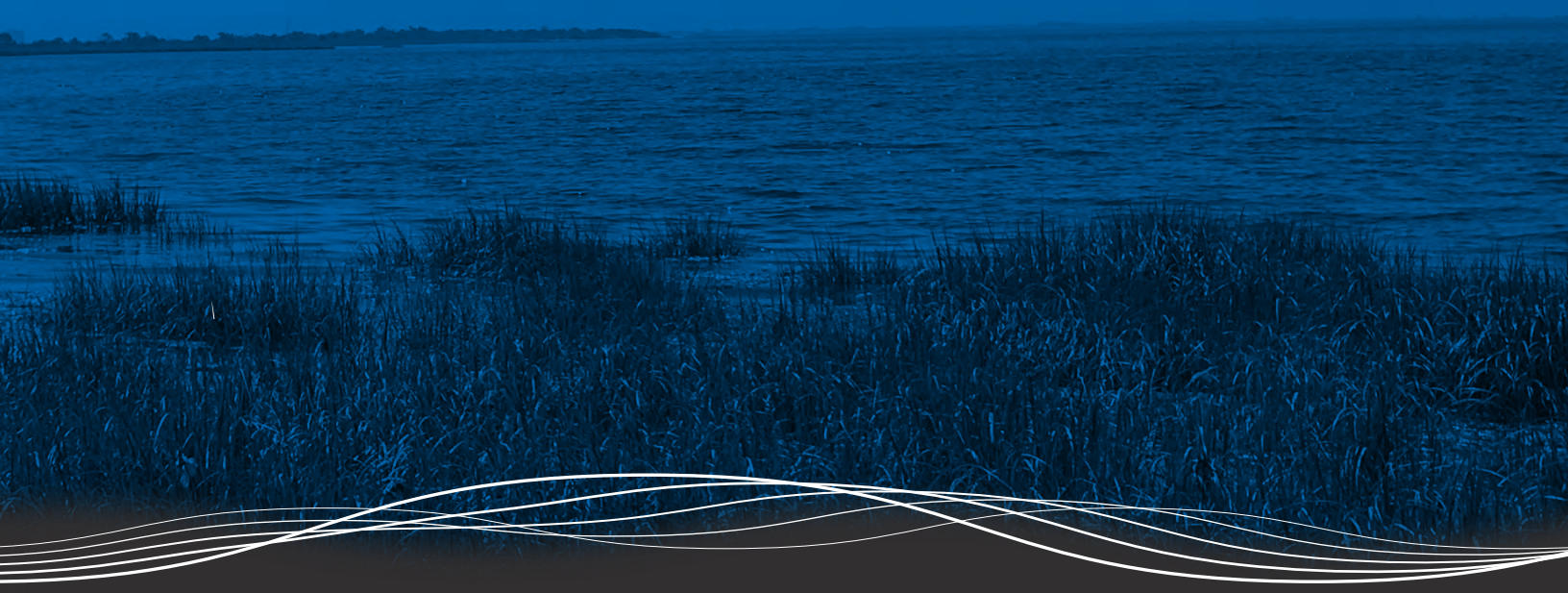
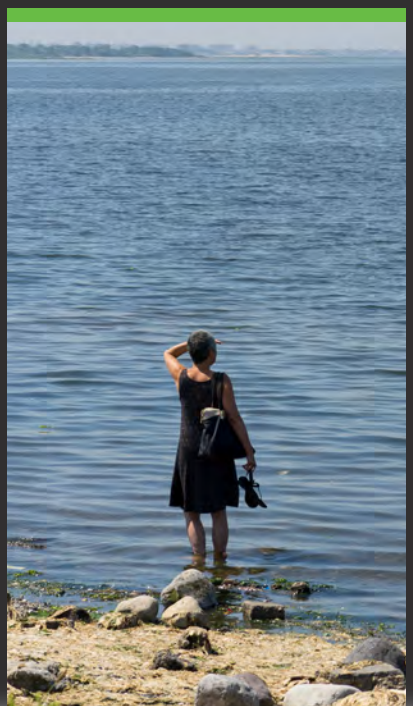
NYC Environmental Protection



Jamaica Bay

Watershed Protection Plan Update 2018



Jamaica Bay

Watershed Protection Plan Update 2018

Prepared by
Bureau of Environmental Planning and Analysis
New York City Department of Environmental Protection

Intent of the 2018 Update and Acknowledgments

This update of the Jamaica Bay Watershed Protection Plan provides a status update on the state of Jamaica Bay and summarizes the results of strategies and research performed to inform future efforts.

The Jamaica Bay Watershed Protection Plan 2018 Update was developed by the New York City Department of Environmental Protection (DEP), Bureau of Environmental Planning and Analysis with assistance from the Science and Resilience Institute at Jamaica Bay and Hazen and Sawyer.

Executive Acknowledgments

Bill de Blasio	Mayor, City of New York
Vincent Sapienza	Commissioner, DEP
Angela Licata	Deputy Commissioner, DEP

DEP Development Team

Pinar Balci	Assistant Commissioner, Bureau of Environmental Planning & Analysis
John McLaughlin	Managing Director, Ecosystem Services, Green Infrastructure & Research, Bureau of Environmental Planning & Analysis

Science and Resilience Institute at Jamaica Bay (Chapter, if Applicable)
Adam Parris
Kathryn Graziano

Water Quality
Brett Branco

Restoration Ecology
Anthony Dvarskas
Christopher Seslar

Community and Social Resilience
Donovan Finn
William Solecki

Hazen and Sawyer

Sandeep Mehrotra	William Pitzer	Liza Faber
Jeffrey Neale	Michael Schilling	Taylor Nesbit
Dahlia Thompson	Alexandra Reardon	Gai Ho
Jazzmin Awa-Williams	John Ramirez	

Table of Contents

Introduction

Importance of Jamaica Bay

Jamaica Bay — one of the largest coastal wetland ecosystems in New York State — provides a nourishing home to diverse flora and fauna and unique recreation space for New Yorkers and visitors from around the world.

Containing more than 20,000 acres of self-sustaining wetlands, islands, marshes, and shorelines, Jamaica Bay supports a wide range of habitats and wildlife, while also providing a diversity of recreational opportunities.

Situated within the five boroughs of New York City (NYC), the Bay offers City residents a unique opportunity to get closer to nature and enjoy outdoor activities. You can find people hiking, wind surfing, swimming, fishing, horseback riding, boating, picnicking, flying kites and model airplanes, and golfing in and around Jamaica Bay.

As the urbanization of NYC has expanded towards the Bay over the last 150 years, the ecologically rich habitat of Jamaica Bay has eroded. A significant portion of the land surrounding Jamaica Bay has been repurposed and water quality has declined, damaging the previously rich ecosystem of Jamaica Bay.

JAMAICA BAY ASSETS

DIVERSE ECOSYSTEMS

Jamaica Bay supports a wide range of habitats and wildlife that in turn serve many ecosystem and social functions for residents of and visitors to Jamaica Bay. The Bay's wetlands, islands, marshes, and shorelines serve as critical habitat for many species of fish, birds, reptiles, amphibians, mollusks, and mammals.

URBAN REFUGE

Jamaica Bay is valued by local home and business owners for its beauty and aesthetic. In addition to providing recreation, the Bay serves as an educational center for people of all ages and is a focal point for research on local marine life.

NATURAL RESILIENCE

Jamaica Bay provides natural flood control and protection against storm surges for New York City. The coastal wetland ecosystem also naturally removes pollutants, maintaining beneficial water quality in the Bay.

OUR VISION

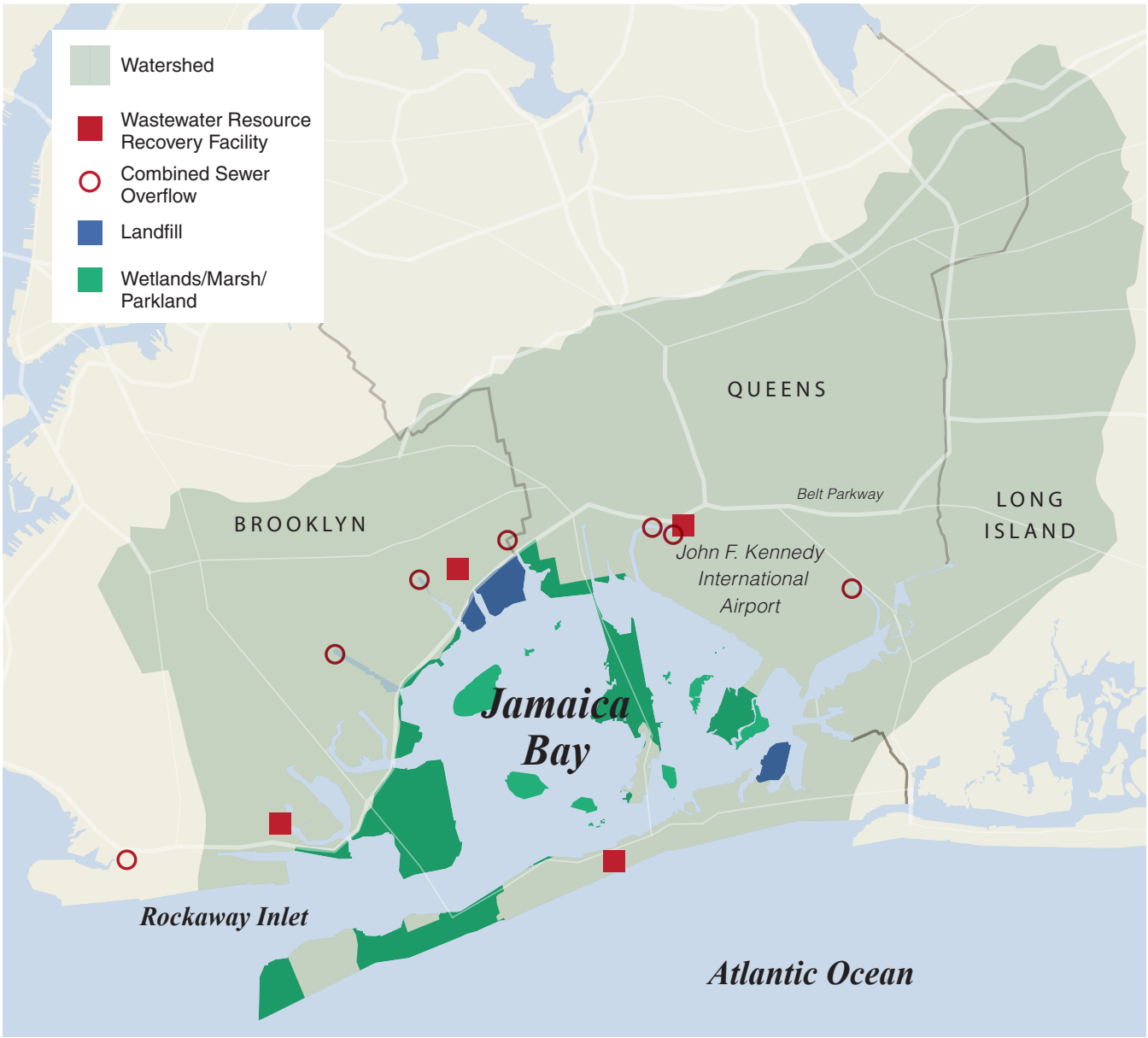
The Jamaica Bay watershed is a place where New Yorkers and visitors coexist with natural areas and clean water that harbor healthy waterfowl, fish, and shellfish populations. It is a place where urban communities embrace environmental stewardship and where wetlands and other natural areas are protected and restored for future generations. The Jamaica Bay estuary is once again a cultural and recreational hub for Brooklyn and Queens, where residents swim, fish, boat, and enjoy nature.

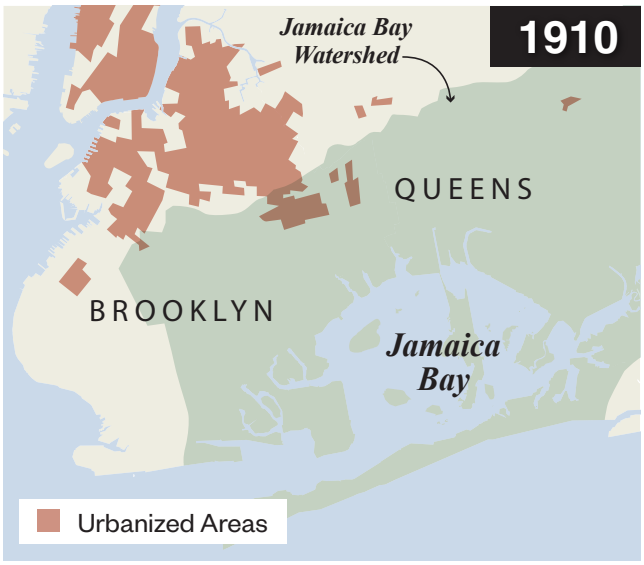
The Urbanization of Jamaica Bay

As the urbanization of New York City pushed eastward toward Jamaica Bay, activities common to this urbanization impacted the ecosystems, land use and functions of the Bay. The primary contributor of pollutants to the Bay currently include wastewater resource recovery facility effluent, combined sewer overflows (CSO), and stormwater runoff.

Certain physical changes made to the Bay and to the watershed to accommodate industry, manufacturing, transportation, recreation, and residents have also irreparably changed the landscape, the ecology, and the recreation the Bay can provide.

Completion of the Brooklyn Bridge in 1883 is often cited as the beginning of the rapid urbanization of Brooklyn, Queens, and Long Island, which together - along with 10,000 acres of parkland - comprise the entirety of the Jamaica Bay watershed.

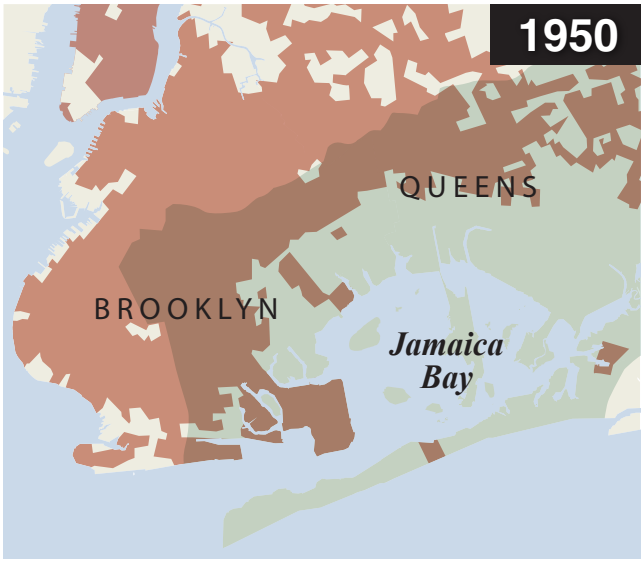




In 1903, construction of the Jamaica Wastewater Resource Recovery Facility (WRRF) was completed, as was the dredging of the channel to Mill Basin and many other channels. Fort Tilden was built on the Rockaway peninsula and Cross Bay Boulevard was constructed.

Throughout these early decades of the 1900s, the primary uses of Jamaica Bay shifted from seasonal fishing and hunting by nomadic Native Americans to permanent farming and fishing by colonist residents. Construction of bulk heads and retaining walls became common.

