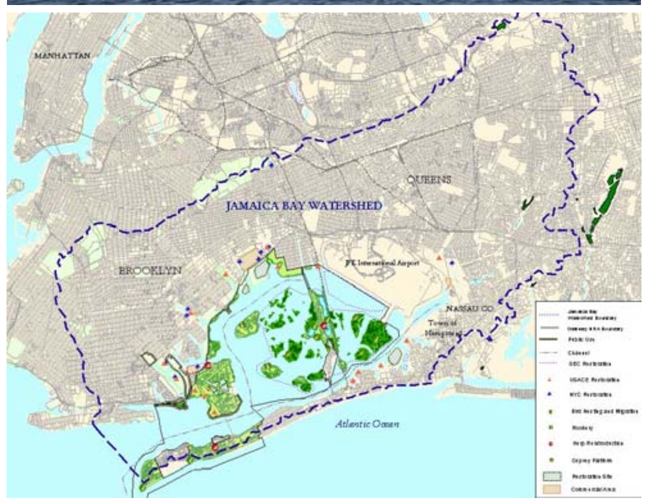


Jamaica Bay Watershed Protection Plan
Volume I – Regional Profile

New York City Department of Environmental Protection
Emily Lloyd, Commissioner
October 1, 2007

www.nyc.gov/dep

TABLE OF CONTENTS

ACKNOWLEGEMENTS

Photo Credit: The photos on the cover, and many of the photos in the body of this *Jamaica Bay Watershed Protection Plan* were provided by Don Riepe/American Littoral Society. Thanks, Don.

Cover Map Credit: Thank you, National Park Service.

Chapter 1 - Introduction

1.1 THE VALUE OF JAMAICA BAY

The value of Jamaica Bay is evident to all who have watched a glowing sunset while on its waters, or a flight of waterfowl coasting in for a landing. The residents who grew up fishing along its shorelines, boating around the tidal marshes, or exploring the natural areas of the estuary will attest to the value of the Bay as an important part of their lives and their identities. At the same time, the Jamaica Bay landscape has a more practical use, as a living-space, work-space, or travel corridor. These two values reflect an important aesthetic and function, but represent only a fraction of the myriad of values and roles associated with Jamaica Bay.

> *"To stand at the edge of sea, to sense the ebb and flow of the tides, to feel the breath of a mist moving over a great salt marsh, to watch the flight of shore birds that have swept up and down the surf lines of the continents for untold thousands of years, to see the running of the old eels and the young shad to the sea, is to have knowledge of things that are as nearly eternal as any earthly life can be."*
>
> *-Rachel Carson*

For thousands of years, Jamaica Bay has served as an important ecological resource for flora and fauna. The Bay has evolved over the last 25,000 years as an important and complex network of open water, salt marsh, grasslands, coastal woodlands, maritime shrublands, brackish and freshwater wetlands. The wildlife use of these systems is commensurate with this complex network of natural systems. These natural communities support 91 species of fish, 325 bird species (of which 62 are confirmed to breed locally) and are an important habitat for many species of reptiles, amphibians and mammals. The Bay is a critical stopover area along the Atlantic Flyway migration route and is one of the best bird-watching locations in the western hemisphere. The approximately 20,000 acres of water, islands, marshes, and shorelines support seasonal or year round populations of 214 species of special concern, including state and federally endangered and threatened species. Because of its geographic size and very diverse functioning natural habitats, it is no surprise that Jamaica Bay is a nationally and international renowned birding location.

Jamaica Bay, one of the largest coastal wetland ecosystems in New York State, is a component of the National Park Service's (NPS) Gateway National Recreation Area (GNRA). A significant portion of the Bay, approximately 9,100 acres, has also been designated by the NPS as the Jamaica Bay Wildlife Refuge and is designated by the New York State Department of State (NYSDOS) as a Significant Coastal Fish and Wildlife Habitat. The diversity of bird species and breeding habitats within the Bay were important factors in these designations. The Jamaica Bay Wildlife Refuge was also the first site to be designated by the National Audubon Society as an "Important Bird Area." It is clear that Jamaica Bay is currently functioning as a regional habitat for many different species of wildlife.

Unfortunately, the valuable resources that comprise Jamaica Bay are being lost. The Jamaica Bay estuary is only about half of its pre-colonial extent and the salt marsh wetlands that have been a defining ecological feature of the Bay are decreasing at an accelerating rate. The more estuarine habitat that is lost within the Bay's watershed and elsewhere in the Northeast and

Mid-Atlantic regions, the more valuable the remaining habitat in Jamaica Bay becomes. Jamaica Bay retains irreplaceable value for its self-sustaining ecological functions, as well as the proximity of its assets by foot, rail and car to the urban metropolis. As one critical tidal estuary in a series that extends up and down the East Coast, Jamaica Bay provides ecological values far beyond its borders. The precious assets include:

- The ecological value of the tidal estuary, locally, regionally and internationally;
- Diverse habitats including salt marsh, coastal grasslands, woodlands, maritime shrubland, and brackish and freshwater wetlands;
- The recreational value for bird watching, wildlife viewing and fishing, as well as for other recreational activities such as bicycling, swimming, walking, boating/canoeing and picnicking;
- The local value of the viewshed;
- Aesthetic values to adjacent landowners;
- The socioeconomic benefits to the City of having the Bay as a resource, and of the City's identification with the Bay;
- The research and education value for local marine research and as the site of an outdoor classroom;
- The natural function of sediment trapping;
- The natural functions of flood control and infrastructure protection against storm surges; and
- The natural function of pollutant attenuation.

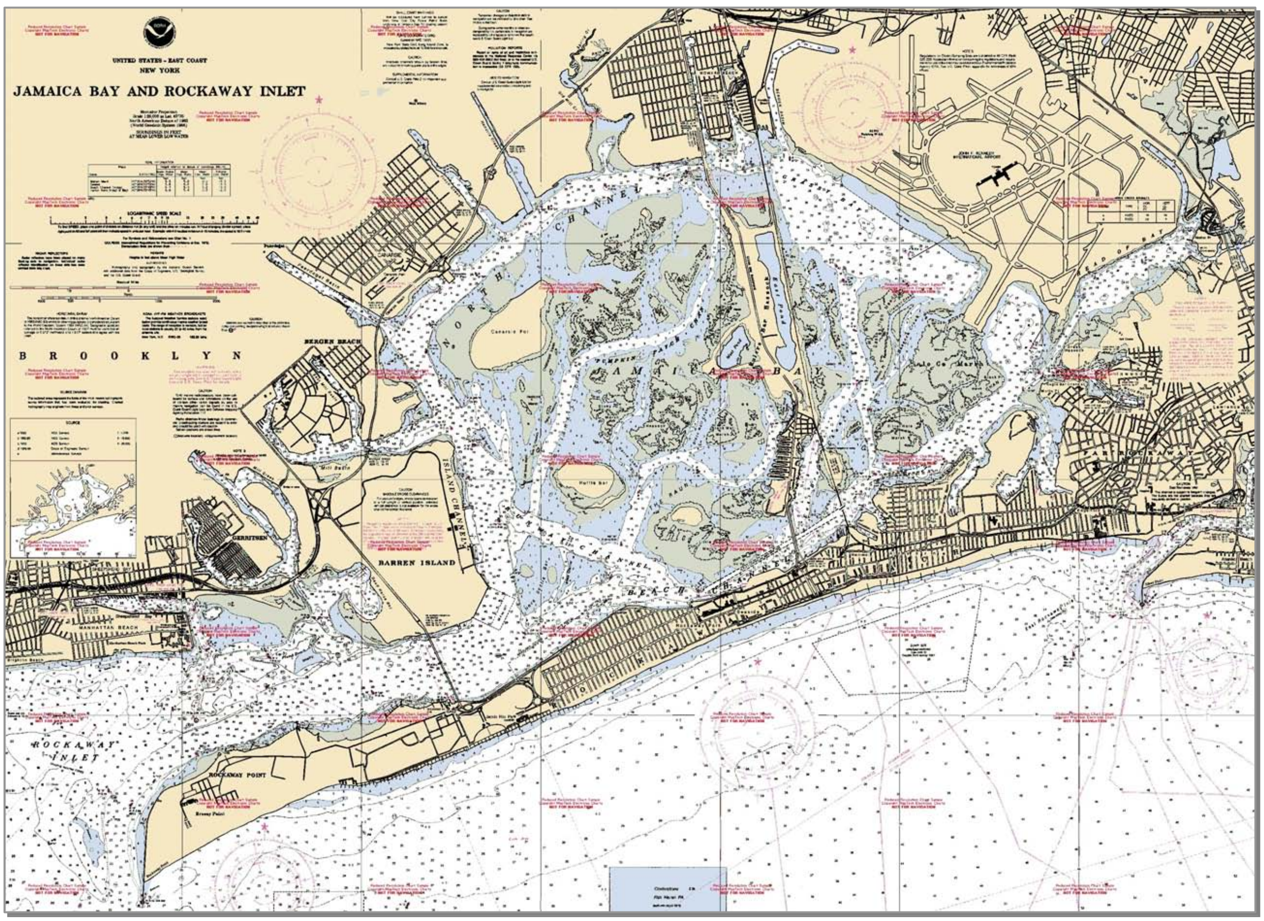


FIGURE 1.1.1 Jamaica Bay Watershed, 2002; Source: NOAA

Over the last 150 years, interior wetland islands and perimeter wetlands have been permanently removed as a result of extensive filling operations; shorelines have been hardened and bulkheaded to stabilize and protect existing communities and infrastructure; deep channels and borrow areas have been dredged, altering bottom contours and affecting natural flows; and natural tributaries along with their important benefits of balanced fresh water and coarse sediment exchanges have essentially disappeared leaving behind deposits of silts and particulates from urban runoff. These activities have synergistically affected historic flow patterns in the Bay, eradicated natural habitat, impacted water quality, and modified the rich ecosystem that was present prior to the extensive urban development of the watershed.

It has become apparent that some ecological functions and valuable environmental resources provided by the Jamaica Bay watershed to the surrounding communities and region are at risk. Living resources and natural processes that have been self-sustaining since the last glacial epoch are in jeopardy and may need to be sustained through environmental intervention in perpetuity. It is only now, when we are realizing the effects of centuries of changes within Jamaica Bay and its watershed that the true value of sustaining and maintaining our natural heritage in this ecologically productive area has become starkly evident.

1.2 IS JAMAICA BAY LIKE CENTRAL PARK?

Central Park has long been the emerald jewel of Manhattan. It is known and recognized world-wide, both visually and as a unique environmental resource of the City of New York and its people.

The reasons that Central Park has reached this status are many and varied but, largely, it is because the City took the initiative to protect and preserve the park. Community groups act as unofficial monitors and partners of the City in acknowledging the value of the park to its urban and cultural environment. The City has approached its obligation with a long-term and institutionalized dedication. This ethic has been possible because it developed over time, because Central Park has become a symbol that is cross-linked with the City's identity, and the park is totally within the control and jurisdiction of the City.

What has created and sustained Central Park is also in abundance within the Jamaica Bay watershed – committed advocates. The preservation of Jamaica Bay has engaged the efforts of federal, state and city governments and a strong and active network of community organizations and advocates. The foundation for grass roots, popular and governmental support is in place and ready for Jamaica Bay.

However, the protection of Jamaica Bay as an environmental resource presents more significant challenges. The protection of Jamaica Bay is intimately connected to its vast watershed and the uses and activities contained within it. Today, the Jamaica Bay watershed is a densely populated urban region. Highways encircle and cross the

Definitions

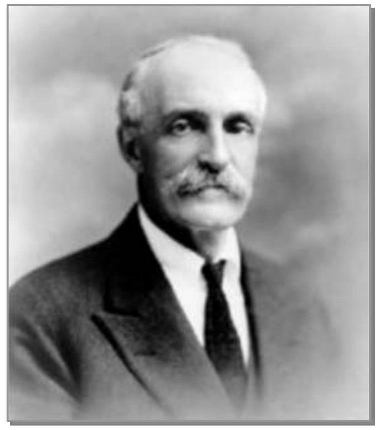
Conservation: Regulated, sustainable use of environmental resources for commercial and public uses.

Preservation: Limited, restricted use, or maintenance, of environmental resources to prevent exploitation and degradation.

Restoration: "…a process in which a damaged resource is renewed. Biologically. Structurally. Functionally." (John J. Berger.1987. Restoring the Earth: How Americans are Working to Renew our Damaged Environment)

Bay, as does a rail line. One of the best known international airports in the world was developed by filling in a large portion of the Bay with dredged material from other portions of the Bay; residential areas were formed by placing fill in marshes in the Bay and along its shores. Highways and other development have resulted in restricted access to the shoreline. Urban residential development along the shoreline has brought its environmental stresses and future development still threatens vital wetlands and other open spaces that remain.

Other regions in the country such as the Great Lakes and Chesapeake Bay have faced many of the same challenges. However, watershed planning in these regions is successfully advancing the goals of improving the degraded value of their respective aquatic resources and can provide models for the Jamaica Bay watershed.



Gifford Pinchot

(August 11, 1865 – October 4, 1946)

As the first Chief of the United States Forest Service (1905-1910) and the Republican Governor of Pennsylvania (1923-1927, 1931-1935), Pinchot became famous for reforming the management and development of forests in the United States and his advocacy of scientific conservation for the planned use and renewal of the nation's forest reserves: "the art of producing from the forest whatever it can yield for the service of man." He coined the term conservation as applied to natural resources. (www.answers.com /topic/gifford-pinchot).

1.3 LOCAL LAW 71 AND INTRODUCTION 376

This *Jamaica Bay Watershed Protection Plan* (JBWPP) was put into motion by the City Council. Under Local Law 71 (LL 71), signed by Mayor Bloomberg on July 20, 2005, the New York City Department of Environmental Protection (NYCDEP) is required to "assess the technical, legal, environmental and economical feasibility" of a variety of protection measures as part of the JBWPP development process. The objective of the bill, originally sponsored by the City Council Committee on Environmental Protection chaired by Council Member Gennaro, was to ensure a comprehensive watershed approach toward restoring and maintaining the water quality and ecological integrity of the Bay.

The implementation of the final JBWPP is intended to
provide an evaluation of the current and future threats to the Bay and ensure that environmental remediation and protection efforts are coordinated in a focused and cost-effective manner.

LL 71 also required that an advisory committee be formed to assist NYCDEP in fulfilling its responsibilities. The Jamaica Bay Watershed Protection Plan Advisory Committee (JBWPPAC) is composed of seven members: four selected by the Mayor and three selected by the Speaker of the Council. While each member was selected based on their affiliation with a specific organization, the group was also responsible, in part, for representing the broader public interest in the process. Member representation includes the NPS, Natural Resources Defense Council (NRDC), Jamaica Bay Eco Watchers, Marine Sciences Research Center at Stony Brook University, Port

Authority of New York and New Jersey (PANY/NJ), U.S. Army Corps of Engineers (USACE), and a community/ environmental activist.

LL 71 was amended (Introduction No. 376) on August 16, 2006 to extend the development of the JBWPP by one year. Under that amendment, the Draft *Jamaica Bay Watershed Protection Plan* was completed on March 1, 2007 and this Final *Jamaica Bay Watershed Protection Plan* has been submitted to the City Council on October 1, 2007.

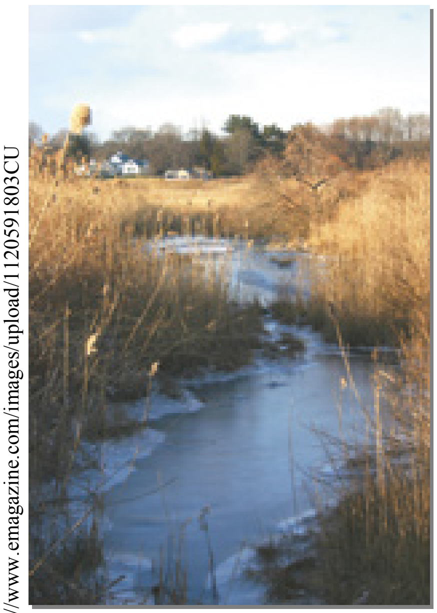
1.4 ORGANIZATION OF THIS PLAN

The *Jamaica Bay Watershed Protection Plan* is organized into two volumes as described below. Each of these volumes is designed to be stand-alone, yet work together to provide complete information about the Bay's existing conditions and future management strategies throughout its watershed.

Volume 1. Jamaica Bay Watershed Regional Profile

This volume presents a description of the context within which this *Jamaica Bay Watershed Protection Plan* has been developed, that is, the history of Jamaica Bay, the key issues currently affecting the Bay, and current management efforts. It contains:

- the current set of geographical, geophysical, water quality, and ecological data for the Bay and its watershed;
- information on the human uses of the watershed, including land use, zoning, and recreation and access; and
- a description of the stakeholder institutions, their distinctive jurisdictions and mandates, current planning efforts, and public outreach programs.



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Tidal Wetlands

"Intertidal marsh and coastal fresh marsh tidal wetlands are the most biologically productive of all tidal wetlands areas. Furthermore, since they receive twice-daily tidal flushing, the products of vegetative photosynthetic activity and decomposition in these zones are readily transported to adjacent waters for use in the estuarine food chain. Their intertidal location also makes them among the most effective wetland zones for flood and hurricane and storm protection. Both their intertidal location and their highly productive nature makes them among the most effective wetland zones for cleansing ecosystems and for absorbing silt and organic material. Because of these high values and their sensitive location at the land and water interface, intertidal and coastal fresh marshes must be the most stringently protected and preserved tidal wetlands zones. Even small portions of these zones are critically important resources. Consequently, only very limited types of land use and development are compatible with the values of these areas." (6 NYCRR 661.2(D)).

Volume 2. Jamaica Bay Watershed Protection Plan:

This volume provides the vision, objectives, and potential management and implementation strategies for the *Jamaica Bay Watershed Protection Plan*. There are three primary sub-sections:

- an introduction to watershed planning concepts;
- the framework for the plan including the vision, issues identification, objectives, and management strategies; and
- Objectives, Potential Management Strategies, and evaluation methods to address six categories:
  - Category 1: Water Quality Improvements
  - Category 2: Restoration Ecology
  - Category 3: Stormwater Management Through Sound Land Use
  - Category 4: Public Education and Outreach
  - Category 5: Public Use and Enjoyment
  - Category 6: Coordination and Implementation

Volume I, *Jamaica Bay Watershed Regional Profile*, has several purposes. It is intended to be a comprehensive reference document for Jamaica Bay. It also provides the information needed to identify issues of concern that face the Bay, setting the stage for developing management strategies to address these issues.

Volume I provides an extensive body of existing research, studies, and data, compiled and analyzed in order to clearly understand the issues facing the Bay, current efforts to address these issues and existing gaps in protection measures that continue to adversely impact the water quality and ecological integrity of the Jamaica Bay watershed. This *Regional Profile* provides information about the diverse landscape of the Bay and its watershed, water quality of the Bay and the current status of the ecological system as a whole. It is intended to be a comprehensive but not exhaustive compilation and reference guide for existing data and information about the watershed both past and present. Key planning issues identified set the stage for actions that will need to be implemented to preserve and restore the valuable asset that is Jamaica Bay.

Although this task was not required by LL71, NYCDEP felt that it was a necessary first step given the complexities of the issues facing Jamaica Bay and the extensive body of research and publications about the Bay that needed to be consolidated. For this reason, Volume 1 is intended to provide useful and relevant information for decision-making while also serving as a centralized repository of existing information about the Bay.

Volume 2, the *Watershed Protection Plan*, is intended to serve as a blueprint for the future management of the Bay and its watershed to achieve a shared vision for Jamaica Bay. Therefore, Volume 2 starts with the vision for the Bay and issues that need to be overcome to achieve the vision. For each of the issues, objectives for the Bay were set and, for each objective, potential management strategies, or actions, are identified to address the objective. This *Jamaica Bay Watershed Protection Plan* also documents the steps that will need to be undertaken to evaluate each management strategy before a recommendation can be made as to its feasibility and effectiveness (see sections entitled "Strategy Assessment Approach" under each Management Strategy). Where possible in these sections, potential future implementation strategies were also identified. While implementation approaches will be discussed in the *Watershed Protection Plan* for each of the recommended strategies, the further development of implementation steps for many of the recommended strategies will be an ongoing process after the *Watershed Protection Plan* is completed in October 2007.

Chapter 2 - Jamaica Bay and Its Watershed: Landscape and Setting

2.1 JAMAICA BAY

The Jamaica Bay watershed is situated at the southwestern tip of Long Island and is located primarily within the Boroughs of Brooklyn and Queens, New York City. A relatively small portion of the Bay is located in the Town of Hempstead, Nassau County, New York. The watershed is approximately 91,000 acres (142 square miles) in size. The Jamaica Bay estuary connects with Lower New York Bay to the west through Rockaway Inlet. The estuary encompasses about 20,000 acres (31 square miles), measuring approximately 10 miles at its widest point east to west and approximately 4 miles at its widest point north to south. Figure 1.1.1 shows the Jamaica Bay watershed.

Jamaica Bay has evolved from a landscape of grasslands, woodlands, freshwater streams and salt marsh wetlands teeming with birds and a diverse array of animal life to one of the most densely urbanized areas in the United States. While the ecological function of Jamaica Bay has been altered, it still serves as an invaluable natural resource for the region.

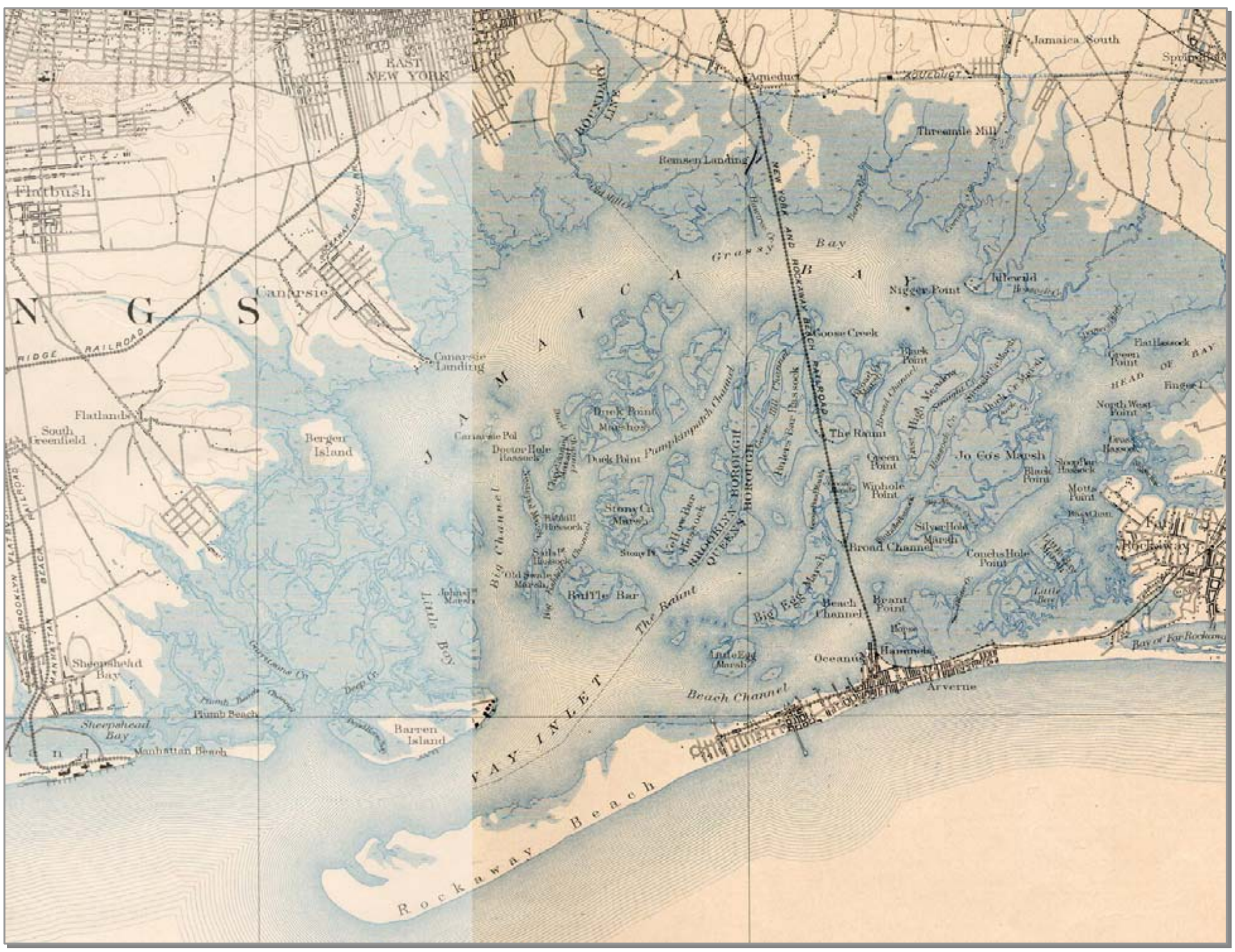


FIGURE 2.1.1 Jamaica Bay, 1889; Source: US Coast and Geodetic Survey, NYC

2.2 HISTORICAL SETTING

The changes which have occurred to the landscape of the Jamaica Bay watershed date back to the cultural history of Euro-American settlement in the New York City region. The trends and settlement patterns of these peoples influenced what Jamaica Bay is today. Much of the description of the history that follows was summarized from Black (1981) and other sources as cited herein.

The Early Years and the Settlement of Brooklyn

The area now known as Brooklyn, situated at the southwestern tip of Long Island, was originally inhabited by a group of Native Americans who called themselves the Lenape, which means "the People." They included the Nayack and the Canarsee, who planted corn and tobacco and fished in the rivers.

The Dutch, who settled in Manhattan in the early 1600s, began to buy land across the river in 1636. As a result of diseases, such as smallpox (new to America), war, land deals that were not always honorable, and other factors, by the 1680s the native people had lost all claims to the rolling, heavily forested landscape.

Canarsie Beach, Brooklyn; Source: New York Public Library

The Dutch founded five villages: Bushwick, Brooklyn, Flatbush, Flatlands, and New Utrecht. Gravesend, a sixth village, was founded in 1643 by Lady Deborah Moody, an Englishwoman who was fleeing religious persecution in England and the Massachusetts Bay Colony. The British captured the Dutch territory in 1674, and gathered the six villages into Kings County, part of the crown colony of New York.

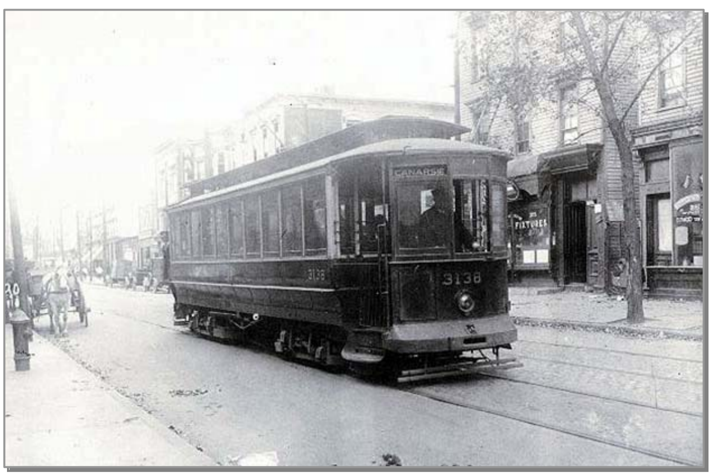
A census taken in 1698 counted 2,017 people in Kings County. About half of these early settlers were Dutch. The others came from Germany, England, France, and Scandinavia, and included a large number of black slaves brought from Africa. Slavery was prevalent in these rich farmlands during the 18th century. By 1771, just before the Revolutionary War, slaves represented nearly one third of the population of Kings County. Slavery would not become illegal in New York State until 1827.

During the Revolution, British troops nearly destroyed George Washington's inexperienced Army at the battle of Brooklyn in 1776. The fighting ranged from Gravesend to Gowanus, and the Colonial Army narrowly escaped annihilation by slipping across the East River to Manhattan during a foggy night. The British then occupied Manhattan and Brooklyn for the duration of the war.

The village of Brooklyn, directly across the East River from Manhattan, was the funnel through which the food grown on Long Island's rich farmlands passed to New York City. As New York City flourished, so did Brooklyn, its nearest neighbor. Rowboats, sailboats, and horse-powered ferries plied the waters of the East River, and speculators and merchants began to buy land along the waterfront. The U.S. Navy opened a shipyard on Wallabout Bay in 1801, and Robert Fulton began a steam-ferry service across the East River in 1814, allowing wealthy businessmen to live in Brooklyn Heights and commute across the river.

In 1860, 40% of Brooklyn's wage earners worked in Manhattan, and ferries carried more than 32 million passengers a year. However, they could not keep up with the demand for transport. To ease some of the congestion and link the two great cities, plans to build a bridge were proposed. The New York Bridge Company was founded in 1865 and constructed the Brooklyn Bridge, which opened in 1883. The bridge brought a new wave of people into Brooklyn, particularly immigrants seeking relief from the high rents and small apartments of New York City.

The city of Brooklyn expanded to accommodate the new population, eventually swallowing up all of Kings County, itself being annexed by New York City in 1898. The construction of bridges to Long Island contributed to an acceleration in the development and growth of Brooklyn and Queens and of the upland portions of the Jamaica Bay watershed. A review of historical maps shows that until the turn of the 20th century, the area of Brooklyn adjacent to the Jamaica Bay estuary was largely undeveloped. The shoreline, as depicted in the maps, was marshland, with the exception of limited development at Canarsie (because of local high ground extending into the marsh area). As transportation networks were developed following the turn of the 20th century, urban infrastructure expanded around the perimeter of the estuary.



Trolley on Rockaway Parkway; Source: New York Public Library

The early years of the 20th century saw a vast expansion in the population and urbanization of Brooklyn. Innovations in transportation, funded by tax dollars from New York City, brought new bridges, trolley lines, elevated railroads, and subway lines that extended farther and farther into the heart of the borough. Trolleys began to traverse the streets of Brooklyn in 1890, the Williamsburg Bridge was completed in 1903, the first subway line was cut under the East River in 1908, and the Manhattan Bridge opened in 1909. Each expansion opened new areas for settlement and development. The rural character of Brooklyn was quickly vanishing.

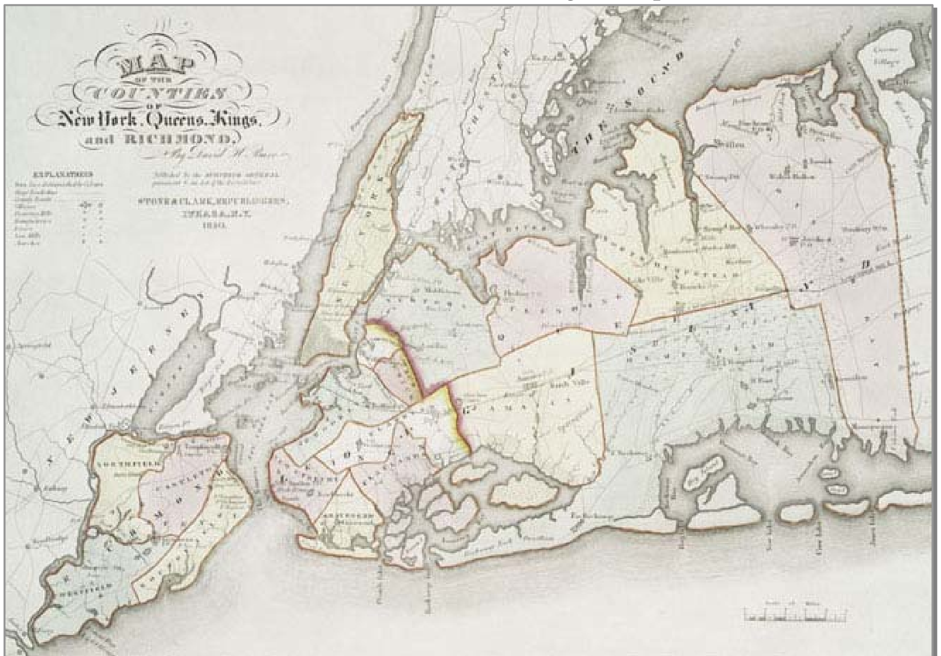
The Settlement of Queens

The expansion of rapid transit brought sudden transformation to the Borough of Queens as well. When the Pennsylvania Railroad purchased the Long Island Rail Road in 1900, then electrified it through Queens in 1905-1908, and opened the Penn Tunnels under the East River in 1910, it brought virtually the whole of Queens within the suburban commuting zone of Manhattan. A record number of new communities were founded at this time. Forest Hills (1906) South Ozone Park (1907) Howard Beach (1911) and Kew Gardens (1912) were some of the towns that were built.

The most momentous event in the history of Queens occurred in 1909 when the long planned Queensboro Bridge was finally opened. This opened a direct link to the county and ended the dependence on ferries. A whole new road system grew up to accommodate the traffic, and Queens Boulevard, a 200 feet wide roadway, was laid out as the main arterial highway of the new borough.

From 1915 onward, much of northern and southwestern Queens came within reach of the New York City subway system. In June 1915 the Interborough service opened to Long Island City and later to Queensboro Plaza (1916) and Astoria (1917). Another branch extended along Queens Boulevard and the newly laid out Roosevelt Avenue, reaching Corona in 1917 and Flushing in 1928. In southern Queens, the Brooklyn Rapid Transit Company built an elevated line along

Liberty Avenue through Ozone Park and Woodhaven to Richmond Hill in 1915 and along



Queens, 1840; Source: New York Public Library

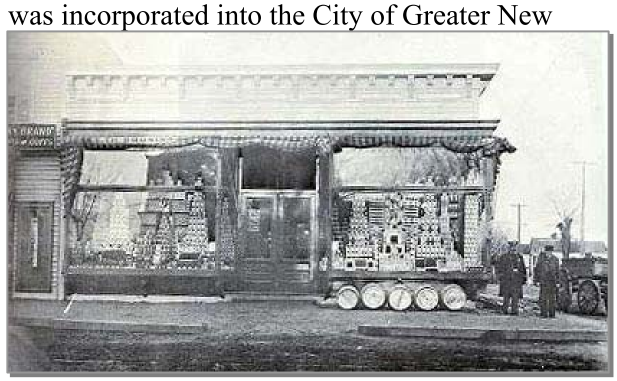
Jamaica Avenue from the Brooklyn border through Woodhaven and Richmond Hill to Jamaica during 1917-1918. As all developers and realtors knew, these massive improvements in transportation, especially the opening of Queens to five-cent fare service, promised rapid growth. Farms and open areas began to vanish and endless rows of new streets and one family houses began to spread out all over Queens.

During the 1920s, the population of Queens more than doubled from 469,042 to 1,079,129, a growth rate of 130 percent. Although the Great Depression of the 1930s ended this boom, growth of another kind was underway, with the construction of more bridges (the Triborough Bridge in 1936 and the Bronx-Whitestone in 1939), roadways (the Interboro Parkway in 1935 and the Grand Central Parkway in 1936), and airports (LaGuardia Airport in 1939 and Idlewild in 1948, renamed JFK Airport in 1963).

Although a part of Queens, Rockaway was settled separately and earlier than other areas around Jamaica Bay. In 1833 the Rockaway Association, a group of wealthy individuals who wanted to develop a fine oceanfront hotel in Rockaway, purchased most of the oceanfront property on the old homestead from descendants of Richard Cornell. The Marine Hotel was erected on the site of the original Cornell home.

Transportation to and from Rockaway originally consisted of horse-drawn carriages and horses. A ferry took passengers from downtown Manhattan to Brooklyn, and by the mid-1880s, the steam railroad succeeded the stagecoach, terminating at the present Far Rockaway station of the Long Island Railroad. Benjamin Mott deeded to the railroad company a seven-acre tract of land to be utilized as a railroad depot. The coming of the railroad to Far Rockaway increased land values and resulted in a boom to the businesses in the area. By 1888, the Village of Far Rockaway was large enough to apply for incorporation.

On July 1, 1897 the Village of Rockaway Park was incorporated into the City of Greater New



E. Theodore Bruning's Cash Grocery, Rockaway Parkway, 1908; Source: www.geocities.com/buddychai2/Brooklyn/canarsie.html

York. Streets were graded and sections of Rockaway Park, Belle Harbor and Neponsit began to be developed.

The completion of the Cross Bay Bridge in 1925, the further development of the beach and boardwalk in 1930, the completion of the Marine Parkway Bridge in 1937 and the improvements to the railroad services in 1941 were all factors that made Rockaway more accessible to the working class people of New York.

Development in the Jamaica Bay Estuary

In pre-European settlement times, the Lenape and their ancestors used the Jamaica Bay estuary primarily as a shellfishery, as evidenced by the shellfish middens that can still be found in excavations around the Bay. The dry land at Canarsie was the site of one of their settlements, providing direct access to the Bay. It is probable that they also hunted and fished in the shallow marshlands that extended around the perimeter of the estuary.

It was not until the early 19th century that the first European settlers began to develop the Jamaica Bay estuary. In the 1830s, John Norton made a large land purchase in the area of what is now

Historic Barren Island; Source: New York Public Library

known as Norton Basin (Rhoads *et al.,* 2001). In 1833, Norton built a large hotel known as the Marine Pavilion on marshes that had been filled using Bay sediments dredged to make access channels in the shallow waters. What seems like an interesting historical note actually is typical of the manner in which the natural marshland and Bay ecology has been managed over the last two centuries. The history of Jamaica Bay is replete with similar examples, some of which follow.

Historic Barren Island was home to fertilizer plants in the 1850s and continuing into the 1930s. Black (1981) noted that commercial statistics in a 1906 report to Congress indicated that the island

Mill Basin, Brooklyn; Source: New York Public Library

and Mill Creek were the only productive areas immediately around the Bay. Barren Island was expanded and extended with fill until it became what is now known as Floyd Bennett Field. Similarly, fill was used to expand Bergen and Mill Islands until they were joined together and to the mainland.

In the early 1900s, Mill Island was the home of a dredging contractor and dry dock operator. The present Mill Basin and East Mill Basin are the channelized remnant of the natural waterway that once surrounded the island. Bedford Creek was bulkheaded in the first quarter of the 20th century, eventually becoming today's Paerdegat Basin. Likewise, the natural form of the Canarsie shoreline underwent considerable filling in the first half of the 20th century until Sand Bay and other formations disappeared. Shell Bank Basin was created from a considerably smaller creek tributary to the larger Bay.

Although there was occasional discussion of dredging channels to allow navigation by larger vessels, Jamaica Bay has never had significant use for passenger or commodity shipping. As a practical matter, the Bay was too shallow for the types of vessels needed to accommodate a commercial port, and the magnitude of dredging to prepare it for such use, while proposed at various times, never has taken place. A 1917 report by the City's Bureau of Public Improvements (CNY, 1917) noted the establishment of several industries on Mill Basin. Dredging of an 18 feet deep and 500 feet wide channel from the entrance of the Bay to Mill Basin had been performed in the summer of 1912. This channel, proposed by the Jamaica Bay Improvements Commission, was to extend around the Bay. The Bureau of Public Improvements predicted that Jamaica Bay would "…in time become the port of entry for a considerable amount of domestic commerce." Basins would be constructed back from the main channel in the Bay and bulkheads constructed to docking facilities. While some of the dredging moved forward, the larger vision died for practical reasons, including the growth of commercial harbor facilities elsewhere in New York Harbor.

According to Black (1981), the islands of the Bay (except for the larger Barren, Bergen, and Mill Islands and Ruffle Bar) consisted "…almost entirely of meadows and marsh with no uplands…" What is now Broad Channel Island is comprised of what were formerly Big Egg Marsh, Goose Pond Marsh, Rulers Bar Hassock and Goose Creek Marsh. Fill was used to connect and eliminate these natural marsh formations, which have been developed to the community that exists today. The residents of Broad Channel Island continue to debate further development on the island in an attempt to conserve what little remains of the natural environmental heritage.

Jamaica Bay was not conducive to a commercial fin fishing industry, but it has long supported a recreational fishery. In the 17th and 18th century, subsistence fishing occurred in small settlements around the Bay. By contrast, from the mid-1800s to the early 1900s, the Bay sustained a strong commercial shellfishing and sportfishing industry. Issues of water quality resulted in the closing of the shellfish beds in 1923. In 1917 (CNY, 1917), it was estimated that 750,000 to 1,000,000 bushels of seed oysters were planted and harvested annually, as were 300,000 bushels of hard clam seeds. Soft "steamer" clams grew naturally in the Bay, and clamming was estimated to yield about 270,000 bushels a year. Not surprisingly, the entrance to the Bay has undergone significant natural change in recent history. In 1835 Rockaway Point was located near the east boundary of Jacob Riis Park. Material from a shoal south of Rockaway Point was used to extend the point four miles to the west in the following century (CNY, 1917). The federal Board of Engineers for Rivers and Harbors in a 1964 report (Board of Engineers, 1964) studied options (never built) to reduce shore erosion in Jamaica Bay and along the Atlantic shore of the Rockaways. It proposed a series of levees along the Bay shore of Jacob Riis Park (as well as along the Atlantic shore of the Rockaways), a 4,530 foot stone hurricane barrier with a navigation inlet across the entrance to Jamaica Bay from just west of Jacob Riis Park across to what was still described as Barren Island (which is still noted as the home of the U.S. National Air Station), and shorter levees at specific locations in Mill Basin.

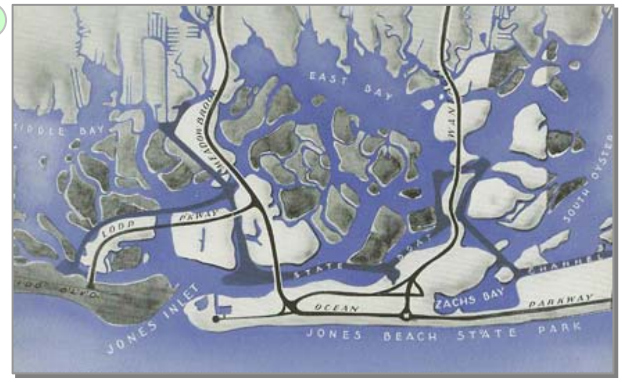
In its 1917 report (CNY, 1917), the Bureau of Public Improvements already noted that Jamaica Bay was "…without any inflowing fresh water feeders of consequence." The Bay is described as shallow, averaging 4.7 ft in depth at low tide, with channels reaching extreme depths of 66 ft in Big Channel east of Barren Island, 32 ft in Beach Channel south of Ruffle Bar, and 47 ft deep north of Rockaway Point. Continued dredging has modified these metrics, not necessarily to the benefit of the estuarine ecosystem. The channels and the Bay would continue to change over the next 90 years, the result of continued development in the watershed and a lack of knowledge of ecological principles with respect to resource planning of the Bay, and the impacts that these alterations would have on aquatic communities, water circulation, and dissolved oxygen and other constituents of the water column.

In 1938 (CNY, 1938), Robert Moses, the City's Commissioner of the Department of Parks, sent a letter to Mayor Fiorello LaGuardia that set a new vision for Jamaica Bay. He decried the 1922 plan that proposed to turn the Bay into a major industrial port "…greater than the combined ports of Liverpool, Rotterdam and Hamburg." Instead, he promoted a residential and recreational program for the Bay, suggesting that there was other space available for industrial expansion, such as Staten Island. Moses proposed:

- to completely rezone the Bay and its surrounding area
- transfer of "all islands to the Park Department for recreational use, including protection of scenery and waters"
- "encouragement of swimming, fishing, boating and preservation of wild life"
- "public use of the meadowlands adjoining Cross Bay Boulevard, including Big Egg Marsh"
- "purification of the polluted waters of the bay…"

This was a new vision for the Bay which Moses said at the time was "…the only large area in New York City whose character is undetermined, the only one which a tremendous public improvement can be insured with comparatively small expense by prompt official action." However, little was done to implement the controls that Moses suggested; the rate of development in and around the Bay continued, largely unabated until modern times.

It is important to understand the modifications that have occurred to the Bay in the last 150 years. Islands have been removed by dredging or extended to the nearby mainland by fill; shorelines have been altered by dredge and fill activities; bulkheads have been installed to stabilize and protect shorelines; channels and borrow areas have been dredged, altering bottom contours and affecting flows; and natural tributaries have essentially disappeared – their remains deposits of silts and particulates from urban runoff. These activities have conspired to affect historic flow patterns in the Bay, eradicated natural habitat, impacted water quality, and modified the rich ecosystem that still was present in the Civil War



Robert Moses Plan
(Jones Beach)

"The plan to preserve the islands in Jamaica Bay in their natural state has its parallel in the Great South Bay in Nassau and Suffolk Counties where the most important islands have been dedicated to the state for park purposes. This map shows the islands (in white) between Jones Beach State Park and the mainland which will forever be preserved in their present state." (CNY Department of Parks, 1938).

Robert Moses Plan
(Boating)

"The present channel system, inadequate for deep draft tug boats and commercial vessels, is of sufficient depth and entirely satisfactory for the average small pleasure boat, with the exception of a relatively short section in the northeastern part of the bay. By dredging the channel shown on the map 10 feet deep and 200 feet wide, at a cost of $200,000, a complete circulatory channel system for motor launches will be provided. The cost of dredging alone under the industrial and commercial plan now on the city map is estimated at approximately $20,000,000." (CNY Department of Parks, 1938).

