Chapter 3: Affected Environment

The information in the "Affected Environment" chapter describes resources and values that may be changed if an action alternative is implemented. In addition to describing the resources, available data on existing conditions is included.

Natural Resources

Soils and Geology

Geology and Physiography

Gateway National Recreation Area (Gateway or the park) is spread out in three units in the boroughs of Brooklyn, Queens, and Staten Island, New York, and in Monmouth County, New Jersey. The park is generally considered part of the Atlantic Coastal Plain province. Coastal plain materials are from formations of sand and gravel characterized by a relatively high degree of weathering. Most of the park in New York City is covered by deposits from an ice age that began about 1.6 million years ago; Sandy Hook (in New Jersey) was not glaciated (NRCS et al. 2001). Stratification or layering is common in outwash deposits from glaciers and is displayed in metropolitan surface materials.

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The area geology includes crystalline bedrock, sedimentary rocks, and igneous intrusive rocks. In many places, these are covered with human-deposited fill. The bedrock for the Jamaica Bay and Staten Island Units consists of Cretaceous age rocks, including the Raritan Formation, the Monmouth Group, and the Matawan Group, and in some places unconsolidated Cretaceous sediment of the Magothy Formation (Fisher et al. 1970, as cited in Edinger et al. 2008a). The surficial geology of these two units is primarily outwash sand and gravel with small amounts of till moraine at Fort Wadsworth and significant areas of artificial fill (e.g., at Floyd Bennett Field and Great Kills Park). The surficial geology of the Sandy Hook Unit is Holocene age (Stanford 2000, as cited in Edinger et al. 2008a). The original sedimentary and igneous rocks have been folded, faulted, and in some places melted and recrystallized during several cycles of mountain building. Although bedrock exposures are common in Manhattan and the Bronx, for the most part they are buried beneath younger deposits. Serpentine, a green metamorphic rock, forms the backbone and highest point on Staten Island (NRCS et al. 2001). Most of the park's landscapes are characterized by relatively flat to slightly undulating topography, with elevations ranging from sea level to less than 50 feet above mean sea level (NRCS et al. 2001).

Soils

The Jamaica Bay Unit contains the greatest proportion of tidal marsh inside the park, which is underlain in large part by poorly drained glacial outwash soils in the Ipswich series. In some areas, considerable amounts of organic materials have accumulated since the retreat of the glaciers. The unit also contains urban land, which is a mix of human-deposited materials (NRCS et al. 2001). For example, Floyd Bennett Field in the Jamaica Bay Unit was constructed on saltmarsh now covered by dredged materials, rubble, fly ash, and wastes (see "Soils and Geology" impacts common to both action alternatives section for more information) and in some cases paved to create space for runways, hangars, and historically for the railroad across Jamaica Bay. The Fountain Avenue and Pennsylvania Avenue former landfills occupy space on the northern edge of Jamaica Bay. Each is about 80 feet high and covers 100 acres of former saltmarsh habitat.

Areas covered by glacial outwash south of the terminal moraine on Staten Island include Miller Field and Great Kills Park. These are either sand or well-drained soils of the Bernardston series, the latter covering most of the park sites in the Staten Island Unit (Edinger et al. 2008a). Pockets of windblown sediment can also be found blanketing the surface in some areas. The red sand of Great Kills Park is human deposited from hydraulic dredging of glacial deposits from offshore sandbars (NRCS et al. 2001).

The Sandy Hook Unit is covered with beach sands and less well-drained depressions of the Hooksan series, as well as urban land and other human-deposited fills (Edinger et al. 2008a).

Shorelines and Coastal Processes

Although the three units of the park total only about 8,300 acres in land area (and a total of 21,680 acres of land and National Park Service [NPS]-managed waters), they include 75 miles of shoreline. The Sandy Hook Unit's shoreline on the Atlantic Ocean and Raritan Bay (to the west) covers more than 6 miles, but it is the park sites in the Jamaica Bay Unit that compose the majority of the park's shoreline (NRCS et al. 2001).

Coastal processes include marine processes such as tides, coastal currents, storm surges, and shoreline dynamics. These forces are some of the most significant drivers of geomorphological processes (which relate to the origin and development of landforms) at the park. Humans have also shaped landforms at the park, starting with historical uses such as agriculture and progressing to more recent ones such as urbanization, dredging and filling, diverting freshwater flows, and hardening of the shores with development and massive sand stabilization efforts.

Coastal Sediment Supply and Movement

Ocean shores at the park are fed by sediment carried along the coast by the longshore current in a process called littoral drift. Longshore transport provides material that contributes to a natural development of the barrier island profile, including the formation of offshore bars, beach slopes, beach berm, dunes, and foredune habitat. The strength of waves and currents, the angle at which waves strike the shore, tidal cycles, and the size and weight of sand grains the current carries all help define how and where the sediment will be deposited. At Gateway, the longshore current travels from east to west along Long Island and from south to north along the northern New Jersey coast. The dominant wave action is from the southeast, a function of prevailing winds and storms in the tropics and the South Atlantic. The sources of material carried by the longshore currents offshore of park sites vary as described below, but sources include Headlands in New Jersey and remnants of glacial moraines in New York Bay (see the "Marine Resources" section of this GMP/EIS for distinctions between New York Bay, New York Bight, and New York Harbor).

The amount of sediment input (sources), deposition (sinks), and transport out of the system is the sediment budget. Usually, the sediment budget is expressed in terms of some volume of sand gained or lost per year for a given area. Whether the sand is lost to an offshore sink,

inland to a bay, or transported to the next area downdrift is not important to the potential for accretion (adding of sediment) or erosion (removal of sediment) of a coastline (Psuty et al. 2009). In general, most park sites at Gateway are experiencing a long-term negative sediment budget. However, there are portions of the park that are expanding while others are eroding; this is true of the Sandy Hook Unit, for example.

When natural conditions prevail, the topography of the ocean shoreline is a broad beach backed by a vegetated foredune. The beach, dunes, and island core exchange sediment with each other and with the nearshore environment in different measure during the seasons. Sand is moved from offshore to onshore at different times of year by a variety of mechanisms, including tides, waves, and storms. In general, sand is stored offshore in sandbars during storms and migrates back to the beach during quieter times. Coastal dunes accumulate sand in the upper margin of the beach; their growth depends on wind transport and water moved during storms. Foredunes are dynamic, and can become steepened or scarped when storms erode beaches, or be pushed inland by storm surge and sand transported by strong waves. Very strong storms such as hurricanes or nor'easters can transport sand across the spit and into bays in a process called "overwash," or can cut a channel from ocean to bay, creating inlets and shoals in the bays. The back beach area is only flooded during winter storms and the highest spring tide surges. Winter coastal winds redistribute some of the sand to the back dunes, which can reach 20 to 30 feet above mean sea level in undisturbed areas.

Storms can cause the erosion or accretion of large quantities of sediment over a relatively short time. This was the case with Hurricane Sandy, which resulted in more than 160,000 cubic meters of sand moved across parking lots, roads, and buildings, and erosion substantial enough in some spots to uncover historic batteries and blockades that had been buried several feet deep.

Although sand transported by the longshore current can be sequestered naturally along the route—in inlets, for example—human activity also interrupts littoral drift. Dredging and stabilizing of inlets for navigation interrupts the magnitude of sediment transported; this is true of areas of Raritan Bay and Rockaway Inlet in the study area. Groin fields and jetties block and redirect longshore flows, resulting in the accumulation of material on the updrift side of these structures. The long-term impact of these structures varies based on local sediment transport regimes and on the size, effectiveness, and integrity of the structure. Whereas the structures that influence longshore transport are local, their impacts can be both local and regional in effect. More information on jetties and groins at specific park sites and their effects is presented below.

When a sediment budget is positive, the shoreline will migrate seaward; the opposite is true in a negative sediment budget, as the dune beach system will be displaced landward as sand is eroded and transported downdrift. As sea-level rise accelerates over time, the amount of sand in the sediment budget available for deposition will define an important element in the vulnerability of a coastline to increasing erosion and loss.

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Coastal Processes at Park Beaches

The two major coastal landform components of Gateway are the barrier spits that compose Sandy Hook on the New Jersey coast and the Jacob Riis Park–Breezy Point stretch of the New York coast (Psuty et al. 2009). These are both products of the longshore transport of sand, which has extended the two barrier features toward Lower New York Bay. In other parts of the park, Plumb Beach was formed as a remnant of the eastern terminus of the Coney Island barrier, and Great Kills Park is located on the remnant of a barrier spit that formerly extended southwesterly along the ocean-facing margin of Staten Island.

Breezy Point Tip is the westernmost extension of the Rockaway Peninsula. East of Breezy Point Tip are two additional park sites that also lie on the Rockaway Peninsula: Fort Tilden and Jacob Riis Park. Each is supplied by eastern Long Island longshore transport of sediments originally deposited as glacial outwash.

Coastal Processes at the Jamaica Bay Unit

Rockaway Peninsula

Breezy Point Tip is the westernmost extension of the Rockaway Peninsula. East of Breezy Point Tip are two additional park sites that also lie on the Rockaway Peninsula: Fort Tilden and Jacob Riis Park. Each is supplied by eastern Long Island longshore transport of sediments originally deposited as glacial outwash. The Rockaway Peninsula is at the end of this sediment pathway, which transports sand along the south shore of Long Island at a rate of about 450,000 cubic yards/year (344,000 cubic meters/year) (Hess and Harris 1987, as cited in Psuty et al. 2009).

East of the park sites (i.e., further updrift in the longshore transport chain), sand is dredged at Little Rockaway Inlet and deposited downdrift to nourish beaches in the Rockaway communities. In addition, starting in 1975 and continuing to 2004, 17 million cubic yards (13 million cubic meters) of sediment were dredged from offshore to help supply these same beaches (USACE records; Yasso and Hartman 1976 and Neresian 1977, as cited in Psuty et al. 2009). Despite these beach nourishment efforts, a long and effective groin at the eastern end of Jacob Riis Park prevents longshore transport of sand to NPS-managed lands. Instead, a sand-starved, highly mobile beach profile exists at Jacob Riis Park, preventing the development of a stable foredune that could otherwise help reduce coastal erosion during storms. Further west, a foredune has formed at Fort Tilden despite riprap and wooden bulkheads along this site's entire length. At Breezy Point Tip, a jetty built in 1933 to prevent longshore transport from filling in the Rockaway navigation channel has resulted in the accretion of sand seaward for a distance of 2.8 miles. The accumulation has reached its maximum and filled the area between the point and the jetty, although an increase in height could occur (Psuty et al. 2009).

Hundreds of thousands of cubic yards of sand was blown and washed ashore by an 11- to 13-foot storm surge in each of these three areas during Hurricane Sandy in 2012, resulting in damage to buildings, roads, and other structures. Although dunes were overwashed and eroded at Breezy Point Tip and Fort Tilden, and buildings and facilities flooded and covered in sand at Jacob Riis Park, only debris removal was recommended to help restore coastal resources in NPS assessment documents (NPS 2012c). The exposure of wooden bulkheads at Fort Tilden is considered a human safety hazard and this area is closed to the public until an access plan is developed by the NPS. Although the rubble and debris trapped by the

bulkheads and exposed after the hurricane is increasingly reburied by sand, it is considered part of the hazard. Sediment washed onto the upland area of Fort Tilden, including on roads and parking lots, was placed near dunes in protective berms (NPS 2012c).

Plumb Beach

Plumb Beach is an access point to the shore along the outer bay area of Rockaway Inlet. It is a remnant of the eastern end of the Coney Island barrier island and its associated tidal inlet delta, but it is isolated from the general barrier evolution by the western extension of the Rockaway Peninsula (Psuty et al. 2009). Plumb Beach is also separated from longshore sediment supply through the dredging of the navigation channel into Sheepshead Bay west of the site. The effect of these changes and the completion of the inlet jetty at Rockaway Point in 1933 to stabilize Rockaway Inlet has been to switch net sediment transport at Plumb Beach from westward to eastward (NPS 2010a). Creation of the Belt Parkway in the 1930s resulted in a large amount of fill placed on the shoal inland of Plumb Beach and the establishment of a reformed shoreline at the seaward margin of the fill (Psuty et al. 2009). Because there was no natural source of sand coming into this area, net erosion displaced the shoreline inland toward the Belt Parkway.

Several episodes of beach nourishment and riprap placement in the central portion of Plumb Beach, including efforts by both New York City Department of Parks and Recreation and the U.S. Army Corps of Engineers,were observed in aerial photo evidence, as was the severe erosion and loss of the existing pathway near the Belt Parkway in 1985 (Psuty et al. 2009). However, sand deposited in the central portion of the park site continues to be transported from west to east, adding to the eastward-extending spit. The western margin of Plumb Beach is stabilized with a bulkhead structure and an offshore breakwater of old tires that was constructed in the early 1980s to intercept incident waves and reduce the wave energy reaching the remaining beach.

Recognizing the need for more consistent intervention, the park and the USACE analyzed options for stabilization of the shoreline to protect the Belt Parkway in a 2010 planning document and environmental assessment (NPS 2010a) and began to implement the first phase in 2011 by adding 150,000 cubic yards of sand. The next phase of the project begins in 2013 and consists of the construction of two terminal groins and an offshore breakwater to help reduce wave energy and retain sand.

Coastal Processes in the Staten Island Unit

The three coastal areas of the park shoreline on Staten Island—Great Kills Park, Miller Field, and Fort Wadsworth—are each situated where glacial deposits are being reworked by waves and currents but little of the natural topography remains. Large amounts of beach nourishment and dredged sediment and multiple shore structures have altered these sites. Each site is eroded somewhat by longshore transport from the northeast moving southwest. Although the transport does not add sand to these sites because of updrift groins, it does create a depositional spit at Crooke's Point on the western edge of Great Kills Park (Psuty et al. 2009).

Great Kills Park

Great Kills Park was constructed at least in part by excavation of sediment to create the Great Kills Park Harbor; dredged materials were used to build up the surrounding land, including a connection from the mainland to Crooke's Point Island. The cumulative effect of the groins deliberately installed to trap sediment from the longshore current was doubled when a very long outfall pipe installed in 1975 effectively stopped the remaining sediment from reaching Great Kills Park (Psuty et al. 2009). A jetty at Crooke's Point on the western edge of Great Kills Park keeps the harbor from filling in, but the beach immediately to the west (downdrift) is eroding. Sanitary landfills in the 1940s covered the saltmarsh behind the beach and increased its elevation by 35 feet. Nonetheless, the beach is a popular visitor destination. Portions of the Great Kills Park site north of the harbor have been closed recently due to the discovery of radium ~~radon~~ from medical waste in the early landfills. The accreting Crooke's Point was at one point a sand spit, which was separated by a storm in the early 1900s to become an island. Crooke's Point was reconnected using the dredge material from the harbor, which was used to fill in the saltmarshes and three creeks.

Miller Field

The shoreline of Miller Field extends between two groins for about 2,000 feet (630 meters), about 1,600 feet (500 meters) of which is within park boundaries. The shoreline is completely composed of artificial fill and is manipulated by the placement of this fill and the sand-capturing ability of the two groins. Sand trapped by the groins and held by a sand dike is used to nourish this small beach (Psuty et al. 2009).

Fort Wadsworth

A beach on the seaward-facing side of Fort Wadsworth is a product of fill placed in the 1950s. The northern 250 feet (75 meters) is lined by riprap and bounded by an offshore breakwater. Otherwise, the beach gently slopes toward a sand dike. No new sand is being transported to this site; it is exposed to waves entering the bay between Sandy Hook and Breezy Point and will continue to erode over time.

Coastal Processes at the Sandy Hook Unit

Sandy Hook is located at the intersection of the New Jersey shore with the ancient valley of the combined Raritan and Hudson Rivers, now flooded as Raritan Bay. It extends in width from several hundred feet to a mile. Several saltmarshes lie along the western side of the spit. Sand dunes line its eastern side, protecting grasslands, shrublands, woodlands, and forest vegetation from overwash flooding during most storms. Although the barrier spit extends northward 11.2 miles from its origin at the coastal headlands in Monmouth Beach, only the distal end (farthest from shore) is part of the park. Sandy Hook derives its sediment from northerly transport along the New Jersey shoreline; the source of this sediment is eroding headlands immediately updraft of Sandy Hook, which is considered insufficient to maintain the current shoreline in the long term (NRCS et al. 2001). Sand that makes up the spit is transported north by longshore current along the New Jersey coast and the east

side of Sandy Hook, and is supplemented by sediments derived from the Shrewsbury and Navesink River estuaries (USGS n.d.a). Plum Island, in Raritan Bay on the bayside of Sandy Hook, is a remnant of an old overwash fan formed by several intense storms that also separated Sandy Hook from the mainland in the 1800s (USGS n.d.a).

The supply and availability of sediment changes along the length of Sandy Hook, in some part due to its orientation but also because of built groins. Caldewell (1966, as cited in Psuty et al. 2009) estimated the volume of sand moved along the shoreline through longshore transport at about 500,000 cubic yards (382,000 cubic meters) per year. The southern portion of Sandy Hook is nearly north–south in its orientation, which means it is eroded by wave energy to a greater degree than it is fed by the longshore current. The natural source of sediment to supply the basal portion of Sandy Hook is more limited than for its northern portion (Psuty et al. 2009). About halfway into the NPS-managed lands, the shoreline changes to a north-northwest direction, where wave energy and deposition of sediment balance. This continues for 1.6 miles (2.5 kilometers), when orientation changes to due northwest, further lowering the wave energy and resulting in a positive sediment budget and accretion area north of Sandy Hook. Because there is a limited natural source of sediment to supply the basal portion of Sandy Hook, at times during the period from 1733 to 1900 it was detached from the mainland, making it an island. During this same time it has also reconnected to the mainland in two places—at the Highlands and at Long Branch, where it is connected now (Psuty et al. 2009).

This portion of the coast shows signs of erosion, both because sand supplies are inadequate to buffer continuous loss, and because of the presence of a 7.5-mile-long seawall and several groins. The groins were built over several decades in Monmouth Beach and Sea Bright south of the park, and the seawall was constructed from Monmouth Beach to the southern boundary of the park (NPS 2004c). Immediately north of the seawall, accelerated erosion developed after 1950 and increased through 1976 (Psuty et al. 2009), with loss rates that peaked at 230,200 cubic yards/year (176,000 cubic meters/year) (Psuty and Namikas 1991, as cited in Psuty et al. 2009). This area north of the seawall was dubbed the “critical zone” by Sherman et al. (1976, as cited in Psuty et al. 2009).

Although the town replenishes the sand on the beach side of the wall, it has been eroded away several times by strong storms (USGS n.d.a). In addition, the NPS has placed more than 5.2 million cubic yards (4 million cubic meters) of sediment in the vicinity of the critical zone since 1975 (Psuty and Ofiara 2002, as cited in Psuty et al. 2009). A 2004 environmental assessment of options to maintain the beaches in this portion of Sandy Hook (NPS 2004c) found that 1.5 million cubic yards of sand was needed every five to seven years, although beach nourishment efforts by Sea Bright and the U.S. Army Corps of Engineers (USACE) offset this estimate by about half. The source of sediment was identified in the environmental assessment as sand in the longshore, swash bars, and migratory shoals offshore of the northern accreting end of Sandy Hook (NPS 2004c), and a pipeline to transfer sand slurry from Gunnison Beach to the critical zone was put in place. The result of the slurry and beach nourishment has been to reduce the net rate of sediment loss and to increase available sediment in the critical zone.

In the northern part of Sandy Hook, a series of dune ridges representing earlier stages of accretion is now stranded inland as this portion continues to grow. In addition to the seawall and groins south of the park site, a few groins were built on what is now NPS-managed land at Sandy Hook. These structures, at Battery Gunnison and North Beach, are usually covered in sand and are not considered important in sand transport processes (Psuty et al. 2009).

As a result of the 2012 Hurricane Sandy, sand was blown or washed from the beaches west over much of the spit, covering vegetation and park facilities such as roads and parking lots. As noted above, this cross-peninsula transport of sand from the ocean to the interior and bay shoreline is a natural process resulting from storm surge that increases the elevation of dunes and sometimes of inland areas of the spit, making it more resilient to future storm events.

Jamaica Bay and its saltmarsh islands form one of the most recognizable and striking features in New York City.

The bayshore at Sandy Hook also shows signs of erosion. At one point just north of Spermaceti Cove, the wooden posts of a seawall built in 1912 are now nearly 150 feet from the shoreline standing in bay waters. The NPS returned the 160,000 cubic yards of sand cleared from roads and parking lots at Sandy Hook to the beach.

Shoreline of Jamaica Bay

Jamaica Bay and its saltmarsh islands form one of the most recognizable and striking features in New York City. Tidewater grasslands colonized postglacial outwash plains at the ends of many creeks and streams on Long Island to form these islands. In addition to the saltmarsh islands, many more hundreds of acres of “fringing marshes” once adjoined the mainland. Much of this habitat is now gone because of development, dredging, and pollution, as described below and in other sections of this GMP/EIS (see the “Wetlands and Floodplains” and “Vegetation” sections, for example). Benthic soils in the bay are more likely to be sandy in the western portion (east to the Rockaway Inlet) and silty in the eastern portion (NYCDEP 2007).

In 1878, the secretary of war and New York City began a major landscape modification to establish the bay as a major seaport. Broad channels were dug and the dredge spoils were used to fill in marsh areas and to create raised land for docks and piers. Later, marshland was filled in the construction of Floyd Bennett Field and what is now John F. Kennedy International Airport. The Marine Parkway Bridge, which connected Flatbush Avenue to the Rockaways, was completed in 1937, hastening the development of the protective barrier islands. Large landfills and sewage sludge disposal removed additional marshland. As a result, soils in the Jamaica Bay Unit, including those in the bay itself, are altered. The inorganic mass of marsh sediments has decreased in Jamaica Bay marshes since European settlement, while organic matter has increased over the same period (Peteet et al. 2004 and 2008, as cited in Rafferty, Castagna, and Adamo 2011). The upland areas adjacent to the marsh are largely underlain by urban fill or dredged materials. The primary sources of freshwater into the bay are four wastewater treatment facilities and numerous combined sewer overflow (CSO) pipes, although eight large and several smaller tributaries also empty into the bay. All of the tributaries have been altered by channelization and tend to have

little or no freshwater flow other than that conveyed by the CSO and/or storm sewers (NYCDEP 2007). Combined with wastewater effluent, they have increased nitrogen loading by more than 400 percent in the last 110 years (Rafferty, Castagna, and Adamo 2011) and changed the composition of nutrients in bay soils. Total organic carbon, a measure of organic material in sediments, was greater than 3.5 percent across nearly 40 percent of bay soils tested in 1998, a condition associated with decreased abundance of benthic aquatic species and biomass (Hyland et al. 2000, as cited in NYCDEP 2007). Soils along the northern and eastern portions of Jamaica Bay were also found to be contaminated with heavy metals and pesticide and other hydrocarbon residues such as polychlorinated biphenyls (PCBs), dichloro-diphenyl-trichloroethane (DDT), and chlordane in studies conducted from the 1970s through the 1990s.

By the 1960s, when the true ecological value of the saltmarshes was realized, the original 25,000 acres of Jamaica Bay saltmarsh and surrounding freshwater wetlands had diminished to about 13,000 acres (USGS n.d.a). A panel of experts convened by the NPS in 2001 investigated possible causes and identified relevant research needs. The panel theorized that increases in wave energy from waves and tides, a sediment deficit from dredging, the westward extension of the Rockaway Peninsula and eight terminal groins reducing sediment movement from the ocean into the bay, and sea-level rise were possible contributors.

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Air Quality

Introduction

Gateway is located in New York City, New York, and Monmouth County, New Jersey, and air quality in the park is typical of that found in an urban area. Ambient air quality is affected by stationary, mobile, and area source emissions. Six air pollutants are regulated by National Ambient Air Quality Standards (NAAQS) under the Clean Air Act and are called "criteria" pollutants. These include carbon monoxide (CO), nitrogen oxides (NOx), particulate matter (PM2.5 and PM10 combined), ozone, sulfur oxides (SOx), and volatile organic compounds (VOCs).

Air quality is an integrating resource that often affects numerous resources and values including the health of ecosystems, viewsheds, and visitor health and visitor experience.

National Ambient Air Quality Standards and Public Health

Carbon Monoxide

CO, a colorless and odorless gas, is produced in the urban environment primarily by the incomplete combustion of gasoline and other fossil fuels. In urban areas, approximately 80 to 90 percent of CO emissions are from motor vehicles. Because CO is a reactive gas that does not persist in the atmosphere, concentrations can vary greatly over relatively short distances. Elevated concentrations are usually limited to locations near crowded intersections, heavily traveled and congested roadways, parking lots, and garages (NYCPC 2012b).

Ozone, Volatile Organic Compounds, and Nitrogen Oxides

Ozone is formed through a series of reactions between NOx and VOCs that take place in the atmosphere in the presence of sunlight. Because the reactions are slow and occur as the pollutants move downwind, elevated ozone levels are often found many miles from sources of the precursor pollutants. The effects of NOx and VOC emissions from all sources are therefore generally analyzed on a regional basis. Both stationary and mobile sources contribute to the combined total of these pollutants. The total vehicle miles traveled by cars, shuttles, buses, and other vehicles that bring visitors to the park are all considered sources of mobile emissions (FHWA 2006).

In addition to being a precursor to the formation of ozone, nitrogen dioxide (NO2; one component of NOx) is also a federally regulated criteria pollutant. NO2 is formed from the transformation of nitrogen oxide (NO) in the atmosphere. This pollutant is mostly generated by large stationary point sources and has not traditionally been considered a local concern. However, with the promulgation of a new 1 hour average NAAQS for NO2, local mobile sources such as vehicle emissions have become more important to managing this pollutant.

Particulate Matter

PM is a broad class of air pollutants that includes particles of a wide range of sizes and chemical compositions, either as liquid droplets (aerosols) or as solids suspended in the atmosphere. Fine particulate matter (PM2.5) is smaller, less than or equal to 2.5 microns in size, whereas coarse particulate matter (PM10) is less than or equal to 10 microns. The constituents of PM are numerous and varied and they are emitted by a wide variety of sources (both natural and human-made). Natural sources include salt particles resulting from the evaporation of sea spray; windborne pollen, fungi, molds, algae, yeasts, rusts, bacteria, and material from live and decaying plant and animal life; and particles eroded from beaches, soil, and rock. Naturally occurring PM is generally greater than 2.5 microns in diameter. Major human-made sources include the combustion of fossil fuels (e.g., vehicular exhaust, power generation, boilers, engines, and home heating), chemical and manufacturing processes, construction and agricultural activities, ship traffic, and wood-burning stoves and fireplaces (NYCPC 2012b). PM10 is often part of dust, soot, and ash.

PM2.5 has the ability to reach the lower regions of the respiratory tract, delivering with it other compounds that adsorb to the surfaces of the particles, and is extremely persistent in the atmosphere.

Sulfur Oxides

SOx (primarily sulfur dioxide [SO2]) emissions are mostly associated with the combustion of sulfur-containing fuels (e.g., oil and coal). Monitored SO2 concentrations in New York City are lower than the current NAAQS, largely due to federal restrictions on the sulfur content in diesel fuel for on-road vehicles. Federal limits on stationary sources have also greatly reduced SO2 emissions in the east.

NPS Air Quality Conditions and Current Trends

The NPS Management Policies 2006 clarifies that the NPS will seek to "perpetuate the best possible air quality in parks" (NPS 2006a, section 4.7.1). This means establishing desired conditions for air quality that are consistent with the Clean Air Act, NAAQS, and other policy goals. Currently, the NPS focuses on three primary measures and associated desired conditions to evaluate natural resource-based air quality conditions in national parks: ozone concentrations, wet deposition of acidic compounds or nitrogen, and visibility.

Ozone

The NAAQS for ozone is set by the U.S. Environmental Protection Agency (EPA) and is based on human health effects. However, studies show that some plant species are more sensitive to ozone than humans are. Accordingly, the NPS Air Resources Division (ARD) recommends a desired condition for ozone that is lower than the human health-based NAAQS.

Currently, ozone conditions at Gateway are not meeting NPS ARD–recommended desired future conditions. The estimated ozone level from 2005–2009 at Gateway was 82.1 parts per billion (ppb), much higher than the reference condition of 60 ppb and a condition that warrants significant concern. Table 3-1 describes and assesses ozone conditions and trends at Gateway in more detail.

Deposition

Nitrogen and sulfur compounds deposited from air pollution can harm soils, vegetation, lakes, and streams through acidification or fertilization. Deposition is measured in kilograms per hectare per year (kg/ha/yr) of wet nitrogen or sulfur deposition. The NPS ARD–recommended desired condition for deposition is determined to be protective of all ecosystems based on current scientific understanding.

For 2005–2009, estimated wet sulfur deposition at Gateway was 5.2 kg/ha/yr, substantially higher than the reference condition of 1 kg/ha/year and one that warrants significant concern. Table 3-1 describes and assesses nitrogen and sulfur deposition conditions and trends at Gateway in more detail.

Visibility

Visibility is a measure of how far and how well a person can see a distant and varied scene. Pollutant particles in the atmosphere scatter and absorb light, creating a haze that impairs scenic views. The deciview (dv) metric measures visibility changes as perceived by the human eye (analogous to the decibel scale) and is used by the air regulatory community to track visibility conditions and trends. The Clean Air Act established a national goal to return visibility to "natural conditions" in Class I areas. Natural visibility conditions are those estimated to exist in a given area in the absence of human-caused visibility impairment (EPA-454/B-03-005). The NPS ARD recommends a visibility desired condition that is consistent with this Clean Air Act goal. Based on the Organic Act mandates, the NPS ARD recommends the same desired conditions for Class I and Class II parks. Gateway is a Class II park.

Currently, visibility conditions at Gateway are not meeting NPS ARD–recommended desired conditions and therefore warrant "significant concern" as indicated by the NPS ARD standards. For 2005–2009, estimated average visibility in Gateway was 12.0 dv above estimated natural conditions, whereas desired conditions are less than 2 dv above natural conditions. This is a condition status that also warrants significant concern. Table 3-1 describes and assesses visibility conditions and trends at Gateway in more detail. As detailed in the analysis of impacts on air quality in chapter 4 of this GMP/EIS, the great majority of pollutants, including those that affect visibility, come from sources outside the park.

Table 3-1. Air Quality Conditions and Trends at Gateway.

Indicators of Condition	Specific Measures	Condition Status/ Trend[a]	Rationale	Reference Condition
Ozone	Annual 4th-highest 8-hour concentration		**Condition:** The estimated ozone level from 2005 to 2009 at Gateway was 82.1 parts per billion (ppb); therefore, condition status warrants significant concern. Gateway falls within a county designated by the EPA as "nonattainment" for the ground-level ozone standards of an 8hour average concentration of 75 ppb. A risk assessment that considered ozone exposure, soil moisture, and sensitive plant species concluded that plants at Gateway were at high risk for ozone damage. Ozone-sensitive plants in the park include quaking aspen *(Populus tremuloides)* and chokecherry *(Prunus virginiana).* **Trend:** During 2000–2009, ozone levels at Gateway monitor improved. **Confidence:** The degree of confidence at Gateway is high because there is a nearby or on-site ozone monitor.	NPS ARD Benchmarks: Resource is in Good Condition: ≤ 60 ppb Warrants Moderate Concern: 6175 ppb Warrants Significant Concern: ≥ 6 ppb
Deposition	Sulfur wet deposition		**Condition:** For 2005–2009, estimated wet sulfur deposition was 5.2 kilograms per hectare per year (kg/ha/yr)[b]; therefore, the condition status warrants significant concern. Although Gateway receives among the highest measured sulfur wet deposition of all monitored parks, a risk assessment evaluating ecosystem sensitivity ranked Gateway's ecosystems as having low sensitivity to acidification effects relative to all Inventory and Monitoring parks. Acidification effects include changes in water chemistry that impact aquatic vegetation, invertebrate communities, amphibians, and fish. **Trend:** No trend information is available because there are no on-site or nearby wet deposition monitors. **Confidence:** The degree of confidence at Gateway is medium because estimates are based on interpolated data from more distant wet deposition monitors.	NPS ARD Benchmarks: Resource is in Good Condition: < 1 kg/ha/yr Warrants Moderate Concern: 13 kg/ha/yr Warrants Significant Concern: > 3 kg/ha/yr

Table 3-1. Air Quality Conditions and Trends at Gateway (continued).

Indicators of Condition	Specific Measures	Condition Status/ Trend[a]	Rationale	Reference Condition
Deposition	Nitrogen wet deposition		**Condition:** For 2005–2009, estimated wet nitrogen deposition was 4.4 kg/ha/yr[b]; therefore, the condition status warrants significant concern. Gateway receives among the highest measured nitrogen wet deposition of all monitored parks. A risk assessment evaluating ecosystem sensitivity ranked Gateway's ecosystems as having moderate sensitivity to nutrient enrichment effects relative to all Inventory and Monitoring parks. Nitrogen deposition may disrupt soil nutrient cycling and affect biodiversity of certain vegetative communities, including wetland plant communities. **Trend:** No trend information is available because there are no on-site or nearby wet deposition monitors. **Confidence:** The degree of confidence at Gateway is medium because estimates are based on interpolated data from more distant wet deposition monitors.	NPS ARD Benchmarks: Resource is in Good Condition: < 1 kg/ha/yr Warrants Moderate Concern: 13 kg/ha/yr Warrants Significant Concern: > 3 kg/ha/yr
Visibility	Haze index[c]		**Condition**: For 2005–2009, estimated average visibility in Gateway was 12.0 dv above estimated natural conditions[d]; therefore, the condition status warrants significant concern. **Trend:** No trend information is available because there are no on-site or nearby visibility monitors. **Confidence:** The degree of confidence at Gateway is medium because estimates are based on interpolated data from more distant visibility monitors.	NPS ARD Benchmarks: Resource is in Good Condition: < 2 dv above natural conditions[d] Warrants Moderate Concern: 28 dv above natural conditions[d] Warrants Significant Concern: > 8 dv above natural conditions[d]

Sources: Kohut 2004; NPS ARD 2013; Sullivan et al. 2011a, 2011b.

[a]Interpolations of air quality monitoring data averaged over a five-year period (2005–2009) are used to evaluate conditions. Trend analyses are completed using 10 years (2000–2009) of data from on-site or nearby monitors.

[b]Reporting units for wet deposition conditions and trends are different. Wet deposition trends are evaluated using pollutant concentrations in precipitation (micro equivalents/liter) so that yearly variations in precipitation amounts do not influence trends analyses. Wet deposition conditions are based on nitrogen and sulfur loading (kilograms per hectare per year) to ecosystems.

[c]Visibility trend and condition calculations are expressed in terms of a haze index in deciviews (dv); however, the benchmark metrics are different. Condition assessments are based on interpolation of the five-year average current visibility minus estimated average natural visibility, where average visibility is the mean of visibility between 40th and 60th percentiles. Visibility trends are computed from the haze index values on the 20 percent haziest days and the 20 percent clearest days, consistent with visibility goals in the Clean Air Act.

[d]Natural visibility conditions are those estimated to exist in a given area in the absence of human-caused visibility impairment. The Clean Air Act established a goal of restoring visibility in all Class I areas to natural conditions. Estimated annual average natural condition equals 8.1 dv at Gateway.

Condition Status		Trend in Condition		Confidence in Assessment	
	Warrants Significant Concern		Condition is Improving		High
	Warrants Moderate Concern		Condition is Unchanging		Medium
	Resource is in Good Condition		Condition is Deteriorating		Low

NAAQS and Current Conditions

The New York Department of Environmental Conservation maintains an air quality monitoring system that includes the Jamaica Bay Unit. Data from the early 2000s indicate that the pollution levels for CO, NOx, and PM10 were below the NAAQS (FHWA 2006). The ozone concentrations exceeded the NAAQS for both the 1-hour and 8-hour averaging period. The PM2.5 concentration for the 24-hour averaging period met the NAAQS, but the annual concentrations continued to violate the standard. Table 3-2 shows measured concentrations at or near the park in assessment of the impacts of possible transportation methods at Jamaica Bay studied in 2005 and 2006 (FHWA 2006). For this table, data were taken from several sources, including Jamaica Bay Transportation Studies (FHWA 2006) and two recent New York City EISs (NYCPC 2012a, 2012b).

Table 3-2. Concentrations of Regulated Pollutants Compared to NAAQS.

Pollutant	Averaging Period	Concentration Measured at Gateway or Nearby	NAAQS (Federal Standard)
CO	8-hour	2.5 ppm	9 ppm
CO	1-hour	3.2 ppm	35 ppm
NO_x	Annual	47 μg/m^3	100 μg/m^3
NO_x	1-hour	126 μg/m^3	0.1 ppm or 188 μg/m^3
SO_2	1-hour	67.7 μg/m^3	0.075 ppm or 196 μg/m^3
Ozone	8-hour	0.086 ppm	0.075 ppm
Ozone	1-hour	0.116 ppm	0.12 ppm
PM_{10}	Annual	20 μg/m^3	50 μg/m^3
PM_{10}	24-hour	50–53 μg/m^3	150 μg/m^3
$PM_{2.5}$	Annual	16.3 μg/m^3	15 μg/m^3
$PM_{2.5}$	24-hour	36.5 μg/m^3	35 μg/m^3

Sources: FHWA 2006; NYCPC 2012a, 2012b.
CO = carbon monoxide; ppm = parts per million; NOx = nitrogen oxides;
μg/m3 = micrograms per cubic meter; SO2 = sulfur dioxide; PM10 = particulate matter ≤ 10 microns;
PM2.5 = particulate matter ≤ 2.5 microns

As mentioned in the "National Ambient Air Quality Standards and Public Health" section, the EPA has recently finalized a new 1 hour NO2 standard (February 29, 2012). The measured NO2 amount reported in table 3-2 is less than the new standard, but does not yet meet the criteria for attainment. This is because additional monitoring is required to determine whether concentrations are met over several years of data collection. Therefore, the EPA has designated the entire state of New York as "unclassifiable/attainment" for the new 1-hour NO2 standard.

The EPA also established a new 1-hour SO2 standard, replacing the 24-hour and annual standards, effective August 23, 2010. Based on the available monitoring data, all New York State counties had met the 1-hour standard as of 2011, but additional data were needed to make attainment designations.

Attainment

As noted in the "NPS Air Quality Conditions and Current Trends" section, Gateway is designated a Class II air quality area. This designation protects air quality by allowing only limited increases over baseline concentrations for NOx, SO2, and PM. These pollutants are characteristic of the EPA's New York-New Jersey-Connecticut Air Quality Control Region, an area that includes the park. Table 3-2 shows concentrations of pollutants and table 3 3 summarizes the air quality attainment status for the six criteria pollutants in the region. Those pollutants for which Gateway and the surrounding area meet the NAAQS are designated as "attainment" status. For those pollutants that are still above the levels allowed by the NAAQS, Gateway and the surrounding area is designated as "non-attainment," and for those pollutants for which the park and regional area had been in non-attainment but has improved to meet attainment standards, the park is listed as a "maintenance area."

Table 3-3. Gateway Air Quality NAAQS Attainment Status (2006).

Pollutant		Averaging Period	Attainment Status
CO		8-hour	Maintenance area
NO_x		Annual	Attainment
Ozone		1- and 8-hour	Non-attainment
PM	PM_{10}	Annual and 24-hour	Attainment
	$PM_{2.5}$	Annual and 24-hour	Non-attainment
Pb		Quarterly	Attainment
SO_2		Annual/24-hour and 3-hour	Attainment

Source: FHWA 2006.
CO = carbon monoxide; NOx = nitrogen oxides; PM10 = particulate matter ≤ 10 microns; PM2.5 = particulate matter ≤ 2.5 microns; Pb = lead; SO2 = sulfur dioxide

Gateway-specific CO Measurements

The Jamaica Bay Transportation Studies document (FHWA 2006) also measured CO, which is indicative of vehicle use, at Floyd Bennett Field and Jacob Riis Park and predicted how this would change over time assuming reasonably foreseeable future changes in EPA regulations and park compliance with the new regulations. At Floyd Bennett Field, the Federal Highway Administration found that 1-hour CO concentrations under the 2005 existing conditions ranged from 6.1 to 6.3 ppm (NAAQS is 35 ppm). The 2005 existing condition 8-hour CO concentrations ranged from 4.3 to 4.4 ppm (NAAQS is 9 ppm). Under the 2025 no-action alternative in the environmental assessment, the analysis predicted that the 1-hour CO concentrations would range from 5.8 to 6.0 ppm and the 8-hour CO concentrations from 4.1 to 4.2 ppm (FHWA 2006).

Jacob Riis Park 1-hour CO concentrations under the 2005 existing conditions ranged from 5.7 to 6.3 ppm. The 2005 existing condition 8-hour CO concentrations ranged from 4.0 to 4.4 ppm. Under the 2025 no action alternative in the environmental assessment (FHWA 2006), the predicted 1-hour CO concentrations would range from 5.4 to 5.8 ppm and the 8-hour CO concentrations would range from 3.8 to 4.1 ppm. The predicted CO scenario was similar at the adjacent Fort Tilden.

Water Resources

Groundwater

Groundwater is subsurface water stored in aquifers (bodies of permeable rock or sediment capable of storing or transmitting water) and is a primary source of freshwater for a variety of human uses, including drinking water, agriculture, and commercial or industrial use (NRCS et al. 2001). The Sandy Hook and Staten Island Units overlie the New Jersey Coastal Plain aquifer system (EPA 2010). One of its constituent aquifers, the Sandy Englishtown aquifer, is at or near the surface of the southern portion of Sandy Hook (Herman et al. 1998). The Jamaica Bay Unit lies over the Brooklyn–Queens System composed of the Upper Glacial, Jameco, Magothy, and Lloyd aquifers. The Upper Glacial aquifer, composed of glacial moraine deposits up to 300 feet thick, is exposed at the surface throughout all of Kings and Queens Counties and overlies the three lower aquifers, which are generally composed of sands and gravels (EPA 2012).

Natural recharge to both aquifer systems is primarily through surface water derived from precipitation that percolates through natural habitats or restricted porous urban surfaces such as lawns and parks.

Natural recharge to both aquifer systems is primarily through surface water derived from precipitation that percolates through natural habitats or restricted porous urban surfaces such as lawns and parks (EPA 2010; NYCDEP 2007). Some seepage also occurs from the bottoms of lakes, ponds, and streams; however, most freshwater sources in the watersheds surrounding Gateway have been filled, diverted into the storm sewer system, or altered by channelization (NYCDEP 2007). Natural discharge in the New Jersey Coastal Plain aquifer is primarily to the surface through streams and springs that ultimately flow into bays or the ocean. Some surface discharge also occurs in the Brooklyn–Queens aquifer; however, much of the groundwater that is not pumped for human uses discharges laterally into surrounding saltwater bodies (EPA 2012). Groundwater pumping reduces the rate and volume of freshwater discharge to surrounding saltwater bodies, which can lead to saltwater intrusion at the freshwater/saltwater interface (NYCDEP 2007), although this in not currently occurring in the aquifers supplying Gateway.

Brooklyn–Queens and New Jersey Coastal Plain aquifer systems underly park sites. Historically, the Brookly-Queen aquifer supplied fresh water to meet the expanding growth of the New York City area in the late 1800s and into the 20th century. Pumping groundwater in Brooklyn ended in 1947 over concerns from saltwater intrusion and fell to 10 million gallons per day in Queens as water from upstate New York was increasingly used (NYCDEP 2007). The New Jersey Coastal Plain aquifer system has experienced a regional decline which has resulted in saltwater intrusion into many of its aquifers (EPA 2010). The EPA has defined as the New Jersey Coastal Plain system as a sole-source aquifer (SSA), an administrative designation that requires the EPA to review certain proposed projects in the designated area to protect groundwater resources from contamination. Areas that receive an SSA designation must use the aquifer to supply at least 50 percent of its drinking water needs and demonstrate that alternate sources would be physically, legally, or economically infeasible to use. Much of the surface water that would normally recharge the aquifers is intercepted by the impervious surfaces of the highly urbanized watershed or channeled into storm sewers and CSOs that flow to the bays before they have an opportunity to percolate (USACE and PA 2009; NYCDEP 2007). Thus Gateway, with its open spaces, natural habitats,

and soils with coarse particles that allow for rapid movement of water into the soil (NRCS et al. 2001), is an important resource for groundwater recharge to sustain the region's important aquifers.

Surface Water

More than half of Gateway's area is composed of 16,200 acres of surface water systems, including the Atlantic Ocean, estuarine wetlands and bays (Jamaica, Sandy Hook, and Lower New York Bays), creeks and tributaries, and freshwater wetlands and ponds (NRCS et al. 2001). Lower New York Bay provides deeper marine habitat, while Sandy Hook and Jamaica Bays have shallower waters, generally less than 20 feet deep (USACE and PA 2009). The characteristics of these water bodies are discussed in more detail in the "Marine Resources" section of this GMP/EIS. For much of the surface waters of the bays, including the extensive saltmarshes and mudflats, the most important hydrologic features are the semidiurnal tides of the bays and ocean (Edinger et al. 2008b). The Hudson and Raritan Rivers are the primary natural sources of freshwater to the regional estuary system, with the Navesink and Shrewsbury Rivers contributing locally to the Sandy Hook Bay estuary. However, Hudson and Raritan River flows have been reduced by upstream reservoirs, impoundments, and water treatment facilities. Contributions by natural tributaries, now mostly filled or diverted, have been replaced in importance throughout most of the region by outflows from water treatment plants, CSOs, and stormwater runoff, which cause localized increases in freshwater flow that reduce natural salinity gradients (USACE and PA 2009).

Dredging has increased the overall water volume in Jamaica Bay, for example, which was historically 11 feet deep on average but has increased to an average depth of 16 feet, in part from shipping channels and borrow pits up to 50 feet deep. This has resulted in an overall 350 percent increase in water volume (NYCDEP 1994, as cited in NYCDEP 2007). The deeper waters created by dredging act as a sediment sink (NYCDEP 2007), which has consequences for sediment accretion important to saltmarsh development throughout much of the region (USACE and PA 2009); however, in Jamaica Bay, factors such as excess nitrogen loading and phytotoxins (e.g., hydrogen sulfide [H_2S]) appear to be more important contributors to saltmarsh loss (Renfro et al. 2010). Shoreline alterations and dredged sediment sinks also affect natural flows and flushing, resulting in decreased water quality (USACE and PA 2009). Dredging and other engineering modifications in Jamaica Bay have also expanded tidal ranges to increase the maximum elevation of high tides, which is further amplified by rising sea levels (Swanson and Wilson 2008). These hydrological changes have contributed to saltmarsh losses in Jamaica Bay.

Compared to estuarine and marine waters, freshwater wetlands and ponds (deepwater habitats) as defined by Cowardin et al. (1979) are few in number at Gateway. Freshwater wetlands cover approximately 24 acres, including forested swamps, marshes, swales, and wetlands created as part of mitigation projects (Edinger et al. 2008b). Most permanent ponds in Gateway were created by artificial dredging. Three large permanent ponds were created in the Jamaica Bay Wildlife Refuge to improve wildlife habitat. The two largest ponds, East Pond (118 acres) and West Pond (45 acres), are artificially controlled by drainage valves to Jamaica Bay and have brackish water, whereas the smaller Big John's Pond is a

dredged freshwater pond (NRCS et al. 2001). The West Pond was breached by the Hurricane Sandy storm surge and is currently freely mixing with saltwater from Jamaica Bay. Nike Pond, Round Pond, and North Pond are small permanent ponds at Sandy Hook. Other ponds at the park are seasonal and dry up during drought conditions; these ponds include one artificially created pond in Great Kills Park on Staten Island, and several in the Floyd Bennett Field, Fort Tilden, and Breezy Point sections of the Jamaica Bay Unit (NRCS et al. 2001).

Water Quality

Water quality in bays, estuaries, and tributaries has been gradually improving since the Clean Water Act and other environmental legislation spurred the implementation of regulations and abatement programs to control the discharge of contaminants and pollutants from municipal and industrial sources.

Water quality in bays, estuaries, and tributaries has been gradually improving since the Clean Water Act and other environmental legislation spurred the implementation of regulations and abatement programs to control the discharge of contaminants and pollutants from municipal and industrial sources. The Staten Island and Sandy Hook Units have better water quality than Jamaica Bay because they receive a greater volume of freshwater from the Hudson and Raritan Rivers, resulting in greater mixing of freshwater and saltwater, which helps regulate pH and salinity, dilute contaminants, and lower bacterial counts. During the summer monitoring season, waters off Staten Island and Sandy Hook only occasionally exceed limits for bacterial counts set by state water quality standards (NPCA 2007a).

In contrast, Jamaica Bay suffers from water quality issues because it is relatively enclosed. Tidal flushing is limited to the Rockaway Inlet, whereas freshwater flows are primarily contributed by urban runoff and sewer outflows. Overall, recent water quality trends in Jamaica Bay show improvement, including increased dissolved oxygen (DO) and decreased fecal coliform counts. However, the 240–340 million gallons per day of treated sewage effluent flowing into Jamaica Bay continues to be a major source of pollution, including treatment byproducts such as chlorine, and heavy metals and other contaminants that are not eliminated by water treatment facilities (NPCA 2007a). In addition, large rain events can overwhelm the sewer system capacity, resulting in untreated wastewater and raw sewage entering the bays of the Hudson-Raritan estuary system (USACE and PA 2009).

The four wastewater pollution control plants (WPCPs) that flow into Jamaica Bay are the most important source of nitrogen, phosphorous, silica, and carbon loads, while CSOs concurrently contribute the highest quantity of pathogens (e.g., fecal coliform) (NYCDEP 2007). Sewage effluent also carries the largest concentrations of nickel, zinc, copper, and cadmium, heavy metals that are not eliminated by treatment in WPCPs. Landfill leaching is a smaller source of heavy metals, and atmospheric deposition is the most important source of lead contamination (NPCA 2007a). Other contaminants include pharmaceuticals, soaps, floating debris (e.g., trash), and stormwater ~~toxic~~ runoff from the John F. Kennedy International Airport (USACE and PA 2009). Although WPCP and CSO outflows and other overland runoff are a well-understood source of pollution and contaminants, groundwater discharge into the estuary from subterranean zones of the surrounding aquifer system are another potential source of dissolved metals, nitrogen, and other compounds, and requires further study (Beck et al. 2009; Benotti et al. 2006).

Nitrogen and phosphorous are typically limiting nutrients in estuarine ecosystems, keeping algal growth in check. An estimated 36,600 pounds per day of nitrogen are discharged into

Jamaica Bay from WPCP outflows, accounting for 95 percent of the nitrogen load (NYCDEP 2007). Excess nutrient loading, a condition known as eutrophication, stimulates the growth of invasive plants and causes phytoplankton and algae blooms. Counts of chlorophyll a, a photosynthetic pigment produced by algae and used in water quality monitoring to indicate eutrophication, have been increasing in Jamaica Bay over time (NYCDEP 2007). High nitrogen levels can decrease root production in saltmarsh plants, decreasing their ability to accumulate organic material and hold sediments together and leading to saltmarsh loss as plants and sediments are washed away by the erosive force of storms (Rafferty, Castagna, and Adamo 2010; Kolker 2006, as cited in JBWPPAC 2006). High nitrogen levels also increase microbial decomposition, reducing the accumulation of organic matter and limiting the ability of saltmarshes to maintain an elevation that keeps pace with rising sea levels (Rafferty, Castagna, and Adamo 2010).

High nutrient loads from WPCP outflows are a major contributor to low DO levels in Jamaica Bay. DO ranges from 3.5 to 18.5 milligrams per liter (mg/L), sometimes falling below the 5.0 mg/L threshold specified by state water quality standards for waters suitable for recreation and fishing. Long periods of low DO can harm or kill larval fish and shellfish, and lead to odor problems from production of H2S gas in oxygen-deficient sediments. High concentrations of DO in the water column can also indicate poor water quality, and typically occur when algal blooms near the surface create very high to supersaturated DO concentrations as a byproduct of photosynthesis. While there is high year-to-year variability in measured DO concentrations, long-term monitoring suggests DO levels are trending toward improvement (NYCDEP 2007).

In addition to reducing infiltration and recharge of groundwater aquifers, the increase in hard or impervious surfaces from urbanization causes excess sediment to be conveyed by runoff. This sediment-laden runoff can reduce water clarity, impacting sensitive organisms and habitats including oyster reefs, eelgrass beds, fish, and aquatic invertebrates. Runoff can also increase erosion through scouring, which has deteriorated interior islands and shorelines over time (USACE and PA 2009). Water clarity in Jamaica Bay has declined by more than 20 percent over the past 30 years (JBWPPAC 2006).

Subaqueous Sediments

Contaminants dissolved or suspended in water adhere to organic compounds and settle into sediments. Before pollution regulations were put in place, large quantities of chemicals, including heavy metals, pesticides, PCBs, DDT, and dioxin, were discharged into the waters of Jamaica Bay, polluting the sediments of the bay and its wetlands. Contaminated sediments are difficult to remove; therefore, these “legacy chemicals” persist and exceed acceptable levels in many areas of the bay. In addition to these historical sources, chemicals from modern sources including industrial discharges, WPCP discharges, CSOs, stormwater runoff, non-point source discharges, landfill leachates, atmospheric deposition, and chemical and oil spills continue to contaminate Jamaica Bay sediments. Many chemicals that taint sediments are readily absorbed into animal fat cells, where they can accumulate to dangerous levels. As a result, consumption advisories are in place for some of the region’s fish and shellfish species (USACE and PA 2009).

Coastal wetlands and eelgrass beds, marine plant ecosystems once extensive throughout the estuary, perform a variety of water quality functions, including stabilizing sediments and retaining and recycling nutrients.

Wastewater discharge into Jamaica Bay and other estuarine waters includes trace organic compounds from contaminants such as household and industrial products, personal care products, pharmaceuticals, detergents, and pesticides. Some of these compounds and their chemical breakdown products have hormone-like properties (e.g., "estrogenic compounds") that disrupt reproduction, development, and other endocrine-mediated processes in aquatic organisms (Furlong et al. 2010; JBWPPAC 2006). These compounds can affect the reproduction of some fish populations by skewing the male-to-female sex ratios (Furlong et al. 2010); for example, winter flounder from Jamaica Bay, which also show reduced hatch rates and delayed development (McElroy 2006, as cited in JBWPPAC 2006). Water treatment processes can influence the amount of endocrine-disrupting trace organics discharged into bay waters. A recent study showed aerobic digestion of activated sludge removed 90 percent of estrogenic compounds, while anaerobic treatment of biosolids actually increased the amount of estrogenic compounds (Furlong et al. 2010). Because biosolids are sometimes used as a soil amendment, more research is needed to investigate groundwater discharge from biosolid-amended soils as a potential source of contamination (Furlong et al. 2010).

Coastal wetlands and eelgrass beds, marine plant ecosystems once extensive throughout the estuary, perform a variety of water quality functions, including stabilizing sediments and retaining and recycling nutrients. Coastal wetlands can capture and attenuate high levels of nitrogen, reducing the effects of eutrophication and nitrogen loading that contribute to low DO levels. Coastal wetlands can effectively capture up to 95 percent of chemical substances discharged into the saltwater ecosystem (Ringenary, pers. comm. 2013a). In addition to continued controls on municipal and industrial outflows, restoration of coastal wetlands and eelgrass beds is an essential component of effective water quality improvement plans in the region of Gateway (USACE and PA 2009). While eelgrass beds have been virtually eliminated from the Gateway's vicinity and are absent within the boundaries of the park, much of Jamaica Bay and the bayside coastal areas of Sandy Hook may provide suitable restoration sites (USACE and PA 2009). Wetland restoration projects could also expand the 1,200 acres of saltmarsh in Gateway, which are concentrated mostly in Sandy Hook and Jamaica Bays (Edinger et al. 2008b).

Wetlands, Floodplains and Flooding

New York City and the adjacent region of New Jersey are built around a complex of narrow rivers, estuaries, islands, and waterways that are strongly influenced by tides and weather. Much of the metropolitan region, including most of Gateway, is low in elevation and is at risk from strong storm surge flooding for both tropical systems and nor'easter cyclones (Colle et al. 2008). The complex coastal geometry and bathymetry surrounding the New York City metropolitan region can increase the water levels and create difficult coastal flood forecasts. Storm surge is enhanced in this region by the relatively shallow continental shelf and the southward bend in the coast from Long Island to New Jersey, which can funnel water toward the New York City harbor area when there are low-level easterly winds (Bowman et al. 2005, as cited in Colle, Rojowsky, and Buonaiuto 2010). Although coastal flooding from strong storms is most likely and potentially most damaging, the coastal marsh and back-bay areas of the region can also lead to localized flooding (Colle, Rojowsky, and Buonaiuto 2010).

Floodplains

As demonstrated in October 2012 when Hurricane Sandy struck, the area is also vulnerable to flooding from hurricanes, although by the time Sandy made landfall in New York City, it had been downgraded to post-tropical cyclone status.

Coastal Flooding—*Extreme Storms*

As demonstrated in October 2012 when Hurricane Sandy struck, the area is also vulnerable to flooding from hurricanes, although by the time Sandy made landfall in New York City, it had been downgraded to post-tropical cyclone status. Nonetheless, the cyclone brought winds of up to 85 mph and total rainfall of about 1 inch across the city. Some of the heaviest damage in the area was in the New York Harbor and included Gateway and other NPS properties (NPS 2013a). A combination of high tides, wind-blown waves, and the enormous circulation of the superstorm pushed water to a peak surge of nearly 14 feet (Fleshler and Nolin 2012). Its amplified wave height and reach, along with strong winds, pushed sand across roads, parking lots, and structures, flooded structures and destroyed machinery, and took beach sands with it as it receded, resulting in a patchwork of coastal erosion and inland areas covered in sand.

Hurricane Sandy is not an isolated event. For example, in 1992 a winter storm—or "nor'easter"—caused water levels at the southern tip of Manhattan to peak at about 8 feet above mean sea level (Colle, Rojowsky, and Buonaiuto 2008). Hurricanes have struck New York City, including memorable storms in 1821 and 1938 and several in the mid-twentieth century (NYCOEM 2013). A major hurricane could result in storm surges of 30 feet in some parts of the city (NYCOEM 2013). Sea-level rise may also be increasing flood risk in the region and along the entire coastline.

