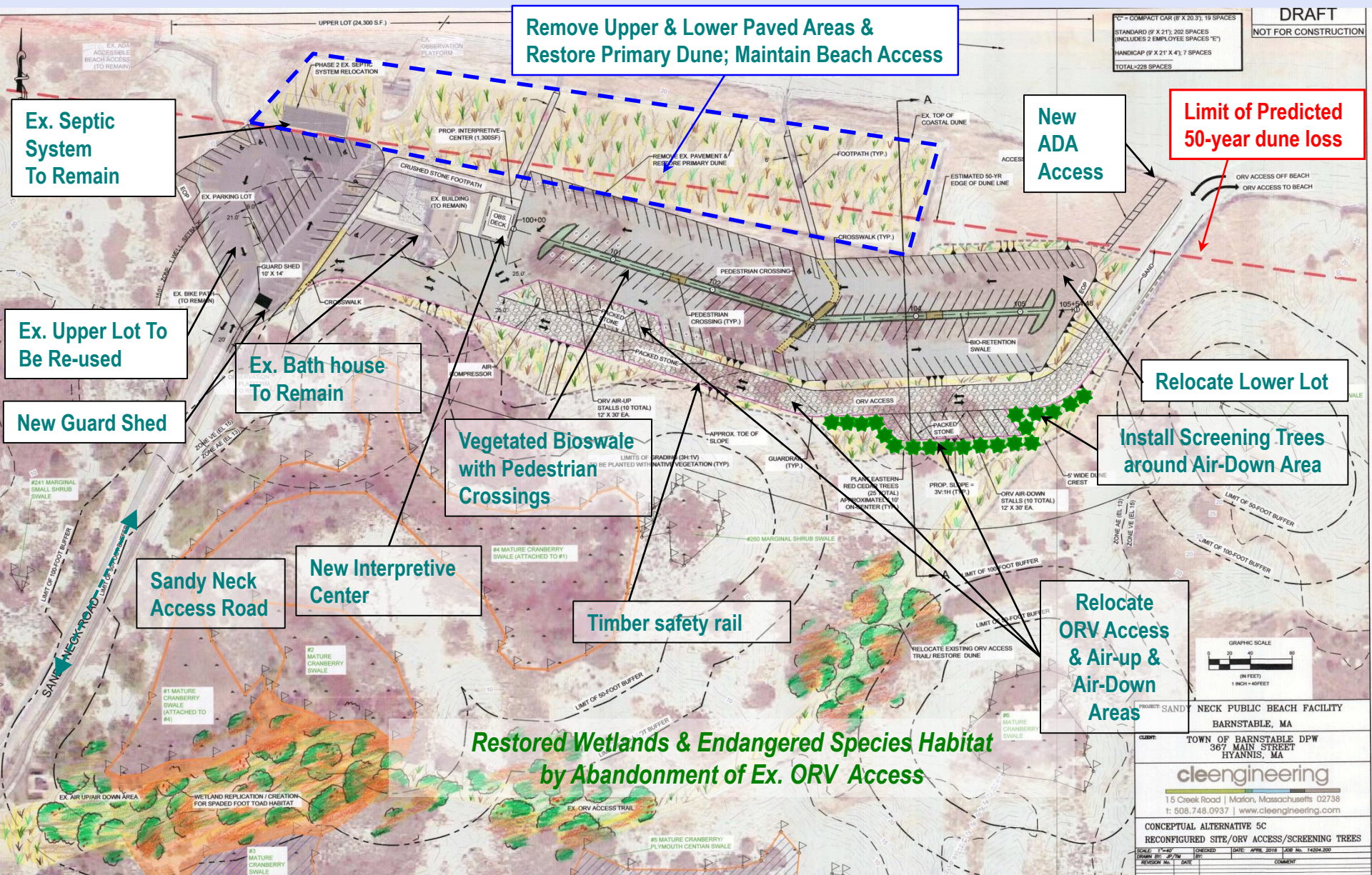
CLIENT: TOWN OF BARNSTABLE DPW
367 MAIN STREET
HYANNIS, MA

cleengineering
15 Creek Road | Marion, Massachusetts 02738
t: 508.748.0937 | www.cleengineering.com

