

Session 2 — Concurrent Breakout Presentations



Resilient Shorelines

Location: Room 1

Genesis of Shoreline Designs at Wagon Hill Farm and Lessons Learned – *Tom Ballestero (UNH Coastal Habitats and Restoration Team)*

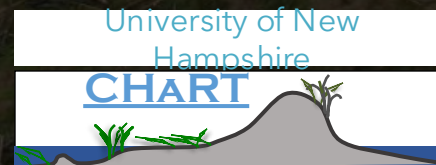
Resolving Salt Marsh Ownership in Hampton Seabrook Estuary – *Aidan Barry (NHDES) and Rob Pruyne (Rockingham Planning Commission)*

Designing Resilience: Nature-based Climate Solutions in New England – *Jennifer Martel, Amy Bell Segal, and Beth Kirmmse (American Society of Landscape Architects)*

The Wagon Hill Farm Living Shoreline: How we got there and what we learned



Tom Ballestero, Civil & Environmental Engineering
David Burdick, Jackson Estuarine Lab
University of New Hampshire



People

- CHaRT

- Tom Ballestero
- Dave Burdick
- Gregg Moore

- NHDES

- Kirsten Howard
- Kevin Lucey
- Mindy Bubier
- Lori Sommer
- Dave Price

- UNH

- Cat Ashcroft
- Trevor Mattera
- Grant McKown

- Town of Durham

- Mike Lynch
- Rachel Gasowski
- Greg Moore
- Todd Selig
- Ellen Snyder

- Strafford Regional Planning Commission

- Kyle Pimental

- Streamworks

- Joel Ballestero

Change from 1992 to 2015



Recognition of the Problem

- Shoreline erosion required moving a fence twice: approximately 25 feet inland over a 30 year period
- Town reached out to NHDES, both then reached out to UNH
- First efforts of monitoring aimed at documenting causes
- Meetings then scheduled monthly over 3 years (Jan 2016 – Dec 2019)

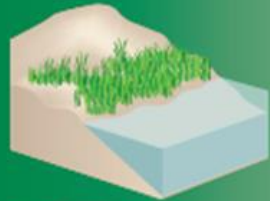
Fence moved 2002

Ranges of Options

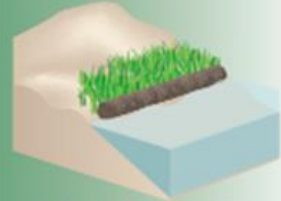
GREEN - SOFTER TECHNIQUES

GRAY - HARDER TECHNIQUES

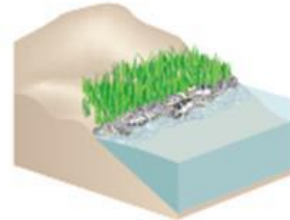
Living Shorelines



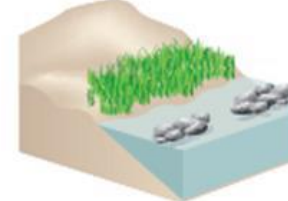
VEGETATION ONLY -
Provides a buffer to upland areas and breaks small waves. Suitable for low wave energy environments.



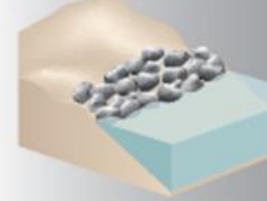
EDGING -
Added structure holds the toe of existing or vegetated slope in place. Suitable for most areas except high wave energy environments.



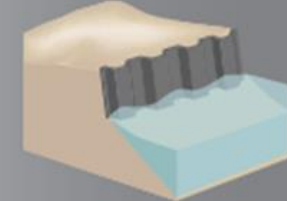
SILLS -
Parallel to vegetated shoreline, reduces wave energy, and prevents erosion. Suitable for most areas except high wave energy environments.



BREAKWATER -
(vegetation optional) - Offshore structures intended to break waves, reducing the force of wave action, and encourage sediment accretion. Suitable for most areas.



REVETMENT -
Lays over the slope of the shoreline and protects it from erosion and waves. Suitable for sites with existing hardened shoreline structures.

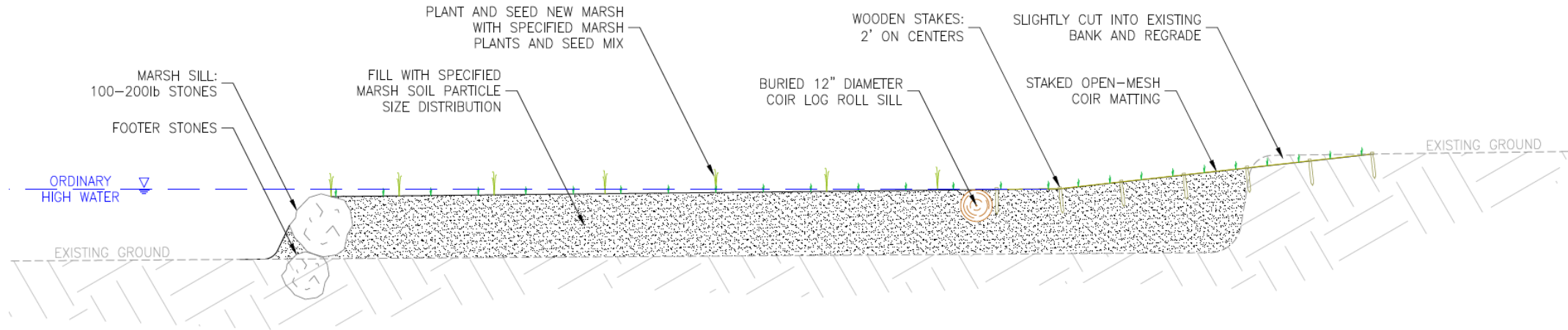


BULKHEAD -
Vertical wall parallel to the shoreline intended to hold soil in place. Suitable for high energy settings and sites with existing hard shoreline structures.

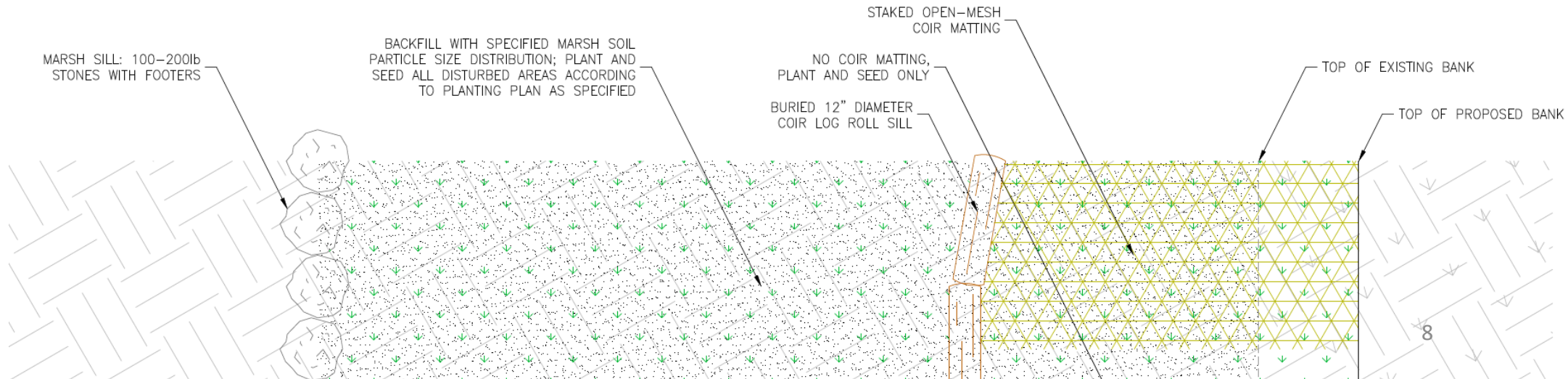
Shoreline Solution Genesis

- Dec 2016 Options (for MHW today and MHW at mid century)
 - Build out shoreline to 1989 limit. Rock Sill at water's edge. Coir logs at grade change
 - Build out shoreline to 1989 limit. Rock Sill at water's edge. Coir logs and rock at grade change
 - Build out shoreline to 1989 limit. Rock Sill with root wads at water's edge. Coir logs and rock at grade change

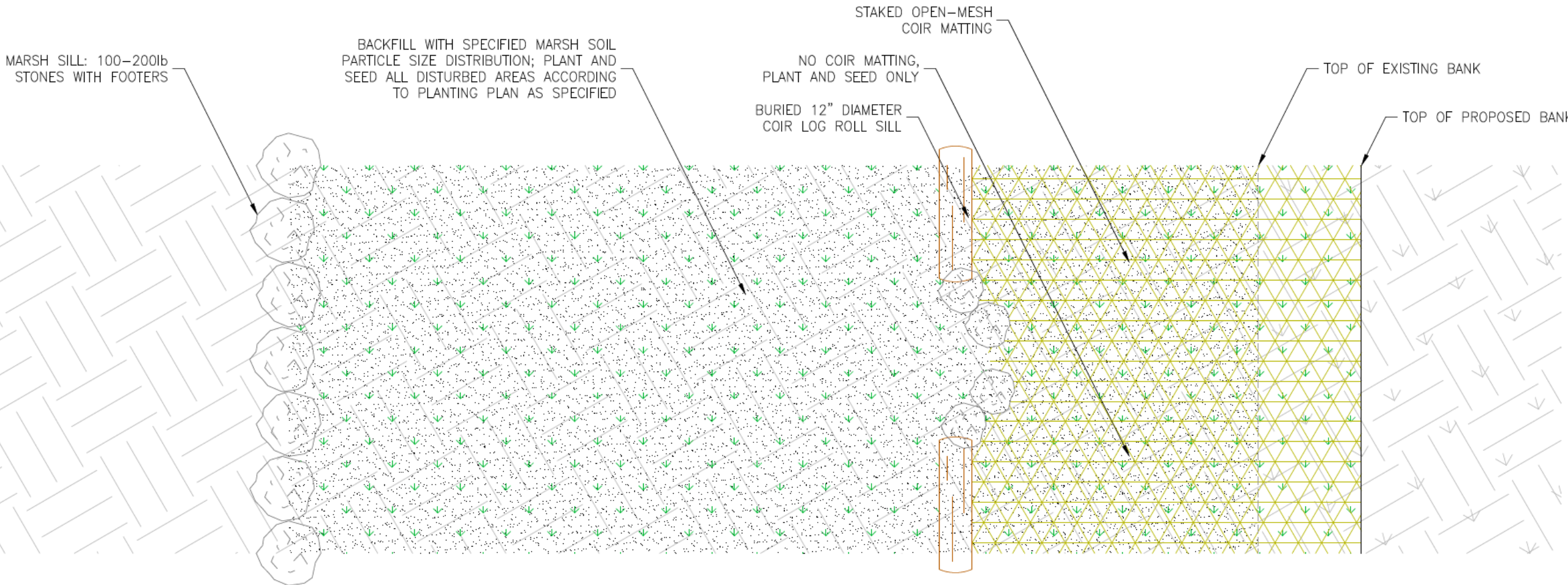
First Concept – Dec 2016: Rock Sill, coir log at grade change



SECTION VIEW

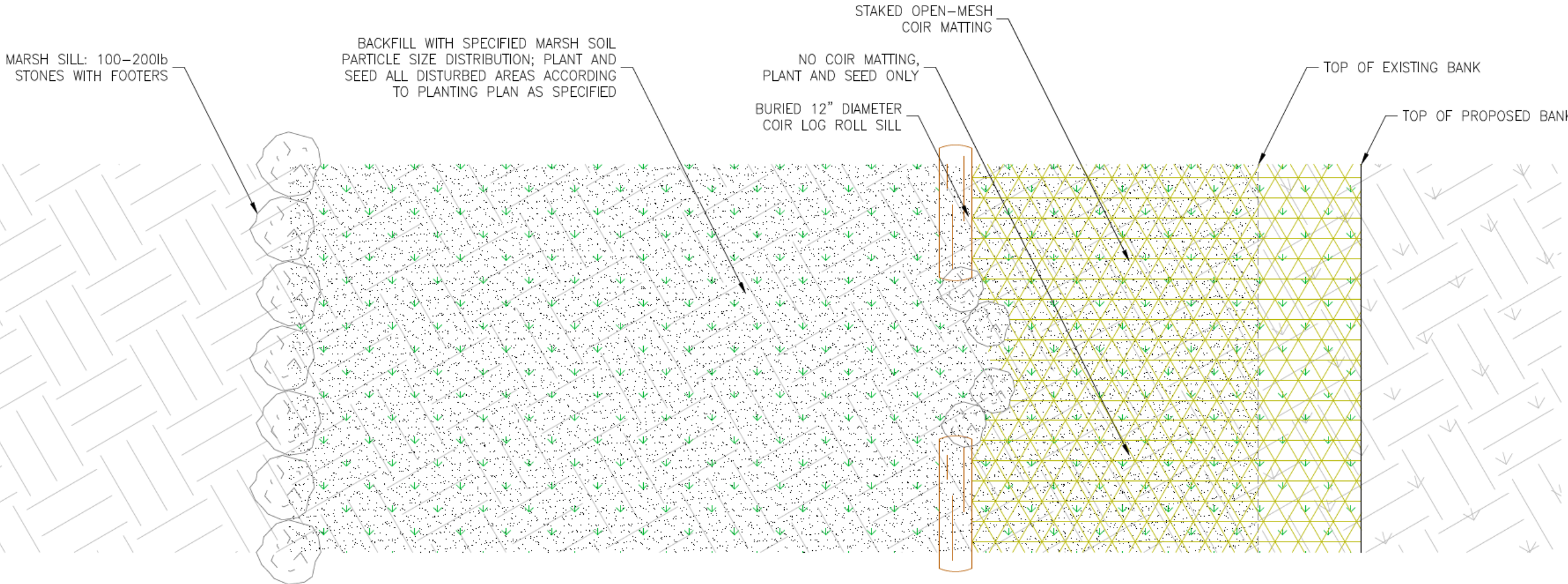


Dec 2016 Alternative 1 – Rock sill, Coir Logs/rock at grade change



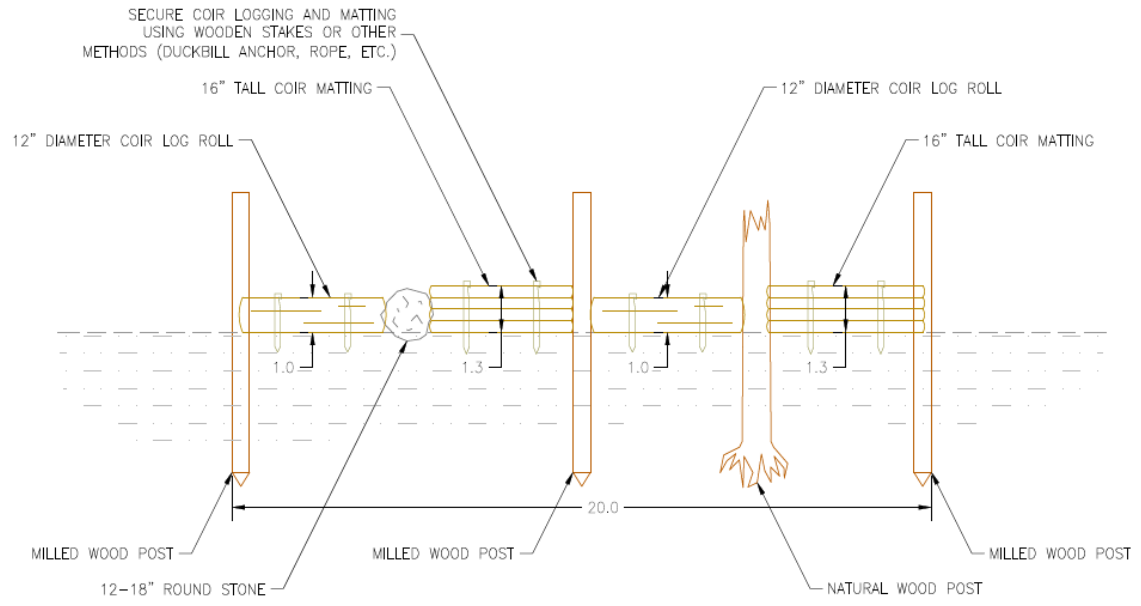
PLAN VIEW

Dec 2016 Alternative 2 – Rock Sill with Root Wads, Coir Logs/rock at grade change



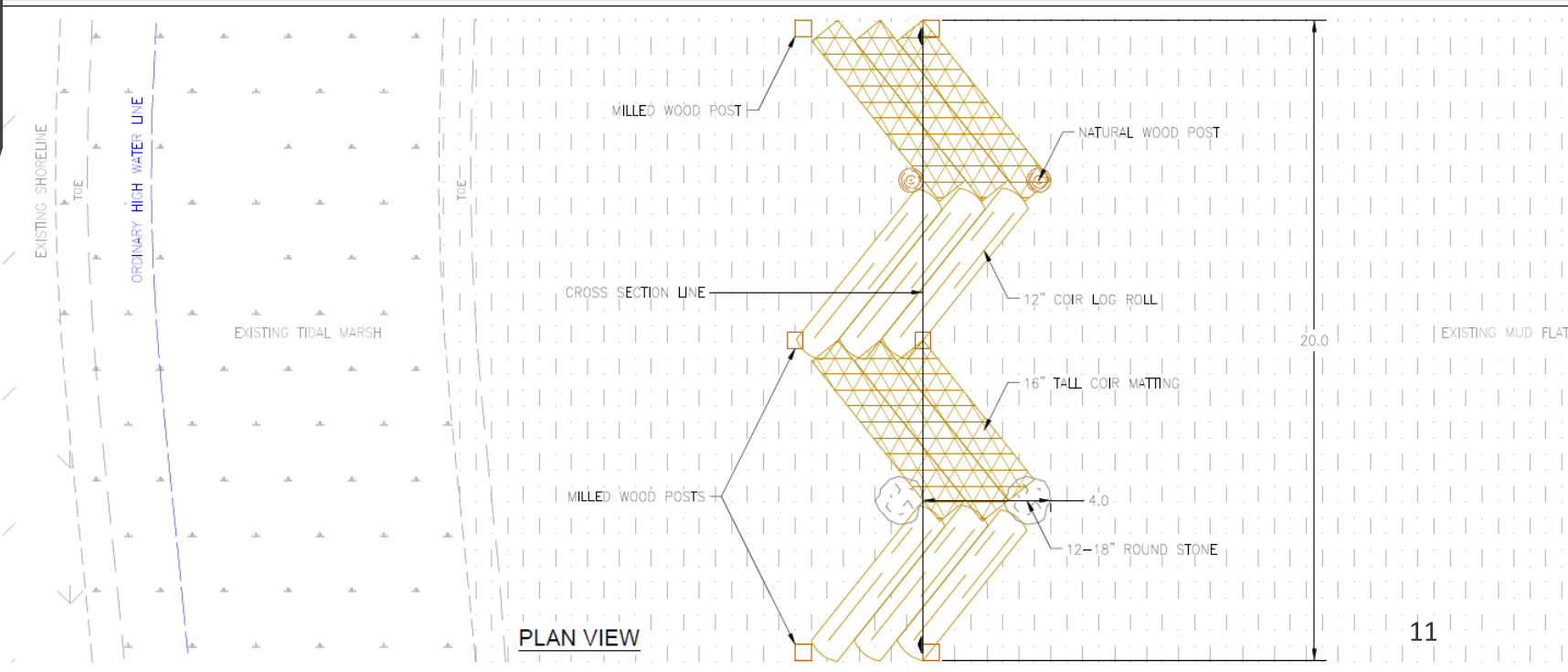
PLAN VIEW

Dec 2016
 Alternative 3 –
 Wood Crib Sill,
 Coir Logs/rock at
 grade change



SECTION VIEW

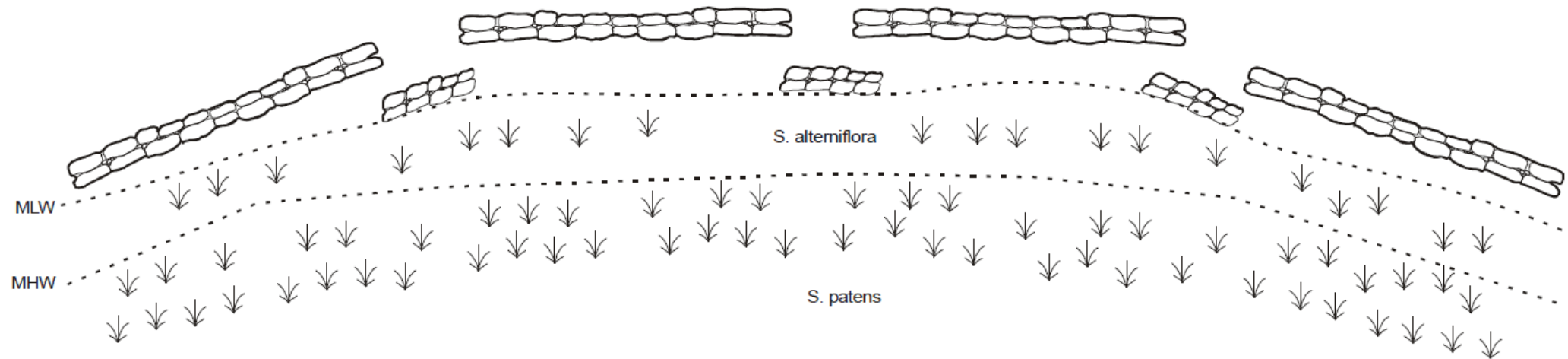
NOTE: THE STRUCTURE WILL BE PLACED SEAWARD OF ANY EXISTING MARSH, IN THE MUD FLATS