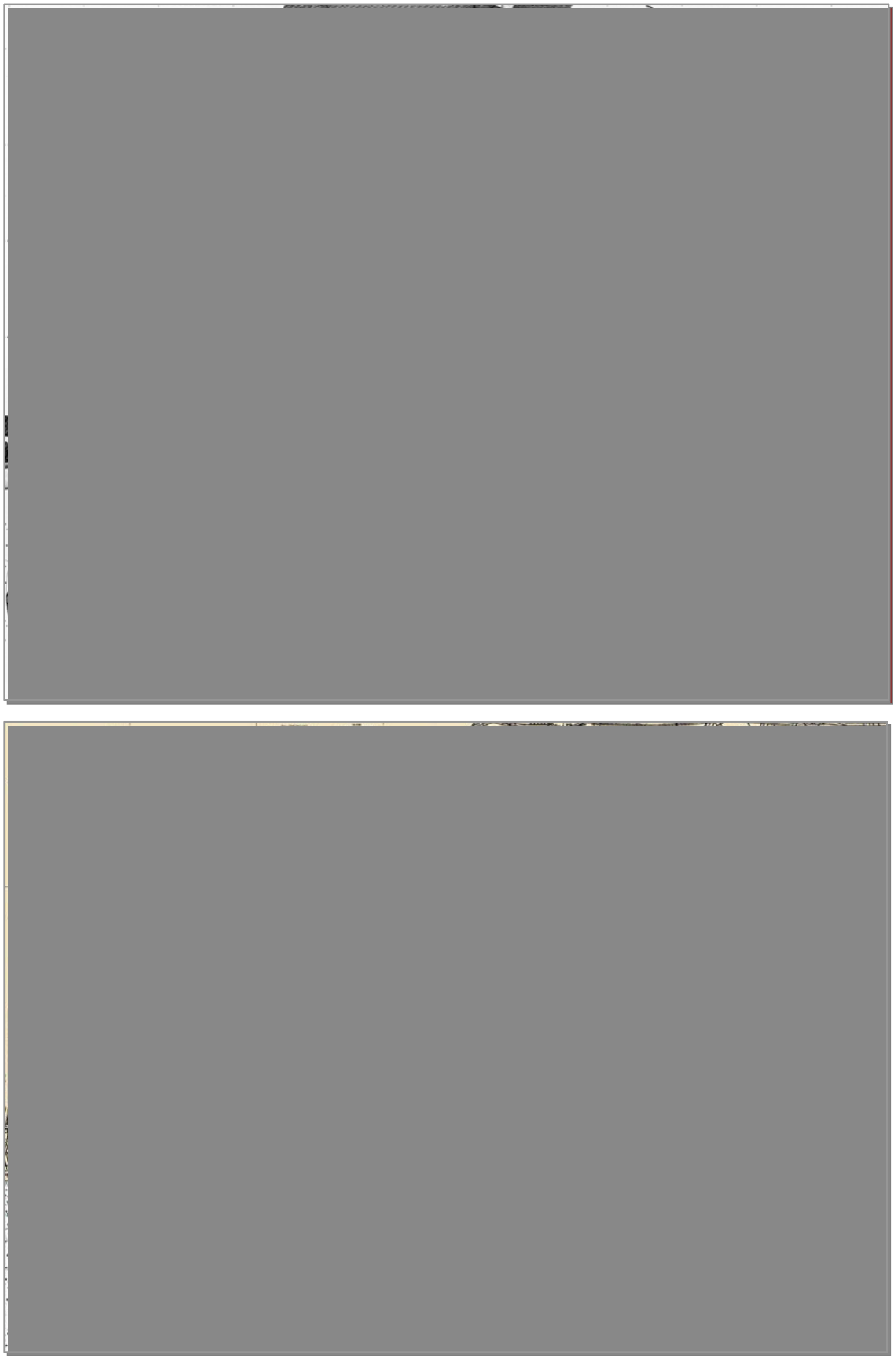


FIGURE 2.2.2 Jamaica Bay, 2002; Source: NOAA

era of the 19th century. A comparison of conditions in the Bay in 1899 and today is presented in Figures 2.2.1 and 2.2.2.

The tributaries to the Bay, in particular, have undergone extensive physical changes over the years. Fresh water that feeds the tributaries is almost solely from combined sewer overflows (CSOs), storm sewers, and wastewater pollution control plants (WPCPs). They have been dredged and bulkheaded, and widened or narrowed; most bear little resemblance to the original water courses that passed through the original channels. For example, in the 1930s, Paerdegat Basin was dredged with a main channel depth of 16 feet below mean low water for its entire length and connected to the dredged shipping channels in Jamaica Bay; however, the navigable channel has not been maintained since its original dredging. Hendrix Creek has been greatly affected by channelization and filling; the width of the creek has been made a uniform 60 to 80 feet; and its depth (at low tide) reduced 2 to 5 feet. Spring and Ralph Creeks (which is tributary to Spring Creek) have retained some semblance of their original channel configuration; however, the system as a whole has been altered to the point where freshwater input is derived almost exclusively from CSOs, storm sewers, and WPCPs.

2.3 GEOGRAPHICAL SETTING

The Watershed

In a natural or non-urban setting, the watershed of a body of water would be delineated by the topography of the area. Any overland flow or stormwater runoff (*i.e.*, rainfall or snow melt) within the watershed would flow down hill collecting in drainage ways, ditches, streams, creeks, and rivers until reaching the main receiving waterbody. Based strictly on the topography of the area, the Jamaica Bay watershed encompasses portions of the Boroughs of Brooklyn and Queens in New York City, and portions of the Towns of Hempstead and North Hempstead in Nassau County. Together, the land area of the watershed, based on topography alone, of the Bay is approximately 71,000 acres. Figure 2.3.1 shows the topographic watershed boundary for Jamaica Bay without regard to the collection and discharge of sanitary and stormwater sewers. Elevations within the watershed range from sea level to a maximum of approximately 250 feet, to the west of Queens and Nassau County border near the Cross Island Parkway.

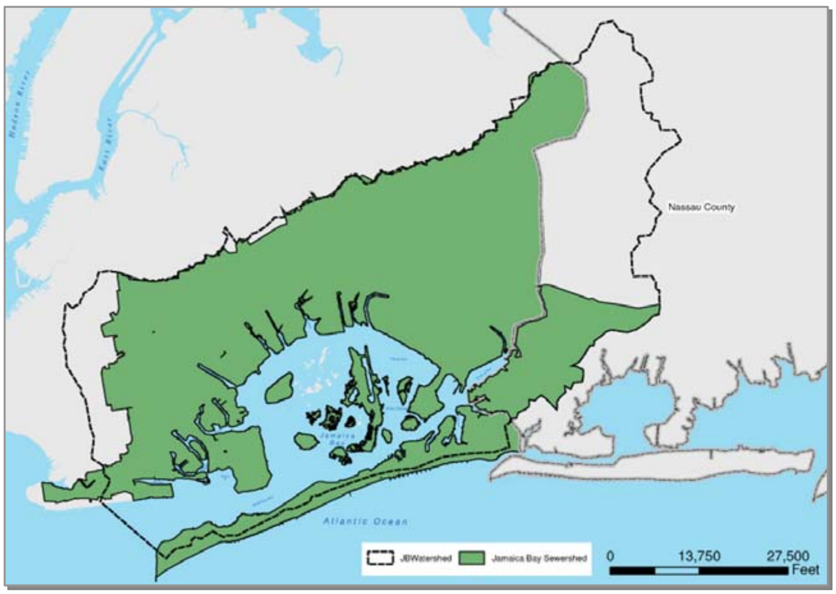


FIGURE 2.3.1 Jamaica Bay Sewershed and Watershed; Source: NYCDEP

Eight tributaries empty into Jamaica Bay — Sheepshead Bay, Paerdegat Basin, Fresh Creek, Hendrix Creek, Spring Creek, Shellbank Basin, Bergen Basin, and Thurston Basin. The term "tributary" refers to the dead ended canals located around the Bay. The term "basin" usually refers to the watershed, but in Jamaica Bay refers to the receiving water. All the Jamaica Bay tributaries have been highly altered over the years through channalization and tend to have little or no freshwater flow. They all receive CSOs from the Jamaica Bay watershed and several receive treated effluent from four NYC WPCPs and an auxiliary plant (*i.e.*, Spring Creek, Bergen Basin, and Hendrix Creek). The Bay also receives treated effluent from a Nassau County WPCP that discharges into Mott Creek, a minor tributary of Jamaica Bay.

FIGURE 2.3.2 Gateway National Recreation Area; Source: US National Park Service, 1994

The land area that is actually tributary to Jamaica Bay (approximately 47,000 acres in New York City) is the area served by combined and separated sewer systems, or the sewershed, that collect and convey sanitary wastewater, as well as stormwater. The collected flow is then discharged to Jamaica Bay. Therefore, portions of the area within the topographic boundary that otherwise would define the watershed, the western-most portion of the watershed in Brooklyn and the majority of the eastern-most portion in Nassau County, are not in the sewershed of the Bay. Runoff from those areas is diverted from Jamaica Bay by sewers that collect and convey both sanitary wastewater and runoff to other water bodies. In this area of Brooklyn, runoff is taken by the sewers and eventually discharged to the Lower Bay of New York. For flows in Nassau County, collected runoff is directed either to the Brosewere Bay and the Atlantic Ocean to the south or from the north

side of the terminal moraine that characterizes Long Island (see Chapter 2.5), to Long Island Sound to the north. However, runoff from an area in the extreme southwest corner of Nassau County, including the Village of Cedarhurst and treated effluent from the Cedarhurst WPCP, does flow into Jamaica Bay.
The City portion of the watershed's land area is approximately 53,000 acres. Land uses in the Jamaica Bay watershed include residential, commercial and industrial lands, landfills, as well as vacant, undeveloped lands, marshes, wetlands, parks, and the John F. Kennedy International Airport (JFK Airport). The airport, located on the eastern edge of the Bay, occupies approximately 4,300 acres on the eastern edge of the Bay (see Chapter 6, *Land Use and Development*, for more detail on land uses).

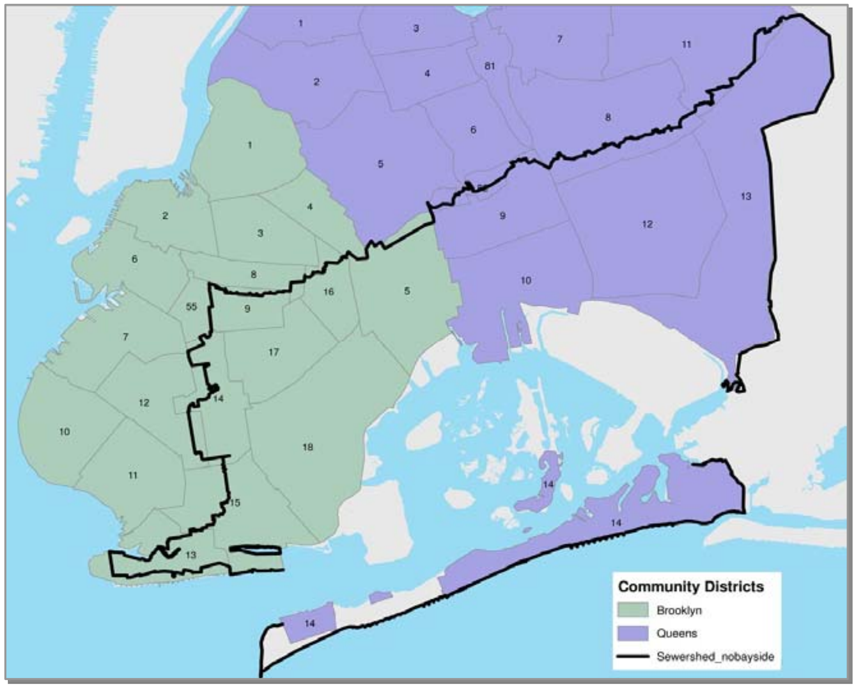


FIGURE 2.3.3 Sewershed Community Districts; Source: NYCDEP

The Bay includes areas of open water, tidal flatlands, salt marshes, and a number of islands. The largest island in the Bay is Broad Channel Island. Broad Channel Island is connected to the mainland and Rockaway by Cross Bay Boulevard. Other transportation connections across the Bay are the Marine Parkway Bridge extending from the Floyd Bennett Field area to the west end of the Rockaway peninsula and the "S" and "A" subway lines of the Metropolitan Transportation Authority (MTA) which crosses the Bay at Broad Channel Island.

The Bay has been designated by the New York State Department of Environmental Conservation (NYSDEC) as a Critical Environmental Area (CEA), the only one in New York City, and by the NYSDOS as a significant Coastal Fish and Wildlife Habitat as part of its Coastal Zone Management Program. A portion of Jamaica Bay is included in the National Park Service Gateway National Recreation Area (NPS GNRA). The GNRA also includes part of Sandy Hook across the Lower New York Harbor on the New Jersey shore.

The Bay

Jamaica Bay is the largest estuarine waterbody in the New York City metropolitan area covering an area of approximately 20,000 acres (approximately 17,177 acres of open water and 2,695 acres of upland islands and salt marshes marshes). It is bounded on the west and northwest by Brooklyn, on the north and northeast by Queens. The northeastern and southeastern corners of the Bay are bordered by Nassau County. The northern shore of the Rockaway Peninsula, a part of Queens, forms the southern boundary. The Bay is connected to the Atlantic Ocean through the Rockaway Inlet and has a tidal range of approximately 5 to 6 feet. It measures approximately 10 miles at its widest point east to west and approximately 4 miles at its widest point north to south. The mean depth of the Bay is approximately 13 feet with maximum depths reaching 30 to 50 feet in navigation channels and borrow pit areas.

Dredging and filling of the Bay over the past century has significantly altered not only the bottom of the Bay but also its shoreline, and the number and shape of the Bay's islands and marsh lands. The alteration has resulted in the loss of many of the Bay's tidal marshes, portions of the Bay becoming channelized, the disappearance or bulkheading of many of the Bay's tributaries, and the loss of many islands due to dredging and channelization work over the years. However, other islands have been created by dredging and filling operations.

2.4 CLIMATOLOGICAL SETTING

The New York City/Jamaica Bay region experiences a humid continental climate moderated by proximity to the Atlantic Ocean (NYSCO, 2006). Three air masses provide the dominant climatic conditions for the area. Primarily in the winter months, masses of dry, cold arctic air arrive from the northern interior of the United States and Canada. In the summer, prevailing winds from the south and southwest convey warm, humid air from the Gulf. The third great air mass flows inland from the North Atlantic Ocean, producing cool, cloudy, and damp weather conditions, moderating temperatures during the warmer months. Most storm and frontal systems moving eastward across the continent pass through or proximate to the New York City metropolitan area, while storm systems moving northward along the Atlantic coast also have a strong influence on New York City's regional weather.

An understanding of climate characteristics of the watershed, particularly rainfall and climate change effects, is important for development of the Volume 2, *Jamaica Bay Watershed Protection Plan*. The intensity of storm events influences the volume of stormwater and CSO events. Climate change affects the length of the growing season and has led to changes in the rate of sea level rise and loss of wetlands. These climatological processes as they relate to Jamaica Bay are explained further below.

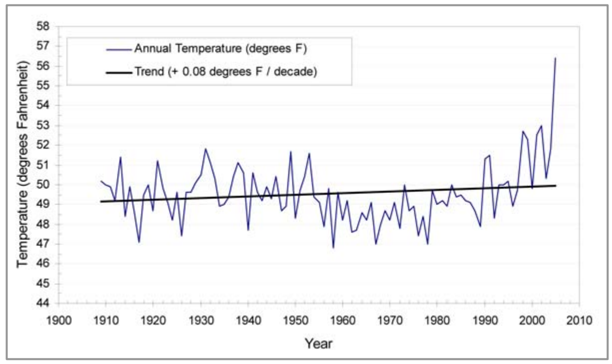


FIGURE 2.4.1 Mean Annual Temperatures for the New York Metro Region (at New York Central Park); Source: National Climatic Data Center (NCDC), 2006

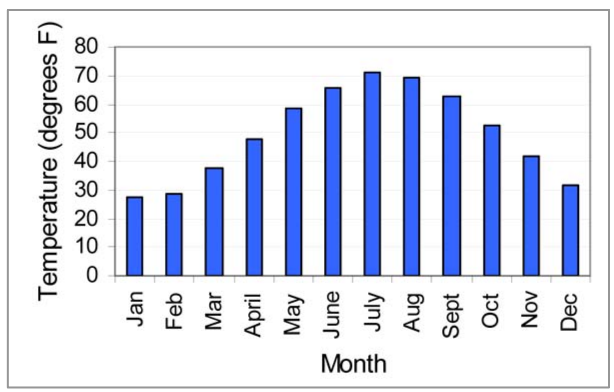


FIGURE 2.4.2 Mean Monthly Temperatures for the New York Metro Region (at New York Central Park); Source: National Climatic Data Center (NCDC), 2006

Temperature

The average annual regional temperature is about 50°F (NCDC, 2006). In the last decade, New York City has experienced its five highest mean annual temperatures to occur in the last century, a surprising and potentially significant statistic (NCDC, 2006, Figure 2.4.1). Due to local warming from the urban heat island effect, these temperatures are likely to be elevated compared to less developed areas in the region. Large cities tend to have somewhat unique climate characteristics, due to the prevalence of dark surfaces (generally pavement and rooftops) that absorb more heat from the sun, and less vegetation to provide shade and temperature regulation. Heat from urban areas affects the length of the growing season and plant survival while wind patterns are influenced by surface structures such as tall buildings (Sukopp, 1998).

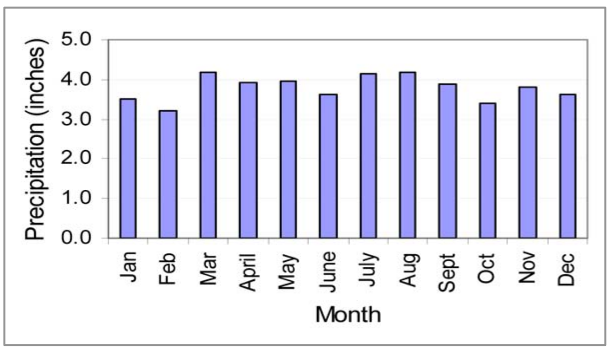


FIGURE 2.4.3 Average Monthly Precipitation for the New York Metro Region (at New York Central Park); Source: National Climatic Data Center (NCDC), 2006

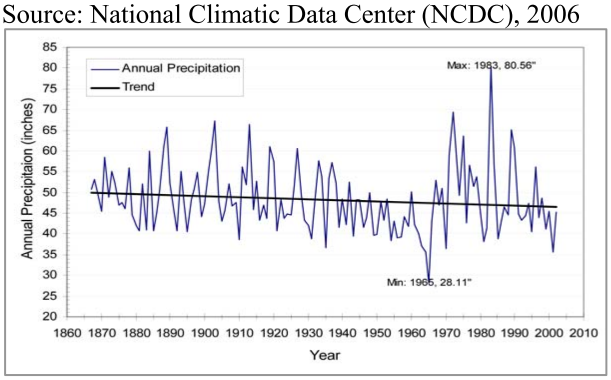


FIGURE 2.4.4 Annual Precipitation for the New York Metro Region (at New York Central Park); Source: National Climatic Data Center (NCDC), 2006

Precipitation

Moisture for precipitation originates primarily in the Gulf of Mexico and Atlantic Ocean through atmospheric circulation patterns. There are no distinct dry or wet seasons in the New York City region (Figure 2.4.3). In the Jamaica Bay area, minimum precipitation occurs in the winter season, with an average monthly accumulation of about 3.5 inches on Long Island to average summer highs of 4 inches along the New York coastal zone. Monthly winter snow accumulations of between 3 to 10 inches occur in New York City and Long Island. Occasionally, the amounts may exceed 20 inches as a result of recurring coastal storms (nor'easters). Annual precipitation for the New York Metro area (as measured in Central Park) is depicted in Figure 2.4.4. Average annual precipitation for the Jamaica Bay region is 45 inches, while the average snowfall is 29 inches (NCDC, 2006).

Long term rainfall statistics were evaluated for the establishment and selection of an "average year" as the design rainfall condition for all activities related to New York City's CSO and related programs; this design rainfall condition is consistent with the U.S. Environmental Protection Agency's (USEPA's) CSO Control Policy. Storm intensity and frequency were evaluated in the years 1970 – 2002 using data collected at John F. JFK Airport; this information provides a perspective on the average storm in New York City (see Table 2.4.1, following). Based on these data, 1988 was selected as representative of the average year.

TABLE 2.4.1 Long Term Statistics, JFK Airport Rainfall Record (1970-2002)

Rainfall Parameter	Long Term Median	Average Year (1988)
Total volume, inches	39.4	40.7
Intensity, inches/hr	0.057	0.068
Number of storms	112	100
Storm duration, hours	6.08	6.12

Rainfall in the region is usually sufficient during the growing season for most needs. Severe droughts are rare, but periods of low precipitation can stress available water supplies and result in moisture deficiency for upland vegetation. Tidal marshes in Jamaica Bay are not impacted by drought to the extent of freshwater wetlands and uplands, although a temporary decline in freshwater input to the Bay does result in locally increased salinity levels, which may affect some aquatic species.

The metropolitan New York City area is subject to severe flooding of highways, streets, and low-lying ground. The replacement of the natural soil cover with cement, asphalt, and other impervious materials encourages flooding from moderately heavy rains that historically would infiltrate into the ground or run off into natural stream channels. The shorelines of Jamaica Bay are subject to tidal flooding during storm surges from winds generated by hurricanes and large coastal storms. These storm surges have the potential to drive tidal waters well inland, causing extensive property damage and shoreline erosion.

Climate Change and Sea Level Rise (SLR)

As the earth and its oceans warm, ice sheets at the poles melt and sea water thermally expands, both contributing to sea level rise (SLR) (Wigley and Raper, 1987). As the sea levels rise, Eastern coastal states are susceptible to the loss of coastal lands due to erosion and inundation. In particular, sea level rise poses a direct threat to the health of tidal wetland systems that provide essential habitat to migratory and resident fish and birds.

There are no long term tide gauges in Jamaica Bay. SLR information is derived from a tide gauge in Battery Park, Manhattan, which has been recording data since 1856 and has one of the longest known records in the United States. Information from this gauge indicates a SLR of 2.7 mm/yr in the Jamaica Bay watershed (Hartig *et al.,* 2000). If wetland surface level accretion (addition to the land by deposition of water-borne sediment) is not sustained with the pace of SLR, there is concern that the remaining island salt marsh wetlands in Jamaica Bay will vanish in a few generations' time (USACE, 2005).

In 2000, the International Panel on Climate Change (IPCC) suggested that the rate of SLR is expected to double in the next 50-100 years even if a significant reduction in current climate warming greenhouse gases emission trends occurs (IPCC, 2002). Furthermore, the data implies that if nothing is done to our current rate of greenhouse gas production, the rate of SLR could triple in the next 50-100 years (IPCC, 2002). It has been estimated that by 2020 the mean SLR could be between 2.7-7.3 mm/yr, and by 2050 the sea level could be expected to rise between 2.7-13.7 mm/yr (Hartig *et al.*, 2000). Using these rates of sea level rise, by 2050 the mean sea level in Jamaica Bay could increase by 12 centimeters (0.4 feet) to 47 centimeters (1.5 feet) in elevation.

A direct result of SLR will include the extensive, accelerated loss of uplands and shoreline wetlands from wave driven erosion and tidal inundation. While some upland areas may not become directly inundated, salt spray, storm surges, and saltwater intrusion are likely to affect plant and animal species that do not normally have contact with higher salinity waters. Wetlands utilize natural landward migration as a means of adapting to slower rates of SLR. In Jamaica Bay, the process of landward migration is frequently arrested by hardened shorelines, leaving these wetland areas vulnerable to becoming overwhelmed by increasing rates of SLR. The degree to which sea level rise contributes to the accelerating loss of salt marsh islands in Jamaica Bay is as yet unquantified, but is identified as one of the factors in their disappearance (NPS, 2004).

2.5 GEOLOGY AND SOILS

Geology

The metamorphic bedrock formations that underlie Long Island are more than 400 million years old, while the overlying sands and clays were deposited about 70 million years ago (Mills, 1974). The bedrock, or basement formation, that lies beneath Long Island slopes to the south and east at depths ranging from 2,000 feet below the surface along the southern edge of Long Island to being near the surface, particularly in the northwestern portions of Queens and Brooklyn (Mills, 1974). However, due to the general depth of the bedrock, there are few, if any, outcrops anywhere in the watershed area. Figure 2.5.1 shows the geology underlying Long Island.

The surface features of Long Island that form the general topography seen by the casual observer are the result of glacial advances and retreats. Moraines are elongated ridges that are formed at the edge of a glacier. Moraine formations consist of rocks, sand, and gravel that have been carried by the glacier, sometimes from distant locations (Rogers, W. B., *et al*, nd). Moraines deposited at the ending limit of a glacier, such as those found on Long Island, are called terminal moraines. The two terminal moraines that are found on Long Island are the Harbor Hill and Ronkonkoma (Rogers, W. B. *et al.*, nd). The outwash plain is that area beyond the margins of a glacier where meltwater deposits sand, gravel, and mud washed out from the glacier. On Long Island

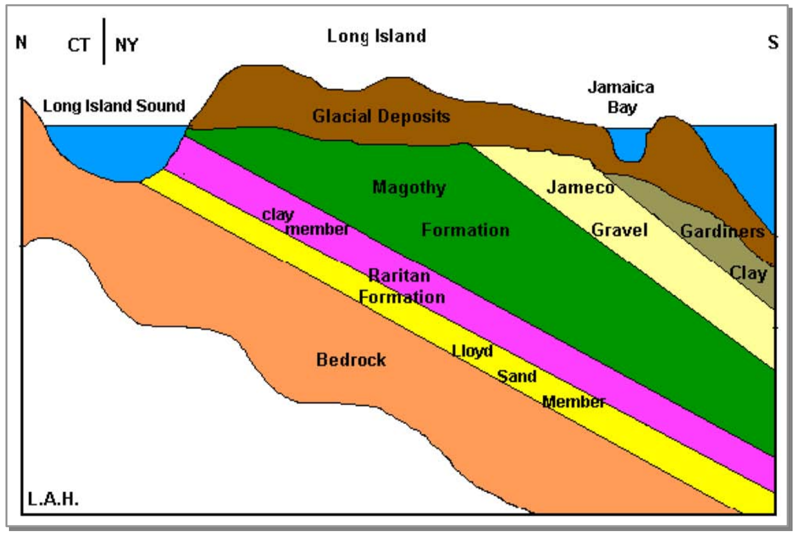


FIGURE 2.5.1 Coastal Plain Geology Underlying the Glacial Deposits of Western Long Island; Source: US Department of

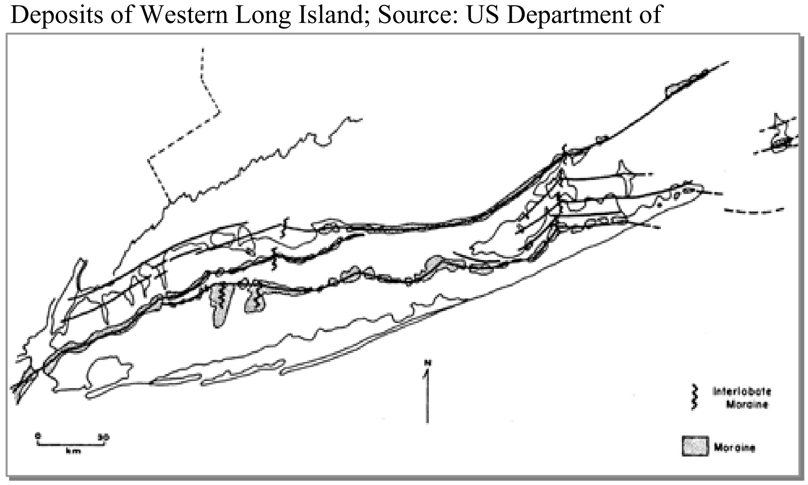


FIGURE 2.5.2 Terminal Moraine and Correlation of Recessional Moraine Segments Across Long Island; Source: Sirkin, L. Late Wisconsianan Glaciation of New England, 1982

the outwash plain extends southward from the Harbor Hill and Ronkonkoma moraines (Figure 2.5.2).

With respect to the Jamaica Bay watershed, it is the Harbor Hill moraine and the outwash plain that has had the most influence in shaping the surface of the watershed area. The Harbor Hill moraine is a continuous ridge extending from Brooklyn on

Definitions

Moraine: A large body of drift (consisting of till, stratified drift, or both that has been shaped into a rounded ridge... At the outer margin of a glacier that has reached its maximum extent, the ice pushes up debris into a ridge whose trend follows the edge of the ice. This ridge is known as *terminal moraine.* (Sanders, J.E., *et. al*., 1976).

Urban Land: "…Areas where at least 85 percent of the surface is covered with asphalt, concrete, or other impervious building material. These areas mostly are parking lots, shopping centers, industrial centers…" (U.S. Soil Conservation Service).

the west to Port Jefferson on the east. High points of the Harbor Hill moraine are found near Lloyds Neck (approximately 280 ft) and Eatons Neck (approximately 230 ft) on the north shore of Long Island, about 18 and 25 miles northeast of the Jamaica Bay watershed, respectively. The outwash plain from the Harbor Hill moraine extends southward sloping from the ridgeline to the Atlantic Ocean (Bennington, J.B., nd).

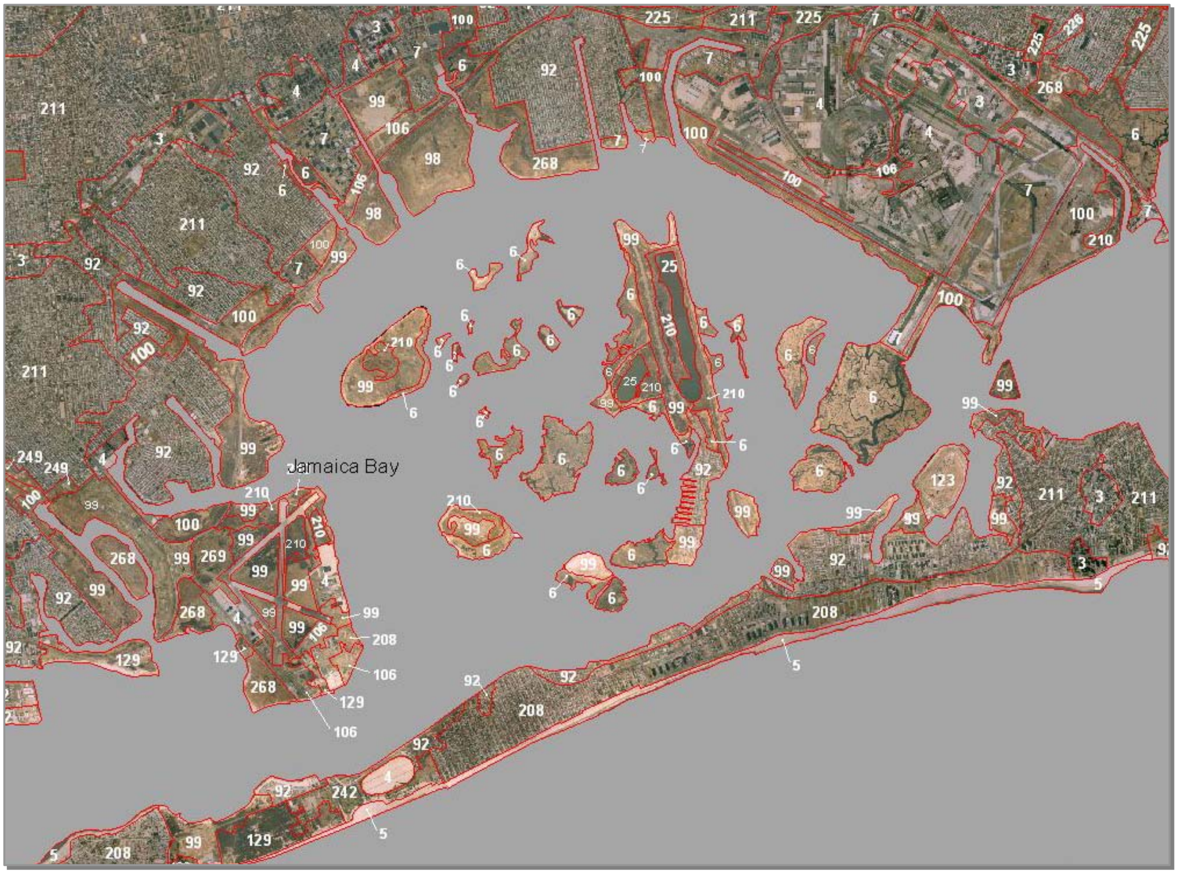


FIGURE 2.5.3 Jamaica Bay Reconnaissance Soil Survey; Source: NRCS

Soils

The composition of a soil in any given location depends on the geologic forces that acted on the area, the source or sources of the mineral formations that contributed to the makeup of the soil and, often of great significance, man's activities that may have altered the surface layers. In the case of Long Island, the results of repeated glacial advances and retreats of the area were the primary origin of the area's soils (USDA, 2005b). Over time, the physical structure of the surface soils has been subjected to wind, rain, and runoff. These forces serve to erode soils from one area and deposit them in another. Naturally occurring soils found in valleys and streams, on hills and sloped areas are the products of these forces.

Man made (anthropogenic) forces have influenced the surface soils that are now found in the Jamaica Bay watershed (see Figure 2.5.3). Many of the soils found along the shoreline *(i.e.*, within 1/4 mile) of the Bay have been greatly influenced by residential, commercial, and industrial development, landfilling with waste materials, and dredging operations and are non-native or not undisturbed, even if they consist of local materials. Shoreline slopes are often characterized by a gentle slope (less than 5 percent slope) along natural shoreline banks where they have not been channelized or otherwise altered with piers, boat slips, or bulkheads to stabilize the banks. Areas away from the immediate shoreline (*i.e.* greater than 1/4 mile) of the Bay are generally characterized as “urban” soils or those areas where the soil has been covered by pavement and/or buildings. For detailed soil information see Chapter 4, Ecology.

Although the majority of the area within the topographic watershed that is within Nassau County does not contribute flow to Jamaica Bay, the soils there are also generally described as urban soils (USDA 1987).

2.6 HYDROLOGY

There are four aquifers underlying the Jamaica Bay area as shown on Figure 2.5.1 (USGS, 1999). Together these aquifers make up the Brooklyn-Queens Aquifer System:

- Lloyd Aquifer, the deepest
- Magothy Aquifer
- Jameco Aquifer
- Upper Glacial aquifer

The Lloyd Aquifer consists mainly of fine to coarse sands and interbedded gravels, silt and clay. The thickness of the Lloyd Aquifer ranges from essentially zero at its northern edge under Long Island Sound to 200 to 300 feet thick under the southern portions of Brooklyn and Queens. It is found perhaps 90 feet below sea level in northern Queens and over 800 feet below sea level under the southern portion of the Jamaica Bay watershed area (USGS, 1999).

The Magothy Aquifer consists mainly of very fine to coarse sand and silty sand with small amounts of interbedded clay and silt. As with the Lloyd Aquifer, the thickness of the Magothy Aquifer ranges from essentially zero at its northern edge under Long Island Sound but reaches a thickness of 200 to 500 feet thick under the southern portions of Brooklyn and Queens. It is found perhaps 100 to 200 feet below sea level in northern Queens and over 400 feet below sea level under the southern portion of th[illegible]y watershed area (USGS, 1999).

> “*More than just the substrate for creating growth, the soil is Earth’s primary filter, cleansing and recycling water and decaying material; is also a major component of the earth’s planet’s water-storage and water-cycling processes.*
>
> *- Dr. David Suzuki*”

The Jameco Aquifer consists mainly of coarse sand and gravel in its northern reaches to finer particles in the south. The thickness of the Jameco Aquifer ranges from essentially zero at its northern edge in the central part of the Jamaica Bay watershed but reaches a thickness of no more than 200 feet thick under the southern portions of Brooklyn and Queens. It is found perhaps 90 to 100 feet below sea level at its northern edge and over 200 below the sea level below the southern portion of the Jamaica Bay watershed area (USGS, 1999).

The Upper Glacial Aquifer overlies the other units and may be found at the surface throughout nearly all of Brooklyn and Queens. As such, it is characterized by the unconsolidated mixtures of clay, sand, gravel, and boulders that are common to the outwash plain south of the Harbor Hill Moraine (USGS, 1999).

Fresh ground water from the Brooklyn-Queens Aquifer system starts as precipitation in the form of rainfall and snowmelt (USGS, 1999). This recharge process is achieved by precipitation that finds its way to the aquifer through the percolation or the slow seepage into the ground from the surface, either through porous areas such as lawns, parks, or cemeteries, or by seepage from the bottoms of lakes, ponds, and streams.

Of course, not all of the precipitation reaches the aquifer. This process is important for Jamaica Bay: since the watershed is highly urbanized and includes many impervious surfaces; precipitation runs off of buildings, roads, and other paved, concrete or constructed surfaces and into sewers. This water, and the waste materials and contamination that it picks up, is then conveyed by storm sewers or CSOs directly to the Bay and its tributaries, or to WPCPs and eventually to the Bay as treated discharges.

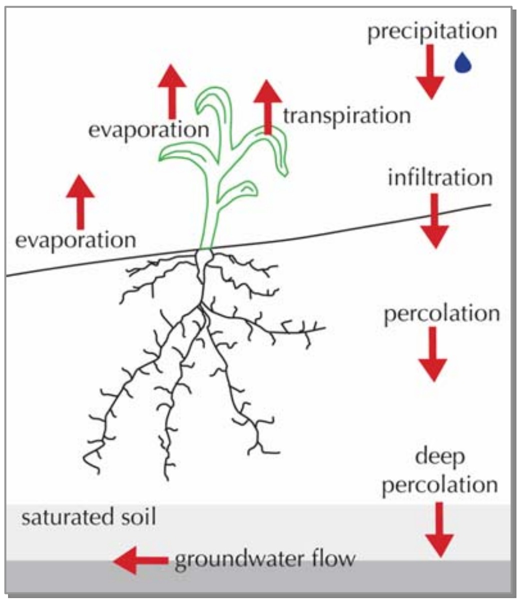


FIGURE 2.6.1 Ground Water Percolation; Source: University of Kentucky

There are no significant or naturally flowing streams or other surface water features in the Brooklyn and Queens areas that, in other areas, would be expected to contribute to the recharge of the underlying aquifers. Streams and their drainage areas that once flowed through the Jamaica Bay watershed have been covered over by the expansion of streets, roads, residential housing, commercial uses, and industrial growth. There are few ponds and lakes in the area to contribute fresh water to the aquifer.

In naturally vegetated areas, approximately 50% of the precipitation is captured by plants and returned directly to the atmosphere through evapotranspiration (USGS, 1999). Due to the relatively high degree of impervious surfaces (*i.e.,* paved areas) within the watershed, much of the precipitation does not escape through evapotranspiration and does not recharge the aquifer system but runs off to be collected in the combined sewer system. This collected runoff eventually is discharged to Jamaica Bay via the existing WPCPs and CSO points located around the Bay. For further discussion of surface water within the Bay see Section 4.2 – Aquatic Environment.

As noted, natural fresh water flow into Jamaica Bay is negligible in comparison to the discharge from four WPCPs and numerous outfalls into the Bay. These WPCPs, and storm sewers, are the largest source of fresh water to Jamaica Bay as natural flow has been greatly diminished due to urbanization. Inflow from the Hudson River and ground water flow also contribute fresh water to the Bay.

The component of precipitation that is not lost through evapotranspiration or through the sewer system does make its way into the ground to recharge the aquifer where there are permeable surfaces such as lawns, landscaped and vegetated areas, natural areas, and other land that is undeveloped, unpaved, or both.

Once in the aquifer system, ground water in the Upper Glacial Aquifer generally moves laterally and discharges to the surrounding salt water bodies (USGS, 1999). Ground water that is able to make its way by moving vertically to the lower aquifers also eventually discharges to the surrounding salt water bodies.

The hydrologic characteristics of Jamaica Bay have also been affected by the dredging and filling that have taken place. Prior to urbanization and development of the watershed, the Bay had a maximum depth of approximately eleven feet. But dredging of navigational channels and the provision of about 90 million cubic yards of fill for projects such as the JFK Airport expansion, has increased the depth as much as 50 feet in certain locations (*e.g.*, Grassy Bay). Similarly, much of the Bay's shoreline has been filled with a variety of materials including dredged sediment but also municipal waste, incinerator ash, and other historic fill.

2.7 GROUND WATER SUPPLY

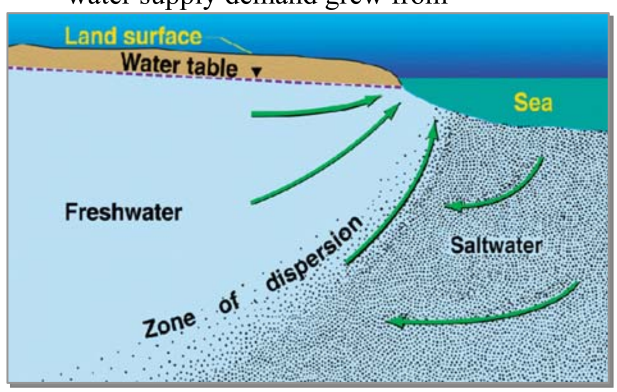
The ground water aquifer system underlying western Long Island served as a public water supply for much of Brooklyn and Queens as well as for Nassau County beginning in the mid-1800s. Before then, private wells tapped into the shallow aquifer provided much of the water for drinking, washing, and sanitary needs of the area's population. With the swift increase in population and commerce in the area in the late 1800s and following the turn of the century the relatively ready availability of fresh water pumped from the aquifer was used to meet the demands of the expanding growth.

Historically, the aquifer system has come under pressure from:

- the *increasing demand* to supply fresh water to meet the expanding growth of the area, and
- the *decreasing ability* of the area to recharge the aquifer system due to the increased amount of impervious area associated with growth.

In the past, ground water from the Brooklyn-Queens Aquifer system was pumped out to provide drinking water for parts of southeastern Brooklyn and Queens and also for parts of Nassau County. A brief summary of the use of the Brooklyn-Queens Aquifer in Brooklyn and Queens was reported by the USGS (USGS, 1999).

- In 1904 the ground water aquifer supplied virtually all of the approximately 42 million gallons per day (MGD) for public use and approximately 14 MGD for industrial use in both Brooklyn and Queens. By 1916, public use had grown to approximately 54 MGD and industrial use to 34 MGD.
- In 1917, the City extended a water supply tunnel into the area which brought fresh water obtained from upstate. This resulted in a reduction of the ground water pumped out to meet the public water supply demand. However, both public and industrial demands on the aquifer continued to increase.
- In the period of 1918 to 1930 the public water supply demand grew from



Salt Water Intrusion

Under natural conditions, the movement of fresh ground water from coastal aquifers is toward the sea, in the case of the Brooklyn and Queens area, the Atlantic Ocean. This movement prevents salt water from moving into or intruding into the aquifer system. The interface between fresh water and salt water is kept near the coast or far below land surface and is actually a zone in which fresh water and salt water mix.

Ground water pumping can reduce the rate and volume of fresh water flow toward coastal discharge areas and allow salt water to move landward. Salt water intrusion decreases the volume available for fresh water storage in the aquifer system, and, in extreme cases, can result in the abandonment of supply wells.

approximately 34 MGD to 92 MGD while the industrial demand grew from approximately 34 to 70 MGD.

- The period of 1931 to 1946 saw significant changes in the water supply system for Brooklyn and Queens. In 1936, a second water tunnel was developed for the delivery of water to the area. However, this second tunnel merely met the water demand for new growth; the ground water aquifer was still relied on to provide fresh water to prior customers. Therefore, the withdrawal from the aquifer remained relatively constant at 70 to 90 MGD. Concurrently, the use of the ground water for industrial use began to decline due to concerns over salt water intrusion (see sidebar on page 25 for more discussion of this phenomenon).