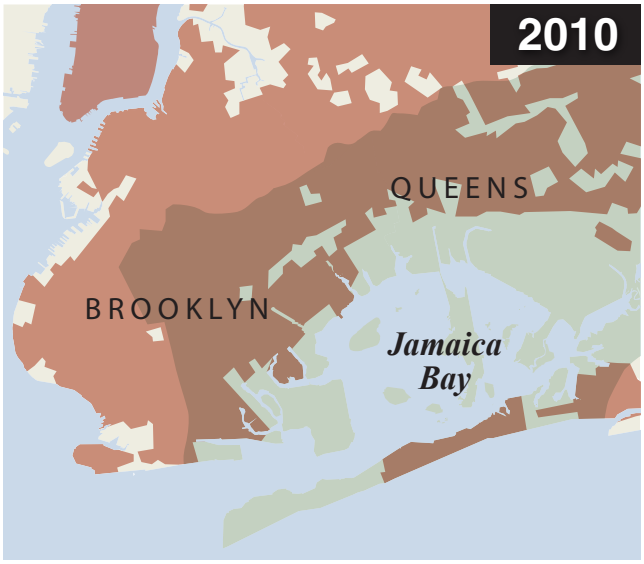
At the same time, primary uses of land throughout the watershed shifted from agricultural/industrial dominant to recreation and residential communities.



1930 saw further development of The Rockaway Beach neighborhood and its boardwalk. Floyd Bennett Field began operation along the Jamaica Bay shoreline as the first municipal airport in NYC.

Three more WRRFs - Coney Island, Rockaway, and 26th Ward - began operation in the watershed in the mid-1900s. In 1940, Idlewild golf course began its transformation into Idlewild Airport, later to be known as JFK International Airport. By 1960, JFK Airport was already being expanded.

The Clean Water Act was passed in 1972. That same year, Jamaica Bay became the purview of the National Parks Service. In the years following, Fort Tilden was decommissioned and all the landfills abutting the Bay were closed.



By 2010, New York City urbanization had reached its furthest extents and restoration of previously removed habitats has begun. Local Law 71 and the Jamaica Bay Watershed Protection Plan were passed in 2005 and 2007, respectively, beginning the formalization of strategies to improve water quality, restore ecosystems, and enhance public access and education of Jamaica Bay and its watersheds.

Protecting Jamaica Bay

Recognizing the value of Jamaica Bay, the New York Department of Environmental Protection (DEP) has invested significant resources into restoring the Bay to the highest water quality standards.

Jamaica Bay Management Strategies and the Impact on Water Quality

Each of the 66 strategies that has been implemented since the release of the original Jamaica Bay Watershed Protection Plan in 2007 falls into one of six categories. The list of strategies can be found at the end of this plan. The next upcoming investment in the Jamaica Bay watershed is the implementation of the Long Term Control Plan. Details on these planned strategies are found on the following page.

Water Quality
Reduce nitrogen loadings, CSOs, and flooding; increase dissolved oxygen; and develop scientific monitoring program.

Restoration Ecology
Restore salt marsh islands in the Bay and preserve and enhance natural areas along periphery of the Bay and watershed.

Stormwater Management and Sewer Buildout
Explore land use and development practices to reduce impervious surfaces and create natural systems to reduce stormwater runoff such as best management practices.

Great Strides

Over the last decade, great strides have been made to restore water quality in Jamaica Bay to its highest standards, and to maintain the ecosystems that make it unique.

Elders Point East — 2007

Elders Point East included 40 acres of marsh island restoration

Penn/ Fountain Landfill — 2008

Landfill restorations to wetland areas removed landfill leachate as a source of pollution to the Bay

Porous Pavement — 2009

Implementation of porous pavement at English Kills Aeration Facility reduced impervious area and treated stormwater runoff

Regulator 2 Automation — 2010

Automation of regulators in Bergen Basin reduced CSO discharges

North/ South Conduit — 2011

Implementation of green infrastructure in roadway medians helped pilot green alternatives within NYC to inform the future city-wide green infrastructure program

The passing of Local Law 71 in 2005 called for a Jamaica Bay Watershed Protection Plan (JBWPP), which outlined management strategies to improve water quality, restore natural ecology, and foster community and social resilience.

This report outlines how DEP - in partnership with other city, state, and federal entities, the scientific community, nonprofits, environmental groups, and others - has implemented the strategies recommended in the original Plan and subsequent updates.

The implementation of the management strategies identified under the JBWPP are well underway, 66 of the 72 strategies have been implemented resulting in a 92% completion.

Public Education

Increase personal connections to Jamaica Bay and awareness of the linkage between human activities and ecological health.

Public Use & Enjoyment

Ensure and enhance public access, recreation, and enjoyment opportunities within Jamaica Bay's diverse natural, cultural, and scenic resources.

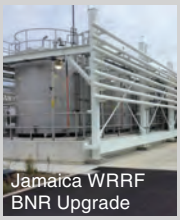
Coordination

Foster partnerships and collaboration to enhance strategy implementation and to coordinate advocacy efforts.

LTCP Recommended Plan for Jamaica Bay and the Watershed

Will build upon the investments already made, continue to provide furthur water quality improvements, as well as, enhance economic, social, and environmental co-benefits.

WATER QUALITY IMPROVEMENTS
Achieved through Strategic Investments


Jamaica WRRF BNR Upgrade

$600 Million
Biological Nutrient Removal (BNR) Upgrades across four wastewater resource recovery facilities (JA, 26W, RK, and CI) that discharge to Jamaica Bay

$32 Million
Ecosystem Restoration and Research Efforts to support pathogen reduction and dissolved oxygen improvement under the Jamaica Bay Watershed Protection Plan


Paerdegat CSO Facility

$1 Billion
Past and Existing Grey Infrastructure investments to reduce combined sewer overflows

$1.9 Billion
Southeast Queens Sewer Buildout commitment over the next decade under the OneNYC Plan

$300 Million
Existing and Planned Green Infrastructure commitment over the next decade under the OneNYC Plan

ELEMENTS OF THE RECOMMENDED PLAN

Additional 379 greened acres in Bergen and Thurston Basin tributary areas

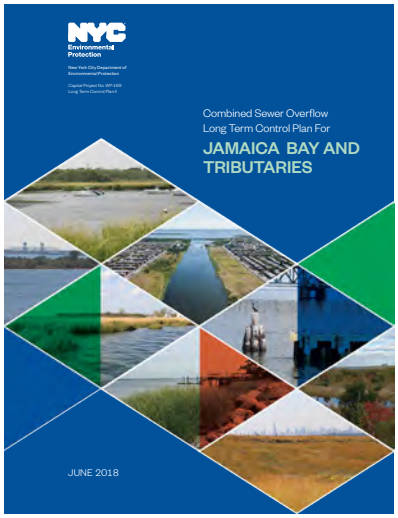
50,000 CY of environmental dredging in Bergen Basin

7 acres of ribbed mussel colony creation

50 acres of wetland restoration

LTCP Recommended Plan

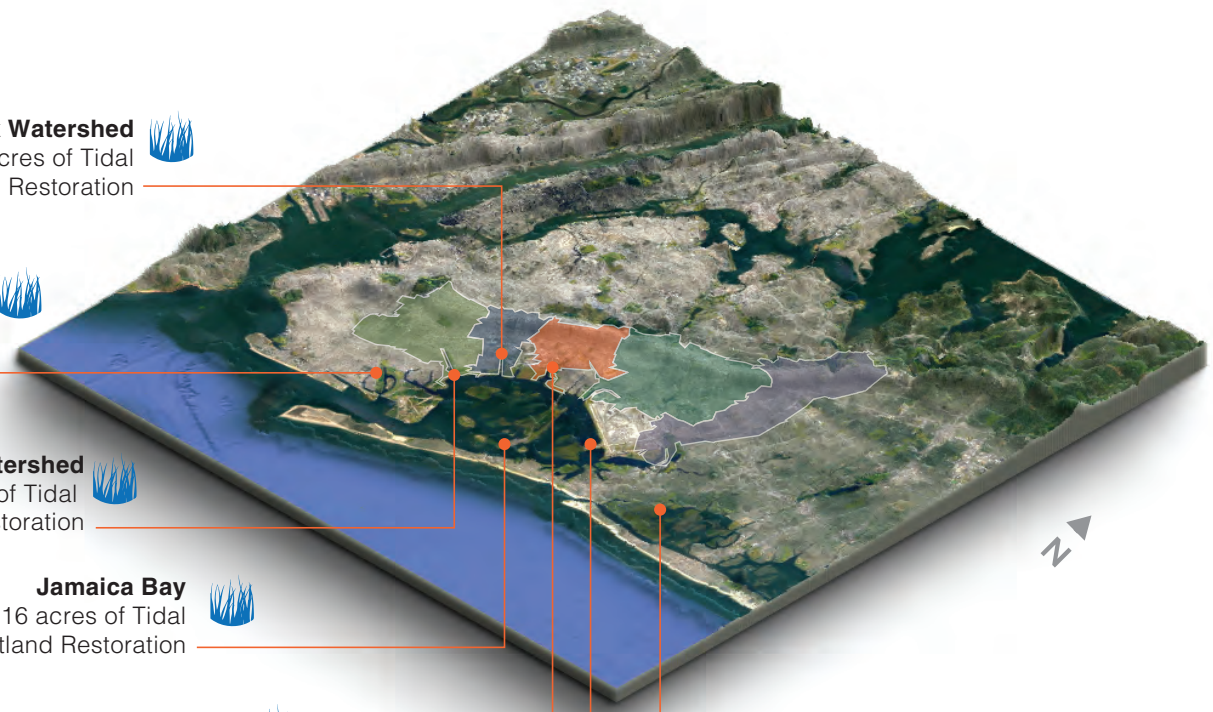
will build upon these past investments and provide further water quality improvements.



This LTCP has been developed in an effort to better understand and address CSO impacts on water quality within Jamaica Bay. Throughout the process for developing this LTCP, DEP collected water quality data, performed extensive collection system and water quality modeling, held multiple public meetings and analyzed potential CSO control alternatives based on costs and model predicted water quality improvement.

The selection of the Recommended Plan was based on multiple considerations including:

- Public input
- Environmental and water quality benefits
- Community and societal impacts
- Issues related to implementation, operation and maintenance (O&M)
- Cost-performance and cost-attainment evaluations



Hendrix Creek Watershed
3 acres of Tidal
Wetland Restoration

Paerdegat Basin Watershed
4 acres of Tidal
Wetland Restoration

Fresh Creek Watershed
14 acres of Tidal
Wetland Restoration

Jamaica Bay
16 acres of Tidal
Wetland Restoration

Spring Creek Watershed
13 acres of Tidal
Wetland Restoration

Bergen Basin Watershed
232 acres of Green Infrastructure Expansion
50,000 CY Environmental Dredging
3 acres of Ribbed Mussel Colony Creation

Thurston Basin Watershed
147 acres of Green Infrastructure Expansion
3 acres of Ribbed Mussel Colony Creation

TRIPLE BOTTOM LINE BENEFITS

- **Water quality improvement through the filtering of the ribbed mussels**
- **Reduce CSO discharges to Bergen and Thurston Basins by 15MGY**
- **Provide air quality improvement**
- **Stormwater discharges by 234 MGY**
- **Carbon footprint reduction**
- **Habitat creation**
- **Property value improvement**
- **Heat island construction reduction**

The Current Update to the Jamaica Bay Watershed Protection Plan

The 2018 Update aims to provide a comprehensive look at the state of Jamaica Bay, 10 years after enaction of the initial Plan.

As part of this Update, DEP has partnered with the Science and Resilience Institute at Jamaica Bay (SRIJB), along with members of other academic institutions, who evaluated peer-reviewed independent literature to identify current trends within Jamaica Bay. The partnership embarked on a process to evaluate the current state of Jamaica Bay within three categories: water quality, ecological restoration, and community and social resiliency. While some aspects of Jamaica Bay have been thoroughly researched and recorded, other parts require further data and research to determine current and future trends.

DEP and SRIJB hosted a workshop on October 10th, 2018 to gain feedback on the identified trends from members of regulatory agencies, other managing City, State, and Federal departments, non-profit organizations interested in Jamaica Bay, community groups, and academic institutions. The feedback gathered on each of the topics, trends, and supporting information helped shape the content of this document. The trends sections of this report helps to synthesize and evaluate decades of ongoing scientific research on a diverse array of issues. To synthesize this work, methodologies developed through the US National Climate Assessment, the Intergovernmental Panel on Climate Change, and the New York City Panel on Climate Change that standardize uncertainty characterization and communication were used. The key trends, shown in bold, often include estimates of likelihood or confidence in various trends. These estimates were developed through traceable accounts where authors were asked to consider the balance of quantitative and qualitative evidence from multiple studies, datasets, and sources, including those represented at our workshop. The traceable accounts were modified in form to create a more user-friendly document readable for a public audience. Further information on the traceable accounts, including how likelihood and confidence was assigned, can be obtained by contacting the Science and Resilience Institute at Jamaica Bay.

At the October 2018 workshop, a variety of stakeholders reviewed and discussed preliminary findings of the academic research into water quality, ecological restoration, and community and social resilience of Jamaica Bay. The feedback gathered helped shape the content of this document.

There are many stakeholders who share stewardship of Jamaica Bay, ranging from regulatory and governmental agencies to community groups and non-profits, and from research institutions to the residents and businesses within the watershed. Each group has a vested interest in improving the water quality, ecosystems, and social resilience of the Bay.

The original Jamaica Bay Watershed Protection Plan released in 2007 identified and described most of the stakeholders within the Bay. In the decade since, these seven stakeholders have funded and/or implemented the majority of the management strategies.

The efforts of these agencies have had the substantial support of two other essential groups:

Community groups and non-profits have coordinated consistent volunteer participation in cleaning up the Bay (trash clean up events) and vegetating ecological restorations.

Residents and local business owners maintain a sustaining personal connection to Jamaica Bay, influencing its protection and prosperity for generations to come.

Chapter 1

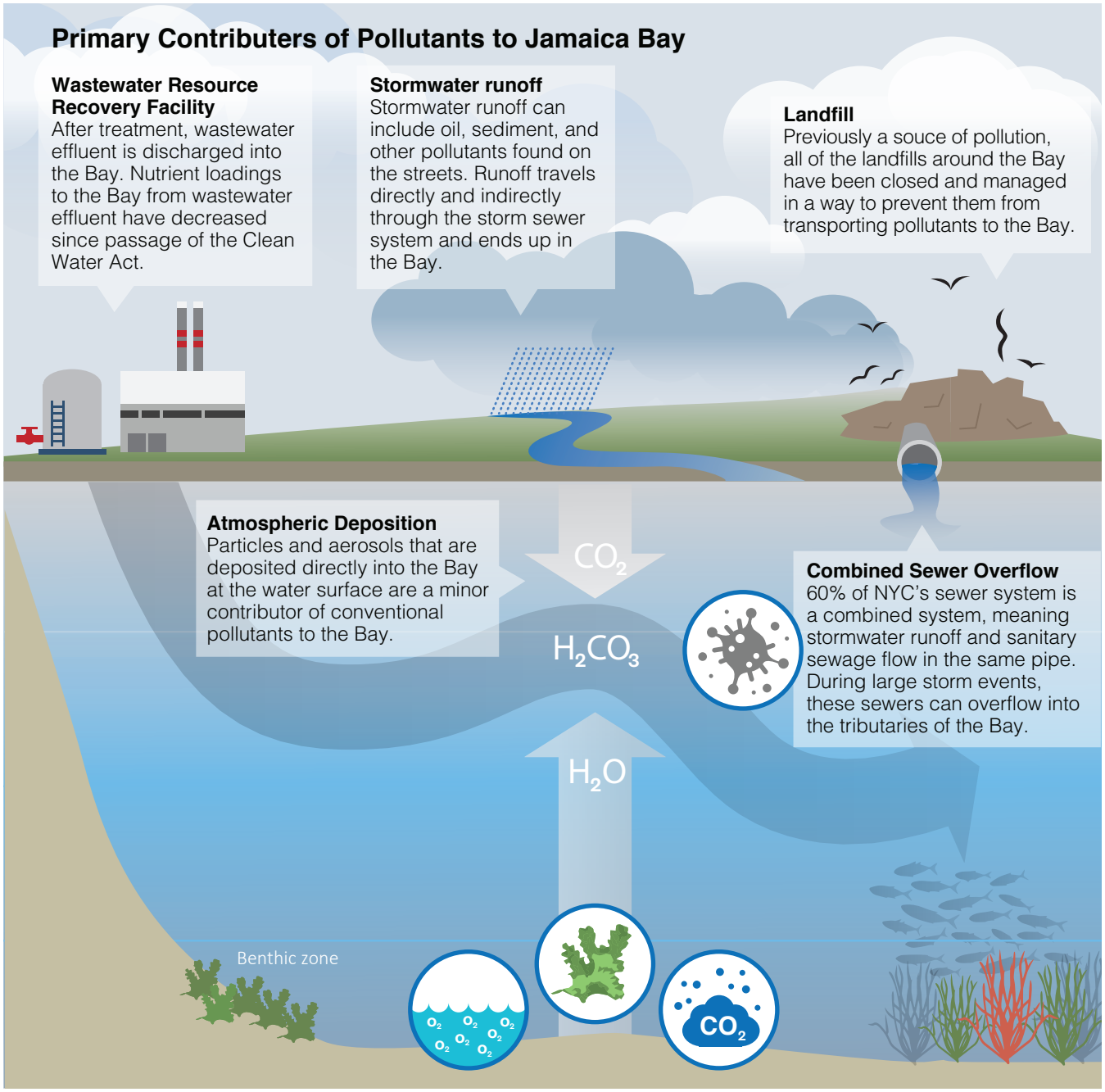
Water Quality

Drivers of Water Quality in Jamaica Bay

Water quality is paramount to the livelihood of Jamaica Bay and efforts to reduce nutrient loadings to the Bay have largely succeeded. It may be some time before we learn the long-term effects of these reductions, due to the complexity of interactions between water quality drivers and indicators.

