Isabel Umland

Climate Corps Independent Study

Project Name: Land Reclamation After Managed Retreat at Groton Long Point

Introduction:

Groton Long Point is a private beach community located in Groton Connecticut facing Long Island Sound, neighboring Bluff Point State Park. The neighborhood was chartered in 1921 by the town of Groton and functions as a private borough.[1] The flourishing summer vacation destination is now endangered by sea level rise and storms. The area consists mainly of beach and marsh, with a long outstretched peninsula guarding an inlet and marshland further inland. Much of the beach area of Groton Long Point has been developed, with houses several feet from the shoreline, protected only by a low seawall. The shoreline is well protected by Long Island and Fisher's Island, which act as breakwaters and shelter the area from most storms.[2] However, in 2012 Hurricane Sandy inflicted serious damage to the neighborhood, with 215 of the 589 housing units being impacted. Up to 3ft of flooding was present, with the majority of properties being affected at just 1-2ft of surges.[3[

At an elevation of only 0-20 feet (Fig 1) the neighborhood of Groton Long Point (GLP) is at serious risk of flooding due to sea level rise, storm surge, and coastline erosion. As seen in figure 3, surges of up to six feet pose a serious threat to wipe out most of the neighborhood if steps are not taken to preserve the coastline[4] The Town of Groton itself acknowledges that the entirety of Groton Long Point is in a flood zone, and has suggested in its hazard mitigation plan to convert some areas of the shoreline to marshland to prevent flooding.[5] Additionally, the neighborhood is at extreme risk during flooding due to the presence of only one route of access and egress, Groton Long Point Rd. Officials have acknowledged that the risk storms pose to the bridge on this road could prove "catastrophic."[5] Via coastline restoration and the removal of residential and impervious structures, the natural coastline can be protected to maintain coastline integrity and prevent flooding further inland. The best course of action to preserve the ecosystem and coastline of Groton Long Point is to restore the area to its natural state, and protect the coastline through marsh restoration, beach enhancement, and vegetation management. Through a combination of natural techniques such as dune restoration, living shorelines, and floodpath adjustment, the shoreline can be restored to its natural state with added protection against surges and flooding. To return the coastline to its pre-development state, all infrastructure (buildings,

roads, pipes etc) will need to be torn down or removed. Only after this has been done can steps be taken to nourish the beach, replant local flora, and encourage ecosystem restoration.

Groton Long Point has been divided into zones based on the plan for their restoration (Fig 7). Zone 1 refers to the inlet between the jetty and the mainland. Zone 2 is the coastline facing Long Island Sound, Zone 3 is the current wetland area, and Zone 4 is the residential area of higher elevation.

Figure 0: A vintage postcard of Groton Long Point from the mid-20th century via WorthPoint.com

