





COASTAL EROSION

CHAPTER 4.2

Coastal erosion plays a significant role in New York City's retreating coastlines. It also amplifies the city's vulnerability to a variety of hazards including coastal storms, which deplete natural resources, damage infrastructure and expose New Yorkers to the risk of physical harm as well as economic hardship.

WHAT IS THE HAZARD?

In its natural state, our coastline is in dynamic equilibrium. Wind and waves move sand and sediment from one location to another, and what is eroded is replaced with sand and sediment from somewhere else. Coastal storms may remove significant amounts of sand, creating steep, narrow beaches. As long as sand and sediment are not removed from the entire system during storms, waves will return them during calmer periods, widening beaches and creating gentle slopes.

However, human activities such as dredging, construction, and land use management may permanently remove sand and sediment. In some cases, even ill-conceived erosion control structures built to prevent erosion in one location may actually increase it in adjacent locations by blocking sand movement, deflecting or increasing wave energies, and removing vegetation, thus disrupting the natural balance of shoreline change.

Long-term shoreline change can occur gradually or rapidly—as it does during storms. During the most intense storms, entire beaches may be eroded, while other portions of the shoreline, such as bluffs, may become unstable and collapse. How quickly a shoreline erodes can be hard to measure over time, as rates vary from one year to the next and may be masked in areas that undergo periodic beach nourishment. One way that geologists measure erosion is as a rate of shoreline loss per year.

WHAT IS THE RISK?

Erosion has already diminished portions of New York City's 520-mile coastline. While much of the city's coastline is densely developed and engineered, around 30 percent of it consists of parks and recreational areas.

Along our coastline, erosion rates vary significantly depending on the exact location and type of geology. Areas along the city's southern shore are at greatest risk, as they are exposed to wave action from the Atlantic Ocean. Some of the highest erosion rates have been observed near stabilized inlets and engineered structures – like groins or seawalls – that disrupt the natural movement of sand and sediment.

AREAS AT RISK

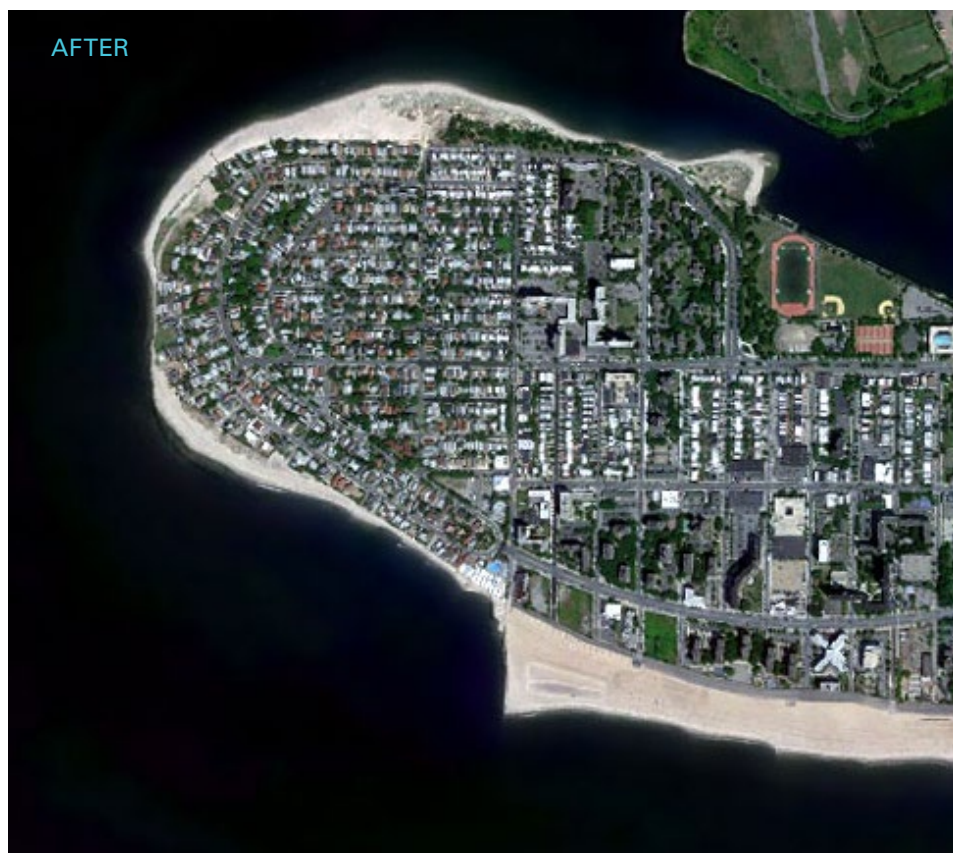
The New York State Department of Environmental Conservation's Coastal Erosion Management Permit Program identifies and regulates areas particularly vulnerable to coastal erosion. The State has identified three such Coastal Erosion Hazard Areas in New York City:

- Coney Island, in Brooklyn
- Rockaway Peninsula, in Queens
- The south shore of Staten Island

SEAGATE GROIN

SOURCE: USACE/BROOKLYNDAILY.COM

Since its construction in 1995 (before photo), the groin that extends into the water perpendicular to the shore, has worsened erosion on the western side (after photo), exposing property, while the beach on the east side has remained intact.