Water quality has significant consequences for every living organism within the Bay, and for naturally occurring ecosystems, such as oyster beds, marsh islands, and mudflats.

Changes in pollutant loading, climate (eg. temperature, precipitation, wind), and other physical characteristics, such as changes in depth from dredging, affect water quality.



Water Quality Indicators

We monitor a variety of water quality indicators to gauge ecosystem health and classify waterbodies for intended uses. Today, the open waters of Jamaica Bay are classified by New York State for bathing or other recreational uses (Class SB) while the tributaries are classified for secondary recreational uses such as fishing or boating (Class I).

These classifications carry specific regulatory limits for water quality indicators such as dissolved oxygen (DO), fecal coliform, and Entercoccous bacteria, which are indicators of sewage contamination. Nitrogen, although not a pathogen and posing no threat to human health, can limit DO and affect overall waterbody health. Examining these indicators offers deeper insight into the overall ecological health of Jamaica Bay.

NITROGEN

Nitrogen promotes harmful algal growth, and nitrogen toxicity has been suggested to limit the survival of aquatic plants and may contribute to marsh loss. Reducing nitrogen loading has been a focus of the JBWPP and current levels are meeting nitrogen limits, a 12-month rolling average of 31,118 lbs/day Total Nitrogen, set in August 2017.

DISSOLVED OXYGEN

Dissolved oxygen is necessary for the survival of aquatic life. Low dissolved oxygen levels can also lead to odor problems in a water body. In 2005, dissolved oxygen levels were above New York State Department of Environmental Conservation (NYSDEC) standards and met water quality standards. Current levels continue to exceed NYSDEC water quality standards, with a 2017 surface water DO summer average of 7.37 mg/L.

PATHOGENS

Coliform bacteria are unlikely to cause illness, but their presence in water indicate that pathogens could also be present. Enterococcus bacteria is also measured as an indicator of sewage contamination. From 2005 onward, the water quality in Jamaica Bay meets the bathing criteria, and summer fecal coliform levels are well below the bathing standards for fecal coliform and Enterococcus. However, during wet weather conditions, the Bay does experience localized spikes in fecal coliform which may temporarily exceed the standard and result in the issuance of bathing advisories.

CHLOROPHYLL A

Chlorophyll a is a good indicator of the amount of algae in water. High concentrations of chlorophyll a in the Bay are indicative of eutrophic (highly nutrient enriched) conditions, which are exacerbated by the slow turnover of water within the Bay. Jamaica Bay has the widest range of individual chlorophyll a measurements of the four geographic Harbor survey regions. The measurements of chlorophyll a averaged at 24.62 µg/L in 2017.

Water Quality Management Strategies and Effects on Jamaica Bay

Many of the management strategies implemented since the original Plan was issued have targeted improving water quality in Jamaica Bay and its tributaries.

The water quality objectives have largely been achieved through the implementation of green and gray infrastructure and strategies. Some strategies have focused on reducing larger point-source pollutant loadings while others have focused on improving both water quality and ecosystem function of the Bay and the watershed.

OBJECTIVE

Reduce nitrogen loading to the tributary basins and Jamaica Bay.

WRRF Treatment Upgrades

Addition of step feed biological nutrient removal (BNR) with chemical addition at 26th Ward and Jamaica WRRFs have provided some of the largest reductions of nitrogen loading to Jamaica Bay.

Anticipated WRRF Upgrades

Construction of step feed BNR has also been initiated at Rockaway and Coney Island WRRFs to further reduce nitrogen loading to Jamaica Bay.

Eco-Pilots

Pilot projects to reintroduce and grow ribbed mussels and oyster reefs both improve water quality and increase biodiversity and bivalve populations within the Bay.

The ribbed mussel pilot project showed ribbed mussel population growth within Jamaica Bay and the potential for water quality improvements as a result of a larger scale implementation. DEP is continuing to partner with academic institutions to study the potential water quality improvements within the water column and identify the best structural configurations to encourage significant densities of ribbed mussel population growth.

The first Oyster Reef pilot project included evaluating if environmental and climatic conditions were suitable for oyster growth. It was determined that oyster populations were sustaining and appeared healthy and that Jamaica Bay water quality is within normal tolerances for the Eastern Oyster.

Since publishing the Jamaica Bay Watershed Protection Plan in 2007, DEP has implemented 66 strategies, corresponding with an improvement in water quality in the Bay.

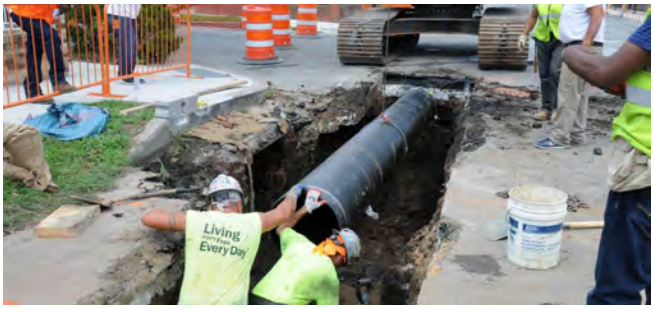
OBJECTIVE

Reduce CSO and other discharges to the tributary basins to improve pathogen and DO levels.

Facility Upgrades

Implemented improvements include construction of the Paerdegat CSO Facility, upgrades to Spring Creek CSO Facility, upgrades to 26th Ward WRRF preliminary treatment, bending weirs and new parallel interceptor in the Jamaica WRRF drainage area.

Sewer System Improvements



High-level sewer separation in the Fresh Creek drainage will reduce CSO discharges into Fresh Creek. Cleaning of the sewers is a city-wide program, including a focus on the 26th Ward WRRF sewersheds. In 2010, sediment was removed from sewers in Williams Street, Hegeman Avenue, and Flatlands Avenue sewers.

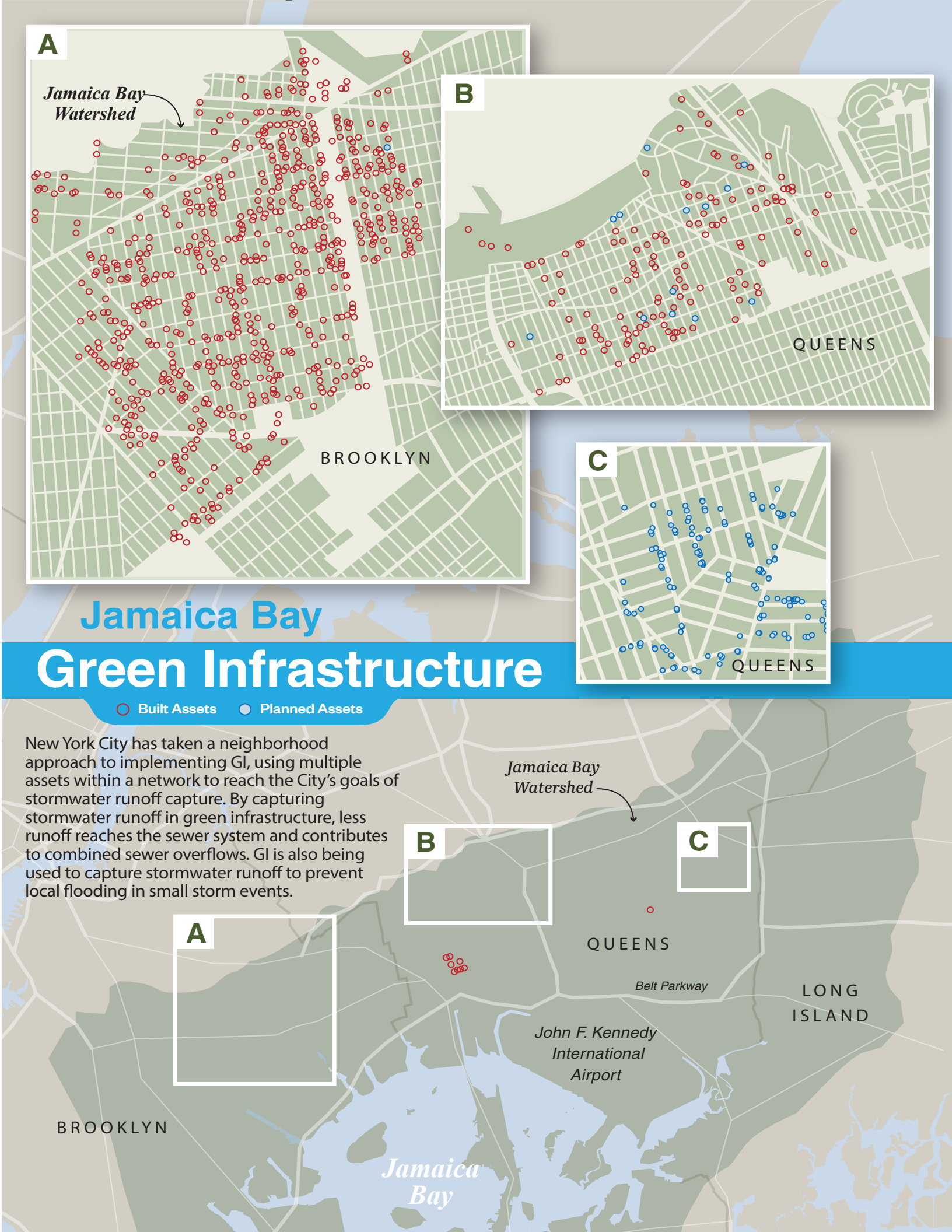
CSO Long Term Control Plan (LTCP)

A LTCP was submitted to NYSDEC in July 2018 for review and approval. It recommends a “green approach” that includes 50 acres of wetland restoration, 7 acres of ribbed mussel biofiltration, 379 acres of additional green infrastructure, and 50,000 cubic yards of environmental dredging. (See details on page 8.)

Green Infrastructure Program

In addition to reducing stormwater runoff to the sewers during frequent rain events, green infrastructure provides many co-benefits, including improving air quality, providing jobs in construction and maintenance, and increasing green space for communities throughout the watershed.

Upgrades to the 26th Ward WRRF improved operations of preliminary treatment reliability enabling the plant to capture and treat more wet weather flow, reducing CSO into Fresh and Hendrix Creeks.


A
Jamaica Bay Watershed
BROOKLYN
B
QUEENS
C
QUEENS
Jamaica Bay
Green Infrastructure
Built Assets
Planned Assets
New York City has taken a neighborhood approach to implementing GI, using multiple assets within a network to reach the City's goals of stormwater runoff capture. By capturing stormwater runoff in green infrastructure, less runoff reaches the sewer system and contributes to combined sewer overflows. GI is also being used to capture stormwater runoff to prevent local flooding in small storm events.
Jamaica Bay Watershed
B
C
A
QUEENS
Belt Parkway
LONG ISLAND
John F. Kennedy International Airport
BROOKLYN
Jamaica Bay

OBJECTIVE

Increase dissolved oxygen levels and improve aesthetics in tributary basin areas of chronic hypoxia to improve ecological productivity.

Environmental Dredging

Environmental dredging in Hendrix Creek and Paerdegat Basin has removed built up sediment from combined sewer overflows.

Tidal Wetland Restoration

The restoration of areas such as landfills has returned wetland space to its original use after years of serving another purpose within the Bay. DEP is continuing to monitor these restoration locations and examine vegetation health.

OBJECTIVE

Promote the use of on-site best management practices in new and existing development.

Public Property Green Infrastructure

Green infrastructure constructed at PS 50 aims to remove stormwater runoff from impervious areas, keeping it out of the combined sewer system. The green infrastructure types piloted include rain gardens and a turf field.

Best Management Practice Design Manual

The stormwater manual of various green infrastructure practices aims to provide design guidance for anyone wishing to provide stormwater management on their property. The design guidance includes important criteria and calculations to determine impacts of any proposed infrastructure.

Four major indicators of environmental change reported as part of the Harbor Water Quality program are:

1. Dissolved oxygen
2. Bacteria
3. Secchi Transparency
4. Chlorophyll

Nitrogen is also measured by the City to track compliance with maximum monthly and 12 month rolling average limits for Total Nitrogen, and to comply with the special conditions anticipated under the revised State Pollution Discharge Elimination System (SPDES) Permit.

OBJECTIVE

Develop a robust and coordinated scientific monitoring program.

The Harbor Water Quality Survey has added 22 monitoring stations within Jamaica Bay and its tributaries since the original Jamaica Bay Watershed Plan in 2007. The most stations were added within the tributaries to Jamaica Bay to provide more localized data and information. Additionally, four monitoring stations were added within the Jamaica Bay Interior.

Trends in Water Quality

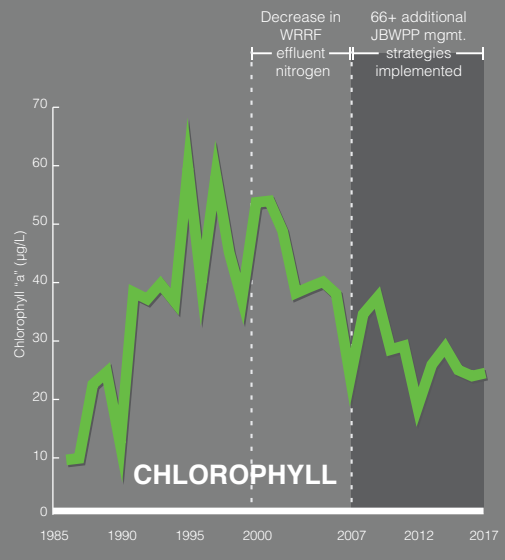
Jamaica Bay's water quality is the product of a multitude of drivers, systems and functions throughout its watershed and along the coastline, as well as interactions within the water column itself. We characterize water quality based on a variety of indicators and attempt to correlate changes in these indicators to changes made or observed in known drivers of water quality, such as wastewater effluent and physical changes to the Bay.