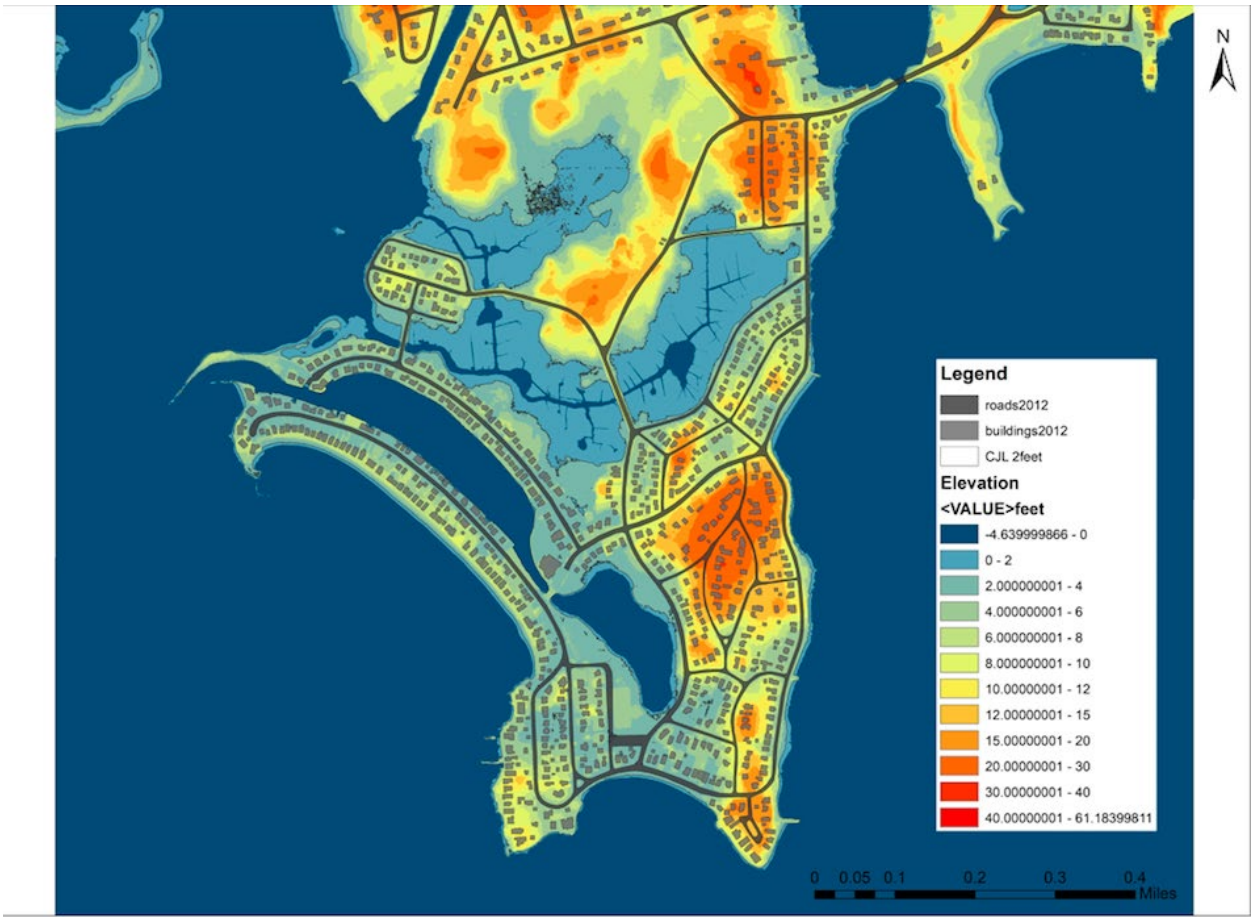

Figure 1 - Coastline Elevation via CT ECO Lidar DEM (Digital Elevation Model) by Tao Wu

