

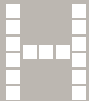
OFFICE
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URBANIZATION

RESEARCH REPORT

Long Beach Is...?
Long Beach Could Be...?
Place-Based Scenarios
for a Cultural Landscape
in a Changing Climate

EDITION

2024



LONG BEACH IS...?
LONG BEACH COULD BE...?
Place-Based Scenarios
for a Cultural Landscape
in a Changing Climate

Harvard University Graduate School of Design
Office for Urbanization

Sarah Whiting, Dean
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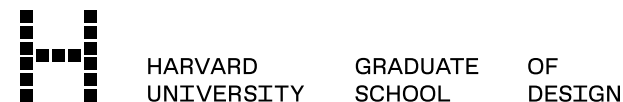
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in a Changing Climate

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This research report documents the work of the 2023-2025 Daniel Urban Kiley Teaching Fellowship in Landscape Architecture at the Harvard University Graduate School of Design. This work builds on the ongoing multi-year collaboration between the Harvard University Graduate School of Design Office for Urbanization, Water Alliance, TownGreen, and the Town of Manchester-by-the-Sea. Additional support for this investigation was generously provided by the Cliff Garten Research Funds.



Kira Clingen, "Aerial photograph of ocean, cottages, and marsh at Long Beach," 2023.

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Acknowledgments

This report documents the work of an investigation at the Harvard University Graduate School of Design's Office for Urbanization from 2023-2024. This work was undertaken as part of the 2023-2025 Daniel Urban Kiley Fellowship in Landscape Architecture, awarded to Kira Bre Clingen. The research and this report would not have been possible without the generous contributions of many people.

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Thank you to Matthew Lioe, Research Assistant, for his diligence drawing sections. Last, but not least, thank you to Sarah Page, Research Associate, for her invaluable perspective, camaraderie, and positive attitude flying drones in freezing temperatures.



Kira Clingen, "Long Beach cottages and seawall composite collage," 2023.

Introduction

What is Long Beach?

Long Beach is a neighborhood on the coast of Rockport, Massachusetts that was developed on top of a sandy barrier beach. Unlike most neighborhoods, the seasonal cottages at Long Beach are owned by individuals and families, while the land underneath the cottages is owned by the Town of Rockport. Cottage owners lease the land from the Town of Rockport in ten-year increments. These lease agreements provide critical revenue for the Town of Rockport. They have also become increasingly contested due to the impacts of the climate emergency.

Some of the families that own cottages in the neighborhood have been coming to Long Beach for decades or even generations, long enough to see this cultural landscape change.¹ These changes include upgrades to cottages, damages to the seawall, and even shifts in the shape of the beach. In the coming years, these changes will accelerate. The impacts of anthropogenic climate change require stakeholders at Long Beach to make decisions about the future of this landscape in the present day. These choices are not new. While the climate emergency accelerates the urgency to make adaptation decisions, many different groups of people have made choices about how to live at Long Beach for thousands of years.²

The individual and collective decisions made at Long Beach about how to develop, play, and use this landscape reflect broader cultural and value systems. Over the past century, these value systems have prioritized development and private property ownership. However, these systems can be difficult to understand when looking at the beach. This report is an exercise in climate “landscape literacy” that establishes an ecological baseline³ and describes how the relationships between people and the Long Beach landscape have changed over time.⁴ This report uses visual storytelling to make these past changes, and the underlying value systems at Long Beach, visible, while building an understanding of future climate projections.

There are many existing reports and studies that have been undertaken to describe and understand Long Beach. These reports include studies by engineering firms on the existing conditions of the seawall, beach, and dune system at Long Beach, as well as municipal reports that document hazards and vulnerabilities in the Town of Rockport.⁵ This report synthesizes the recommendations made in these previous studies, and proposes future scenarios that integrate design and ecological planning.

¹Cultural landscape is a term used by organizations and scholars in many disciplines. The Cultural Landscape Foundation, a non-profit organization, defines cultural landscapes as “landscapes that have been affected, influenced, or shaped by human involvement. A cultural landscape can be associated with a person or event. It can be thousands of acres or a tiny homestead. It can be a grand estate, industrial site, park, garden, cemetery, campus, and more. Collectively, cultural landscapes are works of art, narratives of culture, and expressions of regional identity.” The Cultural Landscape Foundation describes four categories of cultural landscapes: designed, ethnographic, vernacular, and historic sites. Within these categories, Long Beach is a vernacular landscape. “About Cultural Landscapes,” *The Cultural Landscape Foundation*, 2024, www.tclf.org/places/about-cultural-landscapes.

²There are many different decision makers and stakeholders at Long Beach. Each group has made different decisions about the beach, and these choices have not been made in linear or organized processes. The beach is classified and regulated under various political, watershed, geological, and ecological boundaries by different agencies and organizations. These boundaries intersect and overlap, sometimes creating confusion over who has the jurisdiction to make decisions at Long Beach.

³Ecological baselines are important to understand how the environment has changed over time. Shifting baseline syndrome refers to the gradual lowering in accepted norms for the condition of the natural environment. Without past data, memories, or experience with historic conditions, members of each generation accept environmentally degraded conditions as being normal. Fisheries scientist Daniel Pauly first identified the concept of “shifting baseline syndrome” in 1995, describing how fishers and marine scientists use the catch size and species composition in the beginning of their careers as a baseline to compare overtime. Pauly used anecdotes from fishers, as well as local studies, to illustrate how many fish species have been extirpated over time. See Daniel Pauly, “Anecdotes and the shifting baseline syndrome of fisheries,” *Journal of Ecology and Evolution* 10, no. 10 (1995): 430.

⁴Landscape architect Jane Wolff developed a case study of methods to build landscape literacy by “observing, documenting, and reconsidering the complex circumstances that emerge in so many intensely inhabited places.” She uses this method in her book *BAY Lexicon*, which looks at the edge of the San Francisco Bay. Wolff writes that “most people love the landscape better than they understand it.” This is especially true of the wastewater system buried underground, and the species that have been introduced overtime and are only visible during certain times of day or seasons of the year. The landscape architectural drawings in this report are an attempt to continue Wolff’s work of putting “varied, complicated content into language that cuts across disciplinary boundaries and levels of expertise.” Jane Wolff, “Introduction: Why a Lexicon?” *BAY Lexicon* (Montreal: McGill-Queen’s University Press, 2021).

⁵Most recently, the Long Beach Options Committee, created at Rockport Town Meeting in 2021, developed a suite of options for Long Beach. The Committee noted that, if the leases were renewed in 2023, which they were, the Town would have “additional time for long term research and planning.” This report attempts to support these efforts. Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 17.

⁶Scenario planning evolved in corporate boardrooms during the 1980s to assist companies making decisions in an increasingly interconnected and turbulent world. As a methodology, scenario planning is useful in situations with high degrees of uncertainty, including the climate crisis. Therefore, scenario planning is used by the Intergovernmental Panel on Climate Change (IPCC) and other organizations. Place-based scenario planning is derived from *Exploratory Scenario Planning*, which Jeremy Stapleton describes as “a method for cities and regions to create actionable plans for sustainable, resilient adaptation to social, technological, economic, environmental, and political forces beyond their control.” See Jeremy Stapleton, *Exploratory Scenario Planning: How to Navigate an Uncertain Future* (Cambridge, MA: Lincoln Institute of Land Use Policy, 2020), www.lincolnst.edu/publications/policy-briefs/exploratory-scenario-planning

⁷*Compound Vulnerabilities: The Case of Cape Ann and Regenerative Landscapes: From Conservation to Adaptation* are two scenario planning reports completed in collaboration with the City of Gloucester, Town of Manchester-by-the-Sea, Town Green, and Water Alliance. The projects are accessible at: capeann.officeforurbanization.org. Charles Waldheim/Office for Urbanization, *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Harvard University Graduate School of Design, 2022) and Charles Waldheim/Office for Urbanization, *Regenerative Landscapes: From Conservation to Adaptation* (Cambridge, MA: Harvard University Graduate School of Design, 2024).

⁸The National Oceanic and Atmospheric Administration defines a watershed as “a land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean.” Watersheds are defined by topography. Water flows from high points, or ridges, downhill, eventually draining into the ocean. The path that water takes downhill defines the boundaries of a watershed. “What is a watershed?” National Oceanic and Atmospheric Administration, 2024, www.oceanservice.noaa.gov/facts/watershed.html

⁹Watersheds are identified across multiple scales, from local to regional. Long Beach belongs both to the North Coastal Watershed, a sub-watershed that covers 168 square miles on the North Shore of Massachusetts, and also the Gulf of Maine watershed. Philip W. Conkling, founder of the Island Institute, a non-profit organization dedicated to the islands and waters of the Gulf of Maine, argues that we must understand the watershed to understand any individual place along the Gulf of Maine. He writes, “the problems that confront us are symptomatic of our failure to think of the region as an interconnected whole, as an ecosystem.” See Philip W. Conkling, *From Cape Cod to the Bay of Fundy: An Environmental Atlas of the Gulf of Maine* (Cambridge, MA: MIT Press, 1995): 5.

This report is organized in two parts: *Long Beach Is...?* and *Long Beach Could Be...?* These parts can be read as a single report from cover to cover, or separately, depending on the level of interest of the reader.

Long Beach Is...? is a cultural landscape story that describes how Long Beach has changed physically, ecologically, and culturally since colonization, how Long Beach is changing now, and how Long Beach will continue to change in the future due to the impacts of climate change. This chapter uses archival maps, municipal reports, photographs, and architectural drawings to illustrate the ongoing story of waves, weather, plants, animals, and people in the Long Beach landscape over thousands of years.

Long Beach Could Be...? is a place-based scenario planning exercise that describes and compares six plausible, alternative futures for the neighborhood. This chapter uses architectural drawings and mapping to prompt decision-makers toward climate adaptation choices in the near future.

Place-based scenario planning is a form of long-term strategic planning unique to the design disciplines.⁶ This method is used to create images of multiple plausible futures to inform decision-making in the present. While place-based scenario planning uses probabilistic scientific data and engineering models that forecast future climate impacts, the method shifts emphasis from statistical probability to ways of thinking about the future. The goal of scenario planning is not to predict the most likely outcome, but to reveal biases and blind spots in complex and non-linear situations, like climate change and municipal adaptation planning. This report builds on the multi-year place-based scenario planning exercise undertaken by the Office for Urbanization at the Harvard University Graduate School of Design that looks at climate adaptation across the Cape Ann region.⁷

The place-based scenario planning exercise addresses challenges and opportunities around climate adaptation on Long Beach, while recognizing that the neighborhood is connected to the broader cultural, infrastructural, and ecological systems in Rockport, across Cape Ann, and throughout the greater Gulf of Maine watershed.^{8 9} The Gulf of Maine is a semi-enclosed international watershed in the northeastern Atlantic, stretching from the Bay of Fundy in Canada south to Cape Cod in the United States of America.¹⁰ Like Long Beach and its unique land ownership structure, the Gulf is an outlier. It is warming 97% faster than other oceans on the planet. Warming sea surface temperatures, storm surge, and sea level rise will bring many changes to communities

¹⁰The underwater topography of the Gulf includes ridges on the Georges and Browns Banks that create a nearly enclosed circulatory system of ocean currents. Warmer water south of Cape Cod and colder waters from the northern oceans combine in the Gulf of Maine, creating unique ecosystem conditions, and high marine productivity in the Gulf. See Christopher Leahy, John Hanson Mitchell, and Thomas Conuel, *The Nature of Massachusetts* (Reading, MA: Addison-Wesley Publishing Company, Inc., 1996), 27.

¹¹The writer Amitav Ghosh cautions against seeing climate change as “radically new,” or to imagine that the climate change era is a “break from the past” with “phenomena that are waiting to be identified as unprecedented and utterly novel.” Instead, he writes that it’s important to understand how climate change exacerbates existing issues around displacement, justice, and migration. Amitav Ghosh, “A Fog of Numbers,” *The Nutmeg’s Curse: Parables of a Planet in Crisis* (Chicago: University of Chicago Press, 2021).

¹²Political scientists Kelly Levin, Benjamin Cashore, Steven Bernstein, and Graeme Auld define a “super wicked problem” as having “four key features: time is running out; those who cause the problem also seek to provide a solution; the central authority needed to address them is weak or non-existent; and irrational discounting occurs that pushes responses into the future.” See Kelly Levin, Benjamin Cashore, Steven Bernstein, and Graeme Auld, “Playing it forward: Path dependency, progressive incrementalism, and the “Super Wicked” problem of global climate change,” *IOP Conference Series: Earth and Environmental Science* 6 (2009): 1-7.

¹³The term “polycrisis” was first coined by the French theorist Edgar Morin, but became popular in 2016 as a way to describe the challenges of governance in the 21st century, which require changes to the dominant economic and social structures to address these intersecting crises. See Michael J. Albert, *Navigating the Polycrisis: Mapping the Futures of Capitalism and the Earth* (Cambridge, MA: MIT Press, 2024).

¹⁴Amitav Ghosh notes how climate change is understood through research and data in the western world, which is often contained to academic and professional environments. He writes, “while there is every reason to be grateful to climate scientists and other specialists for the work they do, this should not obscure the fact that academically credentialed experts are by no means the only diviners of climate change. People who make their living from the land, or the forest, or the sea have also known, for a while, that the Earth’s physical realities are changing dramatically.” The author acknowledges that she does not live on Long Beach, and is less familiar with the changes in this landscape than the people who live in the neighborhood, walk their dogs across the beach, or live on Cape Ann. This report is not a substitute for community-driven action. Instead, it aspires to contribute design thinking and visual storytelling to the ongoing dialogue around adaptation at Long Beach. See Amitav Ghosh, “A Fog of Numbers,” *The Nutmeg’s Curse: Parables of a Planet in Crisis* (Chicago: University of Chicago Press, 2021).

along the Gulf of Maine coastline. The scenarios outlined for adaptation at Long Beach therefore apply to other barrier beach systems along the Gulf.

While climate change is accelerating landscape changes, the climate impacts we are experiencing in the twenty-first century are the result of past choices.¹¹ These choices include emitting fossil fuels into the atmosphere while developing coastal areas, filling wetlands, and paving the ground with impervious surfaces. While these were historically piecemeal choices made by different actors and enabled by different policies, these decisions have created a “super wicked problem” that requires governments, institutions, and policies to respond with forward-looking decisions on medium and long-term time horizons. This counteracts our tendency as consumers and voters to prioritize immediate, individual interests and delay required collective long-term adaptations.¹²

Adaptation also requires us to acknowledge climate change as one part of an ongoing polycrisis, in which many disparate crises interact.¹³ On Long Beach, the decay of public infrastructure, inflated construction costs, increasingly extreme weather, biodiversity loss, and the failure to mitigate climate change intersect. Decision-making in the polycrisis requires a synthetic understanding of how potential risks and solutions interact with each other. At Long Beach this provides an opportunity to make adaptation decisions that can potentially mitigate risk to life and property, address the housing crisis in Rockport, and restore the barrier beach ecosystem.

This report is not a master plan. The maps, drawings, diagrams, and images in this report are to be used for illustrative purposes only. The author of this report is not authorized to make any decisions about the future of Long Beach.¹⁴ Instead, this report is intended to assist stakeholders at Long Beach in understanding the landscape at Long Beach and how it is changing in service of climate adaptation.

Footnotes on the left-hand page define terms, sources, and provide additional resources for the text on the right-hand page.

¹Practice Landscape, *Park Lake Ecological Assessment* (New York: Practice Landscape, 2024), www.practicelandscape.com/project/plsubwatershed

How to Read this Report: Text

The primary text in this report is printed on the right-hand page. The left-hand page includes footnotes that define terms and provide additional references and resources for the primary text.¹

This report is divided into two chapters: the Cultural Landscape Story and Place-Based Scenario Plan.

The Cultural Landscape Story includes three sections:

- How has Long Beach Changed?
- How is Long Beach changing?
- How will Long Beach continue to change?

The Place-Based Scenario Plan includes three sections:

- Critical Certainties
- Critical Dialectics
- Scenarios

References are listed at the end of the report, along with a list of additional resources for people interested in learning more about scenario planning, Long Beach, and the Gulf of Maine watershed.

¹The visual analysis in this report includes multimedia modes of representation that center on the landscape at Long Beach. This analysis is a contribution to a larger discourse in architecture and design around the use of representation to visualize alternative futures. Architect Kenneth Frampton outlines this argument succinctly, writing, “At broad scales, the creative use of landscape representation to project alternative futures for urban form, infrastructure investment, ecological restoration and environmental management can be a powerful counter to the technocratic dominance of other forms of knowledge. The understanding of the particularity and distinction of local and regional landscapes can provide a point of resistance to the homogenizing effects of globalization.” See Kenneth Frampton, “Toward a Critical Regionalism: Six Points for an Architecture of Resistance,” in *The Anti-Aesthetic. Essays on Postmodern Culture* (Port Townsend, WA: Bay Press, 1983), 16–30.

How to Read this Report: Imagery

There are different forms of visual analysis¹ in this report, including:

Drone Imagery: Three drone flights were completed in 2024. Drone images are perspectival views of the Long Beach landscape and its surroundings, as well as planometric views looking downward. Drone photography is used to capture the landscape at a higher resolution than satellite imagery.

Historic Imagery: Archival photographs and historical maps from the United States Geological Survey, Town of Rockport, Library of Congress, Sawyer Free Library, and Massachusetts Digital Commonwealth are included in this document.

Sections: Sections, or cross-sections, are drawings that use an imaginary cutting plane through the ground as though it has been sliced in half. These drawings show the vertical relationships between elements that are above-ground, like trees, utility poles, homes, and subsurface structures like roots, wastewater pipes, foundations, and soils.

Maps: Maps are drawings on a horizontal plane that show the features of a place. Maps are scaled drawings that highlight physical, administrative, and ecological features.

Plans: Plans are drawings on a horizontal plane that show the horizontal spatial relationships between features and objects. The plans in this report document existing relationships and illustrate proposed future scenarios.

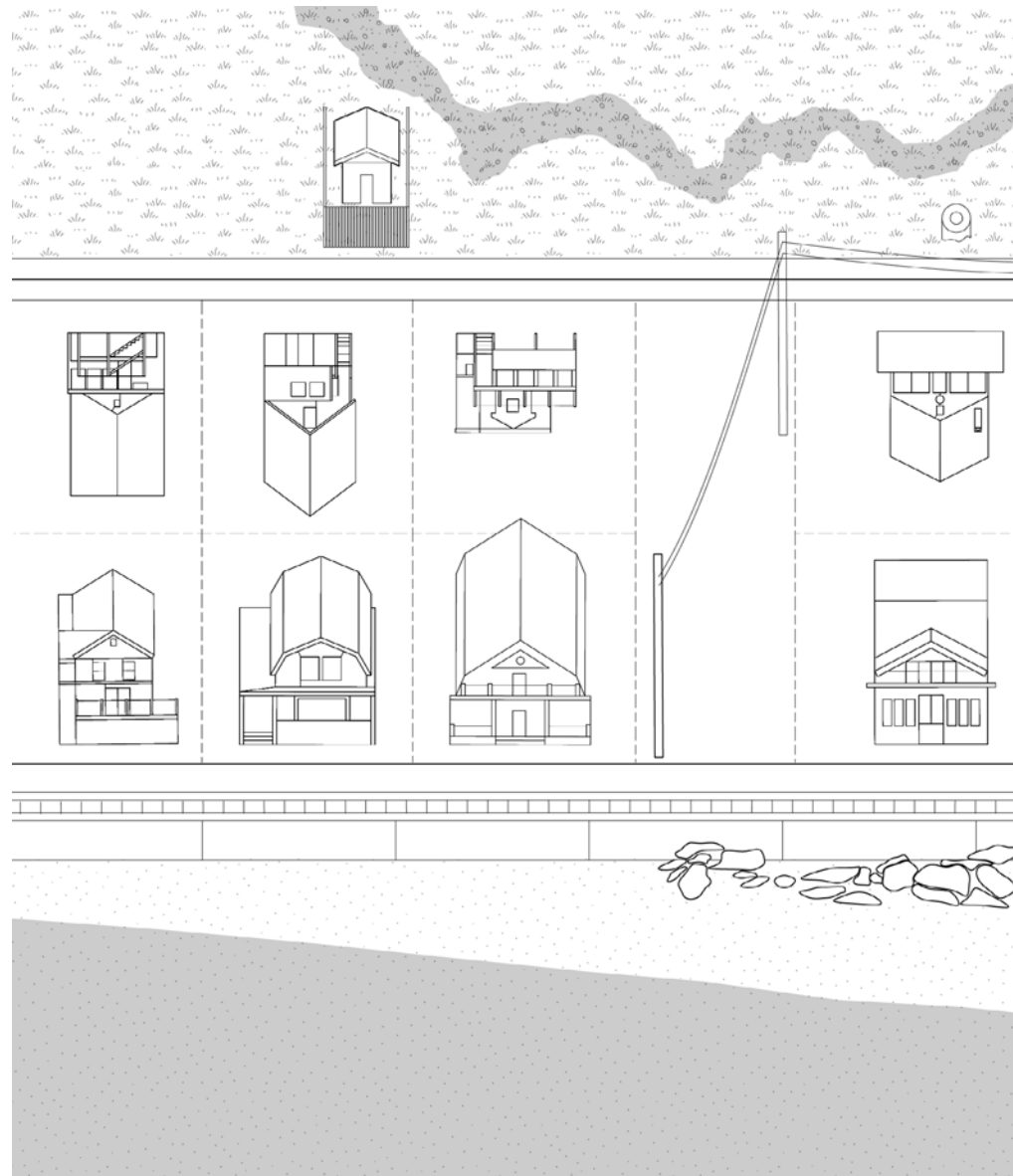
Site Photographs: Four site visits were conducted from summer 2023 to summer 2024. Photographs of the seawall, cottages, infrastructure systems, and marsh from these visits are included in this report.

Timeline: Timelines are graphic representations of events that are arranged chronologically along a line.

Found images that were not produced by the author are presented on a gray background. This includes archival postcards, photographs, and maps, as well as municipal and consulting reports.



Kira Clingen, "Long Beach looking northeast toward Thatcher Island," 2024.



LONG BEACH IS...?

LONG BEACH COULD BE...?

A Cultural Landscape Story

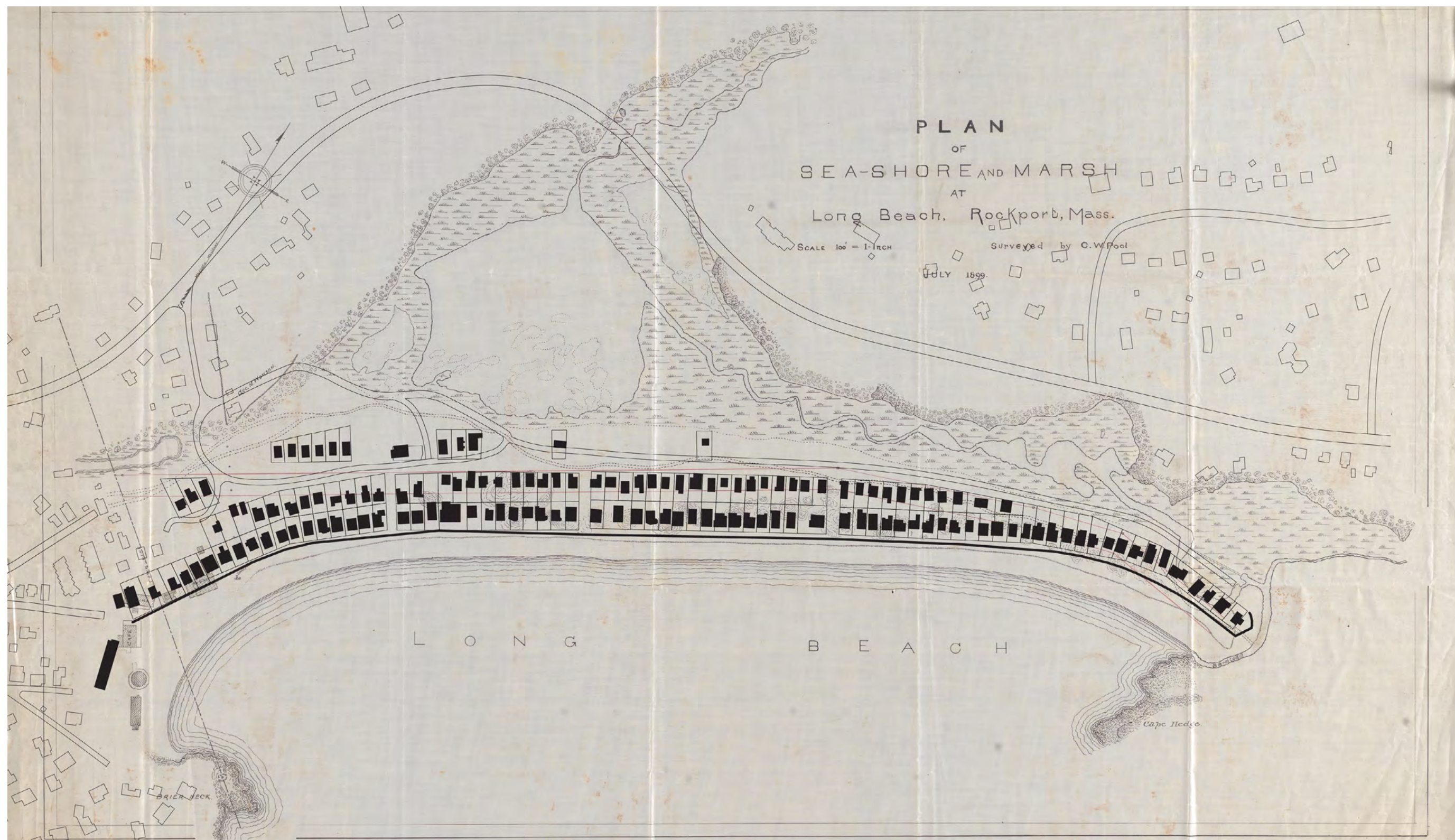


Kira Clingen, "Saratoga tidal creek and Cape Hedge cobble berm," 2024.

How has Long Beach Changed?

“Long Beach is a living tapestry woven with the threads of our town’s history.”

- Preserve Long Beach, 2023



C.W. Pool, *Plan of sea-shore and marsh at Long Beach, Rockport, Mass.*, map, Digital Commonwealth, 1899 with overlay of cottages, seawall, and roadways by Kira Clingen, 2024.

What is the underlying geology at Long Beach?

Four-hundred and fifty million years ago, the underlying bedrock at Long Beach, appropriately named “Cape Ann granite,” was formed.¹ At that time, during the Pleistocene epoch,² the sea level was significantly lower, and the coastline extended sixty miles east of its present-day location.³ Just over 10,000 years ago, at the end of the last ice age during the Quaternary Period, the Laurentide ice sheet retreated from eastern Massachusetts. The glacier scraped across the sea floor, scouring the Cape Ann granite bedrock as rock, sediment, and sand⁴ dropped out of the glacier.^{5 6}

After this period, sea levels rose. A sediment core taken from Saratoga Marsh behind Long Beach suggests that the area was a freshwater marsh⁷ before sea levels rose and the wetlands transitioned to salt marsh as salinity⁸ levels increased.^{9 10} This transition likely occurred on Cape Ann around 3,000 to 4,000 years ago, when sea level rise slowed to around 0.2 and 1.6 millimeters per year, and spit beaches¹¹ formed along headland coasts. The dual processes of glacial retreat and marine erosion shaped the string of barrier beaches stretching from Good Harbor Beach to Pebble Beach on the southeastern side of Cape Ann. These geomorphological processes lay the foundation of Long Beach’s story.

¹At Long Beach, the Cape Ann granite is more specifically identified as alkali-feldspar granite with quartz content 15-25%. See W.H. Dennen, *Bedrock geologic map of the Gloucester and Rockport Quadrangles, Essex County, Massachusetts*, Office of the Massachusetts State Geologist Digital Conversions Series 07-01. Scale 1:24,000, 1992.

²An epoch is a unit of geologic time. Each epoch is defined by global-scale changes to planet Earth. There is currently a debate in the field of geology as to whether the Holocene epoch has ended, and whether we have moved into a new epoch, called “the Anthropocene” epoch. The term “Anthropocene” was first coined by a Russian geologist in 1922, and refers to the “magnitude, variety, and longevity of human-induced changes, including land surface transformation and the changing of the atmosphere.” Geographers Simon L. Lewis and Mark A. Maslin suggest that the start of the Anthropocene is either in 1610 or 1964. The choice of date is important, as it places emphasis on the arrival of Europeans in the Americas, or the first use of the Atomic bomb as defining moments in our planet’s history. See Simon L. Lewis and Mark A. Maslin, “Defining the Anthropocene.” *Nature* 519 (2015): 171–80.

³At this time, the sea level was 400 feet lower than it is today. A small vertical fall in sea-level creates a great horizontal retreat of the shoreline. Similarly, a small vertical rise in sea-level creates a great horizontal advance in sea level. See Jeffrey R. Benoit, *Massachusetts Shoreline Change Project* (Boston, MA: Office of Coastal Zone Management, 1989), 5.

⁴Sand is defined by grain size, and has many different compositions. The Massachusetts Office of Coastal Zone Management defines sand as “loose material which consists of grains ranging between 0.0625 and 2.0 millimeters in diameter.” Carl Carlozzi, Kathryn King, William F. Newbold, Jr. *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 62.

⁵Geologist and Cape Ann resident Martin E. Ross self-published a detailed book on the geological history of Cape Ann. See Martin E. Ross, *Cape Ann: Its Physical and Environmental Geology* (Gloucester, MA: Martin E. Ross, 2015).

⁶Rockport Open Space and Recreation Committee, *Open Space and Recreation Plan for the Town of Rockport* (Rockport, MA: Town of Rockport, 2018), 22.

⁷The Massachusetts Office of Coastal Zone Management defines a marsh as a “treeless form of wetland, often developing in shallow ponds or depressions, river margins, tidal areas, and estuaries. Marshes may contain either salt or fresh water. Prominent among the vegetation of marshes are grasses and sedges.” Carl Carlozzi, Kathryn King, William F. Newbold, Jr. *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 61.

⁸The Massachusetts Office of Coastal Zone Management defines salinity as “a measure of the quantity of dissolved salts in sea water. Formally defined as the total amount of dissolved solids in sea water in parts per thousand (0/00) by weight when all the carbonate has been converted to oxide, the bromide and iodide to chloride, and all organic matter is completely oxidized.” Carl Carlozzi, Kathryn King, William F. Newbold, Jr., *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 62.

⁹Chelsey L. Pino and J. Bradford Hubeny, “Late Quaternary Stratigraphic History of the Saratoga Creek Salt Marsh, Rockport, MA,” Marine and Coastal Science poster, Geological Society of America Northeastern Section 51st Annual Meeting, 2016.

What did the landscape at Long Beach look like pre-Colonization?

Long Beach is a vernacular landscape¹² that has been shaped by Agawam and Pawtucket peoples, colonial settlers, and their descendants.¹³ There is a pervasive myth that indigenous peoples did not terraform, build, or change the landscape in the region that is now known as New England, and that European colonists arrived to find a pristine continent that had been shaped only by waves, wind, and sunlight. This is far from the truth. Indigenous peoples on Cape Ann had shaped and stewarded the region’s ecosystems for thousands of years before European colonists arrived beginning in 1605, when the French explorer Samuel de Champlain sailed to Long Beach.

De Champlain wrote in his journal, “having gone half a league we perceived upon a rocky point [Emmons Point] several Indians who ran dancing along the shore [of Long Beach] towards their companions to inform them of our coming.” His ship anchored near Salt Island, off the coast of contemporary Good Harbor Beach before sailing south.¹⁴ The following year, in 1606, de Champlain returned and drew *le Beau port, a map drawn for Les Voyages*.¹⁵ The map includes a series of three rolling dunes in the location of Good Harbor Beach, and Salt Island offshore, cutting off before Brier Neck. He describes the landscape, including the islands offshore, as being heavily forested.¹⁶

The colonists after de Champlain brought new plant and animal species that transformed the landscape, as well as an exclusive sense of property, fixed boundaries, permanent settlements, and a capitalist economic system.¹⁷ The colonists not only introduced new systems, they also built over existing indigenous development, including gardens, shell middens, and hunting grounds.¹⁸

Within twenty years of de Champlain’s first voyage to Cape Ann, the indigenous population of Essex County was decimated by European disease and colonial violence.¹⁹ While his map and his journal provide limited textual and visual descriptions of the environmental and geological conditions on Cape Ann prior to European colonization, other historians and local authors can contribute to our understanding of how Long Beach has changed since the arrival of European colonists.

¹⁰The Saratoga Marsh formed during the same period as the New England Great Marsh. Geologist Duncan M. Fitzgerald and his colleagues drew this conclusion from studying the Great Marsh, the largest salt marsh in New England, spanning from northern Massachusetts to southern New Hampshire. The paper provides background information on how the marshes across New England were formed, and how they are likely to change due to sea level rise. The scientists find that “large portions of the high marsh are likely to be converted to low marsh by 2050, and that the entire marsh high platform will become low marsh prior to 2070.” Duncan M. Fitzgerald *et al.*, “Largest marsh in New England near a precipice,” *Geomorphology* 379 (2021), 107625.

¹¹The Massachusetts Office of Coastal Zone Management defines a spit beach as a “small, elongated point of land, mostly sand, extending into a body of water.” Spit beaches are a type of barrier beach that is connected to the mainland at one end. Spit beaches develop due to littoral currents, which are “currents moving parallel to the shore, usually developed by wave fronts that have an angular approach to the shore. The current causes shifting of beach sand along the shore.” Spits often develop between headlands, or points of land with sheer drops that are surrounded by water on three sides. Long Beach developed between the granite headlands of Brier Neck and Cape Hedge. Carl Carlozzi, Kathryn King, William F. Newbold, Jr. *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 61-62.

¹²The Cultural Landscape Foundation defines vernacular landscape as one category of cultural landscape. Vernacular landscapes “are landscapes that evolved through use by the people whose activities or occupancy shaped those landscapes. Through social or cultural attitudes of an individual, family, or a community, the landscapes reflect the physical, biological, and cultural character of those everyday lives.” “Vernacular Landscapes,” *The Cultural Landscape Foundation*, 2024, www.tclf.org/vernacular-landscapes

¹³Native Land is an online, community driven map that identifies the traditional stewards of Native American Lands. The aim of the initiative is to “help map Indigenous territories, treaties, and languages.” “Native Land Map,” *Native Land*, 2024, <https://native-land.ca>

¹⁴Historian Marshall H. Saville has annotated Samuel de Champlain’s journals with the modern-day locations of his travels. See Marshall H. Saville, “Champlain and his Landings at Cape Ann, 1605, 1606,” *American Antiquarian Society* 43, part 2 (Oct. 1933): 447-469.

¹⁵Samuel de Champlain, *le Beau port*, map drawn for Les Voyages, printed in Paris, 1613.

¹⁶On his second voyage, Samuel de Champlain described the trees as nut trees, sassafras, oaks, ashes, and beeches. Marshall H. Saville, “Champlain and his Landings at Cape Ann, 1605, 1606,” *American Antiquarian Society* 43, part 2 (Oct. 1933): 459.

¹⁷See William Cronon, *Changes in the Land: Indians, Colonists, and the Ecology of New England* (New York: Hill and Wang, 1983).

¹⁸Mary Ellen Lepionka is an independent scholar whose research centers the Indigenous history of Essex County. She researched and wrote about the evidence of indigenous settlements on Cape Ann, including trails that connected the main Indigenous villages. While she has not written about indigenous uses on Long Beach specifically, one of the trails became the basis for Route 127A, or Thatcher Road, the emergency evacuation route from Long Beach that cuts through the Saratoga Marsh. Mary Ellen Lepionka, “Where were the Indigenous settlements in Essex County?” *Indigenous History of Essex County, Massachusetts*, 2024, www.capeannhistory.org

¹⁹See Mary Ellen Lepionka, “What is the Real Story of the English Occupation of Cape Ann?” *Indigenous History of Essex County, Massachusetts*, 2024, www.capeannhistory.org

²⁰ Allen Chamberlain, *Pigeon Cove: its early settler and their farms, 1702-1840* (Pigeon Cove: Village Improvement Society of Pigeon Cove, 1940), 14.

²¹ C.W. Pool, *Plan of sea-shore and marsh at Long Beach, Rockport, Mass.*, map, Digital Commonwealth, 1899.

²² Thomas E. Babson, “Evolution of Cape Ann Roads and Transportation, 1623-1955,” *Essex Institute Historical Collections* Vol XCI (1955): 326.

²³ Thomas E. Babson, “Evolution of Cape Ann Roads and Transportation, 1623-1955,” *Essex Institute Historical Collections* Vol XCI (1955): 327.

²⁴ Thomas E. Babson, “Evolution of Cape Ann Roads and Transportation, 1623-1955,” *Essex Institute Historical Collections* Vol XCI (1955): 325.

²⁵ The Boston and Northern Street Railway, *Boston and Northern Street Railway*, map, 1906.

²⁶ The Seashore Trolley Museum in Kennebunkport, Maine collects and displays historic trolley line cars that were used across the New England seashore from Massachusetts to Maine.

How did people access Long Beach?

According to historian Allen Chamberlain, “the Town [of Rockport] laid out a road from Long Cove, now Rockport Harbor, to Starknaught Harbor beach landing, now Little Good Harbor beach, and so to Gloucester” in 1708.²⁰ Nevertheless, the road does not appear in C.W. Pool’s 1905 *Plan of sea-shore and marsh at Long Beach, Rockport, Mass.*²¹

Rockport resident and namesake of the Babson Reservoir, Thomas E. Babson, describes how people arrived at the pavillion in the early twentieth century via an electric trolley ran from Gloucester to Rockport. The “double wire and trolley pole system” of railways ran adjacent to Thatcher Road behind the Saratoga Marsh complex, with “spurs to Rocky Neck and Long Beach.”²²

Babson writes, “the line to Long Beach opened in June 1895, and operated only in summer. The early type of open cars with single trucks were used on it. They had a habit of galloping like a horse. Guard bars were let down on both sides before the crossing the trestle that carried the tracks over the sandy marsh behind Litle Good Harbor Beach. Even so, a careless passenger was occasionally tossed of into the dunes.”²³

The trolleys delivered people, as well as goods, to Long Beach. Babson writes that “merchandise was sold door-to-door from wagons built to their special purposes: meat, fish, fruit and vetetables, ice, bread and pastry, soap and tallow - and there were even chair and ladder trucks.”²⁴

Long Beach was just one destination in a much larger network of trolleys running along the eastern coast of Massachusetts. These railways began as local companies that were absorbed in a series of mergers. The Gloucester and Rockport Street Railway, including the tracks on the Rockport spur, were transferred to the Boston and Norhern Street Railway system in 1901. A 1906 map of the Boston and Northern Street Railway System, which absorbed the Gloucester and Rockport, shows the Long Beach terminus and routes into Boston. By 1936, the trolley railway was not in use.^{25 26}

The spur to Long Beach is now Rockport Road. Nonetheless, there is a history and precedent of mass transit bringing residents and tourists to Long Beach that has fallen away in favor of personal automobiles in the twenty-first century.

What was the ecology of Long Beach before the cottages were constructed?

Henry C. Leonard, a chaplain and author of the local history *Pigeon Cove and Vicinity*, described the profile of the beach and the wood behind it in 1873. Leonard writes, “Between Cape Hedge and Brier Neck, the half mile of Long Beach is of sand, and wide and smooth; but behind the sand, hardened by the tramping waves, are sand-knolls thrown up by the winds.”²⁷

At that time, the beach was covered by sand dunes that shifted gradually with the seasons, and dramatically during major storms. During the summer months, gentle waves brought sand onto the beach, creating a high, steep beach profile with a small offshore sand bar. During the winter, powerful nor’easters and erosive wave action flattened the steep beach profile that accumulated during the summer, creating a much larger sandbar offshore.²⁸ These dynamic processes allow barrier beaches like Long Beach to respond to wind and waves by migrating over the seasons. After major storms, when overwash shifts sand inland, beach grass often grows on overwash fans, trapping windblown sand, and forming new dunes. These dunes then dissipate wave energy, protecting vegetation and development inland of barrier beaches like Long Beach.²⁹

Leonard continues, “Long Beach is backed by a marsh. On rising ground behind the marsh, and spreading over hundreds of acres receding to Cape Pond and Beaver Dam, is a grand wood but slightly damaged by the ruthless axe.”³⁰

The “ruthless axe” refers to the deforestation of Cape Ann’s forests. Colonists chopped gray birch (*Betula populifolia*) trees for firewood, and logged eastern white pines (*Pinus strobus*) for shipbuilding.³¹

Leonard does not describe any buildings on Long Beach in 1873, and it is unclear when the first cottages were erected at Long Beach. The Procter Brothers, who published a volume titled *Pleasure drives around Cape Ann* in 1896, noted cottages on Long Beach as early as that year. They also describe how day trippers accessed the beach via public transportation.

The Procter Brothers write, “We also see... the trestle over which the Long Beach cars, freighted with human beings, run to that beautiful spot, Long Beach, where the Casino and the hills and dales, massive boulders and smooth beach afford amusement and delight to the thousands of pleasure seekers. Here are many cottages, also, occupied by out-of-town people.”³²

²⁷ Henry C. Leonard, *Pigeon Cove and Vicinity* (Boston, MA: F.A. Searle, 1873), 102.

²⁸ See Carl Carlozzi, Kathryn King, William F. Newbold, Jr., *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 22-30.

²⁹ The Massachusetts Office of Coastal Zone Management has published several guides to barrier beach management. These guides describe and inventory these unique coastal resources. See Massachusetts Barrier Beach Task Force, *Guidelines for Barrier Beach Management in Massachusetts* (Boston: Office of Coastal Zone Management, 1994), 13.

³⁰ Henry C. Leonard, *Pigeon Cove and Vicinity* (Boston, MA: F.A. Searle, 1873), 102.

³¹ Ecologist William Cronon writes that “colonists were usually far more interested in conserving their own labor than in using available timber resources to the full,” about the deforestation of the New England landscape during the colonial period. See William Cronon, “Taking the Forest,” *Changes in the Land: Indians, Colonists, and the Ecology of New England* (New York: Hill and Wang, 1983).

³² Procter Brothers, *Pleasure drives around Cape Ann* (Gloucester, MA: Procter Brothers, 1896), 24.

When were the cottages constructed at Long Beach?

Despite Leonard's written description, no cottages appear on the *Plan of Sea-Shore and Marsh at Long Beach, Rockport, Mass* drawn by Surveyor C.W. Pool in July 1899. The drawing shows buildings on the Gloucester side of the dune, including a café, casino across the town boundary in Gloucester, and two buildings, labelled “Kenney” and “Morgan” on the Rockport side. Pool draws what appears to be the sandy knolls, as well as the tidal marsh, salt pannes,³³ and a foot path across the beach between the ocean and the marsh. Thatcher Road does not appear on the drawing. The Saratoga tidal channel³⁴ meanders through the marsh into a large tidal pond that empties during low tide and fills during high tide. Pool or his predecessor drew two parallel red lines through a series of stone posts that may indicate the proposed location of the roads.³⁵

In May 1904, Rockport Town Engineer Harrison P. Wires drew the *Plan of Property of the Town of Rockport, Mass., at Long Beach Showing Layout of Lots*. Wires drew four rows of 185 lots with three roads in the locations of the current day firebreaks. A footbridge from Cape Hedge Beach to Long Beach is denoted. The plan does not show any existing buildings on Long Beach.^{36 37}

By August 31, 1906, when Engineer Malcolm Rich drew a *Plan Showing Details for the Construction of a Bulkhead at Long Beach, Rockport, Mass to be Built by the Town of Rockport*, there were 45 cottages documented on Long Beach. All but one cottage was constructed in the first row, facing the ocean. The cottages toward the Gloucester side were constructed adjacent to each other, with gaps between cottages further down the beach toward Rockport.^{38 39}

Throughout the early twentieth century, cottages were steadily constructed. The 1917 Sanborn Fire Insurance map, drawn by the Sanford Map Company, shows 95 cottages built in two rows, with the majority of buildings constructed on the first row facing the ocean, as well as the Summer Dance Hall owned by the Long Beach Association, and a pavilion. The pavilion stands at the entrance to the beach on the Gloucester side, with a boardwalk leading out to the cottages. All of the buildings were constructed of wood, meaning the summer homes were vulnerable to fire.⁴⁰

³³Ecologist P.C. Swain, the author of the Guide to Massachusetts Natural communities, writes that salt pannes are “poorly drained, salty areas” in salt marshes. Pannes in low marsh areas usually do not have vegetation, while salt pannes in high marsh areas may have glasswort (*Salicornia* spp.). P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020).

³⁴A tidal channel is a network of branching or meandering channels that connect tidal flats, salt marshes, and the ocean. The salinity in the channel varies depending on the level of the tide. See Carl Carlozzi, Kathryn King, William F. Newbold, Jr. *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975).

³⁵C.W. Pool, *Plan of sea-shore and marsh at Long Beach, Rockport, Mass.*, map, Digital Commonwealth, 1899.

³⁶Harrison P. Wires, *Plan of property of the Town of Rockport, Mass., at Long Beach, showing layouts of lots*, map, Digital Commonwealth, 1904.

³⁷Construction in estuarine zones, like the roads that Harrison P. Wires designed, change the circulation of fresh and salt water. Laying roads, trestles, culverts, or building bridges in estuaries like the Saratoga Estuary reduces the area available to the species that live there. See Carl Carlozzi, Kathryn King, William F. Newbold, Jr. *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Office of Coastal Zone Management, 1975), 32.