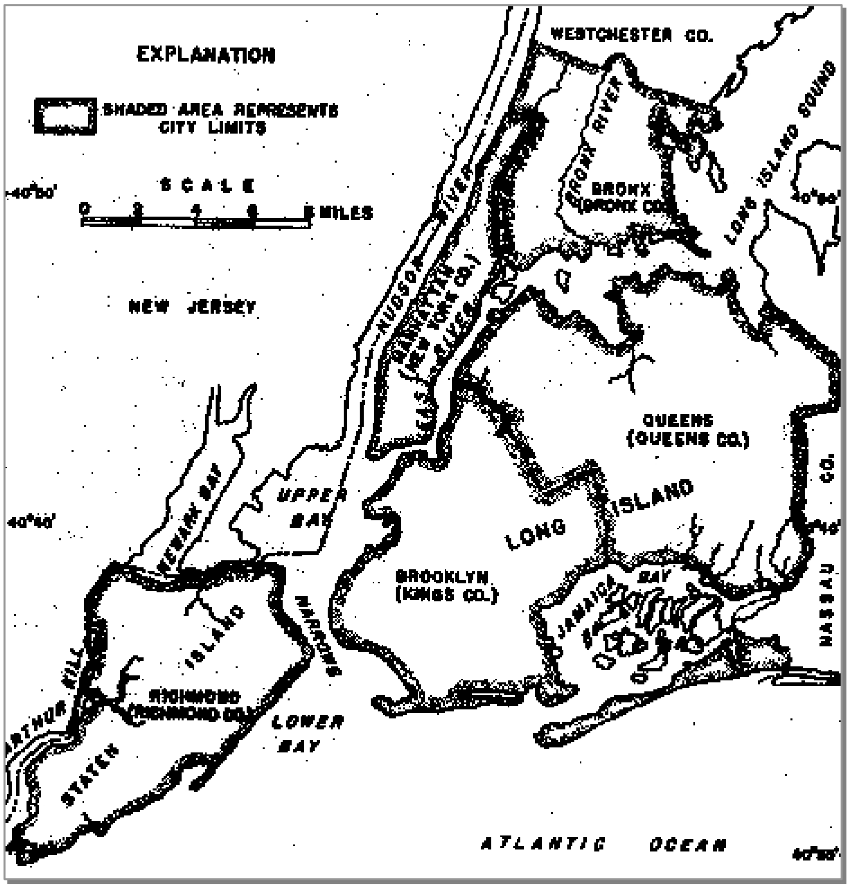


FIGURE 2.7.1 Location and Geologic Setting of Brooklyn-Queens Aquifer System; Source: U.S. Environmental Protection Agency

- In 1947, essentially all pumping of the ground water in Brooklyn ended, again due to concerns over salt water intrusion. Meanwhile, pumping to provide water to parts of Queens went from approximately 45 MGD in the late 1940s to nearly 70 MGD in the 1970s. After 1974, both public and industrial water supplies from the aquifer fell to less than 10 MGD as water was increasingly provided from the upstate water supply system.

What aquifer supplied the ground water used for drinking water?

- In 1904 virtually all of the ground water was pumped from the Upper Glacial Aquifer, the shallowest of the four aquifers making up the Brooklyn-Queens Aquifer System. Withdrawals from this aquifer occurred through to the late 1940s in Brooklyn when use of the ground water was ceased. During that time, the Upper Glacial aquifer provided approximately 15–25 MGD for users in Brooklyn and an average of approximately 20 MGD, ranging from about a minimum of 15 MGD to a maximum of over 45 MGD for users in Queens, up until the 1970s (Figure 2.7.1).
- The Jameco Aquifer, the next lower aquifer, was used sporadically in Brooklyn up until the 1940s, and up until the 1970s in Queens. An average of about 5 MGD was pumped from the Jameco Aquifer.
- The Magothy Aquifer was not used to provide ground water to Brooklyn users. In

Queens, pumping from this aquifer was generally less than 5 MGD up until the early 1960s. From the early 1960s to the mid-1970s, the use of the Magothy aquifer increased from about 10 to 45 MGD.
- The Lloyd Aquifer was used for a short time in the early 1930s to provide ground water to Brooklyn users and, even then, at a rate of less than 4 MGD. In Queens, this aquifer was used from the early 1900s up until the 1970s providing about 2 MGD from the early 1900s through 1930 and about 5 MGD from 1930 until the 1970s.

In 1996, New York City purchased the 69 wells of the Jamaica Water Supply (JWS) company that had been operating the ground water supply wells in Queens and, through the NYCDEP, took responsibility for the provision of water to the Queens residents serviced by the JWS company.

In 2004, the wells owned by the New York City provided an average of 6.4 million gallons of water per day water to approximately to 350,000 people. In 2006, the ground water system supplied approximately 2 MGD. The area for which ground water is used covers 29 square miles in southeastern Queens and includes the following neighborhoods: Cambria Heights, Hollis, Holliswood, Jamaica, Jamaica Estates, Kew Gardens, Laurelton, Queens Village, Richmond Hill, Rosedale, St. Albans, South Jamaica, South Ozone Park, and Springfield Gardens. Only seven wells were used for this purpose and represented less than 1% of the City's total water usage.

Due to the decreasing withdrawal of ground water from the Brooklyn-Queens Aquifer System, the ground water table in portions of Brooklyn and Queens has begun to rise. The rise in the water table has led the NYCDEP to pump ground water in excess of that needed to supply the residents of the service area to the sewer system in order to avoid the flooding of basements by ground water. However, in contrast to the rise in the ground water table in portions of the Jamaica Bay watershed, the urbanization and development has increased the degree of impervious surface area and has resulted in there being less recharge of the underlying aquifers as noted above.

In addition to the general lowering of the ground water table from reduced recharge, the quality of the ground water has deteriorated due to contamination from a variety of sources. Included among the sources of contamination are salt water intrusion, percolation of surface water that contains road salt, leaking sewer lines, and spills of chemicals and petroleum products.

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Photograph by Don Riepe, American Littoral Society

Chapter 3 - Water Quality

3.1 BACKGROUND

Jamaica Bay has been impacted over time by development in its watershed: dredging, filling and other significant alterations to the Bay, as well as natural processes. There are many sources of water that affect the water quality conditions within Jamaica Bay. These sources include:

- WPCPs that treat the sewage from residences, industries and other land uses in the watershed/sewershed;
- CSOs that contain a mixture of storm runoff and sewage when there is too much flow for the WPCPs to handle;
- Storm sewers that carry rainfall runoff, along with anything that may be on roofs, yards, and the streets;
- Landfill leachate;
- Ground water;
- Direct rainfall/Atmospheric deposition; and
- Tidal exchange with the Lower Harbor via the Rockaway Inlet.

In addition to the pollutant sources listed above, the water quality conditions are further exacerbated by the historical alterations to the Bay's geometry and morphology. The impacts of these sources and alterations vary throughout the Bay. The poorest water quality in the Bay can be found in Grassy Bay in the eastern portion of the Bay and the North Channel.

Overall attainment of coliform water quality standards is primarily influenced by conditions following wet weather events. Requirements of Class I waters are not attained for fecal coliforms in a few tributaries during months with a large number of wet weather events. Areas within the Bay's tributaries and dead end canals are prone to reduced water quality due to the input of contaminated surface runoff and poor flushing.

> "*Water is the most critical resource issue of our lifetime and our children's lifetime. The health of our waters is the principal measure of how we live on the land.*"
>
> *- Luna Leopold*

Jamaica Bay has been extensively modeled. Water quality modeling is a critical component of the *Jamaica Bay Watershed Protection Plan* development process. Modeling enables the ability to test hypotheses regarding the issues and high priority problems facing the Bay. Although modeling has limitations and may not provide conclusive findings to the issues involved, the results provide valuable information that can be used to further improve the focus of the *Jamaica Bay Watershed Protection Plan*, refine potential management strategies, and develop final recommended actions.

3.2 WATER QUALITY OF THE BAY

3.2.1 Water Quality Standards

The NYSDEC assigns classifications to all of the waterbodies within its jurisdiction. These classifications are assigned such that "The discharge of sewage, industrial waste or other wastes shall not cause impairment of the best usages of the receiving water as specified by the water classifications at the location of the discharge and at other locations that may be affected by such discharge." (6NYCRR Part 701). Two of the classifications developed by NYSDEC apply to waters within Jamaica Bay: Class SB and Class I. Class SB applies to the open waters of Jamaica Bay, Shellbank Creek, Gerritsen Creek and Mill and East Mill Basins. Class I applies to the remaining tributaries of Jamaica Bay. The best usages of Class SB waters are primary and secondary contact recreation and fishing. These waters must also be suitable for fish propagation and survival. Class I waters have best usages of secondary contact, and must be suitable for fish propagation and survival. Associated with each of these classifications are

TABLE 3.2.1

Class	Coliform Bacteria		Dissolved Oxygen
	Total	Fecal	
SB	Monthly median <2,400/100 mL	Monthly geometric mean <200/100 mL	>5.0 mg/L
	80% <5,000/100 mL		
	80% <5,000/100 mL		
1	Monthly geometric mean <10,000/100 mL	Monthly geometric mean <2000/100 mL	>4.0 mg/L

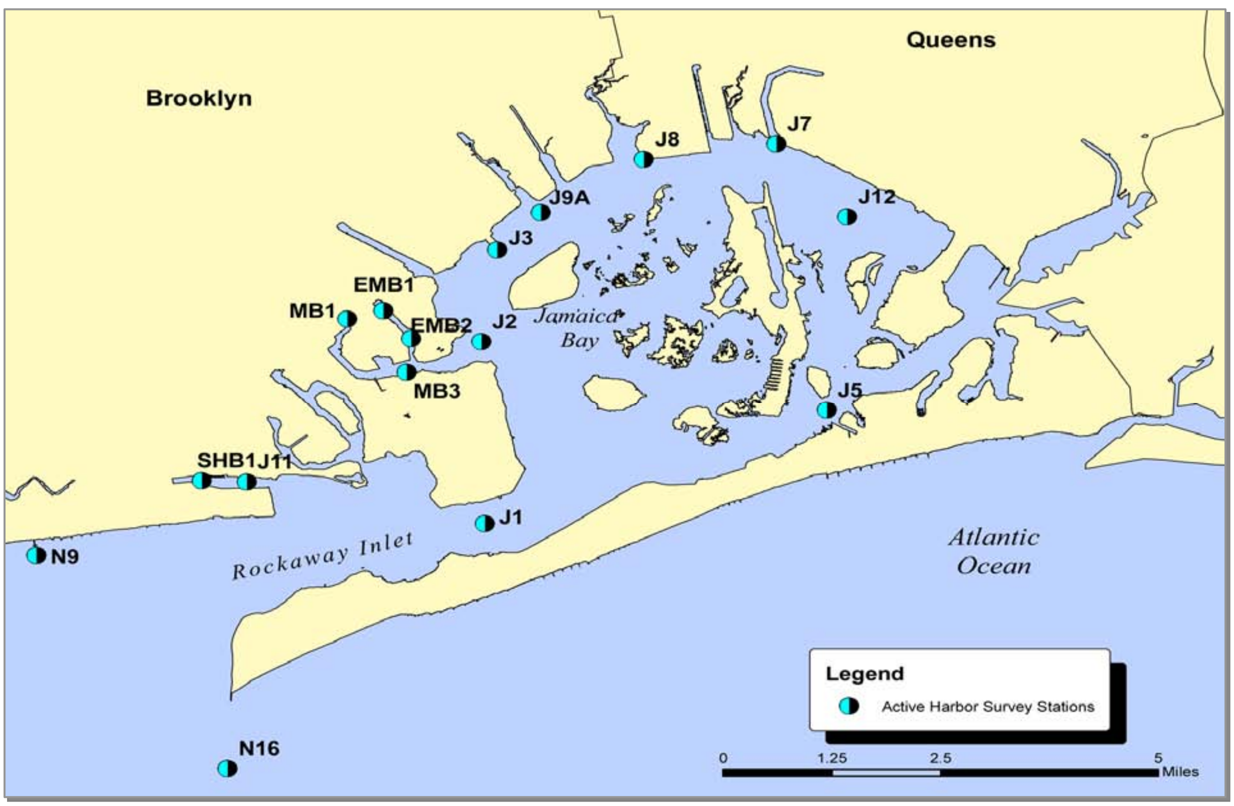

FIGURE 3.2.1 Active Harbor Survey Stations; Source: HydroQual, Inc.

water quality standards that are assigned such that each waterbody can achieve its best usage. Water quality standards for these waters specify numerical dissolved oxygen and coliform requirements and narrative standards.

As shown in Table 3.2.1 the numerical dissolved oxygen water quality standard for Class SB is a never-less-than concentration of 5.0 mg/L. Concentrations of microbial levels, such as coliform bacteria, are measured in terms of statistical probablities and are reported in terms of "Most Probable Number" (MPN). The Class SB total coliform standard requires that the monthly median value not exceed 2,400 MPN/100 mL and more than 20 percent of the samples, from a minimum of 5 examinations, not exceed 5,000 MPN/100 mL. The fecal coliform standard requires that the monthly geometric mean, from a minimum of five examinations, shall not exceed 200 MPN/100 mL. The Class I water quality standards applied to tributaries and embayments of Jamaica Bay have a dissolved oxygen standard requiring a never-less-than concentration of 4.0 mg/L. The Class I total coliform standard requires that the monthly geometric mean, from a minimum of five examinations, shall not exceed 10,000 MPN/100 mL. The fecal coliform standard requires that the monthly geometric mean, from a minimum of five examinations, shall not exceed 2,000 MPN/100 mL. This is presented in tabular form in Table 3.2.1.

Ambient water quality is monitored by NYCDEP at a number of monitoring stations throughout the Bay as shown in Figure 3.2.1. Data gathered at these sites is presented below for nitrogen, dissolved oxygen, pathogens, and chlorophyll a.

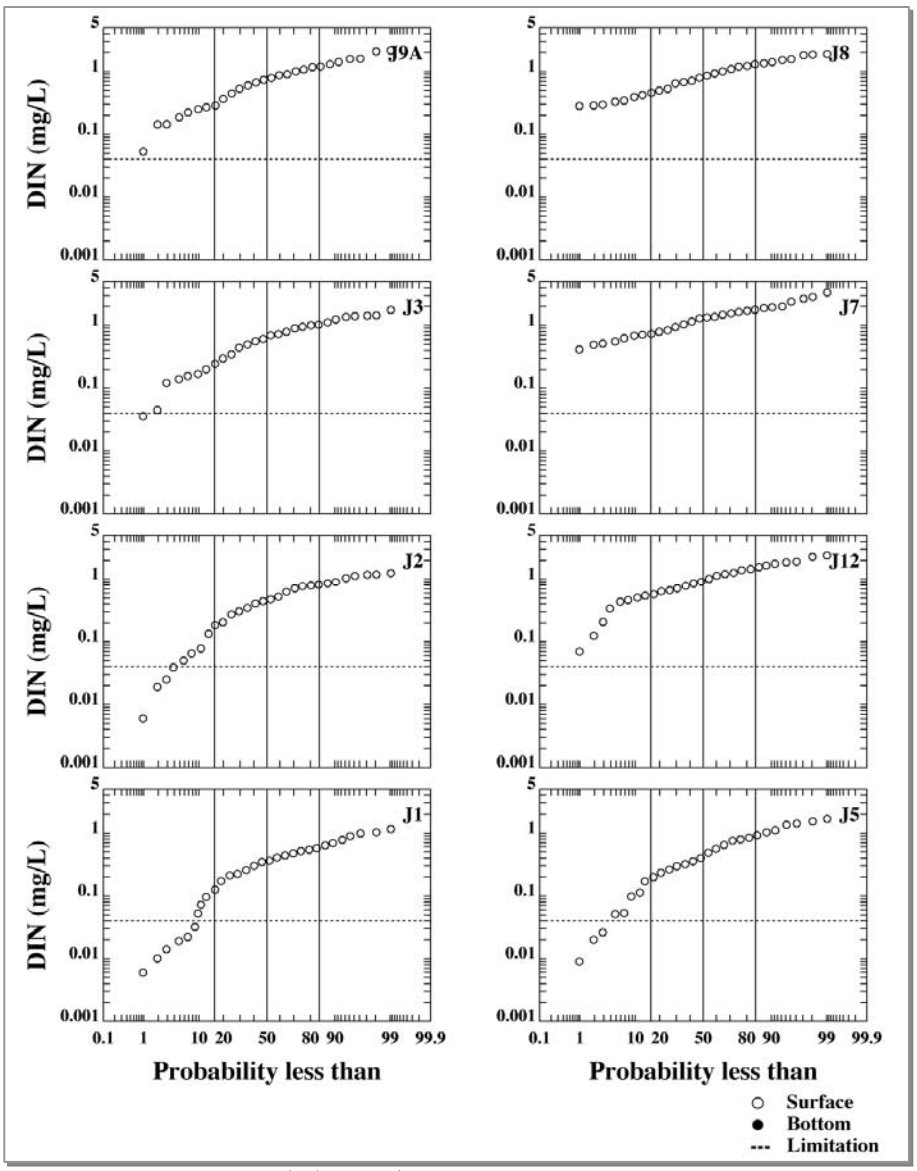

FIGURE 3.2.2 DIN mg/L in Jamaica Bay, 2001 – 2005.

3.2.2 Nitrogen

Nitrogen concentrations are a major contributor to low dissolved oxygen levels in Jamaica Bay. A primary source are the four WPCPs that discharge to the Bay.

Algae are simple plants that require nutrients, light and the appropriate temperature to grow. The macronutrients that are required for growth are nitrogen and phosphorus. If either nitrogen or phosphorus concentrations in the water column are low, algal growth becomes nutrient limited. In most estuarine systems, nitrogen is typically the limiting nutrient. This means that algae typically run out of available nitrogen before they run out of phosphorus. However, within Jamaica Bay, nitrogen and phosphorus are in excess; before these can be depleted, light required for chlorophyll production becomes the limiting growth factor.

A concentration of less than 0.04 mg/L of dissolved inorganic nitrogen (DIN) is thought to begin to limit algal growth. Jamaica Bay has levels in excess of 0.04 mg/L DIN. Nitrogen toxicity also has been implicated in limiting the survival of some aquatic plants and may contribute to marsh loss. DIN consists of ammonia (NH_3), nitrite (NO_2) and nitrate (NO_3).

Figure 3.2.2 presents the year-round DIN data collected in Jamaica Bay from 2001 through 2005. The data show that except for rare occasions in the western and southern portions of the Bay (sampling locations J1 and J5), the DIN concentrations are well above the limiting concentration for algal growth. In some locations the median DIN concentration would have to be reduced by more than a factor of ten to approach nutrient limiting conditions. The daily average loads of nitrogen forms from the four WPCPs that discharge to the Bay are presented in Table 3.2.3

TABLE 3.2.3

	Total Nitrogen	36,400	51,500

3.2.3 Dissolved Oxygen

One of the more important constituents that is monitored within the bay is dissolved oxygen (DO). DO is important for the propagation and survival of aquatic life. Low dissolved oxygen levels can also lead to odor problems resulting from the creation of hydrogen sulfide (H_2S) gas in the sediment.

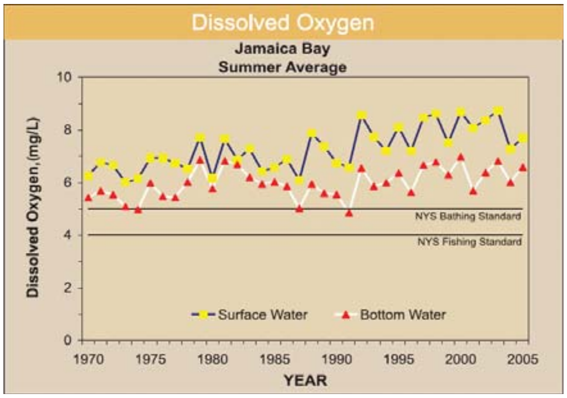

FIGURE 3.2.4 2005 Harbor Survey Program

During 2005, surface and bottom DO levels in Jamaica Bay were above NYSDEC standards. 2005 surface and bottom average summer DO levels were 7.70 mg/L and 6.59 mg/L, respectively. High variability was measured in DO levels in Jamaica Bay. Supersaturated DO levels are common due to algal blooms. These blooms result in large, sudden, and variable DO changes. During 2005 DO levels were lowest in the eastern portion of the bay at station J12 in Grassy Bay. DO levels increased moving westward from J12 to J1. This trend was particularly noticeable in the bottom waters.

Figure 3.2.3 presents probability distributions for surface and bottom DO concentrations measured by Harbor Survey at eight stations during the period of 2001 through 2005. Although average DO concentrations in Jamaica Bay meet the DO water quality standard, there are periods when DO levels decline below the standard. The areas nearest the Rockaway Inlet at station J1 attain the standard most often, while the Grassy Bay station J12 attains the standard least often.

Trends

Average DO levels were well above the 5.0 mg/L standard as early as 1970; Figure 3.2.4 from 2005 Harbor Survey Program. DO variability is high within and between years and the gap between surface and bottom waters has been increasing since the 1980s. High surface DO levels are often due to supersaturated conditions attributable to algae blooms and eutrophic waters.

A simple analysis of trends in summertime DO concentrations in Jamaica Bay was completed by HydroQual, Inc. for the DO data collected during June through September in the years 1995 through 2005 as part of the NYCDEP's Harbor Survey Program. The analysis was completed at the request of the NYCDEP and the Jamaica Bay Watershed Protection Plan Advisory Committee to determine if trends could be observed in the DO data over the past ten years. Concerns were raised that water quality may have degraded over this time period.

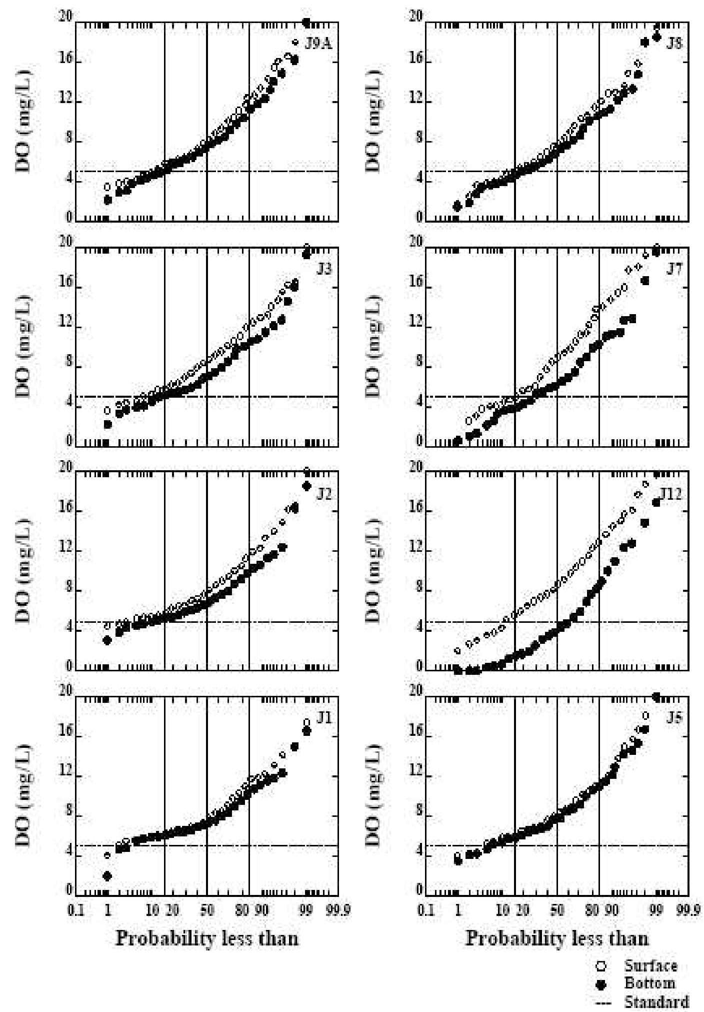

FIGURE 3.2.3 Dissolved Oxygen mg/L in Jamaica Bay 2001-2005

During the eleven year period examined, NYCDEP has reduced the nitrogen loading to Jamaica Bay from the four WPCPs from greater than 50,000 lb/day to less than 40,000 lb/day.

A visual inspection of the data does not show obvious trends due to the year-to-year variability. For a more rigorous analysis, a simple linear regression analysis was completed on the mean DO concentration for the summer data collected at each water quality monitoring station. In this analysis a line of best fit is computed for the data and a slope and correlation coefficient is calculated for the line. A positive slope corresponds to an increasing trend in DO concentrations. A higher slope corresponds to a greater change. The correlation coefficient describes how well the DO concentration is correlated to the year. A perfect straight line would have a correlation coefficient of 1.0. No correlation would have a correlation coefficient of 0.0. This analysis has limitations because the number of samples collected at each station varied from year to year from eight samples to seventeen samples. Also, the range and standard deviation of the data was not taken into account.

A few general statements can be made from this regression analysis. The first is that regression lines for stations near the mouth of Jamaica Bay (N9, N16, J1) (see Figure 3.2.1 for station locations) have very flat slopes and very low correlation coefficients. This indicates very little change in the DO concentrations over the period examined.

Second, only a few locations had negative slopes for the regression lines, which indicates decreasing DO levels. These stations include the surface measurements at stations J2 (Outside Mill Basin), J3 (Canarsie Pier), J11 (Sheepshead Bay), and J12 (Grassy Bay). Of these stations only stations J11 and J12 had high correlation coefficients, and station J12 has only five years of data. The declines in surface DO concentrations may correspond to reduced primary productivity by phytoplankton.

Finally, the remaining stations indicate a trend of increasing DO concentrations. Of these remaining stations, only regression lines from station J5 (Beach Channel), and the bottom regression lines from stations J7 (outside Bergen Basin), J8 (outside Bergen Basin), J12, and J9A (outside Fresh Creek) have correlation coefficients greater than 0.4. The slopes of data collected at these stations range from 0.087 mg DO/L per year to 0.155 mg DO/L per year. Over a ten year period the expected increase in DO concentrations would be 0.87 mg/L to 1.55 mg/L during the summer.

Overall, the Harbor Survey monitoring data indicate that there is a fair amount of year-to-year variability in DO concentrations. The general trends in the data indicate the DO concentrations have either stayed the same or improved slightly over the period of 1995-2005. The locations with declining DO concentrations had DO concentrations well above the DO standard. Figure 3.2.5 shows the existing quality of Jamaica Bay bottom waters. The figure is a graphical representation of model output based on 2005 loads and 1988 meteorological conditions.

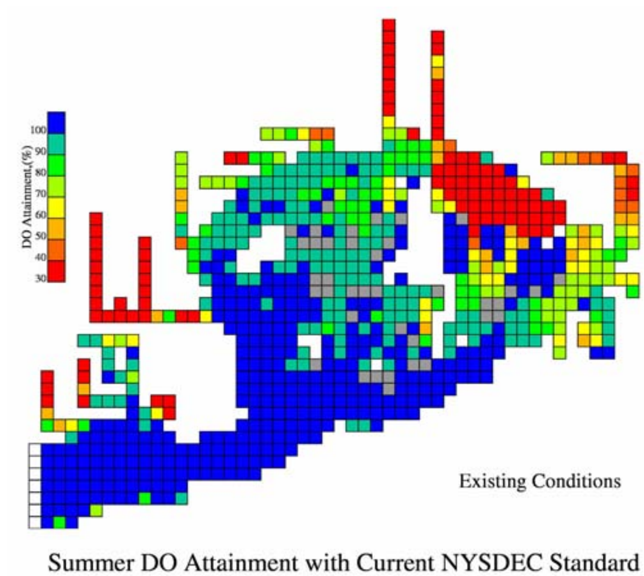

FIGURE 3.2.5. Dissolved Oxygen Bottom Waters Summertime

3.2.4 Pathogens

In 2005, sanitary water quality was superior for Jamaica Bay. Summer fecal coliform (FC) levels were well below the 200 cells/100mL SB standard for all stations. Under wet weather conditions, the Bay experiences localized degradation. At these times, spikes in FC may temporarily exceed the SB standard of 200 cells/10mL for the entire northern portion of the Bay (from Mill Basin to Bergen Basin). Mean FC levels in Jamaica Bay as a whole have been at or below the 200 cells/100mL standard for bathing over the past 20 years. FC levels peaked at 200 in 1990, and reached a low of 23 in 1998. During 2005 the FC summer geometric mean was 24 cells/100mL.

An additional NYSDEC standard for primary contact recreational waters is a maximum allowable enterococci concentration of a geometric mean of 35 cells/100 mL for a representative number of samples. This standard, although not promulgated, is now an enforceable standard in New York State since the USEPA established January 1, 2005 as the date upon which the criteria must be adopted for all coastal recreational waters. Enterococci concentrations for 2000-2005 are on average less than 10 cells 100 mL refer to Figure 3.2.6. 2005 Harbor Survey Program.

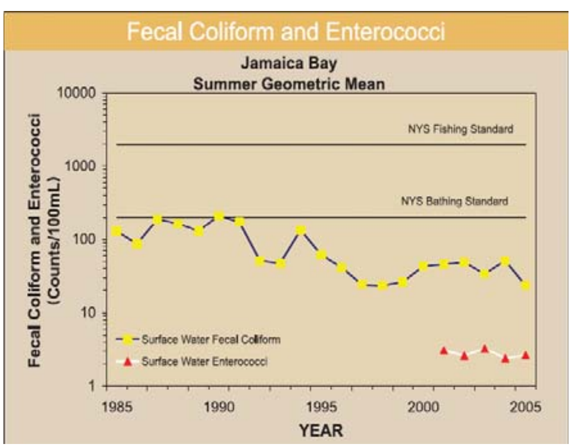

FIGURE 3.2.6 2005 Harbor Survey Program

3.2.5 Chlorophyll α

Chlorophyll α is another constituent that can be used to understand the water quality in the Bay. Algae produce chlorophyll a in order to capture light for photosynthesis. Chlorophyll a is a good indicator of the amount of algae in the water.

In most estuarine systems nitrogen is the limiting nutrient, which means that algae typically deplete nitrogen in the water before they deplete phosphorus. However, within Jamaica Bay, nitrogen and phosphorus are in excess and light for chlorophyll production becomes the limiting factor. As noted earlier, a concentration of less than 0.04 mg/L of DIN is thought to begin to limit algal growth.

High chlorophyll α concentrations in Jamaica Bay are indicative of eutrophic (highly nutrient-enriched) conditions. The slow turnover of water within the Bay allows for the development of large standing phytoplankton populations. Of the four geographic Harbor Survey regions, Jamaica Bay continues to display the widest range of individual chlorophyll α measurements. Chlorophyll α values range from a high of 171 μg/L at Station J8 (Spring Creek) to a low of 1.4 μg/L at Station J1 (Rockaway Inlet). All nine Stations have summer averages above 20 μg/L. On average, chlorophyll α concentrations for the Bay measured 39.6 μg/L. This is consistent with recent years, but well above levels that are indicative of enriched or eutrophic waters.

Trends

Chlorophyll α concentrations in Jamaica Bay have increased over the past 18 years. Yearly summer averages peaked in 1995 at 58.7 μg/L. Average concentrations from 1999 to 2004 ranged between 37 μg/L and 54 μg/L. These conditions have coincided with prolonged algae blooms in Jamaica Bay and reports of nuisance algae in the tributaries.

FIGURE 3.3.1 Jamaica Bay Tributaries; Source: HydroQual, Inc.

3.3 WATER QUALITY OF THE TRIBUTARIES

3.3.1 The Tributaries

Eight large and several smaller tributaries empty into Jamaica Bay - Sheepshead Bay, Paerdegat Basin, Fresh Creek, Hendrix Creek, Spring Creek, Shellbank Basin, Bergen Basin, and Thurston Basin (see Figure 3.3.1). The term "basin" usually refers to the watershed, or area of land that drains into a water body. In Jamaica Bay this term refers to the receiving water. In the context of Jamaica Bay, tributaries, canals, creeks and basins are generally former natural tributaries that are currently dead ended, usually with significantly modified configuration as compared to their pre-1700s condition. All of the Jamaica Bay tributaries, basins, creeks, and canals have been highly altered over the years through channelization and tend to have little or no freshwater flow other than that conveyed by CSO and/or storm sewers. They generally have been dredged wider and deeper than their natural condition, and have CSO outfalls and sometimes storm sewer outfalls at their head end. Some tributaries and basins have natural fresh water tributaries still present. For example, streams within portions of Nassau County drain to Thurston Basin/Head of Bay. Also, Spring Creek drains to Old Mill Basin. What people generally refer to as Spring Creek is actually Old Mill Basin.

Paerdegat Basin, Fresh Creek, Hendrix Creek, Bergen Basin and Thurston Basin all receive CSO overflows from the Jamaica Bay watershed and Hendrix Creek also receives treated effluent from the 26th Ward WPCP. Spring Creek receives effluent from the Spring Creek Auxiliary WPCP, a CSO retention tank. These waterbodies also receive some amount of direct runoff of storm water and storm water discharges from storm drains, as well as direct rainfall. The combination of pollution inputs and lack of fresh water or tidal flushing are the main factors that create poor water quality conditions within these tributaries.

Generally, existing water quality in Fresh Creek, Hendrix Creek, and Spring Creek fail to attain standards at the headend for DO and bacteria. Water quality conditions in Bergen and Thurston Basins are discussed below.

3.3.2 Bergen and Thurston Basins

The receiving waters of Thurston and Bergen Basins were sampled during the summer of 1995 as part of the Jamaica Tributaries CSO Facility Planning Project (Hazen and Sawyer, 1996). Sampling occurred during wet weather and dry weather to provide information on existing water quality conditions and data for the development of a mathematical water quality model. Samples were collected from five stations along Thurston Basin, four stations along Bergen Basin, three stations along Shellbank Basin and one station in Hawtree Basin. Primary parameters were scheduled to be collected 100% of the time while secondary and tertiary parameters were collected 50% and 10% of the time, respectively. Field investigations included the following studies. On all sampling days, each station was sampled two to four times between 0800 and 1600 hours. Water samples were collected from two feet below the surface and two feet above the bottom.

As part of the Waterbody/Watershed Facility Plan for Bergen and Thurston Basins, a supplemental receiving water quality monitoring program was initiated in 2005 to update current water quality conditions and the water quality model. Three dry and two wet weather surveys were conducted. Receiving water samples were collected at approximately the same station locations sampled during the Jamaica Tributaries CSO Facility Planning Project except for Station TB5 in Head of Bay. The water quality parameters sampled in Bergen Basin replicated those collected during the original facility plan monitoring effort and included dissolved oxygen, total and fecal coliform, enterococci, chlorophyll a, biochemical oxygen demand, total suspended solids, salinity, temperature, and conductivity. Water quality samples collected in Thurston Basin consisted of temperature, salinity, and enterococci.

Dissolved Oxygen

In each basin, average DO concentrations are lowest at the head end under both dry and wet weather conditions due to accumulated organic matter from combined sewage and stormwater discharges as well as the confined nature of the basins. Average DO levels progressively increase toward the mouth as a result of tidal mixing with Jamaica Bay. Dissolved oxygen reaches supersaturation levels at several stations due to photosynthetic activity in surface waters.

In 1995, Thurston Basin attained dissolved oxygen standards only 30 to 50 percent of the time in the surface water samples and 10 to 30 percent of the time in the bottom waters. There were many factors contributing to the failure to meet standards, including dry weather sewage discharges at the head which have subsequently been abated, excessive algal growth, raw sewage discharges at the mouth in the Meadowmere/ Warnerville communities, storm and combined sewer discharges at the head, and a 1,200 foot long sediment mound at the head of the Basin. As discussed in Section 3.6 below, these conditions are being corrected.

For Bergen Basin, 1995 DO standards were not attained from 1 to 40 percent of the time for surface waters and 0 to 20 percent of the time for bottom waters. The standards were not being met for the following reasons: improper sanitary connections to the sewer system which have subsequently been abated, excessive algal growth, combined and storm sewer discharges, Jamaica WPCP effluent discharge, and the sediment mound at the head end of the basin. Sampling results from 2005 indicate DO has improved significantly in Bergen Basin with attainment of water quality criteria increasing to 60 to 80 percent in surface waters and 30 to 60 percent in bottom waters. Average DO concentrations in

Hawtree Basin; Photograph: L. Kachalsky. O'Brien & Gere

DO concentrations is evident throughout both basins. Additionally in 1995, impacts to DO from improper sanitary connections to storm sewers and the discharge of Jamaica WPCP effluent to the head of Bergen Basin in combination with the sediment mound were more acute in the upper and middle portions of the basins while Jamaica Bay was affected to a lesser extent. In the mid 1990s, due to hydraulic issues with the Jamaica WPCP outfall to Grassy Bay, treated effluent was discharged to Bergen Basin. Also, the large diurnal fluctuations in DO levels found in the basins resulting from widespread photosynthetic activity and algal decomposition mask the impact of organic loadings from CSOs on DO concentrations under both dry and wet weather conditions.

Bacteria

In 1995, Thurston Basin showed a general decreasing trend toward the mouth for total and fecal coliforms on the surface and bottom. Stations TB1 and TB2 exceeded state standards for both total and fecal coliforms on the surface. Station TB5, in Head of Bay, met the monthly median total coliform standard of 2,400 cells/100ml, but had greater than 20% of samples greater than 5,000 cells/100ml at the surface and bottom. In 1995, the sources of coliform bacteria to Thurston Basin were dry weather discharges (50 identified homes which have subsequently been abated, and raw sewage discharge at the mouth in the Meadowmere/ Warnerville communities which is presently being abated by the NYCDEP (New York Times, 2007) and combined sewer and storm sewer discharges at the head end.

Bergen Basin displayed the most chronic coliform problem, failing to meet state standards for total and fecal coliforms for all surface water stations. However, total and fecal coliform concentrations were below NYSDEC water quality criteria in bottom waters. The concentration disparity between top and bottom is due to stratification, which is typical in confined basins of this nature.

The 1995 wet weather coliform levels in Bergen Basin were elevated due to CSO and storm water discharges. In 1995, Bergen Basin was receiving sanitary flow from improper sanitary connections to storm sewers and effluent from the Jamaica WPCP which resulted in dry weather coliform concentrations above NYSDEC water quality standards as well. Sampling results from 2005 revealed cessation of Jamaica WPCP effluent discharges to Bergen Basin and abatement of improper sanitary connections to storm sewers has led to an approximate 50 percent reduction in total coliform concentrations and a five fold decrease in fecal coliform concentrations and resulted in dry weather coliform concentrations below NYSDEC water quality standards.

3.4 POLLUTANT SOURCES

3.4.1 Background

As noted previously, there are numerous sources of pollutants that contribute to the water quality impairment of Jamaica Bay including CSOs, WPCPs, storm sewers, landfill leachate, ground water, atmospheric deposition and tidal exchanges (see Figure 3.3.1). With respect to landfill leachate, the major landfills around the Bay have been remediated (capped) and closed, so that the potential for ground water transport of contaminants in leachate to the Bay has been greatly reduced.

Each of these sources discharge different pollutants to the Bay. The contribution of each source and its affect on water quality is described below.

3.4.2 Wastewater Discharges

The NYCDEP owns and operates four major secondary treatment WPCPs that discharge into Jamaica Bay: Coney Island, 26th Ward, Jamaica and Rockaway WPCPs. These plants discharge the majority of the fresh water that enters the Bay, approximately 258 MGD. Each of the NYC plants accepts sanitary wastewater as well as CSO for treatment. The treated wastewater is then discharged to Jamaica Bay. Due to a finite hydraulic capacity, during wet-weather events, CSOs will discharge to the Bay.

The Nassau County wastewater treatment plant, Cedarhurst, discharges approximately 0.9 MGD into Motts Creek at the eastern end of the Bay. Nassau County and NYC's plants combined contribute more than 90 percent of the nitrogen, phosphorus, and silica loading and more than 80 percent of the carbon/BOD loading to Jamaica Bay.

As a result of loadings, particularly nitrogen and phosphorus, from the above dischargers, Jamaica Bay is a highly enriched (eutrophic) system. The available nitrogen and phosphorus contribute to the growth of algae, which reduces water clarity. In addition, these algae eventually die and settle to the bottom sediment and the decomposition process requires a great deal of oxygen. As a result, oxygen in the overlying water becomes depleted and causes stress on the aquatic life subjected to the low dissolved oxygen levels. This can result in aquatic life mortality and/or the inability or impaired ability of aquatic organisms to propagate.

From Top Left to Bottom Right: Coney Island WPCP, Jamaica Bay WPCP, 26thWard WPCP, and Rockaway Parkway WPCP; Souce: Google TeleAtlas, 2005

The WPCPs that discharge into Jamaica Bay apply disinfection to the effluent discharge. As a consequence, WPCPs contribute one percent or less to the bacteria concentrations in Jamaica Bay. However, due to the chlorine used for disinfection, WPCPs are the primary source of total residual chlorine to the Bay.

The Contaminant Assessment and Reduction Project (CARP) grew out of the Hudson River Estuary Program (HEP). HEP's Comprehensive Conservation and Management Plan (CCMP) calls for 13 specific actions to reduce continuing inputs of toxic chemicals to the environment, including the reduction of municipal discharges of chemicals of concern. CARP is a cooperative effort of New York, New Jersey, USEPA, and USACE. One of its key objectives is to "Establish baseline levels of contaminants of concern in water, sediments and fish tissue" (www.carpweb.org).

Figure 3.4.1 Jamaica Bay WPCP Locations; Source: O'Brien & Gere

As part of its ongoing program, CARP sampled wastewater treatment plant effluents throughout the Hudson River estuary, including limited sampling of the four WPCPs in Jamaica Bay in 1999 and 2000 (Litton, 2003). The analytical results indicated the presence of a variety of CARP's chemicals of concern in the WPCP effluents. However, no specific pattern as to why certain chemicals or quantities were detected in the effluent of one WPCP and not another was attributed to the results or conclusions drawn during the study. Furthermore, the CARP study addressed effluent concentrations for individual plants and not toxic loadings. (Litton, 2003).

The New York City and Nassau County WPCPs, including one auxiliary WPCP also operated by NYCDEP, are described below:

Jamaica WPCP (NYC)

The Jamaica WPCP is permitted by the NYSDEC under State Pollutant Discharge Elimination System (SPDES) permit number NY-0026115. The facility is located at 150-20 134th Street in the Jamaica section of Queens, on a site approximately 26 acres in size adjacent to Bergen Basin. The Jamaica WPCP serves an area of approximately 26,000 acres in the southeast section of Queens.

The Jamaica WPCP has been providing full secondary treatment since 1978 including primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Jamaica WPCP has a design dry weather flow capacity of 100 MGD, and is designed to receive a maximum flow of 200 MGD with 150 MGD receiving secondary treatment. Flows over 150 MGD receive primary treatment and disinfection. The daily average flow during 2006 was 88 MGD, with a dry weather flow average of 83 MGD.

Rockaway WPCP (NYC)

The Rockaway WPCP is permitted by the NYSDEC under SPDES permit number NY-0026221. The facility is located at 106-21 Beach Channel Drive in the Rockaway Park section of Queens, on a site approximately 12 acres in size adjacent to Jamaica Bay. The Rockaway WPCP serves an area of approximately 6,260 acres on the Rockaway Peninsula.

The Rockaway WPCP has been providing full secondary treatment since 1978 including primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Rockaway WPCP has a design dry weather flow capacity of 45 MGD, and is designed to receive a maximum flow of 90 MGD with 67.5 MGD receiving secondary treatment. Flows over 67.5 MGD receive primary treatment and disinfection. The daily average flow during 2006 was 23 MGD, with a dry weather flow average of 23 MGD.

26th Ward WPCP (NYC)

The 26th Ward WPCP is permitted by the NYSDEC under SPDES permit number NY-0026212. The facility is located at 122-66 Flatlands Avenue in the Spring Creek section of Brooklyn, on a site approximately 57 acres in size adjacent to the Hendrix Street Canal. The 26th Ward WPCP serves an area of approximately 5,910 acres in the eastern section of Brooklyn near Jamaica Bay including the communities of Ocean Hill, Brownsville, Broadway Junction, Highland Park, and Cypress Hills.

The 26th Ward WPCP has been providing full secondary treatment since 1979 including primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The 26th Ward WPCP has a design dry weather flow capacity of 85 MGD, and is designed to receive a maximum flow of 170 MGD with 127.5 MGD receiving secondary treatment. Flows over 127.5 MGD receive primary treatment and disinfection. The daily average flow during 2006 was 58 MGD, with a dry weather flow average of 50 MGD.

Coney Island WPCP (NYC)

The Coney Island WPCP is permitted by the NYSDEC under SPDES permit number NY-0026182. The facility is located at 2591 Knapp Street in the Sheepshead Bay section of Brooklyn, on a site approximately 30 acres in size adjacent to Shell Bank Creek. The Coney Island WPCP serves an area of approximately 15,100 acres in southern/central Brooklyn.

The Coney Island WPCP has been providing full secondary treatment since 1994 including primary screening, raw sewage pumping, grit removal and primary settling, air activated sludge capable of operating in the step aeration mode, final settling, and chlorine disinfection. The Coney Island WPCP has a design dry weather flow capacity of 110 MGD, and is designed to receive a maximum flow of 220 MGD with 165 MGD receiving secondary treatment. Flows over 165 MGD receive primary treatment and disinfection. The daily average flow during 2006 was 89 MGD, with a dry weather flow average of 83 MGD.

CSO outfall at Bergen Basin. Photo: L. Kachalsky, O'Brien & Gere

Spring Creek AWPCP (NYC)

The Spring Creek Auxiliary WPCP is located at the head end of Old Mill Creek, at the confluence with Spring Creek. The facility is located in the 26th Ward WPCP drainage area; however, it also receives wet weather flow from the Jamaica drainage area. The Spring Creek A WPCP is designed to retain 10 to 12 million gallons. The design objectives for this facility are: to provide contact time for chlorine to disinfect; remove floating solids; hold overflow and remove heavy solids; and return stored volume to the 26th Ward WPCP.

Cedarhurst WPCP (Nassau County)

The Cedarhurst WPCP is permitted by the NYSDEC under SPDES permit number NY-0022462. The facility is located on Peninsula Boulevard at Hanlon Drive, Cedarhurst. The Cedarhurst WPCP is designed to treat 1 MGD that is then discharged to Mott Creek, a tributary of Jamaica Bay. The Cedarhurst WPCP serves an area of approximately 440 acres in size. Separate stormwater sewers direct stormwater flow directly to the Bay.