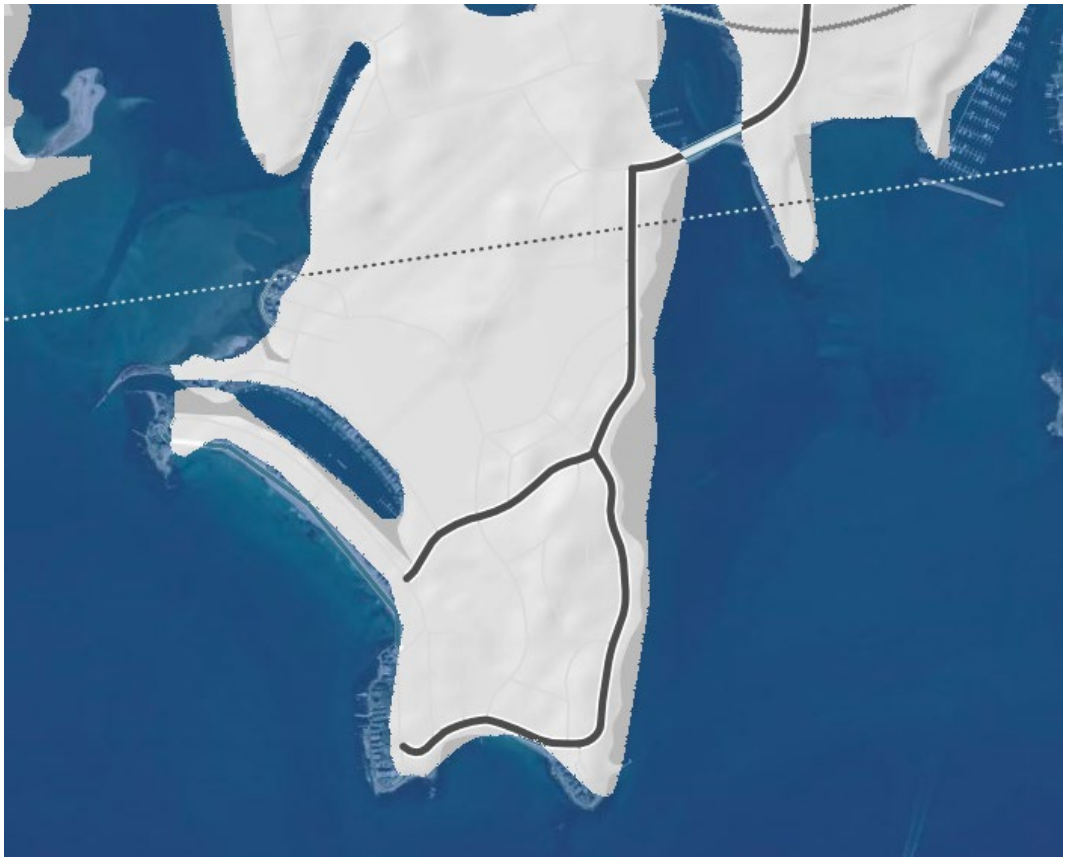

Figure 2: Current Coastline with 0 sea level rise via Risk Finder

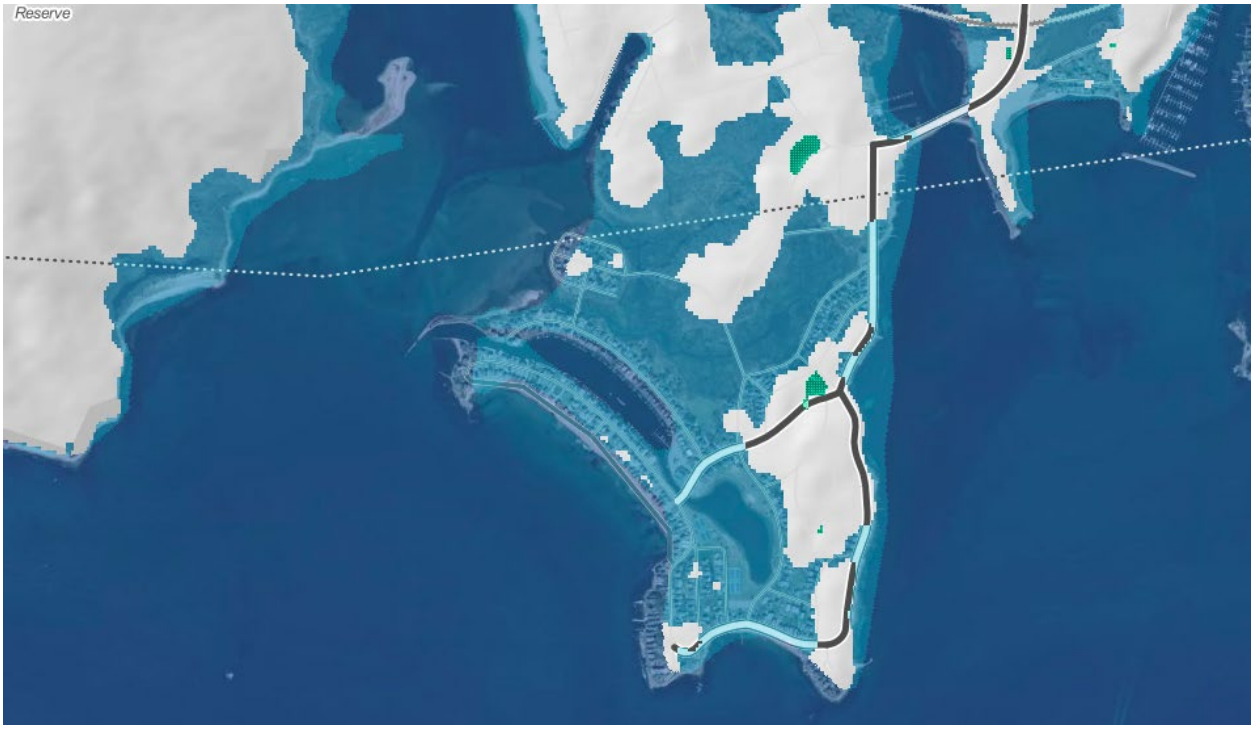

Figure 3: Coastline +6ft of sea level rise via Risk Finder

Figure 4: Storm surges after Hurricane Sandy via [Flood Factor]

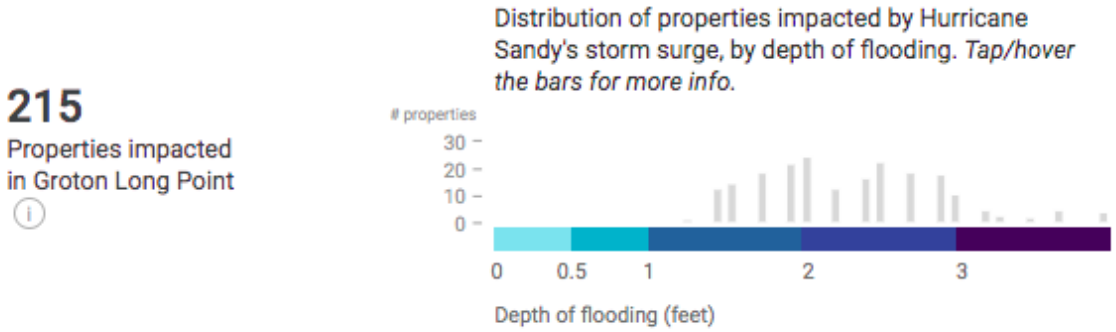

Figure 5: Properties affected by hurricane sandy at GLP

Figure 7: Assigned zones based on restoration plan

Method

Zone 1:

Zone 1 and the coastline around it will utilize living shoreline technology to maintain coastline integrity, prevent erosion, and encourage biodiversity. As shown in figure 8, the inlet would be restored with vegetation only as the area is protected and experiences low wave energy. Once all infrastructure has been removed, a living shoreline will be implemented and dune restoration will act as a natural barrier. Towards the water, local salt tolerant vegetation will be planted to maintain the shoreline. This area, along with the rest of restored Groton Long Point, will remain closed to the public to retain coastline integrity, encourage nesting of local birds, animals, and insects, and protect biodiversity.

Living shorelines are multipurpose conservation projects intended to prevent erosion, maintain coastline integrity, and repair ailing ecosystems. As opposed to traditional coastline preservation techniques such as sea walls, break waters, and other immovable structures, living shorelines utilize nature's existing techniques to maintain coastline integrity.[6][7] Living shorelines consist of dense vegetation planted along the shoreline in addition to minor structures that are naturally integrated into the ecosystem as needed. In addition to cost and longevity, living shorelines provide many benefits traditional coastline structures would not. Living shorelines improve water quality while providing a habitat for local wildlife. Living shorelines are also resilient and can resist most storms and surges, and are usually able to self repair when damaged (depending on severity of storm).[7][8] Over time, living shorelines become more effective as they grow and spread, and root systems become established. The living shoreline at Groton Long Point will consist of vegetation to absorb wave energy and trap soil and sand to prevent erosion. Dense vegetation will work to trap sediment, absorb waves, and clean and filter water.

In Zone 1, a vegetation only living shoreline will be installed. This will consist of creating dunes on the existing shoreline to provide a barrier against storm surges and to protect inland areas. Dune construction is the process of using sand, sediment, rocks, and other materials to create an artificial beach dune. Typically, the materials to construct artificial dunes are brought in from off-site. In the case of Zone 1, no engineered core at the center of the dune will be necessary as the area is well protected from waves and surges.

Dunes require upkeep and nourishment, particularly after storms, as they are vulnerable to erosion.[9] In order to prevent continuous erosion, beach grass and other salt tolerant vegetation will be planted on the top and sides of the dune. In addition to providing stability to the dune, vegetation also provides habitat and food for local wildlife.[8] A list of plants suitable for dune planting is listed later in this report. In front of the dune and beach, marsh grass will be planted in order to buffer tides and further prevent erosion. Roots hold onto sediment and grass stalks absorb wave energy, further protecting the beach. Additionally, living shorelines provide habitats for wildlife, filter and clean water, and sequester carbon.[8] As shown in Figure 8, high marsh areas and low marsh areas are distinguished based on tide levels and mean high water. Different marsh grasses will be planted in these areas accordingly.