1 KEY TREND

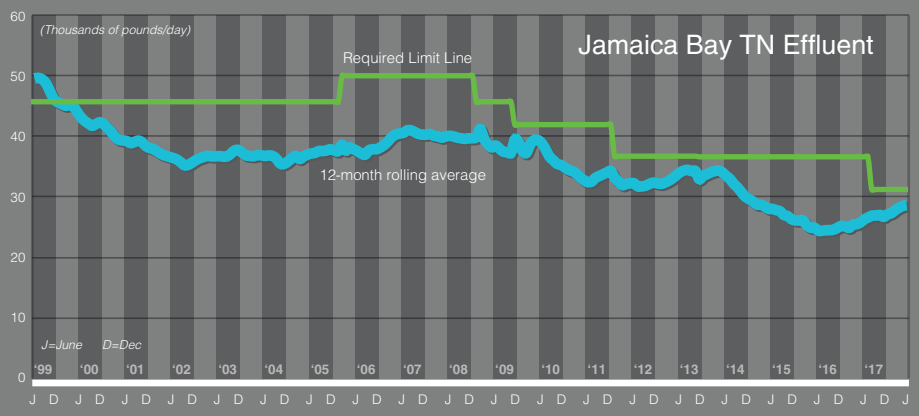
Nitrogen reductions from Wastewater Resource Recovery Facilities (WRRFs) have very likely caused decreases in chlorophyll and nitrogen concentrations in the Bay since 1999 while increasing water clarity.

From 1999 until now, there has been a significant decrease in the total effluent nitrogen load. DEP directly measures the impact of wastewater resource recovery facility upgrades on effluent nitrogen loading to Jamaica Bay presented at right as Jamaica Bay TN Effluent.

The long-term trends in dissolved oxygen (surface and bottom waters), chlorophyll a, water clarity (measured as Secchi depth), and nitrogen concentration are all improving as demonstrated by average annual or summertime bay-wide averages.



Chlorophyll a concentration increased from the 1980s to the mid-1990s, but has decreased since then.



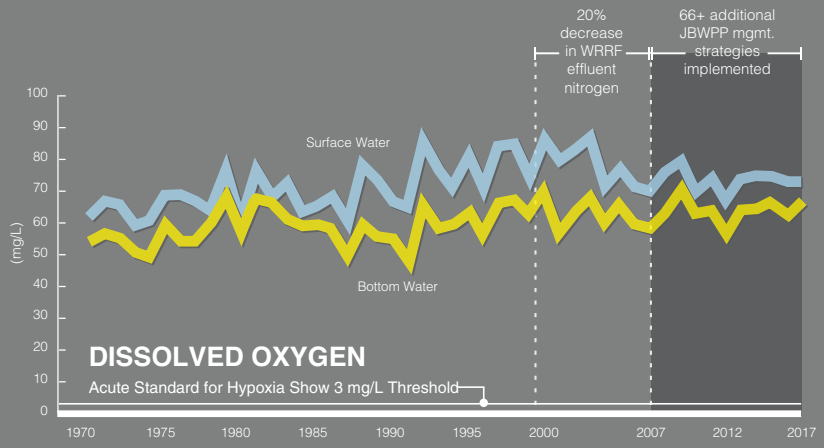
WRRFs are operated to keep nitrogen below the required limits. Upgrades to Rockaway and Coney Island WRRFs are ongoing to further reduce effluent nitrogen.

2 KEY TREND

Due to changes from a long history of development and bottom topography modifications, some locations in the Bay experience periods of near bottom low oxygen conditions (hypoxia) during the summer. Since 1995, there is no clear trend in how frequently these conditions occur from year to year for any particular site.

Hypoxic conditions of less than 3.0 mg/L, the New York State acute standard for Class SB waters, have been documented by DEP, NPS and academic researchers in the bathymetric altered eastern portions of the Bay. DEP Harbor monitoring data and research from Stony Brook University shows that some sites in the Bay fall below this standard during the late summertime, particularly in the northern and eastern reaches of the Bay, but this occurs infrequently. There is no clear trend in how often particular sites fall below 3.0 mg/L or 4.8 mg/L from year to year since 1995.

More research is needed to determine how the duration and extent of bottom hypoxia will change with ecosystem restoration, or whether or not existing hypoxic conditions are adverse.



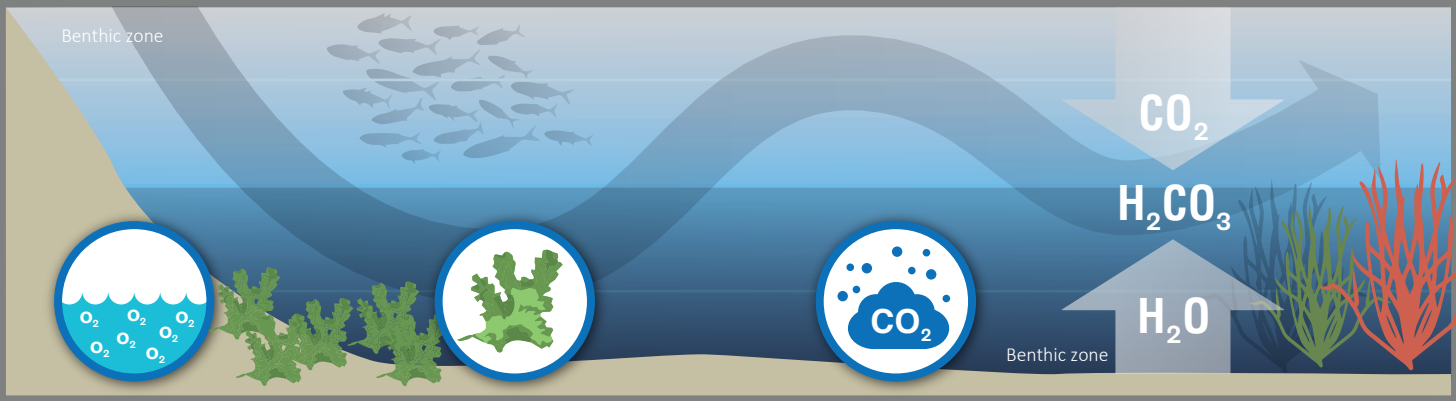
There is low confidence that water quality will continue to improve in response to the completed WRRF upgrades to reduce nitrogen loadings to Jamaica Bay.

KEY TREND 3

The response of water quality to nitrogen load reductions in the Bay is complex and there is incomplete knowledge of all the feedbacks and time delays between load reduction and the ecosystem functions that control water quality. It is not clear how much more water quality improvement might result from further management actions such as ecosystem restoration.

Correlations are difficult to draw because the different drivers of oxygen concentrations appear to demonstrate impact at different time scales. At a year-over-year time scale, DO in the Bay is not correlated with nutrient loadings and chlorophyll concentrations. However, research from Stony Brook University documents very strong correlations between chlorophyll, dissolved oxygen, and pH at the 24-hour timescale.

Blooms of sea lettuce potentially pose significant challenges to further improving water quality and the success of ecosystem restoration, because sea lettuce blooms may restrict sunlight from reaching plant life within the water column, reducing oxygen for other organisms, resulting in hypoxic conditions or dead zones. Additionally, the breaking down of sea lettuce deposits on the Bay bottom requires high amounts of oxygen by the organisms, reducing available oxygen in the water column. Academic researchers found that 90% of Jamaica Bay's bottom is blanketed by sea lettuce during summer months and intertidal biomass of sea lettuce has likely not changed significantly since 1995. As a result, it is not likely that sea lettuce blooms are responsive to nitrogen.



KEY TREND 4

Stormwater management in the watershed has reduced the volume of stormwater and combined sewer overflows to the Bay since 2010, and as a result has reduced the loading of pathogens and emerging contaminants.

The Jamaica Bay LTCP outlined DEP's ongoing work to reduce CSOs as well as the Recommended Plan for expansion of green infrastructure, wetland creation, ribbed mussel colony creation, and environmental dredging in Bergen and Thurston Basins. DEP estimates 202 million gallons a year in CSO reduction as a result of ongoing and planned green infrastructure projects, and an additional reduction of 15 million gallons a year under the Recommended Plan.

The Recommended Plan, detailed previously, will provide increased co-benefits for the watershed in the form of improved air quality, carbon footprint reduction, reduced urban heat island effect, habitat creation, and water quality improvements.

Chapter 2

Restoration Ecology

Ecosystems in Jamaica Bay

One of the largest coastal wetland ecosystems in New York State, Jamaica Bay contains 20,000 acres of self-sustaining wetlands, islands, marshes, and shorelines.

UPLAND

WETLAND

SALT MARSH

Woodland
Woody vegetation in sheltered areas along the coast protects shorelines and provides habitat for mammals, birds, and other species.

Shrubland
Dry seaside bluffs exposed to onshore winds and ocean spray. Shrubland can convert into other habitats during changing conditions such as significant storm damage.

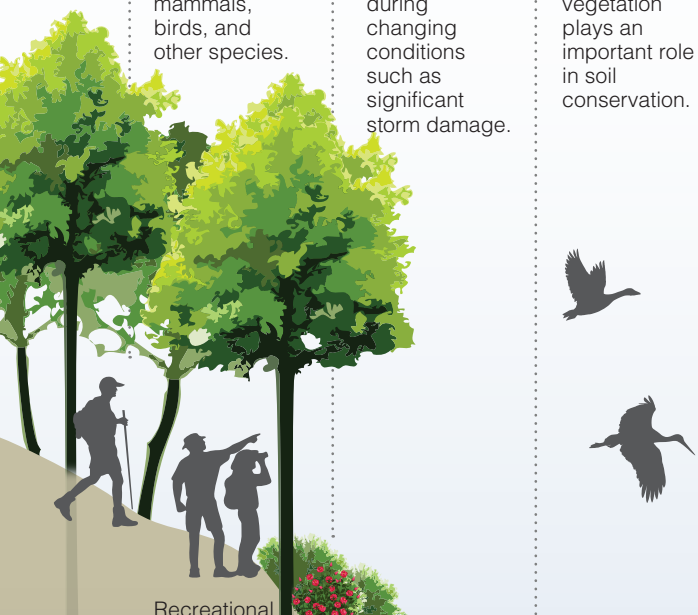
Grassland
Low-lying areas near the coast influenced directly by strong winds and ocean spray. The vegetation plays an important role in soil conservation.

High Marsh
Vegetated area flooded occasionally during storm events and higher than normal high tides. The salt marsh habitats help dissipate wave energy from severe storms and floodwaters.

Low Marsh
Tidal zone where plants are under water twice daily during tidal cycles. The salt marsh is important for shellfish, finfish, and waterfowl.

Mudflat
The mudflat is an unvegetated transition zone between open waters and vegetated marsh habitat.

Open Water
The habitat for many of the aquatic animals and species that provide biodiversity and important life cycle functions.



Recreational activities common in the upland habitats include hiking, walking, and bird watching.

Snowy Egret

The various habitats support different species of mammals, birds, and other animals. Jamaica Bay is known best for its extensive bird habitats, serving a diverse population of bird species.

Wetland systems can be tidally influenced. The levels below represent typical thresholds for water levels due to tides within wetland habitats.

Mudflat and Open Water Detail (right)

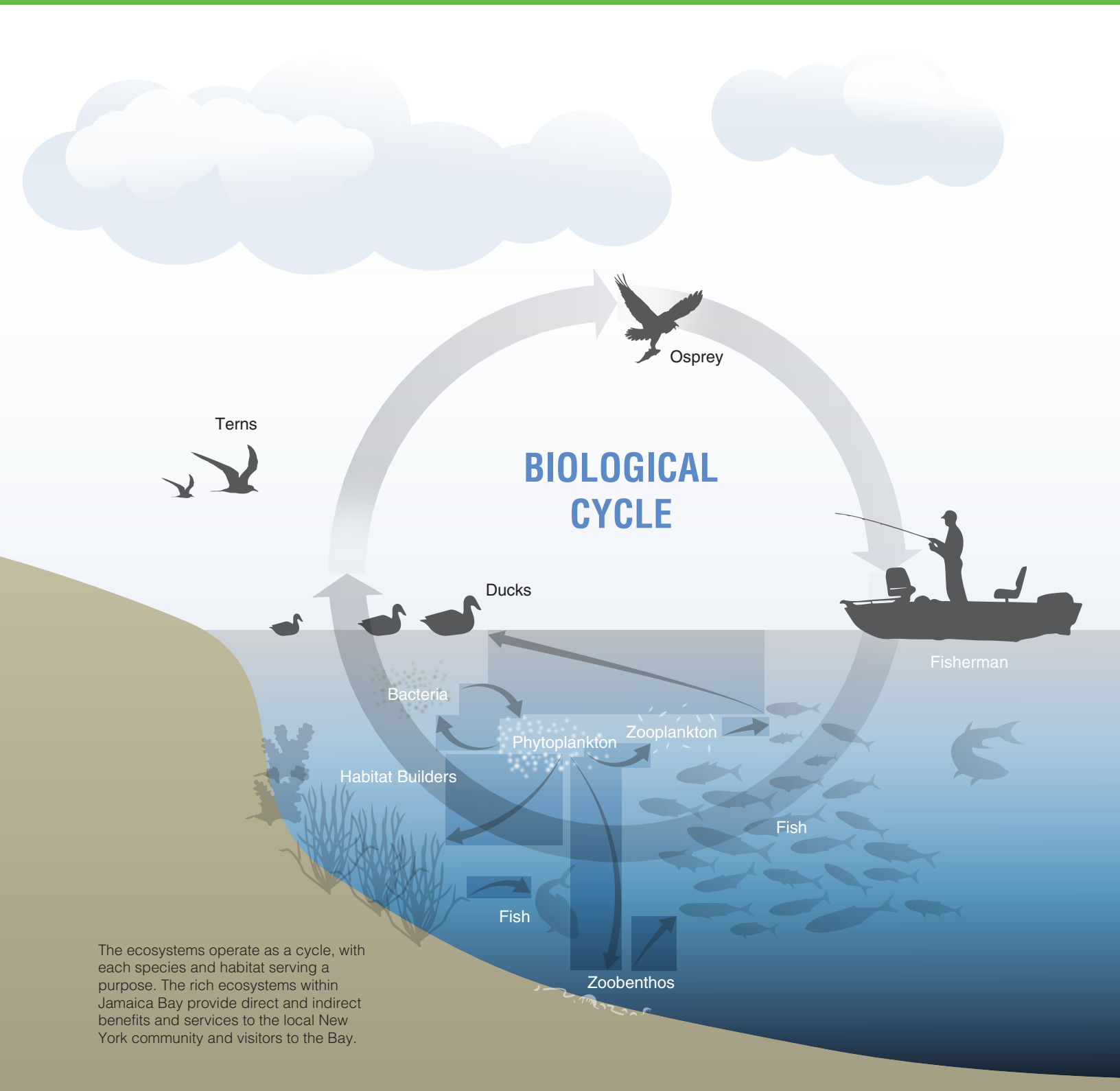
Mean Higher High Water

Mean High Water

Mean Tide

The salt marshes of the Bay are critical for many groups of animals including shellfish, finfish, and waterfowl.The Bay is also a critical stopover area on the Atlantic Flyway migration route and is an especially important animal habitat for birds that use the Bay for feeding. Other natural functions of the Jamaica Bay ecosystem include sediment trapping, natural flood control and infrastructure protection against storm surges, and natural pollutant attenuation.

Storm events and sea level rise can have consequences for marsh habitat and associated ecosystem services through erosion of the areas, deposition of debris, and smothering of vegetation with sediment. Separate modeling work has identified the presence of vegetation to be important in determining likelihood of erosion during events such as Superstorm Sandy.



The ecosystems operate as a cycle, with each species and habitat serving a purpose. The rich ecosystems within Jamaica Bay provide direct and indirect benefits and services to the local New York community and visitors to the Bay.

Restoration Ecology Management Strategies and Effects on Jamaica Bay

Many of the management strategies implemented since the original Plan was issued have targeted restoring ecosystems in Jamaica Bay and its tributaries.