CONCEPTUAL ALTERNATIVE 5B
RECONFIGURED SITE/ORV ACCESS & REUSE AIR-DOWN

SCALE: 1/8" = 1'-0" CHECKED: DATE: April 2018 DRAW NO: 14204-300
DRAWN BY: 22/740 DATE: REVISION NO. DATE COMMENT

Conceptual Alternative 5C: Parking Lot & ORV Access Relocation with Screening Trees



Remove Upper & Lower Paved Areas & Restore Primary Dune; Maintain Beach Access

DRAFT
NOT FOR CONSTRUCTION

CF - COMPACT CAR (8' X 20.3'), 19 SPACES
STANDARD (9' X 21'), 202 SPACES (INCLUDED 2 EMPLOYEE SPACES 'E')
HANDICAP (9' X 21' X 4'), 7 SPACES
TOTAL - 228 SPACES

Ex. Septic System To Remain

New ADA Access

Limit of Predicted 50-year dune loss

Ex. Upper Lot To Be Re-used

Ex. Bath house To Remain

Relocate Lower Lot

New Guard Shed

Vegetated Bioswale with Pedestrian Crossings

Install Screening Trees around Air-Down Area

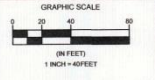
Sandy Neck Access Road

New Interpretive Center

Timber safety rail

Relocate ORV Access & Air-up & Air-Down Areas

Restored Wetlands & Endangered Species Habitat by Abandonment of Ex. ORV Access



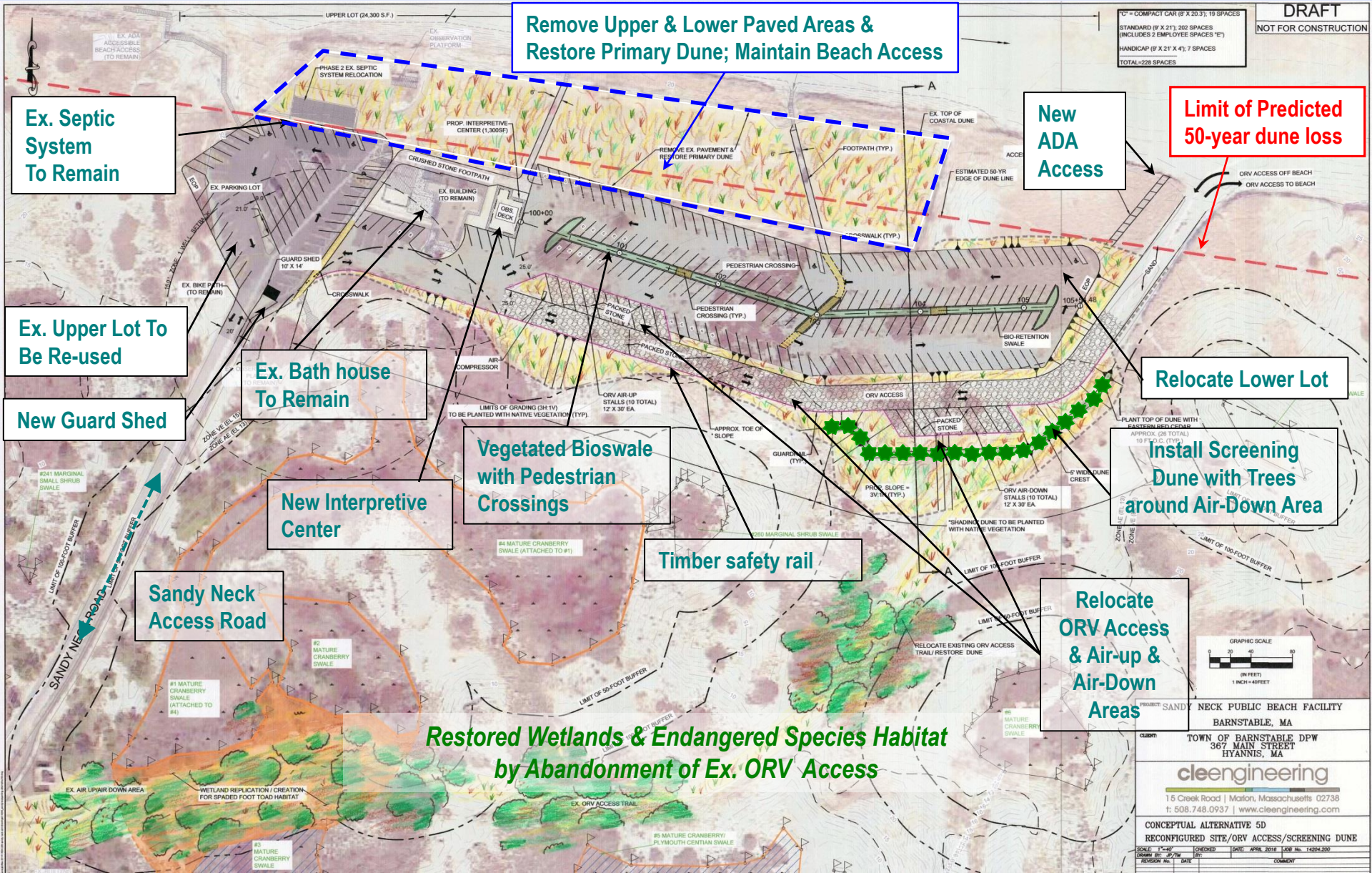
PROJECT SANDY NECK PUBLIC BEACH FACILITY
BARNSTABLE, MA
CLIENT TOWN OF BARNSTABLE DPW
367 MAIN STREET
HYANNIS, MA