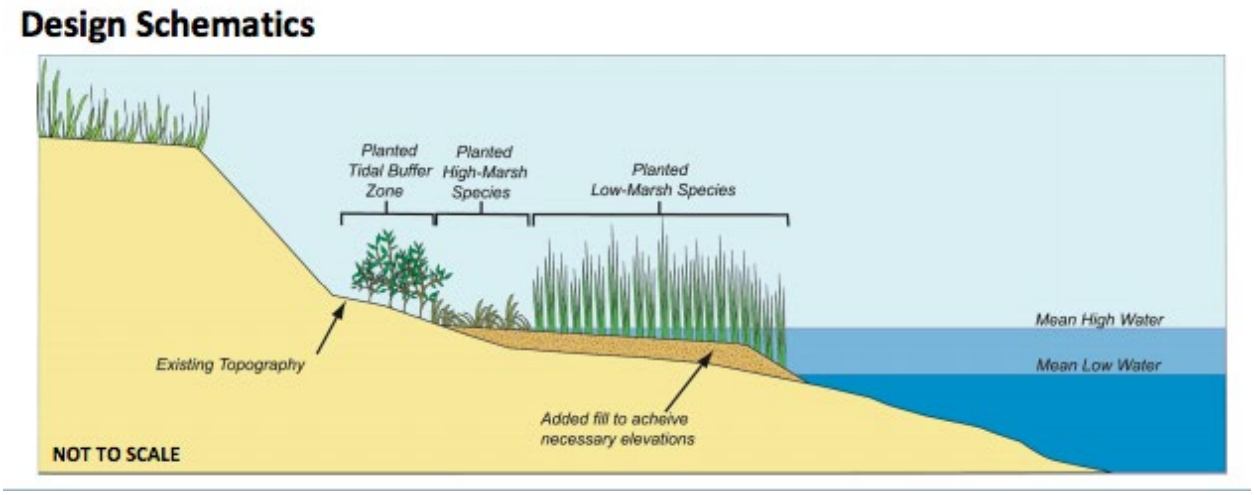

Figure 8: Vegetation only living shoreline with marsh grass via [Living Shorelines in New England: State of the Practice]

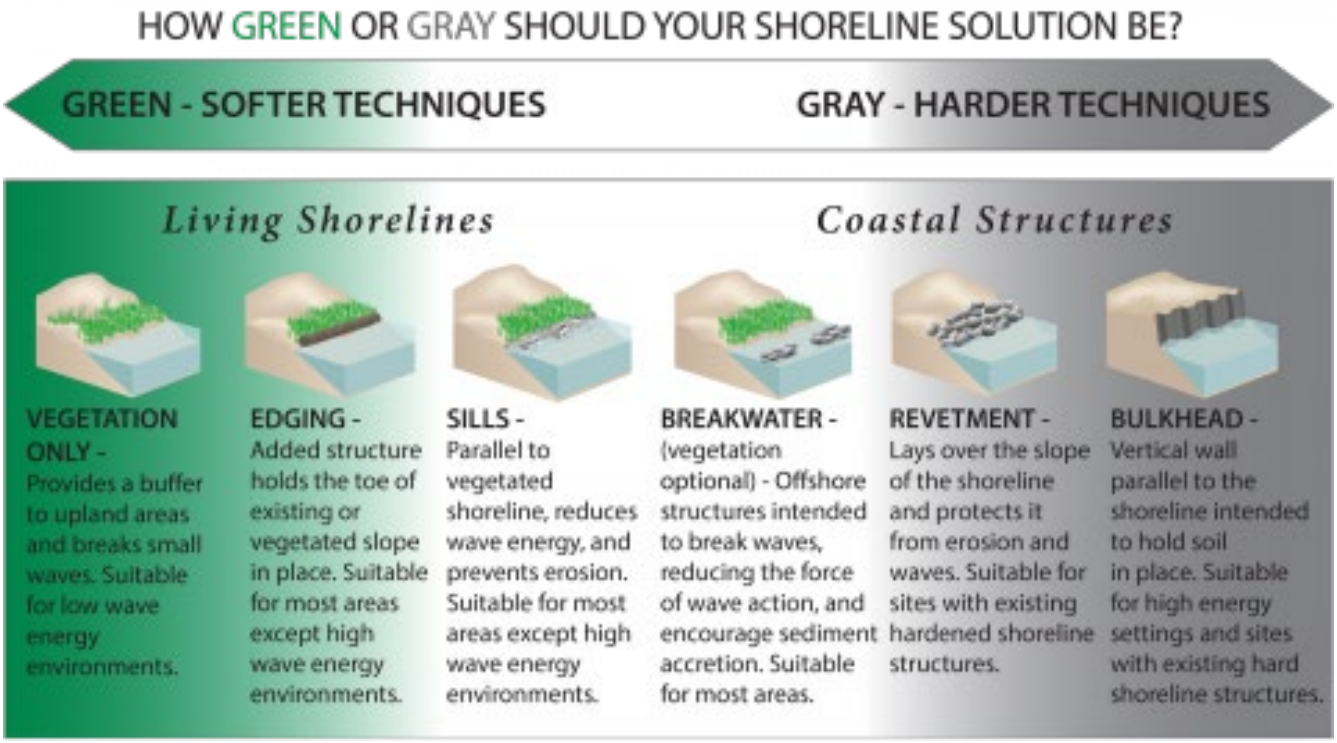

Figure 9a: Shoreline restoration techniques via [NOAA]

Figure 9b: Benefits of Living Shorelines via NOAA

Zone 2:

Zone 2 faces the Long Island Sound and experiences high wave energy, tides, storms, and surges. Therefore a "green" living shoreline will not be suitable. To reduce erosion and maintain the shoreline, dune reconstruction with dense vegetation will be implemented. A series of rock sills (with open spaces between the sills to allow for animals to move in and out) will also be constructed along the shoreline to reduce erosion and dampen wave energy. Vegetation on the dune will be used to maintain structural integrity, prevent erosion and runoff, and create habitats for local wildlife. Marshes behind the rock sills will prevent erosion and maintain coastline integrity while absorbing wave energy.