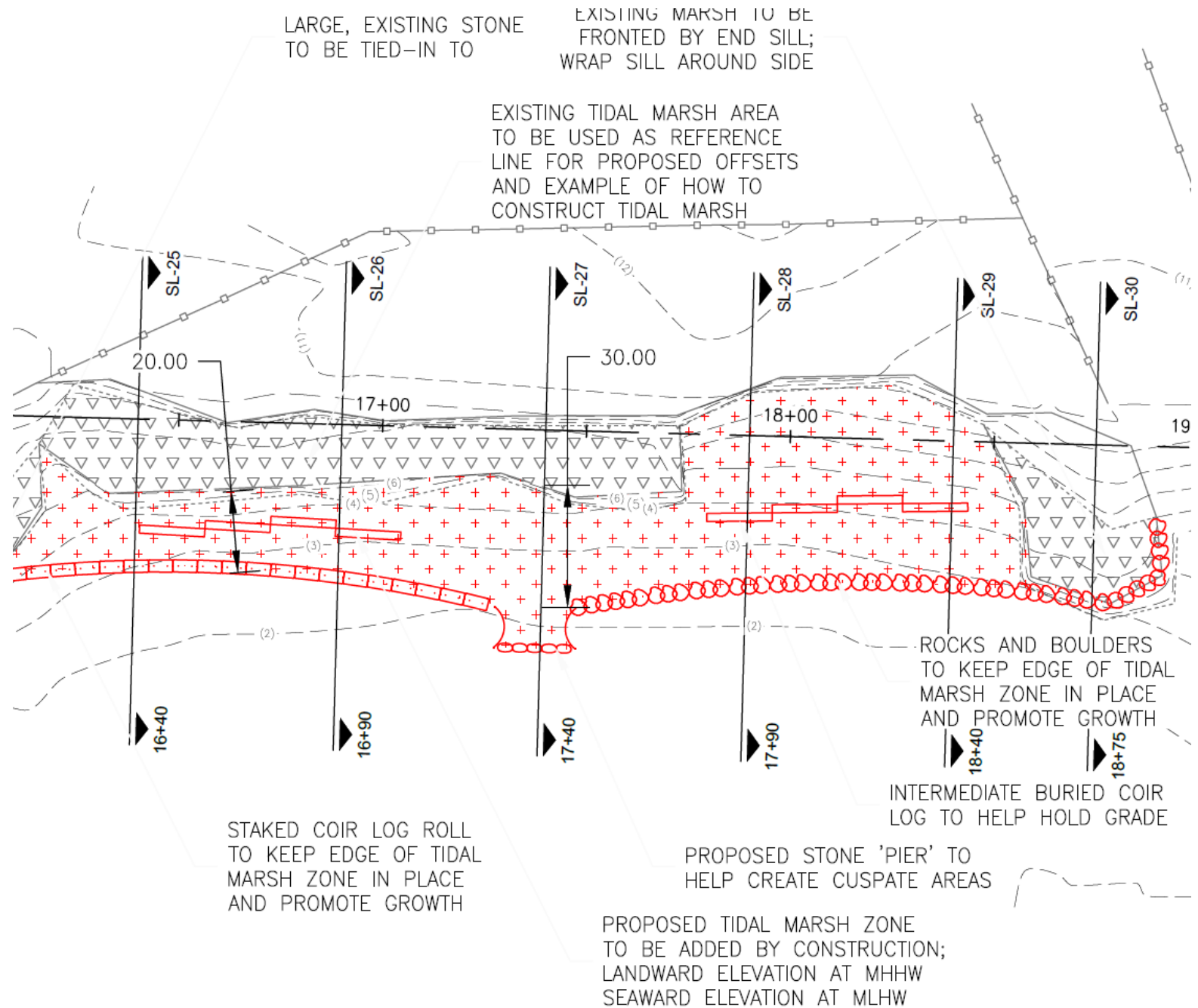
PLAN VIEW

Dec 2016 Alternative 4 – Vented Sill, Coir Logs/rock at grade change

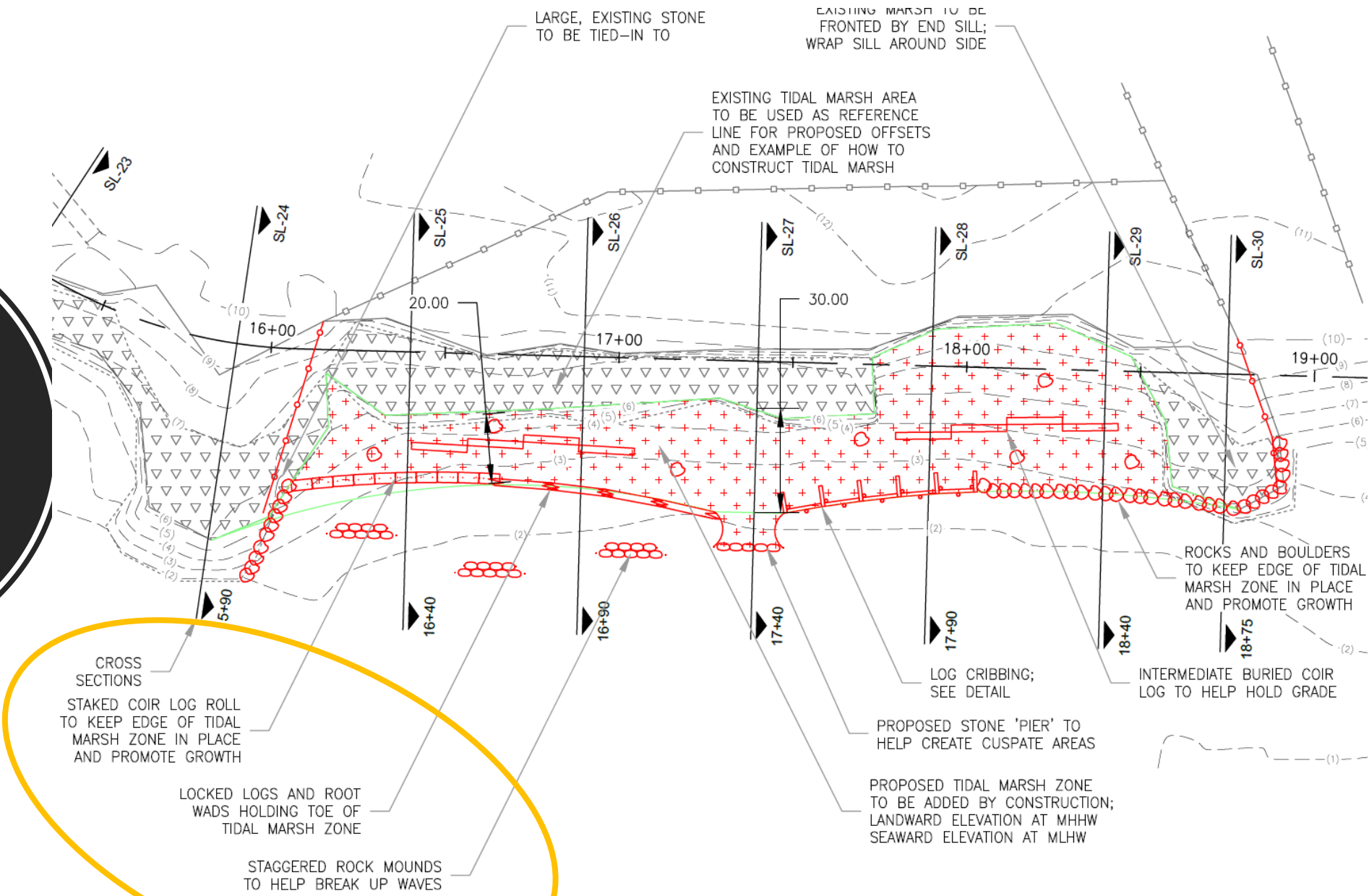
Offset or Staggered Vented Sill



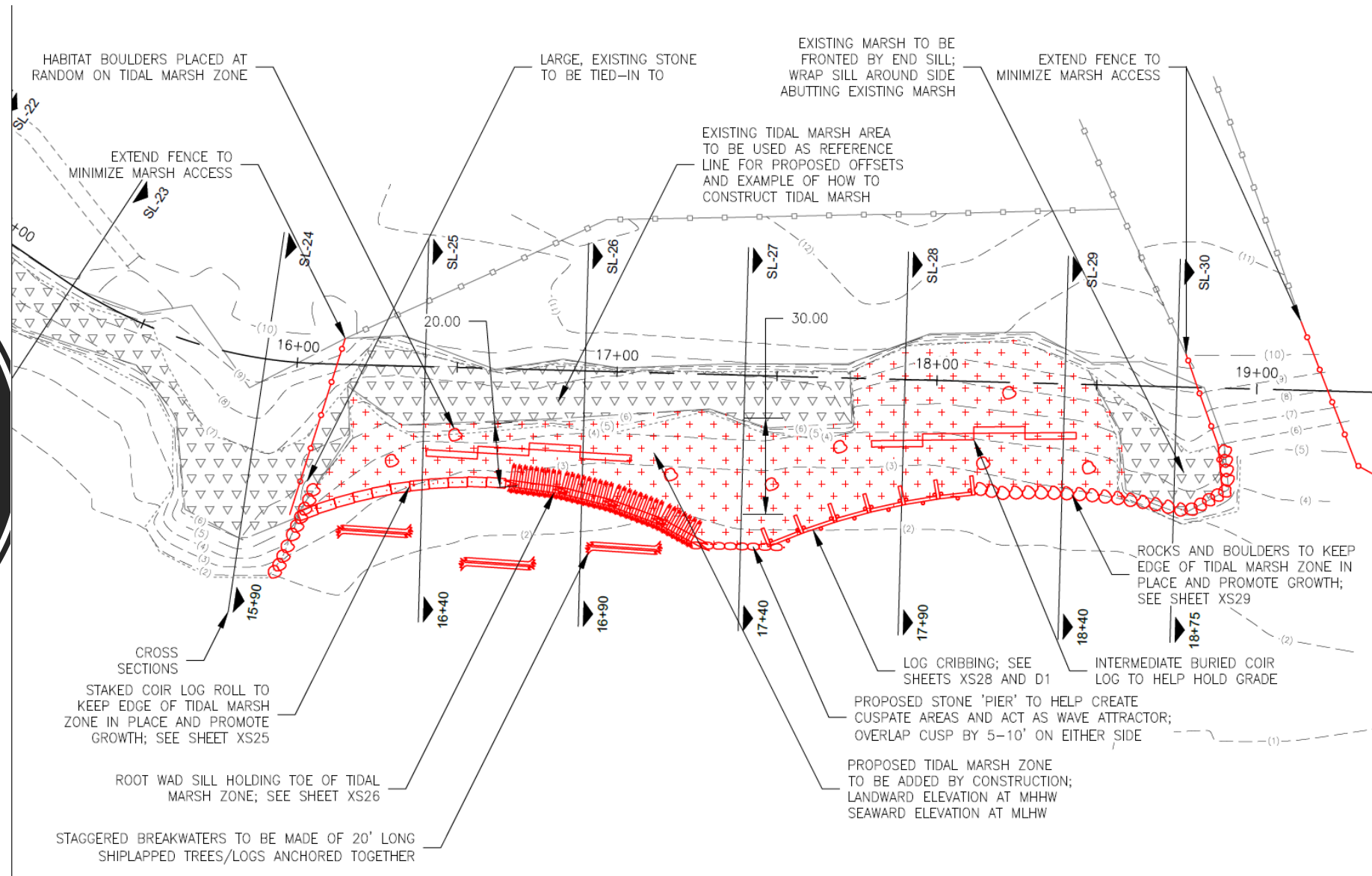
Jan 2017 The plan view. Cusps with extended center (pier). Coir and rock sills



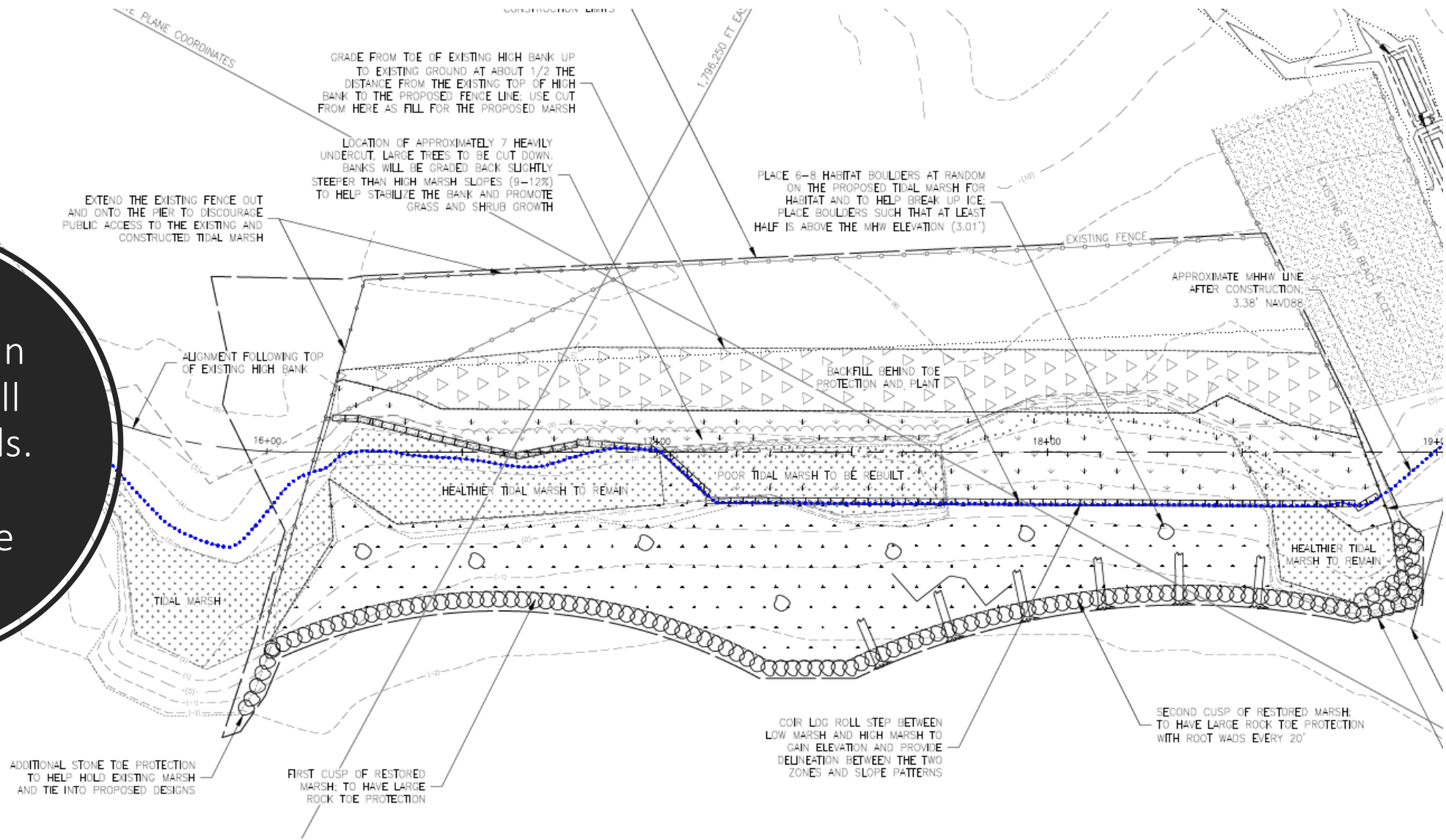
Feb 2017 plan view. Cusps with extended center and submerged rock breakwaters



Jun 2017 plan view.
Everything but
the kitchen sink



May 2018 plan view. Rock sill with root wads. Coir log at grade change



Constructed in 2019...What Was Learned?

Thoughts on the Process

- Expertise of team
Designs and execution of living shorelines can be done by individuals, but expertise from biological and ecological science is well complemented by physical scientists and engineers and vice-versa.
- Public-Client-Agency engagement
All parties need to be included at the start and provide their input. This process can require substantial time and effort and needs to be included in the entire project process.
- Project timeline
Be prepared for a lengthy planning phase, and leave extra time for planning, permitting, and construction. Do not rely on a tight schedule happening as planned.
- Understand all project components
Know or investigate all the steps necessary to achieve the final product. Know all the data to collect (local tidal datums, tidal timing relative to a reference, seasonal salinity, topography, permitting components (like shoreland tree scoring), design details, and much, much more. Understand the steps and collect as much data as possible.

Thoughts on the Design

- Determine cause(s) for impairments
Spend time initially to identify all the causes for impairments seen – whether location-specific or site-wide – and plan to address all of them. One source of instability can undermine the project overall. Anticipate ‘black swans.’
- You cannot overthink upland (uphill) stormwater runoff
The more land uphill from your site, the more you need to design for runoff. Runoff can easily lead to rilling or even gullyng. It is best to divert the water away from the entire living shoreline site and use existing drainageways. If existing drainageways do not exist, you will need to create one and most likely armor it.
- Understanding wrack and how it may collect at the restored site. How does it collect now and on nearby marshes?
- Slope stability
The new marsh sediment is essentially sand. As such, it will liquify between every high tide event prior to plant roots holding it in place. Therefore, the sill must be able to prevent a slope failure from the liquified material.

Thoughts on the Design

- Coir logs
The coir logs are brittle, especially the larger the diameter, and are vulnerable to trampling. They are best used parallel to the shoreline to: break slope, change vegetation type, and/or use for inspection. Plants easily colonized the coir log within 2 years. After 3 years, they were very weathered. They should be embedded at least half their diameter along with staking. Use materials that are plastic-free.
- Living shoreline approach
Survey the area of interest and look for natural models where physical and biological systems are working together to produce a stable shoreline. Replicating these models may provide the best solution to shoreline erosion problems.
- Sod versus bare root stock versus plugs
Sod is a great concept, but growers may not yet have enough experience to produce healthy plants. The salt marsh grasses can be grown in fresh water, but at least 6 weeks before planting, should be slowly brought to the expected salinity at the site. Plugs are more easily popped out of the sediments by herbivores (Canada geese) or ice in winter than other planting techniques. We have also seen geese and ducks dabbling to liquify the sand substratum and pull out both plugs and bare root stock.

Thoughts on the Design

- The Edge
The seaward edge needs to survive long after construction. Coir logs will only last 3 years and therefore plants must take over by then. Salt marsh plants develop erosion-resistant peat after 15-20 years, so edges will still need protection on higher energy shorelines. Plan for coir replacement or rely on longer-lasting materials. Rock should be sized to remain in the face of extreme tide, wave, velocity and ice action. Rock can be colonized by beneficial algae to create habitat. The edge elevation should extend vertically to at least 0.3 ft higher than the marsh elevation immediately behind it.
- Coir versus geosynthetic versus graded filter
Between the sill and the new marsh sediments, a rock sill will require a filter to prevent the finer marsh sediments from moving through the sill to the water. Coir netting works well but only survives for a few years. Plant roots are insufficient to hold the marsh-edge sediments after 3 years; gaps will initiate and grow without a filter between the sill and new marsh sediments. Geosynthetics are commonly used between different size materials such as at the marsh edge, however they invariably are made of plastics. In lieu of geosynthetics or coir products, a graded filter should provide particle stability at the marsh edge.

Thoughts on Construction

- Construction

Understand the nature of constructing in a tidal system will be much more difficult than dry land. Tides make construction windows much shorter, even rendering some work days impassable within the tidal range. Plan for these events by having alternate efforts to do (constructing upland fence, replenishing stockpiles, planting constructed lands, etc.). Understand the limitations of working near shorelines – limited working space, minimal access, public access, etc.

Thoughts on Inspection and Maintenance

- Inspection and adaptive management
Frequent monitoring during construction, post-construction (short term) and post-construction (long term) is imperative. Construction inspection is necessary to ensure that the site is built as designed, or more importantly, to address design changes due to conditions only evident during construction. Short term post-construction inspection is primarily to assess plant growth (or lack thereof) and that the system is meeting design objectives. Wrack, drainage, traffic, invasive species, and nuisance species can each create significant consequences if not addressed as soon as identified.
- Maintenance
Have a dedicated entity that is responsible for maintaining the project long-term. There can be many (anticipated or not) issues that arise in the years following construction, so have stated objectives for the project and a thorough maintenance plan.

Thoughts on Inspection and Maintenance

- Protection from people
Keeping people and pets out of the marsh improves its survivability. The fence was the most important facet of the WHF project.
- Protection from herbivory (a critical issue at Cutts Cove)
Geese and ducks can quickly destroy plants, especially where sites were planted with bare root stock and a group of animals has learned how to exhume the nutritious rhizomes by dabbling. They are challenging to control but can be kept out using snow fencing. Strings stretched across the marsh and decorated with reflective materials was not an effective technique to deter hungry animals. Similarly, the lowly common periwinkle (an invasive exotic species from Europe) can obliterate salt marsh plants along shorelines where waves of thousands of animals move shoreward. Low fencing can block the waves of snails, but maintenance removal of snails within planted areas is important until plants proliferate to full cover.



Before



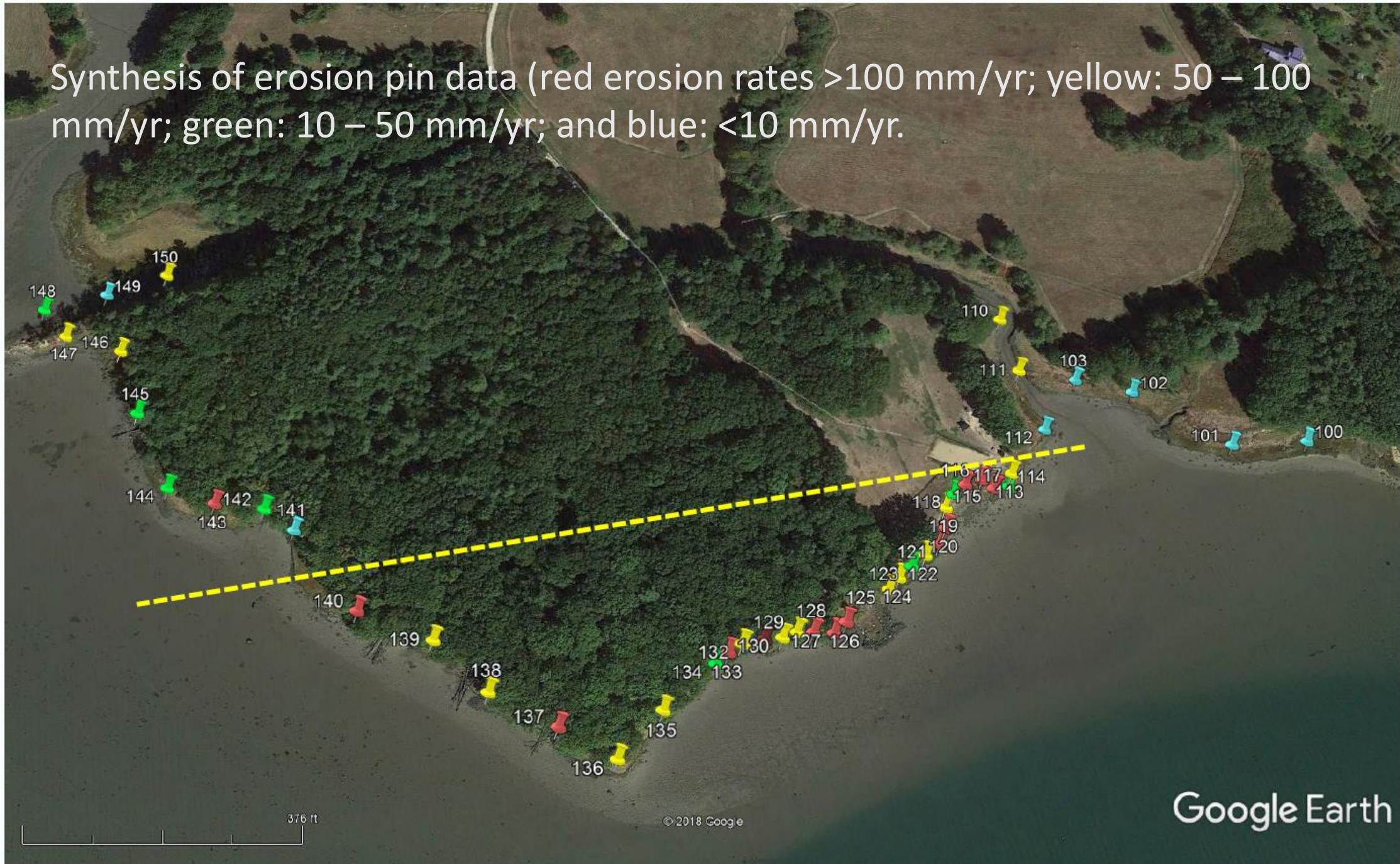
After



Final Design



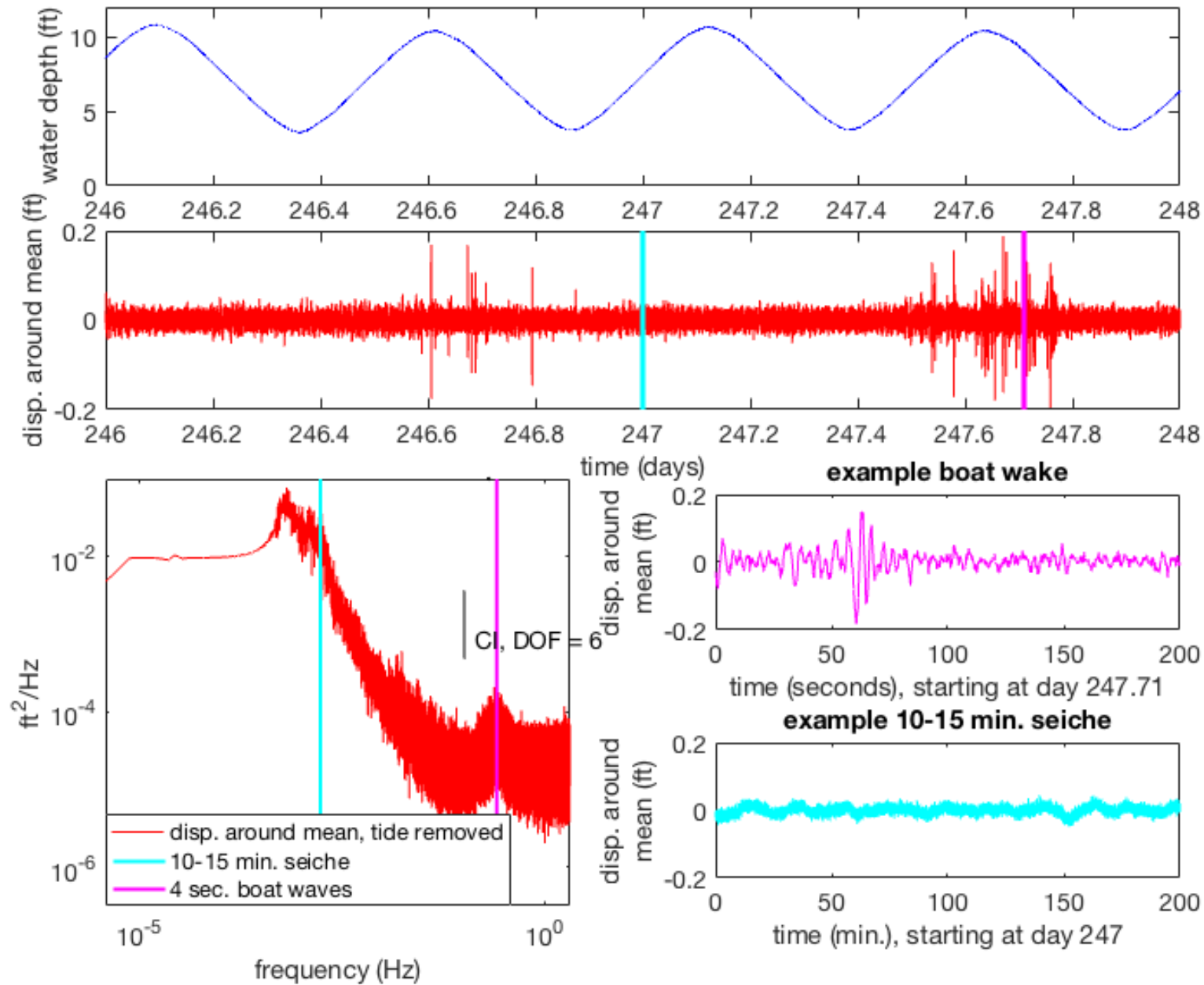
Synthesis of erosion pin data (red erosion rates >100 mm/yr; yellow: 50 – 100 mm/yr; green: 10 – 50 mm/yr; and blue: <10 mm/yr).



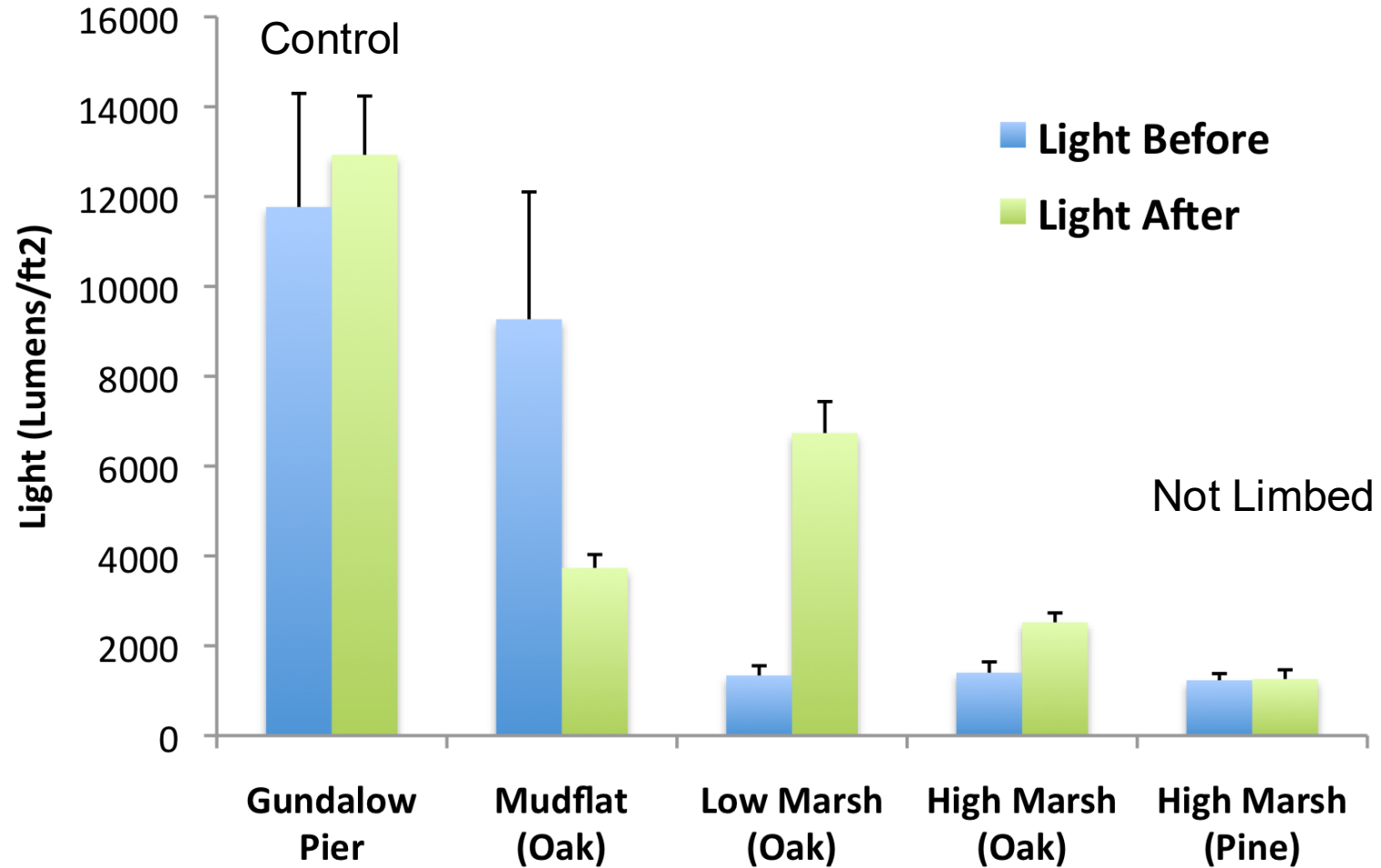
Wagon Hill Farm wave analysis, Aug. 28 - Sept. 4 2016

tidal displacement: ~8 ft, boat wake height max: ~0.4 ft, ambient wave height: ~0.05 ft, seiche height: ~0.1 ft

Energy: 3200 J total (incl. tides), 0.02 J in boat wake, 0.03 J in seiche



Light Reaching Marsh Surface Before and After Limbing



WHF Data Collection

Potential Causes of Erosion

- Waves
- Increased foot /pet traffic
- Decreased light
- Increased Sea Level
- Ice Damage
- Plant disease or herbivory
- Lack of Sediment supply
- Eroded shoreline promotes erosion cycle
- Stormwater

Data Collection

- [to eliminate potential causes and inform design]
- High intensity water levels
 - Wildlife cameras
 - Light meters
 - Water level recorders
 - Wildlife cameras
 - Observations
 - Trial structure
 - Erosion pins

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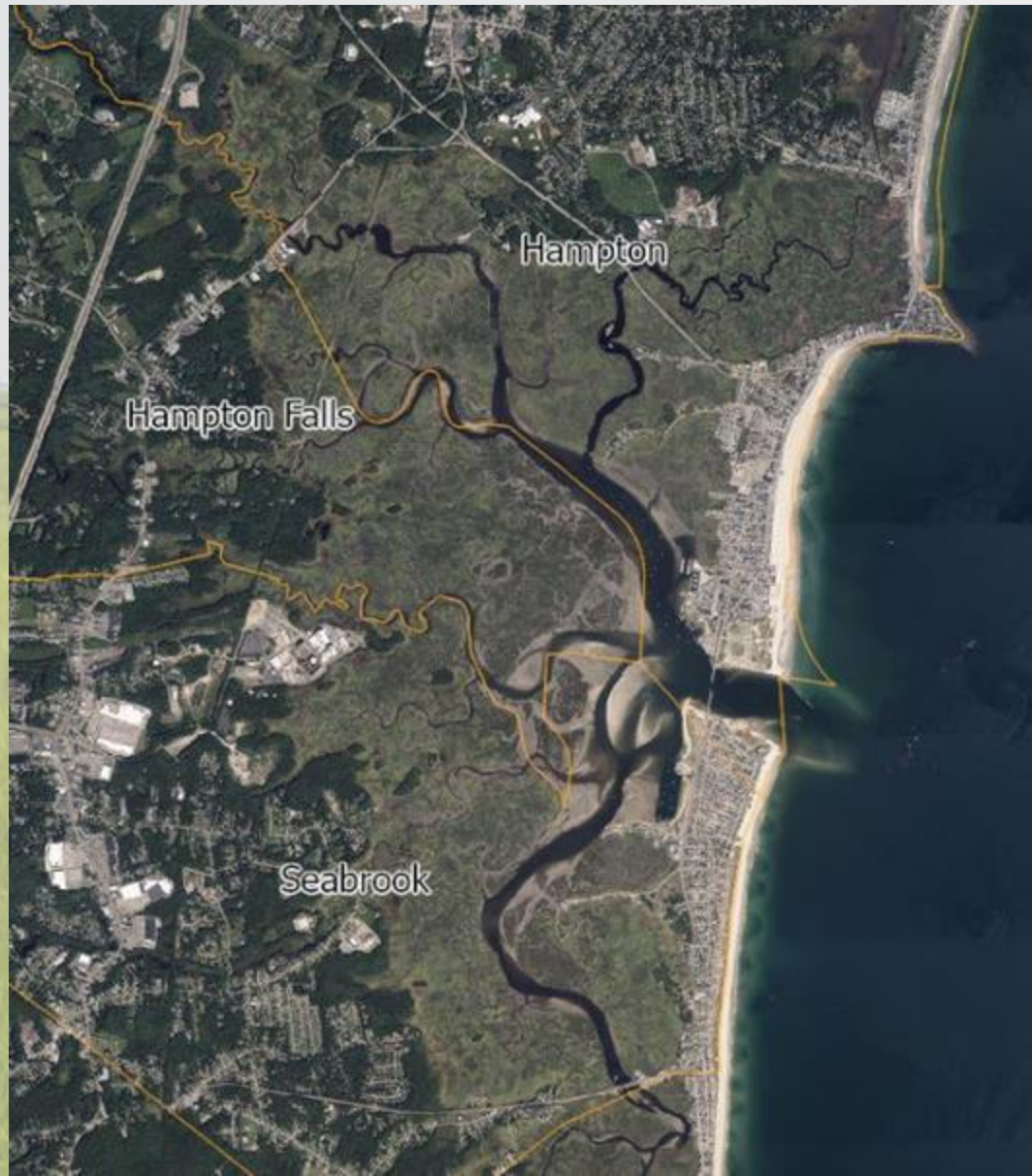
Salt Marsh Ownership in the Hampton Seabrook Estuary