Although tropical cyclones like Sandy primarily flood coastal areas where the storm comes ashore, winter storms or nor'easters can cause much wider-ranging damage and major coastal erosion (Colle et al. 2010). Climatologists have found there is an average of 12 winter storms along the eastern coast of the United States each year. A 2000 study (Zhang et al., as cited in Colle, Rojowsky, and Buonaiuto 2010) found no significant trends in the number and intensity of these storms or accompanying large wave surge events over the last several decades, although variability occurs from year to year or even decade to decade.
Flooding from storm surge, high tides, and wind during Hurricane Sandy occurred in the following locations:

In the Jamaica Bay Unit (NPS 2012f):

- Flooding damaged the Canarsie Pier shoreline and the structures on the pier.
- Some of the islands in Jamaica Bay (east islands and hassocks) were flooded.
- Jamaica Bay Wildlife Refuge East and West Ponds were breached, and the West Pond remains breached.
- Lower-elevation vegetative communities were flooded.
- All of Fort Tilden was flooded from both the ocean and bay side with enough force to diminish dunes by several feet on the beach side.

Storm surge in the New York/New Jersey area usually varies from 0.5 to 1 meter, but has reached 2 meters, as it did in 1985 during Hurricane Gloria.

- In Fort Tilden, the Shore Road and fisherman's parking lot were covered in sand, and a significant portion of the road was reduced to rubble, indicative of high waves and strong winds from south to north.

- At Jacob Riis Park, coastal flooding removed a massive amount of beach, but winds also covered much of the park north of the beach in sand. Ocean waters flowed through the first floor of the bathhouse and protective dunes adjacent to it were destroyed.

In the Staten Island Unit (NPS 2012c):

- At Fort Wadsworth, the shoreline south of the Verrazano-Narrows Bridge was flooded, although steep grading helped protect the rest of the fort.

- Wind and storm surge carried sand to cover parking lots and block roads at Great Kills Park.

In the Sandy Hook Unit, considered by the NPS as the park unit mostly heavily affected by Hurricane Sandy (NPS 2012c):

- Flooding damaged most NPS infrastructure and rendered water and wastewater systems inoperable (NPS 2012d).

- Much of the interior areas of the cedar/holly forest were flooded, as were other interior areas of maritime shrub lands (NPS, pers. comm. 2013e). Dunes here normally protect these areas from overwash flooding during storms.

- In the vicinity of the Sandy Hook Visitor Center, structures were swamped by floods, destroyed by wind, and covered in sand.

- Roads were covered in sand and substantial loss of beach occurred in some areas (notably the area near Sea Gull's Nest).

Coastal Flooding—*Average Storms*

Storm surge in the New York/New Jersey area usually varies from 0.5 to 1 meter, but has reached 2 meters, as it did in 1985 during Hurricane Gloria. Fortunately, Gloria made landfall during a low tide cycle; as noted earlier, Hurricane Sandy came ashore during a high tide cycle. In analyzing storm surge for the years 1959 to 2007, Colle, Rojowsky, and Buonaiuto (2010) found 253 data points for storm surges between 0.5 and 0.6 meter and only 4 data points for storm surges greater than 1.5 meters. For these years, this study found between 0 and 14 minor (less than 1 meter) events and on average between five 5 and 7 per year. Wind direction was not correlated with the size of a storm surge, but wind speed was. Wind speeds associated with larger surge (greater than 1 meter) were 44 percent stronger than those for minor storm surge. High tide combined with storm surge and wind speed also increased flooding, and is associated with a coastal flood advisory and/or warning depending on the storm surge.

Wetlands

Localized Flooding in Wetlands

As noted earlier, localized flooding can occur in low-lying areas, such as wetlands or former wetlands. The Jamaica Bay Unit contains the largest proportion of tidal marsh in Gateway—a landscape that is naturally gently sloping and subject to tidal flooding. Although wetlands are low lying and can experience flooding, they are also important as floodwater storage areas, as well as for floodwater conveyance, wave attenuation, and erosion control (USDA et al. 2001). Gateway also has several fringing estuarine or saltmarsh wetlands subject to coastal or tidal flooding, and inland floodplains include the swamp white oak forest and parts of Floyd Bennett Field.

Wetland Ecosystems

Wetland ecosystems are characterized by saturation, with water as the dominant factor influencing substrate or soil development (hydric soils). Vegetation in wetlands is dominated by hydrophytes, or plants with physiological adaptations to saturated conditions. Wetlands are classified according to characteristics of their hydrology, soil, and vegetation (Cowardin et al. 1979).

Wetlands at the park are the natural legacy of Pleistocene glacial scouring, followed by thousands of years of dynamic coastal processes such as wave action, longshore currents, erosion, and sediment accretion. Human disturbances including historical land uses, dredge and fill activities of the bays and marshes, hard-edged constructed shorelines, ongoing urban development, sewage and wastewater outflows, and the introduction of nonnative, invasive species have altered the natural extent, function, and type of wetland habitats at Gateway, contributing to the overall "poor" rating of natural resource conditions at the park (NPCA 2007a). In addition to the value of wetlands in storing and conveying floodwater discussed earlier, wetlands also reduce erosion by protecting coastlines from wave action, improve water quality by removing sediments and contaminants, and provide habitat for fish, wildlife, and unique plant communities (NRCS et al. 2001). These ecosystem services are diminished when wetland systems are degraded, fragmented, or lost, spurring the effort by regional managing agencies including the NPS to mitigate and restore wetlands in the New York Harbor region (NYCDPR 2010; USACE and PA 2009; NYCDEP 2007; JBWPPAC 2006; NPS 2004d).

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Wetland Types: Estuarine

Estuaries are nearshore aquatic habitats where ocean water mixes with freshwater runoff from the land (the watershed), creating a gradient of salinities (Lawrence, Roman, and Frame 2010). Fluctuating water levels, salinity gradients, mixing of warm and cold waters, and sediment and nutrient loads contribute to the productivity and biodiversity of estuarine ecosystems (Levinton and Waldman 2006). The hydrology, water chemistry, vegetation, and soil development in estuarine wetlands are affected by factors such as tides, wind and low-energy wave action, and mixing of saltwater with freshwater from runoff or precipitation (Cowardin et al. 1979). The Hudson and Raritan rivers and outflows from urban water

treatment facilities are the primary sources of freshwater, sediment, and nutrients to the park's estuarine ecosystems (Lawrence, Roman, and Frame 2010).

Within the park, the significant estuarine areas are Jamaica Bay and Sandy Hook Bay (Lawrence, Roman, and Frame 2010), with some additional smaller areas along the coastline of the Great Kills section of the Staten Island Unit. Most of the over 11,700 acres of estuarine wetland communities within park boundaries are intertidal marshes and mudflats (Edinger et al. 2008b), including the numerous islands and "hassocks" (islands of peaty or mucky soil saturated by high tides) of the Jamaica Bay Wildlife Refuge (Rowan 2012). These wetlands range from North Atlantic high saltmarshes at the high-water mark, to North Atlantic low saltmarshes near open water in the regularly flooded intertidal zone, to North Atlantic Coast estuarine intertidal mudflats that are completely exposed only during low tides. Other tidally influenced wetlands, including salt panne marshes and brackish meadows, occur within the complex of saltmarshes and mudflats, whereas non-tidal wetlands such as coastal salt pond marshes occur in the splash zone on beaches and behind dunes.

North Atlantic Coast estuarine intertidal mudflats are saline habitats characterized by a silty mud substrate rich in organic matter, with moderate fluctuations in salinity and moisture due to low-energy wave action.

North Atlantic Coast estuarine intertidal mudflats are saline habitats characterized by a silty mud substrate rich in organic matter, with moderate fluctuations in salinity and moisture due to low-energy wave action. At the park, they are located at Great Kills in the Staten Island Unit and in Jamaica Bay at the Jamaica Bay Wildlife Refuge and Plumb Beach. Intertidal mudflats typically lack vegetation, although some are densely covered by sealettuce *(Ulva lactuca),* a green algae (Edinger et al. 2008b). Historically, mudflat vegetation was dominated by eelgrass, a species that is extirpated here but that once formed extensive beds throughout Jamaica and Sandy Hook Bays (Lawrence, Roman, and Frame 2010).

North Atlantic low saltmarsh, dominated by smooth cordgrass, is flooded twice daily by tides, allowing the development of deep, poorly drained soils, sometimes with thick organic deposits, ranging from mucky peat to mucky fine sandy loam in the Ipswich, Pawcatuck, and Sandy Hook series (Edinger et al. 2008b; NRCS et al. 2001).

Further inland, **North Atlantic high saltmarsh** vegetation is irregularly flooded by high and spring tides along the coastlines of the Sandy Hook Unit and the Breezy Point, Fort Tilden, Floyd Bennett Field, Canarsie Pier, and Jamaica Bay Wildlife Refuge sections of the Jamaica Bay Unit. Soils range from mucky peat to coarse sand in the Matunuck, Sandy Hook, Bigapple, Breeze, Ipswich, and Jamaica series, and the characteristic vegetation includes cordgrass and inland saltgrass (Edinger et al. 2008b; NRCS et al. 2001).

Cordgrass-dominated saltmarshes are maintained by annual accretion of sediment, anchored by the roots of vascular vegetation. These habitats are rapidly disappearing from the park, with losses as high as 50 acres per year. They erode or lose vascular vegetation and transform into mudflats due to a combination of factors including pollution, excess nutrient enrichment, reduced sediment deposition from dredging and constructed coastlines, and sea-level rise (NPS 2010b; NPCA 2007a). Since colonial times, an estimated 80 to 95 percent of the New York Harbor saltmarshes have disappeared (NRCS et al. 2001). In addition to rapid saltmarsh losses, many habitats have been invaded by a nonnative strain of common reed *Phragmites australis,* which responds to disturbance and forms dense colonies that exclude most other plant species. *Phragmites* is also present in much of the park's freshwater

wetland habitat and covers about 1,120 acres of wetlands in the park (Mellander, pers. comm. as cited in Lawrence, Roman, and Frame 2010).

Approximately 12 acres of **salt panne** marshes occur in shallow, poorly drained depressions within or at the margins of high and low saltmarsh communities in Sandy Hook and Jamaica Bay. These impounded depressions are created by ice-scouring, rafting flotsam, peat compaction, mosquito ditch levees, or erosion of tidal creek banks. Evaporation during low tides results in hypersaline conditions, resulting in a prevalence of bare peat or muck substrate. Vascular plants are typically sparse or absent, although some pannes may be characterized by dense stands of salt-tolerant glasswort species (Edinger et al. 2008b). The mucky peat to finer-grained sandy soils were formed from deep sediments derived from the Sandy Hook, Matunuck, Hooksan, Bigapple, and Jamaica soil series (NRCS et al. 2001).

Between high saltmarshes or beaches and more upland communities, **brackish meadows** are wetland grasslands dominated by switchgrass and saltmeadow cordgrass that occur on freely draining, shallow, sandy peat overlying glacial till. Soil moisture is maintained by groundwater seepage and irregular tidal flooding, usually during spring tides or storm surges. Most of the 26 acres of brackish meadow occur in the Sandy Hook Unit, with some communities near Canarsie Pier in Jamaica Bay (Edinger et al. 2008b). Brackish meadows are considered imperiled in New York State and may be at high risk of extinction (Lawrence, Roman, and Frame 2010).

Less than 4 acres of one non-tidal estuarine wetland type, **coastal salt pond marsh,** occur in the Breezy Point and Floyd Bennett Field sections of the Jamaica Bay Unit, separated from the ocean by surrounding beaches, dunes, and maritime shrub lands. Overland flow and precipitation contribute freshwater, whereas storm overwash, tidal breaches, and seepage across the barrier beach provide an infrequent source of saltwater. Vegetation is most abundant in mudflat areas of the ponds that occasionally become exposed when water levels draw down. These mudflats are typically dominated by dwarf spikerush or smooth cordgrass (Edinger et al. 2008b).

Between high saltmarshes or beaches and more upland communities, brackish meadows are wetland grasslands dominated by switchgrass and saltmeadow cordgrass that occur on freely draining, shallow, sandy peat overlying glacial till.

Wetland Types: Palustrine

Palustrine wetlands are fed by freshwater sources including groundwater, overland runoff, and precipitation. They include all non-tidal wetlands, and wetlands in tidal areas that have less than 0.05 percent salinity derived from ocean salts (Cowardin et al. 1979). Historically, freshwater wetlands were extensive in the region as a result of the numerous drainage basins created by complicated glacial topography. However, 95 percent of these wetlands have been lost to centuries of urban development (Lawrence, Roman, and Frame 2010). Today, about 24 acres of freshwater and brackish palustrine wetlands remain in the park (Edinger et al. 2008b), including forested swamps, marshes and swales, wetlands along the margins of artificial ponds, and wetlands created as part of mitigation projects.

Three large **artificial ponds** in Jamaica Bay Wildlife Refuge were created to improve wildlife habitat diversity. East Pond (118 acres) and West Pond (45 acres) are brackish ponds overlying former saltmarshes that were impounded when shallow channels feeding the ponds were

filled with dredged sediments. Big John's Pond, between the two brackish ponds, is a smaller excavated freshwater pond that supports floating aquatic vegetation. Over time, the salinity of brackish water in East Pond and West Pond diminished to create a freshwater marsh community. Both East Pond and West Pond were breached because of storm surge from Hurricane Sandy. Although East Pond has been repaired, West Pond remains in a breached condition and open to tidal influence and Jamaica Bay. Water level in West Pond never exceeds that of high tide (NPS, pers. comm. 2013e; Rowan 2013).

Two unique wetland communities, **woolgrass marsh** and **mixed forb marsh,** have grown up in and around the ponds, particularly East Pond, and are not found elsewhere in Gateway. Artificial maintenance of East Pond regulates the hydrology of both irregularly flooded marshes. The 1 acre woolgrass marsh, dominated by eastern marsh fern with woolgrass bulrush and *Phragmites*, occurs on deep, poorly drained sandy soil in the Jamaica series. The 0.3-acre mixed forb marsh occurs on Jamaica gravelly sand and is characterized by a diverse assemblage of characteristic species including fox sedge, spotted joepyeweed, common boneset, and chairmaker's bulrush (Lawrence, Roman, and Frame 2010; Edinger et al. 2008b).

The **Northeastern Atlantic brackish interdunal swale** community occurs between coastal sand dunes on very deep sands in the Hooksan and Jamaica series. In Gateway, these swales are at Sandy Hook and in the Breezy Point section of the Jamaica Bay Unit. Hydrology and salinity levels vary due to the seasonally high groundwater table, sporadic tidal overwash, and salt spray. Vegetation is dominated by saltmeadow cordgrass with common threesquare and chairmaker's bulrush (Edinger et al. 2008b).

Similar to estuarine wetlands, most palustrine communities at Gateway have been invaded by an alien genotype of *Phragmites*. Japanese knotweed is another nonnative invasive species associated with disturbed areas that tends to form dense monocultures that exclude other plant species. The Japanese knotweed gravel bar wetland type occurs on fill derived from Greenbelt loam and Bigapple coarse sand. It can be found at Sandy Hook and in the Fort Wadsworth section of the Staten Island Unit (Edinger et al. 2008b).

Forested wetlands at Gateway include red maple/blackgum basin swamp and southern New **England red maple seepage swamp** vegetation associations, and swamp white oak forest. The 3 acre Southern New England red maple seepage swamp occurs only on the east side of East Pond in the Jamaica Bay Wildlife Refuge. Soils are Barren series sand transported to the site as fill, and the forest canopy is co-dominated by red maple and gray birch over a sparse understory (Edinger et al. 2008b). **Red maple/blackgum basin swamp** is an imperiled community with only 20 to 30 forests known in New York state, including one 0.3-acre patch in the north-central interior portion of the Sandy Hook Unit (Lawrence, Roman, and Frame 2010; Edinger et al. 2008b). This acidic, nutrient-poor wetland type dominated by blackgum occurs on very deep, poorly drained Jamaica sand (Edinger et al. 2008b).

The **swamp white oak forest** occurs only at Miller Field in the Staten Island Unit as a 12-acre remnant of undeveloped habitat surrounded by dense urban development (Lawrence, Roman, and Frame 2010). This forest occurs on very deep Pompton loam soils formed over

glacial outwash that are seasonally flooded in late winter and may contain vernal pools (Rowan 2013; Edinger et al. 2008b). The site was likely wetter in the past before storm sewer diversions were built in the 1980s, and the resulting drier conditions may contribute to the decline of swamp white oak, which can compete with other trees due to its tolerance of seasonal flooding. The swamp white oak forest is managed as a wetland under the 1979 GMP, but the community does not meet the criteria for wetland classification because it does not have hydric soils. More research is needed to determine whether hydric soils occur and what the historical hydrological regime of this forest is (Rowan 2013).

Marine Resources

This section describes general characteristics of soils, water, vegetation, and wildlife that are key to understanding the marine zone, an area that includes ocean waters and benthic (bottom or subaqueous) habitat and onshore to the intertidal community. Backdune and more inland vegetation or wildlife that occupy these habitats are discussed in the "Vegetation" or "Wildlife" sections of the GMP/EIS. Gateway includes approximately 27,025 acres of coastal lands and waters in New York and New Jersey. Nearly two-thirds of the park is estuarine and ocean waters. Approximately 1,700 acres of these waters are ocean and another nearly 16,000 acres are estuarine. The park has about 75 miles of shoreline (including islands) parkwide, including 31 miles of ocean beaches (Lawrence, Roman, and Frame 2010).

Figure 3-1 New York Bight.

The marine habitats of Gateway lie primarily in the nearshore zone of the New York Bight (see figure 3-1), a great expanse of shallow ocean between Long Island to the north and east and the New Jersey coast to the south and west. The term "bight" is a mariner's term for a bend or curve in the shoreline, and the New York Bight is outlined by the east/west-trending coast of Long Island and north/south-trending coast of New Jersey, which create a right angle where they intersect (USGS n.d.b). The average salinity of ocean areas is about 32 parts per thousand (ppt), subject to input from extreme periods of flooding rains. Winter water temperatures can be below 37°F, while summer temperatures can exceed 77°F (USFWS 1997c). This coastal zone is dominated by tides that influence horizontal movement and transport of water, sand, and other sediments.

The New York Bay (see figure 3-2) lies generally north of the Bight and is divided into the upper and lower New York Bay. Sandy Hook and Breezy Point Tip frame the entrance to Lower New York Bay. New York Harbor lies at the mouth of the Hudson River, which feeds the Upper New York Bay. Although the mix of saltwater and freshwater in the harbor and upper bay vary seasonally, tidally, and during and after storm events, average flow from the Hudson River to the harbor is 683 cubic meters per second. High and low tides occur twice daily (NPCA 2007b).

Figure 3-2. New York Bay and Harbor.

The Nearshore Ocean Zone

The nearshore zone is defined as that area of open water from the mean low-water line offshore to the 66 foot depth contour line (USFWS 1997c). The nearshore zone of the New York Bight is located between the boreal waters of New England and the semitropical region to the south; this intersection of habitat types is important to marine species diversity. The New Jersey nearshore zone, which extends from Sandy Hook to Cape May, is characterized by a high-energy sandy beach to the north and an extensive estuary system protected by barrier islands to the south. The underwater topography includes scour troughs and ridges formed by storm currents (USFWS 1997c).

More than 100 species of marine and anadromous boreal, temperate, and semitropical migratory fish use this productive ecosystem as a feeding area (Frame, pers. comm. 2013a). A number of these species are commercially important or caught by sport fishers, including weakfish *(Cynoscion regalis),* striped bass *(Morone saxatilis),* summer flounder *(Paralichthys dentatus),* and winter flounder *(Pseudopleuronectes americanus).* Atlantic menhaden *(Brevoortia tyrannus)* also provide an important food source for marine wildlife, including fish, birds, and marine mammals. Anadromous species that use the Hudson or other coastal rivers to spawn include Atlantic sturgeon *(Acipenser oxyrinchus)*, blueback herring *(Alosa aestivalis),* and Atlantic tomcod *(Microgadus tomcod)* (USFWS 1997c). The shallow nearshore area off the park sites along the Rockaway Peninsula is habitat for the endangered Atlantic sturgeon and is an important recreational fishery (Lawrence, Roman, and Frame 2010).

Because Gateway's boundaries extend to one-quarter mile offshore, it is likely that most of its managed ocean waters are in the nearshore zone. Historically, these ocean waters and bottom were populated by diverse species of marine mammals and sea turtles, but today they are best known for recreational fishing (Lawrence, Roman, and Frame 2010). Marine mammals continue to use the nearshore habitat of the New York Bight, however, and a number of porpoises, seals, and whales migrate along the coast (USFWS 1997c). Seals also haul out on park sites, including Hoffman and Swinburne Islands, during the winter months (Ringenary, pers. comm. 2013b).

The "benthos" is collectively all the organisms that live on the bottom or in the bottom sediments. Invertebrates, including clams and other shellfish, crustaceans (crabs and lobster), annelids (worms), shrimp, gastropods, and echinoderms (e.g., starfish) occupy benthic habitat in the nearshore. Although a brief survey in 2009 recorded at least 42 species of benthic invertebrates at the park (Ecology and Environment Inc. 2009, as cited in Lawrence, Roman, and Frame 2010), other longer-term studies of the bight have recorded 699 species of benthic macrofauna (USFWS 1997c).

Farther out to sea and not usually within the one-quarter mile offshore considered to be park waters is the continental shelf ecosystem. This is a vast zone of shallow water, which in

the New York Bight is adjacent to estuary systems that nurture or protect a number of fish species, contributing to the area's biodiversity (USFWS 1997c).

Like other aquatic systems, the nearshore marine environment is a ladder or pyramid of trophic levels of plants, herbivores, and carnivores, ultimately converting inorganic chemicals and the sun's energy into living matter. At each higher trophic level, total biomass decreases. The primary producers are plankton (small or single-celled plants or photosynthetic and cyanobacteria that serve as food for a number of animals), including zooplankton (very small, free-floating invertebrate animals), and filter-feeding benthic species. Zooplankton in turn serves as food for a wide spectrum of larger animals. Primary production is regulated by water temperatures and mixing, and there are sharp seasonal differences in plant growth and availability of phytoplankton (USFWS 1997c).

The center of Jamaica Bay is dominated by subtidal open water and extensive low-lying islands with areas of saltmarsh, intertidal flats, and uplands important for colonial nesting waterbirds.

Marine Environment at Gateway Park Sites

As noted above, the NPS manages waters out to one-quarter mile from its lands. These waters include the nearshore environments off lands on the Rockaway Peninsula (Breezy Point, Jacob Riis Park, and Fort Tilden), Plumb Beach, Sandy Hook and Raritan Bay, and the southeast shore of Staten Island, as well as Rockaway Inlet and Jamaica Bay. The geomorphology of beaches or shorelines at these sites is described in the "Soils and Geology" section of this chapter of the GMP/EIS.

Jamaica Bay and the Rockaway Inlet

Although Jamaica Bay is brackish (30 ppt or less salt) and not marine (greater than 30 ppt and less than 50 ppt salt), it is directly open to the Lower New York Bay and Atlantic Ocean via Rockaway Inlet and is discussed in this section because of the connection. Breezy Point Tip is located on the tip of the south edge of this inlet. Salinity in Jamaica Bay is 20–26 ppt. It is located adjacent to the confluence of the New York Bight and New York Bay where the right angle between the New Jersey and Long Island coasts intersect (USFWS 1997b). Freshwater input directly to Jamaica Bay is primarily from polluted sources, such as four wastewater treatment plants.

Historically, Jamaica Bay was shallow, averaging 11 feet deep on average. Because of dredging for shipping channels, and borrow pits to produce material to build up John F. Kennedy International Airport and other development, the average depth has increased to 16 feet (NYCDEP 1994, 2007). The center of Jamaica Bay is dominated by subtidal open water and extensive low-lying islands with areas of saltmarsh, intertidal flats, and uplands important for colonial nesting waterbirds. Because Jamaica Bay is located at the intersection of not only cooler ocean waters from the north and warmer currents from the south but also of the Hudson River–Raritan Bay estuary, it is considered part of a regionally important fish, wildlife, and plant habitat complex that also includes Breezy Point Tip (USFWS 1997b). Shorebirds, raptors and other land birds, waterfowl, and various migratory insects are concentrated near the coastlines. These migratory species are further massed into the remaining open space and waters of Jamaica Bay by the lack of habitat in surrounding urban land.

Atlantic ribbed mussels are a major biomass component of the park's saltmarsh and mudflats, and other shellfish species such as northern quahog (Mercenaria mercenaria), intertidal soft clam (Mya arenaria), and Atlantic surf clam (Spisula solidissima) occupy the nearshore and Rockaway inlet area.

Between them, the marine environments of Jamaica Bay and Breezy Point Tip support seasonal or year-round populations of over 200 rare or listed species, including 48 species of fish and 120 species of birds (USFWS 1997b). Listed species in the waters in and around these two park sites include Kemp's Ridley and loggerhead sea turtles *(Lepidochelys kempii, Caretta caretta),* piping plovers *(Charadrius melodus)*, seabeach amaranth *(Amaranthus pumilus),* and roseate terns *(Sterna dougallii).* Dozens of the species of fish found in Jamaica Bay (including many that are commercially important, such as winter flounder) use the bay as a nursery. A few islands in the bay support waterbird nesting colonies for species including glossy ibis *(Plegadis falcinellus),* great egret *(Ardea alba)*, snowy egret *(Egretta thula),* cattle egret (Bubulcus ibis), black-crowned night-heron *(Nycticorax nycticorax),* and tricolored heron *(Egretta tricolor).* The bay is also considered an important migratory stopover site for shorebirds; although these species use much of the bay, they focus on the intertidal areas during low tide and the East and West Ponds during higher tides for feeding. The benthic environment of Jamaica Bay provides habitat for many invertebrates, fish, and diving ducks. Sandy beaches and intertidal mud flats throughout Jamaica Bay and especially the beaches at Plumb Beach support a large population of horseshoe crabs *(Limulus polyphemus).*

Atlantic ribbed mussels are a major biomass component of the park's saltmarsh and mudflats, and other shellfish species such as northern quahog *(Mercenaria mercenaria),* intertidal soft clam *(Mya arenaria),* and Atlantic surf clam *(Spisula solidissima)* occupy the nearshore and Rockaway inlet area. Jamaica Bay hosts significant waterfowl concentrations, averaging about 11,000 birds in ground counts from 1980 to 1992. Species include greater scaup *(Aythya marila),* American black duck *(Anas rubripes),* brant *(Branta bernicla),* Canada goose *(Branta canadensis)*, and bufflehead *(Bucephala albeola).* Harbor seals *(Phoca vitulina)* are found in Jamaica Bay and at Breezy Point Tip, and humpback whales *(Megaptera novaeangliae)* and bottlenose dolphins *(Tursiops truncatus)* occasionally feed in the area adjacent to Rockaway inlet. Breezy Point Tip supports some of the largest nesting sites for rare or endangered shorebirds, including least terns *(Sterna antillarum),* black skimmers *(Rynchops niger),* roseate terns (very rarely), American oystercatchers *(Haematopus palliatus),* and piping plovers. It is also a concentration area for migratory shorebirds, raptors, waterfowl, and land birds, especially during summer and fall.

Raritan Bay including Sandy Hook and Staten Island

Parts of the Raritan Bay are brackish, receiving direct inflow from the Raritan, Shrewsbury, and Navesink Rivers and other small tributaries along the shoreline of Staten Island and New Jersey, as well as indirectly from the Hudson River through the New York Bay. Dredged channels in the bay are up to 35 feet deep, but otherwise the bay is shallow—less than 20 feet deep for the most part. The area is subject to a wide range of fluctuations in temperature, salinity, and DO (USFWS 1997a).

The Staten Island shoreline along Raritan Bay from New Dorp Beach to Tottenville includes beach and intertidal and subtidal mudflats extending about one-quarter mile from the shoreline. Great Kills Park includes large areas of disturbed marsh ingrown with *Phragmites* and coastal shrub thicket at Crooke's Point.

Sandy Hook divides Raritan and Sandy Hook Bays from the New York Bight. On its wide northern end it supports an extensive foredune vegetated with American beachgrass *(Ammophila breviligulata).* The western side of the spit consists of extensive tidal mudflats, sandflats, and saltmarsh dominated by low marsh cordgrass. There are more than 200 rare or listed species using the waters and shorelines of Raritan Bay and Sandy Hook, including piping plover, two species of sea turtles, and three whale species. More than 90 species of fish have been counted in Raritan Bay and Sandy Hook Bay, including brackish-water species like mummichog *(Fundulus heteroclitus)* and white perch *(Morone americana)* (USFWS 1997a). In the larger bay, ocean fish species as well as lobster *(Homarus americanus),* blue crab *(Callinectes sapidus),* and horseshoe crab are taken in a dredge fishery. Spawning habitat for horseshoe crab on Sandy Hook provides an important food source for migrating shorebirds, which are abundant. Like Jamaica Bay and Breezy Point Tip, Sandy Hook and Raritan Bays provide a variety of habitats for migrating and wintering waterfowl, waterbirds, and shorebirds, with counts of 20,000 birds per season in the summer and fall to 60,000 in the winter. Sandy Hook is also home to beach-nesting piping plovers.

Offshore of Staten Island lie Hoffman and Swinburne Islands, constructed in the 1800s using dredged sand, rock, and concrete. The islands were initially used to quarantine immigrants, but the buildings have since turned to ruins and grass was planted in the 1960s. In the absence of human disturbance, both islands have become wooded and are important habitat for colonial nesting waterbirds, wading birds, and seabirds. In 2007, Hoffman Island was home to 567 nests of seven wading bird species and 188 nests of herring gulls *(Larus argentatus)* and great black-backed gulls *(Larus marinus)* (Bernick et al. 2007, as cited in Lawrence, Roman, and Frame 2010). Adjacent Swinburne Island had 264 double-crested cormorant *(Phalacrocorax auritus)* nests and 310 gull nests. Swinburne and Hoffman Island are also used as a haul-out location for seals (Lawrence, Roman, and Frame 2010).

Vegetation at Ocean Beaches at Gateway Park Sites

Although the park manages nearshore ocean waters, no surveys or other information about vegetation in these marine areas is available. Besides this submerged habitat, only one vegetation association is considered by Edinger et al. to be truly marine; that is, it grows between the high tide line and the sea (Edinger et al. 2008b). This is the North Atlantic Coast estuarine intertidal mudflat, a vegetative community that covers over 9,000 acres of park lands and tidal areas. However, because they grow on the ocean side of the foredune (the first dune landward of the beach) or exist only where storm surge reaches, other vegetative communities are discussed along with the North Atlantic Coast estuarine intertidal mudflat in this section of the GMP/EIS. These are the North Atlantic upper ocean beach, North Atlantic coastal plain vine dune, northern beachgrass dune, beachgrass/panicgrass dune grassland, and overwash dune grassland.

The intertidal zone is the area between the land and sea that is covered by water at high tide and uncovered at low tide and is immediately landward of the nearshore zone. The intertidal areas in estuaries like Jamaica Bay include hundreds of acres of mudflats and low and high saltmarsh and are rich in food resources for a variety of wildlife. Ocean shores in the park are otherwise covered in beaches, most of them sandy and used for recreation.

North Atlantic upper ocean beach is the formal name of beach habitat just above mean high water. While this vegetation type is not considered rare and is found throughout the park, it nonetheless provides habitat for a number of protected plant and animal species.

Beaches are the most dynamic habitats in the park, changing continuously with the wind and tides and sometimes changing radically during hurricanes and nor'easters. Animals and plants that thrive on beaches are well adapted to its changing nature. The beaches on the Rockaways and at Sandy Hook are called "barrier beaches" because they lie on barrier peninsulas that are separated from the mainland by an estuary or bay. A description of the beaches and coastal processes in the park is available in the "Soils and Geology" section of this GMP/EIS.

In the descriptions of vegetation associations taken from Edinger et al. (2008b), the name of the association is in bold type.

North Atlantic coast estuarine intertidal mudflat is the only vegetation association (i.e., a community of associated plants) considered by Edinger et al. (2008b), the team that comprehensively inventoried park vegetation most recently, to be a truly marine or intertidal community. Intertidal mudflats cover more than 9,000 acres of park lands and waters, making it the most abundant of all vegetation associations at Gateway. This vegetation type is found on saline mudflats, is completely exposed at low tide, and is tidally flooded twice daily. The substrate consists of silt and mud that is rich in organic matter and poorly drained at low tide. It is subject to moderate fluctuations in salinity and moisture and is washed by low-energy waves. The mudflats are nearly devoid of vegetation, although the marine alga sealettuce *(Ulva lactuca)* can cover 40 percent or more of the exposed area. Smooth cordgrass *(Spartina alterniflora)* can occur sporadically, colonizing from adjacent low saltmarsh communities. This community occurs in the Great Kills Park section of the Staten Island Unit and the Floyd Bennett Field and Jamaica Bay Wildlife Refuge sections of the Jamaica Bay Unit.

North Atlantic upper ocean beach is the formal name of beach habitat just above mean high water. While this vegetation type is not considered rare and is found throughout the park, it nonetheless provides habitat for a number of protected plant and animal species. At the park, it is characterized by native plant species American searocket *(Cakile edentula)* and seaside sandmat *(Chamaesyce polygonifolia).* Rare plants include the federally threatened seabeach amaranth as well as the globally vulnerable seaside knotweed (*Polygonum glaucum)* and state imperiled sanddune sandbur *(Cenchrus tribuloides)* (Edinger et al. 2008b). Invasive plants include Russian thistle *(Salsola kali)*. Rare birds in this ocean beach area include piping plover, least tern, common tern, and black skimmer (Lawrence, Roman, and Frame 2010).

Foredune Habitat

Plants and animals that thrive in the foredune environment are well adapted to the winds and waves, and this dynamic environment promotes biological diversity. Vegetation upland from the beach and foredune is described in the "Vegetation" section of the GMP/EIS; marsh and wetland vegetation is described in the "Wetlands and Floodplains" section.

Edinger et al. (2008b), who described 35 vegetative communities at Gateway, named the plant association on active foredunes the **northern beachgrass dune** community. Although this vegetation grows on dynamic, active foredunes, it also occupies more protected

interdune areas (Edinger et al. 2008b). The dominant grass is American beachgrass, but there may also be other grasses and forbs. Rare plants documented in this community at Gateway include sanddune sandbur and Oakes' evening primrose *(Oenothera oakesiana),* both of which are New York state-listed threatened plants. The northern beachgrass dune community is found along the upper edge of ocean beaches throughout the park.

The **beachgrass/panicgrass dune grassland** community at Gateway occurs on active foredunes, but in areas mostly outside the influence of storm tides and only in combination with the northern beachgrass dune community. While the beachgrass/panicgrass dune community is characterized primarily by bitter panicgrass *(Panicum amarum),* many other native plants such as American beachgrass, field sagewort *(Artemisia campestris),* and pink fuzzybean *(Strophostyles umbellata)* are also present. Several species of lichens of the genus *Cladonia* are found in this community. This community is globally imperiled, at a high risk of extirpation, with only an estimated 65–100 communities remaining. The vegetation is particularly vulnerable to trampling or off-road vehicle use because it is very fragile and does not easily recover from disturbance (Edinger et al. 2008b). In Gateway, beachgrass/panicgrass dune grassland is documented only at the northernmost end of Sandy Hook (Edinger et al. 2008b).

The **overwash dune grassland** is dependent on overwash sand that is deposited during storm surges. It is usually not more than a few acres in size and its highly ephemeral nature requires a large dune system to survive. It often is in a mosaic with the northern beachgrass dune community. In the park, overwash dune grassland is also found on dredge fill deposits, where it is dominated by saltmeadow cordgrass *(Spartina patens).*

The **North Atlantic coastal plain vine dune** community occurs on foredunes up to the crest, exposed to wind, salt spray, and occasional overwash by storm tides. Eastern poison ivy *(Toxicodendron radicans)* shrubs dominate at the park, often accompanied by native Virginia creeper *(Parthenocissus quinquefolia)* and nonnative, invasive Japanese honeysuckle *(Lonicera japonica).* The community is globally imperiled and at risk of extinction. The soil is Hooksan series sand, a substrate characteristic of the rarest plant communities at Gateway. The North Atlantic coastal plain vine dune community is found at Sandy Hook, Fort Tilden, and in the Jamaica Bay Wildlife Refuge (Edinger et al. 2008b).

Threats to the Marine Zone

The New York Bight is in a heavily urbanized watershed supporting the largest coastal population of people in the United States (USFWS 1997c). Major threats affecting the bight include coastal urbanization, wetland and coastal use modifications, ocean dumping and waste disposal, port development and maintenance, agricultural practices and development, transportation, energy production, marine mineral mining, and cumulative nonpoint sources of pollutants. The ocean area of the New York Bight has traditionally been used for the disposal of waste, including sewage sludge, dredged materials, chemical wastes, and radioactive materials. This use has degraded the habitats and associated organisms in the waters. Organic loading of riverine, estuarine, and coastal waters is an emerging problem.

Symptoms of this loading are the increasing prevalence of excessive algae blooms, shifts in algal species composition, high sediment biological oxygen demand at affected sites, and anoxic events in near coastal and estuarine waters. Domestic waste discharge and other household nonpoint source contaminants are major sources of the contaminant burden to the nearshore waters and benthos. Domestic waste includes fecal contaminants, heavy metals, agricultural runoff, leachate from landfills, highway and urban runoff, chemical and oil spills, and contaminated (with PCBs and polycyclic aromatic hydrocarbons [PAHs]) sediment movement in some of the riverine and bay areas. Atmospheric contaminants are another domestic nonpoint source (USFWS 1997c).

Urban sprawl and suburbanization have exerted tremendous pressure on the integrity and health of the coastal ecosystem, including those of Raritan Bay and its watersheds, as well as some of the upland and wetland buffer areas around the shoreline of Jamaica Bay. Intense demand for home sites, resorts, marinas, and commercial development has resulted in the loss of valuable wetland resources through filling, dredging, ditching, diking, and shoreline modification. Increased population intensifies recreational uses of the coastal areas, including the demands for boating facilities and access to the water (USFWS 1997b).

Sea-level rise and warming temperatures most experts attribute to climate change (NY Academy of Sciences 2010) are also forces that currently affect marine resources and would increasingly do so in the future. Sea level rise can increase shoreline erosion along beaches and in Jamaica Bay, inundate vegetation or nests of shorebirds or terrapins and cause saltwater intrusion into groundwater aquifers that then contaminate fresh or brackish water habitat (Columbia University 2009). Warming temperatures increase evaporation of brackish or freshwater habitat and are known to be associated with increased competitive advantage of invasive vegetation.

Mining for sand and gravel, as well as exploration and production drilling for oil or minerals of the outer continental shelf, affect marine biota and their habitats. Sand and gravel mining can result in loss of benthic organisms that live in the sediment; mining modifications of the substrate in the plume area can sometimes be measured in miles. Oil spills and spills of other hazardous materials are a major threat to marine waters in the area. Deep borrow pits in areas of minimal flushing can have decreased DO and may become seasonally or permanently anaerobic where mixing does not occur regularly (USFWS 1997b, 1997c).

Extensive recreational use of Gateway beaches has resulted in disturbance of wildlife like nesting birds and has increased demand for parking, access, and other facilities that could further disturb wildlife or eliminate habitat (USFWS 1997a).

The nonnative, invasive Japanese sand sedge *(Carex kobomugi)* is an aggressive, invasive colonizer of dunes on the beaches of the North Atlantic Coast. It successfully outcompetes native grasses and herbs such as American beachgrass, field sagewort, and seaside goldenrod. It grows on dynamic, shifting sand dunes, usually beyond the influence of storm tides. Edinger et al. (2008b) report it only at Sandy Hook, where it has a large enough presence to be classified as a separate vegetative community and is spreading exponentially (Lawrence, Roman, and Frame 2010).

Vegetation

Vegetation at the park is classified by its location and present assemblage of species. Many of these plant communities are highly altered due to urban influences; approximately 45 percent of Gateway's 700 identified plant species are nonnative to the New York City maritime environment (Frame, pers. comm. 2013b). Generally, the beaches and mudflats at the park are not vegetated, or if they are, coverage is sparse. Adjacent to the intertidal area or beach are the dunes, which begin with the foredune. The processes that form and shape the dunes are described in the "Soils and Geology" section of this chapter of the GMP/EIS. Behind the foredune are the dunes and interdunes (swales between the dunes), where the vegetation includes more than 260 native vascular plants, including 12 that are rare (NPCA 2007c). Moving farther inland and away from the influence of salt spray and wind, dune vegetation gives way to shrubs and then to maritime forest. On the inland side of beaches, such as along the western side of Sandy Hook and throughout Jamaica Bay, are expansive saltmarshes composed primarily of grasses *(Spartina)*, as well as sandy hills and shores.

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Vegetation at Gateway has been surveyed recently (Edinger et al. 2008b) and classified into 35 associations. Of these, 20 are maintained by maritime influence including strong salt spray, high winds, and coastal processes such as dune deposition, shifting, and overwash. Edinger et al. (2008b) divides these maritime communities into marine associations, estuarine associations, and terrestrial associations. Most of the remaining communities are classified as human-modified associations.

Marine, intertidal beach, and foredune vegetation associations are discussed in the "Marine Resources" section of this chapter. These include the North Atlantic Coast estuarine intertidal mudflat, the North Atlantic upper ocean beach, North Atlantic coastal plain vine dune, northern beachgrass dune, beachgrass/panicgrass dune grassland, and overwash dune grassland.

Estuarine associations are those that grow in habitat that is semi-enclosed but with access to open ocean or tidal flows and that are at least occasionally diluted by freshwater runoff. Seven estuarine vegetation associations grow at the park, including brackish meadow, mid-Atlantic salt shrub, North Atlantic low saltmarsh, North Atlantic high saltmarsh, salt panne, coastal salt pond marsh, and Northeastern Atlantic brackish interdunal swale. These associations are discussed in the "Wetlands and Floodplains" section of this chapter of the GMP/EIS.

The grasslands, shrublands, and forests of terrestrial maritime communities, as well as human-modified associations, are the focus of this section of the document, although maps and descriptions of park sites in the last subsection include a synopsis of the types and conditions of all vegetation. Terrestrial maritime associations described by Edinger et al. (2008b) include North Atlantic Coast backdune grassland, northern beach heather dune shrubland, northern bayberry dune shrubland, northern tall maritime shrubland, mid-Atlantic maritime salt shrub, maritime red-cedar woodland, maritime holly forest, and successional maritime forest. Terrestrial maritime vegetation associations are made up of "salt-pruned" trees and shrubs with contorted branches and wilted leaves; they also usually

have a dense vine layer. Often, they grow in narrow bands parallel to the shoreline (Edinger et al. 2008b). Descriptions of each of these associations are taken primarily from Edinger et al. (2008b). Human-modified associations (whose descriptions are also primarily from Edinger et al. 2008b) are discussed in the "Invasive Species and Human-modified Associations" subsection.

Terrestrial Maritime Vegetative Communities

Backdune Associations

North Atlantic Coast Backdune Grassland. This community occurs in a natural setting on deep, stabilized sands of old interdunes and backdunes. It can also occur in disturbed settings following clearing of maritime shrubland and other backdune communities or on sandy dredge spoil. The substrate can be fine sand, coarse sand, gravelly fine sand, or (less commonly) loamy sand. Soils are derived from various natural and nonnatural sediments, including household landfills capped with sand, sandy dredge fill, eolian (windblown) and marine sediments, and sandy fill mixed with demolished construction debris. The vegetation of this association is variable and depends on landscape setting and land-use history. It is dominated by gray clubawn grass *(Corynephorus canescens)* in more disturbed settings and by little bluestem *(Schizachyrium scoparium).* This association occurs in the Great Kills Park section of the Staten Island Unit, in the Sandy Hook Unit, and in all sections of the Jamaica Bay Unit.

Northern Beach Heather Dune Shrubland. This is a dwarf shrubland association that occurs in well-developed sand dune systems on stable secondary dunes. Conditions are xeric; plants must be adapted to low moisture, high surface temperature, and high light intensity. The substrate is fine sand in the Hooksan series. The natural setting for this community is in flat openings within northern tall maritime shrubland, maritime red-cedar woodland, and mid-Atlantic maritime salt shrub. At Gateway, it can also be found in a disturbed setting surrounded by Japanese black pine *(Pinus thunbergii)* forest. This dwarf shrubland is characterized by woolly beachheather *(Hudsonia tomentosa)* occurring with other low-growing shrubs, including eastern red cedar *(Juniperus virginiana)*, beach plum *(Prunus maritima),* flameleaf sumac *(Rhus copallinum),* Japanese black pine, northern bayberry *(Myrica pensylvanica),* and black cherry *(Prunus serotina).* This association occurs in the Sandy Hook Unit and in the Fort Tilden and Floyd Bennett Field sections of the Jamaica Bay Unit. Northern beach heather dune shrubland is globally vulnerable and at risk of extinction.

Northern Bayberry Dune Shrubland. This association occurs on protected slopes and hollows of dry, stabilized maritime backdunes. The substrate is coarse to fine sand consisting of very deep, excessively drained soils formed in eolian sands, sandy marine sediments, or sandy dredge spoils. The vegetation of this dense, short maritime shrubland is dominated by northern bayberry with flameleaf sumac. Northern bayberry dune shrubland is at risk of extinction in New York State (Edinger et al. 2008b, as cited in Lawrence, Roman, and Frame 2010). This association occurs in the Sandy Hook Unit and in the Breezy Point, Fort Tilden, Floyd Bennett Field, Canarsie Pier, and Jamaica Bay Wildlife Refuge sections of the Jamaica Bay Unit.

Northern Tall Maritime Shrubland. This community is usually very dense and often occurs inland of northern bayberry dune shrubland in sheltered settings. The substrate is most commonly coarse to fine sand originating from marine sediments, eolian deposition, or dredge fill. Vegetation is dominated by northern bayberry, flameleaf sumac, black cherry and many associates, including autumn olive *(Elaeagnus umbellata),* multiflora rose *(Rosa multiflora),* white poplar *(Populus alba),* and others. Vines are commonly draped in and over shrubs. This association occurs in the Sandy Hook Unit; the Great Kills and Miller Field sections of the Staten Island Unit; and in all sections of the Jamaica Bay Unit.

Mid-Atlantic Maritime Salt Shrub. This shrubland usually forms an ecotone between high saltmarsh and adjacent upland vegetation, but it also occurs in patches on areas of slightly higher elevation within maritime dunes. It occurs above mean high tide but can be flooded by storm tides. The substrate is primarily fine sand to mucky, fine, sandy loam consisting of very deep, excessively drained to very poorly drained soils formed in eolian sands, sandy marine sediments, dredge fill, or thick sandy deposits with a thin organic surface layer. This tidal shrubland is dominated by a fairly dense cover of Jesuit's bark *(Iva frutescens)* and eastern baccharis *(Baccharis halimifolia).* Associated tall and short shrubs include northern bayberry, flameleaf sumac, and black cherry. This association occurs in the Sandy Hook Unit and in all sections of the Jamaica Bay Unit.

Maritime Forests

Maritime forests are situated on barrier islands and peninsulas, which are subjected to wind-driven salt spray and occasional inundation by storm-driven ocean surges. Stands may represent seral stages of the barrier island forest, perhaps held in stasis for a century or longer by specific site conditions, including soil depth or nutrients, temperature, or intense storms. Much of the barrier island forest along the New Jersey and New York coasts has been lost to urban development, and two types of barrier island forest—maritime red-cedar woodland and maritime holly forest—are globally imperiled. In the park, both of these occur only at Sandy Hook, on the deep, non-glacial sediments of Hooksan soil series.

Maritime Red-cedar Woodland. This association occurs on inactive old sand dunes in association with maritime holly forest or maritime dunes or on the upper edge of low saltmarsh. Most commonly, the substrate is fine sand consisting of very deep, excessively drained soils formed in eolian sands or sandy marine sediments. The community has also formed on sandy dredge spoils. Tall shrubs and saplings are moderately abundant (nearly 30 percent cover) and consist of a mix of species, many of which are also represented in the canopy. This maritime woodland community has an open canopy (just over 50 percent cover) that is strongly dominated by eastern red cedar. The most abundant associated canopy species are black cherry, American holly *(Ilex opaca),* and common hackberry *(Celtis occidentalis).* Occasionally, individual trees will also extend up above the canopy into a sparse emergent layer. Additional tree species are Japanese black pine, blackjack oak *(Quercus marilandica),* black oak *(Q. velutina),* northern red oak *(Q. rubra),* black locust *(Robinia pseudoacacia),* and red maple *(Acer rubrum).* In Gateway, this association is only found in the Sandy Hook Unit. It is globally imperiled and considered to have a high risk of extinction.

Maritime forests are situated on barrier islands and peninsulas, which are subjected to wind-driven salt spray and occasional inundation by storm-driven ocean surges. Stands may represent seral stages of the barrier island forest, perhaps held in stasis for a century or longer by specific site conditions, including soil depth or nutrients, temperature, or intense storms.

Maritime Holly Forest. The rarest association in the park is the maritime holly forest, which is located only on the west shore of Sandy Hook. At 231 acres, it is the largest one of only two known occurrences in the world, with the other, coincidentally, located on NPS land at Sunken Forest on Fire Island National Seashore. This association occurs on old, inactive dunes with undulating topography. Some patches show evidence of past fire in charred stumps and multi-trunked American holly. The substrate is a variable mix of loamy/organic sand and medium sand with a covering of litter and duff. Soils within this community are in the very-deep-to-bedrock and excessively drained Hooksan series formed in eolian sands or sandy marine sediments. Maritime holly forest at Gateway is strongly dominated by American holly with black cherry, eastern red cedar, common hackberry, red maple, and common serviceberry *(Amelanchier arborea).* Holly trees at Sandy Hook range in age from 15 to 162 years old (Forrester et al. 2004, as cited in Lawrence, Roman, and Frame 2010). Holly survival is very high, particularly relative to co-occurring species like black cherry or American hackberry, as is its reproductive success in the park (Lawrence, Roman, and Frame 2010). The maritime holly forest at Sandy Hook is considered the finest example of this vegetative community in the world (Art 1992, as cited by Lawrence, Roman, and Frame 2010). It is globally imperiled and at high risk of extinction. The height of the trees, the low profile of the dunes, and a coastline geography that heightens storm surges all make the Sandy Hook maritime holly forest highly susceptible to storm damage (Forrester et al. 2008, as cited in Lawrence, Roman, and Frame 2010). The Sandy Hook holly forest has experienced strong winds that caused blowdowns and gaps approximately 11 times since 1788 (Boose et al. 2001, as cited in Lawrence, Roman, and Frame 2010), including from Hurricane Sandy in 2012, which caused flooding but no significant blowdown of trees noticeable in the immediate aftermath. Large numbers of holly trees appear now to be dead, apparently from being flooded for an extended period of time (Lane, pers. comm. 2013). Longer-term changes may have occurred, but they are yet unknown (Rowan 2012, as updated by NPS 2013e).

Successional Maritime Forest. This maritime forest community occurs most often on stabilized backdunes, generally leeward of secondary maritime dunes or in protected hollows. It can also be found farther inland in association with tall maritime shrubland. Substrates are somewhat poorly drained to excessively drained, coarse to fine sands originating from marine- or eolian-derived sand or sandy dredge fill. The somewhat open tree canopy (to 50 feet [15 meters] tall) of this successional maritime forest is strongly dominated by black cherry with common hackberry. Associated canopy species include red maple, American holly, white poplar, black locust, and lesser amounts of eastern red cedar, Japanese black pine, and eastern cottonwood (Populus deltoides). This association occurs in the Sandy Hook Unit, in the Great Kills Park section of the Staten Island Unit, and in the Fort Tilden, Floyd Bennett Field, Canarsie Pier, and Jamaica Bay Wildlife Refuge park sites of the Jamaica Bay Unit. The present plant composition in the North Forty of Floyd Bennett Field is very diverse (Greller 1984 and Wijesundara 1997, as cited in Lawrence, Roman, and Frame 2010), with 125 plant species in three separate forest communities, including successional maritime forest. This association is considered rare although it includes nonnative tree species.

Invasive Species and Human-modified Associations

Much of the natural vegetation at the park has been disturbed or altered by humans, either historically or recently (NRCS et al. 2001). Forests have been cut for use as firewood or building materials, and formerly forested lands have been converted to pasture or agricultural uses. Saltmarshes have been filled to create tracts of housing or other development or dredged for substrate on which to build them. Floyd Bennett Field, Jamaica Bay Wildlife Refuge, and Great Kills Park all contain land that was created from material dredged from what are now park waters and neighboring bays or marine environments as well as from areas outside park boundaries (NRCS et al. 2001). In addition, as described in the "Soils and Geology" section of this chapter of the GMP/EIS, humans have altered shoreline dynamics along the length of Sandy Hook and most of Breezy Point to change the availability of sand, which not only supports beach vegetation but is moved inland by water and wind to supply inland and even nearshore saltmarsh habitats.

Nonnative plants are common throughout the park, composing from one-third to nearly all species at some park sites (NPCA 2007c). Although some nonnative plants became established as a result of disturbance and disruption of native habitats by the historical activities described above, others were deliberately planted. Much of the Staten Island Unit is landscaped, for example, using nonnative species such as bluegrass *(Poa pratensis).* Other nonnative species, like Russian or autumn olive *(Elaeagnus angustifolia, E. umbellata),* red chokeberry *(Aronia arbutifolia),* and buckthorn *(Rhamnus frangula),* were planted to supplement wildlife habitat, especially for migratory birds (NPCA 2007c).

Like many other eastern locations, several Japanese species have found habitat at the park, including Japanese sand sedge, Japanese honeysuckle, Japanese black pine, and Japanese knotweed *(Polygonum cuspidatum).* The Japanese sand sedge is an invasive colonizer of dunes of the North Atlantic Coast and successfully outcompetes a number of native dune species, including American beachgrass. An alien strain of *Phragmites* (common reed; *Phragmites australis)* has infested fresh and brackish wetland communities so that it now covers an estimated 1,120 acres, or nearly 5 percent of the park lands and waters (Mellander, pers. comm. 2005, as cited in Lawrence, Roman, and Frame 2010).

Human-modified Vegetation Associations

Human-modified vegetation associations include early successional woodland/forest, Japanese black pine forest, Japanese sedge maritime dunes, little bluestem old field, northeastern modified successional forest, northeastern old field, and reed/grass tidal marsh. Very small patches of two additional associations—hardwood plantation and Japanese knotweed gravel bar—also grow in the park but are not described in this GMP/EIS because of the limited area they occupy. Much of the Japanese black pine in the park has been lost to disease.

Early Successional Woodland/Forest. This successional shrubland or open woodland or forest includes northern hardwoods occurring in various settings following disturbance such as clearing, fragmentation, and deposition of fill material. The substrate is coarse sand formed from sandy dredge fill. The community often occurs in a mosaic with other disturbed or successional communities, such as successional maritime forest and reed/grass tidal marsh, or even with paved areas. In the forests or woodlands, the open canopy is composed of a mix of early-successional species, including white popular, quaking aspen *(Populus tremuloides),* gray birch *(Betula populifolia),* and black cherry. The shrubland expression of this community is characterized by a dense layer of tall shrubs that are strongly dominated by white poplar, with northern bayberry and black cherry. This association occurs in the Great Kills Park section of the Staten Island Unit and in the Fort Tilden, Floyd Bennett Field, Canarsie Pier, and Jamaica Bay Wildlife Refuge sections of the Jamaica Bay Unit.

Japanese Black Pine Forest. This association occurs on old, inactive, undulating dune deposits; some patches may be natural and others were probably planted intentionally. The substrate is well-drained, sandy fill, which can be moist below 4–6 inches (10–15 centimeters), covered by a layer of pine needles, duff, and loamy sand. Nonnative Japanese black pine is the dominant canopy and subcanopy tree of this vegetative community, with black cherry the only documented associated tree species. Shrub cover is sparse and usually shorter than 3.3 feet (1 meter) in height. This association occurs in the Sandy Hook Unit and in the Fort Tilden, Floyd Bennett Field, and Jamaica Bay Wildlife Refuge sections of the Jamaica Bay Unit. As noted above, most of the park's Japanese black pine has been lost to disease.

Japanese Sedge Maritime Dunes. This association occurs on coastal sand dunes with sandy, unstable substrates with no soil profile development. Eolian processes cause active sand deposition and erosion. The sand substrate is usually visible, and litter accumulation from plant debris is nearly absent. This community occurs on foredunes that receive the force of wind and salt spray, but it is generally beyond the influence of most storm tides. Vegetation is dominated by nonnative Japanese sedge in association with (and outcompeting) typical maritime dune species, including field sagewort and American beachgrass. This association is limited to the Sandy Hook Unit, New Jersey.

Little Bluestem Old Field. This association occurs on coarse sand to sandy loam and consists of well-drained to somewhat poorly drained soils formed in sandy dredge fill and loamy fill over sandy sediments. The vegetation association occurs in disturbed areas and is generally maintained by mowing. Adjacent communities include northern tall maritime shrubland, northern bayberry dune shrubland, northeastern old field, and North Atlantic Coast backdune grassland, as well as parking lots and airstrips. This successional vegetation is dominated and characterized by little bluestem. Associated species vary widely according to land-use history and adjacent vegetation; they can include weeping lovegrass *(Eragrostis curvula),* purple lovegrass *(E. spectabilis),* gray clubawn grass, or a host of other grass or forb species. This association occurs in the Great Kills section of the Staten Island Unit and the Fort Tilden, Floyd Bennett Field, and Spring Creek sections of the Jamaica Bay Unit.

Northeastern Modified Successional Forest. This is an early-successional woody vegetative community that occurs on sites that have been cleared of vegetation or otherwise heavily modified. The environmental characteristics of sites where this vegetative community grows in the park are highly variable. Substrates can range from coarse sand derived from sandy dredge fill to loam that developed over either glacial till or loamy fill material. Vegetation is characterized by dominance of successional and/or invasive species in all layers. The tree canopy and subcanopy are composed of a mix of species, including tree of heaven *(Ailanthus altissima),* black locust, white mulberry *(Morus alba)*, and black cherry. In the park, this association occurs on artificial, newly created uplands, such as the species-rich forest in the North Forty area of Floyd Bennett Field, and is present in all three units of Gateway.

Northeastern Old Field. This association occurs in an extremely variable assortment of sites, from mowed fields to disturbed maritime dunes. Substrates range from coarse sand and sandy loam to mucky peat. The vegetation of these successional old fields is extremely variable and depends on past and current land use as well as surrounding vegetation. The herbaceous layer is often dominated by common wormwood *(Artemisia vulgaris)* with a variety of grasses and forbs. This association occurs in the Great Kills section of the Staten Island Unit and in the Fort Tilden, Floyd Bennett Field, and Canarsie Pier sections of the Jamaica Bay Unit.

Reed/Grass Tidal Marsh. This association is often adjacent to and commonly intermingled with mid-Atlantic maritime salt shrub. It occurs in a range of tidal wetland habitats, and substrates range from coarse to fine sand or (less often) mucky peat or mucky, fine, sandy loam. Soils can be derived from eolian sands or dredge fill. The association is characterized by dense stands of Phragmites, which tends to grow in colonies of tall, stout, leafy plants, often to the exclusion of all other vascular plant species. This association occurs in the Sandy Hook Unit, the Great Kills section of the Staten Island Unit, and in all of the sections of the Jamaica Bay Unit.

