5. Coastal Erosion

A. Hazard Profile

i. Hazard Description

Coastal erosion is the loss or displacement of land along the coastline resulting from beach-ocean interaction often coupled with human activity.

In its natural state, the coastal system is in dynamic equilibrium. Sand and sediment are moved from one location to another, driven primarily by wind, waves, long shore currents, tides, runoff of surface waters, or groundwater seepage. However, the sand and sediment do not leave the system altogether unless human activities, such as dredging, permanently remove them from a particular location. Coastal storms may take away significant amounts of sand, creating steep, narrow beaches. As long as sand is not removed from the entire system during storms, waves will return the sand during calmer periods, widening beaches and creating gentle slopes.

The removal and deposition of sand changes beach shape and structure. Sand may be transported to landside dunes, deep ocean trenches, other beaches, and deep ocean bottoms.

Human activity may worsen coastal erosion through poor land use methods. Building without considering the impact on erosion or without an understanding of the changed hydrodynamics may increase erosion or shift it to adjacent areas. In many cases, ill-conceived coastal erosion control structures, built with the intention of *preventing* erosion in one location, may actually *increase* erosion in adjacent locations.

Coastal erosion poses many challenges to coastal communities when valuable property is lost to this dynamic process. Beach erosion control and restoration are thus leading concerns in coastal communities.

ii. Severity

Coastal erosion can be gradual or occur rapidly—as it does during storms, for instance. During storms, erosion can be severe, and during the most intense storms entire beaches may be lost while other portions of the shoreline may become unstable and collapse into the waterways.

Long-term erosion is often difficult to measure since it can vary significantly from year to year. Human activities, such as dredging and beach nourishment projects, also make it difficult to determine how much beach is being lost through natural processes.

Geologists measure erosion in two ways: as a rate of linear retreat (feet of shoreline recession per year) or volumetric loss (cubic yards of eroded sediment per linear foot of shoreline frontage per year). According to the Evaluation of Erosion Hazards study conducted by the Heinz Center (2000), the average annual erosion rate on the Atlantic coast is roughly two to three feet per year. Along New York City's coastline, erosion rates vary significantly depending on location (see Location, below).

iii. Probability

Long-term shoreline change is a continuous process and therefore 100% certain for the locations in New York City described below. The probability of rapid erosion events will vary based on a number of factors including the recurrence intervals for coastal storms (see section 6. Coastal Storms).

iv. Location

Areas along the city's southern shore are most at risk of coastal erosion. These areas are exposed to the effects of wave action from the Atlantic Ocean as well as from the waters of Lower New York, Gravesend, Raritan, and Jamaica Bays. Some of the highest erosion rates have been observed near stabilized inlets and hardened structures, which disrupt the natural movement of sand. Because so many factors are involved in coastal erosion—including seasonal fluctuations and human activity—sand movement will not be consistent year after year in the same location, or between nearby locations.

To protect against the effects of coastal erosion, the New York State Department of Environmental Conservation (NYS DEC) has developed the Coastal Erosion Hazard Area (CEHA) permit program. This program identifies coastal locations that are particularly vulner-

able to erosion and provides written approval of regulated activities or land disturbance to properties within these areas.

NYS DEC has identified three distinct CEHAs for New York City:

- Coney Island, Brooklyn
- Rockaway Peninsula, Queens
- South shore, Staten Island

Approximately 1,428 acres are located within these three CEHAs, representing 0.7% of New York City's land area.

Within the CEHAs, NYS DEC manages and regulates the following:

- Natural Protective Feature Areas (NPFAs), such as the near shore, beaches, bluffs, primary dunes, and secondary dunes. NFPAs protect natural habitats, infrastructure, and built structures from wind and water erosion and storm-induced high water.

- Structural Hazard Areas (SHAs), which are areas landward of the NPFAs that have demonstrated a long-term average recession rate of one foot or greater per year.

The United States Army Corps of Engineers (USACE) monitors coastal erosion rates for each of the CEHAs in New York City. The most recent values that New York City has for coastal erosion were obtained from USACE and measured between 1966 and 1988. During this period, erosion rates along the western Rockaway Peninsula were around two feet per year, while erosion rates along the eastern Rockaway Peninsula were closer to five feet per year. Along the ocean shore of Coney Island, the erosion rate was measured at 1.3 feet per year, although historically the rate was higher (2.5 feet per year between 1836 and 1966). The shoreline is generally stable along the South shore of Staten Island, with several exceptions, including Oakwood Beach and Annandale, which are eroding faster than the citywide average. As Figure 3.5.45: Shoreline Change for Annandale, Staten Island, 1924 to 2012 (Source: DoITT, OEM GIS), below, shows, parts of the Annandale shoreline retreated as much as 125 feet between 1924 and 2012.

CEHA maps depict regulated areas, including the landward limit of the NPFAs and SHAs, and indicate the recession rate in feet per year, where applicable. The maps now available were last updated in 1988, although they are currently being evaluated and revised to reflect changes in NPFA and SHA boundaries and in natural protective features. The map updates also require a comparison of historical imagery to more recent imagery to determine long-term shoreline recession rates.