³⁸The front elevation drawings of the wooden bulkhead show the profile of the existing dune. The top of the 3,300' bulkhead was drawn 80" above the sand, buried 70" deep. See Malcolm Rich, *Plan showing details for the construction of a bulkhead at Long Beach, Rockport, Mass.*, to be built by the Town of Rockport, architectural drawing, Digital Commonwealth, 1906.

³⁹The 1961 Army Corps of Engineers report notes, “the Town of Rockport built a timber bulkhead about 3,300 feet long to protect the sand dunes forming the beach crest. Details concerning the structure are not known. This bulkhead was completely destroyed by a storm on March 4, 1931.” *United States Army Corps of Engineers, Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 15.

⁴⁰The Sanborn Map Company published surveys of Rockport in 1885, 1892, 1897, and 1902, none of which include Long Beach. The map notes that the buildings were not insured against fire. Sanborn Map Company, *Sanborn Fire Insurance Map from Rockport, Essex County, Massachusetts*, map, Library of Congress Geography and Map Division, 1917.

When was the seawall constructed at Long Beach?

On March 4, 1931, a storm destroyed the wooden bulkhead in front of the cottages.⁴¹

⁴² The *Proposed Shore Protection at Long Beach Rockport Plan and Profile* and accompanying sheet of *Details*, drawn in July 1931 by District Waterways Engineer Francis L. Sellew shows two options to replace the bulkhead: a steel piling bulkhead, and a concrete seawall,⁴³ constructed in front of the old bulkhead, toward the ocean. The proposed bulkhead, made of oak piles and steel sheet piling, is proposed to stand 14' 3-1/2" above the sand, at an elevation of 21' at the top of the wall. The proposed seawall was drawn to an elevation of 20'. The construction of cottages continued, with 111 cottages drawn, 75 in the front row facing the ocean and 36 in the second row.⁴⁴

Just one year after the seawall was constructed, in January 1933, a nor'easter weakened the seawall. It was immediately rebuilt and reinforced. The Army Corps writes "to prevent further damage, about 2,000 tons of stone riprap was placed at the seaward toe of the wall starting at a point 400 feet from the west end of the wall and extending eastward about 800 feet."⁴⁵ Harrison Wires drew the curved concrete portion of the seawall toward Cape Hedge Beach in 1934. This extension reaches an elevation of 20' at the top of the wall, with the masonry foundation extending 4' below ground.^{46 47}

In 1940, Matt A. Hautala, the Rockport Town Engineer, drew the *Plan Showing Street Bounds Lots at Long Beach Rockport, Mass.* The concrete seawall is drawn, as well as the three firebreaks, and Old County Road behind the cottages appears laid out on the plan. The plan shows 112 cottages in three rows, with 73 cottages in the first row, 37 in the second, and 2 in the third row.⁴⁸

⁴¹United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 15.

⁴²It is unclear exactly how and when the first wooden bulkhead was destroyed. The Long Beach Options Committee Report notes that the wooden bulkhead was "destroyed by fire and storms the previous year" in 1930. Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 14.

⁴³A seawall is a structure made of concrete, masonry or sheet piles. Seawalls are built parallel to the shore to protect inland areas from storm surge. Seawalls, bulkheads, and revetments can all cause erosion in front of them, as they reflect storm waves, and diminish sand sharing between dunes, beaches, and other nearshore areas. See *Massachusetts Barrier Beach Task Force, Guidelines for Barrier Beach Management in Massachusetts* (Boston: Office of Coastal Zone Management, 1994), 109.

⁴⁴Francis L. Sellew, *Proposed shore protection at Long Beach, Rockport, plan and profile*, architectural drawing, Digital Commonwealth, 1931.

⁴⁵United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 16.

⁴⁶Harrison P. Wires, *Plan layout retaining wall, Long Beach, Rockport, Mass.*, architectural drawing, Digital Commonwealth, 1934.

⁴⁷The Army Corps of Engineers records the top elevation of the 1931 seawall as 21 feet above mean low water. United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 16.

⁴⁸Matt A. Hautala, *Plan of showing street bounds, lots at Long Beach, Rockport, Mass.*, map, Digital Commonwealth, 1940.

⁴⁹Robert L. Grayce, “Cape Ann Forests,” *Essex Institute Historical Collections* Vol 88 (1952): 212-213.

⁵⁰The Long Beach Options Committee report lists the date of the storm as March of 1958. Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 14.

⁵¹United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 16.

⁵²Different reports cite a different number of structures at Long Beach. The Long Beach Options Committee identifies “149 cottages and accessory buildings located on and behind the dune.” A 2018 lawsuit between Paul M. and Eleanor K. Butman and the Board of Assessors of the Town of Rockport identifies “154 dwellings in the Long Beach neighborhood, divided among three rows.” The Rockport Open Space and Recreation Plan states, “[Long Beach’s] approximately 150 privately owned seasonal cottages occupy land leased fro the town and use a combination of Rockport and Gloucester Services.” See Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 6; *Butman et al. v Assessors of Rockport*, No. F327814 (Commonwealth of Massachusetts Appellate Tax Board January 17, 2017); and Rockport Open Space and Recreation Committee, *Open Space and Recreation Plan for the Town of Rockport* (Rockport, MA: Town of Rockport, 2018), 6.

How has Long Beach changed since World War II?

The forest behind the Saratoga estuary was cleared for development after World War II. Ecologist Robert L. Grayce writes, “on the high ground behind the salt marshes of Cape Hedge Beach and Long Beach, this scraggly [Pitch] pine thrived for long unmolested, forming an artistic backdrop for the sparkling waves and white sands. Since the close of World War II, it has been invaded here by summer cottages and housing developments. It has been spared from overcutting because of its shade value from summer sun when breezes are offshore, and, esthetically, because it enhances the beauty of the scene and adds to property values.” Grayce also noted the tree’s ecological value as a “sand binder” to reduce erosion on the beach.⁴⁹ Erosion became a major point of concern on Long Beach after World War II due to the need to protect the cottages, which provided an increasing amount of revenue to the Town, and the increasing expenses of the seawall.

Between April 1st and 2nd, 1958, another nor’easter undermined the seawall.⁵⁰ Two sections of the 1931 seawall fell onto the beach. The Army Corps writes that “this exposed the sand dunes and summer cottage development to damage from wave attack. Temporary stone riprap and wooden bulkheads were placed in these exposed areas following the storm.” The destroyed portions of the seawall were rebuilt in 1959. The newly constructed seawall included a twenty foot stone apron at the seaward toe of the wall, “thereby providing revetment along the toe of the entire old and new sections of the Long Beach seawall.”⁵¹ The construction costs were paid for by the Massachusetts Department of Public Works.

Today, there are 154 cottages and outbuildings on Long Beach, as well as transportation, electrical, water, and wastewater systems that support the summer community. Additional storms, both nor’easters and hurricanes in 1976, 1985, 1991, and 2018 have further damaged the seawall.⁵²

How has development at Long Beach impacted the greater watershed?

The seawall, cottage roofs, patios, tennis court, and access roads are impervious surfaces⁵³ that have changed the hydrology of the watershed at Long Beach. As the surface of Long Beach was developed, the soils underneath were altered. Fill was dumped over the existing dune behind the seawall.⁵⁴ In 2012, the geotechnical engineering firm Vine Associates took a soil boring through the fill behind the seawall that provides more detail. They found that the first 2’ of fill is a medium to dense fill made up of fine to coarse sand, with trace silt. Beneath the top 2’ of fill lies a “native” fill composed of medium to dense and fine to medium sand, trace silt, and trace gravel. A marine sand layer, composed of dense and very dense fine sand, with trace silt and organics, extends down to at least 31’, the deepest Vine Associates bored through the sand.⁵⁵ The soil underneath the fill is Hooksan sand, an “excessively drained” soil that makes up barrier beach dunes, including those at nearby Good Harbor Beach.⁵⁶ While Hooksan sand allows water to drain downwards, impervious soils⁵⁷ and surfaces do not. Instead, water remains on impervious surfaces and pools, or runs off, unable to percolate into the soil, which can cause erosion.

Behind the beach and the former dune, the soils underneath the Saratoga estuary are classified as Ipswich-Westbook mucky peats. These soils are “deep, very poorly drained soils in tidal marshes subject to inundation by saltwater twice a day,” with parent material consisting of partially decomposed herbaceous organic material: marsh grasses.^{58 59} Cape Hedge and Brier Neck are classified as Chatfield-Hollis-Rock outcroppings, a soil association of “loamy soils formed in glacial till” with “areas of exposed bedrock.”⁶⁰

This bedrock, which we know as Cape Ann granite, is extremely hard, and close to the surface. It lies under a thin layer of organic topsoil. The lack of topsoil has made it challenging to install the waste and wastewater infrastructural systems that are required to support the cottages. While these systems are underground, invisible to the naked eye, installing them required blasting through bedrock in an expensive and invasive process that was likely completed after World War II, during the most intensive period of development on Long Beach.

The following section, “How is Long Beach Changing?” describes these infrastructure systems, as well as the natural communities at Long Beach, and how this beloved cultural landscape is changing today.

⁵³ Impervious surfaces are hard surfaces such as roads, driveways, and roofs that do not allow water to infiltrate into the ground. As watersheds are urbanized, vegetation is replaced by impervious surfaces, reducing the area where infiltration to groundwater can occur. This increases the amount of stormwater runoff that drains across roads, driveways, patios, and roofs, collecting debris, pollutants and chemicals, vehicular fluids, sand, and salt before entering storm sewers, ditches, or swales. While some runoff may be collected, at Long Beach, it runs into the salt marsh, and ultimately into the ocean.
See “Impervious Surfaces and Flooding,” *United States Geological Survey*, accessed August 1, 2024, www.usgs.gov/special-topics/water-science-school/science/impervious-surfaces-and-flooding

⁵⁴ This soil is classified as Urban Land-Udorthents, a generic term used for “excavated, filled, and made land,” or soil that originated in one place and was dumped in another. The United States Department of Agriculture describes udorthents as “areas from which soil has been excavated and areas where soil material has been deposited. Udorthents are associated with many different soils and with Urban land. Udorthents do not have a developed profile, which most other soils have, and have fewer buildings and paved areas than Urban land. United States Department of Agriculture, *Soil Survey of Essex County, Massachusetts, Southern Part* (Washington, D.C.: United States Department of Agriculture, 1984), 87-88.

⁵⁵ Vine Associates bored four borings 4’ to 8’ from the sidewalk. See Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 3.

⁵⁶ “Web Soil Survey,” *United States Department of Agriculture*, accessed June 24, 2024.

⁵⁷ The Massachusetts Soil Survey describes impervious soil as “a soil through which water, air, or roots penetrate slowly or not at all. No soil is absolutely impervious to air and water all the time.” United States Department of Agriculture, *Soil Survey of Essex County, Massachusetts, Southern Part* (Washington, D.C.: United States Department of Agriculture, 1984).

⁵⁸ The Rockport Open Space and Recreation Plan includes a soil map for the Town. See *Town of Rockport, Rockport Open Space and Recreation Plan 2018-2025* (Rockport, MA: Town of Rockport, 2018), 24. The data used to make this map can be found on the United States Department of Agriculture (USDA) Web Soil Survey, which allows users to search by their location. “Web Soil Survey,” *United States Department of Agriculture*, accessed June 24, 2024, www.websoilsurvey.nrcs.usda.gov/app/WebSoilSurvey.aspx. The survey identifies each type of soil, as well as information about the elevation the soil type is found at, mean annual precipitation, air temperature, drainage, and the depth to the water table under the soil. A glossary and additional information can be found in the United States Department of Agriculture, *Soil Survey Manual* (Washington, D.C.: United States Department of Agriculture, 2018).

⁵⁹ The USDA also provides a PDF guide to the soil survey specifically for Essex County. See United States Department of Agriculture, *Soil Survey of Essex County, Massachusetts, Southern Part* (Washington, D.C.: United States Department of Agriculture, 1984), 3.

⁶⁰ United States Department of Agriculture, *Soil Survey of Essex County, Massachusetts, Southern Part* (Washington, D.C.: United States Department of Agriculture, 1984), 7.

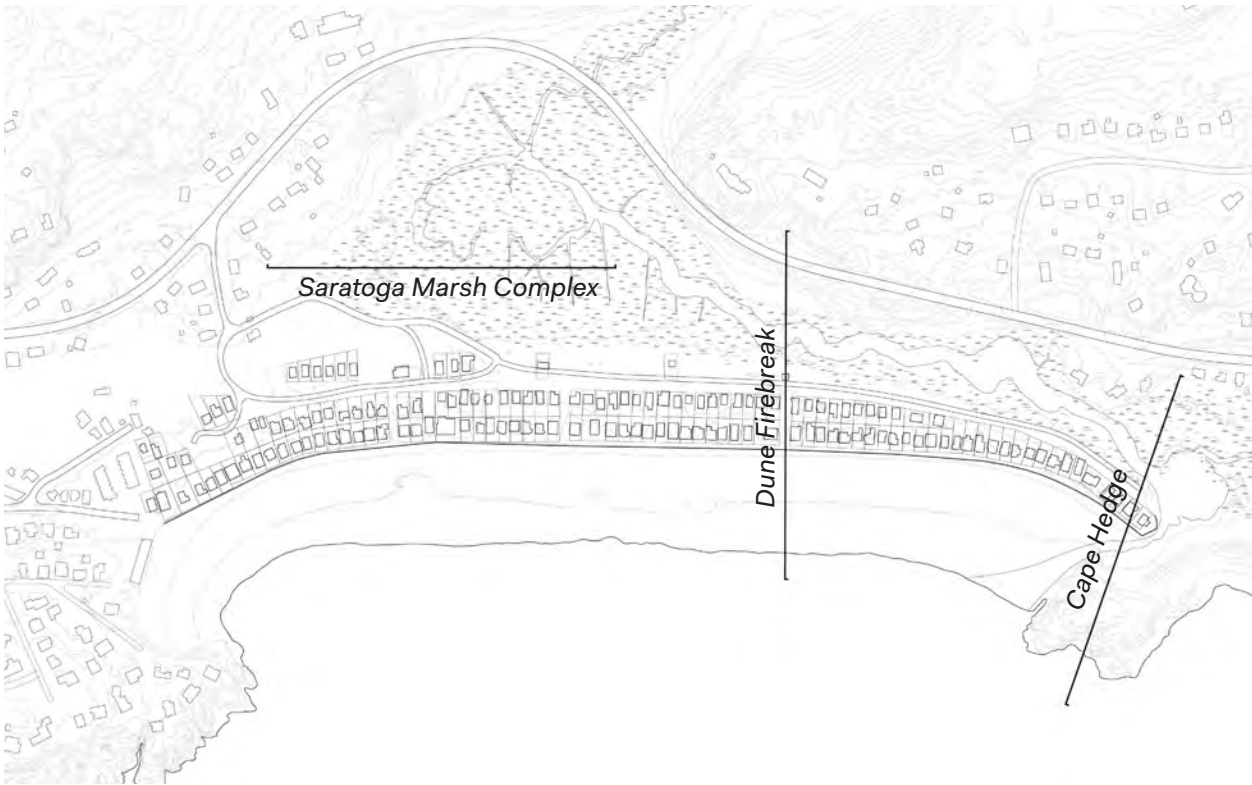
Sections over Time

The following section drawings show how Long Beach has changed at three different times in three places: the Saratoga Marsh complex, a firebreak on the dune, and the northeastern edge of Long Beach at Cape Hedge. The sections show how the topography has been regraded, tidal flow altered, and infrastructure systems constructed to support the cottages.

The time periods were chosen to show specific developments including the seawall and cottages, wastewater system, roads, and rising water levels in the marsh.

Each drawing is constructed from different historic maps, photographs, and reports. Many of these drawings have inconsistencies in topography, the information that is shown, and the level of accuracy that is recorded.

By translating information from different sources and mediums into a consistent graphic language, we can use these sections to observe and compare changes in the landscape over time. We can also use them to speculate on future changes in the landscape by drawing tidal datums that show local water levels increasing over time.

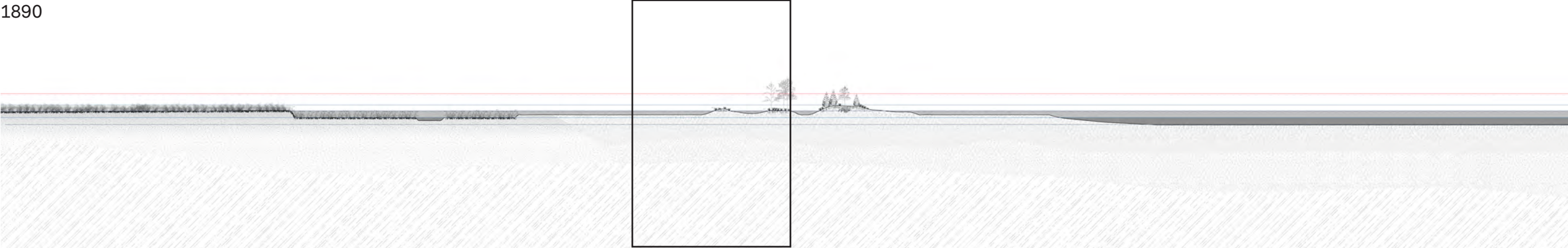


- Section Cut Line
- Vertical Datums
 - FEMA VE Zone
 - Top of Seawall
 - 100-year flood stillwater
 - Mean high higher water
 - Mean high water
 - NAVD88
 - Mean low water
 - Mean lower low water

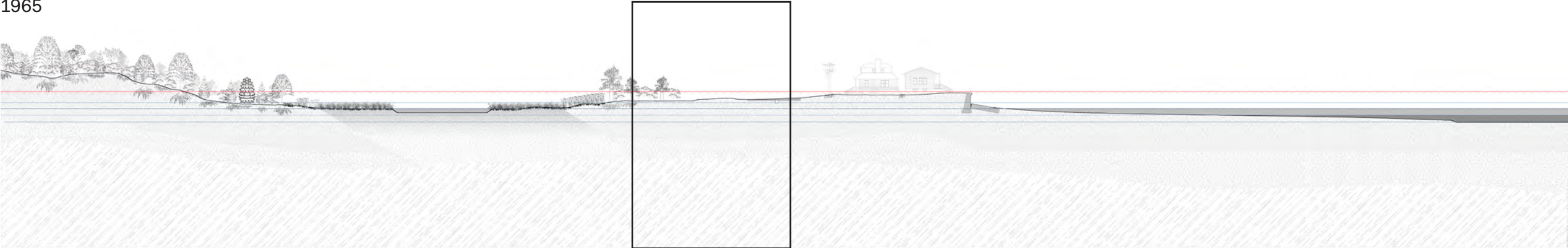
Vertical datums are surfaces of zero elevation to which heights are referenced. The current vertical datum is the North American Vertical Datum of 1988 (NAVD88). These datums are drawn on each section.

Dune Firebreak

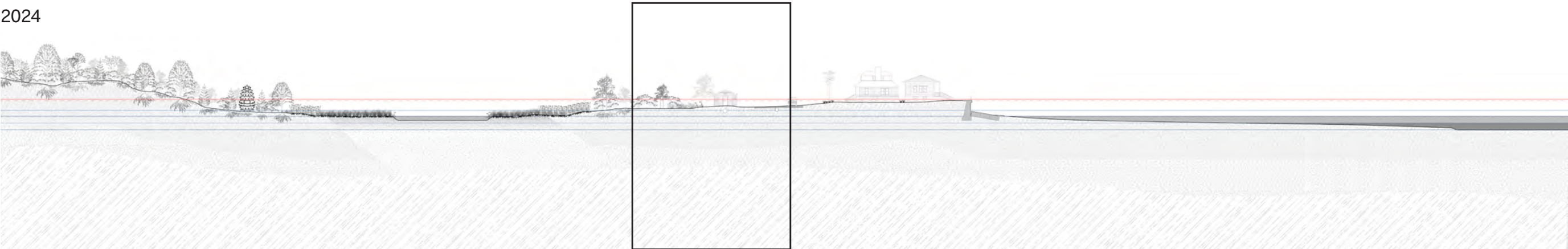
1890



1965

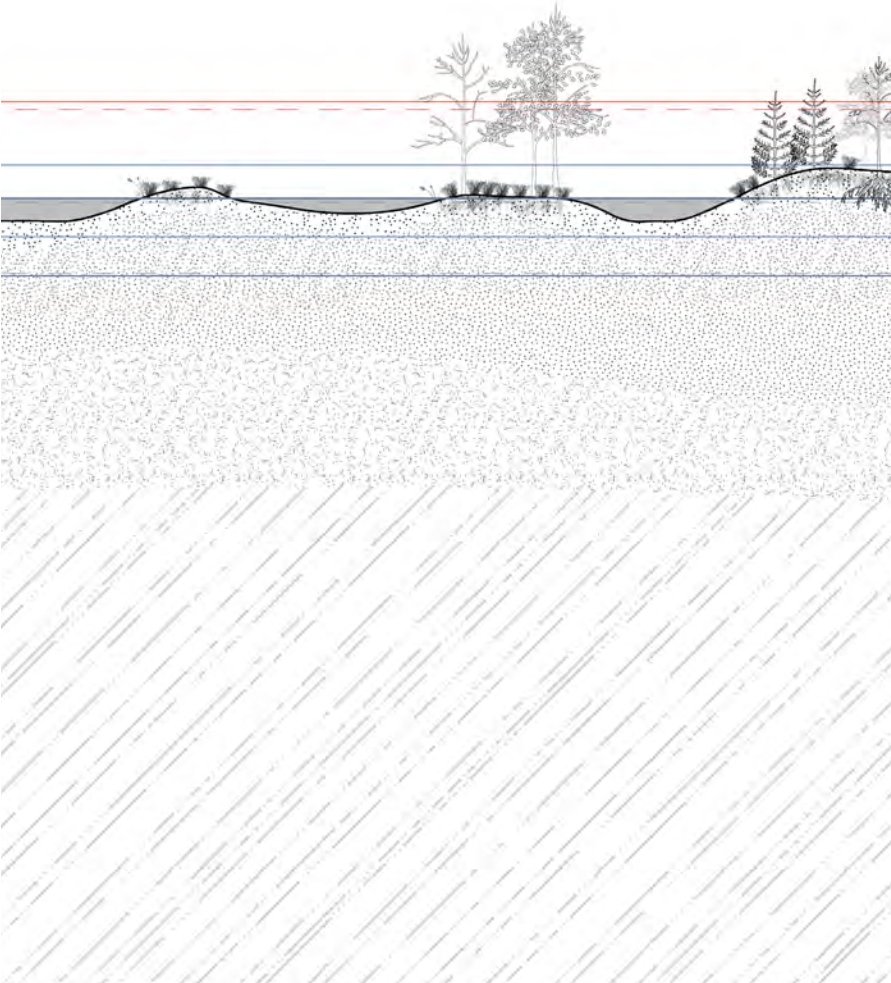


2024

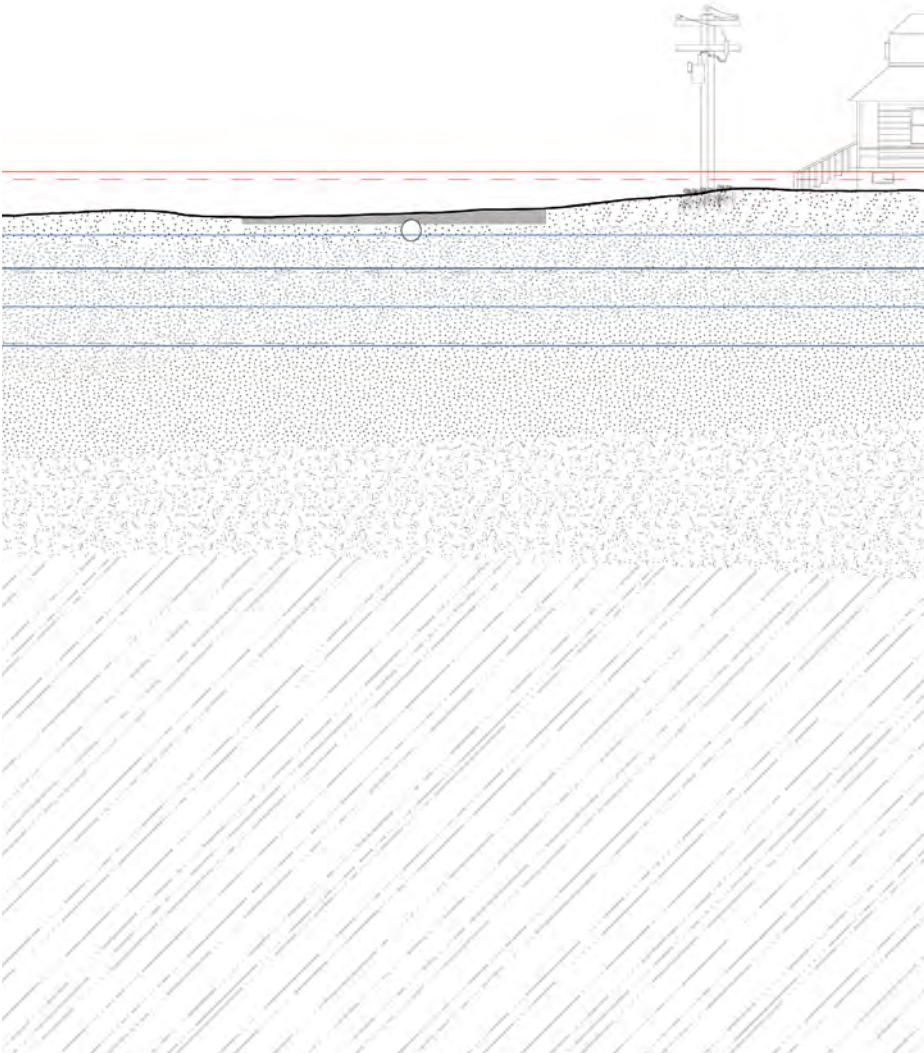


Dune Firebreak

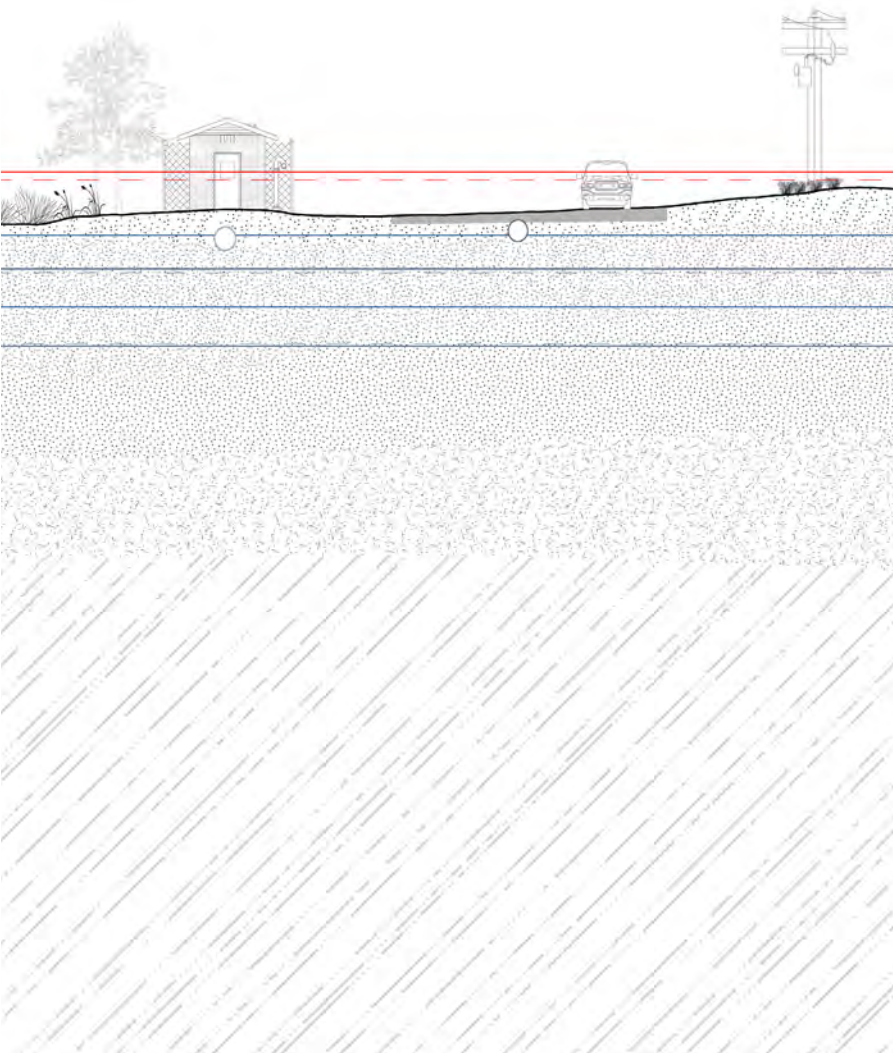
1890



1965

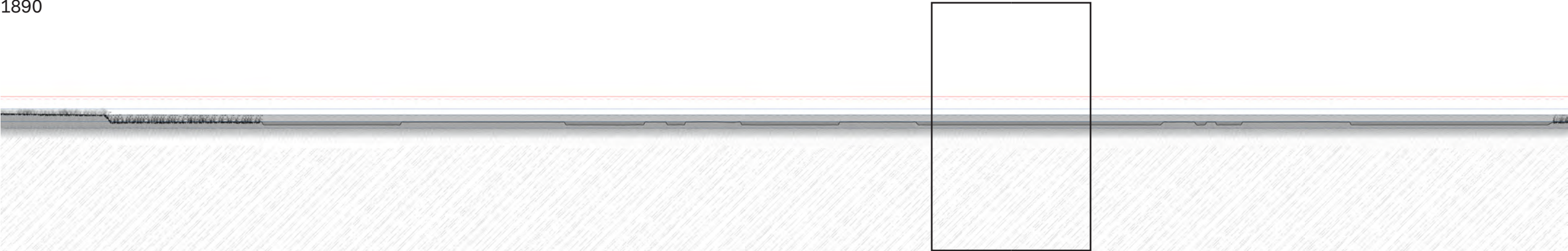


2024

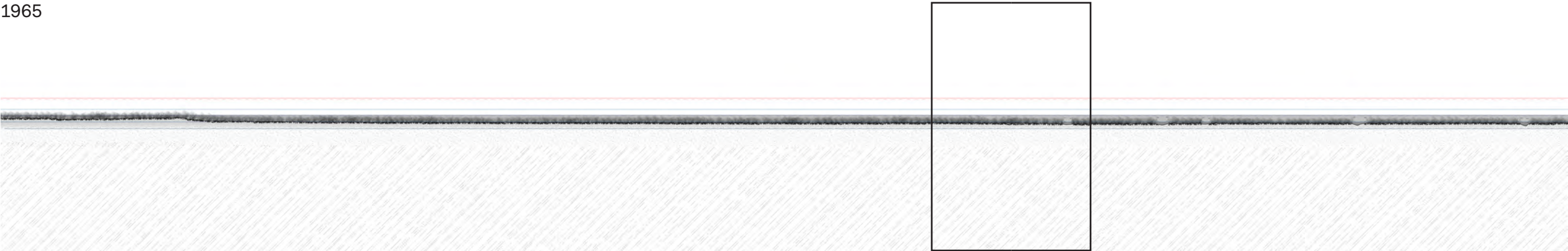


Saratoga Marsh Complex

1890



1965



2024

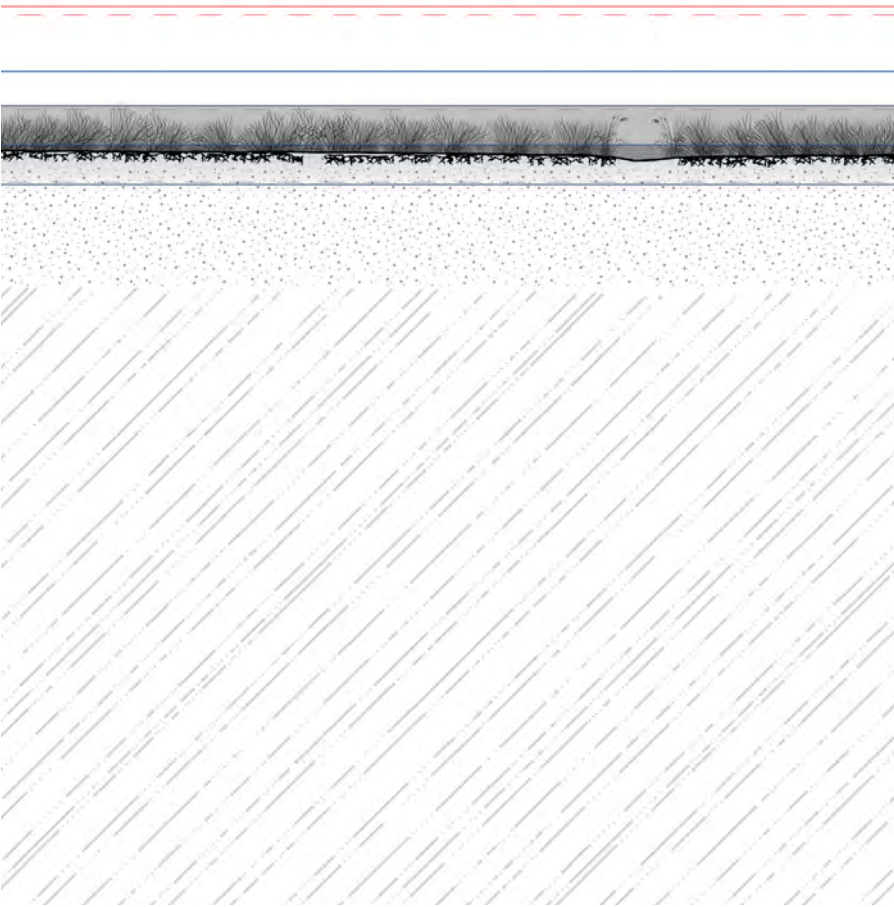
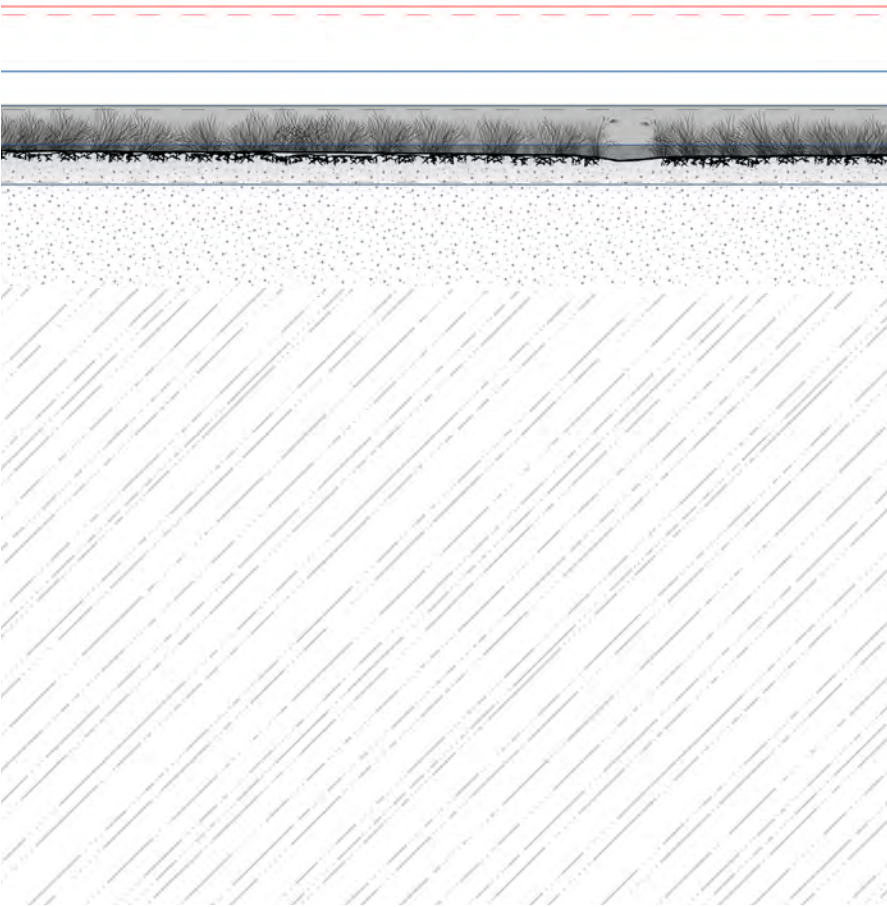
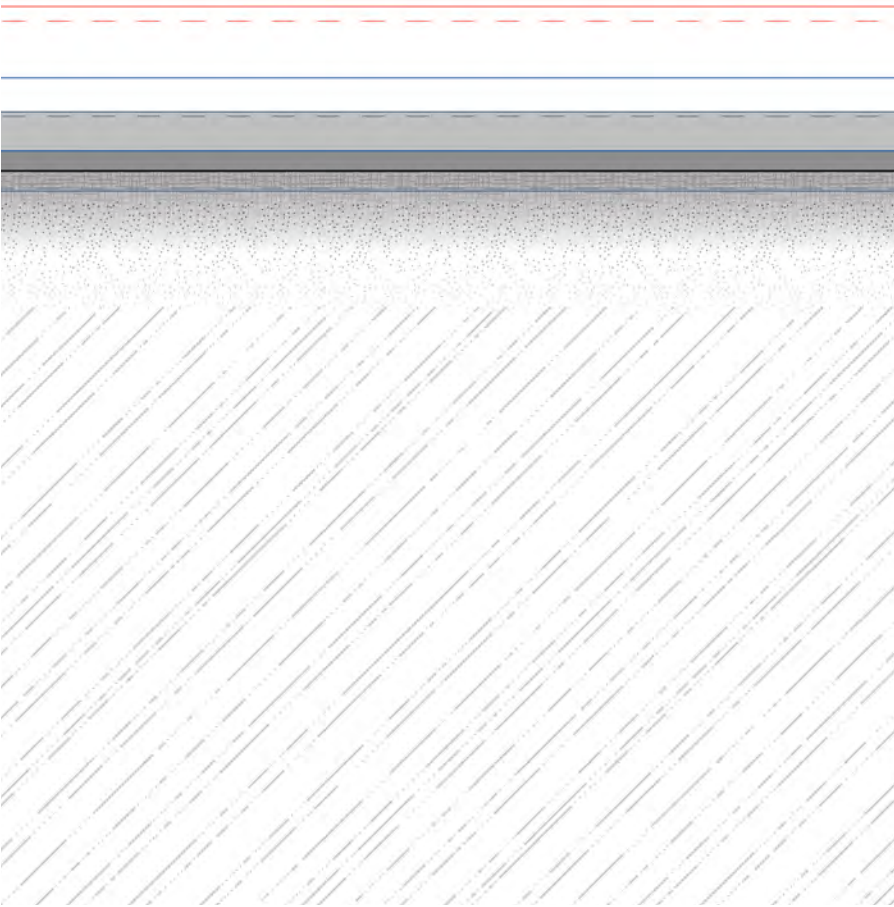


Saratoga Marsh Complex

1890

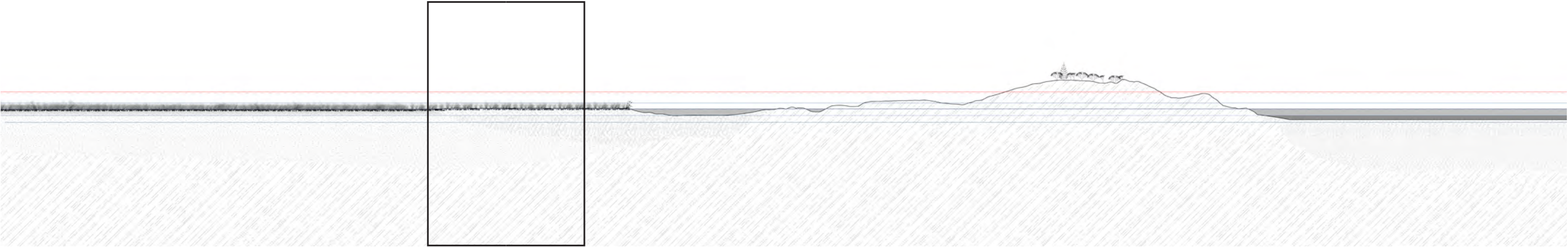
1965

2024

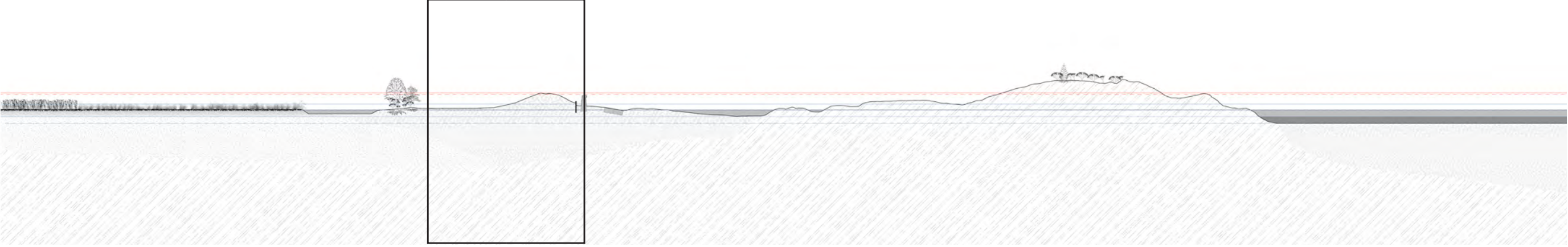


Cape Hedge

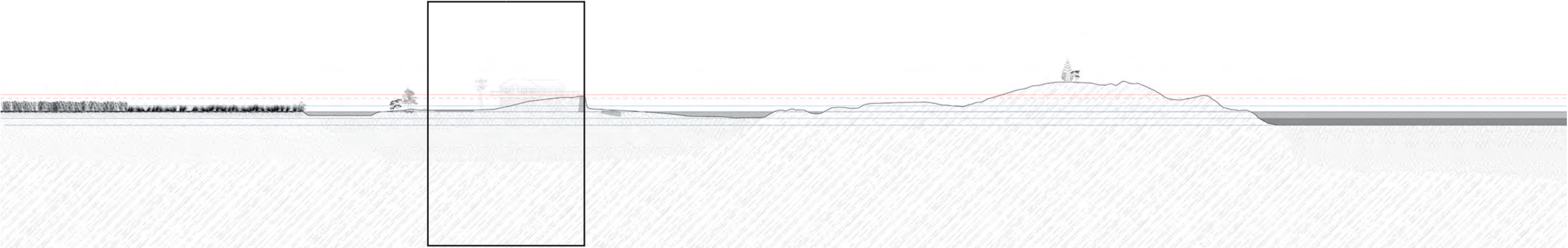
1890



1945



2024



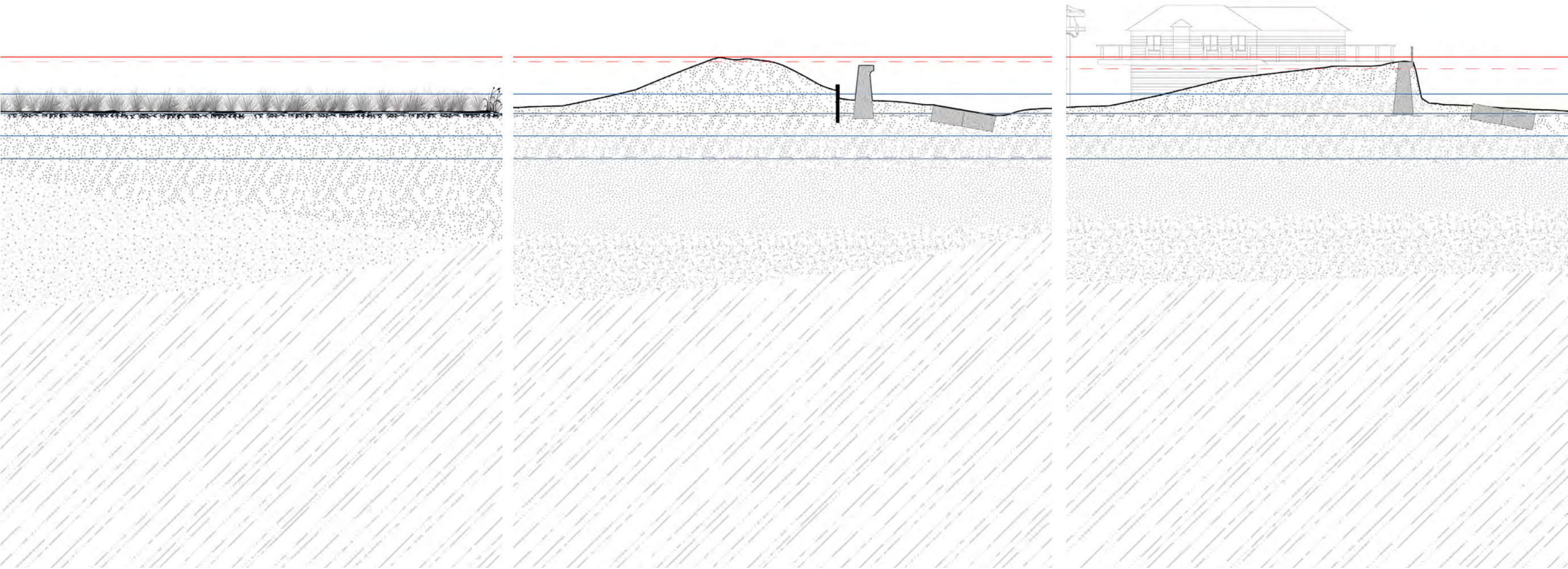
Early drawings of Cape Hedge and the surrounding marsh do not show the dune extending toward the tidal channel at the northeast end of Long Beach.