**SEABROOK-HAMPTONS
ESTUARY ALLIANCE**

**May 21, 2026
Climate Summit
Aidan Barry, NHDES Coastal Program
Robert Pruyne, Rockingham Planning Commission**





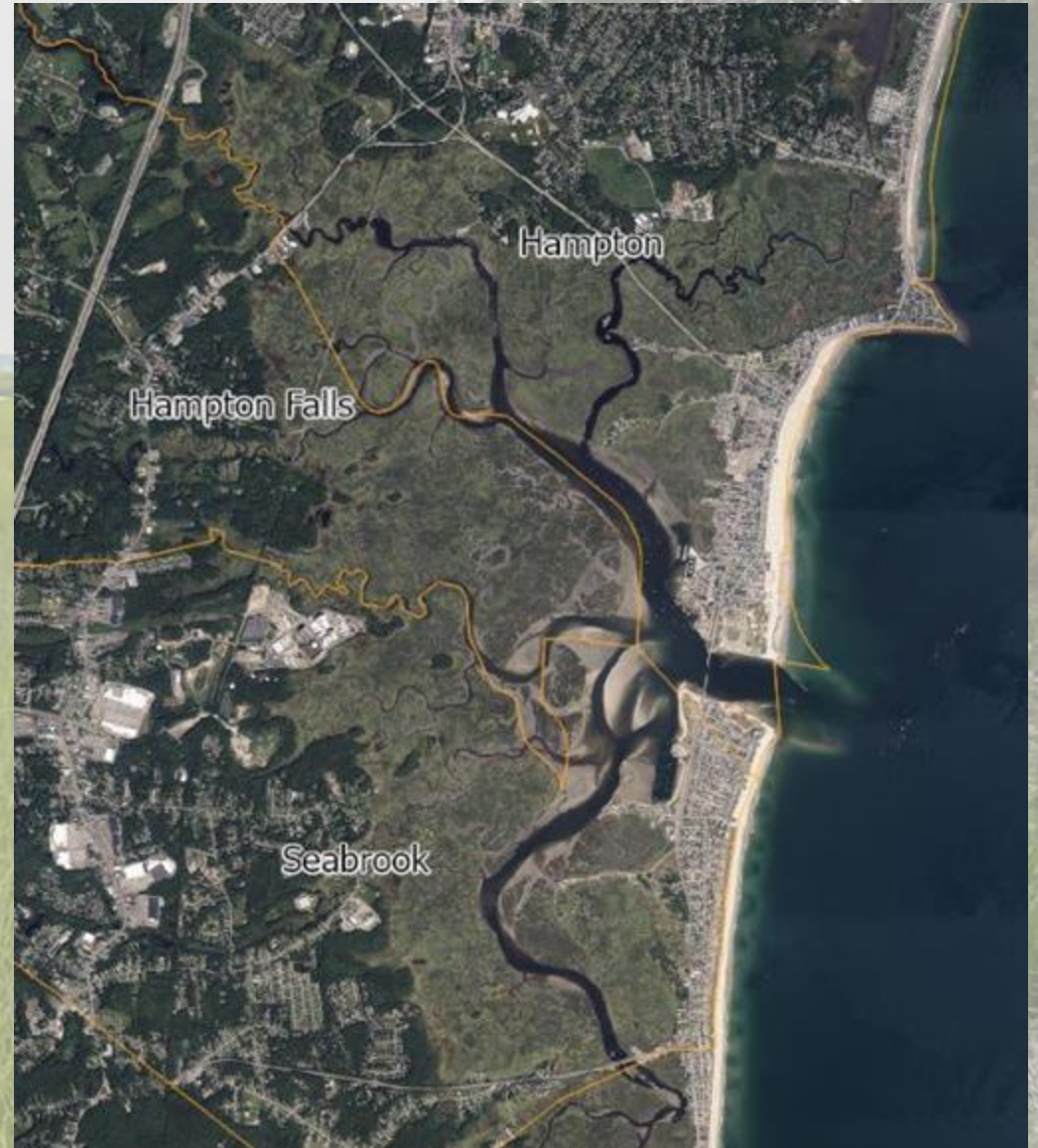


Raise Your Hand If
You Think...

**The marsh looks and acts the
same as when the towns were
first incorporated**

Raise Your Hand If
You Think...

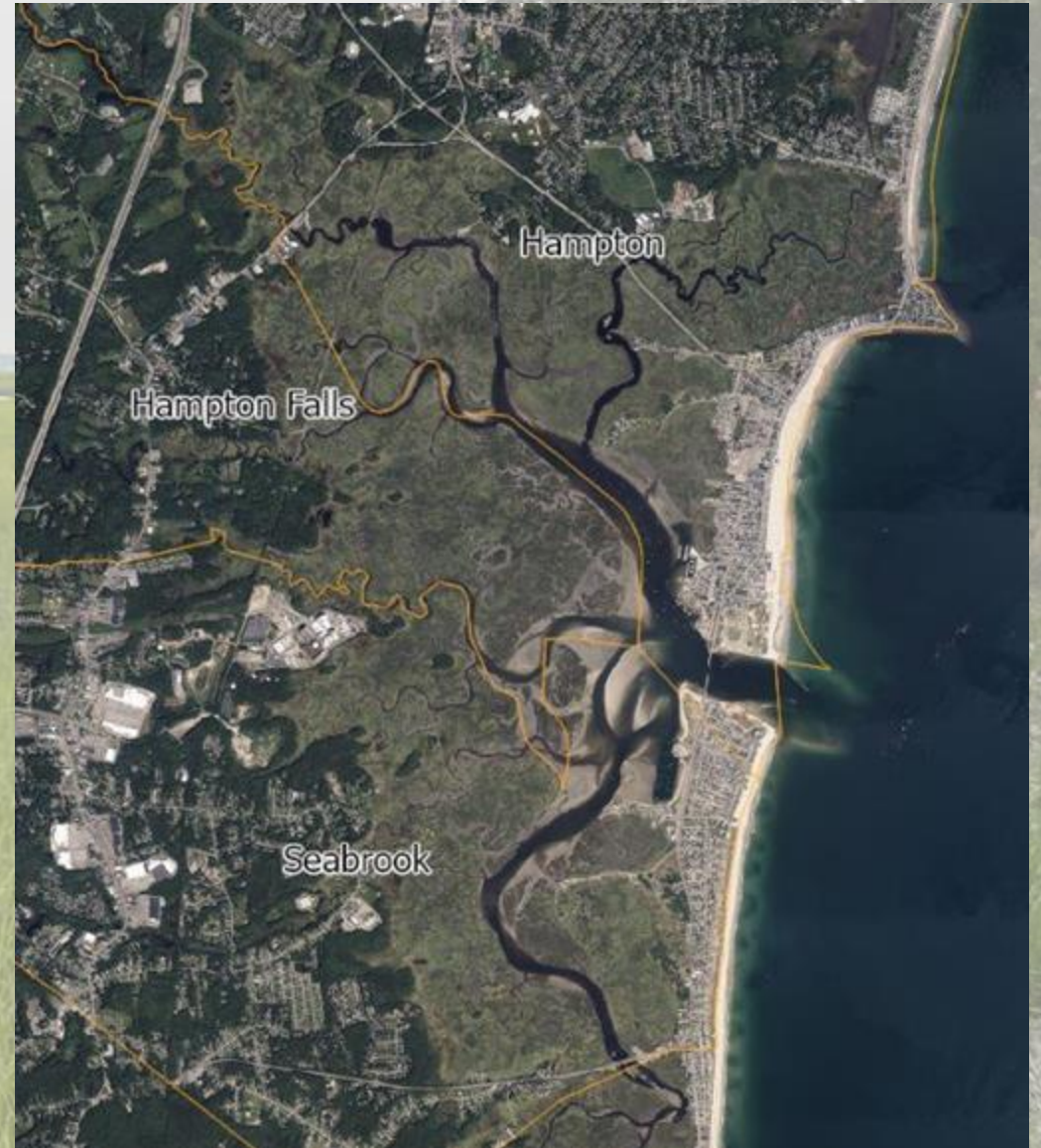
**The towns own & manage the salt
marsh in the HSE**



Raise Your Hand If
You Think...

The towns own & manage the salt
marsh in the HSE

**The State owns & manages the
salt marsh in the HSE**

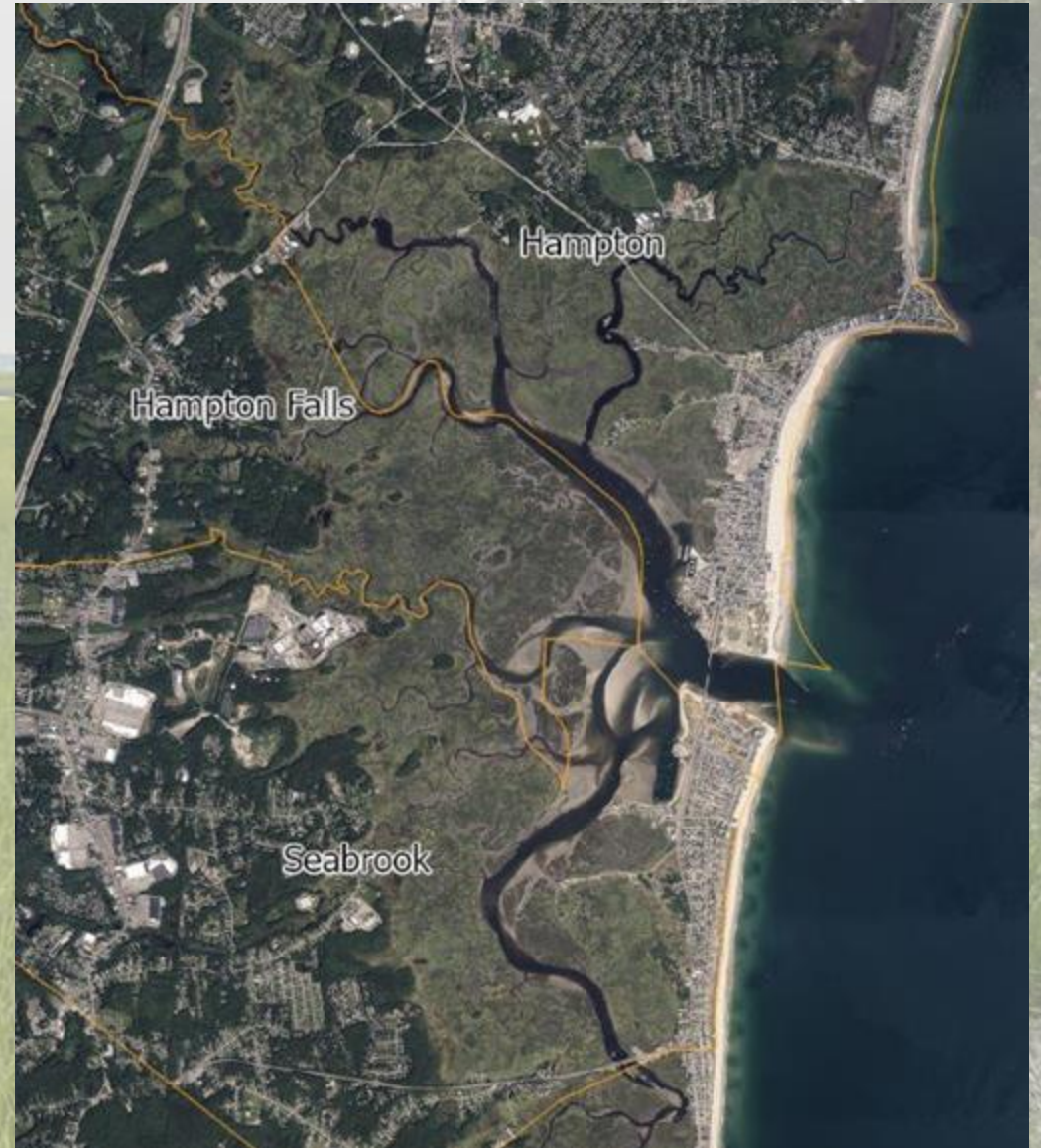


Raise Your Hand If
You Think...

The towns own & manage the salt
marsh in the HSE

The State owns & manages the salt
marsh in the HSE

You own salt marsh in the HSE



Legacy of Salt Marsh Farming



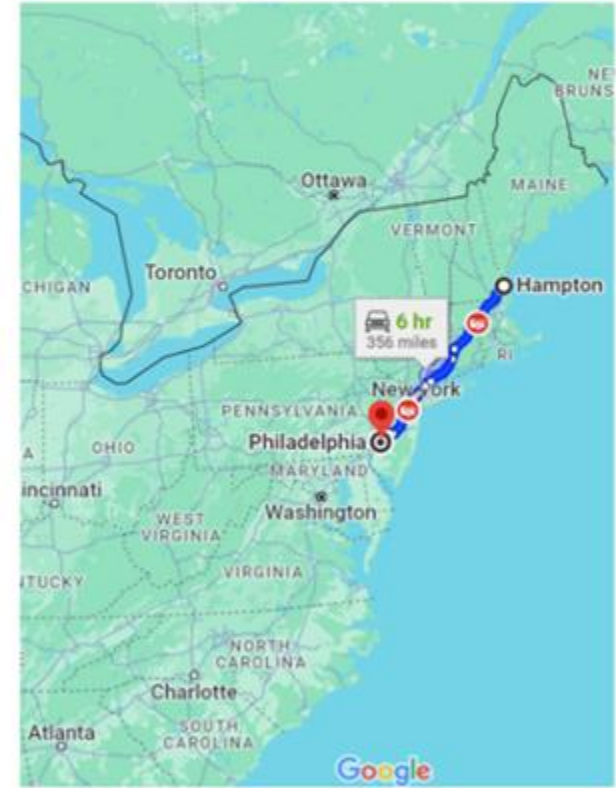
Farmers Building a Staddle



Series of Agricultural Ditches

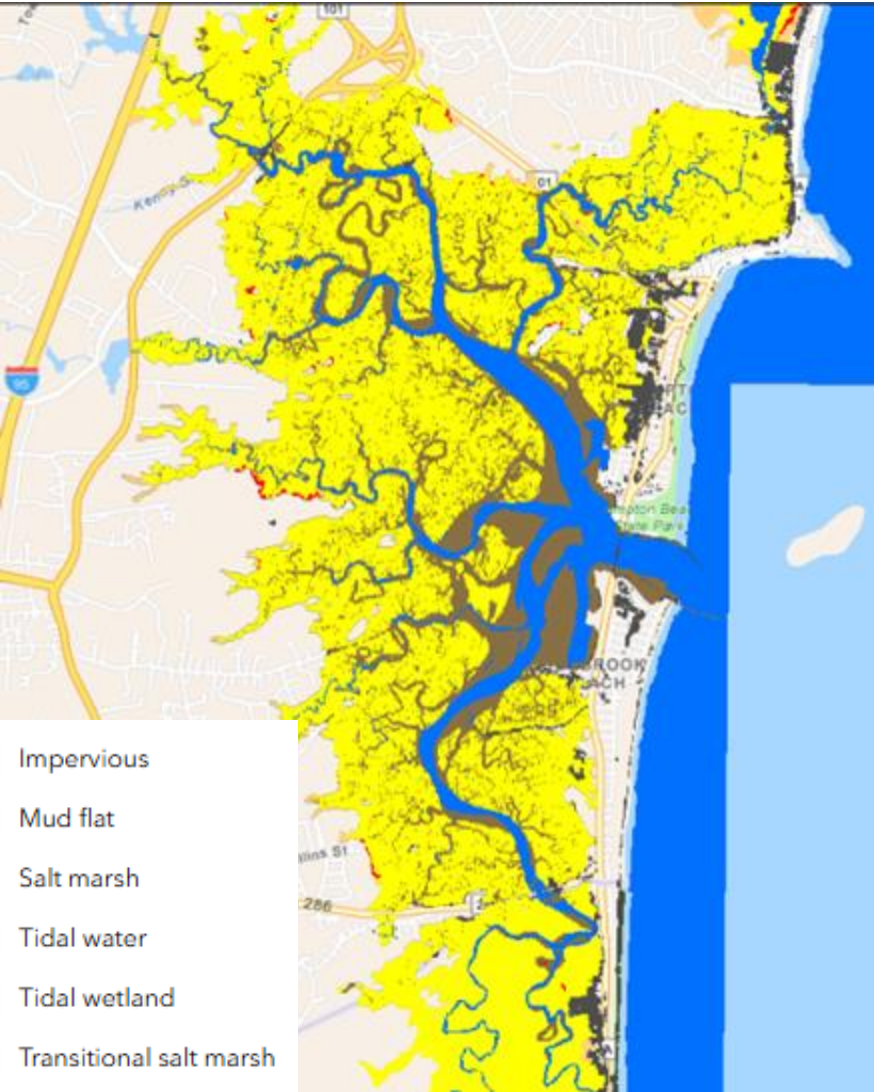


Over 370 miles of Ditches
Mapped in Hampton
Seabrook Estuary



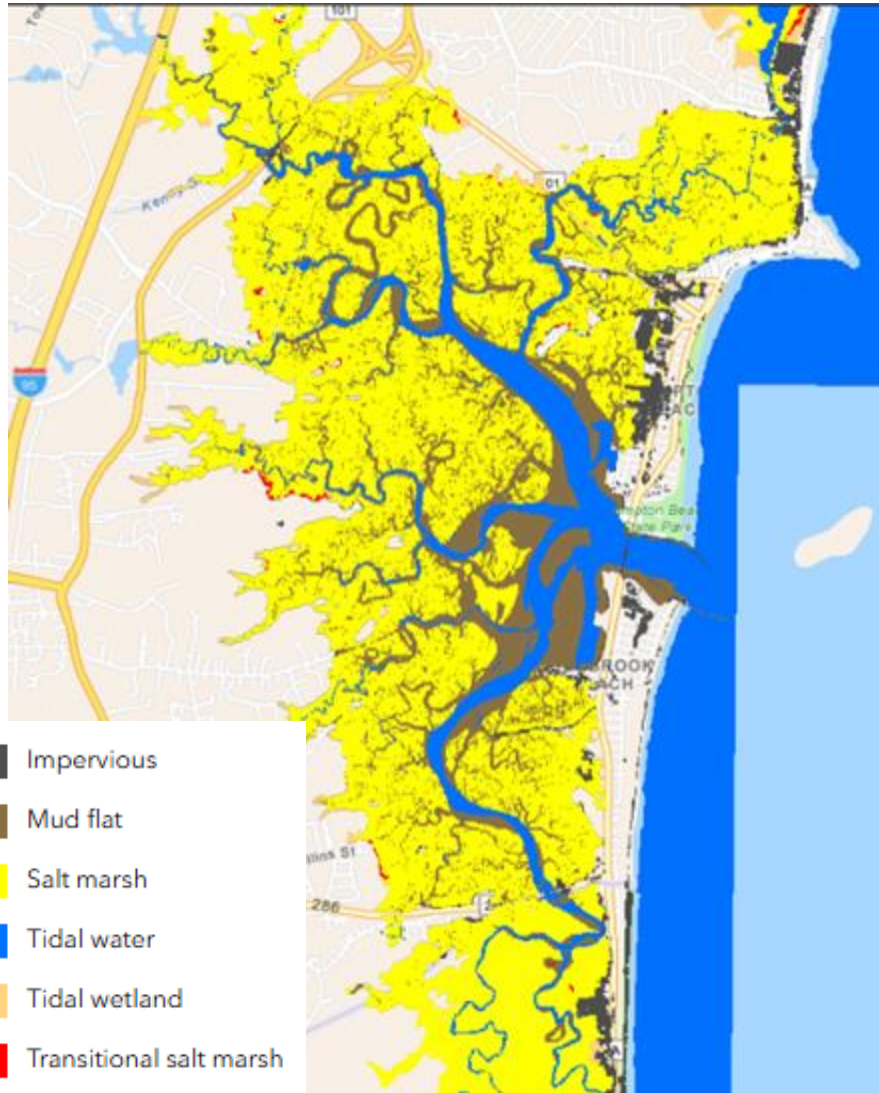
356 Miles from
Hampton to Philadelphia

Present Day



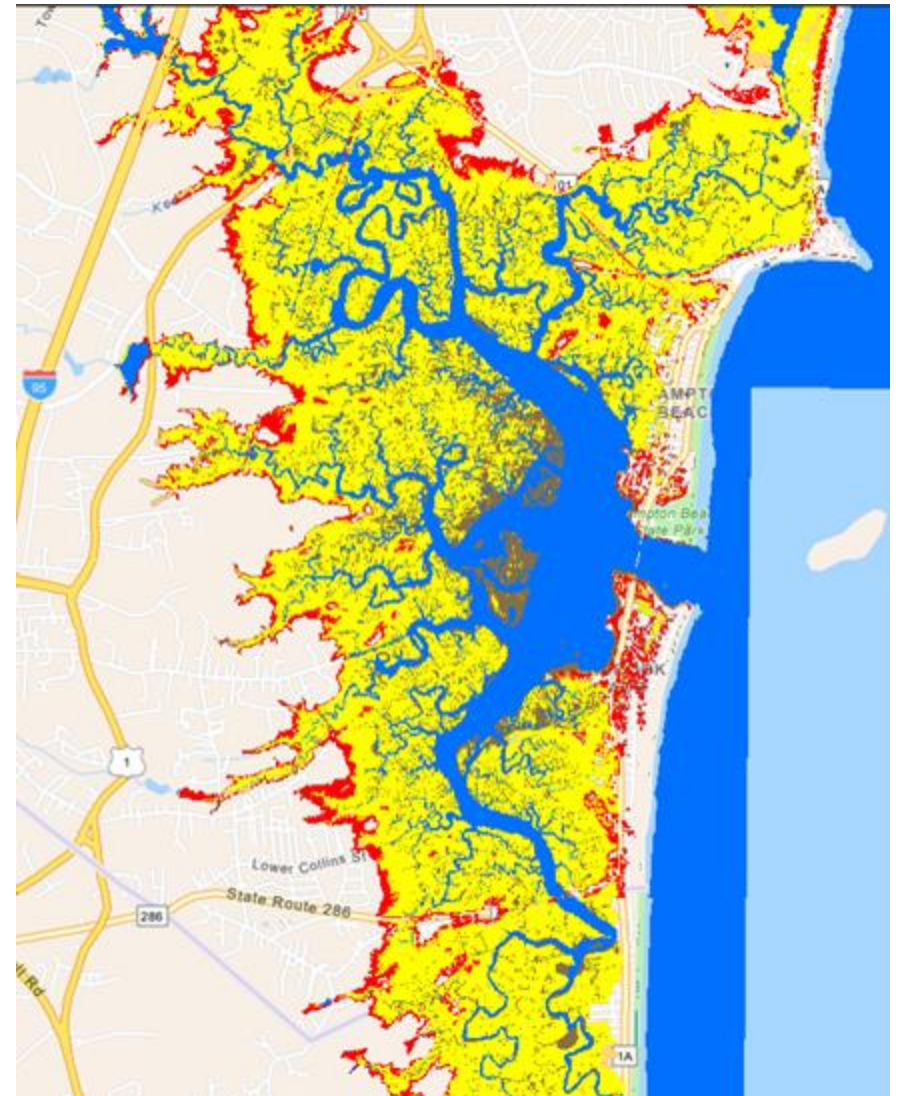
(SLAMM, 2022)

Present Day



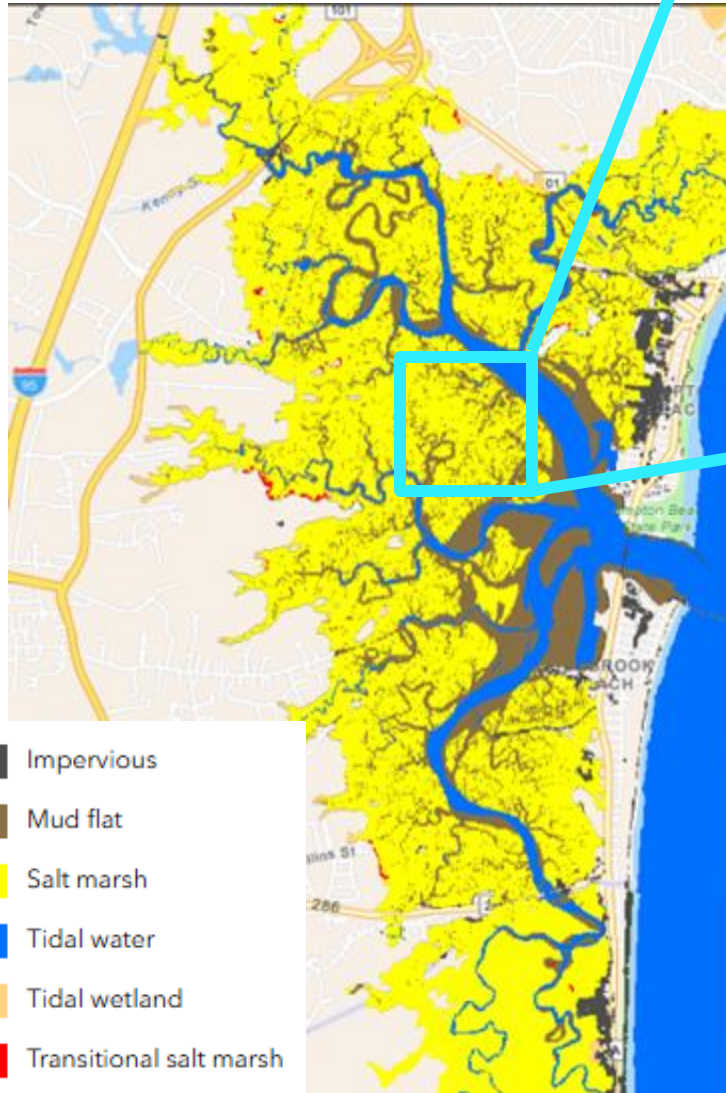
(SLAMM, 2022)

+4' SLR (2100+)