NYC COASTAL EROSION HAZARD AREAS

SOURCE: OEM; NYS DEC (CEHA)



LOCATION OF BUILDINGS IN NYC COASTAL EROSION HAZARD AREAS

SOURCE: OEM; NYS DEC (CEHA)

The New York State Department of Environmental Conservation is currently evaluating and updating the State's Coastal Erosion Hazard Area maps to reflect changes in hazard area boundaries that have occurred since the current maps were developed in the 1980s. These maps will provide a more accurate identification of shoreline features and historical erosion rates than was attainable when the current maps were developed. New maps are currently under development for Coney Island and the south shore of Staten Island, and drafts of these maps are expected to be released for public review in 2015. For the Rockaway Peninsula, the map revision process will begin after the U.S. Army Corps of Engineers (Army Corps) completes the ongoing beach restoration project in late 2014.

Erosion occurs at a much faster rate during coastal storms, when large sections of beaches, dunes, and bluffs may be lost in a matter of days or even hours. For example, according to the Army Corps, 3.5 million cubic yards of sand in the Rockaway Peninsula and 679,000 cubic yards of sand in Coney Island were lost during Hurricane Sandy.

VULNERABILITY

Coastal erosion can damage public and private property and infrastructure because it brings the water's edge closer. Unchecked, erosion may eventually result in structures becoming flooded or the ground beneath them giving way. This could undermine foundations, resulting in structural failure or collapse.

GIS analysis shows approximately 1,428 acres and roughly 135 buildings and other structures located within New York City's Coastal Erosion Hazard Areas. The majority of these structures, with the exception of one hotel complex on the Rockaway Peninsula, are not permanently occupied or of high market value (for example, they include public bathrooms and beach concession stands). But as natural buffers and recreational areas – such as wetlands, dunes, beaches, bluffs, sand bars, and barrier islands or spits – are eroded, the Coastal Erosion Hazard Area boundaries may migrate landward, putting structures not currently threatened at greater risk. Significantly, those natural features also protect property and structures from other hazards such as storm surge and wave action.



SHORELINE CHANGE IN ANNADALE, STATEN ISLAND 1924-2012

SOURCE: NYC DOITT (IMAGERY), NYC OEM

Sea level rise is expected to worsen coastal erosion, especially during significant storms. According to the New York City Panel on Climate Change, sea level around New York City has risen 1.1 feet since 1900 and is projected to rise up to an additional 2.5 feet by 2050. However, it is not currently possible to determine exactly how much erosion is directly attributable to sea level rise.

HOW DO WE MANAGE THIS RISK?

Much of our shoreline has already been engineered to protect against erosion. However, areas highlighted on the map still face a chronic threat. Much of our shoreline is owned and managed by public entities, although several private sector parties also play roles. An integrated approach for managing coastal erosion risks involves a combination of major structural protections, environmental controls, and regulatory and policy controls. The following section identifies a sampling of the strategies.

MAJOR STRUCTURAL PROTECTIONS

As mentioned above, structures intended to prevent erosion may in fact increase it. But in many cases, such structures remain the only feasible option for significantly reducing erosion and flooding during major storms, given the financial and political realities of the real estate landscape and environmental concerns. Engineered structures that are properly sited and sized, on the shore or in the water, can help limit the forces of coastal erosion and hold the shoreline in place. Which kind of structure to build depends on the specific features of the location.

On-shore structures

- **Seawalls** are massive stone, rock, or concrete structures built parallel to the shoreline and designed to hold the shoreline in place while resisting the force of waves and erosion.
- **Revetments** are structures typically made of stone rubble or concrete blocks (also known as riprap)



GROINS ALONG THE ROCKAWAY PENINSULA

SOURCE: NYC DCP, 2013

placed on a sloped surface to protect underlying soil from erosion and to reduce wave forces.

- **Bulkheads** are vertical retaining walls, typically made of wood or sheet steel, intended to hold soil in place and allow for a stable shoreline.

In-water structures

- **Groins** are structures that extend perpendicular from the shore into the water to trap sand, prevent erosion, and break waves.
- **Breakwaters** are offshore structures parallel to the shoreline that are typically made of rock. By breaking waves, they reduce erosive forces on the shoreline.
- **Artificial reefs** are fully or partially submerged structures made of rock, concrete, or other materials that are designed to break waves, reduce erosive forces on the shoreline, and provide marine habitat.

As a result of collaborations among New York City, the Army Corps, and the New York State Department of Environmental Conservation, many engineered erosion-control structures are in place along our coastline. For example, along the Rockaway Peninsula, groin construction began between 1922 and 1927, and today there are 48 groins in Jacob Riis Park/Fort Tilden towards the western end of the peninsula. There are also series of bulkheads and riprap revetments along inland waterways like the East River.