cleengineering
15 Creek Road | Marion, Massachusetts 02738
t: 508.748.0937 | www.cleengineering.com

CONCEPTUAL ALTERNATIVE 5C
RECONFIGURED SITE/ORV ACCESS/SCREENING TREES

SCALE: 1"=40'
DRAWN BY: [blank] CHECKED: [blank] DATE: APRIL 2016 LOG NO. 14204.200
DESIGN NO. 27700 REV: [blank] REVISION NO. DATE COMMENT

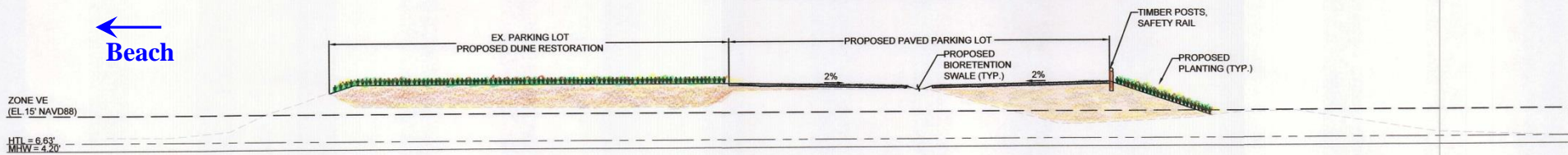
Conceptual Alternative 5D: Parking Lot & ORV Access Relocation with Screening Dune



Typical Sections Alternatives 5A thru 5D

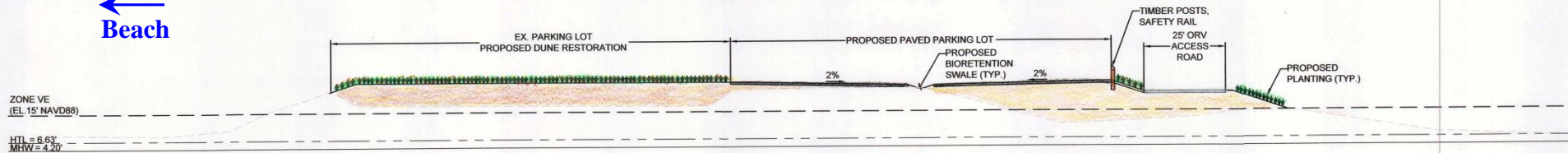
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ALTERNATIVE 5A - RECONFIGURED SITE