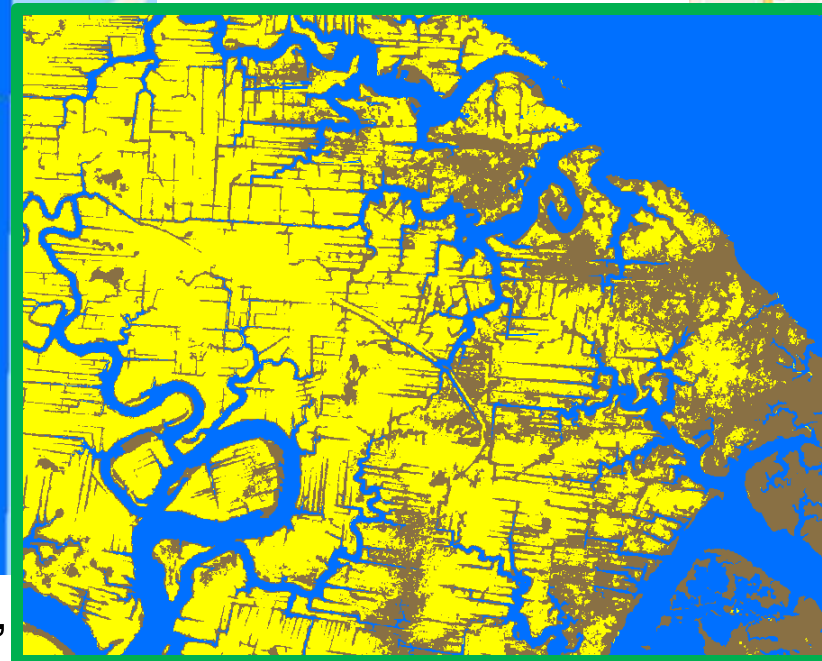
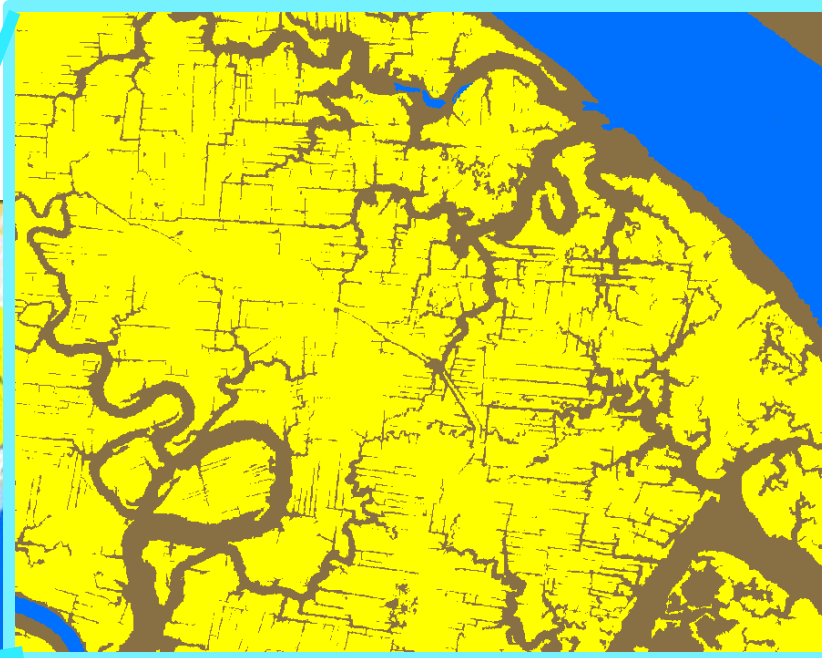


(SLAMM, 2022)

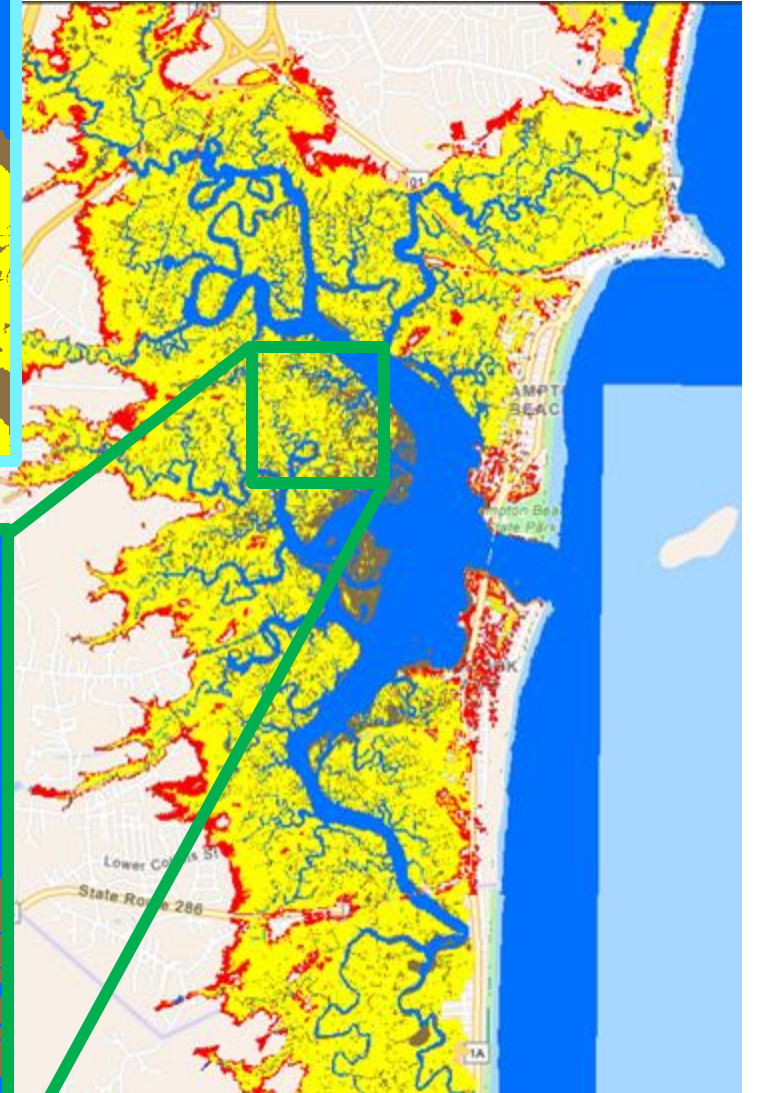
Present Day



(SLAMM,



+4' SLR (2100+)



(SLAMM, 2022)

Restoration: Ditch Remediation



Permits Require Landowner Consent



The State of New Hampshire
Department of Environmental Services



Robert R. Scott, Commissioner

WETLANDS AND NON-SITE SPECIFIC PERMIT 2022-02544 PAGE 1 OF 3

NOTE CONDITIONS

PERMITTEE: JAMES SULLIVAN
100 WINNACUNNET RD
HAMPTON NH 03842

PROJECT LOCATION: SALT MARSH ALONG RTE 101 BETWEEN LANDING ROAD & GLADE
PATH, HAMPTON
TAX MAP 250 LOT 273-16

WATERBODY: UNKNOWN

APPROVAL DATE: DECEMBER 22, 2022

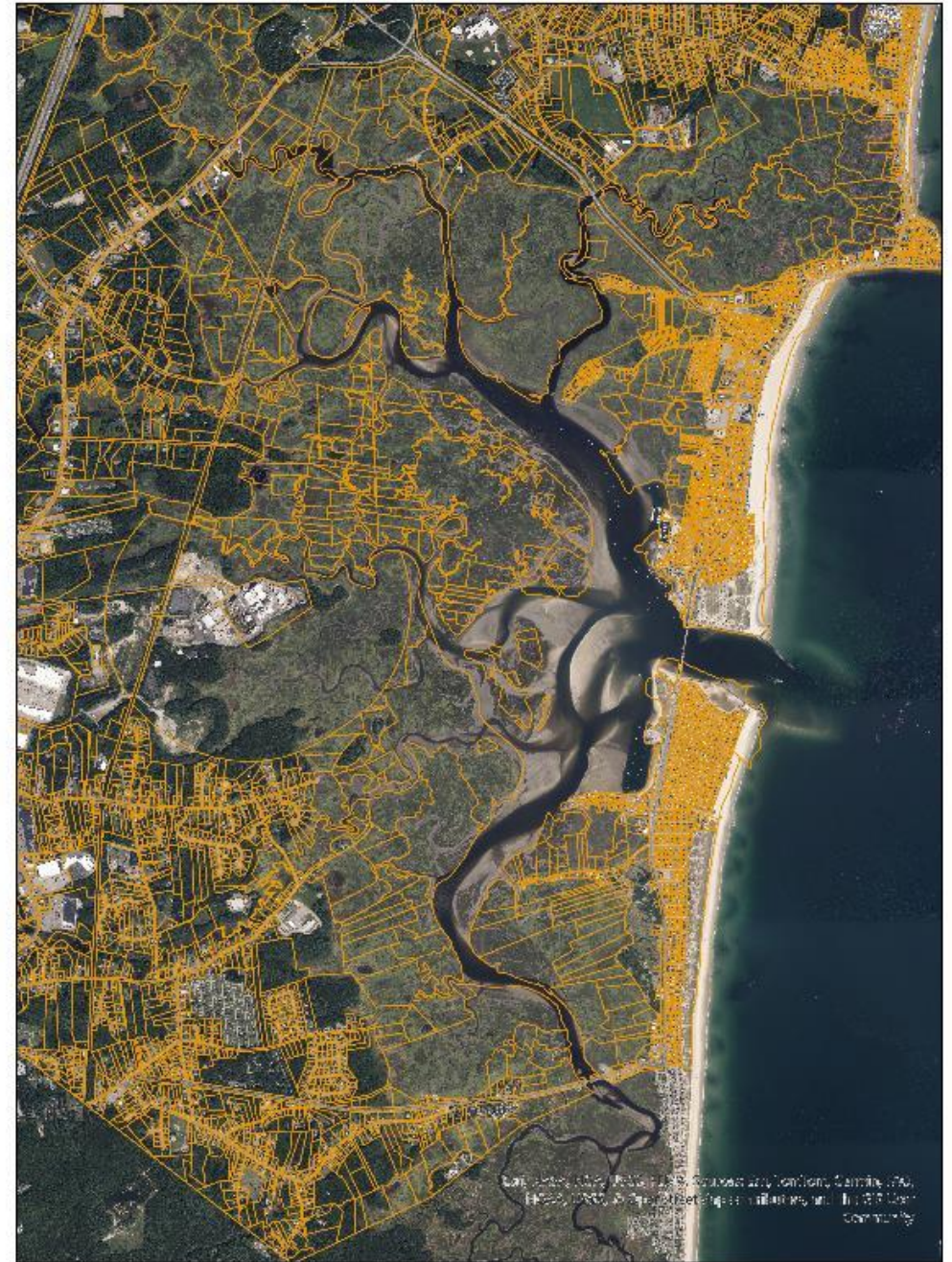
EXPIRATION DATE: DECEMBER 22, 2027

Based upon review of permit application 2022-02544 in accordance with RSA 482-A and RSA 485-A:17, the New Hampshire Department of Environmental Services (NHDES) hereby issues this Wetlands and Non-Site Specific Permit. To validate this Permit, signatures of the Permittee and the Principal Contractor are required.

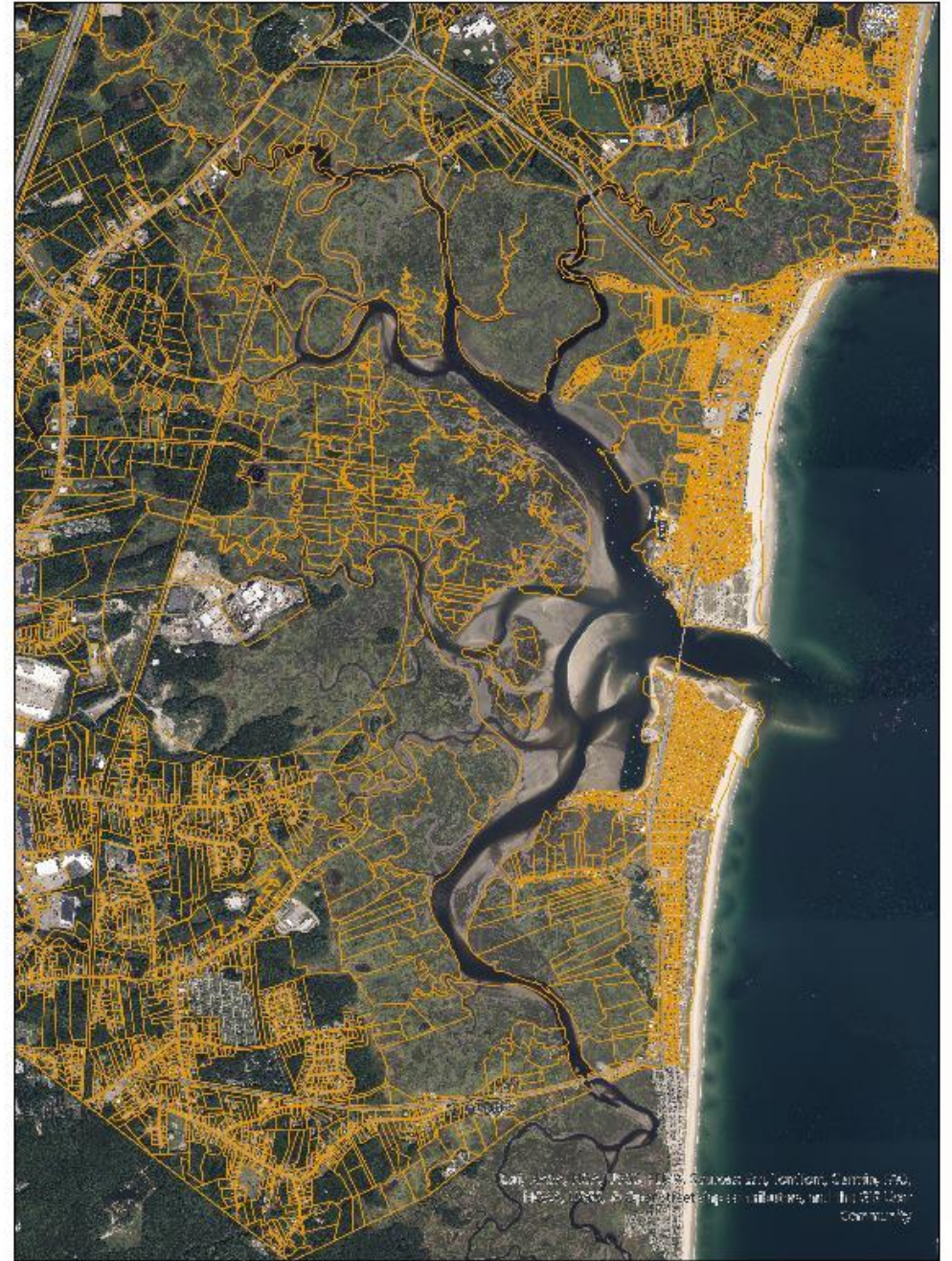
PERMIT DESCRIPTION: Permanently impact 7,923 linear feet of ditches for remediation by filling the ditches with mowed high marsh grass and 1,220 linear feet of hand excavation to create microrunnels. This project will lead to the restoration of the salt marsh following historic ditching.

THIS PERMIT IS SUBJECT TO THE FOLLOWING PROJECT-SPECIFIC CONDITIONS:

1. In accordance with Env-Wt 307.16, all work shall be done in accordance with the plans SLR dated August 29, 2022 as received by the NH Department of Environmental Services (NHDES) on September 1, 2022.
2. In accordance with Env-Wt 314.02(b) and (c), for projects in the coastal area, the permittee shall record any permit issued for overwater structures, shoreline stabilization, and any work in the tidal buffer zone, tidal wetlands, or sand dunes at the registry of deeds in the county in which the property is located. Any limitations or conditions in the permit so recorded shall run with the land beyond the expiration of the permit. The permittee shall provide the department with a copy of the permit stamped by the registry with the book and page and date of receipt.
3. In accordance with Env-Wt 310.03(a), no other work shall be done on the subject property pursuant to another expedited permit (EXP) or a statutory permit-by-notification (SPN) for a period of 12 months from the date the EXP was issued unless the property owner submits information, including a plan, to demonstrate that the proposed work is wholly unrelated to and separate from the work already done under the EXP or SPN, and the proposed work and the work already done under the EXP or SPN do not, when combined, constitute a project for which a standard permit is required.
5. In accordance with Env-Wt 307.03(a), no activity shall be conducted in such a way as to cause or contribute to any violation of surface water quality standards specified in RSA 485-A:8 or Env-Wq 1700; ambient groundwater quality standards established under RSA 485-C; limitations on activities in a sanitary protective area established under Env-Dw 302.10 or Env-Dw 305.10; or any provision of RSA 485-A, Env-Wq 1000, RSA 483-B, or Env-Wq 1400 that protects water quality.
6. In accordance with Env-Wt 307.10(i) in addition to the limitations on tidal dredging in Env-Wt 600, no dredging shall occur in tidal waters during a fish migration or larval setting stage of fish and shellfish, which is between March 15 and November 15.



- 370+ miles of ditches
- Over 1,200 unique parcels
- Do we have the ownership right?





SOCIETY FOR THE PROTECTION OF NEW HAMPSHIRE FORESTS
SALTMARSH PARCEL LOCATIONS & BOUNDARIES

A report on my investigation of the locations of SPNHF owned parcels.

by Gregory A. Smith

Sept 6, 1995

I. Hampton Saltmarsh Lot Location Difficulties - Generally

[The following section includes a brief general history of saltmarsh ownership from literature and inquiries, and also personal conclusions based upon my own research into the locations of specific lot locations.]

The Hampton saltmarsh, once of considerable value to farm operations, was divided among owners of upland farms when the town was originally laid out. At that time, Hampton included what is now Rye, North Hampton, Hampton Falls, Seabrook, Kensington, Kingston, East Kingston, Danville and Sandown so most of the farms in those towns had saltmarsh lots, too. A few of these farms that are still operating may continue to retain as part of their property their pieces of now-unused saltmarsh.

When saltmarsh hay and thatch was actively harvested by these farmers, everyone knew where his or her piece of marsh was located and who owned all the nearby pieces. This was true through the first two decades of this century. John D. Fogg's short book *Recollections of a Salt Marsh Farmer* (available at the state library or for purchase through the Seabrook Historical Society) illustrates this point well and discusses boundaries markers in general as well as the location of many specific parcels in Hampton Falls and Seabrook.

Marsh lot bounds were generally marked by edges of creeks, by drainage ditches and by stones placed in ditches, per Fogg. Fogg also indicated that the ditches and stones of lots he harvested around 1920 were still easily locatable in 1968.

My inquiries and research at the county registry, local historical societies, town offices, and with other locally knowledgeable people was not exhaustive, but was considerable. There was agreement by everyone I asked who was likely to know (including a surveyor), that the marsh lots were never surveyed. Indeed, no original maps of marsh lots, either sketches of specific lots or overall marsh layout maps were found and it is generally believed locally that none exist. The only exceptions are right-of-way maps for transmission lines, the railroad and the Department of Transportation (the latter's, being more recent, are not very reliable for ownership research, in my opinion). Another exception is the 1974 reconstruction of ownership of all the saltmarsh lots within the Seabrook Station's exclusion zone, a massive undertaking whose resulting lines I dispute in a number of areas.

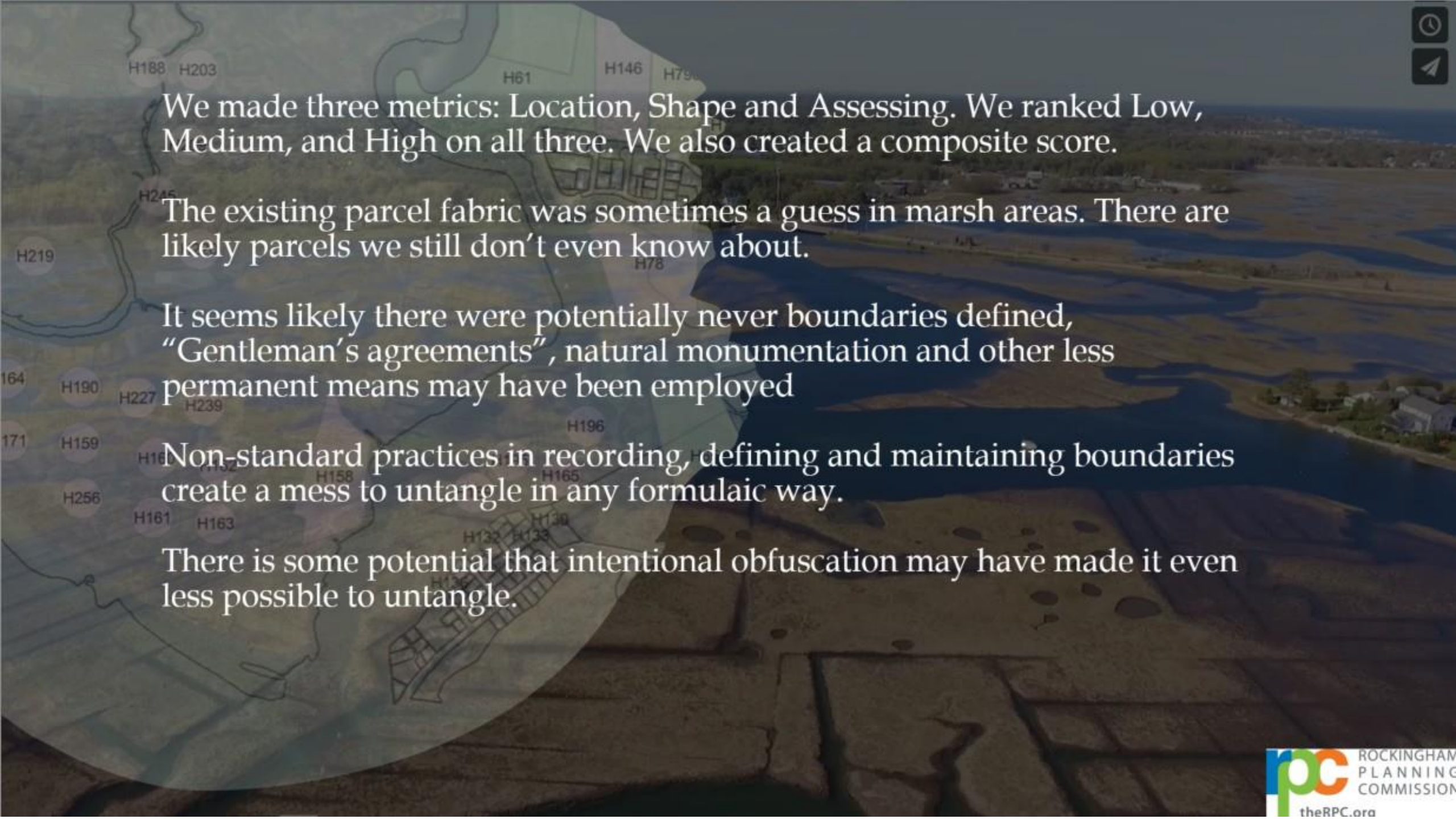
When saltmarsh hay and thatch was actively harvested by these farmers, everyone knew where his or her piece of marsh was located and who owned all the nearby pieces.

Marsh lot bounds were generally marked by edges of creeks, by drainage ditches and by stones placed in ditches, per Fogg.

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What we imagined and
what we got!



We made three metrics: Location, Shape and Assessing. We ranked Low, Medium, and High on all three. We also created a composite score.

The existing parcel fabric was sometimes a guess in marsh areas. There are likely parcels we still don't even know about.

It seems likely there were potentially never boundaries defined, "Gentleman's agreements", natural monumentation and other less permanent means may have been employed

Non-standard practices in recording, defining and maintaining boundaries create a mess to untangle in any formulaic way.

There is some potential that intentional obfuscation may have made it even less possible to untangle.

URL to mapping tool: <https://tinyurl.com/3tz48546>

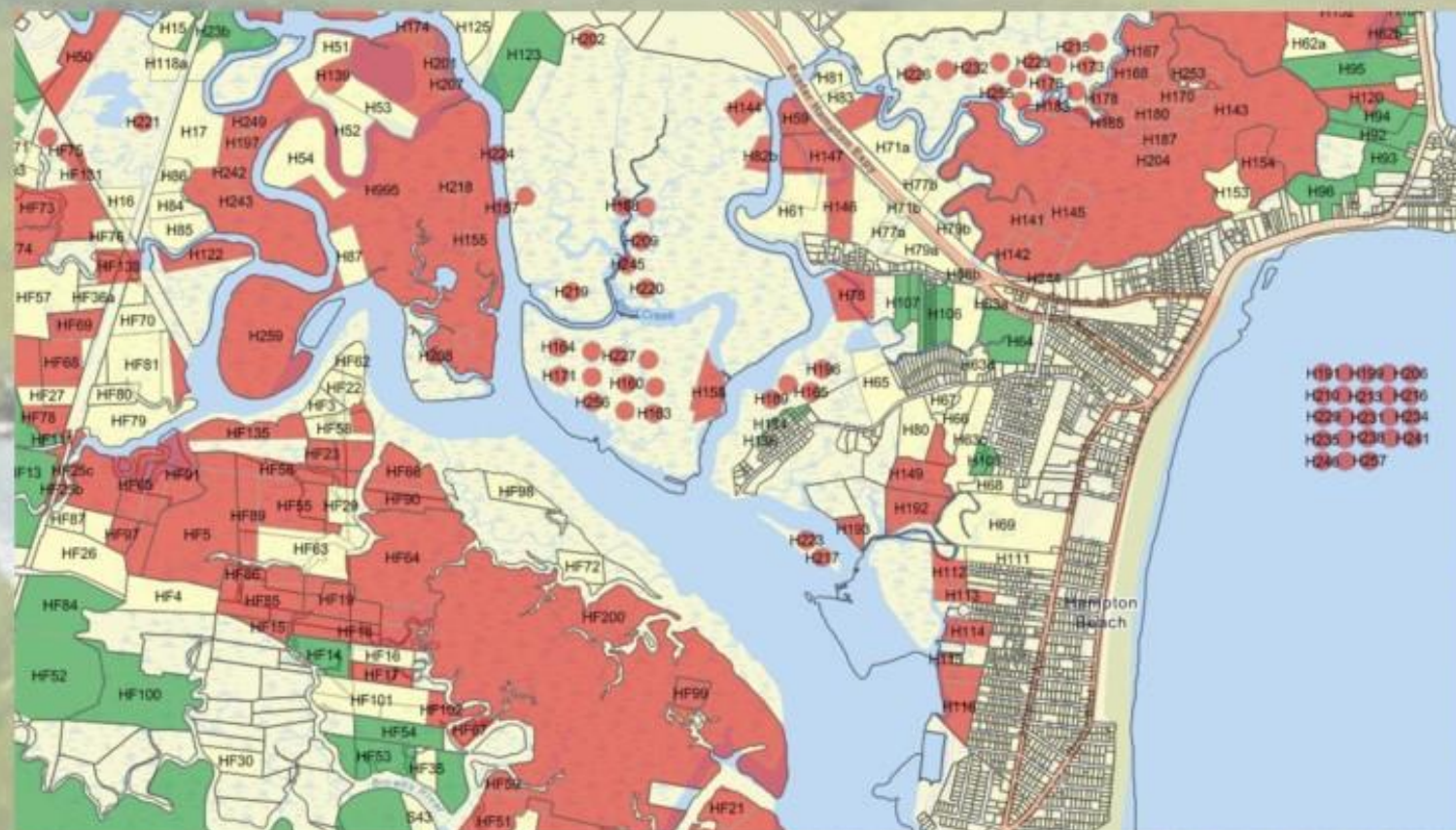
Project Parcels Final Accuracy Assessment

Final Accuracy Rating Score

High

Medium

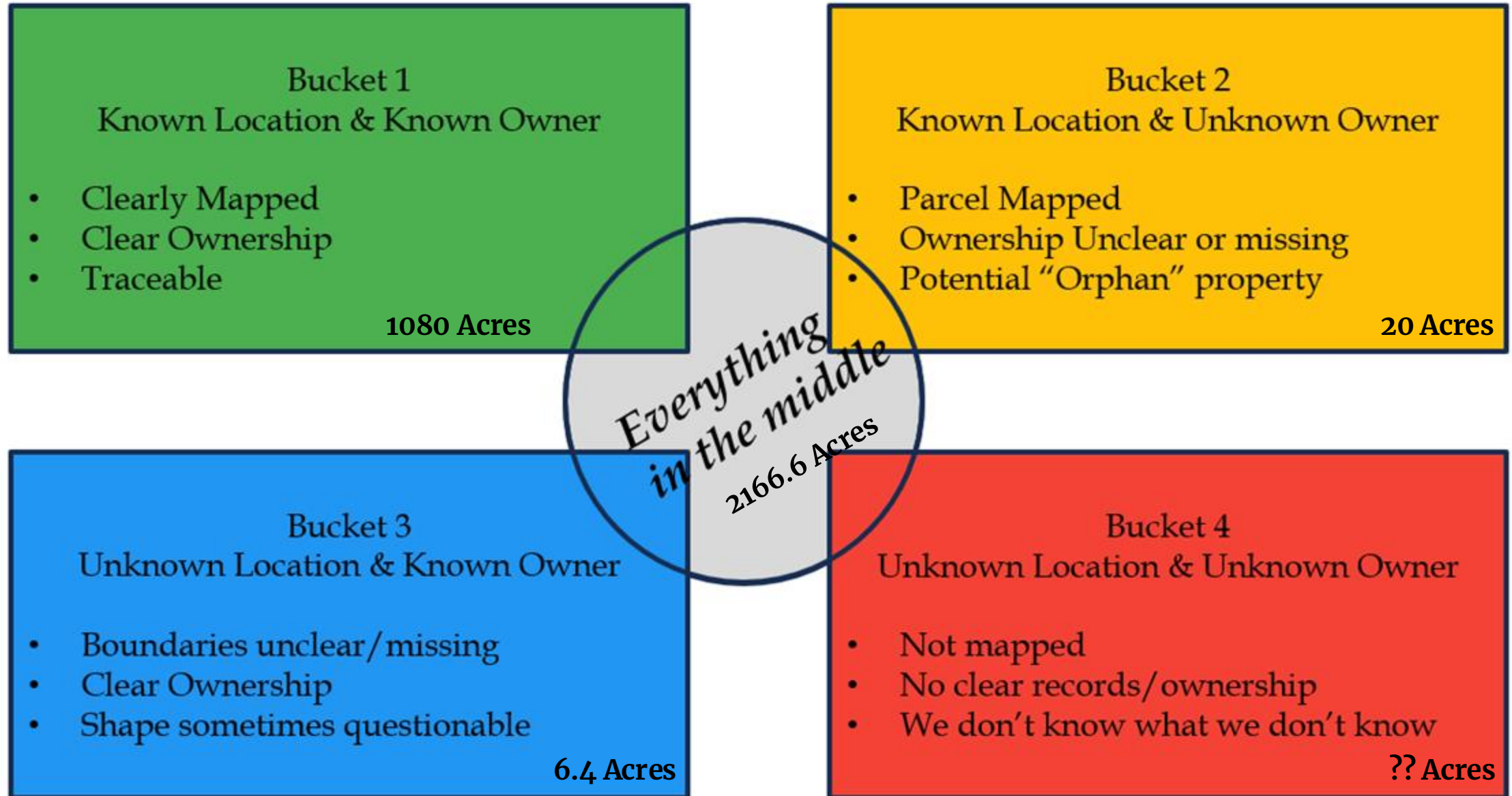
Low



Notes:

- Circles for unlocated parcels. Where located on a chunk of land, we think they are in that area, where on water, we have no clue.
- Ranking of location, assessing, shape. Additionally, we created a composite score to rank the parcels overall.