The ecosystem objectives have largely been achieved through the restoration of tidal wetlands and marsh wetland habitats. Some strategies have focused on reducing larger point source pollutant loadings while others have focused on providing improved maintenance and ecosystem function of the Bay and the watershed.

OBJECTIVE

Restore the salt marsh islands in Jamaica Bay.

Elders East

The restoration of the degraded marsh island was a coordinated effort between many agencies led by DEP. Subsequent observation of breeding horseshoe crabs and diamondback terrapins suggest successful habitat restoration.

Rulers Bar

Rulers Bar restoration, although smaller than some of the other nearby restorations, included approximately 10 acres of marsh island habitat. The restoration of Rulers Bar included public participation, using volunteers and community groups to assist in the planting effort to vegetate the restored habitats.

Yellow Bar Hassock

Yellow Bar Hassock Marsh restoration included the addition of 67 acres of new marsh island, most of that being tidal wetland. Nearly 30 acres of new marsh were planted with native seeds collected from other areas of Jamaica Bay.

Ecological restorations, similar to the Yellow Bar Hassock Restoration shown, improve habitats previously lost within the Bay. The addition of these habitats improve ecosystem functions and services provided by Jamaica Bay to the community.

A

New York City Department of Environmental Protection

New York State Department of Environmental Conservation

United States Army Corps of Engineers

Five major stakeholders involved in various habitat restorations around Jamaica Bay

New York/ New Jersey Port Authority

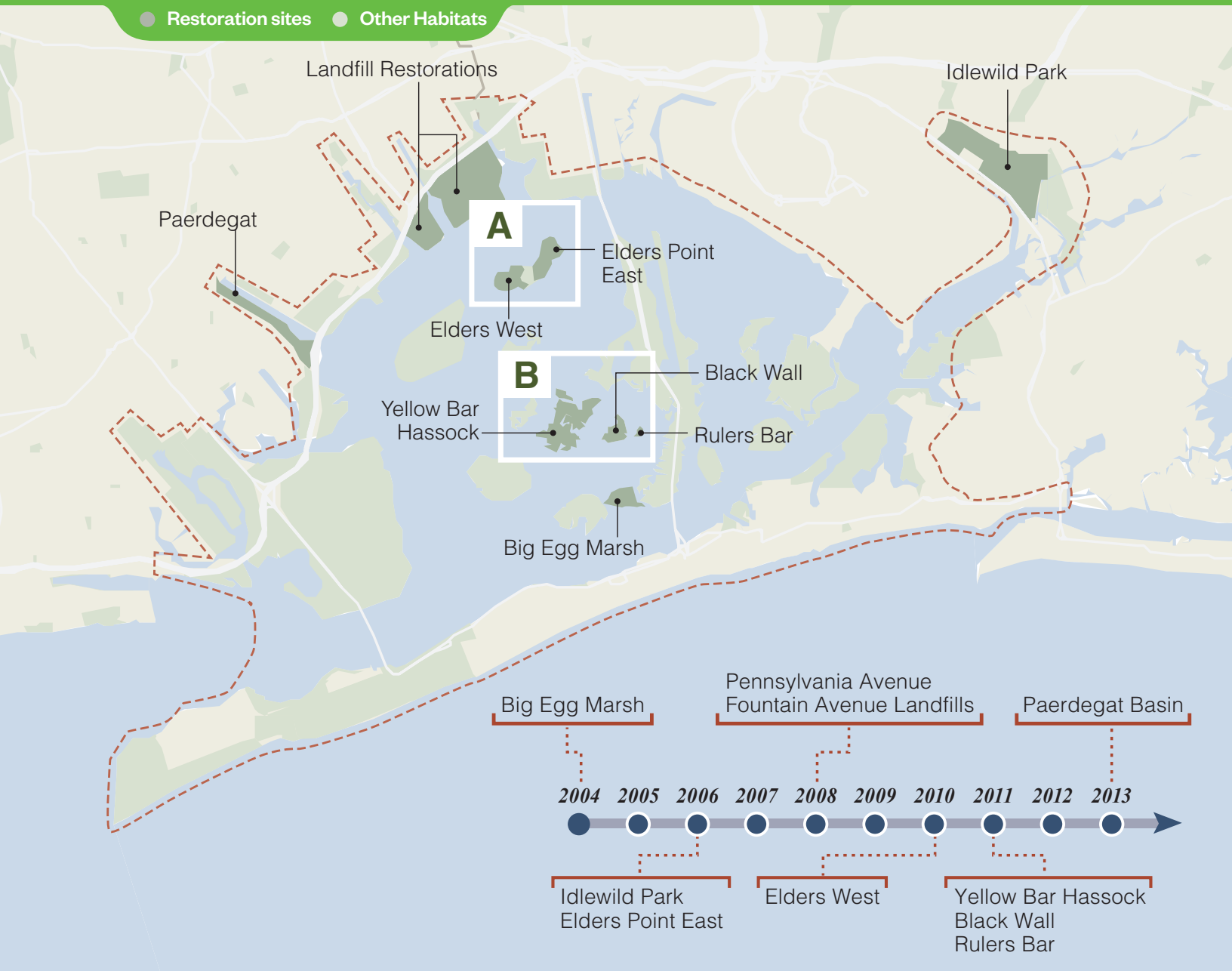
National Park Service

B

In addition to the major restoration projects these stakeholders have completed, volunteers from the community have assisted in the planting of these restoration sites.

Jamaica Bay Habitat Restorations

Restoration sites Other Habitats



OBJECTIVE

Preserve and enhance natural areas along periphery of the Bay and watershed.

Paerdegat Restoration

In coordination with the construction of the Paerdegat CSO Facility, DEP restored 38 acres of wetland and coastal grasslands within Paerdegat Basin and created a 5 acre Ecology Park.

Trash Collection Events

DEP expanded trash collection events beyond the Labor Day holiday to prevent trash from reaching the waterbodies further. The Clean Streets, Clean Beaches program continues this effort city-wide.

The Trash Free Waters Challenge

DEP launched the Trash Free Waters Challenge citywide with the aim to achieve a 5 percent reduction in the distribution of single-use plastic bags. The challenge targets upstream plastic pollution by encouraging behavior changes in both retailers and consumers, largely through small changes to supermarket and grocery store operations. Early participants have access to free reusable bags, educational material, impact tracking and guidance from DEP.

Members of the National Supermarket Association meet with DEP to kick off the Trash Free Waters Challenge.

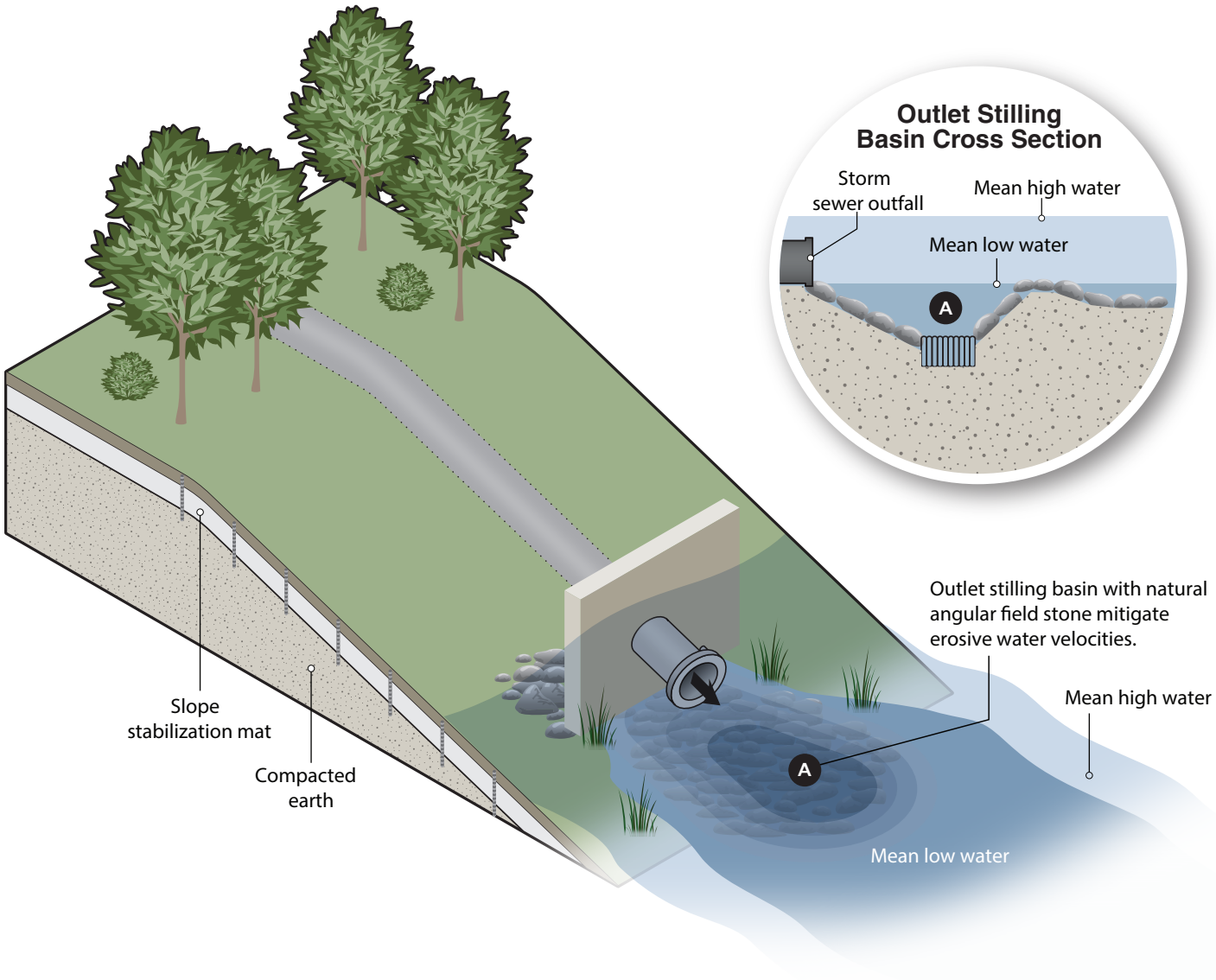
Outfall Rehabilitations

During the build out and replacement of sewer outfalls, DEP supplemented the gray infrastructure improvements with rehabilitation of the habitats in proximity to the outfall to provide water quality benefits and prevent ecosystem erosion from the outfalls.

The situational alternatives for these projects include:

1. Required wetland mitigation
2. Stormwater Best Management Practices
3. Habitat restoration

This interface of green and gray infrastructure mitigates impacts from updating gray infrastructure. The addition of green solutions assists in improving natural habitats throughout the waterbodies and watershed.



Trends in Ecological Restoration

The ecosystem within Jamaica Bay has changed drastically over time through development of the Bay and the watershed. As a result, ecosystem functions and services associated with the Bay have also changed. The following key trends provide the current findings on the status of ecosystems, habitats, and flora and fauna.

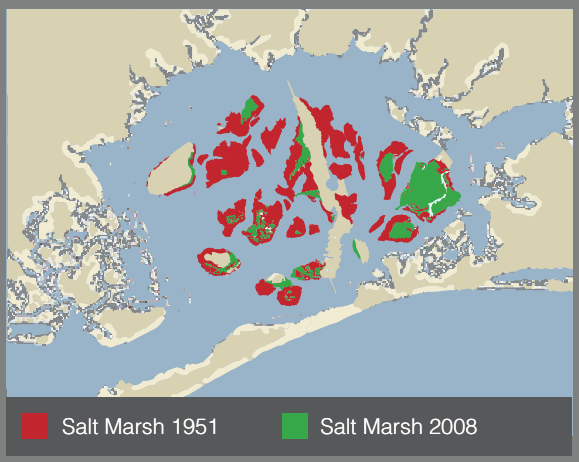
1 KEY TREND

Since the 1900s, habitat loss, particularly of marsh areas and oyster reefs, has occurred in Jamaica Bay as a result of substantial anthropogenic changes. There is limited long-term data available to provide quantitative comparison of biodiversity and species population stemming from this habitat loss.

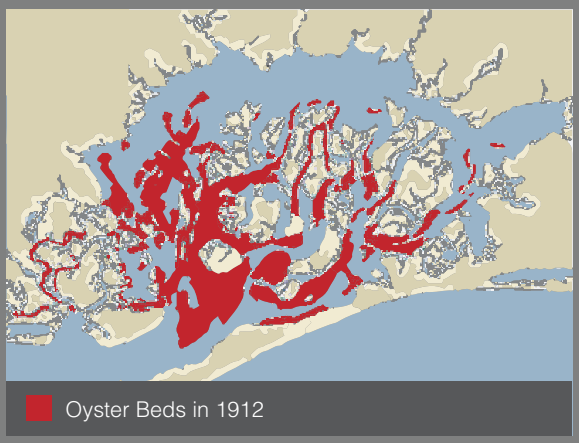
Habitat loss in Jamaica Bay, particularly for marsh islands and oyster reefs, has been well documented. Despite differences in the estimates of loss and rate of loss, the trend of loss of habitat on these marsh islands is clear. In the 1800s, seeding of oysters occurred in the Bay and as a result there was significant coverage of oyster reefs as of 1912. After this time, these reefs and their associated industries declined with industrialization and the discharge of wastewater into the Bay.

Seagrass beds, also once significant in Jamaica Bay, have been less documented and trends assessment is challenging. Surveys conducted in the 1870s provide anecdotal presence and absence information.

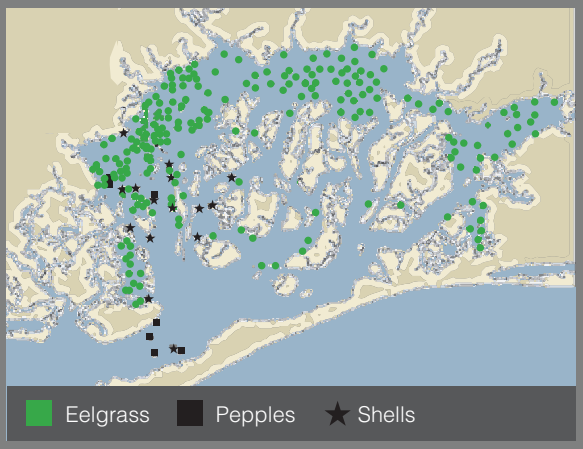
There is limited information to determine the impacts of habitat loss on species behavior, interactions, and populations in Jamaica Bay. Different species thrive in different habitat types so changes in habitat will impact species differently. Other anthropogenic drivers, such as bathymetry changes, filling, and changes in water quality, may also be cause impacts to species within Jamaica Bay.



