



Manhattan's Fort Washington Park and its famous Little Red Lighthouse

Credit: NYC Parks

Parks

New York City boasts some of the most magnificent public parks in the world. From wild to manicured, from shoreline to inland, these parks run the gamut in program and design. Large or small, they offer New Yorkers and visitors alike seemingly endless opportunities for recreation. Playgrounds, waterfront esplanades, wetlands, hiking trails, dog runs, boating and kayaking areas, athletic courts and fields, beaches and swimming pools, monuments and historic buildings—all these can be found in the city's parks.

This system of parks and open spaces spans over 29,000 acres, covering 14 percent of the city and

encompassing 1,942 sites across all five boroughs. Not surprisingly, because of the vast extent of the city's parks system, when Sandy hit, the impact felt across New York was also felt in parks citywide. From trees downed by Sandy's winds to large stretches of boardwalk and beaches overwhelmed by Sandy's surge, the storm not only wrought hundreds of millions of dollars in damage, but also disabled spaces that, in many cases, were the heart and soul of the neighborhoods they served. With centers for distributing food and other needed supplies, parks were the places where communities came together to begin the road to recovery.

As devastating as Sandy was to the parks system, the storm also taught two important lessons: First, with certain exceptions, much of the parkland emerged with only moderate damage; this showed that, where properly designed, parks and other open spaces actually can withstand the blow of a severe storm. Moreover, in many cases, they acted as the first line of defense for the neighborhoods and infrastructure that they fronted, revealing that parks serve an important protective purpose.

These lessons are critical because New York's parks are not only vulnerable to today's climate-related threats, but are likely to become more so as climate change continues. This is true not only with respect to acute conditions such as storm surge, but also with respect to chronic conditions such as increased temperatures and rainfall. Even modest changes can wreak havoc on the many species of plants and animals found in the city's parks—species that, in many cases, have evolved over eons to thrive in a climate that now is changing rapidly. Indeed, climate change not only threatens the natural landscape of the city's parks but actually threatens the city itself, putting at risk plants that help retain stormwater, provide shade, and make the city livable.

Given the many important roles played by the city's park system, it is critical that New York take steps today to improve the system's resiliency. In keeping with the overarching goals of this report—to minimize the impacts of climate change and enable quick recovery after extreme weather events—the City will pursue strategies that will strengthen parks themselves so they, in turn, can act as stronger buffers for adjacent communities. The City also will develop the tools to analyze and modify its park system for these many roles in an era of increasing change.

How the Parks System Works

New York is fortunate to host parks owned and operated by the City, State, and Federal governments, as well as several that are managed jointly. For example, Hudson River Park along the west side of Manhattan is managed by a trust that is jointly controlled by the City and the State. The National Park Service, meanwhile, manages a 22-acre national monument on Governors Island, while the Trust for Governors Island, a not-for-profit created by the City, manages the other 150 acres. The planned transformation of Jamaica Bay into a world-class site for recreation, ecological restoration, wildlife protection, and scientific research is an expansive example of City-Federal cooperation. (See sidebar: *Jamaica Bay*)