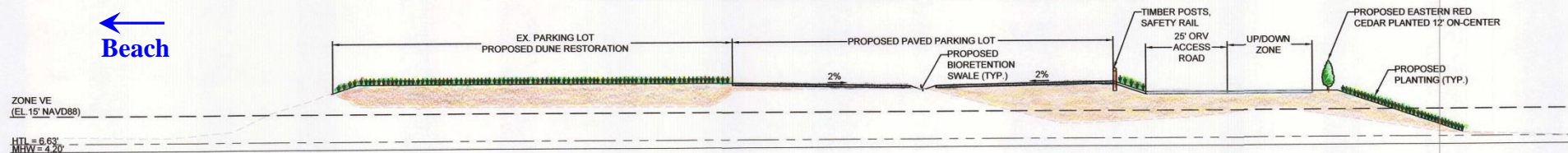
← Beach

ALTERNATIVE 5B - RECONFIGURED SITE/ORV ACCESS & REUSE AIR-DOWN



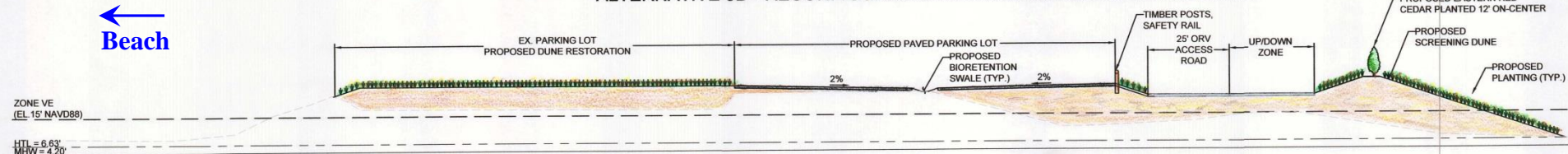
← Beach

ALTERNATIVE 5C - RECONFIGURED SITE/ORV ACCESS/SCREENING TREES



← Beach

ALTERNATIVE 5D - RECONFIGURED SITE/ORV ACCESS/SCREENING DUNE



Shrubs



Artemisia cana
Hoary Sagebrush



Morella pensylvanica
Northern Bayberry



Prunus maritima
Beach Plum



Viburnum trilobum
American Cranberry

Groundcovers



Ammophila brevifluga
American Beachgrass



Hudsonia tomentosa
Beach Heather



Lathyrus japonicus
Beach Pea



Solidago sempervirens
Seaside Goldenrod

Additional Bioretention Plants



Hibiscus moscheutos
Swamp-Rose Mallow



Ilex glabra
Inkberry Holly



Panicum virgatum
Switch Grass



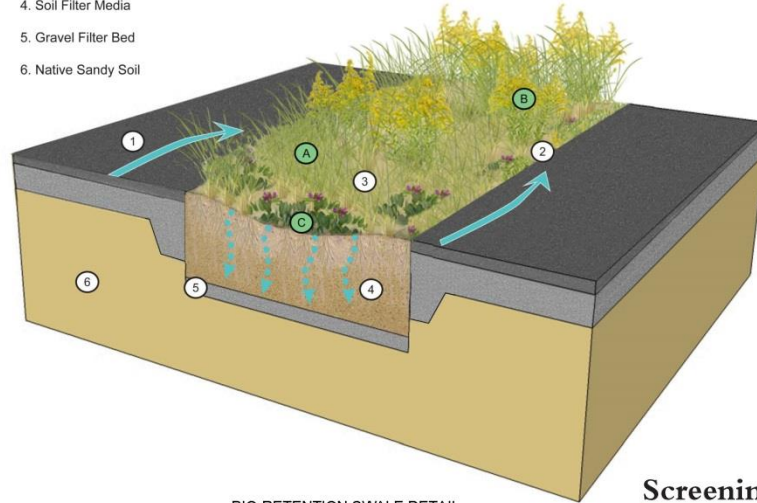
Schizachyrium scoparium
Little Bluestem

LEGEND

1. Parking Surface
2. Curb Cut
3. Bioswale
4. Soil Filter Media
5. Gravel Filter Bed
6. Native Sandy Soil

PLANTING LIST

- A. American Beach Grass
- B. Seaside Goldenrod
- C. Beach Pea



BIO-RETENTION SWALE DETAIL
NTS



PEDESTRIAN CROSSING DETAIL
NTS

Screening Trees



Juniperus virginiana
Eastern Redcedar



Pinus rigida
Pitch Pine

CONCEPTUAL ALTERNATIVES COST SUMMARY

ALT. NO.	DESCRIPTION	EST. CAPITAL COSTS ¹	EST. MAINTENANCE COST (49 YEARS)			TOTAL EST. COST (Capital + Maint. Costs Over 50 Years)
			Description	Budgeted Cost per Event ¹	Total (49 Years) ²	
1	CANTILEVER BULKHEAD	\$ 2,316,790	Annual Sand Nourishment (49 Events @ ±3,000 CY/YR)	\$ 75,000	\$ 8,384,765	\$ 10,701,555
2	STONE REVETMENT	\$ 1,480,000	Annual Sand Nourishment (49 Events @ ±3,000 CY/YR)	\$ 75,000	\$ 8,384,765	\$ 14,060,399
			Revetment Repair/Reconstruction (Assume 4 events)	\$ 400,000	\$ 4,195,634	
3	BIOENGINEERED STABILIZATION (Sand Bags)	\$ 565,000	Assume 5 yr design life; Re-build required in Years 5, 10, 15, 20, 25, 30, 35, 40, 45 (9 events)	\$ 565,000	\$ 11,438,880	\$ 18,870,210
			Annual Sand Nourishment (40 years @ ±3,000 CY/YR)	\$ 75,000	\$ 6,866,330	
4	BEACH NOURISHMENT (Off-site Compatible Sand Source)					