Salt marsh extents in Jamaica Bay in 1951 and 2008 (from nin.ciesin.columbia.edu)



Oyster bed areas in Jamaica Bay in 1912 (from Waldman 2018)

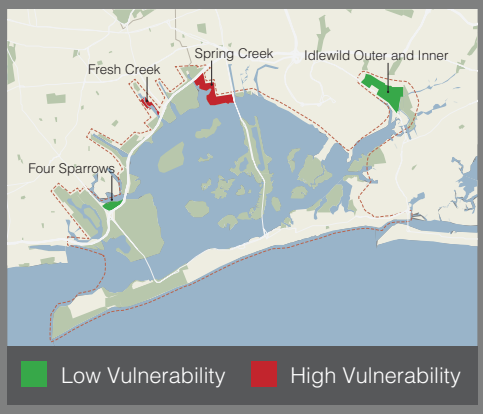


Seagrass documentation in Jamaica Bay from surveys (from Waldman 2018)

ECOSYSTEM

FUNCTIONS
The physicochemical and biological processes that occur within the ecosystem to maintain terrestrial life.
(Source: Kremen, 2005)

SERVICES
The set of ecosystem functions that are directly linked to benefit human well-being.
(Source: Kremen, 2005)



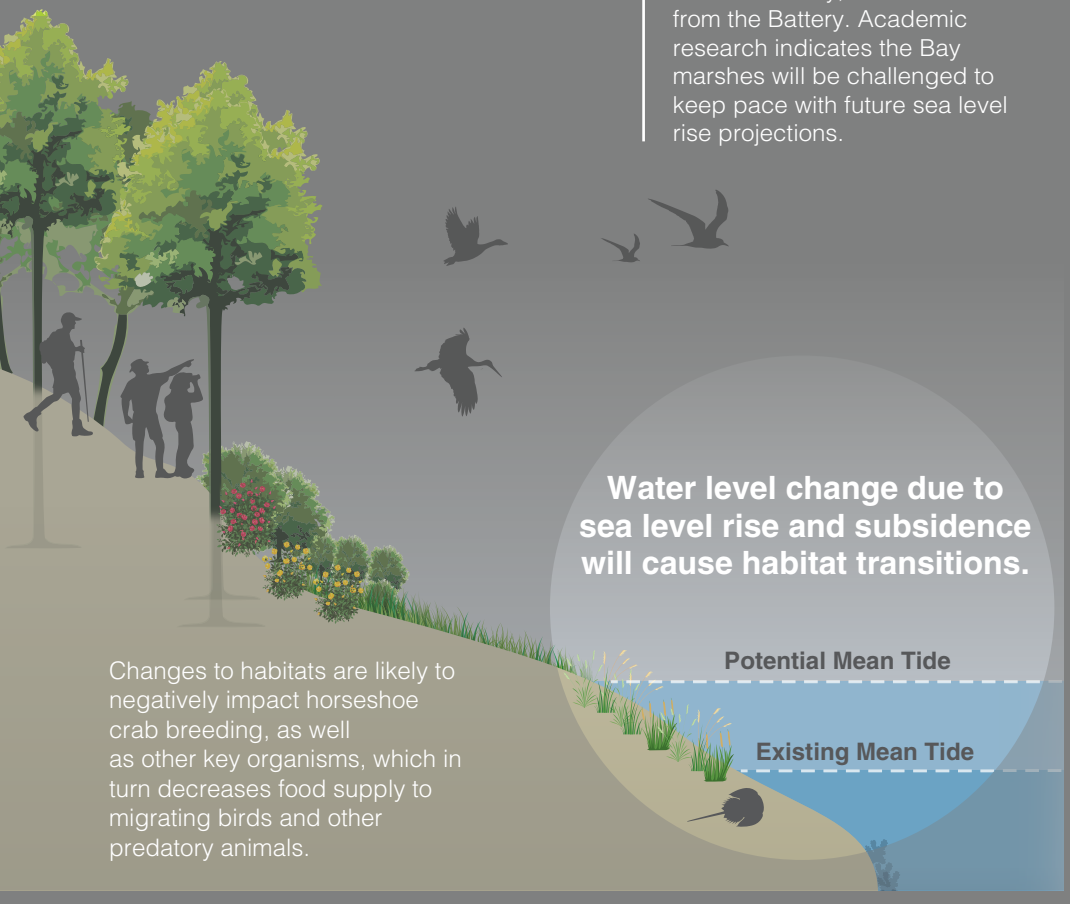
NYC Parks believes that the Jamaica Bay marshes at Idlewild have a lower vulnerability, while those at Spring Creek and Fresh Creek have a high vulnerability.

2 KEY TREND

Without restoration or preservation of upland corridors for marsh migration, habitat loss will likely continue in response to sea level rise and loss of sediment, negatively impacting ecosystem services associated with these areas.

Accelerated sea level rise poses a notable risk to low-lying, shallow gradient ecosystems. Hardened shorelines associated with densely populated coastlines impede the natural migration of barriers, increasing the vulnerability of these areas to flooding. Sea level rise has been estimated to be 2.7 mm/year in Jamaica Bay, based on data from the Battery. Academic research indicates the Bay marshes will be challenged to keep pace with future sea level rise projections.

NYC Parks performed an assessment of marsh habitat at risk on 25 marshes citywide, assessing condition and vulnerability, that indicated Jamaica Bay marshes were particularly vulnerable to sea level rise. NPS also led an evaluation as part of the Natural Resource Condition Assessment at Gateway, which included a broader set of marshes, including marsh island sites and locations at Canarsie. The NPS evaluation identified elevations in categories of significant and moderate concern. It indicated that 19% of Bay marsh sites fell within "significant concern", with an additional 21% of "moderate concern."



Changes to habitats are likely to negatively impact horseshoe crab breeding, as well as other key organisms, which in turn decreases food supply to migrating birds and other predatory animals.

Recent research from the Columbia University Lamont – Doherty Earth Observatory, NASA Goddard Institute, and Town of Hempstead, identified that organic material accretion has allowed for the marshes in Jamaica Bay to keep up with sea level rise. Jamaica Bay, historically, is sediment starved from urbanization of the surrounding land and watershed, mostly in the form of mineral sediment decrease. The organic matter has made up for the loss of mineral sediment, likely due to nitrogen loadings from WRRFs, and vertical accumulation of organic matter has allowed for many marshes to outpace sea level rise, temporarily preserving remaining marshland.
(Source: Peteet et. al, 2018)

Trends in Ecological Restoration

KEY TREND 3

Ongoing habitat restoration efforts related to marshes and oyster reefs since the early 2000s are likely to slow declines in biodiversity and ecological function, thereby increasing ecosystem services in Jamaica Bay.

New habitat addition through restoration of marsh islands and fringing habitat in Jamaica Bay has been a successful and ongoing effort. Since 2003, restorations have focused on restoring salt marsh island habitat within Jamaica Bay, on both salt marsh islands and in fringing marsh areas surrounding Jamaica Bay.
A total of approximately 150 salt marsh island acres (60 hectares) have been restored. Supporting these estimates, remote sensing analyses have indicated that 54.9 hectares of sand, mudflat, and water became salt marsh between 2003 and 2013.

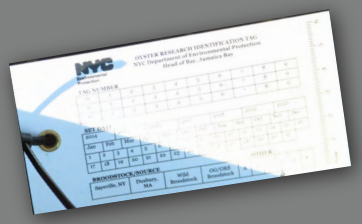
The National Parks Service has begun monitoring as new marshland has been restored, but we do not have comparable data pre-restoration. Research on other geographies indicates increased potential for restored marsh areas to support fish and bird species compared with non-restored marshes.

Restoration of oyster reefs in Jamaica Bay has also been researched in pilot studies since the 2000s. The pilot studies demonstrated oyster seed survival and growth, and oyster survival in Jamaica Bay waters. Water quality monitoring will determine what benefits the oysters may have on measures linked to ecosystem services.

Head of Bay Oyster Restoration

Wetland restorations in Jamaica Bay since 2004 and oyster reefs from the Billion Oyster Project.

A larger oyster restoration effort with 40,000 oysters at Head of the Bay began in 2016 through joint efforts by the DEP and the Billion Oyster Project.



Salt Marshes

Available Trails

Horseshoe Crab Populations

Ribbed Mussel Colonies

Marinas Access

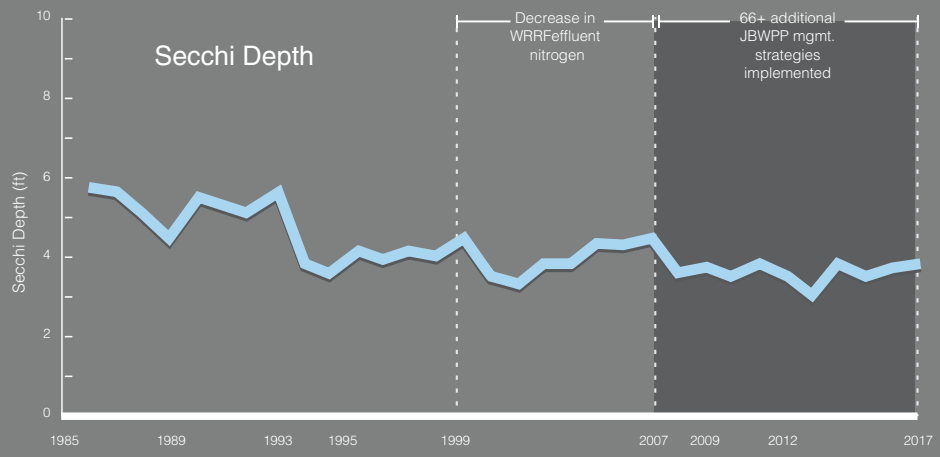
Fish Diversity

Fauna Habitats

4 KEY TREND

Nitrogen reduction in Jamaica Bay should lead to improved quality and quantity of ecosystem services, though fuller assessment of Jamaica Bay uses is required.

Decreases in nutrient loadings are expected to improve ecosystem services through multiple pathways. The ecosystem services that have frequently been evaluated include recreational beach use, recreational fishing, commercial fishing, and the amenity value of clear water.



Secchi depth is a measurement of water clarity. A decreasing secchi depth trend indicates better water clarity.

5 KEY TREND

Access to Jamaica Bay waters has become limited with the residential, commercial, and industrial development that occurred late 1800s. This limited access consequently limits the recreational benefits resulting from ecosystem restoration.

Restoration activities may maintain or increase the fish and bird populations present in Jamaica Bay. A combination of other inputs, such as boat ramps and access points, are required to allow for improvements to ecosystem services. Ecosystem services and public value on species of flora and fauna are limited by access to the Bay. Public value currently mostly depends on recreational use.

Access to Jamaica Bay is discussed in Chapter 3: Community and Social Resilience.

Chapter 3

Community and Social Resilience

Human Connection to Jamaica Bay

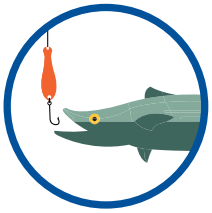
More than 20,000 years ago, Jamaica Bay evolved from glacial action. In one of the earliest conflicts between Native Americans and European settlers, a war in the mid-1600s drove the Lenape tribe out of Jamaica Bay. The settlers developed what they called New Netherland, developing agriculture on the uplands of the watershed and some artisanal fisheries. Further Dutch colonization proceeded rapidly, including damming, diking, and deforestation.

Current Use

The current uses of Jamaica Bay are mostly focused on the local residential community, recreational uses, and tourism within the area. The diverse ecosystems and landscapes within Jamaica Bay and the watershed create a strong sense of community and culture that is unique to the Bay.

Bird Watching

There are 332 bird species sighted in Jamaica Bay over the last 25 years. Many of these birds are part of the North Atlantic Flyway migration routes while others nest regularly in the Bay.



Recreational Fishing

Fishing in Jamaica Bay is encouraged from piers, beaches, and boats. The NPS has designated fishing areas.

Tourism

JFK Airport is a major access point for tourists for all of NYC. Jamaica Bay serves tourism through many recreational uses and wildlife and nature tourism activities.

Recreational Boating

There is a variety of boating activities in Jamaica Bay, most of which include hand-launched boats such as canoes, kayaks, and rowboats. Sailing is also popular in the summer.

Residential

Over 2.8 million people live in the Jamaica Bay watershed. The watershed and bay are a large part of many communities' identity.

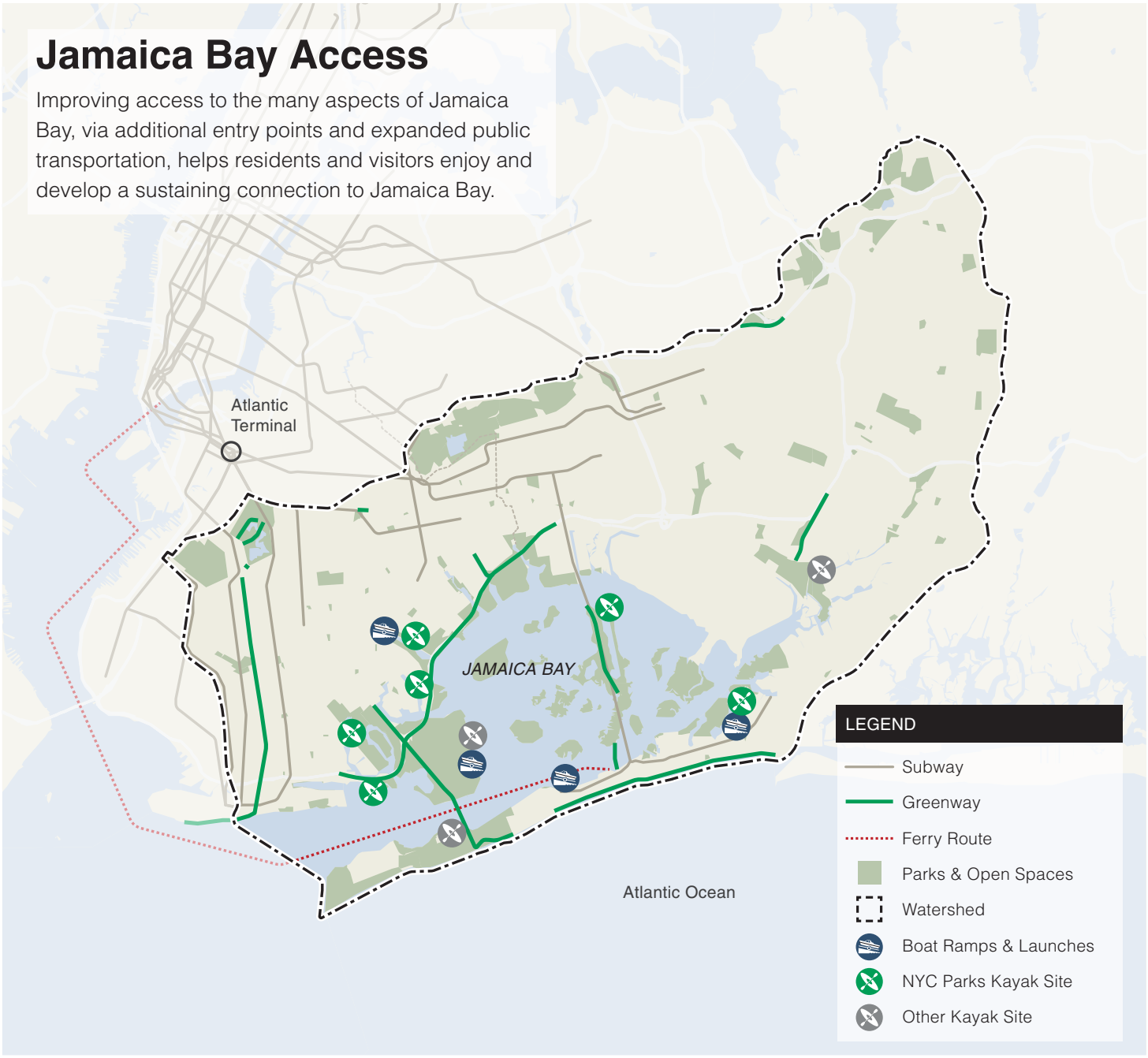
Other Recreation

Other recreational activities include archery, cross country skiing, golfing, hiking, biking, horseback riding, picnicking, and camping.

Historical Uses

Jamaica Bay Access

Improving access to the many aspects of Jamaica Bay, via additional entry points and expanded public transportation, helps residents and visitors enjoy and develop a sustaining connection to Jamaica Bay.



Industrial/Tourism/ Residential

Residential/Tourism/Recreational

1900s | 1920s | Present Day

Community Use and Education Management Strategies and Effects on Jamaica Bay

The original Plan identified goals and strategies to expand education and enjoyment for the communities in Jamaica Bay and its tributaries.

These social objectives have been the most challenging to achieve, but by partnering with other stakeholders in the Bay and the watershed, many strategies have been implemented.