Cape Hedge

1890

1945

2024



The first seawall was constructed in front of a wooden bulkhead in 1931, and has since undergone piecemeal repairs after particularly damaging storms, including a nor'easter in 2018.

How is Long Beach Changing?

“Long Beach is Rockport’s largest, and, arguably, most beautiful beach.”

- Long Beach Options Committee, 2022



Kira Clingen, "Exposed manhole cover at Long Beach," 2024.

What are the current issues at Long Beach?

The Long Beach cottage leases were renewed for a ten-year period from January 1, 2024 through December 31, 2033.^{1,2} A series of local and regional newspaper coverage highlighted the ongoing debate about what to do at Long Beach, and the values and beliefs that people hold about this landscape.³ While there is near universal agreement that Long Beach is a beautiful “summer paradise,” there is a debate as to whether the seawall should be rebuilt, or the cottages removed due to climate impacts.^{4,5,6}

The debate over the leases reflect the challenges of making a decision in a landscape that has become contested by different groups with different priorities. The split ownership structure at Long Beach makes this more challenging: cottage owners own the structures while the Town of Rockport owns the parcels beneath the cottages, firebreaks, seawall, marsh, infrastructure systems, and beach. Public access varies throughout the year. The public is permitted on all Town-owned land, but may not cross across the parcels when the cottages are occupied.⁷

Over the next ten years, the leases, property, and parcel taxes will provide roughly 8% of the Town of Rockport’s annual revenue.⁸ Renewing the leases provides time to consider the best options for the future of Long Beach through a variety of lenses, including economic considerations, but also ecological, infrastructural, and climatic concerns.

This section catalogs and describes the different infrastructural systems⁹ at Long Beach. All of these systems rely on natural resources. When they work properly, they are invisible. The complexity of these systems often obscures the connection between the landscapes from which these resources are extracted, and the resource as it arrives in our homes. We see tap water running from the faucet with little idea of the reservoir that collected falling rainwater or the system of water mains and pump stations that delivers water into our kitchens. The time and distance that natural resources travel through these systems can obscure how vulnerable they are, not only to disruption locally, like a tree limb falling on a power line in the front yard, but also regionally, like increasing drought-stricken reservoirs and flooded emergency evacuation routes.

¹Board of Selectmen, *Long Beach Memo and Lease Renewal* (Rockport, MA: Town of Rockport, 2023).

²Different reports cite a different number of structures at Long Beach.

³The local newspaper The *Gloucester Daily Times* published several op-eds on Long Beach by residents in favor of managed retreat, and residents in favor of rebuilding the seawall. As an example of an op-ed for retreat, see Ian Crown, “Commentary: Long Beach’s future and Rockport’s finances,” *Gloucester Daily Times*, July 5, 2023, which presents a case for ending the leases due to climate change concerns. As an example of an op-ed for seawall reconstruction see Jane E. Fox Dobson, “Letter: Vote yes to repair Long Beach seawall,” *Gloucester Daily Times*, April 5, 2024. Residents were also interviewed for a piece in the Boston Globe. See Billy Baker, “Long Beach in Rockport is a summer paradise. It may also be a climate disaster waiting to happen,” *Boston Globe*, August 4, 2022.

⁴The group Preserve Long Beach, which advocates to rebuild the seawall, writes on their website, “Long Beach is a sanctuary for both nature and people.” “About,” *Preserve Long Beach*, accessed September 2, 2024, www.preservelongbeach.com

⁵For cottage owner Antoinette Giugliano, economic concerns should take priority. In an interview for the Gloucester Daily Times, he shared, “Long Beach seawall is a pivotal foundation to the Town of Rockport’s future economic stability.” Stephen Hagan, “Group: Save seawall, save town,” *Gloucester Daily Times*, March 8, 2024.

⁶For another individual sharing their feedback in the Rockport Hazard Mitigation Plan, concerns about climate change inform their ideas about Long Beach. In the optional comments for the plan, one resident wrote, “Long Beach is at risk of ocean storm surges and winds damaging seasonal large 2 to 3 story houses that have been allowed to be built by the Selectmen at the edge of the ocean in front of an old seawall built for small 1 story cottages. These houses should be removed and a public park made for all Rockport residents since there is NO

PARKING and minor access for year round residents to access Long Beach... Income lost from removal of these houses will never meet the cost of building a new seawall to protect these out-of-town lease holders who sued the town to keep year-round residents out of Long Beach and want to buy our Long Beach land, making matters more dangerous!” Town of Rockport, *Town of Rockport Hazard Mitigation Plan* (Rockport, MA: Town of Rockport, 2020), Optional Comments 20.

⁷Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 9.

⁸Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 10.

⁹The term infrastructure was first used in 1927 in response to the Great Flood along the Mississippi River to describe “the set of systems, works and networks upon which an industrial economy is reliant – in other words, the underpinnings of modern societies and economies.” Today, the Federal Emergency Management Agency defines infrastructure as “the structures, facilities, and equipment for roads, highways and bridges; public transportation; dams, ports, harbors and other maritime facilities; intercity passenger and freight railroads; freight and intermodal facilities; airports; water systems, including drinking water and wastewater systems; electrical transmission facilities and systems; utilities; broadband infrastructure; and buildings and real property; and structures, facilities and equipment that generate, transport and distribute energy including electric vehicle (EV) charging.” “Infrastructure,” *Federal Emergency Management Agency*, accessed September 2, 2024, www.fema.gov/glossary/infrastructure

¹⁰ Pierre Belanger, *Landscape as Infrastructure* (New York: Routledge, 2017), 432-433.

¹¹ The term “ecological infrastructure” was first used by the UNESCO Man and Biosphere Program in 1984. The design of ecological infrastructure emphasizes “the integration of ecological ideas into the design of municipal infrastructure at the initial stage of project construction, taking into account the inherent ecological losses caused by municipal infrastructure to ensure the integrity of structure and function of ecosystems, and provides ecosystem services needed for sustainable development.” Shoukai Sun, Yuantong Jiang, and Shuanning Zheng, “Research on Ecological Infrastructure from 1990 to 2018: A Bibliometric Analysis,” *Sustainability* 12, no. 6 (2020).

¹² In this report, physical infrastructure systems refer to the structures, facilities and equipment for wastewater, water, electrical, transportation, the buildings in the Long Beach neighborhood, and the seawall, which is considered resilient physical infrastructure.

¹³ The National Oceanic and Atmospheric Administration (NOAA) defines sea surface temperature as “the temperature of the top few millimeters of the ocean. This temperature directly or indirectly impacts the rate of all physical, chemical, and most biological processes occurring in the ocean. SST is globally monitored by sensors on satellites, buoys, ships, ocean references stations, autonomous underwater vehicles and other technologies.” “Sea Surface Temperature,” *National Oceanic and Atmospheric Administration*, accessed September 1, 2024, www.ecowatch.noaa.gov/thematic/sea-surface-temperature

What are the infrastructure systems at Long Beach?

It’s important to understand how these systems, which were built to be standardized, monofunctional, and permanent, are increasingly stressed. The infrastructure systems at Long Beach can be thought of as local nodes in a greater regional system. Therefore, upgrades or maintenance at Long Beach do not adequately address the systemic issue of aging infrastructure that is subject to increasingly erratic climatic events.¹⁰ Just like the seawall at Long Beach stops the transfer of sediment up and down the coast to Good Harbor and Pebble Beaches, disruption at the Gloucester Wastewater Treatment Plant may have a significant impact on the quality of life and ecology at Long Beach.

The following pages use maps, photographs, and text to describe both the local and regional vulnerabilities of infrastructural systems at Long Beach. These systems are separated into two categories: ecological infrastructure systems¹¹ and physical infrastructure systems.¹²

The first section catalogs the natural communities at Long Beach. These communities are the basis of ecological infrastructure systems at Long Beach. Establishing an ecological baseline is important to gauge future changes in the Long Beach ecosystem, such as the conversion of high marsh grass to low marsh as sea levels rise, and increasing sea surface temperatures,¹³ which affect the communities of plants and animals that can live on Long Beach.

The physical systems have been built alongside, on top of, and in some cases underneath the ecological systems at Long Beach. Physical infrastructure at Long Beach includes:

- Buildings (Housing)
- Coastal Resilience Infrastructure (Seawall)
- Electrical System
- Transportation System (Roads, Sidewalks, Culverts)
- Wastewater System
- Water System

This section maps the different physical systems at Long Beach in relationship to the ecological systems at the beach.

What are the natural communities at Long Beach?

The plants and animals that live at Long Beach are heavily influenced by the wind and tides that scour the coast in the Gulf of Maine Coastal Lowland Ecoregion.¹ Long Beach is a hybrid landscape that includes many different species. Some, like saltmarsh grasses and blue mussels, have grown here for thousands of years without human intervention or management. Others, like housecats and hydrangeas, are domesticated and ornamental species that have been introduced by people around the cottages. Still other species like bittersweet, are advantageous,² or invasive species that were introduced by people and eventually escaped the lawns around the cottages.

These introduced species play an important part in shaping the ecology at Long Beach, though they are not accounted for in assessments of natural communities, which are groups of plants and animals that commonly live together.

There are many different classification systems for natural communities.² Plants grow in communities that are established in specific microclimates where they are best adapted to soil, salinity, wind, and water conditions. Topography and water flow, therefore, are the two primary factors that affect the distribution of these natural communities. This report uses the Massachusetts Division of Fisheries and Wildlife primary classification system of terrestrial, palustrine, and estuarine communities, all of which occur on Long Beach from the uplands behind the beach down to the Atlantic Ocean.

- Estuarine communities “are tidal wetlands with fresh to salt water”
- Palustrine communities are wetland communities where there is flooding or saturated soil conditions
- Terrestrial communities “occur in upland areas on predominantly well-drained soils” ³

The maps on the following pages describe the natural communities that exist at Long Beach. While natural communities are determined by plant species, the fauna, or animals, that typically live or make use of these communities, are also briefly described.

¹An ecoregion is a “broad area of relatively homogeneous vegetation, soils, climate, geology, and patterns of human use.” Like watersheds, various agencies classify different ecoregions at different scales. They are used to inventory and assess environmental resources. MassWildlife defines the Gulf of Maine Coastal Lowland Ecoregion as “a 10- to 20-mile wide coastal strip extending north from the Boston Basin. The ecoregion has relatively low relief, and elevations are mostly from sea level to 250 feet. Extensive glacial deposits blanket this region, with sand beaches that front large salt marshes. The vegetation mosaic includes oak forests, extensive post-settlement white pine, pitch pine in sandy areas, and saltmarsh.” P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 8-11.

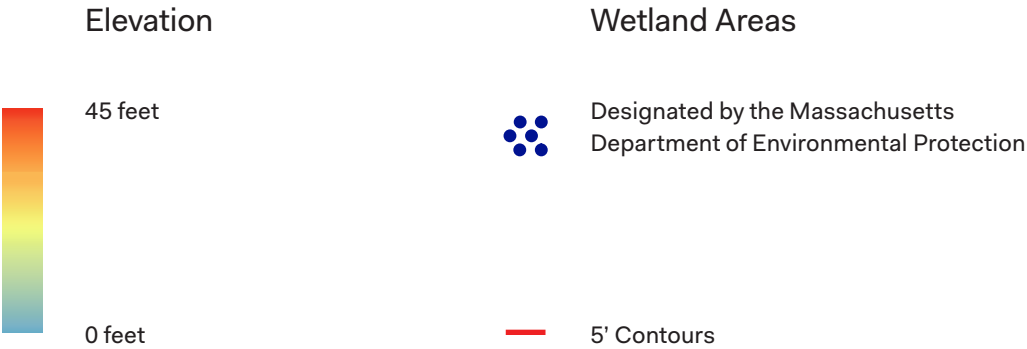
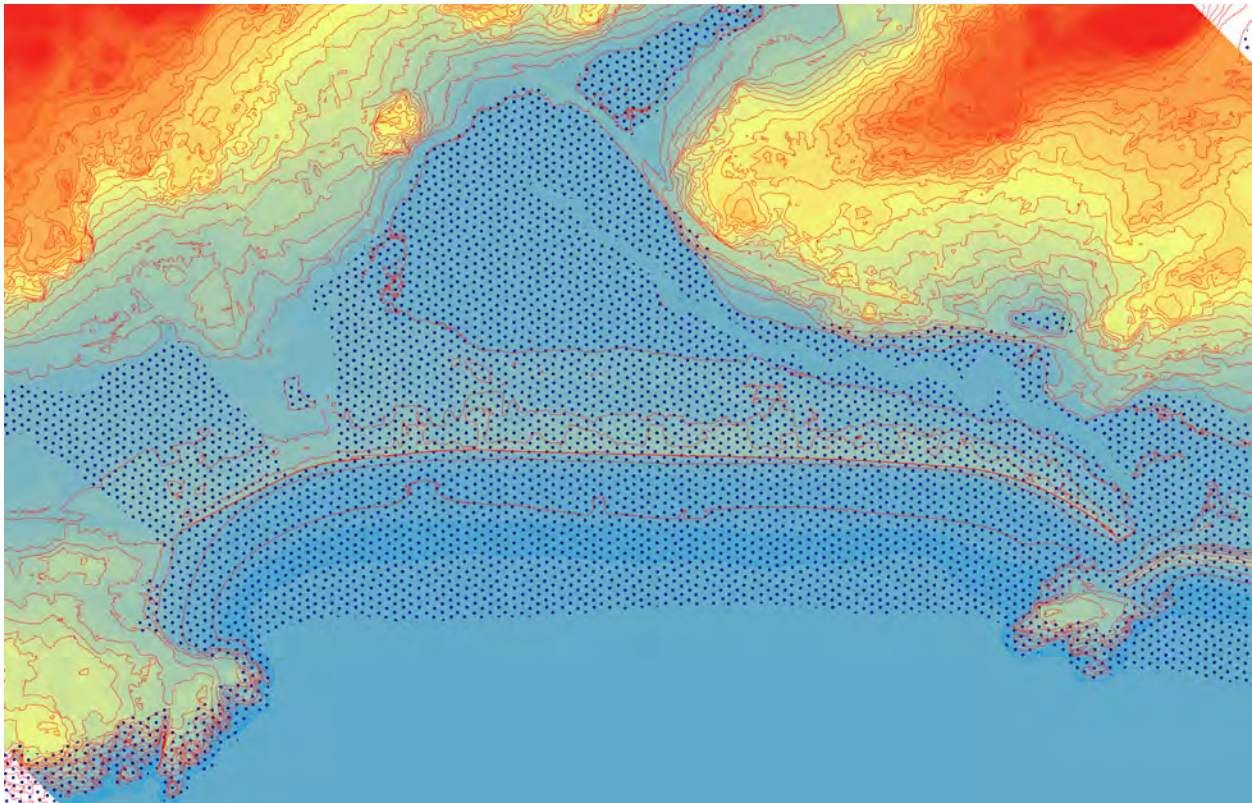
²The language used around invasive species can often be xenophobic. There are many introduced species that have been growing in the New England landscape for generations, such as Norway maples. Landscape architects Thomas Rainer and Claudia West write that it can be devastating to see landscapes like Long Beach, that were at one point pristine barrier beach ecosystems, alive and growing with invasive and ornamental species. They caution, however, that the loss of native species can “fuel a kind of nostalgia for the past, a belief that we can put things back the way they were. In its uglier incarnations, this impulse creates an inflated moralism around the debate over native and exotic plants. What is worse, it makes an ideology out of localism, elevating a plant’s geographic origin over its performance.” Thomas Rainer and Claudia West, *Planting in a Post-Wild World* (Portland: Timber Press, 2015), 15.

³Cape Ann resident Christopher Leahy is the former Director of Mass Audubon’s Center for Biological Conservation, and the Gerard A. Bertrand Chair of Natural History and Field Ornithology at Mass Audubon. His book *The Nature of Massachusetts* describes the natural communities of Massachusetts as “rooms in the house of nature.” Each chapter of the book classifies a natural community, describing the dominant species of

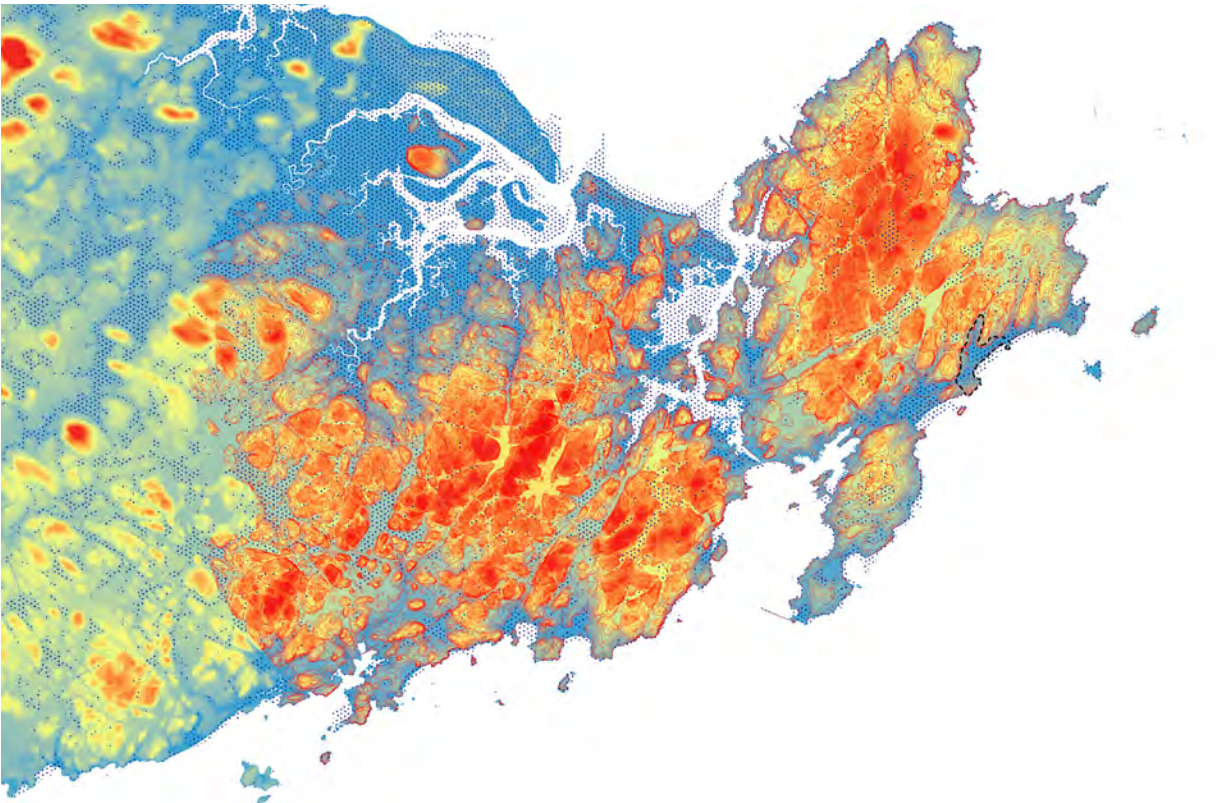
plants, birds, mammals, and crustaceans. Each chapter also includes information about the history of the community, its distribution, extent in Massachusetts, conservation status, places to visit, and a list of further reading. See Christopher Leahy, John Hanson Mitchell, and Thomas Conuel, *The Nature of Massachusetts* (Reading, MA: Addison-Wesley Publishing Company, Inc., 1996).

⁴Natural communities are not discrete, and they do not have neat boundaries. There is overlap between the plants and animals found in different communities, and many plants and animals use many different community types in their habitats. According to the Massachusetts Division of Fisheries and Wildlife, “natural communities are defined as groups of species that are found together over and over again, usually in particular environmental conditions. Occurrences of a community type tend to be in sites with similar chemistry, soils, moisture, slopes, temperature ranges, and other physical conditions. In a given community type, certain species, especially plants, occur together in similar structures and proportions. A particular community type may have species that occur only or primarily in that type of community. When those species are present, they are indicative of the presence of that type of community and are therefore called indicator species.” P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 1-5.

How does topography and water flow affect the distribution of wetlands?



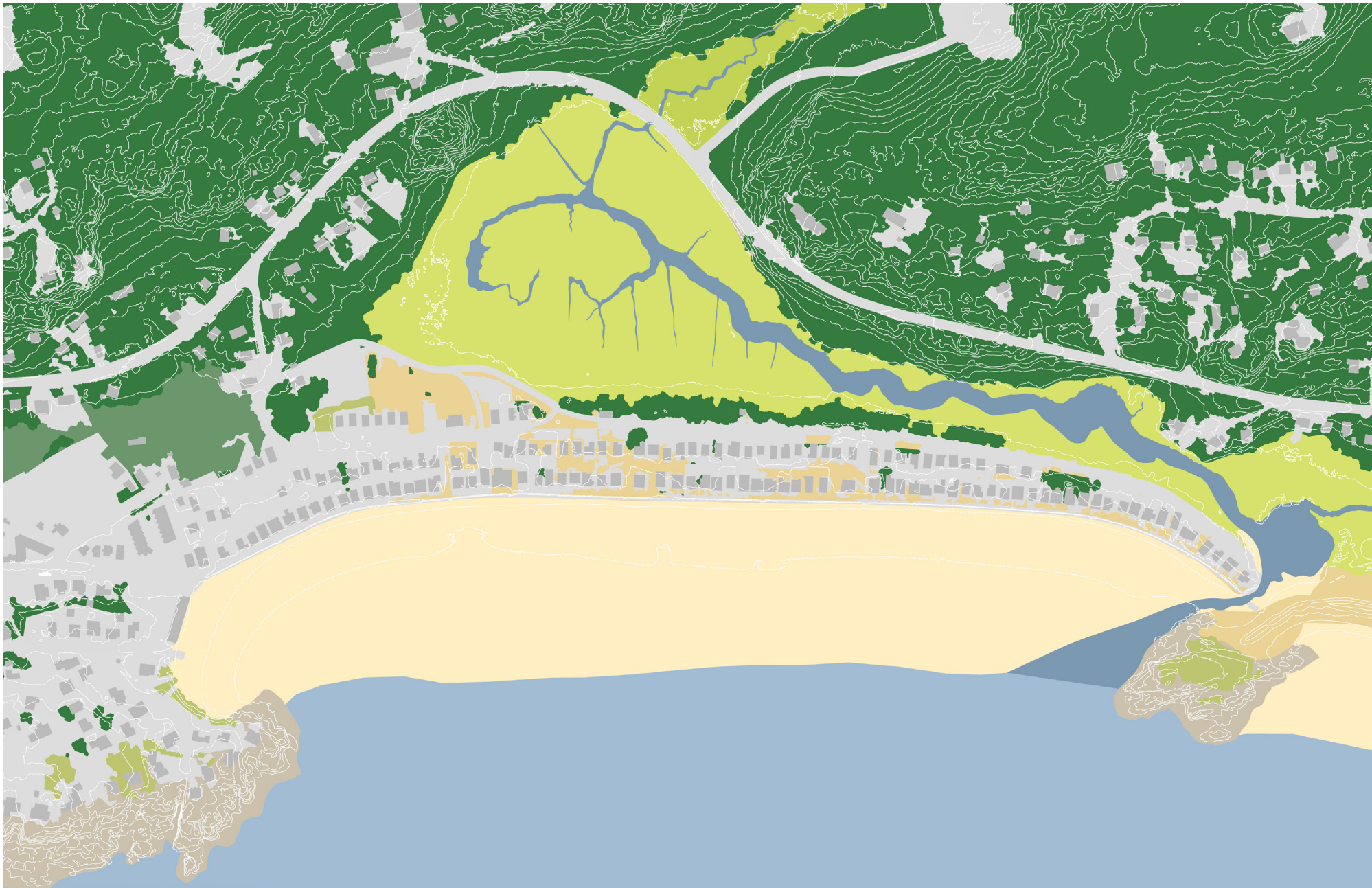
This Digital Elevation Model (DEM) shows the elevation (height) of Long Beach from sea level (0') to 45'. Water drains from the high areas (shown in red) toward the marsh and the ocean (shown in blue).



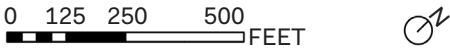
On Cape Ann, water drains from the inland high points (shown in red) toward the marshes and the ocean (shown in blue).

Natural Communities of Long Beach and Surroundings

Community	Acres	%
Estuarine		
Marine Intertidal Sand Beach	33.9	14.2
Marine Intertidal Rocky Shore	7.6	2.8
Salt Marsh	25.1	9.4
Brackish Tidal Marsh	2.4	0.9
Palustrine		
Freshwater Swamp	3.5	1.3
Terrestrial		
Maritime Dune	3.5	2.5
Maritime Shrubland	2.0	0.8
Coastal Forest	87.0	32.5
Other		
Ocean	50.4	18.8
Tidal Creek	8.2	3.0
Impervious Surface	54.9	20.5
5' Contours		



The natural communities at Long Beach are classified in this map, which covers 268 acres of Long Beach and the surrounding neighborhoods. The area of each natural community and the percentage of the map the community covers are listed to emphasize that, while it's important to consider each community individually, they are all interconnected in a larger ecosystem.

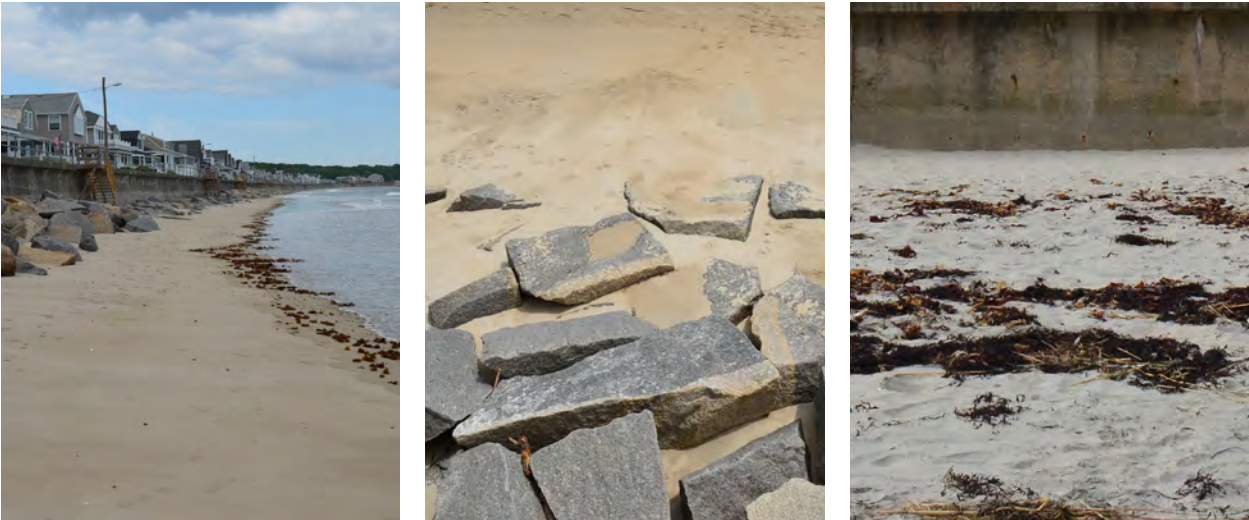
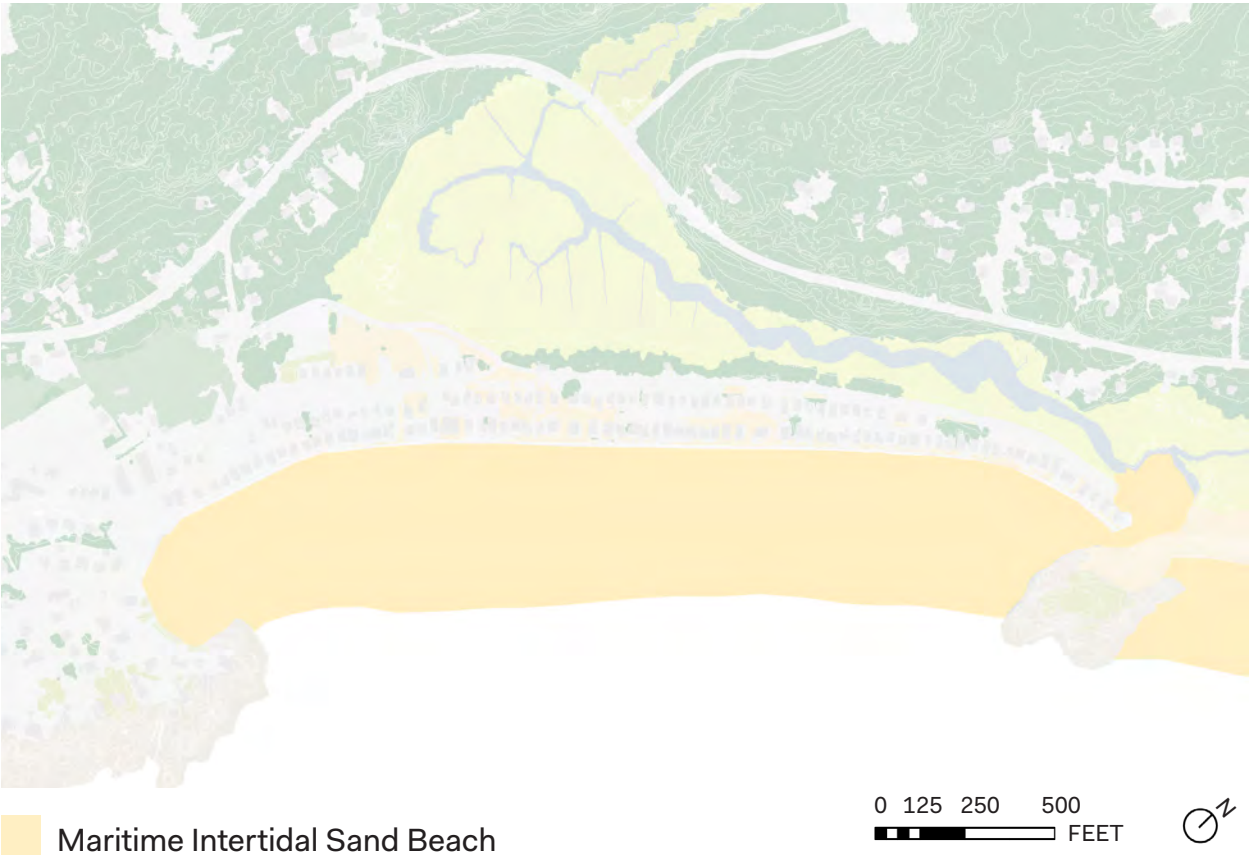


Marine Intertidal Sand Beach

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 293-294.

Long Beach is exposed between high tides. The marine intertidal sand beach is a high energy habitat located below the wrack line and above the low tide line. Invertebrates, including shellfish and crabs, as well as shorebirds like Herring and black-back gulls live here, along with sandpipers and crabs.¹

Sea level rise and coastal erosion will continue to narrow the available sandy beach above the low tide line, thereby decreasing the amount of marine intertidal sand beach at Long Beach.



The rising tide at Long Beach covers and uncovers the marine sand beach twice daily. The wrack line is the line of seaweed, often bladderwrack, that marks the height of the highest tide on the beach.

Marine Intertidal Rocky Shore

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 295-296.

²See Carl Carlozzi, Kathryn King, William F. Newbold Jr., *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Massachusetts Office of Coastal Zone Management, 1975), 24-26.

³See Christopher Leahy, John Hanson Mitchell, and Thomas Conuel, "Rocky Shore and Intertidal Zone," *The Nature of Massachusetts* (Reading, MA: Addison-Wesley Publishing Company, Inc., 1996), 41-47.

The rocky shore is an internationally rare community, ranging from the top of the high tide splash zone to the limit of light penetration beneath the ocean. This high stress environment is submerged twice daily by the tides. Like the salt marsh, the rocky shore is striated into distinct zones based on light and salinity: the splash zone with limited vegetation, the high tide zone with barnacles and periwinkles, the black-green algae zone with rockweed and bladderwrack, and the low-tide zone with kelp and benthic invertebrates.

Rocky intertidal habitat is found along the perimeter of Cape Hedge and Brier Neck. The rocky shore supports blue mussels, fish including fourspine stickleback, cunner, and birds including Herring Gulls, as well as Sandpipers and Plovers that feed in the rocky intertidal habitat, and roost in the zone at high tide.^{1 2 3}



The intertidal rocky shore at Long Beach is found around Brier Neck and Cape Hedge. Different zones are exposed depending on the tide.

Salt Marsh

¹BioMap is an online tool developed to share scientific data and resources to “help state and local governments, land trusts, non-government organization, and other conservation partners strategically plan projects to conserve wildlife and their habitats.” BioMap defines Critical Natural Landscape areas as “large landscape blocks that are minimally impacted by development, as well as buffers to core habitats and coastal areas to enhance resilience.” Commonwealth of Massachusetts and The Nature Conservancy, *BioMap2*, accessed July 19, 2024, www.biomap-mass-eoeea.hub.arcgis.com/

²Carl Carlozzi, Kathryn King, William F. Newbold Jr., *Ecosystems and Resources of the Massachusetts Coast* (Boston, MA: Massachusetts Office of Coastal Zone Management, 1975), 13-15.

The Saratoga Creek estuary behind Long Beach is designated as Critical Natural Landscape by BioMap, a tool developed by MassWildlife and The Nature Conservancy. ¹ At Long Beach, this includes 34.74 acres of wetlands stretching behind Long Beach to Cape Hedge Beach, including 2.53 acres of wetlands behind Thatcher Road.

Saltmarshes are one of the most biologically productive ecosystems on the planet, due to the amount of detritus that is produced by cordgrass (*Spartina alterniflora*) one of two dominant species in temperate salt marshes.

Cordgrass grows in low marsh areas that are regularly inundated by high tide, while the other dominant grass species, saltmarsh hay (*Spartina patens*), grows in high marsh areas that are not inundated regularly. Looking out over Long Beach, it's easy to identify these vegetative zones, which are defined by saltwater inundation and elevation. Cordgrass grows straight along the tidal channel, while saltmarsh hay can be identified by its signature velvety cow licks that appear late in summer, when the grasses are pushed over by the tide. Other species, including black grass (*Juncus gerardii*) grow toward the edges of the salt marsh.²



Salt Marsh



Salt marsh cordgrass (*Spartina alterniflora*) grows along the banks of the Saratoga tidal creek. Salt marsh hay (*Spartina patens*) is identifiable by its “cow-lick” like appearance in summer and early fall.

³P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 297.

⁴Landscape historian John Stilgoe provides a rich description of the history and cultural meaning of salt marshes from the Colonial period through the early twentieth century in *Alongshore*. He describes the end of profitable salt marsh haying in the late nineteenth century, and the beginning of salt marsh ditching in the 1910s in an attempt for property owners to drain their marshes. This practice was expanded as part of the New Deal, and also included a series of pest control programs, including the invention of greenhead fly traps, which are visible in marshes across Cape Ann. See John Stilgoe, *Alongshore* (New Haven: Yale University Press, 2004).

⁵An example of this ditching can be seen in the aerial drone photograph titled, “Saratoga marsh ditches and salt pannes.” Notice how the bank is calving into the tidal channel.

Salt marshes are dynamic ecosystems that are constantly changing. Bacteria decompose dead cordgrass, which are then consumed again by bacteria and fungi, and then reconsumed by worms, crustaceans, mollusks, insects, and other fish. This process of decomposition forms salt marshes, and the basis of the marine ecosystem. This process takes place as “peat develops in the higher marshes, marsh plants extending into flats in stabilized areas as plants trap sediments and organic material, raising the surface area” and growing the marsh.³

Salt marshes can grow in two directions: vertically or horizontally. They can grow vertically, or accrete, as peat accumulates above the reach of the daily tides, and high marsh takes root in areas that are sheltered from wave energy. Salt marshes can also migrate horizontally, moving into inland habitats when terrestrial plants die from salt spray blown in during storms, or, increasingly from sea level rise. At Long Beach, the granite bedrock that rises behind the Saratoga Marsh will prevent horizontal migration, meaning that the Saratoga Marsh will likely transition to low marsh, and eventually tidal flats, or degraded areas without vegetation, if the marsh cannot accrete faster than the sea is rising.

Sea level rise is not the only anthropogenic change to affect salt marshes. These landscapes were historically seen as wastelands. They were considered unproductive, and were filled with rubble, soil, and garbage to support development and transportation networks, or drained for agricultural land. The salt marshes on the eastern seaboard, including Cape Ann, have been altered by humans for centuries, first to support the colonial agricultural economy, and later in a misguided attempt to control the mosquito population. During colonial times, saltmarsh hay was harvested by farmers to use as fodder for cattle during the wintertime. Later, in the mid-twentieth century, straight line mosquito ditches were carved out of marshes. These ditches were meant to bring saltwater deep into the marsh to flush out mosquito larvae and control populations. This experiment did not successfully control mosquito populations. Instead, the ditches have disturbed the hydrology of marsh systems.⁴ During storms in the Saratoga Creek estuary, when wave energy surges through the tidal channel, the banks of the ditches erode, and the mouths of the ditches calve into the channel, washing the mud and marsh grasses into the ocean.⁵

⁶NOAA, “Seaview Street Salt Marsh Restoration,” NOAA (Rockport, MA: NOAA, 2003).

⁷Many species spend part of their life cycle in freshwater and part of their life cycle in salt water. The American eel is a catadromous species, born in freshwater before returning to saltwater to spawn and die at the end of its life, which can be up to 50 years. An anadromous species is born in freshwater and moves from freshwater to saltwater, before returning to freshwater to spawn. Anadromous species at Long Beach include striped bass and rainbow smelt. See Christopher Lahey, John Hanson Mitchell, and Thomas Conuel, *The Nature of Massachusetts* (Reading, MA: Addison-Wesley Publishing Company, Inc., 1996).

The flow of saltwater through the Saratoga estuary is further limited by two culverts. The box culvert under Thatcher Road limits the exchange of salt water through the tidal creek and freshwater from the upland pond and freshwater stream. A smaller culvert under Seaview Street was replaced in 2003, but still limits water flow in the marsh.⁶ Undersized culverts lead to longer periods of flooding. Restricted tidal flow ralso educes the influence of saltwater in marshes, which can favor invasive species including common reed (*Phragmites australis*) and purple loosestrife (*Lythrum salicaria*). These species compete with the *Spartina* salt marsh species.

In 2003, Rockport’s Middle School Science Club conducted fish sampling and found mummichogs (*Fundulus heteroclitus*), rainbow smelt (*Osmerus mordax*), silversiders (*Atheriniformes sp.*) and sticklebacks (*Gasterosteidae sp.*) in the salt marsh. They also note that the marsh is nursery habitat and forage for marine fish, and a migratory route for American eel (*Anguilla rostrata*), a species that spawns in the Atlantic Ocean before traveling upstream to freshwater to live the majority of their lives, then migrate back to the ocean.⁷ Additionally, the team found that storm waters break over the barrier beach at Cape Hedge and flood the salt marsh with sea water, while the marsh is flooded with freshwater after heavy rain events. While undeveloped barrier beaches are able to shift with seasons and storms, the parking lot at Cape Hedge and seawall at Long Beach limit the ability of these natural communities to adapt to these changes.

Brackish Tidal Marsh

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 282-283.

Brackish tidal marsh occurs along the edges of salt marsh near stream inputs and freshwater transition areas, including the pond that feeds into the Saratoga Marsh above Thatcher Road. The vegetation in this area is varied, including salt marsh hay (*Spartina patens*) and cordgrass (*Spartina alterniflora*), and herbs that grow in mudflats.¹

Brackish tidal marsh provides essential wildlife habitat for specialist and generalist bird species, and provides spawning habitat for American eels. Reduced water flow due to the growth of Phragmites and sea level rise are the primary threats to this community.



Brackish Tidal Marsh



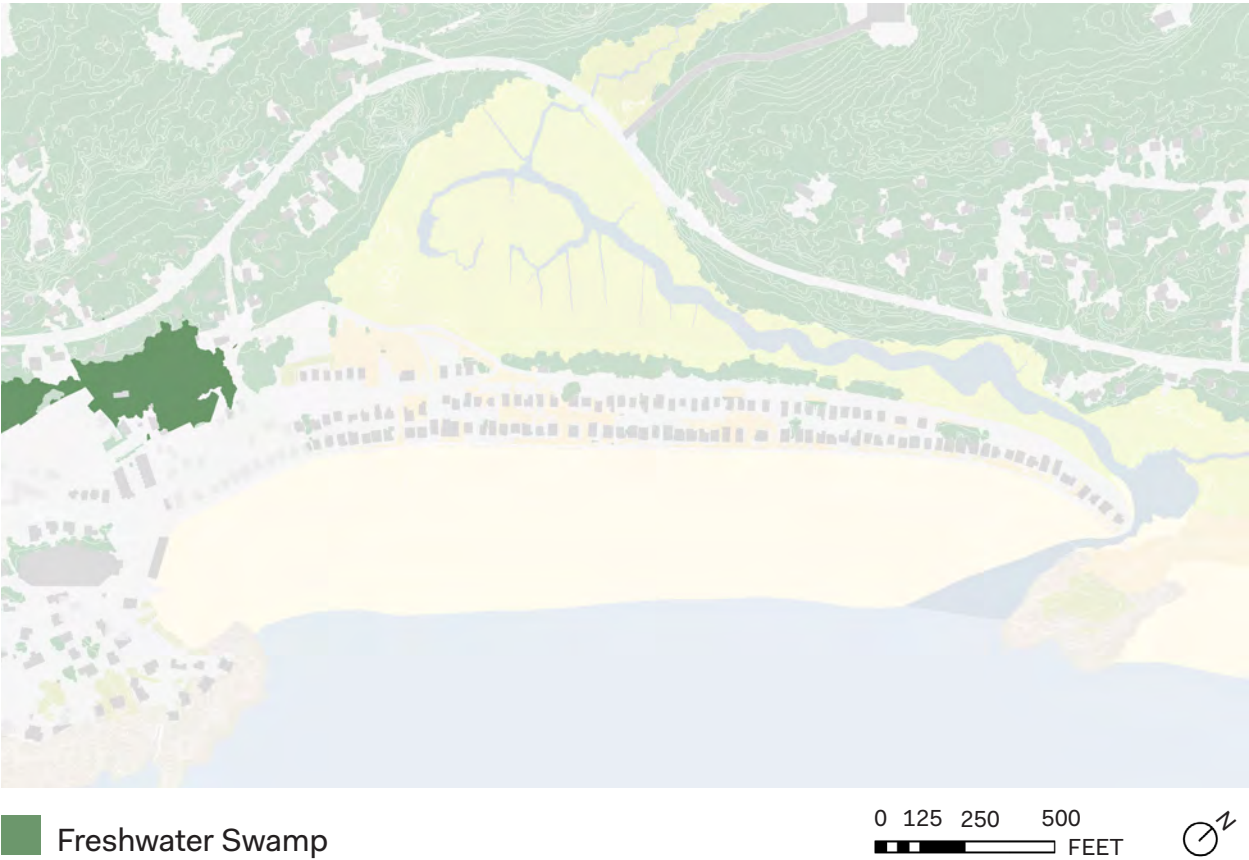
A culvert allows water to pass under Thatcher Road twice daily during high tides. This part of the marsh also receives water that drains down the slopes from higher points in Rockport.

Freshwater Swamp

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 201-203.

Behind Long Beach, freshwater flows from a small patch of wooded deciduous swampland on Farm Lane, down Saratoga Creek, through the culvert below Thatcher Road (Route 127A) and into the salt marsh.

The freshwater swamp areas around Long Beach are border thickets that are seasonally flooded, often during spring and early summer. This acidic swampland has limited red maple (*Acer rubrum*) canopy, and a dense understory of shrubs.¹



Maritime Dune

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 63-65.

²Town of Rockport Board of Selectmen, *Long Beach Regulations* (Rockport, MA: Town of Rockport, 2024).

Barrier beach systems have a mosaic of different communities that live in the harsh, dynamic environment of dune systems.¹ At Long Beach, the dune system has been stabilized by the seawall, and many of the vascular plants that are typically found in the maritime dune community have been replaced by ornamental species by cottage owners. Still, American beachgrass and (*Ammophia brevigulata*), seaside goldenrod, beach pea (*Lathyrus japonicus*), seabeach sandwort (*Honckenya peploides*) and beach heather (*Hudsonia tomentosa*) are visible in the firebreaks and between the manicured lawns at Long Beach. Small, stunted red cedars (*Juniperus virginiana*) grow in the firebreaks and neglected spaces between the cottages. Bearberry (*Arctostaphylos uva-ursi*), bayberry (*Morella pensylvanica*) grow on the landward side of the dunes.

The dune community has been disturbed by vehicle and foot traffic, compaction, and construction. Development has altered wind patterns, and therefore the deposition of sand and vegetation. Cottage owners are prevented from “removing, smothering, or cutting of natural dune and salt marsh vegetation,” and further prohibited from applying synthetic pesticides, herbicides, or fertilizers.²



Maritime Dune



Seaside goldenrod (*Solidago sempervirens*), beach rose (*Rosa rugosa*), and American beach grass (*Ammophila brevigulata*) grow between the ornamental lawns near the cottages at Long Beach.

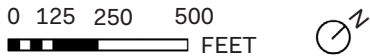
Maritime Shrubland

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 79-80.