Dune construction will be utilized along the shoreline in Zone 2 in a similar fashion to Zone 1. Pre-development, the shoreline of Groton Long Point was backed by dunes.[2] By constructing an artificial dune along the shoreline, the beach will be returned to its natural pre-development state. Since the existing beach in Zone 2 is already heavily trafficked and used for recreational purposes, dune construction poses a small risk of habitat destruction. Constructing dunes in fact will encourage breeding and nesting of local wildlife and provide a naturally protected habitat.[10]

Rock sills are lines of rocks constructed horizontally along the shoreline intended to break waves and reduce erosion. Additionally, rock sills absorb wake created by passing vessels.[10] As shown in Figure 10a-b, rock sills are constructed up against the existing shoreline with sand filled in behind on which marsh grass is planted. Sill marshes provide additional protection for the shoreline and reduce wave energy. Sills also allow for the accumulation of sediment and sand between them and the shoreline, elevating the shoreline over time and providing additional protection.[12] The rock sills at Groton Long Point will be constructed from local rock, and will be rough to encourage wildlife growth along them. The sills will be placed along the entire shoreline with short openings about every 100 ft to allow wildlife to pass between the beach and the ocean. Since there is no currently known optimal spacing of rock sills to allow best passage for wildlife, the standard 100 ft will be employed unless further research shows a different pattern is best suited to the environment.[11] In addition to erosion control and coastline protection, rock sills create valuable habitats for fish, shellfish, algae and other water dwelling creatures.[7]

Figure 10a: Rock sill shoreline at NCCOS lab in North Carolina via NOAA

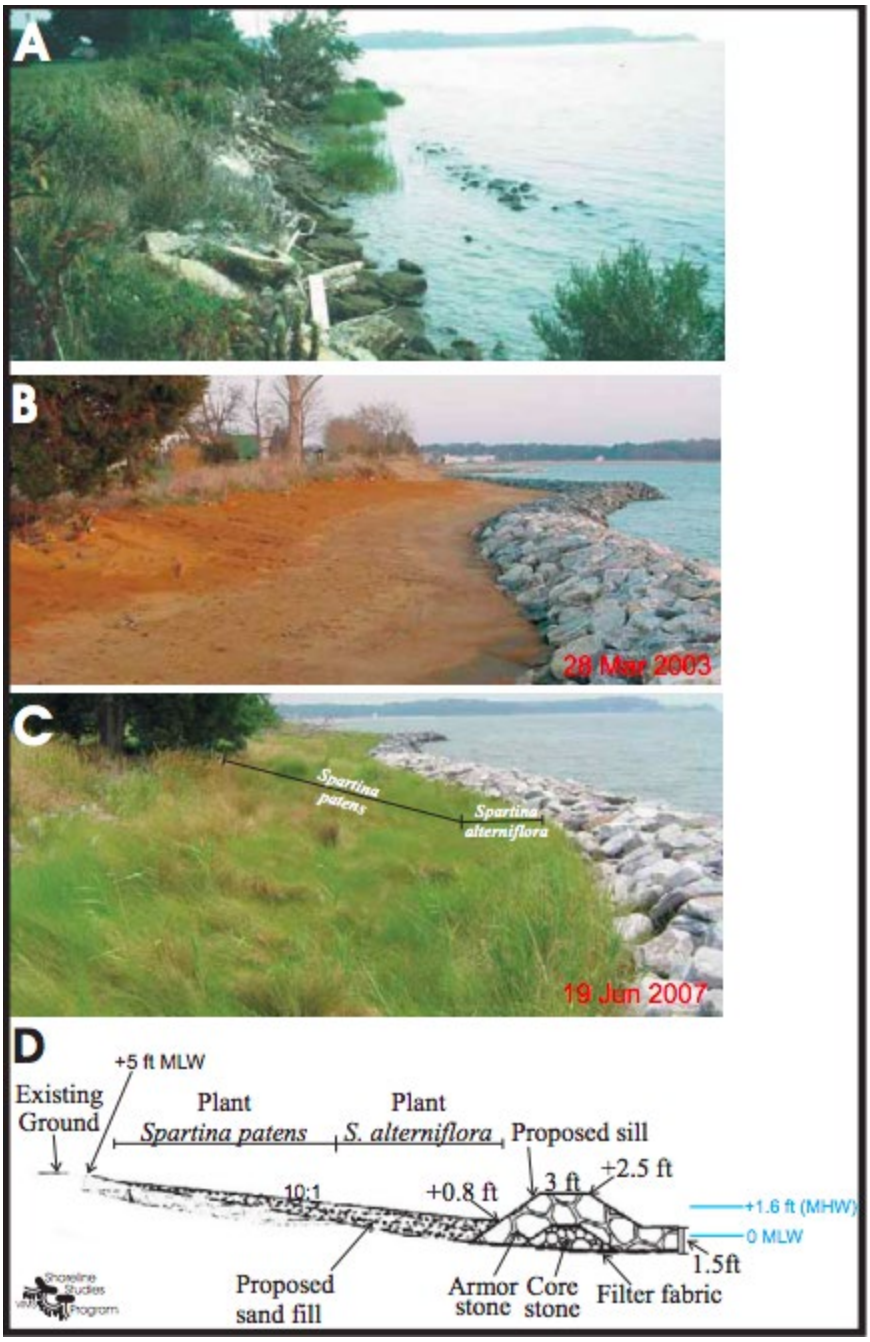

Figure 10b: Progress of stone sill and marsh planting in Webster Field Annex, St. Mary's County, Maryland via [Living Shoreline Design Guidelines for Shore Protection in Virginia's Estuarine Environments]