Other WPCP Sources

In addition to the municipal WPCPs listed above, there are a number of industrial wastewater dischargers within the watershed for which SPDES permits have been issued. These industrial dischargers include the following:

- JFK Airport, Queens, discharges to Bergen Basin
- Lefferts Oil Terminal, Queens, discharges to Bergen Basin
- Keyspan Generation (Far Rockaway Power Station), Queens, discharges to Motts Basin
- Carbo Industries, Nassau County, discharges to Jamaica Bay
- Carbo-Concord Oil, Nassau County, discharges to Jamaica Bay
- ExxonMobil, Inwood, Nassau County, discharges to Head of Bay

Storm sewer outfall in Fresh Creek
Photograph: L. Kachalsky, O'Brien & Gere

3.4.3 Combined Sewer Overflows

Combined sewers are sewers that convey both sanitary and stormwater flow. During dry weather, all of the sanitary flow is delivered to a WPCP for treatment. During wet weather, the volume of

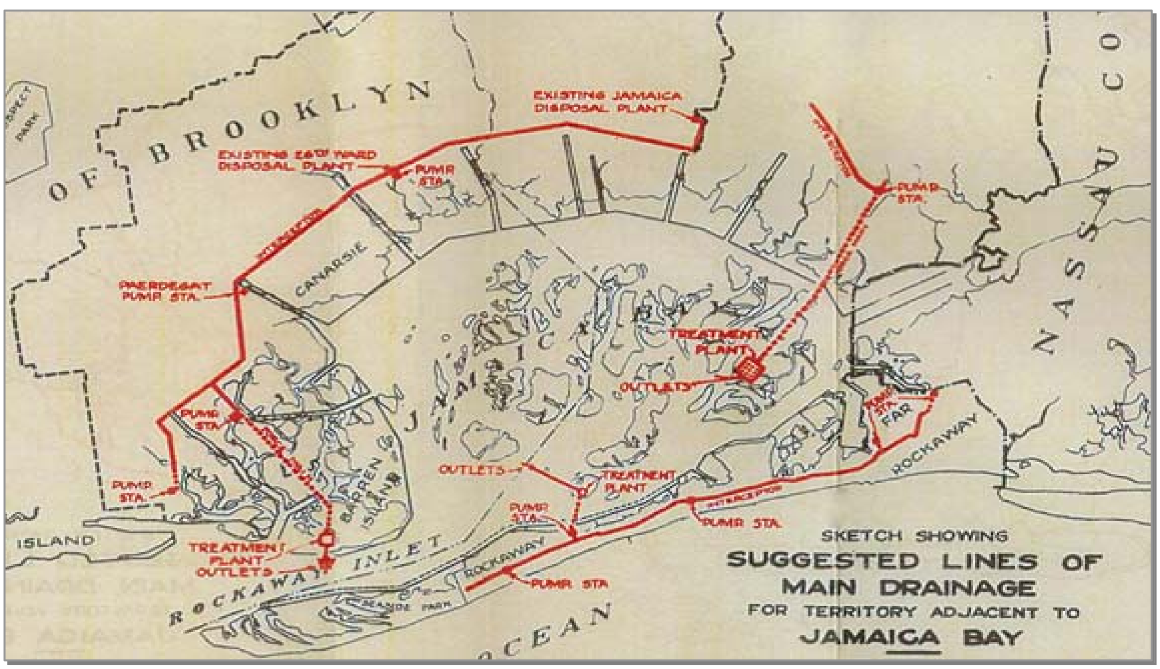

FIGURE 3.4.2 Bay Drainage Plan; Source: Secty. of the Army, 1965

sanitary and stormwater flow can surpass a WPCP's ability to accept the flow. In such cases, regulators in the sewer system act as relief valves that convey some of the untreated sanitary and stormwater mixture through an outfall into a tributary or directly into the Bay.

There are six combined sewer overflow pipes that discharge to Jamaica Bay tributaries. Overflows occur intermittently during wet weather and contain diluted sanitary flow; therefore, CSOs contribute only a small portion of the carbon, nitrogen, phosphorus and silica loading to Jamaica Bay. Nutrient loadings from CSOs are less than five percent of the total nutrient load to the Bay. Carbon loadings from CSOs are approximately 15 percent of the carbon loading to the Bay. On the other hand, since the CSO volume is not disinfected, CSOs are the major contributor (85-95 percent) of bacteria to the Bay. In addition, since the CSO flow does not pass through a WPCP, solids that would have been removed by treatment settle to the bottom of the tributaries near the CSO outfall creating localized sediment mounds. While CSOs have a small impact on the Bay as a whole, they have major impacts on the water quality of the tributaries to which they discharge.

3.4.4 Storm Sewers

Storm sewers collect the rainfall that falls on neighborhoods in separately sewered areas and direct the flow into the Bay and the tributaries that surround the Bay. The runoff contains the pollutants found in rainwater, "floatables" (mostly litter that washes into storm drains during rainy weather), and any pollutants picked up during its travel to the sewer. Storm sewers contribute less than one percent of the nutrient loadings and less than three percent of the carbon loading to Jamaica Bay. The contribution of bacteria to the Bay from storm sewers is approximately five to fifteen percent of the total loading to Jamaica Bay. Storm sewers are minor contributors to the pollutant loading to the Bay as a whole, but can have a major impact on the tributaries to which they discharge. Limited data make it difficult to assess the relative contribution of storm sewers to the toxics loads.

3.4.5 Landfills

Three landfills border Jamaica Bay: Pennsylvania Avenue, Fountain Avenue and Edgemere. All three are closed and have either been capped or are in the process of being capped. The landfills are now minor contributors of conventional pollutants to the Bay.

Based on limited data, it is estimated that landfills contribute less than one percent of the carbon, nitrogen, and phosphorus loadings to the Bay. Litton (2003) does not report loading estimates of toxics for landfills in Jamaica Bay.

3.4.6 Ground Water

Available estimates for ground water discharge to Jamaica Bay range from 10 MGD (Gibbs and Hill, 1984) to approximately 30 MGD (Misut and Voss, 2004). Misut and Voss also estimate that pre-development ground water flow to the Bay was approximately 47 MGD. Pollutant concentrations associated with this ground water are largely unknown. Based on the flow volume and contaminant concentrations, ground water could have an important impact on water quality in the Bay.

3.4.7 Atmospheric Deposition

Atmospheric deposition includes dry-fall of particles and aerosols, and wet-fall. Any deposition that occurs on land is included in the CSO and storm sewer sources. The remainder is deposition directly onto the Bay. Since the Bay's surface area is relatively small (20 sq mi), atmospheric deposition is a minor contributor of conventional pollutants to the Bay. Available estimates (see below) indicate that atmospheric deposition contributes a very small amount of phosphorus, and less than two percent of the carbon and nitrogen loading to the Bay.

3.4.8 Tidal Exchange and Rockaway Inlet

Water is tidally exchanged between the Lower Bay of New York Harbor and Jamaica Bay through the Rockaway Inlet. In general, the water quality in the Rockaway Inlet is the best in Jamaica Bay. However, there may be times when pollutants from outside of the Bay can be transported into the Bay through the Rockaway Inlet. The exchange of pollutants in this manner is difficult to quantify since much of what is imported into the Bay during flood tide is exported during ebb tide. Since the volume of the Bay can increase by as much as a third between ebb tide and flood tide, it is important to be aware of the potential impacts of Lower Bay water on Jamaica Bay.

3.5 RELATIVE CONTRIBUTION OF POLLUTANT SOURCES

Table 3.5.1 provides a summary of the estimated loads from various sources in Jamaica Bay. The WPCP estimates are based on data collected during 2002 and 2003. CSO and stormwater estimates are based on modeled flows from RAINMAN (a runoff model developed for NYC) and sanitary and stormwater concentrations collected for Jamaica Bay. The rainfall is based on 1988 conditions that have been established as a representative benchmark for the area. Atmospheric deposition is based on 1988 rainfall and deposition data collected as part of the Jamaica Bay Eutrophication Study during 1995-96. The landfill estimates, which have limited accuracy, are based on estimated leachate flows and concentrations, and are the least reliable of the estimates of contributions to the Bay. Ground water is not included because reliable estimates are not available. Dry weather overflows (DWOs) are excluded because no DWOs have been identified in the Bay. The Rockaway Inlet is also not included, as it tends to be a net exporter of pollutants.

The loadings presented in Table 3.5.1 clearly show that the WPCPs are the major contributors to the phosphorus, nitrogen, silica, and carbon loadings to Jamaica Bay. CSOs are just as clearly the major contributors to the pathogen loadings to the Bay. The pathogen loadings assume that there are currently no dry weather overflows in the Bay.

TABLE 3.5.1 Load Summary – Sources of Inputs; Source: HydroQual, Inc.

System Name	WPCP	CSO	Stormwater	Atmospheric Deposition	Landfills
Total Phosphorus (lb/day)	6,100	140	20	10	No Est.
Total Nitrogen (lbs/day)	36,600	1,040	140	630	170
Total Silica (lb/day)	17,900	700	100	No Est.	No Est.
Total Organic Carbon (lb/day)	32,800	5,600	1,050	630	320
BOD5 (lb/day)	22,500	4,900	640	No Est.	No Est.
Enterococci (org./yr)	8.37E+14	5.72E+17	1.08E+17	No Est.	No Est.
Fecal Coliform (org./yr)	1.82E+14	1.85E+18	2.58E+17	No Est.	No Est.
Total Coliform (org./yr)	7.27E+14	9.76E+18	6.93E+17	No Est.	No Est.

Additional modeling tools and technologies are being used to further refine and illustrate potential loading contributions in the Bay and its tributaries. InfoWorks software, a GIS-compatible model system, is being used to model the sewer system including baseline and future sanitary flows. The Jamaica Bay Eutrophication Model (JEM) was developed to assess numerous water quality remediation alternatives such as relocation of existing outfalls from WPCPs, various levels of nitrogen removal at WPCPS, bathymetric recontouring of Jamaica Bay, as well as other alternatives including combinations of outfall relocation, treatment, and recontouring. JEM is an appropriate tool for assessing water quality in the Bay as a whole. The North Channel Eutrophication Model (NCEM) is a full eutrophication model with a sediment nutrient flux submodel developed specifically for Jamaica Bay tributaries.

3.6 CURRENT PROGRAMS TO ADDRESS WATER QUALITY CONCERNS IN JAMAICA BAY AND ITS TRIBUTARIES

NYCDEP has completed facility plans and is implementing multi-phased programs to address the impacts of WPCPs and CSOs discharges on the open water and tributary waterbodies of Jamaica Bay. The programs focus on particular water quality parameters such as dissolved oxygen, coliform bacteria, floatables, settleable solids, oil and grease, and nuisance conditions. The NYCDEP has implemented various projects within the Jamaica Bay Watershed to improve the water quality in the tributaries and open waters of Jamaica Bay. These projects include WPCP upgrades, CSO reduction facilities and floatables control facilities. Landfill closures and restoration projects have also mitigated a source of pollution to the Bay. These efforts are discussed in Chapter 4, *Ecology*.

Many of these projects are being undertaken pursuant to the Nitrogen Control Consent Order/ consent judgment or the CSO Consent Order as described in the following two sections.

3.6.1 Nitrogen Control Order on Consent/Consent Judgment

The NYSDEC and the NYCDEP entered into a Nitrogen Control Order on Consent (Index # CO2-20020131-7) on April 22, 2002 that updated SPDES permits of the four Jamaica Bay WPCPs in order to reduce the total nitrogen load discharged into Jamaica Bay. One of the goals of the Nitrogen Order on Consent was to control the occurrence of eutrophic conditions in Jamaica Bay by reducing the total nitrogen load discharged to the open waters of the bay, thereby improving attainment of dissolved oxygen water quality standards.

Presently, the SPDES permits of the four Jamaica Bay WPCPs establish two types of limits on permissible aggregate nitrogen discharges. These include: (a) the “Maximum Monthly Average Limit,” defined as the average of the individual samples for that month; and (b) the “12-month Rolling Average Limit,” defined as the average daily total nitrogen load for the current month, averaged with the eleven previous months average level. The aggregate Maximum Monthly Average Limit for the Jamaica Bay WPCPs under the current SPDES permit is 54,600 pounds per day, and the aggregate 12-month Rolling Average Limit for the Jamaica Bay WPCPs is 45,300 pounds per day. The rolling average has recently been increased to 49,500 pounds TN during construction of Contract 12 Upgrades at 26th Ward WPCP per the nitrogen order on consent. After completion of construction activities at 26th Ward WPCP, the rolling average goes back to 45,300 pounds per day.

The Consent Order obligated the NYCDEP to undertake and submit to the NYSDEC, for review and approval, a Comprehensive Jamaica Bay Report that is to include recommendations and an implementation schedule for improving water quality in Jamaica Bay either through treatment or non-treatment.

The Order on Consent for Nitrogen was superseded on January 10, 2006 by a Consent Judgment (Index # 04-402174). The Consent Judgment required that the Comprehensive

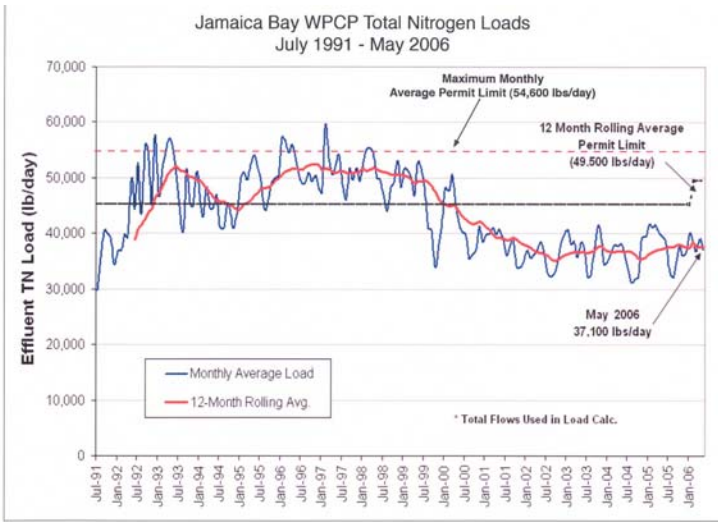

FIGURE 3.6.1 Jamaica Bay WPCP Total Nitrogen Loads, Source: NYCDEP

Jamaica Bay Report be submitted to the NYSDEC on October 31, 2006. The Consent Judgment also requires that that construction of Phase I Plan Improvements to the 26th Ward WPCP be completed by June 30, 2008 and that said improvements to the 26th Ward WPCP result in a Combined Nitrogen Effluent Limit for the Jamaica Bay WPCPs of 45,300 pounds per day.

NYCDEP has completed a Comprehensive Jamaica Bay Water Quality Plan, and the plan was submitted to the NYSDEC on October 31, 2006.

3.6.2. CSO Consent Order

NYCDEP entered into an Administrative Consent Order with NYSDEC on June 26, 1992 to govern NYCDEP's obligations for its CSO program. It required NYCDEP to implement CSO abatement projects in nine facility planning areas divided into two tracks: those areas where dissolved oxygen and coliform standards were being contravened (Track One), and those areas for which floatables control was necessary (Track Two). The 1992 Order was modified on September 19, 1996 to add catch basin cleaning, construction, and repair programs.

NYCDEP and NYSDEC negotiated a new Consent Order that was signed January 15, 2005 that supersedes the 1992 Order and its 1996 Modifications with the intent to bring all NYCDEP CSO-related matters into compliance with the provisions of the federal Clean Water Act and New York State Environmental Conservation Law. The new Order, noticed by NYSDEC in September 2004, contains requirements to evaluate and implement CSO abatement strategies on an enforceable timetable for 18 waterbodies and, ultimately, for City wide long-term CSO control in accordance with USEPA CSO Control Policy.
NYCDEP and NYSDEC also entered into a separate Memorandum of Understanding (MOU) to facilitate water quality standards reviews in accordance with the CSO Control Policy.

3.6.3. Comprehensive Jamaica Bay Water Quality Plan

As discussed above, pursuant to the Nitrogen Control Consent Judgment, NYCDEP submitted a Comprehensive Jamaica Bay Water Quality Plan to the NYSDEC on October 31, 2006. As part of this Plan, both treatment and non-treatment alternatives were being investigated to reduce the total nitrogen load and improve water quality within the open waters of Jamaica Bay.

Treatment alternatives for nitrogen reduction that were evaluated in the Comprehensive Plan included various levels of treatment for nitrogen removal at the four WPCPs that discharge to the Bay:

- Low Level (Level 1): 12 mg/L – 16 mg/L
- Mid Level (Level 2): 9 mg/L – 13 mg/L
- High Level (Level 3): 5 mg/L – 9 mg/L
- Limit of Technology (LOT): 4.1 mg/L – 4.4 mg/L.

Conceptual designs were developed for each of the treatment options for each of the four WPCPs.

Concept level designs and associated cost estimates were developed for conveying treated effluent from the Jamaica, 26th Ward, Coney Island and Rockaway WPCPs to either the Atlantic Ocean or Rockaway Inlet via outfall tunnels. The alternatives selected for evaluation consisted of conveying:

- treated effluent via tunnels to Rockaway Inlet;
- treated effluent to the Atlantic Ocean
- Jamaica WPCP effluent only;
- Jamaica and 26th Ward WPCP effluents;
- Jamaica, 26th Ward and Rockaway WPCP effluents;
- Jamaica, 26th Ward and Coney Island WPCP effluents; and
- Jamaica, 26th Ward, Coney Island and Rockaway WPCP effluents.

Additionally, non-treatment alternatives were evaluated, including the recontouring of Grassy Bay, recontouring of Grassy Bay and North Channel, and the aeration of Grassy Bay.

The Plan is currently under review by NYSDEC.

3.6.4 Other Water Pollution Control Plants Projects and Program

26th Ward WPCP

At present, there are two phases of construction underway at the 26th Ward WPCP which include the following elements:

- An upgrade of the low-level pumps with some work on the high-level main sewage pumps.
- Miscellaneous Improvements, under which the plant is being further upgraded for biological nutrient removal via separate centrate treatment.

Contracts in the planning/design phase for the 26th Ward WPCP include:

- installation of new emergency generators at the facility,
- rehabilitation of the four existing preliminary settling tanks and the construction of two new preliminary settling tanks and
- construction of a new main sewage pump station and chlorine contact tank to allow the WPCP to handle an additional 50 MGD of wet weather flow.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Total Residual Chlorine (TRC) Program

In accordance with SPDES permit requirements, the NYCDEP is implementing a Citywide Total Residual Chlorine (TRC) Management Program, to develop strategies to bring all fourteen WPCPs into compliance with more stringent TRC effluent limits, so that discharges of treated wastewater will not cause TRC receiving water standards to be exceeded.

Currently, all WPCP effluents are chlorinated, to meet disinfection requirements based upon the pathogen indicators total and fecal coliform. The existing permitted TRC limit for each WPCP is 2 mg/L. The NYSDEC has developed lower TRC effluent limits for each WPCP, based upon receiving water dilution modeling, and acute (fish survival) and chronic (fish propagation and survival) receiving water standards for TRC of 13 ug/l and 7.5 ug/L, respectively.

The first four compliance actions identified in the WPCP SPDES TRC Schedules of Compliance have been met including:

- preparation of a TRC scope of work,
- evaluation and verification of the proposed TRC limits,
- evaluation of treatment and non-treatment alternatives, including wastewater characterization and bench scale testing, and
- conclusion of the TRC limit evaluation.

In accordance with the fifth SPDES compliance action, facility plans to achieve the new, lower TRC limits at the Coney Island, Jamaica and Rockaway WPCPs have been drafted and are undergoing review. Based upon existing disinfection facilities and procedures, historical data and the bench scale results, optimization of the existing chlorination systems is being recommended to meet proposed effluent TRC limits of 0.53 mg/L and 0.59 mg/L at the Jamaica and Rockaway WPCPs, respectively. Bench scale testing, historical data and evaluation of the existing disinfection system indicates that dechlorination will be required to achieve the proposed new effluent limit of 0.64 mg/L at the Coney Island WPCP.

NYCDEP has selected the 26th Ward WPCP as the location of a full-scale disinfection demonstration facility, where chlorination/ dechlorination and UV-disinfection will be operated side-by-side in adjacent chlorine contact tanks for a period of one year. The effectiveness of the two technologies on the low ammonia effluent that will be produced by the BNR WPCPs will be evaluated, along with operability and maintenance requirements under identical conditions. The SPDES schedule of compliance requires operation of the disinfection demonstration facility to begin by April 2009.

3.6.5 Combined Sewer Overflow Retention Projects and Programs

Long-Term CSO Control Planning

NYCDEP is undertaking a Long Term Control Plan (LTCP) for controlling CSOs. The Plan will integrate all CSO Facility Planning Projects and the Comprehensive City-wide Floatables Abatement Plan, will incorporate on-going Use and Standards Attainment (USA) Project work in the remaining waterbodies, and will develop Watershed/Waterbody Facility Plan reports and the LTCP for each waterbody area. A number of the projects applicable to Jamaica Bay are described below.

Jamaica Bay CSO

The CSO Order on Consent requires a number of facility projects and upgrades for Jamaica Bay. Below are descriptions of the projects and implementation schedules.

Spring Creek AWPCP Upgrade

This entails various upgrades to the CSO retention the CSO facility. Construction Completion Due April, 2007.

A. 26th Ward Drainage Area Sewer Cleaning and Evaluation and other projects

There are particular sewers in the 26th Ward WPCP drainage area that field work has shown have significant quantities of grit/debris. Hydraulic modeling work has indicated that cleaning of those sewers could reduce the amount of CSO discharge to Fresh Creek.

The subsequent result would be an increase in CSO discharge to the Hendrix Street Canal necessitating a wet weather capacity increase of 50 MGD to the 26th Ward WPCP. Being that that sewer cleaning will take place prior to the upgrade of the 26th Ward WPCP, an interim dredging program consisting of dredging the head end of Hendrix Street Canal to a depth of 2 feet below mean low water will be undertaken to abate odors at Hendrix St. Canal.

The schedule for this element as per the CSO Order on Consent is:

1. Initiate Final Design: January, 2007 Phase I is underway.
2. Final Design Completion Including CPM Analysis: June, 2007
3. Notice to Proceed with Construction: June, 2008
4. Construction Complete: June, 2010

B. 26th Ward Wet Weather Expansion
The schedule for this element as per the CSO Order on Consent is:
1. Initiate Final Design: June 2006
2. Final Design Completion Including CPM Analysis: June 2010
3. Submit Form 2A SPDES Application: June 2009
4. Notice to Proceed with Construction: June 2011
5. Construction Complete: December 2015

C. Drainage Basin Specific Long Term Control Plans

Being reported on under the Citywide Long Term Control Plan for CSO Project

The schedule for these plans as per the CSO Order on Consent is:
1. Submit Approvable Drainage Basin Specific LTCP for Jamaica Bay: August 2012
2. Submit Approvable Drainage Basin Specific LTCP for Spring Creek: August 2012
3. Submit Approvable Drainage Basin Specific LTCP for Fresh Creek: August 2012
4. Submit Approvable Drainage Basin Specific LTCP for Hendrix Creek: August 2012

D. Paerdegat Basin CSO Retention Facility

The Paerdegat Basin CSO Retention Facility is located in southeastern Brooklyn, at the intersection of Flatlands and Ralph Avenues. The facility will receive combined sewer overflows from a drainage area of approximately 6,000 acres within the Coney Island WPCP service area. The facility is currently under construction. Upon its completion, the facility will consist of a four bay underground storage tank and operations buildings. The stored CSO (up to 20 million gallons in-tank plus 30 million gallons in-line) will be pumped back to the Coney Island WPCP for treatment after each rain event.

Jamaica Tributaries CSO
The Jamaica Tributaries project area includes the Jamaica WPCP sewershed area and the tributaries that receive wet weather discharges from the drainage area. These tributaries include Bergen, Thurston (in the southeast portion), Shellbank, and Hawtree Basins, which are located in the northeast portion of Jamaica Bay. There are several projects that are being advanced. These include:

- Meadowmere & Warnerville DWO Abatement – This project includes construction of a new pumping station, force main and sanitary sewer collection system in southeast Queens, to convey flows from the communities of Meadowmere and Warnerville to the Jamaica drainage area collection system for treatment at the Jamaica WPCP. This project will eliminate the dry weather discharges that currently occur within these two communities that are not presently connected to City's collection system.
- Expansion of Wet Weather Capacity of Jamaica WPCP – An additional 50 MGD of wet weather flow will be treated at the Jamaica WPCP to reduce CSO discharges to Bergen Basin.
- Destratification Facility – The system is designed to reduce temperature stratification during the summer season. This stratification leads to poor water quality conditions in the basin resulting in the emission of nuisance odors. This project currently has an operating pilot facility at Shellbank Basin that has produced results over the last six summer seasons.
- Laurelton and Springfield Blvd. Drainage Plan – A drainage plan for 7,000 acres in southeast Queens is being developed to address flooding and to construct high-level storm sewers in a

1,450 acre CSO drainage area tributary to Thurston Basin. The drainage plan will identify the necessary capital sewer projects required to alleviate flooding and convert this CSO drainage area to a high level storm sewer system.

- Regulator Automation – Automation of key regulators was recommended in response to the 1988 SPDES permit requirements that called for telemetry in collection system regulators to detect dry weather overflows. The Citywide Collection Facilities Supervisory Control and Data Acquisition (SCADA) System Project will automate key collection system regulators via the installation of electro-hydraulic actuators capable of controlling flows to the sewer interceptor.

City-Wide Comprehensive CSO Floatables Plan

The NYCDEP developed a floatables abatement plan for the CSO areas of New York City in June 1997. An update of the Plan was subsequently drafted in July 2005 to reflect the completion of some proposed action elements, as well as changes to SPDES permits and modifications of regional Waterbody/Watershed Facility Plans and CSO Facility Plans. The objectives of this plan are to provide substantial reductions in floatables discharges from CSOs throughout the City.

Structural elements of the City-Wide Comprehensive CSO Floatables Plan consist of the following elements:

- Inspection of catch basins city-wide for missing hoods and the replacement of missing hoods to prevent floatables from entering the sewer system, as well as retrofitting, repairing, or reconstruction of catch basins requiring extensive repairs or reconstruction to accommodate a hood.
- Capture floatables at wet-weather CSO storage/treatment facilities
- Capture floatables at end-of-pipe and in-water facilities, including the Interim Floatables Containment Program (IFCP).

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Chapter 4 - Ecology

4.1 THE JAMAICA BAY ECOSYSTEM

"Ecology is the study of how organisms interact with the living (biotic) and nonliving (abiotic) things that surround them" (ricegenomics.plbr. cornell.edu/glossary.htm). Ecological conditions within the Jamaica Bay watershed vary greatly between the non-urban areas (primarily within and surrounding the Jamaica Bay estuary), and the urban areas (including the majority of the upper watershed), reflecting the extreme differences in the composition of these landscapes.


Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

The rich biodiversity that characterizes the Jamaica Bay estuarine ecosystem arises from a complex assemblage of open water, salt marsh and freshwater wetlands, shoreline, and upland habitat located immediately adjacent to some of the most densely populated land in the United States. Large numbers of migratory and resident birds, fish, and other organisms utilize these habitats as important feeding, breeding, and resting areas. The diversity of plants and animals found in the estuary is in part due to its unique position in the landscape (shielded from the open waters of the Atlantic by the Rockaway Spit and located along the Atlantic Flyway bird migration route) and the legal protection given to the remaining natural areas. The Jamaica Bay estuary is located adjacent to other ecologically rich areas (the New York Bight of the mid-Atlantic and the Hudson–Raritan River estuaries) while its proximity to the ultra-urban development of New York City concentrates wildlife into the remaining available habitat, as does the landform of Long Island.

In contrast to the ecological richness of the estuary, the upper 71,000 acre watershed of Jamaica Bay is comprised of the highly urban communities of Brooklyn and Queens, as well as a small portion of Nassau County. Three hundred years ago, the area north of Jamaica Bay harbored numerous freshwater wetlands and uplands with grassland, shrubland, and forest plant communities. Creeks meandered through large wetlands on their way to Jamaica Bay, providing extensive habitat for water birds. Most of the precipitation that reached the ground surface infiltrated into the soil or collected into natural stream channels. The mass of nutrients entering the Bay from the watershed was small and did not create water quality problems in the Bay.

In terms of total area, the urban environment is the dominant feature of the modern day landscape. Residential, commercial, industrial, and transportation infrastructure have replaced the native vegetation. In the last century, urban expansion has resulted in the filling of tidal salt marsh and freshwater wetlands; loss of all freshwater riparian habitat areas; and the loss of upland grassland, shrubland, and forest habitat. The Bay has been dredged for fill material used in shoreline development. Creeks have been channelized or routed through pipes, and shorelines have been hardened. Only a small portion of the precipitation infiltrates into the ground; rather, it runs off roofs and streets into sewers, gathering pollutants, eventually flowing through pipes to Jamaica Bay. The movement of nutrients into the Bay is much greater now than in the past due to the growing human population. The associated waste materials end up in the treated sanitary sewer and stormwater systems and ultimately flow into tributaries of Jamaica Bay and the estuary itself.

TABLE 4.1.1 Primary References for the Ecology Section of Jamaica Bay

TITLE	AUTHOR	DATE
Jamaica Bay Marsh Islands Draft Integrated Ecosystem Restoration Project and Environmental Assessment	USACE	2005
Jamaica Bay Ecosystem Research and Restoration Team (JBERRT) Final Report	USACE	2002
Significant Habitat and Habitat Complexes of the New York Bight Watershed	USFWS	1997
Jamaica Bay Comprehensive Watershed Management Plan (Draft)	NYCDEP	1994
Buffer the Bay Revisited: An updated Report on Jamaica Bay's Open Shoreline and Uplands	Trust for Public Land and NYC Audubon Society	1992
Benthos Study: Jamaica Bay Wildlife Refuge, Gateway National Recreation Area	Franz and Harris	1985

The impact of urbanization has directly resulted in the ecologically degraded state of the Jamaica Bay watershed. It is important to note that many natural areas have not only been eliminated or damaged, but the processes which sustain healthy ecosystems have been significantly altered, thereby jeopardizing the long term functionality and sustainability of the Bay estuary and the upper watershed. The Ecological Model depicted in Figure 4.1.1 graphically represents the cause and effect of these anthropogenic alterations to the landscape.

The following sections use existing publications and studies to characterize the ecology of Jamaica Bay, including aquatic, wetland, sediment quality, shoreline, upland, and urban habitats. Following these general descriptions, more specific information on the composition, distribution, and condition of vegetation, wildlife (including macroinvertebrate, shellfish, fish, finfish, bird, mammal, reptile, and amphibian communities), and invasive species in the Jamaica Bay watershed is included.

4.2 AQUATIC ENVIRONMENT

In the Jamaica Bay watershed, the aquatic environment is composed of brackish or marine water areas (the tidally-influenced open water in the estuary) and freshwater features (such as lakes, ponds, and streams in the upper watershed).

As stated above and demonstrated upon examination of aerial photographs, it is readily apparent that the upper watershed is dominated by the dense urban grid of Brooklyn and Queens, and is almost completely devoid of surface waters. In fact, almost 100% of the freshwater tributaries to Jamaica Bay have been piped. Apart from several ponds in the upper watershed and two large freshwater ponds on Bay marsh islands, the freshwater ecological component of Jamaica Bay is a small fraction of its historical extent. Prior to urbanization, tributaries such as Fresh Creek, Paerdegat Creek, Bergen Creek, and Hassock Creek would run from the upper watershed, sometimes for many miles, before meeting tidal waters and opening into the estuary.

Freshwater ecosystems typically support a diverse array of macroinvertebrate, fish, and amphibian organisms, which in turn attract larger predators such as birds, reptiles, and mammals. The riparian ecosystems which surround these freshwater areas are also ecologically rich and diverse areas. As a result of the complete eradication of freshwater channels in the watershed, these ecosystems and the associated biological communities have been almost completely extirpated. The few remaining ponds provide limited freshwater or riparian habitat for fish and wildlife, and are primarily artificial impoundments.

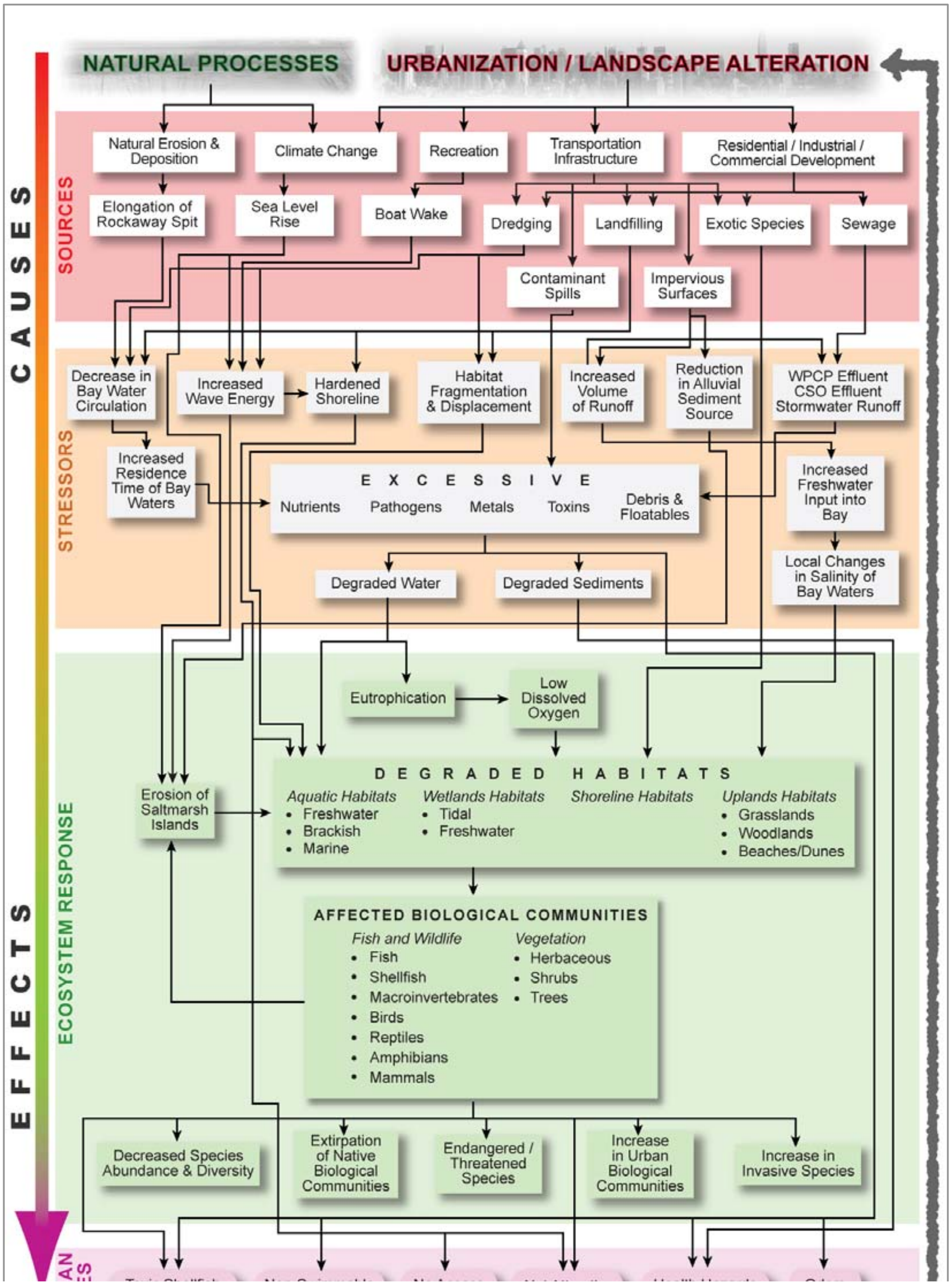


FIGURE 4.1.1 Jamaica Bay Watershed Ecosystem Model; Source: Biohabitats

The Jamaica Bay estuary is where these fresh waters now piped from the upland watershed into the tributaries and open waters meet salt water entering the Bay from the ocean via Rockaway Inlet. The majority of water in the Jamaica Bay estuary is brackish (a mixture of fresh water and sea water). Thus, the salinity of the Bay is intermediate between that of the fresh water flowing in tributary streams or out of sewer outfalls and the salt water of the ocean. Typically, fresh water flowing into the Bay has a salinity of less than one part per thousand, while ocean water has a salinity of about 34 parts per thousand (3.4%). Salinity in the Bay generally varies from about 23 to 27 parts per thousand (2.3% to 2.7%) (Gordon *et al*., 2002). Salinity varies for different parts of the Bay and is generally higher (above 26.5 parts per thousand) in the western and southern portions and lower (below 26.5 parts per thousand) in the eastern and northern portions. Water temperatures in the Bay range from 16º – 24 º C. Fresh and salt water do not mix uniformly, thus distinct differences in Bay water salinity and temperature (stratification) in time and space occur throughout the Bay.


Return A Gift Pond, Floyd Bennett Field; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Jamaica Bay is a highly productive estuary. Historically, productivity had been limited by the availability of nitrogen. Today, ever increasing concentrations of readily available nitrogen in the Bay stimulates additional primary production. This includes the potential for stimulating the growth of aggressive non-native plants, phytoplankton and macro-algae “blooms.” Nitrogen levels in the water of Jamaica Bay are elevated due to large volumes of treated sewage effluent from the WPCPs and episodic overflows from CSOs entering the Bay, mostly from the densely urbanized Brooklyn and Queens sub-watersheds. It is estimated that 36,600 pounds of total nitrogen are discharged to the Bay each day from WPCPs, which accounts for 95% of all nitrogen entering the Bay (NYCDEP, 2005).

Landfilling activities combined with the dredging of the first “borrow pits” in the late 19th and early 20th centuries have profoundly altered the aquatic environment in the Jamaica Bay estuary. Prior to 1800, the estuary was shallow with an average depth of about 3 feet and a surface area of about 25,000 acres. The draining and filling of marsh and meadow lands, over the past 150 years, has reduced the size of the open water and

Borrow Pits

Borrow pits are deep areas of the Bay bottom that were dredged for fill material to expand the upland zone along shoreline wetlands for development. Floyd Bennett airfield and JFK airport were created from Bay dredge material as was the connection of several islands to the landward shorelines around the Bay.
Source: Biohabitats

Dissolved Oxygen in Water

Water is the universal solvent. Many different compounds dissolve in water, including oxygen, nutrients, and various pollutants. Dissolved oxygen (DO) gas is essential for most aquatic organisms, such as shellfish and finfish. Jamaica Bay’s dissolved oxygen levels range from 3.5 – 18.5 milligrams/liter. At times, portions of the Bay are found to have DO levels below the 5.0 mg/l USEPA criteria for support of living organisms. Long periods of DO below 5 mg/L can harm larval life stages for many fish and shellfish species. Thus, maintaining adequate concentrations of dissolved oxygen is required to maintain healthy aquatic life in the Bay.
Source: Biohabitats

wetlands in the Bay to about 13,000 acres (NYCDEP, 1994). Dredging and the removal of sand from the bottom of the Bay have increased the Bay's average depth to 16 feet, with a maximum depth of 40 feet in some shipping channels (NYCDEP, 1994) and more in Grassy Bay. Despite the reduction in surface area, the dredging of the Bay has increased the overall water volume by 350% (NYCDEP, 1994).

The dredging of the bottom of the Bay has had many unintended effects, altering sediment transport dynamics and water quality. The deeper waters of the Bay may now act as a sediment sink, trapping sediment that formerly washed onto and was retained by salt marshes. Lack of sufficient sediment has been cited as a possible contributor to salt marsh disappearance (Gordon and Houghton, 2004). Combined with wave-induced erosion, these two factors may be having a synergistic effect on the rate of salt marsh loss in Jamaica Bay. The water in certain portions of the Bay now stratifies during the summer. Colder water stays on the bottom, and warmer water floats on top, with little mixing until water temperatures equilibrate. The addition of large amounts of nitrogen from WPCP and CSO stimulates the growth of aquatic plants, plankton and algae. A portion of this growth dies and settles into the lower stratified waters where it decomposes during the summer. The process of decomposition consumes much of the available dissolved oxygen. This nutrient-stimulated growth, death and decay results in a reduction of the concentration of oxygen in the bottom layers of the Bay, oxygen levels sometimes fall below the USEPA criterion for aquatic organisms (5.0 mg/L), a level at which the larvae and adults of certain fish and bottom dwelling invertebrate species become stressed and may not survive under long term exposure.

Tides are another key component of the Jamaica Bay estuary, with an average semidiurnal (two

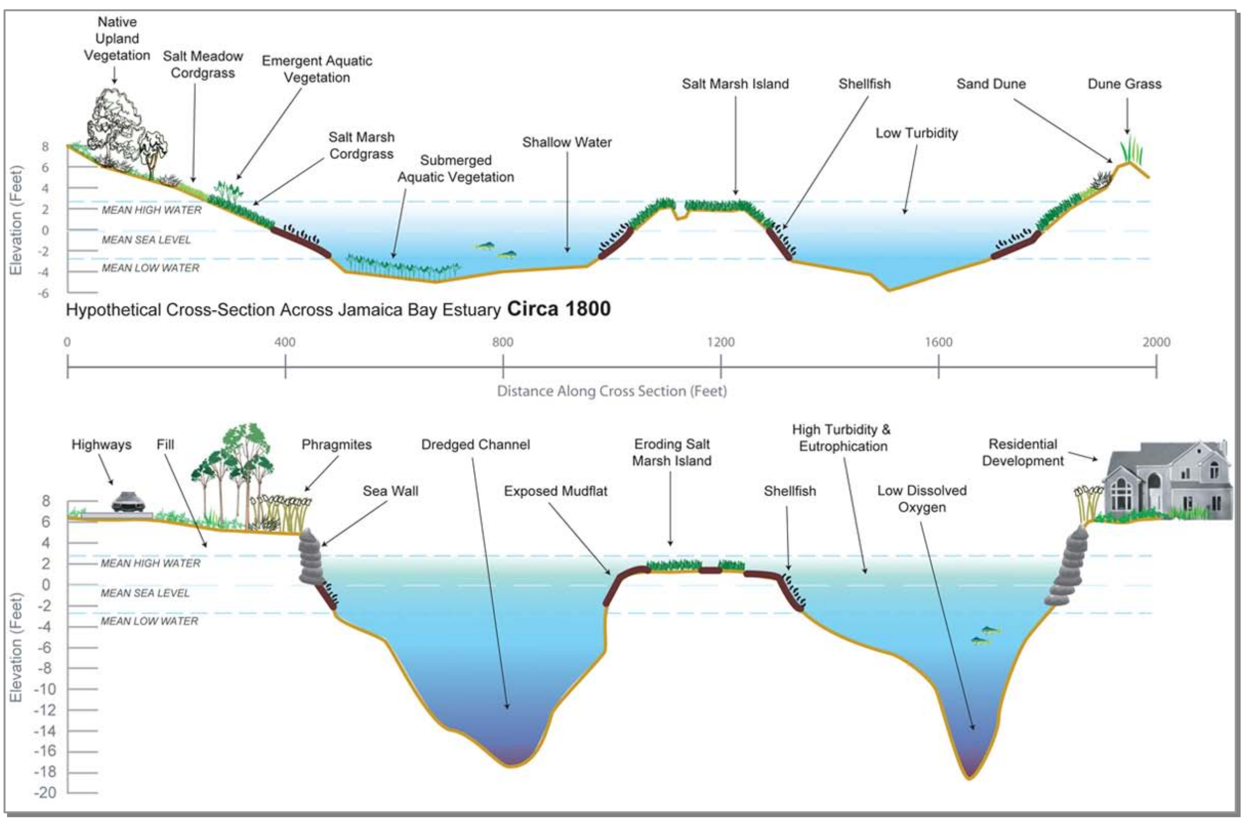


Figure 4.2.1 Changes in the Jamaica Bay Estuary from 1800 to 2000. Source: HydroQual, Inc.

Submerged Aquatic Vegetation

The most common submerged aquatic vegetation (SAV) found in the coastal estuaries of New York, including Jamaica Bay, are eelgrass (*Zostera marina*) and widgeon grass (*Ruppia maritima*). Both of these plants provide valuable food for waterfowl and important habitat for many juvenile fish, crustaceans and mollusks. Today, SAV is rare in the Jamaica Bay estuary. Re-establishment of SAV is limited by reduced light availability, most likely from nutrient induced plankton blooms that result from treated and untreated sewage draining into the Bay. Other factors that have the potential to negatively affect SAV survival include increased wave action, introduced sediment, increased organic loading of the sediment, and mechanical damage from dredging and propeller scars.

high, two low tides per day) tidal range of approximately 5 feet (USFWS, 1997). Tidal elevations vary from approximately 3 ft mean sea level (MSL) at high tide to approximately -2.9 feet MSL at low tide (USACE, 2005). Tidal currents move sediment and other materials around the Bay, mixing salt and fresh water. Salt water from the Atlantic Ocean continually replaces water in the Bay, flushing pollutants into the ocean where they are greatly diluted. Prior to large-scale dredging of the Bay, the 4.5 e-folding residence time of water in the northern regions of the Bay (or the time it takes 99% of the water to be cycled through to the ocean) was about 11 days. Now, the 4.5 e-folding residence time of water in the northern regions of the Bay is 33 days, due to changes in circulation patterns and the larger volume of water in the Bay from decades of dredging (NYCDEP, 1994).