Maritime shrubland occurs in areas that are sprayed directly by salt, with minimal tree canopy. This shrubland grows on the bluffs above the intertidal rocky community on Cape Hedge at Long Beach. The species here include bayberry (*Morella pensylvanica*) and red cedar (*Juniperus virginiana*), as well as black cherry (*Prunus serotina*). The trees and shrubs that grow in this area cannot tolerate inundation by saltwater, but they can tolerate and recover from the salt blown onto their leaves.¹ This area includes oriental bittersweet (*Celastrus orbiculatus*), which could be managed and removed.



Maritime Shrubland



Salt-tolerant trees and shrubs flag in the dominant direction of the wind. Species on Cape Hedge include Eastern red cedar (*Juniperus virginiana*) and bayberry (*Myrica pensylvanica*).

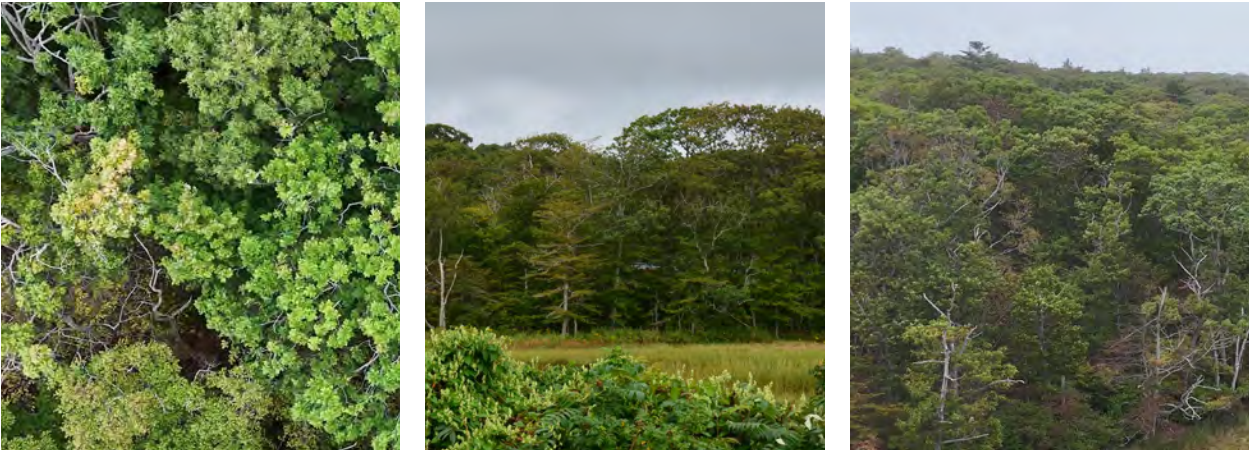
Coastal Forest

¹P.C. Swain, *Classification of the Natural Communities of Massachusetts* (Westborough, MA: Natural Heritage & Endangered Species Program, Massachusetts Division of Fisheries and Wildlife, 2020), 43-45.

Coastal forests are located behind dunes on slopes retreating from the ocean. These forests are protected from daily salt spray, but receive wind and salt during storms. The deciduous canopy is dominated by stunted oaks (*Quercus sp.*). Vines, including poison ivy (*Toxicodendron radicans*) and Virginia creeper (*Parthenocissus quinquefolia*) are present.¹



Coastal Forest



Red oak (*Quercus rubra*), gray birch (*Betula populifolia*), sumac (*Rhus typhina*), red maple (*Acer rubrum*), eastern hemlock (*Tsuga canadensis*), and eastern white pine (*Pinus strobus*) grow along the road and on the upland slopes behind Long Beach.

Ocean and Tidal Channel

¹Dr. Dave Reidmiller, “Gulf of Maine, Explained: Causes & Impacts of Rapid Warming,” *Gulf of Maine Research Institute*, accessed February 20, 2024.

²In addition to winter tides that cover Long Beach with water, king tides are exceptionally high tides that often occur during new or full moons throughout the year. Observations of king tides and other observations of coastal flooding, coastal storm impacts, and shoreline adaptation can be submitted to MyCoast, a reporting tool through the Massachusetts Office for Coastal Zone Management that helps to increase awareness of coastal hazards and inform coastal management. See “MyCoast,” *Massachusetts Office of Coastal Zone Management*, mycoast.org/ma/king-tides.

³The Commonwealth of Massachusetts monitors bacteria levels during the summer, testing at regular periods. These results can be found online at www.mass.gov/info-details/interactive-beach-water-quality-dashboard

Long Beach drains into the Gulf of Maine, an international commons that stretches from the Bay of Fundy in Nova Scotia, Canada to Provincetown at the tip of Cape Cod in Massachusetts, United States. The northern Atlantic Ocean, including the Gulf of Maine, is a climate outlier. Sea surface temperatures in the Gulf of Maine is rising more quickly than 97% of other water bodies on the planet.¹

It can be hard to feel how ocean temperatures are increasing in the chilly waters of the north Atlantic. At Long Beach, the average water temperature during the coldest month, March, is just 39.6°F. In August, the warmest month, the average water temperature rises to a balmy 66.9°F. Like the temperature, the tide ebbs and flows twice daily. The tidal range varies from seven to twelve feet depending on the phase of the moon. During winter high tides² and storms, the Atlantic Ocean reaches the seawall, covering the entire beach with water. During low tide, beachgoers can walk the sandy crescent from Brier Neck across the tidal channel to Cape Hedge, so long as the beach is open. Recently, water quality issues across Cape Ann have closed beaches, including Long Beach. High concentrations of bacteria, especially *Enterococcus* bacteria, are increasingly common after short-duration, heavy rainfall events.³



Legend: Ocean (light blue), Tidal Channel (dark blue). Scale: 0 125 250 500 FEET. North arrow.



The tidal channel near Cape Hedge flushes ocean water through the Saratoga Marsh complex twice daily during high tides.

⁴The United States Environmental Protection Agency provides the general public with information about the conditions of local waterways by combining federal, state, and local data. See “How’s My Waterway?” *United States Environmental Protection Agency*, www.mywaterway.epa.gov

This type of event will become more frequent due to climate change, which will create larger and more erratic periods of precipitation. Water quality is also impacted by activity adjacent to the ecosystem. Inland activity around Long Beach has a direct impact on the watershed. Discharge pollutants from automobiles, nutrients and pesticides from neighborhood lawns, and contaminants directly affect watershed processes and run into the ocean.⁴

What is the relationship between physical and ecological infrastructure systems?

Physical infrastructure systems have been built alongside, on top of, and in some cases underneath the ecological systems at Long Beach. Physical infrastructure at Long Beach includes:

- Buildings (Housing)
- Coastal Resilience Infrastructure (Seawall)
- Electrical System
- Transportation System (Roads, Sidewalks, Culverts)
- Wastewater System
- Water System

This following pages map these physical systems at Long Beach in relationship to the natural communities at the beach.

¹Long Beach Options Committee, *Long Beach Infrastructure Recommendation* (Rockport, MA: Long Beach Options Committee, 2022), 10.

²Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 9.

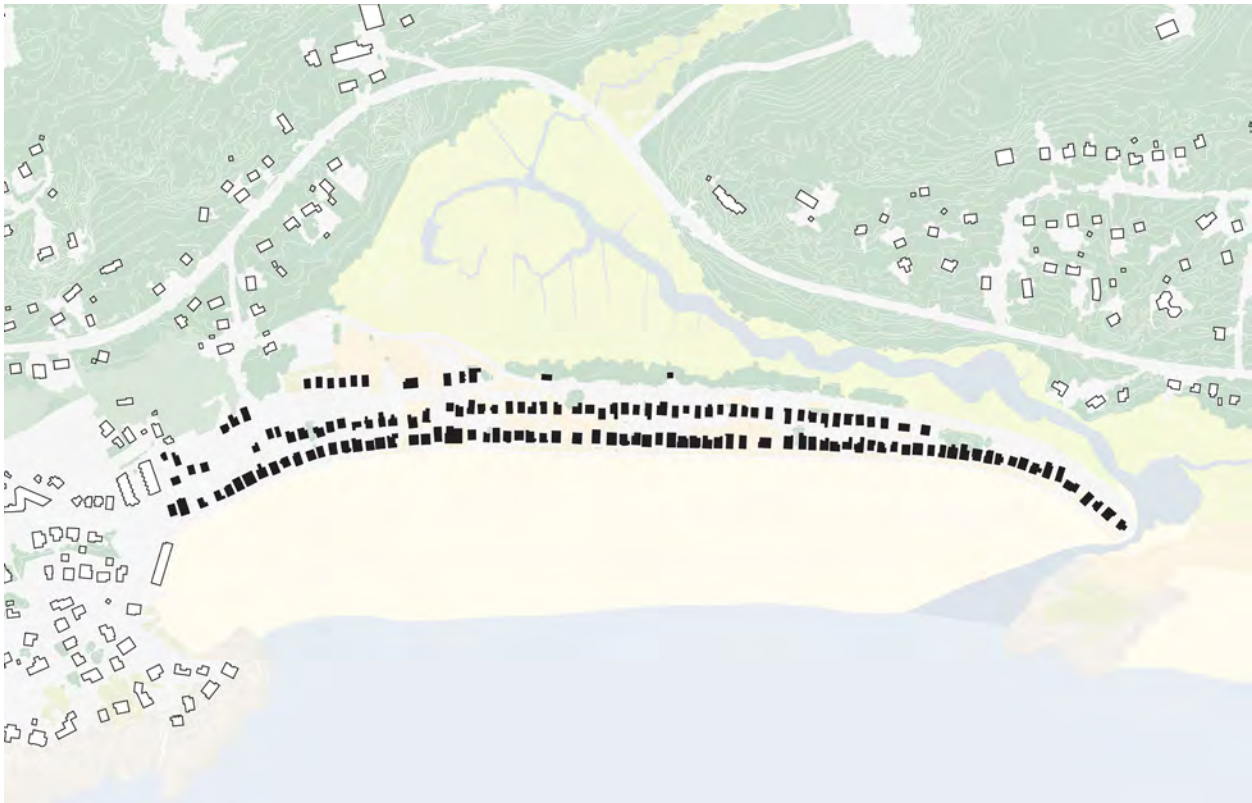
³Town of Rockport, *Press Release: Rockport Long Beach Litigation Settlement* (Rockport, MA: Town of Rockport, 2018).

⁴Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 6.

Buildings (Housing)

The cottages at Long Beach range from basic, seasonal cottages with screened porches and weather-beaten shingles to year-round residences that have been constructed recently with high-quality finishes. The cottages are divided into three lines, or rows. The front row cottages have unobstructed ocean views. The second row of cottages are adjacent to the service road. A limited number of third row cottages lie behind the dune, across Long Beach Road. The cottage owners enjoy access to the beach from wooden staircases spaced every 200 feet along the seawall. The cottages remain seasonal, legally occupied from April 1 to December 1 each year, and are owned by year-round residents of Rockport as well as summer residents. Cottage owners pay leases and taxes on the parcels and structures, resulting in revenues to the Town around \$2,500,000 annually. This revenue increases by around \$150,000 each year.¹ Beyond the leases and taxes they pay on the parcels, the cottage owners patronize businesses in Gloucester and Rockport during the summer.

The Rockport Board of Selectmen may terminate a lease at any time through a 4/5 vote. If a lease is terminated, the lessee is responsible for removing the cottage and all personal property from the parcel.² If the Town decides to sell the parcels, the lessees will have the first right of refusal.³ This process would involve a decision by the Board of Selectmen, authorization by voters at Rockport Town Meeting, and the consent of the Commonwealth of Massachusetts legislature.⁴



■ Long Beach Cottages, Accessory Buildings, and Sewer Pump Station

□ Other Structures

0 125 250 500 FEET

During the early twentieth century, shifting attitudes around recreation, health, and landscape brought Americans to the coast. Like many barrier beaches around the country, the cottages at Long Beach were developed by local residents and out-of-towners who flocked to the ocean for leisure during the summer months.

Why was Cape Ann developed around the ocean?



■ Structures (homes, businesses, other buildings)

0 0.5 1 2 MILES

Sheltered harbors and estuaries were settled first around Cape Ann. Fishing, shipbuilding, trade, and travel all took place on the ocean when Cape Ann was colonized. This seventeenth century pattern of development brings new risks due to sea level rise and increasingly powerful storms in the twenty-first century.

Coastal Resilience Infrastructure (Seawall)

The Long Beach seawall has been the focus of many reports, studies, committees, and recommendations over the past ninety years since it was first constructed. Today, there are three sections of seawall constructed in 1931 measuring 1,745 feet, and two sections constructed in 1958 measuring 1,609 feet. In 2014, Vine Associates found the 1931 pieces to be in “Poor” condition, and the 1958 sections to be in “Acceptable” condition.”¹ In 2014, piecemeal sections of the seawall fronted by a rubble mound revetment² and scour apron were “frequently exposed,” meaning that, “during certain times of year, little or no beach exists at high tide along portions of Long Beach.”^{3 4 5}

While the entire seawall is beyond the typical 50-year life cycle of a similar waterfront structure, Vine Associates noted that the “potential remaining service life of the 1958 seawall may be 20 and 30 years [2034 to 2044] depending on the rate of deterioration and regular maintenance intervals.”⁶

The seawall has been reactively repaired after extreme storms, which frequently overtop the seawall.⁷ In March 2018, a nor’easter significantly damaged the seawall. The Rockport Department of Public Works performed emergency stabilization measures to fill a 150’ void behind the seawall after a portion of the concrete sidewalk collapsed. Interim stabilization measures were undertaken through a \$750,000 grant from the Massachusetts Executive Office of Energy and Environmental Affairs that included a \$250,000 match from the Town of Rockport. The goals of this project were to “mitigate the short-term undermining of the seawall, buffer storm waves and supplement the sediment supply at the site.” The first phase included repairing the western end of the seawall, buttressing the 1931 seawall, and replacing the sidewalk. This involved removing 2,045’ of concrete sidewalk and replacing it with a 4” stone dust walkway that is easier to repair than poured concrete. The voids underneath the seawall were filled with gravel. An additional 2,500 tons of stone revetment were then added to the wall, and, in spring 2019, 8,000 cubic yards of sand were deposited on the beach.^{8 9}

¹Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 2.

²A rubble stone revetment is an alternative to vertical concrete seawalls. Revetments are piles of stone that protect against erosion caused by wave action, storm surge, and currents. Applied Coastal Research and Engineering write that revetments are generally “gently sloped from the crest down below the beach face.” This slope “allows for energy dissipation as waves break across the face, reducing the amount of runoff and overwash that occur with a steeply faced seawall. However, the gentle slope of the revetment covers large areas of beach and bottom lands, further reducing beach width and the natural character of the beach.” Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 49.

³Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 49.

⁴Contributors from across Cape Ann regularly post photos of flooding on Long Beach to Good Morning Gloucester, a local blog. Images taken on March 4, 2018 by contributor Catherine show sinkholes and voids behind the seawall. Images taken on December 23, 2022 show flooding on the road, debris from stairs and the walkway to Cape Hedge Beach that were damaged, and waves crashing over the seawall. Images taken on April 2, 2024 show damage to the seawall and scraped soil along the length of the seawall. See “Winter Storm Flooding Photos Long Beach,” “Paths of Destruction Winter Storm Damage Riley Long Beach #GloucesterMA,” “Long Beach Seawall Status. Storm Damage Photos 2024,” “Storm Prep. Long Beach Photos Aug. & Sept. #RockportMA,” and “Storm Walk on Long Beach After High Tide Backed Off Seawall #WinterStorm,” *Good Morning Gloucester*, 2022-204, accessed September 2, 2024, www.goodmorninggloucester.com

⁵The Long Beach Infrastructure Committee, established in 2017, documented images of seawall failure and sidewalk collapse during storms in 2018. See Long Beach Options Committee, *Long Beach Infrastructure Recommendation* (Rockport, MA: Long Beach Options Committee, 2022).

⁶Vine Associates bored four borings 4’ to 8’ from the sidewalk. See Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 2.

⁷While the seawall is in the FEMA floodplain, this designation is created from previous, historical storm events, and does not represent the real risk of flooding or storm surge due to climate impacts, including sea level rise and increasingly powerful hurricanes. See Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 4.

⁸Executive Office of Energy and Environmental Affairs, *Long Beach Seawall Stabilization Improvements Project* (Boston, MA: Executive Office of Energy and Environmental Affairs, October 26, 2018).

⁹Long Beach is a barrier beach resource, meaning that all repairs to the seawall are pursuant to the Massachusetts Wetlands Protection Act, Chapter 91 License, Section 401 Water Quality Certification from the Massachusetts Department of Environmental Certification, and is subject to a Federal Consistency Review by the Massachusetts Office of Coastal Zone Management.

¹⁰“FEMA Awards Rockport Nearly \$2.8 Million for Long Beach Seawall Repair Project,” *Federal Emergency Management Agency*, accessed July 17, 2024, www.fema.gov/press-release/20230504/fema-awards-rockport-nearly-2-8-million-long-beach-seawall-repair-project

¹¹GZA Environmental Inc., *Long Beach Seawall FEMA Disaster Relief Project No. 73018* (Gloucester, MA: Federal Emergency Management Agency, March 2020).

¹²Massachusetts Barrier Beach Task Force, *Guidelines for Barrier Beach Management in Massachusetts* (Boston: Office of Coastal Zone Management, 1994), 13.

¹³Applied Coastal Research and Engineering Inc., *Long Beach, Rockport, Massachusetts Sediment Transport Study* (Rockport, MA: Town of Rockport, 2014), 48.

In 2023, the Federal Emergency Management Agency awarded the Town of Rockport a \$2,762,936 Public Assistance grant to repair the seawall after it was damaged in 2018.¹⁰ The Town of Rockport provided 25% of the repair costs, amounting to \$920,978. GZA Geoenvironmental Inc. produced the drawings for the project, titled Long Beach Seawall FEMA Disaster Relief. The project involves reconstructing 350 linear feet of the 1931 seawall, and another 43 linear feet of seawall with a concrete access stairway on the western end of the beach toward Gloucester.¹¹ This project was funded by FEMA and the Town of Rockport. The total costs of repairs paid for by the Town of Rockport for the 2018 nor’easter was approximately \$1,170,978.

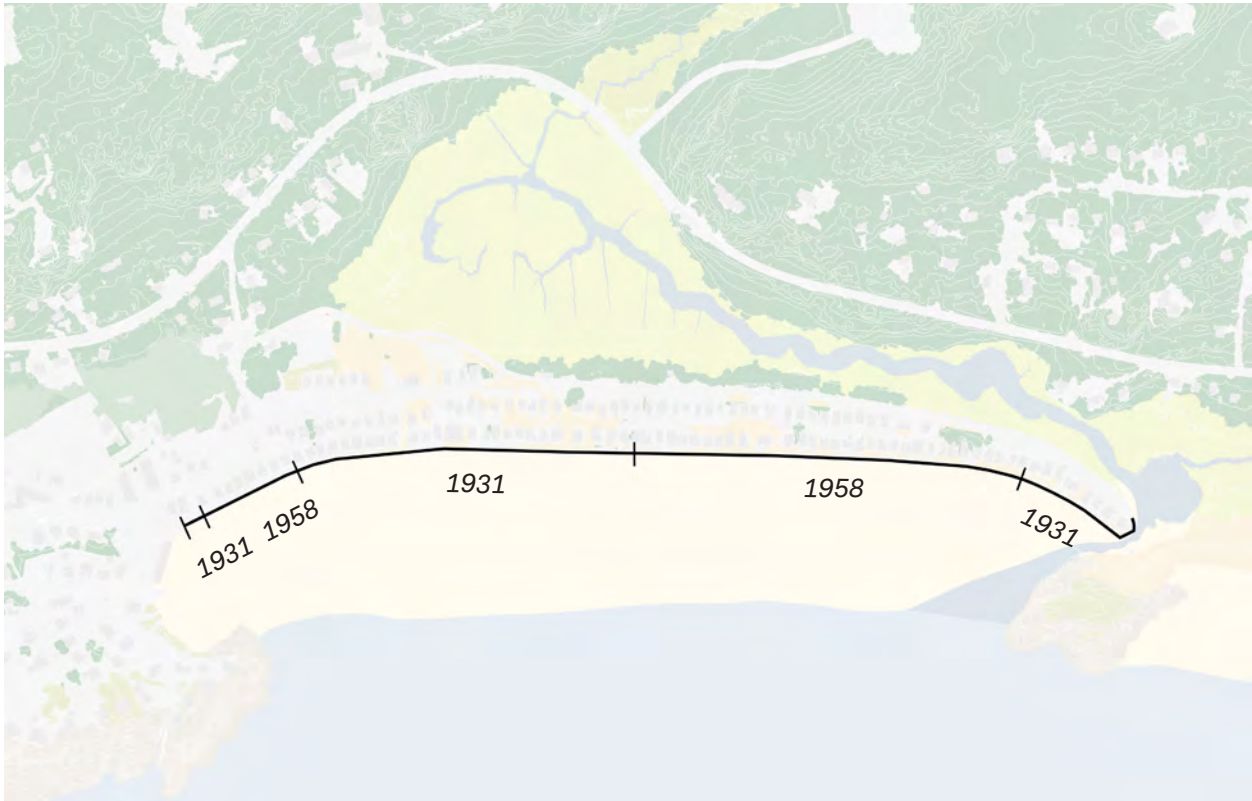
Repairing the seawall does not fix flooding concerns landward of the seawall, or the decreasing beach resource for the public as erosion and sea level rise narrow the width of the beach for longer periods throughout the year. As described in the previous section, “How has Long Beach Changed,” the Long Beach seawall has been damaged by nor’easters, hurricanes, and high tides as early as 1933, just one year after it was first constructed. The immediate failure of the seawall was a chance to understand that the seawall interfered with the natural coastal processes on the spit beach, including the process of overwashing, in which sand migrates landward in response to storms, and the growth of beach grass, which stabilizes the soil and prevents erosion. Already in 1933, the attempt to stabilize Long Beach through armoring had diminished the beach’s defenses against future nor’easters.¹²

While the seawall was built as a form of historic shore projection, it does not take into account the oceanic or geologic coastal processes that have shaped the beach for thousands of years, the adverse environmental impacts of the wall on the marsh, or the feasibility of maintaining the seawall.¹³ Nevertheless, not only was the seawall renovated after it was damaged in the nor’easter, it was extended. Discussion around the future of Long Beach still revolves around the seawall, which precludes other possible futures that would restore the ecological system at the beach.

¹⁴Massachusetts Barrier Beach Task Force, *Guidelines for Barrier Beach Management in Massachusetts* (Boston: Office of Coastal Zone Management, 1994), 13.

Locally, the seawall protects the cottages, but prevents the beach from migrating inland. The 2014 Sediment Transport Study undertaken by Applied Coastal Research and Engineering notes that “it is not possible to maintain the shoreline position without an influx of additional beach sediment due to a combination of ambient sea-level rise, natural cross-shore erosion, and the influence of seawall construction (i.e. exacerbated wave reflection causing additional beach scour).¹⁴

Regionally, the coastline around Cape Ann is heavily armored by seawalls, bulkheads, jetties, and breakwaters that were constructed using granite mined in the nineteenth century. This coastal armoring prevents the flow of sediment along the coast of Cape Ann, leading to a decrease in the width of beaches overtime. Without inputs of sediment from upland regions, shoreline erosion will continue across Cape Ann, which will be exacerbated as sea levels rise.



— Seawall

0 125 250 500 FEET

1958 Year Seawall was Constructed

The pieces of the Long Beach seawall that were constructed in 1931 are fifty years past their expected lifespan. Adapted from GZA Environmental Inc., *Long Beach Seawall FEMA Disaster Relief Project No. 73018* (Gloucester, MA: Federal Emergency Management Agency, March 2020).

Where has the coast been armored across Cape Ann?



— Public and Private Shoreline Stabilization Structures

0 0.5 1 2 MILES

Across Massachusetts, twenty-seven percent of the coast is armored with shoreline stabilization structures. These structures include bulkheads, seawalls, revetments, groins, breakwaters, and sandbags. Data from Massachusetts Office of Coastal Zone Management (CZM) and Massachusetts Department of Conservation and Recreation (DCR), *Shoreline Stabilization Structures* (Boston, MA: Massachusetts Office of Coastal Zone Management, 2015).

¹“System Data Portal,” *National Grid Massachusetts*, accessed April 1, 2022, www.systemdataportal.nationalgrid.com/MA

²Theodore J. Kury, the Director of Energy Studies at the University of Florida, notes that it is impossible to completely protect the electric grid. See Theodore J. Kury, “No easy decisions to ensure a resilient power grid,” *The Hill*, September 17, 2021.

Electrical

Electricity at Long Beach is provided by Massachusetts Electric doing business as National Grid, and delivered through a series of feeder lines, or wires, that are hung from electrical poles. Electricity is delivered to Long Beach through a buried trunk line that first enters Manchester-by-the-Sea from Beverly through Chubb's Creek Marsh. The line runs through downtown Manchester, along Route 127A into Gloucester, and above ground on feeder lines to Long Beach.¹

The electrical system at Long Beach faces two risks: one local, and one regional. Locally, the electrical poles and wires on Long Beach may come down during storms with high winds. While there is limited tree canopy on Long Beach, the power lines along Thatcher Road are susceptible to damage by falling tree branches. Nor’easters bring additional risks of ice accumulation that weighs down power lines.

Regionally, the buried trunk cable in Chubb's Creek is buried in a marsh that intermittently floods. Buried lines are susceptible to damage from water during storm surges or flooding.² Long Beach, therefore, is just one neighborhood on Cape Ann that is at risk of increasing power outages. A regional solution might include digging an additional trunk line that is not dug into a marsh or area that floods, or building a micro-grid that serves East Gloucester and Rockport to avoid electrical lines crossing the Annisquam River.

¹*Butman et al. v Assessors of Rockport*, No. F327814 (Commonwealth of Massachusetts Appellate Tax Board January 17, 2017).

²Town of Rockport, *Town of Rockport Hazard Mitigation Plan* (Rockport: Town of Rockport, 2020), 47.

³Images of coastal flooding at Long Beach and Thatcher Road at Good Harbor Beach, as well as other places in Rockport and Gloucester are available through MyCoast. See “MyCoast: Massachusetts,” *MyCoast*, accessed September 2, 2024, www.mycoast.org/ma

⁴Applied Coastal Research and Engineering, *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 23.

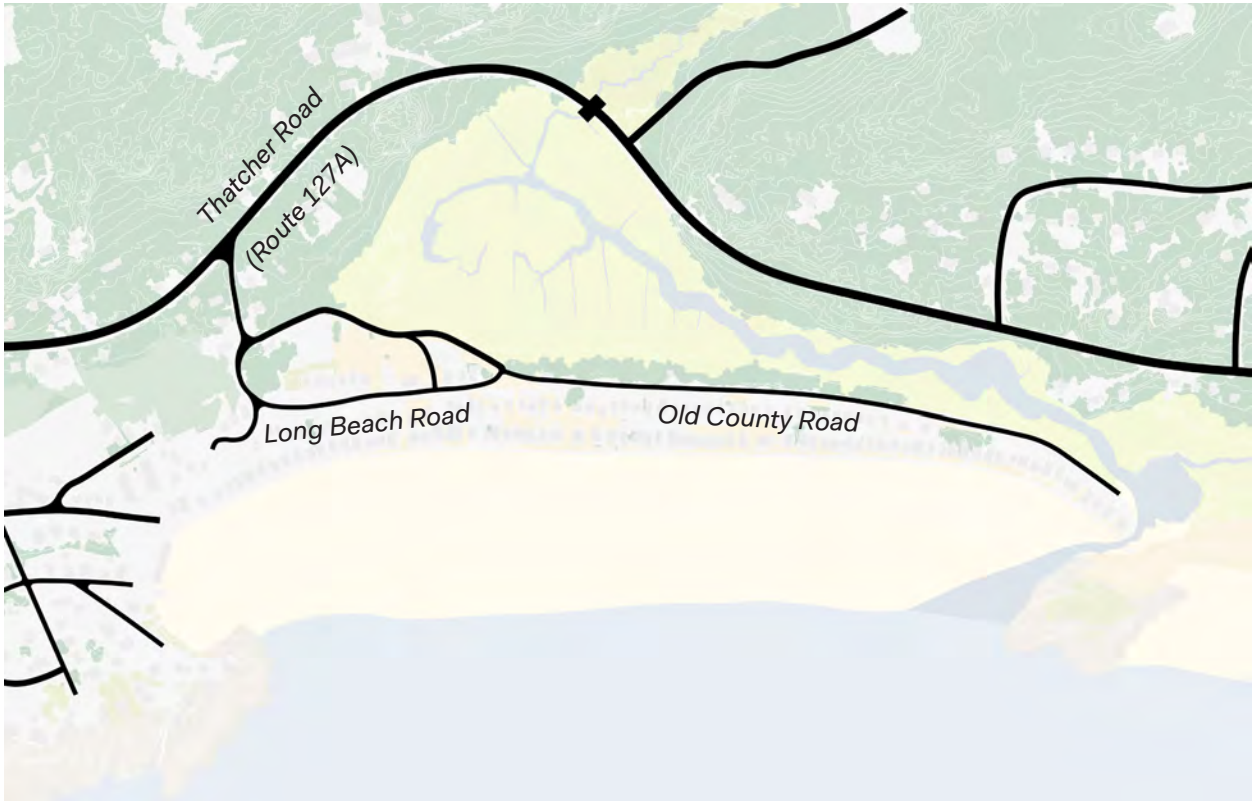
Transportation

Transportation infrastructure at Long Beach includes Route 127A (Thatcher Road), the primary ring road around Rockport, and the primary evacuation route from Long Beach, as well as smaller, secondary roads, parking lots, and culverts, which allow water to pass underneath the roads in the Saratoga Marsh complex.

Long Beach Road, which becomes Old County Road near 122 Long Beach Road, is private. Long Beach residents pay an annual fee of \$185 for access for themselves and guests. Rockport residents can park in the 240-space lot at Cape Hedge Beach with an appropriate beach sticker. Access and parking for non-Rockport residents at Long Beach is extremely limited. Two private lots near Long Beach charge for parking with variable rates on weekends and weekdays.¹ The public parking lot behind Cape Hedge Beach that provides access to Long Beach has also flooded. The sixteen foot popple stone revetment at Cape Hedge Beach has been rebuilt by the Town of Rockport after it was overtopped during major storms in April 2007 and 2016.²

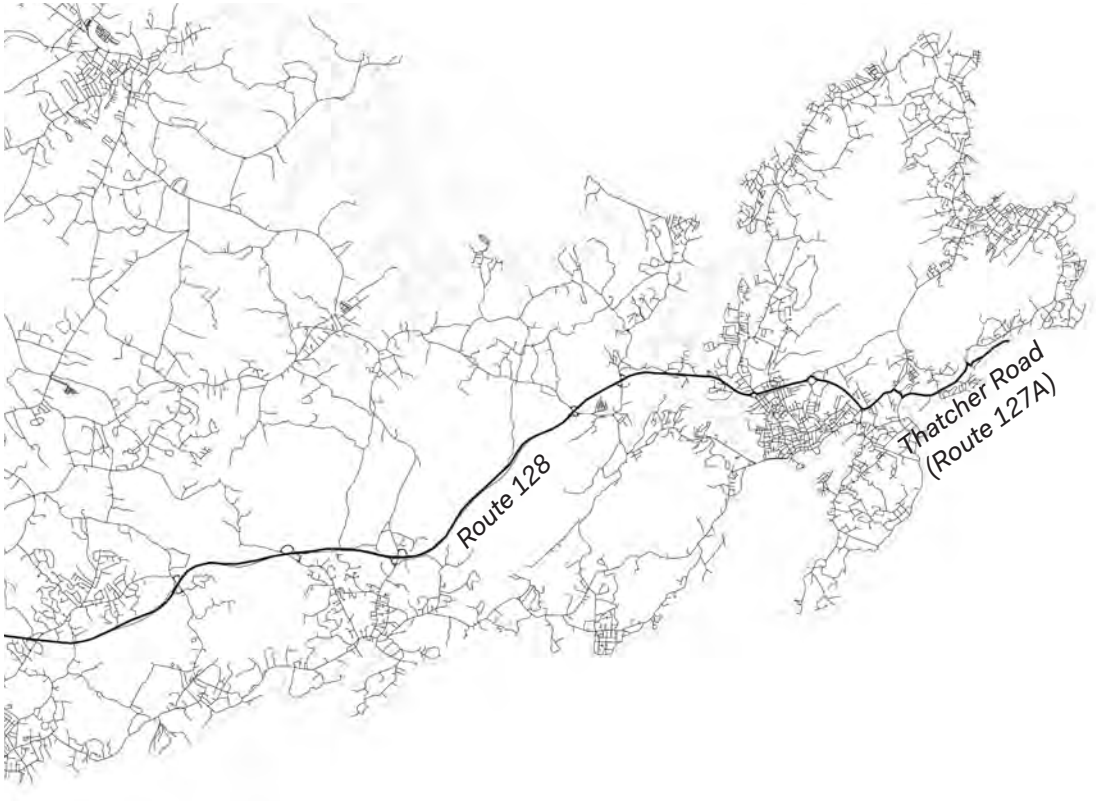
Coastal flooding is a significant problem both locally and regionally. Long Beach/Old County Road floods frequently during storms and high tides, particularly near Saratoga Creek.³ These flooding issues are not new. The salt marsh vegetation growing at the far end of Long Beach Road is evidence that the road is frequently inundated. A photograph taken by the United States Army Corps of Engineers on September 21, 1960, shows the salt marsh encroaching on the roadway, an issue that Applied Coastal Research and Engineering team writes “indicat[es] that coastal flooding along this roadway has been a persistent problem since the barrier beach was developed.”⁴

Thatcher Road is the primary evacuation route for residents of Rockport, including Long Beach. The road already floods during nor’easters and exceptionally high tides in the Good Harbor Beach neighborhood. Coastal flooding along Thatcher Road poses a public safety threat in the event that emergency vehicles like ambulances and fire trucks cannot cross the road to reach those who need assistance, and residents cannot evacuate. If Thatcher Road is flooded, alternative evacuation routes are significantly longer, requiring Long Beach residents to drive northeast toward downtown Rockport, and back on Eastern Avenue, or around the tip of Cape Ann on Route 127, which is also laid at low elevations through former marshlands.



Residents of Rockport and cottage owners access Long Beach via Thatcher Road. Rockport residents may park behind the cobble dune at Cape Hedge beach and cross the metal gangway onto the beach. Cottage owners pay an annual fee to use the privately owned access road to Long Beach.

How do people evacuate from Long Beach in the event of an emergency?



Roads and railways were built in low-lying marshes during the nineteenth century. In the event of an emergency, beachgoers and cottage owners would evacuate on Thatcher Road toward Gloucester. Thatcher Road floods during high tides and storms behind Good Harbor Beach, which could force evacuees to head northeast toward downtown Rockport.

¹Town of Rockport, *Collection System Operation and Maintenance Plan* (Rockport, MA: Town of Rockport, 2021), 8.

²Gravity-fed wastewater systems are conventional systems that transport sewage from homes through buried pipes to a central treatment facility, like the Rockport Wastewater Treatment Facility. Pressure sewer systems are used in places like Long Beach where housing density is low, terrain is flat, and the water table is high. Pressure sewer mains are watertight, and therefore ensure minimal sewage leakage. United States Environmental Protection Agency, *Wastewater Technology Fact Sheet* (Washington, D.C.: Environmental Protection Agency, 2002).

³Infrastructural systems do not always conform to municipal boundaries. The Gloucester Wastewater Treatment Plant handles sewage from Long Beach in Rockport, as well as homes in Essex. The Gloucester Wastewater Treatment Plant is built at an extremely low elevation on filled marshland. The Plant is vulnerable to the same sea level rise and storm surge issues that the cottages on Long Beach face. Wright-Pierce, *Comprehensive Wastewater Management Plan Phase 3 – Detailed Evaluation of Alternatives and Recommended Wastewater Management Plan* (Gloucester, MA: City of Gloucester, 2022), 1-2.

⁴According to the United States Environmental Protection Agency, primary wastewater treatment is the process of “allowing solids to settle and be removed from wastewater.” At the treatment plant, solid waste flows through a screen, which removes large floating objects. Next, sewage passes through a grit chamber where smaller particles settle out into the bottom. Additional particles are settled out in a sedimentation tank, where the speed of flow is reduced, allowing solids that are suspended in water to settle to the bottom, where they form a mass of biosolids. These biosolids are removed from the tanks and can be further treated. United States Environmental Protection Agency, *How Wastewater Treatment Works... The Basics* (Washington, D.C.: United States Environmental Protection Agency, 1998).

⁵Effluent from the Gloucester Wastewater Treatment Plant is released into the ocean through a 14,869’ outfall pipe that discharges approximately one mile southwest of the Dog Bar Breakwater Lighthouse. See United States Environmental Protection Agency, *NPDES Permit No. MA0100625 Fact Sheet Draft National Pollutant Discharge Elimination System Permit to Discharge to Waters of the United States* (Boston, MA: United States Environmental Protection Agency, 2010).

⁶The Woods Hole Group has created a guide to living shorelines. They define a living shoreline as “a set of coastal erosion control practices, ranging from non-structural vegetated approaches to hybrid hard structural/restorative natural methods that address erosion and inundation in a manner that improves or protects the ecological condition of the coastline.” Woods Hole Group, *Living Shorelines in New England: State of the Practice* (Boston, MA: Woods Hole Group, 2017).

⁷A gabion wall is a retaining wall made of cages filled with rocks, concrete, riprap, or sand to slow erosion. Gabion walls stabilize the soil behind the wall, which can be planted. See Woods Hole Group, *Living Shorelines in New England: State of the Practice* (Boston, MA: Woods Hole Group, 2017).

Wastewater

Unlike the water and electrical systems at Long Beach, which bring utilities to the cottages, the wastewater system removes sewage *from* the cottages. Wastewater travels from individual cottages at Long Beach through gravity-fed PVC pipes measuring 8” in diameter that carry waste from higher to lower elevation using the force of gravity. These pipes feed into a pressure sewer pipe that runs into the Long Beach Sewer Pump Station, which was constructed in 1980.^{1 2} Sewage from the Sewer Pump Station then flows to the City of Gloucester Wastewater Treatment Plant, which is located on Essex Avenue in Gloucester.³ The wastewater from Long Beach goes through primary treatment before it is dumped into the ocean at the mouth of Gloucester Harbor.^{4 5}

Locally, there is intense erosion around the sewer manhole near the Saratoga Creek. The manhole could be moved out of the 100-year floodplain, upland toward Thatcher Road. Alternately, a living shoreline⁶ could be installed around the manhole. This would include a gabion wall,⁷ and sediment could be added and stabilized with marsh grasses. However, relocating the manhole does not protect the Long Beach Sewer Pump Station, which is also located in the floodplain. The pump station could be elevated above the design flood elevation (DFE) on Long Beach, or removed from the floodplain.

While these piecemeal measures reduce the risk of a sewage leak or sewer overflow at Long Beach, they do not address the risk due to the low elevation of the Gloucester Wastewater Treatment Plant, which processes the wastewater generated at Long Beach. The Gloucester Wastewater Treatment Plant is at severe risk of flooding. While the plant will be upgraded with secondary wastewater treatment and a flood barrier, unless the plant is relocated, it remains susceptible to flooding during storms.



- Long Beach Sewer Pump Station
- Manhole Cover
- Sewer Line

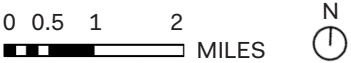


Sewage travels through pipes from the cottages to the Long Beach Sewer Pump Station.

Where does the sewage produced at Long Beach go?



- ⊕ Gloucester Wastewater Treatment Plant
- Sewer Line
- ▲ Sewer Outfall Pipe
- Wastewater Pump Station



Sewage from Long Beach is pumped by a series of sewer pump stations to the West Gloucester Wastewater Treatment Plant. The wastewater goes through primary treatment before it is released to the sewer outfall pipe beyond the mouth of Gloucester Harbor.

¹Matt A. Hautala, *Plan showing proposed location 8" water main from Thatcher Road to Long Beach, Rockport, Mass.*, architectural drawing, Digital Commonwealth, 1951.

²In Massachusetts, wetland resource areas are protected by the Wetlands Protection Act, which protects freshwater and coastal wetlands, marshes, wet meadows, bogs, swamps, vernal pools, banks, reservoirs, lakes, ponds, quarry pits and motions, rivers, streams, creeks, beaches, dunes, estuaries, the ocean, the land under water bodies, lands subject to flooding or inundation by groundwater or surface water, lands subject to tidal action, lands subject to coastal storm flowage or flooding, and lands within one hundred feet of these areas. These one hundred foot areas are often known as riparian buffer zones. Riparian species in buffer zones include aquatic plants that grow in shallow water, hydrophilic plants that grow along the shore, and upland plants that grow in dry soils above water bodies. These buffer zones help to reduce runoff by increasing stormwater infiltration into soil, limiting the amount of nutrients and pollutants that enter water bodies; stabilizing soils with plant root systems; reducing shoreline erosion due to wave action; and improving wildlife and fish habitat by providing food, shelter, and shade. See: "Wetlands Protection Act Regulations," 310 Code of Massachusetts Regulations 10.00 § (2014).

Water

The seasonal water supply that serves the Long Beach cottages is connected to the Rockport municipal water system. The 8" water main that serves Long Beach is made out of ductile iron. Water flows through the pipe during the summer months, and is turned off during the winter when the cottages are not occupied, as the pipe is at risk of freezing due to its shallow depth. The pipe was likely laid in the 1950s. A 1951 plan by Matt A. Hautala, shows the proposed location of the water main, extending from Thatcher Road, under the Saratoga marsh, to Old County Road.¹

Locally, the pipes at Long Beach are exposed to freezing temperatures during the winter, and due to the low-lying elevation of the beach, they may be corroded and rusted by saltwater during flood events. The seasonal limits on water supply at Long Beach eradicate the risk of flooding, and other resilience measures may shut off the water supply at the beach.

Regionally, Cape Ann's water supply is resilient. Cape Pond, Klondike Reservoir, Flat Ledge Quarry, and Carlson's Quarry all feed into Rockport's water supply, and the Town has explored purchasing Johnson's Quarry to increase the water supply resiliency. Potential resilience actions include elevating water pump stations in the FEMA flood zone, enacting water usage restrictions during the summer months or periods of intense drought, and unbuilding structures in buffer zones around reservoirs and ponds by purchasing land and planting dense riparian buffer zones to protect water quality in accordance with the Wetlands Protection Act.²



— Water Main

0 125 250 500 FEET

⌚

Long Beach is served by the Rockport Town water system. The system draws on three reservoirs to supply seasonal water to the cottages.

How does water flow to the taps at Long Beach?



+ Rockport Water Treatment Plant

— Water Main

■ Reservoir

0 0.5 1 2 MILES

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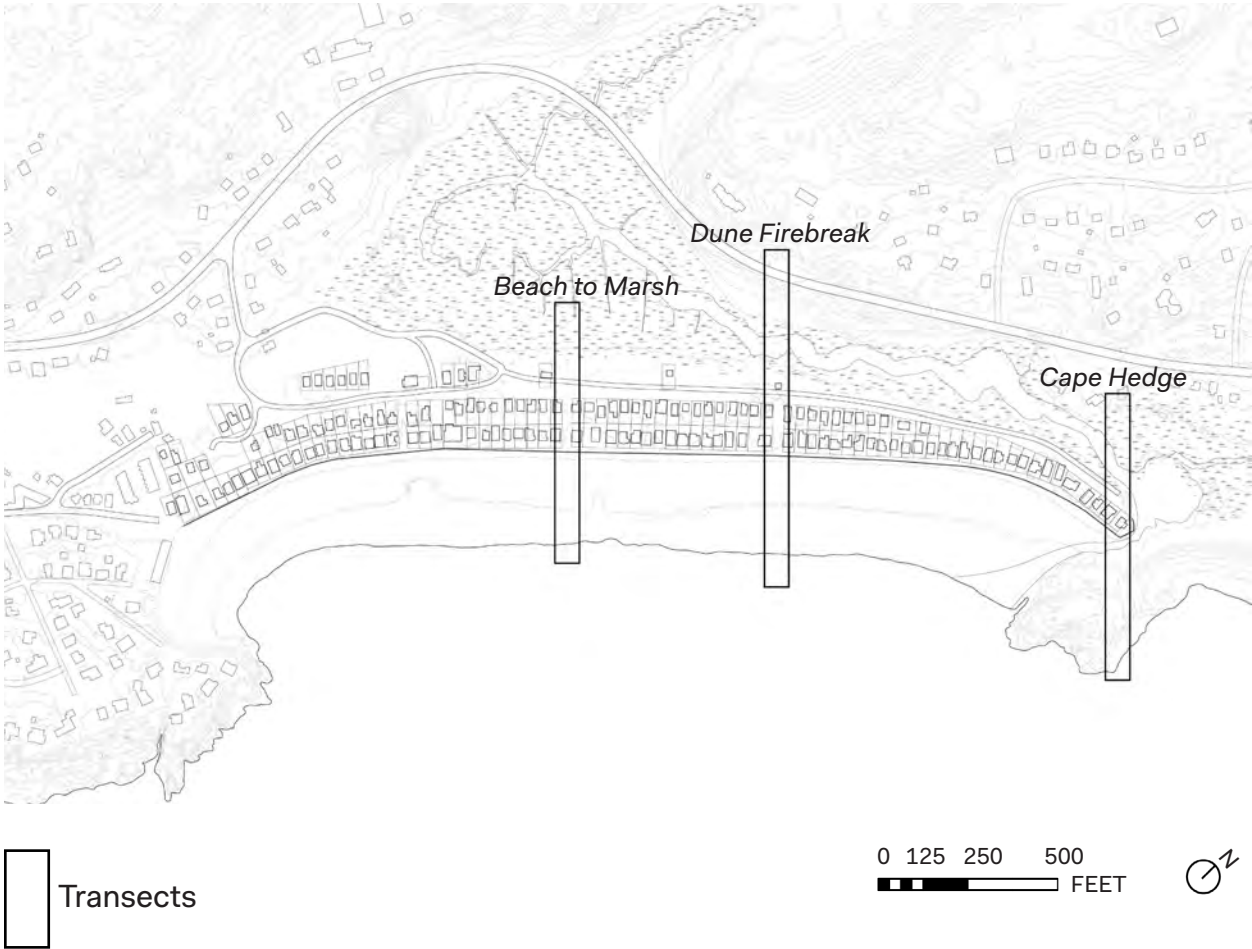
Rockport's drinking water is drawn primarily from Cape Pond and Carlson's Quarry reservoirs, and treated at the Rockport Water Treatment Plant.