Ownership Clarity





Legal Mechanisms for land rights to land and use:

1. Ownership - Fee ownership, Warranty deed, Quitclaim, Quiet title, Tax acquisition.
2. Easements : Not quite ownership
3. Claiming abandoned or Unclaimed Property: RSA471-C –
4. Eminent Domain RSA498-A
5. Public Trust
6. Unique new legislation? Combo of above

Next Phase



- Outreach and Engage with the community to gather local knowledge
- Engage panel of professionals on specific deeds to determine if there's consensus on parcel resolution

What's hopeful?

- Accomplished original conservation goal
- Community buy in
- Leading other states, template



Marsh Scene, Hampton Beach, N. H.

Session 2 — Concurrent Breakout Presentations



Resilient Shorelines

Location: Room 1

Genesis of Shoreline Designs at Wagon Hill Farm and Lessons Learned – *Tom Ballestero (UNH Coastal Habitats and Restoration Team)*

Resolving Salt Marsh Ownership in Hampton Seabrook Estuary – *Aidan Barry (NHDES) and Rob Pruyne (Rockingham Planning Commission)*

Designing Resilience: Nature-based Climate Solutions in New England – *Jennifer Martel, Amy Bell Segal, and Beth Kirmmse (American Society of Landscape Architects)*

Designing Resilience

Nature Based Climate Solutions in New England



Jen Martel, PLA, ASLA

Principal Landscape Architect,
Copley Wolff

Trustee, ASLA-NH

CopleyWolff



Amy Bell Segal, PLA, ASLA

VP of Landscape Architecture,
Sebago Technics

SEBAGO
TECHNICS



Beth Kirmmse, PLA, ASLA

Landscape Architect,

Fuss & O'Neill

FUSS & O'NEILL

Designing Resilience Landscape Architecture



Harborwalk at The Mark, Boston, MA

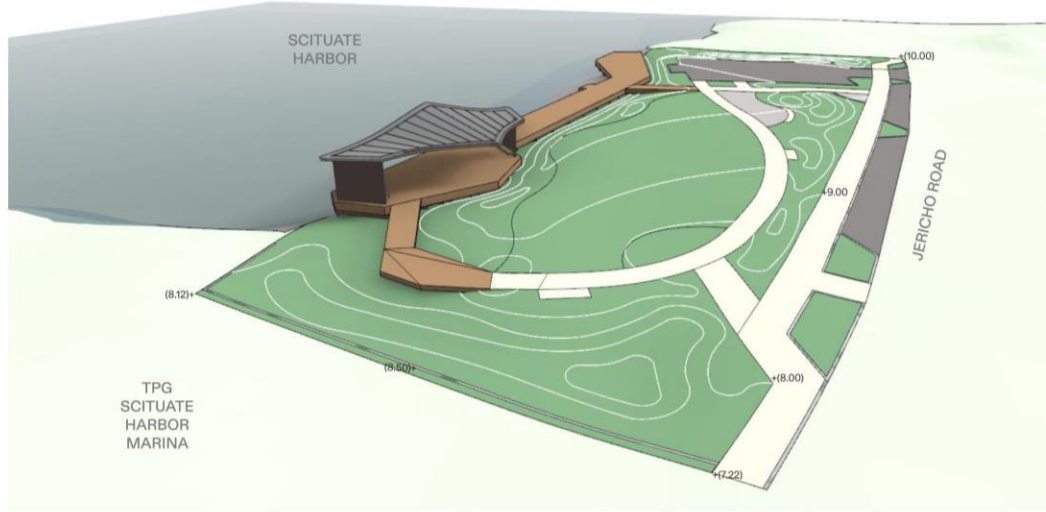
Designing Resilience Landscape Architecture



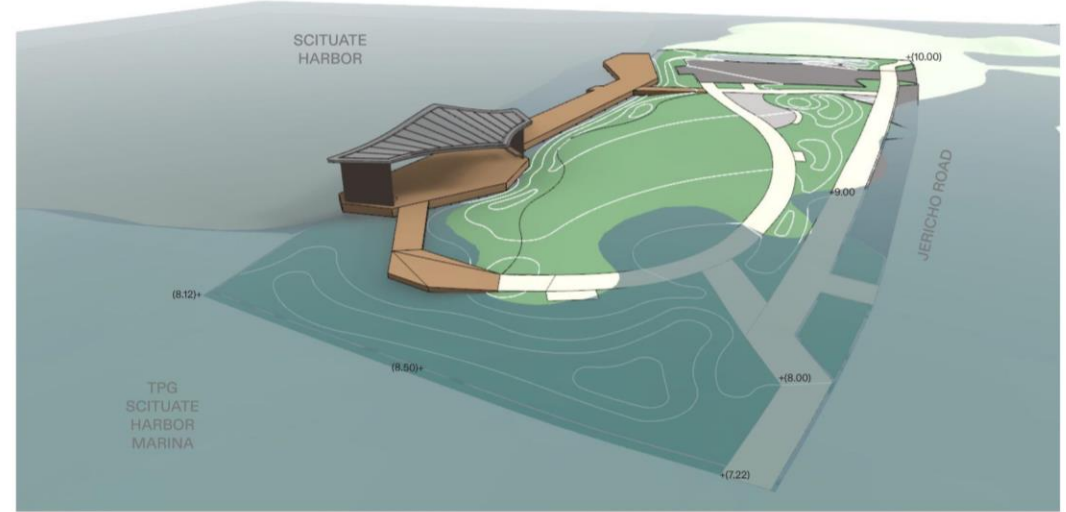
Cochecho River Waterfront Park, Dover, NH

Designing Resilience Landscape Architecture

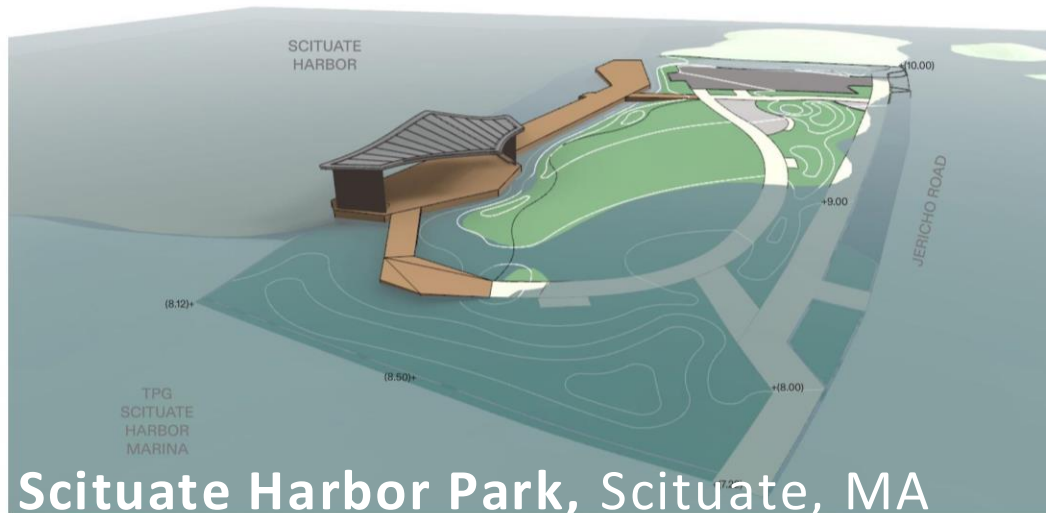
2050 MHHWL - 7.5' Elevation



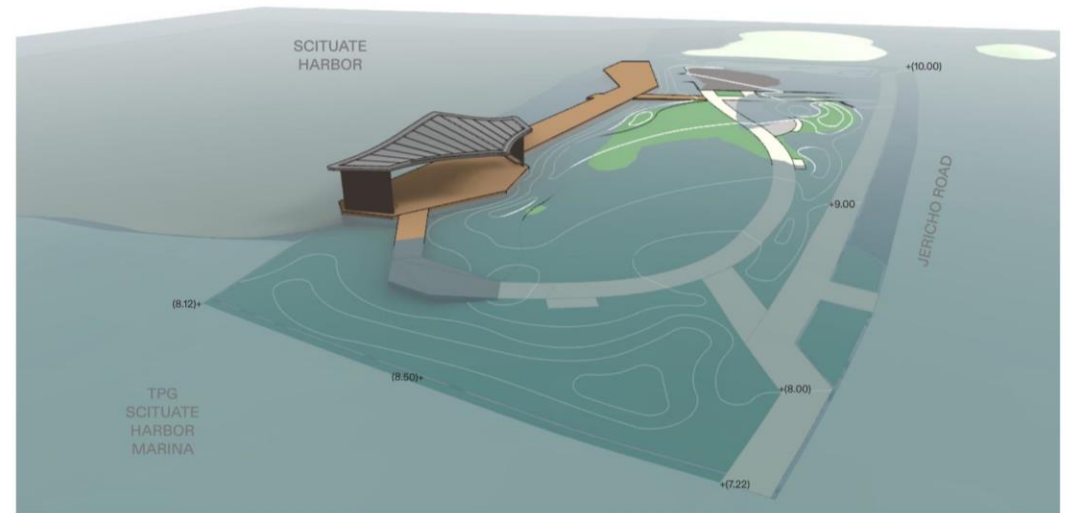
2070 MHHWL - 9.4' Elevation



10' Elevation

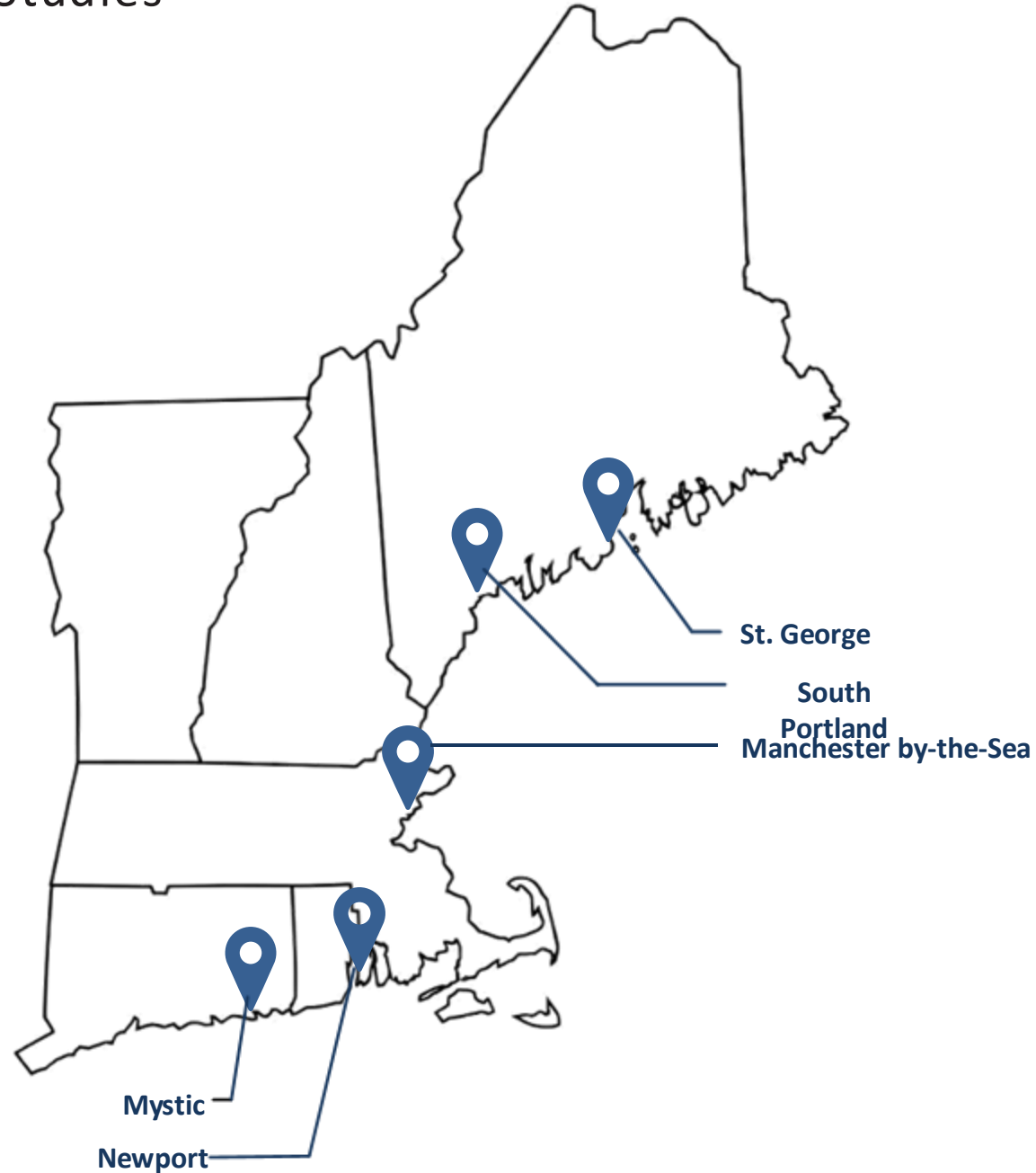


11' Elevation



Scituate Harbor Park, Scituate, MA

Designing Resilience Case Studies



Designing Resilience Case Studies

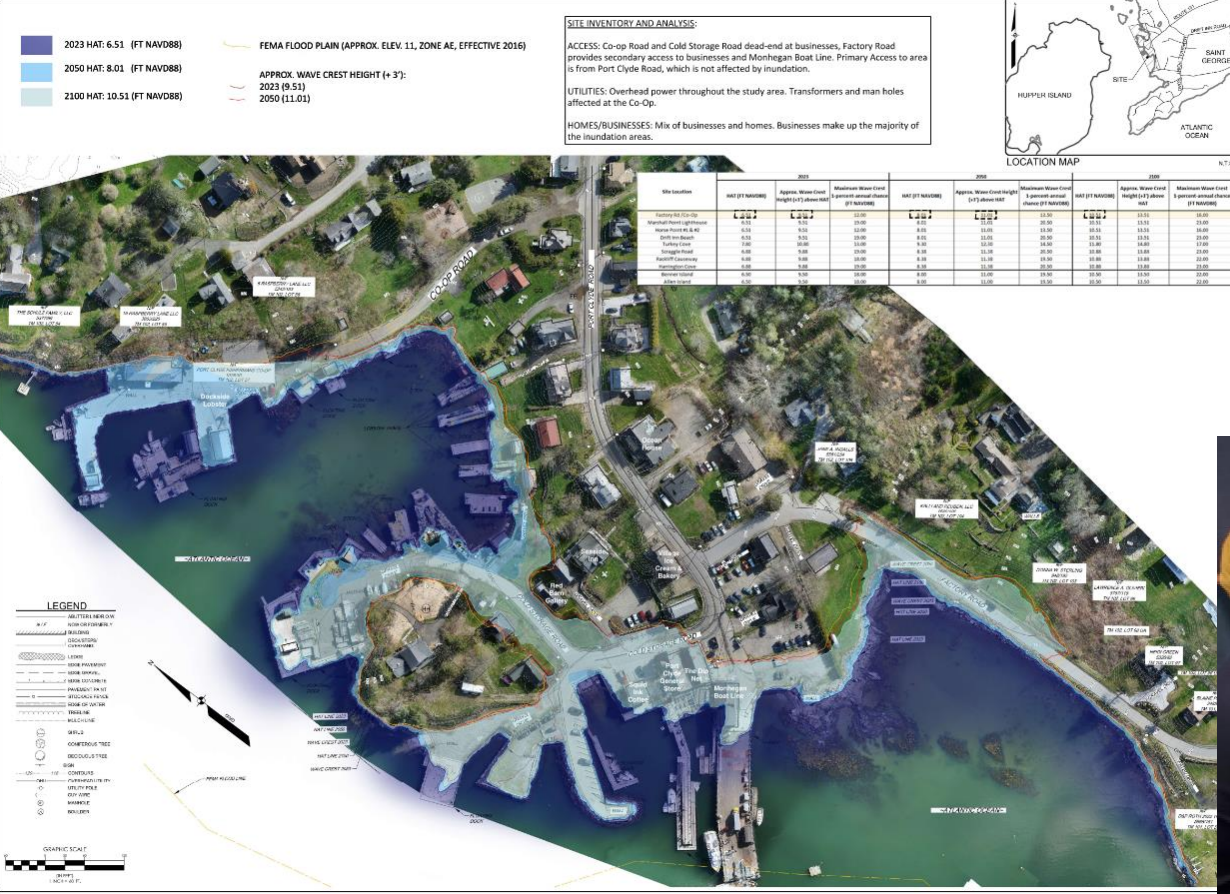
St. George Coastal Resiliency Project



Survey Geomatics & 3D Modeling of Infrastructure Vulnerable to Sea-Level Rise

Designing Resilience Case Studies

St. George Coastal Resiliency Project



PROGRESS POINT

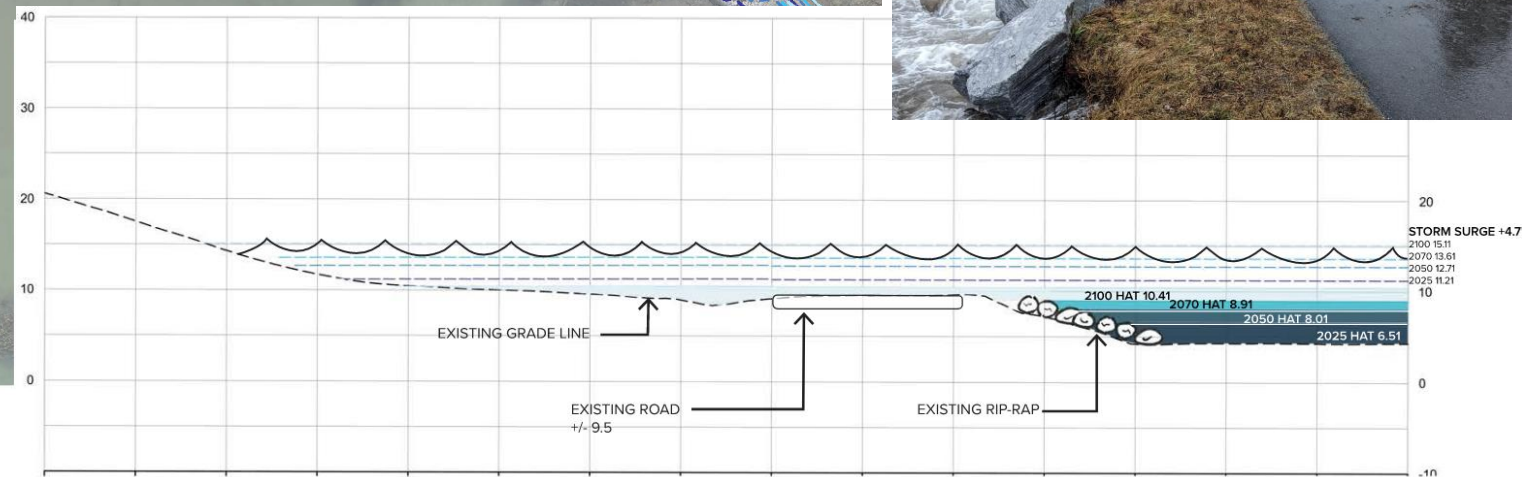
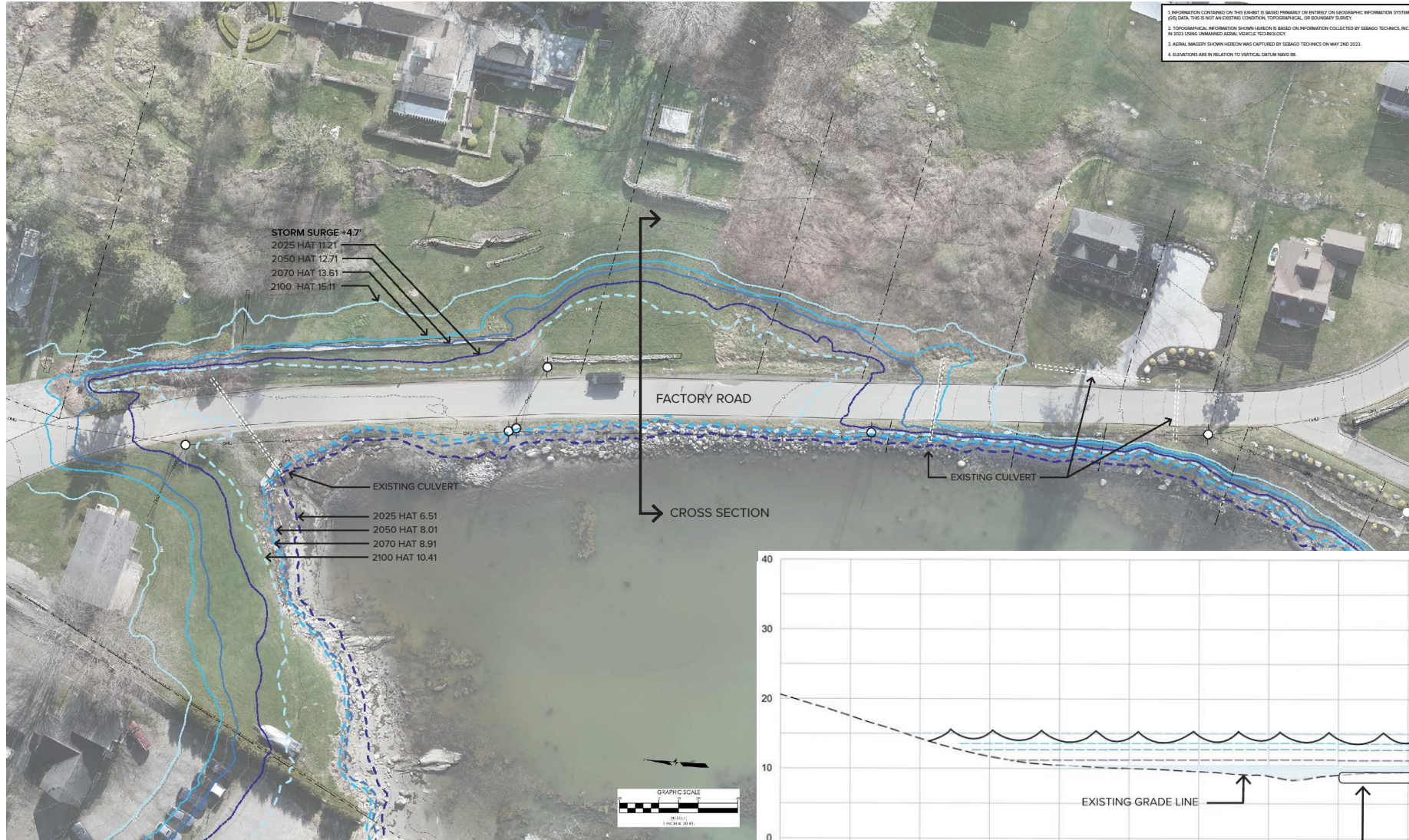
NOT FOR CONSTRUCTION



DESIGN CHARRETTE July 2023
A Landscape Architect at every table

Designing Resilience Case Studies

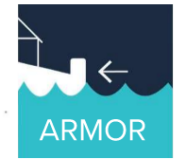
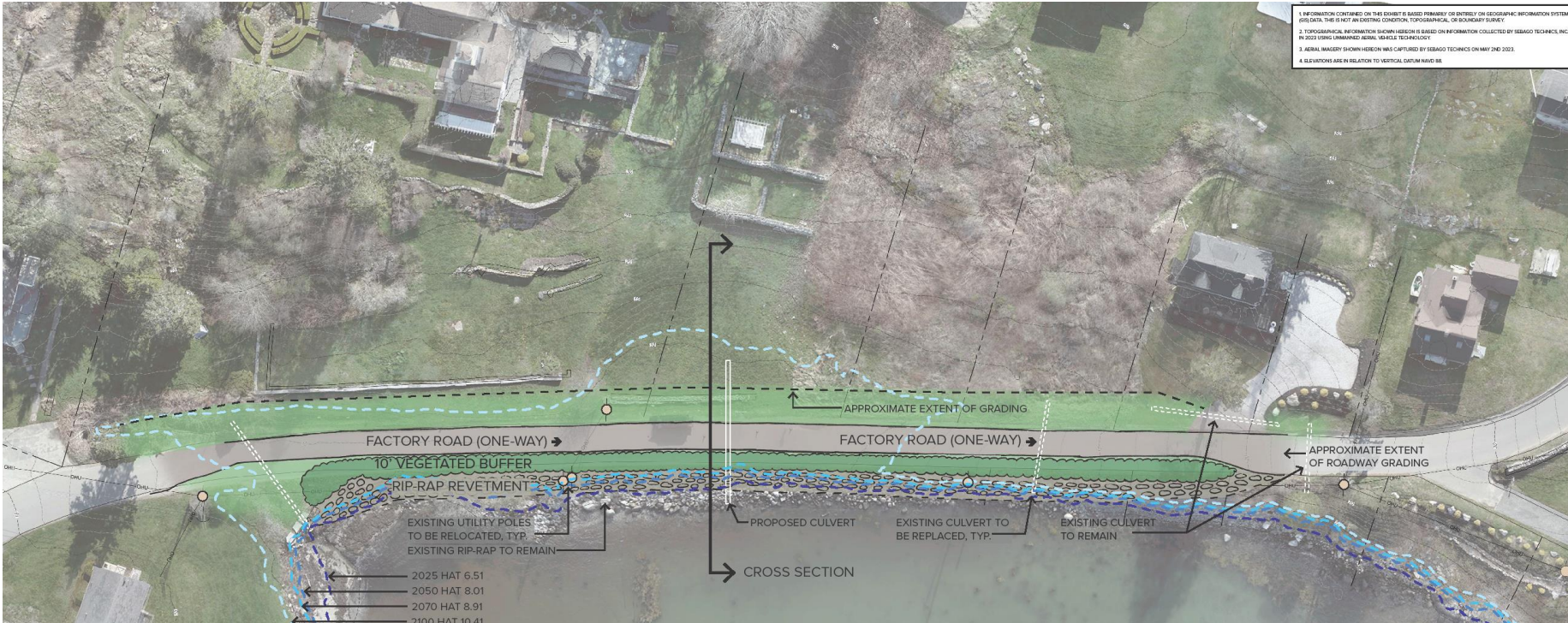
St. George, Maine – Port Clyde Coastal Resilience Plans for Factory Road