CEHA maps for New York City were obtained from NYS DEC's Coastal Erosion Management Unit on January 14, 2008. The maps are dated 1988, with legend updates in 1991. CEHA maps were available only in hard-copy format. For the purposes of this plan, CEHAs were translated from the hard-copy format into GIS format to enable more efficient viewing, sharing, and estimation of assets within the CEHA (see Figure 3.5.46, Figure 3.5.47, and Figure 3.5.48). This was not a formal translation of the hard-copy data into GIS format, and the resulting images are for analysis purposes only and do not serve as official digital representations of the CEHA boundaries in New York City. On the CEHA maps presented here, the CEHA boundaries were drawn at the location of NPFAs. The maps do not designate SHAs.

v. Historic Occurrences

Coastal erosion is an ongoing natural process frequently exacerbated by human activity. However, large-scale erosion events can be caused by significant coastal storms, such as nor'easters or hurricanes (see section 6. Coastal Storms).

B. Vulnerability Assessment

i. Social Environment

Since coastal erosion is a gradual process, it typically does not pose an immediate risk to human life, safety, or well-being. Special needs populations are not necessarily at an increased risk from coastal erosion.

Figure 3.5.45: Shoreline Change for Annandale, Staten Island, 1924 to 2012 (Source: DoITT, OEM GIS)

Figure 3.5.46: Brooklyn Coastal Erosion Hazard Areas (Source: NYS DEC, OEM GIS)

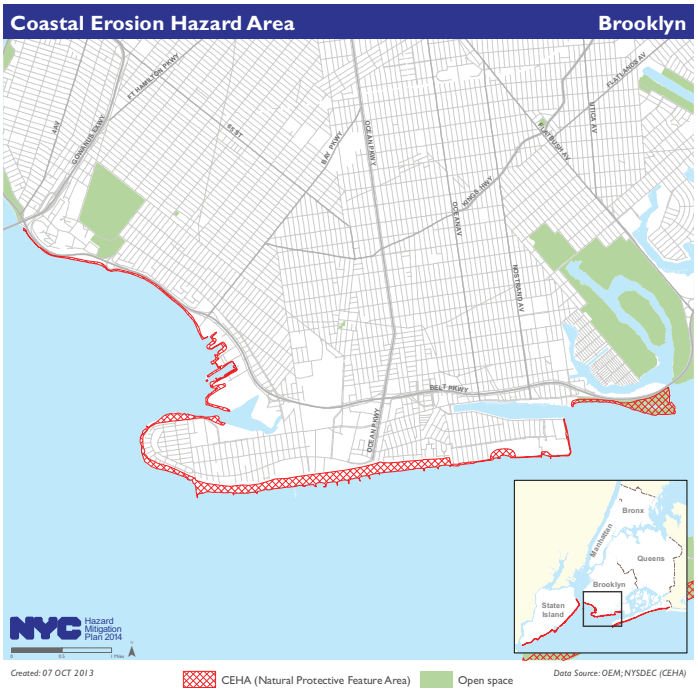


Figure 3.5.47: Queens Coastal Erosion Hazard Areas (Source: NYS DEC, OEM GIS)

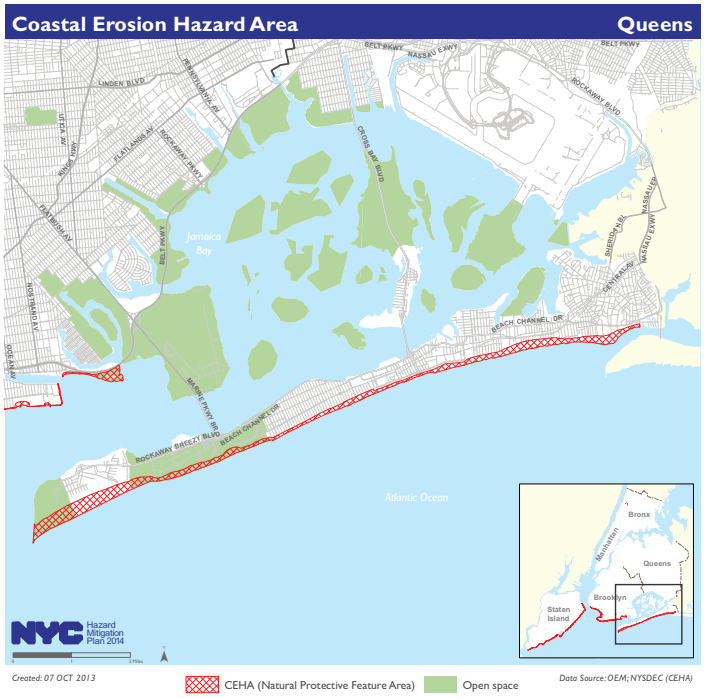
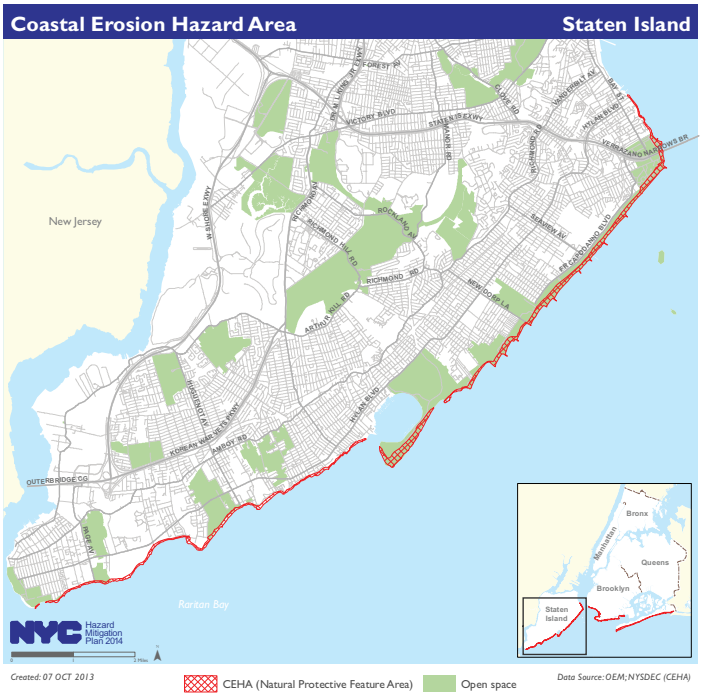