Zone 3:

Since the marsh in Zone 3 is largely undeveloped, heavy restoration and alteration will not be necessary. Instead, the marsh will be enhanced and protected by additional vegetation and the installation of biologs or coir logs to protect vegetation and the shoreline from sea level rise and storms. Marshes are essential to mitigating erosion and sea level rise, as well as providing essential ecosystem services.[13] By maintaining and enhancing the marsh area on Groton Long Point, floods, sea level rise, and tidal surges will be mitigated, protecting inland areas and infrastructure. Due to their dense vegetation and structure, marshes absorb runoff, rain, and flood water. This same dense vegetation prevents erosion due to wave energy absorption, maintains the shoreline and further prevents coastline loss. Additionally, filtering and cleaning capabilities of marsh grasses and growth reduces pollution and encourages biodiversity.[8]

Figure 11: Coir logs made of natural fibers at Felix Neck Wildlife Sanctuary, MA Source: MA Audubon

Coir logs are large round buffers consisting of fiber wrapped in mesh. Their main purpose is to act as buffers to allow new vegetation to take root and become established without interruption from surges and tides. New vegetation will include additional marsh grasses that will filter, protect, and maintain the marsh shoreline. Coir logs are effective at controlling erosion and protecting shorelines due to their size and makeup; they also have the benefit of being biodegradable. Coir logs are typically placed along a marsh shoreline and staked into place to prevent movement. They are usually planted with marsh grasses poked in through holes in the coir. Overtime, typically around a period of 5-7 years, they will slowly biodegrade and integrate

into the ecosystem while continuing to provide ecosystem services.[7] By the time the logs have degraded, root systems in the marsh will have had proper time to establish themselves and will be able to better resist sea level rise and erosion on their own.[8]

Zone 4:

Zone 4 being at a higher elevation will require less coastline protection measures. This area of GLP averages around 15-20ft in elevation, as seen in Figure 1. Similar to Zone 2, the coastline facing the ocean will be protected with a rock sill and dune reconstruction. Since most of the area is further away from the shoreline, it will be considered a backdune area and be densely vegetated with local plants suited to that environment. This area will be prime for wildlife habitation, and will create a protected environment for nesting and breeding. Though the beach and marsh area will be completely closed to the public, an elevated boardwalk will be constructed out to this area. At the end will be a viewing platform with educational signs and graphics explaining the shoreline restoration process. This boardwalk will serve to educate the public about the process of shoreline restoration and why it is necessary. It will also allow the public to appreciate the area and the view without endangering plants and animals or disturbing the ecosystem.

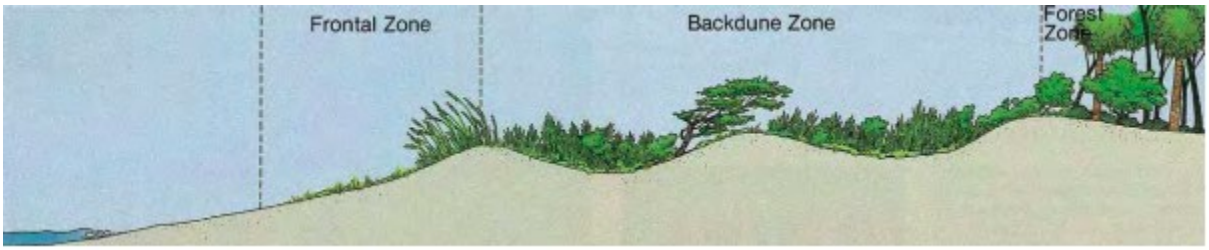

Figure 11: Cross Section of Dune Vegetation Zones via NRCS Native Plants for Coastal Dune Restoration

The backdune area of Zone 4 will be planted with dense local vegetation. This vegetation is less salt and water resistant than foredune vegetation, and more so serves to encourage biodiversity. Many serve as food sources and habitats for wildlife, while stabilizing the dune with deep root networks. The list of selected plants for the backdune area of Zone 4 is listed further down.