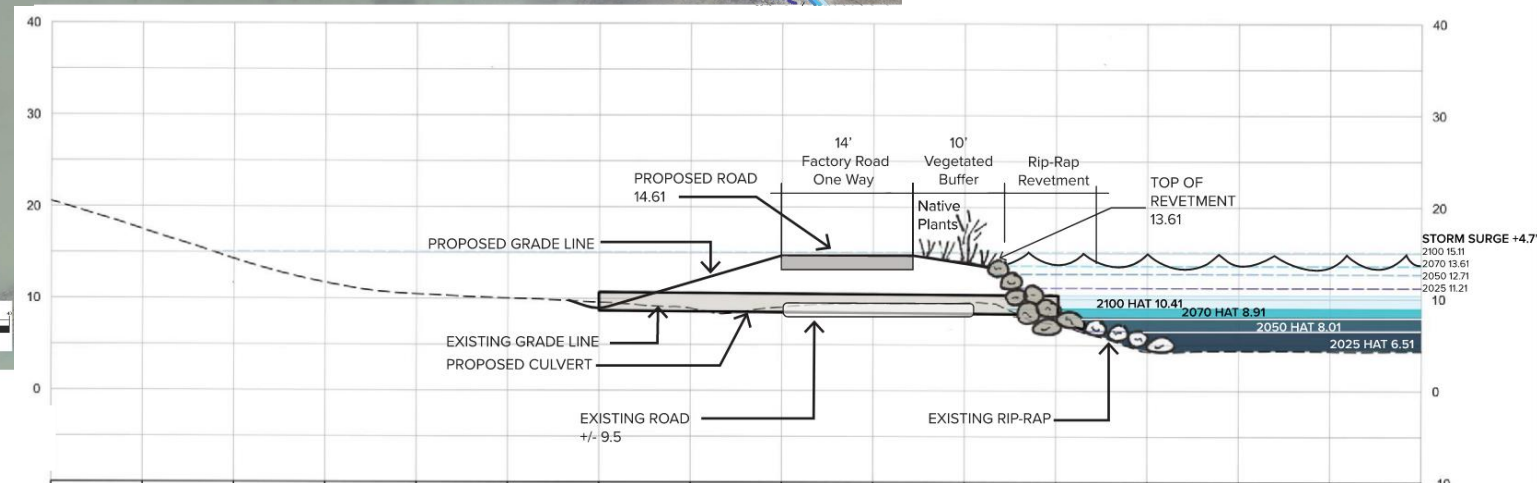
FACTORY ROAD - OPTION 1 - No Action

Designing Resilience Case Studies

St. George, Maine – Port Clyde Coastal Resilience Plans for Factory Road



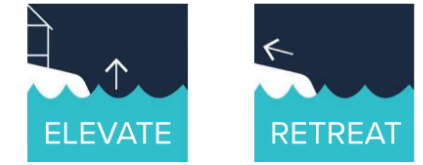
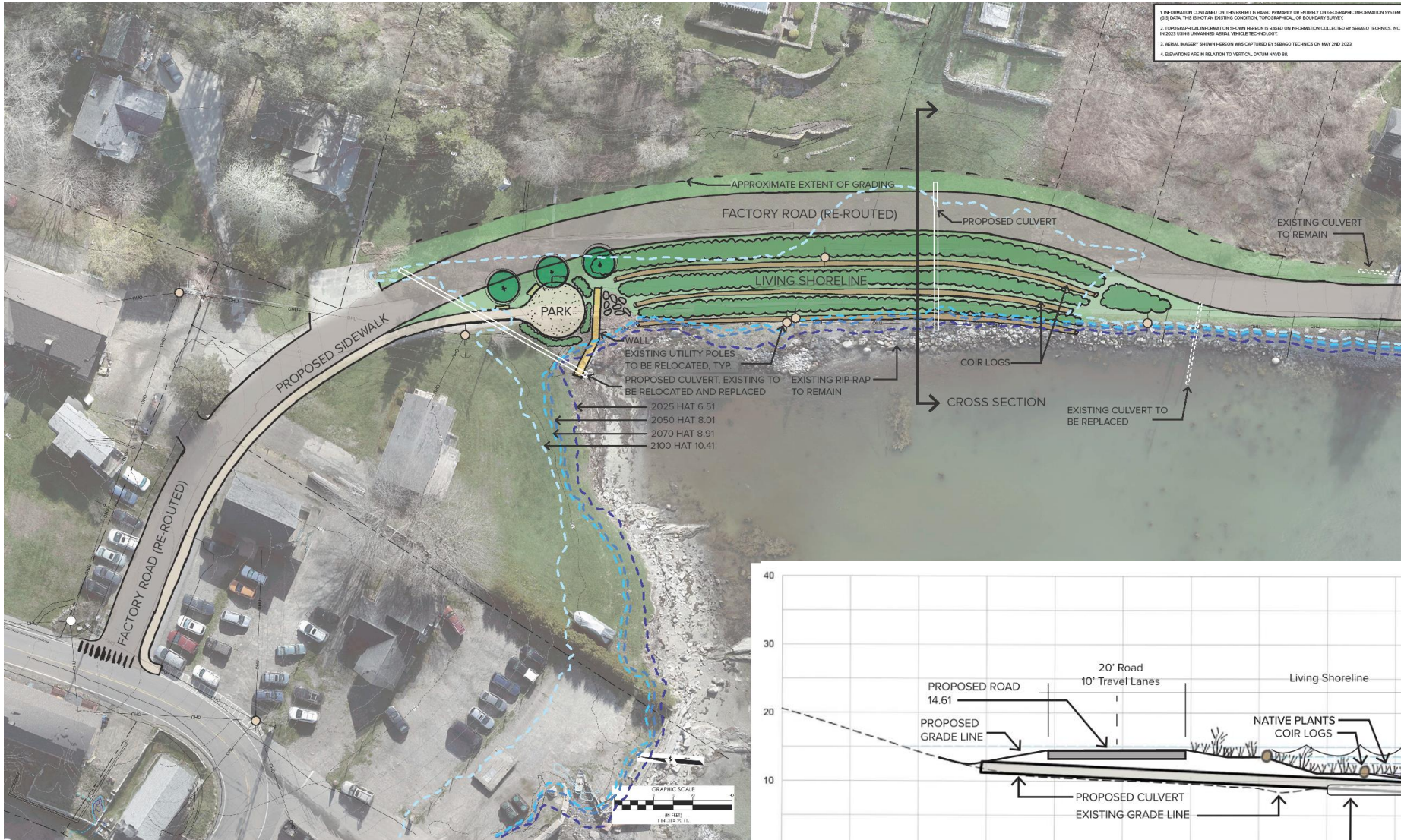
COASTAL RESILIENCE STRATEGIES



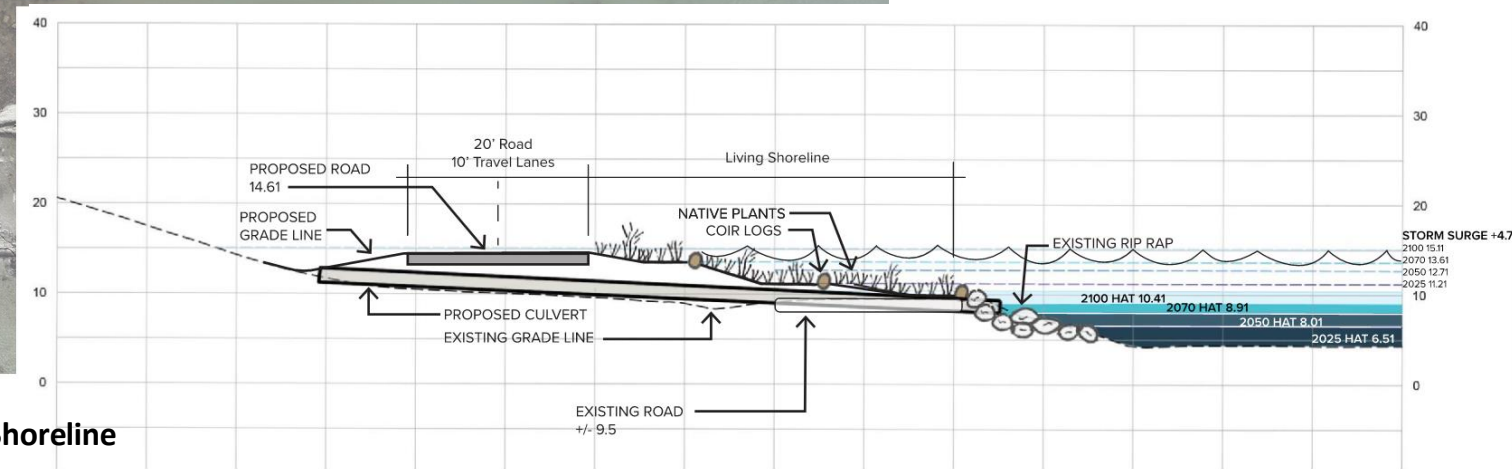
FACTORY ROAD - OPTION 2 - One-way with Revetment

Designing Resilience Case Studies

St. George, Maine – Port Clyde Coastal Resilience Plans for Factory Road



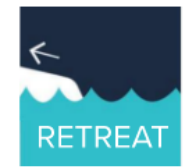
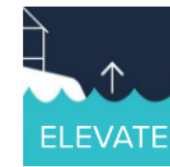
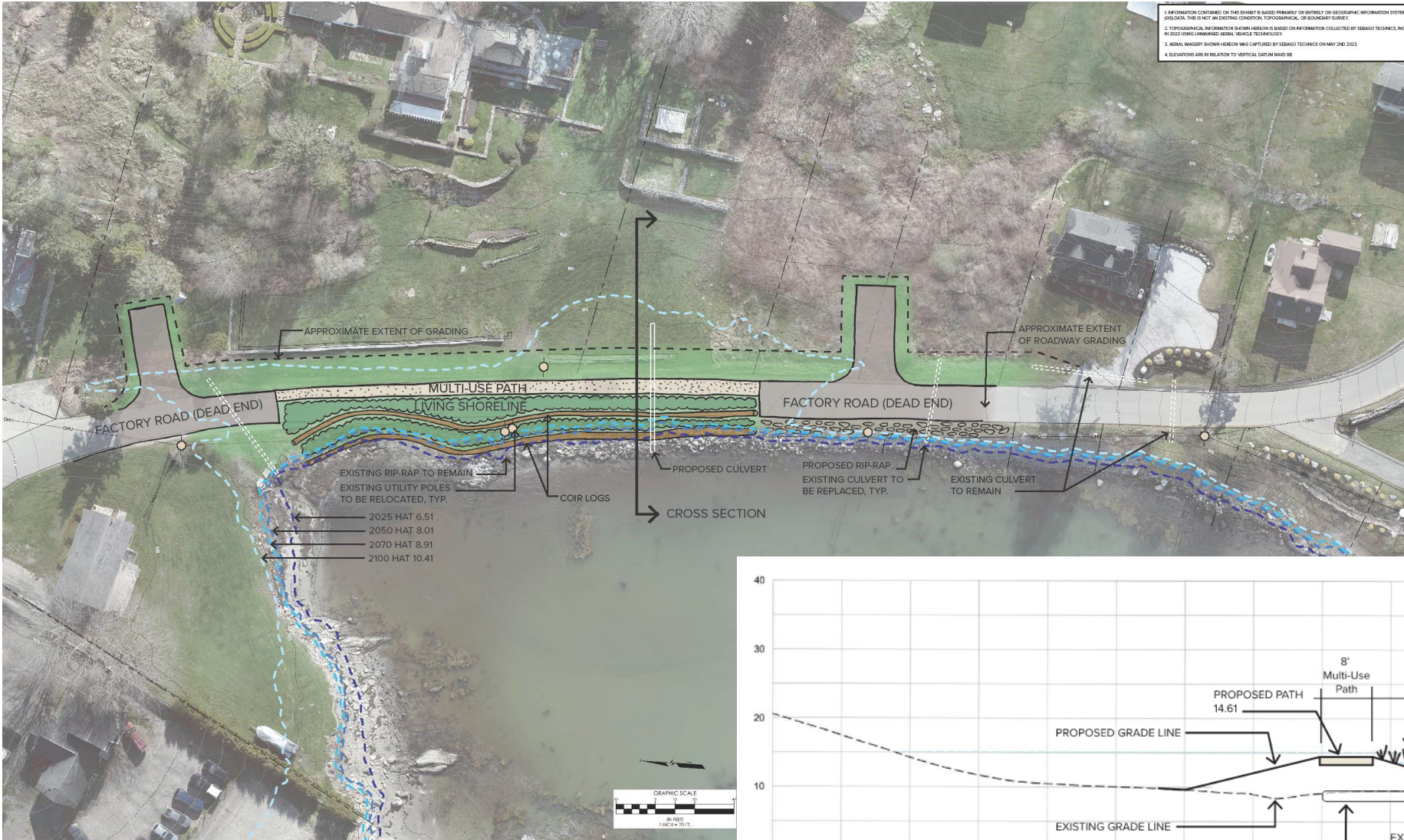
COASTAL RESILIENCE STRATEGIES



FACTORY ROAD - OPTION 3 - Road Realignment and Living Shoreline

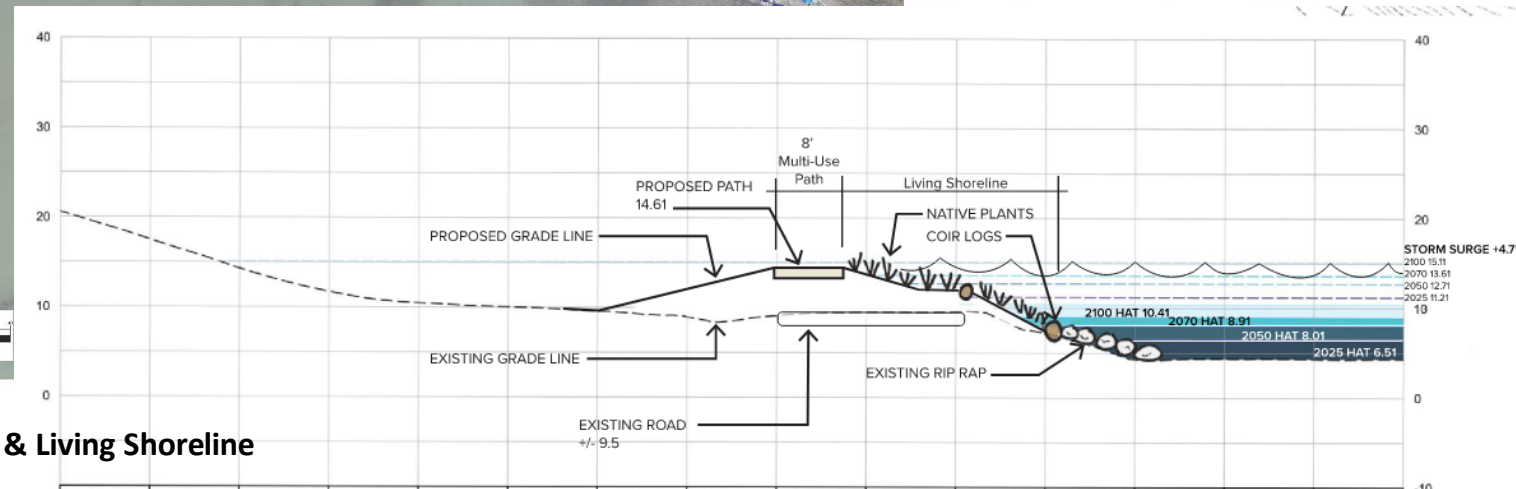
Designing Resilience Case Studies

St. George, Maine – Port Clyde Coastal Resilience Plans for Factory Road



COASTAL RESILIENCE STRATEGIES

FACTORY ROAD - OPTION 4 - Dead-End w/ Multi-Use Path & Living Shoreline



Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine



Before Four Storm Surges/King Tides (2022-2024)

Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine



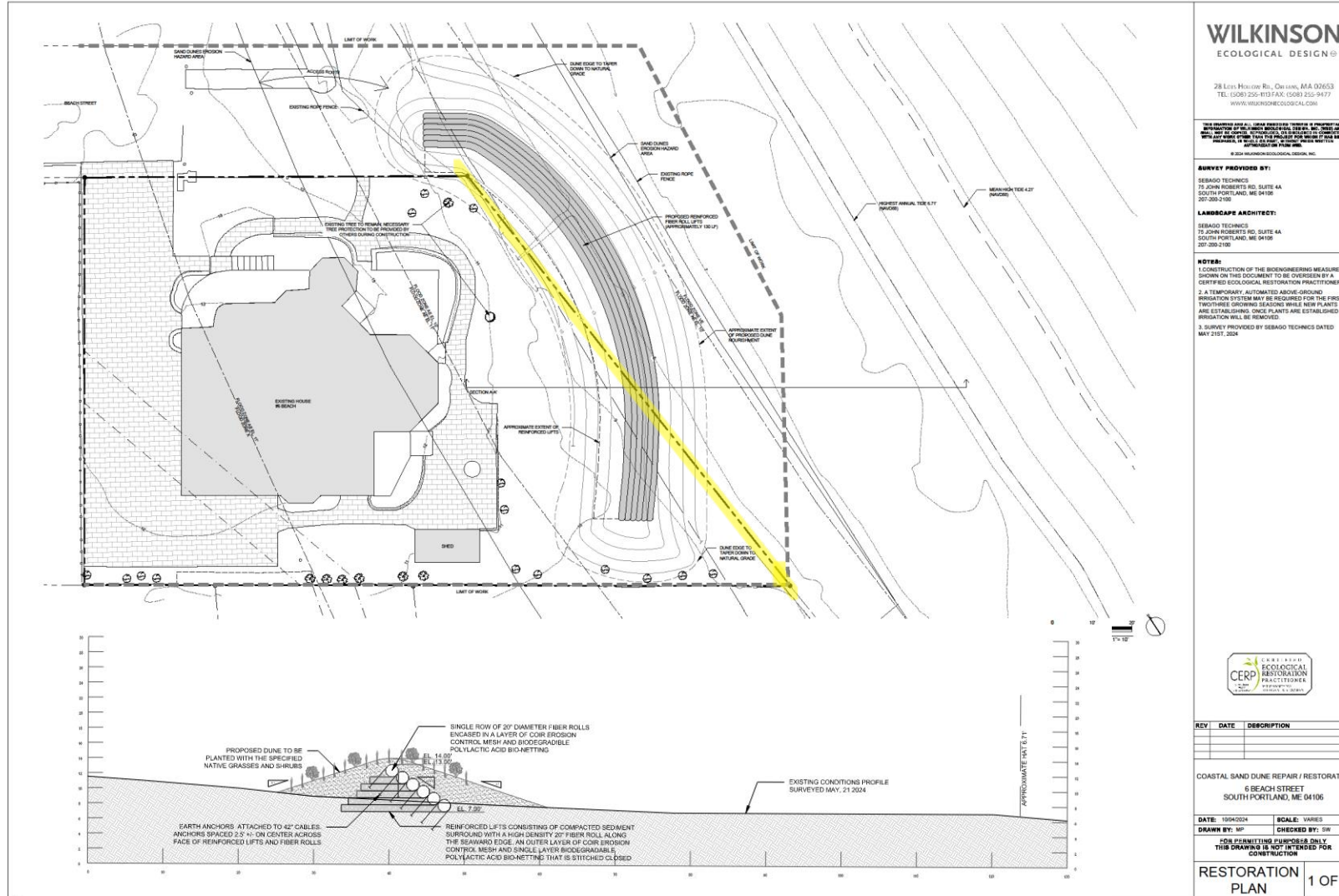
After January 2024 Storm



Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine

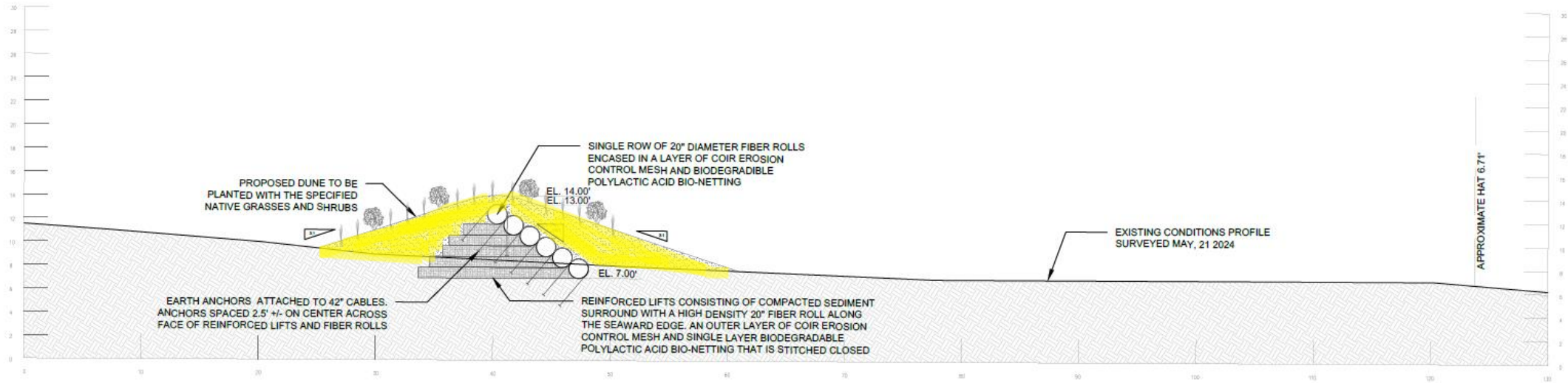


Teamed with
Wilkinson Ecological Design

Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine



2

PROPOSED SECTION A-A'

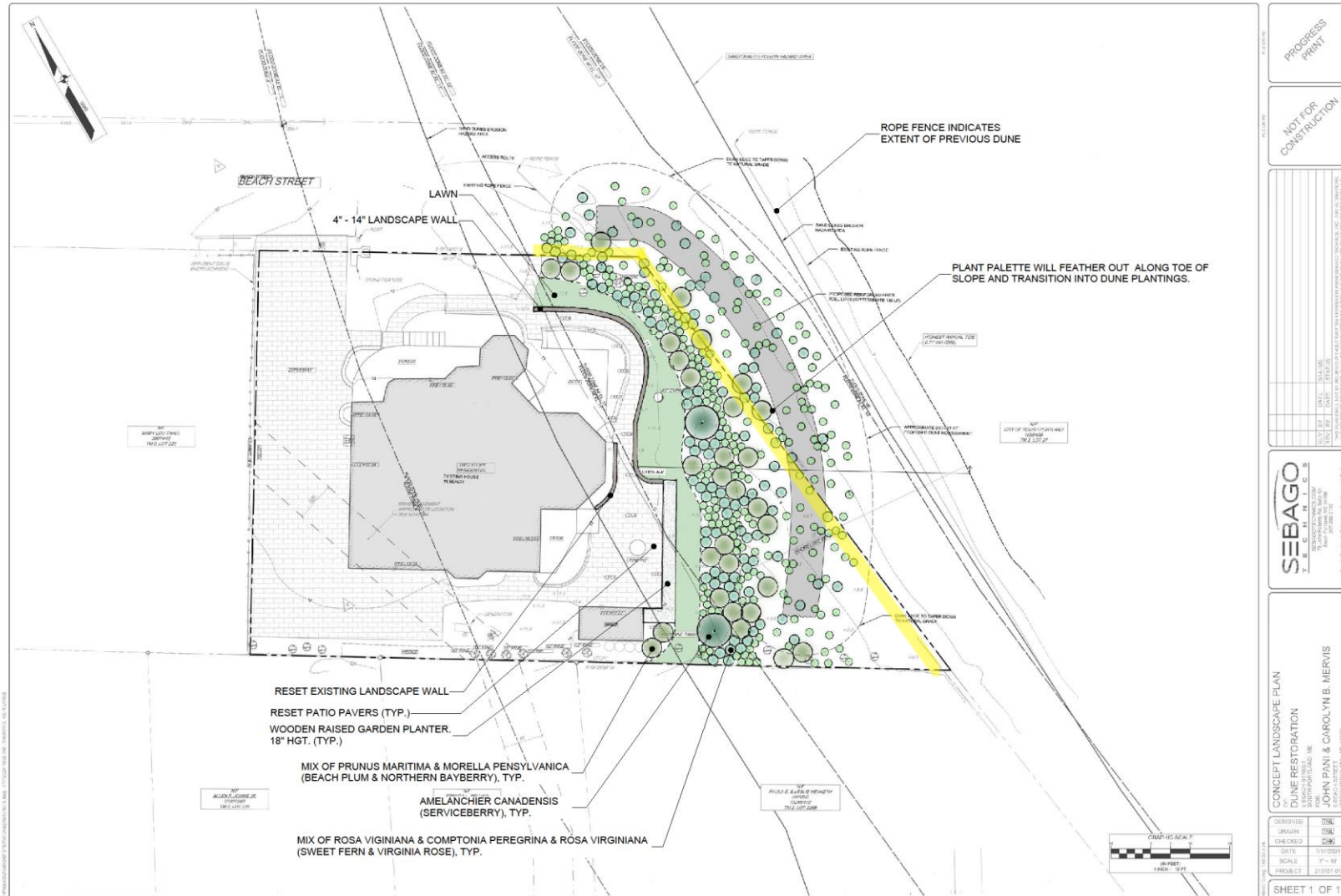
DETAIL PROVIDED BY WILKINSON ECOLOGICAL DESIGN, SPECIALISTS IN COASTAL STABILIZATION CONSTRUCTION
 U.S. PATENT #10,125,462 - #11,459,721 - #11,306,454 - #11,492,771 - #11,306,455

Scale: 1/8" = 1'-0"

Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine



Planting Plan for Private and Public

Designing Resilience Case Studies

Private – Public Sand Dune Restoration

South Portland, Maine



**Dune Restoration - Installed by
Wilkinson Ecological Design**



Designing Resilience Case Studies
Private – Public Sand Dune Restoration
South Portland, Maine



COASTAL VULNERABILITY ACTION PLAN

Plan, Adapt, Transition, and Restore

A Long-term Action Plan for Coastal Resilience
for Manchester-By-The-Sea's Inner Harbor

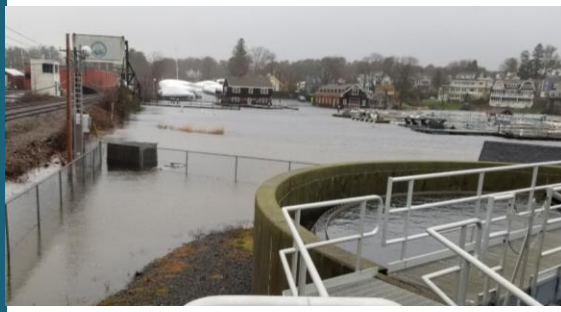
MANCHESTER-BY-THE-SEA

VERSION 1.0 – JUNE 2023



PROJECT BACKGROUND

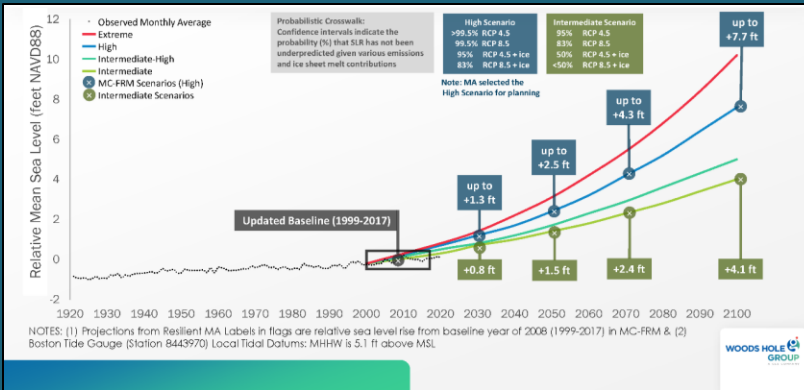
- **Frequent flooding** under current conditions
- **Critical infrastructure** (Town Hall, police station, fire station, wastewater treatment facility) at risk
- **GOAL:** Develop a conceptual roadmap to reduce risk to coastal flooding and increase resilience
- Phased approach linked to emergence of exposure
- Community input was central in guiding the development of the plan