Rare or Unique Vegetation

Rare, state-listed species or species listed as threatened or endangered under the federal Endangered Species Act are discussed in the "Species of Special Concern" section in this chapter of the GMP/EIS.

Of the vegetation associations described here and in the "Marine Resources" and "Wetlands and Floodplains" sections in this chapter of the GMP/EIS, several are locally and/or globally vulnerable or imperiled. Those communities ranked S1 (5 or fewer occurrences) or S2 (6–20 occurrences) by the New York and/or New Jersey Heritage Programs include the following:

- American holly forest—S1 New York and New Jersey; G1
- Successional maritime forest—S1, S2 New Jersey
- Maritime red-cedar forest—S1 New York and New Jersey
- Northern bayberry dune shrubland—S1, S2 New Jersey
- Beachgrass/panicgrass dune—S1, S2 New Jersey
- Northeastern Atlantic brackish interdunal swale—S1, S2 New York and New Jersey

- Brackish meadow—S1, S2 New York
- Coastal salt pond marsh—S1, S2 New York
- North Atlantic upper ocean beach—S1, S2 New Jersey

North Atlantic upper ocean beach also supports several listed species, including seaside amaranth (a New York endangered and federal threatened plant), sanddune sandbur (a New York threatened plant), piping plover (a New York endangered and federal threatened bird), seaside knotweed (a New York rare plant), black skimmer (a New York bird of special concern), and common tern (a New York threatened bird).

Northern beachgrass dune supports species of special concern as well, including sanddune sandbar and Oakes' evening primrose (a New York threatened plant).

Globally rare associations that occur at the park include the following:

- American holly forest—S1 New York and New Jersey; G1
- North Atlantic coastal plain vine dune—G1, G2
- Successional maritime forest—G2, G3
- Maritime red-cedar woodland—G2

G1 (5 or fewer occurrences) indicates the association is critically imperiled globally because of rarity, habitat, or biology; G2 (6–20 occurrences) indicates it is globally imperiled because or rarity, habitat, or biology; and G3 (21–100 occurrences) indicates it is rare and local throughout its range. A ranking of G1, G2, or G3 indicates the community or species is vulnerable to extinction.

Vegetation at Park Sites

A recently prepared assessment (Rowan 2012) of plant communities across the park is summarized in these sections to show their current condition. Updates on conditions after Hurricane Sandy were provided by NPS staff (February 2013). When an additional source is used, it is cited.

Jamaica Bay Unit

Plumb Beach. Plumb Beach has beach and dune areas, as well as saltmarsh and upland shrub/forest communities. The shrublands are in poor condition from foot traffic, which has worn several pathways into this area between the bike path and the dunes or saltmarsh. Although the marsh supports native saltmarsh species with no apparent invasive species, it is highly disturbed in many places. Many areas of the dunes are no longer vegetated due to heavy foot traffic and social paths that crisscross them. Coastal erosion at the western end of the beach periodically threatens the bike path and the Belt Parkway. An effort by the USACE, New York City Department of Parks and Recreation (NYCDPR), and NPS to nourish the beach on the west shoreline added 150,000 cubic yards of sand, which helped it withstand the storm surge from Hurricane Sandy. The east shoreline was not substantially eroded by Hurricane Sandy and remains in relatively good condition.

Floyd Bennett Field/Bergen Beach. Floyd Bennett Field consists of filled saltmarshes between former Jamaica Bay islands and what was once a shallow embayment. Bergen Beach is also a filled saltmarsh. Much of the planted lawns in the center and on the southeastern side of Floyd Bennett Field are now reverting to grasslands. This is a result of a partnership between the New York City Audubon and the NPS in the 1980s and 1990s to create habitat for grassland birds on 140 acres of Floyd Bennett Field. The grasslands provide butterfly and some bird habitat. Very large areas of Floyd Bennett Field, including grasslands on the southeastern side of the site, as well as Bergen Beach and shoreline of Dead Horse Bay between Plumb Beach and Floyd Bennett Field, are dominated in large part by a nonnative, invasive genotype of *Phragmites*. Hardened areas of the Floyd Bennett Field coastline associated with development alternate with eroding mudflats or sandy beaches. Bergen Beach is heavily used, especially by horses, as indicated by bare areas of sand. Many of these paths, as well as an area where restoration of a wetland was attempted, are flooded and at negative grade. Other than some erosion on the north shoreline of Floyd Bennett Field, this area was not substantially affected by Hurricane Sandy.

Canarsie Pier Coastal Area. This portion of Jamaica Bay includes the pier, Fountain Avenue and Pennsylvania Avenue former landfills, and Spring Creek Park and stretches for several kilometers of coastal frontage between them. Much of this land area is now filled, but it once was tidal freshwater or saltwater marsh. The shoreline is now largely dominated by *Phragmites*, particularly in Spring Creek Park. Vegetation here and elsewhere in these park sites shows evidence of heavy use, including bare areas and a network of social trails. Hurricane Sandy resulted in some flooding of the areas east and west of Canarsie Pier. Although the pier was overwashed by storm surge, it did not experience structural damage. The Fountain Avenue and Pennsylvania Avenue former landfills were not affected substantially by the storm.

Frank Charles Memorial Park. This very small community park is vegetated with recreational fields, lawns, and shrubs in the upland and has some saltmarsh and mudflat/intertidal communities interspersed with a cobble/gravel coastline. The site is affected by CSOs (a combination of stormwater and wastewater collected when treatment plants are at capacity) and heavy use. Vegetation here was not substantially affected by Hurricane Sandy.

Hamilton Beach Park. This very small community park is bisected by the Rockaway subway line and is affected by effluent from treated wastewater from an adjacent outfall pipe. Some areas of the park shoreline support saltmarsh vegetation, but it is dominated by *Phragmites*. This site was not substantially affected by Hurricane Sandy.

Jamaica Bay Fast Islands. "Fast" islands are those with dry land; fast islands in Jamaica Bay include Canarsie Pol, Ruffle Bar, Little Egg, and Subway Islands. These islands are primarily human created from dredge spoils, sand, and gravel added to saltmarshes. Upland areas include maritime shrublands and dunes. Intertidal zones are saltmarsh and beach, and there are some freshwater wetlands on the islands. *Phragmites* has invaded some of Canarsie Pol. Habitat on the fast islands is diverse, and a variety of animal species use it. Some of these islands were flooded by storm surge during Hurricane Sandy. Longer-term impacts from the flooding are yet unknown.

Jamaica Bay Hassocks. "Hassocks" are islands that are submerged at a minimum of once a month during the spring high tide; most are submerged twice each day by normal tides. Vegetation is nearly all low or high saltmarsh, although some shrubs or trees grow where fill material keeps them out of the brackish water. *Phragmites* has adapted to grow in higher salinities than it would in other areas at many park sites, but it cannot survive in saltmarshes and so has not invaded the hassocks. The hassocks are an important habitat for wildlife. Like the fast islands, hassocks in Jamaica Bay were flooded by storm surge during Hurricane Sandy.

Jamaica Bay Wildlife Refuge. The land area of this park site was created by filling and excavating various areas, including marsh islands, sand beaches, and submerged habitat in the northern portion of Jamaica Bay. Portions of Grassy Bay, Rulers Bar Hassock, Goose Pond Marsh, Goose Pond, Big Egg Marsh, Broad Creek Marsh, and three other unnamed islands were reconfigured to create the refuge land and water masses. As described in the "Wetlands and Floodplains" section in this chapter of the GMP/EIS, two large water bodies were artificially created at the refuge—both with the intention of making freshwater habitats. A third water body, Big John's Pond, is an excavated freshwater pond covered with floating aquatic vegetation during the warm season. Over time, the salinities of the ponds have changed. A woolgrass marsh and a mixed forb marsh both grow near the ponds (see "Wetlands and Floodplains" in this chapter for more information). The refuge also supports brackish and saltwater wetlands, as well as shrubland, woodland, dunes, and beaches. *Phragmites* covers a large area along the edges of the water bodies on the refuge.

Jacob Riis Park. This park site on the Rockaway Peninsula is bounded to the north by Jamaica Bay and to the south by the Atlantic Ocean. The land area is mostly developed for parking lots and recreational uses; a large beach and dune system on the ocean side is unvegetated. A small area of the northeastern side of the site supports a maritime shrubland; otherwise, vegetation is planted lawn. Hurricane Sandy substantially overwashed and eroded the dunes.

Fort Tilden. Much of the vegetation at this park site, particularly in the back fort area (following Hurricane Sandy), is in relatively undisturbed condition. Plant communities include shrublands and forest, as well as old field associations. Before Hurricane Sandy, dunes were vegetated with North Atlantic coastal plain vine dune association species, including eastern poison ivy and Virginia creeper. However, the storm substantially affected the bayshore and the ocean shore of Fort Tilden. Primary and secondary dunes on the ocean side were eroded and the dune vegetation lost over much of the park site.

Breezy Point. Breezy Point Tip is the terminus of the Rockaway barrier island. The habitat is a unique and relatively undisturbed combination of exposed beach and foredune with secluded backdune and a variety of wetland types, including palustrine, coastal salt pond marsh, brackish interdunal swales, and salt panne pools.

Staten Island Unit

Because of the location of the Staten Island Unit, Hurricane Sandy blew directly onshore rather than alongshore as it did at many other park sites. As a result, extensive flooding and loss of trees and habitat for other vegetative communities took place.

Fort Wadsworth. The shoreline of Fort Wadsworth is located along the New York Harbor at the western terminus of the Verrazano-Narrows Bridge. The bridge terminus is hardened, but otherwise the shoreline is undeveloped near the fort. A beach lies along one shore; the other is vegetated with shrub and successional forest species (Edinger et al. 2008b). Vegetation is characterized by dominance of successional and/or invasive species in all layers. The tree canopy and subcanopy are composed of a mix of species, including nonnative tree of heaven, black locust, white mulberry, and black cherry. Much of this vegetation was blown down or removed by winds and waves during Sandy. Upland of the shore, vegetation is primarily planted lawns, shrubs, and trees.

Miller Field. Most of Miller Field is either planted lawn or developed, although a line of dunes faces the ocean. However, a rare relict swamp white oak forest grows in the farther inland portion of the site. In addition to a few swamp white oaks, the site supports pin oak *(Quercus palustris),* northern red oak, and other tree species. The understory is populated with a suite of invasive species, including multiflora rose, Japanese honeysuckle, and garlic mustard *(Alliaria petiolata).* These species particularly occur along disturbed sites such as the multitude of pathways through the forest. Although Hurricane Sandy did not affect the forest, it did diminish and flatten the dunes.

Great Kills Park, Including Crooke's Point and Associated Coast. The "Soils and Geology" section in this chapter describes natural coastal processes, human-caused changes to them, and historical efforts to alter the configuration and elevation of this part of the park. The beach at Crooke's Point naturally accumulates sand, and vegetation in this area includes that typical of upper ocean beach. Crooke's Point includes overwash habitat and dunes vegetated with American beachgrass along its shore, as well as inland associations such as successional maritime forest and northern tall maritime shrubland. Much of Crooke's Point is covered in invasive vines, the removal of which is a target of an NPS partnership project with volunteers and NYCDPR. Mudflats and vegetation as described in the" Marine Resources" section in this chapter of the GMP/EIS for North Atlantic Coast estuarine intertidal mudflat occupies a portion of the coast at Great Kills Park. In Great Kills, *Phragmites* dominates the majority of the area, particularly north of the Great Kills Harbor and along the northern NPS property line, although additional successional forests grow west of this infestation.

Hoffman Island and Swinburne Island. Hoffman Island is a 14-acre and Swinburne Island a 4-acre artificial island; each was each previously developed and ruins of the buildings remain. The islands are wooded with a variety of deciduous trees and shrubs. Island shores are stone bulkheads and nonnative plant species are common, as are open areas from former human use (Frame, pers. comm. 2013b).

Sandy Hook Unit

The Sandy Hook Unit is unique at Gateway in that it is a larger continuous and contiguous park site. The vegetation is described by habitat type rather than location.

Beaches and Dunes. Dunes at Sandy Hook are vegetated with species (described in the "Marine Resources" section in this chapter of the GMP/EIS), including American beachgrass, American searocket, seaside sandmat, and bitter panicgrass, typical of the upper ocean beach, beachgrass dune, beachgrass/panicgrass dune, and dune shrubland communities. The swales of the dunes are often brackish and support vegetation dominated by saltmeadow cordgrass, although Japanese sedge maritime dune species, including Japanese sedge, has invaded many of the dunes. Sandy beach in the northern end of the island is accreting and the extensive foredune here is vegetated with American beachgrass (USFWS 1997a). Extensive areas of backdune habitat also occur toward the northern end. Beaches at the southern end of Sandy Hook are narrow for reasons described in the "Soils and Geology" section in this chapter. Hurricane Sandy caused extensive damage to NPS facilities and infrastructure through strong winds and a 13-foot storm surge. Sand movement from dunes and beaches was extensive, with overwash moving sediment from the dunes and beaches across the peninsula to cover the unit's main access road with drifts as much as 8 feet deep. Unvegetated dunes were particularly vulnerable.

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Grassland Vegetation. Although most of the Fort Hancock area is developed, Rowan (2012) noted a relatively undisturbed area of grassland in the vicinity, indicating that it was in good condition and provided habitat for insects, butterflies, and ground-nesting birds.

Internal Shrublands, Woodlands, and Forests. Red cedar and holly forests cover about half of the Sandy Hook Unit. In some areas of these forests, springs or possible bogs or wet depressions occur. From the backdunes to the highest and most interior part of Sandy Hook, shrublands grow that are typical of the successional maritime forests described previously, dominated by bayberry, beach plum, and tree of heaven (USFWS 1997a). The backdune and interior maritime shrublands are relatively intact but have been invaded in some cases by Japanese sedge. Although the interior maritime shrublands were flooded by the storm surge associated with Hurricane Sandy, trees remained standing for the most part and long-term impacts are yet unknown.

Bay Coasts, Including Spermaceti and Horseshoe Coves and Plum Island. The bay side of Sandy Hook consists of extensive mudflats, sandflats, and saltmarsh dominated by smooth cordgrass. There are a few small inland brackish marshes or intertidal areas; many of these, as well as much of the bay shorelines, are dominated by *Phragmites*. Spermaceti and Horseshoe Coves have Phragmites along the shorelines in some cases, as does the interior wetland of Plum Island. Horseshoe Cove shows both erosion and accretion in some locations, which may be due to the presence of a battery that acts like a jetty to collect sand on one side. The Hurricane Sandy storm surge increased the erosion of these shorelines.

Wildlife

Other sections of this GMP/EIS describe the meeting of currents, waters, and climate from the north and south in the vicinity of Gateway. Jamaica Bay and Breezy Point on one side and Sandy Hook on the other frame the entrance into New York Bay and Harbor. Park sites in the Jamaica Bay Unit receive an influx of migrating species from the east–west-oriented coastline of New England and Long Island and the Sandy Hook and Staten Island Units from the north–south coastline of the mid-Atlantic coast. This intersection, along with the influence of substantial inflow of freshwater primarily from the Hudson River, concentrates species migrating between the New York Bight portion of the North Atlantic and the Hudson/Raritan Estuary in both directions, and makes for a regionally significant wildlife habitat (USFWS 1997c).

Despite the generally urbanized nature of the region, Jamaica, Raritan, and Sandy Hook Bays encompass important breeding and juvenile nursery habitat for fish. These estuaries and adjacent terrestrial habitat are also important for nesting, foraging, and roosting birds, including waterfowl, shorebirds, colonial-nesting waterbirds, and seabirds like gulls and terns. Upland sites in this area provide rare habitat in the area for grassland bird nesting and foraging and butterfly concentrations (USFWS 1997b). Habitat at Sandy Hook includes ocean beaches populated by listed plant and animal species; inland rare dune, shrub, and forest habitat; and the estuarine shoreline that faces the Raritan and Sandy Hook Bays. This section of shoreline is exposed to intertidal and subtidal influences and is considered important to shellfish and marine, estuarine, and anadromous fish, as well as for its significant migratory and wintering waterfowl concentrations (USFWS 1997a). Like Jamaica Bay, the shoreline provides important fish nursery areas, and its wetlands and uplands provide migratory and wintering spots for waterfowl, shorebirds, waterbirds, and landbirds like songbirds and raptors. The shore is also used as nesting and foraging areas for terrapins. Portions of the Staten Island shoreline also provide wildlife tidal mudflat, dune, and some remnant freshwater wetland and forest habitat.

Despite the generally urbanized nature of the region, Jamaica, Raritan, and Sandy Hook Bays encompass important breeding and juvenile nursery habitat for fish. These estuaries and adjacent terrestrial habitat are also important for nesting, foraging, and roosting birds, including waterfowl, shorebirds, colonial-nesting waterbirds, and seabirds like gulls and terns.

The park is continually inventorying its wildlife species, and as of 2010 had found 326 bird species, 101 fish species, 30 mammal species, 25 reptile and amphibian species, and over 500 invertebrates, including aquatic macroinvertebrates, butterflies, moths, dragonflies, beetles, and other insects (Lawrence, Roman, and Frame 2010). At least 73 bird species nest in the park.

Mammals

The most common mammals at the park include opossum *(Didelphis virginiana),* raccoon *(Procyon lotor*), eastern cottontail *(Sylvilagus floridanus),* eastern gray squirrel *(Sciurus carolinensis),* white-tailed deer *(Odocoileus virginianus),* red fox *(Vulpes vulpes),* and species of rats, mice, and voles including white-footed mouse *(Peromyscus leucopus)* and meadow vole *(Microtus pennsylvanicus).* Migratory bats found at the park include little brown *myotis (Myotis lucifugus),* silver-haired bat *(Lasionycteris noctivagans),* red bat *(Lasiurus borealis),* and hoary bat *(Lasiurus cinereus)* (USFWS 1997b). Although not rare in the region, small

The wildlife group for which the park is best known is birds, particularly the waterbirds, seabirds, shorebirds, and waterfowl that frequent its estuarine and coastal shorelines.

mammals are rare in the urban core of the city and serve as an important food base for the hawks and owls feeding on the islands and shorelines of Jamaica Bay and elsewhere in the park.

As noted in the "Marine Resources" section of this chapter, dolphins, whales, and seals sometimes travel in park-managed waters. Harbor seals are winter visitors to Sandy Hook, Great Kills Harbor, Hoffman and Swinburne Islands, Jamaica Bay, and the Rockaway Inlet area and use local docks, the jetty at Breezy Point Tip, and other locations as haul-out areas. The endangered humpback whale occasionally feeds in New York Bay adjacent to the inlet, and bottlenose dolphins and endangered sperm whales *(Physeter macrocephalus)* have been noted as strandings in the area (USFWS 1997b).

Although the area that is now the park did at one time have larger land mammals, including elk, black bear, and beaver in the 1600s, these and a dozen other mammalian species are now locally extinct (NRCS 2001).

Birds

The wildlife group for which the park is best known is birds, particularly the waterbirds, seabirds, shorebirds, and waterfowl that frequent its estuarine and coastal shorelines. The park is visited annually by 34 species of migratory shorebirds (Harrington, pers. comm. n.d.).

Jamaica Bay, for example, averages mid-winter ground counts of birds at about 11,000, with a peak (during the years from 1980 to 1992) of 36,000 (USFWS 1997b). The migratory and mid-winter concentrations of waterfowl in the Raritan/Sandy Hook Bay complex (which includes both Sandy Hook and the park sites on the shore of Staten Island) average over 60,000 birds (USFWS 1997c).

Breezy Point and Sandy Hook support some of the highest concentrations of beach-nesting birds in the entire New York Bight coastal region, including threatened piping plovers and other rare bird species, such as least terns, black skimmers, and common terns, discussed in the "Species of Special Concern" section of this chapter. Other nesting waterbirds at Breezy Point include great black-backed gull, herring gull, and American oystercatcher. The gulls, terns, and oystercatchers nesting at these park sites feed throughout Rockaway Inlet and Jamaica Bay.

Breezy Point and Sandy Hook are also concentration areas for other migratory shorebirds, waterfowl, and raptors and other landbirds, especially during the summer and fall migrations. The raptor banding station at Breezy Point banded 2,414 raptors during the period from 1978 to 1987 and sighted 15,715 raptors. The most numerous species sighted were American kestrel *(Falco sparverius)* and sharp-shinned hawk (Accipiter striatus), with a total of 9,244 and 4,373 birds, respectively, sighted during that period (USFWS 1997b). Spring hawk counts at Fort Hancock on Sandy Hook average nearly 5,000 birds, with the same two species dominating (USFWS 1997c). Other species consistently sighted include Cooper's hawk *(Accipiter cooperii),* northern harrier *(Circus cyaneus)*, osprey *(Pandion haliaetus),* peregrine falcon *(Falco peregrinus),* and merlin *(Falco columbarius).*

Jamaica Bay's islands, because they are somewhat isolated from predation, support large numbers of colonial-nesting waterbirds as well as a variety of migratory species. At least 326 species of birds have been sighted at Jamaica Bay on its islands and at the wildlife refuge, including confirmed breeding by 62 of those species (USFWS 1997b). A mixed-breed heronry on Canarsie Pol includes a variety of nesting waders, including glossy ibis, great egret, snowy egret, cattle egret, black-crowned night-heron, and tricolored heron. A smaller heronry no longer active occurred on Ruffle Bar in 1995. Recent information from the NYC Audubon (Phillips, pers. comm. 2013) indicates herons and egrets also nest at Elder's Point, Subway Island and Little Egg and that breeding at Canarsie Pol has declined from predation by raccoons and human disturbance in recent years. Although no wading birds nested here in recent years, Canarsie Pol also has nesting by the state-listed threatened common tern, as well as by great black-backed gull, herring gull, and American oystercatcher. Common terns occur on several other islands in the bay, including Jo Co Marsh and Silver Hole Marsh, with smaller numbers at Duck Creek Marsh, East High Meadow, Ruffle Bar, and Subway Island. An average of about 1,000 common terns and a maximum of 1,630 common terns nested on the combined seven colonies in Jamaica Bay between 1984 and 1996 (USFWS 1997b).

Laughing gulls *(Larus atricilla)* recolonized Jamaica Bay in 1979; over 99.9 percent of nesting by this species in the state of New York from 1979 to 2007 was associated with the colony at Joco Island in the park. As of 2008, an estimated 1,280 nests were active at this site (Washburn, Lowney, and Gosser 2012).

Ospreys also nest in the Jamaica Bay Unit and elsewhere in the park. Approximately 18 osprey pairs nest in Jamaica Bay, 14 pairs at Sandy Hook, and 1 pair on Staten Island.

Clapper rails *(Rallus longirostris)* and common moorhens *(Gallinula chloropus)* nest in the saltmarshes. American oystercatchers nest at several islands in Jamaica Bay; they also have nested along the airport shoreline. A variety of other birds breed on the islands and uplands in the bay, including one of only two New York State sites for, and the northernmost nesting extent of, the boat-tailed grackle *(Quiscalus major).* Shorebirds known to breed in or around Jamaica Bay include killdeer *(Charadrius vociferus),* American oystercatcher, willet, spotted sandpiper *(Actitis macularia),* upland sandpiper, and American woodcock *(Scolopax minor).*

In addition to providing wintering and nesting habitat, Jamaica Bay is one of the most important migratory shorebird stopover sites in the New York Bight region, especially during fall migration (July to November). The shorebirds use much of the bay during the migration stopovers, but tend to focus on the intertidal areas during low tide and move to East and West Ponds on Ruler's Bar Hassock during higher tides. The water in East Pond is artificially lowered after July 1 each year. From 1981 to 1990, there was an average of 27 and a maximum of 36 shorebird species counted at the East and West Ponds in the Jamaica Bay Wildlife Refuge during the fall. The most abundant shorebirds during that period were black-bellied plover *(Pluvialis squatarola),* semipalmated plover *(Charadrius semipalmatus),* greater yellowlegs *(Tringa melanoleuca),* ruddy turnstone *(Arenaria interpres),* sanderling *(Calidris alba),* semipalmated sandpiper *(Calidris pusilla),* least sandpiper *(Calidris minutilla),* dunlin *(Calidris alpina),* and short-billed dowitcher *(Limnodromus griseus).* Jamaica Bay is also important during spring migration (March to June) on the ponds for several of these same species, as well as red knot *(Calidris canutus).* Hunting is prohibited in the park by virtue of

The combination of geographic location and configuration coupled with productive bay wetlands, flats, and waters in Raritan and Sandy Hook Bays make this another important migratory staging area in the park for many species of waterfowl on the Atlantic Flyway.

its New York City location, which may contribute to the high numbers of individual ducks and duck species. In one year-round survey of birds at Jamaica Bay, 263,000 individuals of 32 species were recorded (USFWS 1997b).

The combination of geographic location and configuration coupled with productive bay wetlands, flats, and waters in Raritan and Sandy Hook Bays make this another important migratory staging area in the park for many species of waterfowl on the Atlantic Flyway. Peak migration occurs in late October, but November aerial counts in New Jersey waters still average nearly 45,000 birds (USFWS 1997c). The number of horned grebes *(Podiceps auritus),* as well as common and red-throated loons *(Gavia immer, G. stellata),* during migration is regionally significant. Especially notable are the overwintering scaup concentrations, primarily greater scaup, which have increased in this area recently and are an important component of the Atlantic Flyway population. Other significant species populations include Canada geese in the Raritan River and the Navesink system, American black ducks, canvasbacks *(Aythya valisineria),* mallards *(Anas platyrhynchos),* and brant, along with lesser numbers of bufflehead, oldsquaw *(Clangula hyemalis),* mergansers (primarily red-breasted mergansers *[Mergus serrator])*, common goldeneye *(Bucephala clangula),* and American wigeons *(Anas americana).* These waterfowl are not evenly distributed but rather tend to concentrate along the southern Raritan Bay and Staten Island shorelines, where moderate-sized flocks of scaup and American black ducks and smaller groups of brant occur.

Shrublands and woodlands can offer important feeding or resting habitat for songbirds (or "passerines") in the park, such as sparrows, warblers, and other perching species. As noted above, grasslands at Fort Hancock on Sandy Hook and open areas at Breezy Point support very large spring raptor migrations as well.

Grasslands at Floyd Bennett Field became habitat for certain open-country bird species after the airfield was decommissioned in 1950, and stayed that way until the last few decades, when open areas began to transition into shrub and forest. In 1985, a portion of Floyd Bennett Field was cleared and mowed to create grasslands; about 140 acres are still maintained using these techniques. This area is unique in that it is a large grassland in the urban area of New York City, supporting feeding and resting grassland species that are not seen elsewhere in the city. In addition, several birds have or now use this habitat for nesting, including grasshopper sparrow *(Ammodramus savannarum),* horned lark *(Eremophila alpestris),* eastern meadowlark *(Sturnella magna),* upland sandpiper, savannah sparrow *(Passerculus sandwichensis),* northern harrier, American kestrel, and common barn owl *(Tyto alba).* Use of this area by grasshopper sparrows (a state-listed species) increased significantly in average abundance between 1984 and 1992. Since 1996, however, there have been no grasshopper sparrows nesting at Floyd Bennett Field.

Overwintering grassland birds at Floyd Bennett Field include northern harrier, rough-legged hawk (Buteo lagopus), American kestrel, common barn owl, short-eared owl *(Asio flammeus),* horned lark, eastern meadowlark, and savannah sparrow. The bobolink *(Dolichonyx oryzivorus)* is a regular migrant visitor in the grasslands. Grassland birds, especially upland sandpipers, also use the grassland habitat along the runways at John F. Kennedy International Airport (USFWS 1997b).

The bird community at park sites in the Staten Island Unit is most varied at Great Kills Park, including Crooke's Point. Wintering horned larks, snow buntings *(Plectrophenax nivalis),* and Lapland longspurs *(Calcarius lapponicus)* occupy shoreline habitat, and purple sandpipers *(Calidris maritima),* ruddy turnstones *(Arenaria interpres),* and gulls visit jetties at Crooke's Point and north of the tidal flats at Great Kills Park (Audubon New York 2013). Fall migrants are numerous and include red-shouldered hawk *(Buteo lineatus),* rough-legged hawk, and northern harrier, as well as numerous warblers, vireos, orioles, and flycatchers. Shorebirds, wading birds, and waterfowl including herons, ibis, and egrets occupy seasonal ponds after heavy rains. Bank swallows *(Riparia riparia)* nest in cliffs southeast of the parking lot.

Reptiles and Amphibians

Species of reptiles in the park include the estuarine northern diamondback terrapin *(Malaclemys terrapin),* seven species of turtles in the terrestrial maritime environment and freshwater wetlands, six species of snakes, and several sea turtles that swim offshore. The eastern hognose snake *(Heterodon platyrhinos)* has recently been reintroduced to portions of the park (Tanacredi and Badger 1995, as cited in NRCS 2001). An additional eight species of amphibians include salamanders, newts, toads, and frogs, including the northern spring peeper *(Pseudacris crucifer),* reintroduced as a food source for the eastern hognose snake. In addition to the eastern hognose snake and spring peeper, several other reptiles and amphibians have been introduced specifically to the Jamaica Bay Wildlife Refuge area of the park. These include Fowler's toad *(Bufo woodhousii fowleri),* gray treefrog *(Hyla versicolor),* green frog *(Rana clamitans),* spotted salamander *(Ambystoma maculatum),* redback salamander *(Plethodon cinereus),* northern brown snake *(Storeria dekayi dekayi),* smooth green snake *(Opheodrys vernalis),* eastern milk snake *(Lampropeltis triangulum triangulum),* northern black racer *(Coluber constrictor constrictor),* snapping turtle *(Chelydra serpentina),* eastern painted turtle *(Chrysemys picta picta),* and eastern box turtle *(Terrapene carolina carolina).*

Although northern diamondback terrapins and eastern box turtles are not listed, they are considered species of management concern by the park and are discussed in more detail in the "Species of Special Concern" section in this chapter of the GMP/EIS.

Sea turtles use the area offshore of several park sites, and loggerhead sea turtles have occasionally been reported coming on shore in the Jamaica Bay or Breezy Point areas (USFWS 1997b).

Fish

Over 100 species of finfish and shellfish have been counted in park-managed waters, with 90 reported in fisheries hauls in the Raritan and Sandy Hook Bays. The most abundant fish species in the Raritan Bay complex are those tolerant of lower salinities and so require an estuarine habitat like that provided off the Staten Island and east Sandy Hook shorelines. These species include mummichog, hogchoker *(Trinectes maculatus),* weakfish, winter flounder, summer flounder, striped bass, sea bass *(Dicentrarchus punctatus), scup (Stenotomus chrysops),* and spot *(Leiostomus xanthurus).* Commercial fisheries exist for American shad *(Alosa sapidissima),* American eel *(Anguilla rostrata),* and American lobster. Blue crabs and horseshoe crabs are taken in a dredge fishery. Species of clams, oysters, and mussels populate the bays, although

they are closed to direct-market harvest of shellfish due to pollution (USFWS 1997c; Yuhas 2003, New York Department of Environmental Conservation website: **http://www.dec.ny.gov/regs/4014.html#12837;** consulted June 17, 2013). Sandy Hook Bay has been re-classified as a special restricted area (following resolution of water quality issues related to Hurricane Sandy), which mean shellfish taken from here can be sold after depuration in clean water tanks (NJ DEP Marine Water Monitoring website: **http://www.state.nj.us/dep/bmw/sandymonmouth.html;** consulted June 17, 2013).

Waters in Jamaica Bay and ocean-fronting park sites on the Rockaway peninsula are home to an estimated 81 species of finfish and shellfish.

Waters in Jamaica Bay and ocean-fronting park sites on the Rockaway peninsula are home to an estimated 81 species of finfish and shellfish (USFWS 1997b). The majority of species collected in Jamaica Bay, including the commercially important winter flounder, are juveniles using it as a nursery area. Juvenile Atlantic silverside *(Menidia menidia)* composed over 60 percent of all species caught in a seining survey of the bay in 2002 (USACE 2010). Mummichog, Atlantic menhaden, striped killifish *(Fundulus majalis),* and Atlantic silverside compose a prey base in the bay for feeding fish and birds. Recreational landings include scup, bluefish *(Pomatomus saltatrix),* and American eel, many of which are caught in Raritan and Sandy Hook Bays.

Essential Fish Habitat

The regional fisheries management councils, with assistance from the National Oceanic and Atmospheric Administration (NOAA)–Fisheries, are required under the Magnuson-Stevens Fishery Management and Conservation Act to delineate essential fish habitat for all managed species to minimize adverse effects and identify actions to enhance and conserve habitat for these species.

Several of the species listed below are currently in danger of overfishing or are currently overfished, (NOAA websites: **http://www.nero.noaa.gov/hcd/STATES4/conn_li_ny/40307350.html** ~~http://www.nero.noaa.gov/hcd/STATES4/ConnNYNJ.htm,~~ consulted June 14, 2013):

- Whiting *(Merluccius bilinearis)* - eggs, larvae and juveniles at Rockaway Beach, Jamaica Bay; eggs, larvae, juveniles and adults off Sandy Hook.

- Red hake *(Urophycis chuss)* - eggs, larvae and juveniles at Rockaway, Jamaica Bay, Sandy Hook and Staten Island

- Winter flounder *(Pseudopleuronectes americanus)* - all life stages at all park units

- Windowpane flounder *(Scophthalmus aquosus)* - all life stages off Staten Island, Sandy Hook and western Jamaica Bay; juveniles and adults in eastern Jamaica Bay.

- Yellowtail flounder *(Limanda ferruginea)* - eggs and larvae off Sandy Hook

- Atlantic sea herring *(Clupea harengus)* - juveniles and adults offshore of Sandy Hook and western Jamaica Bay; adults in eastern Jamaica Bay; larvae, juveniles and adults off Staten Island

- Monkfish *(Lophius americanus)* – eggs and larvae off Sandy Hook and western Jamaica Bay; eggs, larvae and juveniles in eastern Jamaica Bay.

- Bluefish *(Pomatomus saltatrix)* – juveniles and adults in Jamaica Bay, off Staten Island; all life stages offshore Sandy Hook

- Atlantic butterfish *(Peprilus triacanthus)* - all life stages in eastern Jamaica Bay; larvae, juvenile and adults in western Jamaica Bay and Rockaway beaches, offshore Staten Island; juveniles offshore Sandy Hook

- Atlantic mackerel *(Scomber scombrus)* – all life stages in eastern Jamaica Bay; juveniles and adults in western Jamaica Bay and offshore Staten Island

- Summer flounder *(Paralichthys dentatus)* – larvae, juveniles and adults offshore Staten Island and in western Jamaica Bay/Rockaway quadrant; juveniles and adults in eastern Jamaica Bay and offshore Sandy Hook.

- Scup – all life stages in western Jamaica Bay/Rockaway and offshore Staten Island; juveniles and adults offshore Sandy Hook and eastern Jamaica Bay.

- Black sea bass *(Centropristis striata)* - juveniles and adults at Staten Island, western Jamaica Bay/Rockaway, offshore Sandy Hook; juveniles in eastern Jamaica Bay.

- Ocean quahog *(Artica islandica)*- adults found offshore of Sandy Hook

- King mackerel *(Scomberomorus cavalla)* - all life stages offshore of Staten Island, Sandy Hook, Jamaica Bay/Rockaway

- Spanish mackerel *(Scomberomorus maculatus)* - all life stages at all park units

- Cobia *(Rachycentron canadum)* - all life stages at all park units

- Sand tiger shark *(Carcharias Taurus)* - larvae at all park units

- Dusky shark (*Carcharhinus obscurus)*- larvae and juveniles offshore Staten Island and Sandy Hook; larvae in Jamaica Bay.

- Sandbar shark *(Carcharhinus plumbeus)* – larvae and adults offshore Staten Island; larvae, juveniles and adults at other park sites.

- Tiger shark *(Galeocendo cuvieri)* - larvae offshore Sandy Hook and eastern Jamaica Bay

- Bluefin tuna *(Thunnus thynnus)* - juveniles offshore Sandy Hook

- Skipjack tuna *(Katsuwonus pelamis)* - adults offshore Sandy Hook

The mudflat at Plumb Beach supports other invertebrates, including mud snails and Atlantic ribbed mussels (Geukensia demissa), which provide biomass for horseshoe crabs and a variety of birds.

Invertebrates

Aquatic invertebrates are plentiful in the shallow waters of Jamaica Bay. The muddy sediment of the eastern and northern portions of the bay and sandy soils of the southern and western side support a diverse assemblage of benthic species, measured at 121 in a 1983 survey (USFWS 1997b). Amphipod crustaceans such as marine worms supply food for waterfowl and adult winter flounder. The mudflat at Plumb Beach supports other invertebrates, including mud snails and Atlantic ribbed mussels *(Geukensia demissa),* which provide biomass for horseshoe crabs and a variety of birds. Horseshoe crabs in turn lay abundant eggs, which feed many migrating bird species, and in particular sustain the state-listed red knot, a species that must have this food source to successfully complete its migration to the arctic. Sandy soils offshore of park sites support many mollusks and crustaceans, including northern quahog, soft clam, and Atlantic surf clam. The biodiversity, however, is much impoverished compared with what it must have been before the loss of eelgrass beds and oyster reefs.

Terrestrial invertebrates are largely unsurveyed in the park, although studies of butterflies in the 1990s recorded over 50 species (Tanacredi and Badger 1995, as cited in NRCS et al. 2001). American holly at the park is the host for the rare butterfly, Henry's elfin *(Callophrys henrici),* which has been recorded breeding and overwintering in the Raritan Bay/Sandy Hook area (Lawrence, Roman, and Frame 2010). A slightly more recent survey of Jamaica Bay Wildlife Refuge (USFWS 1997a) counted 54 species of butterflies and skippers at the refuge and in surrounding uplands. This survey noted regular use by several rare butterfly and skipper species, including checkered white *(Pieris protodice),* white-m hairstreak *(Parrhasius m-album),* Appalachian azure *(Celastrina neglectamajor),* tawny emperor *(Asterocampa clyton),* and saltmarsh skipper *(Panoquina panoquin)* (USFWS 1997a). More than 489 moth species have been photo-identified in and around Jamaica Bay (S. Walter, pers. comm. n.d.)

Wildlife in Park Sites

An informal survey of park wildlife types completed by Rowan (2012) was used to compile the following assessments of current wildlife status at park sites.

Jamaica Bay Unit

Plumb Beach. Plumb Beach habitat is composed mostly of native species, and the beach is in relatively undisturbed condition in the eastern portion of the site. The only notes made by Rowan include the presence of horseshoe crabs and the potential for recreational fishing. Although shorebird habitat may be available, the heavy use of the area makes nesting unlikely. However, Plumb Beach continues to provide important stopover habitat for migratory birds, including the stated listed red knot which feeds on the eggs of horseshoe crabs at the site.

Floyd Bennett Field. Open areas of grasslands, meadow, and possible wet areas, including Phragmites, offer habitat for birds, small mammals and their predators (primarily birds), and deer. Rowan noted that feral cats or dogs as well as resident Canada geese are likely present. Grasslands may be used by butterflies, bluebirds, and other grassland or meadow species.

Canarsie Pier Coastal Area, Including Horseshoe Bay, Fountain Avenue and Pennsylvania Avenue Parks, Spring Creek Park Site. The majority of this area is highly disturbed, although mudflats in some areas may support horseshoe crabs. Feral dogs and cats, which may prey on shorebirds or small mammals, are likely present.

Frank Charles Memorial Park. Rowan (2012) did not notice any wildlife and indicated it was likely quite sparse because the park site is small and heavily used.

Hamilton Beach Park. Mudflats at this park site likely support a few invertebrate species. Feral pets are likely present.

Jamaica Bay Fast Islands. The wildlife community on the fast islands, and in particular Canarsie Pol, is important, with wading-bird rookeries and other bird nesting and breeding areas. In addition to its isolation from predators of ground- or colonial-nesting birds, the existing woodland provides habitat for roosting birds.

Jamaica Bay Hassocks. Wildlife at the hassocks is primarily aquatic because these islands are submerged by the tides. Invertebrates and shellfish, crustaceans, waterfowl, seabirds, and shorebirds live and feed in the saltmarsh at lower tide.

Jamaica Bay Wildlife Refuge. The combination of estuarine, saltmarsh, and freshwater habitat provides support for a multitude of migratory bird species, many of which are rare, threatened, or endangered at the state or federal level. The open waters of the refuge ponds support large flocks of resident Canada geese and gulls.

Jacob Riis Park. Although the dune area of this park site could support some wildlife species, habitat is limited by the near absence of vegetation.

Fort Tilden. Habitat in the beach intertidal and splash zone could be home to an abundant assemblage of marine invertebrates. Grasslands and shrublands provide habitat for passerines, including sparrows, warblers, and other species. Fort Tilden is known for raptor migrations between March and May, including many rare or unique species such as northern harriers and ospreys.

Breezy Point Tip. The tip of Breezy Point is excellent shorebird and marine bird/waterfowl habitat. It also is used by terrapins for nesting and is home to surf clams and other invertebrates on relatively undisturbed beach intertidal habitat. Upland dune and shrub habitat is used by a variety of songbirds and waterfowl for feeding, nesting, and resting.

The tip of Breezy Point is excellent shorebird and marine bird/ waterfowl habitat. It also is used by terrapins for nesting and is home to surf clams and other invertebrates on relatively undisturbed beach intertidal habitat.

Staten Island Unit

Fort Wadsworth. Wildlife in Fort Wadsworth would be those species able to live in woodlands and shrublands that are not native to the area. Shoreline areas may support sparse wildlife, although beaches slope quickly to deep water.

Miller Field. The swamp white oak forest may provide habitat for a few woodland birds, although heavy use likely keeps wildlife from permanently residing here.

Great Kills and Crooke's Point. The 1990 amendment to the park's 1979 General Management Plan (NPS 1990c) noted over 80 species of wildlife had been counted in the Great Kills/Crooke's Point area. Species included waterfowl, wading birds, raptors and passerine species of birds. Open areas of beach grass provided habitat for large numbers of amphibians and reptiles. Diamond-backed terrapins (turtles) were found at the harbor on Crookes Point. Green frogs and Fowler's toads were found in shaded areas south of Hylan Boulevard. Small mammals that do not require large areas of cover found at the site included bats, mice, chipmunks, shrews, squirrels and voles. Crookes Point contained diverse wildlife habitat and remains an important habitat for migrating birds and insects, particularly the monarch butterfly. ~~Although Rowan did not observe wildlife, she did note that the wetlands, saltmarsh, and mudflat habitat near shrublands is likely to provide some habitat for native species.~~

Hoffman and Swinburne Islands. These islands are used by herons, ibis, egrets, and other waterbirds in a mixed-species rookery for nesting.

Sandy Hook Unit

Beaches. Rowan indicated that the sparse natural vegetation at Sandy Hook means the beach or foredune wildlife community is less abundant than it could be. Extensive maritime shrublands behind the foredunes may provide habitat for a variety of passerines. As described in the "Species of Special Concern" section in this chapter of the GMP/EIS, abundant shorebird nesting, including for several listed or unique species, takes place on the beaches of Sandy Hook.

Fort Hancock. Grasslands and old fields near the fort support butterflies and other insects, and offer nesting and feeding opportunities for ground-nesting passerines. Small mammals likely occupy the area as well, which contributes to its value as a raptor migration stopover in the spring (USFWS 1997a).

Internal Shrublands and Woodlands. Internal shrublands and woodlands, including the maritime holly forest, can be important roosting or nesting habitat for birds. These habitats include historical nesting by great blue herons *(Ardea herodias)* and black-crowned night-herons, and currently host ospreys and several species of passerines (USFWS 1997a). Horseshoe and Spermaceti Coves. These coves provide saltmarsh, mudflat, and other habitats important for marine birds and waterfowl.

Species of Special Concern

This section of the GMP/EIS lists plants and animals that are named under the federal Endangered Species Act or a state (New York or New Jersey) Endangered Species Act and are referred to as "listed" species throughout the rest of this section. This section also includes species of park management concern, a category that can include rarity, its ecological niche, or need for management because it is invasive, overabundant, a nuisance or a disease vector for example. Where a species is both listed and of management concern to the park, it is described in more detail. Because federally listed species are of particular management concern to the NPS as a federal agency, they are the focus of separate subsections.

Plants

Table 3-4 shows plants that are state or federally listed and that grow in the park. Vegetation associations are described in the "Vegetation" section in this chapter of the GMP/EIS; some of these are considered imperiled in New York or New Jersey, or globally. Although many more plants are listed as threatened or endangered on the New York or New Jersey lists, the species in table 3-4 are the ones whose presence has been verified at Gateway. Information for the descriptions and status is taken from the New York Natural Heritage Program website (http://www.acris.nynhp.org), New Jersey Endangered and Nongame Species Program, and personal communications with NPS staff.

Table 3-4. State or Federally Listed Plant and Animal Species Known to Occur at Gateway.

Scientific Name	Common Name	Listing
Birds		
Accipiter cooperii	Cooper's hawk	SL
Accipiter gentilis	Northern goshawk	SL
Accipiter striatus	Sharp-skinned hawk	SL
Ammodramus henslowii	Henslow's sparrow	SL
Ammodramus maritimus	Seaside sparrow	SL
Ammodramus savannarum	Grasshopper sparrow	SL
Asio flammeus	Short-eared owl	SL
Asio otus	Long-eared owl	SL
Bartramia longicauda	Upland sandpiper	SL
Botaurus lentiginosus	American bittern	SL
Buteo lineatus	Red-shouldered hawk	SL
Calidris canutus	Red knot	SL
Caprimulgus vociferus	Whip-poor-will	SL
Charadrius melodus	Piping plover	FT, SL
Chlidonias niger	Black tern	SL
Chordeiles minor	Common nighthawk	SL
Circus cyaneus	Northern harrier	SL
Cistothorus platensis	Sedge wren	SL
Dendroica cerulea	Cerulean warbler	SL
Dolichonyx oryzivorus	Bobolink	SL
Eremophila alpestris	Horned lark	SL
Falco peregrinus	Peregrine falcon	SL
Gavia immer	Common loon	SL
Haliaeetus leucocephalus	Bald eagle	SL
Icteria virens	Yellow-breasted chat	SL
Ixobrychus exilis	Least bittern	SL

Table 3-4. State or Federally Listed Plant and Animal Species Known to Occur at Gateway (continued).

Scientific Name	Common Name	Listing
Lanius ludovicianus	Loggerhead shrike	SL
Laterallus jamaicensis	Black rail	SL
Melanerpes erythrocephalus	Red-headed woodpecker	SL
Nyctanassa violacea	Yellow-crowned night-heron	SL
Nycticorax nycticorax	Black-crowned night-heron	SL
Pandion haliaetus	Osprey	SL
Passerculus sandwichensis	Savannah sparrow	SL
Podilymbus podiceps	Pied-billed grebe	SL
Pooecetes gramineus	Vesper sparrow	SL
Rallus elegans	King rail	SL
Rynchops niger	Black skimmer	SL,
Sterna antillarum	Least tern	SL,
Sterna dougallii	Roseate tern	FE, SL
Sterna hirundo	Common tern	SL,
Strix varia	Barred owl	SL
Vermivora chrysoptera	Golden-winged warbler	SL
Invertebrates		
Cicindela dorsalis dorsalis	Northeastern beach tiger beetle	FT, SL
Fish		
Acipenser brevirostrum	Shortnose sturgeon	FE, SL
Acipenser oxyrhynchus	Atlantic sturgeon	FE
Reptiles		
Caretta caretta	Loggerhead turtle	FT, SL
Chelonia mydas	Green turtle	FT, SL
Dermochelys coriacea	Leatherback turtle	FE, SL
Eretmochelys imbricata imbricata	Hawksbill turtle	FE, SL
Lepidochelys kempii	Kemp's Ridley sea turtle	FE, SL
Terrapene carolina carolina	Eastern box turtle	SL
Mammals		
Balaenoptera borealis	Sei whale	FE, SL
Balaenoptera musculus	Blue whale	FE, SL
Balaenoptera physalus	Fin whale	FE, SL
Eubalaena glacialis	Northern right whale	FE, SL
Megaptera novaeangliae	Humpback whale	FE, SL
Myotis sodalis	Indiana bat	FE, SL
Phocoena phocoena	Harbor porpoise	SL
Physeter macrocephalus	Sperm whale	FE, SL

Table 3-4. State or Federally Listed Plant and Animal Species Known to Occur at Gateway (continued).

Scientific Name	Common Name	Listing
Plants		
Amaranthus pumilus	Seabeach amaranth	FT, SL
Bidens laevis	Smooth bur-marigold	SL
Cenchrus tribuloides	Sanddune sandbur	SL
Chenopodium rubrum	Red pigweed	SL
Cuscuta polygonorum	Smartweed dodder	SL
Cyperus flavescens var. *flavescens*	Yellow flatsedge	SL
Cyperus lupulinus ssp. *lupulinus*	Hop sedge	SL
Cyperus retrorsus	Retrorse flatsedge	SL
Cyperus schweinitzii	Schweinitz's flatsedge	SL
Digitaria filiformis	Slender crabgrass	SL
Eupatorium leucolepis var. *leucolepis*	White-bracted boneset	SL
Eupatorium torreyanum	Fringed boneset	SL
Galium concinnum	Shining bedstraw	SL
Glaux maritima	Sea milkwort	SL
Juniperus horizontalis	Creeping juniper	SL
Lycopus rubellus	Gypsy wort	SL
Magnolia virginiana	Sweetbay magnolia	SL
Oenothera humifusa	seabeach evening-primrose	SL
Oenothera laciniata	Cut-leaved evening-primrose	SL
Oenothera oakesiana	Oakes' evening-primrose	SL
Polygonum glaucum	Seabeach knotweed	SL
Quercus phellos	Willow oak	SL
Solidago sempervirens var. *mexicana*	Seaside goldenrod	SL
Suaeda linearis	Narrow leaf sea-blite	SL

Sources: NPS n.d.h; NYDEC n.d.a, n.d.b, and n.d.c; NJDEP 2010, n.d.a, and n.d.b.
SL = state listed; FT = federally threatened; FE = federally endangered

Many of the state-listed plants at the park are either saltwater or freshwater wetland or marsh species. These include smooth bur-marigold *(Bidens laevis),* a state threatened plant that is found primarily in freshwater and tidal mudflats; red pigweed *(Chenopodium rubrum),* found along the coast in wet interdunal swales, rocky beaches, and the shores of coastal ponds and saltmarshes; smartweed dodder *(Cuscuta polygonorum)*, which grows in wet meadows and moist shores and riverbanks; and gypsy wort *(Lycopus rubellus),* found in marshes and flooded swamps. High saltmarsh listed plants include a subspecies of seaside goldenrod *(Solidago sempervirens var. mexicana)* and narrow leaf sea-blite *(Suaeda linearis),* although these species are also found in grasslands (goldenrod) or interdunal swales and beaches (sea-blite). Woodland or palustrine wetland state-listed species found at the park

include shining bedstraw *(Galium concinnum),* found in hardwood forests and along the banks or swampy ground next to streams; sweetbay magnolia *(Magnolia virginiana)*, which grows in red maple palustrine wetlands; and willow oak *(Quercus phellos),* which occupies floodplain forests, as well as grasslands or roadside forests where the soil is moist.

Many of these state-listed species are ranked S1 or S2 in the state, which means there are fewer than 5 (S1) or 20 (S2) known occurrences statewide.

The remaining state-listed plants grow on the open sandy areas of the park's coastline, including the upper beach, foredune, and more inland dunes. These include sanddune sandbur *(Cenchrus tribuloides)*, a dune species found at Great Kills Park; creeping juniper *(Juniperus horizontalis),* an evergreen shrub that occupies wetland shores and stream banks in addition to dunes; cut-leaved and Oakes' evening-primrose *(Oenothera laciniata, Oenothera oakesiana),* which grow on dry sandy soils on dunes or along roadsides; seabeach knotweed *(Polygonum glaucum),* which occupies beach and adjacent dune and saltmarsh habitat and has been found in the Sandy Hook Unit of the park; southern arrowwood *(Viburnum dentatum var. venosum),* a species that grows on dry, sandy, coastal habitat including dunes and old fields; slender crabgrass *(Digitaria filiformis),* which grows on sandy disturbed areas near the coast; two species of boneset (white-bracted, *Eupatorium leucolepis var. leucolepis,* and fringed, *E. torreyanum),* which grow in sandy, open habitats including weedy or shrubby roadsides, grasslands, and dunes; and four flatsedges. The flatsedges have been collected from wet sandy sites, beaches, roadsides, and additional areas where the sand is windblown or otherwise mobile. They include yellow flatsedge *(Cyperus flavescens var. flavescens),* hop sedge *(C. lupulinus ssp. lupulinus),* retrorse flatsedge *(C. retrorsus),* and Schweinitz's flatsedge *(C. schweinitzii).*

Many of these state-listed species are ranked S1 or S2 in the state, which means there are fewer than 5 (S1) or 20 (S2) known occurrences statewide. The rarest (S1) species include smartweed dodder, yellow flatsedge, retrorse flatsedge, slander crabgrass, white-bracted boneset, shining bedstraw, creeping juniper, gypsy wort, sweetbay magnolia, cut-leaved primrose, willow oak, seaside goldenrod, and narrow leaf sea-blite.

Although the park does not have specific management goals for any of these state-listed species, it does work toward restoring maritime vegetative communities and many of the species that are rare in the park live in those communities. These include red maple *(Acer rubrum),* red and black chokeberry *(Aronia arbutifolia, A. melanocarpa),* common hackberry *(Celtis occidentalis),* American holly *(Ilex opaca),* eastern red cedar *(Juniperus virginiana),* northern bayberry *(Myrica pensylvanica),* black cherry *(Prunus serotina),* and several species of oak (pin *[Quercus palustris],* white [Q. alba], scarlet *[Q. coccinea],* northern red *[Q. rubra],* black *[Q. velutina]*, and chestnut oak *[Q. prinus]).* The park also lists restoration of the estuarine eelgrass community as of management concern (NPS 2013f).

Federally Listed Plant Species – Seabeach Amaranth

Seabeach amaranth is the only federally listed plant species occurring at the park. Seabeach amaranth *(Amaranthus pumilus)* is a federally threatened species listed in 1993 and is considered endangered by both New York and New Jersey. It is an annual vascular plant

that inhabits upper beaches and overwash areas, primarily at the accreting end of barrier spits like Sandy Hook. It occupies a narrow beach zone that lies at elevations from 0.2 to 1.5 meters above mean high tide. Without overwash to maintain the open, sparsely vegetated habitat required by the species, it can be outcompeted by other plants and eliminated.

Seabeach amaranth has been lost over much of its former range on the east coast, primarily from development and stabilization of barrier island beaches. Coastal storms are considered the single most important natural limitation on the abundance of seabeach amaranth and have both positive effects from habitat creation and negative ones from flooding. The primary nonnatural threat is alteration of habitat from beach erosion and shoreline stabilization (NPS 2004f). Seabeach amaranth was considered extirpated from the state by 1913 until 2000, when it was rediscovered. In 2005, a large population of more than 3,000 plants was found at Sandy Hook; this population remains the largest in New Jersey.

Populations of seabeach amaranth at any given site are extremely variable (Weakley and Bucher 1992, as cited in NPS 2007a) and can fluctuate by several orders of magnitude from year to year. The primary reasons for the natural variability of seabeach amaranth are the dynamic nature of its habitat and the effects of stochastic (random) factors such as weather and storms on mortality and reproductive rates. Although wide fluctuations in species populations tend to increase the risk of extinction, variable population sizes are a natural condition for seabeach amaranth and the species is well adapted to its ecological niche. While the numbers of plants has varied state to state as well, the U.S. Fish and Wildlife Service (USFWS) notes a geographic shift of the largest populations from North Carolina to New York (NPS 2007a).

In addition to the large Sandy Hook population, sites in the Jamaica Bay Unit support seabeach amaranth. Numbers are lower in these park sites; 2007 counts indicated Breezy Point Tip contained 123 plants; Fort Tilden, 11; and Jacob Riis Park, 8 (NPS 2007b). The lower number of plants at Jacob Riis Park is associated with the removal of fencing used to attempt protection of piping plover (Charadrius melodus) nests, because these two species often occur together. The number of plants at Breezy Point Tip grew from 123 in 2007 to 862 plants in 2009, illustrating the variability in the population from year to year (NPS 2009d).

The recovery goals for the park for seabeach amaranth are a long-term average population of at least 2,000 plants and a five-year minimum population of no fewer than 1,000 plants (NPS 2009e). To help in meeting these goals, the park takes the following actions:

- Erecting symbolic fencing (string and post) around plants to create a 10-meter buffer to reduce loss from trampling by visitors

- Keeping habitat for this species available by prohibiting dense planting of other vegetation

- Collecting and storing seabeach amaranth seeds to repopulate in case of catastrophic events or population declines

- Evaluating the potential for, and planting seeds in, suitable areas of the park
- Monitoring the presence and condition of all known populations in the park

Invertebrates

Terrestrial invertebrates are largely unsurveyed in the park, although studies of butterflies in the 1990s recorded over 50 species (Tanacredi and Badger 1995, as cited in NRCS 2001). American holly at the park is the host for the rare butterfly, Henry's elfin *(Callophrys henrici),* which has been recorded breeding and overwintering in the Raritan Bay/Sandy Hook area (Lawrence, Roman, and Frame 2010). A slightly more recent survey of Jamaica Bay Wildlife Refuge (USFWS 1997b) counted 54 species of butterflies and skippers at the refuge and in surrounding uplands. This survey noted regular use by several rare butterfly and skipper species, including checkered white *(Pieris protodice),* white-m hairstreak *(Parrhasius m-album),* Appalachian azure *(Celastrina neglectamajor),* tawny emperor *(Asterocampa clyton),* and saltmarsh skipper *(Panoquina panoquin)* (USFWS 1997b). While only the checkered white butterfly is state listed, each is considered a species of concern by New York.

The park has identified aquatic invertebrates horseshoe crab (Limulus polyphemus), hardshell clam or quahog (Mercenaria mercenaria), and common oyster (Crassostrea virginica) as species of management concern with the objective of increasing the park population of all three. The rare white checkered butterfly is also of management concern at the park, with an increased population as a goal. Eelgrass and oysters are considered key extirpated species (along with Atlantic bay scallop *[Argopecten irradians])* of the original estuarine benthic communities of Jamaica Bay's littoral zone (NPS 2010b).

Federally Listed Invertebrate Species – Northeastern Beach Tiger Beetle

This species is listed as threatened under the federal Endangered Species Act and as endangered in New Jersey.