Transects at Long Beach

These transect drone photographs show the natural communities and infrastructure systems at Long Beach.

Each transect is constructed from many different drone photographs that are laid out in a straight line that cuts through different ecological systems and physical infrastructural systems.

By translating different infrastructural systems into a consistent graphic language, we can start to understand how these systems are layered.



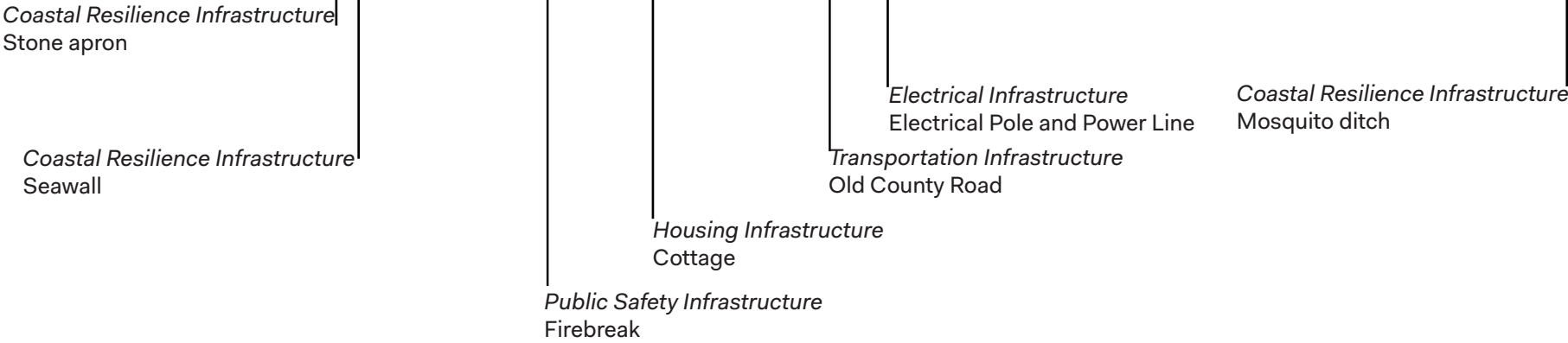
Beach to Marsh

Ecological Infrastructure

Impervious Surfaces



Physical Infrastructure



This transect is a composite of ten photographs arranged next to each other. From right to left, this transect moves from the Atlantic Ocean, over the exposed stone apron and seawall, across the developed dune system, Old County Road, and into the marsh. A mosquito ditch, a failed twentieth century attempt to control insects, is visible on the far left.

Dune Firebreak

Ecological Infrastructure



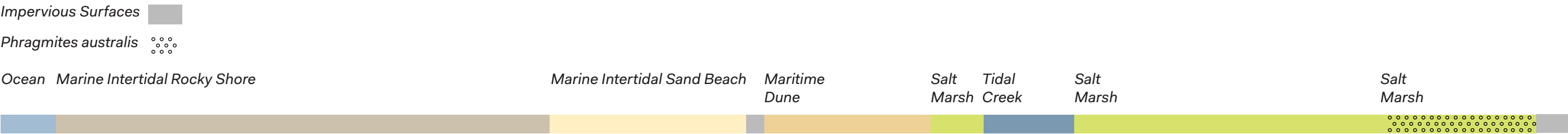
Physical Infrastructure



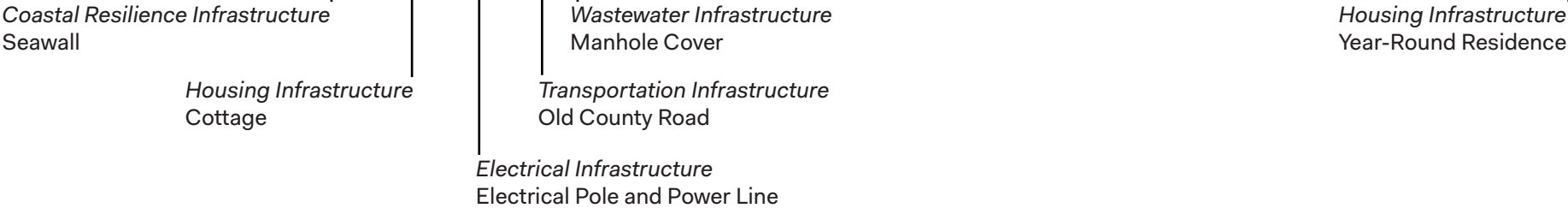
This transect is a composite of eight photographs arranged next to each other. From right to left, this transect moves from the Atlantic Ocean, over the exposed stone apron and seawall, across the developed dune system, Old County Road, through Saratoga Marsh, and over Thatcher Road. This transect highlights the wastewater, electrical, transportation, and water systems at Long Beach.

Cape Hedge

Ecological Infrastructure

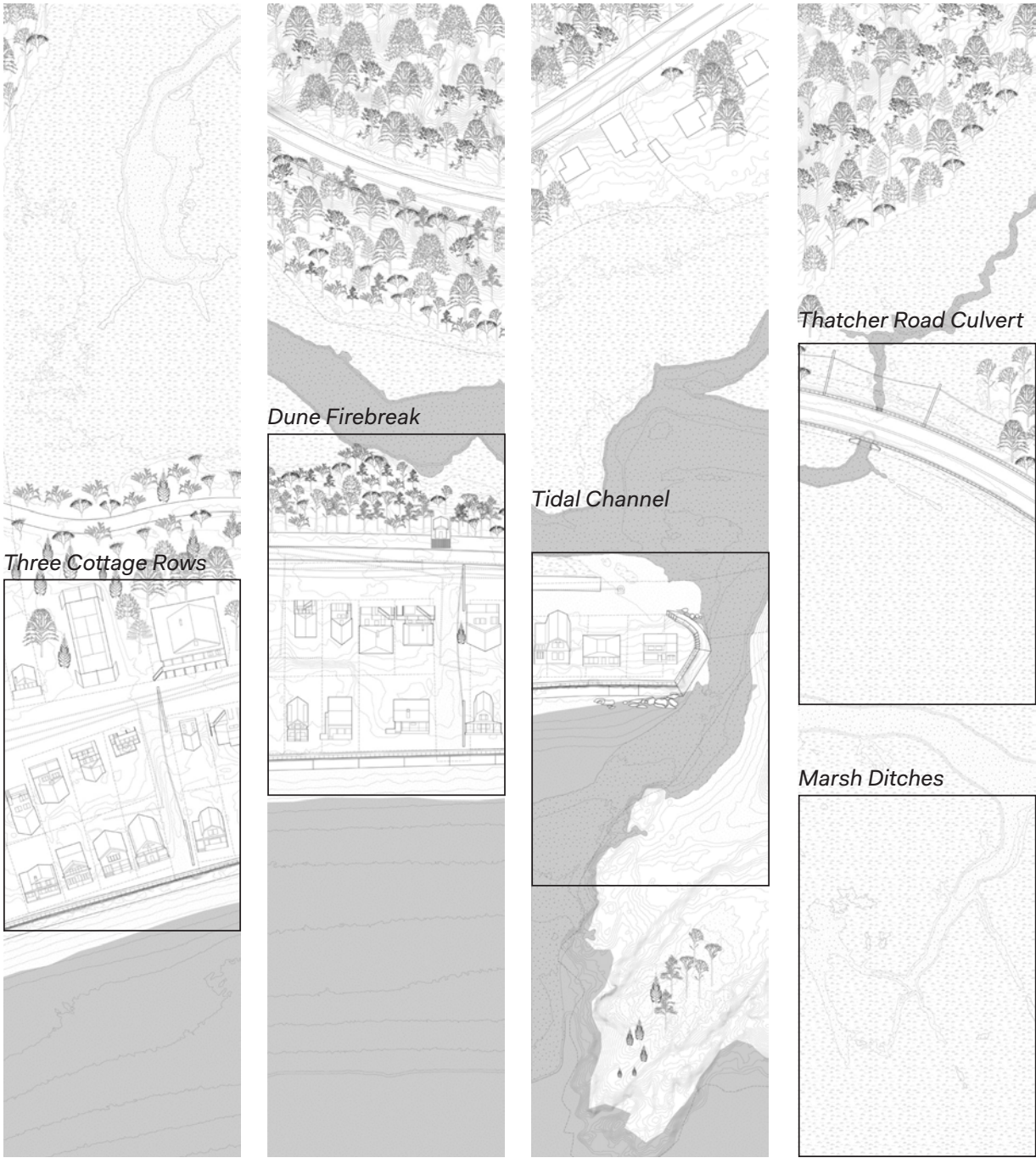


Physical Infrastructure



This transect is a composite of eight photographs arranged next to each other. From right to left, this transect moves over Cape Hedge, across the Saratoga Tidal Channel at low tide, over the seawall, across Old County Road, the tidal channel, the salt marsh, including an area of restricted water flow where *Phragmites* is growing, and moves toward a residential lawn.

Three Cottage Rows

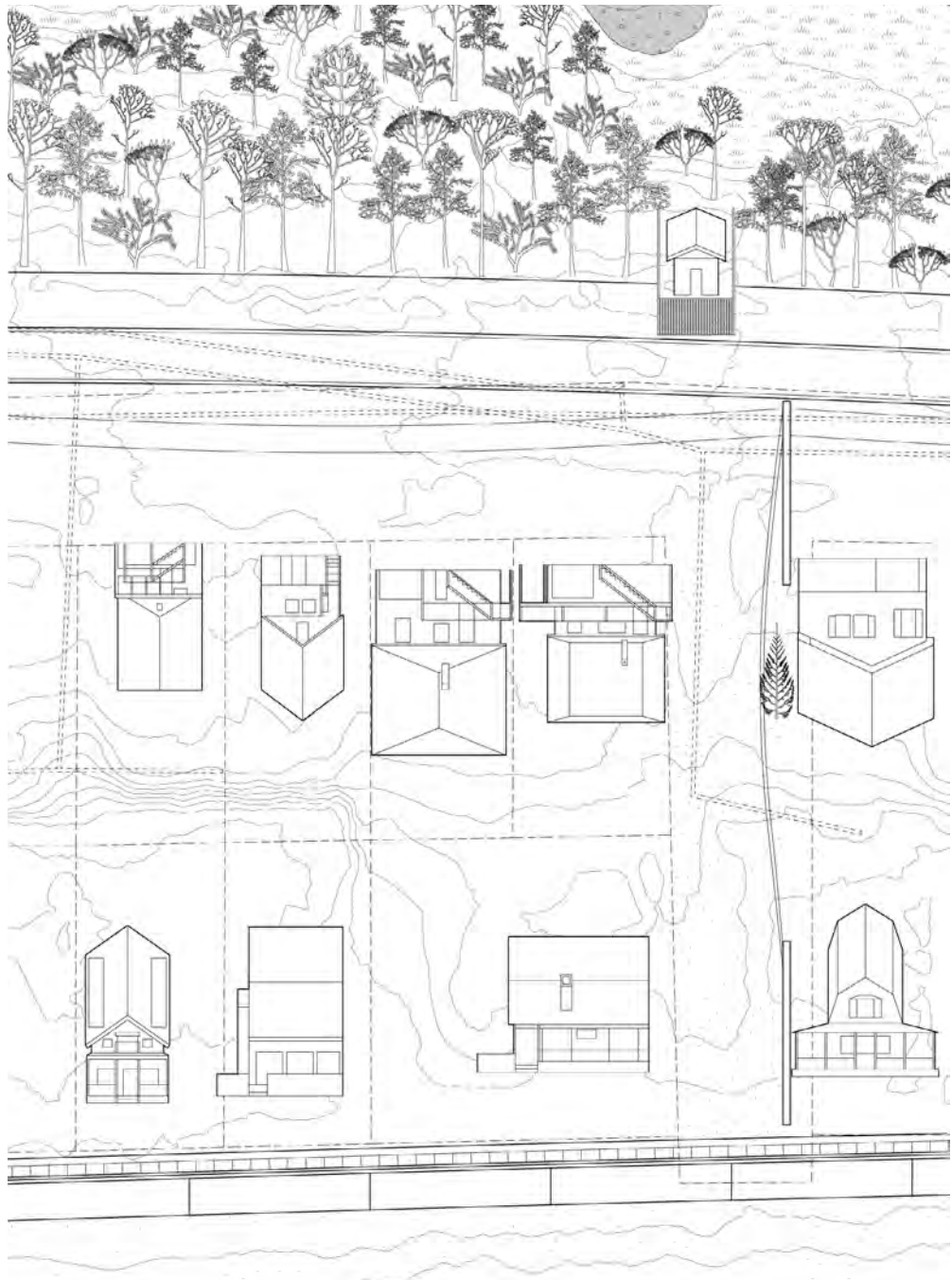


These drawings combine planar contour lines with elevations of trees, buildings, and infrastructure. They are used to describe existing conditions on Long Beach.



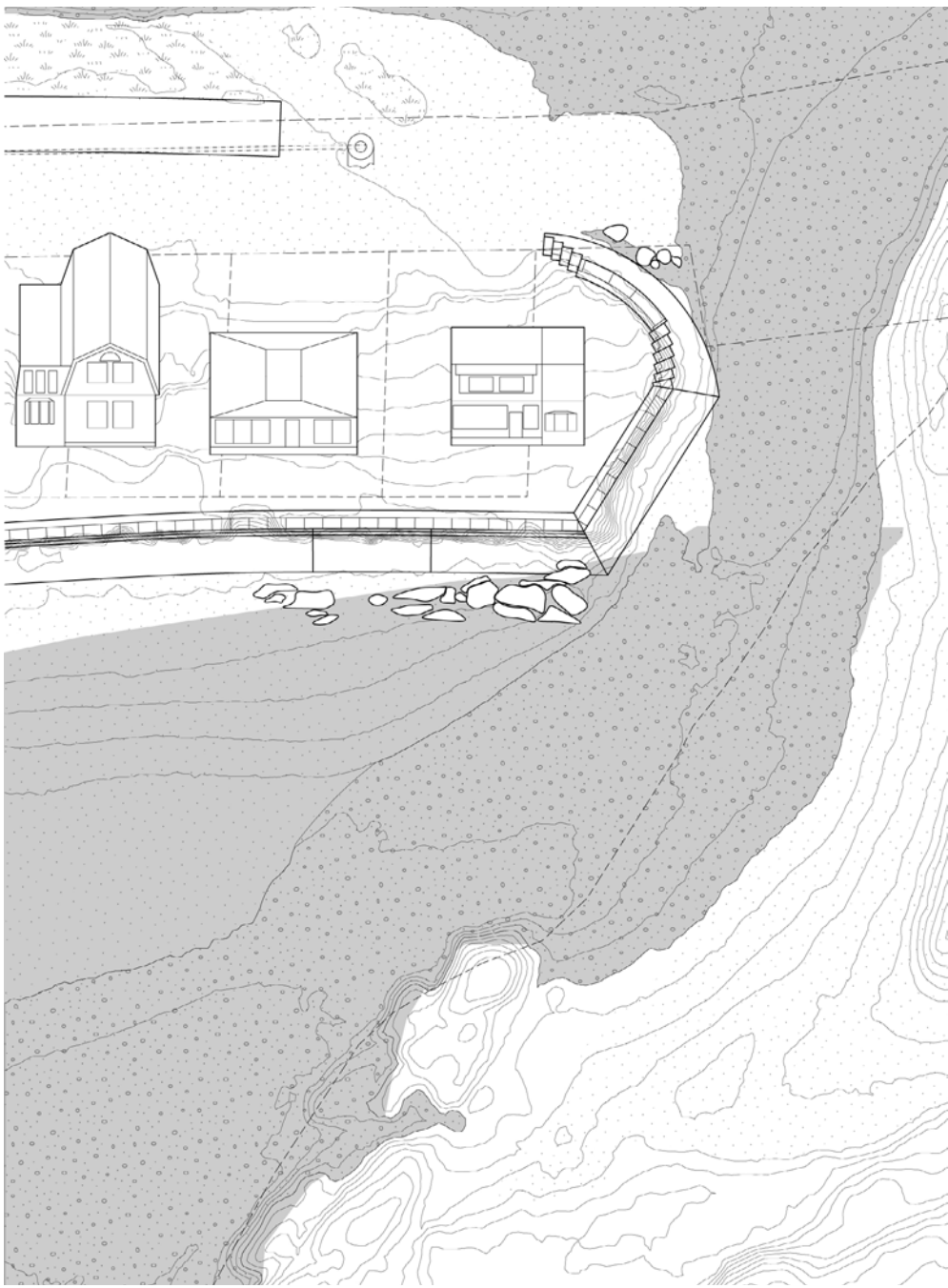
The southwestern side of Long Beach includes a neighborhood tennis court and three rows of cottages.

Dune Firebreak



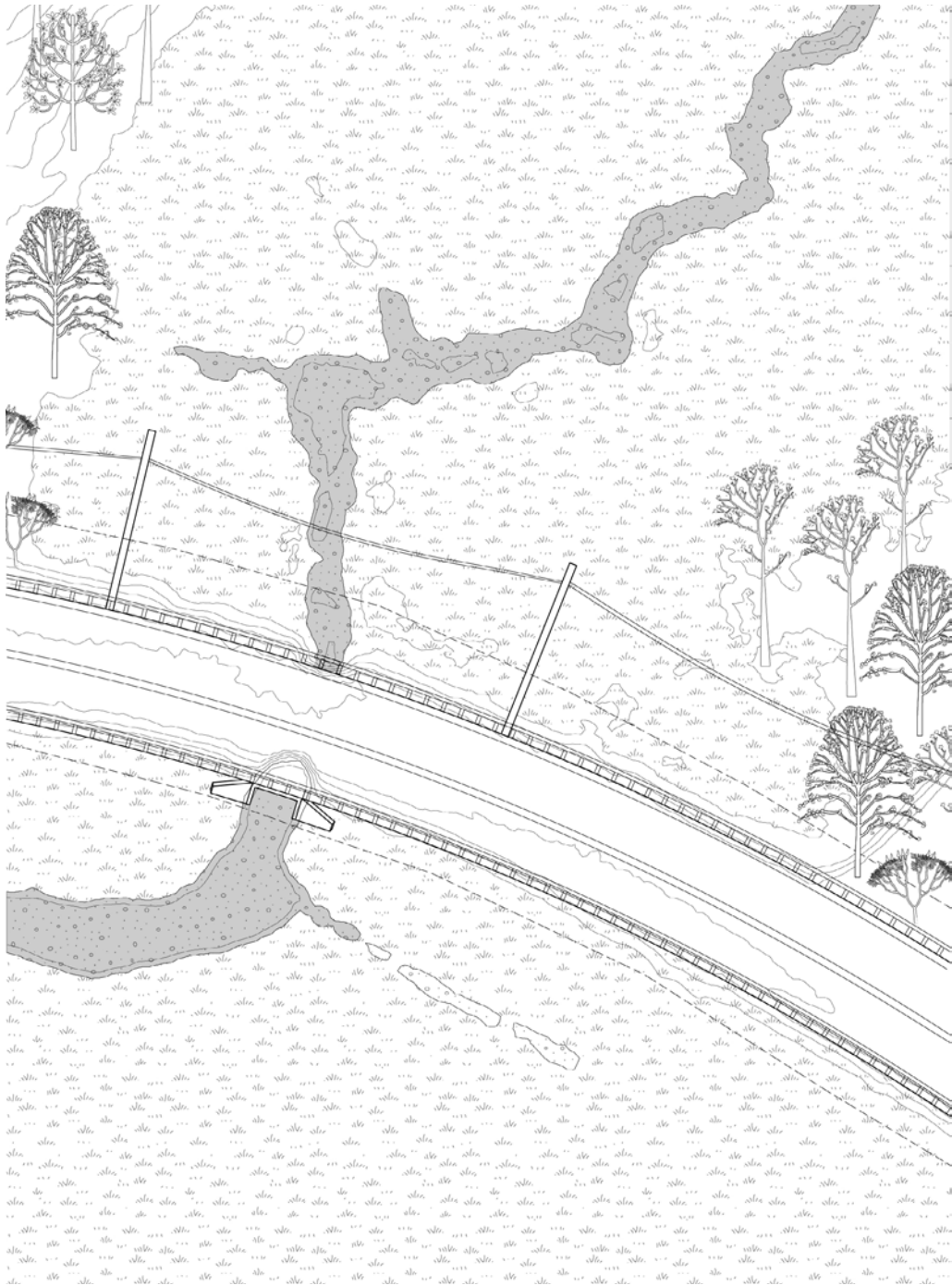
Spontaneous vegetation, including red cedar trees, grow in the firebreaks at Long Beach.

Tidal Channel



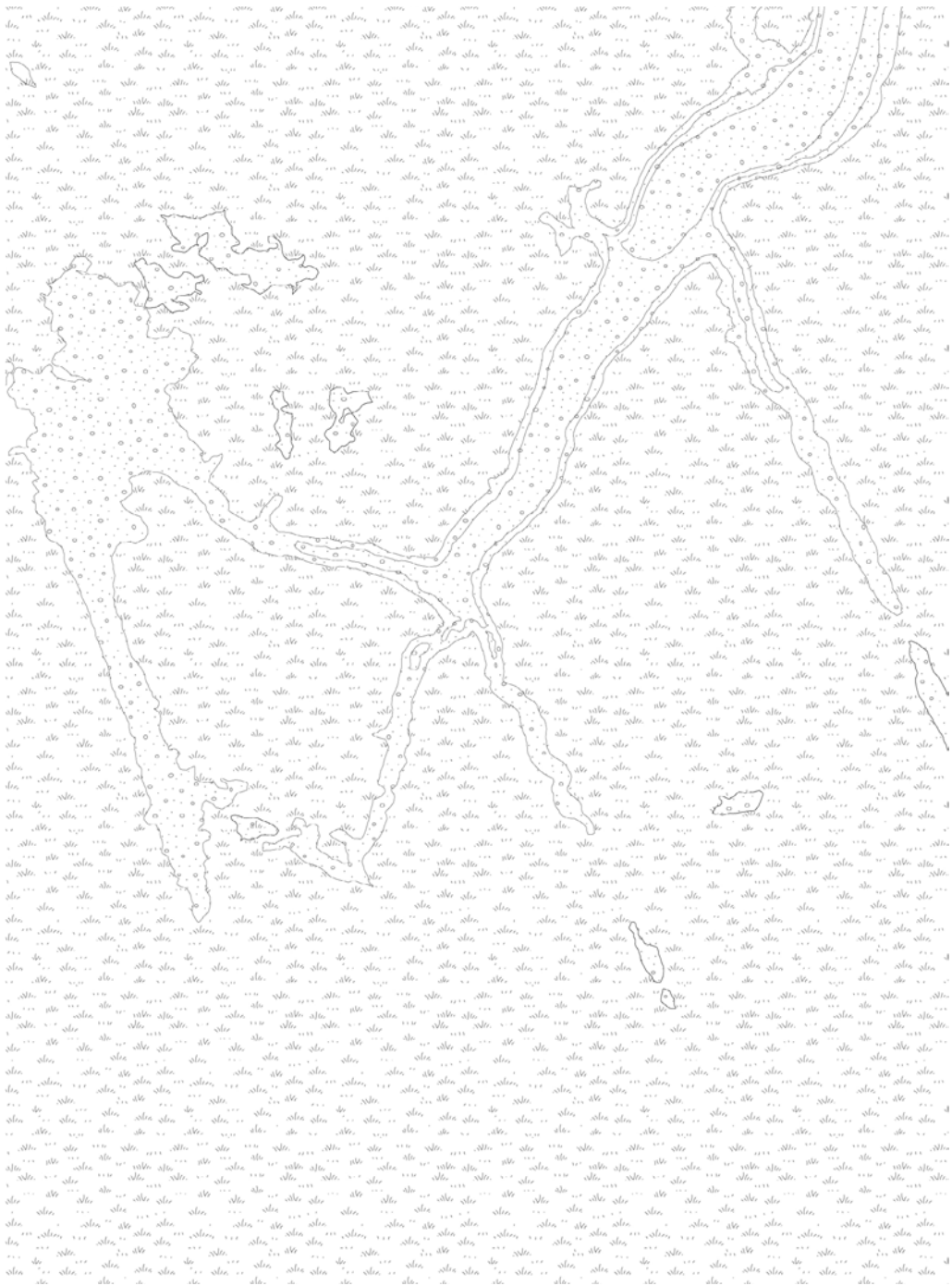
The tidal channel at the northeastern side of Long Beach separates the barrier beach from Cape Hedge and its cobble berm.

Thatcher Road Culvert



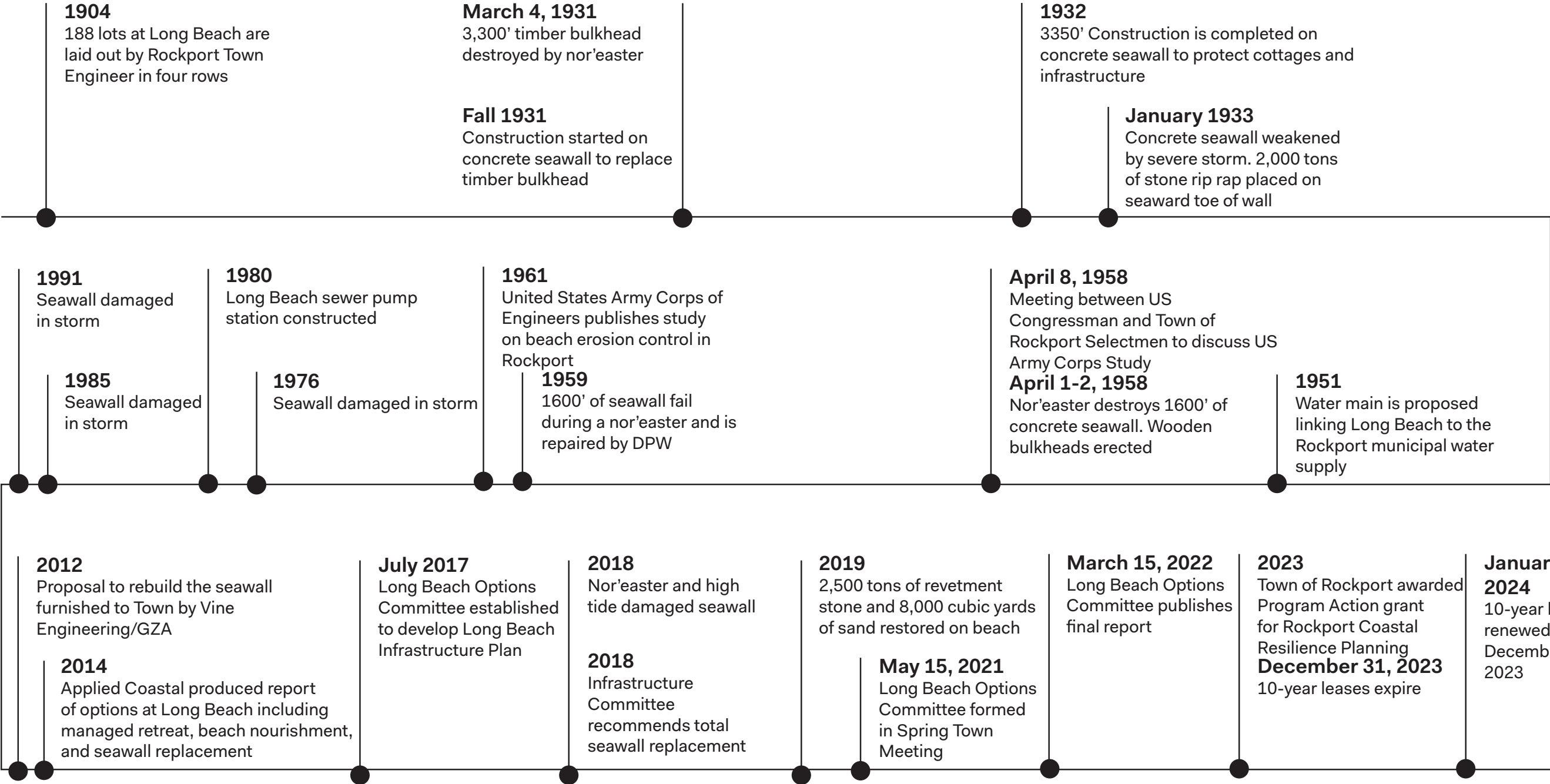
Water flows through the culvert at Thatcher Road twice daily.

Marsh Ditches



Ditches dug into Saratoga Marsh to control mosquitos may increase the rate of erosion in the marsh.

Timeline



This timeline describes an ongoing pattern at Long Beach of natural disasters followed by long-term plans that are put aside for short-term infrastructural improvement projects.



Kira Clingen, "Saratoga marsh ditches and salt pannes," 2024.

How will Long Beach Continue to Change?

“Long Beach in Rockport is a summer paradise. It may also be a climate disaster waiting to happen.”

- Billy Baker, 2023



Kira Clingen, "Saratoga creek looking toward Rockport," 2024.

¹According to the Federal Emergency Management Agency, “hazard mitigation planning reduces loss of life and property by minimizing the impact of disasters. It begins with state, tribal and local governments identifying natural disaster risk and vulnerabilities that are common in their area. After identifying these risks, they develop long-term strategies for protecting people and property from similar events. Mitigation plans are key to breaking the cycle o disaster damage and reconstruction.” “Hazard Mitigation Planning,” *Federal Emergency Management Agency*, accessed September 15, 2024, www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning

²Town of Rockport, *Town of Rockport Hazard Mitigation Plan* (Rockport: Town of Rockport, 2020), 50.

³The United States Geological Survey (USGS) defines a Geographic Information System (GIS) as a “computer system that analyzes and displays geographically referenced information. It used data that is attached to a unique location.” “What is a geographic information system?” *United States Geological Survey*, accessed September 3, 2024, www.usgs.gov/faqs/what-geographic-information-system-gis

How will climate change impact Long Beach?

The 2020 Rockport Hazard Mitigation Plan¹ states “considering the projected climate change impacts on current natural hazards, including increases in precipitation frequency and severity, rises in sea levels, and increases in storm surge frequency and severity, the Long Beach area continues to remain vulnerable.”² Not only is Long Beach vulnerable, but this beloved place will continue to change as coastal erosion, sea level rise, and storm surge exacerbates the receding shoreline. Ultimately, the future of Long Beach depends on whether the beach is allowed to migrate inland to protect the public beach, or whether the seawall is repaired and reinforced to protect the private cottages.

This section uses existing probabilistic studies and GIS³ data of climate impacts on Long Beach, and how they will affect the physical and ecological infrastructure systems described in the “How is Long Beach Changing?” section.

⁴United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 24.

⁵Applied Coastal Research and Engineering Inc., *Long Beach, Rockport, Massachusetts Sediment Transport Study* (Rockport, MA: Town of Rockport, 2014), 14.

⁶Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 41-42.

⁷Applied Coastal Research and Engineering Inc., *Long Beach, Rockport, Massachusetts Sediment Transport Study* (Rockport, MA: Town of Rockport, 2014), 15-18.

⁸For projections for sea level rise, storm surge, temperature, precipitation, and drought, see Massachusetts Office of Coastal Zone Management, *Massachusetts Climate Change Assessment* (Boston, MA: Massachusetts Office of Coastal Zone Management, 2022), Appendix B.

Is Long Beach eroding?

The sandy shoreline is the greatest public amenity at Long Beach. It is also shrinking. Since 1851, the beach in front of the seawall has been steadily retreating, though the rate has varied.⁴ Due to the protected nature of Long Beach between two granitic headlands, Long Beach has eroded more slowly than other beaches in Massachusetts.⁵ Applied Coastal and Engineering determined the shoreline change from 1851 to 2013 in a series of maps, with the rate of retreat taken at intervals every 50’ along the beach. The engineering firm found that the shoreline was eroding at a rate of 0.4 feet per year from 1952 to 2013. In other words, Long Beach has retreated nine feet per decade. Currently, during the summer months there are less than fifty feet of beach during high tide, and no high tide beach width during the winter. In coming decades, this rate will increase as “more of the seawall is exposed to wave conditions, leading to more rapid scouring of the beach from reflected wave energy.”⁶

In addition to the ongoing coastal erosion at Long Beach, Applied Research and Engineering found that sea level had risen 0.7’ between 1931 and 2013.⁷ The rate of sea level rise will accelerate in the near future. The National Oceanic and Atmospheric Administration expects sea levels will rise 1.29 feet from 2008 levels by 2030, 2.49 feet by 2050, and 4.29 feet by 2070.⁸ One foot of sea level rise at Long Beach will cover the northeastern end of Old County Road, the area of marsh dominated by *Phragmites*, and the fringes of the marsh toward Thatcher Road. This model does not account for storm surge, waves, erosion, or other dynamic factors.

How has the shoreline changed at Long Beach?



— 2014 Shoreline
- - 1851 Shoreline



— 2034 Shoreline
- - 2064 Shoreline



The Massachusetts Shoreline Change Project documented how the shoreline of Massachusetts shifted from 1851 to 2014 to help coastal managers, landowners, and property buyers make informed decisions. The Project used historic photographs and digital models to describe shoreline change over the last century. See E.R. Thieler, T.L. Smith, J.M. Knisel, and D.W. Sampson, *Massachusetts Shoreline Change Mapping and Analysis Project, 2013 Update* (Boston, MA: U.S. Geological Survey Open-File Report 2013).

The shoreline, and the amount of publicly available beach, will continue to decrease due to sea level rise and coastal erosion. The estimates of the future shoreline at mean high tide were created in 2014 by Applied Engineering. See Applied Coastal Research and Engineering, Inc., Long Beach, *Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 45-47.

⁹The Massachusetts Coastal Flood Risk Model is available in an online map to see sea level rise and coastal flooding data. See “Sea Level Rise and Coastal Flooding Viewer, *Massachusetts Office of Coastal Zone Management*, 2024, www.experience.arcgis.com/experience/23d861b79aed450eb8972013dd28579b/page/MA-Coast-Flood-Risk-Model

¹⁰Hurricanes are described using the Saffir-Simpson scale. Category 3-5 hurricanes are defined as “major.” The Office of Coastal Zone Management maintains a list of previous hurricanes and their impacts, see “The Worst Massachusetts Hurricanes of the 20th Century,” *Office of Coastal Zone Management*, accessed September 3, 2024, www.mass.gov/info-details/the-worst-massachusetts-hurricanes-of-the-20th-century

¹¹SLOSH modeling is available on the Massachusetts Coastal Flood Risk Model and MassMapper, the online web-based GIS platform for the Commonwealth of Massachusetts. See “Mass Mapper,” *Mass GIS*, www.maps.massgis.digital.mass.gov/MassMapper

¹²The Office for Urbanization at the Harvard University Graduate School of Design has modeled the potential impacts of a Category 3 hurricane in 2038 on Long Beach. The simulation can be viewed online at capeann.officeforurbanization.org/0/impacts-and-aftermath

What is the rate of sea level rise at Long Beach?

The MC-FRM is a probabilistic model that combines sea level rise data with these factors, including storm induced flooding, wave run-up and overtopping flow on land and sea. The model uses historic storm events to predict future surges. The model uses high resolution topography data to project flooding risk at three different timescales: 2030, 2050, and 2070. A 100-year storm in 2030 is expected to have flood depths of 0.5 feet across almost all cottages at Long Beach, while Old County Road will be inundated by almost 4 feet of water. By 2070, the same 100-year storm is expected to submerge the second and third rows of cottages in 10 feet of water.⁹

The Sea, Lake, and Overland Surges from Hurricanes (SLOSH) model computes storm surge during Category 1-4 hurricanes.¹⁰ At Long Beach, SLOSH modeling reveals that the beach and marsh to the bounds of Thatcher Road would be completely inundated during a Category 1 hurricane. A Category 2 hurricane would cover Thatcher Road, Long Beach, and Old County Roads, and many of the cottages in the second row. A Category 3 or higher hurricane would also cover cottages in the first row.¹¹

The Office for Urbanization at the Harvard University Graduate School of Design modeled the potential impacts of a Category 3 hurricane at Long Beach in 2038. The model includes renderings of Long Beach before, during, and after such a storm, and shows the seawall collapsing, as well as the waves, which will overtop the seawall and flood the cottages from both the ocean and marsh sides.¹²

¹ NOAA, Sea Level Rise Viewer, NOAA Office for Coastal Management Sea Level Rise Data: 1-10 ft Sea Level Rise Inundation Extent (Washington, D.C.: NOAA, 2022).

The National Oceanic Atmospheric Administration (NOAA) bathtub modeling of coastal flooding above Mean Higher High Water (MHHW), the average height of daily highest tides. This model does not account for storm surge, waves, erosion, and other dynamic factors.¹

How will sea level rise impact Long Beach?



1' Sea Level Rise



2' Sea Level Rise



3' Sea Level Rise



4' Sea Level Rise

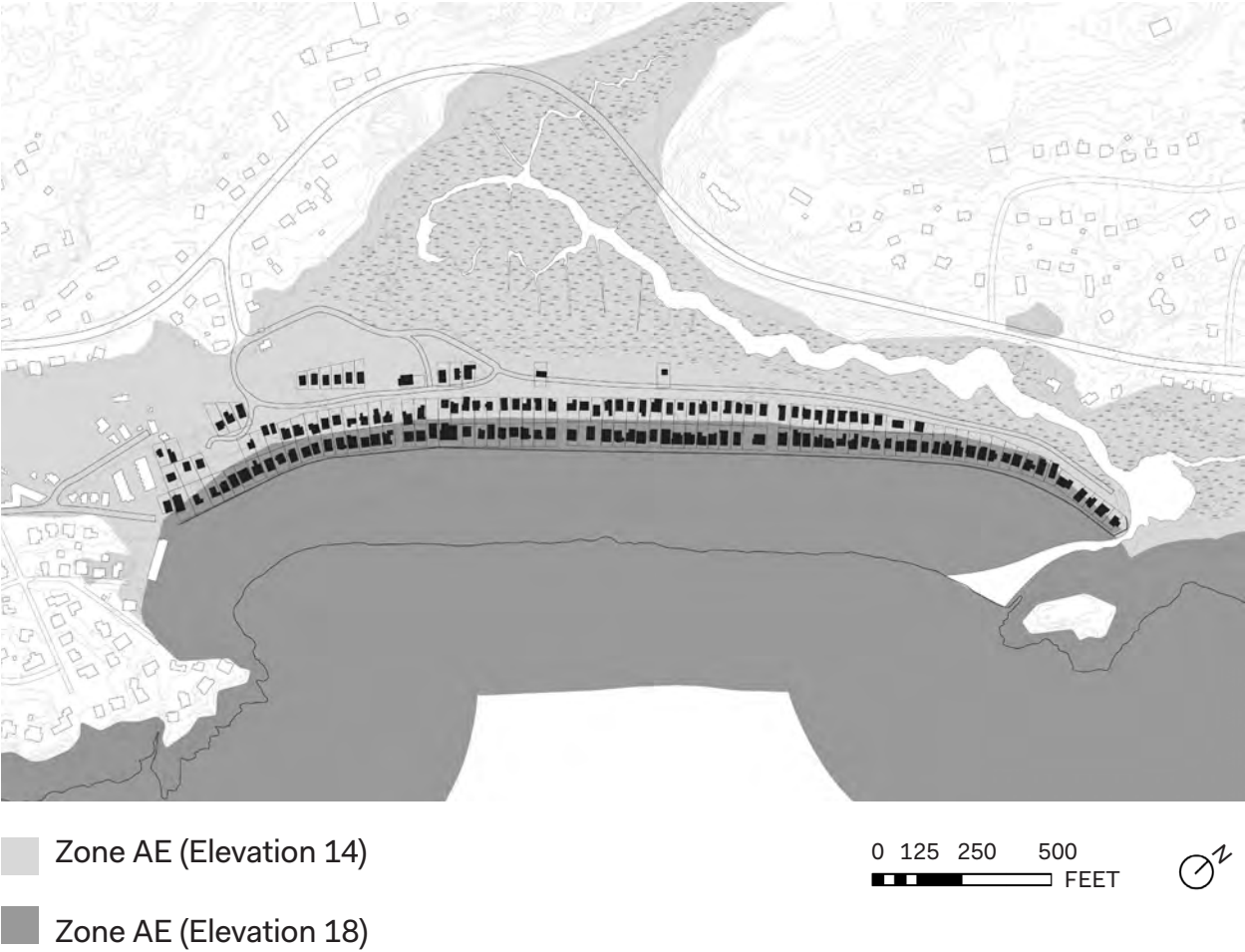


5' Sea Level Rise



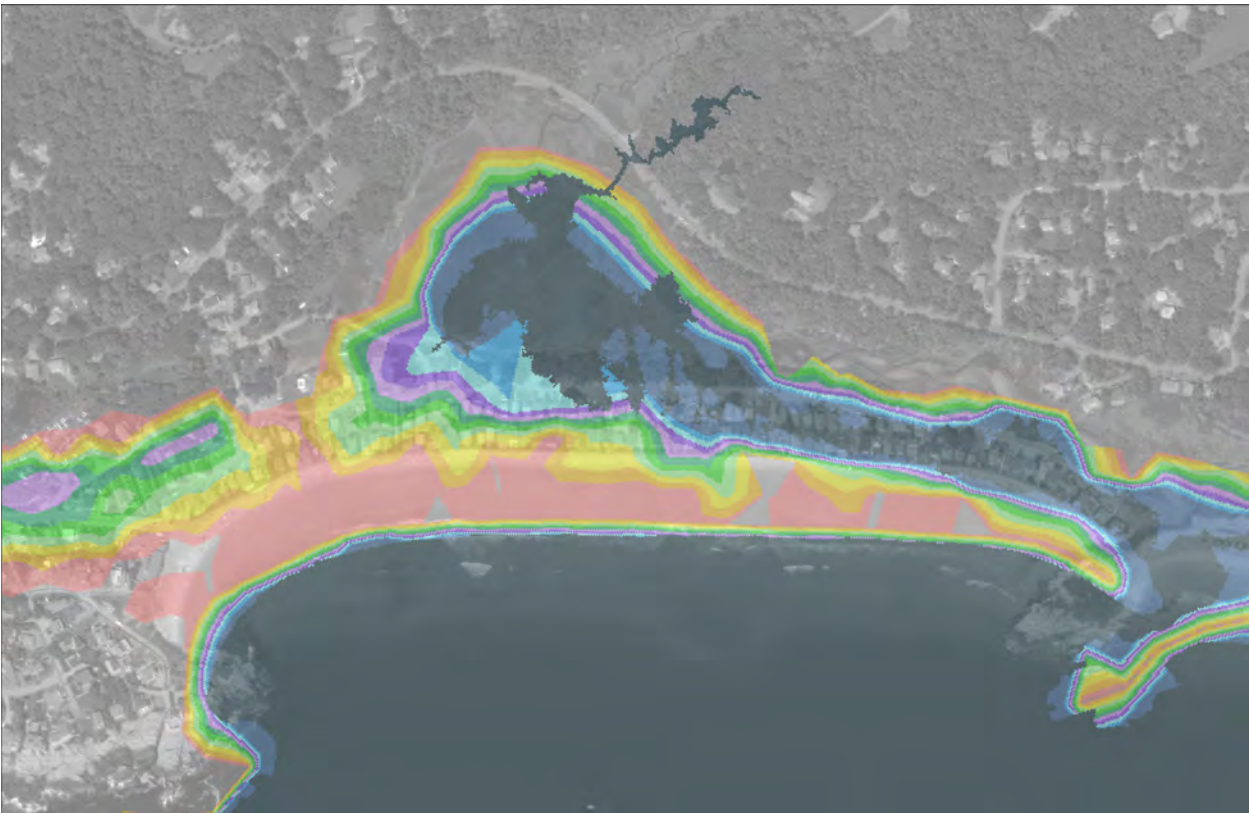
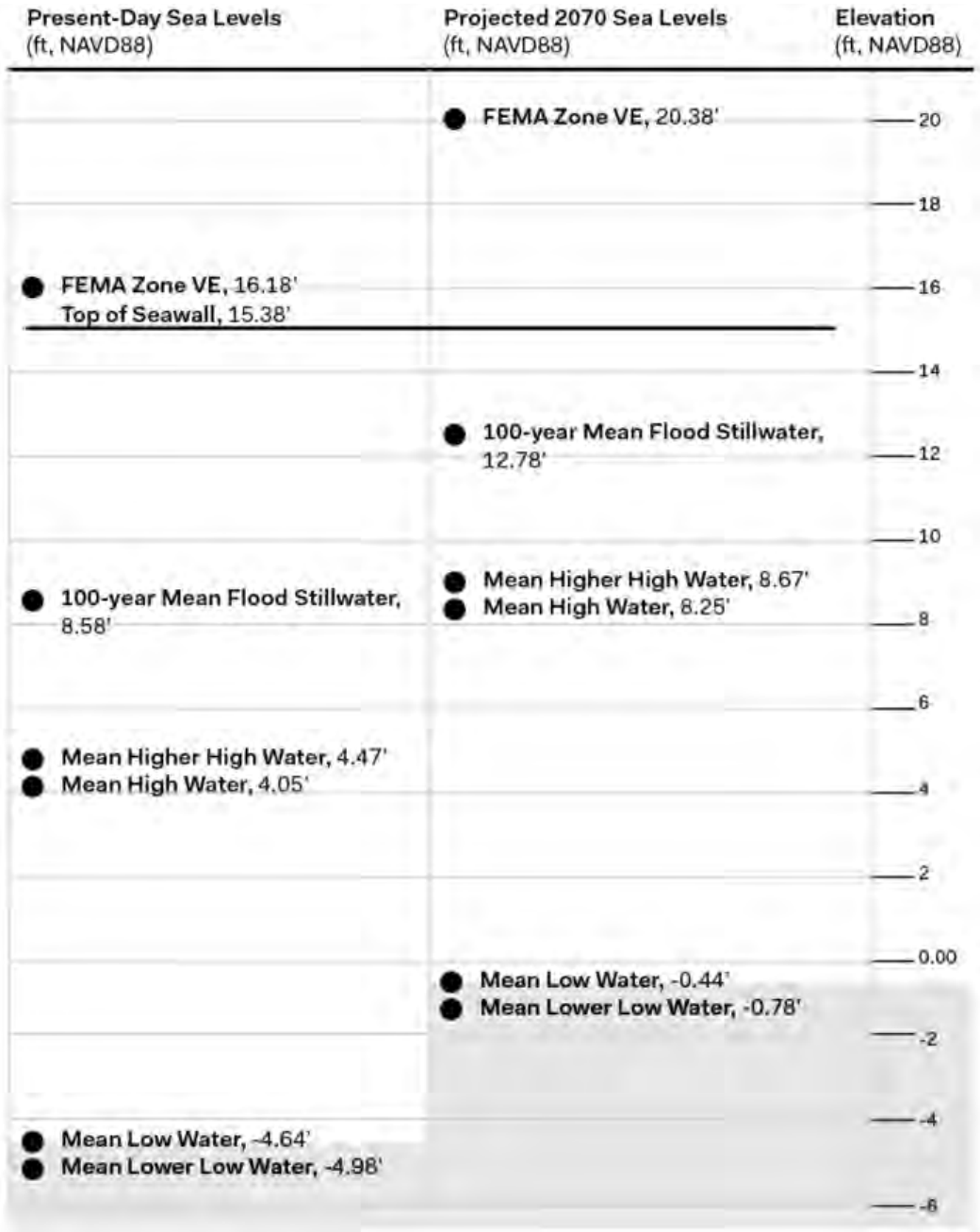
6' Sea Level Rise

What FEMA flood zones is Long Beach in?