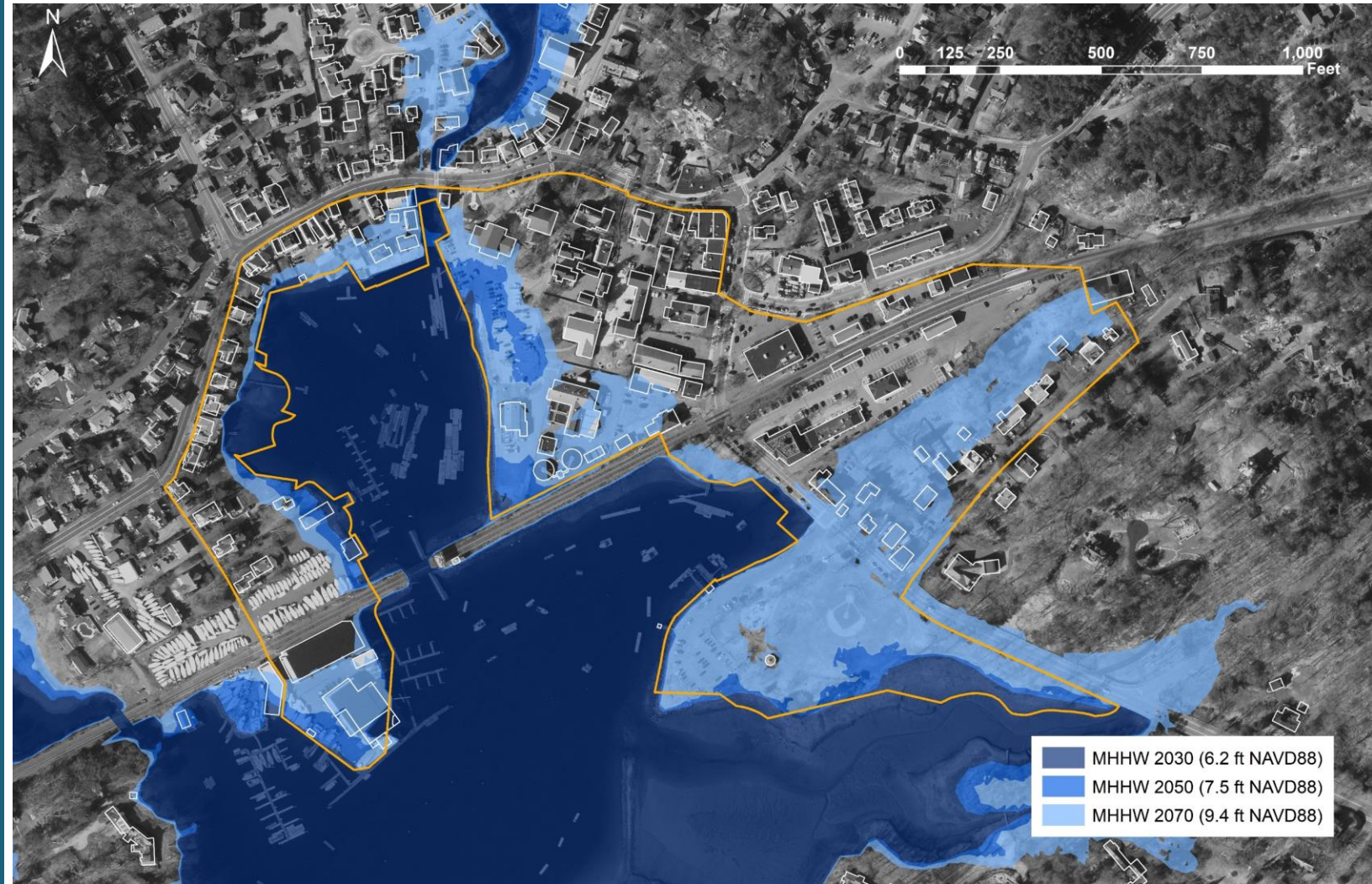
COMMUNICATING SCIENCE

Projected Tidal Benchmarks (elevation in ft. NAVD88)						
	Outer Harbor			Inner Harbor		
	MC-FRM Tidal Benchmarks			Adjusted for Attenuation		
	2030	2050	2070	2030	2050	2070
MHHW	6.2	7.5	9.4	6.2	7.5	9.4
MHW	5.8	7.1	9.0	5.6	6.9	8.8
MLW	-3.3	-2.1	-0.5	-3.1	-1.9	-0.3
MLLW	-3.5	-2.4	-0.7	-3.5	-2.4	-0.7

MC-FRM projected tidal benchmarks and adjustments for Manchester, MA



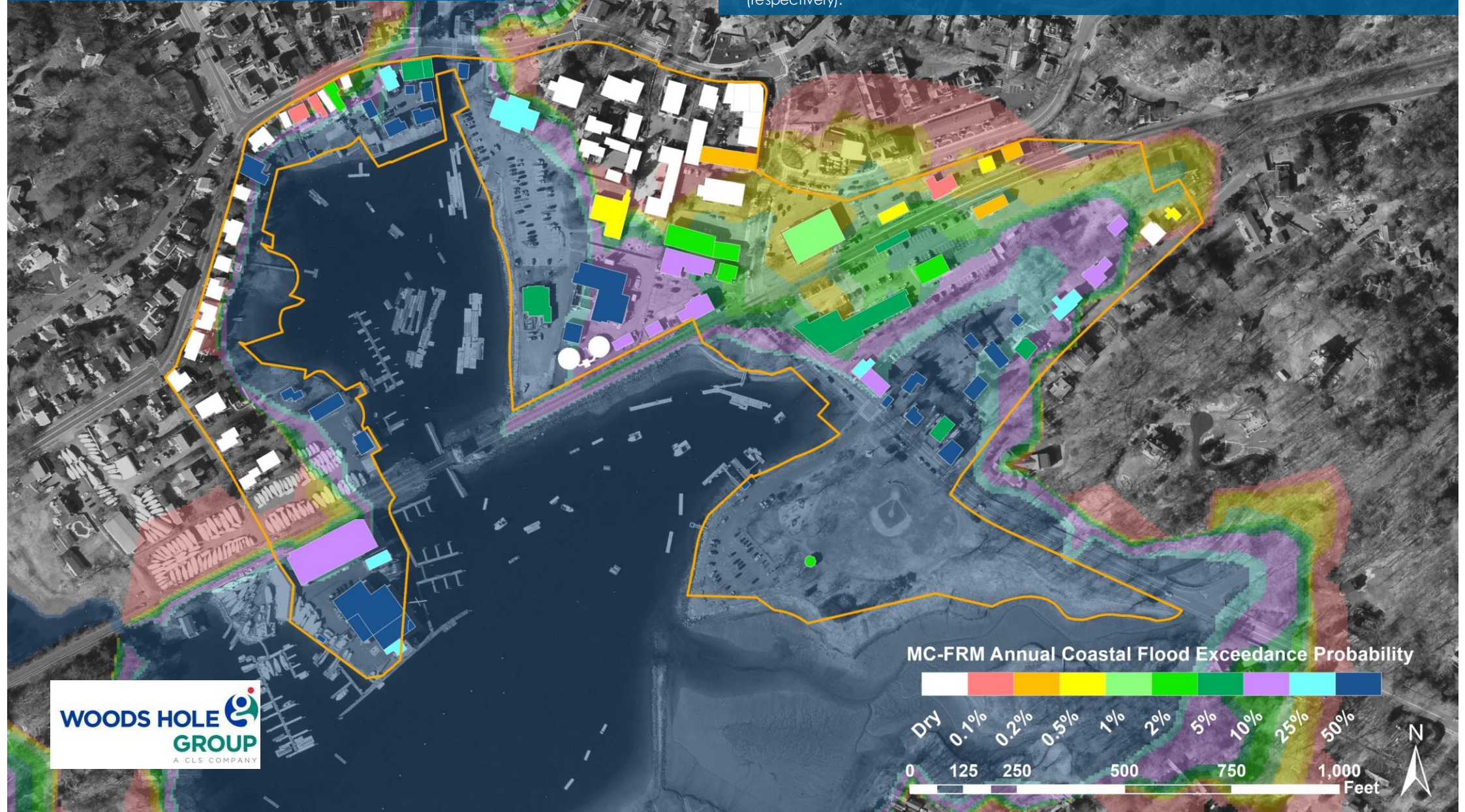
Massachusetts Executive Office of Energy and Environmental Affairs (EEA) probabilistic sea level rise projections: MC-FRM North (DeConto & Kopp, 2017)



Future Projected Tidal Conditions

2050 BUILDING FLOOD PROBABILITY

By 2050, most buildings in high elevation areas on the western side and middle of the project area are still not vulnerable to flooding. Much of the residential area along Beach Street and Tappan Street will be even more susceptible to floods, most being vulnerable to floods from storms with AEPs between 10% - 50%. Many buildings closer to the waterfront are projected to be impacted by storms with AEPs of 50%. Town Hall and the Fire Department on School Street would fall into the 25% and 50% flood risk categories (respectively) given their critical elevations of 9.18 ft and 8.11 ft (respectively).



ENGAGEMENT



SCENARIO 2 | ADAPT + TRANSITION + RESTORE



SCENARIO 2 | ACTION EXAMPLES

LANDSCAPE BERM

Elevated barriers like berms can reduce the risk of coastal flooding in low-lying areas



Elevated berm near coastal shoreline
(Image credit: NFKVA Currents, 2022)

ROAD RAISING WITH CAPPING

Raising low-lying roads can allow access to be maintained during certain flood events and can reduce flood risk in nearby low-lying areas



Road raising project
(Image credit: CC 1.0)

DEPLOYABLE FLOOD BARRIERS

Deployable flood barriers can provide temporary flood protection when needed and then be incorporated into the fabric of the streetscape when not in use – allowing the passage of cars and pedestrians



Flip-up flood barriers that can be remotely deployed and incorporated into the street
(Image credit: Flood Control International)

SCENARIO 2 | ACTION EXAMPLES

FLOODABLE PARK

Floodable parks can be used to help buffer coastal storm events while also serving as a public amenity providing recreational and social gathering opportunities



Modeled example of a floodable park
(Fuss & O'Neill)



Seattle, WA



Tallahassee, FL

Real examples of floodable coastal parks
(Image credit: Marion Brenner and Halff)

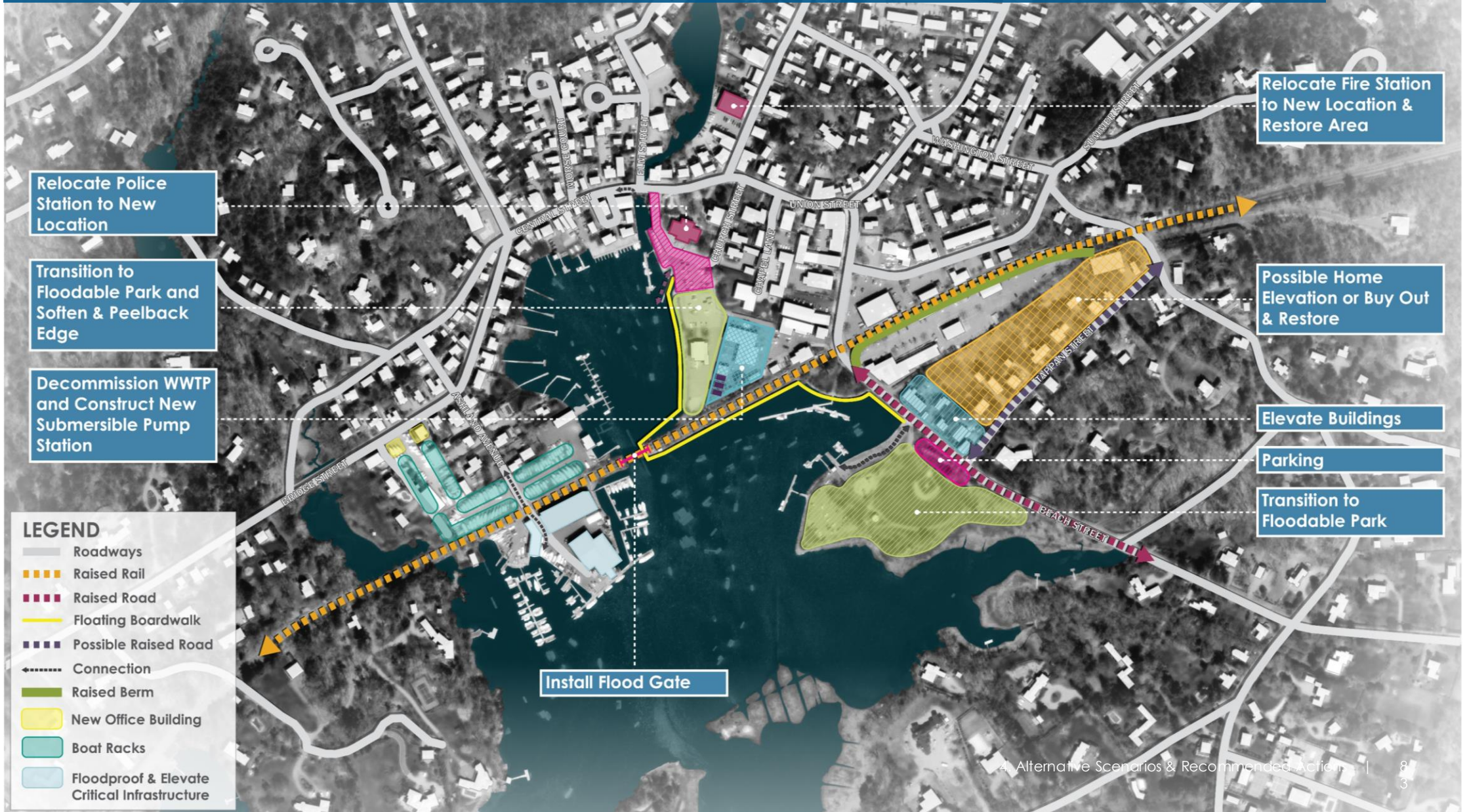
FLOATING BOARDWALK

Floating boardwalks can be incorporated into existing waterfronts to provide a climate resilient approach to improved access to the local waterfront



Modeled examples of coastal waterfront boardwalk
(Fuss & O'Neill)

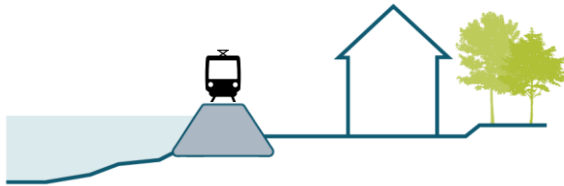
SCENARIO 3A | RAISED RAIL AS FLOOD CONTROL STRUCTURE



SCENARIO 3A | ACTION EXAMPLES

RAISED RAIL AS FLOOD CONTROL STRUCTURE

Raised rail lines can be used to improve the long-term resilience of rail lines to flooding and also reduce the risk of flooding in areas adjacent to the rail lines



Devis Lake, ND

Track raising and embankment widening
(Image credit: Houston Engineering)

FLOOD GATE

Flood gates can be used to hold back flood waters to provide more area-wide risk reduction during storm events



Crest gate mounted to the seabed for flood control (boats allowed to pass when not in use)
(Image credit: Mecan Hydro and Hydro Review)

ELEVATE STRUCTURES

Elevating structures in place can help reduce the risk of flooding while avoiding buyouts and/or relocation



Highlands, NJ



Newport, RI

Elevations of new and historical structures
(Image credit: FEMA and Google Street View)

SCENARIO 3B | FULL RETREAT + RESTORE



SCENARIO 3B | ACTION EXAMPLES

LONG-TERM FULL RETREAT + RESTORATION

Long-term retreat can offer residents/businesses an opportunity to relocate and/or consider buyouts and restoration of flood-prone properties



(Fuss & O'Neill)

REIMAGINED WATERFRONT

In the restored floodable areas, a reimagined waterfront can be established to create new connections to the water and opportunities for improved community access and public amenities



(Fuss & O'Neill)

EASTON'S BEACH NEWPORT, RI RESILIENCY STUDY & FACILITIES PLAN



PROJECT BACKGROUND

EASTON'S BEACH TODAY

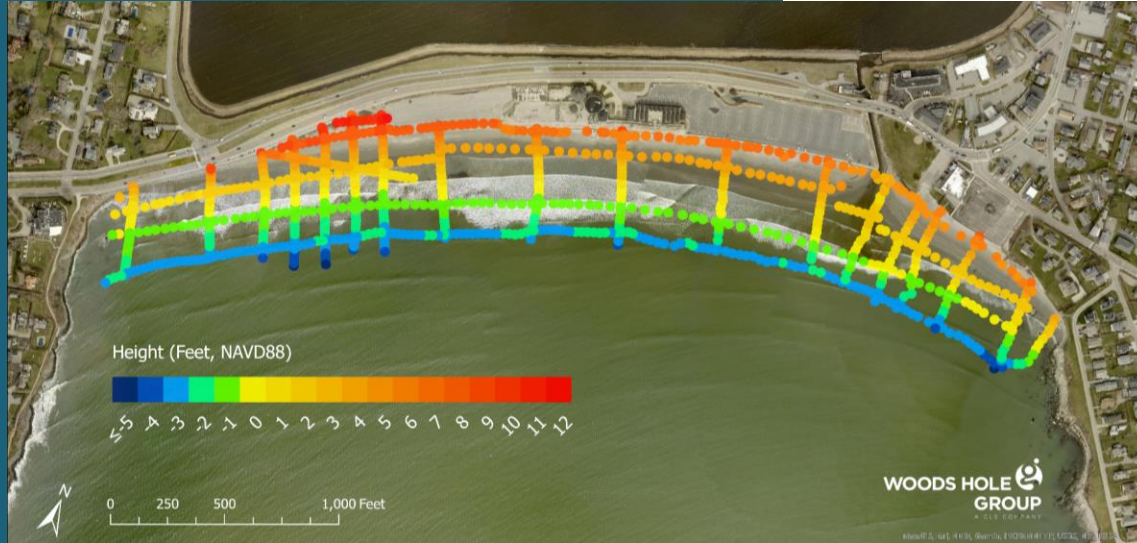
- Increasing frequency and severity of storms pose a significant threat and are exposing the site's vulnerabilities.
- Required repairs and reacting to storm damages is costly and might not lead to the most resilient outcome.

EASTON'S BEACH GOALS

- Create a more resilient waterfront that will serve as a public amenity and sustain shoreline access for all.
- Employ Nature-Based solutions to mitigate the risks to the existence of Easton's Beach.



COMMUNICATING SCIENCE



% Cobble	% Gravel			% Sand			% Fines	
	Coarse	Medium	Fine	Coarse	Medium	Fine	Silt	Clay
0.0	0.0	0.0	0.0	1.1	25.6	73.3	0.0	0.0



Sample ID:
1029_2B

Boring ID: 8

Depth: Surface

Sample Type: Gallon Bag

Test Date: 11/18/2024

Tech: DL

- LOI Performed
- Camsizer Analysis
- Sync Analysis

Coefficients

$D_{10} = 0.1181 \text{ mm}$ $C_u = 1.584$

$D_{50} = 0.1731 \text{ mm}$ $C_c = 0.994$

$D_{90} = 0.2659 \text{ mm}$


Classification

Wentworth Unimodal, Well Sorted
Fine Sand

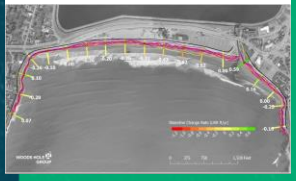


Easton's Beach

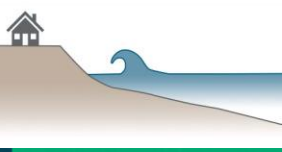
STEP 1
Survey existing conditions



STEP 2
Update long-term topo & bathymetry




STEP 3
Model surf-zone storm effects



STEP 4
Update short-term topo/bathy



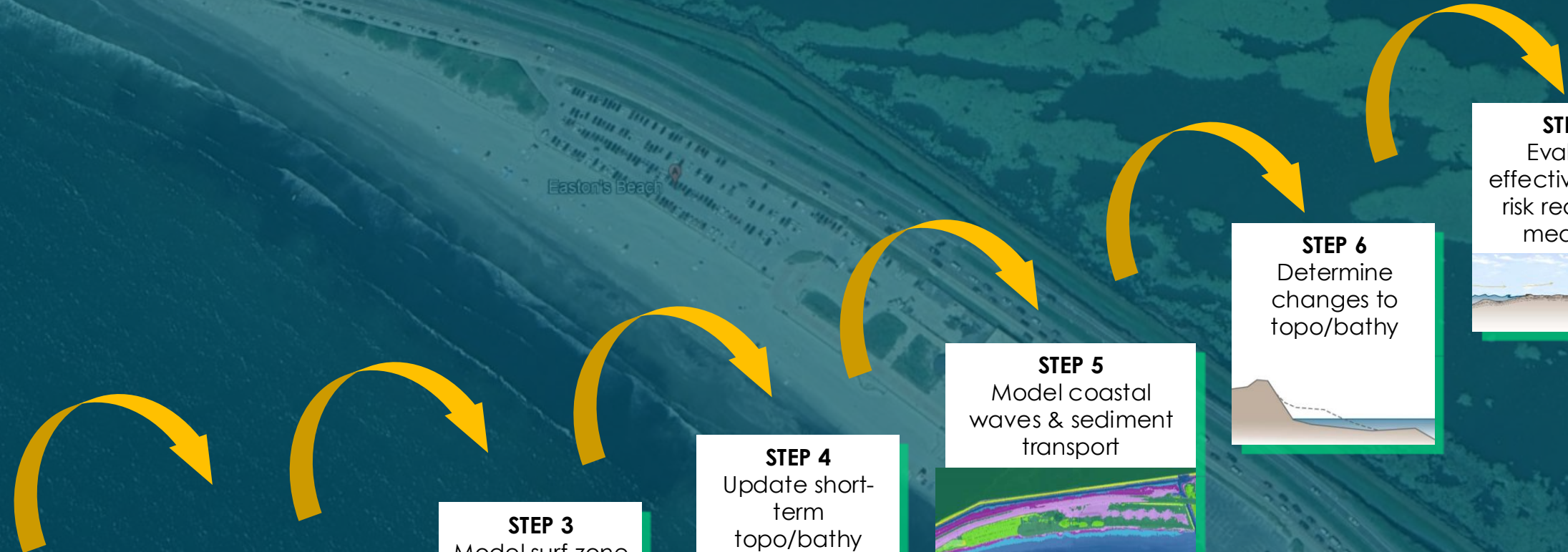

STEP 5
Model coastal waves & sediment transport



STEP 6
Determine changes to topo/bathy



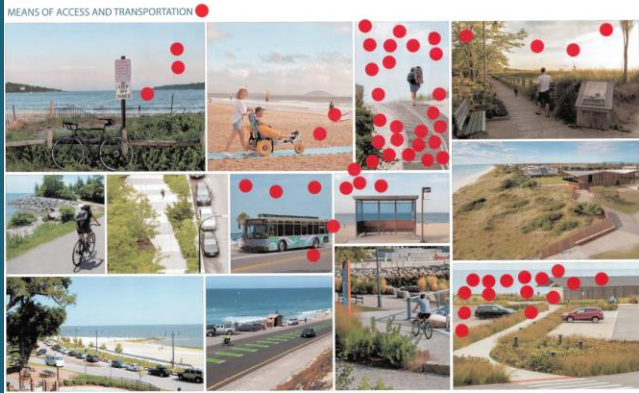
STEP 7
Evaluate effectiveness of risk reduction measures



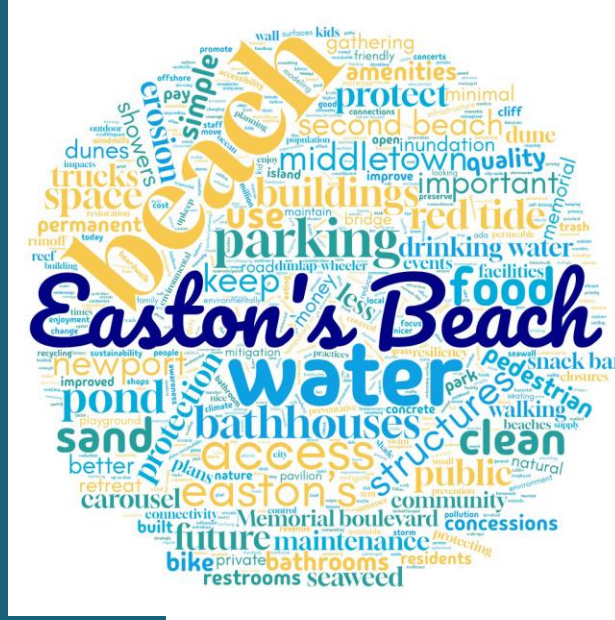
ENGAGEMENT



VISUAL PREFERENCE BOARDS
EASTON'S BEACH - NEWPORT, RHODE ISLAND
CITY OF NEWPORT DBVW ARCHITECTS FUSS & O'NEILL WOODS HOLE GROUP



VISUAL PREFERENCE BOARDS
EASTON'S BEACH - NEWPORT, RHODE ISLAND
CITY OF NEWPORT DBVW ARCHITECTS FUSS & O'NEILL WOODS HOLE GROUP



DESIGN CONCEPTS



DESIGN CONCEPTS



RESILIENT MYSTIC

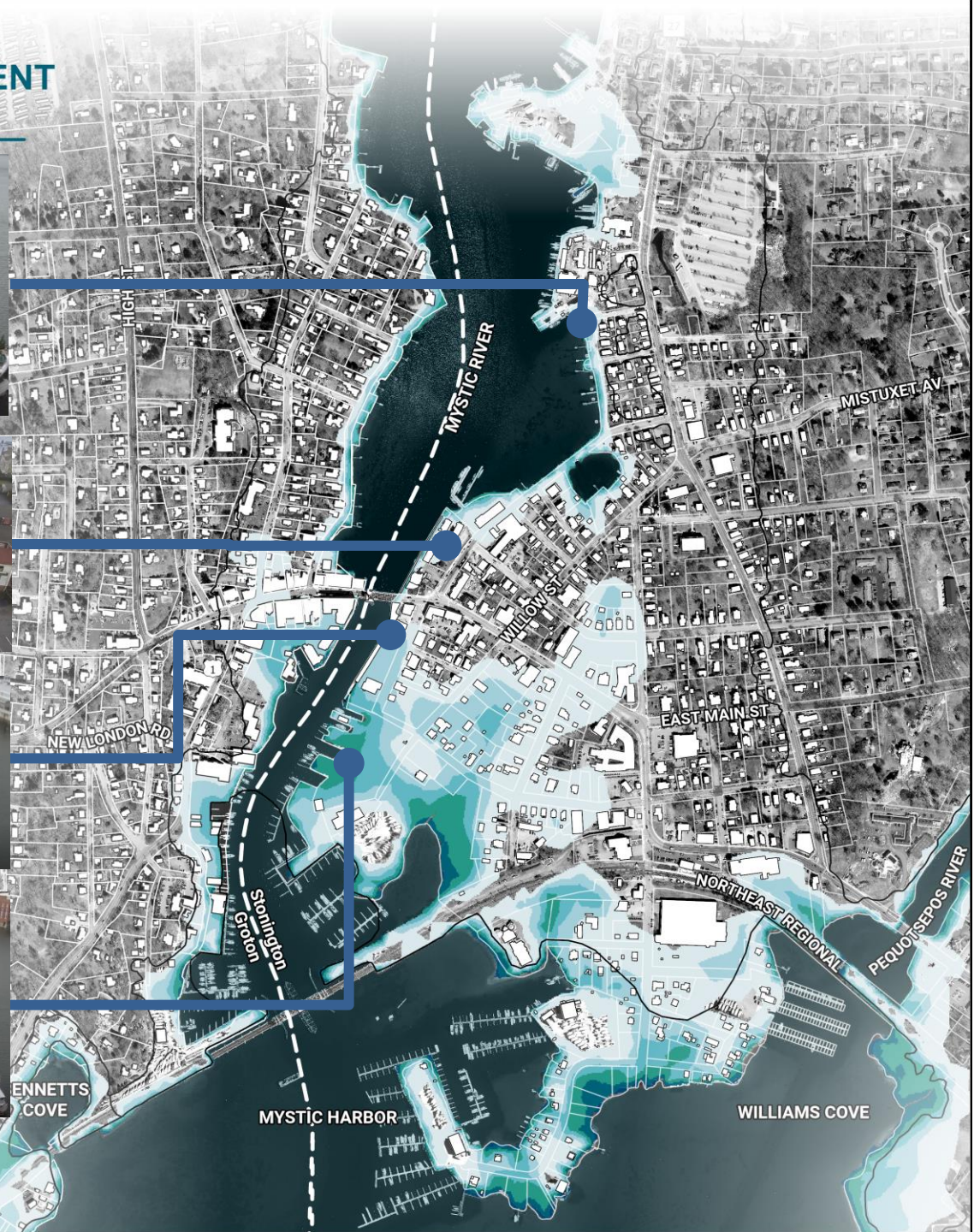
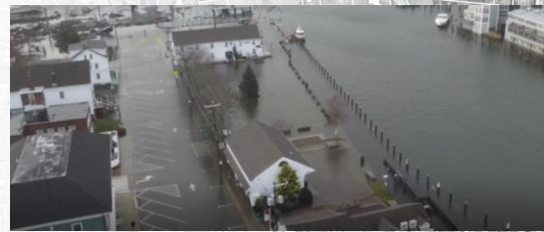
Adaptation Strategies for Downtown Mystic



**FUSS &
O'NEILL**

RESILIENT MYSTIC

PRESENT DAY 10% AEP STORM EVENT COASTAL FLOOD DEPTHS



LEGEND

Present Day Flood Depth

- <1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- > 5 ft

— FEMA Zone AE

*Flooding in December 2022
Photo Credits: Chris Gasiorek*

RESILIENT MYSTIC

PROJECTED FUTURE 10% AEP STORM EVENT COASTAL FLOOD DEPTHS

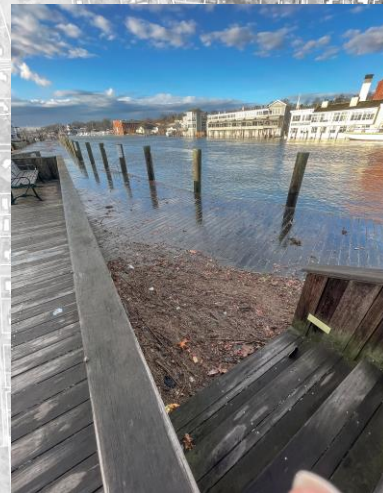
- 10% AEP flood area predicted to grow to ~147 acres.
- Future 10% AEP flood will **surpass** the current 1% AEP flood area.
- Depths of **3+ feet** expected in key residential and transit zones.
- Predicted encroachment on **Amtrak line** and homes along **Holmes and Willow Streets**.