Despite these severe alterations to historic physical properties of the freshwater, brackish, and marine water environments (Figure 4.2.1), macroinvertebrate, fish, and shellfish communities still live and thrive in the aquatic areas of the Jamaica Bay estuary. These particular communities and their utilization of aquatic habitat areas are discussed in greater detail in subsequent sections.

4.3 WETLANDS

If one were to ask a New Yorker what Jamaica Bay is, chances are good that he or she would reply “wetlands.” Wetlands truly are the defining ecological feature of the Jamaica Bay watershed.

There are two wetland assemblages in the Jamaica Bay watershed, salt marshes and freshwater wetlands. Freshwater non-tidal wetlands are typically found in depressions where surface runoff or over bank flooding from streams or rivers collects for extended periods of time, or where ground water intersects the land surface. Historically, several types of freshwater wetlands occurred throughout the watershed, including deep marsh, shallow marsh, shrub swamps, lowland swamp forest, upland swamp forest, and wet meadow (Mockler, 1991).

> “*If one way be better than another, that you may be sure is nature’s way.*”
>
> *– Aristotle*

Today, freshwater wetlands are very limited in extent, comprising less than 1% of their historic coverage in the Jamaica Bay watershed. Their disappearance can be directly attributed to urban development. During the construction of roads, buildings, and other infrastructure, fill and pavement replaced an undetermined acreage of freshwater wetlands. This occurred prior to the enactment of federal and state legislation which protects remaining wetlands areas from further encroachment.

Salt marsh wetlands occur along the Atlantic shoreline in estuaries which are protected from the full energy of the ocean. They occupy the vertical zone between low and high tide as well as the less-frequently inundated areas above mean high water, consisting of three general zones of progressively higher elevation: mudflat, low marsh, and high marsh. Mudflats are unvegetated, appearing only at low tide as an important ecological transition between the vegetated marsh and sub-tidal waters. Low marsh occurs in the portion of the tidal zone where plants are inundated twice daily by normal high tides and exposed twice daily by normal low tides. High marsh occurs just above the mean high tide elevation and is flooded only occasionally during major storms or during extreme (spring) high tides.

Smooth cordgrass or saltmarsh cordgrass (*Spartina alterniflora*) is the characteristic plant species of the low salt marsh. Green filamentous algae, although small and primitive, are also important and can contribute one-fourth of the photosynthesis in a New England salt marsh (Van Raalte and Valiela, 1976). Besides algae, few other plants can tolerate the harsh environmental conditions of the low marsh. Plants inhabiting the low marsh must contend with soils with no oxygen, highly saline water and soil, and alternating flooding and drying. However, life in the high marsh is not so severe for plants due to the lack of daily tidal inundation and flushing. Salt meadow cordgrass or salt hay (*Spartina patens*) is the most abundant plant in the high marsh. Other common plant species of the high marsh include black grass (*Juncus gerardii*), salt grass or spike grass (*Distichlis spicata*), marsh elder (*Iva frutescens*), and seaside goldenrod (*Solidago sempervirens*).

From a habitat standpoint, as well as an economic perspective, the Jamaica Bay salt marshes are critical for three groups of animals: shellfish,

Wetlands Cleaning Water

Salt marshes naturally trap sediment and nutrients that help build the marsh and support its high level of productivity. Generally, nitrogen is considered one of the main limiting factors to plant primary productivity in coastal waters. In Jamaica Bay, nitrogen loading from human waste products has created an over-abundance of available nitrogen, leading to severely impaired water quality. Because of the low oxygen conditions in salt marsh sediments, some bacteria can convert nitrate forms of nitrogen to gaseous forms that are then released to the atmosphere. This process, called denitrification, is a part of a larger significant pathway whereby nitrogen from the water can be removed by wetlands. Additionally, the nutrient phosphorus and some metals attach readily to small particles, that when settled in salt marshes often become bound up in sediments, plant tissue and organic matter, effectively removing these pollutants from the aquatic system in a process called sequestration.
Source: Biohabitats

Salt Marsh; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Salt Marsh Island Erosion

The New York State Department of Environmental Conservation estimates that since 1924, approximately 1,400 acres of tidal salt marsh has been lost from marsh islands in Jamaica Bay. The major losses on these islands have been identified as perimeter erosion, widening of tidal channels and expansion of interior tidal pools (USACE, 2005). In 2000, the National Park Service convened a Blue Ribbon Panel of eminent wetland ecologists to investigate the loss of the marsh islands. They concluded that numerous interrelated processes are responsible, including changes in sediment deposition, increased wave action, contamination of Bay waters, and sea level rise. These and other issues are currently being studied to better understand the mechanisms of degradation. The implications of the accelerating rate of salt marsh island loss are startling: Jamaica Bay could lose most of its salt marsh islands in the next several decades if these recent trends continue. Source: USACE, 2005 finfish, and waterfowl. Several species of invertebrates including fiddler crabs and ribbed mussels spend essentially all of their lives in the salt marsh. Numerous fish species spend all or part of their lives in or around the salt marsh. Mullet and menhaden feed and mature in shallow waters at high tide. Striped bass and shad pass by salt marshes from the ocean on their way to rivers to spawn. Large numbers of waterfowl and other birds use the salt marsh during their spring and fall migrations, and some stay for the summer to nest. for crabs, mussels, and clams. Few large animals inhabit the salt marsh due to the difficulty of moving about on the marsh surface and the lack of other necessary habitat elements to support them. Wave energy and floodwaters from severe storms are dissipated on salt marshes, which can re-grow when damaged by storms. Salt marshes also provide a pleasing contrast to the developed areas that border the Bay as well as recreational opportunities for citizens of the Jamaica Bay watershed.

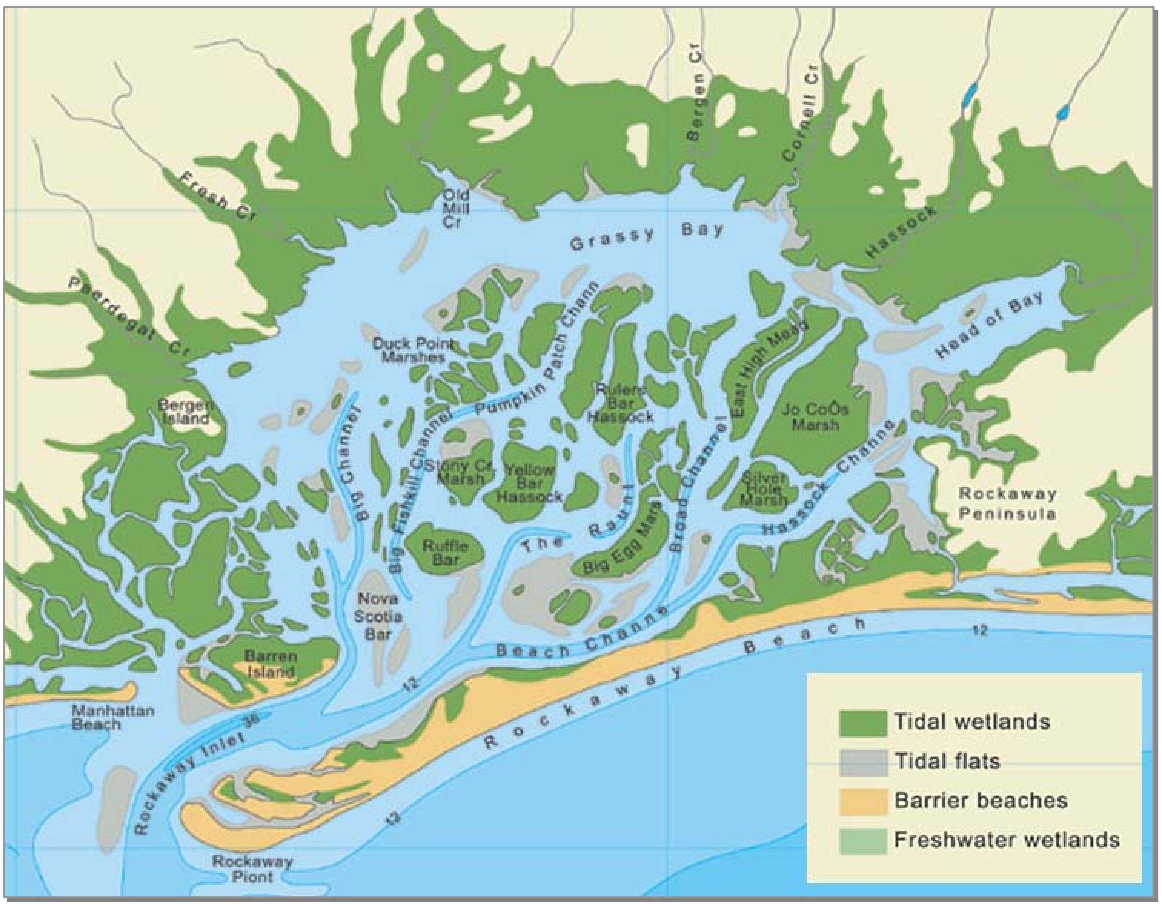


TABLE 4.3.1 Loss of Salt Marsh Islands in Jamaica Bay from 1900 to 1994; Source: USACE, 2005

Several bird species nest in salt marshes, including clapper rail, marsh wrens, and sharp-tailed sparrow. These birds feed on insects, mollusks, and shellfish. Small rodents like the white-footed mouse search for small insects and seeds. Raccoons and mink patrol the salt marsh looking

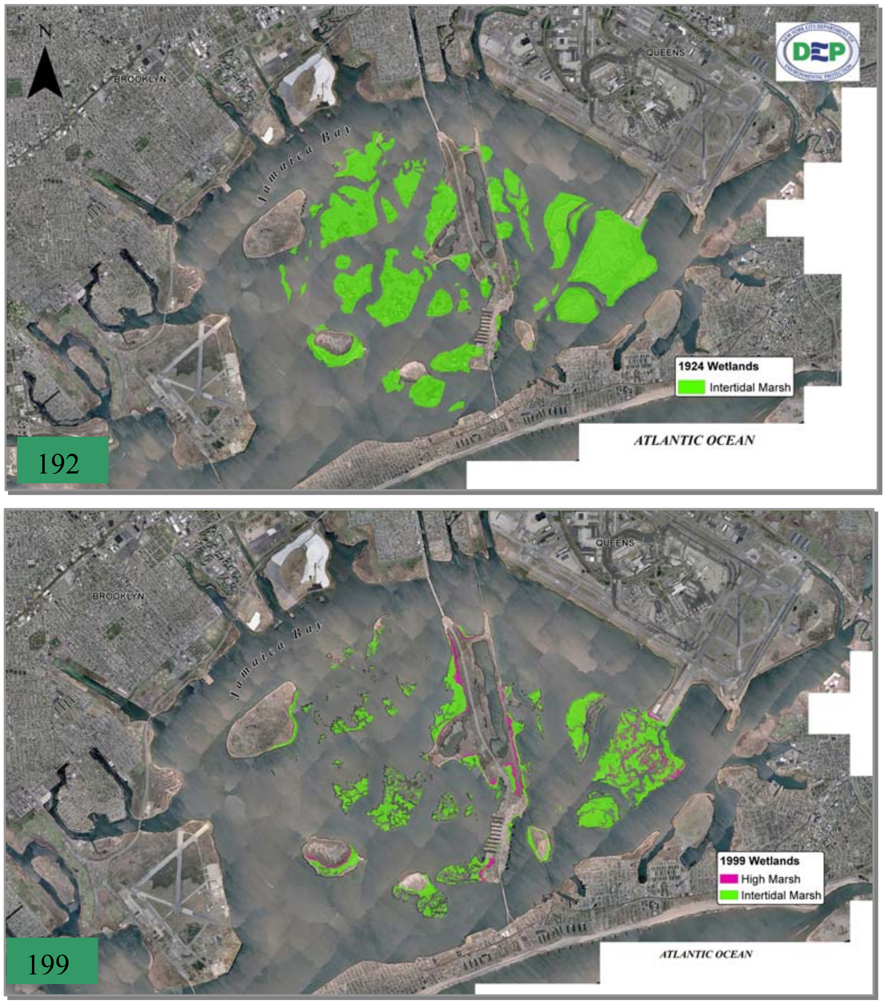


FIGURE 4.3.2 Wetland Loss in Jamaica Bay from 1924 to 1999; Source: NYCDEP

Prior to Euro-American settlement, it is estimated that there were about 16,000 acres of salt marsh in Jamaica Bay (USFWS, 1997, Figure 4.3.1). At first, salt marshes were used by the settlers as pasturelands for livestock. Later, as farming was replaced by manufacturing in the New York City region, salt marshes were filled with debris and then later developed. Large areas of salt marsh were filled with garbage and converted to landfills, which were subsequently converted to parks and commercial and other private uses. As of 1971, only about 4,000 acres of salt marsh remained in the Bay (National Academy of Sciences and National Board of Engineering 1971). Prior to 1974, salt marsh disappearance occurred primarily along the periphery of the Bay due to dredging, filling, and draining activities. Since 1974, the vast majority of salt marshes loss in the Bay is the result of marsh islands that are disappearing, not yet fully explained (see sidebar for more information). Figure 4.3.2 shows the changes in distribution of salt marsh islands in Jamaica Bay between 1924 and 1999 (NYCDEP, 2005). Based on aerial photographs, 780 acres of salt marsh were lost from 1924 to 1974, at an average rate of 0.4% per year (Hartig *et al.*, 2002). Analysis of 1974, 1994, and 1999 aerial photos showed that the rate of loss (44 acres/year) increased to 1.4% per year from 1974 – 1994 with 400 acres of salt marsh lost and further increased to 3.0% per year from 1994 – 1999 with 220 acres of salt marsh lost (Hartig *et al*., 2002) (Table 4.3.1).

	1900	1974		1994		
SALT MARSH ISLAND (SALT MARSH ZONE)	ACRES	ACRES	PERCENT REMAINING SINCE 1900	ACRES	PERCENT REMAINING SINCE 1974	PERCENT REMAINING SINCE 1900
Nestopol (Low)	36.6	5.7	16%	0.6	9%	2%
Jo Co (High and Low)	485.0	414.0	85%	374.0	90%	77%
Elders Point (Low)	120.0	93.0	77%	37.6	40%	31%
Fish Kill Hassocks (Low)	4.9	1.3	27%	0.05	4%	1%
Total Island Marshes (>15 Named Islands)	3,146	1,972	63%	1,572	80%	50%

Wetlands in Jamaica Bay that are not physically destroyed can be degraded directly and indirectly by human activities. Vacant areas of wetland are inviting places to dispose of junked cars, construction debris, and other refuse. Human disturbance creates an opening for invasive plant species that have the potential to suppress native vegetation and create monocultures that are considered less hospitable to wildlife than the native plants. In particular, purple loosestrife (*Lythrum salicaria*) is a threat to the remaining freshwater wetlands, while the common reed (*Phragmites australis*) forms dense stands in fresh to moderately saline wetlands, and is already well established around the estuary.

4.4 SEDIMENT QUALITY IN THE BAY

The sediments in Jamaica Bay have been impacted by the activities of man in the watershed. Not only the dredging and filling of the Bay but also the discharge of effluents from the WPCPs and the CSOs and wet weather flows have contributed to contaminants found in the Bay. A study conducted by the USEPA in 1998 compared sediment data from 1993/4 and 1998 (USEPA, 2003).

The discussion of sediment in Jamaica Bay involves a number of topics that can broadly be divided into two categories. The first category is sediment characteristics, which includes descriptions of the sediment and the quality of the sediment. The second category is the movement of sediments either naturally or due to human involvement, which includes sources and sinks of sediment as well as dredging and placement of sediment. This section of the report will discuss both categories.

Sediment Description

Limited data exists for sediment types in Jamaica Bay. The data that do exist tend to be dated. Feuerstein and Maddaus (1976) measured sediment fractions at 15 sites around Jamaica Bay and created isopleths for sand, silt and clay fractions. The western portion of the Bay from Cross Bay Boulevard to the Rockaway Inlet generally had greater than 80 percent sands. The isopleths are then tightly spaced toward Grassy Bay where the sand component is less than 40%. The western side of the Bay had a silt fraction of approximately 10% while Grassy Bay had 20 to 30% silt. Clay content in the Rockaway Inlet was less than 10 %, and was as high as 50% in Grassy Bay.

Franz and Harris (1985) also analyzed sediments in the Bay. On a Bay-wide basis, bottom sediments were described as "predominantly moderately to well sorted, nearly symmetrical to coarse skewed, mesokurtic to very leptokurtic, fine quartz sands" (a normal distribution is called mesokurtic; leptokurtic is a peaked distribution with thick tails). Some exceptions were noted near the Rockaway WPCP, North Channel Bridge and Barren Island. Muds were found in areas where flows were restricted. Very fine sand and mud covered by dense surface mats of amphipod tubes was found in Grassy Hassock Channel. Grassy Bay was covered with black sticky jelly-like muds. The mud fraction generally increased northwards in the western Bay and along the North Channel.

The Regional Environmental Monitoring and Assessment Program (REMAP) analyzed sediment type in 1993-94 and 1998 (Adams and Benyi, 2003). An area-weighted mean of sampling sites in Jamaica Bay found 30.3 percent silt-clay in 1993-94, and 37.5 percent silt-clay in 1998. The 1998 sampling classified 50 percent of Jamaica Bay as mud. More recently, the Norton Basin Borrow Pit Restoration Project conducted for the USACE and the NYSDEC (Barry A. Vittor and Assoc., 2002) conducted sampling in Norton Basin and Little Bay as well as Grass Hassock Channel and the Raunt. Samples collected in the Raunt were approximately 50 to 60 percent sand and 20 to 40 percent clay. Sediment samples in Grass Hassock Channel tended to be approximately 25 percent sand and 30 to 50 percent clay.

The nature of the bottom substrate at locations around the Bay is important. Different substrates provide different habitats and support different, sometimes interactive communities. Fishes and crustaceans often highly modify mud habitats exploiting the cohesive nature of the fine sediments and organic materials. Burrows of various sizes and configurations, as well as shallow depressions, greatly increase the complexity of such habitats. The mud bottom substrate provides habitat for shellfish and invertebrates, with some of the latter serving as prey for the finfish in the Bay.

Total Organic Carbon (TOC)

TOC provides a measure of how much organic material occurs in sediments. Decomposing salt marsh plants and upland runoff are the primary sources of organic carbon. Open water sites are generally farther away from these sources resulting in lower TOC concentrations than tidal creek habitats.

Franz and Harris (1985) collected TOC data for Jamaica Bay in the early 1980s. In this study they correlated the percent TOC with the condition of the sediment. Sediments with less than 0.5 percent TOC were characterized as clean yellow-brown to gray. Sediments with 0.5 to 1.0 percent TOC were described as dirty with black organics. TOC values greater than 1.0 percent were characterized as usually black, frothy mud and having a hydrogen sulfide (H_2S) (rotten eggs) odor.

Salt Marsh; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Sediments with TOC content less than 0.5 percent were found in the western, central and southern portions of the Bay.

The next category of sediments 0.5 to 1.0 percent TOC were found at Nova Scotia Bar, outside of Mill Basin and Paerdegat Basin, near JoCo Marsh and on the western side of Rulers Bar Hassock (sometimes referred to as the Broad Channel Community). Sediments with TOC levels of 1.0 to 3.0 percent were measured outside of Fresh Creek and Spring Creek, in the areas around Grassy Bay and Grass Hassock Channel. The highest TOC content (> 3.0 percent) was found in Grassy Bay, the area to the southeast of Grassy Bay next to the JFK Airport runway extension, in Fresh and Hendrix Creeks, and near the area around Broad Channel, which was unsewered at the time.

The REMAP program measured TOC in Jamaica Bay during 1998. While the area weighted mean of TOC in Jamaica Bay was 2.6 percent, nearly 40 percent of the Bay had TOC measurements less than 0.5 percent. Another nearly 40 percent of the Bay had TOC measurements greater than 3.5 percent (Adams and Benyi, 2003). Hyland *et al.* (2000) found that extreme concentrations of TOC can have adverse effects on benthic communities; TOC levels below 0.5 mg/g (0.05%) and above 30 mg/g (3.0%) were related to decreased benthic abundance and biomass. The National Coastal Assessment Program (USEPA, in review) has used TOC concentrations of below 2% and above 5% to indicate fair or poor sediment quality.

__Priority Pollutants__

A review of Zeppie (1977), Ramondetta and Harris (1978), Seiger and Tanacredi (1979), Staubitz and Wolcott (1985), Franz and Harris (1985), Bopp *et al.* (1993), and Adams *et al.* (1996) shows that a number of trace and heavy metals and priority pollutants have been found in the sediments of Jamaica Bay. These include cadmium, chromium, copper, iron, lead, mercury, nickel and zinc, as well as chlordane, DDD, DDT, dieldrin, heptachlor, polynuclear aromatic hydrocarbons (PAHs), and polychlorinated biphenyls (PCBs). In general, these contaminants were found in proximity to the outfalls of WPCPs, CSOs, and storm sewers, or near landfills. Contaminants were also found to be highly correlated with the total organic content of the sediment. As such, the most highly contaminated areas were found along the northern and eastern portions of the Bay, especially Grassy Bay, and also on the northeastern side of Nova Scotia Bar. The Brookhaven National Lab has created contour maps of the REMAP data that can be found at: *http://www.bnl.gov/wrdadcon/publications/image/status_jpg.htm*

REMAP also evaluated the biological effects of toxics in the sediment. The Effects Range-Low (ERL) value is the concentration at which adverse biological effects begin to be seen. The Effects Range-Medium (ERM) is the concentration that is usually associated with adverse biological effects (Adams and Benyi, 2003). New York State has adopted the use of some ERLs and ERMs for Sediment Guidance Criteria (NYSDEC, 1999). The REMAP data shows that mercury, chlordane, and high molecular weight PAHs exceeded ERMs in portions of Jamaica Bay.

Prior to the 1972 Federal Clean Water Act, many industries released toxic contaminants into local waterways as unregulated point sources of pollution (USACE, 2004). As a result of that legislation, most point sources have been identified and many of them remediated. Currently, non-point source dissolved pollutants and pollutants that adhere to sediment enter the Bay at storm, sanitary, and combined sewer outfalls. The National Oceanic and Atmospheric Administration (NOAA) ranks sediment samples collected in the late 1980s in Jamaica Bay as being

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

within the top 20 most polluted nationally (out of 110 sites) (NOAA, 1988). Additionally, sediments collected in the 1990s were found to have some of the highest toxicity levels in the New York harbor area (Adams *et al*., 1998).

Researchers have also found that contaminant levels in the sediments have been declining since the 1960s and 1970s. According to Franz and Harris (1985), their metals data showed a significant decrease in the metals concentrations when compared to data collected by Ramondetta and Harris (1978) a decade earlier. Bopp *et al.* (1993) found that metals concentrations decreased by approximately 50 percent from the mid-1960s to the mid-1980s, and that PCBs, chlordane, and DDT-related compounds had decreased by a factor of five between the late 1960s and late 1980s. Bopp hypothesized that improvements in wastewater treatment, and regulations related to the use and release of certain compounds, was the cause for this decline. The NYCDEP (2005) reported that influent loading of metals to WPCPs in NYC during 2003 declined to 29 percent of the loadings received in 1973. The REMAP found chlordane concentrations had a statistically significant decrease between 1993-94 and 1998 in Jamaica Bay.

Sediment samples were analyzed for PAHs, pesticides, metals, PCBs, dioxin and furan congeners, and TOC. Of the 47 parameters analyzed, it was found that concentrations for the majority had decreased from 1993/4 to 1998. Concentrations for the metals (arsenic, chromium, manganese, mercury, and nickel), and for the PAH perylene, were found to have increased during this time period. Generally, sediment quality data throughout the Bay are limited, as are evaluations of historic sediment quality.

While sediment conditions in Jamaica Bay appear to be improving, areas in the Bay are still problematic. Adams *et al.* (1996) reported that 14 percent of Jamaica Bay's sediments are highly toxic and 25 percent of the Bay's sediment is toxic (inclusive of highly toxic) to *Ampelisca abdita*, a polychaete worm, and that 50 percent of the Bay's sediments were toxic using the Microtox assay (which measures toxicity to a bacterium). Adams and Benyi (2003) found 20 percent of Jamaica Bay's sediment to be highly toxic and 32 percent to be toxic based on data collected during 1998.

Sediment Balance

The movement of sediment within Jamaica Bay has become an important issue with regard to marsh loss. Some theorize that marshes can no longer keep pace with sea level rise because sediments do not reach the marshes in enough quantities. Zeppie (1977) measured sediment deposition rates in the marshes at 0.8 cm/yr and in sandy channels at 0.5 cm/yr. This rate is well above the 0.29 cm/yr attributed to sea level rise in some references. However, confirmation of this rate at the present, 30 years later, may be advisable as a factor in decision making, due to changes in contributing variables in and around the Bay.

Sediment sources from the land have been reduced due to urbanization and the paving over of the watershed. Approximately 12,000 acres of marshland that surrounded Jamaica Bay have been filled (JBESG, 1971). Those sediments that do enter the Bay tend to settle out in the deeper areas of the Bay where current velocities are lower. Bopp *et al.* (1993) examined two sediment cores taken from Grassy Bay, one in 1982 the other in 1988. Sedimentation rates in Grassy Bay were estimated to be 1.4 cm/yr from the mid-1960s to the late 1980s, and 1.6 cm/yr between the mid-1950s and late 1980s. These deeper areas were artificially created for shipping lanes and by the removal of material for landfilling. It has been estimated that 125 million cubic yards of material have been dredged since the early 1900s to create shipping channels and to provide fill for use in other portions of the Bay, such as the creation of JFK Airport, Floyd Bennett Field, and Broad Channel Island. It has also been estimated that 70 percent of the current volume of Jamaica Bay is the result of man made changes (JBESG, 1971).

Under pre-urbanized conditions, sediments would have entered the Bay via the tributaries that surround the Bay. Currently, sediments enter the

Bay via the WPCPs, which are designed to remove suspended solids from wastewater, and from CSOs and storm sewers, which discharge into tributaries where much of the sediment settles out. The extension of the Rockaway Peninsula westward from about the location of Jacob Riis Park to its present location has altered flows and restricted the import of sediments from the Lower Harbor.

Modeling conducted by HydroQual (2006) suggests that the changes to the bathymetry of the Bay have changed the shear stress on the bottom sediments, thereby changing the way sediments are distributed within the Bay. Presently, current velocities are strong through the Rockaway Inlet, as well as the North Channel and Beach Channel up to about Cross Bay Boulevard. Here the currents are restricted by the narrow channels, and bottom shear stress significantly declines in the eastern portion of the Bay, which is a depositional zone. Marsh areas in the western portions of the Bay experience some high shear stresses, but on average would appear to be depositional areas. If all of the deep areas of Jamaica Bay were filled to 8 ft below mean low water (MLW), the shear stress in the bottom sediments would change within the Bay. In this case, the shear stress in the channels increases, but in the western marsh areas the shear stress is smaller, which might allow more deposition. The eastern portion of the Bay remains a depositional zone. Based on these results it appears that modifications to the geometry of the Bay have contributed to changes in the sediment distribution in the Bay.

4.5 SHORELINE

Shorelines occur where the Jamaica Bay estuary meets land. In this context, a "shoreline" refers to a narrow strip of land that is located immediately above the mean high tide forming a zone interfacing with adjacent uplands. The shoreline environment includes the upper extent of wetlands areas (high marsh), beaches or dunes, vegetated uplands, and the built environment that abuts the Bay and its tributary creeks and basins (Figure 4.5.1).

Jamaica Bay has extensive shoreline habitat around the Bay's periphery, on larger islands in the central Bay, and along its tributary creek channels. Historically, much of the shoreline of the Bay was fringed with salt marsh wetlands, although there were also unvegetated areas dominated mostly by sands. Shoreline wetlands dissipate wave energy from adjacent waters. Prior to the dredging that deepened much of the Bay, most of the shoreline was subject to low-energy waves due to the shallow water in the

FIGURE 4.5.1 Natural and Artificial Shoreline Habitat Areas in the Jamaica Bay Estuary: Source: NYCDEP

TABLE 4.5.1 Shoreline Area Soils

SOIL TYPE	SOIL DESCRIPTION
Beaches (5)	Nearly level to gently sloping areas of sand or sand and gravel adjacent to the Atlantic Ocean and Jamaica Bay, inundated by saltwater twice each day at high tide. Frequently reworked by wave and wind action, these areas do not support vegetation.
Ipswich-Pawcatuck-Matunuck mucky peats, 0-3 percent slopes (6)	Low lying areas of tidal marsh that are inundated by salt water twice each day at high tide, with a mixture of very poorly drained soils which vary in the thickness of organic materials over sand.
Pavement & buildings, wet substratum-Bigapple-Verrazano complex, 0-8 percent slopes (92)	Nearly level to gently sloping urbanized areas where sandy dredged materials and loamy fill have been placed over swamp, tidal marsh, or water; a mixture of sandy and loamy-capped anthropogenic soils, with up to 80 percent impervious pavement and buildings covering the surface; located along coastal waterways in Staten Island, Brooklyn, and Queens.
Greatkills-Freshkills complex, 3-25 percent slopes (98)	Gently sloping to moderately steep areas where household landfill material is capped by loamy fill of variable thickness.
Bigapple-Fortress complex, 0-8 percent slopes (99)	Nearly level to gently sloping areas that have been filled with sandy dredged materials; a mixture of well drained and moderately well drained anthropogenic soils; located along coastal waterways.
Inwood-Laguardia-Ebbets complex, 0-8 percent slopes (100)	Nearly level to gently sloping areas that have been filled with a mixture of natural soil materials and construction debris; a mixture of anthropogenic soils which vary in coarse fragment content.
Hooksan-Verrazano-Pavement & buildings complex, 0-8 percent slopes (242)	Nearly level to gently sloping areas of dunes that have been partially cut and filled, mostly for parkland and light residential use; a mixture of sandy soils and loamy-capped anthropogenic soils with more than 15 percent impervious pavement and buildings covering the surface; located on Coney Island and the Rockaway peninsula.

Sea Level Rise and Shoreline Erosion

Global warming causes the volume of water in the oceans to expand and it promotes melting of the polar ice caps. These and other factors contribute to sea level rise, which is occurring locally at a rate of about 2.2 mm per year (Hartig *et al.,* 2002). In addition, climate change models project a higher frequency and intensity of storm events as a result of global warming trends. Rising ocean levels combined with augmented storm surges may lead to an increased risk of salt marsh wetland erosion and the destruction of developed infrastructure around the periphery of the Bay. The armoring of shorelines prevents the natural landward migration of wetlands during sea-level rise, a process that normally allows tidal wetlands tp keep pace with long-term changes in climate and ocean levels. Moreover, hardened shorelines reflect wave energy back into the interior of the estuary, leading to further erosion potential for the vulnerable salt marsh islands.

Bay and lower wave height. With the dredging of the Bay and attendant increase in wave height, some shorelines now experience more erosive wave energy.

Shorelines provide important animal habitat, especially for birds that use the areas for feeding. Four species listed as threatened or endangered by the State of New York use shoreline habitat in Jamaica Bay: piping plover, common tern, least tern, and roseate tern (NYCDEP, 1994). These areas function as critical habitat for horseshoe crabs and diamondback terrapins that use unvegetated open shorelines to lay their eggs. Shorelines are also important for recreational uses such as fishing and bird watching.

Shorelines have been altered by human activities perhaps more than any other portion of the Bay. Consequently, the remaining natural remnants are particularly important. During the first half of the

20th Century, many shoreline wetlands around the periphery of the Bay were drained and filled while creeks were straightened, channelized, and armored. Land uses along shorelines now include landfills, parks, sewage treatment plants, highways, airports and residential subdivisions. Many shorelines have been hardened with bulkheads to protect infrastructure on the landward side. Bulkheading a shoreline prevents the natural landward migration of salt marshes, and removes essential habitat for many wildlife communities.

The shoreline area soils are most commonly characterized by the soil types as described in the New York City Reconnaissance Soil Survey in Table 4.5.1 (USDA, 2005b).

4.6 UPLANDS

Uplands are characterized as those land areas that are rarely or never inundated by standing water. Broadly defined, uplands include all environs with the exception of aquatic, wetland and subterranean communities. As a result of the dry, productive soils, upland landscapes tend to be the most desirable places for human habitation and agriculture. Since the early days of Euro-American settlement and continuing through the 20th Century, the large majority of uplands in the Jamaica Bay watershed were cleared of native vegetation and converted to land uses such as pasture, agriculture, landfills, and ultimately the built urban environment. As a part of the urban core of New York City, all upland areas in the Jamaica Bay watershed have been at least nominally impacted by human disturbance, although there are a few locations where traces of the native upland landscape still exists. These undeveloped areas harbor assemblages of grasses, low herbaceous vegetation, shrubs and trees.

The vegetation growing on uplands is essentially a "living filter" for both surface and subsurface water leaving upslope areas. Soil, sediment, and water borne pollutants are trapped, modified or used by vegetation for growth, reducing their effects on adjacent waterbodies and their aquatic systems. The root structures of upland vegetation break up compacted soil allowing for greater retention and infiltration of surface runoff. Upland areas are essential for a large number of terrestrial plant and animal communities, which

"Grass grows by inches but it's killed by feet."

– George Thoma

Floyd Bennett Grasslands; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Historic Grasslands on Long Island

Before the Dutch settled the New York City region, the upland areas of the Jamaica Bay watershed were part of a larger grassland complex that included vast areas of Long Island. Historically, this region was thought to contain some of the largest contiguous grassland habitats east of the Mississippi River (Drennan, 1981).

utilize the complex array of grassland, shrub, woodland, and dune habitats. There are only a few such areas in the watershed which retain valuable terrestrial habitat function for resident and migratory wildlife. Most of these areas are currently protected and under public ownership: the Jamaica Bay Wildlife Refuge, a unit of GNRA, which encompasses the interior of the estuary, including upland areas on Canarsie Pol, Ruffle Bar, and Rulers Bar Hassock; Floyd Bennett Field, under the jurisdiction of GNRA; NYCDEP managed landfills on the perimeter of the estuary; NYCDPR open space areas; and selected areas within JFK Airport.


Grasslands; Source: NYCDEP

Floyd Bennett Field is a former airfield that includes upland and shoreline habitat created by the historic filling of salt marsh in Jamaica Bay. Decommissioned in 1950, the land became a home for grassland and open-country birds until recent decades when shrub and forest species began to colonize the site. Significantly, about 57 hectares (140 acres) of this area has been restored to grassland and maintained through clearing, mowing and burning to support several bird species particular to this habitat type. Additionally, 54 species of butterflies and skippers have been recorded at the Wildlife Refuge and surrounding uplands (USFWS, 1997).

A coastal uplands beach and dune system exists on the bayside interior of the Rockaway Point / Breezy Point tip of the Rockaway Beach peninsula. This area supports high concentrations of nesting birds including small numbers of breeding pairs of the federally listed threatened piping plover (USFWS, 1997). Breezy Point also supports the state-listed rare Schweinitz's flatsedge on the Bay side of Rockaway Spit. Some islands in the Bay support upland communities that include open field, shrub thicket, emerging woodlands, and beach grass dunes (NYSDOS, 1992).

Areas away from the immediate shoreline (*i.e.* greater than 1/4 mile) of the Bay are generally characterized as "urban" soils or those areas where the soil has been covered by pavement and/or buildings. In the New York City area of the watershed, the soil classifications are differentiated mainly by the degree of slope and the underlying soil materials (USDA, 2005b). Soils within the watershed are generally described as follows in Table 4.6.1.

TABLE 4.6.1 Urban Soils Within New York City Portion

SOIL TYPE	SOIL DESCRIPTION
Pavement & buildings, postglacial substratum, 0-5 percent slopes (1)	Nearly level to gently sloping, highly urbanized areas with more than 80 percent of the surface covered by impervious pavement and buildings, over dunes and dune sand, generally located in urban centers.
Pavement & buildings, wet substratum, 0-5 percent slopes (4)	Nearly level to gently sloping, highly urbanized areas with more than 80 percent of the surface covered by impervious pavement and buildings, over filled swamp, tidal marsh, or water, generally located in urban centers.
Freshkills, geotextile liner substratum-Klienkill sandy loams, 3-25 percent slopes (123)	Gently sloping to moderately steep areas where household landfill material is capped with either a geotextile or a clay liner.
Pavement & buildings-Hooksan-Verrazano complex, 0-8 percent slopes (208)	Nearly level to gently sloping urbanized areas of sandy sediments that have been substantially cut and filled mostly for residential use; a mixture of sandy soils and loamy-capped anthropogenic soils, with 50 to 80 percent of the surface covered by impervious pavement and buildings; located along the southern shorelines of Brooklyn and Queens.

4.7 URBAN ECOLOGY

The tidal waters, shoreline, and immediate upland buffers of Jamaica Bay have been the focus of numerous ecological studies, as well as management and policy recommendations. Indeed, these areas harbor the majority of the remaining fish and wildlife habitat and communities that still exist in the watershed. Often overlooked is the Bay's human built environment, the urban zone known as New York City and Nassau County.


Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Urban ecosystems often amplify common, long held concepts in ecology, such as disturbance, species invasions and extinctions, and habitat fragmentation. The air, water, and soils of urban environments are highly modified, impacted physically and chemically by human activity. The impacts these alterations have on plant and animal species composition become greater with increasing urban area and proximity to the city center (Sukopp, 1998).

The city's urban environment is in fact a "new" ecosystem (Kangas, 2004). The notion of an urban ecosystem implies that humans are a part of the system and not separate from it as it has been traditionally thought. The human controls on the urban ecosystem strongly influence the structure and dynamics of plant and animal communities, often in different ways when compared to natural ecosystems (Rebele, 1994). Cities have different climate characteristics than surrounding natural areas with the urban heat island affecting plant growth seasons and survivability while wind patterns are also influenced by surface structures. The covering of soils with concrete and asphalt decreases ground water infiltration while increasing soil compaction. This is ecologically significant as polluted water and sediments are then shunted away through storm sewers to natural waterbodies without the cleansing benefit of filtration through the vegetation and soil substrate.

In an urban environment, living plants do not form the dominant food base, with human and animal consumers in highly urbanized areas requiring food energy imports on a scale many times greater than those supplied by natural systems (Odum, 1983). Energy cycling is not complete within the urban environment (Sukopp, 1998), as natural decomposer connections with waste streams are limited by landfills and cut off by incinerators.

While the majority of wetland and upland areas of the Jamaica Bay watershed have been highly developed into the human built environment, concrete and asphalt occasionally give way to sparsely vegetated developed areas such as small city parks, tree-lined streets, backyards and abandoned lots. Interestingly, graveyards and landfills provide some of the largest "open" spaces in the watershed. While the built environment provides marginally valuable and fragmented habitat, these areas are colonized by opportunistic species of vegetation and utilized by some species of wildlife adapted to contact with the built human environment. Most of these areas, if not

Forests in New York City?

Although highly populated, New York City's five boroughs still collectively host almost 5,000 acres of forested areas (Luttenberg *et al.*, 1993), which accounts for about 2.6% of the total area of New York City. A study examining 100 years of woody plants in the New York metropolitan region found that non-native invasive species are spreading rapidly while native species are in slight decline (Clements and Moore, 2005), a common trend in many urban areas.

abandoned, are highly managed with intentionally introduced native and non-native vegetation. Unintended invasive species such as the ubiquitous tree of heaven are often found in urban environments as well.

TABLE 4.7.1 Common Urban Wildlife and Vegetation Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME	TYPE
Norway maple	*Acer platanoides*	Exotic
Tree of heaven	*Ailanthus altissima*	Exotic
Ginkgo	*Ginkgo bilboba*	Exotic
Black cherry	*Prunus serotina*	Native
Grey squirrel	*Sciurus carolinensis*	Native
Black rat	*Rattus rattus*	Exotic
Norway rat	*Rattus norvegicus*	Exotic
Raccoon	*Procyon lotor*	Native
Opossum	*Didelphis virginiana*	Native
Feral cat	*Felis silvestris*	Domesticated
Feral dog	*Canis familiaris*	Domesticated
Rock pigeon	*Columba liva*	Domesticated
European starling	*Sturnus vulgaris*	Exotic
Common grackle	*Quiscalus quiscula*	Native
Herring gull	*Larus argentatus*	Native
Ring-billed gull	*Larus delawarens*	Native

4.8 VEGETATION

The distinctive vegetation found in the Jamaica Bay estuary and the greater watershed is one of the defining features of the landscape. Plant species are distributed throughout the watershed according to their physiological preferences for environmental factors such as salinity, soil moisture, sunlight, temperature, and nutrients. Ecologists have long noticed that certain plant species tend to grow together, presumably because they share physiologic adaptations to similar environmental conditions. We refer to these broadly defined assemblages of plant species as plant communities.

While extensive vegetation studies have been conducted in the GNRA and adjacent upland buffers, Jamaica Bay is lacking a comprehensive survey of the composition, location, and condition of plant communities in the urbanized areas of watershed. However, Luttenberg *et al*. (1993) list the native plant species that can be expected for New York City and vicinity. The following information relies heavily on the community descriptions in Lutterberg *et al.* (1993) and is augmented by data from studies on specific plant communities in the watershed. Also, as part of its New York Metropolitan Flora Project, the Brooklyn Botanic Garden has prepared a

"Metropolitan Plants Encyclopedia." It "…consists of a series of comprehensive pages on the plants of the New York metropolitan region. For each family, genus, and species in the area there are one or more pages with photos, distribution maps, descriptions, ecological information, references…" and additional information that is being gathered and added periodically (Brooklyn Botanical Garden, 2007).

Sea Lettuce

Sea lettuce, (*Ulva latuca*), is a unique form of vegetation that is actually a macro-algae. It forms dense layers in the shallows of Jamaica Bay and is sometimes seen on mudflats at low tide or washed up on shore from storms. Source: Biohabitats

Sea Beach Amaranth; Source: Newsday, Inc., 2006

Sea Beach Amaranth

Sea Beach Amaranth is a rare plant that grows in beach-dune areas. For years it was thought to be extirpated from New York State, until it was found again in 1990. It is found along sandy beaches of the Atlantic coast, where it grows on the shifting sands between dunes and the high tide mark. Construction of beach stabilization structures that stop the natural movement of sand has degraded much sea beach amaranth habitat.

Herbaceous communities

Wetland herbaceous communities include low salt marsh, high salt marsh, deep freshwater emergent marsh, and shallow freshwater emergent marsh. Salt marsh occurs in sheltered tidal areas. Smooth cordgrass or saltmarsh cordgrass (*Spartina alterniflora*) is the characteristic plant species of the low salt marsh. Few other plant species are adapted to grow in the low marsh because of the harsh environmental conditions associated with fluctuating salinity and alternating wetting and drying.

Salt meadow cordgrass (*Spartina patens*) is the most abundant plant in the high salt marsh, which occurs above the mean high tide to the upper limit of the spring high tide. Other common plant species of the high marsh include black grass (*Juncus gerardii*), salt grass (*Distichlis spicata*), marsh elder (*Iva frutescens*), and glasswort (*Salicornia* spp.). The high marsh is also laced with wildflowers such as salt marsh aster (*Aster tenuifolius*), sea lavender (*Limonium carolinianum*), and seaside goldenrod (*Solidago sempervirens*) (Mack, 1990).

Freshwater marshes are dominated by emergent herbaceous vegetation, plants that are rooted under water and whose leaves extend into the air. Deep emergent marshes, with standing water to a maximum depth of about 2 feet, hosts pickerelweed (*Pontederia cordata*), cattails (*Typha latifolia* and *T. angustifolia*), bulrush (*Scirpus* spp.), arrow arum (*Peltandra virginica*), and other emergent wetland plant species. Shallow emergent marshes typically have standing water to a maximum depth of about one foot and harbor sedges (*Carex* spp.), rushes (*Juncus* spp.), water plantain (*Alisma* spp.), and common threesquare (*Scripus pungens*), among others.

Upland herbaceous communities include maritime beach/dunes, maritime grassland, and oak opening. Oak openings probably no longer occur in the Jamaica Bay area. The maritime beach/dune community is dominated by salt-tolerant grasses and low shrubs occurring on beaches and dunes at Breezy Point/Fort Tilden, Plumb Beach, Bayswater Park, and Arverne (EIS, 2001). The main plant species found in this community are beachgrass (*Ammophilia breviligulata*), northern bayberry (*Myrica pensylvanica*), seaside goldenrod, sea rockets (*Cakile* spp.), and salt spray rose (*Rosa rugosa*).

Goldenrod; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Several endangered, threatened, rare or plant species of concern occur in the beach/ dunes community. They include sea beach amaranth (*Amaranthus pumilus*), seabeach knotweed (*Polygonum glaucum*), sea blite (*Suaeda maritima*), Houghton's umbrella-sedge (*Cyperus squarrosus*), blunt spikerush (*Eleocharis obtusa*), Schweintitz's flatsedge (*Cyperus schweinitzii*), and retrose flatsedge (*Cyperus retrorsus*). The piping plover, common tern, and least tern are rare bird species that nest in this community.