A	530 LF (35,600 CY)	\$ 1,035,000	Replenish 70% of Vol. = ±24,920 CY (Every 2 Yrs = 24 events)	\$ 725,000	\$ 39,559,595	\$ 40,594,595
B	750 LF (47,780 CY)	\$ 1,385,000	Replenish 70% of Vol. = ±33,446 CY (Every 3 Yrs = 16 events)	\$ 970,000	\$ 35,804,192	\$ 37,189,192
C	1000 LF (61,830 CY)	\$ 1,790,000	Replenish 70% of Vol. = ±43,281 CY (Every 5 Yrs = 9 events)	\$ 1,255,000	\$ 25,408,486	\$ 27,198,486
D	1500 LF (90,880 CY)	\$ 2,625,000	Replenish 70% of Vol. = ±63,616 CY (Every 10 Yrs = 4 events)	\$ 1,840,000	\$ 16,264,363	\$ 18,889,363

Notes:

(1) Est. Cost in 2016 Dollars; Costs do not include New Interpretive Center.

(2) Maintenance costs reflect inflation factor of 3% which is compounded annually; Est. Cost in Year $N = (2016 \text{ Est. Cost}) * (1.03)^N$

(3) Benefits assumed to be annual revenue generated at Sandy Neck= \$250,000/yr = \$12.5 mil over 50 years

CONCEPTUAL ALTERNATIVES COST SUMMARY (CONTINUED)

ALT. NO.	DESCRIPTION	EST. CAPITAL COSTS ¹	EST. MAINTENANCE COST (49 YEARS)			TOTAL EST. COST (Capital + Maint. Costs Over 50 Years)
			Description	Budgeted Cost per Event ¹	Total (49 Years) ²	
5	MANAGED SITE RECONFIGURATION					
A	• Relocate Parking Lot	\$ 2,000,000	Annual Maintenance (Sweeping, Bioswale, Pavement Repairs= 49 Events)	\$ 10,000	\$ 1,117,968	\$ 6,154,839
			Primary Dune Restoration/Plantings (Every 5 yrs)	\$ 150,000	\$ 3,036,871	
B	• Relocate Parking Lot • Relocate ORV Access/Reconfigure Existing Air-Down Area	\$ 2,360,000	Annual Maintenance (Sweeping, Bioswale, Pavement Repairs = 49 Events)	\$ 10,000	\$ 1,117,968	\$ 6,514,839
			Primary Dune Restoration/Plantings (Every 5 yrs)	\$ 150,000	\$ 3,036,871	
C	☑ Relocate Parking Lot • Relocate ORV Access w/ Screening Trees	\$ 2,380,000	Annual Maintenance (Sweeping, Bioswale, Pavement Repairs= 49 Events)	\$ 10,000	\$ 1,117,968	\$ 6,534,839
			Primary Dune Restoration/Plantings (Every 5 yrs)	\$ 150,000	\$ 3,036,871	
D	• Relocate Parking Lot • Relocate ORV Access w/ Screening Dune	\$ 2,500,000	Annual Maintenance (Sweeping, Bioswale, Pavement Repairs= 49 Events)	\$ 10,000	\$ 1,117,968.00	\$ 6,654,839
			Primary Dune Restoration/Plantings (Every 5 yrs)	\$ 150,000	\$ 3,036,871	