OBJECTIVE

Raise awareness of Jamaica Bay's Unique Assets and Challenges.

DEP, along with the Jamaica Bay Education Coordinating Committee, created the Jamaica Bay Education Resource Directory to highlight the educational opportunities available within Jamaica Bay. Most of the programs included in the directory target children and family audiences. Other stakeholder groups within Jamaica Bay provide additional educational opportunities for age ranges not highlighted within the Directory.

Education Speaker Visit
Field Trips
Printed Resource
Program for General Public
Professional Development
Web-Based Resource
Summer Program
Volunteer/Internship/ Opportunity

Education Program	Pre-K	Elementary	Middle School	High School	Adults	Families	Program Opportunities
American Littoral Society	●	●	●	●	●	●	
Brooklyn College, City University of New York					●		
Brooklyn Public Library	●	●	●	●	●	●	
Center for International Earth Science Information Network		●	●	●	●	●	
Center for Urban Research, CUNY Graduate Center				●	●	●	
Citizens Advisory Committee, Pennsylvania/Fountain Avenues Restoration		●	●	●	●	●	
The Coastal Marine Resource Center		●	●	●	●	●	
Council on the Environment of New York City			●	●	●	●	
Eastern Queens Alliance		●	●	●	●	●	
Environmental Education Advisory Council					●		
Friends of Gateway		●	●	●	●	●	
Gateway National Recreation Area, National Park Service							
Gateway Institute			●	●	●	●	
Jamaica Bay Unit		●	●	●	●	●	
National Parks of New York Harbor Education Center		●	●	●	●		

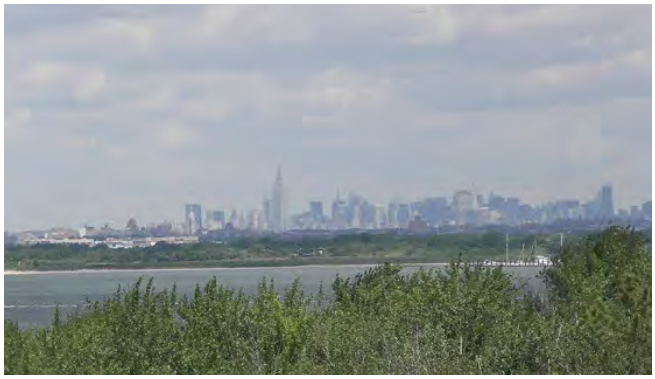
The Newtown Creek Visitors Center offers educational programs by appointment for school age children to learn about NYC's waterbodies, watersheds, and water infrastructure. Students also learn about stewardship opportunities similar to those available in Jamaica Bay.

Education Program (Continued)	Pre-K	Elementary	Middle School	High School	Adults	Families	Program Opportunities
GLOBE New York Metro at Queens College					●		
Mickey Cohen				●	●	●	
New York Aquarium	●	●	●	●	●	●	
New York City Audubon			●	●	●	●	
New York City Department of Environmental Protection	●	●	●	●	●	●	
New York City Department of Parks and Recreation Urban Park Ranger			●	●	●	●	
New York City Soil & Water Conservation District		●	●	●	●		
New York State Department of Environmental Conservation	●	●	●	●	●	●	
New York University Wallerstein Collaborative for Urban Environmental Education					●		
Prospect Park Alliance	●	●	●	●	●	●	
Queens Library	●	●	●	●	●	●	
Queens Museum of Art	●	●	●	●	●	●	
Southern Queens Park Association		●	●	●	●	●	
United States Environmental Protection Agency, Region 2	●	●	●	●	●	●	

OBJECTIVE

Increase public access to Jamaica Bay.

Gateway National Recreation Area



The Gateway program enhances education, recreation, and public access to Jamaica Bay.

Ferry Access

The New York City Ferry system has expanded greatly in recent years, bringing areas including the Rockaways within quick and affordable access to local communities and tourists.

Walking and Bike Paths

The expansion of the Greenway surrounding Jamaica Bay has occurred in stages, extending green corridors accessible through walking or biking around areas of the Bay previously more difficult to access.

Shirley Chisholm State Park

Through DEP's work at the Pennsylvania Ave and Fountain Ave Landfills, $ 235 million was invested by DEP to rehabilitate and restore 407 acres to maritime grasslands and coastal uplands habitat. The land was transferred and is currently being established as Shirley Chisholm State Park.

The park will improve public access to Jamaica Bay. Governor Cuomo's Office has identified that the park "will feature 10 miles of trails for hiking and biking, including bike connector paths that will ultimately join the Pennsylvania and Fountain Avenue properties, waterfront access for kayaking, pop-up environmental education, a pier with a shade structure, picnic areas, concessions, comfort facilities, welcome and wayfinding signage and a park office."

This effort could not have been possible without the restoration and support from DEPNYS, DEC, NYC Parks and the National Parks Service.

OBJECTIVE

Improve public access to a wider range of landscape types in the upper watershed in order to expand the public's understanding of the entire Jamaica Bay watershed.

Greenstreets Program

As roadways continue to be modified to increase pedestrian safety and reduce vehicle speeds in residential areas, NYC Parks and DOT are converting paved street properties, such as triangles and malls, into green spaces with plants.

Million Trees Program

The Million Tree Program planted one million trees within New York City streets in ten years. The addition of these street trees brings greenery, shade, and other benefits to the public further inland from many of the waterways surrounding NYC.

Paerdegat Natural Area Park

The Park fosters public education and interaction with wetland and upland habitats that are found in tributaries and areas around Jamaica Bay.

Southeast Queens Flood Mitigation Program

New York City has made a commitment of $1.9 billion to build a comprehensive drainage system and alleviate flooding in neighborhoods throughout the southeast Queens area, including the neighborhoods of St. Albans, Rosedale, Jamaica, Laurelton and Springfield Gardens, amongst others. Collaboration between multiple city departments including DEP, DDC and DOT, has resulted in a four-pronged approach to improve conditions in the area.

1. Construct quick fixes, such as storm sewer extensions, targeted full size sewers, and green infrastructure to bring near term flooding relief.
2. Build neighborhood sewer projects where there is existing available capacity in the sewer system.
3. Create future capacity for further neighborhood sewer projects by investing in large trunk sewers.
4. Evaluate opportunities to reduce groundwater flooding.

Thus far, roughly 20 percent of the funding has been committed to 10 completed projects and another 10 that are currently under construction. An additional 25 projects are currently in the planning and design phase and will break ground in the coming years. The bulk of the funding will go towards the construction of large trunk sewer spines along 150th Street, Guy Brewer Boulevard, Farmers Boulevard and Springfield Boulevard, with the first of those projects in construction.

As stated by DEP Commissioner Vincent Sapienza, “Shovels in the ground in southeast Queens mean we are one step closer to a true drainage system and some peace of mind for residents and businesses. As we complete each of these projects we will see better drainage, safer roadways, a healthier Jamaica Bay and higher property values across these long underserved neighborhoods.”

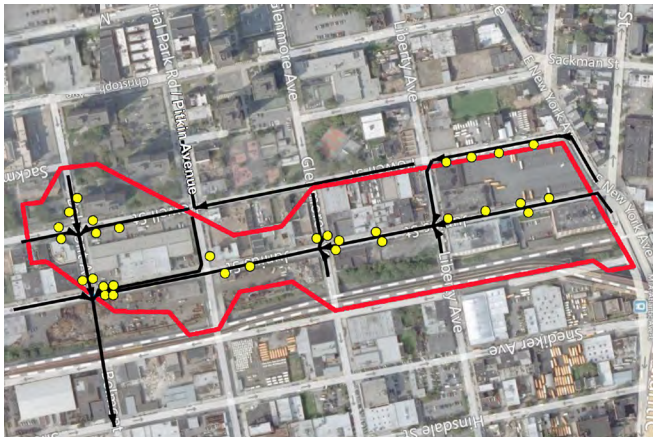
OBJECTIVE

Promote the use of off-site stormwater best management practices as public education and to deliver environmental benefits to the community.

Rain Gardens

The right-of-way green infrastructure program, largely compiled of implementing a network of rain gardens in the sidewalk, aims to improve water quality. These networks also provide many other co-benefits to the community.

Demonstration Projects



Right-of-way demonstration projects in the Jamaica Bay Watershed were constructed and monitored to support the development of the green infrastructure program. These demonstrations were used to measure stormwater runoff managed and water quality benefits from a system of green infrastructure assets in a network.

Median Green Infrastructure

Larger roadway medians are also being tested for wider inclusion in the green infrastructure network. The pilot projects at North and South Conduit proved this strategy to be successful through the management of a whole street network in a pair of larger rain gardens.

Climate Adaptation in Southeast Queens

As part of the ongoing work to alleviate chronic flooding in southeast Queens, DEP is piloting innovative new approaches to flood management that also help reduce clean runoff into Jamaica Bay. DEP has been working with the City of Copenhagen to understand how "cloudburst management" can be applied in New York City to direct stormwater runoff to locations where flooding can be managed safely while minimizing damages and inconvenience to local communities. In the NYC Cloudburst Resiliency Planning Study, DEP identified two pilot locations: New York City Housing Authority's South Jamaica Houses, and the St. Albans neighborhood of southeast Queens.

In 2018, DEP conducted extensive outreach at the South Jamaica Houses to solicit residents' feedback on design for the cloudburst pilot project that will be located there. The design includes a "stormwater corridor" adjacent to the Long Island Railroad tracks that will absorb and filter runoff for everyday rain events and, in extreme rain events, will create spaces that can temporarily and safely fill with water to help reduce flooding in the area. DEP expects to complete design for South Jamaica Houses project in 2019.

Cloudburst concepts include central areas to collect stormwater. A sunken basketball court can provide storage for stormwater while also having benefits for the community such as seating and enhancing recreation space.

Trends in Community and Social Resilience

Community and social resilience in Jamaica Bay and the watershed is enhanced by water quality improvements and ecosystem restoration. Additionally, public education, public access, and stormwater management contribute to improving the public's use of the Bay. The following key trends represent the latest findings relevant to community and social resilience in Jamaica Bay.

1 KEY TREND

Stormwater reductions and water quality improvements have made many neighborhoods in the Jamaica Bay watershed less exposed to flooding impacts and have increased ecosystem services in these communities. However, flood risks remain high in some neighborhoods and the viability of long-term ecosystem services remains at risk.

DEP and other entities have implemented projects to mitigate the area's flood risks. Hurricane Sandy prompted significant planning to address these risks, such as the Special Initiative for Rebuilding and Resiliency (SIRR). The SIRR is New York City's approximately $20 billion plan for making the city more resilient to coastal storms hazards including storm surge through policy changes, large infrastructure projects, and other strategies.

The New York City Department of City Planning and New York City Department of Housing Preservation and Development have conducted numerous planning efforts in neighborhoods affected by Sandy around the Bay. Planning efforts include detailed analysis processes, community-based planning, and design of place-based development strategies to help individual buildings and neighborhoods become more resilient. Resilient Neighborhoods reports published for six communities in Jamaica Bay in 2016 and 2017 are example results of these planning efforts.

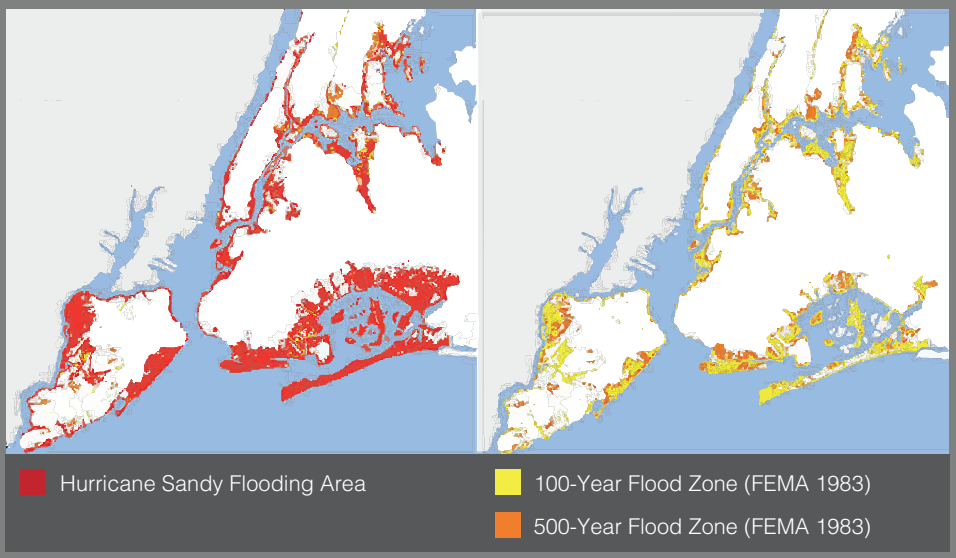
Despite these successes, many risks and vulnerabilities remain. neighborhood, household, and business resiliency is limited by the socio-demographic characteristics and access to resources of many of the neighborhoods in the watershed. These characteristics and limitations may continue to make residents vulnerable to flooding and related risks.

2 KEY TREND

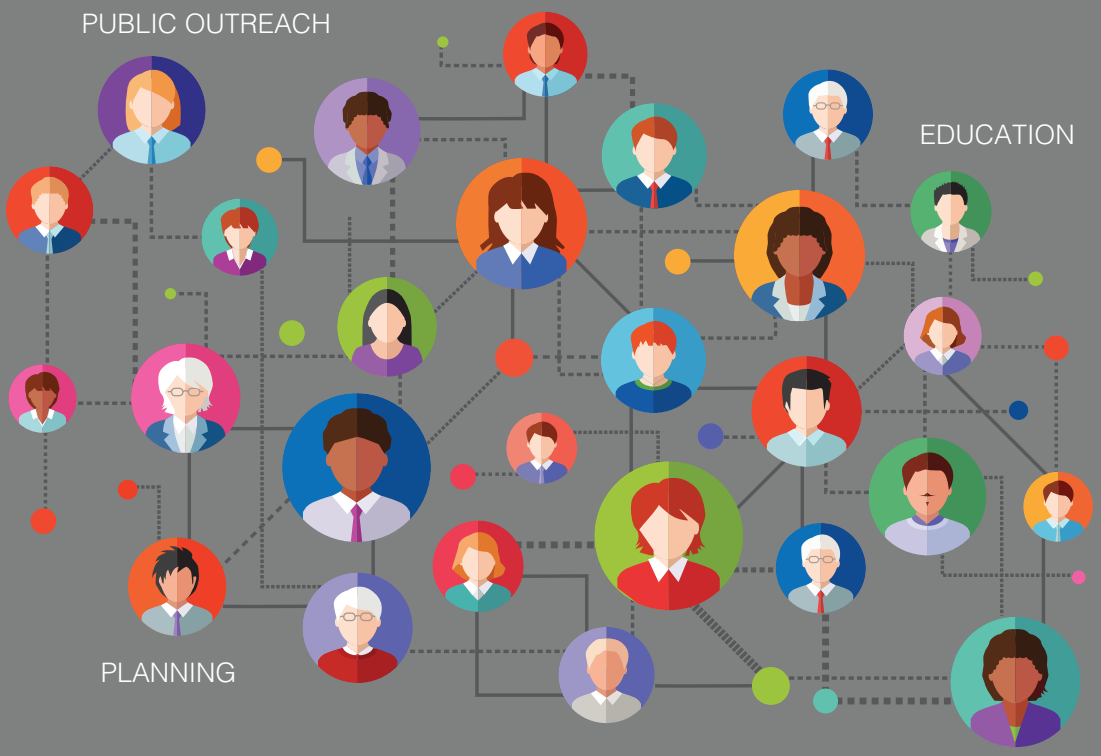
Ongoing watershed protection efforts through DEP's and other agencies/organizations' efforts have helped strengthen local communities' ties to Jamaica Bay and their understanding of the Bay's fundamental ecological processes and associated social and economic benefits.