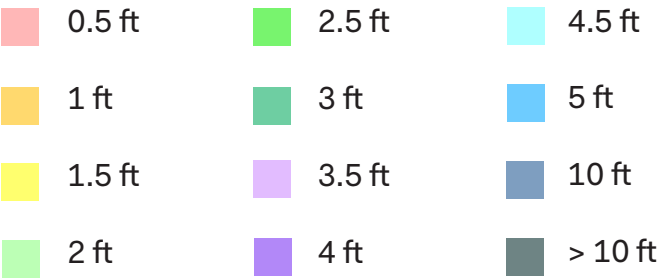


The Long Beach cottages are located entirely within the FEMA floodplain.

How will storm surge combine with sea level rise to reshape Long Beach?

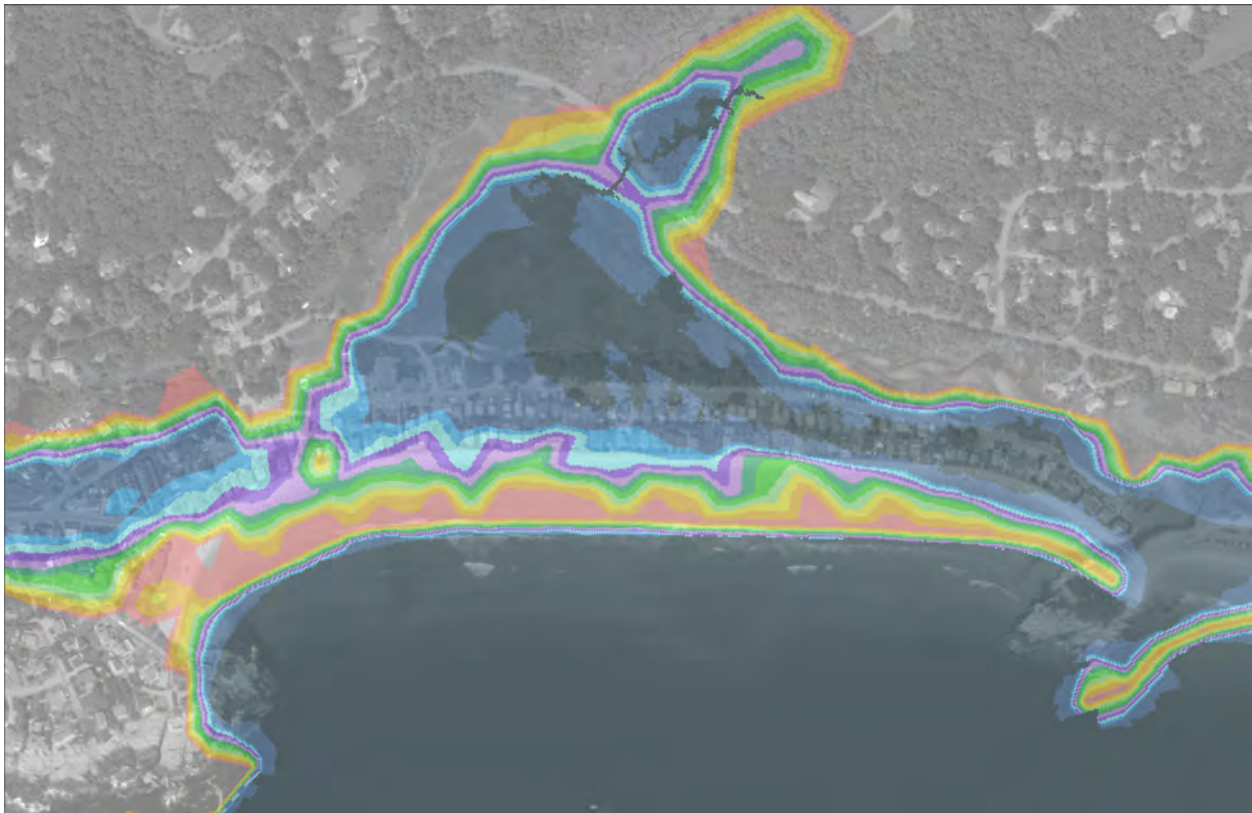


Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2030

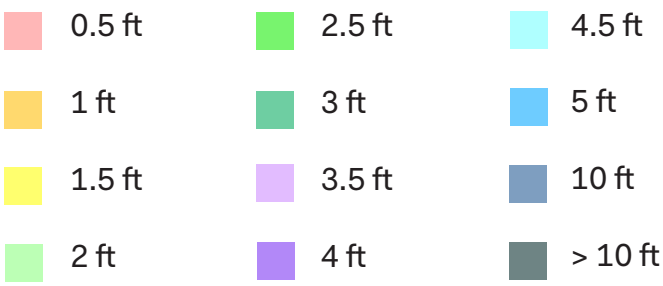
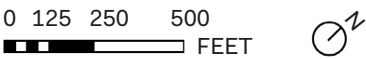


The MC-FRM (Massachusetts Coastal Flood Risk Model) combines sea level rise and storm surge. The model predicts that there will be 4.2' of sea level rise by 2070. Coastal infrastructure, including seawalls, is built for a 50-year lifespan. Therefore, this report uses 2070 as a benchmark.

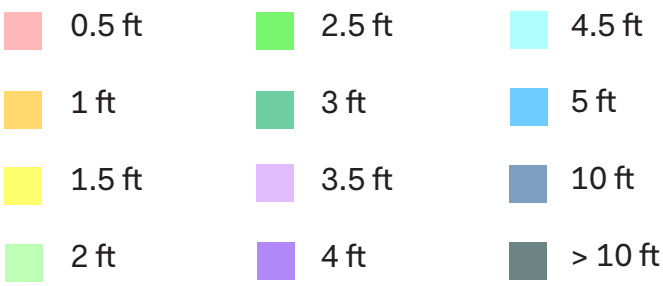
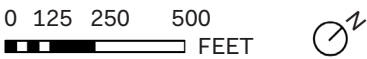
A 1% ACFEP storm is also known as a 100-year storm event. These maps shows the MC-FRM (Massachusetts Coastal Flood Risk Model) that combines sea level rise and storm surge projections. These maps are available online. See "Sea Level Rise and Coastal Flooding Viewer, Massachusetts Office of Coastal Zone Management, 2024.



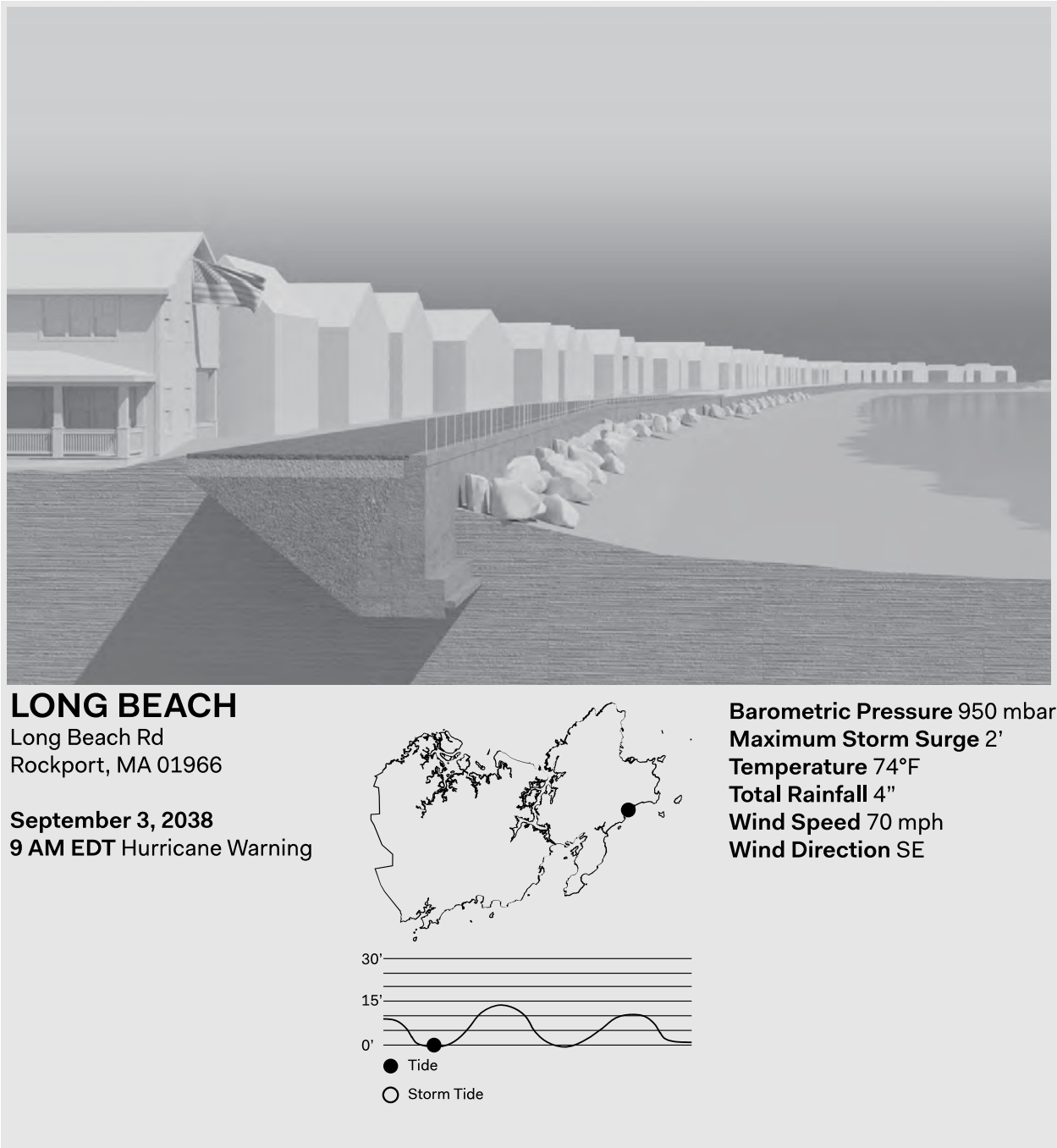
Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2050



Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2070

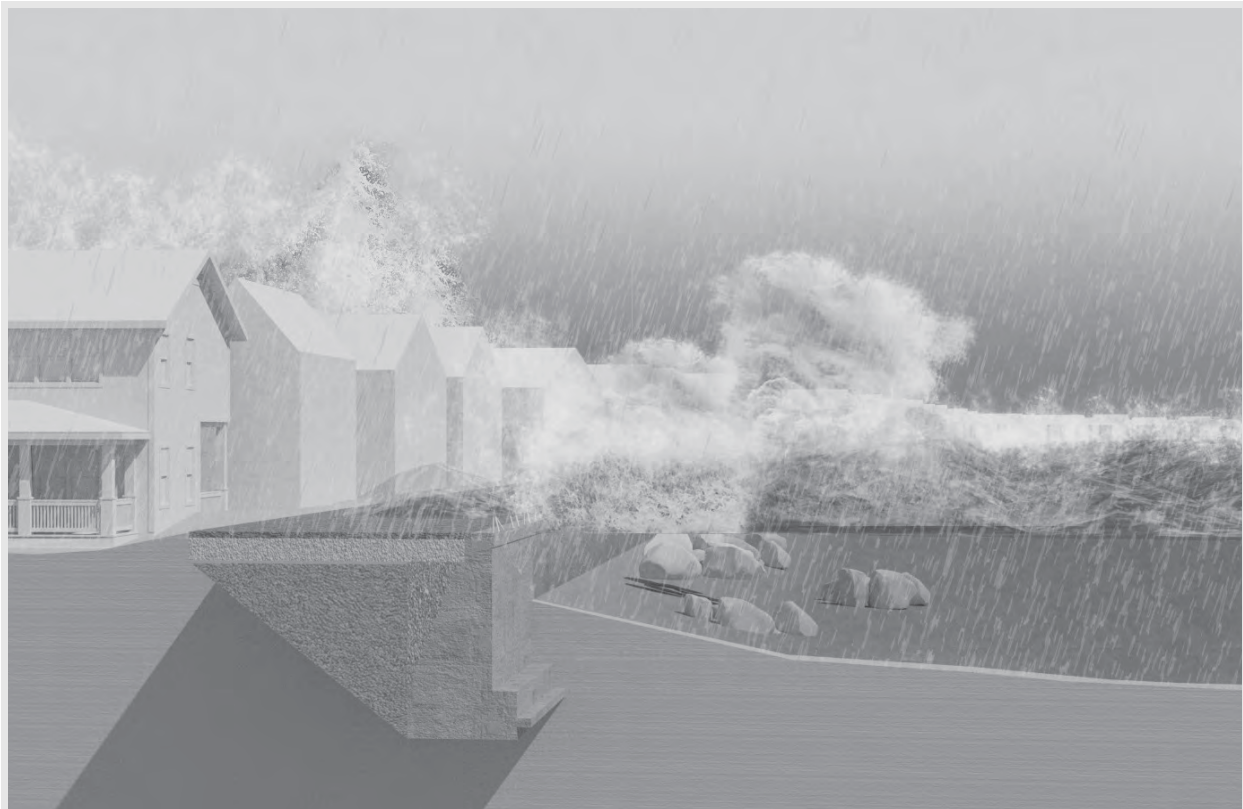


What might a Category 3 hurricane look like at Long Beach?



The Great Storm of 2038 arrives after a rainy summer. Office for Urbanization, “The Great Storm of 2038,” *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Office for Urbanization, 2022), capeann.officeforurbanization.org/0.

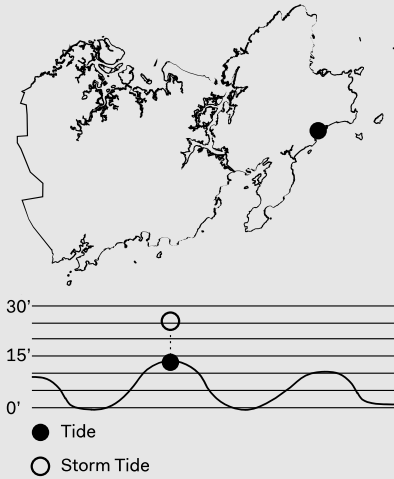
Before the storm, tourists evacuate Long Beach. Water levels in the marsh behind the seawall start to rise rapidly. Office for Urbanization, “Long Beach Before the Great Storm of 2038,” *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Office for Urbanization, 2022).



LONG BEACH

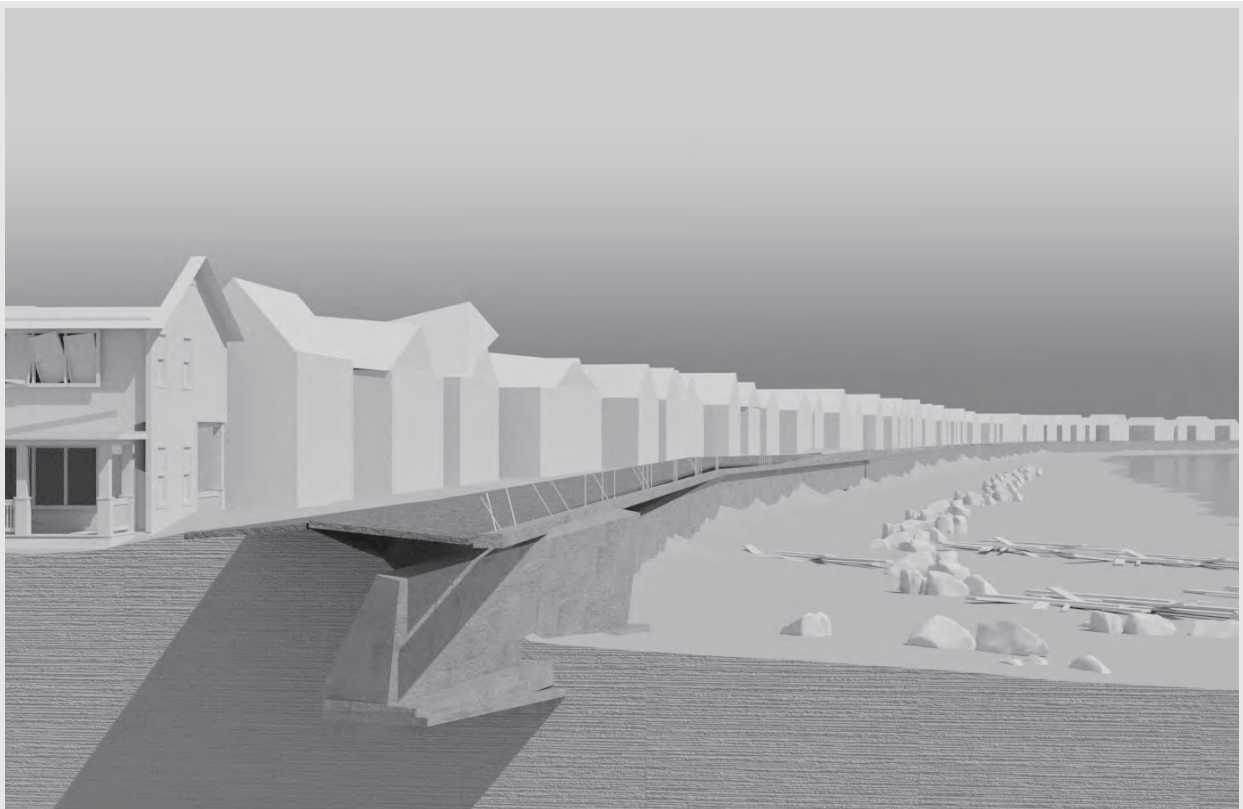
Long Beach Rd
Rockport, MA 01966

September 3, 2038
3 PM EDT Hurricane Warning



Barometric Pressure 920 mbar
Maximum Storm Surge 17'
Temperature 80°F
Total Rainfall 8"
Wind Speed 95 mph
Wind Direction S

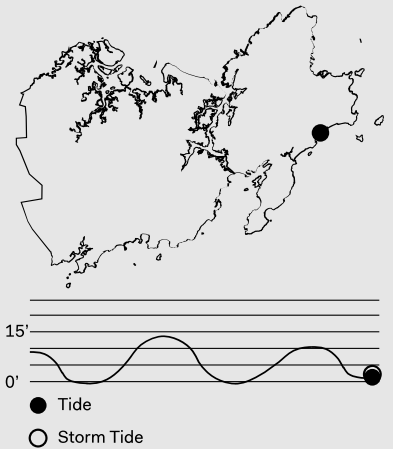
The storm batters the cottages on Long Beach from the marsh and ocean sides. The high tide overtops the seawall and debris crashes into homes along the beach. Office for Urbanization, “Long Beach During the Great Storm of 2038,” *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Office for Urbanization, 2022).



LONG BEACH

Long Beach Rd
Rockport, MA 01966

September 4, 2038
9 AM EDT



Barometric Pressure 1000 mbar
Maximum Storm Surge 1'
Temperature 70°F
Total Rainfall 24"
Wind Speed 20 mph
Wind Direction NE

After the storm residents sort through any belongings they can salvage from the cottages on Long Beach. Office for Urbanization, “Long Beach After the Great Storm of 2038,” *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Office for Urbanization, 2022).

How will the natural communities at Long Beach change in the future?

These climate impacts will affect the cottages and the amount of available beach, as well as the marsh system. The Saratoga Creek estuary is particularly vulnerable to sea level rise due to its location between the seawall and the steep granite bedrock behind the marsh, which limits marsh migration inland, meaning that the marsh will not be able to move horizontally as it is drowned under rising seas. This process will not take place overnight. Instead, the marsh will go through a period of transition in which high marsh grasses convert to low marsh grasses.

To understand this transition at Long Beach, we can reference studies undertaken by the Good Harbor Conservancy at Good Harbor Beach, the spit barrier beach that lies southwest of Long Beach in Gloucester. While Good Harbor has not seen the same level of development at Long Beach,¹³ we can learn a significant amount about the future of the salt marsh and beach at Long Beach from the scientific studies that have been undertaken at Good Harbor, which predict a major loss of high marsh by 2030 due to sea level rise, and almost a complete loss of high marsh by 2070.¹⁴ Due to the large tidal range on the Gulf of Maine, scientists expect that high marsh will convert to low marsh at a lower rate than other marshes with a smaller tidal range in places like the Chesapeake Bay, because the marsh is inundated for longer periods, and there are generally higher rates of sedimentation in marshes with higher sedimentation.¹⁵

While the marsh transitions, *Phragmites*, which tolerates low salinity, will continue to grow in disturbed areas around Thatcher Road and Long Beach Road, where the flow of salt water is restricted. As the sea level rises, *Phragmites* will die back due to increasing saltwater intrusion.

¹³ Good Harbor Beach has not seen the same level of development as Long Beach. A parking lot and beach house have been developed. The dune system at Good Harbor remains intact, while mosquito ditches were dug into the marshes, and there has been ongoing development on filled land toward the back of the Good Harbor marsh, including the Stop and Shop and CVS complex.

¹⁴ There has not been a high marsh to low marsh conversion study for Long Beach, or the Town of Rockport. The engineering firm Kleinfelder studied marsh conversions across the neighboring City of Gloucester. They found that, by 2030, there would be a major loss of high marsh as it transitions to low marsh due to sea level rise. Additionally, “more frequent and higher levels of inundation in the Good Harbor Marsh would make the areas unsuitable for low marsh vegetative cover to survive, resulting in the conversion of low marsh regions to non-vegetated tidal flats.” By 2070, Good Harbor Marsh will “have insignificant high marsh remaining, indicating a breakdown of the diversity in the marsh system.” This marsh will transition to “regularly flooded marsh with expanded tidal flats and larger tidal creeks, and the potential loss of surrounding upland if it were allowed to convert to marsh.” As marshland is lost, storm surge will more easily roll through degraded and lowland marsh areas, which may impact upland infrastructure in the future. See Kleinfelder, *Coastal Climate Change Vulnerability Assessment and Adaptation Plan* (Gloucester, MA: City of Gloucester, 2015): 15-17.

¹⁵ Duncan M. Fitzgerald et al., “Largest marsh in New England near a precipice,” *Geomorphology* 379 (2021): 107625.

How are coastal regulations changing in Massachusetts?

Despite the increasingly precise scientific projections available to understand the near future impacts of climate change, most of the discussion at Long Beach around seawall reconstruction has used the Federal Emergency Management Agency (FEMA)'s floodplain designations. The FEMA floodplain is determined using previous data, and therefore does not reflect the future risks that modeling like MC-FRM or SLOSH account for. Long Beach located within FEMA's AE and VE zones.¹⁶ Zone AE is “the base floodplain where base flood elevations are provided.” The base flood elevation (BFE) is the “elevation of surface water resulting from a flood that has a 1% change of equaling or exceeding that level in any given year.” Zone VE describes “coastal areas with a 1% or greater chance of flooding an additional hazard associated with storm waves. These areas have a 26% change of flooding over the life of a 30-year mortgage.”¹⁷

Coastal regulations and design standards in Massachusetts are also becoming more stringent due to climate change.¹⁸ Wetlands in Massachusetts are protected by 310 CMR 10.00, known as the Wetlands Protection Act. The Massachusetts Department of Environmental Protection has proposed updating these regulations to “promote coastal resiliency against worsening impacts of storms, flooding, and sea level rise through first-time standards to protect the coastal floodplain from damage.”¹⁹ Updated regulations will make it more challenging to permit seawall reconstruction at Long Beach. If the seawall were to be reconstructed, the wall would have to be heightened by 2’ so the top of the wall is higher than the FEMA VE elevation.²⁰

¹⁶The FEMA flood maps are available online in a viewer. See “FEMA's National Flood Hazard layer (NFHL) Viewer,” *FEMA*, www.hazards-fema.maps.arcgis.com

¹⁷“Glossary,” *Federal Emergency Management Agency*, www.fema.gov/about/glossary

¹⁸The Massachusetts Climate Resilience Design Standards provide “a consistent recommended basis-of-discussion across various projects in the Commonwealth considering the following climate parameters: sea level rise/storm surge, extreme precipitation, and extreme heat. The Standards produced include a recommended planning horizon, recommended return period, and a list of applicable design criteria that are likely to be affected by climate change. Resilient Massachusetts Action Team, *Climate Resilience Design Standards and Guidance Section 4: Climate Resilience Design Standards* (Boston, MA: Massachusetts Executive Office of Energy and Environmental Affairs, 2022), 4.

¹⁹These regulations are currently being drafted. The text and public comment are available through the Massachusetts Department of Environmental Protection. See “Public Summary on MassDEP Proposed Revisions to Wetlands Regulations to Ensure a Resilient Comonwealth” (Boston, MA: Massachusetts Department of Environmental Protection, December 13, 2023).

²⁰Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 14.

²¹Town of Rockport, *Town of Rockport Hazard Mitigation Plan* (Rockport: Town of Rockport, 2020), 51.

What should we do at Long Beach?

The 2020 Rockport Hazard Mitigation Plan concludes “managed retreat may be a viable approach [on Long Beach] where the long-term cost of retreat outweighs other shore protection measures,” but acknowledges, “here in Rockport, the land area to retreat away from the shoreline is limited by salt marshes/wetlands, land availability, and safety. Regardless of the approach, the Town should consider alternatives for the Long Beach area.”²¹

This is an apt conclusion. The cost to repair the seawall is projected to be over thirty million dollars, more than fifteen years of tax and lease revenues at Long Beach. Assuming that the appropriate permits and funding could be obtained to repair the seawall, by the time the raised seawall is completed, the beach would be entirely underwater at high tide, inaccessible to the public, while the Town receives no revenue from the Long Beach leases.

Despite the large amount of information available to decision makers, there has not been a definitive answer to the question “what should we do at Long Beach?” The following section describes scenarios that provide alternatives for decision makers to consider.



Kira Clingen, "Long Beach parking lot at Cape Hedge beach," 2024.

¹Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014).

What options have been proposed at Long Beach?

Despite the financial and time investment that federal, state, and local governments have dedicated to studying various options to enhance the recreational quality of the beach, limit erosion, rebuild the seawall, protect the cottages and adapt public infrastructure, there has not been consensus on the future of Long Beach. While these reports have described the fragile beach ecosystem, they have generally focused on the hard infrastructure on the beach, ignoring the ecology and place attachment that people have for the seascapes on Cape Ann.

Ultimately, “a general plan for a design and permitting timeline is difficult to predict, since much of the permitting timeframe will be dictated by the level of interest and/or concerns of the public.”¹

The options that have been proposed previously are briefly outlined over the following pages.

Army Corps of Engineers, 1961

The United States Army Corps of Engineers conducted a Beach Erosion Control Report in 1961. The Corps suggested a Plan of Protection for Long Beach. The Plan detailed “widening the beach by direct placement of sand fill and the construction of a training jetty at the mouth of the tidal creek.”¹ The 400’ jetty would “retain the proposed fill and control the tidal inlet currents, thereby reducing losses of beach material and narrowing the beach.”²

Ultimately, the Corps concluded that “the existing seawall will provide adequate protection from wave damage to improvements at Long Beach and existing public beach areas are adequate for present and prospective recreational requirements.”³

The Corps further “recommended that no project be adopted for the protection or improvement of Long, Cape Hedge or Pebbly Beaches, Rockport, Massachusetts. It is further recommended that protective measures which may be undertaken by local interests based upon their determination of economic justification be accomplished in accordance with plans and methods considered in this report.”⁴

¹The Corps recommended adding sand fill from upland sources to increase the width of the beach to 150-feet between the seawall and mean high water line. United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 20.

²United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 20.

³Letter from W.K. Wilson, Lieutenant General of the United States Army Corps of Engineers to the Secretary of the Army, *Subject: Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts*, June 20, 1962.

⁴United States Army Corps of Engineers, *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts* (Washington, D.C.: US Army Corps of Engineers, 1961), 40.

Vine Associates, 2012

Program 1	Replace the 1931 seawall, and make sidewalk improvements to the 1958 seawall, as well as drainage improvements and stone apron reconstruction across the length of the entire seawall. The estimated cost is \$14,453,325.
Program 2	Replace the 1931 seawall, make sidewalk improvements and toe overlay to the 1958 seawall, as well as drainage improvements and stone apron reconstruction across the length of the entire seawall. The estimated cost is \$15,069,818.
Program 3	Replace the 1931 seawall, make sidewalk improvements to the 1958 seawall, as well as drainage improvements, stone apron reconstruction, and wall extension across the length of the entire seawall. The estimated cost is \$16,165,805.
Program 4	Replace the 1931 seawall, make sidewalk improvements and toe overlay to the 1958 seawall, as well as drainage improvements, stone apron reconstruction, and wall extension across the length of the entire seawall. The estimated cost is \$16,919,296. ³

¹The options are: replace the entire 1931 seawall to match the 1958 profile; make sidewalk and drainage improvements and reconstruct the stone apron of the 1958 seawall while monitoring the wall and cracks; repair vertical cracks in the 1958 seawall in addition to making sidewalk and drainage improvements and reconstructing the stone apron; extend the entire length of the seawall above the 100-year FEMA coastal flood with velocity elevation; install a sheeting cut-off wall below grade at the face of the wall in front of all repairs. Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 13-14.

²Vine Associates recommends redesigning the sidewalk along portions of the 1931 seawall as a self-supporting cantilevered extension, and modifying the 1958 seawall. The 1958 drawing set is used, so as not to decrease the accessible width of the beach. Drainage improvements may include a perforated pipe surrounded by stone set at the elevation of the existing weepholes, some of which also must be cleared of concrete. The stone apron is recommended to be reconstructed using filter fabric, a filter stone layer, and a larger sized toe stone set deeper than the existing apron. See Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 13-14.

³All cost estimates are adjusted for inflation from the 2012 estimates. All estimates include mobilization, 15% contractor overhead and profit, 15% contingency, and construction oversight. Vine Associates, *Rockport Long Beach Seawall – Preliminary Design Report* (Rockport, MA: Town of Rockport, 2012), 16.

Vine Associates created five options¹ for the replacement and rehabilitation of the seawall in 2012. These five options were combined into four programs with an estimated cost. Each of the programs includes redesigning the sidewalk, drainage improvements, and the reconstruction of the stone apron to the 1958 seawall construction specifications.²

¹Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 40-42.

²This cost estimate is adjusted for inflation from the 2014 estimate of \$1,380,000 to remove the seawall and \$350,000 to regrade the dune system. Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 43-44.

³This cost estimate is adjusted for inflation from the 2014 estimate of \$14,850,000. This number was inherited from the 2012 Vine Associates/GZA study. *Applied Coastal Research and Engineering, Inc., Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 51.

⁴This cost estimate is adjusted for inflation from the 2014 estimate of \$7,550,000. Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 51.

⁵Applied Engineering’s 2014 report considered an offshore borrow site where sand could be dredged, but concluded that “the costs for performing a local sand search, conducting the necessary fisheries assessment, developing appropriate regulatory permitting documents, and mobilizing appropriately sized dredging equipment to the beach would not be economically or logistically viable.” The report further notes that the training jetty suggested by the United States Army Corps of Engineers would likely not be effective to maintain the sand, and therefore is not included in their study. Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 51.

⁶Applied Coastal Research and Engineering, Inc., *Long Beach, Rockport, Massachusetts, Sediment Study* (Rockport, MA: Town of Rockport, 2014), 52-54.

Applied Coastal Research and Engineering, Inc. created six scenarios in 2014, beginning with a “do nothing” scenario against which all scenarios are measured against.

Applied Coastal Research and Engineering, 2014

Do Nothing Alternative	The Do Nothing Alternative assumes that the Town does not undertake any maintenance of the beach or seawall, and beach erosion has “reduced the beach’s ability to provide adequate storm protection.” The seawall catastrophically fails between 2036 and 2047 due to ongoing shoreline erosion and the associated reduction of beach height. If the seawall fails during a severe storm event, the seawall is overtopped and dwellings are damaged. The sewer line behind Long Beach is also jeopardized. ¹
Managed Retreat with Dwellings Removed from High Risk Areas	Half of the structures on Long Beach are in the FEMA V-Zone and will experience wave heights over 3 feet during a 100-year storm. These structures are removed to prevent structural damage during winter nor’easters. This is the first step of managed retreat.
Proactive Removal of the Seawall	Following the removal of cottages in the V-Zone, the cottages adjacent to the seawall are removed, followed by the seawall. The landscape is re-graded to form “the barrier beach and dune system that existed before construction of the seawall in 1931.”This dune protects the remaining landward cottages from coastal storms, though it does not protect them from sea level rise. The estimated cost of this seawall removal is \$1,833,540. The estimated cost of regrading the dune system is \$465,028. ²
Seawall Redesign and Reconstruction	The seawall constructed in 1931 is replaced, and improvements are made to the 1959 seawall, including a stone apron and sheet pile cutoff wall on the toe of the seawall. The cost of the redesigned and repaired seawall is \$19,730,500. ³
Alternative Armoring of the Beach	As opposed to replacing the seawall, constructing an armor stone revetment in front of the existing seawall protects the shore and provides passive resistance for the existing wall. The cost of the revetment is estimated at \$10,031,330. ⁴
Beach Nourishment	50,000 or 100,000 cubic yards of sand are brought to Long Beach from an upland site ⁵ and deposited in the center of the beach. The sand is naturally distributed overtime, and expected to last between 16 and 32 years depending on the amount of sediment deposited on the beach. ⁶

¹Long Beach Infrastructure Committee, *Long Beach Infrastructure Recommendation* (Rockport, MA: Long Beach Infrastructure Committee, 2018).

²Cost estimates are adjusted for inflation from 2018 estimates.

The Long Beach Infrastructure Committee, established in 2017, identified “immediate action to stabilize the seawall and associated infrastructure” and developed a plan to “repair or replace parts of, or the entire, Long Beach Seawall including its sidewalks, beach-way ladders, and other related utilities and attachments.” The Committee strongly recommended a total seawall replacement including raising the height of the seawall by 2’.¹

Long Beach Infrastructure Committee, 2018

Go Back to Nature	Relocate the cottages and rebuild the dune system. This option was rejected by the selectmen in March 2022. Estimated to cost \$11,000,000 as well as a loss of \$2,500,000 in taxes and revenues annually.
Continue Current Practice of Patching Broken Parts	The committee recommended against this practice as the seawall is deteriorating more rapidly than this solution could fix.
Replace 1932 Wall and Repair 1958 Wall	The committee recommended against this practice as both the 1931 and 1958 seawalls are past their current lifespans.
Total Seawall Repair	Replace the entire seawall and raise the height by 2’. The expected lifespan of the seawall is 75 years. The estimated cost is \$26,200,000. ²

Long Beach Options Committee, 2022

Option 1a. Renewal of Current Ten-Year Leases without Changes	The leases are renewed at Town Meeting, extending until 2034. The Town retains ownership of the parcels and has additional time for research and planning. During this time, the Town is liable for damages to the cottages, including damage resulting from seawall failure. The nominal estimated income for this option for the lease period 2024-2033 is \$31,920,992.
Option 1b. Renewal of Current Ten-Year Leases, but with Town Indemnified Against Losses Due to Seawall Failure, Beach Movement, Storm Damage and Other Climate-Change-Related Causes	The leases are renewed at Town Meeting in 2023, extending until 2034. The Town is indemnified against losses due to seawall failure, beach movement, storm damage, or other climate related causes. The nominal estimated income for this option for the lease period 2024-2033 is \$31,813,514.
Option 1c. Conditional Renewal of Leases with Additional Changes to Include Climate Change Adaptation (“Managed Retreat”)	The Town is indemnified against losses due to climate-change-related causes and cottage owners acknowledge they are leasing parcels at their own risk. The leases are reviewed and terminated when certain risk thresholds pertaining to the safety of cottage owners are reached, and notified of the lease duration and conditions. Seawall repairs and beach nourishment are made, allowing the Town to maintain a declining revenue stream while warning cottage owners in advance of lease termination. The nominal estimated income for this option for the lease period 2024-2033 is \$31,491,079.
Option 2a. Sell Individual Parcels with the Seawall (but not the beach) included in the Sale	The parcels are surveyed, appraised, and sold separately. Income from the sale goes directly to the Town of Rockport. The seawall would likely have to be sold separately to an association of the new parcel owners after the parcels are sold. Ownership of the dune is separated from the beach and marsh. The nominal estimated income for this option for the lease period 2024-2033 is \$93,505,937.
Option 2b. Sell as Single Parcel with the Seawall (but not the beach) included in the Sale	The parcels are surveyed, appraised, and sold, along with the seawall. Income from the sale goes directly to the Town of Rockport. Ownership of the dune is separated from the beach and marsh. The nominal estimated income for this option for the lease period 2024-2033 is \$99,954,622.
Option 3. “Back to Nature” – Do Not Renew Leases, Remove the Cottages, Seawall, and Utility Infrastructure	The leases are terminated, the cottages, seawall, and utility infrastructure are removed, and the dune system is regraded. The nominal estimated loss for this option for the lease period 2024-2033 is \$14,724,498. ³

¹Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 19-48.

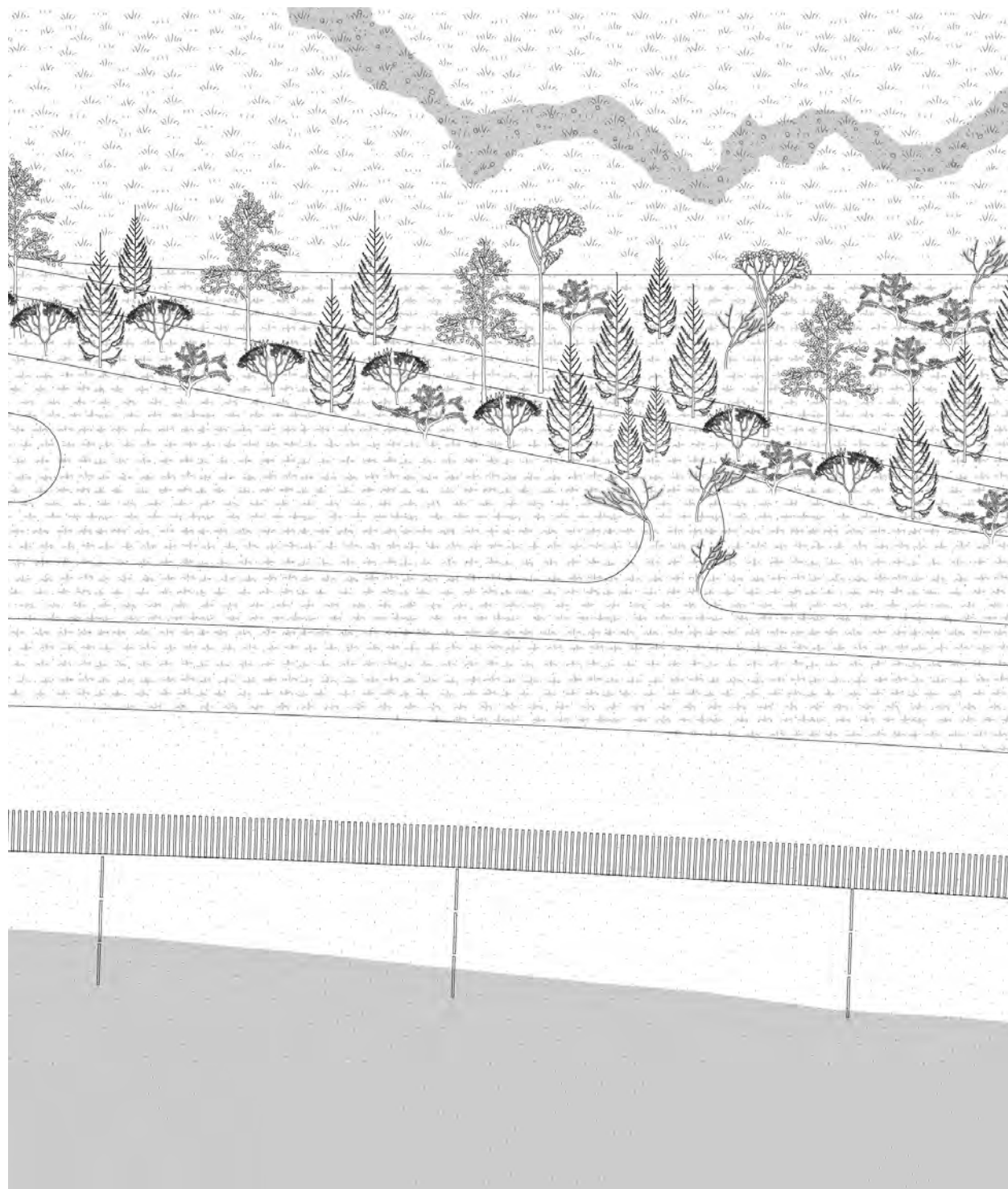
²Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 6.

³All cost estimates are adjusted for inflation from the 2022 estimates. The term “nominal” is defined by the Options Committee as a “value which is neither the worst or best case, but is somewhere in between.” Long Beach Options Committee, *Final Report for Rockport Town Meeting* (Rockport, MA: Long Beach Options Committee, 2022), 29-30.

The most comprehensive set of options and cost estimates¹ for Long Beach are described in the Long Beach Options Committee Final Report, which was compiled in 2022 by a committee composed of Rockport community members. The Committee’s charge was to “consider the Town’s options when the current Long Beach leases expire in 2023, with due regard for environmental issues, in particular rising sea levels, and the need to repair or replace the seawall.”²



Kira Clingen, "Revetment, seawall, and cottages," 2024.



LONG BEACH IS...?
LONG BEACH COULD BE...?
A Place-Based Scenario Plan



Kira Clingen, "Saratoga marsh looking toward Gloucester," 2024.

Critical Certainties

“Long Beach is the only sizeable residential neighborhood in Rockport that is located in a FEMA special flood hazard area.”

- Long Beach Options Committee, 2022

Critical Certainties are statements that are inevitable and known. These include social, technological, economic, ecological, political, and legal realities at Long Beach. While stakeholders can make decisions that address these Certainties, they are beyond the sphere of control of anyone involved at Long Beach.

Critical Certainties

- Long Beach is a treasured cultural landscape
- Land and cottage ownership and access are split between individuals and the Town of Rockport
- The Long Beach leases provide critical revenue for the Town of Rockport
- The Town of Rockport is actively addressing its housing crisis using zoning reforms, including the adoption of by-right accessory dwelling units (ADUs)
- Sea levels are rising and storms are becoming increasingly powerful
- Erosion and sea level rise are decreasing the width of publicly available beach
- Infrastructure floods during storms and high tides
- The seawall is damaged
- The Long Beach ecosystem and its larger watershed are degraded
- Long Beach is connected to upland ecosystems
- Multiple reports, scenarios, and options have been created for Long Beach

Long Beach is a Treasured Cultural Landscape

People have had a presence on Long Beach for thousands of years. The way people use and live at Long Beach is a reflection of shared cultural values.

Today, these values prioritize protecting private property and recreational use of the beach.