The northeastern beach tiger beetle *(Cicindela dorsalis dorsalis)* is a predatory species that forages for insects, lice, and fleas in the sand of the intertidal zone. Adults also scavenge dead crabs and fish. Populations of tiger beetles normally experience very high larval mortality and dramatic year-to-year, two- to threefold fluctuations in abundance, sometimes resulting in local extinction. Weather factors such as flood tides, hurricanes, erosion, and winter storms; mortality due to predators and parasites; and recreational beach use all contribute to the population declines (NPS 2004f).

Early records indicate that the northeastern beach tiger beetle occurred in "great swarms in July" along coastal beaches from Martha's Vineyard south to New Jersey and on both sides of Chesapeake Bay in Virginia and Maryland. Ideal habitat for the adult beetles and their larvae are wide, undisturbed, dynamic, fine sand beaches. The most important

consideration, however, is limited use and disturbance by vehicles and humans; northeastern beach tiger beetles are so sensitive to human disturbance, for example, that a recent management document (NPS 2007a) recommended prohibiting all but emergency NPS off-road vehicle use from tiger beetle areas and limiting human use to fewer than 50 people per week during the summer and fall, and then only as walkers along the water's edge.

Disturbance from vehicular traffic and foot traffic has resulted in the extirpation of the beetle from New York State, particularly from the beaches of Long Island, where it had once been prevalent. Although it was not present in the park in recent times, it was reintroduced to the northern section of Sandy Hook in 1994 using larvae from the Chesapeake Bay. Additional reintroductions of larvae to the park have continued through 2006 (NPS 2007a). NPS monitors this species in coordination with the USFWS though annual surveys. Adult populations are estimated to be around 500 individuals according to annual surveys, although the population size varied dramatically from 1994 to 2003, with a low of 18 in 1996 to a high of 955 in July 2000 (NPS 2004f).

A recent management plan for the park's listed species identifies several measures intended to minimize human disturbance or improve habitat. These include establishing a protection zone at North Beach of Sandy Hook, minimizing NPS vehicle use in beetle larva habitat, removing invasive vegetation that diminishes beetle habitat, and exploring beach nourishment in additional areas of Sandy Hook to cover riprap or other structures and restore habitat (NPS 2009e). No tiger beetle adults or larvae have been reported from other areas of Sandy Hook except the reintroduction areas on North Beach. Recent inventories suggest the population may have once again died out (Avrin, pers. comm. 2013).

Fish

The park has not identified any fish species as of management concern (NPS 2009f, NPS 2013f). Only two listed species are known to occupy park-managed waters; both are federally listed and are described below.

Federally Listed Fish Species

Both the Atlantic sturgeon *(Acipenser oxyrinchus)* and shortnose sturgeon *(Acipenser brevirostrum)* are listed as federally endangered fish species using the marine and estuarine environment offshore of the park. Both are demersal and anadromous, migrating from the marine environment to freshwater to spawn during late winter–early summer in the lower sections of rivers. Juvenile sturgeons remain in freshwater for their first summer before migrating to estuaries in winter. Juveniles remain in the freshwater-estuary system for three to five years before migrating to the nearshore marine environment as adults. Migration into the marine environment has only recently been documented for the shortnose sturgeon (NOAA 2013). Atlantic sturgeons have been found in surveys and recreational landings in Jamaica Bay (NPS 2010b).

Reptiles and Amphibians

One amphibian, the eastern spadefoot toad *(Scaphiopus holbrookii),* is a species of special concern and a species of management concern for the park (NPS 2009f). It is not listed as threatened or endangered, but is rare. This species is found in pine or associated forests, such as the red cedar forest in the park. It is ranked S2 (between 6 and 20 occurrences) and is managed at the park for increased population.

Several federally listed sea turtles (leatherback *[Dermochelys coriacea],* hawksbill *[Eretmochelys imbricata imbricata],* Kemp's Ridley *[Lepidochelys kempii],* and loggerhead *[Caretta caretta])* named in table 3-4 may swim in NPS-managed coastal waters and may occasionally come ashore in the park. However, because no actions in any alternative are expected to affect marine species, they are not discussed further.

Four reptiles are of management concern at the park. While each is a species of concern, none is state or federally listed. The park is managing for increases in population for three of the species—spotted turtle *(Clemmys guttata),* eastern hognose snake *(Heterodon platyrhinos),* and eastern box turtle *(Terrapene carolina carolina)*—and for increased nesting success for the fourth, northern diamondback terrapin *(Malaclemys terrapin).*

The eastern hognose snake occupies sandy areas and feeds on toads and frogs. The park has reintroduced this species to some areas. Although it is not a listed species, it is ranked as S3 (between 21 and 100 occurrences) and is considered a regional species of concern in the northeastern United States (NYDEC 2013a). Both the spotted turtle and the terrapin are semiaquatic; spotted turtles are found in wet woodlands, freshwater marshes and wet meadows, whereas the terrapin is a brackish-water species. Jamaica Bay provides important breeding habitat for terrapins, as well as providing habitat for the largest northern diamond back terrapin population in the northeast (NPS 2010b). Ruler's Bar Hassock and Little Egg Island, as well as dunes south of the Jamaica Bay visitor center (USFWS 1997c), are known nesting sites in the park. Within the Jamaica Bay Unit, 11 other sites have suitable upland habitats for nesting; however, development in these areas limits access and use (NPS 2010b). Of these 11 potential nesting areas, 5 are located along developed portions of the Jamaica Bay north shoreline. Other nesting areas include Dubos Point (outside the park) and Floyd Bennett Field (USFWS 1997c). Both the terrapin and the spotted turtle are of statewide concern and are ranked S3. The eastern box turtle is a land turtle that occupies deciduous forests with a moist forest floor. It is also ranked S3 in New York and is of regional concern in the northeastern United States.

Birds

All state-listed birds at the park are managed to increase occurrence or increase nesting populations. Federally listed birds in the park include piping plover and roseate tern *(Sterna dougallii),* discussed separately below.

Breezy Point Tip, Sandy Hook, and Jamaica Bay are each important habitats for listed and/or rare shorebirds, waterbirds, wading birds, and seabirds. At Sandy Hook, piping plover and

least terns *(Sterna antillarum)* nest, red knots *(Calidris canutus)* rest and feed, roseate terns feed, and ospreys *(Pandion haliaetus)* nest. As noted in the "Wildlife" section in this chapter of the GMP/EIS, migrations are substantial at these locations, with birds concentrating along the shorelines of park sites and adjacent areas. Migratory hawks number in the thousands at Sandy Hook and Breezy Point Tip, with several state-listed species, including sharp-shinned hawk *(Accipiter striatus),* northern harrier *(Circus cyaneus),* and Cooper's hawk *(Accipiter cooperii)* among those sighted at both Sandy Hook and Breezy Point Tip, and osprey and peregrine falcon *(Falco peregrinus)* additionally recorded at Breezy Point Tip. Approximately 25 osprey pairs nest in the Jamaica Bay Unit of the park, 14 pairs at Sandy Hook, and 1 pair on Staten Island. Fourteen pairs of ospreys have nested at the Jamaica Bay Wildlife Refuge and Breezy Point Tip in recent years (USFWS 1997b; NPS 2009d; Frame and Avrin, pers. comm. 2013). Overwintering grassland birds at Floyd Bennett Field include raptor species northern harrier, red-shouldered hawk *(Buteo lineatus),* and short-eared owl *(Asio flammeus),* as well as grassland species horned lark and savannah sparrow *(Passerculus sandwichensis).* Listed grassland birds that have been confirmed nesting at Floyd Bennett Field include horned lark, upland sandpiper *(Bartramia longicauda),* savannah sparrow, and northern harrier (USFWS 1997b). Grasshopper sparrows *(Ammodramus savannarum)* nested in the grasslands at Floyd Bennett Field between 1984 and 1992, but nests have not been found in recent years. Bobolinks *(Dolichonyx oryzivorus)* have also been seen during migration at Floyd Bennett Field. Several of these species also use grasslands along the runways at John F. Kennedy International Airport adjacent to Jamaica Bay.

Jamaica Bay islands are largely isolated from disturbance and predation and as a result support large numbers of nesting waterbirds and diverse populations of migratory birds throughout the year. A heron rookery on Canarsie Pol supported many nesting wading birds, including state-listed black-crowned night heron *(Nycticorax nycticorax)* as well as other species of heron, ibis, and egrets. Canarsie Pol has also been the site of nesting by common terns *(Sterna hirundo)* and American oystercatchers *(Haematopus palliatus),* an unlisted species of special concern in New Jersey ranked as S3 with 21–100 occurrences in New York. A smaller heronry occurred on Ruffle Bar "in 1995," and heron and egret nesting is reported by Audubon to occur at Elder's Point, Subway Island and Little Egg. Common terns occur on several other islands in the bay, including Jo Co Marsh and Silver Hole Marsh, with smaller numbers at Duck Creek Marsh, East High Meadow, Ruffle Bar, and Subway Island. An average of about 1,000 common terns and a maximum of 1,630 common terns have nested on the combined seven colonies in Jamaica Bay since 1984 (USFWS 1997b). Seaside sparrow *(Ammodramus maritimus)* and least bittern *(Ixobrychus exilis)* have also been spotted in the Jamaica Bay Unit.

The bay itself has a variety of habitats, including mudflats, saltmarsh, and sandy shorelines, that are important to shorebirds and other water-dependent species. Twenty-two species of shorebirds are currently found in the Jamaica Bay estuary; historically, 44 species had been identified here. Shallow-water areas also provide fishing habitat for foraging wading birds, including nine species of herons (NYCDEP 2007). Both the federally endangered roseate tern and threatened piping plover nest or have attempted nesting in Jamaica Bay habitat, as have common terns, pied-billed grebes *(Podilymbus podiceps),* peregrine falcons, and northern harriers (NYCDEP 2007).

Nesting by several state-listed shorebirds either currently takes place or has taken place in the recent past in locations at Breezy Point Tip. Common tern nesting numbers have varied from 30 in 1988 (when monitoring first indicated nesting) to more than 4,000 in 1994. In recent years, it has diminished steadily, from 1,990 in 2006 to 324 in 2009 (NPS 2007a, 2009d). This may be a function of increasingly dense vegetation in some Breezy Point nesting areas. Least tern nesting has also been variable at Breezy Point Tip, although it has declined fairly steadily since numbers peaked in 1991 at 1,128 to 18 in 2009. Although 18 is a low number, it represents a substantial increase over the 0 nesting birds at the site in the years 2005–2008 (NPS 2009d). Black skimmers *(Rynchops niger),* a species of special concern listed as S2 by the state of New York and a species of management concern for the park, have apparently ceased nesting at the Breezy Point Tip, given that no nests have been discovered since 2002, although 750 nesting black skimmers were recorded just two years earlier (NPS 2009d). With the scouring effect of Hurricane Sandy in removing shrublands and dense coastal vegetation, it is possible that several or all of these shorebird species will once again nest at Breezy Point Tip. Species recorded at Jamaica Bay and not noted above include bald eagle and yellow-crowned night heron *(Nyctanassa violacea).* Very rarely observed species here include northern goshawk *(Accipiter gentilis),* black rail *(Laterallus jamaicensis),* king rail *(Rallus elegans),* roseate tern, black tern *(Chlidonias niger),* long-eared owl *(Asio otus),* and red-headed woodpecker *(Melanerpes erythrocephalus)* (Davis n.d.).

Bird species recorded at Floyd Bennett Field and not noted otherwise in this section include vesper sparrow *(Pooecetes gramineus);* this species has been seen only rarely in the area (NPS n.d.f).

The park takes multiple measures to protect and enhance habitat for several of its listed birds. These fall into a few main categories, which include increases in program staffing, minimizing human disturbance, managing predators, enhancing and restoring habitat, education, and monitoring. For some species, fireworks or NPS vehicles used on the beach are also issues; a recent management plan (NPS 2009e) lists actions to keep these activities from unduly disturbing nesting birds. The majority of these measures are aimed at sustaining and improving the park's existing piping plover nesting population, but these same actions assist other protected species that live or breed in the same vicinity, such as northeastern beach tiger beetles, least terns, seabeach amaranth, common terns, seabeach knotweed, and seabeach evening-primrose *(Oenothera humifusa),* a state-listed plant in New Jersey. These measures are discussed in more detail in the piping plover subsection below. A few measures to improve conditions for intertidal mudflat or estuarine species such as terrapins, black rails, American bitterns, red knots, horseshoe crabs, and American oystercatchers were also identified in the park's *Shoreside Threatened and Endangered Species Beach Management Plan* (NPS 2009e). Measures include better signs and enforcement for recreational use at Spermaceti and Horseshoe Coves and Plum Island at Sandy Hook to protect habitat for these species; evaluating the potential for restoration of bayside habitats, including the possible removal of shoreline stabilization structures; and *Phragmites* removal.

Federally Listed Birds

Roseate terns *(Sterna dougallii)* are listed as endangered under the federal Endangered Species Act and by both New York and New Jersey. This species nests almost exclusively on rocky or saltmarsh islands where predation pressure is lower than on mainland sites. Colonies are often located close to shallow-water locations where the terns can fish. Roseate terns are threatened by the loss of breeding habitat to development, rising sea level and related storm surge, human disturbance, and predation. A few roseate terns have nested in the park, but recent surveys at Breezy Point Tip did not show any breeding roseate terns here after 1999. Breeding numbers have always been low, peaking in 1998 at six (NPS 2009d).

Piping plovers *(Charadrius melodus)* are small shorebirds listed as threatened under the federal Endangered Species Act. Piping plovers at the park are part of the Atlantic Coast population, one of three population segments listed in the country. No critical habitat has been identified or proposed for this population (NPS 2004f).

Plovers arrive at the park nesting beaches in mid-March; nests are established above the high tide line on coastal beaches, on sandflats at the end of barrier spits, in washover areas cut into dunes, and on suitable dredge material. Access to feeding areas such as bayside flats, inlets, ephemeral pools, and the intertidal beach are important to productivity and survival of chicks. If these access routes from the nest are vegetated, chicks are less able to detect hidden mammalian predators. Eggs can be laid any time from early April to late July and chicks may be present from mid-May until late August. The productivity goal for the mid-Atlantic population established by the USFWS is 1.5 chicks per nesting pair for five years, a goal the park population has not reached on average. There is also extreme variability in nesting success for plovers; productivity at Sandy Hook has ranged from 0.36 chicks per pair to as high as 1.94 in the years 1991 to 2003 (NPS 2004f). Weather and predation, particularly by the park's red fox (Vulpes vulpes) population, is implicated as the cause of the very low number of 0.36 chicks per pair fledged at Sandy Hook in 1997.

Breeding by piping plovers also occurs at park sites along the Rockaway barrier spit, including at the Surf Club, West Beach, Fort Tilden, and Jacob Riis Park. In 2009, the number of chicks fledged per pair ranged from an average low of 0.25 at Jacob Riis Park to a high of 2 at the Surf Club location. Historical data show that nesting at Breezy Point Tip has also been variable, with the number of chicks fledged per pair fluctuating from a high of 1.89 in 2006 to 0.68 in 2009 (NPS 2009d).

The park now constructs predator-resistant fencing around nests to keep foxes, feral cats, opossums, and raccoons from capturing chicks at the nest site. The park also traps potential predators and depending on available staff time can catch quite a few in a given nesting season. For example, 15 cats, 10 opossums, and 10 raccoons were trapped in 2007 at the Breezy Point Tip. Foxes are also caught at the Sandy Hook sites. Crows and gulls also prey on plover eggs and chicks, and the park takes measures such as destroying gull nests in the vicinity of nesting plovers. In recent years, the park has begun to suspect that nesting American oystercatchers may be contributing to piping plover nest abandonment (NPS 2009d).

Recreational activities can be a source of direct mortality and harassment of nesting plovers. Plovers that flush because of human disturbance leave eggs or chicks exposed to predation and excessive temperatures. High concentrations of beachgoers can also keep plovers from using otherwise suitable habitat (NPS 2004f). The park monitors some of the violations by recreationists who enter beaches where posted signs indicate the area is closed. In Breezy Point Tip, even occasional monitoring noted 115 visitors in the closed area, including with pets or motor vehicles.

Once hatched, chicks almost immediately leave the nest and move along the beach and to other areas to feed. This places them outside park-fenced areas and increases their vulnerability to predation or to pedestrian or beach vehicle traffic. Although most of the park is closed to over-sand vehicle traffic, over-sand vehicles are allowed during non-nesting times at Breezy Point Tip and park rangers use them for emergencies and to patrol beaches.

The park has established six protected areas on Sandy Hook. In these areas, no over-sand vehicles are permitted except for NPS law enforcement and emergency use; dogs are prohibited from March to September; and predators are monitored. Exclosures are placed around all plover nests.

The *Shoreside Threatened and Endangered Species Management Plan for the Sandy Hook Unit* (NPS 2009e) noted that, in addition to the USFWS recovery goal of 1.5 chicks per pair on average for five years, the park has set goals of an average nesting population at Sandy Hook of 51–65 pairs for five years, and annual predation losses at or below 15 percent. To help in meeting these goals, the park has proposed additional measures beyond those already established. These include a 100-meter buffer from nests; prohibiting all vehicles, including NPS vehicles, except in emergencies; prohibiting kite flying and kite surfing within 650 feet of protected areas; expanding protection zones if needed; increasing the intensity of predator monitoring and management; removing any attraction for predators, such as trash and fish offal; trapping and relocating foxes and using lethal control when necessary; allowing fireworks only outside the breeding season; prohibiting beach raking between April and December; and the use of signs, meetings, and other education and interpretation media to inform visitors of pet, trash, and closure policies.

Mammals

Several marine mammals that may use park-managed waters are listed. These include sei *(Balaenoptera borealis),* blue *(Balaenoptera musculus),* fin *(Balaenoptera physalus),* humpback *(Megaptera novaeangliae),* and northern right whales *(Eubalaena glacialis),* as well as the state-listed harbor porpoise *(Phocoena phocoena).* All of the whale species are both state- and federally listed as endangered. Humpback whales occasionally feed in New York Bay adjacent to the Rockaway Inlet (USFWS 1997c) and sei, humpback, and sperm whales *(Physeter macrocephalus)* have been noted swimming in Raritan Bay. The park does not have a management objective for any of these species except for the harbor porpoise, where the park has stated a desire to increase the predictability of its seasonal occurrence. None of the actions in any of the alternatives would change conditions for these species or impact them in any way. They are therefore not considered part of the affected environment and are not discussed further in this GMP/EIS.

Indiana bat *(Myotis sodalis)* is a federally and state-endangered species that hibernates in caves and mines during the winter. Its roosts consist of trees, both living and dead. In New York, there are 10 hibernation areas for Indiana bats that appear to be stable. Thirteen maternity and bachelor colonies are also known to be present in the state, although some of these are threatened by increasing development. The total count in New York has recently increased from 13,000 to 40,000 bats, largely because of improvements in counting methods and the discovery of new hibernation areas. A recent (January 2013) survey of listed species in New Jersey indicated that the Indiana bat was not present at Gateway (USFWS 2013).

Cultural Resources

Introduction

For management purposes, the NPS recognizes five categories of cultural resources: archeological resources, historic structures, cultural landscapes, ethnographic resources, and museum collections. Because no effects to ethnographic resources are anticipated from the proposed actions analyzed in this GMP/EIS, that topic has been dismissed and is not discussed further. For this document, the park has chosen to present cultural landscapes in the context of historic districts. The following description of these resources is gleaned primarily from NPS-28: *Cultural Resource Management Guideline* (NPS 1998a).

Archeological resources are the remains of past human activity and records documenting the scientific analysis of these remains. They are typically buried, but may extend aboveground. These resources are commonly associated with pre-contact peoples but also may be products of more contemporary societies. At Gateway, the vast majority of archeological resources fall into this latter category.

Structures include such things as buildings, bridges, roads, forts and associated earthworks, monuments, ruins, and other manufactured objects that extend the limits of human capability. The manufacture and use of structures provide humans the ability to live in harsh climates and in areas far removed from where they work and live.

Historic districts are defined as resources that possess a significant concentration, linkage, or continuity of sites, buildings, structures, or objects united historically or aesthetically by plan or physical development (NPS 1990a).

Cultural landscapes are defined as a geographic area, including both natural and cultural resources, associated with a historic event, activity, or person. Cultural landscapes are listed in the National Register of Historic Places (National Register) when their significant cultural values have been documented and evaluated within appropriate thematic contexts and physical investigation has determined that they retain integrity. They are classified in the National Register as sites or districts or may be included as contributing elements of larger districts (NPS 1998a).

Museum collections are described as assemblages of objects, works of art, historical documents, and/or natural history specimens collected/maintained so they can be preserved, studied, and interpreted for public benefit.

In the following description of existing conditions, the effects on Gateway's cultural resources from Hurricane Sandy in the fall of 2012 must be mentioned. These storm-related effects range from detectable/not substantial to considerable in scope, much of which was dependent on the location of the resources. The most significant damage occurred to resources located immediately along the coastlines, particularly in the Sandy Hook Unit and along Jamaica Bay (Jacob Riis Park, Fort Tilden, Breezy Point Tip), which sustained considerable wind and water damage. Preliminary damage assessment efforts immediately after the storm focused primarily on the historical cultural resources of the park and typically included descriptions of severe erosion and sand redeposition, flooding, and wind damage. Damage assessments are ongoing. The following represents general descriptions of typical storm damage to cultural resources in the park:

- Erosion/exposure of buried resources (e.g., Battery Kessler at Fort Tilden Historic District)

- Flooding/storm surge (e.g., seawall at Battery Weed, Fort Wadsworth Historic District; Jacob Riis Park/bathhouse/associated facilities, Jacob Riis Park Historic District; Fort Hancock and Life Saving Station at Fort Hancock and Sandy Hook Proving Ground National Landmark Historic District, also referred to as Fort Hancock and Sandy Hook Proving Ground)

- Sand deposition (e.g., Jacob Riis Park facilities, Jacob Riis Park Historic District; roads located within Fort Hancock and Sandy Hook Proving Ground National Landmark Historic)

- Wind damage to a variety of structures throughout the park

Many of the park's impacted cultural resources are either listed in or eligible for listing in the National Register. Comprehensive damage assessments are underway and will provide specific information on the condition of any damaged historic properties. Preliminary damage assessments led the park to believe that the National Register status of the majority of the park's resources will be retained.

Cultural Resource Context for Gateway

The cultural resources of the park represent tangible manifestations of humans interacting with their environment and with each other throughout time, up to the present day. To understand the effects of the alternatives on the cultural resources of Gateway, a summary context is presented below. Much of this information is gleaned from archeological overview and assessment documents prepared for Gateway (NPS 2009a, 2011a, 2011b, 2011c). The information provided is intended to be a brief summary of cultural context of the study area; please refer to the documents referenced for additional detail.

Pre-Contact to Contact Context

Because the coastal areas of the park would have provided pre-contact inhabitants with a variety of important natural resources and transportation routes, it is reasonable to assume that undiscovered, buried cultural resources reflecting earlier lifeways may still exist. The potential for such discoveries varies by location and the history of natural and human impacts.

The pre-contact human use of the New York/New Jersey area dates back approximately 12,000 years. Although human history is known to vary locally and regionally within a defined area, it is generally believed that the major pre-contact periods for the Gateway area (as defined by existing material culture assemblages) are as follows:

- Paleo-Indian (ca. 12,500–10,000 years BP)
- Archaic (ca. 10,000–2,700 years BP)
- Woodland (ca. 2,700 years BP to European Contact, ca. AD 1600)

It is believed that Paleo-Indian cultures used the coastal areas of New York and New Jersey by exploiting the megafauna and tundra environment of the Late Pleistocene. It is theorized that inhabitants of the area lived in small, mobile bands whose movements were dependent on proximity to resources. Their subsistence patterns likely included the use of both animal and vegetable resources. Lithic tools characteristic of the period (distinctive fluted points, scrapers, knives, etc.) suggest that hunting, butchering, and animal processing were an important part of the subsistence strategy. Evidence of Paleo-Indian use of the study area is sparse. Although an isolated projectile point was located in Great Kills area of Gateway (NPS 2011a) and other manifestations of Paleo-Indian use of the general region are evident, no Paleo-Indian sites have been recorded within the park boundaries.

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The Archaic period is subdivided into Early, Middle, and Late stages and, in general, is characterized by adaptation to a post-Pleistocene climatic transition. This is reflected by a variety of resource procurement strategies as the more temperate conditions of the Holocene began to prevail. Human use of the study area during this period suggests diverse hunting and gathering activities, likely employed by small, mobile social groups. Human reliance on a wide variety of flora and fauna is apparent, as are a variety of technological innovations (groundstone tools, gouges, knives, net-sinkers, etc.) (JMA 1978). During the later part of the Archaic period, settlement patterns appear to be associated with seasonal resource availability. Although manifestations of human occupation of northern New Jersey and the New York Harbor during the Archaic period have been recorded, no archeological sites dating definitively to this period have been recorded in the study area.

The Woodland period is also divided into Early, Middle, and Late stages and, in general, is characterized by considerable technological changes (e.g., production/use of ceramics), more intensive subsistence practices, an increasing trend toward sedentism (living in one place), larger settlements, changes in social organization, and long-distance trade. Technological advances in tool making are represented by a variety of distinctive projectile point styles and pottery. Woodland sites in and around the study area reflect more intensive and continuous

use and occupation of the area, with a reliance on shellfish and a variety of other floral and faunal resources. Coastal shell middens have "preserved evidence of a variety of shellfish, fish, white-tailed deer, turtle, and other small mammals as well as bone and stone tools and ceramic types" (NPS 2011c, 9). The effects of the introduction/use of pottery significantly improved the efficiency of food preparation and storage, and pottery styles become more stylized and distinctive in the later part of the Woodland period. Horticulture based on maize, beans, and squash becomes apparent during the Late Woodland times, and is often associated with increased social complexity. Village sites near permanent rivers and other water sources were likely occupied year-round, while smaller occupations farther from the coast were used for seasonal hunting and gathering activities. Several sites dating to the Woodland period have been identified within the study area and are characterized by the presence of ceramic sherds (fragments), lithic artifacts, and shell middens indicative of the period (NPS 2011b, 2011c).

The Contact period, beginning around AD 1600, marks a time when indigenous groups were making contact with Europeans along coastal areas of the Northeast. At that time, many indigenous people of the area were living in year-round villages and seasonal camps.

The Contact period, beginning around AD 1600, marks a time when indigenous groups were making contact with Europeans along coastal areas of the Northeast. At that time, many indigenous people of the area were living in year-round villages and seasonal camps. Archeological evidence of their activities includes shell middens, shellfish-processing sites, cemeteries, and forts/trade houses. Numerous communities of Munsee-speaking Delaware Indians are documented in early records written during the first decades of Dutch contact and through archeological evidence. People speaking what Van der Donck later called the Manhattan language lived on the islands of New York Harbor, along the lower Hudson River estuary, and on the shores of Long Island opposite Staten Island (Grumet 2009). At the time of contact with Europeans, at least 13 separate groups of Native Americans were known to reside in the coastal portions of the study area. All of these groups were associated with the larger Algonquian-speaking people of the Lenape (Delaware) cultural group. Prior to contact, human cultures of the area were characterized by a wide diversity of cultural adaptation representing change over thousands of year. The exploration of the Lower Hudson River and the early 17th century fur trade resulted in very rapid Dutch colonization of the area, which brought about a dramatic change in the population, economy, social organization, and material culture of local indigenous groups. Disease, warfare with Dutch settlers, and land loss were the major factors bringing about change in indigenous population levels and ways of life. As access to food, farmland, and resource-collecting areas was being restricted by Europeans, the indigenous peoples who did survive moved inland. The Native American occupation of the area was largely supplanted by European colonization by the time the Dutch handed over New Netherlands to Great Britain in 1664. Contact period settlements typically include small amounts of European goods (metal kettles, glass beads, bottles, etc.) intermixed with larger amounts of indigenous-material cultural items. Several Contact period sites are known to have existed in the area around Gateway, but none have been recorded in the park.

General Historical Context

The following historical context of the study area is focused on presenting information related to cultural resources that have the potential to be affected by proposed park actions, with emphasis on those defined in this GMP/EIS as "fundamental." Fundamental resources

are defined as those considered vital to maintaining the park's purpose and significance. Other cultural resources not considered fundamental are included and presented more broadly.

This summary is not intended to provide a comprehensive narrative on the history of Gateway. Rather, it is designed to provide a summary of the people and events that played a role in the major historical themes of the park: namely, those related to maritime, military, and aviation history. These historical influences have significantly shaped the history of the area and many resources, dating from the Revolutionary War to the Cold War, reflect this.

The historical development of the Gateway area is one involving diverse coastal, island, marsh, and aquatic environments. The structure of settlements, land use, industry, transportation, and landscape modification is complex and closely linked to the development of the entire region. By the mid-17th century, a number of small European settlements existed along the New Jersey and New York coastlines. Like the Native Americans, early settlers made use of the wide range of coastal natural resources—fish, shellfish, and wildlife—for food, and by the mid-19th century, such resource-harvesting endeavors were commercialized. Agriculture was also a major economic activity of settlers in the area, resulting in the need for processing mills. Among others, the Dutch and British established permanent early settlements in the harbor area.

Throughout historical times, the New York Harbor has served as one of the most convenient and active deep-water ports on the eastern seaboard. Surrounded by land favorable for urban development, the harbor consequently became commercially important to the Dutch, the British, and the Americans, eventually supporting New York City. Consequently, defensive strategies have been implemented for centuries to protect the harbor from assault and capture. Early earthwork fortifications, first built by the Dutch and British to repel ground forces and enemy vessels, later gave way to U.S. artillery emplacements and fortifications surrounding the harbor that were designed to destroy enemy vessels and protect local residents. During the last half of the 20th century, defensive structures and weapons related to the Nike Missile Program played a role in the national defense system.

The following summarizes the major historical themes represented at Gateway. Although addressed separately, there is considerable overlap among them. In the discussion, the use of the term "historic districts" refers to historic districts listed in the National Register.

Maritime History

The first recorded European observations of the New York Harbor were made by the Italian explorer Giovanni De Verrazano in 1524. In the early 17th century, explorers had discovered that the natural harbor of New York and the adjacent Hudson River Valley provided wide-reaching access into the region's interior. From the Colonial period to the mid 19th century, early development in the harbor area focused on maritime safety, transportation and trade, and temporary defensive fortifications designed to protect maritime interests and provide harbor defense. The ship-building industry dates to the 17th century in the harbor area and continues today. European development grew rapidly along the coastal areas of what is

now New Jersey and New York, and by the 19th century harbor traffic was extensive (ferries, barges, schooners, clippers, steamships, etc.). As the importance of the harbor for commerce and transportation increased through the years, its defense became imperative and resulted in a variety of temporary and permanent fortifications along the perimeter of the harbor (NPS 2011b) (see "Military History").

Structures dedicated to ship navigation and lifesaving are well represented in the maritime cultural record of the area. The Sandy Hook Lighthouse, a National Historic Landmark, was first illuminated on June 11, 1764, generated by 48 oil-fueled lamps. Today it is the oldest continuously operating lighthouse in the United States and the only surviving one of the 11 lighthouse buildings dating to the Colonial period. The Elm Tree Light, a contributing structure at Miller Army Airfield Historic District, has undergone several transformations. A 1797 map marks an elm tree that was considered a mark for vessels coming and going from New York in the late 18th century. Evidence of it also shows on 1826 and 1850 maps. Although it was not certain that a beacon was actually hung in the tree in these earlier times, there was some kind of light noted in 1852. The current Elm Tree Light was constructed by the U.S. Coast Guard in 1939 to replace an earlier tower that had served as a mark for sailing vessels in the late 18th century (Wren 1974; NPS 1979a). The first Fort Tompkins lighthouse was replaced in 1893 with a new light constructed on the top of Battery Weed (see below) to provide better protection of the shipping lane through the Narrows. The light was visible for 14 nautical miles. The light was decommissioned in 1965 (Olmsted Center for Landscape Preservation 2008).

Structures dedicated to ship navigation and lifesaving are well represented in the maritime cultural record of the area. The Sandy Hook Lighthouse, a National Historic Landmark, was first illuminated on June 11, 1764, generated by 48 oil-fueled lamps.

In the late 17th century, harbor pilots were guiding vessels through the channels of New York Harbor, playing a critical role in preventing shipwrecks and strandings. One archeological site, a former tavern on Sandy Hook, is associated with harbor pilots and s listed in the National Register for its potential to yield information about harbor pilots, among other things. Buoys marking harbor channels existed as early as 1778. In 1889, an electric generator on the north end of Sandy Hook served five buoys in Gedney Channel (NPS 2009a).

Organized lifesaving efforts are known to have existed in the harbor area by the 19th century, with lifeboats stationed at various localities around the harbor (e.g., Rockaway Inlet and others spaced between Sandy Hook and Little Egg Harbor) (PBS&J 2009). During this era, lifesaving stations were also being constructed that would prove crucial for saving shipwreck victims. The Sandy Hook Life Saving Station No. 1, built in 1848 near the tip of Sandy Hook, no longer exists. The extant Spermaceti Cove Life Saving Station (1894) was constructed about 1,000 feet from the No. 1 station and was identified as Station No. 2 (see below for additional information). The station was decommissioned in 1949 as an active U.S. Coast Guard Station and has served as a visitors' center for the park since 1974. Additional lifesaving stations built in 1855, 1872, and 1891 on Sandy Hook no longer exist. There is also mention of a former mid-19th century lifesaving station being located in the Fort Tilden area (NPS 2011c), with the possibility that archeological evidence of it may still be present (Linck 1981).

Lifesaving stations were staffed with volunteers and adhered to no regulations, standards of practice, or reporting requirements. In 1878, the lifesaving system was officially named the U.S. Life Saving Service, which would include paid surfmen and the construction of new stations. Between 1871 and 1914, the service "aided 28,121 vessels, and rescued or aided 178,741 persons, while only 1,455 people lost their lives" (NPS n.d.a, 4). In 1915, the U.S. Life Saving Service merged with the U.S. Revenue Cutter Service to become the U.S. Coast Guard (NPS n.d.a; PBS&J 2009). The U.S. Coast Guard Station is currently located at the northwest end of Sandy Hook. The Spermaceti Cove Life Saving Station on Sandy Hook is an extant example of these structures.

Military History

Seacoast fortifications along the New York Harbor area date to the early days of discovery and colonization of the New Jersey and New York coastlines. Since the Colonial period, the defense of New York Harbor was considered critical for commerce and the defense of the United States. The fortifications included a variety of forts and batteries dating back to the late 18th century and continuing through the Cold War era. Technological advances in weaponry and construction techniques through time resulted in greatly improved fortifications, some of which were built over earlier, outdated structures. The following describes the evolution of the defense systems represented in the New York Harbor areas of Gateway.

Seacoast fortifications along the New York Harbor area date to the early days of discovery and colonization of the New Jersey and New York coastlines. Since the Colonial period, the defense of New York Harbor was considered critical for commerce and the defense of the United States.

First System Defenses

Since the early 18th century, there have been attempts to defend and protect the coast and harbor areas of New York and New Jersey. The first system of defense dates to 1794 when it seemed the United States might be drawn into European wars following the French Revolution (New York City, Landmarks Preservation Commission 1974). Fortifications (batteries, forts) dating to the Revolutionary War and the War of 1812 are mentioned in historical literature, but little evidence of them remains (NPS 2009a). One example, described as a crude defensive structure, is said to have been constructed in the current Fort Wadsworth area and was designed to protect the Narrows area of the harbor (Black 1983).

Second System Fortifications, 1807–1815

Conflicts on the seas arose between the United States and Great Britain in the early 19th century, initiating a new defense program characterized by open batteries built of earth and wood and casemated masonry structures. These structures were centered in the New York Harbor area, particularly the inner harbor close to and on Manhattan. The fortifications were used in the War of 1812 and were built to defend against enemy vessels such as the British ship HMS Victory. The cannons had the ability to fire on enemy ships up to 1 mile away (NPS 2013a). A temporary fortification on Sandy Hook—Fort Gates—included a wooden stockade and blockhouse, constructed in the general area of the current Fort Hancock. Archeological evidence of the fort was likely disturbed by grading and excavating for later building foundations, etc. (NPS 2009a).

Third System Fortifications, 1817–1867

Third System fortifications in the harbor area were characterized by elaborate enclosed masonry structures and were equipped with numerous smoothbore iron cannons that could fire up to 3 miles, a significant improvement over second system defense weapons. These fortifications were also used during the Civil War against potential enemies. Examples of these fortifications are Battery Weed and Fort Tompkins at Fort Wadsworth and the fort at Sandy Hook (which was never completed) (NPS 1984a, n.d.b).

Endicott-era Defenses, 1890–1910

Weaponry developed during the Civil War and after had advanced significantly, making masonry forts and smoothbore cannons obsolete. In 1885, the U.S. government convened the Endicott Board to create a new system of defense. The board, led by Secretary of War William C. Endicott, studied existing U.S. and European weapons technology and submitted a report to President Grover Cleveland in 1886 calling for a comprehensive defense system to protect the United States' most important ports and harbors from naval attack. The defenses were to consist of "high-powered guns and mortars mounted on concrete emplacements; submarine mine-fields; floating batteries and torpedo boats; and rapid-fire guns to protect the minefields" (NPS 1984a, 60). The batteries featured "breech-loading guns made of steel, mounted on 'disappearing' carriages that were designed to recoil behind a parapet wall during reloading, protecting the defenders" (NPS n.d.b, 5).

Table 3-5. Endicott- and Taft- Era Batteries, Fort Hancock and Sandy Hook Proving Ground.

Battery Name	General Description	Approximate Date of Construction
Potter	Large-caliber gun battery; two 12-inch disappearing-carriage guns	1891
Granger	Large-caliber gun battery; two 10-inch counterweight disappearing-carriage guns	1896
Nine-Gun	Large-caliber gun battery	1902
Mills	Large-caliber gun battery	1917
Kingman	Large-caliber gun battery	1917
Mortar	Large-caliber gun battery, prototype for future gun batteries of the Endicott system	1890
Engle	Rapid-fire gun battery, one 5-inch gun on pedestal mount	1898
Morris	Rapid-fire gun battery, four 3-inch guns on pedestal mount	1904
Urmston	Rapid-fire gun battery, four 15-pounders and two 3-inch guns on pedestal mount	1899–1904
Gunnison	Rapid-fire gun battery, two 6-inch counterweight disappearing-carriage guns	1904
Peck	Rapid-fire gun battery	1902
Arrowsmith (Ruin)	Three 8-inch disappearing-carriage guns	1908

Endicott era = 1890–1905; Taft era = 1907–1945

Weaponry included guns with ranges of 7 to 9 miles. High-velocity guns were able to fire projectiles four times heavier and to ranges two to three times greater than earlier weaponry (NPS n.d.b). The use of these long-range guns on enemy ships in the harbor allowed United States Navy vessels the necessary time to reach the enemy. Some Endicott-era defenses remained in use until 1945. Extant examples within Gateway include fortifications at Fort Hancock and Sandy Hook Proving Ground and Fort Wadsworth (NPS 1984a, 1985) (see tables 3-5 and 3-6). Construction during this time at Fort Hancock and Sandy Hook Proving Ground resulted in the demolition of prior defensive fort structures. There is also evidence that ordnance and munitions, both fired and disposed of, related to military operations at Fort Hancock and Sandy Hook Proving Ground are still present on the ground and in the waters adjacent to the Fort (Panamerican Consultants 2001).

Table 3-6. Endicott-Era Batteries, Fort Wadsworth Historic District.

Battery Name	General Description	Approximate Date of Construction
Duane	Five 8-inch counterweight disappearing-carriage guns	1895–1897
Catlin	Six 3-inch rapid-fire guns	1902–1904
Bacon	Two 3-inch rapid-fire guns	1899
Turnbull	Six 3-inch rapid-fire guns	1902–1903
Barbour	Two 6-inch counterweight disappearing-carriage guns, two 4.7-inch rapid-fire guns	1898
Hudson	Two 12-inch counterweight disappearing-carriage guns, one 6-inch counterweight disappearing-carriage gun, one 4.7-inch rapid-fire gun	1898-1899
Mills	Two 6-inch counterweight disappearing-carriage guns	1899–1900
Upton	Two 10-inch counterweight disappearing-carriage guns	1896–1899
Dix	Two 12-inch counterweight disappearing-carriage guns	1902
Barry	Two 10-inch counterweight disappearing-carriage guns	1897–1899
Richmond	Two 12-inch counterweight disappearing-carriage guns	1898–1899
Ayers	Two 12-inch counterweight disappearing-carriage guns	1900–1901

Endicott era = 1890–1905

New York Harbor Defenses, 1907–1945

As was the case with earlier defense systems, many of the Endicott-era defenses were eventually replaced with newer weapons and technology. In 1905, the Taft Board—headed by Secretary of War William Taft—proposed improving the Endicott defenses and adding fortifications to possessions newly acquired in the Spanish-American War (NPS 2006c). Beginning in 1907, Taft-era improvements to existing fortifications included general electrification, telephone communications, searchlights, and motorized ammunition hoists (Layton and Foulds 2010). Observation posts and plotting rooms were used to refine information on target direction and bearing and speed of enemy ships with great accuracy (please refer to "Fort Tilden Historic District—Battery Harris, Battery Construction 220, Battery Kessler, and Nike Missile Launch Site"). This information was then relayed to artillery guns crews for their use in targeting the enemy.

Within a short period (by 1915), it became apparent that the disappearing-carriage guns in use were not sufficient to defend against the longer-range firing capabilities of new battleships. As a result, construction was begun on new large-caliber gun batteries with high-angle gun carriages that had a range of over 20 miles (compared with the 7- to 8 mile range of counterweight-carriage guns). The high-angled carriages on rotating platforms allowed a 360-degree field of fire (Layton and Foulds 2010).

Following World War I, the need to defend against air attacks became apparent, which resulted in additions to the area's defense system including rapid-fire anti-aircraft guns and the use of camouflage techniques. During the post–World War I period and the World War II period, new 16-inch gun batteries were constructed. During the latter period, existing 12- and 16 inch barbette guns were armored with thick concrete enclosures, covered by tons of sand, and camouflaged with natural vegetation. This was intended to render them virtually invisible from the air and impervious to most aerial bombs.

Being waged with airpower, World War II used strategies dramatically different from those used in earlier conflicts. Aircraft carriers became extremely important and radar developed by the U.S. Army on Sandy Hook was employed to provide early warning of approaching enemy aircraft. Examples incorporating Taft-era improvements include structures at Fort Hancock and Sandy Hook Proving Ground and Fort Wadsworth (NPS 1984a, 1985) (see table 3-5).

Nike Missile Defense System, 1954–1974

After World War II, the coastal artillery was abandoned and anti-aircraft guns remained as the only defense for the coastline and harbor. However, the limited capabilities of this defensive strategy—jet planes were able to fly higher and faster than the guns' capabilities—led to the development of the Nike Air Defense Missile (Nike Missile). Between the Cold War years of 1954 and 1974, 19 Nike Missiles encircled the New York Harbor area. The Nike Missile defense strategy required soldiers to be stationed at either the missile launch areas or the radar sites (Integrated Fire Control Area); soldiers lived at the sites and worked 24-hour duty shifts.

The Ajax was the first Nike Missile employed with the capability of destroying a target at 30 miles. The Hercules, with a range of over 96 miles and the ability to carry a nuclear warhead, began to replace the Ajax around 1958. All Nike batteries were disarmed in 1974 in compliance with the Strategic Arms Limitation Talks (SALT) treaty signed by the United States and the Soviet Union.

Nike Missile installations are still evident at Gateway at Fort Hancock and Sandy Hook Proving Ground and Fort Tilden. Both maintained two missile batteries, each with underground magazine storage rooms and large elevators that raised/lowered missiles (NPS 1984a, U.S. Department of the Interior 2009).

Aviation History

Both commercial and military aviation were quickly evolving after World War I. The early history of aviation in the United States is well represented in several Gateway facilities dating back to the early 20th century, including Floyd Bennett Field, Miller Army Airfield, and the Rockaway Naval Air Station (now the site of Jacob Riis Park).

Floyd Bennett Field

New York City opened its first municipal airport in 1931 with the dedication of Floyd Bennett Field. The new state-of-the-art airport was located on Barren Island and was named for a Congressional Medal of Honor recipient and navy pilot, Floyd Bennett. Rated highly by the Civil Aeronautics Board, it included concrete runways, an administration building/terminal, and Hangar Row, consisting of four identical rectangular two-bay aircraft hangars. Floyd Bennett Field was a popular site with aviators seeking to break records, and numerous transcontinental and transatlantic flights used the facility as a start or end point during the 1930s. In 1938, Howard Hughes and his crew, starting and ending their flight at Floyd Bennett Field, completed an around-the-world flight—14,791 miles in 3 days, 19 hours, 8 minutes and 10 seconds—to gather navigational data (NPS 2010c). The interest in these aviation records reflected the public's interest in aviation and contributed to improving both piloting skills and technology (NPS 1978).

New York City opened its first municipal airport in 1931 with the dedication of Floyd Bennett Field. The new state-of-the-art airport was located on Barren Island and was named for a Congressional Medal of Honor recipient and navy pilot, Floyd Bennett.

In 1933, Floyd Bennett Field was the second busiest airport in the country. Unfortunately, very little of the traffic was commercial and the lack of revenue was problematic. In 1939, Municipal Airfield 2 (later renamed LaGuardia Airport) opened. Unable to compete with LaGuardia and Newark Airports, the city sold Floyd Bennett Field to the United States Navy in 1941. During World War II, it was renamed Naval Air Station, New York. The navy expanded the facilities from 387 acres to 1,288 acres and continued to operate the field for 30 years (NPS 2010c).

The navy already had an established presence at Floyd Bennett Field, where pilots and ground crews from a Naval Air Reserve Squadron trained throughout the 1930s. A U.S. Coast Guard Air Station was also established at Floyd Bennett Field in 1936 (NPS 2010c). During World War II, "neutrality patrols" were established to protect the convoys of ships carrying war materials from New York to Great Britain. These patrols, involving PBY Catalinas (flying boats) and other naval patrol aircraft, flew from Floyd Bennett Field and other naval air stations to offer protection to convoys from German U-boats.

The navy's later interest in the helicopter for use in air-sea rescue operations resulted in the establishment of the first helicopter pilot and mechanic training facility in the world at Floyd Bennett Field in 1943. The ability to take off and land vertically would prove invaluable in rescuing downed servicemen in areas inaccessible to other aircraft. The airborne rescue capabilities of the helicopter were proven, and the first associated rescue equipment was developed and tested at Floyd Bennett Field (NPS 2010c, 2011c).

Floyd Bennett Field was redesignated as a Naval Air Reserve Training Station in 1946. In 1950, it was redesignated as the Naval Air Station, New York. In 1971, the navy deactivated the field and soon after, Gateway took over the management of the field. Today, the Ryan Visitor Center (which originally served as the historic passenger terminal) has been renovated to reflect the Golden Age of Aviation in the 1930s. It provides visitors with information and educational exhibits related to the period when Floyd Bennett Field served as New York City's municipal airport. Volunteers with the Historic Aircraft Restoration Project use Hangar B at Floyd Bennett Field to work in the preservation of historic aircraft and interpret them for the public (NPS 2010c) (see the "Other Important Cultural Resources" section in this chapter for additional information on Floyd Bennett Field).

Miller Army Airfield (Miller Field)

When completed in 1921, Miller Field included, among other structures, a concrete seaplane ramp, a sod runway, two landplane hangars, and two seaplane hangars (NPS 1979a). From 1923 to 1940, the New York National Guard's 102nd Observation Squadron was the major air unit at Miller Field. During this period, both military and civilian aircraft used the airfield. It was the home of the only Air Coast Defense Station on the East Coast during World War II when seacoast guns and observation towers were added. During the 1950s and 1960s, Miller Field was used by a variety of military aircraft (NPS 2013b). Other entities that used Miller Field from the 1950s through its closing in 1969 included the Civil Air Patrol, the National Guard, and U.S. Army Reserve troops. It was the last grass runway in New York City when it was deactivated by the army in 1969 (NPS 1979a).

Miller Field was also the site of several early experimental tests by private aircraft manufacturer Remington-Burnelli. In the spring of 1929, the American Aeronautical Corporation assembled and tested two Italian seaplanes—the SS-55 twin-hulled Savoia-Marchetti flying boat and the S-62 Savoia-Marchetti flying boat—at the airfield (NPS 1979a).

In 1973, when Miller Field was transferred to the NPS, about 24 structures existed at Miller Field; all were deteriorated. The landplane hangar was demolished in 1976, and the site was converted to paved areas and playing fields laid out over parts of the old airfield (see "Miller Army Airfield Historic District, Hangar No. 38" in the "Other Important Cultural Resources" section for additional information on Miller Field).

Rockaway Naval Air Station

The Rockaway Naval Air Station was located on undeveloped New York City park land and included 21 buildings in 1918. These included hangars for servicing HS-2 flying boats, for housing blimps, and for housing Navy-Curtiss flying boats, as well as a variety of other aviation-related structures. In 1919, one of the four Navy-Curtiss flying boats that departed from the air station completed the first transatlantic flight "totaling 3,936 miles in 53 hours, 58 minutes" (NPS 2011c, 25). Today, Jacob Riis Park, part of Gateway, occupies the location of the earlier Naval Air Station.

Fundamental Resources

Coastal Defense Resources

Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District—Fort Hancock Parade Grounds, Endicott/Taft-era Batteries, and Nike Launch and Radar Sites

The information presented below is summarized primarily from the Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District nomination form (NPS 1984a), the Fort Hancock and Sandy Hook Proving Ground Historic District nomination form (NPS 1980a), and the Cultural Landscape Report for Fort Hancock (NPS 2006b); please refer to these documents for additional detail.

Fort Hancock is in the Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District in the Sandy Hook Unit of Gateway (figure 3-3). Originally defined as including the more heavily developed northern area of Sandy Hook, it was listed on the National Register in 1980 as a historic district (NPS 1980a). In 1982, the district was designated as a National Historic Landmark, with boundaries encompassing the entire Sandy Hook peninsula, including all NPS, U.S. Coast Guard, U.S. Army, and State of New Jersey property. It also includes the Sandy Hook Lighthouse—also listed as a National Historic Landmark—and the Spermaceti Cove Life Saving Station, listed separately in the National Register (see below). The district also contains approximately 110 significant historic buildings and 16 batteries dating from the last quarter of the 19th century through the first half of the 20th century. The district reflects the history of the U.S. Army's Ordnance Department Proving Ground and Fort Hancock Military Reservation, both vital defense installations protecting New York City from 1895 through the Cold War era. It also played a significant role in the development of radar systems and the radar equipment that would eventually be located on Sandy Hook (NPS 1984a). For nearly 80 years, the fortifications at Fort Hancock and Sandy Hook Proving Ground contributed to the protection of the United States' most important harbor and its largest city, New York (NPS 1984a).

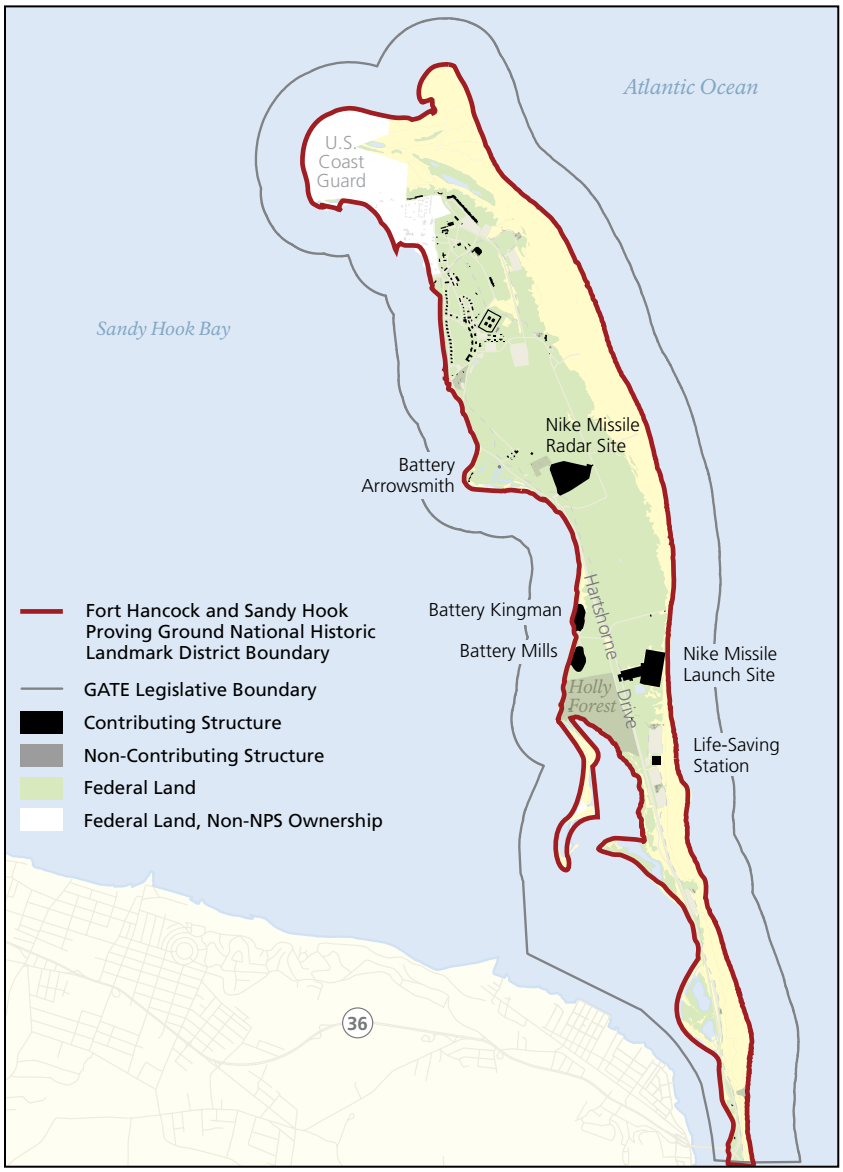
Two separate periods of significance exist for the district. The first period is associated with the Sandy Hook Proving Ground (1874–1919), and the second is related to the theme of coastal defenses associated with Fort Hancock and Sandy Hook Proving Ground (1859–1974) (figure 3-3). Nearly all the structures in the district contribute to its significance. A few examples in Fort Hancock and Sandy Hook Proving Ground include Officers' Row, the enlisted men's barracks, the mess halls, post headquarters, post hospital, bachelor officers' quarters, Sandy Hook Light, and the Spermaceti Cove Life Saving Station, among others (see NPS 1984a for complete listing).

The Sandy Hook Proving Ground operated from 1874 to 1919 and is considered the most significant part of the district, playing a key role in weapons development by the United States. The test facility, located on the northeast edge of the Fort Hancock cantonment, became one of the U.S. Army's most important facilities. Four structures—the Proof Battery, the Brick House, the Powder Magazine, and the Chemistry Lab—exist today as the most

important of the remaining buildings in the proving ground (NPS 1984a). Three are managed by the park; the fourth (the chemistry lab) is managed by the U.S. Coast Guard.

As major technological advances in weaponry were occurring around the world, the proving ground played a vital role in the testing of experimental guns and carriages for the seacoast defenses of the country. All the big guns and mortars and their carriages "mounted in the Nation's Endicott and Taft period coast fortifications from early 1890s through World War II were developed at Sandy Hook and many of them were proved there" (NPS 1984a, 7). The proving ground was deactivated in 1919 when improvements in weapons technology made the short test field at Sandy Hook too small (NPS 2009c).

Figure 3-3. Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District.



Source: NPS 2013b.

In 1886, the Endicott Board called for a comprehensive defense system to project the country's most important ports and harbors from attacks from the sea (see "Military History"). Under this and later programs, Sandy Hook evolved into one of the most important complexes guarding the approaches to the New York Harbor. Once the construction of the Endicott defenses was underway at Sandy Hook, permanent facilities for a garrison were needed. The site of Fort Hancock was selected and plans for an initial 34 buildings were drawn. The site was cleared and graded and a parade was laid out with the officers' quarters arranged along a linear alignment on the western edge of the parade. The enlisted men's barracks were constructed on the eastern side. The buildings are centered on two open space areas—the parade ground and the athletic field (Layton and Foulds 2010; NPS 1984a). Many of the more than 100 buildings at Fort Hancock share stylistic similarities—distinctive buff brick and Classical Revival ornamentation—and are grouped to take advantage of views of Sandy Hook Bay to the west. The initial buildings were completed around 1899 and construction at the fort continued at a steady pace up to 1918, when it began to slow. Today the fort is composed primarily of the buildings erected at the turn of the century (NPS 1984a).

Figure 3-4. Example of Endicott-Era Battery: Battery Peck, Open Battery Commander's Station, Circa 1905-1910, Looking Southeast.

Source: NPS 2010c, 113.

The Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District sustained considerable damage from Hurricane Sandy. Fort Hancock structures experienced flooding (in basements) and many have substantial damage to porches, piers, and columns and will need stabilization. Ninety percent of the structures within Fort Hancock need electrical repair, including Officers' Row House #1, "History House." Roof damage is evident on many structures and sand and debris covered many of the parking areas, roads, and driveways. Numerous trees were blown down. Infrastructure and equipment were lost throughout the area. Erosion/damage around some Endicott-era fortifications and the Nike Missile Launch Site was noted. The museum collection housed at Fort Hancock was at considerable risk and was moved to Fort Wadsworth to ensure its preservation (IMT 2012a, b).

The large, open parade ground is one of the most distinctive features of the Fort Hancock landscape. It is defined by "the architecture of Officers Row, the linear row of senior officers' quarters that back onto the Parade Ground and face Sandy Hook Bay" (NPS 2006b, 16). The parade ground also contributes heavily to the spatial relationship of the landscape, which is central to the historical character of the Fort.

The Sandy Hook Endicott- and Taft-era batteries associated with Fort Hancock and Sandy Hook Proving Ground are presented in table 3-5. For summary information on Endicott/Taft-era batteries, please refer to "Military History."

The boundaries of battery sites extend beyond the aboveground masonry batteries and include "engineered slopes in front of the masonry structures, and battery service areas to the rear of the masonry structures" (Layton and Foulds 2010, 3). This design was an attempt to make the structure indistinguishable from the surrounding landscape at a distance.

All the Fort Hancock and Sandy Hook Proving Ground batteries have experienced some degree of deterioration and loss of integrity. In the case of Battery Arrowsmith, built in 1908, the battery is considered to be in an "extremely ruinous state and coastal storms continue to break apart the remaining structure and the peninsula upon which it sits" (Layton and Foulds 2010, 318). In 1995, gun decks were demolished by the USACE, leaving only about 30 percent of its original structure intact. Still, it is believed that the ruins convey a "sense of the structure's size and shape and is thus contributing" to the district as a ruin (NPS n.d.e).