Figure 3.5.48: Staten Island Coastal Erosion Hazard Areas (Source: NYS DEC, OEM GIS)



ii. Built Environment

Coastal erosion can cause extensive damage to public and private property because it brings structures closer to the water's edge. If erosion is not mitigated, the structures will become inundated with water, resulting in damage or destruction. As the force of water begins to affect the structure, it also places the building's foundation, utilities, and contents at risk.

Shoreline protection and proper structure placement are crucial to withstanding the forces of coastal erosion. Engineering structures—such as seawalls, riprap, armoring, and bulkheads—are used to reduce the risk of erosion in New York City.

In New York City, there are 207 buildings whose footprints intersect a CEHA, although many are just barely touching it (see Table 3.5.25). Buildings with only one edge touching the CEHA might not actually be at risk but may appear to be at risk due to inaccuracies in the data. On the other hand, if a building *centroid* is located within the CEHA—which menas the majority of the building footprint is within the CEHA—the building is considered exposed. Buildings that fall within this category—GIS analysis shows 135 such structures in New York City—are considered vulnerable building stock. The majority of these 135 structures, with the exception of one hotel complex on the Rockaway Peninsula, are not permanently occupied or of high value; they are, for instance, structures such as public bathrooms and beach concession stands.

iii. Natural Environment

Erosion can cause extensive damage to coastal natural resources.

Under natural conditions, beaches (particularly barrier islands or spits like the Rockaway Peninsula) are dynamic features of the landscape. The shape and location of the coastline changes over time, and erosion is one of the processes by which this occurs. In a natural state, some areas erode and some areas accrete, but overall the two processes are in balance.

Although coastal erosion is a natural phenomenon, human activity may exacerbate it. The construction of hardened structures—such as seawalls, jetties, and groins—can contribute to erosion. Shoreline stabilization structures prevent the natural migration of the beach and thereby contribute to a significant imbalance between erosion and accretion, with some areas eroding much faster than they would under natural conditions. These structures may block sand movement, deflect or increase wave energies, and remove vegetation.

Human activities may also contribute to coastal erosion by damaging or destroying natural protective features such as wetlands, dunes, beaches, sand bars, and barrier islands or spits. Increased erosion rates due to human development may also contribute to the loss of habitat or disrupt migration routes for marine and terrestrial animal species.

Table 3.5.25: Acreage and Buildings within NYS DEC-mapped Coastal Erosion Hazard Areas (Source: OEM GIS)

Coastal Erosion Hazard Area (CEHA)	Acreage Exposed	Exposed Building Footprints	Exposed Building Centroids
Coney Island, Brooklyn	305	53	22
Rockaway Peninsula, Queens	708	26	17
South shore, Staten Island	415	146	96
Total	**1,428**	**207**	**135**

iv. Future Environment

According to the New York City Panel on Climate Change, the sea level around New York City has risen 1.1 feet since 1900 and is expected to rise up to an additional 2.5 feet by the middle of the 21st century. Sea level rise is expected to exacerbate coastal erosion in the future, especially during significant storms.

However, exactly how much erosion is directly attributable to sea level rise is unclear. Over planning time frames of 30 to 50 years, the effect of sea level rise is less significant than that of other contributors to shoreline change, and a higher rate of sea level rise is not expected to substantially change the observed rates of shoreline change in the areas experiencing the most severe erosion. Clearly, future erosion rates remain difficult to predict, underscoring the need to establish more baseline data and monitoring stations along the coast to determine annual shoreline changes.

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