Watershed protection efforts have built and enhanced civic capacity in the Jamaica Bay watershed. Efforts organized by NPS, non-profit organizations, NYC Parks and others have used Bay restoration to engage community members in restoration projects while also building awareness and increasing public education about Bay related issues.

Researchers argue that the Bay is in fact a prime example of a social-ecological system in which "social and ecological systems are truly interdependent and constantly coevolving". This suggests that the better communities understand and feel connected to the Bay, the more likely there are to be additional ecological improvements.



The extent of flooding from Hurricane Sandy exceeded the 1983 FEMA 500-year Flood Zone. Resilience to storm events has become a focal point for NYC and its communities.



Wildlife preserves

Parks

Marinas

Recreational boating and fishing

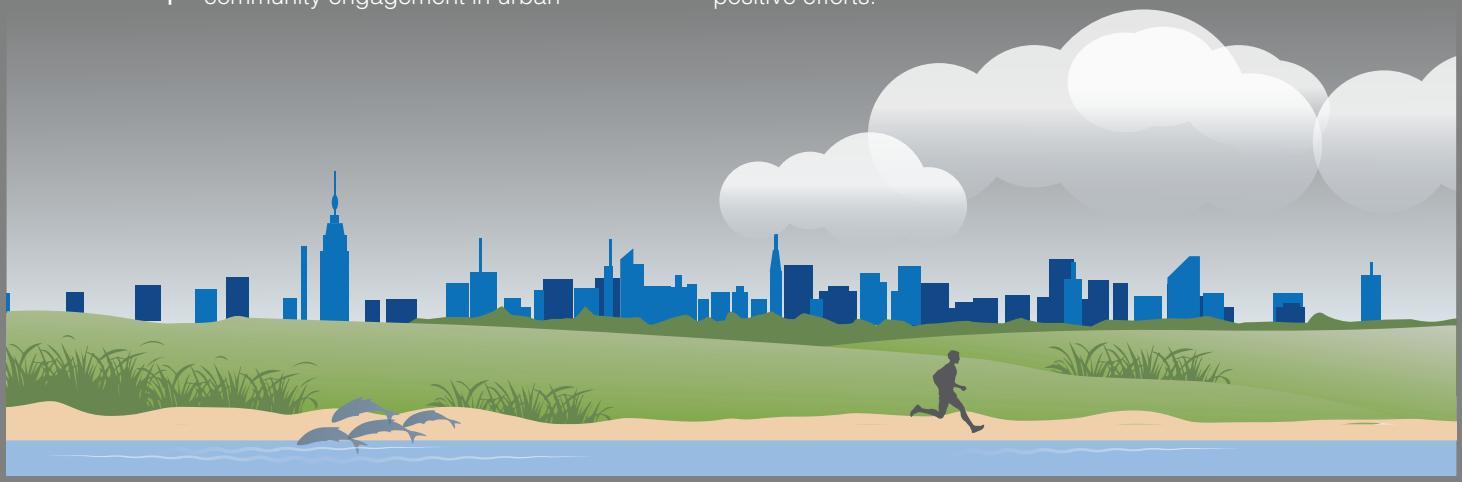
Water quality improvement through the filtering of the ribbed mussels

Property value improvement

KEY TREND 3

Community and social well-being are being enhanced by increasing the ecological health of the watershed. These efforts may also have unintended social and economic effects that can be addressed through public participation in decision-making and other efforts to mitigate risks to communities.

The past decade has brought tremendous advances in civic and community engagement in urban neighborhoods generally, and the Jamaica Bay watershed specifically. Social science research has helped to illustrate and define which approaches might lead to the most positive engagement and meaningful advances both in planning and well-being. Ongoing planning, public deliberation, and education efforts will be critical for enhancing community and social well-being. The post-Sandy context provides a variety of examples of positive efforts.



Management Strategy	Category	Year Implemented
Jamaica Bay WRRF's Upgrades	Water Quality	2015
Minimize Centrate Processing from other WRRFs in Jamaica Bay	Water Quality	2011
Sea Lettuce Harvesting Pilot	Water Quality	2010
Algal Turf Scrubbers Pilot	Water Quality	2010
Oyster Bed Pilot	Water Quality	2010
Ribbed Mussel Pilot	Water Quality	2011
Expanded Sewer Cleaning Program	Water Quality	2010
26th Ward/ Fresh Creek Combined Sewer and Interceptor Cleaning	Water Quality	2010
Expanded Interceptor Inspection and Maintenance	Water Quality	2008
Paerdegat CSO Detention	Water Quality	2011
Inflow/ Infiltration Study with Corrective Measures	Water Quality	2010
Regulators in Bergen Basin	Water Quality	2010
Complete Storm Sewer Build out in Rockaways	Water Quality	2017
Southeast Queens Drainage Plan	Water Quality	2008
Warnerville/ Meadowmere Sewer Project	Water Quality	2009
Install a Third Boat Pumpout Facility at Rockaway WRRF and Seek a No Discharge Designation for Jamaica Bay	Water Quality	2008
Dredge and Recontour Hendrix Creek	Water Quality	2010
Pursue Dredging of Paerdegat Basin, Fresh Creek, Bergen Basin and Thurston Basin	Water Quality	2014
Investigate Potential for Future Aeration in other CSO and Non-CSO Tributaries	Water Quality	2018
Enhanced Scientific Monitoring Program	Water Quality	2010
Reintroduction of Eel Grass Pilot	Water Quality	2009
Establish Salt Marsh Island Wetlands Priority Restoration Review Board	Restoration Ecology	2009
Marsh Island Wave Attenuator Study	Restoration Ecology	2015
Wetland Restoration	Restoration Ecology	2010
Complete Restoration of Pennsylvania Avenue Landfill and Fountain Avenue Landfill	Restoration Ecology	2008
Paerdegat Basin Restoration	Restoration Ecology	2013
Identify Opportunities for Green Infrastructure	Restoration Ecology	2010
Ecological Atlas and LIDAR Imagery	Restoration Ecology	2010
Continue Beach Cleanup Efforts	Restoration Ecology	2007
Transfer HPD Properties in the Edgemere Section of Queens to Parks	Restoration Ecology	2009
Green Roof/ Blue Roof Pilot	Stormwater Management	2010
Rain Barrel Giveaway Program	Stormwater Management	2008
Parking Lot Pilots	Stormwater Management	2011
Bronx River Houses Stormwater Pilots	Stormwater Management	2010
Evaluate Rooftop Detention	Stormwater Management	2010
Porous Pavement on DEP Property	Stormwater Management	2009
Stormwater Rate Structure Study	Stormwater Management	2009
Incentive Programs	Stormwater Management	2008
Cost Sharing Programs	Stormwater Management	2008
Water Conservation Program	Stormwater Management	2008
Zoning Code Parking Lot Design Requirements	Stormwater Management	2007
Code Review	Stormwater Management	2010
Guidelines for the Design and Construction of Approvable Stormwater Management Systems	Stormwater Management	2012

Management Strategy	Category	Year Implemented
CEQR Technical Manual Revision	Stormwater Management	2010
Monitor Benefits of BMP Implementation	Stormwater Management	2012
Zoning Code Pervious Surfaces Requirements	Stormwater Management	2008
DOT Belt Parkway Bridges Demonstration Project	Stormwater Management	2014
Streetside Swale/Tree Pit Pilots	Stormwater Management	2010
North and South Conduit Stormwater Pilot	Stormwater Management	2011
Zoning Code Review - Street Trees	Stormwater Management	2008
PlaNYC Street Tree Planting	Stormwater Management	2007
PlaNYC Greenstreets Initiative	Stormwater Management	2008
East New York Community Forestry Management Plan	Stormwater Management	2007
Springfield Park Project	Stormwater Management	2016
Enhance Jamaica Bay - related Educational Curriculum	Public Education and Outreach	2010
Organize "State of the Bay" Scientific Symposium	Public Education and Outreach	2008
Create a targeted campaign for developers, residents, and business owners to protect Jamaica Bay	Public Education and Outreach	2007
Rockaway/ Gateway Greenway	Public Use and Enjoyment	2010
Laurelton and Cross Island Parkway Greenways	Public Use and Enjoyment	2006
Floyd Bennett Field/ Gateway National Recreation Area	Public Use and Enjoyment	2014
Brooklyn/ Queens Greenway - Eastern Parkway Extension	Public Use and Enjoyment	2010
Jamaica Bay Ecological Improvement Projects	Implementation and Coordination	2010
BMP Implementation through Mayor's Office Interagency BMP Task Force	Implementation and Coordination	2008
Education Steering Committee	Implementation and Coordination	2007
Waterfront Planning	Implementation and Coordination	2010
Monitor and Review Changes to the Watershed	Implementation and Coordination	2007

References

General:

DEP. 2017. 2017 New York Harbor Water Quality Report. http://www.nyc.gov/html/dep/pdf/hwqs2017.pdf

DEP. 2017. 2017 Green Infrastructure Annual Report. http://www.nyc.gov/html/dep/pdf/green_infrastructure/gi_annual_report_2018.pdf

DEP. 2010. NYC Green Infrastructure Plan. http://www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf

DEP. 2018 Jamaica Bay Long Term Control Plan. http://www.nyc.gov/html/dep/pdf/cso_long_term_control_plan/jamaica-bay-june-2018-ltcp-june-2018.pdf

Water Quality:

Benotti, M.J., M. Abbene, and S.A. Terracciano. 2007. Nitrogen loading in Jamaica Bay, Long Island,NewYork: predevelopment to 2005. In Scientific Investigations Report: USGS.

Gobler, C. J., and R. A. Wallace. 2018. Acidification, hypoxia, and algal blooms: Barriers to current and future ecosystem restoration and climate change resilience in Jamaica Bay. Natural Resource Report NPS/NCBN/NRR—2018/1625. National Park Service, Fort Collins, Colorado.

Peterson, B. 2018. Water Quality in Jamaica Bay [Webinar]. In Jamaica Bay Estuarine Composition: From Nutrients to Fish, Research of Jamaica Bay Webinar Series. https://www.youtube.com/watch?v=7lKGl-_32sM&feature=youtu.be, accessed on 10/28/2018.

Wallace, R., and C. J. Gobler. 2015. Factors controlling blooms of microalgae and macroalgae (Ulva rigida) in a eutrophic, urban estuary: Jamaica Bay, NY, USA. Estuaries and Coasts 38:519-533.

Restoration Ecology:

Boyd, J., & Banzhaf, S. (2007). What are ecosystem services? The need for standardized environmental accounting units. Ecological economics, 63(2-3), 616-626.

Brawley, A. H., Warren, R. S., & Askins, R. A. (1998). Bird use of restoration and reference marshes within the Barn Island Wildlife Management Area, Stonington, Connecticut, USA. Environmental Management, 22(4), 625-633.

Burger, J. (1985). Habitat selection in temperate marsh-nesting birds. Habitat selection in birds, 253, 281.

Gornitz, V., Couch, S., & Hartig, E. K. (2001). Impacts of sea level rise in the New York City metropolitan area. Global and Planetary Change, 32(1), 61-88.

Hartig, E. K., Gornitz, V., Kolker, A., Mushacke, F., & Fallon, D. (2002). Anthropogenic and climate-change impacts on salt marshes of Jamaica Bay, New York City. Wetlands, 22(1), 71-89.

Minello, T. J., Able, K. W., Weinstein, M. P., & Hays, C. G. (2003). Salt marshes as nurseries for nekton: testing hypotheses on density, growth and survival through meta-analysis. Marine Ecology Progress Series, 246, 39-59.

National Park Service. (2007). An update on the disappearing salt marshes of Jamaica Bay, New York. Available at: http://www.nytimes.com/packages/pdf/nyregion/city_room/20070802_FinalJamaicaBayReport.pdf.

National Park Service (2018) Natural resource condition assessment: Gateway National Recreation Area. Available at: https://irma.nps.gov/DataStore/Reference/Profile/2256683.

New York City Parks (2017) Towards a salt marsh management plan for NYC: Recommendations for restoration and protection. Available at: http://naturalareasnyc.org/content/3-in-print/3-partner-publications/nycparks_saltmarshstrategyreport_2017.pdf.

Peteet, D. M., Nichols, J., Kenna, T., Chang, C., Browne, J., Reza, M., ... & Stern-Protz, S. (2018). Sediment starvation destroys New York City marshes' resistance to sea level rise. Proceedings of the National Academy of Sciences, 115(41), 10281-10286.

Sarinsky, G. Carroll, M.A., Nduka, E., & Catapane, E.J. (2005). Growth and survival of the American oyster Crassostrea virginica in Jamaica Bay, New York.

Slavin, P., & Shisler, J. K. (1983). Avian utilisation of a tidally restored salt hay farm. Biological conservation, 26(3), 271-285.

Titus, J. G. (1998). Rising seas, coastal erosion, and the takings clause: how to save wetlands and beaches without hurting property owners. Md. L. Rev., 57, 1279.

Waldman, J., & Solecki W. (2018) The great transforma-

tion: Exploring Jamaica Bay in the late 19th and early 20th centuries through newspaper accounts. Natural Resource Report NPS/NCBN/NRR-2018/1607. US Department of the Interior, National Park Service.

Community and Social Resilience:

Allred, Shorna; DuBois, Bryce; Bunting-Howarth, Katherine; Tidball, Keith; Solecki, William D. “Social-Ecological System Transformation in Jamaica Bay.” In Sanderson E.W., Solecki W.D., Waldman J.R., Parris A.S. (eds) Prospects for Resilience. (2016) Washington, DC: Island Press.

City of New York. Special Initiative for Rebuilding and Resiliency (SIRR). “A Stronger, More Resilient New York.” City of New York (2013). Accessed December 20, 2018: https://www1.nyc.gov/site/sirr/report/report.page.

New York City Department of City Planning. Resilient Neighborhoods. Accessed December 20, 2018. https://www1.nyc.gov/site/planning/plans/resilient-neighborhoods.page)

Rahmstorf, Stefan, “Rising hazard of storm-surge flooding.” Proceedings of the National Academy of Sciences. 114, no. 45 (2017) 11806-11808. DOI: 10.1073/pnas.1715895114

Ramasubramanian, Laxmi; Menser, Mike; Rieser, Erin; Feder, Leah; Forrester, Racquel; Leichenko, Robin; Allred, Shorna; Ferenz, Gretchen; Brezin, Mia; Bolstad, Jennifer; Meyer, Walter; and Tidball, Keith. “Strategies for Community Resilience Practice for the Jamaica Bay Watershed.” In Sanderson E.W., Solecki W.D., Waldman J.R., Parris A.S. (eds) Prospects for Resilience. (2016) Washington, DC: Island Press.

Solecki, William D.; Sanderson, Eric W.; Waldman, John R.; Parris, Adam S. “Why Prospects for Resilience for Jamaica Bay?” In Sanderson E.W., Solecki W.D., Waldman J.R., Parris A.S. (eds) Prospects for Resilience. (2016) Washington, DC: Island Press.

Photo Citations

Photos used throughout this document are largely from DEP’s internal library of project and program photos. Photo citations are provided for those not under the jurisdiction of DEP.

Page 3: Google Earth

Page 6: Left to Right: (1) USACE Flickr (3) Google Street view (4) Hazen and Sawyer

Page 7: Left to Right: (1) USACE Flickr

Page 11: Left to Right: (1) CUNY Institute for Sustainable Cities (2) RAND Corporation

Page 27: Clockwise starting at upper right: (1) Ecowatchers Flickr (2) USACE Flickr

Page 29: USACE Flickr

Page 42: Left: National Parks Service

Page 43: Governor Cuomo Flickr

Page 44: Left to Right: (1) Google Streetview (2) NYC Parks

Page 47: Bottom: Grain Collective for NYCHA