Figure 3-5. Looking West at Target Tracking Radars, Fort Hancock and Sandy Hook Proving Ground, Control Area No. 1, Nike Radar Site, Circa 1962.

Source: Layton and Foulds 2010.

In the 1950s, Nike Missile installations—a response to the threats of the nuclear age—were placed on Sandy Hook. The launch area (14.69 acres) consisted of the "launching complex where missiles were stored in underground silos and a radar tracking and control station with equipment for acquiring targets, tracking targets, and tracking the flight of outbound missiles" (Layton and Foulds 2010, 471). The Nike Missile installation at Fort Hancock and Sandy Hook Proving Ground was one of only a few dual battery sites built in the United States that featured two rows of missile launchers and two related groups of radar. Construction was completed on the launch site in 1955 and on the radar site in 1956 (Layton and Foulds 2010).

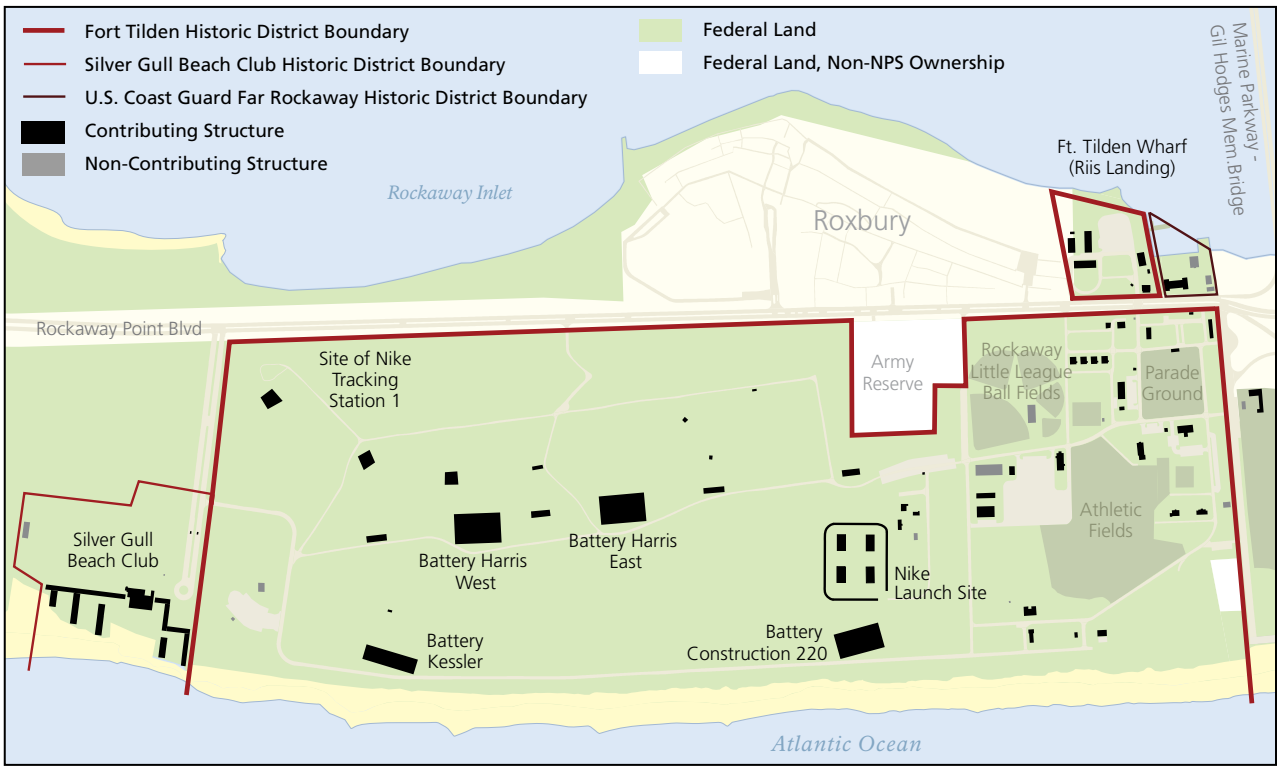
The launch area site is bound by a perimeter fence. On the surface, "double steel doors through which the missile would have passed and the missile launch elevator apparatus are evident" (NPS 1984a, 23). The silos contain no missiles today. The two tracking station towers to the north of the launch site include concrete radar towers and several support buildings (NPS 1984a). Currently, the radar site is interpreted for visitors.

Fort Tilden Historic District—Battery Harris, Battery Construction 220, Battery Kessler, and Nike Missile Launch Site

Located on the Rockaway Peninsula, the fort area was recognized in the early 19th century as a strategic location in the harbor (figure 3-6). Established in 1917, Fort Tilden complemented Fort Hancock and Sandy Hook Proving Ground and Fort Wadsworth as part of the "outer defense system for New York City and the harbor from World War I through the Cold War era" (NPS 1984b, 3). Coordination between Fort Tilden and Fort Hancock and Sandy Hook Proving Ground allowed for the efficient use of "seacoast artillery, anti-aircraft artillery, submarine mining and observation" in these efforts (NPS 1984b, 3). Fort Tilden is believed to illustrate a reorganization of the traditional coastal defense systems and was an integral part of a highly specialized strategy by the army to protect New York Harbor from sea and air attacks.

The fort consists of three areas: the post (administration) area, the fortification area, and Fort Tilden wharf area (Riis Landing) (figure 3-6). The post area reflects the administrative life of the fort (barracks, recreation, etc.). The primary early Taft-era fortifications at Fort

Figure 3-6. Fort Tilden National Register Historic District.



Tilden were Battery Kessler, Battery Construction 220, and Battery Harris (Selvek 2005) (figure 3-6). Later, during the Cold War years, a Nike Missile Launch Site and tracking station were installed.

The post area of Fort Tilden was located on the east quarter of the fort (figure 3-6) and included a number of structures built over several decades. They include the chapel (1941), the recreation building with dance floor (1941), the permanent brick barracks building (1938–1939; later converted to a hospital annex, and subsequently used as a headquarters), the theater (1941), two officers' quarters (1938; WPA construction, two-story, brick, with one-story garage), the double NCO quarters (1918–1919, the oldest permanent structure at the fort), the parade ground (early 1940s), the motor repair shop (1941), an ordnance building (1937–1938; replaced earlier World War I structure), the engineers' office (built soon after World War I), and the engineers' storehouse (1923–1924). The wharf dock (just north of the post area) existed prior to the fort being established and has undergone repairs through the years. This was a critical component of the fort because everything that was shipped to the facility had to come by way of the wharf (NPS 1980b). (Please see additional information on Fort Tilden wharf area provided in "Coastal Defense Support Structures.") Today, several modern playing fields exist in the post area of the fort (figure 3-6).

Battery Construction 220 and Battery Kessler were both constructed along the coastline of the fort. Battery Construction 220 was built in approximately 1917 and was outfitted with two 6-inch guns, separated by about 210 feet. Battery Kessler, originally known as "West Battery," consisted of two 5-inch guns mounted on a circular platform (NPS 1984b).

Constructed in approximately 1922–1924, Battery Harris is located slightly inland and to the north of Battery Construction 220 and Battery Kessler. It is characterized the technical improvements in military weapons at the time (Selvek 2005) (figure 3-6). In 1941, the two guns (16-inch gun placements) were roofed over by concrete casemates, approximately 850 feet apart. They were covered with earth and sand, resembling two oval hills. Together, these structures compose Battery Harris. There is a circular concrete hood projecting over the southern aperture of each gun emplacement. Due to their long range and power, the two guns represented an important factor in the defense of New York Harbor (NPS 1984b).

At the beginning of the Cold War period (1945–1974), a new surface-to-air missile defense program (Project Nike) was developed. The systems were installed at Fort Tilden and Fort Hancock and Sandy Hook Proving Ground. At Fort Tilden, this included the construction of "four magazine double Nike batteries" located at the eastern end of the fort, which were operational by 1955 (Selvek 2005, 47) (figure 3-6). Two missile-tracking stations were constructed at the western end of the fort, with two additional ones to follow. By 1967, the Nike technology had become obsolete and the Fort Tilden installation was decommissioned. By this time, the fort was slowly being shut down as a military installation (Selvek 2005).

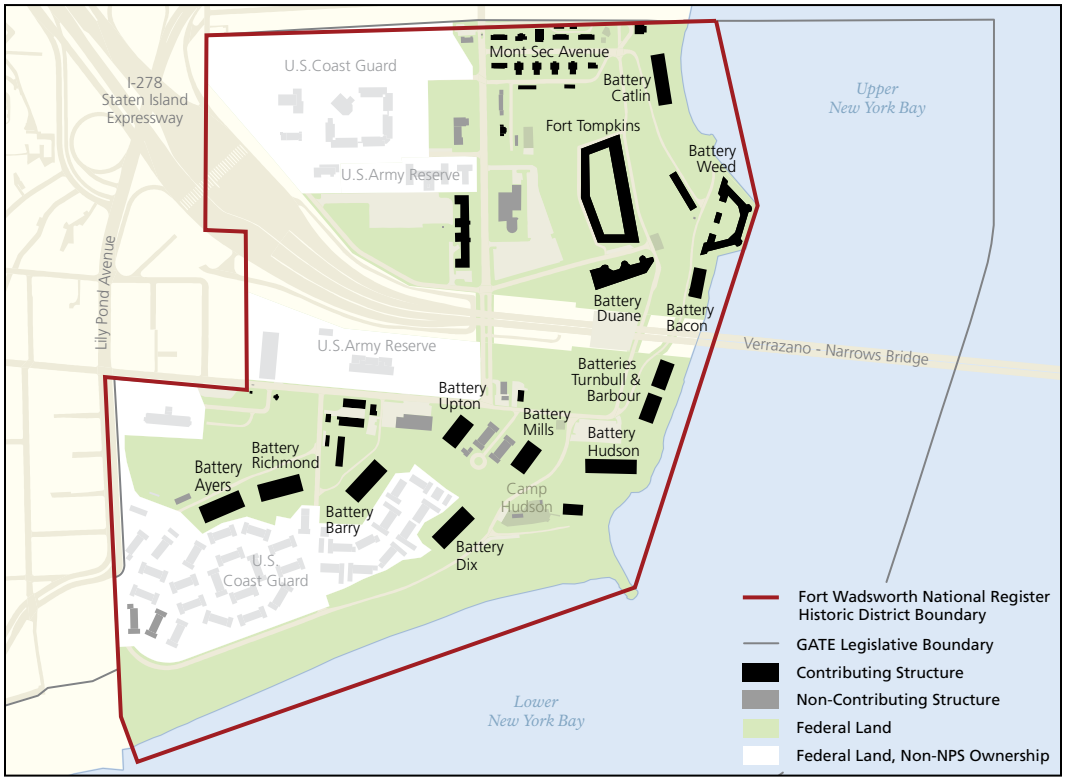
Fort Tilden experienced considerable flood and wind damage from Hurricane Sandy and many contributing features of the historic district were heavily impacted (officers' and enlisted men's buildings, Battery Kessler, small-scale features, etc.). Numerous trees were also downed (IMT 2012c).

Fort Tilden Historic District is considered significant because of its role in the defense network designed to protect New York Harbor. It was determined eligible by the Keeper of the National Register of Historic Places for its association with military history from 1916 to 1967. Contributing resources include the surviving Taft-era gun emplacements and associated structures from World Wars I and II, surviving features associated with the Nike-Ajax and Nike-Hercules missiles, and significant surviving operational, administrative, housing, wharf, and transportation components (U.S. Department of the Interior 2009). All of these elements retain sufficient integrity to contribute to the "significance of the district as an integrated 20th century coastal defense installation" (U.S. Department of the Interior 2009, 47). (Please refer to NPS 1984b, U.S. Department of the Interior 2009, and Selvek 2005 for greater detail on Fort Tilden.)

Fort Wadsworth Historic District—Battery Weed, Fort Tompkins, Torpedo-storage Building, and Endicott-era Batteries

The Fort Wadsworth Historic District is characterized by resources primarily associated with the coastal defense system that has contributed to the protection of New York Harbor for some 200 years (figure 3-7). The site is remarkable for the conspicuous bluff that rises to about 150 feet from the coastline. Damage from Hurricane Sandy in 2012 has left some of these slope areas unstable/unsafe (IMT 2012d). Battery Weed lies at the toe of the slope; Fort Tompkins is located at the highest point (figure 3-7). Both represent major third system fortifications listed on the National Register and retain much of their historic character (NPS n.d.b). The district also includes a number of other batteries and numerous military-

Figure 3-7. Fort Wadsworth National Register Historic District.



Source: NPS 2013b.

related resources ranging in time from the early 1800s to the 1990s, 12 of which have been determined eligible for the National Register (NPS 1985) (see below). It encompasses elements ranging from the post–Civil War period to the Endicott period. A most notable change from its original state is the increased vegetation (mature trees) that now exists; the original fortifications and batteries were covered with low-lying grass to allow for optimal visibility (NPS n.d.b). Management of Fort Wadsworth was transferred to the NPS from the United States Navy in 1994. The U.S. Coast Guard and U.S. Army Reserve also own and occupy a portion of Fort Wadsworth.

According to the National Register nomination form for Wadsworth (NPS n.d.b), important components of the fort include the following:

- Civil War–era fortifications (Battery Weed and Fort Tompkins), including the surrounding open space
- Battery Duane, Battery Catlin, Battery Turnbull, Battery Bacon, Battery Barbour, Battery Hudson
- Torpedo-storage building (Building 147)
- Seawall and dock
- Unrestricted view of New York Harbor
- Hillside below Fort Tompkins and above Battery Weed
- Hudson Road wall from Fort Tompkins turnout to head of Battery Weed Road
- Rail network between the torpedo-storage building and Battery Weed (NPS n.d.b, 9)

Fort Tompkins is located on the site of two earlier fortifications—one British (1779), the other built by the state of New York (1814, never completed). It was originally constructed as support for Battery Weed. What is evident today at Fort Tompkins dates to about 1859, when construction of the granite and brick fort began (construction was completed in 1876). It is a five-sided structure with one side overlooking Battery Weed and the harbor entrance (figure 3-7). The well-preserved fort is believed to be an outstanding example of the third system military architecture (NPS n.d.b) (see "Military History"). Fort Tompkins is also recognized as a Landmark Site by ~~the~~ New York City for its "special historical, aesthetic interest and value as part of the development, heritage and cultural characteristics of New York City" (New York City, Landmarks Preservation Commission 1974, 2).

Many of the existing batteries at Fort Wadsworth are located on the sites of earlier fortifications. Battery Weed, begun in 1847, is one of the earliest structures that remains intact at the fort and was constructed on the site of the former Fort Richmond, a water battery (Black 1983). Battery Weed's construction involved the use of granite blocks in a half-hexagon shape and included a central parade ground (figure 3-8). At the time of its completion (1861–1864) it included 116 cannons, three tiers of casemates, and a fourth barbette tier, each with gun emplacements. Access to the tiers is via circular granite staircases. A seawall follows the perimeter of Battery Weed and at one time functioned as the exterior side of a moat that once surrounded the battery. The seawall is constructed of granite blocks similar in appearance to the construction materials of the battery. Damage to Battery Weed from Hurricane Sandy in 2012 included loss of fencing and damage to the seawall (IMT 2012d).

Figure 3-8. Battery Weed Looking Northeast Across the Narrows Toward Brooklyn (2006).

Battery Weed was garrisoned by a large force from the Fifth Regiment New York Volunteer Artillery. It represents "an important example of a multi-tiered casemated fort—one of only three 4-tiered forts built—belonging to the Third System of American seacoast fortifications" (NPS n.d.b, 5). It is believed to retain a high degree of integrity. Battery Weed is also recognized as a Landmark Site by ~~the~~ New York City for its "special historical, aesthetic interest and value as part of the development, heritage and cultural characteristics of New York City" (New York City, Landmarks Preservation Commission 1967, 2).

Twelve Endicott-era batteries constructed between 1895 and 1904 at Fort Wadsworth have been determined eligible for the National Register (table 3-6). Of these 12, 6 were reconstructed from existing works (rebuilt and renamed) (NPS 1985). Constructed of concrete, granite, and extensive earthworks, these batteries were designed to replace the third system defenses that were unable to defend against new military strategies and weaponry. The number of guns mounted in each battery varied. Their current conditions also vary and most are considered "generally in a state of deterioration" (NPS n.d.b, 6). (For more detail on individual batteries, please refer to NPS n.d.b. For additional information on Endicott-era batteries, please refer to "Military History."). Damage to these resources associated with Hurricane Sandy in 2012 included loss of fencing at Battery Duane, collapse of stone walls and unstable earthworks at Battery Hudson, numerous downed trees, and erosion and scouring around many other coastal batteries/earthworks (e.g., Battery Bacon) (IMT 2012d).

The Endicott-era torpedo-storage building was constructed on the hillside behind Battery Weed between 1892 and 1894 (figure 3-7). It served as the storage area for torpedoes or submarine mines that protected the harbor. The structure is a rectangular, two-story building with a corrugated roof constructed of granite and brick. The southeast portion of the building was substantially damaged by fire in the 1980s, causing a partial roof collapse. Mitigation measures were taken, but the damaged section remains in a deteriorated state; the northern portion of the structure remains "fairly intact" (NPS n.d.b, 7).

Maritime Resources

Sandy Hook Lighthouse

The Sandy Hook Lighthouse (also known as Sandy Hook Light) is designated as a National Historic Landmark. It is also located within the boundaries of the much larger Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District (figure 3-3). Construction on the light began sometime in 1761, with the first lighting in 1764, marking the beginning date for its period of significance. It was the fifth lighthouse to be built in America and now stands as the oldest continuously operating light tower in the nation.

During the Revolutionary War, the Americans extinguished the light so as not to aid the British. The British soon returned it to service and it has remained lit ever since with the exception of a temporary blackout periods during World War II. In addition to its shining beacon, the lighthouse communicated with lookouts on Staten Island during the day by flying various colored shapes from the tower, indicating inbound vessels (NPS 1971).

Figure 3-9. Sandy Hook LIghthouse and Keeper's Quarters.

Source: NPS 2013b.

The lighthouse was built by Isaac Contro and can be described as an octagonal structure, nine stories (103 feet) tall, and tapered from a base diameter of 29 feet to a 15-foot diameter at the top level. It is constructed of bricks on a masonry foundation and its walls are 7 feet thick at the base. It includes 13 windows and a circular iron staircase to the upper levels. A ladder allows access through the vaulted ceiling to the beacon itself, which is protected by a glass and steel cupola. The 45,000-candlepower beacon is approximately 4 feet wide by 8 feet high and is housed in a thick circular glass lens. Graphic depictions of the light in the late 1870s and early 1880s include, among other things, the keeper's quarters, a fenced yard, a second house (probably for an assistant keeper), a farmyard, and a possible chicken coop (Bianchi 2006). Restoration work was completed on the lighthouse in 2000.

Just southwest of the light structure sits the former lightkeeper's house—a two-and-a-half story frame house with hip and gable roof constructed in the early 1880s (figure 3-9) (NPS 1971). The original exterior has not changed substantially except for the addition of asbestos shingles. The interior of the house was renovated by the Coast Guard in 1980 (NPS 1984a); a more recent renovation by the Sandy Hook Foundation occurred in 2000. While the Sandy Hook Unit sustained considerable damage from Hurricane Sandy in 2012 (see Fort Hancock and Sandy Hook Proving Grounds, above), the lighthouse and keeper's quarters do not appear to be damaged.

Spermaceti Cove Life Saving Station

The Spermaceti Cove Life Saving Station was listed in the National Register in 1981 and represents one of only three individual resources recognized within the larger Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District (figure 3-3). It is considered significant due to its association with the earliest federally sponsored efforts (through the U.S. Life Saving Service and U.S. Coast Guard) to save life and property from shipwrecks and its distinctive characteristics of a particular period and type of construction (Lee 2008). It was constructed in 1894 and, at the time, was located 800 yards from the ocean. Since then, that distance has been reduced to 150 feet (NPS 1981a).

Figure 3-10. Spermaceti Cove Life Saving Station, East Elevation.

Source: Lee 2008.

The station was one of at least 28 Duluth-type stations constructed for the U.S. Life Saving Service, which are characterized by "three building sections that form the station; a one-and-a-half story Main Block; a one-story Boat Room; and a four-story Watch Tower" (Lee 2008, 4). The Spermaceti Cove Life Saving Station, described as a one-and-one-half story structure with a two-bay boathouse on one end and a four-story tower on the front with a pyramid roof facing the ocean, exhibits strong Craftsman influence. The boathouse has double doors facing the sea. The front porch was enclosed in the 1930s. Other than the porch, the entire structure is shingled. (Please refer to the National Register nomination form (NPS 1981a) for greater architectural detail.) Effects of Hurricane Sandy on the structure in 2012 included flooding on the first floor and basement (IMT 2012e), the loss of the porch, and damage to some exhibits.

Between 1894 and 1949, the U.S. Life Saving Service conducted numerous rescues from this structure. The Spermaceti Cove Life Saving Station was one of the six to eight original New Jersey U.S. Life Saving Service sites. In 1949, the lifesaving station was decommissioned by

the U.S. Coast Guard and later housed administrative offices for the New Jersey State Park on Sandy Hook. Since 1974, it has served as one of Gateway's visitor centers and remains an important example of late 19th century New Jersey coastal utilitarian architecture (NPS 1981b).

Other Important Cultural Resources

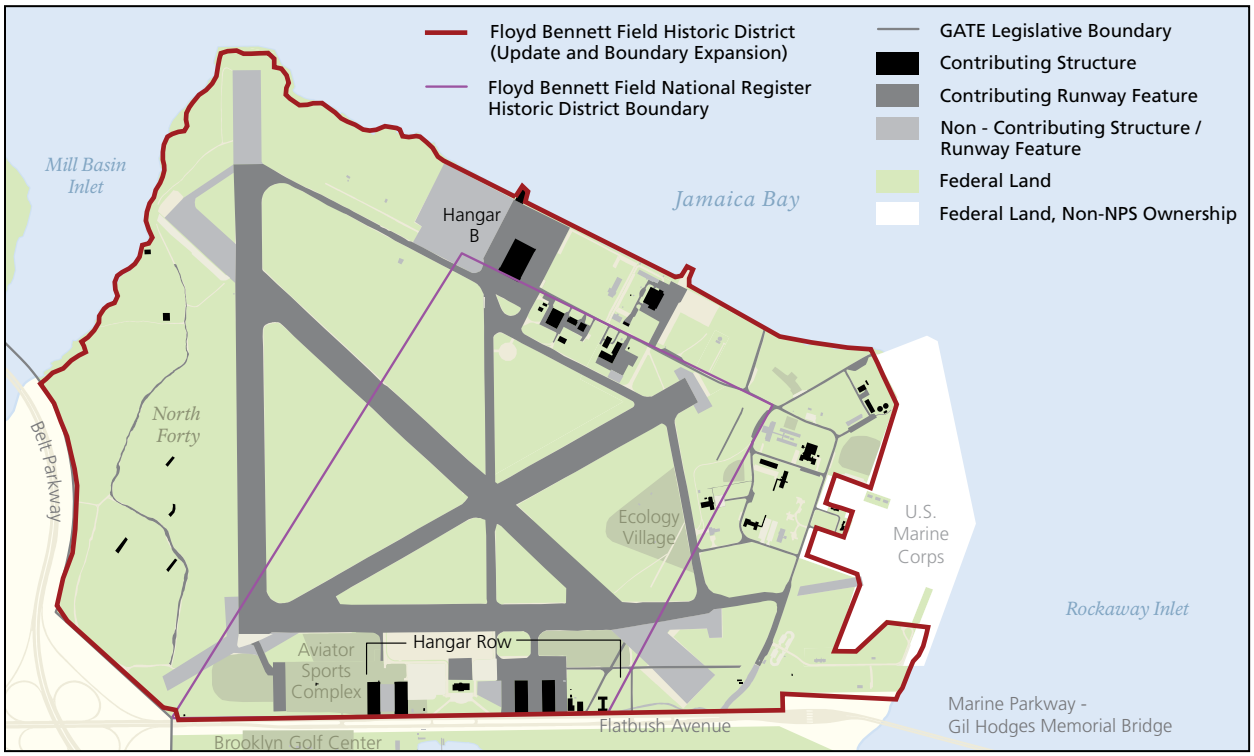
Floyd Bennett Field Historic District

Floyd Bennett Field Historic District was originally listed on the National Register in 1980 (figure 3-11). Its period of significance (1931–1941) was related to its involvement in the evolution of aviation history and municipal airport construction. According to the original National Register nomination, the original complex of steel frame and brick hangars and support building at Floyd Bennett Field still retains the "architectural design and historic cohesion of an early municipal airport" (NPS 1978, 3). A recent determination of eligibility expands the district's boundaries and period of significance. The revision to the period of significance ranges from 1928 to 1945 to incorporate important historical themes not addressed in the original documentation. The district's boundaries have been revised to include all lands east of Flatbush Avenue and south of the Shore Parkway, with the exception of the U.S. Department of Defense land used as a Marine Corps Reserve Center (NPS 2010c). These expanded boundaries conform to federally owned lands administered by the NPS that are historically associated with Floyd Bennett Field and the Coast Guard Air Station Brooklyn (NPS 2010c).

The expanded district is significant for its role in early aviation history. "In the 1930s it was the starting point and terminus for many record-breaking continental and intercontinental flights and important air races in the 'Golden Age' of U.S. aviation history" (NPS 2010c, 1). Its significance also lies in its role during World War II when the navy operated the field as Naval Air Station New York, one of the most vital "home front" navy installations, "ferrying more naval aircraft from regional assembly plants to the West Coast for deployment in the Pacific Theater than any other facility" (NPS 2010c, 1). The district is also significant for its architecture and engineering. Much of Floyd Bennett Field's original structure and setting—hangars, administration building, runways, and taxiways—is still evident and it is one of the few municipal airports that still reflects the pioneering of the aviation industry (NPS 2010c). Hangar B, the largest structure at the field, was completed in 1941 to house seaplanes and currently houses the Historic Aircraft Restoration Project volunteer group and numerous historic aircraft. Hangar B sustained roof damage and broken windows and is in need of stabilization as a result of Hurricane Sandy in 2012 (IMT 2012g).

The historic district's National Register significance lies not only in its association with aviation history and municipal airport construction but also in its association with individuals significant in early aviation (NPS 2010c). The former air terminal at Floyd Bennett Field is currently being used as the Ryan Visitor Center. (Please refer to NPS (2010c) and the "Aviation History" section above for additional information on Floyd Bennett Field Historic District.)

Figure 3-11. Floyd Bennett Field National Register Historic District.



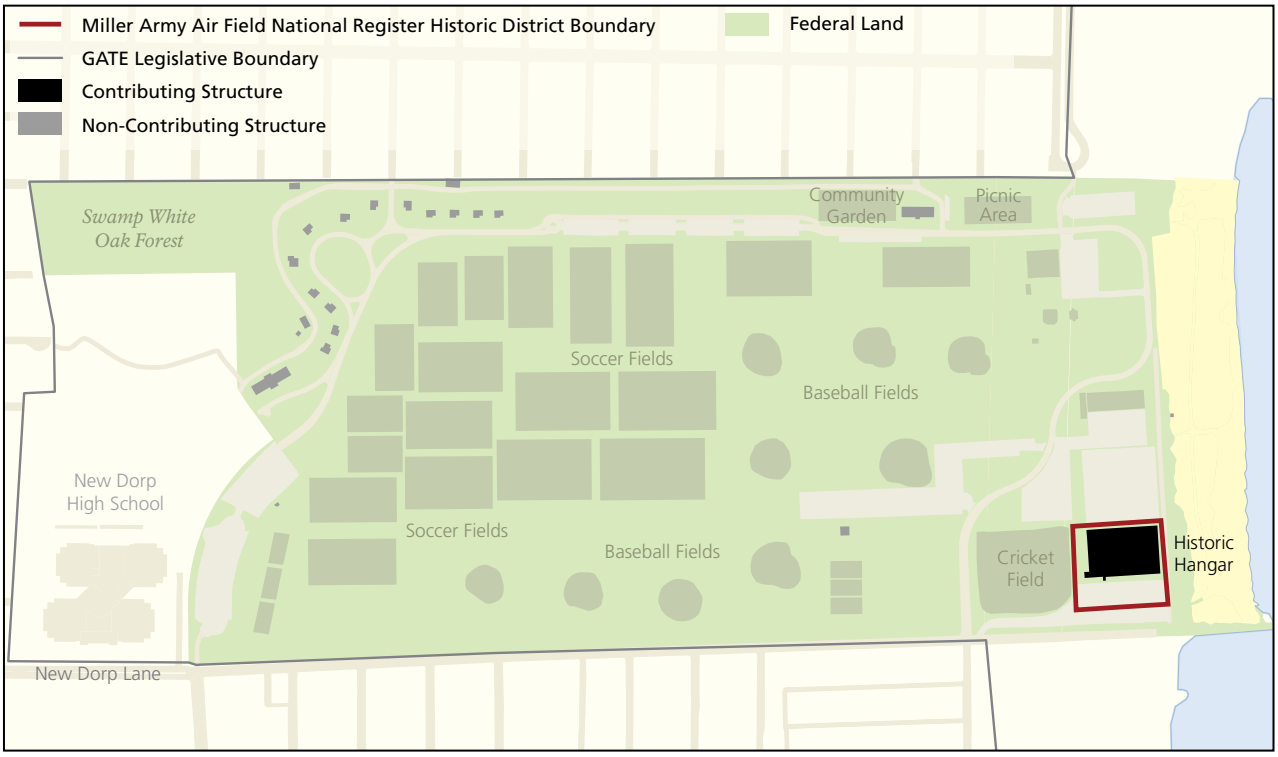
Miller Army Airfield Historic District, Hangar No. 38

Miller Field was established in 1919–1921 as a 180-acre army airfield (figure 3-12). It originally consisted of 38 structures including two double hangars, the most important buildings at the field. The flying field originally encompassed 80 acres, centered on a sod runway running diagonally across the field. When the park acquired the field in 1973, about 24 buildings and structures remained, all in deteriorated condition. The landplane hangar (Building 33) was demolished in 1976 and replaced with paved areas and fenced playfields. Former residential buildings have been renovated for park purposes and do not meet National Register criteria; the runway is no longer distinguishable because of its use as playing field (NPS 1979a). The area nominated was restricted to the double seaplane hangar (Hangar No. 38) and the Elm Tree Light, a total of about 3 acres (NPS 1979a).

Hangar No. 38, constructed in 1920 at Miller Field, is important because of its association with early aviation history (see the "Aviation History" section in this chapter). It was viewed as a part of the Hangar Group of Buildings, which included a variety of support structures (aero repair shop, boiler house, aero storehouse, etc.). It was constructed of a steel frame and stucco walls and consisted of two side-by-side bays. Several additions were made by the Works Progress Administration (WPA) of the Roosevelt administration in 1935–1939. The significance of Hangar No. 38 is its direct association with early aviation history and the history of air coast defenses of New York (NPS 1979a). Hangar No. 38 sustained considerable damage from Hurricane Sandy in 2012 (IMT 2012f).

The Elm Tree Light, an octagonal concrete beacon tower, stands near Hangar No. 38. It was constructed by the Coast Guard in 1939 to replace an earlier tower that served as a mark for sailing vessels in the late 18th century and was abandoned in 1924. The significance of the Elm Tree Light lies in its direct association with the early lighthouse service (NPS 1979a). Miller Field continues to be used by team/league sports teams, bikers, and for self-guided nature tours.

Figure 3-12. Miller Army Airfield National Register Historic District.



Jacob Riis Park Historic District—Bathhouse Pavilion, Central Mall Building

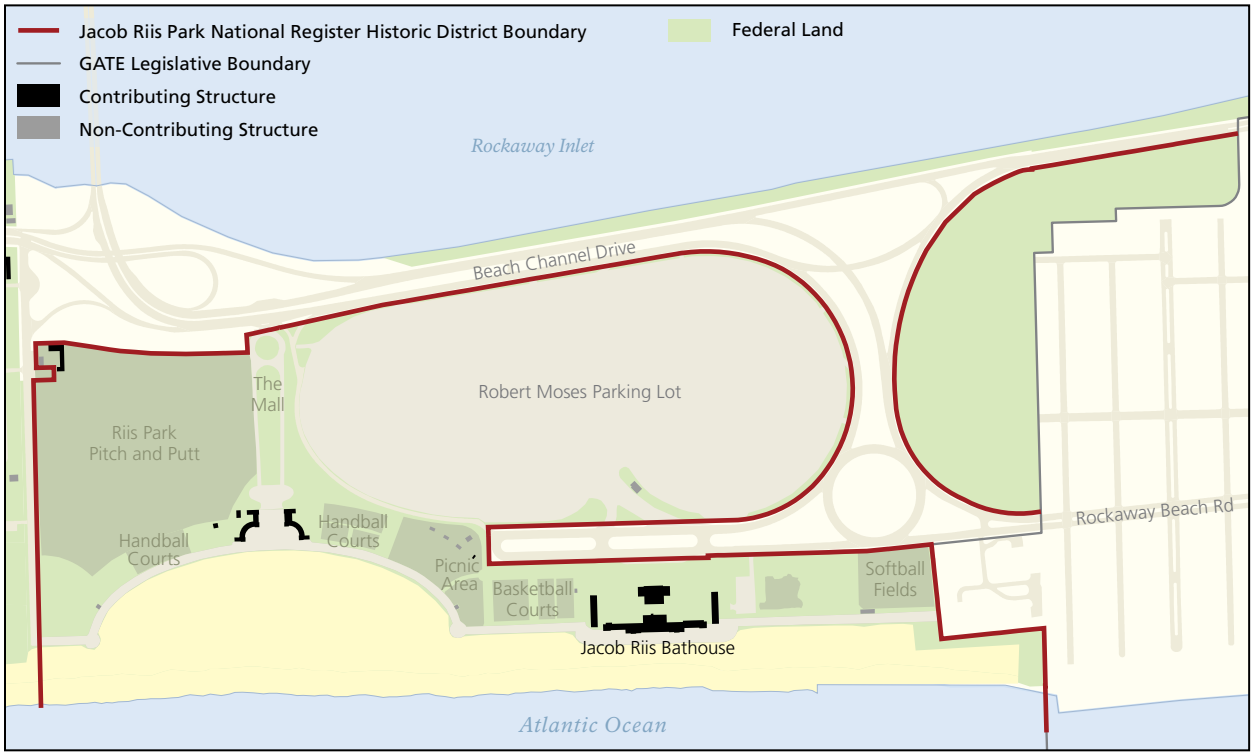
The Jacob Riis Park Historic District, listed in 1981, is considered an "excellent, though greatly deteriorated, example of … municipal recreational planning the 1930s" (Olmsted Center for Landscape Preservation 2002, 2) (figure 3-13). Its historical significance derives from its association with New York City's Commissioner of Parks, Robert Moses, as well as it being a notable work of landscape architecture. The park was completed through the WPA and is associated with this important social and government program (NPS 1979b). The park landscape has lost much of its integrity and has not been well maintained (Olmsted Center for Landscape Preservation 2002). In 2012, Hurricane Sandy resulted in heavy wind and water damage to Jacob Riis Park facilities, including flooding; broken windows; blown out walls, sand deposition in the bathhouse; missing ceramic tiles in the bathhouse; and sand and other debris deposited in structures and across the landscape. The brick courtyard wall was destroyed and heavy erosion is evident along the boardwalk (IMT 2012h).

The 220-acre Jacob Riis Park occupies a mile-long section of the Rockaway Peninsula and provides a variety of recreational activities. The park's three significant recreational buildings were constructed between 1932 and 1937.

The original bathing pavilion—commonly known as the bathhouse—is the dominant feature of the park. The T-shaped, one-story brick masonry structure was completed in 1932. In 1936–37, it was enlarged by a long, two-story addition on the south side of the structure. The entrance to the bathhouse is located on the north wall. The front of the bathhouse is faced with a long arcade supported by pillars and topped with two octagonal turrets (NPS 1979b).

The mall focuses on a crescent-shaped extension of the boardwalk. The twin central mall buildings—constructed of brick and tile masonry—face each other at the southern end of the mall. Constructed in 1936–1937, both are two-story, square buildings, flanked by one-story wings, and connected to a rectangular, single-story wing to the south by a single-story, semicircular wing. Both have flat concrete roofs, concrete cornices, and concrete floors (NPS 1979b).

Figure 3-13. Jacob Riis National Register Historic District.



In addition, a broad promenade plaza adjacent to the original bathhouse was opened in 1932. During an expansion of the original park in 1936–1937, a continuous walkway (the length of the beach) was created, connecting all areas of the park. Both the promenade and boardwalk are considered integral elements of the park and contribute to its historic significance (Lane, Frenchman, and Associates 1992). Another striking feature of the park is the 72-acre parking lot located north of the bathhouse. With a 12,000–14,000 car capacity,

The history of the park's defensive military fortifications and weaponry is manifested in some of the most notable cultural resources in the park.

it was believed to be the largest in the world at that time (NPS 1979b). The parking lot still retains its original integrity and is a contributing element to the district. (Please refer to NPS 1979b; Lane, Frenchman, and Associates 1992; and the Olmsted Center for Landscape Preservation 2002 for greater detail on the Jacob Riis Park Historic District.)

Coastal Defense Support Structures

The history of the park's defensive military fortifications and weaponry is manifested in some of the most notable cultural resources in the park. Places like Fort Wadsworth, Fort Tilden, and Fort Hancock and Sandy Hook Proving Ground, with their associated gun batteries and weaponry, have played critical roles in the history of the country, and particularly in the protection of New York Harbor (refer to discussions about the specific forts). The mission of the forts was to provide support for the soldiers manning the gun batteries. The support that these facilities required to function efficiently cannot be understated and included an important array of services, personnel, and facilities. Often, these forts resembled small towns, including such things as housing, hospitals/medical facilities, bakeries, post exchanges, schools, chapels, theaters, mess halls, transportation facilities, recreation areas, and so on. Many of these support structures still exists today in Gateway. A discussion of a few notable examples follows.

Parade Ground, Fort Tilden

The parade ground at Fort Tilden was built around 1941 with assistance from the WPA. In order to construct it, 11 World War I cantonment buildings were destroyed (NPS 1980b). The parade ground is about 3 acres in size and was designed as the primary ceremonial area at the fort. The WPA placed a steel, 75-foot-high flagpole at the northeast corner of the parade ground near the main fort's entrance; the flagpole was lost during Hurricane Sandy in 2012. The flagpole was set in a cut stone with inscriptions of the installation, organization, and U.S. Army Coast Artillery insignia (NPS 1980b). Plans called for the parade ground to be seeded and landscaped. It was bound by tree-lined roadways and enclosed by structures to the west, north, and south (Selvek 2005). The parade ground contributes to the significance of the Fort Tilden Historic District.

Fort Tilden Wharf Area (Riis Landing), Fort Tilden

The wharf area is located immediately to the northeast of the Fort Tilden post area (figure 3-6). It consists of an area approximately 10 acres in size and was historically considered part of the post. It contained the "main dock, warehouses, maintenance facilities and administration buildings, with rail lines connecting from the main dock through the post area to the fortifications" (Selvek 2005, 2). Although the wharf area contained 19 buildings during the World War II period, only 8 structures remain today, and only pilings remain from the main dock. In the early 2000s, a new ferry dock and parking lot were constructed as part of the Riis Landing redevelopment project. The project included the adjoining complex of buildings once used as the U.S. Coast Guard Station Rockaway (Selvek 2005).

Mont Sec Avenue, Fort Wadsworth

Fort Wadsworth's Mont Sec Avenue was the primary location of officers' housing at Fort Wadsworth from the 1870s to the present day (figure 3-7). The houses consist of ten duplexes and one single-family residence. These houses retain their original form and much of their original detail, both exterior and interior, with the exception of synthetic shingles. One—Mont Sec House—has had its interior restored to its 1890s appearance. One duplex, originally the quarters for the post surgeon and other medical officers, was originally clapboard but is now brick-faced with a mansard roof. Five brick duplexes (Buildings 101, 102, 106, 107, 110) and one residence (Building 115) were constructed by the WPA in the 1930s. Garages behind the houses served the multiple residences (NPS n.d.b).

An associated fort street—New York Avenue—runs perpendicular to Mont Sec Avenue and has served as the main street of Fort Wadsworth since the mid-19th century. Although development in the area has dramatically modified the street in the last half of the 20th century, historically important structures that remain today along New York Avenue include the entry gate and gatehouse, the WPA-era former officers' quarters, and the former barracks (NPS n.d.b).

Fort Wadsworth's Mont Sec Avenue was the primary location of officers' housing at Fort Wadsworth from the 1870s to the present day.

Officers' Row, Fort Hancock, Fort Hancock and Sandy Hook Proving Ground

Eighteen two-and-a-half story structures built along Hartshorne Drive between 1898 and 1899 served as officers' housing at Fort Hancock. Basically identical, all the buildings are constructed of buff-colored brick, chosen because it was less porous than traditional red brick (figure 3-3). The houses are among the most distinctive buildings at Fort Hancock due to the "cohesive architectural ensemble that survives as originally designed" (NPS 2006b, 19). Few alterations have been made to the structures and their surface appearance remains relatively unchanged. Single-car garages were added to some of the houses (Buildings 6–16) in the 1930s. Necessary maintenance has included repairs to leaking roofs, defective flashing, deteriorated brick mortar, faulty gutters/downspouts, decay on wood window sashes/frames, etc. The park manages Building 1 (Officers' Row House #1) as the "History House." Another building (Building 18) is currently used by the American Littoral Society (NPS 1984a; Ehrler, pers. comm. 2013).

Many of the historic structures along Officers' Row experienced damage from Hurricane Sandy in 2012. This included basement flooding and substantial damage to porches, piers, and columns that will require stabilization. Ninety percent of the structures within Fort Hancock need electrical repair, including Officers' Row House #1, "History House" (IMT 2012b). For additional detail, please refer to storm effects discussion above for Fort Hancock and Sandy Hook Proving Ground ("Fundamental Resources").

Other Historic Districts

The Silver Gull Beach Club, the Breezy Point Surf Club, and the Far Rockaway Coast Guard Station have been determined eligible for the National Register by the New York State Historic Preservation Office.

Silver Gull Beach Club Historic District

The Silver Gull Beach Club Historic District is in its original location on the Atlantic Ocean and retains a high degree of integrity in terms of setting, design, materials, workmanship, feeling, and association.

The Silver Gull Beach Club Historic District is located on the Atlantic Ocean shorefront, immediately west of Fort Tilden, on the Rockaway Peninsula. The historic district includes approximately "7.5 acres of relatively flat land that is surrounded on three sides by undeveloped coastal land covered with dense low brush. It is bordered on the south by the Atlantic Ocean, where a wide sandy beach provides uninterrupted vistas to the east and west" (NPS n.d.c, 1).

The district is an oceanfront cabana complex containing a total of 15 contributing (1 site, 7 buildings, 7 structures) and 10 non-contributing (5 buildings and 5 structures) resources. The district's contributing resources include a large clubhouse, 4 court buildings, a pool court, an activity building, recreational facilities, and both paved and unpaved parking areas. The 12,000-square-foot, one-story clubhouse is the central building of the cabana complex. The Silver Gull Beach Club sustained substantial storm damage from Hurricane Sandy in 2012. Cabanas, the pool, and surrounding concrete were destroyed. Large sections of beaches were eroded, large amounts of sand were deposited in parking lots and roads, and buildings within the historic district were damaged (IMT 2012i).

The Silver Gull Beach Club Historic District is in its original location on the Atlantic Ocean and retains a high degree of integrity in terms of setting, design, materials, workmanship, feeling, and association. Only one major alteration—the removal of a set of second-floor cabanas from the clubhouse building—has occurred. "The club continues to serve its original function and it conveys a strong sense of feeling and association as a mid-twentieth-century oceanfront recreational resource" (NPS n.d.c, 5).

The Silver Gull Beach Club is significant at the local level in the areas of entertainment/recreation, social history, community planning and development, and architecture. Its "period of significance is 1962–1963, the years the club was designed, constructed, and opened by its original owner the Atlantic Improvement Corporation" (NPS n.d.c, 8).

Breezy Point Surf Club

The Breezy Point Surf Club is an approximately 60-acre cabana complex in a coastal setting of relatively flat land facing the ocean on the Rockaway Peninsula. The historic district contains 69 contributing buildings, 11 contributing structures, and 1 contributing site; most of these were constructed between 1937 and 1962. The complex has two distinct sections of cabana courts known as the Original Courts and the Ocean Courts, along with several pools and athletic courts. The district reflects a primarily recreational landscape that evolved from 1937 to 1963 in response to increased demand for memberships in the club (NPS n.d.d; IMT 2012i).

The historic district retains a high degree of integrity in terms of its location (original), setting, design, materials, workmanship, feeling, and association. Although routine maintenance has occurred throughout the years, the majority of the original materials are intact and the workmanship of the buildings is still evident. The district retains a strong sense of its feeling and association as a large, recreational oceanfront resort built in the early to mid-19th century (NPS n.d.d). Damage to the Breezy Point Surf Club from Hurricane Sandy in 2012 was not extensive (Ehrler, pers. comm. 2013).

The Breezy Point Surf Club Historic District is eligible for listing in the National Register at the local level in the areas of entertainment/recreation, social history, and architecture. "The period of significance ranges from 1937, when the Club was established, and ends in 1963 when the layout of the cabana complex as it exists today was completed" (NPS n.d.d, 11).

Far Rockaway Coast Guard Station Historic District

The Far Rockaway Coast Guard Station Historic District is located just east of the Fort Tilden wharf area (Fort Tilden Historic District). The Coast Guard facility is considered historically and architecturally significant for its association with the "history of lifesaving services and as a distinctive example of Colonial Revival institutional architecture (NPS 2004e, 3). During the 19th and early 20th centuries, Far Rockaway was the site of numerous marine accidents and shipwrecks. An earlier lifesaving station—established by the New York Life Saving Benevolent Association—operated with volunteers at Far Rockaway as early as 1849 (NPS 2004e). The current station's construction began in 1938 with WPA funds and continued through 1944. The facility was designed with a boat basin, piers, breakwaters, marine railways, and radio communications. Through the years some support facilities have been removed (e.g., boat shop), but the complex is believed to retain substantial integrity of its original construction period (NPS 2004e). In 2012, Hurricane Sandy resulted in moderate damage to the main building, boathouse, garages, and power house (NPS n.d.g).

The Coast Guard facility is considered historically and architecturally significant for its association with the "history of lifesaving services and as a distinctive example of Colonial Revival institutional architecture.

Historic Structures

Historic structures include buildings, bridges, roads, temples, and other manufactured objects that extend the limits of human capability. Structures allow humans to live in harsh climates and in areas far removed from where they work and live (NPS 1998a). Gateway maintains a List of Classified Structures (LCS), a required list identifying historic structures that meet the criteria of the National Register or are elements of resources that do (NPS 1998a). The LCS includes information on the significance of and recommended treatment levels (preservation, restoration, etc.) for each structure. It provides data on all historic structures and their National Register status.

The LCS includes resources that are broadly defined as structures. In addition to buildings, other structures such as dams, mounds, forts, earthworks, etc. are included in this list. For instance, at Gateway, the LCS contains such structures as the Jacob Riis Park boardwalk and promenade, Mont Sec Avenue in Fort Wadsworth, the flagpole at Floyd Bennett Field, and the Elm Tree Light at Miller Field (NPS n.d.e).

Historic structures included in this plan are primarily located within the boundaries of National Register historic districts in the park. These districts include Fort Wadsworth, Fort Tilden, Fort Hancock and Sandy Hook Proving Ground, Floyd Bennett Field, Jacob Riis Park, Miller Field, Silver Gull Beach Club, and Breezy Point Surf Club (see discussions about each of these resources in this section).

The LCS contains 355 structures from these historic districts, with the exception of Silver Gull Beach Club and Breezy Point Surf Club. These two districts have recently been determined eligible for the National Register and the park will likely be adding their contributing structures to the LCS in the near future. Within the park, there are buildings that may be more than 50 years of age which have not been evaluated for NRHP eligibility (Ehrler 2013).

Historic structures encompassed in LCS represent the following historic districts, with examples of building types included:

- Fort Tilden Historic District—Nike Missile installations, Taft-era batteries, post structures

- Jacob Riis Park Historic District—park structures, boardwalk, promenade, parking lot

- Fort Wadsworth Historic District—fort housing, third system and Endicott-era batteries, warehouse, Mont Sec Avenue, torpedo-storage building, seaplane hangar

- Floyd Bennett Field Historic District—hangars, garage/maintenance shop, light beacon, fire pump house, seaplane ramp, runways/taxiways

- Fort Hancock and Sandy Hook Proving Ground National Historic Landmark District—fort housing, bakery, chapel, commissary, mess halls, Sandy Hook Lighthouse and Keeper's Quarters, Spermaceti Cove Life Saving Station, power plant, Endicott/Taft-era batteries, Nike Missile installations

- Miller Army Airfield Historic District—Hangar No. 38, hangar apron, Elm Tree Light

The LCS identifies each structure by name, number, and location. Individual structure summaries include specific data on physical description, historical significance, construction materials, and function and use. Please refer to the Gateway LCS (NPS n.d.e) for additional detail on historic structures identified for the districts above.

The National Register nomination form for Breezy Point Surf Club lists 79 contributing structures, including those related to transportation (roads/parking areas) and recreation (e.g., cabanas, boardwalks and walkways, pools, cabins, showers) (NPS n.d.d). Fifteen contributing structures are listed in the National Register nomination form for the Silver Gull Beach Club, including those related to transportation (roads/parking) and recreation (e.g., clubhouse, pools, cabanas) (NPS n.d.c). (Please refer to the "Historic District" discussions for information on the context of the Gateway historic structures and to the Gateway LCS [NPS n.d.e] for specifics on each structure.)

Archeological Resources

Archeological resources in the park date primarily to later pre-contact (Woodland period) and historical periods (see "Cultural Resource Context for Gateway National Recreation Area"). Cultural manifestations include both surface and subsurface materials. Many of the archeological resources identified in earlier studies can no longer be located (NPS 2009a, 2011a, 2011b, 2011c). This is related to a variety of factors, including inaccuracy of the original recordation, the influence of natural processes (e.g., erosion), and the significant effect of landfilling operations that have occurred throughout the region in the late 19th and 20th centuries.

Pre-Contact Archeological Sites

Most of the recorded pre-contact sites in the park are described as lithic scatters, lithic/ceramic scatters, campsites, or shell middens. Most of these remain undated or are believed to date to the Woodland period. A variety of isolated finds, including a fluted projectile point believed to date to the Paleo-Indian period (NPS 2011a), have also been recovered from park lands. Occasionally, a site will reflect the use of an area during both pre-contact and historical periods (e.g., the VanDeventer-Mouquin site at Fort Wadsworth) (Louis Berger Associates, Inc. 1990; NPS 2011b). The potential for encountering pre-contact archeological resources in the future is dependent on the original sensitivity and later historical use of the area. For greater detail on pre-contact archeological resources and the potential for future discoveries throughout the park, please refer to NPS 2009a, 2011a, 2011b, and 2011c.

Historical Archeological Sites

Certain historical activities tend to leave more substantial structural remains than others (e.g., houses, sheds, foundations, fortifications). Isolated artifacts and light scatters of historical materials may receive less attention. All are considered important clues to historical use of an area and should be used to guide future investigations in the park.

Historical archeological sites recorded in the park include remnants of structures related to residential housing, military activities (forts, etc.), homesteads, and commercial activities; middens/refuse deposits; and transportation rights-of-way. While many are still evident, a considerable number have been destroyed or can no longer be located; in some cases, the area has been filled, covering the site (NPS 2011c). For greater detail on historical archeological resources and the potential for future discoveries throughout the park, please refer to NPS 2009a, NPS 2011a, 2011b, and 2011c.

Investigators speculate that additional archeological resources may be discovered associated with both domestic and military occupations of park lands. For instance, limited archeological materials may remain from 18th and 19th century occupations within the Fort Wadsworth Historic District boundaries. It is believed possible that remnants of shoreline batteries, signaling beacons, and homesteads may exist within specific areas of the district, although their integrity may be compromised (NPS n.d.b). There is also a potential for several significant historical archeological sites within the boundaries of the Miller Army Air Field

Historical archeological sites recorded in the park include remnants of structures related to residential housing, military activities (forts, etc.), homesteads, and commercial activities; middens/refuse deposits; and transportation rights-of-way.

Historic District. For instance, a Dutch settlement—Niealve Dorp, ca. 1600—was located near the present site of the airfield. A country estate on land located within the district boundaries was built in 1843 by William Vanderbilt. In 1936–1937, the Vanderbilt Mansion, water tower, and barns were razed to allow for expansion of the landing field to the west (NPS 1979c).

The potential for the discovery of additional in situ archeological resources in Gateway is influenced by a variety of natural and human factors. These include ancient and historical sea-level fluctuations, erosion and sediment transport due to tidal/wave action, and land filling/land-modification activities in the 19th and 20th centuries. All these factors affect the potential for the discovery of buried archeological resources, and their influence varies by geographic location. Although many natural coastal park areas have been buried beneath deep fill deposits, there are also areas where intact soils and archeological deposits have been recorded. For these reasons, the potential for the identification of intact archeological deposits in the park is strongly dependent on the types and effects of past and ongoing natural and human processes. The potential for discovery of archeological resources in each specific area of the park should be evaluated based on each area's unique set of circumstances.

The potential for submerged cultural resources in the study area includes both pre-contact and historic sites and historical shipwrecks.

Recent and comprehensive archeological assessments that considered the issue of the potential for archeological resources in Gateway included area-specific analyses of the sensitivity for such resources (NPS 2009a, 2011a, 2011b, 2011c). These studies have included consideration of both natural and human impacts on specific park areas, and they have speculated on where the areas of highest potential for archeological resources may be. For instance, in Fort Wadsworth (Staten Island Unit), high-potential areas include pre-contact sites on bluffs within 1,000 feet of the shoreline, 18th century structures, late 19th century batteries, pre-contact sites on bluffs and terraces in the southern and western portions of Fort Wadsworth, and others (NPS 2011b).

The sensitivity for archeological resources located within portions of Breezy Point Tip in the Jamaica Bay Unit stands in contrast to the high-sensitivity areas at Fort Wadsworth. In this second case, the recent formation of the landform and the lack of long-term historical occupation have created a situation in which the potential for archeological resources of any period is very low. The ability to predict to a limited extent the sensitivity of an area for the presence of archeological resources is an outcome of the patterned nature of human behavior. Such predictions have many uses, one of which is their use in project planning.

Submerged Archeological Resources

The potential for submerged cultural resources in the study area includes both pre-contact and historic sites and historical shipwrecks. The identification of the former categories is difficult, at best, and is related to a variety of issues such as the ever-changing beach morphology caused by sediment transport that redeposits and disturbs in situ cultural materials along the coastlines. Changes in sea level through the millennia are also believed to have made larger terrestrial areas available for pre-contact human occupation in the area, much of which is now submerged (Panamerican Consultants 2001). In addition,

significant storm-related coastline alterations (e.g., those caused by Hurricane Sandy) and numerous historical dredging activities in the larger harbor area have disturbed or obliterated resources. That said, the potential for submerged archeological deposits is noted by researchers who report the presence of over 200 artifacts, tentatively identified as ranging from the Early Archaic to Late Woodland periods, recovered along a stretch of beach in Monmouth County, New Jersey. The beach area had been recently renourished by sands dredged from an offshore area east of Sandy Hook and redeposited on the New Jersey beach (Panamerican Consultants 2001, 6).

Prior research indicates that shipwrecks dating to the Colonial period and later are known to occur in the general harbor region, with the potential to exist in waters managed by Gateway (Panamerican Consultants 2001) (see also "Maritime History" under "Historic Context"). For instance, several recent remote-sensing surveys associated with proposed projects around the Sandy Hook Unit and the Fort Wadsworth area have revealed magnetic anomalies indicating the potential for cultural materials of unknown historical significance (NPS 2004a; Panamerican Consultants 2001). A recent survey (PBS&J 2009) within the waters of Jamaica Bay, including waters under the jurisdiction of Gateway, found no significant magnetic anomalies or sonar targets that might indicate the presence of buried/submerged cultural resources. However, the authors provided information on several shipwrecks that are known to be present in waters adjacent to lands managed by the NPS. These include the *Mistletoe*, the *Black Warrior,* the *Ajace*, and the *Cornelia Soule,* all of which sank, burned, or were grounded between 1859 and 1924 (PBS&J 2009, 18). New York State also maintains a list of shipwrecks in Jamaica Bay. These submerged historic resources are also subject to disturbance from weather, development (construction of undersea utility lines, structures, etc.), and dredging activities.

Museum Collections

Gateway manages a variety of museum objects and archival materials that have been collected in the park, as well as some acquired through donations, purchases, and transfers. Museum holdings include significant cultural collections associated with local military, aviation, and maritime history; pre-contact artifacts dating back to the Woodland period; archive and manuscript collections (NPS management records, rare books); and natural history collections (NPS 2011d).

Museum collections at Gateway are currently managed under the Final Collection Management Plan (Collection Management Plan) (NPS 2009b). The Collection Management Plan was drafted prior to the impacts on museum collections resulting from Hurricane Sandy in 2012. Storm damage at Fort Hancock required that collections housed there be salvaged and transferred (ongoing) to storage areas at Fort Wadsworth. Storm-related impacts and concerns mentioned by the Incident Management Team (IMT) after the storm included the continued threats to museum collections posed by lack of climate control and potential flood-related contamination of collections (IMT 2012a). It is assumed that as the impacts of the storm become better defined, further revisions to the Collection Management Plan may be necessary. Despite the considerable effect of consolidating collections into one facility at Fort Wadsworth, in many other regards the Collection Management Plan represents the

most current information on existing conditions related to Gateway's museum collection planning and management. The majority of the following information is gathered from the Collection Management Plan.

In addition, the Scope of Collection Statement guides the management of museum collections at Gateway by defining the scope of "present and future museum collection holdings … that contribute directly to the understanding and interpretation of the park's purpose, themes, and resources" (NPS 2011d, 4). The Scope of Collection Statement is used extensively to assist the park in efforts such as historical military structure restoration and the interpretation of park resources for the public (NPS 2011d). Most of the park's museum collection objects have been acquired through donations, field collections, transfers, and purchases. As of 2012, the park had 1,953 accessions and an estimated 661,786 objects in the museum collection. Of these, 195,760 objects are cataloged.