Notes:

(1) Est. Cost in 2016 Dollars; Cost do not include new Interpretive Center Building

(2) Maintenance costs reflect inflation factor of 3% which is compounded annually; Est. Cost in Year _N = (2016 Est. Cost)*(1.03)^N

(3) Benefits assumed to be annual revenue generated at Sandy Neck= \$250,000/yr = \$12.5 mil over 50 years

CONCEPTUAL ALTERNATIVES RATING SUMMARY

Alt. No.	Description	ESTIMATE COSTS			RATING VALUES					TOTAL RATING VALUE
		Est. Capital Cost ⁽¹⁾	Est. Maint. Cost ⁽²⁾	Total Est. Cost	B/C Ratio ⁽³⁾	Permit Rating	Protection Rating	Enhance Coastal Wetland Resources	Enhance Wildlife Habitat	
					<i>Calculated Value</i>					
1	Cantilever Bulkhead	\$2.32 M	\$8.38 M	\$10.70 M	1.17	0	1	0.5	0	2.67
2	Stone Revetment	\$1.48 M	\$12.58M	\$14.06 M	0.89	0	1	0.5	0	2.39
3	Bioengineered Stabilization (Sand Bags)	\$565K	\$18.30 M	\$18.87M	0.66	1	0	1	0	2.66
4A	Nourishment (530 LF; 35,600 CY)	\$1.04 M	\$39.56 M	\$40.59 M	0.31	1	0	1	0	2.31
4B	Nourishment (750 LF; 47,780 CY)	\$1.39 M	\$35.80 M	\$37.19 M	0.34	1	0	1	0	2.34
4C	Nourishment (1,000 LF; 61,830 CY)	\$1.79 M	\$25.41 M	\$27.20 M	0.46	1	0	1	0	2.46
4D	Nourishment (1,500 LF; 90,880 CY)	\$2.63 M	\$16.26 M	\$18.89 M	0.66	1	0	1	0	2.66
5A	Relocate Parking Lot	\$2.00 M	\$4.15 M	\$6.15 M	2.03	1	1	1	0	5.03
5B	Relocate Parking Lot; Relocate ORV Access with Reuse Ex. Air-Down	\$2.36 M	\$4.15 M	\$6.51 M	1.92	1	1	1	1	5.92
5C	Relocate Parking Lot; Relocate ORV Access with Screening Trees	\$2.38 M	\$4.15 M	\$6.53 M	1.91	1	1	1	1	5.91
5D	Relocate Parking Lot; Relocate ORV Access with Screening Dune	\$2.50 M	\$4.15 M	\$6.65 M	1.88	1	1	1	1	5.88

Notes:

(1) Est. Cost in 2016 Dollars; Costs do not include New Interpretive Center Building

(2) Maintenance costs reflect inflation factor of 3% which is compounded annually; Est. Cost in Year $N = (2016 \text{ Est. Cost}) * (1.03)^N$

(3) Benefits assumed to be annual revenue generated at Sandy Neck= \$250,000/yr = \$12.5 mil over 50 years

□ LONG-TERM RESILIENCY ALTERNATIVES

Limitations & Assumptions:

- All alternatives considered and evaluated are capable of supporting continued on-site access to/from Sandy Neck Beach Park.
- Permittability of alternatives is evaluated with respect to current environmental regulations.
- Future capital costs for parking lot resurfacing and replacement of the existing septic system are applicable to all alternatives and therefore are not included in the Benefit-Cost analysis.
- Annual revenue is assumed to \$250,000 and has been assumed to remain constant over the 50 year evaluation period.

NEXT STEPS:

- Project Review of Alternatives**
- Recommendation Presented to Town Manager**
- Public Presentation of Selected Alternative**
- Preliminary Design of Selected Alternative**
- Permitting of Selected Alternative**
- Request Additional Project Funding through next available round of MA CZM Resiliency Grant Program (FY17).**

~ COMMENTS FROM THE PUBLIC ~