The Jamaica Bay watershed harbors maritime grassland at JFK Airport, Floyd Bennett Field and on the Bay islands in the center of the Bay where upland areas exist. These grasslands often harbor high floristic diversity (Luttenberg *et al.* 1993). Common plant species include beachgrass, broomsedge (*Andropogon virginicus*), switchgrass (*Panicum virgatum*), little bluestem (*Schizachyrium scoparium*), and seaside goldenrod, plus northern bayberry and shining sumac (*Rhus copallinum*) (Nancy, 2001). A study conducted in the mid-1980s indicated that expansion of northern bayberry has caused the decline of maritime grasslands around Jamaica Bay (Rogers *et al.*, 1985).

Shrub communities

Shrub communities include wetland (shrub swamp) and upland (maritime shrubland and successional shrubland) assemblages. The shrub swamp community occurs in areas of seasonal standing water. The common plant species include buttonbush (*Cephalanthus occidentalis*), elderberry (*Sambucus canadensis*), and alder (*Alnus serrulata*). These shrubs provide nesting cover for birds like the yellow warbler and the swamp sparrow.

Maritime shrubland is similar to maritime grassland, but has higher shrub species diversity plus several tree species, such as red cedar (*Juniperus virginiana*) and pitch pine (*Pinus rigida*). The successional shrubland community is a product of human alteration, occurring on sites that have been cleared or otherwise highly disturbed. A variety of trees, shrubs, and herbaceous species invade such disturbed sites. Common trees include grey birch (*Betula populifolia*), hackberry (*Celtis occidentalis*), and black cherry (*Prunus serotina*). Common shrubs include autumn olive (*Elaeagnus umbellata*). Despite their history of disturbance, successional shrublands provide important nesting habitat for numerous songbird species.

Sea Lavender; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Tree communities

New York City harbors five distinct tree communities: floodplain forest and red maple-hardwood swamp communities in wetland areas and Appalachian oak-hickory forest, rich mesopyhtic forest and successional mixed hardwoods in upland areas. Although the vast majority of forest has been cut and built upon long ago, almost 5,000 acres of forest still exists throughout the City's five boroughs today (Luttenberg *et al*. 1993).

Floodplain forest, red maple-hardwood swamp, Appalachian oak-hickory forest and rich mesophytic forest were all representative forest types historically found in the New York City metropolitan area. However, these forest communities probably exist today only in small remnant patches, if at all, while the successional mixed hardwoods community is most likely to be represented. The successional mixed hardwoods community is found on disturbed sites, including most areas of Jamaica Bay that contain forested patches, such as Floyd Bennett Field.

4.9 WILDLIFE

The Jamaica Bay watershed is distinctly divided into densely urbanized areas that are highly disturbed, and functional natural areas that are relatively undisturbed by humans. The upper watershed is home to wildlife typical to dense urban environments, including domesticated animals, rodents and birds that thrive in a human-dominated ecosystem, as well as a host of insects that co-exist in the human landscape. Despite the developed watershed, the Jamaica Bay estuary is rich in fish and wildlife communities, hosting a large diversity and population of resident and migratory species.

Jamaica Bay exhibits very high levels of primary productivity, typical of estuarine systems. The pulsed tidal mixing of marine and fresh waters and the diversity of habitat types ensure that there is an abundance of basic food sources and living conditions available for important fish, bird and other wildlife populations. The significance of the estuary as a valuable habitat area is reflected by the protected status it receives. The NYSDOS has designated the Bay as a Significant Coastal Fish and Wildlife Habitat. The NPS created the Jamaica Bay Wildlife Refuge and the Bay area as a whole is recognized by the U.S. Fish and Wildlife Service (USFWS) as a regionally valuable habitat for migrating birds along the Atlantic Flyway.

Marine, estuarine, migratory, and anadromous fish species all utilize the Bay, areas of which have been recognized by NOAA's National Marine Fisheries Service (NMFS) as being Essential Fish Habitat for numerous species. The estuary is also recognized as essential habitat for communities of mammals, reptiles, amphibians and invertebrates, that use the Bay environment for shelter, a food-source, breeding ground, and nursery resource.

These distinct wildlife communities are further described in the following sections.

Benthic Macroinvertebrates as Biological Indicators

Benthic macroinvertebrates are often used as biological indicators of site specific ecological health and water quality impairment. In estuaries like Jamaica Bay, the amphipods have proven to be particularly sensitive to pollutants while some polychaete worms are considered the most tolerant organisms to environmental degradation. The variability of the total numbers of macroinvertebrate and the number of species found at different sites in the Bay can be measured and used as indicators of excessive organic loading from sewage and sediment contamination by toxic heavy metals and hydrocarbons.

Macroinvertebrates

Invertebrate organisms that are large enough to be retained on a 0.5 millimeter (mm) screen are termed macroinvertebrates. The Bay bottom and the emergent substrate of the Jamaica Bay estuary provides habitat for a large and diverse benthic macroinvertebrate community. In Jamaica Bay, as in other aquatic systems, this group of organisms are understood to mean those species living in (infauna), on or near the bottom (epibenthic) of aquatic environments for some part or all of their life history. While terrestrial macroinvertebrates such as butterflies are also ecologically significant, the focus of this section will be on aquatic macroinvertebrates, reflecting the focus of research efforts in this area.

Horseshoe Crab; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Mudsnails; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

The relative abundance of most aquatic macroinvertebrate species is related to bottom sediment composition. Generally, stable coarse substrates such as rock jetties and submerged shell reefs support diverse assemblages which include many filter feeders. Stable soft bottoms (muddy sands) also have a relatively high diversity of macroinvertebrate species, with a mixture of mobile and stationary forms of deposit and filter feeding organisms. Conversely, muddy substrates are rich in deposit feeders and generally poor in filter feeders, with an overall lower diversity than muddy sands.

The eastern and northern portions of Jamaica Bay are typically characterized by muddy to finer grained sandy substrates while the western and southern sections of the Bay have fine to medium sandy bottom types (USFWS, 1997). A comprehensive survey of the subtidal macrobenthos of Jamaica Bay completed in 1983 found a total of 121 species (Franz and Harris, 1985). The high diversity of species in the Bay was considered to be reflective of the wide range of sediment types.

Many of the benthic macroinvertebrates in Jamaica Bay (table 4.9.1) often go unnoticed as they are generally small, opportunistically feeding infaunal species living inside the bottom substrates of tidal environments. Included among these are the polychaete worms, which are the dominant taxon in terms of numbers of species, and the amphipods (Franz and Harris, 1985). These invertebrates usually have multiple reproductions per year which gives them a capacity for rapid colonization of suitable habitat making them important components in the diets of fish and shorebirds.

Rock piles, piers and jetties in the inlet support a fairly diverse community of marine epibenthic colonial invertebrates such as sponges, bryzoans, hydroids, anemones, tunicates, and others. Meiofauna are very small invertebrates that inhabit algae, rock fissures, and the surface layers of the muddy bay bottom. While this class of organisms is important ecologically, they have not been studied in Jamaica Bay.

Franz and Harris (1985) found that subtidal benthic macroinvertebrate assemblages were stable in terms of species composition and that the diversity and abundance of macrobenthos in the

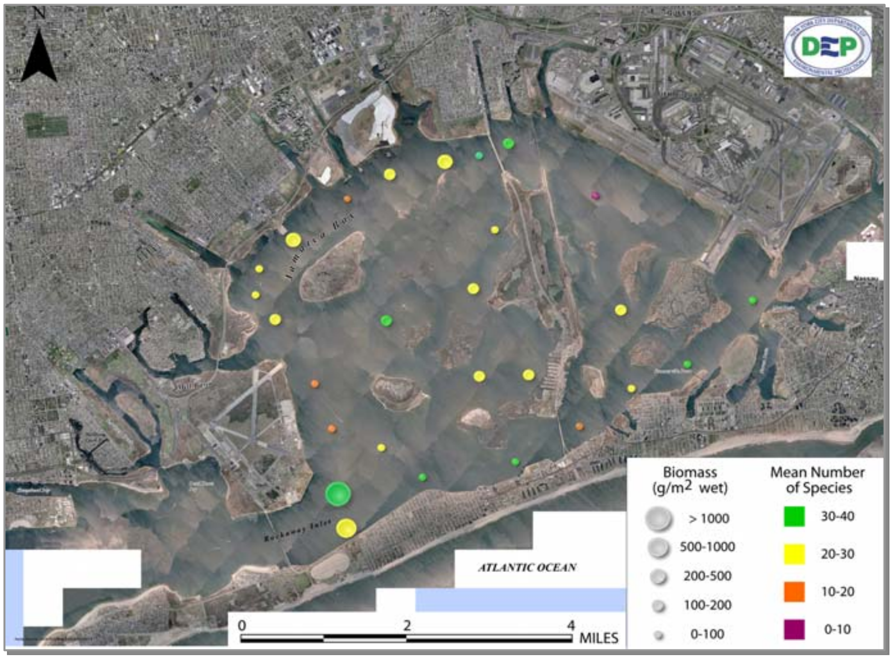


FIGURE 4.9.1 Macroinvertebrate Biomass and Species Abundance at Different Sampling Locations in Jamaica Bay; Source: Franz and Harris, 1995

Bay were comparable to other relatively healthy estuaries. A 1995 survey of Jamaica Bay intertidal benthic habitats by Iocco *et al.* (2000) found the dominant species collected were similar to those of Franz and Harris (1985). This is important because a stable and relatively diverse benthic community provides a range of pathways for energy in the form of nutrients to move up the food chain to a greater diversity of shellfish, fish and birds.

TABLE 4.9.1 Common Macroinvertebrates Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME
Polychaete worm	eg. – *Streblospio benedicti*
Amphipod	eg. – *Ampelisca abdita*
Mud crab	*Neopanope texana*
Mud snail	*Ilyanassa oboleta*
Slipper limpet	*Crepidula fornicata*
Sand shrimp	*Crangon septemspinosa*
Gem clam	*Gemma gemma*

A map of macroinvertebrate biomass (living weight) and the number of species found at each Franz and Harris (1985) sampling station is found in Figure 4.9.1.

Shellfish

The Jamaica Bay estuary supports several species of shellfish including clams, mussels, oysters, and crabs (Table 4.9.2). Many shellfish are filter-feeding bivalves and, while processing water to obtain food, they also ingest and accumulate pollutants released from human sources, effectively cleaning the water. However, shellfish such as oysters and clams in the Jamaica Bay estuary have long become too contaminated for human consumption. This is due to both contamination by pathogens and bioconcentration of environmental contaminants by the filter feeding shellfish.

Jamaica Bay once supported an important shellfish industry at the beginning of the 20th Century. The American, or eastern, oyster (*Crassostrea virginica*) once dominated the local fishing economy, although today it is found in greatly reduced numbers and concentrations as a result of extensive dredging and filling of bottom habitat (Franz and Harris, 1985). In 1921 the shellfishery was closed by the City's Health Department due to pollution from untreated sewage (Seitz and Miller, 2003). While the fishery remains closed to this day, the USFWS (1997) reported several dominant shellfish species are still found in the Bay. Ironically, the closure of the fishery has enabled some shellfish populations to maintain their presence in the Bay, despite decades of habitat destruction from dredging and frequent reports of illegal harvesting.

The Atlantic ribbed mussel (*Geukensia demissa*) may be found in extremely high densities and is common on Jamaica Bay mudflats and salt marshes (USACE, 2005). These mussels are thought to aid in the process of wetland creation and stabilization; the increases in micro-elevation caused by their tightly clustered growths may help in the retention of sediment, water, and organic material, allowing colonizing plants to take root (Rice and Gibbs, 1995). Conversely, D. R. Franz, a researcher at Brooklyn College, investigated the idea that small berms created by ribbed mussels causes localized ponding that leads to the death of saltmarsh cordgrass and consequently salt marsh loss (Franz, 1982). Despite these conflicting theories, it is understood that the species is a major faunal biomass component in the Bay, potentially filtering large volumes of water daily (USFWS, 1997). The blue mussel (*Mytilus edulis*) almost exclusively found attached to piers, jetties and other structures, comprises a smaller proportion of the mussel population (USFWS, 1997).


Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Jamaica Bay is host to an abundance of horseshoe crabs. These crabs spend their lives in subtidal waters but require low-energy intertidal beaches with enough dissolved oxygen to lay their eggs (USACE, 2002). Expansive mudflats and remaining non-hardened shoreline areas function as important breeding areas for the crab, in turn providing vital foraging areas for migrating shorebirds that feed on horseshoe crab eggs in the late spring. It is believed that horseshoe crab spawning in the Bay as a whole is more limited by suitable habitat availability rather than water quality (USACE, 2002). The blue crab is another important shellfish species that utilizes the Bay for significant parts of

TABLE 4.9.2 Common Shellfish Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME
Hard-shelled clam / northern quahog	*Mercenaria mercenaria*
Soft clam	*Mya arenaria*
Blue mussel	*Mytilus edulis*
American / eastern oyster	*Crassostrea virginica*
Blue crab	*Callinectes sapidus*
Horseshoe crab	*Limulus polyphemus*
Atlantic ribbed mussel	*Geukensia demissa*

Jamaica Bay's Oyster Fishery

At the turn of the 20th Century, 266 oyster boats operated from Canarsie, in Brooklyn. At its peak, Jamaica Bay is said to have produced up to 700,000 bushels of oysters per year (Franz, 1982). The Bay developed a reputation for shell fishing, with the Rockaway Oyster being especially popular. In 1906, an estimated four hundred fifty thousand tons of oysters and clams, valued at $2 million, were harvested. By 1917, sewage treatment plants in Queens and Brooklyn were discharging an average of fifty million gallons of inadequately treated waste into the Bay each day, poisoning clams, oysters, and ultimately people. The water became so polluted that in 1921 the City Department of Health abolished shell fishing in Jamaica Bay altogether, destroying both a major industry and a way of life (Seitz and Miller 2003).

its life cycle (Franz and Harris, 1985).

TABLE 4.9.3 Common Fish Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME
Atlantic silverside	*Menidia menidia*
Striped killifish	*Fundulus majalis*
Winter flounder	*Pseudopleuronectes americanus*
Atlantic menhaden	*Brevoortia tyrannus*
Bluefish	*Pomatomus saltatrix*
Striped bass	*Morone saxatilis*
Striped mullet	*Mugil cephalus*

Fish

Highly productive estuaries like Jamaica Bay serve as important nursery areas and feeding grounds for marine, estuarine, migratory, and anadromous fish species (USFWS, 1997). The area supports some of the greatest numbers of fish species in the New York estuary system (Table 4.9.3), with up to 82% of individual species coming from the Atlantic to utilize the estuary for feeding, breeding and nursery habitat (Woodhead, 1991). During their initial life stages, juvenile fishes utilize salt marsh fringes and nearshore areas of higher turbidity as cover from predators and as productive feeding habitat.

Studies conducted to identify the dominant fish in Jamaica Bay found approximately 100 species with juveniles representing the dominant age group (USACE, 2005), confirming the Bay's importance as a nursery for fish. The juvenile Atlantic silverside (*Menidia menidia*) was found to be the most prevalent species caught while seining shallow water areas (USACE, 2002). Killifish (*Fundulus* sp.) species were the second most prevalent nearshore and fringe marsh fish species found in Jamaica Bay. These small, omnivorous, foraging fish species are important food sources for young predatory fish and wading birds.

Other fish species that have been found to utilize the shallow nearshore and salt marsh areas as nursery habitat include alewife herring (*Alosa pseudoharengus*), striped mullet (*Mugil curema*), and winter flounder (*Pleuronectes americanus*). Also regularly found are the Atlantic menhaden (*Brevoortia tyrannus*), bluefish (*Pomatomus saltatrix*), and striped bass (*Morone saxatilis*) (USACE, 2002). These three species of fish are of significant ecological and economic importance. Menhaden form a critical feeding link between plankton and two top predators in the Bay, striped bass and bluefish. Open-water trawls conducted in the Bay found that the winter flounder and summer flounder (*Paralichthys dentatus*) were the first and second most abundant species collected, respectively (USACE, 2002).

Birds

The Jamaica Bay watershed's varied geography provides diverse habitat for a large and varied number of bird species (Table 4.9.4). In addition to providing habitat for numerous permanent residents, the estuary is critical feeding and resting grounds for many migrating species along the Atlantic Flyway during the spring and especially in the fall (USACE, 2005). The Bay is providentially located at the crossroads of two

Clapper Rail; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

migratory pathways for waterfowl. These Jamaica Bay-specific species may be classified into ten major groups: diving ducks, dabbling ducks, Brant geese, non-Brant geese, ibis, herons and egrets, gulls, terns, skimmers, and shorebirds (Burger, 1982). Raptors and land birds are also significant in the upland watershed.

Migratory shorebirds that utilize Jamaica Bay estuary for breeding habitat include: killdeer (*Charadrius vociferous*), American oystercatcher (*Haematopus palliates*), willet (*Catoptrophorus semipalmatus*), spotted sandpiper (*Actitus macularia*), and American woodcock (*Scolopax minor*). Other birds known to nest on Bay islands are the common tern (*Sterna hirundo*), laughing gull (*Larus atricilla*), osprey (*Pandion haliaetus*), and clapper rail (*Rallus longirostris*) (USFWS, 1997). Additionally, Veit *et al.* (2002) identified six species including the clapper rail, willet, Forster's tern (*Sterna forsteri*), salt marsh sharp-tailed sparrow (*Ammodramus caudacutus*), seaside sparrow (*Ammodramus maritimus*), and boat-tailed grackle (*Quiscalus major*) that are salt marsh-dependent for their entire breeding season.

Intertidal habitats such as mudflats, salt marsh, and sandy shorelines are important feeding areas for the 22 species of shorebirds currently found in the Jamaica Bay estuary (Viet *et al.*, 2002). Shallow water areas also provide fishing habitat for wading birds including nine species of herons (USACE, 2002). Historically, 44 species of shorebirds had been identified in the Bay area. The dramatic reduction in the numbers of species of shorebirds is likely related to the destruction of their habitats in the Bay and throughout their migratory ranges.

Migratory waterfowl species such as the black duck (*Anas rubripes*), snow goose (*Chen caerulescens*) and Atlantic brant (*Branta bernicla*)

TABLE 4.9.4 Common Birds Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME
Killdeer	*Charadrius vociferus*
Greater yellowlegs	*Tringa melanoleuca*
American brant	*Branta bernicla*
Herring gull	*Larus argentatus*
Great blue heron	*Ardea herodias*
Barn swallow	*Hirundo rustica*
Common tern	*Sterna hirundo*
Common barn owl	*Tyto alba*

TABLE 4.9.5 Birds at Risk in Jamaica Bay

LISTED	COMMON NAME	SCIENTIFIC NAME
Federally Endangered	Roseate tern Peregrine falcon	*Sterna dougallii* *Falco peregrinus*
Federally Threatened	Piping plover	*Charadrius melodus*
NYS Endangered	Least tern	*Sterna antillarum*
NYS Threatened	Northern harrier Osprey Common tern	*Circus cyaneus* *Pandion haliaetus* *Sterna hirundo*
NYS Species of Concern	Least bittern Cooper's hawk Upland sandpipier Short-eared owl Common barn owl Grasshopper sparrow	*Ixobrychus exilis* *Accipiter cooperii* *Bartramia longicauda* *Asio flammeus* *Tyto alba* *Ammodramus savannarum*

Jamaica Bay's Importance as Bird Habitat

An avian abundance study found 326 species of birds that use the Jamaica Bay Wildlife Refuge including confirmed breeding by 62 species (Mack and Feller, 1995; USFWS, 1997). The USFWS estimates that nearly 20% of North America's bird species migrate through or breed in the Jamaica Bay area (USACE, 2004).

use the open water areas of Jamaica Bay in the winter to congregate and feed during migration periods. Other, year-round "resident" species of waterfowl are the Canada goose (*Branta canadensis*) and mallard (*Anas platyrhynchos*) (USACE, 2005).

The Jamaica Bay estuary provides feeding and nesting habitat for the federally-listed endangered roseate tern (*Sterna dougallii dougallii*), and federally-listed threatened piping plover (*Charadrius melodus*), common tern, pied-billed grebe (*Podylimbus podiceps*), peregrine falcon (*Falco peregrinus*), and northern harrier (*Circus cyaneus*) (USACE, 2005; Mack and Feller, 1995) (Table 4.9.5). The salt marsh islands of the Bay are used by numerous heron and colonial waterbird species as a rookery.

Great Egret; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Impairments to migratory and resident bird populations in Jamaica Bay include habitat destruction and degradation through water pollution, noise, boat traffic, contaminated food sources and oil spills. Predation by introduced and nuisance species such as rats, feral cats, raccoons and gulls create problems for breeding bird populations. In earlier times, hunting, which is no longer allowed in the Bay, impacted some migratory bird species locally (Brody, 1998; West-Valle *et al.,* 1992). The loss of wetland habitat has significantly impacted some bird populations that require these areas for nesting and feeding.

Upland grasslands and scrub/shrub areas are also important bird nesting, cover and feeding habitat for a variety of neotropical migrant land-birds, raptors and a species of shorebird, the upland sandpiper (*Bartramia longicauda*). Habitat for these birds has been significantly diminished and degraded over time. The most numerous neotropical migrant is the barn swallow (*Hirundo rustica*), making up almost 50% of all birds in this group at some locations. Also often sighted are the willow flycatcher (*Empidonax traillii*) and yellow warbler (*Dendroica petechia*), both common breeders in the Jamaica Bay area.

The rise in gull populations such as the herring gull (*Larus argentatus*), was likely due to nearby landfills providing a nearly unlimited food source. These birds can adversely affect the diversity and abundance of colonial waterfowl and shorebirds as they are known to raid nests and generally harass other birds (West-Valle *et al.,* 1992). Gull populations have been declining, due to recent landfill closings; however, they still comprise a significant portion of the bird population that causes major disruptions at JFK Airport (USNPS, 1999). The JFK complex is located next to the Bay, causing conflict between goals of human safety and wildlife protection. Aircraft–bird collisions have led to the active management of gulls through habitat disruptions and shootings (USNPS, 1999). Two upland nesting birds found at JFK Airport and Floyd Bennett Field are the upland sandpiper (*Bartramia longicauda*) and the grasshopper sparrow (*Ammodramus savannarum*), both species of concern (NYSDOS, 1992).

Despite continued stressors on bird populations and their habitat, there has been a noted increase in the numbers of ibises, egrets, herons, cormorants, and ospreys in the past few decades. Biologists attribute these increases to the effectiveness of the 1972 Clean Water Act (Brody, 1998).

Greater Yellowlegs; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Mammals

Although not rare in the greater bioregion, most mammals are rare in the urban core of the Jamaica Bay Watershed. The most typical mammal species observed in surveys (Table 4.9.6) consist of feral dogs and cats, rats and a mole and vole species found along shorelines and in adjacent grasslands (USFWS, 1997; USACE, 2002). Small rodents such as mice and voles are an important food base for the hawks and owls that frequent the Bay area. Raccoons are not uncommon but in large numbers can be considered a nuisance along with the undesired rat population. In addition, the opossum, cottontail rabbit, grey squirrel and several species of bat are also commonly identified in the Jamaica Bay watershed (USFWS, 1997; USACE, 2002).

TABLE 4.9.6 Common Mammals Found at Jamaica Bay

COMMON NAME	SCIENTIFIC NAME
Feral dog	*Canis familiaris*
Feral cat	*Felis silvestris*
Black rat	*Rattus rattus*
Raccoon	*Procyon lotor*
Gray squirrel	*Sciurus carolinensis*
House mouse	*Mus musculus*
Muskrat	*Odantra zibethicus*
Brown bat	*Myotis lucifungus*

Black Squirrel; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Loss of Mammals

Almost 80% of the native mammals that historically inhabited the Jamaica Bay watershed have been extirpated as a result of centuries of human development of the region (USNPS, 2006). Elk, deer, and bear have given way to those animals that have adapted to near the urban environment (Black, 1981). Raccoon populations are now considered a nuisance due to their overabundance, which threatens the survival of native ground nesting bird species (USNPS, 2006).

The muskrat is the only mammal that makes the salt marsh its permanent home and whose presence is indicative of a healthy marsh ecosystem (Mack and Feller, 1990). Four species of bats, including the hoary bat and little brown myotis have also been identified in the Jamaica Bay watershed (USFWS, 1997). Several marine mammals are known to occasionally visit Jamaica Bay including the bottlenose dolphin (*Tursiops truncates*) and harbor seal (*Phoca vitulina*).

Reptiles / Amphibians

Several species of snakes, frogs, toads,

Terrapin; Source: NYCDEP

Sea Turtles in Jamaica Bay

Several species of sea turtle have been observed in Jamaica Bay. These include the federally listed and endangered Kemp's ridley (*Lepidochelys kempii*) and leatherback turtles (*Dermochelys coriacea*). Several species are New York State listed and considered threatened, including the loggerhead (*Caretta caretta*), which is also listed as federally threatened, and green turtles (*Chelonia mydas*) (USACE, 2002).

salamanders and turtles live in the Jamaica Bay estuary and the greater watershed (Table 4.9.7). Extensive alteration of the historic landscape has impacted vital habitat and greatly reduced reptilian/amphibian diversity and abundance. There are plans to re-introduce several species to the Bay's wildlife refuge (USFWS, 1997). Many of the reptiles and amphibians are found in the vicinity of freshwater pools and stormwater outfalls due to physiological dependence on these remaining shallow freshwater areas for all or part of their life histories. The diamondback terrapin is an exception as it is adapted to a wide range of salinities, ranging the marine waters of the Bay and brackish waters of the tidal creeks for foraging and nesting. Their habitat includes both shallow waters and sparsely vegetated and sandy shorelines (USACE, 2002), which the terrapins utilize to lay eggs and sun themselves (Mack and Feller, 1990).

TABLE 4.9.7. Reptiles and Amphibians Found at Jamaica Bay

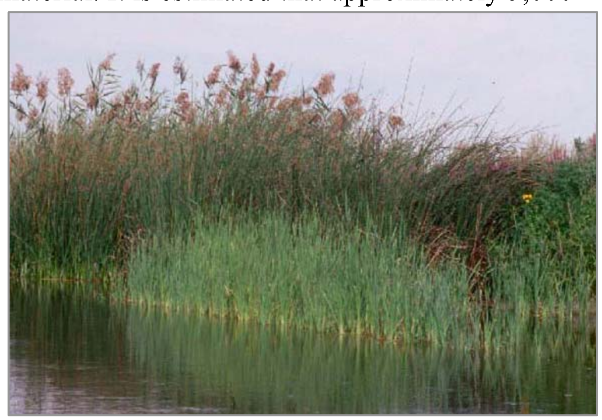
COMMON NAME	SCIENTIFIC NAME
Northern brown snake	*Storeria dekayi*
Northern black racer	*Coluber constrictor*
Snapping turtle	*Chelydra serpentine*
Fowler's toad	*Bufo fowleri*
Green frog	*Rana clamitans*
Redback salamander	*Plethodon cinereus*
Bullfrog	*Rana catesbeiana*

4.10 INVASIVE SPECIES

Many plant and animal species in the Jamaica Bay watershed are living and reproducing outside of their native ranges. These non-native, exotic organisms are generally considered to be invasive species, although some native species may also be considered invasive. Many invasive organisms were deliberately brought to the region for food, fiber, landscaping purposes, or for the pet trade, while others arrived as contaminants in shipments of grain, in ballast water of ships, or as packing material. It is estimated that approximately 5,000 plant species introduced in the United States have escaped into the natural environment (Pimentel *et al*., 2000). A small subset of these species actively and aggressively colonize new areas and pose risks to native ecosystems.

Native vs. Non-Native vs. Invasive

Native species are identified as species that existed in a landscape prior to colonization or agriculture. Non-native and exotic species have been identified as species that have been introduced to an ecosystem by humans, either intentionally or non-intentionally. An invasive species can be identified as having the ability to thrive under adverse conditions. Invasive species can be native or non-native. Their ability to out-compete native organisms for limited sunlight, nutrients and space disrupts the natural balance of an ecosystem. Jamaica Bay is an excellent location for invasive species to find a home due to the high level of disturbance from land alteration and development, and an abundant seed-bank of exotic plants in residential gardens. (Biohabitats, Inc)



Common Reed

Common Reed can form monocultures in wetlands and crowd out native plants.

Along with habitat destruction and fragmentation, invasive species collectively rank as one of the top global threats to biological diversity in natural areas (Randall, 1995). They can affect multiple levels of biological organization (species, communities, ecosystems, and landscapes). These impacts include changes in ecosystem structure and function, species extinctions, species declines, and changes in community composition. The most fundamental effects are alterations of ecosystem structure and function. Problems that arise from invasive species are sometimes permanent (at least in human time scales) and may be the most pervasive influence on biological diversity in many systems (Coblenz, 1990). The Gateway National Wildlife Refuge has a goal to supress or eradicate exotic invasive species in selected areas to ensure pockets of high biodiversity.

The most significant invasive plant species found in the wetter portions of the Jamaica Bay watershed is common reed (*Phragmites australis*). This species produces large quantities of seeds and also spreads vegetatively by sprouting new growth from its fleshy rhizomes. *Phragmites* occurs as a native form although the introduced, non-native form is much more aggressive, readily invading disturbed, wet areas such as degraded wetlands, roadside ditches, and even piles of dredged material. While it is typically found in areas of standing fresh water, it can tolerate moderate salinities (up to 18 ppt) and forms dense monocultural stands, suppressing and overwhelming native vegetation (Byer *et al*. 2004).

Phragmites; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Purple loosestrife (*Lythrum salicaria*) is a very attractive freshwater wetland plant imported from Europe as an ornamental in the late 19th century. It can colonize freshwater marshes and crowd out native plant species, drastically altering wetland composition and structure. This plant has spread throughout the US in freshwater wetland habitats, especially throughout the Northeastern states. It is of no threat to waters with any salinity. Because Jamaica Bay has so few remaining freshwater wetlands areas, it is currently not threatened by purple loosestrife, but it is worth noting that any freshwater restoration efforts in the watershed will have to contend with this plant.

The Jamaica Bay watershed currently has substantial populations of invasive shrubs and trees, including tree of heaven (*Ailanthus altissima*), Oriental bittersweet (*Celastrus orbiculatus*), Japanese knotweed (*Polygonum cuspidatum*), Japanese barberry (*Berberis thunbergii*), and autumn olive (*Eleagnus umbellata*). These species rapidly invade remnant patches of native forest. Garlic mustard (*Alliaria petiolata*) is an herbaceous perennial that rapidly invades shrublands, woodlands, and forests. All of these species tend to crowd out native plant species and compromise wildlife habitat.

The Jamaica Bay watershed harbors a number of invasive, non-native animal species, including Norway rat (*Rattus norvegicus*), black rat (*Rattus rattus*), feral cat (*Felis silvestris*), and feral dog (*Canis familiaris*). Feral and house cats are estimated to kill over one billion birds annually in the U.S. (Stallcup, 1991). The mute swan (*Cyngus olor*) is a European species of waterfowl that is territorially aggressive and threatens nesting native waterfowl (Mockler, 1991).

Two native mammals have successfully exploited their proximity to the human environment and become invasive nuisance species. The opossum (*Didelphis virginiana*) and the raccoon (*Procyon lotor*) have been targeted for further research by the NPS at Jamaica Bay. These animals are considered nuisances in the area due to their large numbers, with raccoons threatening the eggs of reproducing terrapins and birds around Jamaica Bay.

The ribbed mussel (*Geukensia demissa*) is a native invasive invertebrate that can achieve densities up to 10,000 individuals per square meter in Jamaica Bay (Cohen, 2005). Researchers have speculated that berms formed by large numbers of ribbed mussels create ponding within salt marsh islands, leading to salt marsh cordgrass death and the further erosion of salt marsh islands (Franz and Friedman, 2004).

4.11 CURRENT ECOLOGICAL RESTORATION EFFORTS IN JAMAICA BAY

In the last century there has been a growing recognition of water quality, ecosystem, and human use impairments, and an awareness that the rate of degradation is linked with population growth and development in the Jamaica Bay watershed. In response, regulatory agencies in New York City, New York State and the federal government with vested interests in the environmental health of Jamaica Bay have begun to implement programs to curb known and anticipated environmental impacts. Most of this work has been driven by local, state, and federal legislation geared towards environmental preservation and improvement in conjunction with local non-governmental organizations' interest in environmental health and a greater public awareness of and interest in ecological sciences.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

At first, many of these efforts were focused on improving water quality in Jamaica Bay, with the recognition that the impaired shellfisheries were the result of untreated urban sewage and industrial contamination. Later, as the ecological sciences became better understood, a heightened awareness of the importance and value of wetlands and their relevance as vital fish and wildlife habitat spurred an interest in halting landfilling operations and restoring remaining wetland areas. Unfortunately, water quality conditions in the Bay were severely degraded, most of the valuable upland and shoreline habitat areas were already gone, lost to urban infrastructure, and more than 75% of the wetlands had disappeared.

Currently, there are multiple agencies working to improve water quality in the Jamaica Bay estuary and conserve and restore critical habitat areas. Much has been accomplished, including an enormous effort to improve environmental data collection and research and the integration of the

> "*The solution seems to lie in giving local communities control over local resources so that they have the right and responsibility to rebuild nature's economy and, through it, their sustenance.*"
> *- Dr. Vandana Shiva*

resulting information into ongoing mitigation programs. Habitat restoration/conservation efforts include mitigating landfills, restoring wetlands, managing threatened or endangered fish and wildlife, and addressing exotic species.

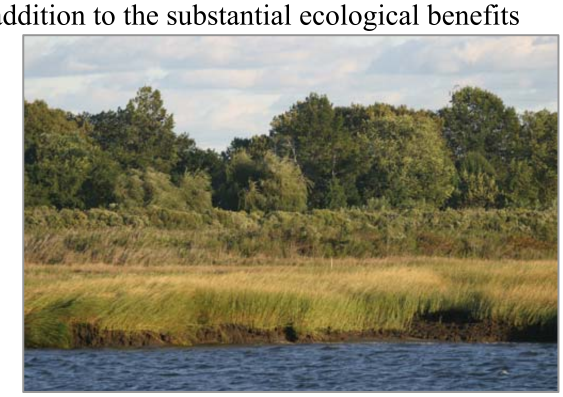
A number of sites have been acquired and are afforded protection as designated New York State Parks or New York City Parks. The New York City parks include Dubos Point, Norton Basin, Brandt's Point, Four Sparrows Marsh, Spring

Vernam/Barbados Peninsula; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Creek, much of Fresh Creek, Conch Point, Paerdegat Basin, the Vernam Barbadoes Peninsula (locally Terrapin Point) and Bayswater State Park. However, some areas have been lost to development, such as the Vandalia Dunes. According to the RPA (2003), "Land preservation in Jamaica Bay, with a few exceptions such as some Arverne/Edgemere watershed sites, is virtually complete…" In addition, a number of significant restoration projects have been implemented by the NYCDEP including the Pennsylvania Avenue and Fountain Avenue Landfills and Idlewild Park projects; by the New York City Department of Park and Recreation (NYCDPR) National Resources Group (NRG) at Dubos Point Wildlife Sanctuary, Four Sparrow Marsh, Fresh Creek, Spring Creek and Marine Park; and the NPS's Big Egg Marsh project. The most substantial project, which has recently been initiated, is the USACE's 60-acre Elder's Point marsh island restoration. Additional information on these restorations is provided below.

Over the course of the past 20 years a large number of other acquisition and restoration sites have been identified throughout Jamaica Bay by a variety of knowledgeable federal, state, city and non-governmental entities. Various reports have considered a range of sites and over time they seem to encompass the same sites that were previously considered. This is not unexpected since there are limited opportunities for identifying new sites within the confines of the Jamaica Bay waterfront. Non-governmental organizations have also played a very important role in identifying land acquisition and restoration sites, most notably the Jamaica Bay Ecowatchers, Tree Branch Network, American Littoral Society and the New York City Audubon Society.

NYCDEP is actively restoring and designing complex environmental restoration projects along the perimeter of Jamaica Bay that will provide substantial wildlife habitat and stormwater quality benefits. Some restorations may not appear to cover large land areas; however, it is important to note that the cumulative incremental improvements and spatial distribution associated with each of these projects adds significantly more ecological value than if they were simply isolated restorations with little geographic connectivity. In addition to the substantial ecological benefits



Bayswater State Park; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

provided, some projects are associated with infrastructure improvement projects that are designed to further remediate the harmful effects of past landfilling activities, provide for the capture and treatment of CSOs and provide effective stormwater management to alleviate street flooding within several communities in the southeast section of the watershed. Each of these restorations were developed using appropriate specifications and designs that incorporate the latest ecological information for the targeted ecosystems. In addition, the species for these projects were selected based on their ecological plant community associations and environmental setting (coastal) to provide much greater ecological value, sustainability and biodiversity than simply placing individual and "out of context" specimens. The plant species were also selected to help re-establish extirpated or less common indigenous coastal flora that have been absent from much of the NYC region since the early 20th Century. The use of appropriate soils that favor the growth of these coastal communities was a key element in the design that will provide long-term sustainability and significantly reduce the potential for the colonization of exotic plant species. This ecosystem approach provides the greatest habitat potential and function and ensures the long-term stability of the restorations by enabling substantial buffering capacity against invasive plants and changes as a result of natural environmental variations. Each of these restorations significantly contributes to improving the ecology of the Bay by restoring degraded lands into productive wildlife habitats, and increasing both plant biodiversity and the natural attenuation of stormwater through evapotranspiration and ground water infiltration. Because of their size and spatial distribution within the landscape, the positive cumulative feedback effect from each of these restorations is further enhanced.

The following provides a brief summary of each of these NYCDEP restorations.

Idlewild Park

The ecological restoration of Idlewild Park was part of a major sewer infrastructure improvement project to reduce street flooding in the southeast and northeast sections of the watershed. Idlewild is situated within the critically important headwaters of Jamaica Bay. Completed in 1997, this project restored 16-acres of indigenous coastal grasslands and woodlands, 5-acres of tidal wetlands and 2.5-acres of freshwater wetlands. As a result of this restoration, the park now has the highest density of Canadian, shadbush or serviceberry (*Amelanchier canadensis*) of any location within the city. NYCDEP maintains an active presence in restoring additional sections of the park through its association with the Eastern Queens Alliance (EQA) and NYCDPR's Natural Resources Group (NRG).

NYCDEP has participated in student planting projects organized by the EQA and is assisting with the groups Master Plan efforts for the continued environmental restoration of the 110-acre park and for expanded community use of this valuable local natural resource. The NYCDEP continues to issue vegetation management contracts to control invasive plants and to restore additional areas. When feasible, restoration requirements from other projects that are not possible at the site of disturbance are directed to Idlewild Park to help expedite the restoration process.

Paerdegat Basin

The ecological restoration of Paerdegat Basin is associated with the NYCDEP's current efforts to treat and capture CSOs to improve water quality within the basin. The construction of a 20-million gallon CSO storage tank with an additional capacity of 10-million gallons of in-line (pipe) storage will capture sanitary wastewater and stormwater during rain events for subsequent processing and treatment at the Coney Island WPCP after the rain event. The ecological restoration component of this project is currently in the design stage and has an expected construction start date of mid to late 2009. Highlights of this project include the restoration of 15 to 20-acres of tidal wetland, 40 to 50-acres of an indigenous coastal grassland/shrubland and a 6-acre Ecology Park. Additional restoration and enhancement of these acreages is expected should USACE's Jamaica Bay Ecosystem Restoration Project (JBERP) receive funding from Congress. The Ecology Park will be designed to showcase many of the ecosystems present within New York City and will enable a close-up view of these communities. The NYCDEP expects the Ecology

Park to be an important environmental tool in helping area residents to gain an understanding of the many ecosystem types found within New York City and the important role they have in maintaining a delicate ecosystem.

Springfield Gardens

As with the Idlewild project, this restoration is associated with NYCDEP's current efforts to alleviate flooding in southeast Queens. Some of the restoration areas overlap with the Idlewild restoration and provide a more contiguous restoration. The project has already restored 2-acres of tidal wetland and 2-acres of indigenous coastal woodlands. We expect that an additional two acres of tidal wetland and coastal grasslands will be restored by the end of 2007.

Innovative "Bluebelt" designs are currently being developed to improve Springfield Lake and the downstream tidal channel that is connected to Thurston Basin. The re-grading of the lake shoreline, invasive plant removal and the planting of freshwater wetland plants will help to restore much of the lost ecological function of this important community resource. The restoration of the tidal channel will allow greater tidal flushing for improved water quality to the backwaters of Jamaica Bay. The design of this project is consistent with the goals of the Master Plan for Idlewild Park currently being developed by the EQA.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Hendrix Creek Bond Act Restoration

With partial funding from the New York State Clean Water/Clean Air Bond Act, this project will include 0.25-acres of tidal wetland restoration and 0.8-acres of a coastal woodland buffer. This restoration complements the much larger upland restoration of the Pennsylvania Avenue Landfill and will provide a much greater ecological benefit with the vastly improved upland habitats and wildlife corridors of the landfill. Work on this project is expected to begin in fall 2007. The NYCDEP continues to pursue additional funding from a variety of other sources and grant programs for the restoration of additional locations around Jamaica Bay.

Thursby Avenue Wetland Restoration

This project will include 0.4-acres of tidal wetland restoration and 0.4-acres of a coastal woodland buffer along the shoreline of Sommerville Basin. Using the fishing piers constructed at the Edgemere Landfill by the Department of Sanitation New York (DSNY), partial public access to this restoration site is permitted. Work on this project is expected to begin late spring 2007.

Pennsylvania and Fountain Landfills

NYCDEP is responsible for the remediation and closure of two inactive hazardous waste sites, the Pennsylvania Avenue and Fountain Avenue landfills on Jamaica Bay. Although not required as part of the remediation, due to the location of these landfills within a sensitive environmental area, the NYCDEP took a proactive lead stewardship role in developing an innovative and comprehensive ecological restoration plan for these properties that would be consistent with and enhance the existing natural features of Jamaica Bay. In addition, the ecologically sound end-use design plan, with input from local community groups also considered future passive public uses in the post landfill remediation phase.

The landfills represent the largest restoration of this type undertaken in New York City in over 100 years and will provide significant habitat improvements for Jamaica Bay. The planting plan includes over 40 native tree and shrub species and over 30 forb (wildflowers) and graminoid (grasses) species. To ensure that a sufficient number of plants would be available for the planting phase of the project, NYCDEP initiated a contract growing program at several area nurseries three years ago for the approximately 35,000 trees and shrubs that will be needed for the restoration. The contract growing of these plants enabled NYCDEP to use local provenance plant material that is better acclimated to our soil and climate conditions and ensures the dissemination of local genotypes. This plan also enabled the use of plants that are not readily available in the nursery trade. The use of seed grown plants has been maximized to the greatest extent possible to increase the genetic diversity of the planting.

The first planting began at the Pennsylvania Avenue Landfill in spring 2006 and the first plant will arrive at Fountain Avenue Landfill in spring 2007. Because of the large size of the total restoration area and the number of plants, in time the landfills will become a regional seed source to disseminate the new species to other parts of the New York City metropolitan area. The actual restoration limits can extend far beyond the physical restoration.

A land ethic...reflects the existence of an ecological conscience, and this in turn reflects a conviction of individual responsibility for the health of the land. Health is the capacity of the land for self-renewal. Conservati[illegible] to understand and preserve this capacity.

- Aldo Leopold

The following components used for the landfill restorations should be considered when developing future coastal upland restoration projects around the Bay:

- Initiate contract growing of most plant materials
    - Maximize the use of seed grown plants
    - Limit the use of cuttings when seed germination is difficult or slow
- Develop soil sample collection program for analysis from existing plant communities targeted for restoration to closely "mimic" natural soil conditions of proposed plant communities:
    - higher sand content soils
    - low organic matter
    - low nutrients
    - low pH
- Use smaller plant material that will acclimate faster to the site and grow healthier
- Use varying sizes of same species to "mimic" a natural and uneven aged stand
- Use high wildlife value and low maintenance warm-season grasses over conventional low wildlife value and high maintenance cool-season lawn grasses
- Select appropriate plant material for site and existing environmental conditions (aesthetics should be considered least)
- Specify tight seasonal windows for various planting types
- Limit provenance of plant material to within a 150-mile radius of the planting site
- Species specific mycorrhizal fungus soil inoculation to help restore soil biological diversity and activity (this should not be used in intact natural systems)
- Landscape subcontractor minimum qualifications

Restoration projects recently completed by NYCDPR include the restoration of Four Sparrow Marsh. Four Sparrow Marsh restored nearly 3-acres of tidal wetlands, a 0.7-acre woodland buffer, and removed invasive vegetation, anthropogenic soils and shoreline debris. The restoration of Gerritsen Creek is included under JBERP, but has been selected out as a separate project with an individual timeline because this project also has funding from the New York State Clean Water/Clean Air Bond Act. A description of this restoration is outlined below.

Under the JBERP, for which NYCDEP is the local matching grant sponsor, a team of federal, state and local agency ecologists, biologists and other environmental professionals reviewed approximately 50-sites around the Bay for their restoration potential. After a careful review by this professional team, a number of larger restorations sites were identified that afforded the opportunity of restoring and enhancing multiple ecosystem types to maximize ecological biodiversity.

Although not currently authorized for funding by Congress, a brief summary of the proposed restoration efforts from JBERP Conceptual Plan are as follows.

Dead Horse Bay – The restoration of this site will include removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of coastal dune and maritime forest habitats and to discourage the re-introduction of invasive plants, the re-grading of the shoreline to establish correct tidal wetland low marsh elevations for the planting of saltmarsh cordgrass and high marsh planting of salt hay and other high marsh plants.