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The Gateway museum collections represent the history and significance of important cultural resources in the park. The park manages collections associated with the following significant resources: Fort Hancock and Sandy Hook Proving Ground (Sandy Hook Lighthouse, Spermaceti Cove Life Saving Station), Fort Wadsworth, Miller Field, Great Kills Park, Jacob Riis Park, Fort Tilden, Floyd Bennett Field, Jamaica Bay Wildlife Refuge, the Breezy Point Tip, and other areas of the park (NPS 1981a, 2011d). Such collections include site-associated objects (e.g., ordnance, furnishings, weapons, coins), uniforms, aircraft, and large weapons. Significant archival collections include, among other things, materials donated by veterans who served at the various park sites, both civilian and military. Significant archeological collections include objects related to Fort Hancock and Sandy Hook Proving Ground (e.g., munitions, ordnance), Fort Wadsworth (objects related to past military/community life at the fort), and Miller Field.

The natural resource collection is divided into three disciplines: biology, geology, and paleontology. The purpose of the collection is "to support scientific research, resource management, and education; provide baseline data of park natural resources; document changes these resources are undergoing because of internal park conditions and external effects; provide a database for researchers concerned with resource use by the park's pre-contact occupants; preserve important or locally significant species collected in response to specific research or interpretive needs; to guarantee the protection of specimens whose in-situ preservation cannot be assured" (NPS 2011d, 10).

Gateway's museum collection began in 1968 at Fort Hancock (Fort Hancock and Sandy Hook Proving Ground) and became the focus of the Sandy Hook Unit collection when the U.S. Army transferred the fort to the NPS in 1972. Fort Hancock remained the main storage location for the park's collection of objects, archives, archeological collections, and other items. In 1995, the NPS gained possession of Fort Wadsworth (Staten Island), where additional collections were then housed. Prior to being stored at Fort Wadsworth, collections were also stored at Floyd Bennett Field. Before Hurricane Sandy hit the area in 2012, collections at Fort Hancock were curated in three storage locations (Buildings 32, 47, 125), whereas Fort Wadsworth used two locations (Building 210 basement and Building

210 first-floor storage). None of these storage locations was considered large enough to accommodate the current museum collection and its potential growth, and none was used solely for the storage of museum objects (NPS 2009b, 86).

When Hurricane Sandy hit the New Jersey/New York coastline in the fall of 2012, its impact (storm surge, wind, etc.) seriously jeopardized the collections at Fort Hancock. The Sandy Hook Unit of the park sustained considerable storm damage and the most sensitive collection materials were salvaged from Fort Hancock and taken to Fort Wadsworth to ensure their preservation. Collections at both Fort Wadsworth and Floyd Bennett Field were not seriously impacted by the storm. It is tentatively planned for rest of the Fort Hancock collections to be moved to Fort Wadsworth permanently (Mahan, pers. comm. 2013a). New challenges for appropriate storage space exist today with the recent consolidation of these materials.

The Gateway museum collections are purposefully "evaluated for their contributing value to the park's resources based on the park's enabling legislation, the park's mission statement, the sites' National Register documentation, and established themes developed in park planning documents such as the Long-range Interpretive Plan" (NPS 2009b, 14; 2004b). The primary themes identified in the Long-range Interpretive Plan and included in the Collection Management Plan (NPS 2009b) include the following:

- The Wonders, Dynamics, and Challenges of an Urban Estuary
- Fighters, Falcons, Monarchs, and Missiles: A Heritage of Flight
- From Colonial Outpost to World Power: The Changing Nature of National Defense
- Immigrants to Presidents: Symbols and Stories of the American Odyssey
- Shaping the Modern World: Innovations in Health, Recreation, and Transportation

In the Collection Management Plan, the park staff has examined a variety of issues important to the adequate preservation of museum collections. Summaries of existing conditions related to specific issues and upon which recommendations are presented in the Collection Management Plan, are summarized below. Please see NPS 2009b for detailed recommendations addressing each issue.

Scope of Collection Statement. Use new Scope of Collection Statement guidelines and periods of significance as filters for accepting new collections; deaccession collections that fall outside of the Scope of Collection Statement or that were accessioned in error; and work with the Resource Management Division to establish and maintain collections related to each unit of the park.

Museum Records. Among other things, address staff training, standardization of cataloging protocols, and resolution of existing problems related to artifact cataloging and descriptions.

Use of and Access to Collection. Research and registration forms are being successfully used to access collection storage areas. Expand use of all NPS researcher registration forms and establish a dedicated research space for museum collections. Improve accessibility of

The Gateway museum collections are purposefully "evaluated for their contributing value to the park's resources based on the park's enabling legislation, the park's mission statement, the sites' National Register documentation, and established themes developed in park planning documents such as the Long-range Interpretive Plan."

resource management records for researchers. Accessioning and processing of archival collections currently in curatorial custody should be accomplished under the guidance of a professional archivist.

Archives and Manuscript Collections. Establish a clear direction for management of park archives and manuscript collections. Archival materials not cataloged into the museum collection are constantly at risk. Use cataloging methods that will clarify contextual information, how items are associated, why they are significant for the park, and why/how they came to be curated by the park. The addition of a professional archivist would aid in conducting an overdue appraisal with the National Archives and Records Administration to ensure that NPS and other agency records can be examined holistically by provenance.

Archeology Collections. Duplication of archeological records has occurred in some instances but the overall effort to accession and document these materials has improved. The collections can continue to enhance the quality of museum exhibits and educational and interpretive programs. A complete survey of these materials is greatly needed to identify museum-quality objects. Attaching photographs to their electronic catalog records will make these materials more accessible to staff and researchers. Additional cataloging and rehousing of the collection is necessary to improve the current storage conditions and at the same time, a survey can be completed.

Collection Storage. The NPS Service-wide Storage Plan (2006c) recommends upgrading the existing facilities at Fort Wadsworth to improve climate control and to consider as an option for infrequently used collections from other area parks. Portions of the summary of this issue as presented in the Service-wide Storage Plan and the Collection Management Plan are outdated because the description of the Fort Hancock storage areas has changed so dramatically. The damage to Fort Hancock caused by Hurricane Sandy required some sensitive collections housed there to be moved (ongoing) to Fort Wadsworth on Staten Island, and the park currently plans to house all collections there for the foreseeable future (Mahan, pers. comm. 2013a). It is also expected that the recommendations for collection storage at Fort Wadsworth will be revised due to the transfer of collections from Fort Hancock. Both plans ultimately suggest the need to work within the ongoing general management plan effort to identify and evaluate feasible long-term alternatives that address the need to consolidate the Gateway collections.

Exhibits. The preservation focus is on the exhibition of textiles and paper-based objects; the substitution of high-quality color photographs for paper-based objects, when appropriate; the rotation of textile items on exhibit for more than six months; the monitoring of objects; and the maintenance of a list of all exhibit items on a biannual basis.

Curatorial Staff. Several positions need to be created in the Resource Management Division to improve the curatorial program and records management. In addition, there is a need for training designed to improve the quality of the program. Park management should provide overall guidance and ensure that funding and resources are prioritized appropriately.

Funding and Programming. NPS-wide programs maintain a five-year funding cycle; it is important that Gateway projects be submitted and programmed to these multi-year lists. The park should improve the updating and revising of the Annual Checklist Program to reflect existing conditions for museum collections. Additional staffing is a critical need.

Visitor Use and Experience

Spanning three New York City boroughs and the northernmost portion of the New Jersey shore, Gateway's park lands stand in sharp contrast to the nearby metropolitan area and offer abundant opportunities for residents and visitors to recreate and experience nature and historic settings. Natural areas; water, beaches, and coastal views; historic coastal defense and maritime structures; diverse recreation opportunities; and educational and interpretive programming combine to create rich and varied visitor experiences at Gateway.

The Gateway lands and waters serve many millions of visitors a year, making Gateway an important urban park environment on the East Coast and in the New York and New Jersey Metropolitan area.

Visitor Use and Characteristics

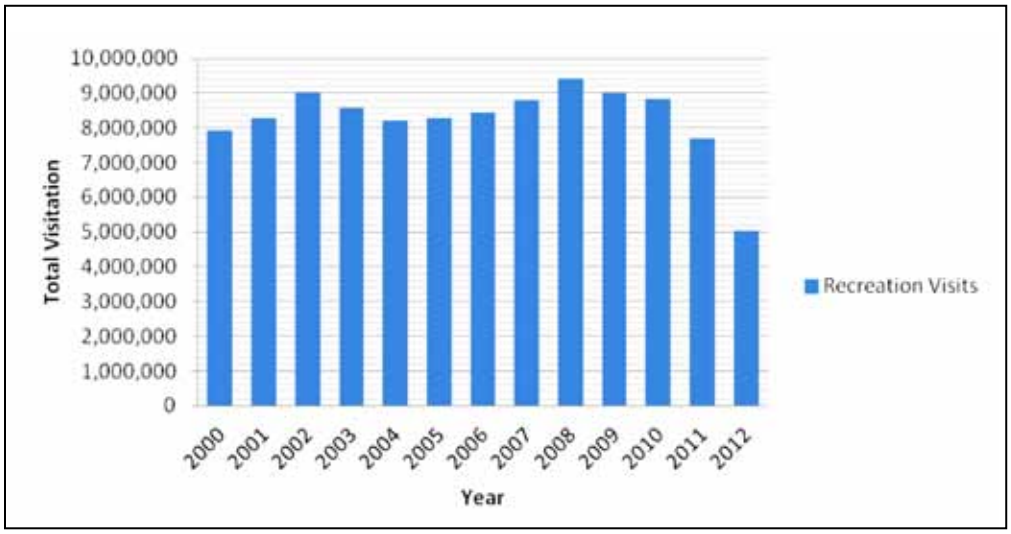
To inform the general management planning effort for Gateway, in 2009 the NPS commissioned Pennsylvania State University's Department of Recreation, Park, and Tourism Management to synthesize findings from past visitor studies and analyze areawide demographics characteristics and projected trends (Mowen, Graefe, and Graefe 2009). Relevant visitor characteristics from the Pennsylvania State University synthesis are summarized in this section (see the "Visitation Patterns" section in this chapter) along with park visitation statistics reported on the NPS Integrated Resource Management Applications portal (NPS 2013c, 2013d).

The Gateway lands and waters serve many millions of visitors a year, making Gateway an important urban park environment on the East Coast and in the New York and New Jersey Metropolitan area. Encompassing 27,025 acres of land and water in New York City and New Jersey, the three units of Gateway form an expansive public green space for both the local urban population and tourists to enjoy.

In 1974, the first year that the park reported visitation, Gateway had over 3.8 million visitors. Substantial increases and a few intermittent decreases have occurred since then, but annual visitation has remained around 9 million total visitors over the last 10 years (NPS 2013c) (figure 3-14 on next page).

Gateway recreation visitation typically ranks it within the top five parks in the national park system (NPS 2013c). Many of the sites in Gateway are in the "backyard" of New York City and New Jersey residents, who use the park lands for recreation and exercise. At most park sites, people from the local area account for the majority of visitors. A review over the last five years indicates that visitor use levels peak in the summer months, decrease in the fall, and are lowest in the winter and spring.

Figure 3-14. Gateway Recreation Visitation by Year (2000-2012).

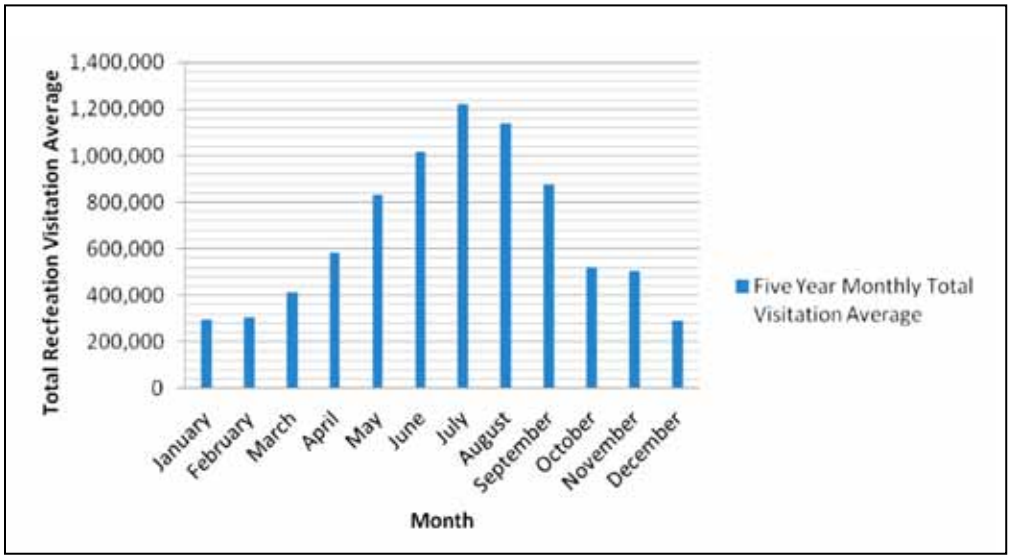


Source: NPS Public Use Statistics Office.

Note: Storms impact visitation numbers. Hurricane Irene in 2011 impacted visitation, and Hurricane Sandy in 2012 caused the park to close for just over two months.

The weather patterns along the northeastern seaboard are the largest influence on these demand fluctuations because visitor demand is tied to outdoor recreation activities (NPS 2013d) (see figures 3-14 and 3-15). This seasonal visitation pattern is reflected in the highest beach use occurring in the summer through early fall. Interpretive and Education and Visitor Services park staff focus on the pulses of school group programming, which typically occur in the spring and fall, with youth group visitation in summer. In addition, at the Jamaica Bay Wildlife Refuge, the spring and fall bird migrations typically result in visitation increases.

Figure 3-15. Gateway Recreation Visitation By Month (2008-2012) Five-Year Average.



Source: NPS Public Use Statistics Office

Annual Visitation

Since 2000, annual recreation visitation has fluctuated between 5 and 9.4 million, typically hovering between 7.7 and 9.4 million (figure 3-14). Recreation visitation has been selected as the more appropriate element to measure since it relates to individuals visiting the park for the purpose of recreation visits. Non-recreation visitation includes suppliers and vendors traveling in and out of the park for non-recreation purposes. Visitation in 2012 was only 5 million because of park closures (November 2012–December 2012) due to Hurricane Sandy that resulted in unusually low visitation in the last quarter of the year. For example, in December 2012, total visits were down 96 percent from December 2011; annual park visitor numbers were down 40 percent from 2011 totals. Additionally, in 2011 Hurricane Irene impacted visitation levels. Subtracting the 2012 visitor numbers, annual visitation since 2000 has averaged 8.5 million. Interestingly, in the park's early years of establishment between 1975 and 1986, annual visitation averaged 8.9 million, so no substantial change in annual visitation has occurred over the course of the park's 38 years (NPS 2013c).

Seasonal Visitation

Summer is when the most people visit Gateway, with July and August typically being the park's busiest months. The spring and fall also see high visitation, and then numbers begin to taper off in November through February, with the quietest time during January (NPS 2013d).

Visitation Patterns

The last parkwide visitor study conducted at Gateway was the *Gateway National Recreation Area General User Study* administered by the NPS Cooperative Park Studies Unit in 1991 (NPS 1991). Although efforts were made to survey visitors across all three park units, a majority of survey respondents were from the Sandy Hook Unit (59 percent), Great Kills (20 percent), and Jacob Riis Park (16 percent). Thus, overall study findings should be considered with this setting bias in mind. The 1991 survey revealed the following characteristics of the Gateway user:

- The average age was 43.7 years, with 46 percent under 30 years old.
- Most visitors were in larger groups, with an average of 5.9 people per group.
- Only 17 percent visited these Gateway units alone.
- Over the past 12 months, 36 percent visited 10 or more times and 25 percent visited only 2 to 4 times.
- Approximately 60 percent of respondents visited for two to five hours and were more likely to report visiting with family (39 percent) than with friends, friends/family, or alone.

The 2003 *Floyd Bennett Field Visitor Study* revealed additional information on the patterns and characteristics of Gateway visitors (NPS 2003a). Although study results and the visitation patterns they reveal are specific to Floyd Bennett Field, it is worth noting that the study's findings are consistent with future projections identified in the NPS Northeast Region's visitation trends report (Godbey et al. 2001).

The *Floyd Bennett Field Visitor Study* assessed race/ethnicity and found that a majority of visitors were White (82 percent), but a sizable minority was African-American (15 percent) or Hispanic (9 percent). The study showed frequent visitation to Floyd Bennett Field, with 47 percent visiting 21 or more times in the past 12 months and 53 percent reporting that they visit once a week. Visitors tended to arrive at midday (68 percent). A majority (56 percent) stayed four or more hours during their visit and visited in small groups of one to two people (72 percent). Floyd Bennett Field was more likely to attract single visitors or groups composed of friends only (versus friends/family, family) (NPS 2003a).

In 2007, the National Parks Conservation Association (NPCA) commissioned an online poll of New York City residents' awareness of, use of, and attitudes toward Gateway. This poll was conducted by Zogby International, Inc. (Zogby) and targeted a broad sample of New Yorkers who were both park users and nonusers. The NPCA/Zogby study revealed that nearly half (47 percent) of New York City area residents were unaware of Gateway, and 39 percent had never visited the park. Forty-four percent of New York City area residents who had visited Gateway evaluated the park facilities as below average in comparison to other national parks, particularly regarding restrooms, beaches, historic buildings, and trails (NPCA 2007d). When asked why they rated Gateway lower, respondents commonly noted dirty water, limited recreation opportunities, poor beaches, dirty bathrooms, poor facility conditions, and overcrowding. This poll also found that a majority of respondents (63 percent) believed that Congress and the Administration should increase the federal budget to benefit Gateway and agreed that both the city and state should also help fund restoration efforts at Gateway (53 percent) (NPCA 2007d).

The Pennsylvania State University research team used data from this online poll to create a general picture of both Gateway user and nonuser characteristics. The Pennsylvania State University research team compared socio-demographic characteristics of poll respondents who said that they had recently visited Gateway ("Recent User"—less than five years ago), had visited Gateway a long time ago ("Lost User"—more than five years ago), and who had never visited Gateway ("Never User"). Results of this analysis revealed that Gateway Never Users were more likely to be younger (18 to 29 years) (table 3-7). This finding is consistent with the general observations made at the Gateway staff workshops. At the same time, however, the 50- to 64-year-old baby boomer respondents were more likely than other age groups to have visited Gateway more than five years ago (Lost Users) (Mowen, Graefe, and Graefe 2009).

User comparisons also revealed that females were much more likely than males to be Never Users, whereas males were much more likely than females to be Recent Users (table 3-7). Low-income households (under $35,000 annually) were more likely to be Never Users, whereas middle- and higher-income households were more likely to be Recent Users (table 3-7). Finally, African-Americans were more likely than other race/ethnic groups to be Gateway Never Users, Asians were more likely than other race/ethnic groups to be Recent Users, and respondents from the Other race category were least likely to be Recent Users. These results indicate that strategies to attract and appeal to females, African-American residents, younger adults, and low-income people should continue and expand if Gateway is to be relevant to future New Yorkers (Mowen, Graefe, and Graefe 2009).

Table 3-7. Demographic Comparison of Gateway Never, Recent, and Lost Users.

Demographic Characteristic	Never Visited (Never Users)	Visited More than 5 Years Ago (Recent Users)	Visited within the Last 5 Years (Lost Users)
Age Group			
18–29	55.5%	5.8%	38.7%
30–49	43.0%	19.7%	37.3%
50–64	33.9%	30.0%	36.2%
65+	38.2%	31.4%	30.4%
Sex			
Male	33.0%	23.4%	43.7%
Female	47.6%	24.1%	28.3%
Household Income			
$0–$34,999	61.0%	24.0%	15.0%
$35,000–$74,999	45.4%	18.9%	35.8%
$75,000 or Greater	33.1%	28.1%	38.8%
Race/Ethnicity			
White	39.5%	23.5%	37.0%
Hispanic/Latino	39.4%	33.0%	30.3%
African-American	48.2%	24.1%	27.7%
Asian	42.9%	0.0%	57.0%
Other	44.1%	35.3%	20.6%

Source: NPCA 2007d.

Visitor Experience and Recreation

Gateway offers a wide array of recreational opportunities and programming throughout the year. Interpretive and recreational offerings range from ecology walks and kayak lessons to history tours and urban camping. The park's trails and natural areas invite self-guided exploration and discovery of the habitats and historic resources, whereas the Gateway beaches present opportunities for relaxation and retreat from the more congested urban environs that surround the park. Finally, the park's athletic fields, picnic facilities, and playgrounds provide community-based recreation opportunities and attract neighboring residents into the park.

From their 2009 synthesis of visitor survey data, the Pennsylvania State University research team found that the most popular recreational activities at Gateway were swimming, picnicking, fishing, bicycling, sunbathing, walking/hiking, gardening, birding, and visiting historic sites. Activity trends identified by Gateway staff are increases in walking (including dog walking), bicycling, fishing (including net fishing), and special events, and decreases in sunbathing (Mowen, Graefe, and Graefe 2009). Recreational activities that were frequently cited as "favorites" during public scoping included boating, fishing, kayaking, biking, swimming, hiking, birdwatching, canoeing, crabbing, exploring, wind surfing, scuba diving,

historic ship viewing, and sightseeing (NPS 2012b). Introduced in all three units in the summer of 2011, camping is also emerging as an increasingly popular park recreational use.

The visitor survey cards collected during 2006 to 2008 by each unit showed that overall, the highest satisfaction lies with recreational services (such as learning about nature, history, or culture; outdoor recreation; and sightseeing), at 85 percent, followed by visitor services (such as assistance from park employees, park maps/brochures, and ranger programs), at 79 percent (Mowen, Graefe, and Graefe 2009). The survey also showed that 75 percent of respondents were satisfied with facilities (such as visitor centers, restrooms, walkways/trails, and campground/picnic areas).

The multiple types of recreation opportunities and visitor experiences available at Gateway are described below.

Trails and Opportunities for Exploration, Adventure, Discovery, and Solitude

Trails are a significant part of the park and offer many recreation opportunities. Trails open up Gateway park lands for recreational use and facilitate the exploration and enjoyment of the park's natural habitats, coastal defense resources, and maritime resources. Approximately 33 miles of official NPS trails at Gateway, which range from paved surfaces to single-track paths, provide walker and hiker access to and through the park's developed and natural areas. With little elevation change, most trails are easy to moderate in terrain and from 0.1 mile to 6 miles in length. Although some trails are heavily used and traverse developed areas, others provide backcountry-like experiences where visitors venture into relatively remote areas and encounter few if any developed facilities. Portions of Gateway's trails are open to bicycles, including the 6.1 miles of multi-use paths at Sandy Hook.

Water-based Recreation

With all its park lands bordering a water body and two-thirds of the park's 27,025-acre area covered in water (17,500 acres), Gateway offers an abundance of water-based recreation opportunities, including fishing, scuba diving, boating, swimming, surfing, and wind sports such as kite boarding, sailing, and windsurfing. Nearly every park site in Gateway provides fishing access. Additionally, there are many hand-launch sites for kayaks, canoes, and other small non-motorized watercraft. Water-based recreation programming includes seining programs, canoe and kayak tours, boat tours, and sailing classes.

Beaches

Beaches play an important role in recreational activities for visitors in the park. Guarded swim beaches at Sandy Hook, Great Kills Park, Jacob Riis Park, and the Breezy Point Surf and Silver Gull Beach Clubs provide places for visitors to walk, jog, sunbathe, picnic, surf, and swim. Visitation to these beaches is highly weather dependent, with the heaviest use occurring during the summer months. Unguarded beaches at Fort Wadsworth, Miller Field,

Fort Tilden, Breezy Point Tip, and Plumb Beach offer a more natural visitor experience and provide opportunities for fishing, wind sports, beach walks, surfing, and nature study.

Marinas

Gateway has two marinas, both of which are concession-run recreation facilities: Nichols Marina in Great Kills Harbor at Great Kills Park and Gateway Marina in Dead Horse Bay at Floyd Bennett Field. The Nichols Marina was extensively damaged by Hurricane Sandy, but the NPS has committed to reconstructing a marina at Great Kills Park. Both marinas accommodate motorized and non-motorized watercraft and offer dockage as well as boat storage. Overnight stays at the marinas are prohibited.

The Rockaway Yacht Club on the inlet side of Fort Tilden is currently operated under a lease and is not open to public recreation.

Camping

In 2011, camping opportunities were expanded across the park, and camping is now offered as an overnight recreational use in all three park units. With only 87 campsites parkwide, camping opportunities at Gateway are limited compared to camping at more distant and remote national parks. However, the opportunity Gateway affords to camp in the New York City metropolitan area is a unique recreation experience.

Three varieties of camping experiences are offered at Floyd Bennett Field and include programmatic camping at Ecology Village, walk-in tent camping at Goldenrod and Tamarack Campground (40 sites), and recreational vehicle (RV) camping at an RV park (20 sites). On Sandy Hook and Staten Island, walk-in tent camping is offered at Camp Gateway (20 sites, on Sandy Hook) and Camp Hudson (7 sites, on Staten Island). Walk-in campsites typically include a picnic table, grill, and fire ring.

Because Fort Wadsworth's Camp Hudson opened on July 6, 2011, approximately half the campsites were occupied during the week throughout July 2011. Weekends were completely booked, as was the entire month of August. Although more than half the visitors to Camp Hudson are local, the small site has attracted visitors from all corners of the globe, thanks in part to Reserve America (a free iPhone application) and to Frommer's travel guide, *NYC Free & Dirt Cheap* (NPS 2012a).

Picnicking

Visitors enjoy opportunities for picnicking at designated picnic sites in Gateway parks. Group picnic facilities are offered at Guardian Park at Sandy Hook, Miller Field, Jamaica Bay Wildlife Refuge, Frank Charles Memorial Park, Canarsie Pier, Fort Tilden, and Jacob Riis Park.

Additionally, picnicking on the beaches is common during the summer months.

Community Gardening

Community gardening is a current recreation use at Miller Field, Fort Tilden, and Floyd Bennett Field. Each park unit has a community garden with several plots. The community garden at Floyd Bennett Field is very large, at 7.5 acres, whereas the 2-acre garden at Miller Field hosts 100 plots and the garden at Fort Tilden is only 0.5 acre.

Concession-operated Recreation

Several concession-run recreation facilities operate in the park. These include two beach clubs on the Rockaway Peninsula, the Riis Park Pitch-n-Putt at Jacob Riis Park, and the Aviator Sports Complex and driving range at Floyd Bennett Field. As mentioned earlier, Gateway's two marinas are also operated by concessioners.

Equestrian Use

Bergen Beach is distinguished as the only area in the park that offers equestrian use. Operated by a concession, the Jamaica Bay Riding Academy at Bergen Beach features an arena and stables as well as trails. People currently board horses at Bergen Beach (approximately 100 horses) and there is limited equestrian programming.

Athletic Fields and Community-based Recreation

Both the Staten Island and Jamaica Bay Units contain parks with athletic fields, courts, and playgrounds that support a substantial amount of community-based recreation such as sports leagues and tournaments. Community-based recreation is a popular recreational use, and during public scoping many people showed support for continuing organized sports leagues and for community groups using park buildings.

The major athletic field complex at Gateway is at Miller Field. With over 30 playing fields, the park sees intensive community use and can attract 10,000 to 15,000 young people over a weekend. Smaller field complexes and court facilities (including paddle tennis, basketball, handball, and shuffleboard) are in Frank Charles Memorial Park, Hamilton Beach Park, and Jacob Riis Park. Traditional playground equipment can be found at Canarsie Pier, Miller Field, Great Kills Park, and Jacob Riis Park.

The Great Kills Park community-based recreation facilities have been closed since 2010 because of the discovery of radium and ongoing cleanup efforts. (For more about the Great Kills Park closure, see the "Health and Safety" section in this chapter.)

At Fort Tilden, the Rockaway Little League leases a clubhouse and land (five ball fields and one multipurpose field) at Fort Tilden to conduct Little League activities. Community groups also use buildings at Fort Tilden to host community activities and art programming. Additionally, there are rugby and soccer fields at Fort Tilden that are used by the public.

Opportunities for Visitors with Disabilities

The NPS is committed to implementing all practicable efforts to make NPS facilities, programs, and services accessible and usable by all people, including those with disabilities. Accordingly, most administrative offices and visitor contact stations; some trails, campgrounds, and fishing access; and most interpretive and visitor service facilities are accessible. Recreation facilities in undeveloped areas, outside the immediate influence of buildings and roads, have typically not been modified to be universally accessible.

Use Permits and Reservations

Although Gateway does not have an entrance fee, many of the recreation uses require permits. Fishing parking permits are required for some fishing sites in the Staten Island and Jamaica Bay Units and for all-night fishing on Sandy Hook. A fee of $50 is collected for each fishing parking permit issued. These fees are used to offset the costs of administering the permitting program. The permit is valid for the calendar year in which it is issued. Additionally, there are beach parking fees at Jacob Riis Park and Sandy Hook.

Special-use permits are required by the NPS for several other recreation activities in addition to fishing, including the following: parking (beach, surfing, off-road, nature study, and archery), public camping, youth group camping and programs, overlook, picnics, ceremonies, athletic fields, gardens, facility, special events, after-hours park access, filming, photography, and other activities.

Visual Quality: Scenic Natural and Historic Settings

Nature study / wildlife observation and discovering historic sites are two recreation opportunities at Gateway that are associated with the park's scenic qualities.

The open, natural spaces and historic settings preserved in Gateway are a dramatic contrast to the surrounding city environment and provide an attractive location for the park's many recreational uses. During scoping for this plan, the public expressed appreciation for the scenic qualities of the park and the quiet and solitude that they offer. The importance of maintaining access to the park's diversity of natural landscapes and preserving the opportunity to experience nature and view wildlife and native plants was also noted.

Nature Study

Wildlife observation is a prevalent recreation activity for visitors in all three units, with the most popular wildlife observation or nature study activity being birding. Opportunities for watching wildlife and taking in natural scenes are available throughout the park from trails, blinds, park roads, and the water. Urban naturalists and birders seek diverse habitat in the park to maximize the number of species seen, typically looking for places that offer access to different ecosystems. In particular, the Jamaica Bay Wildlife Refuge and Sandy Hook are the most popular destinations for naturalists and birders. Jamaica Bay is an international destination for birders. Jamaica Bay Wildlife Refuge, Sandy Hook, Floyd Bennett Field, and Fort Tilden include trails through natural areas and viewing blinds or other observation facilities that help facilitate and encourage nature study.

Discovering Historic Sites

Learning about the area's history is also an important part of the Gateway visitor experience tied to the park's scenic and preserved historic settings. Cultural resource–based recreation opportunities include self-guided exploration and discovery of forts and batteries along trails as well as the guided tours and programming.

The opportunities to "discover" historic structures and view signs of military and maritime history enrich the visitor experience at several Gateway park sites. At Fort Wadsworth, Fort Tilden, and Sandy Hook, for example, visitors can follow a trail from the more popular areas of the park into the backcountry and find themselves alone in the presence of impressive batteries and fortifications. Some of the more visible and prominent structures, such as Battery Weed and Fort Tompkins, are interpreted on site with signs and overlooks, whereas others, like Battery Harris East and Battery Kessler at Fort Tilden, have no interpretive signs and therefore carry a bit of mystique to the visitor trying to determine their role in defending New York City.

Night Skies

Section 4.10 of NPS Management Policies 2006 (NPS 2006a) recognizes that the natural lightscapes of parks are a natural resource and value that exist in the absence of human-caused light. As such, the NPS is directed to preserve this resource and value to the greatest extent possible. The natural lightscape of a park plays a role in natural resource processes and affects biological behavior, as well as being a feature that contributes to the visitor experience. Viewing of the night sky is an important aspect of visitor experience in Gateway and "darkness and night sky" is recognized in this GMP/EIS as one of the park's fundamental values.

Given its context in the New York City metropolitan area, the park's night sky visibility is affected by light pollution from the urban environment throughout the park; however, the light pollution is dissipated in the more remote reaches of the park. For example, Sandy Hook night skies are less impacted by human-caused light sources than those of the Staten Island and Jamaica Bay Units due to Sandy Hook being more distant from New York City and urban development.

While completely natural night skies are not obtainable given the surrounding urban environment of New York City, many of Gateway's park sites do offer relatively dark night skies, where the overnight or evening visitor can experience night skies in a natural setting with only dim and distant artificial lights. In the interior and/or more remote sections of the following park lands, artificial light sources do not impair night sky viewing opportunities: Sandy Hook, Great Kills Park, Breezy Point Tip, Fort Tilden, Jamaica Bay Wildlife Refuge, Bergen Beach, and Floyd Bennett Field. Currently, astronomy programs that draw audiences to appreciate the park's night sky are incorporated into programming at Floyd Bennett Field's Ecology Village and at Great Kills Park.

Sources of artificial lighting in the developed areas of the park that intrude into the natural lightscapes include but are not limited to lit building entrances, operations and maintenance structures, parking lots and pathways lit as necessary to meet safety requirements, the lighthouse at Sandy Hook, night lighting at the Riis Park Pitch-n-Putt course, and lights at the Great Kills and Gateway marinas. Where possible, the park does use dark-sky-compliant lighting.

Soundscapes

The NPS mission addresses the protection and enhancement of acoustical environments and soundscapes. A soundscape can be defined as the human perception of acoustic resources (i.e., physical sound sources). The acoustical environment is the combination of all the acoustic resources within a given area. This includes natural sounds and cultural sounds, as well as non-natural human-caused sounds. Gateway's fundamental values include "Feelings associated with open space in a high-density area" and "Direct sensory experience with natural elements," both of which are affected by the acoustical environment (NPS 2012b). In an urban environment like Gateway, the acoustical environment and soundscapes fluctuate with the numbers of visitors who introduce human-caused sounds into the environment and with surrounding land uses.

The soundscapes of Gateway park lands, especially on their coastal edges and in their interiors, are less noisy than the park's urban surroundings.

The NPS is required to preserve, to the greatest extent possible, the natural soundscapes of parks. NPS *Management Policies 2006* (Section 4.9, "Soundscape Management") and Director's Order 47: *Soundscape Preservation and Noise Management* (NPS 2006a, 2000), recognize that soundscapes are a park resource and state that the NPS is to restore degraded soundscapes to natural conditions whenever possible and protect natural soundscapes from degradation due to noise (i.e., undesirable human-caused sound). In addition, the NPS recognizes the value of cultural soundscapes, which play an important role in connecting park visitors to the history and heritage of NPS cultural resources. NPS Management Policies 2006, Section 5.3.1.7, states, "[t]he Service will preserve soundscape resources and values of the parks to the greatest extent possible to protect opportunities for appropriate transmission of cultural and historic sounds that are fundamental components of the purposes and values for which the parks were established" (NPS 2006a).

The soundscapes of Gateway park lands, especially on their coastal edges and in their interiors, are less noisy than the park's urban surroundings. Noise is generally defined as unwanted or objectionable sound that alters or disturbs quality of life or communication. It also affects physical health if it is very loud or continuous. Most environmental noise, particularly in urban areas, consists of a variety of frequencies of common, distant noises that create relatively constant background noise levels. In New York City, the primary source of noise in most areas is traffic (NYCPC 2013). Average decibel levels in the region range between about 60 and 74 A-weighted decibels (dBA), but can fluctuate from as low as about 55 dBA to as high as 84 dBA (NYCPC 2012, 2013). Comparable sound levels are human conversation, 60–65 dBA; a heavy truck passing at 15 meters (80–90 dBA); or background noise in an office (50 dBA) (Cowan 1994). Periodic loud noises, such as construction sounds, horns honking, road noise, trucks driving by, or low-level aircraft, are easily perceived above background noise levels. Many of Gateway's natural areas offer a unique opportunity to find a relatively quiet place amid a loud urban soundscape.

Acoustical environments include natural, cultural, and human-caused sounds. Natural soundscapes include all naturally occurring sounds, such as birdcalls or thunder. They also include the "natural quiet" that occurs in the absence of human-caused sound. The opportunity to experience natural sounds and quiet is a fundamental part of visitor experience at Gateway.

The most common human-caused sources of noise at Gateway are listed below. Some of these sound sources, such as watercraft and operational noises, temporarily impact the acoustical environment. In contrast, the sounds of streets and human voices are part of the acoustical environment of an urban park, such as Gateway.

Watercraft. Noise from motorized watercraft and other vessels on Gateway's waters, as well as ship noise, can be heard at the park. These noise sources include the Staten Island Ferry horn, which is particularly acute at Fort Wadsworth.

Vehicles. The busy thoroughfares, traffic patterns, and city streets surrounding Gateway's park lands generate sounds such as honking, emergency vehicle sirens, road noise, road construction, and trains. The Verrazano-Narrows Bridge is a significant source of transportation noise at Fort Wadsworth.

Aircraft. Commercial airplanes fly low over several of the Jamaica Bay park lands as they approach and departure from John F. Kennedy International Airport. This noise is particularly loud on the waters of Jamaica Bay and at the Jamaica Bay Wildlife Refuge. Commercial helicopter flights also fly low over several areas of park lands and impact the park experience. In addition, banner planes advertise along the beaches and impact the natural beach soundscape.

Airports and Development. As airports seek to enhance their services and facilities, the interface between national parks and airport areas increases.

Human Voices. The voices of people recreating and picnicking, as well as associated sounds of human use, including radios, can be heard throughout the park. Popular recreation destinations like Miller Field and Jacob Riis Park tend to be crowded with visitors and this activity amplifies the sound of human voices. These noises are also intensified during special events hosted on the park lands (e.g., tournaments at Miller Field, the New York Marathon at Fort Wadsworth).

Park Operations and Maintenance. Temporary sounds from park operations and maintenance include lawnmowers, construction, heavy machinery needed for natural resource restoration projects, generators, and the park's and partners' trucks.

Human-caused noise is perceptible throughout most of the park lands in the Staten Island and Jamaica Bay Units and to a significantly lesser degree in the more remote Sandy Hook Unit. These human-caused noises, however, dissipate as one moves into the interior of most of Gateway's park lands, and the sounds and quiet of the natural soundscape become

apparent. The coastal edges of Gateway's park lands, in particular, are soundscape "havens," where the natural soundscape is perceptible and the noises of the urban surroundings is diminished.

The peninsula of Sandy Hook is isolated and is, therefore, a place almost free of human-caused sounds in Gateway. Away from visitor facilities, crowded beaches, and Hartshorne Drive, most of the sounds heard are natural and include waves, wind, and birdcalls. At the campground, in recreation areas on the bayside, on northern beaches (e.g., North Beach and Gunnison Beach), and along the multiple use paths, the natural soundscape predominates and there are few human-caused sounds other than human voices. Although there is more activity at Fort Hancock and the sounds of other visitors, cars, and the ferries create human-caused noise, it is still a relatively quiet environment where visitors can appreciate the natural soundscape.

In the Staten Island and Jamaica Bay Units, the quietest places where visitors can retreat from the noises of the urban surroundings include Crooke's Point at Great Kills Park, Breezy Point Tip, Fort Tilden, Jamaica Bay Wildlife Refuge, Bergen Beach, and Floyd Bennett Field's North Forty area.

Education, Interpretation, and Understanding

In addition to the recreational opportunities throughout the park, Gateway offers varied experiences to visitors through interpretation, education, and stewardship programs, including the only overnight tent camping program in New York City for school and youth groups. The Gateway Interpretation and Education Division manages various interpretive and educational activities for individuals, youth, school groups, and families, which are designed to illuminate and build appreciation for Gateway's history and ecology. The interpretation and education division is responsible for connecting people to the park and is heavily engaged in community outreach. Educational and interpretive programs are developed to encourage more enjoyment of park resources and facilitate a greater appreciation of the cultural and historical significance of the park setting and historic structures, located strategically at the entrance to New York Harbor. Programs offered by the park and its partners range widely from living history reenactments to ranger-led wildlife observation walks to lantern tours of the coastal defense forts.

In addition to the recreational opportunities throughout the park, Gateway offers varied experiences to visitors through interpretation, education, and stewardship programs, including the only overnight tent camping program in New York City for school and youth groups.

The Gateway interpretive and educational programs were noted and supported during public scoping. It was suggested that programs and activities should target a wide range of ages, from youth to senior citizens, and should be offered throughout the day and the year to accommodate different schedules. Several people suggested that expanding the number of partnerships with local educators and educational institutions, nonprofit groups, community organizations, and interest groups would increase the capacity of Gateway's educational programming. In the Sandy Hook Unit, there are several partners who provide the majority of education programs, and similar arrangements would be desirable in the Jamaica Bay and Staten Island Units.

Pre-visit Information and Orientation

According to anecdotal information collected by park staff, most visitors to Gateway rely on information from friends and relatives who have been to the park, the Internet, and the park website. The park website contains helpful trip planning information, including directions, operating hours, fees and reservations, description of park activities and recreational opportunities, photos and media, background information and interpretive media, photos and multimedia, downloadable maps, and general park management news. Additionally, the park website is updated regularly and is a valuable source of information during park alerts and/or closures due to adverse weather conditions.

Entrances to Gateway parks are signed, but sign design is not consistent across the park and signs are not always clearly visible. Because of poor wayfinding and a lack of NPS visibility at parks like Fort Wadsworth, visitors not familiar with the area or with Gateway often become confused and disoriented. The park is trending toward using new methodologies and technologies such as Quick Response tags and other mobile phone technologies to better inform visitors and potential visitors.

Park bulletin boards and information kiosks throughout the park include standardized "You Are Here" map boards and information about Gateway and the particular unit visitors are in. This is the primary source of orientation for many park visitors, especially in areas that have no staffed contact station.

Interpretation

Interpretation is delivered through various media and at several locations. Learning opportunities range from self-guided tours of historic settings to formal educational programs. Visitor and park information centers are at Jamaica Bay Wildlife Refuge, Floyd Bennett Field, and Fort Wadsworth's Mont Sec House as well as at Horseshoe Cove, Sandy Hook Lighthouse, and Fort Hancock History House on Sandy Hook. At these facilities, visitors can interact with rangers, view exhibits, and learn about activities such as ranger-led tours, self-guided tours, and recreation opportunities. The visitor contact stations at Fort Wadsworth and Canarsie Pier are no longer staffed or open to the public.

Park staff interprets Gateway resources by several methods, including exhibits, ranger tours and talks, educational brochures, campfire programs, and outdoor interpretive panels (known as wayside exhibits). Digital media, including podcasts and social media posting, are also used to share information about the park's resources and history. At Sandy Hook and Fort Wadsworth, NPS partners conduct living history programs.

Educational Programming

The Education and Interpretation Division offers natural and cultural resources education programs to school groups, youth groups, and community organizations. The programs provide hands-on opportunities for learning and promote the protection of natural and cultural resources in the park and the environment as a whole. These programs support the curriculum goals of New York and New Jersey schools.

Environmental education programs are offered in several Gateway sites. For example, at Ecology Village in Floyd Bennett Field, the NPS provides curriculum-based overnight camping programs for school groups and nonprofit organizations, as well as teacher training sessions. Other park sites that have environmental education programming, such as naturalist and wildlife hands-on studies, include the Jamaica Bay Wildlife Refuge, Education Field Station at Great Kills Park, Fort Wadsworth, and Sandy Hook.

Junior Ranger Program

The Junior Ranger Program is available for students and families at the Jamaica Bay, Staten Island, and Sandy Hook Units. The program provides young people age 7 to 12 an enjoyable and meaningful way to explore the resources and history of the park. Upon completion of the program, junior rangers receive a certificate and a patch.

The program provides young people age 7 to 12 an enjoyable and meaningful way to explore the resources and history of the park.

Volunteer Stewardship

Gateway volunteer programs offer opportunities for visitors to become involved in stewardship of the park. In 2012, Gateway had 4,929 volunteers who worked 87,255 hours, with most volunteers ranging in age from 26 to 55. Volunteer programs typically involve cleanups, defined construction projects, habitat restoration, and conservation. One volunteer activity is the BioBlitz, a 24-hour rapid assessment of what lives in a particular area at a given time orchestrated by park staff, partners, and volunteers. In 2011, nearly 150 volunteers and students participated in the Sandy Hook BioBlitz, which was conducted by a partnership between the NPS and the American Littoral Society. The BioBlitz and other natural resource stewardship activities bring school-age young people, college students, naturalists, and community residents to the park, offering them a deeper connection with park lands and exposure to the natural, cultural, and recreational resources that Gateway offers. Other volunteer programs include the Historic Airplane Restoration Project, Floyd Bennett Garden Association, Ranger Rick at the Ecology Village in partnership with National Wildlife Federation, and the Sandy Hook Association working with Clean Ocean Action.

Partner Involvement

Partners play a role in promoting understanding, education, and interpretation. Partner organizations like the Audubon Society, the American Littoral Society, and the National Wildlife Federation develop and operate independent interpretive activities such as birding tours and naturalist walks. Gateway also partners with local nonprofits and other partners to offer introductory recreational programming, such as kayak lessons. Finally, “friends” groups are instrumental in securing funding to help maintain historic structures, fund programs, and develop new initiatives.

Health and Safety

Gateway experiences safety issues similar to those found in any national park as well as facing additional visitor safety challenges due to its urban location. Although the park staff makes considerable efforts to provide safety information in easily accessible locations and

formats, there are many points of entry into Gateway, and visitors are sometimes unaware of and unprepared for potential hazards.

Gateway's more remote natural areas and expansive waters can create hazards for visitors. The lack of lights creates problems for some urban visitors, accustomed to having streetlights and other ambient lighting, who are unprepared for darkness. This can result in people becoming lost or hurt when trying to navigate in the dark.

Gateway's waters, which include the Atlantic Ocean as well as Jamaica Bay, Sandy Hook Bay, New York Bay, and Rockaway Inlet, have associated dangers. Between 2000 and 2010, 33 visitors drowned in the waters of Gateway. Several of the drownings involved multiple victims, as people attempting to rescue the initial victim also drowned. The primary causes of the drownings are alcohol consumption, inability to swim, and swimming in deceptively calm areas that in reality have steep underwater drop-offs and strong currents. Serious injuries to swimmers in the ocean surf are primarily neck and back injuries caused by diving into shallow water and dislocations caused by pounding surf. Additionally, boat traffic and heavy winds on the water bodies create hazards for small, human-powered watercraft such as kayaks.

The most frequent injuries received by visitors occur from slips, trips, and falls. These occur primarily while climbing on rock jetties or other structures; from loose gravel, ice, or wet leaves on multi-use pathways; and while ice-skating at the concession-run sports complex.

Given the high level of visitation at Gateway, conflicts between users can sometimes pose safety problems, such as those between vehicles and pedestrians and between vehicles and bicyclists. Occasionally, incidents are also reported between walkers and bicyclists sharing the multi-use paths and greenways. Visitor use conflicts also exist between surfers, swimmers, fishers, and boaters, which can lead to serious injuries.

Closed or unmaintained cultural resources and facilities also pose risks to visitors who explore them. Many coastal defense structures across the park are in very poor and unsafe condition. They present climbing hazards with unstable surfaces and sharp objects. Although these structures are not open to public access, they are unfenced or inadequately fenced.

Health Benefits and Physical Activity

Located in a major metropolitan area, Gateway can help improve the community's health by offering residents opportunities for personal fitness, active recreation, and other physical exercise, as well as healthy food from the park's community gardens.

With its many opportunities for recreation and for connecting with nature, Gateway improves the psychological and physiological health of the New York City area residents. The park's open spaces and natural areas provide healthy retreats from the congestion of high-density urban living. They also offer healthy environments for young people to recreate and to explore and connect with the natural world.

Radiation Remediation at Great Kills Park

In 2010, sections of Great Kills Park were closed to visitation due to health and safety concerns following the discovery of radium (NPS 2010d). This section of the park remains closed today.

Small sources of radium were found in discrete areas at Great Kills Park. These radium sources, found buried more than a foot below the ground's surface, have been removed; however, since then, additional areas exhibiting above-background radiation readings have been identified within the footprint of the historical landfill at this park site. Investigation into the source of the radium contamination is ongoing; based on the limited information available, it is believed that the radium came from discarded medical treatment sources brought to the landfill site (NPS 2010d). Radium present in these items has probably leaked over time, resulting in contamination of the soil directly surrounding the sources. To ensure public safety, the NPS initiated a wider investigation into the extent of radium at the site in the form of a Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, or Superfund) process in 2010. The goals of this CERCLA process are to determine the nature and extent of the contamination, evaluate and select an option for cleanup, and return the park to a condition unencumbered by contamination. As they are identified, the sources of radium are removed from the site for proper storage and disposal at an out-of-state facility. As of 2010 when the CERCLA process was initiated, the NPS (with technical assistance from the USACE) had removed radioactive sources and surrounding contaminated soil from the five locations with the highest radiation readings (NPS 2010d). The radiation at these sites averaged 4.12 milliroentgens per hour (mR/h) and dropped to 0.46 mR/h 3 feet away. Background radiation for this area is 0.02 mR/h (NPS 2010d).

Exposure to radiation can cause cancer, and the improper handling and disposal of radium sources can be harmful to the public. For this reason, the NPS has restricted access to portions of Great Kills Park since 2010. These areas of the park will remain closed until the matter is thoroughly investigated and appropriate cleanup is implemented.

Social and Economic Development

The social and economic conditions of the New York and New Jersey metropolitan area influence Gateway and how it is managed. Conversely, the park contributes to the social and economic conditions of the area as a whole. This section describes the existing conditions related to this relationship by highlighting the park's quality-of-life benefits as well as the New York and New Jersey metropolitan area's demographic and economic trends.

This section summarizes the existing social and economic conditions of the Borough of Staten Island, portions of the Boroughs of Queens and Brooklyn in New York City, and portions of Middlesex and Monmouth Counties in New Jersey. Discussions with NPS staff have indicated that although there are visitors to Gateway from Manhattan, the preponderance of visitors are from these three areas. These three areas have been identified as the primary market drawing areas (PMDAs) for the majority of visitors to Gateway.

The "Social and Economic Environment" section typically includes projections for how the PMDA is projected to change over the next 20 years. However, after the October 2012 impact of Hurricane Sandy, local city and county officials from New York and New Jersey are still estimating the hurricane's impacts on the economic and demographic profile of these market drawing areas. As such, the following analysis is primarily a summary of what was known prior to the hurricane with regard to economic and demographic profile and estimated long-term projections. As information becomes definitely available from New York City and New Jersey regarding post hurricane resettlement, these findings could be reevaluated.

The Importance of Parks to a Community

Park and open space areas in and around an urban area are key contributors to the quality of life in the community. This becomes even more significant in very large metropolitan areas, where population densities and travel distances to open, public lands are greater. The PMDA falls within the New York Metropolitan Statistical Area, which is the largest metropolitan area in the United States. Thus, in addition to parks and open space in New York City and Middlesex and Monmouth Counties in New Jersey, Gateway plays a vital role in sustaining and enhancing the quality of life for the residents of the New York and New Jersey area.

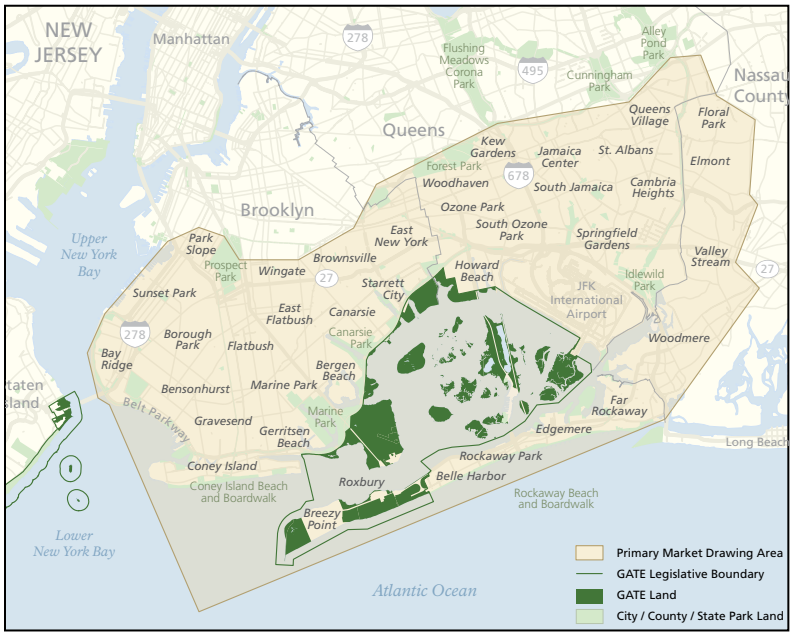
Population and Community Trends

The current and future management of Gateway is directly affected by the population dynamics and composition of the communities that surround it. As the population grows, there will be an increase in visitor use and demands for the park to accommodate traditional and new outdoor recreation opportunities.

Information in this section was developed through interviews with the NPS based upon their understanding of the visitor profiles to each unit in Gateway. This affected area has been identified in this report as the PMDA for activities at Gateway. In New York City, the PMDA includes the Borough of Staten Island for the Staten Island Unit and portions of the Boroughs of Queens and Brooklyn for the Jamaica Bay Unit. The Jamaica Bay Unit's PMDA was developed through comparison of the neighborhood tabulation area developed for New York City Comprehensive Waterfront Plan to a market drawing area developed as part of the NPS Gateway National Recreation Area Supply and Demand Analysis. The PMDA for the Sandy Hook unit includes Middlesex and Monmouth Counties. Figures 3-16 through 3-18 are maps of each of the sub-elements of the PMDA.

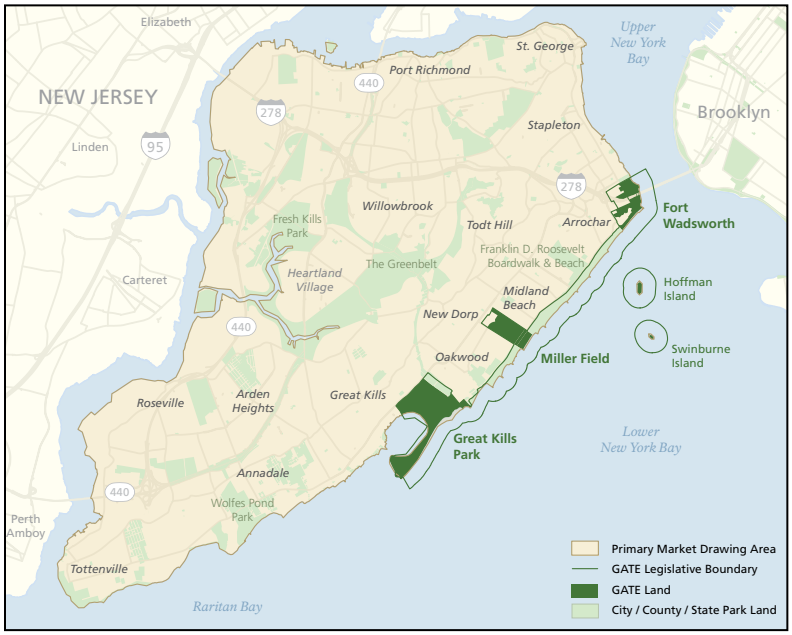
Long-term population forecasts within the range of a 20-year planning horizon are typically part of the GMP process. The planning authorities in New York City and New Jersey have developed planning documents that include 30-year forecasts. The New York City Department of Planning undertook a 30-year population forecast in December of 2006. Recent interviews with the New York City Department of Planning indicate that a revision of these population forecasts was planned for the spring of 2013. With the impact of Hurricane Sandy, these projections are now planned for revision by the summer of 2013. Therefore, the New York City Planning Department is of the opinion that the 30-year population forecasts should be evaluated more for their overall trends rather than for specific population data.

Figure 3-16. Gateway National Recreation Area PMDA by Unit – Jamaica Bay, New York.



The New York City population projections by age/sex and borough for the period 2000 to 2030 estimated population growth by borough. In this study, Staten Island was projected to increase its population by 24.4 percent by 2030; Queens by 15.1 percent; and Brooklyn by 10.3 percent. The 2006 study indicated that the preponderance of growth was estimated to occur within the first 5 years of the projection period (2000 to 2005) (NYCDCP 2006). If the 30-year growth rates were converted to equal annual growth rates, this would equate to 0.81 percent annual growth for Staten Island, 0.50 percent for Queens, and 0.34 percent for Brooklyn.

Figure 3-17. Gateway National Recreation Area PMDA by Unit - Staten Island, New York



The New Jersey Department of Labor and Workforce Development also developed 30-year population projections (NJDLWD n.d.). The NJDLWD notes that "these projections, which are neither predictions nor forecasts, reflect identifiable long-term economic and demographic trends which have been implicitly or explicitly incorporated into the models. In other words, the projections are an extrapolation of past and current trends into the future. These projections are best used as a reference framework for planning, research, and program evaluation." These data, developed prior to Hurricane Sandy, indicated that within the New Jersey component of the PMDA, Middlesex County was proposed to grow by 21 percent and Monmouth County was projected to grow by 11 percent by the year 2030. Converting these 30-year growth rates to equal annual growth rates would equate to an annual growth rate of 0.7 percent for Middlesex County and 0.36 percent for Monmouth County.

Using 2010 census data, ESRI has forecasted the PMDA for the Gateway National Recreation Area at an estimated population of 4.66 million in 2012 (U.S. Census Bureau 2010; see figure 3-19). Prior to Hurricane Sandy, this PMDA was projected to experience an increase in population to 4.77 million by 2017, for a compound annual growth rate of 0.60 percent. This estimated annual growth rate is within the range of the individual forecasted 30-year annual averages mentioned previously. However, should the population basis change as a result of Hurricane Sandy, the future growth rate may also change.

Figure 3-18. Gateway National Recreation Area PMDA by Unit - Sandy Hook, New Jersey.