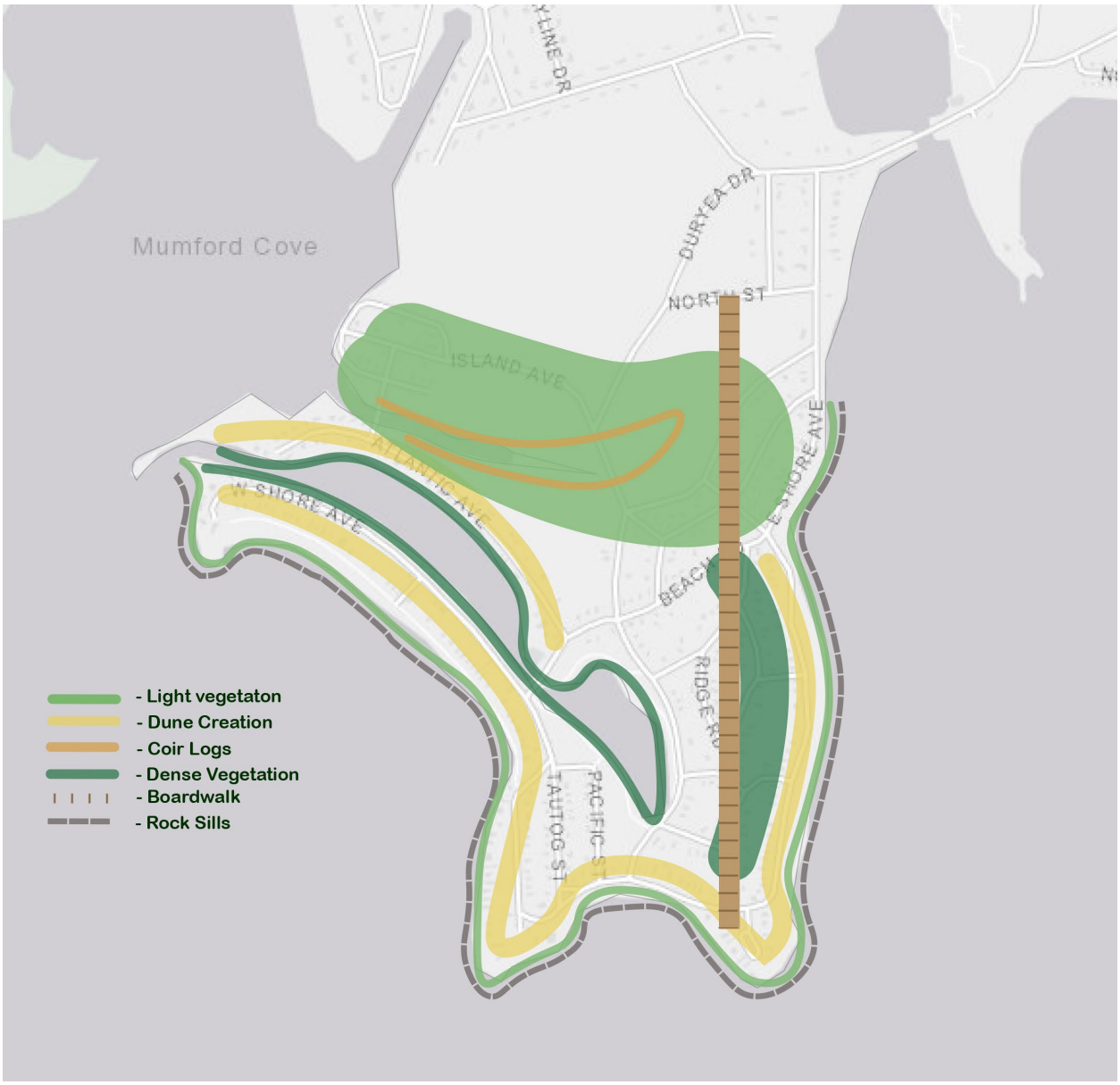

Figure 12: Map of proposed alterations to GLP by Isabel Umland

List of plants necessary for project:

For Dunes/Beach:

The beach will require an entire restructuring and replanting after demolition and removal of infrastructure. Following is a small selection of plants ideal for planting on the exposed coastline that can tolerate salinity and coastline conditions.

American beach grass (Ammophila breviligulata): American Beach Grass is the ideal dune and beach grass, as indicated by its name. The native species has a high salt tolerance and is found on

most northeastern American dunes and beaches. It spreads quickly and easily, and can be used as extensive ground and dune cover to prevent dune collapse and beach erosion.[14][15]

Sea Rocket (Cakile edentula): Sea Rocket is a dune plant native to North America and New England that tolerates harsh weather and soil conditions and provides stabilization. Sea Rocket is also a flowering plant that attracts pollinators, as well as providing a lovely flower to look at.[16] [17]

Virginia rose (*Rosa virginiana):* Is a salt tolerant flowering shrub found along most of the Eastern Seaboard. Virginia rose is often found in dry sandy areas and does well in sunny salty habitats.[14][18]

For Marsh:

The marsh is largely undeveloped and needs little to no restructuring or replanting. The best move is to maintain the current undergrowth, but add support via grasses to stabilize the shoreline and provide more cover for local wildlife. These plants will also be used to create the living shoreline marshes in Zones 1 and 2.

Spikegrass/Saltgrass (Spartina patens): Spikegrass is a marsh grass native to New England that can be found in most marshes. The grass, akin to its name, has a high salinity tolerance and can tolerate wet and marshy conditions. Saltgrass has an essential function in marshes to filter and clean runoff and pollutants from water, providing natural filtration and ecosystem protection. The grass also serves as nesting grounds for local birds and fish, providing protection and breeding grounds to local wildlife. This species grows best in high marshes with infrequent flooding, and will be planted in higher elevated areas of the marsh.[14][19]

Saltmarsh Cordgrass (Spartina alterniflora): Saltmarsh cordgrass is often planted and intermixed with saltgrass in marshes and both provide similar essential functions. Saltmarsh cordgrass has a natural root structure that aerates the soil and provides burrows for crabs and mussels. Similar to saltgrass, saltmarsh cordgrass also provides essential ecosystem functions such as water filtration, erosion prevention, and soil nutrients. This plant is often found in low marshes that experience frequent flooding (daily tidal flooding: two highs and two lows over roughly 24 hours) and will be planted in lower areas of the marsh.[14][20]

For Backdune:

Zone 4 being the highest elevated and most densely populated area will need extensive replanting and revitalization to establish it as a backdune. Backdunes are characterized by having denser vegetation with thicker and more complex root networks. Back Dunes are home to many birds and other coastline dwellers and serve as nesting and breeding sites, burrows, and feeding areas. Along with aforelisted plants such as American beach grass and beach plum, several other species will be planted for beautification, ecosystem services, and dune stabilization.[16]