Flooding behind Saint Patrick's Church in December 2023. (Photo Credit: Rick Newton) The flood depths seen here can be expected to increase with SLR.



Flooding at Schooner Wharf January 2024 (Photo credit: Lyndsey Pyrke-Fairchild)



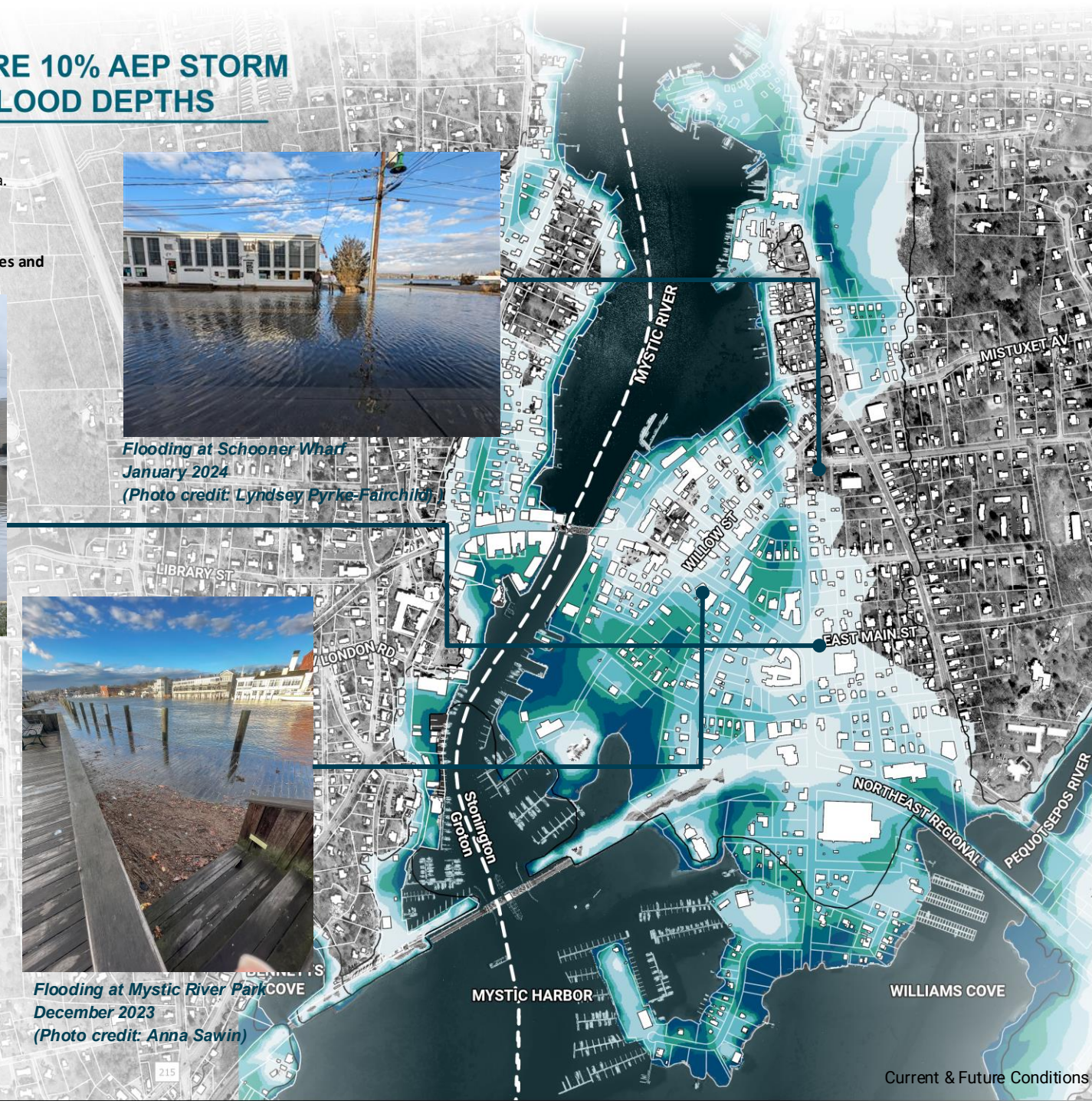
Flooding at Mystic River Park Cove December 2023 (Photo credit: Anna Sawin)

LEGEND

Projected Future Flood Depth with 20" of Sea Level Rise

- <1 ft
- 1-2 ft
- 2-3 ft
- 3-4 ft
- 4-5 ft
- > 5 ft

— FEMA Zone AE



ENGAGEMENT



affordable for younger residents
safe bike travel
living with the sea
solve parking + traffic
safe pedestrian paths
sustainable housing
resilient mixed-use affordable housing
owner occupied housing
thoughtful tourism
water dependant uses
healthy wetlands
wildlife cooridors
learning, planning, action-oriented community
resource preservation + conservation
more trees

true connected community
clean waterways
thinking regionally globally
No modern architecture
safety & security
diversification of business
diversity of community
bike use
less air b&b
dreaming and working together|live & work

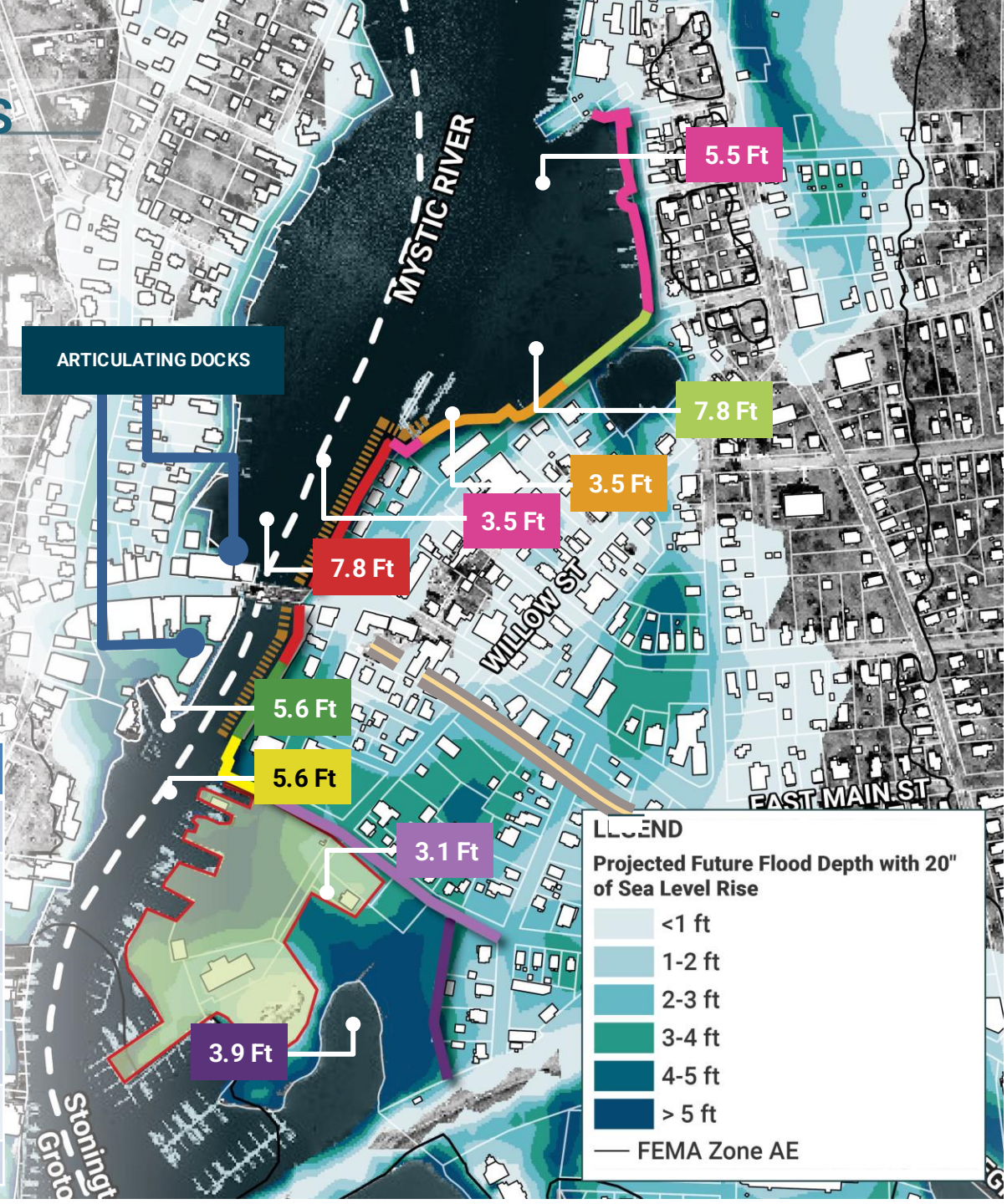


RESILIENT MYSTIC SHORELINE ADAPTATIONS

- Smaller-scale shoreline adaptations can complement the implementation of the Resilient Corridor
 - This system would combine seawalls, living shorelines, elevation of open space, and berms
- Designed to reduce the impacts of flooding as a “first line of defense” up to the 10% AEP storm with 20 inches of sea level rise

MITIGATION STRATEGY LEGEND	
	SECTION A: Deployable Floodwall
	SECTION B: Living Shoreline Adjacent to Walkway
	SECTION C: Seawall at Schooner Wharf
	SECTION D: Seawall with Articulating Dock
	SECTION E: Mystic River Park
	SECTION F: Deployable Plank Flood Wall
	SECTION G: Berm with Multi-Use Trail at Washington St
	SECTION H: Flood Protection Berm
	Elevated Bulkhead - Mitigation Strategy by Private Property Owner as Permitted

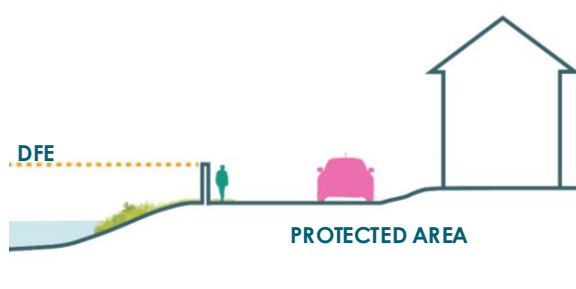
Estimated Costs (not including accompanying traffic studies)
Section A (Deployable Floodwall): \$1.75 million
Section B (Living Shoreline): \$1.75 million construction costs
Section C (Seawall): \$870,000
Section D (Articulating Dock plus seawall): \$7.1 million
Section E (Elevate Mystic River Park): \$1 million
Section F (Deployable Plank Floodwall): \$2 million
Elevated Bulkhead: \$2.1 million



RESILIENT MYSTIC SHORELINE ADAPTATIONS

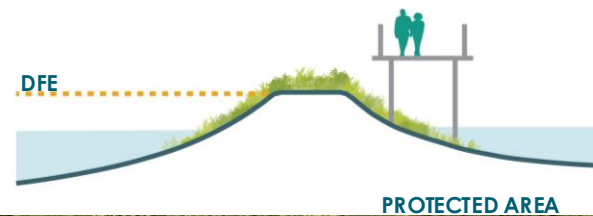
SECTION A: DEPLOYABLE FLOODWALL

- Deploy a 5.5-ft wall along Bay Street
- Preferable to permanent floodwall in this setting to maintain the relationship between pedestrians and the river



SECTION B: LIVING SHORELINE ADJACENT TO WALKWAY

- Replace the bulkhead that supports the road from the intersection with Frazier Street and Bay Street with a pedestrian boardwalk, partially submerged living shoreline berm, and tide gate



SECTION C: SEAWALL AT SCHOONER WHARF

- Mitigate the future 10% AEP storm with a 3.5-ft high seawall along the perimeter of the Schooner Wharf parking lot
- Permanent wall would be set atop grade at the parking lot



ASSUMPTIONS:

DFE (El. 13-ft) = FEMA BFE (El. 11-ft) + 2-ft for non-critical facilities

RESILIENT MYSTIC SHORELINE ADAPTATIONS

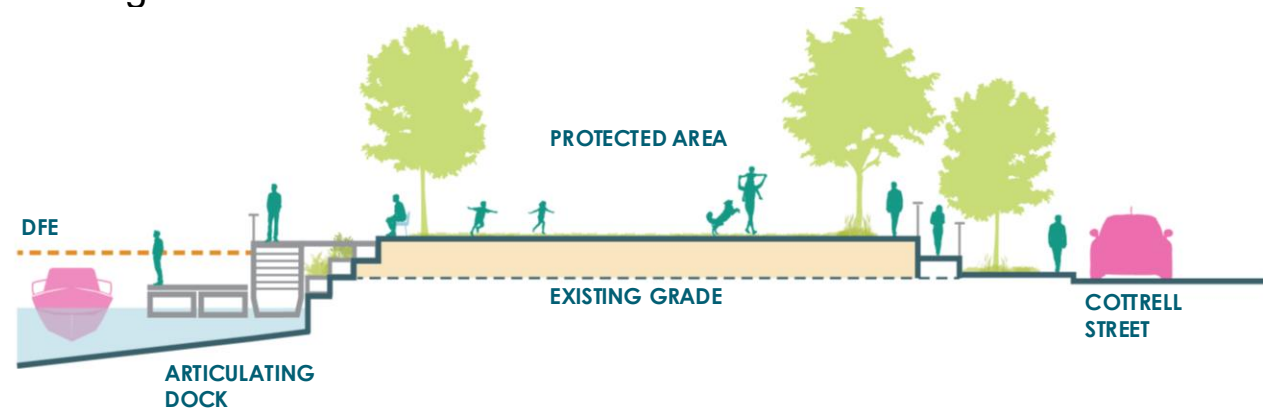
SECTION D: SEAWALL WITH ARTICULATING DOCK

- A permanent wall is feasible at this location because it would not obstruct views from nearby condos
- Dock would need to articulate



SECTION E: ELEVATE MYSTIC RIVER PARK

- Elevated park would preserve and/or enhance the recreational value of this amenity against flooding
- Transition existing fixed dock to a floating dock moving in response to fluctuating water levels



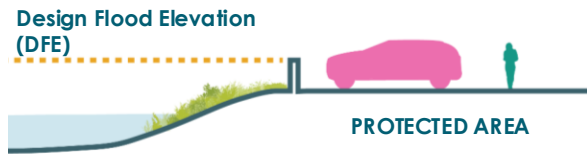
ASSUMPTIONS:

DFE (El. 13-ft) = FEMA BFE (El. 11-ft) + 2-ft for non-critical facilities

RESILIENT MYSTIC SHORELINE ADAPTATIONS

SECTION F: DEPLOYABLE PLANK FLOOD WALL AT SOUTHERN END OF MYSTIC RIVER PARK

- Semi-permanent flood wall at Mystic River Park would link planks between installed posts to create a barrier during flood events



SECTION G: BERM WITH MULTI-USE TRAIL AT WASHINGTON STREET

- Repurpose the eastbound lane of Washington Street as a berm crowned by a pedestrian walkway to mitigate mild to moderate flooding on the north side of the street



SECTION H: FLOOD PROTECTION BERM AT JACKSON AVENUE

- Negotiate easements along the western edge of Jackson Avenue to host a berm to reduce flood risks



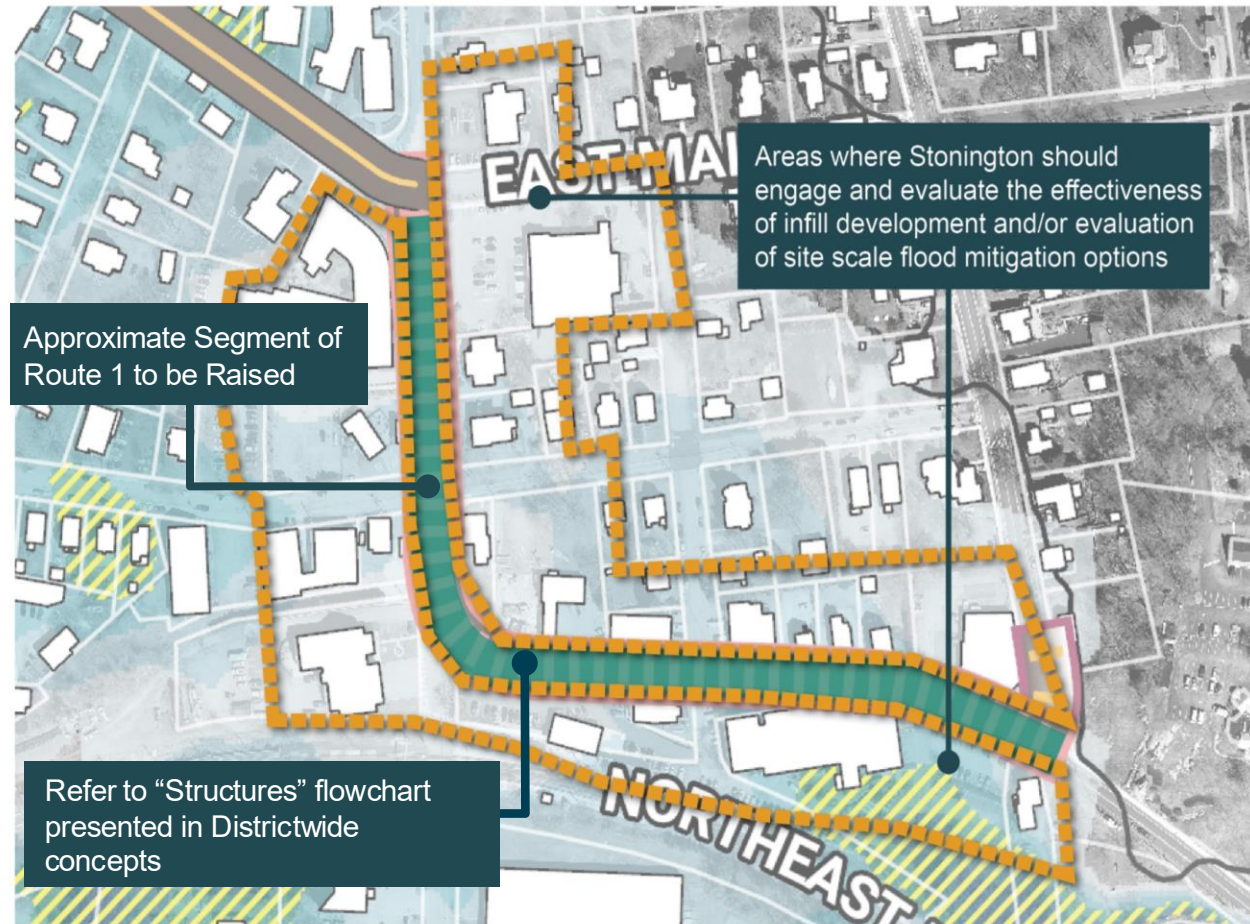
- A corresponding strategy should be developed for properties lining the corridor
- Property owners along the Resilient Corridor should consider elevating structures within their current footprints
- Building elevations should be performed in accordance with all relevant guidelines and statutes, including the following elevation standards:
 - Freeboard Value Approach (FVA)
 - 0.2% Annual Chance Flood Approach
 - Climate Informed Science Approach (CISA)



Two cross-sections demonstrating road elevation options within the Resilient Corridor with accompanying structure elevations. Streetscape additions could include an off-street shared-use path, green infrastructure, and building elevations tying into the raised road.

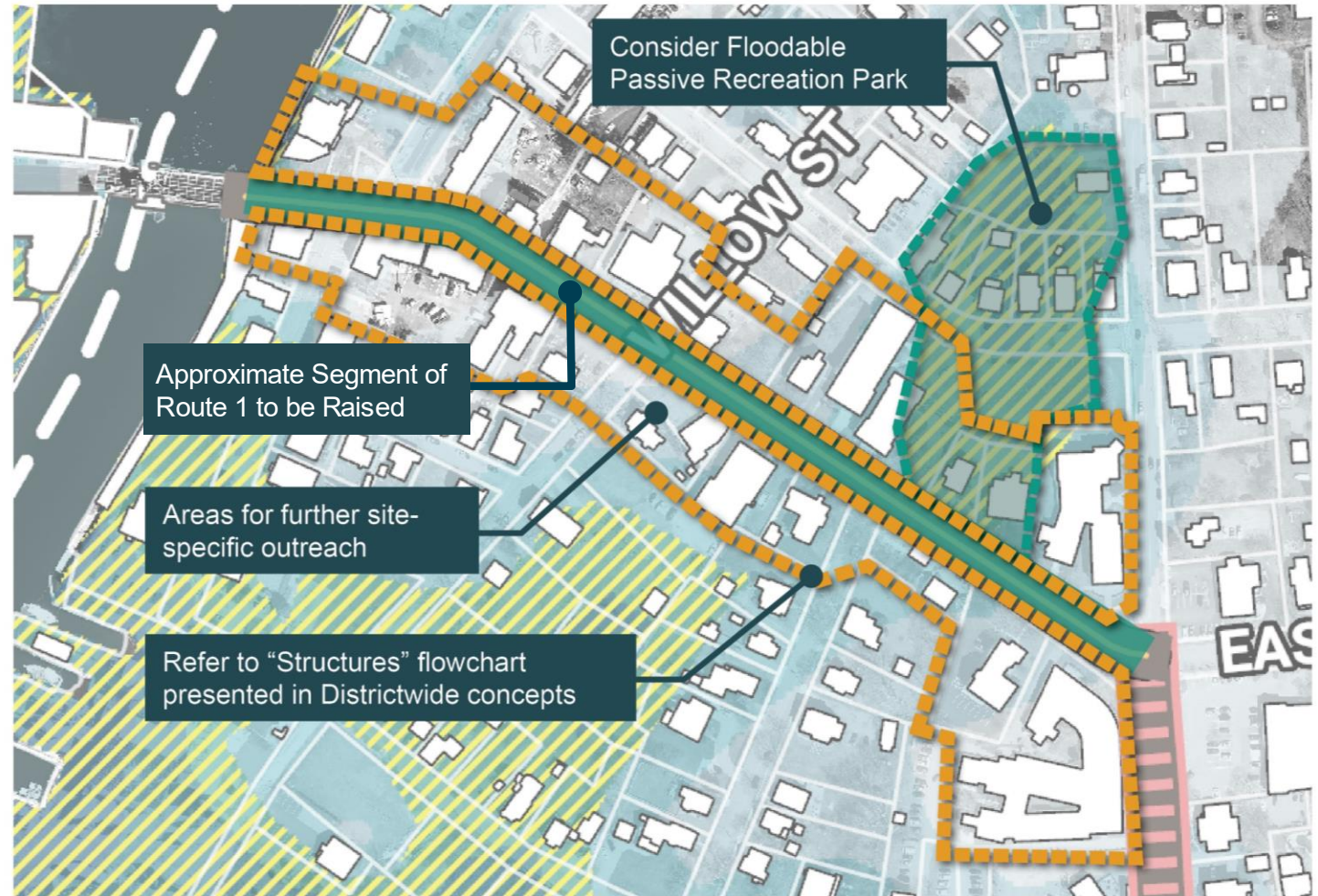
PHASE I

- Preserve access to critical facilities: the Mystic Fire Station, Apple Rehab, and CVS Pharmacy
- Elevate the Mystic Fire Station to the FEMA 500-year flood elevation of 18.5 ft
- Elevate Apple Rehab and CVS to 13 ft
- Several sites that currently provide surface parking would be candidates for infill development, or as destinations for relocated structures
- Must assess and manage rain runoff to ensure water flows out of the neighborhood toward the Mystic River
- Proactive engagement with property owners



PHASE II

- Accompany the road's elevation between the Bascule Bridge and Broadway Avenue
- Current uses - restaurants, shops, office buildings, houses of worship, and a gas station – to follow guidance on structural adaptation
- The extent of the Phase II road elevation is dependent on if and how shoreline hardening is adopted in Concept 3



STRUCTURAL ELEVATIONS

- Elevate structures to meet the road where possible
- Ramps and stairs can be modified to maintain easy first floor access
- Parking at grade under structures



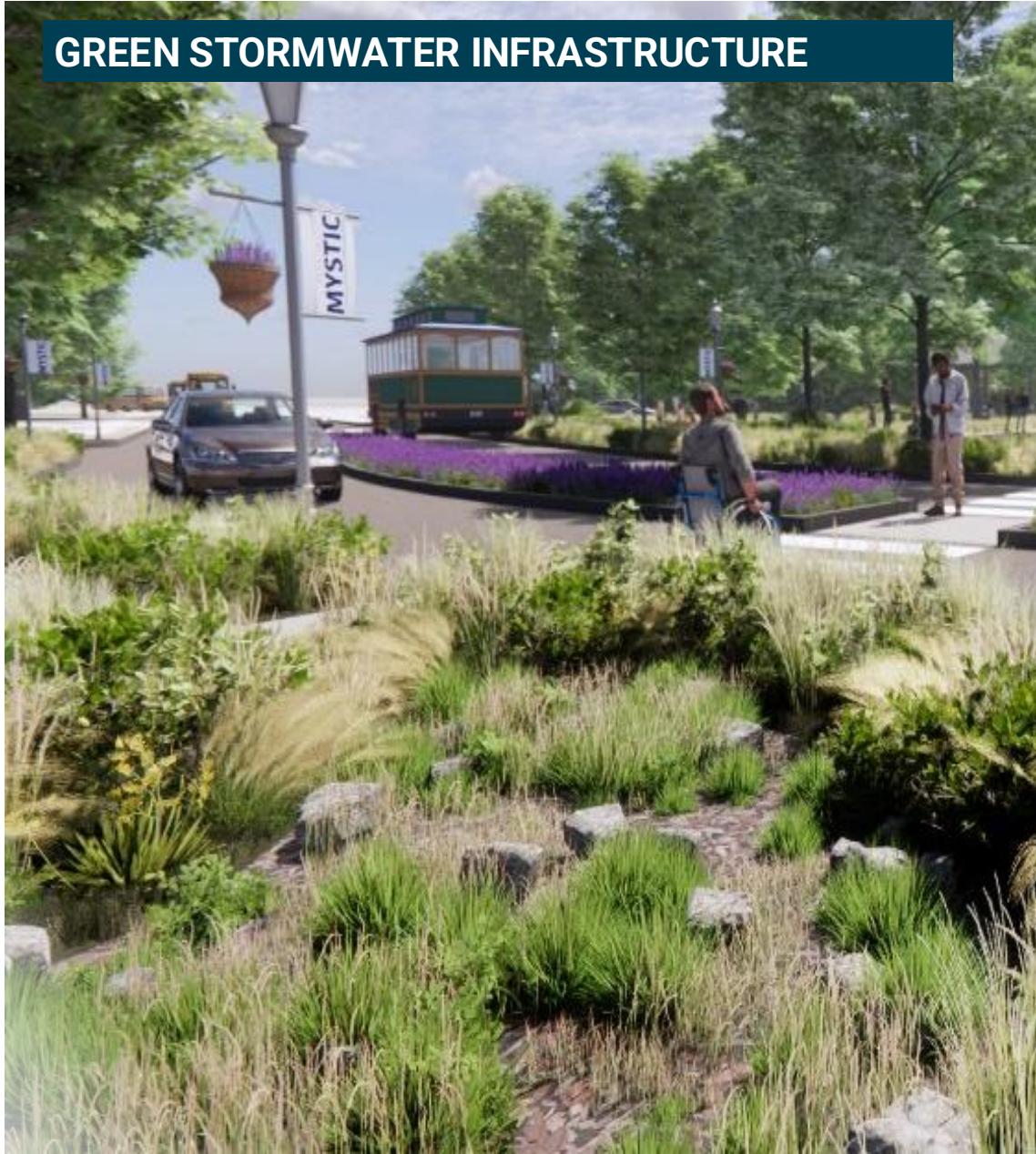
RESILIENT MYSTIC

ROUTE 1 RESILIENT CORRIDOR – PHASE II

Floodable first floor may be used for temporary “pop-up” events, seasonal outdoor cafes or temporary markets



GREEN STORMWATER INFRASTRUCTURE



FLOODABLE PASSIVE RECREATION

A person is riding a bicycle on a paved path in a park-like setting. The path is bordered by a metal railing and a stone wall. There are informational signs and benches along the path. The scene is outdoors with trees and plants.

Designing Resilience
Thank you!