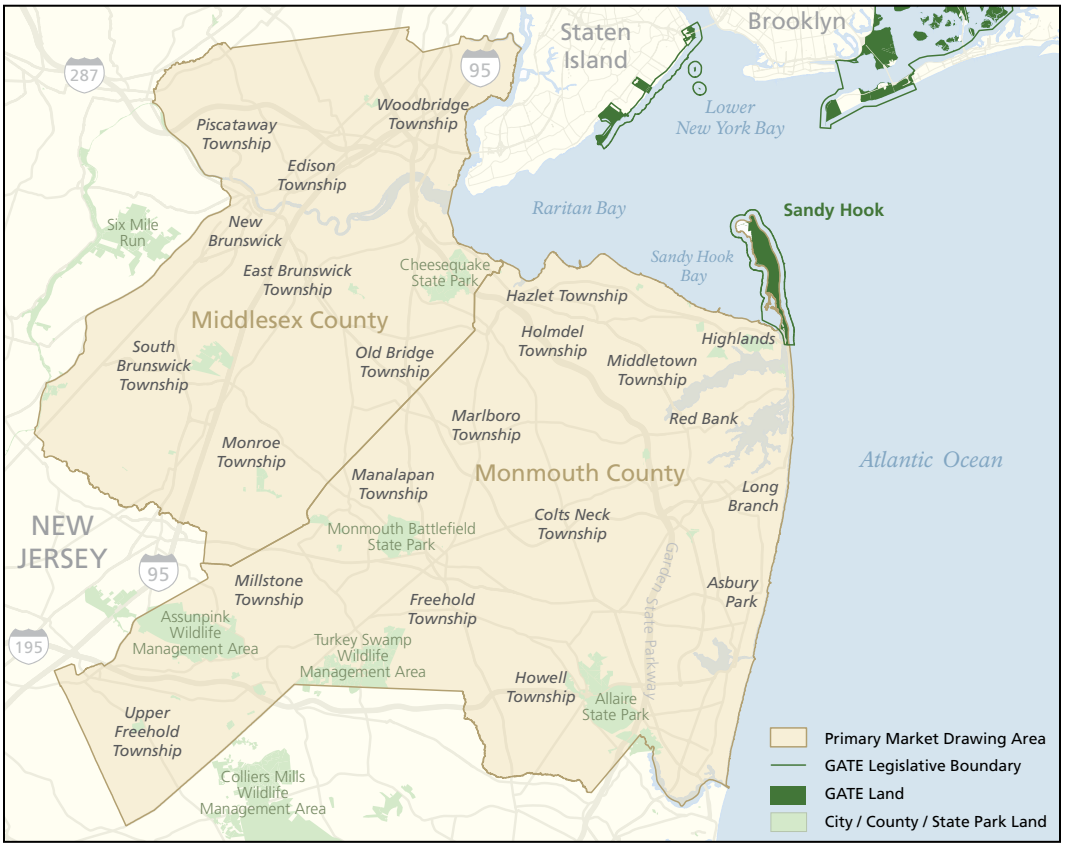
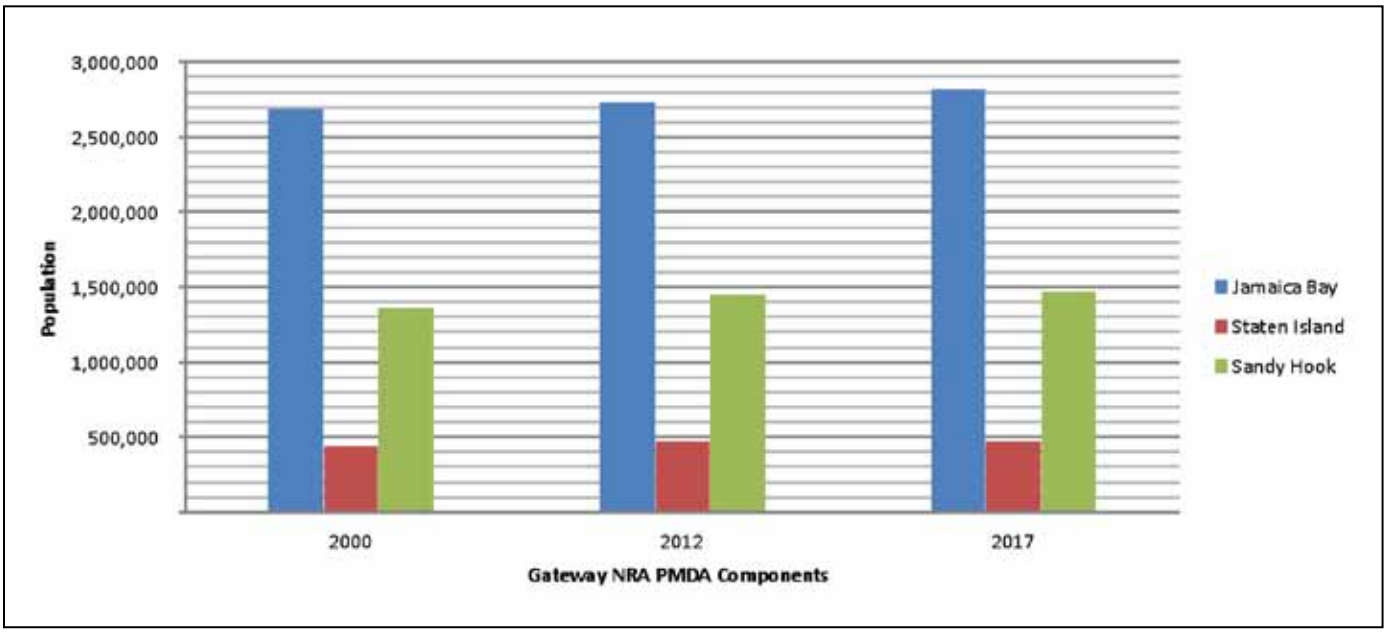


Figure 3-19. 2000-2017 Estimated Population Growth, Gateway PMDA by Unit.



Source: U.S. Census Bureau 2010.

People and Households

In addition to assessing the status and forecast for overall population growth within the PMDA, understanding the changing characteristics of area residents and the composition of the community's households is important. This section discusses the community characteristics of median age, household size, race, income, poverty levels, and education levels.

Median Age and Household Size

As of 2012, the PMDA sub-elements had a median age of 36.2 for Jamaica Bay, 38.6 for Staten Island, and 39.2 for Sandy Hook. The average household size within the PMDA sub-elements was 2.89 for Jamaica Bay, 2.78 for Staten Island and 2.73 for Sandy Hook. (U.S. Census Bureau 2010). The data summarized in table 3-8 show that the median age is anticipated to increase for all the sub-elements and that the average household size is anticipated to decrease for Jamaica Bay but increase slightly for Staten Island and the Sandy Hook PMDA.

A review of the New York City Planning Department population projections by age/sex and borough for the period 2000 to 2030 indicates that the most significant population age cohort that is anticipated to increase is the elderly population. The aging of large baby boom cohorts, a decline in fertility, and improvements in life expectancy all contribute to a general aging of the population, despite more pronounced migration losses. The New York City Planning Department population projections estimate that by 2030, the school-age population and the population age 65 and over will have nearly converged, accounting

Table 3-8. Median Age and Average Household Size for Gateway PMDA by Unit (2010, 2012 and 2017)

PMDA Unit	2010		2012		2017	
	Age	Size	Age	Size	Age	Size
Jamaica Bay	36.0	2.88	36.2	2.89	36.7	2.88
Staten Island	38.3	2.78	38.6	2.78	39.0	2.79
Sandy Hook	38.9	2.73	39.2	2.73	39.5	2.74

Source: U.S. Census Bureau 2010.
Age = median age; size = average household size

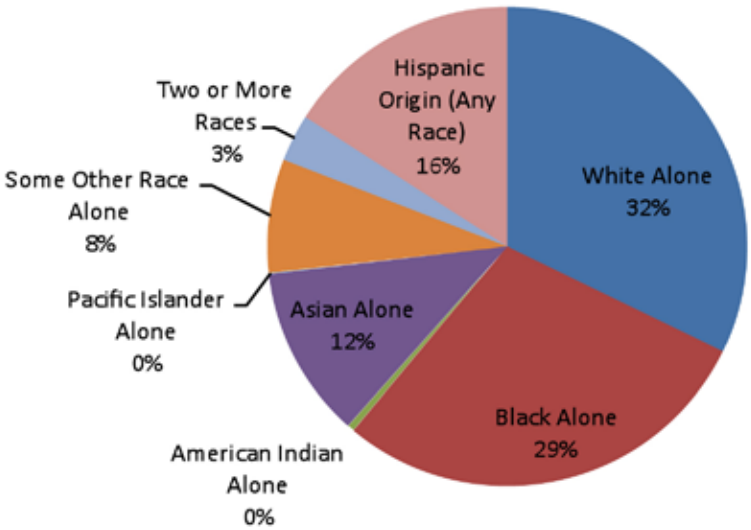
for 15.4 percent and 14.8 percent of the city's population, respectively. In New York City, it is estimated that Staten Island will see the largest percentage increase in the elderly population and that Brooklyn will continue to have the largest elderly population in the city. Overall, the study indicates that New York City's future population will be shaped by low fertility, continued net outmigration, and an aging population.

The New Jersey Department of Labor and Workforce Development population projections for age cohort in the Sandy Hook Unit PMDA provide a similar perspective. In 2010, it was estimated that the school-age population was approximately 26 percent of the population and the population over age 65 was 13 percent. By 2030, it was estimated that the school-age population would be 24 percent of the overall population and the population over age 65 would represent 20 percent.

Race

The PMDA for Gateway includes both densely populated city neighborhoods and suburban environments. The race/ethnicity of the PMDA sub-elements illustrates the diversity in users who are attracted to the outdoor recreation opportunities that Gateway offers. Figures 3-20 through 3-22 provide a 2012 estimate and percentages for each of the racial/ethnic groups

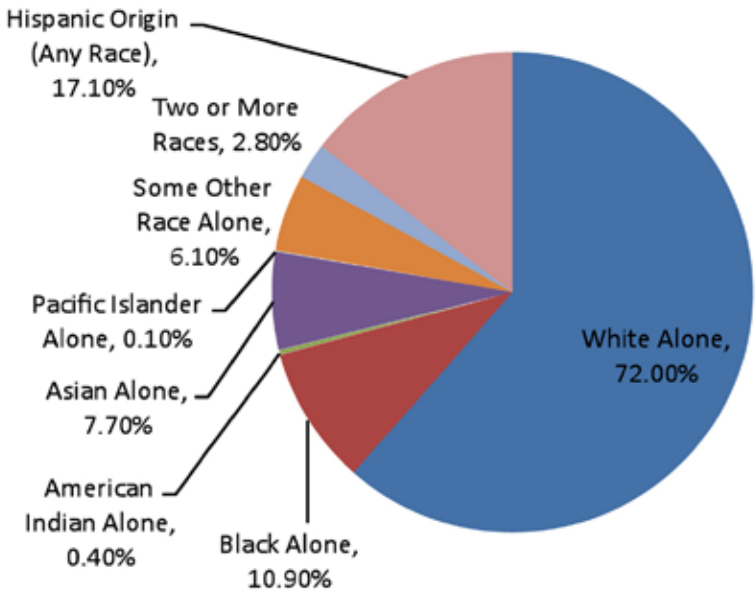
Figure 3-20. Population Estimates for Jamaica Bay PMDA - 2012



Source: U.S. Census Bureau 2010.

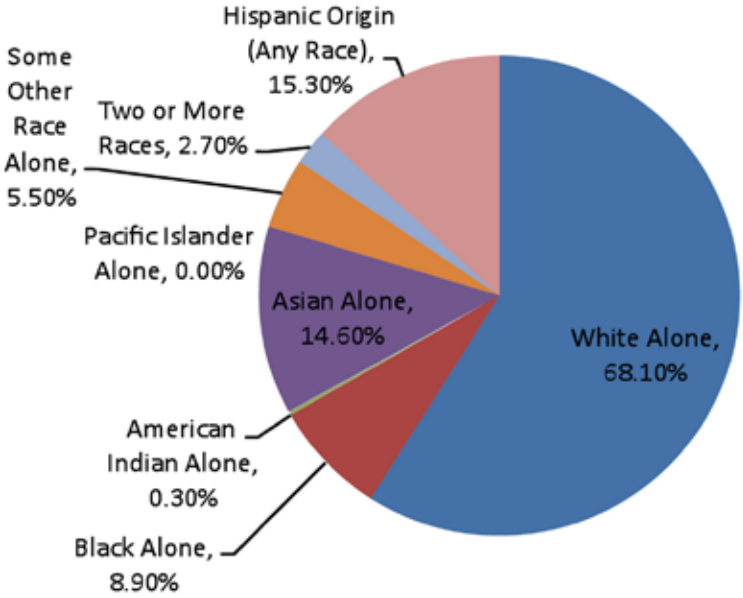
supporting each unit's PMDA. It is important to note that the methods that the 2010 census used for identifying race/ethnicity allows for a dual reporting of ethnicity. As such, the total percentages are greater than 100 percent.

Figure 3-21. Population Estimates for Staten Island PMDA - 2012



Source: U.S. Census Bureau 2010.

Figure 3-22. Population Estimates for Sandy Hook PMDA - 2012



Source: U.S. Census Bureau 2010.

From a park management standpoint, understanding the racial makeup of the community can help shed light on ways to make the park more inviting, develop better outreach with the community, and improve park program relevance. In addition, this awareness contributes to improving the quality of life in the community. As discussed in the "Visitor Use and Experience" section, many people from the PMDA's diverse racial, ethnic, and cultural groups are not visiting Gateway.

The U.S. Census uses the racial/ethnicity information to develop a diversity index for each area of analysis. This index represents the amount of diversity represented in the population. The Jamaica Bay Unit's PMDA has the highest diversity index, at 80.3 for 2012, and it is projected to increase to 81.1 by 2017. The Staten Island Unit's PMDA is similar to the Sandy Hook Unit's PMDA, at 61.9 and 63.5, respectively, in 2012, and these two diversity indices are estimated to increase to 64.8 and 67.0 by the year 2017. These trends reflect the national trends toward greater diversity. In the case of the Jamaica Bay Unit's PMDA, the anticipated increase in diversity is expected to consist of an increase in the Asian and Hispanic population and a corresponding decrease in the white and black racial/ethnic groups. In the Staten Island Unit's PMDA, the diversity trend is anticipated to involve an increase in the Hispanic population, as well as the Black and Asian race/ethnicity groups of the population. For the Sandy Hook Unit's PMDA, the diversity trend is based on an increase in the Hispanic, Black, and Asian race/ethnicity groups of the population. These immediate-term increases in population diversity emphasize the importance of NPS efforts to improve outreach and eliminate barriers that might keep people of all races and ethnic groups from experiencing the park.

Income, Poverty, and Education

Other factors that play a role in park management and visitation trends are the income levels and poverty levels of residents who live near the park. Per capita income varies significantly between the three Gateway PMDAs. The U.S. Census for 2010 and projections for 2012 indicate that the highest per capita income is in the PMDA for the Sandy Hook Unit, at $36,649, with the lowest per capita income at $23,155 for the PMDA surrounding the Jamaica Bay Unit. The Staten Island Unit's PMDA closely resembles that of the Sandy Hook Unit PMDA at $32,941. Forecasts of income over the next five years show moderate growth, but the position of these figures in relation to the others does not change (table 3 9).

Table 3-9. Estimated Income for Gateway Unit PMDAs (2012 and 2017).

PMDA Unit	2012		2017	
	MH Income	PC Income	MH Income	PC Income
Jamaica Bay	$48,261	$23,155	$56,216	$26,605
Staten Island	$72,905	$32,941	$82,484	$37,514
Sandy Hook	$78,710	$36,649	$89,316	$42,426

Source: U.S. Census Bureau 2010.
MH income = median household income; PC income = per capita income

The U.S. Census Bureau does the American Community Survey, the most recent of which was completed for the period from 2005 to 2009. This survey provides insight into poverty levels within census tracts. A review of the data from this survey supports the per capita income data of the PMDAs. Approximately 17 percent of the households in the Jamaica Bay PMDA were below the poverty level, whereas an estimated 10.3 percent of the Staten Island PMDA households and 6.7 percent of the Sandy Hook PMDA households were below the poverty level.

The level of education attained by community residents can often correlate to these income and poverty characteristics. Table 3-10 summarizes the percentage of residents in each area (25 years or older) who attained various levels of education as of 2009 (U.S. Census Bureau 2009). The Jamaica Bay PMDA has the lowest percentage of the population with college degrees, at 33.6 percent, compared to the Staten Island PMDA at 35.7 percent and the Sandy Hook PMDA at 44.7 percent.

Table 3-10. Percentage of Population to Reach Various Levels of Education by Gateway PMDA (2009).

Educational Attainment	Jamaica Bay	Staten Island	Sandy Hook
No Schooling	2.0%	1.0%	0.8%
Nursery to Grade 12 – No Diploma	18.6%	11.6%	10.0%
High School Graduate, GED, or Alternative	31.3%	34.0%	28.3%
Some College, up to 1 or More Years, No Degree	14.6%	17.7%	16.2%
Associate's Degree	7.2%	7.8%	6.7%
Bachelor's Degree	16.9%	16.6%	23.4%
Master's Degree	6.9%	8.3%	10.7%
Professional School Degree	1.9%	2.2%	2.5%
Doctoral Degree	0.7%	0.7%	1.5%

Source: U.S. Census Bureau 2009.
Note: Population surveyed included those 25 years of age or older

Employment Trends

Employment opportunities typically correlate to educational background and impact household income. Within the Gateway PMDA, the healthcare and social assistance industry is the largest employer, providing from 11.5 percent of overall employment for the Sandy Hook PMDA up to 19.8 percent for the Jamaica Bay PMDA (see table 3-11). The retail and educational services are the next-largest employment sectors for residents in the PMDA.

Table 3-11. Civilian Employment for Population age 16+ by Industry by Gateway Unit PMDA.

Industry	Jamaica Bay	Staten Island	Sandy Hook
Agriculture, Forestry, Fishing, and Hunting	0.1%	0.0%	0.3%
Mining, Quarrying, and Oil and Gas Extraction	0.0%	0.0%	0.1%
Construction	6.3%	7.2%	6.1%
Manufacturing	4.7%	3.3%	8.9%
Wholesale Trade	2.8%	2.4%	3.9%
Retail Trade	9.6%	9.5%	11.3%
Transportation and Warehousing	7.9%	6.3%	5.0%
Utilities	0.5%	1.1%	0.7%
Information	2.9%	2.6%	3.8%
Finance and Insurance	6.1%	9.9%	8.4%
Real Estate and Rental and Leasing	2.7%	2.7%	1.9%
Professional, Scientific, and Technical Services	5.8%	6.7%	9.2%
Management of Companies and Enterprises	0.1%	0.1%	0.1%
Administrative and Support and Waste Management Services	4.1%	3.9%	3.6%
Educational Services	9.0%	10.5%	9.8%
Health Care and Social Assistance	19.8%	15.9%	11.5%
Arts, Entertainment, and Recreation	1.6%	1.5%	1.8%
Accommodation and Food Services	5.7%	4.6%	5.2%
Other Services, Except Public Administration	5.5%	4.3%	4.2%
Public Administration	4.8%	7.7%	4.1%

Source: U.S. Census Bureau 2009.

Housing and Urban Growth

This section will identify current and projected trends in the housing market and highlight housing indicators such as home values, housing affordability, own/rent ratios, and single-family/multifamily dwelling ratios. The New York and New Jersey metropolitan areas are recognized for their high median home values. The composition of the household stock and ownership patterns within the PMDA is a function of the urban environment that surrounds Gateway. Table 3-12 illustrates that median home prices are highest in the Staten Island Unit's PMDA, followed by the Jamaica Bay and Sandy Hook Units' PMDA. The lower home value in the Sandy Hook Unit's PMDA may be attributed to the lower land values in the suburban environments. As would be anticipated, single-family detached homes (59.15 percent) and owner-occupied homes (64.2 percent) are found at a greater percentage within the Sandy Hook Unit's PMDA due to its suburban setting. The density of development is greater in the Jamaica Bay and Staten Island Units' PMDAs, and as such, the value of open space and supporting recreation areas is an important value provided by Gateway.

Table 3-12. Housing Value, Stock, and Ownership Patterns, Gateway Unit PMDAs

Housing Type	Jamaica Bay		Staten Island		Sandy Hook	
	2012	2017	2012	2017	2012	2017
Median Home Value	$423,011	$467,729	$441,256	$473,330	$327,749	$360,990
Household Stock						
Single-family Detached	18.8%	NA	33.9%	NA	59.1%	NA
Multi-family Attached	81.0%	NA	65.7%	NA	39.8%	NA
Household Stock						
Owner Occupied	35.4%	36.6%	58.7%	59.9%	64.2%	64.6%
Renter Occupied	56.9%	56.3%	35.1%	34.0%	29.0%	28.6%

Source: U.S. Census Bureau 2009.
NA = not applicable

Economic Effects of the Park on the Community

Just as population growth and community demographics have effects on the management and use of Gateway, the park also has effects on the economy of the community around it. Like many other economic engines in the New York and New Jersey area, Gateway contributes to the local and regional economy by generating business and revenue, creating jobs, and indirectly fueling economic growth in other industries. This section identifies these economic impacts of the park and provides a synopsis of the overall PMDA economies.

Park Contributions to the Economic Stability of the Area

The park has many direct and indirect positive effects on the area's economy. This impact can be traced to several sources and attributes, such as money spent by visitors at local businesses, jobs created at these local businesses due to visitor demand, NPS jobs created at

the park, NPS contracts with local businesses, and other area tourism generated by the park. This section will highlight some of these factors and explain the relevance to the overall PMDA economy.

Contributions to Local Economy from Gateway Visitor Expenditures

Each year, millions of park visitors contribute hundreds of millions of dollars to the region surrounding Gateway. This money directly sustains the revenue stream and jobs at hotels, restaurants, and stores that serve park visitors. Primarily, businesses in the boroughs of Staten Island, Queens, and Brooklyn and Monmouth and Middlesex Counties in New Jersey that are adjacent to Gateway are the direct beneficiaries of this economic contribution. In addition, the visitor money stream can also have other indirect, or secondary, effects. For example, this injected money that directly supports local businesses and jobs eventually recirculates into the local economy and beyond. This recirculation happens when the local businesses in the communities surrounding Gateway buy products or services from other sources (e.g., from wholesale suppliers), or when employees at the local businesses use their income earned at the local businesses in communities surrounding Gateway at other businesses in the area to sustain their lifestyle (e.g., grocery shopping, entertainment). This secondary effect is often referred to as an economic "multiplier," because one dollar injected into the local economy often has more than one dollar's effect on the local economy.

With funding from the NPS Social Science Research Program, researchers at Michigan State University have created the NPS "Money Generation Model 2" (MGM2) to measure these direct and indirect contributions from visitors to local economies. Stynes and Propst used the MGM2 to analyze the effect that visitors to units of the NPS had on the local economies in 2011. This is the most recent data set available for analysis. The 2011 data is based on spending profiles from 2010 adjusted to 2011 using Bureau of Labor Statistics consumer price indices for each spending category. Consumer prices remained fairly stable between 2010 and 2011, except for an increase of 26 percent in gas prices and a 10 percent increase in transportation costs. Visitor segment mixes were assumed to be unchanged except as reflected in overnight stays or new visitor surveys. Except for parks with new visitor surveys, average party sizes, lengths of stay, and reentry factors were assumed to be unchanged from 2010. Visit and overnight stay figures for all parks were updated to 2011 from the NPS public use statistics. Table 3-13 provides an overview of Gateway's spending, economic, and payroll impacts on the local economy.

As an urban park, as opposed to a destination park, the preponderance of Gateway visitation is in the form of day-use recreation visits. Although overnight visitors spend significantly more than day visitors, the size of the day-use market results in significant economic impacts on the surrounding area. In total, park visitors spent $150 million in the local region surrounding the park in 2011. This spending figure excludes airfare and other trip spending outside a 60-mile radius from the park, as well as any durable goods and major equipment.

The model also estimated how this injected money circulated through the local economy, as summarized in table 3-13. Jobs include full-time and part-time jobs, with seasonal positions adjusted to an annual basis. Labor income covers wages and salaries, including income of

Table 3-13. Spending, Economic and Payroll Impacts of Gateway on Local Economy.

Type of Visitation/Spending	Amounts
Public Use Data	
Recreation Visits	7,697,727
Overnight Stays	8,165
Visitor Spending	
All Visitors	$150,947,000
Non Local Visitors	$60,712,000
Impact of Non-local Visitor Spending	
Jobs	668
Labor Income	$30,724,000
Value Added	$50,537,000

Source: Yue, Mahoney, and Herbowicz 2013.

sole proprietors and payroll benefits. Value added is the sum of labor income, profits and rents, and indirect business taxes. The $150 million of total visitor spending result supports 668 jobs, labor income of $30.7 million dollars, and value added of $50.5 million.

Contributions to the Local Economy from National Park Service Operations

The employment offered by the NPS also contributes to the local economy. The social and economic benefits of this job base are twofold. First, the jobs made available by the park and its partners provide hundreds of residents with a steady income that helps sustain their lives and those of their families. Secondly, similar to the economic effects of revenue generated by park and monument visitation (as previously explained), the income earned by park and partner employees also has direct and secondary effects on the local economy. These employees contribute to the local economy by spending the money they earn on goods and services in the community. This spending directly supports local businesses and their growth. The local communities also benefit directly via the sales tax generated by this spending. In addition, secondary economic benefits (i.e., the multiplier effect) are realized when this money eventually circulates further into the PMDA economy and beyond. Because NPS employees reside throughout the entire region, the economic effect of their earned salaries (and subsequent spending in their respective communities) extends throughout the area as well.

Business and Industry Trends

The PMDA provides employment opportunities to local residents as well as residents from other areas. A review of the business types within the PMDA provides insight into the industries that surround Gateway. As table 3-14 illustrates, retail trade establishments are the largest category of businesses within the PMDA. This is followed by other service businesses; professional, scientific, and tech services; and construction firms. This table provides confirmation that the PMDA provides a diverse economic base.

Table 3-14. Percentage of Businesses by North American Industry Classification System Code in the Gateway PMDAs (2011).

Types of Businesses within Areas	Jamaica Bay	Staten Island	Sandy Hook
Agriculture, Forestry, Fishing, and Hunting	0.1%	0.1%	0.3%
Mining	0.0%	0.0%	0.1%
Utilities	0.1%	0.1%	0.2%
Construction	6.8%	11.2%	9.4%
Manufacturing	3.0%	2.3%	3.4%
Wholesale Trade	5.1%	4.0%	5.1%
Retail Trade	19.1%	14.2%	15.0%
Transportation and Warehousing	3.5%	2.2%	2.7%
Information	1.9%	1.9%	2.0%
Finance and Insurance	4.0%	5.3%	5.0%
Real Estate, Rental, and Leasing	4.9%	4.3%	4.8%
Professional, Scientific, and Tech Services	6.4%	8.7%	9.8%
Management of Companies and Enterprises	0.1%	0.1%	0.1%
Administrative and Support and Waste Management and Remediation Services	4.0%	6.3%	5.8%
Educational Services	3.2%	3.1%	2.7%
Health Care and Social Assistance	8.4%	8.2%	8.0%
Arts, Entertainment, and Recreation	1.0%	1.7%	2.0%
Accommodation and Food Services	8.6%	8.5%	6.8%
Other Services (Except Public Administration)	15.8%	13.4%	10.9%
Public Administration	0.8%	1.3%	2.6%
Unclassified Establishments	3.1%	3.2%	3.4%

Source: Infogroup 2012.

Transportation

Each park unit in Gateway has a unique history and associated purpose, which has influenced visitation and reflects how visitors access each unit, circulate among and within the units, and find their way around each unit. For example, some units have no water access, some are not served internally by public transportation, and some reach capacity on a regular basis during peak season. Due to the geographic separation and differing visitor attractions among park units and park sites within a unit, regional transportation access to each area and means of internal circulation are very distinct. In addition, dedicated transportation facilities are also unique within each unit and park site.

Transportation is intricately tied to the varied visitor activities provided in each unit. For example, the Sandy Hook Unit draws beachgoers, sailboarders, surfers, and kite boarders, who sometimes transport large recreational gear, whereas Fort Wadsworth (in the Staten Island Unit) is popular with cyclists and pedestrians seeking ranger-led tours. At Great Kills Park on Staten Island, waterways and water transportation modes are crucial. The Jamaica Bay Unit provides fishing, kayaking, wildlife sightseeing, and beach and cycling opportunities. Each unit also offers different types of alternative access. Access to and within each unit varies by transportation mode, and each unit provides varying degrees of parking and wayfinding.

Some facilities such as the Jamaica Bay Wildlife Refuge are so unique that they draw visitors from throughout the region, while other facilities that provide more standard recreational amenities such as the ball fields at Miller Field tend to draw from the immediately surrounding areas.

In October 2012, Hurricane Sandy came ashore in the New York area, resulting in damage from wind and flooding from rain, overflowed rivers, and storm surge, which in some areas exceeded 13 feet. Damage to transportation-related structures from Sandy included the following, reported by park unit.

In the Jamaica Bay Unit (NPS, pers. comm. 2012f):

- Jamaica Bay Wildlife Refuge East and West Ponds were breached, and the West Pond remains breached, resulting in damage to trails and a subway route.
- All of Fort Tilden was flooded from both the ocean and bay side, damaging transportation infrastructure.
- The Shore Road and fisherman's parking lot were covered in sand.
- At Jacob Riis Park, winds covered much of the park north of the beach in sand.
- Bicycle and pedestrian paths were damaged.

In the Staten Island Unit:

- Wind and storm surge carried sand to cover parking lots and block roads at Great Kills
- Nichols Marina was extensively damaged at Great Kills Park.
- Bicycle and pedestrian paths were damaged.

In the Sandy Hook Unit, which the NPS identified as the park unit mostly heavily affected by Hurricane Sandy:

- Flooding damaged all NPS infrastructure (NPS 2012c).
- A significant loss of beach sand occurred, covering roads and parking lots with sand.
- Bicycle and pedestrian paths were damaged.

Most of the repairs needed to open the park for the summer have been completed as of July 2013. Some damaged roads or paths have not yet been repaired, but planning and implementation of repair strategies may occur outside the context of the GMP. Therefore, this section describes the transportation conditions that exist as a result of the storm, as well as conditions that existed prior to the storm, such as congested roads and parking areas, assuming that such issues would likely return once the storm damage has been repaired and the closed park units reopen. Data were collected from various park and local information sources, from maps, and through examination of the park's transportation facilities during field visits in 2010 prior to Hurricane Sandy. Unless otherwise noted, the condition of the park facilities was generally good during field visits in 2010.

Regional Transportation Overview

The park units that compose Gateway and the regional transportation routes that serve them are shown in figure 3-23. Despite being in an urban area with the most extensive public transit in the nation, the three Gateway units are not connected to each other by transit, and function as independent destinations in a transit riders eyes. Only one public transit service, a single bus route, links Brooklyn and Staten Island, but it does not serve the NPS parks in both those boroughs (it originates and terminates in Bay Ridge). No public transit links the Sandy Hook and Staten Island or Jamaica Bay units to each other.

Jamaica Bay Unit

The Jamaica Bay Unit is on the southwestern tip of Long Island in the boroughs of Brooklyn and Queens, New York. Composed of multiple districts, Jamaica Bay is accessible by car via several key routes and bridges. The Belt Parkway and Flatbush Avenue provide access to Canarsie Pier and Floyd Bennett Field districts from the north, east, and west. Continuing across the Marine Parkway Bridge allows access to Jacob Riis Park, Fort Tilden, and Breezy Point. ~~although Breezy Point is currently open only to pedestrians due to the damage resulting from Hurricane Sandy (IMT 2012j).~~ Belt Parkway and Woodhaven Boulevard provide access to the Jamaica Bay Wildlife Refuge from the north, east, and west. These routes connect to Cross Bay Boulevard, which extends across the Joseph Addabbo-North Channel Bridge into the Jamaica Bay Wildlife Refuge. Routes from the south and local roadway access include Rockaway Freeway, Beach Channel Drive, and Rockaway Point Boulevard.

Regional transit access to the districts of Jamaica Bay can be made via bus connections to subway stations at Flatbush Avenue, Rockaway Park/Beach 116th Street, Rockaway Parkway, and Broad Channel. Ferries run between Riis Landing on Rockaway, the Brooklyn Army Terminal in Bay Ridge, and Pier 11 on Wall Street. New York Beach Ferry service is available

during summer weekends and holidays. ~~As a result of the closure of the A train following damage from Sandy, New York Water Taxi service was established weekdays throughout the year. It is uncertain what the availability of the water taxi service will be once A train service resumes.~~

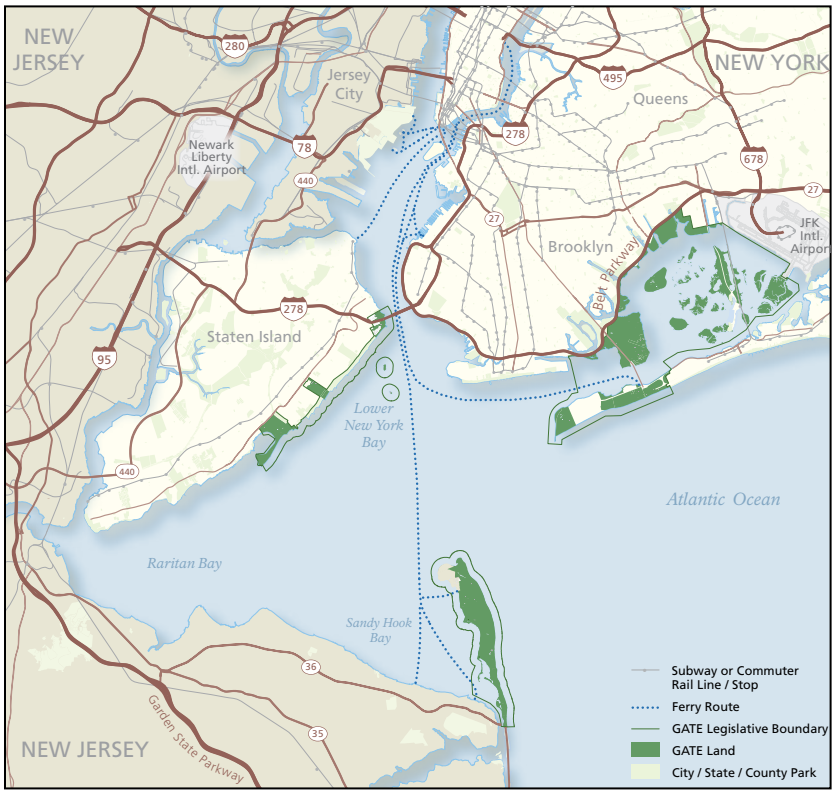
Staten Island Unit

The Staten Island Unit, which is composed of three park sites located along the east and southeast shores of Staten Island, is accessible by car via the Verrazano-Narrows Bridge from Brooklyn or the Goethals or Bayonne Bridge or the Outerbridge Crossing from New Jersey to the Staten Island Expressway (Route 278). The Staten Island Ferry service from Lower Manhattan also provides public transit access and connections to local bus routes at the Saint George Ferry Terminal.

Sandy Hook Unit

The Sandy Hook Unit is a barrier spit that lies along the Atlantic shores of eastern New Jersey. From North Jersey and New York, Sandy Hook is accessible by car via the New Jersey Turnpike, Garden State Parkway, and Route 36 through the Highlands. From South Jersey, roadway access is via Garden State Parkway and Route through the Town of Sea Bright. New Jersey Transit operates one bus route near the park entrance, and commuter bus service to Highlands is available from New York. During the summer season, direct ferry service is available to Sandy Hook from Manhattan daily, with internal shuttle bus service providing

Figure 3-23. Regional Transportation Networks.



beach access in the park. The ferry docks sustained damage from Hurricane Sandy, but are identified by the NPS as a high priority for repairs (IMT 2012j). Year-round ferry service between Manhattan (Pier 11 and East 35th Street) and Highlands, New Jersey, is also available, providing access within approximately 3 miles of the park.

Bicycle Facility Classifications

Various types of bicycle facilities exist in or near some park units. While trails, greenways and bike lanes do connect several of the park districts within Gateway, there is currently no bike sharing infrastructure and bike rentals have only recently been introduced. The Aviator Sports and Events Center (an NPS concessionaire) at Floyd Bennett Field does rent bicycles for $7 per day during spring and summer. There are currently bike rentals at Fort Hancock on Sandy Hook and in the summer of 2013 a commercial use authorization was issued for bike rentals to be established at Canarsie Pier, Riis Park and Riis Landing. There is a need for additional roadway markings (i.e. bicycle lanes or shared lane markings) and signage to make navigating Gateway's park units clear and comfortable for most bicyclists and park users.

Cycling culture is well established in New York City and cycling is growing in popularity as a convenient general means of travel for accessing park and recreation. PLANYC and other programs supported by city agencies actively promote cycling. In 2010, it was reported that the city's bike network of on-street, and physically separated cycle tracks has grown to over 150 miles of painted bicycle lanes and this bike infrastructure continues to grow (NPS 2010g). NYCDCP's 2009 Bike Share Opportunities report indicated that bicyclists make up 0.6 percent of all commuters in New York City.

The breakdown of modal share for accessing Gateway's parks has not been determined so it is unknown how many park users access the park via bicycle. Previous transportation planning reports have recommended that NPS develop a survey to distribute to park visitors inquiring about their mode of access and travel times to Gateway, and also to gauge their interest in non-motorized alternatives.

Bicycle facilities are generally classified as follows:

- Separate Facility (Class I) – A non-motorized facility, paved or unpaved, physically separated from motorized vehicular traffic by an open space or barrier. Also called bicycle path, bike trail, non-motorized trail, multi-purpose trail, or some combination thereof.

- Bike Lane (Class II) – A portion of a roadway that is designated by striping, signing, and pavement markings for the preferential or exclusive use of bicyclists. Often done in pairs, each one being one-way and adjacent to the outside through-travel lane. Also called bicycle lanes.

- Bike Route (Class III) – A segment of road designated by the jurisdiction having authority, with appropriate directional and informational markers, but without striping, signing, and pavement markings for the preferential or exclusive use of bicyclists. Also called bicycle route.

- Bike Friendly (Class IV) – A roadway not designated by directional and informational markers, striping, signing, nor pavement markings for the preferential or exclusive use of bicyclists, but containing appropriate bicycle-friendly design standards such as wide-curb lanes and bicycle-safe drain grates (International Bicycle Fund 2011).

Individual Park Units

Jamaica Bay Unit

Overview

The Jamaica Bay Unit is along the southeastern tip of Long Island on a peninsula that includes Jamaica Bay, the Jamaica Bay Wildlife Refuge, Floyd Bennett Field, Jacob Riis Park, Fort Tilden, Canarsie Pier, Breezy Point, Plumb Beach, and Bergen Beach. It is bounded by the Belt Parkway (New York State Route 27) to the north, John F. Kennedy International Airport to the east, Sheepshead Bay to the west, and the Atlantic Ocean to the south (FHWA 2006). Several city-owned parks, beaches, small towns, industrial areas, and community areas are also located along the peninsula between the ocean and Jamaica Bay. Under the Cooperative Management Agreement that NPS signed with the City of New York in July 2012, and with the City as a Cooperating Partner in the GMP process, these adjoining lands will be increasingly managed collaboratively and represent a unified destination for some users.

Jamaica Bay can be accessed via private car, city bus, subway, ferry, bicycle, or kayak, or on foot. The Marine Parkway Bridge connects Jacob Riis Park to Floyd Bennett Field and Brooklyn. The Cross Bay Bridge connects the southern side of the peninsula to Jamaica Bay. Some districts in Jamaica Bay are within walking distance from residences via existing sidewalks. All of the parks within the Jamaica Bay Unit, with the exception of Floyd Bennett Field are within walking distance of residential neighborhoods. Riis Landing abuts the Roxbury neighborhood, Jacob Riis Park abuts the Neponsit neighborhood, and the new NPS site at Pennsylvania Avenue is located near the Spring Creek Towers housing development. Bicycle/pedestrian access is enhanced by the Belt Parkway Bikeway that runs along the northern edge of Jamaica Bay, including the entire frontage of the new sites at Pennsylvania and Fountain Avenues. In recent summers, entrepreneurial, for-profit van services have sprung up to bring beach-goers from parts of Brooklyn to points on the Rockaway Peninsula.

The Jamaica Bay Greenway Missing Links Study (NPS 2010g) identified a number of issues with the existing road infrastructure affecting both access and safety for pedestrians and bicyclists, including the following:

- High-volume, high-speed arterials with commercial traffic and conflicting turning movements
- Complex traffic weaving/merging
- Lack of signs and wayfinding to key destinations
- Lack of north/south connector roads accommodating to bicyclists and pedestrians
- One-way street patterns that make travel by bicycles circuitous and non-intuitive

Floyd Bennett Field

Private Vehicle and Waterborne Transportation Parking Facilities

Two large parking lots provide a total of 200 spaces at Ryan Visitor Center at Floyd Bennett Field. Informal parking also exists along the tarmac, taxiway, and runway areas. Parking areas are typically only fully utilized during special events. During extremely large special events, drivers are directed to park on runways and tarmac areas. Several thousand cars could be parked in this manner if desired.

According to traffic data collected in 2004 and compiled in the Jamaica Bay Transportation Studies report by Federal Highways Administration (FHWA 2006), Flatbush Avenue carries approximately 26,000 vehicles per day on weekdays and about 19,000 vehicles per day on weekend days. Excluding the summer season, there are approximately 1,600 vehicles per weekday entering/exiting Floyd Bennett Drive and about 1,000 vehicles per weekend day. During the summer months, traffic activity (exclusive of special events) can be up to 3,000 vehicles per day on both weekdays and weekend days. Typical peak hour traffic on Flatbush Avenue is 1,500 (AM) to 1,900 (PM) vehicles per day weekdays and 2,100 vehicles per day on Saturday midday. Peak hour traffic using Floyd Bennett Drive is 150 vehicles (AM) to 200 vehicles per day (PM). Saturday midday peak hour traffic is slightly more than 200 vehicles per day (FHWA 2006).

The Gateway Marina, adjacent to Floyd Bennett Field, provides 500 slips for private watercraft and includes picnic areas, restrooms, and shower facilities. Transient dockage is available daily, monthly, or for longer stays.

Public Transportation Services

One public city bus route (Q35) serves Floyd Bennett Field. This route travels south from Brooklyn, stops at the Brooklyn Marine Park located on the southwest side of Floyd Bennett Field and continues south terminating in Rockaway Park; northbound, it also stops near Aviator Complex. Bus service includes all weekends and holidays (with some service reductions on holidays).

Train access includes the Red/2 to Flatbush Avenue, Blue/A to Rockaway Park / Beach 116th Street. A transfer to the Q35 bus is required to access the park from either train stop. Train service includes all weekends and holidays (with some service reductions on holidays).

Figure 3-24 shows the location of these facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

The Belt/Shore Parkway Bikeway at the northern edge of Jamaica Bay connects to the Rockaway Greenway Bikeway, a paved multi-use path adjacent to Floyd Bennett Field and Jamaica Bay Wildlife Refuge. Biking is allowed on the Floyd Bennett Field historical runways and Fort Tilden trails. The Aviator Sports and Events Center (an NPS concessionaire) at

Floyd Bennett Field rents bicycles for $7 per day during spring and summer. The Jamaica Bay Greenway heads south from Floyd Bennett field and crosses the Marine Parkway Bridge (a "must walk" bridge) providing a linkage to Riis Landing. However, there is no separated multi-use path (Class I) connecting from Riis Landing to Riis Park.

Floyd Bennett Field has a designated launch and landing site for the New York City Water Trail.

Figure 3-24 shows the location of these facilities. Table 3-15 provides more detailed information.

Plumb Beach

Private Vehicle and Waterborne Transportation Parking Facilities

Plumb Beach is accessible by automobile via Belt Shore Parkway. There is a parking lot at Plumb Beach that NPS operates in partnership with New York City Parks. Plumb Beach is a designated launch site for the Jamaica Bay Kayak Trail.

Figure 3-24. Jamaica Bay Transportation Services and Facilities.

Table 3-15. Jamaica Bay Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes.

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Jamaica Bay Greenway		Parallel to Belt Parkway from Plumb Beach to 78th Street	Yes	NA	No	Yes	Multi-use	Paved	Yes
Floyd Bennett Field									
Hiking Trails		North Forty trail system, N end of Floyd Bennett Field							
No	Yes	Yes	Yes	Ped	Dirt	Yes			
Access Path		Goldenrod and Tamarack Campgrounds	No	No	No	Yes	Ped	Dirt	Yes
Hiking Trails		Saltmarsh, Express Return, and Milestone Trails, SW end of Floyd Bennett Field							
No	No	No	Yes	Ped	Dirt	Across Flatbush Dr at Ranger Station			
Bike Lane		Marine Parkway–Gil Hodges Bridge	Yes	Yes	No	Yes (must use sidewalk on W side)	Bike	Paved	Yes
Jacob Riis Park/Fort Tilden/Breezy Point Tip									
Access Path		Rockaway Point Yacht Club NE end of Breezy Point Tip	No	No	No	Yes	Ped	Paved	No
Hiking Trails		Maritime Forest Trail System, Fort Tilden	No	No	Yes	Yes	Ped	Dirt	Yes
Access Paths		10 paths on Atlantic side of Fort Tilden to beach	No	No	No	Yes	Ped	Sand	W side only
Boardwalk		Outside park; parallels Atlantic Ocean from Beach St 126 E to Beach St 80	No	No	No	Yes	Ped	Boardwalk	No

Table 3-15. Jamaica Bay Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes (continued).

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Boardwalk		S side Jacob Riis Park	No	No	No	Yes	Ped	Boardwalk	Yes
Jamaica Bay Wildlife Refuge									
Bike Lane		Cross Bay Veterans Memorial Bridge	Yes	Yes	No	No	No	Paved	Yes
Access Path		Visitor center	No	No	No	Yes	Ped	Dirt	Yes
Hiking Trails		W pond	No	Yes	Yes	Yes	Ped	Dirt/sand	Yes
Hiking Trails		E pond	No	Yes	Yes	Yes	Ped	Dirt/sand	Yes
Bike Lane		Frank M. Charles Memorial Park	Yes	Yes	No	No	Bike	Paved	Yes

NA = not applicable; N = north; ped = pedestrian; SW = southwest; W = west; NE = northeast; E = east; S = south

Jamaica Bay Wildlife Refuge

Private Vehicle and Waterborne Transportation Parking Facilities

Private vehicles can park at the visitor center for the Jamaica Bay Wildlife Refuge. No overflow lots or other informal parking spaces are available, which puts a strain on the existing facilities when the main lot is full.

Public Transportation Services

The Cross Bay Boulevard is a major four-lane arterial in the Broad Channel neighborhood that connects the Jamaica Bay Wildlife Refuge to the New York City Transit Broad Channel station and the Veterans Memorial Bridge. The Veterans Memorial Bridge leads to the Rockaways and connects to NPS districts around Jamaica Bay.

Two limited-stop bus routes, Q52 and Q53, provide access to the refuge from the same bus stop immediately adjacent to the visitor center entrance. Bus service includes all weekends and holidays (with some service reductions on holidays). The Q52 travels between Elmhurst in Queens and Arverne near Rockaway Park. The Q53 travels between Woodside, Queens, and Rockaway Park.

Train access includes the Blue/A to Broad Channel Station in conjunction with a 0.75-mile walk to the park. Train service includes all weekends and holidays (with some service reductions on holidays). Damage to the A Line track bed, signal, power, and communication systems from Hurricane Sandy forced a complete shutdown of the train service in the immediate aftermath of the hurricane. ~~Work is currently underway to restore A Line service to the Rockaways; the MTA is aiming for a summer restoration~~. The two major breaches have been rebuilt and the railroad tracks have been fully restored. All structurally compromised areas have been fixed and major work continues on refurbishing critical operational systems for signals, communications, power, and electrical (MTA n.d.).

Figure 3-24 shows the location of these facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

Bicycle lanes and a paved multi-use pathway next to Cross Bay Boulevard provide bicycle and pedestrian access to the refuge. A two-way multi-use path parallel to Cross Bay Boulevard is available for cyclists and pedestrians traveling to the Jamaica Bay Wildlife Refuge. Additionally a boardwalk edges the East Pond. Given gaps in the bike infrastructure south of Veterans Memorial Bridge there is limited connectivity between the refuge and the Rockaway peninsula. Proposed improvements to establish bike routes and lanes south of the bridge would allow for greater connectivity to Riis Park via Rockaway Beach Boulevard.

Figure 3-24 shows the location of these facilities. Table 3-15 provides more detailed information about them, which was gathered prior to Hurricane Sandy.

Jacob Riis Park/Fort Tilden/Breezy Point Tip

Private Vehicle and Waterborne Transportation Parking Facilities

Jacob Riis Park provides one large parking lot with over 5,000 spaces. The parking lot is significantly over sized and does not fill up even on busy summer weekends.

Jacob Riis Park generates 100 vehicular trips (65 entering and 35 exiting) during the weekday morning peak hour and 210 trips (60 entering and 150 exiting) during the weekday evening peak hour (2006 FHWA). During the Saturday midday peak hour, the Park generates 540 vehicular trips (450 entering and 90 exiting). Approximately 30 percent of the traffic to the Jacob Riis Park beach area arrives from the east and most vehicles use Rockaway Beach Boulevard. On Saturday midday, the hourly volumes on Rockaway Beach Boulevard are approximately 500 vehicles, including 150 (30%) that are related to Jacob Riis Park beach activities (2006 FHWA).

Two kayak launch spots are located in Jacob Riis Park: Riis Landing and Rockaway Point Yacht Club. Riis Landing is centrally located on the northern side of the park near the Marine Parkway Bridge. Rockaway Point Yacht Club is located on the northwestern edge of the park. No water access is provided at Breezy Point or Fort Tilden (NPS n.d.k).

Public Transportation Services

The Q35 provides bus service from Brooklyn to Jacob Riis Park, continuing eastbound along Rockaway Beach Boulevard to Rockaway Park. The Q22 provides bus service between Rockaway Point and Jacob Riis Park, continuing across the Rockaway Peninsula to Rockaway Park and Far Rockaway. Bus service includes all weekends and holidays (with some service reductions on holidays).

Train access includes the Red/2 to Flatbush Avenue and the Blue/A to Rockaway Park / Beach 116th Street. These train routes require taking the Q35 bus from either location or the Q22 bus from Rockaway Park / Beach 116th Street. Train service includes all weekends and holidays (with some service reductions on holidays).

Figure 3-24 shows the location of these facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

Jacob Riis Park contains two sections of the Jamaica Bay Greenway multi-use path. The greenway is an off-street path for cyclists and pedestrians that serves as a bicycle commuter path for local residents. One section travels along the northern edge of Jacob Riis Park parallel to Beach Channel Drive. This section extends from the eastern boundary of Jacob Riis Park to Marine Parkway Bridge, where it continues north across the bridge toward Floyd Bennett Field and south along Beach 169th Street to connect with the Jacob Riis Park Promenade section. Cyclists must dismount on the bridge (Jamaica Bay Greenway Missing Link Study 2010).

Jacob Riis Park contains two sections of the Jamaica Bay Greenway multi-use path. The greenway is an off-street path for cyclists and pedestrians that serves as a bicycle commuter path for local residents.

The Jacob Riis Park Promenade is a boardwalk in the southern portion of Jacob Riis Park. This section of the boardwalk extends east from the Jacob Riis Park boundary and terminates at Beach 193rd Street. The boardwalk suffered damage during Hurricane Sandy; further assessment is needed to identify any safety hazards to visitors (IMT 2012j). A short path also veers north from the promenade at Haan Road to terminate at Steele Road (RPA 2012).

A "protected bike path" connects to the Jamaica Bay Greenway at the intersection of Beach 169th Street and Rockaway Point Boulevard. Per the Regional Plan Association for New York, New Jersey, and Connecticut, a protected bike path is differentiated from a bicycle lane, which is defined as an "on-street striped route," and from a shared lane, which is defined as an "on-street marked route." Therefore, it is assumed that a protected bike path is a Class I separate facility (RPA 2012). The bike path extends approximately 4 miles east to the Fort Tilden park boundary. The bike path was covered in sand by Hurricane Sandy (IMT 2012j).

Figure 3-24 shows the location of these facilities. Table 3-15 provides more detailed information.

Riis Landing

Private Vehicle and Waterborne Transportation Parking Facilities

Riis Landing provides one 84-space parking lot for the entire site. This lot is generally not heavily used nor filled given the relatively low level of activity that currently occurs on the landing. It is only during a marine charter excursion, that the parking lot fills and visitors must park across Rockaway Point Boulevard in one of the parking lots located at Fort Tilden (2006 FHWA).

Fort Tilden parking areas are used when the Riis Landing parking is full. Fort Tilden's T-4 parking lot is used for after-school activities and during evenings. Daytime restrictions on the T-4 lot discourage use.

Figure 3-24 shows the location of these facilities.

Canarsie Pier is a popular local fishing location and offers several recreational opportunities, such as seasonal kite-flying activities, youth group paddling, and a summer concert series.

Public Transportation Services

The Q35 bus route provides bus service from Brooklyn to Jacob Riis Park, continuing eastbound along Rockaway Beach Boulevard to Rockaway Park. The Q22 bus route provides bus service between Riis Landing and Rockaway Point, continuing northbound across Broad Channel into Queens. The New York Water Taxi travels between Riis Landing, Brooklyn Army Terminal (Bay Ridge), and Pier 11 Wall Street. The Water Taxi operates weekdays throughout the year. The New York Beach Ferry also provides service to Riis Landing on summer weekends and holidays. Connections are available from Pier 11, which is near South Street Seaport, Manhattan, and a short walk from Wall Street. Ferry service has been inconsistent and caters to different travel markets (e.g., visitor and commuter). Current facilities lack appropriate access and parking to support increased use.

Figure 3-24 shows the location of these facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

Riis Landing contains two sections of the Jamaica Bay Greenway multi-use path mentioned under "Jacob Riis Park/Fort Tilden/Breezy Point." A protected bike path connects to the Jamaica Bay Greenway at the intersection of Beach 169th Street and Rockaway Point Boulevard. The bike path extends approximately 4 miles east to the Fort Tilden park boundary (RPA 2012).

Figure 3-24 shows the location of these facilities. Table 3-17 provides more detailed information.

Canarsie Pier

Canarsie Pier is a popular local fishing location and offers several recreational opportunities, such as seasonal kite-flying activities, youth group paddling, and a summer concert series. NPS rangers lead paddling trips from a kayak launch and provide fishing demonstrations (NYHP 2012).

Private Vehicle and Waterborne Transportation Parking Facilities

Canarsie Pier is located on Brooklyn's mainland, allowing for more direct access than some other districts. The pier is immediately adjacent to the Belt Parkway where it intersects Rockaway Parkway. The pier provides parking for approximately 300 private vehicles.

Public Transportation Services

The B42 bus route travels Rockaway Parkway from the L subway station to Canarsie Pier and back. The B42 bus route operates daily, all times. Train access includes the Gray/L to Rockaway Parkway in conjunction with the B42 bus to the pier entrance.

Figure 3-24 shows the location of these facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

The ~~Rockaway Gateway~~ Jamaica Bay Greenway parallels the Belt Parkway and Jamaica Bay's shoreline, providing a connection to Canarsie Pier from the north and south. No hiking trails or paths exist in the Canarsie Pier district itself. Recreational kayakers can paddle a loop route into the bay from Canarsie Pier. No designated blueways connect the pier to other areas. However, paddlers could connect with kayak launches at Floyd Bennett Field southwest of Canarsie Pier and Jamaica Bay Wildlife Refuge east of Canarsie Pier.

Figure 3-24 shows the location of these facilities. Table 3-15 provides more detailed information about them, but reflects pre-Sandy conditions.

Staten Island Unit

The Staten Island Unit is on the southeastern shore of Staten Island in Lower New York Bay and includes Fort Wadsworth, Miller Field, and Great Kills Park.

Fort Wadsworth

On the easternmost tip of Staten Island, Fort Wadsworth is bisected by the Verrazano-Narrows Bridge, which connects the island to Brooklyn. Visitors access Fort Wadsworth via private car, city bus, or bicycle, or on foot. No internal shuttle service is provided within the site. Fort Wadsworth is not accessible by water and no functional dock exists to facilitate water access.

Private Vehicle and Waterborne Transportation Parking Facilities

Interior roads in Fort Wadsworth are closed to private vehicles. Four visitor parking lots are provided for visitors traveling from New York Avenue and USS North Carolina Road; two are paved and two are composed of gravel or gravel and grass. No water access is provided, although there is a non-functional dock known as Torpedo Wharf that could be used for watercraft. The dock is west of the Verrazano-Narrows Bridge and Battery Weed. The National Parks of New York Harbor Conservancy offers a "Gateway to America" water tour created by the conservancy and the NPS. Although this tour includes the Statue of Liberty, Brooklyn Bridge, Ellis Island, and the Narrows between Staten Island and Brooklyn, it does not include Fort Wadsworth (NYHP 2010). However, the conservancy's "America's Frontline" tour does feature Fort Wadsworth.

Public Transportation Services

Two public city bus routes, the S51 and S81, travel through Fort Wadsworth along Battery Road and New York Avenue. The S51 operates daily between Lincoln Ave/Richmond Rd and the St. George Terminal via Fort Wadsworth between 6:00am-7:00pm. During the weeday afternoon peak perio, the S81 runs limited-stop from the St. George Ferry Terminal to Lincoln Ave/Richmond Rd via Fort Wadsworth. Although the S51 operates 24 hours, the segment through Fort Wadsworth only operates during the span mentioned above. Also the

S81 only operates during the peak afternoon period. Route S53 and express routes X4, X5, X7 and X8 are near the park, with stops at the intersection of Lily Pond Avenue and Battery Road. The express routes travel between Staten Island and Manhattan and operate on weekdays only; the other routes operate 24 hours daily. Schedules vary, with more frequent service during morning and afternoon rush hours. Only folding bicycles are allowed aboard local and limited Staten Island buses, and a $5 lifetime bicycle permit is required. The Staten Island Ferry does accommodate bicycle use.

The Staten Island Railway stops at the town of Clifton, north of Fort Wadsworth at Bay Street, where the S51/S81 bus routes also stop. Visitors traveling by train could take the S51 or S81 bus from the Clifton train stop into Fort Wadsworth or could cycle along the Class 3 bicycle route that follows Bay Street to the park site. Standard bicycles are not allowed on the Staten Island Railway trains during morning and afternoon rush hours, although folding bicycles are allowed on trains at all times. Train schedules vary from approximately every 5 to 10 minutes during the morning/evening rush hour to every 30 minutes other times during weekdays. Train schedules are approximately every 30 or 60 minutes on weekends.

No public water access is provided to or from Fort Wadsworth, although Torpedo Wharf could be used for public ferries. Figure 3-25 shows the location of these services.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

An unmarked paved walking route leads to Mont Sec History House; Batteries Catlin, Weed, Bacon, Turnbull, Barbour, and Duane; the overlook; Fort Tompkins; and Camp Hudson. The route follows a paved sidewalk and paved roadway (authorized vehicles only). Several dirt access paths provide access to designated fishing areas on the southeast side of the park.

The New York City Greenway, a paved multi-use path, enters the southernmost corner of the park, connecting Miller Field to Fort Wadsworth. This path suffered damage from Hurricane Sandy, particularly to the pavement, drainage, and guardrails (IMT 2012j). Several additional bicycle lanes or routes exist or are proposed for the area (described under “Cumulative Impacts” in the “Environmental Consequences” chapter). An existing Class 3 bicycle route enters Fort Wadsworth from the north on Bay Street, which becomes New York Avenue once inside the park. A Class 2 bicycle lane follows Father Capodanno Boulevard from Midland Avenue, just north of Miller Field, to Lily Pond Avenue, which traverses Fort Wadsworth’s western boundary. This bicycle lane connects with the Class 3 route on Bay Street mentioned above. While biking is popular at Fort Wadsworth, there are no bicycle parking facilities in Fort Wadsworth.