Northern Bayberry (Morella pensylvanica): A shrub native to North American on the East Coast, Northern Bayberry is a plant often used for dune stabilization for many reasons. The shrub is hardy and can tolerate high salinity and harsh weather conditions. It is well adapted to dune environments, and is well suited for back dune growth, as it encourages growth of more landward vegetation and bridges the gap between foredune and wooded and shrub vegetation away from the shore. The plant is also ideal for wildlife preservation as a food source late into the winter due to winter resistant fruit.[21][14][22]

Seaside Goldenrod (Solidago sempervirens): This plant is a perennial coastal plant that is native to the Northeastern Seaboard. It is ideal for backdune growth as it thrives in the transitional area between coastal dune and grassland. Seaside goldenrod is salt tolerant and drought tolerant, making it an ideal dune candidate. Seaside goldenrod is also essential in preventing erosion and encouraging dune stability, Its long root length allows it to trap sand and soil to prevent erosion. Seaside Goldenrod also provides essential nesting and breeding areas for local birds, including endangered species such as the piping plover. The plant is also flowering and attracts a variety of pollinators, and provides beautiful scenery.[23]

High tide bush (Iva frutescens): High tide bush is a salt tolerant shrub native to New England. It grows well on sandy soils and tolerates salinity and flooding well. These factors make it an ideal candidate for shoreline growth as it can be used as dune cover and in the marsh area.[14][24]

Beach plum (Prunus maritima): This bush has a high salt spray tolerance making it a suitable candidate for coastline growth. This shrub can also be used to stabilize dunes and provide natural ground cover to prevent erosion and coastline loss. It has the added benefit of flowering and fruiting, attracting insects, birds, and wild animals.[14][21][25]

Planting:

All plants will be obtained from nurseries when possible to prevent any harm to existing ecosystems, since the scale and number of plants required is so large. In order to maximize growth and health, planting of most plants will take place in late spring to early summer: April, May and June. Planting can continue into summer if needed.[11] American Beach Grass is typically planted between November and April, with early March being the optimal time.[10]

Maintenance:

The purpose of living shorelines are to be self-maintaining ecosystems that need little upkeep. However, new marshes and dunes are vulnerable to erosion, floods, and storms. Thus, while the living shoreline is in its early stages, plantings will need to be monitored. Additional plantings in the event of a storm or other disturbance will be necessary to maintain the ecosystem and prevent further erosion. If plantings do not take proper root during early spring and summer, additional planting during fall will help develop root systems.[8] Pesticides and herbicides should be used sparingly and only when absolutely necessary. This is to maintain water quality, reduce maintenance, and protect wildlife. Proper steps should be taken to prevent the spread of invasive species in the area. Only locally and federally approved plants should be planted in the area, and proper removal of invasive species should be undertaken when encountered. Phragmites australis and rosa rugosa are two invasive species commonly found on Connecticut beaches. Though these species are not banned in the state, they spread rapidly and overcrowd beaches, endangering other plants.[10] Planting these plants should be avoided at all cost and removed when encountered.

Artificially constructed dunes are typically constructed to be wider and higher than naturally occurring dunes. This is to prevent erosion and prolong the lifespan of said dunes.[8] Dunes that have developed root networks are less vulnerable to erosion, but after storms and floods, some dune nourishment is necessary.[9] The dunes constructed at GLP may need nourishment after storms or every several years to maintain the coastline. Once root networks have been established however, maintenance will be minimal. If erosion begins to occur at a rapid rate, steps can be taken to secure the dune in other ways. Dune fencing and christmas trees are two examples. Securely installed fences in front of dunes can reduce erosion and keep dunes in place

during storms and surges. Sand fencing may interrupt some nesting and breeding habits of local wildlife however. Christmas trees, securely wired together and staked down into the dune can trap sand and sediment that would otherwise erode. However, since these two options can be easily washed away, they need to be securely installed away from the high tide line to maximize effectiveness.[10]

Coir logs should be securely staked into place during installation to prevent migration or dislodgement.

Figure 13a: Sand fencing along a dune in Bogue Banks, NC via NOAA

Figure 13b: Christmas trees used to trap sand at Waterford Beach, CT, via Connecticut Beach Dune Guide

Permits:

Multiple state, local, and federal permits will be required to install the living shoreline. Via DEEP, the Connecticut Department of Energy and Environmental Protection, multiple state permits will need to be obtained. Since the project requires the placement of rock, sand, and fill in CT tidal waters, a Water Quality Certificate is needed from DEEP and the Army Corps of Engineers to ensure adherence to the Clean Water Act and CT Water Quality Standards.[26] The project will also need a Certificate of Permission from DEEP for Beach Nourishment, Tidal Wetland Restoration, and other similar coastline modifications. A general permit from DEEP for Coastal Maintenance is also necessary.[27] Locally, a Town of Groton Land Use Application is required to build on and modify the shoreline.[28] Federally, a CT Regional General Permit for minor activities is needed from the Army Corps of Engineers.[29]

	Local	State	Federal

Applications	Town of Groton Land Use Application		
		Water Quality Certificate	
Permits		DEEP Certificate of Permission	CT Regional General Permit
		DEEP Coastal Maintenance	

Conclusion:

This is a theoretical report based on observable data. This report is far from exhaustive, and further research is necessary to make this proposal effective. Data from experts, local officials, and specialists will be necessary to determine cost and effectiveness, as well as many other factors. These plans rely on the managed retreat of all residents of Groton Long Point as well as the town sanctioned removal of all infrastructure. No cost analysis has been done for this project, and scientific research into the applicability of these methods at Groton Long Point is yet to be done. For these reasons, this plan remains entirely theoretical. Going forward, this plan can be used as a base point for coastline restoration projects on the Connecticut shoreline.

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