Other areas targeted for such measures include Riker's Island in the East River – where the City's Department of Corrections is designing a project to harden the erosion-prone northern shoreline – and Plumb Beach in Brooklyn, where the Army Corps, in partnership with the City's Department of Parks and Recreation, is completing the construction of groins and a breakwater to protect the Belt Parkway.



WATER EDGE TYPE

SOURCE: NYC DCP, 2011

EDGE CLASSIFICATION

NATURAL

- | | |
|---|--|
| — SANDY | — ROCKY |
| — MARSHY | — UNDEFINED |

ENGINEERED

- | | |
|---|---|
| — BULKHEAD | — PIERS FILLED |
| — RIPRAP | - - - - - PIERS ON PILES |



LIVING SHORELINE IN BROOKLYN BRIDGE PARK

SOURCE: NYC DCP, 2013

ENVIRONMENTAL CONTROLS

Placing natural buffers and protective features on the shore or in the water can help hold the shoreline in place.

On-shore controls

- **Beach nourishment** is the process of placing sand (typically dredged from nearby ocean bottoms) on engineered beaches to increase the elevation and distance between upland areas and the shoreline. This creates a buffer that dissipates storm and wave energy away from formerly eroding areas.
- **Vegetation** is often planted on beaches, dunes, and unstable shorelines to anchor sand or soil in place.
- **Living shorelines** consist of plants, sand, or soil, often combined with hard structures, to stabilize the shoreline, prevent erosion, and maintain habitats.

In-water controls

- **Constructed wetlands** are new or restored tidal wetlands that use plants to anchor the soil in place, prevent erosion, and create wildlife habitat.
- **Vegetated islands** are offshore floating or fixed structures, such as anchored mats or infill islands, that can prevent erosive forces by breaking waves. They provide ecological benefits as well.

New York City has been pursuing beach nourishment since the early twentieth century. For example, an estimated 25 million cubic yards of sand were placed on Rockaway Peninsula beaches between 1922 and 1999. The City continues to pursue beach nourishment and other “soft” stabilization projects along open ocean shorelines.

On the Rockaway Peninsula, the Army Corps and the State, with the support of the City’s Department of Parks and Recreation, are completing restoration activities on beaches devastated by



BEACH NOURISHMENT AT ROCKAWAY BEACH

SOURCE: USACE, 2013

Hurricane Sandy to their originally authorized profiles. Future beach maintenance is being evaluated as part of a reformulation study.

On Coney Island, repair and restoration activities have been completed. Upcoming project modifications are being implemented to reduce rapid erosion and undesirable migration of placed fill.

The City is also beginning to explore environmental alternatives such as living shorelines and constructed wetlands. Brooklyn Bridge Park has become a laboratory for innovative softer shoreline design, including living shorelines with wetlands, a sand beach, and offshore reefs.

REGULATORY AND POLICY CONTROLS

Coastal erosion can also be reduced through smarter land use methods and by limiting development in erosion hazard areas. The New York City Department

of City Planning is the local lead in managing and protecting our waterfront. It manages the *NYC Waterfront Revitalization Program*, which provides guidance for ensuring projects are consistent with local goals and State and Federal policies.

For new development, the State Department of Environmental Conservation enforces regulations within all State-designated Coastal Erosion Hazard Areas. Properties in those areas are regulated under the State's Environmental Conservation Law, which limits coastal development in order to protect sensitive areas. The Coastal Erosion Management Regulations (6 NYCRR Part 505) provide for a permitting program that addresses all proposed construction in the Coastal Erosion Hazard Areas. The construction or placement of a structure, or any action or use of land which materially alters the condition of land, including grading, excavating, dumping, mining, dredging, filling or any disturbance of soil, is a regulated activity which may require a Coastal Erosion Management Permit from the Department.

There are two separate jurisdictions that make up the Coastal Erosion Hazard Areas. They are as follows:

- **Natural Protective Feature Areas** – These areas protect New York State’s natural protective features (which include nearshore areas, beaches, bluffs, and dunes). Alterations of these areas may reduce or eliminate their protection, and lower the reserves of sand or other natural materials available to replenish storm losses through natural processes. The landward limit of the Natural Protective Feature Area is delineated on the Coastal Erosion Hazard Area Maps.
- **Structural Hazard Areas** – These are regulated areas landward of the Natural Protective Feature Areas, and are only delineated along shorelines that are receding at an average rate of one foot or more per year. The landward limit of the Structural Hazard Area, if applicable, is delineated on Coastal Erosion Hazard Area Maps. Currently, there are no Structural Hazard Areas within New York City, although this may change with the updated maps currently under development.

Other types of regulatory measures include the following:

- **Construction permits** are often required by coastal erosion management regulations for new construction or modification of existing structures, to ensure they will not worsen erosion.
- **Setbacks or buffers** specify a minimum distance from the erosion hazard area for land use or development of new structures along the shoreline. Regulatory setbacks are identified on the State’s Coastal Erosion Hazard Area maps. The setbacks are only marked in areas with a long-term average erosion rate of 1 foot or greater per year.