Figure 3-25 shows the bike paths, greenways, blueways, hiking trails, and pedestrian routes for this unit. The map key symbols correspond to Table 3-15, which provides more detailed information about these facilities (gathered prior to Hurricane Sandy).

Figure 3-25. Fort Wadsworth Transportation Services and Facilities.

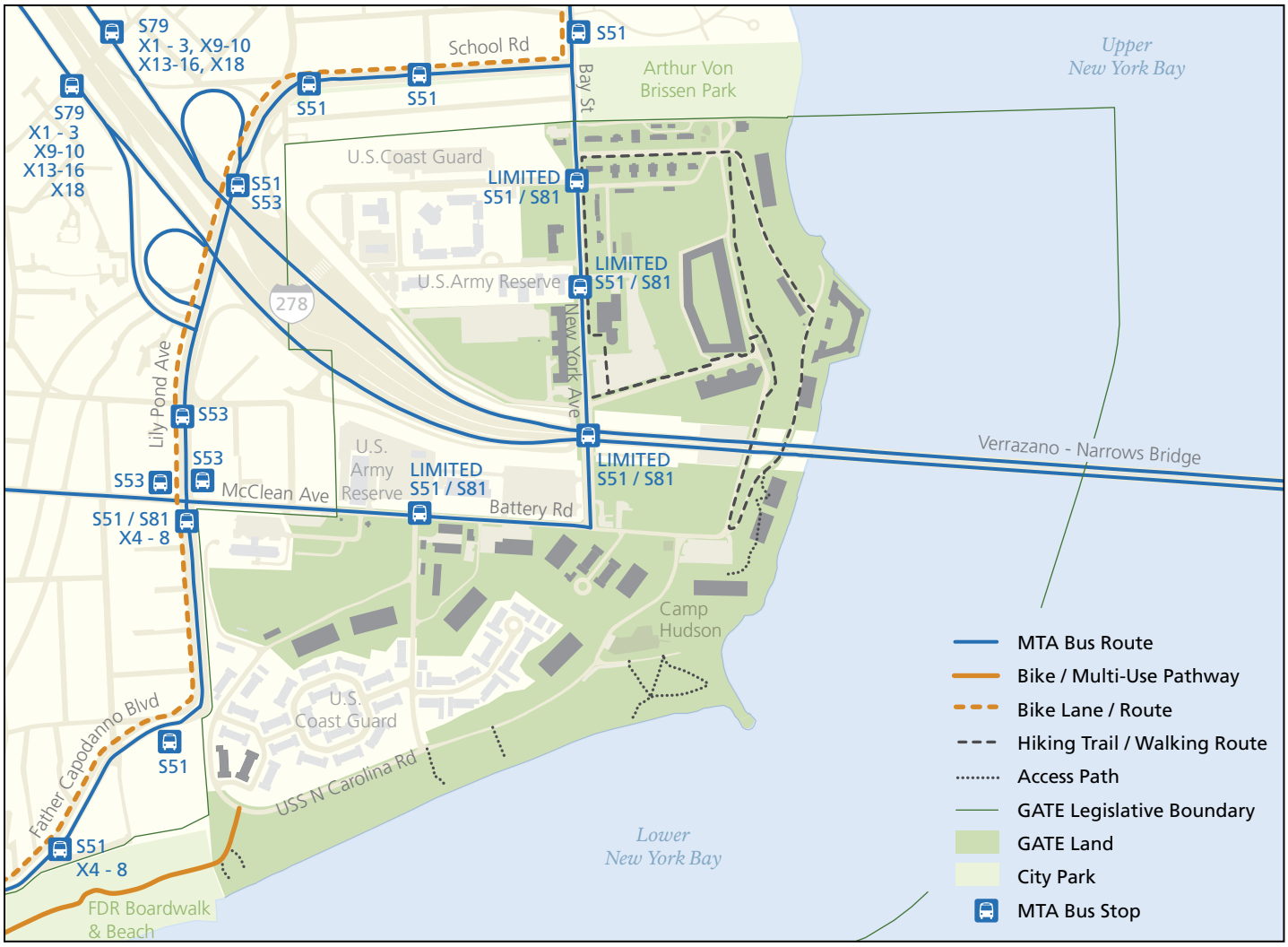


Table 3-16. Fort Wadsworth Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes.

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Walking Route		Begins/ends B120 parking lot	Yes	No	No	Yes	Ped	Sidewalk + paved	Yes
Access Path		On walking/ biking route – S of Battery Barbour	No	No	No	Yes	Ped	Dirt	No
Gravel Drive		Range Road – parking lot	No	No	No	Yes	Ped	Gravel	Yes
Access Path		Range Road – parking lot	No	No	No	Yes	Ped	Dirt	Yes
Access Path		Range Road – parking lot	No	No	No	Yes	Ped	Dirt	No
Access Path		Range Road – parking lot	No	No	No	Yes	Ped	Dirt	No
Access Path		USS NC Rd – S of Battery Dix	No	No	No	Yes	Ped	Dirt	No
Access Path		USS NC Rd – N of USS TN Rd	No	No	No	Yes	Ped	Dirt	No
Bike Path (New York City Green-way)		USS NC Rd – S of USS TN Rd	Yes	Yes	No	Yes	Multi-Use	Paved	No
Access Path		Bike path – S of USS NC Rd	No	No	No	Yes	Ped	Sand	No
Access Path		Bike path – S of access path	Yes	No	No	Yes	Ped	Sand	No
Proposed Bike Route		Proposed bike route through park	Yes	Yes	No	NA	Bike	Paved road	No
Class 2 Bike Lane		Existing Class 2 bike lane W of park	Yes	No	No	NA	Bike	Paved road	No
Class 3 Bike Route		Existing Class 3 bike route N of park	Yes	No	No	NA	Bike	Paved road	No

S = south; ped = pedestrian; USS NC = USS North Carolina; N = north; USS TN = USS Tennessee; NA = not applicable; W = west

Miller Field

South of Fort Wadsworth, Miller Field is home to a variety of sports fields, a bocce court, playgrounds, and picnic area. Recreation is the focus at Miller Field, particularly team sports. Like Fort Wadsworth, Miller Field can be accessed via private car, city bus, or bicycle, or on foot.

Private Vehicle and Waterborne Transportation Parking Facilities

Nine visitor parking lots, all of which are paved, exist at Miller Field. Traffic congestion forms at Miller Field during parking lot turnover, creating a line of cars waiting to enter and exit the park. None of the parking lots required permits, although sports groups needed a permit to use the site's facilities. According to the Gateway State of the Park 2008, the parking facilities have been renovated, allowing easy access to the sports fields. No water access is provided (NPS 2008).

Public Transportation Services

One limited-stop bus, the S76/S86, travels between Oakwood Beach and the St. George Ferry Terminal. No bus routes enter Miller Field, unlike Fort Wadsworth. Other routes travel nearby on Hylan Boulevard, stopping where it intersects New Dorp Lane: the S78, S79, and express routes X1, X2, X3, X8, and X9. The X1 epxress route operates weekdays, Saturdays, and Sundays. The S78 route travels between Tottenville and Saint George Ferry Terminal. The S79 Select Bus Service (SBS) travels between the Staten Island Mall and the Bay Ridge in Brooklyn. The express routes travel between Staten Island and Manhattan and operate on weekdays only; the other routes operate daily. Schedules vary, with more frequent service during morning and afternoon rush hours. Bicycle restrictions and transit services are as described for Fort Wadsworth.

The Staten Island Railway stops where the rail line intersects New Dorp Lane. Visitors traveling by train could take the S76/S86 bus from the train stop directly to either of the Miller Field park entrances. Bicycle restrictions and train schedules are as described for Fort Wadsworth. No public water access is provided to or from Miller Field. Figure 3-26 shows the location of these services.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

Several segments of walking routes and access paths exist in Miller Field. Like Fort Wadsworth, numerous access paths lead to fishing locations along the coastline, but no water access and no public docks are provided. A gravel road, used for hiking, begins at Miller Field's northeast entrance near the visitor's contact station and leads to the swamp white oak forest at the park's northwestern corner. This route was in fair condition prior to the hurricane. Where the gravel road ends, a fire road continues farther into the forest.

Figure 3-26. Miller Field Transportation Services and Facilities.

An access path leads from Memorial Circle, where the New York City Greenway begins, to Shore Road. Several access paths lead to the designated fishing area along Lower New York Bay. These paths filled with sand during the hurricane (IMT 2012j).

The New York City Greenway multi-use path begins and ends at Miller Field, paralleling the Lower New York Bay north to Fort Wadsworth. The greenway enters Miller Field near Memorial Circle in the northeast corner of the park, where the route begins and ends. As mentioned above, this route provides a connection to Fort Wadsworth. Figure 3-26 shows the location of these facilities. Table 3-16 provides more detailed information.

Table 3-17. Miller Field Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes.

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Bike Path (New York City Greenway)		Bike path – N of Memorial Circle	Yes	Yes	No	Yes	Multi-use	Paved	Yes
Access Path		Swamp white oak forest	No	No	No	Yes	Ped	Other – dirt	No
Access Path		NW of Shore Rd	No	No	No	Yes	Ped	Paved	Yes
Access Path		Parallel to Shore Rd	No	No	No	Yes	Ped	Paved	No
Access Path		SE of Memorial Circle	No	No	No	Yes	Ped	Sand	No
Access Path		Access from access path	No	No	No	Yes	Ped	Sand	No
Access Path		Access from access path	No	No	No	Yes	Ped	Sand	Yes
Access Path		Access from access path	No	No	No	Yes	Ped	Sand	No
Access Path		Access from access path	No	No	No	Yes	Ped	Sand	No
Access Path		NE from parking lot	No	No	No	Yes	Ped	Sand	No
Access Path		NE from parking lot	No	No	No	Yes	Ped	Sand	No
Access Path		NE of historic hangars	No	No	No	Yes	Ped	Sand	No
Access Path		E of historic hangars	No	No	No	Yes	Ped	Sand	No
Access Path		Access from access path	No	No	No	Yes	Ped	Sand	No
Gravel Road		N end of park	No	No	No	Yes	Ped	Gravel	No
Class 2 Bike Lane		Existing Class 2 bike lane N of park	Yes	No	No	NA	Bike	Paved road	No
Proposed Bike Route		Proposed bike route S of Miller Field	Yes	No	No	NA	Bike	Paved road	No
Proposed Bike Route		Proposed bike path from New York City Greenway S to Oakwood Beach	Yes	Yes	No	NA	Bike	Paved road	No

N = north; ped = pedestrian; NW = northwest; SE = southeast; NE = northeast; E = east; NA = not applicable; S = south

Great Kills Park

Great Kills Park is on a peninsula that features an inlet harbor, barrier ocean beach, and open space. Like Fort Wadsworth and Miller Field, Great Kills Park can be accessed via private car, city bus, or bicycle, or on foot. Waterways and water access are crucial components of this Staten Island site, unlike Fort Wadsworth and Miller Field.

Private Vehicle and Waterborne Transportation Parking Facilities

Several paved and gravel lots, some requiring permits, provide parking at Great Kills Park. Parking lots provide access to boating, fishing, trailheads, and an educational field station. Prior to the hurricane, a total of 15 parking facilities were available to visitors, although the lot at the model airplane flying field and at ball fields 1, 2, and 3 were closed due to environmental contamination issues (radiation). ~~Two standard bicycle racks—one at the educational field station and one north of Nichols Marina—were provided.~~ The "Entrance Parking East" lot is not on NPS property and is maintained by the city. Two lots at Crooke's Point require permits.

No public watercraft access, such as a public ferry, is provided. Prior to Hurricane Sandy, Great Kills Park provided watercraft access and docking facilities at Nichols Marina for private boaters. The marina was open only to slip leaseholders. A boat ramp was also provided for visitors to the northeast of the marina. Hurricane Sandy damaged the marina in 2012; the permanent docks are now gone. Most of the boats that were moored at the docks were badly damaged or lost. ~~A floating pile of debris at the boat ramp was the responsibility of the New York Department of Environmental Compliance, which is also planning for its removal. Up to 13 boats are sunk in the water next to the Great Kills shoreline and are the responsibility of the U.S. Coast Guard to retrieve and remove. Numerous boats on the Great Kills beaches are the responsibility of the individual owners to retrieve and remove. The NPS has provided supervision for removal by private towing companies thus far.~~ The parking lot and roadway to the marina were also heavily damaged (IMT 2012j).

New York City established a temporary ferry to Manhattan from Great Kills as a result of Hurricane Sandy. Launched on November 25, 2012, the temporary ferry service from Great Kills to Manhattan brought relief to, and eased the commutes of, neighborhoods that saw some of the worst damage from Hurricane Sandy. The schedule ran from Great Kills Park to Pier 11 at Wall Street, continuing on to 35th Street. Vessels left from a newly installed temporary landing near the marina in Great Kills Park along Buffalo Street, and three parking areas in Great Kills Park were available to ferry riders arriving by car. Additionally, a shuttle bus provided by New York City Transit links the ferry landing with the S78 and SBS S79 bus stop at Buffalo Street and Hylan Boulevard and parking areas. The ferry service concluded January 25, 2013, and there are no plans to extend the service at this time (NYCDOT 2013).

Public Transportation Services

Several public city bus routes travel Hylan Boulevard, which parallels Great Kills Park's northwestern boundary, stopping at the park entrance and at an access path into the park. These routes include S78 and S79 Select Bus Service (SBS), described under "Miller Field," and express routes X1, X4, X5, X7, X8, and X24.The express routes travel between Staten Island and Manhattan and operate on weekdays only; the other routes operate daily. The X1 express route operates weekdays, Saturdays and Sundays. Schedules vary, with more frequent service during morning and afternoon rush hours. Bicycle restrictions are as described for Fort Wadsworth.

The Staten Island Railway stops where the rail line intersects Bay Terrace Avenue, which is northwest of the park. However, no bus routes access this train stop. Train users with bicycles could potentially cycle along roads that are not official bicycle lanes or routes to the proposed bicycle route that would follow Hylan Boulevard to the park entrance. Bicycle restrictions and train schedules are as described for Fort Wadsworth. Figure 3-27 shows the location of these facilities.

Figure 3-27. Great Kills Park Transportation Services and Facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

A combined paved and gravel (wheelchair-accessible) multi-use path begins at the entrance to Great Kills Park, roughly following Buffalo Street and extending 1.5 miles to the swimming beach and Nichols Marina. The path offers opportunities for walking, jogging, cycling, and rollerblading. As a result of the hurricane, erosion of sand near the walkway is a potential hazard to path users but could be mitigated through sand relocation. An area of approximately 150 feet was washed out or damaged during the storm, posing a potential safety risk to community users. The Blue Dot Trail, a 1.5-mile path paralleling Hylan Boulevard along the park's northwestern boundary, offers views of diverse wildlife and natural habitats (NYHP 2009). A footbridge near Hylan Boulevard needs to be assessed for damage from the hurricane (IMT 2012j). Three additional hiking trails exist at Crooke's Point on the tip of the Great Kills Peninsula: White Trail, Orange Trail, and Yellow Trail. Access paths extend from the White Trail and the parking lots (by permit only) in this area to fishing areas that surround the peninsula. Other access paths in the park provide access to the bay or harbor. However, the access path from ball field 3 to the Blue Dot Trail is currently closed due to radiation (see "Health and Safety" in this chapter for more information). Trail repairs and bike path repaving due to Hurricane Sandy began in the winter and will continue until they are complete.

The New York City Water Trail (New York City Water Trail) also designates a kayak landing area at Great Kills Park district, without identifying a specific location (NYCDPR n.d.). Figure 3-27 shows the location of these facilities.

Table 3-18. Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes.

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Multi-use Path		Hylan Blvd and Buffalo St	Yes	No	No	Yes	Multi-use	Paved	Yes
Access Path		Parking Area A	No	No	No	Yes	Ped	Other – dirt	Yes
Access Path		S of beach center	No	No	No	Yes	Ped	Sand	Yes
Access Path		S of access path	No	No	No	Yes	Ped	Sand	Yes
Access Path		S of access path	No	No	No	Yes	Ped	Sand	Yes
Access Path		S of access path	No	No	No	Yes	Ped	Sand	Yes
Access Path		Crooke's Point Parking Lot	No	No	No	Yes	Ped	Sand	Yes
Access Path		Crooke's Point Parking Lot	No	No	No	Yes	Ped	Sand	Yes
Access Path		Crooke's Point Parking Lot	No	No	No	Yes	Ped	Sand	Yes
Access Path		Crooke's Point Parking Lot	No	No	No	Yes	Ped	Sand	Yes
Hiking Trail		White Trail	No	No	Yes	Yes	Ped	Other – dirt	Yes
Access Path		Access from hiking trail	No	No	No	Yes	Ped	Other – sand	No

Table 3-18. Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes (continued).

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Hiking Trail		Orange Trail	No	No	No	Yes	Ped	Other – dirt	No
Hiking Trail		Yellow Trail	No	No	No	Yes	Ped	Other – dirt	Yes
Hiking Trail		Crooke's Point Parking Lot	No	No	No	Yes	Ped	Other – dirt	Yes
Access Path		Crooke's Point Harbor Parking Lot	No	No	No	Yes	Ped	Other – dirt	Yes
Access Path		Overflow launch/ trailer parking	No	No	No	Yes	Ped	Other – dirt	Yes
Access Path		Buffalo St	No	No	No	Yes	Ped	Crushed gravel	Yes
Access Path		Education Field Station	No	No	No	Yes	Ped	Crushed grave	Yes
Hiking Trail (Blue Dot Trail)		Hylan Blvd/Buffalo St Entrance to Bulkhead Rd	No	No	No	Yes	Ped	Other – dirt, paved	Yes
Access Path		Access from Hylan Blvd to Blue Dot Trail	No	No	No	Yes	Ped	Paved	No
Access Path		Blue Dot Trail to Ball Field 3 Parking Lot	No	No	No	Yes	Ped	NA	Yes
Access Path		NW park boundary and Wetland Rd	No	No	No	Yes	Ped	Crushed gravel	No
Class 3 Bike Route		Proposed bike route on Hylan Blvd	Yes	No	No	NA	Bike	Not yet developed	No
Proposed Bike Route		Proposed bike path through park	Yes	No	No	NA	Bike	Not yet developed	No
Class 3 Bike Route		Proposed bike route on Mansion Ave (outside park)	Yes	No	No	NA	Bike	Not yet developed	No

Ped = pedestrian; S = south; NA = not applicable

Sandy Hook Unit

Gateway's Sandy Hook Unit is a barrier beach peninsula on the northern tip of the New Jersey shore. Like the Staten Island sites, Sandy Hook is primarily accessed via private car, by bicycle, or on foot. In addition, prior to Hurricane Sandy, a seasonal (summer-only) ferry provided access between the Fort Hancock Historic District and Manhattan. A shuttle bus connection took visitors from the ferry landing to attractions throughout the park and back.

Sandy Hook was perhaps the most damaged unit of Gateway by Hurricane Sandy in 2012. A 13-foot storm surge washed over Sandy Hook, depositing 5-foot drifts of sand along 3 miles of the main road (Foderaro 2012). Restoration work to date has included clearing roads and trails, stabilizing park facilities, and redistributing sand that had filled roadways and parking lots. Due to the extensive damage resulting from Hurricane Sandy, the Sandy Hook Unit was closed to the public until park facilities were restored in May 2013 (IMT 2012a).

Private Vehicle and Waterborne Transportation Parking Facilities

Within the Fort Hancock Historic District in Sandy Hook prior to Hurricane Sandy, 8 visitor parking facilities were provided, with an additional 13 facilities outside Fort Hancock, for a total of 21 parking facilities. Two of these facilities—one at the visitor center and one at Gunnison Beach—provided bicycle parking, offering a total of 11 spaces. The majority of Sandy Hook's car parking lots required permits. Visitors accessing the fishing beach on the ocean side just north of the visitor center parked along a paved road leading from Hartshorne Drive. However, Hartshorne Drive was damaged by Hurricane Sandy and the road edge was in need of repair. Parking lots provided access to boating, fishing, trailheads, and an educational field station. Parking near Pennington Drive in Fort Hancock was in fair condition prior to Hurricane Sandy, showing some cracks and shallow holes in the pavement. Some of the lots in Fort Hancock, particularly overflow lots, were gravel and were heavily damaged by the storm (IMT 2012j).

Although the park includes more than 4,000 parking spaces at highly visited beaches and concessions, as well as approximately 900 spaces elsewhere (primarily at Fort Hancock and fishing access at Parking Lot F), the current parking supply is not sufficient to serve all of Sandy Hook's recreational visitors on peak summer weekends. During these times, vehicles approaching the park back up past the Shrewsbury Bridge into Highlands and Sea Bright, congesting local streets, blocking driveways, and increasing safety, air quality, and noise pollution problems. Regional traffic congestion becomes an even bigger issue when the park reaches capacity, because vehicles on Route 36 need to turn around and leave the Sandy Hook area when parking areas fill and the park gates are closed. Parking Area D, where long lines of cars form, is particularly problematic because many traffic-related incidents occur due to high turnover caused by the area's proximity to the primary beach concession area. Park rangers are required to direct traffic at Parking Area D when long lines of traffic there and on Hartshorne Drive become an issue. Hartshorne Drive becomes congested in the evening as beachgoers from the northern areas of the park leave for the day (Volpe Center 2003).

Although no private watercraft docking facilities are provided, Sandy Hook did provide public watercraft access prior to Hurricane Sandy. A seasonal ferry traveled between the Fort Hancock Historic District and Manhattan during the summer. Fares were approximately $40 round-trip. Repairing the docks was a high priority, and the ferry is once again operational during the summer months (IMT 2012j).

The NPS removed the one-sided barge that was in place at the Sandy Hook Bay Ferry Landing in Fort Hancock in 2009. Currently, there is a new NPS-owned barge/dock. The park began preparing an environmental assessment in 2009 for a new pier with wave attenuation devices, a floating ferry dock, improved parking, and a waiting area for ferry passengers. The new pier would be placed in the same location as the existing pier and barge, behind the Fort Hancock Chapel (NPS 2009i). As of July 2013, these facilities have not yet been built. Figure 3-28 shows the location of these facilities.

Public Transportation Services

Two bus routes—Academy route 36 and New Jersey Transit route 834—travel to the town of Highlands on the mainland near Sandy Hook. Route 36 travels between Long Branch, which is directly south of Sandy Hook, and the Port Authority. Route 834 travels between Red Bank, which is southwest of the park, and Highlands. Bicycles are permitted at all times on buses with bicycle racks on the front or with underfloor luggage compartments on a first-come, first-served basis. Currently half of the New Jersey Transit bus fleet is "bike friendly." Bicycles are not permitted on articulated buses.

Unlike the Staten Island Unit, which has bus routes immediately adjacent to park site boundaries, Sandy Hook has bus routes that approach the park unit but visitors need additional transportation to and through the park. Visitors dropped off near the park entrance would have to walk 2 miles to the nearest bathing beach (Volpe Center 2004).

The North Jersey Coast Line provides train service to the town of Red Bank, which is southwest of the park. Visitors accessing the park by train then have to transfer to bus route 834 to Highlands. However, as described above, no public transportation is available from Highlands to or through Sandy Hook. Collapsible bicycles are accommodated on all New Jersey Transit trains at all times. Standard-frame bicycles are permitted only in accessible cars except during rush hour, on holidays, on the days prior to holidays, and on the Friday after Thanksgiving. There is a limit of two bicycles or Segway® Personal Transporters per accessible car. There is no additional charge for bringing a bicycle on a train.

Public ferries access the town of Highlands and nearby Atlantic Highlands, traveling to and from various destinations in Manhattan. These ferries, some of which are private charters, operate year-round with varying frequency. However, once arriving in Highlands, no public transportation is available from Highlands to or through Sandy Hook.

A seasonal public ferry with a capacity of 400 people operates during the summer between a ferry landing at Fort Hancock and Manhattan. Visitors arriving by ferry at Fort Hancock can take a shuttle bus from the Fort Hancock Ferry Landing to the Fort Hancock Museum, North Beach, Gunnison Beach, and Beach Area E. The shuttle provides a connection to the multi-use pathway that runs most of the length of the peninsula. The shuttle bus does not travel to the entrance gate to transport visitors into the park. Figure 3-28 shows the location of these facilities.

Figure 3-28. Sandy Hook Transportation Services and Facilities.

Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes

A multi-use pathway starts at Sandy Hook's entrance, following Hartshorne Drive and ending in Fort Hancock. The NPS provides mobile bicycle racks at all beach locations when needed. The multi-use pathway was ruptured in several locations during Hurricane Sandy in 2012, but has since reopened (IMT 2012j). Prior to the hurricane, the multi-use pathway was being expanded to loop around Fort Hancock. Phases 1 and 2A of the pathway were complete. The first phase of the multi-use pathway, completed in 2004, was approximately 5.5 miles in length and provided non-motorized access from Sandy Hook's entrance to the Fort Hancock Ferry Landing. Phase 2A, which was completed in 2008 and 2009, added approximately 3.1 miles of trail and created a loop between the North Beach Plaza, the Gunnison Beach Plaza, and the Mortar Battery at Fort Hancock (NPS 2012h).

Hiking trails begin at the Sandy Hook visitor center and Area M near Nine-Gun Battery just north of Fort Hancock, which is a loop near North Pond. Several paths provide foot access to beach and fishing locations, including Gunnison Beach and North Beach. Sidewalks parallel some roads in Fort Hancock. Many of these trails and some boardwalks were damaged during Hurricane Sandy and needed repair. The NPS expects to reopen trails and fishing areas for summer 2013 (IMT 2012j).

Figure 3-28 shows the location of these facilities. Table 3-19 provides more detailed information about them, which was gathered prior to Hurricane Sandy.

Table 3-19. Sandy Hook Bike Paths, Greenways, Blueways, Hiking Trails, and Pedestrian Routes.

Type		Location	Biking	Greenway Access	Hiking	Walking	Mode	Surface Type	Parking
Multi-use Path		Fee Plaza (Main Gate) to Parking Lot I	Yes	No	No	Yes	Multi-use	Paved	Yes
Hiking Trail		Old Dune Trail	No	No	Yes	Yes	Ped	Sand	Yes
Access Path		Visitor center	No	No	No	Yes	Ped	Boardwalk + sand	Yes
Access Path		Visitor center	No	No	No	Yes	Ped	Boardwalk	Yes
Hiking Trail		Holly Forest	No	No	Yes	Yes	Ped	Boardwalk + sand	Yes
Access Path		Gunnison Beach	No	No	No	Yes	Ped	Boardwalk + sand	No
Hiking Trail		Horseshoe Cove	No	No	Yes	Yes	Ped	Other – mixed	No
Hiking Trail		Observation deck	No	No	Yes	Yes	Ped	Sand	Yes
Hiking Trail		South Beach Dune Trail	No	No	Yes		Ped	Sand	Yes
Hiking Trail		Nike Missile Launch Site	No	No	Yes	Yes	Ped	Sand	Yes
Multi-use Path (Ft Hancock)		Continued from Fee Plaza (Main Gate)	Yes	No	No	Yes	Multi-use	Paved	Yes
Access Path (Ft Hancock)		Parking Lot G – Gunnison Beach walkway	No	No	No	Yes	Ped	Paved – sidewalk	Yes
Multi-use Path (Ft Hancock)		Knox Rd	No	No	Yes	Yes	Ped	Paved	Yes
Access Path (Ft Hancock)		Gunnison Beach Complex	No	No	No	Yes	Ped	Sand and boardwalk	Yes
Access Path (Ft Hancock)		North Beach Complex	No	No	No	Yes	Ped	Sidewalk	Yes
Access Path (Ft Hancock)		Sandy Hook Proving Ground	No	No	No	Yes	Ped	Sand and gravel	Yes
Sidewalk (Ft Hancock)		Hartshorne Dr	No	No	No	Yes	Ped	Paved	Yes
Sidewalk (Ft Hancock)		Magruder Rd, Kearney Rd	No	No	No	Yes	Ped	Paved	Yes
Sidewalk (Ft Hancock)		Sandy Hook Proving Ground	No	No	No	Yes	Ped	Gravel	Yes

Ped = pedestrian

Park Management, Operations, and Facilities

Staffing

The approved GMP will bring significant new challenges for Gateway operations and management that will be dependent on the availability and efficient management of additional funding and staff resources.

The park management team and staff are responsible for all day-to-day management and operations of Gateway. In 2010, the park was staffed by 316 full-time equivalent employees (FTEs), which include full-time, part-time, term, temporary, and student employment. The staff and volunteers of more than 70 park partners supplement the NPS staff, which fulfills critical roles in all aspects of park operations and maintenance. In Fiscal Year (FY) 2010, the park's operations appropriation was $26.5 million, the majority of which goes to pay salaries and benefits and fixed costs such as electricity, gasoline, and other utility costs. The park attracted some 9.4 million visitors in 2010.

Across all divisions of the park staff, volunteers (from retired seniors to youth conservation corps and college interns) supplement and assist with the work of the career NPS staff, providing volunteer labor to support the goals of the park, while gaining personal experience, knowledge, and professional experience. Going forward, the park will certainly benefit from a growing amount of such assistance.

Office of the Superintendent

The Office of the Superintendent includes managerial activities of the superintendent, the deputy superintendent, office of communication, volunteer coordinator, and strategic planning and initiatives, as well as administrative staffs. The Office of the Deputy Superintendent is responsible for park management, including staff, in the areas of administration, business management, cultural resources, interpretation, education, safety, facility/asset management, natural resources, science, planning and compliance, budget, human resources, IT, fleet and property management, and visitor resources and protection.

Resource Management Division

The division of planning, managed within the Resource Management Division, is responsible for planning, environmental review, transportation, and design. The staff provides park management with the technical expertise and policy guidance needed to plan for the preservation and protection of the park's natural and cultural resources, determines and provides for appropriate public use, and manages public involvement in the planning and decision-making process. The planning staff coordinates with other park divisions; park partners; other federal, state, and local agencies of government; and consultants to carry out their mission and responsibilities.

Cultural Resources

Cultural resource staff are responsible for the management of Gateway's cultural resources, including archeological sites, fortifications, historic structures and museum collections. This includes overseeing resource protection and preservation as well as assisting with interpretation of cultural resources.

Cultural resource staff are currently working with facility management to document the baseline conditions of all park cultural resources in an effort to guide future operations and programs. Volunteers are necessary to support the park staff, given the large number, diversity, and significance of the park's cultural resources.

All alternatives in this GMP/EIS envision the park "banding" cultural resources to identify those whose condition will stay the same or improve, those where some action will be taken to slow but not stop deterioration, and those historic structures that are ruins and that will receive no maintenance. The cultural resources management division, along with facility managers and others, would be tasked with accomplishing this objective to the extent possible depending on the availability of funding, staff, time, and resources.

Cultural resource staff are responsible for the management of Gateway's cultural resources, including archeological sites, fortifications, historic structures and museum collections. This includes overseeing resource protection and preservation as well as assisting with interpretation of cultural resources.

Natural Resources

Natural resource staff are responsible for the management of Gateway's natural resources including its land-based and marine habitats. Natural resource staff are involved in research, monitoring as well as resource protection and habitat restoration projects.

Resource and Visitor Protection Division

The environmental and safety offices, along with the U.S. Public Health Service, are responsible for environmental protection, occupational health and safety, and lifeguard and emergency medical services. It also manages the park's sustainability programs, including addressing best management practices related to minimizing the impacts of climate change. Minimizing the impacts of park operations, including energy use and carbon footprint, is a priority. The group also handles comprehensive water, energy, and hazardous and universal waste management; air permits; hazardous material and hazardous waste remediation projects; and all regulatory requirements associated with these activities.

The safety of Gateway visitors and the protection of resources are management priorities. Staff exercise appropriate safety awareness and law enforcement and ensure resource and visitor protection as well as adherence to park rules and regulations. The environmental and safety office's focus is on ensuring that employees and visitors are safe.

The park relies on the U.S. Park Police for resource and visitor protection in the New York units of the park (Jamaica Bay and Staten Island). Commissioned rangers provide visitor and resource protection in the Sandy Hook Unit. Existing staff resources are proactively managed to maximize law enforcement coverage and visitor safety. Ensuring a strong park ranger / law enforcement presence is a priority in controlling use and protecting resources.

In the New York units, structural and wildfire management is provided under an agreement between the New York City Fire Department (FDNY) with the assistance and cooperation of the NPS. Sandy Hook's structural and wildland fire management is the responsibility of the NPS with the support of local entities under mutual aid agreements.

Office of Asset Management

The asset management division is responsible for ensuring the physical integrity of park assets with a strong emphasis on facility maintenance and operations.

Physical assets that are the responsibility of the asset management division include all park buildings, utilities, roads, trails, grounds, housing, and historic structures, except for those facilities that have been transferred to park partners, lessees, or concessioners for their use. Maintenance responsibilities are divided geographically among the three units, as well as by asset types. Maintenance work performed is supplemented by crews from the conservation corps and by volunteers who assist with assigned projects throughout the park. These additional labor resources help reduce the backlog of needed repairs.

Finding viable contemporary uses for hundreds of historic structures is a priority preservation strategy for Gateway. The maintenance of historic infrastructure in the park is a constant challenge, requiring ever-increasing resources as these buildings age. Deferred maintenance is also challenging, and historically, a majority of asset management needs have gone unmet annually due to insufficient funding.

With over 27,025 acres of marshes, wildlife sanctuaries, and recreational and athletic facilities; miles of sandy beaches; indoor and outdoor classrooms; picnicking and camping facilities; hundreds of historic structures and military installations; airfields; a lighthouse; and ocean and bay waters, this park offers urban residents a national park experience in an urban area. Emergency stabilization of facilities and infrastructure due to damage from Sandy had been largely completed by early 2013, but many of these facilities will remain closed until recovery is accomplished later in the next two or three years.

Hurricane Sandy impacted infrastructure systems, buildings, fleets, and equipment in all three units of Gateway, leaving 92 of these facilities and systems in serious condition and another 74 in poor condition. The storm's impacts required more immediate decision making about the future of many of these facilities and systems than might have otherwise been the case, and Gateway is currently deeply engaged in critical decision making in full consultation with partner agencies, communities, and support organizations. Decisions are being made regarding which systems and facilities would be restored and fully used in park operations and visitor programs; which would be stabilized and maintained as contributing elements of the cultural landscape; and which would be allowed to deteriorate as part of a Ruins Subzone. Each decision on the future of individual buildings would be made by the NPS with all appropriate consultation, documentation, and compliance. Decisions made to date are discussed in the "Asset Management" section. All areas, including flooded buildings, have been stabilized so that their condition does not worsen.

Interpretation and Education Division

With 9.4 million visitors in 2010, Gateway is among the most heavily visited parks in the national park system. Visitors come from a wide diversity of socioeconomic backgrounds. The interpretation and education division is responsible for connecting people to the park, and is heavily engaged in community outreach. Educational and interpretive programs are developed to encourage more enjoyment of park resources and facilitate a greater appreciation of the cultural and historical significance of the park setting and historic structures, located strategically at the entrance to New York Harbor.

The professional staff of the division strives to ensure that visitors are informed and oriented, both before they arrive and throughout their visit. Directing visitors to points of interest or appropriate interpretive opportunities is a major function of various interpretive strategies and tools, and requires constant vigilance and planning to promote visitor use and enjoyment while minimizing impacts on park resources. More actual and virtual interpretive programs are required to reach a broader audience and to increase visitor understanding and enjoyment of what they are experiencing. The GMP anticipates visitor services and facilities that are appropriately scaled and sensitively located to meet the needs of visitors, minimize impacts on park resources, and enhance visitor education and safety.

The demand for more education and interpretive programs far exceeds what the park is currently able to deliver. Many significant resources in the park are inadequately interpreted due to limited staff and funding for program development. Park partners are therefore called on to help meet public demand for educational and interpretive programs. All alternatives in the GMP/EIS envision increased partnership engagement using interagency agreements, concession contracts, leases, cooperative agreements, and other vehicles to increase and secure shared responsibilities for providing interpretive and educational programs at the park and in the adjacent communities.

Educational and interpretive programs are developed to encourage more enjoyment of park resources and facilitate a greater appreciation of the cultural and historical significance of the park setting and historic structures, located strategically at the entrance to New York Harbor.

Office of Business Services

The business services and partnership division oversees complex contracts and partnership agreements that provide key services within the park. The division also manages leases, concessions, and the legal aspects of park and partner projects.

Partners and Other Entities

In addition to programs offered by the NPS, park visitors can enjoy programs provided by a number of nonprofit organizations. Park partners provide conservation, restoration, and protection; environmental education; outreach programs; and recreational opportunities that support the goals of the park while achieving their own organizational missions.

For example, since 2010, MillionTreesNYC and the NYCDPR have been helping to plant native trees and shrubs and weed out invasive plants at Floyd Bennett Field. Similarly, beginning in 2011, park staff and volunteers, with the assistance and skills of the NYCDPR, began a major vegetation restoration project at Crooke's Point, a 28-acre peninsula located at Great Kills

Park in the Staten Island Unit. Great Kills Park has severely degraded habitat dominated by several particularly aggressive invasive, nonnative plant species. Approximately 85 percent of the project area at Crooke's Point consists of invasive vines; without intervention, this degraded plant community would remain a poorly functioning habitat for many years. Starting with a 2-acre plot, members of this partnership are continuing to remove invasive, nonnative vegetation and replace it with species native to local maritime habitat.

Gateway is also exploring a new partnership with the NYCDPR to create a newly integrated partnership park around Jamaica Bay that would include New York City and NPS park lands. The goal of this partnership is to make a contiguous park that benefits people and wildlife while leveraging the use of limited tax dollars. Opportunities exist for a similar approach in the Staten Island Unit.

Eight official NPS cooperating partner organizations operate out of facilities at Fort Hancock, including the Marine Academy of Science and Technology (which teaches high school students), the Sandy Hook Child Care Center, the Sandy Hook Foundation (the park unit's official "Friends" group), the American Littoral Society, and the New Jersey Sea Grant Consortium, among others.

Concessioners provide critical services to enhance visitor experience at the park. There are nine operators providing food services, beach club facilities, equestrian services, golf, a sports complex, and marina facilities.

Each year, close to 5,000 volunteers in the NPS Volunteers in Parks Program contribute over 80,000 hours of their time to protect Gateway's natural and historical resources and to assist visitors. A major benefit of volunteering, in addition to the needed work accomplished, is that volunteers who work 250 hours can receive a pass entitling them to free entry to any federal lands for a year, including all national parks and forests.

Park Facilities

Because of Gateway's large size, in combination with its diversity of natural and cultural resources and history of land use, the NPS is responsible for managing and maintaining numerous facilities in the park. The park contains approximately 1,300 assets, including buildings, trails, utilities, and other structures and landscapes (see table 3-20).

Historic and Non-historic Buildings

Gateway has an infrastructure dominated by hundreds of historic buildings and cultural landscapes, as well as deeply impacted natural features. Much work is needed to bring the diverse infrastructure of the park up to a standard of care that would continue to accommodate a growing diversity and volume of visitors annually. As would be expected for older facilities, the identified deferred maintenance backlog for historic buildings is significantly higher than the identified deferred maintenance backlog for the non-historic buildings (see table 3-21).

The general condition of non-historic buildings is better than that of historic buildings, due to aging facilities and systems requiring maintenance and repair of worn, aged, and obsolete components. Table 3-22 presents the ranked condition of the historic and non-historic buildings as determined by the facility condition index values extracted from the Park Asset Management Plan (NPS 2012e) which is the multi-park coordinating plan for the NPS units in New York Harbor.

Buildings represent 47 percent of the assets at Gateway, a large associated operations and maintenance requirement, and a significant operations and maintenance expenditure (see table 3-23). The Base O&M Benchmarks in this table represents what is required to properly maintain the assets and this figure is significantly higher than the budget that has been allocated.

Table 3-20. Assets at Gateway National Recreation Area.

Asset Type	Number of Assets	Percent of Total
Roads	129	10
Parking	190	15
Trails	58	4
Maintained Landscape	70	5
Building	607	47
Water	27	2
Wastewater	20	2
Electrical System	49	4
Fuel System	12	1
Dam	9	1
Marina/Waterfront	23	2
Monument/Memorial	6	0
Archeological Site	6	0
Fortification	60	5
Towers	13	1
Other	22	2
Total	1,301	100

Source: NPS 2007c.
Note: Due to rounding, percentages may not add up to 100.

Table 3-21. Number and Type of Buildings and Cost to Bring them to Adequate Condition.

Asset Type	Asset Count	Deferred Maintenance Cost
Historic Buildings	211	$115,901,704
Non-historic Buildings	396	$68,675,416

Table 3-22. Condition of Historic and Non-Historic Buildings at the Park.

Rank	Historic Buildings		Non historic Buildings	
	#	%	#	%
Good	80	38	265	67
Fair	25	12	22	6
Poor	69	33	84	21
Serious	37	18	25	6
Total	211	101	396	100

Source: NPS 2007c.
Note: Due to rounding, percentages may not add up to 100.

Table 3-23. Operations and Maintenance Cost, Funding, and Gaps for Park Buildings.

Asset Type	Asset Count	Base O&M Allocations	Base O&M Benchmarks	Coverage	O&M Funding Gap
Buildings	607	$2,780,307	$13,568,073	20%	$10,787,766

O&M = operations and maintenance

Nearly 35 percent of Gateway's buildings are historic, and so carry special legal and regulatory requirements for maintenance. A few buildings are managed and maintained by the partner or concession organization occupying them. For example, at Fort Tilden, the Rockaway Theatre Company offers live performances at the historic Post Theatre and the Rockaway Artists Alliance offers classes, exhibitions, and special events at two repurposed buildings.

Officers' Row at Fort Hancock is a fundamental cultural resource that the park struggles to maintain. The buildings are in disrepair and are vulnerable to the potential threat of future sea-level rise.

The bathhouse, batteries, and other historic structures located on the shorelines of Jacob Riis Park and Fort Tilden are also subject to potential damage from sea-level increases. Many cultural resources are less than 20 feet above sea level and therefore vulnerable to flooding during storm events.

Maintained Landscapes

Gateway maintains diverse natural and cultural landscapes for public use, such as vistas of Jamaica Bay, wetlands, historic parade grounds, and stretches of sandy beaches. Gateway's beaches and natural areas provide unique refuges from the noise and stresses of urban living. In some cases, the landscape attributes are surprising and unique. The grasslands at Floyd Bennett Field are the largest little bluestem old field grasslands in New York City, and provide bird habitat and a stopover for grassland birds in the heavily developed New York metropolitan area.

Although earthen landscapes that historically camouflaged coastal defenses (e.g., Battery Harris East at Fort Tilden) were typically managed as natural landscapes in the past, under this GMP such human-made landscapes will be managed as cultural landscapes and proactively maintained and interpreted as such. Many of the prominent structures are overgrown and unsafe for visitors; visitor access to these structures is prohibited until funds can be obtained to provide more proactive management. The park is currently prioritizing which of these structures are suitable for future park use; those whose condition will be improved; those that would be stabilized; and those that would be documented but allowed to continue to deteriorate or that would be removed and the site restored. Decisions to date are discussed in the "Asset Management" section.

Landscapes at the park can present a constant and demanding management challenge. In some cases, the landscapes are degraded and not sustainable, such as most of the estuaries within the park boundaries. The deterioration of the saltmarsh at Jamaica Bay is severe because the rate of replacement of saltmarsh cannot keep pace with a loss rate that approximates 30–50 acres per year. Because the deterioration is likely a result of many factors outside NPS control (including sea-level rise), the park is unable to maintain the landscape as it would like or as solely natural conditions would dictate.

Trails, Roads, and Parking

The park staff maintains paved and unpaved roads throughout the park. These roads are enumerated and described in the "Transportation" section in this chapter. Roads require continual maintenance and the lack of funding reduces the park's ability to maintain them at an optimum level.

Approximately 33 miles and 58 different trails at Gateway, ranging from paved surfaces to single-track paths, provide access for walkers and hikers to and through the park's developed and natural areas. Because Gateway is an urban park, the trails receive heavy use and require diligent maintenance and upkeep. The full, required budget and staffing for this maintenance is unavailable through NPS sources (see table 3-24) and would require supplemental sources.

Table 3-24. Required Funding for Operations and Maintenance of Roads, Parking and Trails.

Asset Type	Asset Count	Base O&M Allocations	Base O&M Benchmarks	Coverage	O&M Funding Gap
Roads	129	$422,610	$861,422	49%	$438,812
Parking	190	$605,669	$1,915,011	32%	$1,309,342
Trails	58	$260,761	$1,204,507	22%	$943,746

O&M = operations and maintenance

Entrances to Gateway parks are signed, but sign design is not consistent across the park and signs are not always clearly visible. Because of poor wayfinding and a lack of NPS visibility at areas like Fort Wadsworth, visitors not familiar with the area and with Gateway often become confused and disoriented. The NPS recently completed a comprehensive sign plan. Hurricane Sandy damaging or destroying many of the park's signs provides an opportunity to implement the sign plan sooner than would have been possible before the storm. Social networking, websites, use of quick response code tags, and other technological innovations in interpretive media and communications need to continue to be expanded to connect with broader audiences and potential visitors.

Gateway is accessible via public transportation systems (see the "Transportation" section in this chapter of the GMP/EIS), but the park and its regional partners continue to plan to improve transportation linkages for even better recreation and visitor access.

Utilities

Entrances to Gateway parks are signed, but sign design is not consistent across the park and signs are not always clearly visible.

Adequate water and wastewater capacity are critical to operating the facilities at all sites in the park. System needs vary over time and can be stressed by increases in use as well as by the age and level of maintenance of the infrastructure. Planning for utilities is critical in order to ensure excellence in operational effectiveness, sustainability, and conservation of water and energy resources. The wastewater treatment plant at Sandy Hook needs complete system replacement of all pumps, electronic controls, wiring, auxiliary power units, and all lift stations because of damage from Hurricane Sandy. In addition, all wastewater treatment piping and manholes need to be cleared from sand/debris incursion. Water system pumps, injection treatment systems, and controls need to be replaced. All water lines need to be disinfected. This process is estimated to require at least six months and planning is currently underway by the Denver Service Center of the NPS (NPS 2013j).

Park Maintenance Facilities

Maintenance facilities including maintenance yards and equipment storage facilities are located in all three units of the park. For efficient operations, park maintenance staff requires secured vehicle parking, the ability to receive cell and radio transmissions, access to arterial roads and highways for moving equipment, boat harbor access, and access to mass transit. Many of these criteria are not being fully met by the existing facilities.

At Sandy Hook, both the south and north maintenance shops, including vehicles, vehicle lifts, and associated equipment, were completely flooded by Hurricane Sandy. This has temporarily compromised the park's maintenance capability and imposed a major repair and restoration burden.

Public Safety Facilities

Currently, public safety staff shares space with other divisions throughout the park, with the exception of ranger stations and fire management facilities on Sandy Hook. This is less than ideal because there are certain public safety functions that need to be exclusive and secured.

Further, efficient operation requires adequate space for training and meetings, visibility to the public for reporting incidents, adequate cell and radio coverage, and access to public transportation for staff. Current public safety facilities do not meet these requirements in each location, and reassignment of space for public safety is desirable.

NPS Staff Housing

The park continues to provide a limited number of housing units for employees in all three units. Non-NPS housing in the New York area is some of the most expensive in the United States. Recruitment and retention of employees for the park is hindered by the high cost of housing and other living expenses.

Some staff housing was damaged by Hurricane Sandy. Most Sandy Hook housing units suffered basement flooding, a few experiencing flooding of the first floor, and seven units experienced no flooding. Fourteen park staff members and their families at Sandy Hook were made homeless as a result of the storm. Similar damage to park housing occurred at Fort Tilden in the Jamaica Bay Unit; basements were flooded in housing units, necessitating replacement of boilers, water heaters, and electrical panels as well as some mold abatement. The park housing at Fort Wadsworth was untouched and at Miller Field in the Staten Island Unit, only the electric service was impacted (NPS, pers. comm. 2013e).

Interpretive and Visitor Services Facilities

The condition of visitor facilities throughout the park requires extensive restoration and maintenance attention, in part due to the effects of Hurricane Sandy. For example, some visitor structures at Sandy Hook, such as the theater, suffered first-floor flooding. The theater needs all seating, carpet, and the stage replaced, with mold abatement throughout. At Jacob Riis Park, the historic bathhouse was damaged but is structurally sound, and the large parking lot was undercut in areas. The ferry docks, boardwalk, beach pavilion water fountains, lighting fixtures, and historic ships rail were damaged or destroyed. In contrast, the main park visitor center, the William Fitts Ryan Visitor Center, only had one broken window and the marina at Jamaica Bay was untouched. At Great Kills Park Marina on Staten Island, the docks were completely washed away, and access roads overwashed and covered in sand. The marina is currently closed, but the park staff intends to offer a three-year concession contract in 2013 to get it open again as quickly as possible.

Asset Management

With a large number of facilities and constrained funding, the park staff strives to address the challenge of maintaining assets in acceptable condition and sustaining them over time. Park staff is responsible for maintaining nearly 1,300 assets.

For the same NPS-occupied and NPS-maintained assets, annual special project funding of approximately $7.4 million covers only a small portion of its $300 million in deferred maintenance backlog.

Operations and Maintenance Funding Priorities

Assets maintained and managed by the park's maintenance division (e.g., non-partner assets) were categorized into priority levels based on a variety of factors (see table 3-25). Those factors include the importance of the assets to the mission of the park and the recognized level of maintenance needed to keep the assets operational to suit their intended functions.

Table 3-25. Operations and Maintenance Planned Funding Summary.

O&M Optimizer Priority Band	Asset Count	Base O&M Allocations	Base O&M Benchmarks	Coverage	O&M Funding Gap
Highest	116	$1,035,348	$2,457,972	42%	$1,422,625*
High	337	$3,047,951	$8,983,687	34%	$5,935,735*
Medium	483	$787,999	$3,224,858	24%	$2,436,859
Lower	76	$1,864	$252,081	1%	$250,217
Lowest	212	$2,027	$776,373	0%	$774,346
Totals	1,224	$4,875,189	$15,694,970	31%	$10,819,781

O&M = operations and maintenance
*Gap for bands 1 and 2: $7,358,360.

Funding is then directed towards the highest-priority assets, while lower-priority assets are maintained to the best level that limited available funding allows. However, even with prioritization, $7.36 million in priority band 1 and 2 assets would remain unfunded and therefore represent the most pressing unfunded needs for operations and maintenance.

Removal or Reuse of Assets

Removing unneeded, non-historic assets that are not mission related is essential to keeping the portfolio a manageable size and allowing available funding to be spent on a smaller pool of higher-priority assets. In developing the GMP, the park staff identified potential assets that could be disposed of over the life of the plan. The facilities identified through this process generally consist of non-historic structures in poor condition with no mission-related use existing or planned. Another major emphasis of the park needs to be the leasing or reuse by others of historic structures to maintain them without it being a drain on the park's limited budget.

Addressing Deferred Maintenance

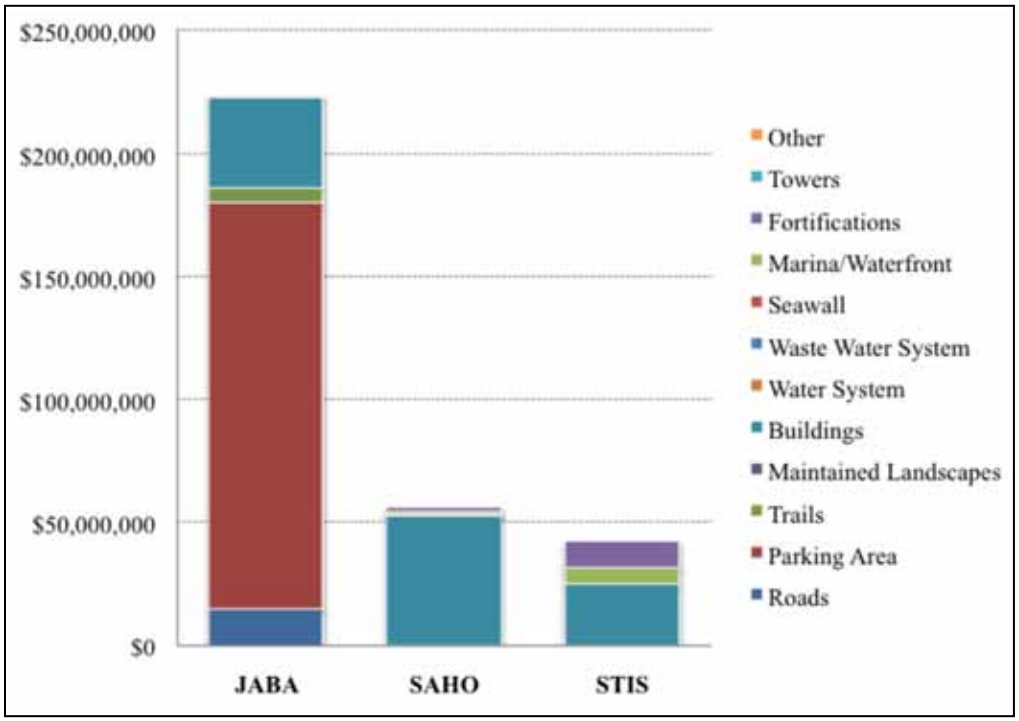
Recognizing that the park cannot reasonably address all of its deferred maintenance in the short run, the park has a schedule of facility projects that extends out 10 years (see figure 3-26). This plan addresses the highest-priority assets and most critical equipment needs. The condition of these more important assets would show the most rapid improvement,

measured by the facility condition index. If 100 percent of project funding were applied to critical needs and projected component renewal, the park would stabilize the condition of the critical components of its portfolio.

The GMP process has also identified deferred maintenance savings that would be achieved by taking the actions proposed. Deferred maintenance issues can be addressed through several actions recommended in the GMP/EIS alternatives, including removal, stabilization, restoration, renovation, and preservation of facilities.

Gateway has been among the most effective units in the national park system at using its authority to lease historic and non-historic structures to other entities that then operate and maintain them, thereby removing them from NPS maintenance responsibility. Many more such opportunities remain at Gateway.

Figure 3-29. Deferred Maintenance Backlog Summary by Asset Type.



JABA = Jamaica Bay Unit; SAHO = Sandy Hook Unit; STIS = Staten Island Unit

Improving Sustainability to Manage Assets

In a funding-constrained world, it is extremely helpful for the park to identify more efficient ways to operate and manage its assets. The park staff has identified goals for achieving a higher level of sustainability, including managing and tracking energy performance, using renewable fuels, conserving water in high-use areas, and continuing to enact best practices in waste management. The park managers also recognize the need to communicate sustainability goals to park staff and to collaborate with park partners. These measures are opportunities for the park to find cost savings and become more fiscally responsible.

Coordination between the GMP and the Park Asset Management Plan

The park continues operations under the coordinated Harbors Parks Facility Management Program. The current Park Asset Management Plan continues to provide guidance and will continue to be actively implemented. Asset data from the Park Asset Management Plan helped to inform the development of the GMP. The updates of the Park Asset Management Plan, in light of the planning process for the GMP, provide an extraordinary opportunity for park managers to promote sound asset management principles, incorporate the value and objectives of partnership relationships, and advance sustainability goals in a coordinated manner.

Sustainability: Energy Resources and Resource Conservation

Sustainability can be described as the result achieved by doing things in ways that do not compromise the environment or its capacity to provide for present and future generations. Sustainable practices minimize the short-term and long-term environmental impacts of development and other activities through resource conservation, recycling, waste minimization, and the use of energy-efficient and ecologically responsible materials and techniques.

The park has been taking measures to reduce its energy consumption and is pursuing sustainable practices whenever possible in decisions regarding park operations, facilities management, and development.

Over the past several years, the federal government has been placing more emphasis on adopting sustainable practices. In 1993, the NPS Guiding Principles of Sustainable Design (guidebook) provided a basis for achieving sustainability in facility planning and design, emphasized the importance of biodiversity, and encouraged responsible decisions (NPS 1993). The guidebook describes principles to be used in the design and management of visitor facilities that emphasize environmental sensitivity in construction, use of nontoxic materials, resource conservation, recycling, and integration of visitors in natural and cultural settings. In 2012, NPS released the "Green Parks Plan," which articulates a vision for reducing the agency's carbon footprint and outlines approaches for sustainable park management (NPS 2012d). In accordance with the guidebook, the "Green Parks Plan," and Gateway's own "Climate Friendly Parks: Framework for Local Action Planning," the park is working to reduce greenhouse gases through increased awareness about climate change and management of transportation, buildings and facilities, grounds and lands, and waste (NPS 2003b). Park staff strives to minimize energy costs, eliminate waste, and conserve energy resources by using energy-efficient and cost-effective technology wherever possible.

The park has been taking measures to reduce its energy consumption and is pursuing sustainable practices whenever possible in decisions regarding park operations, facilities management, and development. Sustainability practices and projects recently implemented at the park include the following:

- **Adopting the U.S. Green Building Council's Leadership in Energy and Environmental Design** (LEED) standard's for new building projects. For example, the visitor center at Jamaica Bay Wildlife Refuge is a Gold LEED-certified building.

- **Enabling and promoting alternative modes of transportation for visitors.** The park has made bicycle and pedestrian improvements in all three units, including improvements to the Jamaica Bay Greenway; an extension of the Staten Island Greenway along the southern tip of Fort Wadsworth to connect NYCDPR parks; connecting Miller Field with the Staten Island Greenway; and extensions to the Sandy Hook Multi-use Path. Additionally, the park is working with partners to plan and secure funding for a project to improve bicycle and pedestrian connections along the eastern Staten Island shore from the Saint George Ferry Terminal to Great Kills Park. Additionally, the park is working with local governments and private groups to increase mass transit options for accessing the park including ferries, and express and local buses. With these transportation-related improvements, park access and visitor circulation is becoming less dependent on cars and vehicle miles traveled in the park are being reduced.

- **Increasing the use of fuel-efficient and/or alternative-fueled vehicles.** The park has begun to upgrade its fleet and replace aging fleet vehicles with energy-efficient vehicles.

- **Encouraging the adaptive reuse and rehabilitation of existing structures and buildings.** Rather than expending additional resources on the construction of new buildings, park management is committed to adaptively reusing existing structures to meet future administration, operations, and visitor needs.

- **Exploring options for renewable energy development.** Gateway is currently reliant on non-renewable energy sources, but park management has initiated discussions and begun exploring the feasibility of developing renewable energy on park sites such as the landfill sites in Jamaica Bay.

- **Developing interpretive programs that address sustainable park and non-park practices.** The park is currently developing an interpretive program that will discuss climate change at the Jamaica Bay Wildlife Refuge. In the context of climate change, the interpretive program will explain the park's efforts to reduce the emission of greenhouse gases as well as adapt to the changing climate.