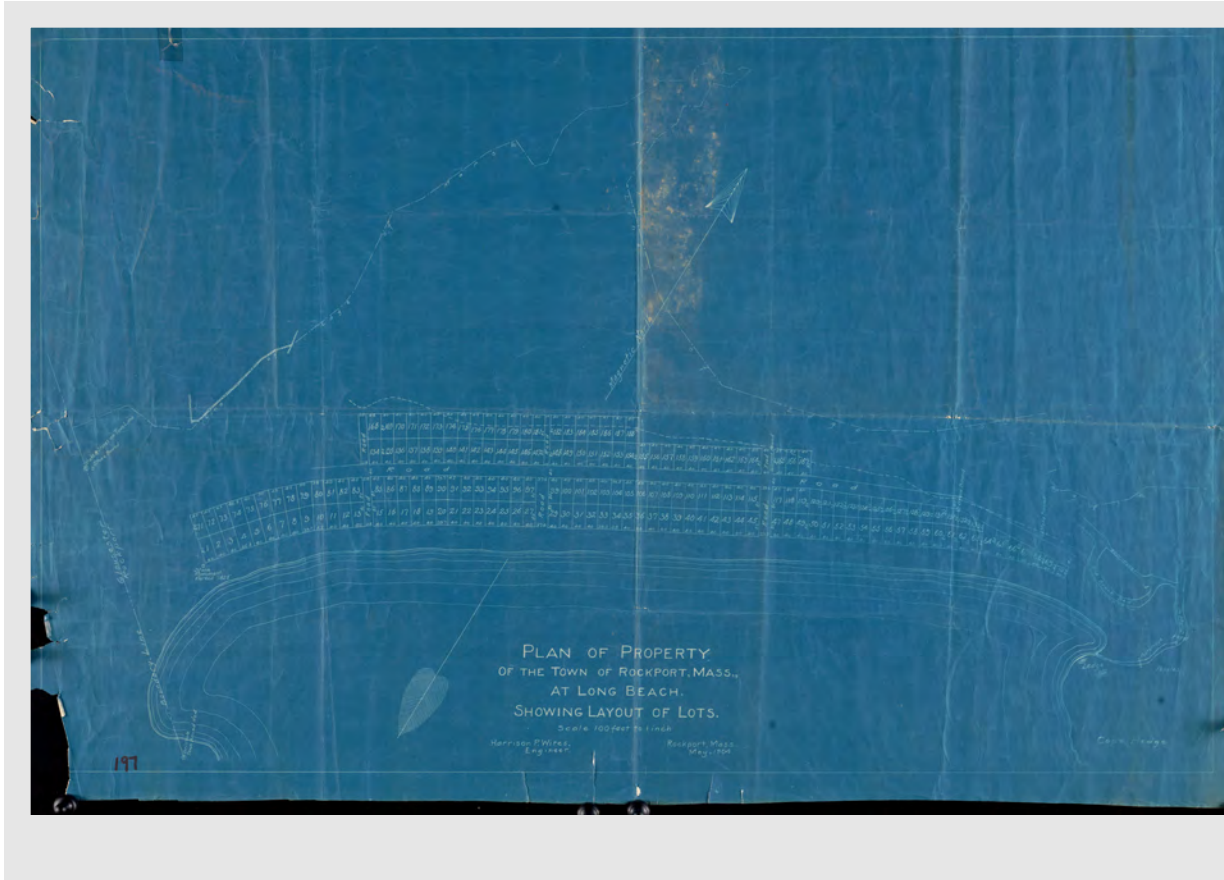


Long Beach between Gloucester and Rockport, Mass, Long Beach, Rockport, Mass., postcard, 1945.

Individuals and families own the cottages at Long Beach. The Town of Rockport owns the land underneath. Cottage owners have seasonal access to their properties. They also pay for access to the road and parking behind Long Beach.

The general public is allowed access to the seawall, sidewalk, beach, and firebreaks. During the winter season, the public is also allowed to cross over the parcels. Rockport residents with a valid sticker may park in the lot behind the cobble berm at Cape Hedge Beach and cross over to Long Beach, or pay to park in the private parking lots adjacent to Long Beach.

Land and Cottage Ownership and Access are Split between Individuals and the Town



Harrison P. Wires, *Plan of property of the Town of Rockport, Mass., at Long Beach, showing layouts of lots*, map, Digital Commonwealth, 1904.

The Long Beach parcel leases and property taxes provide 8% of the revenue for the Town of Rockport each year. The Long Beach Options Committee notes that the ten-year annual income from the leases and property taxes for the period ending in 2034 is \$31,813,514.

Leases Provide Revenue for the Town of Rockport

Gloucester Daily Times - 03/08/2024

Page : A01

Preserve Long Beach says Rockport needs revenue



PAUL BILODEAU/Staff file photo

Rockport received a \$2.8 million from FEMA for repairs to the Long Beach seawall after it was damaged in March 2018. The group Preserve Long Beach is campaigning for Town Meeting to provide \$700,000 in matching funds to repair the wall.

Group: Save seawall, save town

BY STEPHEN HAGAN
Staff Writer

ROCKPORT — Some residents are calling on fellow townspeople to approve an article at annual Town Meeting in April that would pay for repairs to a deteriorating seawall at Long Beach.
The group Preserve Long Beach has created a website, www.preservelongbeach.com, to promote that goal.
Antoinette Giugliano serves on the Long Beach Executive Committee and chairs its Education and Outreach Program. She said the website was designed by Rockport residents for Rockport residents, adding the intent is to draw attention to the needed seawall repairs.
The initiative is not simply about fixing a wall, but about supporting

“Many Rockport residents may not realize that the Long Beach seawall is a pivotal foundation to the town of Rockport’s future economic stability.”
Antoinette Giugliano, Long Beach Executive Committee

Rockport’s financial needs, with the income generated from the town-owned properties at Long Beach. The revenue supports Rockport schools and provides for the overall economic viability of the town, Giugliano said.
“Many Rockport residents may not realize that the Long Beach seawall is a pivotal foundation to the town of Rockport’s future economic stability,” she said. “Urgent improvements to the seawall are needed immediately to avoid catastrophic failure.”
The seawall is almost 100 years old, and the opportunity exists for town

officials to take advantage of a \$2.8 million FEMA grant that was awarded in 2019.
Select Board Vice Chair Ross Brackett said Thursday while no formal position has been yet agreed to, he believes the board will ultimately decide to back the measure.
“I think we should be fixing the wall,” he said. “I only know that we put it on (the warrant) so there should be support for it already. I’m for it.”
The website, www.preservelongbeach.com.

See BEACH, Page A8

March 8, 2024 7:53 am (GMT -5:00)

Powered by TECNAVIA

Stephen Hagan, “Group: Save seawall, save town,” *Gloucester Daily Times*, March 8, 2024.

Like other communities in Massachusetts, the Town of Rockport has a year-round housing crisis. Recent amendments to the Rockport Zoning Bylaws allow for by-right Accessory Dwelling Units (ADUs) in Town.

There is also a longstanding history of moving homes in Rockport and across Cape Ann. Historically, homes have been lifted and transported on flat-bed trucks.

The Town of Rockport is Actively Addressing its Housing Crisis



Author unknown, *The White Ellery House in the process of being moved*, 1947, photograph, Cape Ann Museum, 1947.

Sea levels are rising more quickly along the Gulf of Maine than in other oceans around the planet. By 2070, there will be an estimated 4.29' of sea level rise at Long Beach. Storms that arrive on top of sea level rise have the potential to be more erosive and do more damage than storms experienced in the past.

Sea Levels are Rising and Storms are Strengthening



US Army Corps of Engineers “Tidal creek and Long Beach from shingle ridge at Cape Hedge Beach,” *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts*, photograph, September 20, 1960.

Kira Clingen, “Tidal creek and Long Beach from cobble hedge berm at Cape Hedge,” photograph, November 4, 2023.

Long Beach has eroded by 9' per decade since 1851. Erosion continues to decrease the amount of publicly accessible beach, with high tide frequently reaching the seawall during the winter season.

Erosion and Sea Level Rise are Decreasing the Width of Publicly Available Beach



US Army Corps of Engineers “Exposed stone apron near tidal creek at east end of beach,” *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts*, photograph, September 21, 1960.

Kira Clingen, “Exposed revetment looking toward Gloucester” photograph, September 12, 2023.

The infrastructure systems at Long Beach already flood during high tides and storms. These infrastructure systems include Old County Road and the manhole at the end of the road.

Aging infrastructure is a problem that extends beyond Long Beach, and local fixes at the beach will not fix larger regional issues.

Infrastructure Continues to Flood during Storms and High Tides



Kira Clingen, “Exposed manhole on Long Beach road,” photograph, September 12, 2023.

Kira Clingen, “Old County Road, electrical poles, and manhole, ” photograph, November 5, 2023.

The seawall at Long Beach has been damaged by a series of storms, and is past its life expectancy. The estimated cost to replace the seawall and elevate it above the 2070 design flood elevation is \$26,200,000.

The Seawall is Damaged



USACE, "Concrete seawall lying on beach was destroyed by strrm of April 1-2, 1958. Temporary bulkheads protect cottages," *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts*, photograph, April 30, 1958.

Kira Clingen, "Long Beach seawall looking toward Cape Hedge Beach" photograph, September 12, 2023.

There are signs of disturbed hydrology in the Long Beach ecosystem, including *Phragmites* along the edges of Thatcher, Long Beach, and Old County Roads, calving creek banks along the Saratoga Marsh complex, and the increasingly exposed stone apron in front of the seawall, a sign of coastal erosion. The impervious surfaces in the marsh, including the seawall and cottages, also disturb the flow of water across the beach and the larger watershed.

The Long Beach Ecosystem and its Larger Watershed is Degraded



Kira Clingen, “Phragmites at Long Beach” photograph, September 12, 2023.

Kira Clingen, “Back of Cape Hedge parking lot” photograph, November 5, 2023.

Any development, construction, or infrastructural upgrades at Long Beach will impact the string of beaches stretching from Gloucester to Rockport on the southeastern side of Cape Ann.

The flow of sediment between these beaches is particularly important to consider in order to maintain these beaches in perpetuity.

Long Beach Is Connected to Upland and Coastal Ecosystems

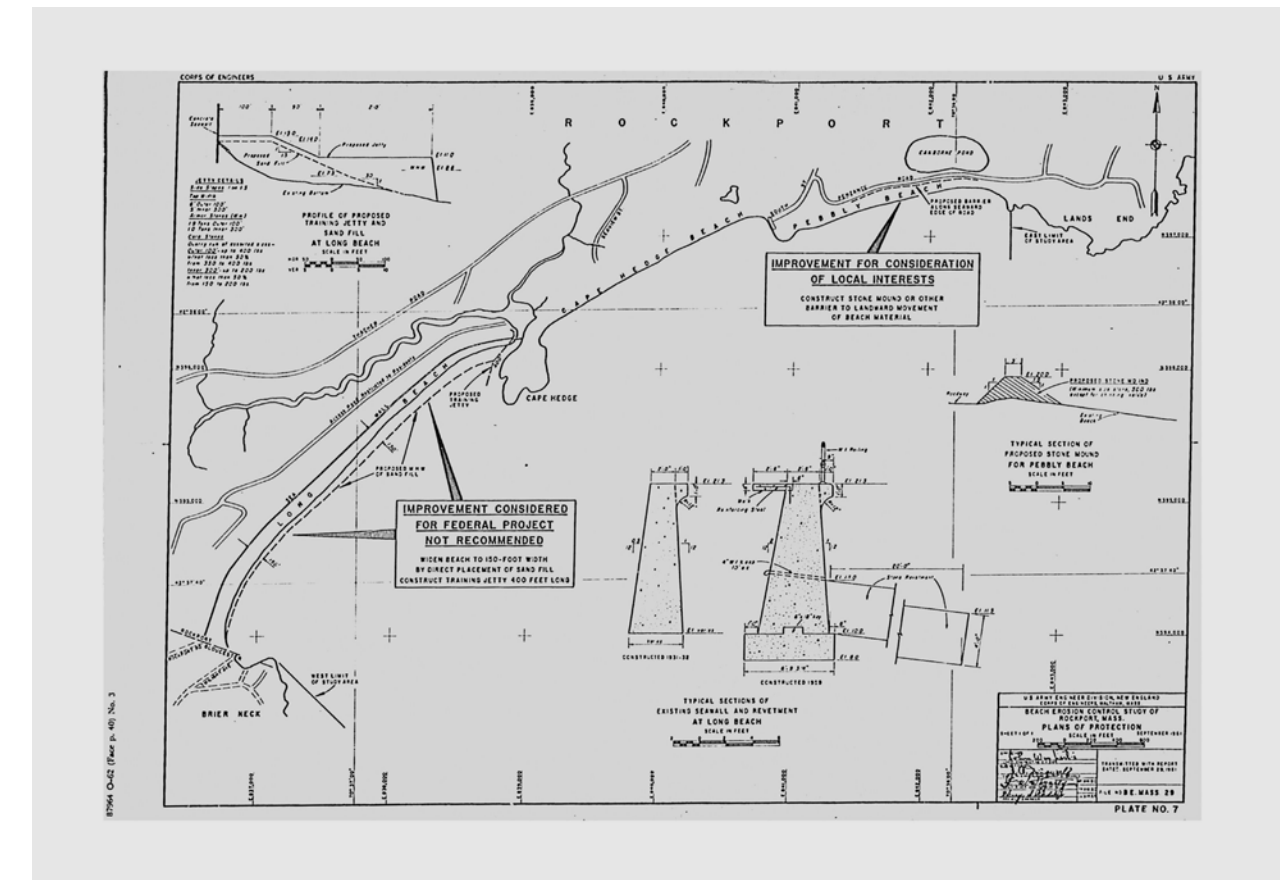


United States Geological Survey, *Gloucester, MA*, Washington, D.C.: USGS, map, 1918.

Kira Clingen, “Pebble Beach, Cape Hedge Beach, and Long Beach” photograph, September 18, 2024.

Multiple Reports, Scenarios, and Options have been Identified for Long Beach

Despite the wealth of information contained in reports, scenarios, and presentations convened around Long Beach, there has been no comprehensive decision or long-term plan for the future of the cottages, the seawall, or the beach itself.



US Army Corps of Engineers "Plate No. 1," *Beach Erosion Control Report on Cooperative Study of Rockport, Massachusetts*, map, 1961.



Kira Clingen, "Saratoga marsh looking across Thatcher Road," 2024.

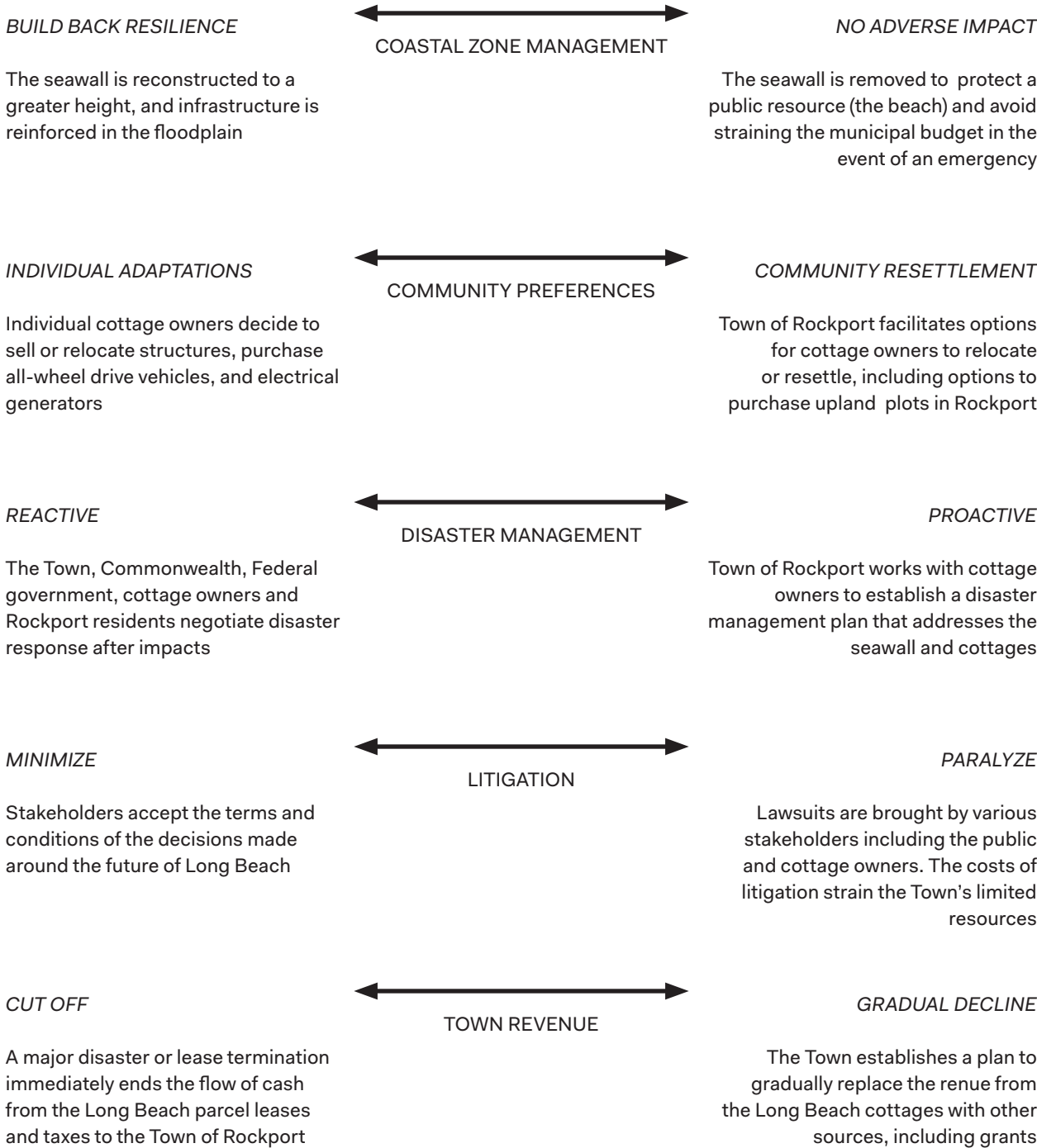
Critical Dialectics

“A general plan for a design and permitting timeline is difficult to predict, since much of the permitting time-frame will be dictated by the level of interest and/or concerns of the public.”

- Applied Coastal and Engineering, 2014

Critical Dialectics are unknowns that lead to divergent choices. Critical Dialectics include events that communities have no control over, like nor'easters and hurricanes, and situations that decision-makers can affect through advocacy, policy making, design, litigation, and funding.

The Dialectics are arranged on an axis that represents extremes.





Kira Clingen, "Long Beach looking toward Gloucester from Cape Hedge Beach," 2024.

Scenarios

“Eventually, the ocean is going to take it back.”

- Jayne Knott, hydrologist, 2024

¹Kira Clingen, “Place-Based Scenario Planning: A Design Research Methodology for Climate Adaptation,” in *Resilient Urbanism*, ed. Gihan Garunaratne (London: Taylor and Francis, forthcoming 2025).

²See Thomas J. Chermack, *Scenario Planning in Organizations: How to Create, Use, and Assess Scenarios* (San Francisco: Berrett-Koehler Publishers, Inc., 2011); Jeremy Stapleton, *Exploratory Scenario Planning (XSP): Navigating an Uncertain Future* (Cambridge, MA: Lincoln Institute, 2022); and Nardia Haigh, *Scenario Planning for Climate Change: A Guide for Strategists* (London: Routledge, 2019).

What could Long Beach be?

Scenario planning evolved out of military intelligence in the 1970s as a tool for corporations to make strategic plans in situations with high degrees of uncertainty. Scenario planning is often used in complex situations with multiple stakeholders and high degrees of uncertainty, like climate change.

Place-based scenario planning uses design thinking to frame the complexity of climate change issues across scales, while grounding them in place.¹

These scenarios are meant to be descriptive, memorable, and plausible.² They are described using a brief narrative, a plan drawing, rendering through a perspective view, and followed by a matrix that describes the way the ecological and physical infrastructures at Long Beach will change depending on the preferred scenario. These scenarios are not exhaustive descriptions of what will happen in the future. Instead, they are plausible ideas to generate discussion and adaptation by the decisionmakers on Long Beach.

Scenario 0 is the steady-state, or “do nothing” scenario. This scenario can be used to measure the other proposed scenarios against.

¹A nearby example of a forced sale due to coastal erosion comes from Nantucket. The Carlin-Gifford sold their home, assessed for \$2,000,000, for \$200,000 in 2024. When they purchased the home in 1988, the home was separated from the Atlantic Ocean by three houses, one road, and one acre of land. Overtime, coastal erosion claimed the homes and road. The Carlin-Giffords sold their home to a neighbor after they estimated that the house would be claimed by the ocean within a year. There are many other examples of homes dropping significantly in value due to coastal erosion on Nantucket, Martha's Vineyard, and other barrier beaches across the United States. Jason Graziadei, "Erosion Firesale: Nantucket Waterfront Home Assessed at Nearly \$2 Million Sold for Just \$200,000," *Nantucket Current*, July 2, 2024.

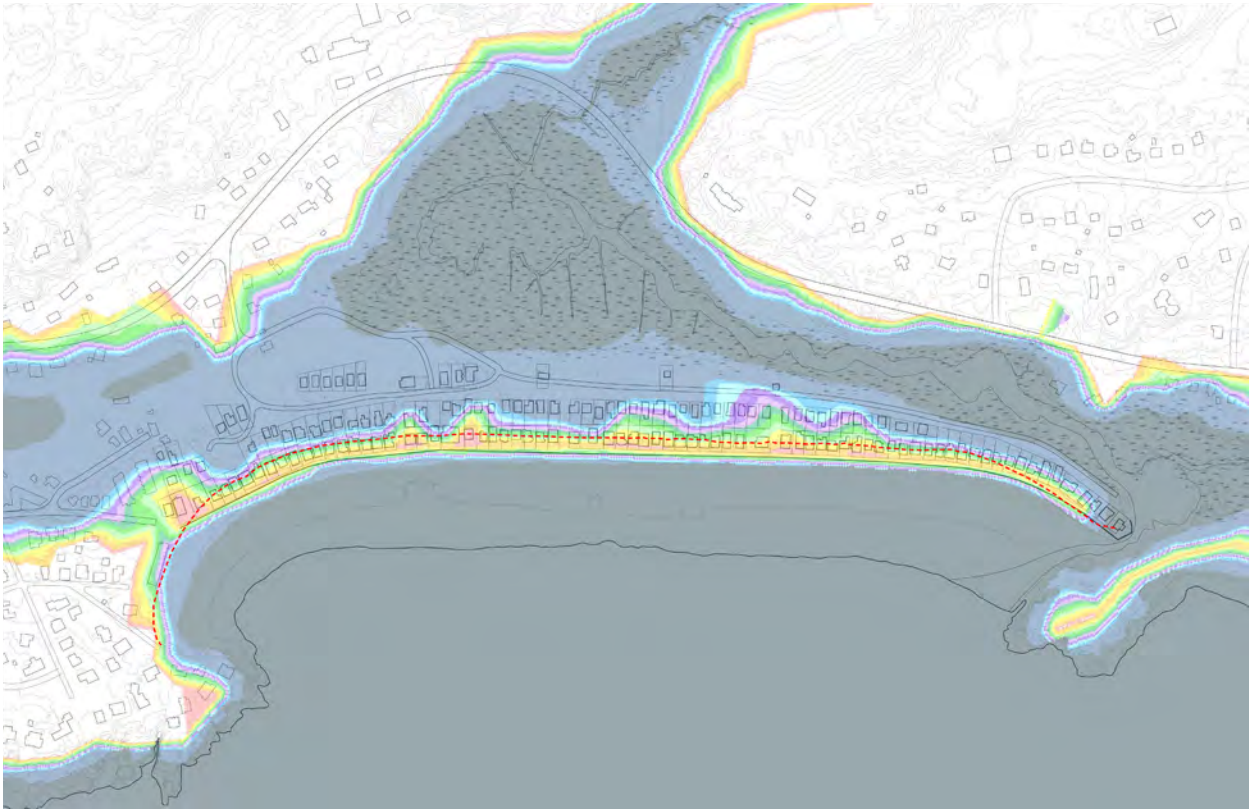
²The Office for Urbanization, "The Great Storm of 2038," *Compound Vulnerabilities: The Case of Cape Ann* (Cambridge, MA: Harvard University Graduate School of Design, 2022), officeforurbanization.org/0/impacts-and-aftermath

Scenario 0: Renew and Do Nothing

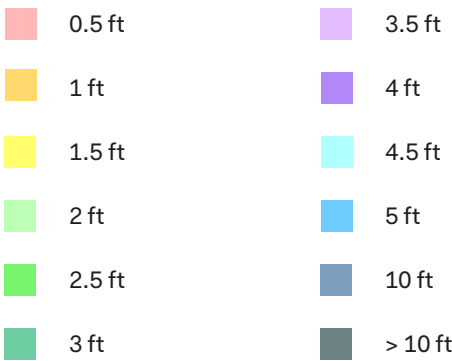
The Long Beach leases are renewed in 2034. Due to issues with permitting and financing, the seawall has not been repaired since 2018. The Rockport Department of Public Works has made piecemeal repairs immediately after nor'easters on sections of collapsed sidewalk and added sandbags to cover the exposed base of the wall. The wooden staircases and bridge to Cape Hedge Beach have been damaged and not have been replace, limiting access to the beach for cottage owners and the general public. Public access is also limited at high tide, when the beach is frequently covered by water lapping against the seawall. Many of the cottages have been put on the market by individual owners triggered by dropping coastal property values across Massachusetts.¹

In 2038, a Category 3 hurricane arrives at Long Beach in September. The storm arrives at high tide, and the surge overtops the seawall and rushes through the Saratoga tidal channel, flooding the cottages from the ocean and marsh, and collapsing the remaining portions of the 1931 seawall, as well as significant lengths of the 1958 wall.² In the aftermath of the storm, the Gloucester Wastewater Treatment Plant malfunctions, cutting off wastewater management for two weeks. Cottage owners bring a series of lawsuits against the Town. With litigation threatening to last for years and without public utilities, some cottage owners salvage their properties and remove them on flatbed trucks while the seawall lies on the beach.

Scenario 0: Renew and Do Nothing



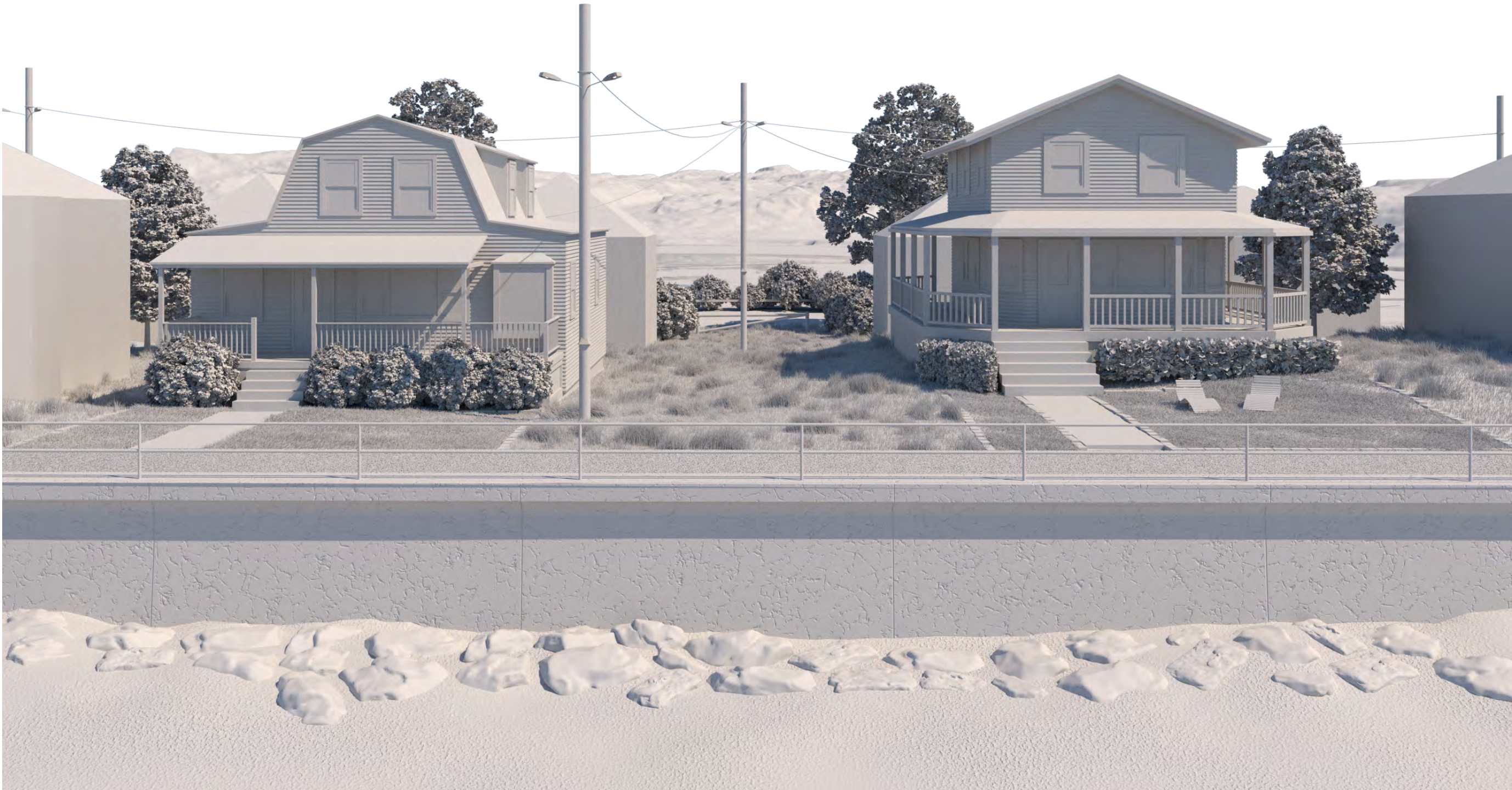
Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2070



2064 Shoreline



The seawall and cottages remain on Long Beach.



This rendering shows the seawall as it exists with the minimal repairs completed in 2018. APOCATOPIA, “Scenario 0: Renew and Do Nothing,” 2024.

¹Beach nourishment is the process by which sediment, usually sand, that has eroded or drifted away is replaced from other sources. Beach nourishment can reduce storm damage to coastal structures by dissipating wave energy across the surface zone. However, it is a temporary solution and is a repetitive process that must be deployed regularly. It is also becoming increasingly difficult to enact, due to limited sediment resources and increasingly stringent environmental regulations. See Woods Hole Group, *Living Shorelines in New England: State of the Practice* (East Falmouth: Woods Hole Group, July 2017).

²Beach nourishment is not an effective long-term climate adaptation measure, and can also be ineffective over the short-term. An example of beach nourishment being washed away almost immediately after being deposited comes from Salsbury, Massachusetts, where the Town spent \$600,000 on shore protection that was washed away during a nor'easter. The Town purchased 14,000 tons of Salisbury. Residents argued that the sand was a worthy investment, as it protected 150 beachside properties, while critics claimed that taxpayers should not bear the costs of beach nourishment to protect a limited number of homes. Michael Casey, "Salisbury, Mass. Spent \$600K on shore protection. A winter storm washed it away days later," *WBUR*, March 14, 2024.

³Climate adaptation measures include individuals or families purchasing solar panels, all-wheel drive vehicles, or additional flood protection insurance using their personal means to insure or protect themselves against climate change.

Scenario 1: Renew and Repair

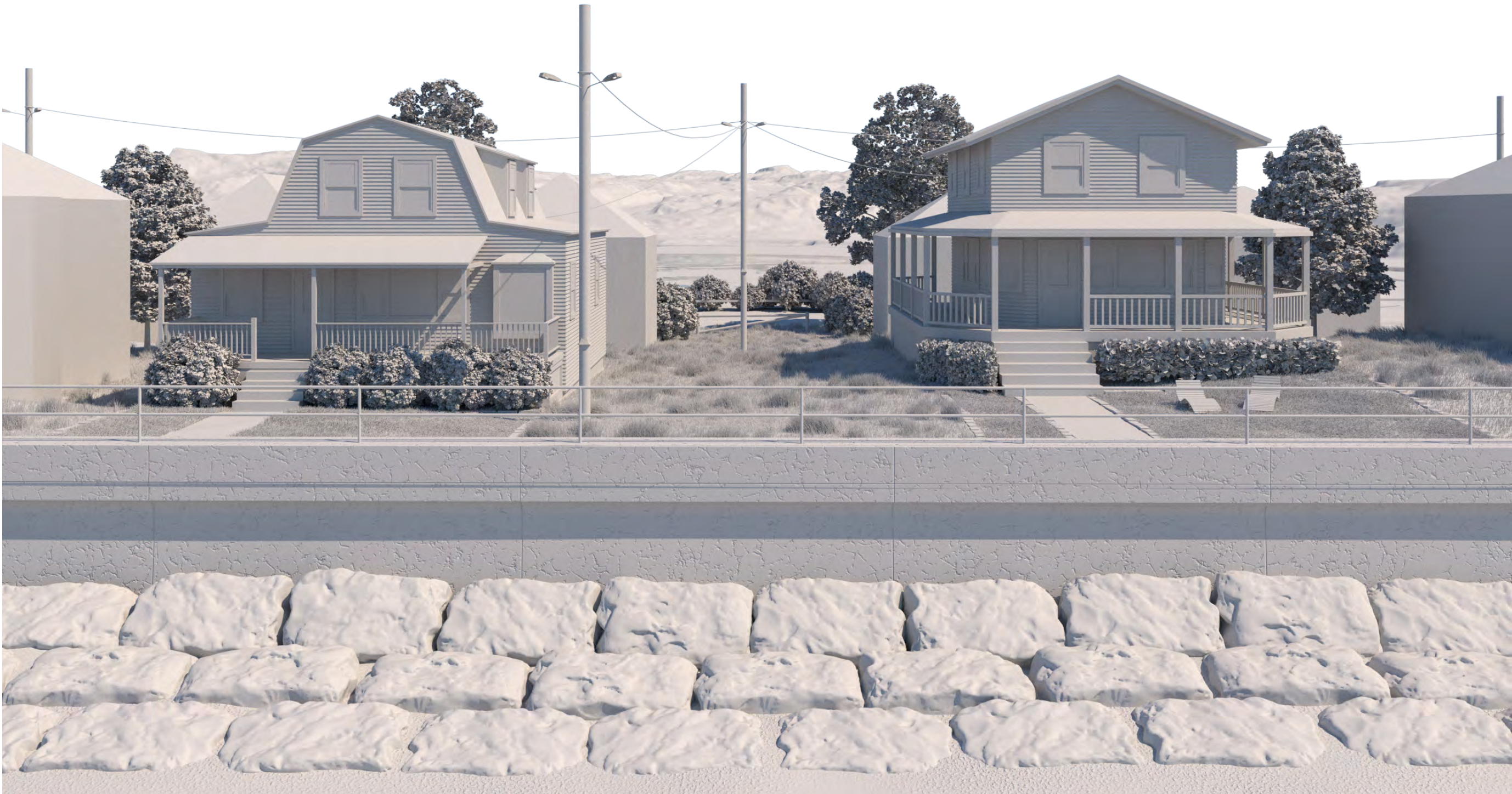
The Rockport Town government dedicates itself to applying for grants to reconstruct the Long Beach seawall. An override is passed to match funds in 2025, and the seawall is reconstructed to two feet above its current elevation in keeping with updated wetland design guidelines. Reconstruction is finished in 2028. That year, a late season nor'easter washes away the sand deposited for beach nourishment^{1 2} and storm surge overtops the seawall.

By 2030, the beach and Long Beach Road are underwater during most high tides. Cottage owners enjoy the summer from their lawns, while the public has limited access to the beach due to ongoing flooding and damage to the Cape Hedge parking lot and staircases. Cottage owners purchase all-wheel drive vehicles to compensate for deteriorating road conditions and emergency generators for more frequent power outages during increasingly powerful storms.³

Scenario 1: Renew and Repair



The seawall is reconstructed above the 100-year floodplain. Construction finishes in 2028.



This rendering shows the seawall raised 2' above the 100-year floodplain with a new stone apron to reinforce the wall. APOCATOPIA, "Scenario 1: Renew and Repair," 2024.

¹Potential lawsuits were identified in the Long Beach Options Committee final report. They are: cottage owners suing the Town in the event of seawall failure during a major storm; cottage owners suing the Town if the leases are terminated early; residents suing the Town for divesting of a natural resource if Long Beach is sold; or residents and cottage owners suing the Town for beach ownership. See Long Beach Options Committee, *Long Beach Infrastructure Recommendation* (Rockport, MA: Long Beach Options Committee, 2014).

²In 2015, a community member filed a lawsuit claiming that it was unlawful for the public to cross leased parcels to access Long Beach. Additional tenants at Long Beach followed the same lawsuit shortly thereafter. The Town settled this suit before it went to trial. In their decision, the Board of Selectmen wrote “chief among these [factors] was the financial impact to the Town of continuing to litigate both lawsuits. The Board and the Town’s attorneys firmly believe that the lease is lawful in every way, and were optimistic that the Town would prevail at trials... however, the litigation was expected to drag on for several more years, at great expense to all of the Town’s citizens and taxpayers.” See Town of Rockport, “Press Release: Rockport Long Beach Litigation Settlement (Rockport, MA: Town of Rockport, 2018).

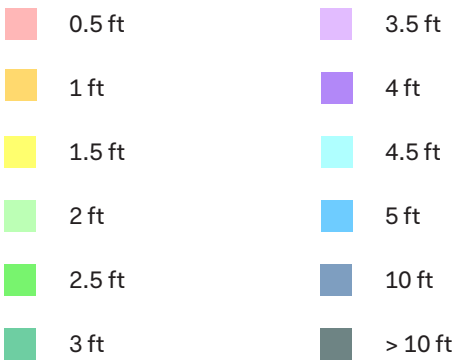
Scenario 2: Sell as Single Parcel

The Town of Rockport sells the parcels, excluding the firebreaks, sidewalk, and roads, to the newly created Long Beach Homeowner’s Association (LBHA). The LBHA then sells the parcels to individual cottages. While the Town of Rockport is finalizing the terms of sale for the seawall to the LBHA, a nor’easter causes significant damages to the remaining portions of the 1931 seawall. The LBHA sues the Town for damages to cottages during the seawall collapse, and the Town sues the LBHA for backing out of the sale. After tensions rise between cottage owners and Rockport residents sitting in the firebreaks during exceptionally high tides when the beach is covered, a group of Rockporters threaten to sue the Town for limiting their access to the public beach.^{1 2} Amidst the stalemate, some cottage owners sell their individual properties as the seawall continues to deteriorate.

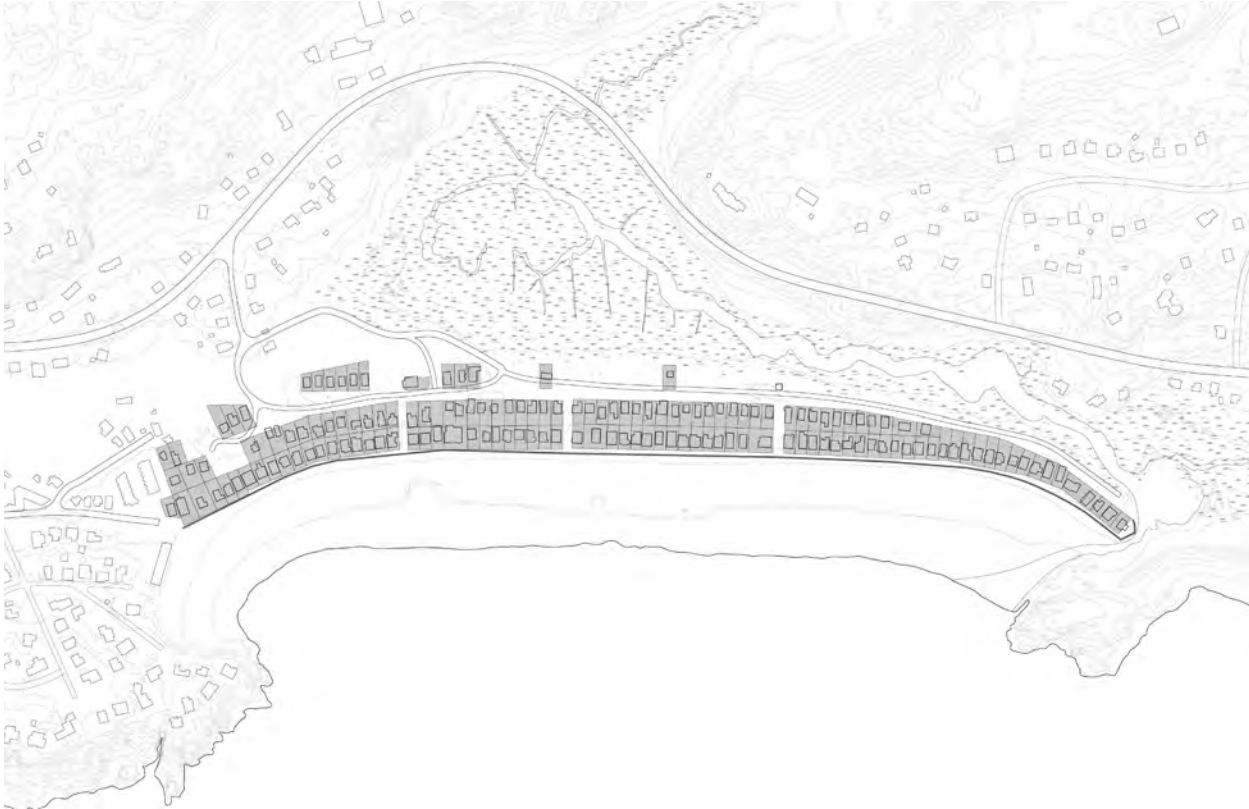
Scenario 2: Sell as Single Parcel



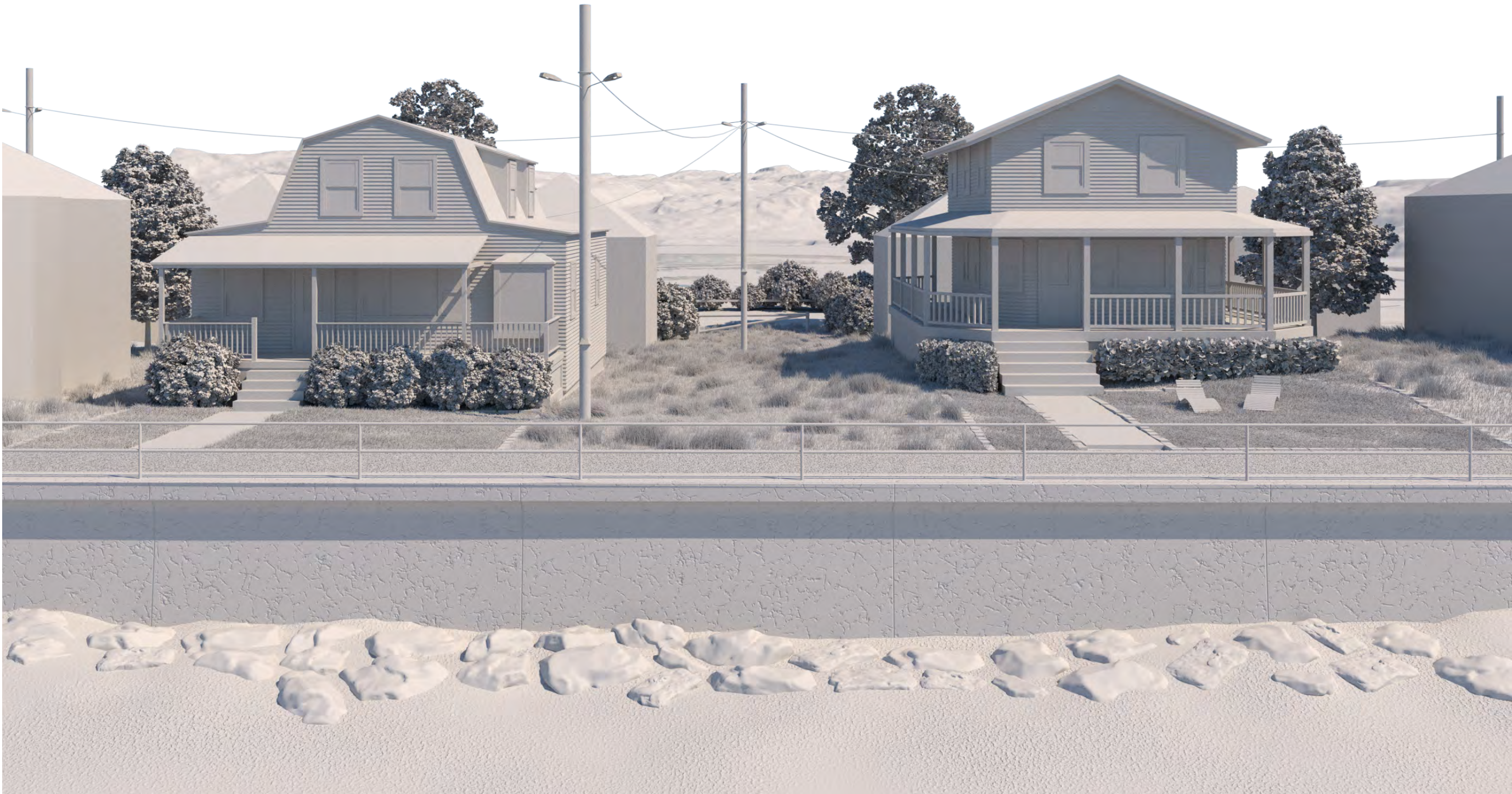
Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2030



2064 Shoreline



The parcels are sold to the Long Beach Homeowner's Association, splitting ownership at Long Beach between the Rockport public and a private group.