Gerristen Creek; Photograph by Ralph McClurg, O'Brien & Gere

Gerristen Creek – Removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximately 8-acres of coastal grassland and shrubland habitats and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 8-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 0.5-acre planting of salt hay and other high marsh plants.

Fresh Creek; Photograph by Ralph McClurg, O'Brien & Gere

Paerdegat Basin – The restoration of this site under JBERP will supplement the restoration currently being designed as part of the Paerdegat Basin CSO project and includes the removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximately 2.5-acres of coastal meadow and approximately 46-acres of coastal scrub/shrub habitats and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 26-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 6-acre planting of salt hay and other high marsh plants.

Fresh Creek - Removal of anthropogenic fill-derived soils and invasive plant control, re-contouring of tributary bottom for increased tidal flushing, placement of ecosystem appropriate soils for the restoration of approximately 42-acres of coastal scrub/shrub habitat and restoration of approximately 108-acres of maritime forest habitats and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 36-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 12-acre planting of salt hay and other high marsh plants.

Spring Creek - Removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximately 42-acres of coastal dune and restoration of approximately 120-acres of maritime forest habitats and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 25-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 9-acre planting of salt hay and other high marsh plants.

Elder's Point Marsh; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Hawtree Point - Removal of anthropogenic fill-derived soils and invasive plant control, the placement of ecosystem appropriate soils for the restoration of approximately 2-acres of coastal scrub/shrub habitat and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland high marsh elevations for the approximate 0.06-acre planting of salt hay and other high marsh plants.

Bayswater State Park - Removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximately 1-acre of coastal dune habitat and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximately 3-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 0.5-acre planting of salt hay and other high marsh plants.

Dubos Point - Removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximately 2-acres of maritime forest habitat and to discourage the re-introduction of invasive plants, the regrading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 3.5-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 1.0-acre planting of salt hay and other high marsh plants.

Brant Point - Removal of anthropogenic fill-derived soils and invasive plant control, placement of ecosystem appropriate soils for the restoration of approximate three acres of maritime forest habitat, three acres of coastal meadow habitat and to discourage the re-introduction of invasive plants, the re-grading of the shoreline to establish correct tidal wetland low marsh elevations for the approximate 2-acre planting of saltmarsh cordgrass and appropriate high marsh elevations for the approximate 1.0-acre planting of salt hay and other high marsh plants.

Elders Point Salt Marsh Islands - The Marsh Islands ecosystem is an integral part of Jamaica Bay, which has been targeted for restoration by the USACE, the Port Authority, NPS, NYCDEP, NYSDEC, the Natural Resource Conservation Service (NRCS), and Harbor Estuary Program (HEP). The restoration effort is being led by the USACE and will be monitored by the agencies to ensure that this and future restoration efforts in

Jamaica Bay provide long-term environmental benefits to the estuary.
Elders Point is comprised of two separate islands, Elders Point East and Elders Point West, that total approximately 21 vegetated acres. Originally, one island comprised of approximately 132 acres, the loss of marsh in the center portion bisected the island, resulting in two separate islands connected by mudflat. The restoration plan for Elders East and Elders West includes restoring the existing vegetated areas and the sheltered and exposed mudflats by placing fill material up to an elevation that is suitable for low marsh growth. This includes hand planting more than 700,000 plants on Elders East and replanting more than 200,000 plants on Elders West. On Elders East, saltmarsh cordgrass will be planted throughout the low marsh zone of the site. A mixture of saltmarsh cordgrass, salt hay, and spike grass will be planted in the elevation zones between the low marsh and upland. Fill material will be placed between the existing vegetation in such a manner as to avoid damage to the existing vegetation. A no-planting area covering approximately five acres on the southeast side of Elders West will be established to evaluate project progress. Saltmarsh cordgrass will be planted throughout the remainder of the site.

In 2006, seed for the replanting was collected, processed and stored in facilities operated by the NRCS. The seed was germinated and grown and planting has begun at Elders Point East. To facilitate planting at Elders Point West, additional seed is currently being collected, processed and stored for planting next spring. The NRCS is overseeing the growing at their Plant Materials Centers in Cape May, NJ, Beltsville, MD, Lansing, MI and Alderson, WV. In March 2006, the Corps awarded a $13 million contract for the Elders Point (East) Island Restoration in Jamaica Bay, to Galvin Brothers of Great Neck, NY. To re-contour Elders Island, the Corps is pumping more than 300,000 cubic yards of sand that was dredged from various channels in the harbor. Once tidal flow to the areas has been reestablished, water and sediment quality will be improved, promoting the return of native fish and wildlife.

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Tiger Swallowtail Butterfly; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Chapter 5 - Public Access, Open Space, and Recreation

The development of areas along the shoreline makes it difficult to access large areas of the Bay. Highways encircle the Bay. JFK Airport consumes a large area of the waterfront. Landfills, which also restrict access to the shoreline, are being restored and will provide passive open space in the years to come.

However, there are many areas where the beauty and natural features of the Bay can be experienced. Access and recreational opportunities are afforded at the GNRA, the largest and most unique open space area in the Jamaica Bay watershed. The Jamaica Bay Unit, which includes a portion of the GNRA, is over 12,000 acres in area and offers recreational opportunities that include golfing, swimming, horseback riding, boating, hiking, self-led and ranger-led tours, picnicking, archery, model airplane flying, and wind surfing. The Jamaica Bay Unit includes the following facilities:

- Jamaica Bay Wildlife Refuge – Approximately 9,100 acres of salt marshes, fresh and brackish ponds, upland fields and woods, and the open water area and islands of the Bay.
- North Shore District – Approximately 2,000 acres of open space and the facilities of Floyd Bennett Field, Canarsie Pier, Dead Horse Bay, Plumb Beach, and Bergen Beach.
- Breezy Point District – Approximately 1,000 acres of both open space and developed recreational facilities on the Rockaway Peninsula including Jacob Riis Park, Fort Tilden, West Beach, and the Breezy Point Tip. It also includes Frank Charles Park and Hamilton Beach in the Howard Beach area on the north side of Jamaica Bay.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

The recreational opportunities along the shoreline and on Jamaica Bay are typified by such activities as bird watching, hiking, picnicking, and sightseeing. Fishing is also a popular activity on the Bay and is available from the shoreline at many locations. Fishing from boats is popular but opportunities to launch boats by the general public are limited. There are over 50 private marinas located around the Bay providing boat slips and launch ramps. While these provide access to the Bay for boating activities, public access for launching boats from these facilities is limited by membership fees or launch fees charged for their use. There are only a few free, public access locations - Beach Channel, NYCDPR's Paerdegat Basin Park, and GNRA's Floyd Bennett Field - to launch non-motorized boats directly in the Bay. There is a NYCDPR facility at Sheepshead Bay allow the launching of non-motorized car top boats (*e.g.*, small rowboats, kayaks, and canoes).

Landfills that were located in areas adjacent to the Bay have been closed and have been or are in the process of being converted to open space available for passive recreational purposes. Former landfill areas include lands near Spring Creek and Hendrix Canal along the northern shoreline of the Bay, and in the Edgemere and Sommerville areas of the Rockaway peninsula on the southern shoreline of the Bay.

TABLE 5.1.1 Representative New York City Parks in the Jamaica Bay Watershed

NAME	LOCATION	SIZE (acres)	FACILITIES
Bergen Beach Park	Brooklyn, Ave. T & E. 71st St	1	Playfields
Breukelen Park	Brooklyn, Louisiana & Flatlands Avenue	16	Playfields
Four Sparrows Marsh	Brooklyn, Mill Basin	68	Wildlife refuge
Marine Park	Brooklyn, Flatlands & Gerritsen Avenue	798	Playfields and natural areas
Paerdegat Basin Park	Brooklyn, Bergen Avenue & E. 76th Street	161	Wildlife refuge
Brant Point Wildlife Refuge	Queens, Bayfield & Decosta Avenues	24	Wildlife refuge
Broad Channel Park	Queens, Bayfield & Decosta Avenues	17	Playfields, library
Dubos Point Wildlife Refuge	Queens, Decosta Avenue & E. 63rd Street	45	Wildlife refuge
Idlewild Park	Queens, Rockaway Boulevard & 149th Street	159	Wildlife refuge
Jamaica Bay Park	Queens, Mott Basin	148	Wildlife refuge
Rockaway Community	Queens, Conch, and Sommerville, Basins	254	Playfields and natural areas
Terrapeninsula	Queens, between Vernam & Barbadoes Basins	20	Wildlife refuge

Recreational resources in the watershed also include City and state parks. Table 5.1.1 lists some of the city parks in the watershed lands surrounding the Bay. There are also several additional playgrounds and ballfields in the immediate area of Jamaica Bay.

Southeastern Queens, in particular, has been identified as an area with limited public access.

There is one New York State Park, Bayswater Point, which is located on a peninsula extending out into Mott Basin in the East Rockaway area. Bayswater Point State Park is 12 acres in size with terrain varying from beachfront to wetlands to woodlands. The variation in terrain provides habitat for migrating and nesting birds. This 12-acre park is a remnant of the estate of banker Louis A. Heinsheimer. The 175-foot-wide mansion on the site, "Breezy Point," was demolished in 1987, although a conservatory that was attached the house remains. The state hopes to preserve and improve the existing natural systems at this location and, if practicable, restore lost habitat areas. Passive recreation, such as hiking and nature study, are available at Bayswater Point.

The access provided by the City, state and federal sites described above is primarily reachable by residents in the western and southern neighborhoods of the watershed such as Mill Basin, Mill Island, Marine Park, Bergen Beach, Canarsie, Sheepshead Bay, Neponsit, Belle Harbor, Seaside, Breezy Point, and the Rockaways. There are other areas along the shoreline, comprising approximately half of the Bay, where public access is restricted due to property ownership, the presence of hazards, and lack of amenities including parking and trails.

Bayswater Point State Park; Source: NYSDEC

Chapter 6 - Land Use and Development

6.1 WATERSHED NEIGHBORHOODS

The Jamaica Bay watershed includes the sewershed area primarily located in New York City as well as a portion of the southwest corner of Nassau County, as described in Chapter 2. The watershed encompasses a rich composite of communities and neighborhoods, representing an amalgam of cultures. The City's watershed neighborhoods, listed by community board are presented in Table 6.1.1 and described below. Figure 6.1.1 shows the watershed boundary as defined for this report and the locations of the Community Districts in the watershed.

Brooklyn

Community District 5:

City Line – This neighborhood is bordered by Atlantic Avenue and North Conduit Boulevard. The area was named when Brooklyn was still a separate city, before 1898. Housing consists of one- and two-family homes, small apartment buildings, and row houses.

Cypress Hill – The area is bordered by Atlantic and Pennsylvania Avenues and Eldert Lane. It was formerly known as Union Place. Much of the housing in this area consists of one-, two-, and multi-family homes.

East New York – This area is bordered by Jamaica Avenue, Eldert Lane, the Belt Parkway, and Junus Street. It was formerly known as Ostwout. Growth of this working class neighborhood was spurred by the construction of the Williamsburg Bridge and the IRT subway. The housing in this area consists of multi-family homes and row houses.

Highland Park – This area is bordered by Pennsylvania, Liberty, and Force Tube Avenues. Housing consists of a mixture of one-family homes and row houses.

COMMUNITY DISTRICTS	NEIGHBORHOODS INCLUDED IN THE WATERSHED
Brooklyn	
5	City Line, Cypress Hill, East New York, Highland Park, New Lots, Spring Creek
8	Weeksville/Carrville
9	Wingate
12	Ocean Parkway
13	Brighton Beach, Coney Island,
14	Flatbush
15	Gerritsen Beach, Manhattan Beach, Sheepshead Bay
16	Brownsville, Ocean Hill
17	East Flatbush
18	Bergen Beach, Canarsie, Flatlands, Marine Park, Mill Basin/Mill Island
Queens	
8	Briarwood, Holliswood, Jamaica Estates, Jamaica Hills
9	Kew Gardens, Richmond Hills, Woodhaven
10	Howard Beach, Lindenwood, Ozone Park/South Ozone Park
12	Hollis, South Jamaica, Springfield Gardens, St. Albans
13	Bellerose, Cambria Heights, Floral Park, Glen Oaks, Laurelton, Queens Village, Rosedale/Brookville
14	Arverne, Belle Harbor, Breezy Point, Broad Channel, Edgemere, Far Rockaway, Neponsit, Rockaway Park, Seaside, Sommerville

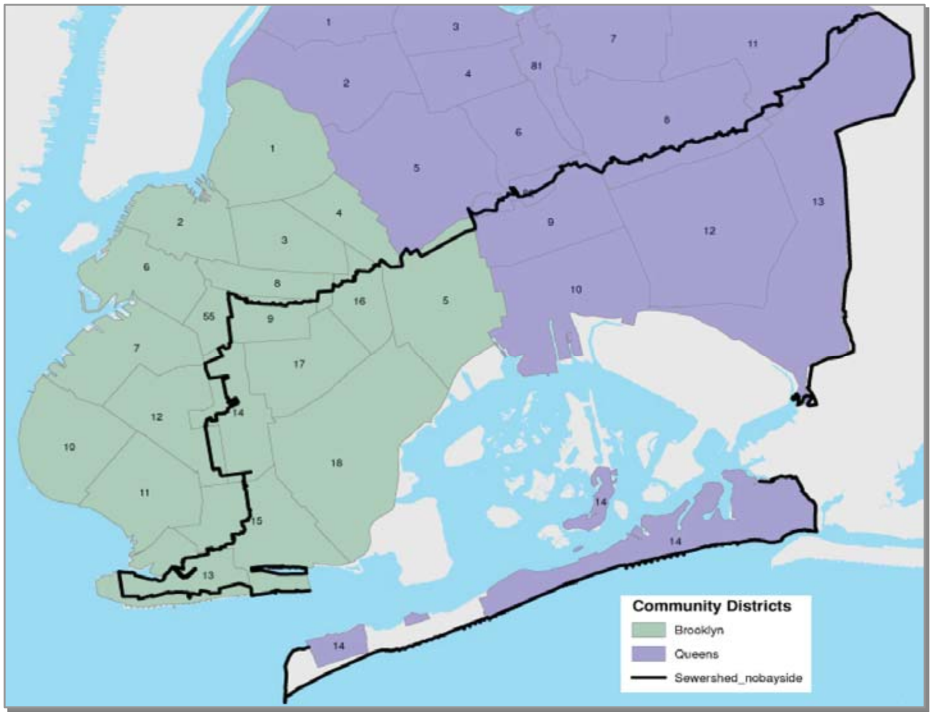


FIGURE 6.1.1 Watershed Boundary; Source: NYCDEP

New Lots – This area is bordered by New Lots, Fountain, and Pennsylvania Avenues and Linden Boulevard. The housing in this area consists of two- and multi-family homes and row houses.

Spring Creek – The area is bordered by Fountain and Pennsylvania Avenues, Linden Boulevard, and the Belt Parkway. The housing in this area consists of two- and multi-family homes and several apartment complexes. The 26th Ward WPCP is located at the head of Hendrix Canal and the Auxiliary WPCP is located at the head of Spring Creek in this area.

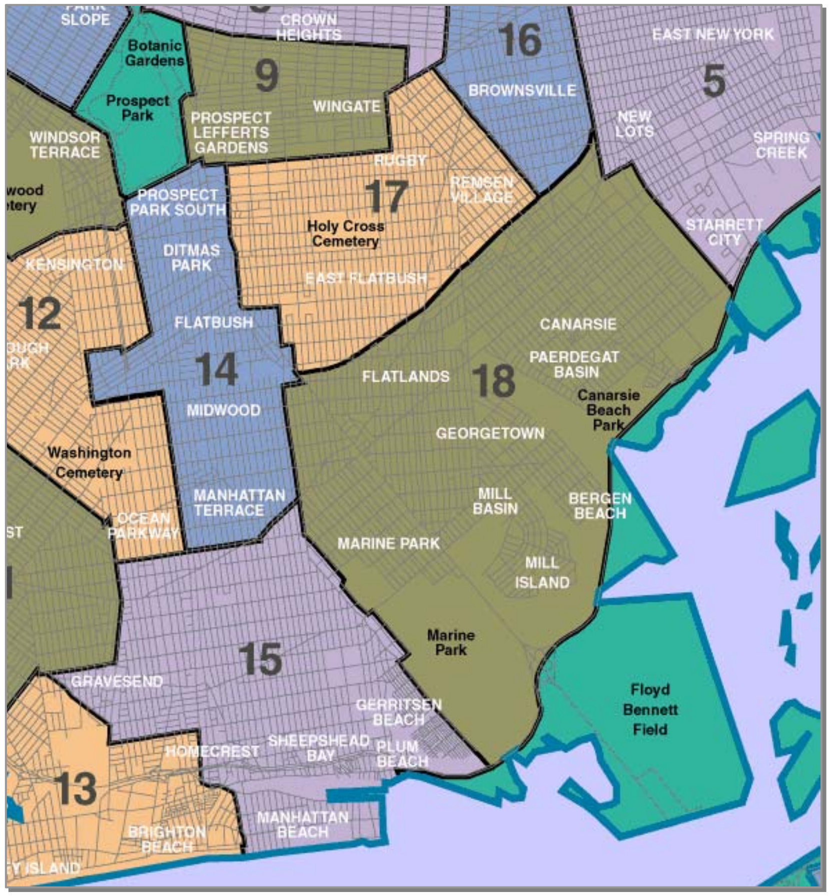
Community District 8:
Weeksville/Carrville – This small area is bordered by Bergen Street and Rochester, St. Mark's, and Utica Avenues. The area grew into a significant African-American community with a professional population that included ministers, teachers, the first female African American physician in the state, and the first African-American police officer in New York City. The housing in this area consists of mostly multi-family homes and some one- and two- family homes.

Community District 9:
Wingate – The area is bordered by Empire Boulevard, Troy and Nostrand Avenues, and Winthrop Street. It was formerly known as Pig Town because of the pig farms that were prevalent in this area of Brooklyn. The housing in this area consists of multi-family homes and row houses.

Community District 12:
Ocean Parkway – This neighborhood is located along Ocean Parkway, extending from Prospect Park to Coney Island. The area along Ocean Parkway consists of apartment buildings and one- and two-family homes.

Community District 13:
Brighton Beach – The area borders on the Atlantic Ocean, between the Belt Parkway, Coney Island and Manhattan Beach. It was developed as a seaside resort after the Civil War. The housing in this area consists of multi-family homes and apartment buildings.

Coney Island – The area was once an island but is now part of a peninsula forming the northern border of the Rockaway Inlet to Jamaica Bay. The area still contains an amusement park, a baseball stadium as well as one-, two- and multi-family homes and apartment buildings.



Brooklyn, Community District 13, 14, 15, 16, 17, and 18; Source, NYCDCP

Community District 14:
Flatbush – This neighborhood is bordered by Parkside, Coney Island, Rogers, and Flatbush Avenues, and Avenue H, The area's name derives from the Dutch for "level forest." It includes the areas of Ditmas Park, Ditmas Park West, Midwood, Prospect Park South, Caton Park, and Albemarle-Kenmore Terraces. Housing in this neighborhood ranges from historic one-family homes to multi-story apartment buildings.

Community District 15:
Gerritsen Beach – The area is bordered by Avenue U, Gerritsen Avenue, Plum Beach, and Knapp Street. The housing in this neighborhood consists of one-family homes.

Manhattan Beach – This neighborhood is bordered by Shore Boulevard (Sheepshead Bay), Esplanade (Atlantic Ocean), and Corbin and Seawall Avenues. Kingsborough Community College is located at the eastern end of this area. The housing in this neighborhood consists of one-family homes.

Sheepshead Bay – The area is bordered by Ocean Parkway, Gerritsen Avenue, Knapp Street, and the Belt Parkway. It also includes the areas of Homecrest and Madison. The housing in this neighborhood ranges from one- and two-family homes to multi-story apartment buildings.

Community District 16:
Brownsville – The area is bordered by Van Sinderen and East New York Avenues, Rockaway Parkway, and Avenue D. Housing in this area consists of multi-family row houses and multi-story apartment buildings.

Ocean Hill – The area is bordered by Ralph Avenue, Fulton Street, and Eastern Parkway Extension. Housing in this area is typified by two- to four-family homes.

Community District 17:
East Flatbush – This area is bordered by Bedford, East New York, Flatbush, and Foster Avenues, Empire Boulevard, and Avenue H. Included within East Flatbush are the neighborhoods of Erasmus, Farragut, Remsen Village, Rugby, and Wingate (Community District 9). Housing in this neighborhood ranges from one- and two-family homes to row houses to multi-story apartment buildings.

Community District 18:

Bergen Beach – This neighborhood, a former island, is bordered by Bergen, Ralph and Veterans Avenues and Avenue Y. This neighborhood, which includes the Georgetown area, became a popular residential area in the 1980s. Housing consists mainly of one- and two-family homes.

Canarsie – The area is bordered by Foster, Ralph and Paerdegat Avenues, the Shore Parkway, and East 108th Street. It includes the Paerdegat Basin area as well as Canarsie Pier, a part of the GNRA. Housing consists of multi-family homes and apartment buildings.

Flatlands – The area is bordered by Nostrand, Ralph, and Flatbush Avenues, and Avenues H and T. The housing in this area consists of two- and multi-family homes and row houses.

Marine Park – This area is bordered by Nostrand, Gerritsen, and Flatbush Avenues and Avenues U and V. The housing in this neighborhood consists of one-family homes.

Mill Basin/Mill Island – This neighborhood is bordered by Flatbush and Veterans Avenues, East 68th Street, Avenue T, and Mill Basin. Residential development began in the late 1940s. The area known as Mill Island is a part of this neighborhood. Housing consists mainly of one- and two-family homes.

Queens

Community District 8:

Briarwood – The area is bordered by Hillside Avenue, the Grand Central Parkway, 164th Street, Queens Boulevard and the Van Wyck Expressway. This residential area features one and two-family homes, with apartment buildings.

Queens, Community District 14; Source, NYCDCP

Holliswood – This area is bordered by Hillside and McLaughlin Avenues, 188th Street, and Francis Lewis Boulevard. It is an area of one-family homes on winding streets; apartment buildings are found along the periphery of this development. The area is characterized by the hilly terrain that runs roughly east/west through this part of Queens.

Jamaica Estates – The area, west of Holliswood, is bordered by Hillside Avenue, 188th Street, and Union Turnpike. It is a residential neighborhood with Tudor, colonial, and ranch homes. There are also multi-story apartment buildings in the area.

Jamaica Hills – This area, west of Jamaica Estates, is bordered by Union Turnpike and Hillside Avenue. The area is mainly residential with one-, two- and three-family homes.

Community District 9:
Kew Gardens – This area is bordered by Queens Boulevard, Lefferts Boulevard, Metropolitan Avenue and Union Turnpike. This neighborhood consists of large homes on winding streets, with pre-war apartment buildings near the major shopping thoroughfares.

Richmond Hills – This area is bordered roughly by Hillside, Jamaica, and Myrtle Avenues, and Lefferts Boulevard. It is located at the western end of the string of hills that run east/west through this part of Queens. The housing in this area consists primarily of one and two-family homes.

Woodhaven – The area is bordered by a public park, Forest Park, Park Lane South, and Atlantic Avenue. Housing consists of attached and semi-attached colonial homes, with some fully detached Victorian style homes. Cooperative apartments are located along Woodhaven Boulevard and Park Lane South. Woodhaven Boulevard and Jamaica and Atlantic Avenues are the major commercial streets.


JKF International Airport; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Community District 10:
Howard Beach – This neighborhood is bordered by the Belt Parkway, Jamaica Bay, JFK Airport, and Brooklyn. The coastal areas, with some homes built on pilings, have a nautical character; inland there are apartment complexes but one and two-family homes dominate. Cross Bay Boulevard is the major commercial street.

Lindenwood – This area is bordered by the Belt Parkway, Conduit Avenue and the Brooklyn-Queens border. It is characterized by a large housing complex built in the 1950s in northern Howard Beach. Six- story and garden apartment buildings predominate.

Ozone Park/South Ozone Park – This area is bordered by Atlantic Avenue, Drew Street, the South Conduit, and 108th street. This area is characterized by single family homes.

Community District 12:
Hollis – This area is bordered by the Rockaway branch of the Long Island Railroad, Jamaica and Murdock Avenues, and Francis Lewis Boulevard. It is culturally diverse with Victorian-style and row houses.

South Jamaica – This area is bordered by the Long Island Railroad, Liberty Avenue, the Van Wyck Expressway, and Merrick Boulevard. Housing consist of one and two-family homes and a number of smaller apartment buildings, along with Rochdale Village, a public housing project located on the site of the former Jamaica Race Course.

Springfield Gardens – The area is bordered by the neighborhoods of St. Albans and Laurelton, JFK Airport, and Farmers Boulevard. The area consists primarily of one- and two-family homes.

St. Albans – This neighborhood is located southeast of the Jamaica neighborhood and northeast of the neighborhoods of Springfield Gardens and Laurelton. Housing consists mainly of one- and two-family homes. The St. Albans Veterans Administration Extended Care Center, formerly a naval hospital, is located on the site of a former golf course.

Community District 13:
Bellerose – This neighborhood is located on the eastern edge of Queens along the border with Nassau County and centered on Hillside Avenue. It is primarily a residential area of one- and two-family homes.

Cambria Heights – This area is located along the Belt Parkway, which separates it from Nassau County. Linden Boulevard is the main shopping street of this middle-class community of one- and two-family homes.

Broad Channel; Source: http://www.forgotten-ny.com

Floral Park – This neighborhood is located at the eastern edge of Queens and is adjacent to the Village of Floral Park in Nassau County. The main thoroughfare is Tulip Avenue. It is a community of one- and two-family homes.

Glen Oaks – This area is bordered generally by Union Turnpike, 76th Avenue, Commonwealth Boulevard, and 263rd Street. Glen Oaks Village is a self-managed cooperative residential housing development located in northeastern Queens. It consists of nearly 3,000 garden style apartments.

Laurelton – This neighborhood, east of JFK Airport, is bordered generally by the Belt Parkway and Springfield and Merrick Boulevards. The area is filled with one- and two-family homes in Spanish and English Tudor styles.

Queens Village – This area is roughly bordered by Jamaica, Hillside, and Braddock Avenues and Springfield Boulevard. The area consists primarily of one- and two-family homes.

Rosedale/Brookville – These areas are bordered by Springfield Gardens, Valley Stream (in Nassau County), Laurelton, and JFK Airport. They are at Far Rockaway – Far Rockaway is located at the eastern end of the Rockaway Peninsula, and bordered by Nassau County, Beach 32nd Street, the eastern edge of New York City with the border between Queens and Nassau County.

Community District 14:

Arverne – This area is bordered roughly by Beach 54th and 90th Streets, Rockaway Boulevard, and the Atlantic Ocean. Much of the land is vacant, with urban renewal plans underway.

Belle Harbor – This neighborhood is bordered by Jamaica Bay, Beach 130th and 141st Streets, and the Atlantic Ocean. Housing consists primarily of one- and two-family homes.

Breezy Point – This area is bordered by 201st and 222nd Streets, Jamaica Bay, and the Atlantic Ocean. This neighborhood is a gated, cooperative community at the western end of the Rockaway peninsula.

Broad Channel – This neighborhood occupies the southern portion of Broad Channel Island, the only inhabited island in Jamaica Bay. Except for a commercial section of Cross Bay Boulevard, the area is residential. The northern section of the island is part of GNRA and is managed by the NPS.

Edgemere; Source: http://www.forgotten-ny.com

Edgemere – This area is bordered roughly by Beach 32nd and 54th Streets, Jamaica Bay, and the Atlantic Ocean. There are number of one- and two-family homes, but much of the land is vacant, with urban renewal plans underway.

and the Atlantic Ocean. Housing in this area is a mixture of one- and two-family homes, apartment buildings with new beach homes, and waterfront development.

Neponsit – This area is bordered by Jacob Riis Park (Beach 149th Street), Beach 141st Street, Jamaica Bay, and the Atlantic Ocean. The housing in this area is primarily one- and two-family homes.

Rockaway Park – This area is bordered by Beach 118th and 130st Streets, Jamaica Bay, and the Atlantic Ocean. The housing in this area is primarily one- and two-family homes.

Seaside – This area is bordered by Beach 90th and 118th Streets, Jamaica Bay, and the Atlantic Ocean. The housing in this area is primarily apartment buildings and year-round private homes.
Sommerville – This area is bordered roughly by Beach 54th and 72nd Streets, Rockaway Boulevard, and Jamaica Bay. The housing in this area is primarily one- and two-family homes.

Nassau County

In Nassau County only a portion of the watershed based on topography actually drains to Jamaica Bay. All or portions of the following areas of Nassau County are assumed to drain to Jamaica Bay:

Incorporated areas: Village of Cedarhurst.
Unincorporated Areas: Inwood, South Valley Stream, Valley Stream, and Woodmere.

Based on a review of aerial photographs and topographic mapping of the area, approximately 9,100 acres in Nassau County are tributary to the Bay.

6.2 LAND USE PLANNING AND ZONING

6.2.1 Land Use

The City portion of the watershed's land area that drains to the Bay is approximately 47,000 acres. Land use in the Jamaica Bay watershed is predominantly residential with much of the residential units consisting of one- and two-family homes (37%) .

Despite this predominance of low density residential development, the Jamaica Bay watershed overall is an extensively developed geographic area with impervious coverage approaching approximately 65%. Two high-density areas are also located within the watershed that represent a mixture of residential, commercial and industrial land use districts: Downtown Jamaica in Queens located at the northeastern part of the watershed and Broadway Junction-East New York which straddles the Brooklyn-Queens border in the northern reach of the watershed.

TABLE 6.2.1 Land Use 2005, of the Jamaica Bay Drainage Area in Brooklyn and Queens.

TYPE	DRAINAGE AREA
1-2 Family Residential	37.1%
Multi-Family Residential	9.9%
Mixed Res./Commercial	1.7%
Commercial/Office	2.7%
Industrial	1.9%
Transportation/Utility	13.3%
Institutions	5.4%
Open Space/Recreation	22.1%
Parking Facilities	1.4%
Vacant Land	3.8%
Miscellaneous	0.7%

Source: New York City Department of City Planning, RPAD, 2006

Table 6.2.1 presents the land use of the Brooklyn and Queens portion of the Jamaica Bay watershed or drainage area. Approximately 47% of the land use in the Queens and Brooklyn portions of the Jamaica Bay watershed is residential (1 and 2-Family or Multi-Family). Figure 6.2.1 maps the different land use types within the watershed.

Land uses within the Nassau County portions of the watershed were estimated based on aerial photography. The results of this analysis are provided below in Table 6.2.2.

Residential Land Use

Residential properties, the predominant land use in the watershed, range from one-family homes to row houses to high rise apartment buildings. Based on the land use data obtained from New York City Department of City Planning (NYCDCP), approximately 47% of the land area has been developed for residential use in addition to a small percentage of mixed use (residential/commercial).

Commercial Land Use

Commercial properties in the watershed area of the Bay include the wide variety of uses

TABLE 6.2.2 Land Use, Assumed in Percent within Nassau County Watershed

LAND USE	NASSAU COUNTY
1-2 Family Residential	40.0%
Multi-Family Residential	14.0%
Mixed Res./Commercial	3.0%
Commercial/Office	3.7%
Industrial/Manufacturing	4.0%
Transportation/Utility	3.0%
Public Facilities/Institutions	7.5%
Open Space/Recreation	16.5%
Parking Facilities	2.4%
Vacant Land	5.0%
Miscellaneous	0.9%

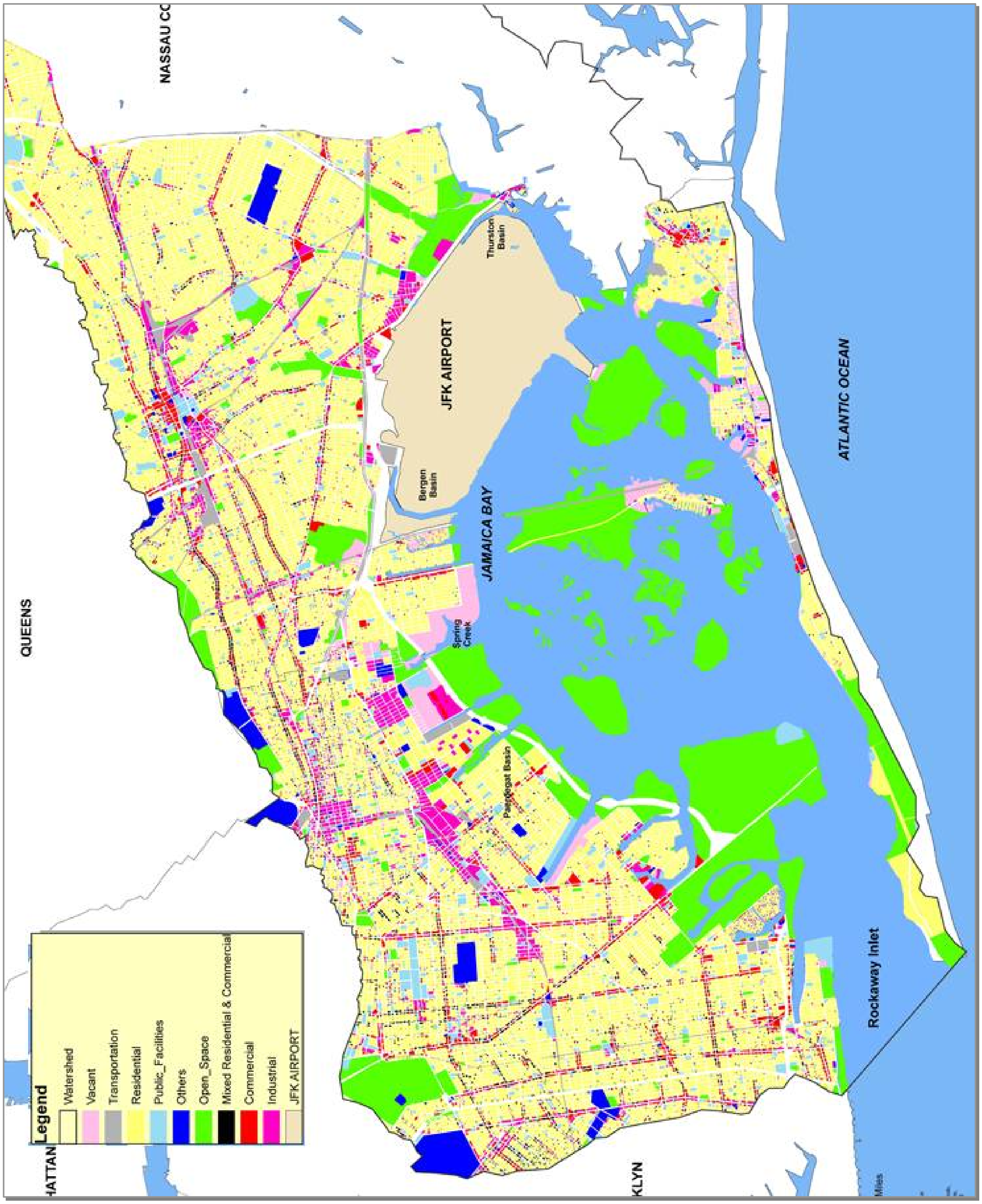


FIGURE 6.2.1 Jamaica Bay Watershed Land Use Map; Source: NYCDEP

representative of any metropolitan area. Based on land use data obtained from NYCDCP, approximately, 2.7% of the land area of the watershed has been developed for commercial use in addition to a small percentage of mixed use (residential/commercial).

Industrial Land Use

Industrial use properties are also present in the areas surrounding the Bay and represent approximately 1.9% of watershed land within NYC, a relatively small portion of the watershed area. Among the industries located in the Jamaica Bay watershed are the following:

- automotive parts
- plastics packaging
- architectural building products
- metal parts fabrication
- fuel storage facilities
- printing/newspaper publication.

Open Space

A significant percentage of the watershed, 22.1%, is classified as open space due to the presence of NPS properties and facilities. The Jamaica Bay Unit of the GNRA consists of approximately 12,000 acres including the waters surrounding the Jamaica Bay Wildlife Refuge but also significant land areas that surround the Bay including Floyd Bennett Field, Canarsie Pier, Dead Horse Bay, Plumb Beach, Bergen Beach and portions of the Rockaway Peninsula. GNRA property within the watershed is characterized as open space on the land use map (see Figure 6.2.1). The watershed contains numerous city parks and one state park. See Chapter 5 for additional information on open space resources in the watershed.

Transportation/Utility

Transportation/utility comprises approximately 13.3% of the watershed area; however, this percentage is primarily due to a single property. JFK Airport, a significant land use within the watershed, is classified as a transportation/utility in Table 6.2.1 above and coded as an airport in the land use map (see Figure 6.2.1). JFK Airport is approximately 4,930 acres in size and is located in the southeastern Queens portion of the waterfront on property owned by the New York New Jersey Port Authority.

Residential Use; Photograph by Ralph McClurg, O’Brien & Gere

Cement Plant East of Jamaica Bay; Photograph by Ralph McClurg, O’Brien & Gere

Golf Course on Head of Bay; Photograph by Ralph McClurg, O’Brien & Gere

Vacant

Based on 2005 land use data, vacant land comprises approximately 3.8% of the watershed. However, it is critical to ground verify these data in particular and it cannot be assumed that these properties remain undeveloped. Rather, these parcels may be in different stages of development or associated with another land use type.

TABLE 6.2.3 NYC Zoning of the Jamaica Bay Drainage Area, 2005

TYPE	DRAINAGE AREA
Low Density Residential (R1-2, R2, R2A, R2X, R3-1, R3-2 R3A, R3X, R4, R4-1, R4A, R4B)	40.7%
Medium Density Residential (R5, R5B, R6, R6A, R6B, R7-1, R7A, R7B)	22.2%
High Density Residential (R8A, R8B, R8X)	1.2%
Commercial (C3, C4-1, C4-2, C4-3, C4-3A, C4-4, C4-5X, C4-6, C6-1, C6-1A, C7, C8-1, C8-2, C8-4)	2.9%
Manufacturing (M1-1, M1-2, M1-3, M1-4, M1-5, M2-1, M3-1, M3-2)	14.7%
Other (non-city designated parks, unclassified, etc.)	19.5%

Other

Other land uses in the watershed area of the Bay include institutions, parking facilities, and miscellaneous uses that do not fall into discrete or defined categories.

6.2.2 Zoning

The watershed is primarily comprised of residential zoning districts at approximately 64%. As mentioned above, the residential areas of the watershed are characterized primarily by low density housing; approximately 41% percent of the watershed consists of R1, R2, R3, and R4 districts. In contrast, 22% of the watershed consists of medium density residential zoning districts including R5, R6 and R7 districts and 1% of the watershed is zoned as R8 or other high density residential zoning districts. Commercial zones are a small percentage of the overall watershed at approximately 3% and manufacturing zones are larger at 15%. The large percentage of "Other" in the table below mostly accounts for the federally-designated NPS property of the GNRA Jamaica Bay Unit.

NYC Zoning Resolution

It was the intention from its initial passage in 1916 that the City's Zoning Resolution would be a living document, evolving as the need arose due to changes in technology, as well as variations in community growth patterns that were not and could not be foreseen in 1916. Although the Zoning Resolution was frequently amended to meet new and changing conditions, its basic form and content remained relatively static until 1961. Over that period, New York City, as well as the rest of the world, saw remarkable transformations in every segment of the community and how it went about the everyday business of life. The City's population had grown from approximately 5,000,000 in 1916 to nearly 8,000,000 in 1960; major airports, multi-lane expressways, and radio and television towers had become a part of the community's landscape. It was time to undertake a major overhaul of the Zoning Resolution and bring it into alignment with the current times.

Among the concepts that were included in the updating of the Zoning Resolution were the following:

- In order to accommodate different types of land uses within the three main categories of residential, commercial, and industrial or manufacturing, a greater level of specific land use districts and definitions of acceptable uses were established.
- Maps were incorporated as part of the Zoning Resolution to indicate the location and boundaries of districts established by the Resolution.
- The maximum size, or bulk, of a building was set by establishing a floor area ratio (FAR) as part of each zoning district.
- An open space ratio (OSR), lot coverage limitations, and density restrictions were established to control the concentration of development and to allow for the orderly planning of new schools, utilities, and transportation routes.
- Contextual zoning was recognized as a means to regulate new buildings in a manner that

would maintain the character of an existing neighborhood as it evolved over the years.

- Although skyscrapers were beginning to be constructed by 1916, the degree of impacts to the residents or occupants of a neighboring property on their ability to have access to the sky itself was not imagined. The 1961 version of the Zoning Resolution incorporated requirements to provide light and air at street level of certain residential districts.

Special Districts

Another innovation of the 1960 Zoning Resolution was the provision for "special use districts." Special use districts have been utilized "...to achieve the specific planning and urban design objectives in defined areas with unique characteristics" (NYCDCP, 2006). Special use district provisions specify various requirements or building incentives that are tailored to preserve or promote distinctive qualities of an area that may not be easily accommodated within the general language of the zoning resolution.

Zoning

"The dotted bands along each side of the Shore Parkway and Southern Parkway have been determined as a residential district in order to protect these parkways and to promote a desirable residential development next to them. The two solid black areas indicate proposed industrial centers; one situated at Mill Basin and the other at the head of the Bay near the Nassau County Line. Both of these are logical industrial sites and are adequate in size to provide for industrial expansion for a great many years to come. In addition there are existing business districts along the Rockaway peninsula shown in black cross-hatching on the map. The remainder of the region bounded on the north by the Shore and Southern Parkways, on the south by Jamaica Bay, on the east by Rockaway Boulevard, and on the west by Flatbush Avenue and Marine Park, should be zoned predominantly for residential purposes, exclusive of the waterfront and bay which should be devoted to recreation." (NYC Department of Parks, 1938).

Within the Jamaica Bay watershed is the Sheepshead Bay special district and the Ocean Parkway special district.

The Sheepshead Bay district was identified to protect and strengthen that neighborhood's waterfront recreation and commercial character. New commercial projects and residential development must meet conditions that will support the tourist-related activities along the waterfront. Provision for widened sidewalks, landscaping, useable open space, height limitations, and additional parking areas have been established.

The Ocean Parkway special district encompasses a band of streets east and west of the parkway extending from Prospect Park in the north to Brighton Beach on the south. The purpose of the special district is to enhance the character and quality of this broad landscaped parkway, a designated scenic landmark.

In 1993 special zoning regulations relative to development of waterfront areas were adopted. Waterfront zoning regulations control uses of piers, platforms, and floating structures and, for many new developments along waterfront areas, it applies special bulk regulations and mandates provision for public access to the waterfront. It also allows for the development of Waterfront Access Plans (WAPs) for stretches of shoreline with unique conditions and opportunities and to provide for visual corridors with unobstructed views and public open space with new residential and commercial developments.

Jamaica Bay is designated as a Special Natural Waterfront Area (SNWA) in NYCDCP's New Waterfront Revitalization Program (WRP). The program, originally adopted in 1984, is the City's principal coastal zone management tool. The program was revised in 2002 and, as a result, established ten policies designed to maximize the benefits derived from economic development, environmental preservation, and public use of the waterfront, while minimizing conflicts among these objectives. As a SNWA, proposed projects along Jamaica Bay's edge are reviewed to ensure consistency with the WRP policy specific to protecting and restoring the quality and function of ecological systems within its coastal area.

6.3 REFERENCES

New York City Department of City Planning (NYCDCP). 2006. Zoning Resolution of the City of New York, 12/15/61, as amended (as of 7 April 2006). New York, NY. http://www.nyc.gov/html/dcp/html/zone/zonetext.shtml

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Chapter 7 - Watershed Stakeholders and Public Outreach Efforts

"*To stand at the edge of sea, to sense the ebb and flow of the tides, to feel the breath of a mist moving over a great salt marsh, to watch the flight of shore birds that have swept up and down the surf lines of the continents for untold thousands of year; to see the running of the old eels and the young shad to the sea, is to have knowledge of things that are as nearly eternal as any earthly life can be.*"

- Rachel Carson

7.1 GOVERNMENTAL AND REGULATORY AGENCIES

The governmental management of Jamaica Bay and its watershed is a complex of jurisdictions at multiple governmental levels. These jurisdictions may have related goals, but often approach them from different perspectives or mandates. Multiple agencies conduct activities within or in relation to the Bay and its watershed which have an impact on its protection and sustainability. The following lists some of the government agencies and the general types of jurisdiction or interest of these agencies regarding Jamaica Bay.

Federal Agencies

Army Corps of Engineers (USACE)
USACE is responsible for investigating, developing and maintaining the nation's water and related environmental resources. As such, USACE is involved, either as the agency having primary responsibility for managing investigation projects or as an interested agency providing input to other agencies, on projects regarding the Bay's natural environment. USACE, in cooperation with the NYSDEC, regulates the protection of freshwater wetland areas.

The USACE regulates the placement of dredged or fill material or structures over or within waters of the US, including tidal wetlands, under Section 404 of the Clean Water Act and Section 10 of the Rivers and Harbors Act. Activities that are proposed in tidal wetlands require authorization under the USACE Nationwide Permit program.

Tidal wetlands are not mapped by USACE. USACE will determine the jurisdictional boundaries of tidal wetlands following their review and verification of a tidal wetland delineation. USACE will issue a document entitled a Jurisdictional Determination approving the wetland limits for a five year period.