This rendering shows no change from Scenario 0. Selling the parcels and seawall will not affect the landscape at Long Beach. APOCATOPIA, “Scenario 2: Sell as Single Parcel,” 2024.

Scenario 3: Renew Landward Leases

After one family takes advantage of Rockport’s amended zoning policy and relocates their cottage to their backyard as an accessory dwelling unit (ADU), the Town of Rockport sets up a series of meetings to discuss managed retreat.¹² These meetings invite cottage owners, local government officials, aging residents looking to sell their land in other areas of Town, and Rockporters interested in purchasing and moving the weatherized cottages into Town as backyard ADUs. Cottages in the FEMA VE floodzone are given five years to demolish their properties or relocate in a rolling easement³ policy with clear guidelines that cottages will be removed when their parcels are overwashed six times during a calendar year, or flooded by more than two feet of standing water for twenty-four hours.

Water level monitors are installed to capture flood conditions throughout the year. The former lawns of the removed cottages are replanted with beach grass. Over the course of five years, cottages are gradually removed. When a powerful nor’easter floods the remaining cottages and damages the seawall, it is removed, and the dune system is reshaped.⁴ The dune protects the remaining second row cottages, which will remain until sea level rise or storm surge pushes them out.

land use but prevent shore protection of coastal lands through regulation, or by transferring any right to armor the coast from owners inclined to do so to organizations that will not. This approach enables ecosystems to migrate inland and avoids the costs and hazards of protecting low lands. This strategy includes local zoning that restricts shore protection, regulations that prohibit shore protection or require removal of structures on beaches and in wetlands. These strategies can be paired with property rights approaches including affirmative easements, conservation easements, restrictive covenants, migrating property lines that move as the shore erodes, and transferable development rights. Rolling easements can preserve beaches and other eroding shores, preserve public access along the shore, help wetlands to migrate inland, and facilitate the landward relocation of roads and other infrastructures. See James G. Titus, *Rolling Easements* (Washington, D.C.: EPA, 2011).

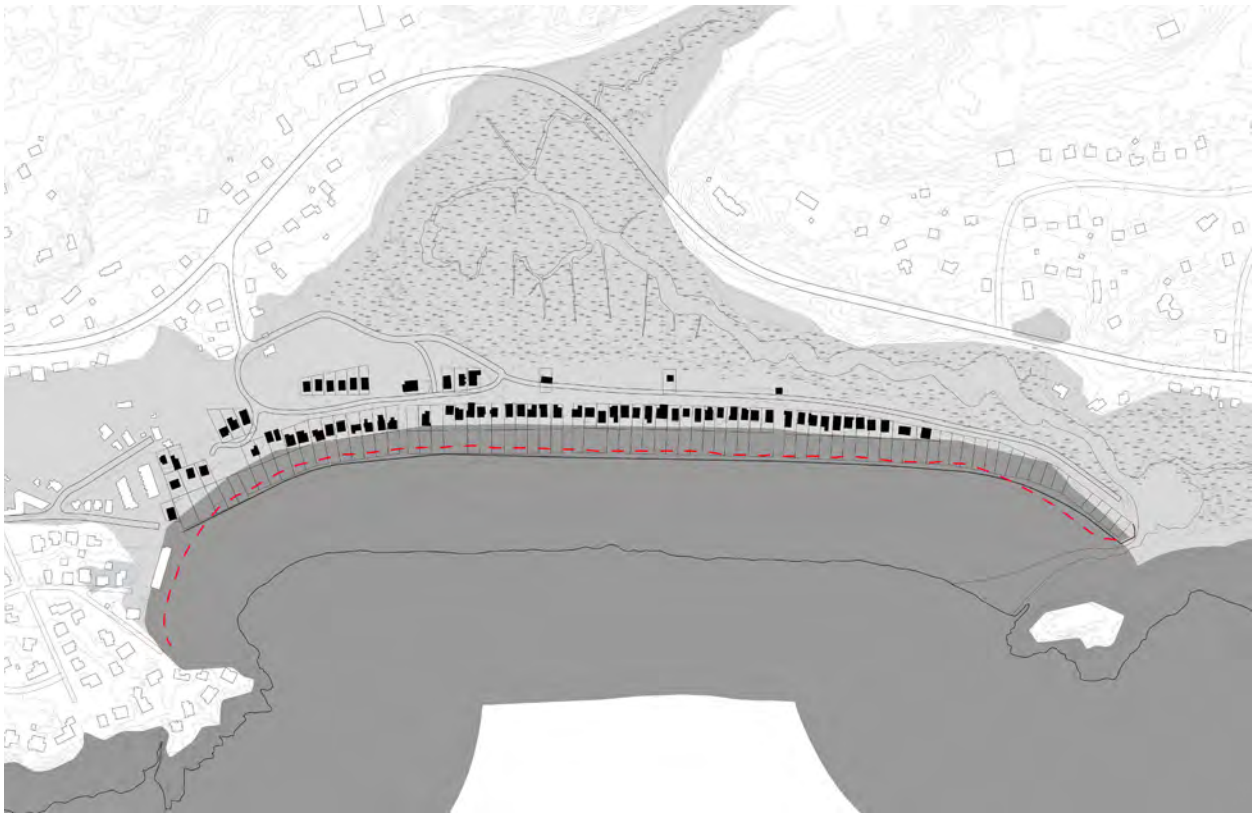
⁴ Another option for managed retreat is a sea level purchasing option (SLPO). A SLPO can be structured similar to a life estate, in which the owner may choose to stay as long as they want, or until a specific number of flood events is reached, but they cannot sell or pass the property to their family. Instead, the property will be transferred to the Town of Rockport for disposal or removal at the end of the owner’s lifetime. See Richard T. Henderson, “Sink or Sell: Using Real Estate Purchase Options to Facilitate Coastal Retreat,” *Vanderbilt Law Review* 72, no. 2 (2018).

¹ Peter Plastrik and John Cleveland define three types of retreat: traumatic post-disaster retreat, chaotic, market-driven retreat, and forward-looking planned retreat. Forward-looking planned retreat, or managed retreat is a group of practices and strategies to reduce risk and relocate people from the floodplain overtime. As climate adaptation Professor and lawyer AR Siders writes, “Managed Retreat can be transformational by “changing perceptions, anrratives, and norms about climate adaptation. Specifically, retreat may change social discourse by embodying climate risks, creating empathy, and questioning techno-optimistic approaches to adaptation” like reconstructing the seawall. In the case of Long Beach, discussing retreat can turn climate risks and adaptation into immediate and personal experiences, instead of abstract and distant events. See Peter Plastrik and John Cleveland, *Can It Happen Here? Improving the Prospect for Managed Retreat by US Cities* (Innovation Network for Communities and Summit Foundation, 2019) and AR Siders, Idowu Ajibade, and David Casagrande, “Transformative potential of managed retreat as climate adaptation,” *Current Opinion in Environmental Sustainability* 50 (2021): 272-280.

² Professor and lawyer AR Siders gave a webinar presentation to the Long Beach Option Committee. A newspaper article summarizing her talk is available online, see Michael Cronin, “Long Beach Option Committee learns more about managed retreats,” Gloucester Daily Times, January 28, 2022. Another webinar in which Siders answers specific questions about managed retreat is available through America Adapts. See America Adapts, “Everything you wanted to know about Managed Retreat (but were afraid to ask)” with Dr. AR Siders, *Youtube*, www.youtube.com/watch?v=gtDn_xQVyjc

³ Easements are property interests that enable someone other than the owner of a property to use the land in a specific way. Rolling easements are a broad group of approaches for migrating inland, including removing buildings, roads, and other structures from land as it becomes submerged. The easement “rolls” upland as sea level rise and coastal erosion cause coastline encroachment. Rolling easements do not restrict

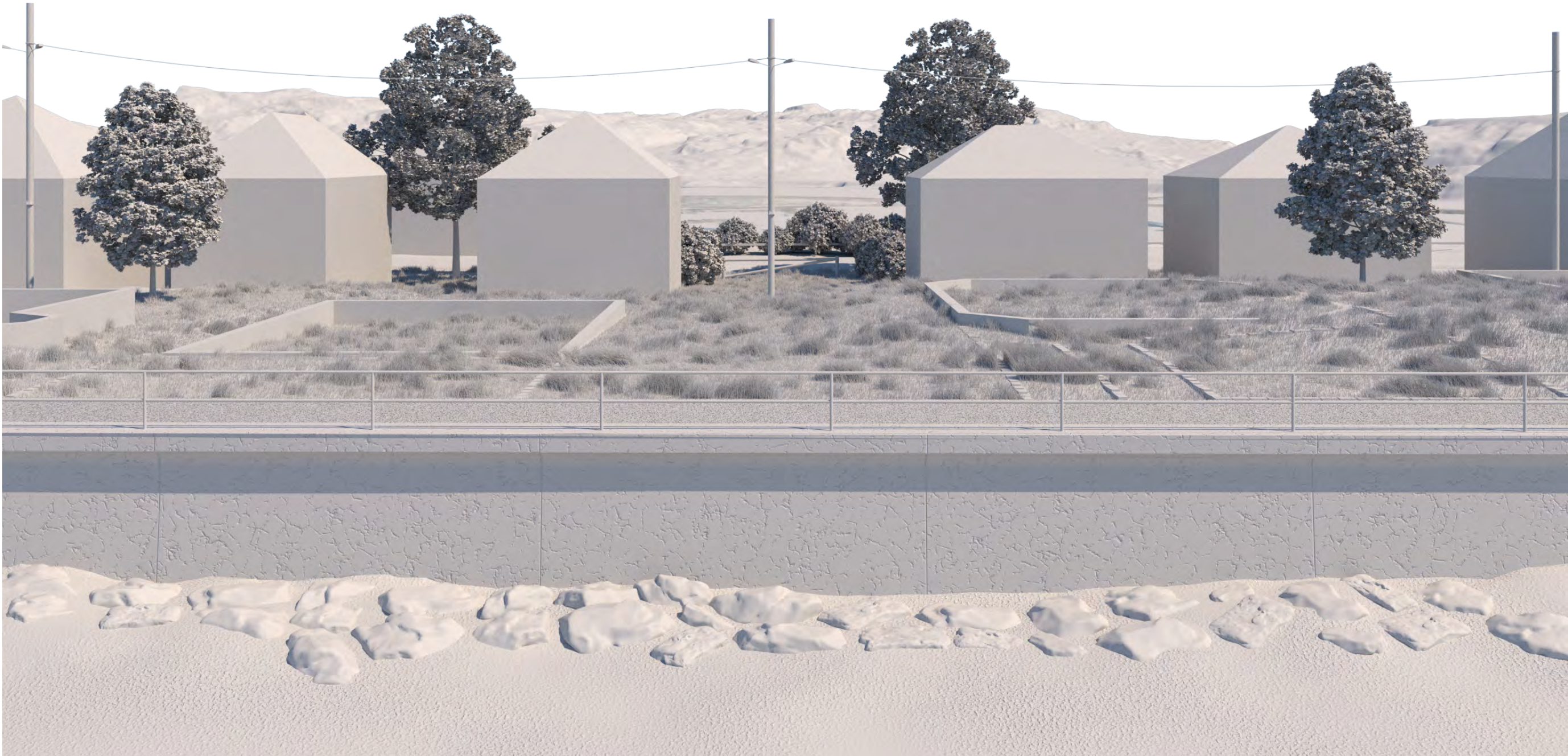
Scenario 3: Renew Landward Leases



- Cottages remaining after 5 years
- Zone AE (Elevation 14)
- Zone VE (Elevation 18)
- 2034 Shoreline



Phased retreat begins at Long Beach, beginning with the removal of cottages in the FEMA VE floodplain. Clear guidance is issued, allowing homeowners the time to find parcels to relocate their cottages or to demolish them.



This rendering shows the front row of cottages in the FEMA VE floodplain removed. APOCATOPIA, “Scenario 3: Renew Landward Leases,” 2024.

Scenario 4: Relocate the Cottages

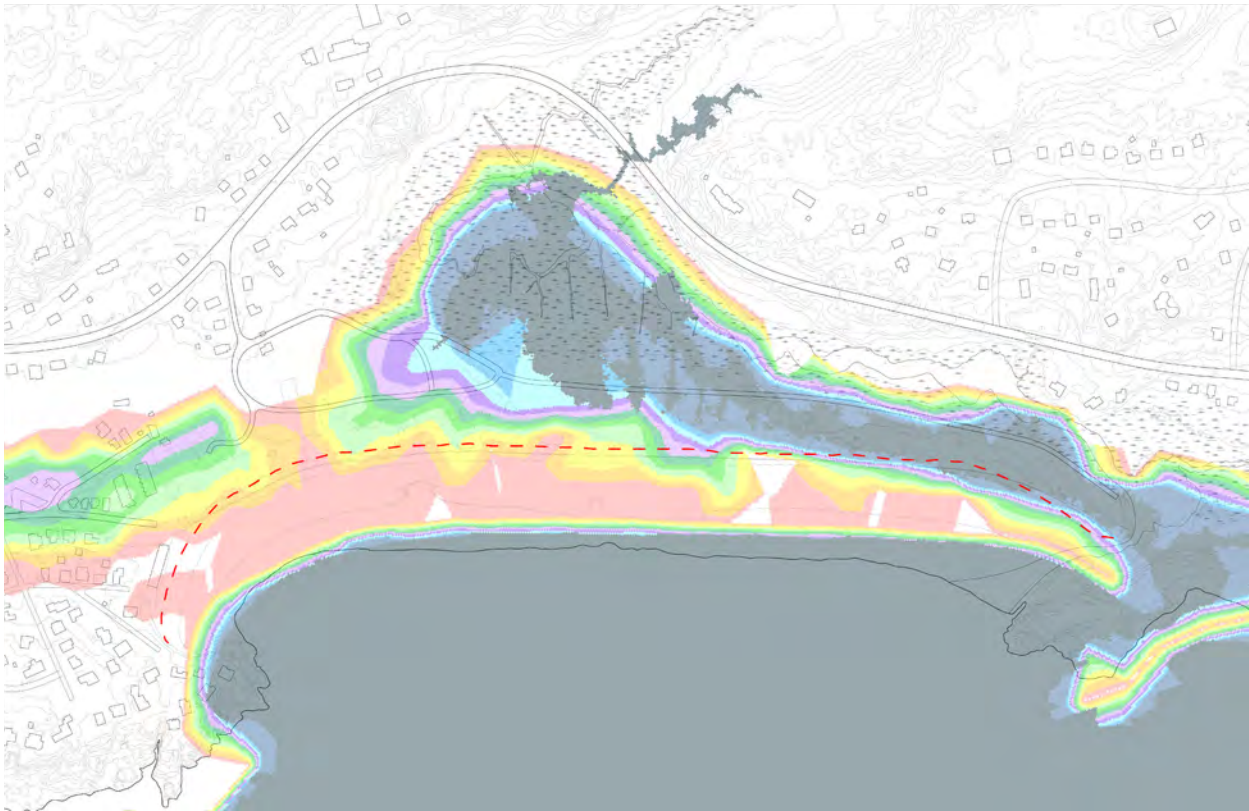
The Rockport Board of Selectmen receive an estimate to reconstruct the seawall above the design flood elevation¹ and decide to terminate the Long Beach leases through a 4/5 vote due to a lack of funds in 2026.² After one family takes advantage of Rockport's amended zoning policy and relocates their cottage to their backyard as an accessory dwelling unit (ADU),³ the Town of Rockport sets up a series of meetings to discuss managed retreat. These meetings invite cottage owners, local government officials, aging residents looking to sell their land in other areas of Town, and Rockporters interested in purchasing and moving the weatherized cottages into Town as backyard ADUs. The cottage owners have two years to relocate the structures off their Long Beach parcels, at which point the remaining cottages are demolished and removed from site, followed by the seawall and buried infrastructural systems. The parcels are reshaped into a dune system that moves with the seasons, preserving beach access for future generations of Rockporters.

¹The Design Flood Elevation is the anticipated flood elevation to which an asset, such as a building or seawall, should be designed to protect the asset. The design flood elevation is developed considering the amount of freeboard, or distance above flood level, and wave height during storms. Therefore, the design flood elevation increases overtime to account for sea level rise. The typical life for a seawall or other coastal resilience infrastructure is 50 years, therefore the Long Beach seawall and cottages should use a DFE that meets the 2070 time horizon at a minimum. The DFE adds 24" of freeboard, or floodable space, for critical facilities, infrastructure, and buildings with residential ground floor buildings. In buildings that are prone to flooding, such as the Long Beach cottages, utilities should be elevated above the design flood elevation. This includes domestic hot water heaters, electrical equipment, conduits, panels, wiring, generators, and air conditioning units. See City of Boston, *Climate Resilience Design Standards & Guidelines* (Boston, MA: City of Boston, 2018).

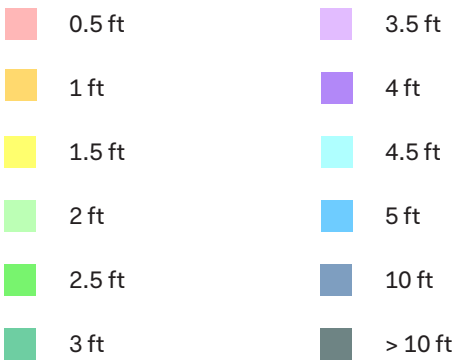
²Ending the leases is an example of a "No Adverse Impact" floodplain management approach. According to the Massachusetts Office of Coastal Zone Management, No Adverse Impact (NAI) is a "forward-thinking, fair, and legally defensible approach to coastal land management." NAI is a set of "do no harm" principles to protect the rights of residents, businesses, and visitors in the community by requiring that public and private projects are completed so they do not: pose a threat to public safety; increase flood or storm damage to public or private property; strain municipal budgets by raising community expenditures for storm-damage mitigation, stormwater management, emergency services, and disaster recovery efforts. These principles help to reduce the number of lawsuits filed against local governments and greatly increase the chances that local governments win legal challenges to their floodplain management practices. See Office of Coastal Zone Management, *Introduction to No Adverse Impact (NAI) Land Management in the Coastal Zone* (Boston, MA: Massachusetts Office of Coastal Zone Management, 2022).

³Like other communities across the country, the Town of Rockport has a housing crisis. In 2022, the Town of Rockport amended its Zoning By-Laws to streamline the process of developing accessory dwelling units (ADUs) in Rockport.

Scenario 4: Relocate the Cottages



Flood Depths during a Coastal Flooding Event with a 1% Annual Coastal Flood Exceedance Probability (ACFEP) in 2030



2064 Shoreline



The cottages are removed from Long Beach over a period of two years.



This rendering shows the process of relocating the cottages before deconstructing the seawall. APOCATOPIA, “Scenario 4: Relocate the Cottages,” 2024.

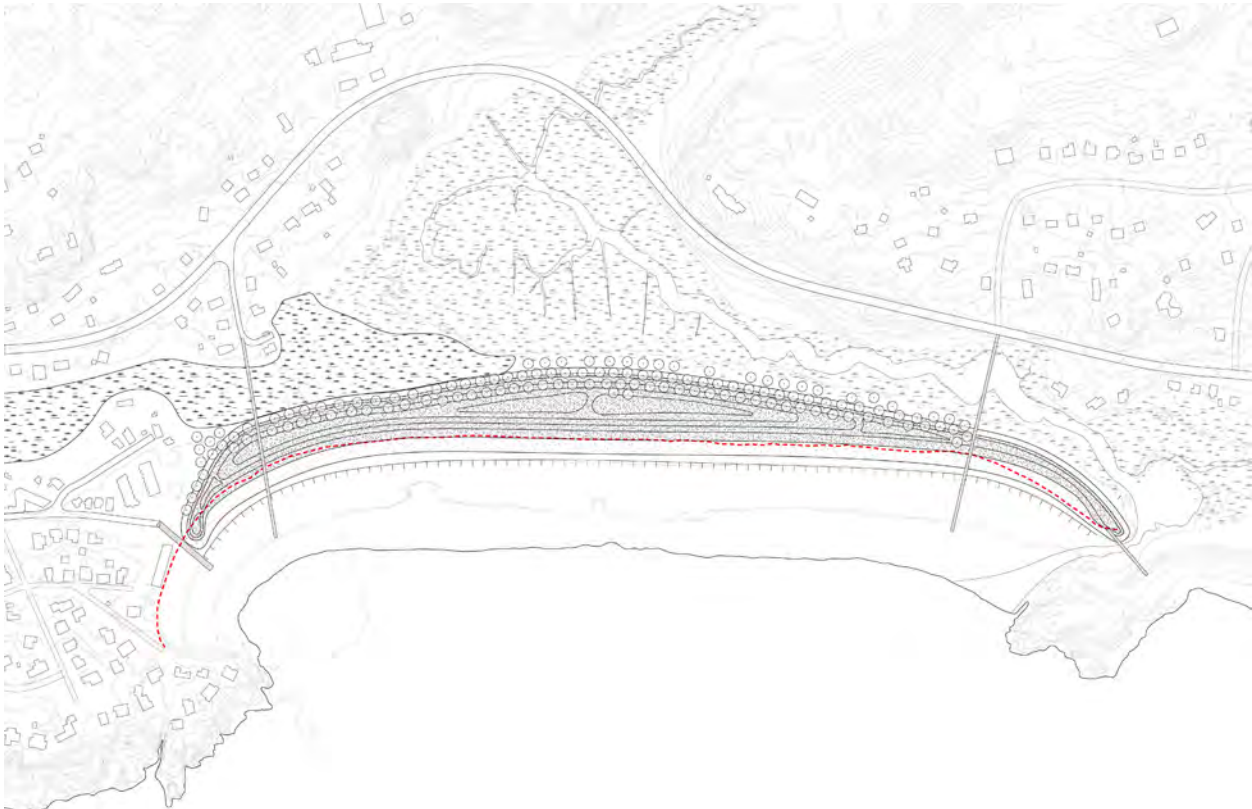
¹Depaving involves removing asphalt from roadways and regrading them into blue streets. Blue streets channel water during flood events, and are gradually divested. Individual vehicle owners assume responsibility for additional damage to their cars. See Sasaki, “Designing with Water: Creative Solutions from Around the Globe,” *Preparing for the Rising Tide Series* 2 (August 2014).

²Ditches can be filled using saltmarsh grasses. An ongoing ditch remediation project in Ipswich has demonstrated how ditch remediation can preserve habitat and buffer wave energy. See “Saving the Great Marsh: Ditch Remediation, Habitat Preservation and Resilience Building at the Landscape Scale,” *Trustees*, December 6, 2022, www.onthecoast.thetrustees.org/great-salt-marsh-restoration

Scenario 5: Restore the Ecosystem

The cottages are removed, followed by the seawall, buried utilities, and roads, which are depaved.¹ The dune system is regraded, and boardwalks are constructed to bring beachgoers from Cape Hedge Beach across the Saratoga Creek and through the dunes without trampling the newly planted beachgrasses and seaside plant communities. The marsh ditches are filled,² and the marsh exchanges sediment with the dune, lessening the impacts of sea level rise on the grasses. Buses from downtown Gloucester and Rockport bring the public to the beach, which changes shape during the summer and winter months.

Scenario 5: Restore the Ecosystem



2064 Shoreline

0 125 250 500
FEET



Access boardwalk

Restored dune complex

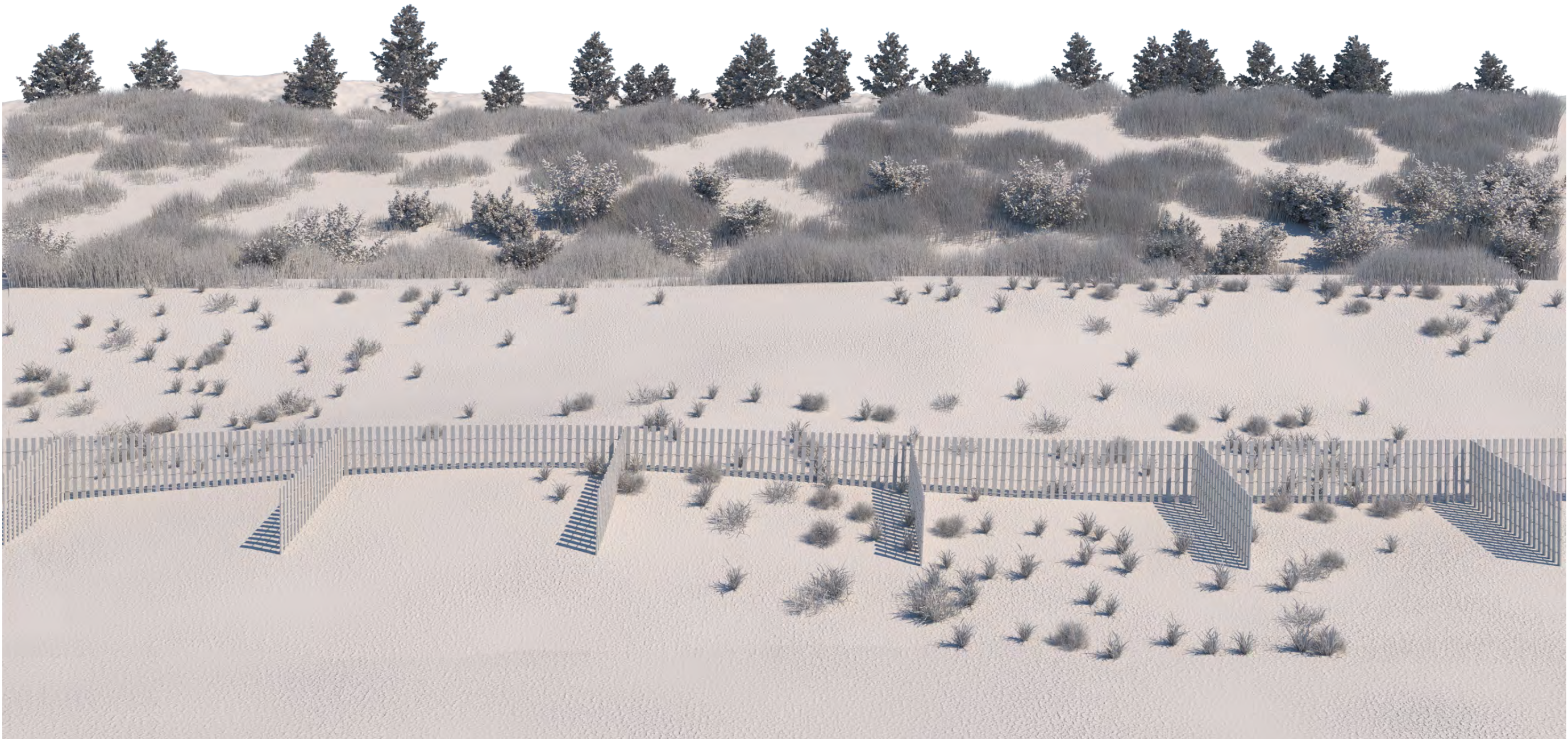
American beachgrass (*Ammophila breviligulata*)

Planted pitch pine, beach plum, bayberry buffer (*Pinus rigida*, *Prunus maritima*, and *Myrica pensylvanica*)

0 125 250 500
FEET



The dune system is restored at Long Beach. Dune grass and a robust coastal forest protect inland areas from storm surge.



This rendering shows the restored dune ecosystem at Long Beach after the cottages and supporting infrastructure systems are removed. APOCATOPIA, “Scenario 5: Restore the Ecosystem,” 2024.

Scenario Plans 0-2

Renew

Scenario

0: Renew and Do Nothing

The front row of cottages in the FEMA VE floodplain are susceptible to flooding when waves overtop the seawall in strong storms. The southwesterly ends of Old County Road floods during high tides, and there is no vehicle access to Long Beach or Old County Roads during storms.

Increasing power outages are reported at Long Beach due to tree branches blown down by higher winds during increasingly powerful storms. Cottage owners purchase generators as a backup supply of power.

The Sewer Pump Station floods regularly at high tides. Powerful storms disrupt the Gloucester Wastewater Treatment Plant, dumping untreated sewage into the ocean. Erosion around the manhole continues to accelerate, exposing the sewer main at Long Beach.

The southwestern end of Old County Road floods regularly during high tides. Old County and Long Beach Roads flood during storms, limiting access to cottages. Thatcher Road in Gloucester is flooded at increasing intervals, closing the primary emergency evacuation route from Long Beach.

The seawall continues to scour Long Beach, increasing the rate of erosion. Storms frequently overtop the seawall, flooding the front row of cottages. The 1931 portions of the seawall topple and collapse early during a storm. Waves batter and damage the front row of cottages irreparably.

Water bans are imposed due to drought-induced water shortages during peak summer months.

Beach erosion accelerates as the base of the seawall is exposed during increasingly frequent storms. By 2033, the beach is covered by water and inaccessible at high tide.

Lawns and ornamental plants are increasingly stressed by higher temperatures and longer periods of drought. Salt-tolerant ruderal species, including beach rose, as well as bittersweet and poison ivy, grow on the firebreaks and between cottages.

High marsh grass converts to low marsh grass steadily as sea level rises each year. Phragmites stands are pushed inland to the edges of Thatcher Road due to rising salinity.

The low marsh grass on the sides of the creek banks is denuded by green crabs. The lack of vegetation exacerbates the erosion of the tidal channel during storm surges.

The Town of Rockport owns and stewards the beach, dune, and Saratoga marsh.

The cottages are owned by individuals and trusts.

The Town of Rockport owns the parcels and leases them to individual cottage owners. The parcel leases are not increased by more than 4% each year.

The Town of Rockport owns and maintains the seawall.

Cottages and parcels may only be accessed by cottage owners and guests between April and December 1. The beach, seawall, sidewalk, firebreaks, and bridge to Cape Hedge Beach are always publicly accessible.

Scenario

1: Renew and Repair

DEFEND: The front row of cottages are defended against storm surge by the extended seawall. Old County and Long Beach Roads flood more frequently as water overtops the marsh during storms and high tides, sometimes flooding the back row of cottages.

DOUBLE UP: Secondary wooden braces are installed to reinforce electric poles along Thatcher Road and throughout Long Beach.

ELEVATE AND BUFFER: The Sewer Pump Station is elevated above the design flood elevation. A gabion wall is constructed and living shoreline planted around the manhole cover. Storms continue to disrupt the Gloucester Wastewater Treatment Plant despite these improvements.

ELEVATE: Long Beach and Old County Roads are depaved to gravel and allowed to flood. Cottage owners are responsible for vehicle upgrades and maintenance, and park in the field next to the Long Beach Association. Thatcher Road is elevated across the Saratoga Marsh.

The seawall is elevated above the FEMA 100-year storm projection, yet a powerful winter storm overtops the seawall just two years after construction is finished, flooding the front row of cottages. The rate of scouring increases as the base of the seawall is exposed.

0: Water bans are imposed due to drought-induced water shortages during peak summer months.

BUFFER: 50,000 cubic yards of upland sand is dumped onto the center of the beach in front of the seawall, and widens the beach profile for five years. Depleted upland sand resources and increasingly stringent permitting regulations do not allow for a second nourishment.

BUFFER: American beach grass and other native, halophytic species replace lawns and ornamental gardens. Pesticides and herbicides are banned on Long Beach to reduce chemical runoff into the ocean.

BUFFER: The straight ditches dug through the marsh are filled and planted with plugs of high marsh grasses.

0: The low marsh grass on the sides of the creek banks is denuded by green crabs. The lack of vegetation exacerbates the erosion of the tidal channel during storm surges.

0: The Town of Rockport owns and stewards the beach, dune, and Saratoga marsh.

0: The cottages are owned by individuals and trusts.

0: The Town of Rockport owns the parcels and leases them to individual cottage owners. The parcel leases are not increased by more than 4% each year.

0: The Town of Rockport owns and maintains the seawall.

0: Cottages and parcels may only be accessed by cottage owners and guests between April and December 1. The beach, seawall, sidewalk, firebreaks, and bridge to Cape Hedge Beach are always publicly accessible.

Sell

Scenario

2: Sell as Single Parcel

1: DEFEND: The front row of cottages are defended against storm surge by the extended seawall. Old County and Long Beach Roads flood more frequently as water overtops the marsh during storms and high tides, sometimes flooding the back row of cottages.

0: Increasing power outages are reported at Long Beach due to tree branches blown down by higher winds during increasingly powerful storms. Cottage owners purchase generators as a backup supply of power.

0: The Sewer Pump Station floods regularly at high tides. Powerful storms disrupt the Gloucester Wastewater Treatment Plant, dumping untreated sewage into the ocean. Erosion around the manhole continues to accelerate, exposing the sewer main at Long Beach.

0: The southwestern end of Old County Road floods during high tides. Old County and Long Beach Roads flood during storms, limiting access to cottages. Thatcher Road in Gloucester is flooded at increasing intervals, closing the primary emergency evacuation route from Long Beach.

0: The seawall continues to scour Long Beach, increasing the rate of erosion. Storms frequently overtop the seawall, flooding the front row of cottages. The 1931 portions of the seawall topple and collapse early during a storm. Waves batter and damage the front row of cottages irreparably.

0: Water bans are imposed due to drought-induced water shortages during peak summer months.

0: Beach erosion accelerates as the base of the seawall is exposed during increasingly frequent storms. By 2033, the beach is covered by water and inaccessible at high tide.

0: Lawns and ornamental plants are increasingly stressed by higher temperatures and longer periods of drought. Salt-tolerant ruderal species, including beach rose, as well as bittersweet and poison ivy, grow on the firebreaks and between cottages.

0: High marsh grass converts to low marsh grass steadily as sea level rises each year. Phragmites stands are pushed inland to the edges of Thatcher Road due to rising salinity.

0: The low marsh grass on the sides of the creek banks is denuded by green crabs. The lack of vegetation exacerbates the erosion of the tidal channel during storm surges.

The beach and marsh are owned and stewarded by the Town of Rockport. The dune, including the firebreaks, parcels, and seawall, is owned by the Long Beach Home Owners Association (HOA).

0: The cottages are owned by individuals and trusts.

The parcels are owned by the Long Beach Home Owners Association (HOA), which may survey, appraise, and sell cottages to individual owners.

The Town of Rockport sells the seawall to the Long Beach Home Owners Association (HOA).

Cottages and parcels may only be accessed by cottage owners and guests. The beach, seawall, sidewalk, firebreaks, and bridge to Cape Hedge Beach are always publicly accessible.

This matrix describes the different infrastructural, ecological, access, and ownership considerations in each scenario, and compares them.

Infrastructure SystemsEcological SystemsAccessOwnership

Housing Cottages
Electric Powerlines
Wastewater Pump and Lines
Transportation Roads
Resilience Seawall
Water Mains
Terrestrial Beach
Terrestrial Dune
Estuarine Marsh
Estuarine Tidal Creek
Beach, Dunes, Marsh
Cottages
Parcels
Seawall
Public and Private

Scenario Plans 3-5

Retreat

Scenario 3: Renew Landward Leases

RELOCATE: The cottages are inspected. Structurally sound buildings in the FEMA VE zone are relocated on flatbed trucks to their owners' lots, to residents of Rockport as accessory dwelling units (ADUs), or to open land on Cape Ann. Structurally insufficient buildings are demolished.

Power lines in the FEMA VE flood zone are removed.

0: The Sewer Pump Station floods regularly at high tides. Powerful storms disrupt the Gloucester Wastewater Treatment Plant, dumping untreated sewage into the ocean. Erosion around the manhole continues to accelerate, exposing the sewer main at Long Beach.

MONITOR: The southwestern end of Old County Road floods during high tides. Old County and Long Beach Roads flood during storms, limiting access to remaining cottages. A tidal gauge is installed, and the roads are depaved after 45 flood events during a single year.

REMOVE: The seawall is removed after the cottages in the FEMA VE zone are relocated, and the sand behind the former seawall is regraded and replanted into a dynamic dune system that shifts with the seasons.

0: Water bans are imposed due to drought-induced water shortages during peak summer months.

0: Beach erosion accelerates as the base of the seawall is exposed during increasingly frequent storms. By 2033, the beach is covered by water and inaccessible at high tide.

RESTORE: The parcels where cottages have been removed are replanted with American beach grass, goldenrod, and other native halophytic foredune species to stabilize the soil after the impervious seawall, road, driveways, and patios are removed.

0: High marsh grass converts to low marsh grass steadily as sea level rises each year. Phragmites stands are pushed inland to the edges of Thatcher Road due to rising salinity.

0: The low marsh grass on the sides of the creek banks is denuded by green crabs. The lack of vegetation exacerbates the erosion of the tidal channel during storm surges.

0: The Town of Rockport owns and stewards the beach, dune, and Saratoga marsh.

Individuals and trusts own the cottages that are not removed. Removed cottages are sold individually and relocated on flatbed trucks, some to residents of the town of Rockport as assisted dwelling units (ADUs) and others relocated to open land on Cape Ann.

The Town of Rockport owns the parcels and leases them to the remaining cottage owners. The parcel leases are not increased by more than 4% each year.

0: The Town of Rockport owns and maintains the seawall.

Remaining cottages and parcels may only be accessed by cottage owners and guests between April and December 1. The beach, dune boardwalks, and bridge to Cape Hedge Beach are always publicly accessible.

Scenario 4: Relocate the Cottages

RELOCATE: The cottages are inspected. Structurally sound buildings are removed on flatbed trucks to be relocated to their owners' lots, to residents of Rockport as assisted dwelling units (ADUs), or to open land on Cape Ann. Structurally insufficient buildings are demolished.

REMOVE: Power lines are removed on Long Beach.

REMOVE: The wastewater treatment pipes are excavated and removed from Long Beach. The sewer pump station is then deconstructed.

REMOVE: Long Beach and Old County Roads are depaved and planted with native halophytic phytoremediating species. Thatcher Road is elevated across the Saratoga Marsh to ensure Rockport's primary evacuation route is accessible during storms.

REMOVE: The seawall is removed after the cottages are relocated, and the sand behind the former seawall is regraded and replanted into a dune system that shifts with the seasons.

REMOVE: The water mains are excavated and removed from Long Beach.

BUFFER: The dune and beach are a dynamic system in which the beach profile changes during the winter and summer months. The rate of erosion on Long Beach slows, and the beach shifts inland into the area formerly occupied by the dune overtime.

RESTORE: The dune is replanted with a community of American beach grass, goldenrod, and other native halophytic foredune species to stabilize the soil after the impervious seawall, road, driveways, and patios are removed.

0: High marsh grass converts to low marsh grass steadily as sea level rises each year. Phragmites stands are pushed inland to the edges of Thatcher Road due to rising salinity.

0: The low marsh grass on the sides of the creek banks is denuded by green crabs. The lack of vegetation exacerbates the erosion of the tidal channel during storm surges.

0: The Town of Rockport owns and stewards the beach, dune, and Saratoga marsh.

Cottages are removed and sold individually and relocated on flatbed trucks, some to residents of the town of Rockport as assisted dwelling units (ADUs) and others relocated to open land on Cape Ann.

After the cottages are removed, the dune is no longer parcelized. The Town of Rockport owns the dune.

The seawall is crushed and the concrete debris is removed from Long Beach.

Long Beach is public. The sandy beach, boardwalks over the restored dune, and bridge to Cape Hedge Beach are always publicly accessible.

Sell

Scenario 5: Restore the Ecosystem

RELOCATE: The cottages are inspected. Structurally sound buildings are removed on flatbed trucks to be relocated to their owners' lots, to residents of Rockport as assisted dwelling units (ADUs), or to open land on Cape Ann. Structurally insufficient buildings are demolished.

4: REMOVE: Power lines are removed on Long Beach.

4: REMOVE: The wastewater treatment pipes are excavated and removed from Long Beach. The sewer pump station is then deconstructed.

4: REMOVE: Long Beach and Old County Roads are depaved and planted with native halophytic phytoremediating species. Thatcher Road is elevated across the Saratoga Marsh to ensure Rockport's primary evacuation route is accessible during storms.

4: REMOVE: The seawall is removed after the cottages are relocated, and the sand behind the former seawall is regraded and replanted into a dune system that shifts with the seasons.

4: REMOVE: The water mains are excavated and removed from Long Beach.

4: BUFFER: The dune and beach are a dynamic system in which the beach profile changes during the winter and summer months. The rate of erosion on Long Beach slows, and the beach shifts inland into the area formerly occupied by the dune over time.

4: RESTORE: The dune is replanted with a community of American beach grass, goldenrod, and other native halophytic foredune species to stabilize the soil after the impervious seawall, road, driveways, and patios are removed.

BUFFER AND RESTORE: The straight ditches dug through the marsh are filled and planted with plugs of high marsh grasses. Volunteers weed purple loosestrife, Phragmites, and other species.

DEFEND: A living shoreline is established with reef balls to support the banks of the tidal creek from calving and create habitat for fish in the Saratoga Creek estuary. Volunteers harvest green crabs during molting season and remove them from the marsh.

0: The Town of Rockport owns and stewards the beach, dune, and Saratoga marsh.

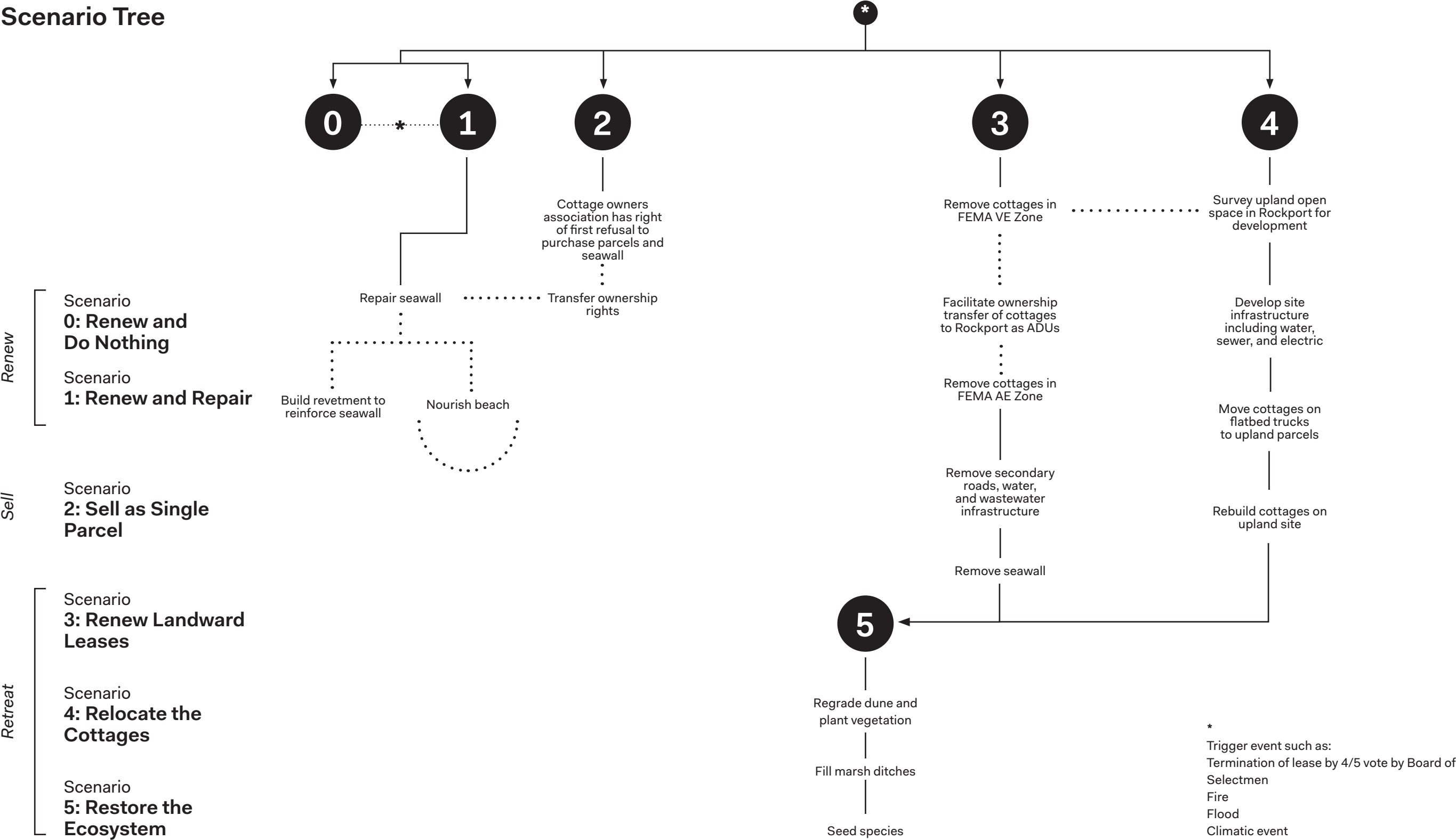
4: Cottages are removed and sold individually and relocated on flatbed trucks, some to residents of the town of Rockport as assisted dwelling units (ADUs) and others relocated to open land on Cape Ann.

4: After the cottages are removed, the dune is no longer parcelized. The Town of Rockport owns the dune.

4: The seawall is crushed and the concrete debris is removed from Long Beach.

4: Long Beach is public. The sandy beach, boardwalks over the restored dune, and bridge to Cape Hedge Beach are always publicly accessible.

Scenario Tree



Renew		Sell	Retreat		
Scenario 0: Renew and Do Nothing	Scenario 1: Renew and Repair	Scenario 2: Sell as Single Parcel	Scenario 3: Renew Landward	Scenario 4: Relocate the Cottages	Scenario 5: Restore the Ecosystem
					

These renderings show the six scenarios proposed to generate discussion over the future of Long Beach.

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