In order for a USACE Section 404 nationwide permit to be valid, a Water Quality Certification from NYSDEC (under Section 401 of the Clean Water Act) and a Coastal Zone Consistency Management Determination from the New York State Department of State (NYSDOS) (under Section 307 of the Coastal Zone Management Act) must be received. These two approvals are required before an USACE permit approval can be granted.

The USACE regulates the discharge of dredged or fill material into all freshwater wetlands and has jurisdiction over all wetland areas, regardless of size, within the Jamaica Bay Watershed. USACE does not regulate an adjacent area (wetland buffer). Since USACE does not rely on wetland maps, it will determine the jurisdictional boundaries of freshwater wetlands following its review and verification of a freshwater wetland delineation. USACE will issue a document entitled a Jurisdictional Determination approving the wetland limits for a five year period.

In order for a USACE Section 404 nationwide permit to be valid, a Water Quality Certification from NYSDEC (under Section 401 of the Clean Water Act) and a Coastal Zone Management (CZM) Determination from the NYSDOS (as previously described) must be received. These two approvals are required before USACE permit approval can be granted.

The January 9, 2001 “SWANCC decision” (Solid Waste Agency of Northern Cook County vs. USACE) regarding the scope of regulatory jurisdiction under the Clean Water Act found that “non-navigable, isolated and intrastate” waters were no longer regulated under the statutory authority of the CWA. The redefinition of the term “waters of the United States” as promulgated under this ruling effectively eliminated for the time being USACE’s jurisdiction over isolated wetlands. Other cases working their way through the courts may continue to redefine this issue.

Environmental Protection Agency (USEPA)

USEPA is responsible for, among other obligations, the development and implementation of regulatory programs to protect the environment. Air emissions, water and wastewater treatment, and water quality programs affecting Jamaica Bay are ultimately under the jurisdiction of the USEPA. Included in the USEPA’s efforts are the New York-New Jersey HEP and the development of the Comprehensive Conservation and Management Plan (CCMP) for the NY-NJ harbor area, including Jamaica Bay. The USEPA has a mandate to improve, and jurisdiction over, water quality under the Clean Water Act. The agency works with state, local and tribal authorities to carry out nationwide water monitoring projects, and has been a participant in water quality studies of Jamaica Bay

Federal Aviation Administration (FAA)

FAA is primarily responsible for the advancement, safety and regulation of civil aviation, as well as overseeing the development and maintenance of airport facilities. With the presence of JFK Airport on the eastern shoreline of Jamaica Bay, the FAA is directly involved in activities affecting the management of the airport and its impacts on the Bay. Among the many issues of concern to airport operations, FAA provides guidance on certain land uses that have the potential to attract hazardous wildlife on or near public use airports. Land use practices that attract or sustain hazardous wildlife populations on or near airports can significantly increase the potential for wildlife strikes. FAA recommends that the guidance provided apply to all land use planners, and developers of projects, facilities, and activities on or near airports.

Fish & Wildlife Service (USFWS)

USFWS works to conserve, protect and enhance fish, wildlife, and plants and their habitats. Several investigations have been conducted by USFWS to identify aquatic species of Jamaica Bay and the New York bight. The NPS has supported research into marsh loss and other ecological issues relating to Jamaica Bay through the Blue Ribbon Panel, JABERRT and other programs. It has performed restoration activities, and conducts panel discussions and educational programs about the Bay and its ecosystems.

National Park Service (NPS)

The Jamaica Bay Unit is the primary steward of Jamaica Bay through the various opportunities it offers visitors to GNRA and efforts to promote stewardship among those living and working in its watershed. The Unit's Education Programs include day and overnight trips to the Bay for school children of all ages as well as public education and recreation programs for adults. The Jamaica Bay Institute, also located at GNRA, serves as a repository for informational resources and data related to the Bay to increase knowledge of the Bay among the research community and resource managers. Finally, the Unit has conducted several public processes to bring government agencies together and engage the public in the identification of common concerns and future visions of Jamaica Bay.

Natural Resource Conservation Service (NRCS)
NRCS provides leadership in the conservation, maintenance, and improvement of the nation's natural resources and environment. One of the most visible efforts of NRCS has been, in cooperation with the New York City Soil and Water Conservation District and Cornell University, the preparation of soil survey reports for New York City, Gateway National Recreation Area, and Nassau County. These reports are often used in evaluating soil properties and their suitability for proposed development projects.

National Oceanic and Atmospheric Administration (NOAA)
NOAA, a part of the U.S. Department of Commerce, is responsible, at the federal level, for CZM which has as its objective the comprehensive management of the nation's coastal resources, ensuring their protection for the future, giving consideration to competing economic, cultural, and environmental interests. NOAA is also responsible at the federal level for the Coastal and Estuarine Land Conservation Plan (CELCP) which was established to protect coastal and estuarine lands considered important for their ecological, conservation, recreational, historical or aesthetic value.

Coast Guard (USCG)
The mission of USCG includes providing security patrols for the nation's coastal waterways including New York Harbor and Jamaica Bay as well as safety, rescue, and environmental emergency response teams.

New York State Agencies

Department of Environmental Conservation (NYSDEC)
NYSDEC is the primary state agency that is responsible for the protection of the state's natural resources and environment. Regulatory programs administered by NYSDEC control water, land and air pollution in order to enhance the health, safety and welfare of the people of the state and their overall economic and social well being. For Jamaica Bay this means that the NYSDEC is involved with, among other initiatives directly related to Jamaica Bay, the permitting and monitoring of the WPCPs that discharge to the Bay, and the regulation of tidal and freshwater wetlands.

NYSDEC regulates activities in mapped tidal wetlands under Article 25, the Environmental Conservation Law (the specific implementing regulations are in 6 NYCRR Part 661). In general, the regulated tidal wetlands consist of all tidal waters of the state and all associated tidal marshes, mudflats and shorelines. In addition to mapped tidal wetlands, the State also regulates all activities that will occur within an "adjacent area." In New York State the "adjacent area" extends up to 300 feet from the mapped tidal wetland; however, in New York City, because of existing development, the "adjacent area" has been reduced to a maximum of 150 feet beyond the mapped tidal wetland limits. The width of the "adjacent area" can be modified (reduced) where there are existing man-made structures such as buildings, roads, railroads, bulkheads, or seawalls. In addition, the "adjacent area" will also not extend beyond a point above 10 feet above mean sea level.

NYSDEC tidal wetlands maps include several ecological zones: coastal fresh marsh; intertidal marsh; coastal shoals; bars and flats; littoral zone; high marsh or salt meadow; and formerly connected tidal wetlands. Intertidal marsh and coastal fresh marsh are offered the greatest regulatory protections due to their high ecological and flood protection values.

NYSDEC requires Tidal Wetland permits for activities that will alter wetlands or wetland adjacent areas. A range of potential activities have been identified by NYSDEC. These potential activities are categorized as Generally Compatible Uses, Presumptively Incompatible Uses or Incompatible Uses. The regulations also provide development restrictions for specific uses, such as minimum building setbacks (75 feet in New York State and 30 feet in New York City); on site sewage disposal minimum setback; percentage of adjacent area that may be covered by impervious surface; minimum lot size; roadway setbacks (75 feet in New York State and 30 feet in New York City); and stormwater management facilities. Generally Compatible Uses will require submission of a Minor Permit application whereas Presumptively Incompatible or Incompatible Uses require a Major Permit application.

In New York City, activities in freshwater wetlands are regulated by the NYSDEC under Article 24 of the Environmental Conservation Law (and its implementing regulations in 6 NYCRR Parts 662, 663, 664 and 665). The NYSDEC regulates wetlands that are greater than 12.4 acres and/or wetlands that are smaller that possess unique and unusual characteristics. In addition, the state-designated wetlands include a 100-foot width adjacent area or wetland buffer, which also is regulated by the NYSDEC. The NYSDEC has prepared maps depicting the locations of all protected wetlands in the state. Wetlands are classified Class I – IV, with Class I wetlands being the most valuable.

As with the tidal wetlands program, the freshwater wetlands regulations assign different levels of compatibility for certain projects depending on the intended use, proximity to the wetlands, and the class of wetland affected. Permit applications are reviewed for environmental impact, economic and social need and feasibility of alternatives that would have less wetlands impacts. Mitigation, the construction of new wetlands at a minimum of a 2:1 average ratio, may be required as a condition of wetlands permits.

Department of State (NYSDOS)
Through NYSDOS's Division of Coastal Resources a variety of programs and initiatives that help to revitalize, promote and protect the State's waterfront resources. In cooperation with the NOAA, NYSDOS's responsibilities include the implementation, at the state level, of the CZM program and the CELCP.

Office of Parks, Recreation & Historic Preservation (OPRHP)
OPRHP works to provide interpretative and educational opportunities of natural, historic, and cultural resources.

NY/NJ Port Authority
NY/NJ Port Authority manages and maintains the airports, bridges, tunnels, bus terminals, PATH and seaport that are critical to the region's trade and transportation capabilities.

Interstate Environment Commission
IEC is a joint agency of the States of New York, New Jersey, and Connecticut. Its programs include activities in air pollution, toxics, and resource recovery facilities; however, the main focus of IEC is water quality. It has taken

an active role in enforcement actions and legal suits aimed at obtaining compliance with existing regulatory programs and permit conditions. The Port Authority is responsible for JFK Airport, one of largest single land uses in the Jamaica Bay watershed. The Port Authority has taken an active role in ecological issues in the watershed, including water quality and ecosystem restoration.

New York City Agencies and Local Boards

Department of City Planning (NYCDCP)
NYCDCP is responsible for the City's physical and socioeconomic planning including land use and zoning. It assists the officials at the borough level and the community boards in matters related to the development of private as well as city owned lands consistent with the City's zoning resolution. NYCDCP also administers the WRP and, as a result, must determine if a project that is proposed for the coastal zone and requires a local, state, or federal discretionary action, is consistent with the WRP policies and intent of the program before the project is able to move forward.

Department of Environmental Protection (NYCDEP)
Among the responsibilities of NYCDEP are the planning, design and construction of major water quality related capital projects. Specifically, NYCDEP is responsible for operating and upgrading the City's 14 WPCPs, operating and upgrading the sewer system and controlling CSO discharges. These projects foster the continued improvement of water quality within the New York Harbor and estuaries. For Jamaica Bay, this includes operation and management of the four WPCPs that discharge to the Bay and developing a CSO control plan for the drainage area. NYCDEP is also completing the capping and restoration of the Pennsylvania Avenue and Fountain Avenue landfills and, upon completion; the Department will cede these areas totaling approximately 400 acres to NPS for maintenance as passive recreational areas. The NYCDEP also directs the ongoing investigations of the Bay's ecology and the identification of both capital projects and management efforts to improve the Bay's water quality. It was designated by Local Law 71 to develop this Watershed Protection Plan for Jamaica Bay.

Department of Parks & Recreation (NYCDPR)
NYCDPR manages over 26,000 acres of parkland in the City including approximately 7,000 acres of natural, undeveloped lands. The City's parklands support diverse plant and wildlife populations, including numerous rare, threatened and endangered species. Among the City parks in the Jamaica Bay watershed are: Bergen Beach Park, Four Sparrows Marsh, Marine Park, Broad Channel Park, Idlewild Park, and the Vernam-Barbadoes Peninsula.

Department of Transportation (NYCDOT)
The NYCDOT manages much of the City's transportation infrastructure, including city streets, highways, sidewalks, and bridges including the Belt Parkway that traverses much of the watershed. It is also responsible for oversight of private ferry operations on city-owned piers.

Economic Development Corporation (NYCEDC)
NYCEDC encourages the use of strategic and/or underutilized properties for economic development. NYCEDC's activities also include conducting planning and feasibility studies and oversight of transportation and infrastructure projects that contribute to the City's economic growth. The NYCEDC controls some important lands in the Bay's watershed.

City Council

The New York City Council is the law-making body of the City of New York. It is comprised of 51 members from 51 different Council Districts throughout the five boroughs. The Council monitors the operation and performance of city agencies, makes land use decisions and has sole responsibility for approving the city's budget. It also legislates on a wide range of other subjects. (http://www.nyccouncil.info/tools/about_council.cfm) The City Council passed Local Law 71 which required the preparation of this Jamaica Bay Watershed Protection Plan, and has had an active role in passing legislation to improve the sustainability of the City, the health of its residents, and for the protection of the environment.

Borough Offices of Brooklyn; Borough Offices of Queens

The two boroughs bordering Jamaica Bay are each involved in the day-to-day management of the many aspects of community life. Among the various matters that the boroughs are responsible for on the local level are economic development, land use planning and zoning, parklands, transportation, and housing. The boroughs interact with regulatory agencies, departments, commissions, and boards at the city, state, and federal levels.

Community Boards

As described previously in Chapter 6 there are numerous Community Districts that comprise the Jamaica Bay watershed; specifically, Community Districts 5, 8, 9, 12, 13, 14, 15, 16, 17 and 18 in Queens and 8, 9, 10, 11, 12, 13, and 14 in Brooklyn. Community Districts were created throughout the City to serve as an organizational mechanism for the diverse neighborhoods, uses and population that make up the City. Each district includes a Community Board which has important advisory roles in dealing with land use and zoning matters, the City budget, municipal service delivery and many other matters relating to their communities' welfare.

7.2 NON-GOVERNMENTAL AND COMMUNITY ORGANIZATIONS

As one of the most ecologically diverse and scenic areas in the New York Metropolitan region, Jamaica Bay has many supporters. From Marine Park to Broad Channel, Paerdegat Basin to Far Rockaway, citizens, environmentalists, elected officials, and agency staff have demonstrated extraordinary commitment to protecting the Bay. Though united in the common goal of conservation, these groups and individuals have focused on a range of objectives, including preserving habitat; enhancing quality of life in communities surrounding the Bay and raising awareness about local ecology and critical issues facing the Bay.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

To accomplish these objectives, neighborhood-based and regional environmental organizations have initiated activities as diverse as beach clean-ups, testimony at public hearings, marsh restoration, environmental education and grassroots advocacy. In addition, there are many local groups that promote conservation through enjoyment of the Bay and its shoreline, as well as national organizations that have initiated projects to study and protect the Bay. These include, but are not limited to, the American Littoral Society, Baykeeper, Jamaica Bay Ecowatchers, the Eastern Queens Alliance, Natural Resources Protective Association, Jamaica Bay Task Force, Friends of Gateway, NYC Audubon Society, Natural Resources Defense Council, and the Jamaica Bay Guardian.

Lastly, colleges and universities have fostered a greater understanding of Jamaica Bay's ecology through in-depth research focused on a range of subjects.

7.3 PUBLIC OUTREACH PROGRAM TO SUPPORT THIS PLAN

On July 20, 2005, LL71, to develop a Watershed Protection Plan for Jamaica Bay, was signed by Mayor Michael

Bloomberg. The law also stipulates a framework for public participation activities. The core of the public involvement program is its Advisory Committee, which served as the central mechanism for reaching out to the public and obtaining input essential to developing a comprehensive and implementable plan.

LL71 established two primary means of involving members of the public in the development of recommendations for protecting Jamaica Bay and implementing related public education components. Section 2.h.1 of the law created an advisory committee to "provide advice to the [NYCDEP] Commissioner for the duration of its term and provide final recommendations to the commissioner and the speaker of the council on the watershed protection plan." Section 2.b.6 addressed development of a public education program "for schools, developers, commercial facilities, civic groups and other local organizations and entities to increase awareness about the ecological significance and degradation of Jamaica bay" and activities being undertaken by NYCDEP and others on its behalf.

Jamaica Bay Watershed Protection Plan Advisory Committee.

As detailed in LL71, Section 2.h. (2), the Jamaica Bay Watershed Protection Plan Advisory Committee was composed of seven members: four selected by the Mayor and three selected by the Speaker of the Council. While each member was selected based on his affiliation with a specific organization, the group was also responsible, in part, for representing the broader public interest in the process. The members of the Advisory Committee are listed below:

- Doug Adamo, National Park Service[1]
- Manuel Caughman, resident, community and environmental activist
- Len Houston, U.S. Army Corps of Engineers
- Dan Mundy, resident, Jamaica Bay EcoWatchers
- Brad Sewell, Natural Resources Defense Council[1]
- Larry Swanson, Marine Sciences Research Center – State University of New York at Stony Brook
- Christopher Zeppie, Port Authority of New York & New Jersey.

Throughout its term, the Advisory Committee has held regular working sessions and panel discussions/workshops with outside experts to discuss specific topics critical to developing its recommendations. The Advisory Committee also has held monthly meetings with NYCDEP to review data and other relevant information. In addition, at the start of its term, the Advisory Committee participated in a boat tour of Jamaica

[1] Elected co-chair at November 29, 2005 Advisory Committee meeting.

Bay with NYCDEP Commissioner Emily Lloyd and members of the project team.

During its term of service, the Advisory Committee focused on numerous topics related to water quality, ecological integrity of Jamaica Bay, zoning and land use, interagency coordination, public outreach and education, and funding. Initial activities included development of draft goals related to restoration and maintenance of Jamaica Bay's water quality and ecological integrity; definition of the geographic boundaries of the Jamaica Bay watershed and sewershed for use in development of recommendations; and development of measures to assess the actions to be included in the *Jamaica Bay Watershed Protection Plan*. Specific topics addressed by NYCDEP and the Advisory Committee at meetings, working sessions, and technical presentations by outside experts included the following:

- computer modeling of stormwater impacts on water quality that would benefit the Advisory Committee in preparing it recommendations - approach, framework, number and types of runs to be performed, outputs, and other considerations
- existing and projected water quality in Jamaica Bay - dissolved oxygen levels, nutrients, sulfides, flushing rates, nitrogen loading, recontouring of the Bay, water quality standards (current and proposed)
- green infrastructure, including potential for providing incentives and removing barriers to use of green technologies
- zoning and land use opportunities - acquisition of public and/or private parcels abutting wetlands, increase in size of wetlands buffer zone, zoning changes, and other land use policy options
- sea level rise/surface elevation and its potential impact on marshland loss
- Best Management Practices (BMPs) for the control of stormwater
- JFK Airport and impact on Jamaica Bay - deicing techniques/procedures, stormwater management, and other operational practices
- interagency coordination for the efficient implementation of Jamaica Bay protection measures
- coordination of existing and future research efforts
- public education and outreach - need for expanded opportunities, coordination of educational and outreach programs, targeted Jamaica Bay school curricula, etc.
- adaptive management
- restoration of marshlands/wetlands loss
- borrow pit restoration
- management of the aesthetic landscape of Jamaica Bay, including removal of floatables
- need for safe, public access to Jamaica Bay, particularly in southeastern Queens.

Public Forums

In order to gather public input for consideration in developing its recommendations, the NYCDEP and Advisory Committee conducted two sets of public meetings: introductory public meetings and public meetings to present recommendations.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Introductory Public Meetings

These sessions were scheduled to review LL71, introduce members of the Advisory Committee to the public and discuss goals of the *Jamaica Bay Watershed Protection Plan* and associated activities and schedules. The first meeting, held in conjunction with the Jamaica Bay Task Force (JBTF), a key stakeholders group, took place on Wednesday, January 11, 2006 at 6:30 p.m. at the Ryan Visitors Center at Floyd Bennett Field, Brooklyn. The second meeting was held on

Thursday, February 9, 2006 at 6:30 p.m. at the Performing Arts Center at York College in Jamaica, Queens.

Each meeting included an open house that provided visual displays detailing project information. NYCDEP representatives and members of the Advisory Committee were available to informally discuss the project and answer questions both before and after the presentation. Handouts included copies of LL71, comment sheets, and information on accessing related web sites. Other available materials included NYCDEP brochures and informational materials addressing general water quality and watershed/sewershed issues, as well as promotional materials provided by stakeholder groups and local constituencies.

A brief presentation, given by NYCDEP and members of the Advisory Committee, provided an overview of LL71; a summary of problems facing Jamaica Bay, along with potential solutions; and a description of current protection efforts being conducted by NYCDEP and other agencies and organizations. A list of the many regulatory authorities with jurisdiction over Jamaica Bay was also reviewed. Brad Sewell, Advisory Committee Co-Chair, elaborated on the Advisory Committee's role in the process, emphasizing that the group would retain an independent voice, while working in cooperation with NYCDEP. Mr. Sewell indicated that the main function of the Advisory Committee would be to suggest new approaches to protecting the watershed, while representing the varied views of the many involved stakeholders. A public comment period followed the presentations. Each meeting was recorded by a stenographer.

Meeting attendees included residents, business and property owners, agency representatives, elected officials, and community organizations. Over 100 people attended the Brooklyn meeting and more than 60 people attended the meeting in Queens. To publicize the meetings, display ads were placed in local newspapers; press releases and community calendar announcements were sent to community newspapers and local cable television stations; and meeting notices were placed on the web sites of NYCDEP and the Jamaica Bay Research and Management Information Network (JBRMIN). The JBTF also distributed Save-the-Date notices for each session to members of its listserve. Similar announcements were sent to the National Park Service's Jamaica Bay Institute listserve.


Snow Geese; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Summary of Comments

Over 25 persons presented testimony or submitted written comments at the two initial public meetings. Major issues are summarized below:

Brooklyn

- Suggestion to acquire property (public or private) in the vicinity of Jamaica Bay in order to enhance public access to the Bay.
- Need for additional information in order to better understand the ecology of the Bay (flushing rate, loss of sedimentation, salt marsh loss and restoration, sea level rise, etc.).
- Opposition to filling of borrow pits, particularly with dredged material.
- Concern about overall water quality, including impact of nitrogen loading from local water pollution control plants, floatables, stormwater discharges, etc.
- Comments about composition of the Jamaica Bay Watershed Protection Plan Advisory Committee, selection process for

appointing members and the Committee's length of service.
- Concern about increased presence of Asian Shore crabs in Jamaica Bay.
- Need to establish educational programs.
- Support for reducing impervious surfaces.
- Need for interagency coordination.
- Comments related to overall schedule of project and need to identify funding sources.

Queens
- Suggestions to use green building techniques in new construction to minimize impervious surfaces adjacent to the Bay/Support for use of green streets and landscaping.
- Need for protection and preservation of Idlewild Park.
- Need for increased public access to the Bay, especially in eastern Queens.
- Support for limits on development in areas bordering the Bay/Need for new and/or enhanced regulations to encourage the creation of open spaces as part of any new industrial development/Need to build sustainable communities.
- Importance of enforcing wetland regulations.
- Need to control development through regulatory and economic incentives.
- Support for acquisition of vacant (public and private) parcels for parkland.
- Opposition to plans to redirect Brookville Boulevard.
- Request for demapping of Nassau Expressway.


Four Sparrow Marsh; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

- Concern about impact of JFK Airport on Jamaica Bay (stormwater runoff, deicing, fuel farm, other operational issues).
- Support for use of natural systems (salt marsh, oyster colonies, etc.) for filtering and removal of nitrates.
- Need for broad public outreach and increased public education in order to increase awareness of the Bay's history, ecological significance, and precarious condition as a resource requiring protection.
- Need to reduce stormwater runoff to sewer system/Support for channeling flow to the Bay.
- Suggestion to create an interagency task force to maintain ongoing communication and foster coordination across jurisdictional boundaries.
- Concern about rising ground water table/Suggestion to identify possible uses (potable/non-potable) for ground water supply.
- Concern about increased presence of Asian Shore crabs in Jamaica Bay and impact on salt marshes/Need to assess population and impact on marshlands.
- Need to identify funding sources to implement elements of the *Jamaica Bay Watershed Protection Plan*.

Public Meetings to Present Recommendations
A second series of public meetings was held to discuss NYCDEP's project status and the Advisory Committee's draft recommendations.

Public Workshop; Source: NYCDEP

These meetings were scheduled to provide opportunities to receive public comments for the continued development of the *Jamaica Bay Watershed Protection Plan* and before submission of the Advisory Committee's final recommendations to the NYCDEP Commissioner and Speaker of the Council.

Advisory Committee Recommendations
LL71, which required the preparation of the *Jamaica Bay Watershed Protection Plan* and established the Advisory Committee, also required that the Advisory Committee present its recommendations for the *Jamaica Bay Watershed Protection Plan* to the City Council by July 1, 2006. On June 29, 2006, the Advisory Committee published and submitted the document titled "Planning for Jamaica Bay's Future: Preliminary Recommendations on the Jamaica Bay Watershed Protection Plan." This document included 61 recommendations in three primary groupings: degraded water quality, compromised ecology, and inadequate planning and outreach. Also as required by Local Law 71, On September 1, 2006, the NYCDEP submitted to the City Council the agency's initial responses to the preliminary recommendations of the Advisory Committee in the document titled "Interim Report, September 1, 2006."

Detailed discussions relating to the Advisory Committee's recommendations continued with the NYCDEP throughout the remainder of 2006.

Public Workshop
On December 7, 2006, a public workshop was held at Kingsborough Community College in the Jamaica Bay watershed. The objective of the workshop was to present to the public the potential management strategies presently under consideration, and to solicit additional potential strategies from the public. Attendance was approximately 100 people. NYCDEP contacted a number of individuals from public and private organizations active in the protection of Jamaica Bay, and from academic institutions who are and have performed research on and are knowledgeable about the Bay, and specifically invited these individuals to attend and participate in the workshop. Commissioner Lloyd of NYCDEP opened the workshop with a keynote presentation. The input from the workshop to the plan was significant – in particular, comments received at the workshop caused this *Jamaica Bay Watershed Protection Plan* to be reorganized and the number of categories focused from six to five through the combination of two related topics.

Web sites
An additional means of providing public access to project information was offered via NYCDEP's project web site (http://www.nyc.gov/html/NYCDEP/html/news/cac-jb.html). The site, which is updated as information became available, includes LL71, a list of Advisory Committee members and their affiliations, public meeting materials (presentations, transcripts, public notices, and press releases), an information request form, contact information, and links to other informational materials. Jamaica Bay materials can also be found on the JBRMIN web site maintained by the Center for International Earth Science Information Network at Columbia University (http://nbii-nin.ciesin.columbia.edu/jamaicabay/jbwppac/advisorycommittee.html).

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Chapter 8 - Previous and Current Planning Efforts

8.1 THE PAST

Over the years there have been many plans proposed for Jamaica Bay and the surrounding area. Chapter 2 describes some of the proposals of years past. These plans have not always considered the natural environment of the Bay and its watershed. Among the projects was a proposal to "...reclaim what is practically waste land and water..." (Grout, 1905) into a major port for commerce. The dredging of a number of areas of the Bay to provide the needed depth of water for shipping channels, the reclamation of salt marshes, the filling in of other shallow areas and hummocks, the construction of piers, and the bulkheading of the Bay's islands and shores throughout the entire extent of the Bay were to be included in the project. Needless to say, the objective of turning the Bay into a major port was not realized. However, various aspects of the proposal were carried out including:

- dredging of the Bay for the purpose of maintaining navigation, not for ocean going merchant ships but primarily for the benefit of recreational boaters;
- the construction of many miles of bulkheads to stabilize shorelines; and
- the construction of countless piers and docks to accommodate private recreation boats ranging from small run-abouts to luxury yachts, ferries, and sightseeing boats.

In contrast, over the past 20 to 25 years there have been numerous planning efforts to focus efforts on restoring the Bay. These plans included a myriad of technical site investigations, sampling and analysis programs, or other studies undertaken by various government agencies with regard to Jamaica Bay. It may literally be impossible to identify every investigation, study, or evaluation program that has been conducted.

> *"Nature will bear the closest inspection. She invites us to lay our eye level with her smallest leaf, and take an insect view of its palm."*
>
> *– Henry David Thoreau*

Recognizing that the passage of LL 71 was preceded by a long history of activism and public education, the NYCDEP and the JBWPPAC attempted to learn as much as possible about previous and ongoing projects and programs. This understanding of other efforts has avoided "re-inventing the wheel" and has set the stage for greater coordination among all concerned stakeholders.

A few of the more significant planning reports are summarized in the sections below.

8.2 RESTORATION/CONSERVATION PLANS

A large number of projects for improving or protecting the water quality and wildlife habitat of Jamaica Bay have been proposed over the past 20+ years. The primary contributing agencies have been the USACE, NYSDEC, NYCDEP, NPS, USFWS, New York/New Jersey HEP, as well as a number of non-governmental organizations. A number of significant studies have been performed and reports have been prepared for either the larger NY/NJ Harbor Estuary region or more specifically, for Jamaica

Bay. Table 8.2.1, following, presents a summary of several key initiatives taken in the last 15 years.

Of the programs summarized in Table 8.2.1, many had well-considered planning phases. Studies continued to confirm and build upon the foundations and findings in previous reports. However, until very recently, the record of the implementation of recommendations for restoration projects has been spotty. The LL 71 that established the process leading to the preparation of this *Jamaica Bay Watershed Protection Plan*, and the Plan itself, recognize the importance of implementation strategies. This will be a major focus of the Final Plan to be issued in October 2007 and beyond with future plan updates.

Additionally, there have been several other plans of note:

- The "Buffer the Bay" report was jointly prepared by the TPL and the New York City Audubon Society (NYCAS) in 1987. In 1992, the "Buffer the Bay Revisited" plan was prepared to expand on the previous report. The focus of these reports was to identify undeveloped lands adjacent to Jamaica Bay and to characterize their ownership status. The 1987 report identified a total of 11 sites. The 1992 report found that four of the recommended sites, or 154 acres had been protected. This report also added three additional sites worthy of protection.
- The 1994 Jamaica Bay Comprehensive Management Plan found that 18 sites identified in the "Buffer the Bay Revisited plan" and the "New York State Open Space Plan" had been acquired for preservation.
- The Draft 2005 "New York State Open Space Conservation Plan" identifies four important remaining sites suitable for acquisition. The four sites are Hook Creek, LILCO Property at Beach 116th Street, Sea Girt Avenue Wetlands, and Spring Creek/Fresh Creek. Significant NYCDEP parklands identified as both Spring Creek (approximately 92 acres) and Fresh Creek (approximately 38 acres) have already been acquired.

TABLE 8.2.1 Key Planning Initiatives

PROGRAM	DESCRIPTION	DETAILS
Restoration of Natural Resources Through the Jamaica Bay Damages Account: Reconnaissance Report (NYSDEC, 1993)	Presented a range of restoration projects developed by city, state and federal agencies (NYSDEC, NYCDPR, NPS, Trust for Public Lands).	Included 55 projects in Bay; updated in 1997 with 25 additional sites. To be funded by NYSDEC's Jamaica Bay Damages Account (JBDA). Several notable projects implemented.
Jamaica Bay Comprehensive Management Plan (NYCDEP, 1994)	Qualitatively screened a wide range of ideas ("alternatives to abatement alternatives") in three major categories: Engineering, Issues, Ecosystem Restoration.	Ecosystem Restoration strategies: • Cleanup of selected areas within the Bay (10 upland and shoreline sites) • Sediment studies • Sediment removal and remediation • Landfill remediation • Habitat restoration (11 intertidal and high marsh sites) • Manmade systems (wetland and freshwater pond construction) • Aquatic toxicity • Continuous water quality monitoring • Grass land habitat • Nutrient import export and flux
Jamaica Bay: Navigational	Identified habitat	Evaluated 42 restoration sites, several with

PROGRAM	DESCRIPTION	DETAILS
Channels and Shoreline Environmental Surveys, Final Report (USACE, 1997)	restoration sites	more than one restoration option. Provided site location maps, description of existing conditions, general restoration recommendations, and potential construction complaints.
Significant Habitats and Habitat Complexes of the New York Bight Watershed (USFWS, 1997)	Jamaica Bay and Breezy Point identified as Complex #16	Breezy Point, Floyd Bennett Field and the Jamaica Bay Islands identified as "focal areas" with high ecological function and value. Report serves as foundation for a number of restoration projects, including Marsh Island Restoration Plan for 90 acres of intertidal marsh within Elders point Marsh and Yellow Bar Hassock.
Comprehensive Conservation and Management Plan (NY/NJ Harbor Estuary Program [HEP], 1997)	Section 320 of the Clean Water Act	NY/NJ Harbor Estuary designated an "Estuary of National Significance" (1988). CCMP provides long-term strategies and intermediate actions to protect, restore and enhance habitat. Recommends 24 restoration sites and 2 acquisition sites in Jamaica Bay ecosystem, with 11 restoration sites designated "Highest Priority Sites."
Jamaica Bay Ecosystem Research and Restoration Team, Final Report, March 2002, Volumes I, II, and III.	Jamaica Bay Ecosystem Research and Restoration Team established (2000) to perform a detailed study of 12 sites in Jamaica Bay.	Coordinated by NPS and Aquatic Research and Environmental Assessment Center (Brooklyn College); funded by USACE, NYSDEC, NYCDEP. Detailed inventory (physical, geophysical, vegetation, water quality, soils, sediment, wildlife). Sites reduced to 8 for conceptual design: Dead Horse Bay, Paerdegat Basin, Fresh Creek, Spring Creek South, Hawtree Point, Bayswater State Park, Dubos Point, Brant Point. NYSDEC committed to using $2.5 million of JBDA funding for one or more sites.
Blue Ribbon Panel (convened by NPS, 2001)	To address issue of marsh loss and sea level rise in Jamaica Bay	Recommended "pilot projects to build back recently submerged marshes and to reduce erosion of existing marshes." Big Egg Marsh project constructed by NPS in 2003. USACE environmental assessment (2005) identifies restoration of 90 acres of salt marsh within Elder's Point Marsh (60 acres, presently under way) and Yellow Bar Hassock.
Hudson-Raritan Estuary (HRE) Environmental Restoration Feasibility Study – Jamaica Bay Study Area Report (SAR)(USACE, 2004)	Prepares list of potential restoration sites	List of 48 sites (including 23 of HEP's 24 sites). Only very general recommendations for restoration opportunities provided. Currently, plans and specifications for restoration of Gerritsen Creek area of Marine Park completed and awaiting federal funding.

8.3 OTHER NEW YORK CITY PLANS RELEVANT TO JAMAICA BAY

New York City Comprehensive Waterfront Plan. NYCDCP, 1992.

The Comprehensive Waterfront Plan documented the realization that New York City's waterfront was a valuable resource but that decades of inattention and misuse had left much of the City's waterfront in poor condition. The Comprehensive Waterfront Plan set in motion a program to identify specific measures to restore this resource to productive use and for the increased enjoyment of the general public.

The Comprehensive Waterfront Plan acknowledged the experience gained from prior planning efforts while addressing the existing conditions and the legal and regulatory requirements affecting the use and development of the City's waterfront. The plan identified four principal functions of the City's waterfront:

- The Natural Waterfront: beaches, wetlands, wildlife habitats, sensitive ecosystems and the water itself comprised the "natural" waterfront
- The Public Waterfront: parks, public walkways and commercial areas, piers, street ends, vistas and waterways that offer public open spaces and waterfront views comprised the "public" waterfront
- The Working Waterfront: water dependent, maritime and industrial use and various transportation and municipal facilities comprised the "working" waterfront
- The Redeveloping Waterfront: land uses that had changed from previous uses or where vacant and underutilized properties provided the potential for beneficial change comprised the "redeveloping" waterfront.

To balance these competing interests on a more local basis, separate waterfront plans for each borough of the City were then prepared. These individual waterfront plans gave consideration to the goals, resources and major issues, and the short- and long-term approaches, for the respective boroughs in guiding land use change, planning and coordinatio n, and public involvemen t. Each

plan, though prepared as a separate document, was linked to the others so that a comprehensive strategy for the entire New York City waterfront would be identified.

The waterfront plans for Brooklyn and Queens, the two boroughs that surround Jamaica Bay, with the exception of the relatively small portion of the Bay that borders on Nassau County, addressed similar issues. The portions of the respective waterfront plans that addressed the Jamaica Bay/Rockaway area were identical in both plans since there was little, if any, to differentiate the goals and objectives for the waterfront areas between the two boroughs.


Breezy Point; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

The two plan documents are summarized below.

Plan for the Queens Waterfront – New York City Comprehensive Waterfront Plan, NYCDCP, 1993; and Plan for the Brooklyn Waterfront – New York City Comprehensive Waterfront Plan, NYCDCP, 1994.

While these plans were prepared in the early 1990s, the setting descriptions of the Bay's setting and that of the surrounding area are still appropriate in 2006. It was stated in the Brooklyn and Queens waterfront plans that:

"The central planning issue for Reach 17 (Jamaica Bay/Rockaway) is the need to balance its differing functions – as a superb natural resource, as a setting for public recreation, as a working waterfront of inestimable importance to the region, and as a redevelopment opportunity for providing homes and jobs for New Yorkers."

Issues and recommendations were identified for each of the four functions described as the Natural, Working, Public and Redeveloping Waterfronts. Examples of the recommendations are listed below.

The Natural Waterfront

- Designate Jamaica Bay a Special Natural Waterfront Area.
- Limit dredging to maintenance of established navigation channels.
- Examine options for reducing shoreline erosion and habitat disturbance caused by boating activity.
- Clean, fence or install bollards around wetland areas that are subject to illegal dumping and increase enforcement of bans on illegal dumping.
- Develop and implement containment plans for closed landfills.
- Establish an interagency task force (NYCDCP, NYCDEP, NYCEDC, NPS, NYSDEC) to work with the Port Authority to minimize adverse water quality impacts of JFK operations.
- Map the 65 acres of Four Sparrow Marsh as a natural area park.
- Create a Paerdegat Basin Natural Area Preserve to protect and enhance emerging habitats and to provide continuous public access around the basin.

- Map as parkland the area of Spring Creek containing Old Mill Creek and associated tidal wetlands, including isolated privately owned parcels; demap unbuilt streets within the proposed park.
- On Sommerville Basin, consolidate city-owned lots and a privately-owned parcel containing wetland under NYCDPR control.
- Map the vacant land at Vernam/Barbadoes Peninsula as parkland.

The Public Waterfront

- Map new public parks as recommended in the Edgemere Neighborhood Land Disposition Plan.
- In cooperation with NYCDPR and the National Park Service, identify possible sites for boat launches.
- Explore the feasibility of limited public access to the natural areas.

The Working Waterfront

- Accommodate the expansion needs of JFK Airport

The Redeveloping Waterfront

- Rezone areas adjacent to Four Sparrow Marsh, Spring Creek, Mill Basin, Edgemere, Arverne Avenue, and Broad Channel.

The New Waterfront Revitalization Program. NYCDCP, 2002

The New WRP is the city's principal coastal zone management tool. The WRP was originally adopted in 1982 and was revised in 2002. It establishes the New York City's policies for the development and use of the waterfront areas and provides the framework for evaluating proposed projects for consistency with the discretionary actions allowable within the identified coastal zone areas with those policies. The intent of the WRP is to provide the guidelines to maximize the benefits from economic development, environmental protection, and public use of the waterfront while minimizing the adverse impacts and conflicts among those objectives.

All discretionary land use actions and projects involving use of state or federal lands within the mapped coastal zone boundary must be found consistent with the policies of the WRP. For consistency with the WRP, an action or project that is found to be consistent with the WRP will not substantially hinder the achievement of any of the policies and will advance the attainment of one or more of the policies.

The original WRP identified 56 policies. In the 2002 revision, these policies, many of which were vague or redundant, were consolidated to 10 policies. However, each of the 10 policies has two or more detailed components that provide a greater level of specificity. The 10 principal policies are:

- Support and facilitate commercial and residential redevelopment in areas well-suited to such development.
- Support water-dependent and industrial uses in New York City coastal areas that are well-suited to their continued operations.
- Promote use of New York City's waterways for commercial and recreational boating and water dependent transportation centers.
- Protect and restore the quality and function of ecological systems within the New York City coastal area.
- Protect and improve water quality in the New York City coastal area.

- Minimize loss of life, structures and natural resources caused by flooding and erosion.
- Minimize environmental degradation from solid waste and hazardous substances.
- Provide public access to and along New York City's coastal waters.
- Protect scenic resources that contribute to the visual quality of the New York City coastal area.
- Protect, preserve and enhance resources significant to the historical, archaeological, and cultural legacy of the New York City coastal area.

Each of these policies has direct applicability to proposed actions and projects in the Jamaica Bay area. In addition to consistency with the listed policies the compatibility of a proposed actions or project with existing neighboring uses must also be taken into consideration.

8.4 OTHER ENVIRONMENTAL PROGRAMS

In addition to the specific planning documents summarized above, there are several other initiatives and programs that have relevance to existing and future planning efforts aimed at the improvement of Jamaica Bay. Some of these are summarized below.

Critical Environmental Areas

A state or local government may designate a specific geographical area as a critical environmental area (CEA). These areas must be of exceptional or unique character. The NYSDEC has designated Jamaica Bay, its tributaries, tidal wetlands and adjacent areas as a CEA. This designation heightens the level of environmental review that a proposed project must face before it is allowed to proceed. According to the Buffer the Bay Revisited (1992) report, "arguments have been made for the extension of the CEA designation to the Bay's contiguous vacant uplands." Upland areas within the Jamaica Bay watersheds only receive protection as a result of being located adjacent to wetlands, inasmuch as they are regulated as adjacent areas. In New York City, the regulated adjacent areas can be reduced in width significantly for certain uses.

Parklands

Open space is better protected when it is designated as parkland. However, parklands have many competing uses, especially between natural, open space and for recreation.

The Forever Wild Program is an initiative of the NYCDPR to protect and preserve the most ecologically valuable lands within the five boroughs. This designation has been assigned to the following parks within the Jamaica Bay watershed: Marine Park Preserve, Dubos Point Wildlife Sanctuary, Four Sparrows

"Adopt the pace of nature: her secret is patience."
– Ralph Waldo Emerson

Marsh, Forest Park, Rockaway Beach/Arverne Shorebird Preserve, Fresh Creek Park Preserve, Spring Creek Park Preserve, Idlewild Park, and Paerdegat Basin Park Preserve.

In August 2005, the New York City Council passed Local Law 83 of 2005 (Int. 566-A), which established a task force to determine the feasibility of transferring City-owned wetlands to the NYCDPR. Where possible, transferring such wetlands will ensure they are effectively managed and protected. Wetlands are among the most productive ecosystems in the world and provide unique benefits, including water quality improvement, flood protection, shoreline erosion control and opportunities for recreation and aesthetic appreciation. In New York City, there are now only approximately fourteen square miles of wetlands, where one hundred square miles once existed.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Tree Removal and Planting

Trees located along street boundaries and trees located within New York City parks are regulated by the NYCDPR. Regulated activities include, but are not limited to, pruning, fertilizing, spraying for the control of insects and disease, planting, installing decorative lights, tree grates and/or tree guards, and removing or relocating an existing tree. The replacement trees may be transplanted on site, at a park near the site, or monies may be provided to the NYCDPR's tree nursery to purchase trees for planting throughout the city. Projects that may affect existing trees in the Jamaica Bay watershed would be subject to the requirements of this program.

Photograph by Don Riepe, Jamaica Bay Wildlife Refuge

Significant Coastal Fish and Wildlife Habitat Program

This program, under the NYSDOS, rates habitats using a quantitative system to identify the degree to which a habitat is essential to the survival of a large portion of a particular species; supports species which are threatened or endangered; supports populations that have significant commercial, recreational, or educational value; or exemplifies a habitat type that is not commonly found in the state or coastal region. Jamaica Bay in Brooklyn and Queens has been designated and mapped by the NYSDOS as a Significant Coastal Fish and Wildlife Habitat. Proposed developments are reviewed on a case-by-case basis with respect to the critical parameters identified by the habitat designation. The NYSDOS will recommend measures to mitigate potential impacts and may not approve projects that propose unavoidable adverse habitat impacts.

City Environmental Quality Review

The City Environmental Quality Review (CEQR), Executive Order No. 91, as amended, requires environmental analysis for decisions on physical activities, such as construction projects, that chance the use or appearance of any natural resource or structure. The goal of CEQR is analogous to the state's version, which became effective at about the same time.

State Environmental Quality Review

The New York State Environmental Quality Review Act (SEQRA), Environmental Conservation Law Article 8, established a process that requires consideration of environmental factors early in the planning process of many types of projects. SEQRA first became effective on

September 1, 1976. It established a systematic process for environmental review, and incorporated provisions for public review and comment. The goal of SEQRA was to ensure that impacts to the environment were given consideration, and also to provide the methods for a transparent public process.

Uniform Land Use Review Procedure

On June 1, 1976, the City Planning Commission (CPC) adopted the Uniform Land Use Review Procedure (ULURP) which became applicable starting on July 1, 1976. The intent in requiring ULURP was to establish a standardized procedure whereby applications affecting the land use of the city would be publicly reviewed. Key participants in the ULURP process are the NYCDCP and the CPC, Community Boards, the Borough Presidents, the Borough Boards, the City Council and the Mayor.

The types of actions that require review include:

- changes to the City's Zoning Map;
- mapping of subdivisions or platting of land into streets, avenues or Public Places;
- designation or change of zoning districts
- special Permits within the Zoning; Resolution requiring approval of the CPC;
- site selection for capital projects;
- revocable consents, requests for proposals and other solicitations or franchises, and major concessions;
- improvements in real property the costs of which are payable other than by the City;
- housing and urban renewal plans and project pursuant to city, state and federal laws;
- sanitary or waterfront landfills;
- disposition of city owned property; and
- acquisition of real property by the city.

8.5 REFERENCES

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Sea Star; Photograph by Don Riepe, Jamaica Bay Wildlife Refuge