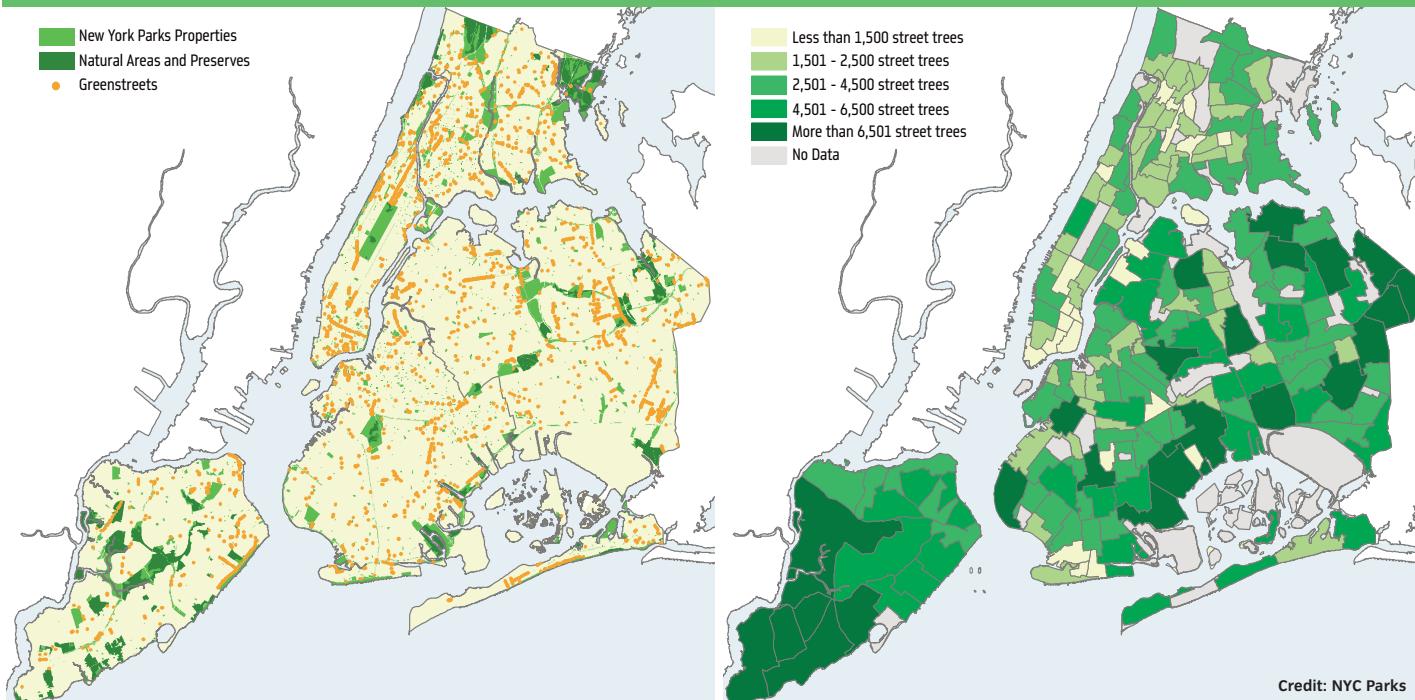
Jamaica Bay

Jamaica Bay is one of New York's largest natural features, covering over 10,000 acres of parkland in Brooklyn and Queens managed by both the City and the Federal governments. The Bay contains rare native habitats such as salt marshes, forests, and freshwater ponds. The Bay also is home to a stunning array of wildlife, including over 50 species of butterflies, and a bird sanctuary visited by 330 different species.

The accelerated loss of marshland within Jamaica Bay over the 20th century prompted many governmental initiatives to preserve and restore the Bay's ecology. With the goal of better aligning their Jamaica Bay-area holdings and to foster greater collaboration, in July 2012, then-Secretary of the Interior Ken Salazar and Mayor Bloomberg signed a landmark Cooperative Management Agreement governing Jamaica Bay-Rockaway Parks.

As part of this Agreement, the City is embarking on several initiatives with leadership support from the Rockefeller Foundation and additional support from Bloomberg Philanthropies, Moore Charitable Trust, National Grid, and the Secunda Family Foundation. First, the City aims to expand wetland restoration that it had begun around Jamaica Bay, guided by the Comprehensive Restoration Plan developed under the United States Army Corps of Engineers with support from the National Park Service, the City, and many other regional entities. These efforts are also guided by the Department of Environmental Protection's Jamaica Bay Watershed Protection Plan. Second, the City will establish interagency working groups to explore the feasibility of restoring the historic shallow basin profile of Jamaica Bay to benefit both habitat and the environment while reducing storm surge-related flood risks in areas surrounding the Bay. Third, the City, in partnership with the National Park Service, will establish the Jamaica Bay-Rockaway Parks Conservancy to promote visitation, education programs, scientific research and recreational opportunities. Finally, the Agreement also seeks to establish a Science and Resilience Center at Jamaica Bay to catalyze research and fieldwork in the Bay. Among other things, the new Center will facilitate an exchange of information among policy-makers and academics on issues of coastal and urban resiliency that are relevant to cities around the world. The Center also will address local issues facing the Bay, including opportunities to improve water quality and continue to restore degraded natural areas.

New York City's Parks System



The City also partners with non-governmental bodies in the management of parks. For example, Central Park, Forest Park in Queens, the Staten Island Greenbelt, and Prospect Park are supported in part by independent conservancies, which raise funds for the operation and maintenance of those parks. (See sidebar: *Public-Private Partnerships*)

For the most part, however, when New Yorkers visit parkland in the five boroughs, they are visiting recreational assets that are both owned and managed by the City through the Department of Parks & Recreation (DPR). These properties, therefore, are the primary focus of this report. (See map: *New York City's Parks System*)

The City's parks system can be categorized into four main types of properties: beaches and waterfront parks, inland parks, natural areas and preserves, and Greenstreets infrastructure.

Beaches and Waterfront Parks

Among DPR's assets, its beaches, boardwalks, and waterfront parks constitute by far its most expansive category, covering over 7,300 acres or 30 percent of its total land area. This parkland connects millions of city residents and visitors to the water. In fact, in 2012 alone, the city's beaches welcomed over 21 million people, providing them with a wide range of recreational opportunities and amenities. Especially in recent years, the city's waterfront parks also have spurred the development of residences and businesses along their peripheries. Examples of waterfront parks include Rockaway Beach in

Queens, Coney Island in Brooklyn, Orchard Beach in the Bronx, Battery and Riverside Parks in Manhattan, and Midland Beach in Staten Island. Waterfront parks can be found along 150 miles—or almost 30 percent—of the city's total coastline.

Inland Parks

New York's 1,942 parks are home to more than 1,000 playgrounds, 800 athletic fields, 550 tennis courts, 60 public pools, and 30 recreation centers, as well as many other active and passive assets. Connecting these parks to one another and to the city's waterfront and beaches are over 100 miles of Greenways that provide residents and visitors alike with pedestrian- and cyclist-friendly corridors.

Natural Areas and Preserves

The city's 9,900 acres of natural areas include forests, grasslands, and wetlands—representing over a third of the acreage in DPR's system. Natural areas provide many benefits, including air quality improvements, carbon sequestration, enhanced wildlife habitats, stormwater retention, shoreline protection, and native plant life preservation. The city's wetlands, for example, shelter a wide variety of plants and animals. These areas protect the quality of waterways by absorbing nutrients and filtering sediment and contaminants.

Freshwater streams play an important role in New York city's ecosystem as well as manage stormwater runoff. Today, however, there are few natural streams remaining in New York City, with many now piped underground. Some,

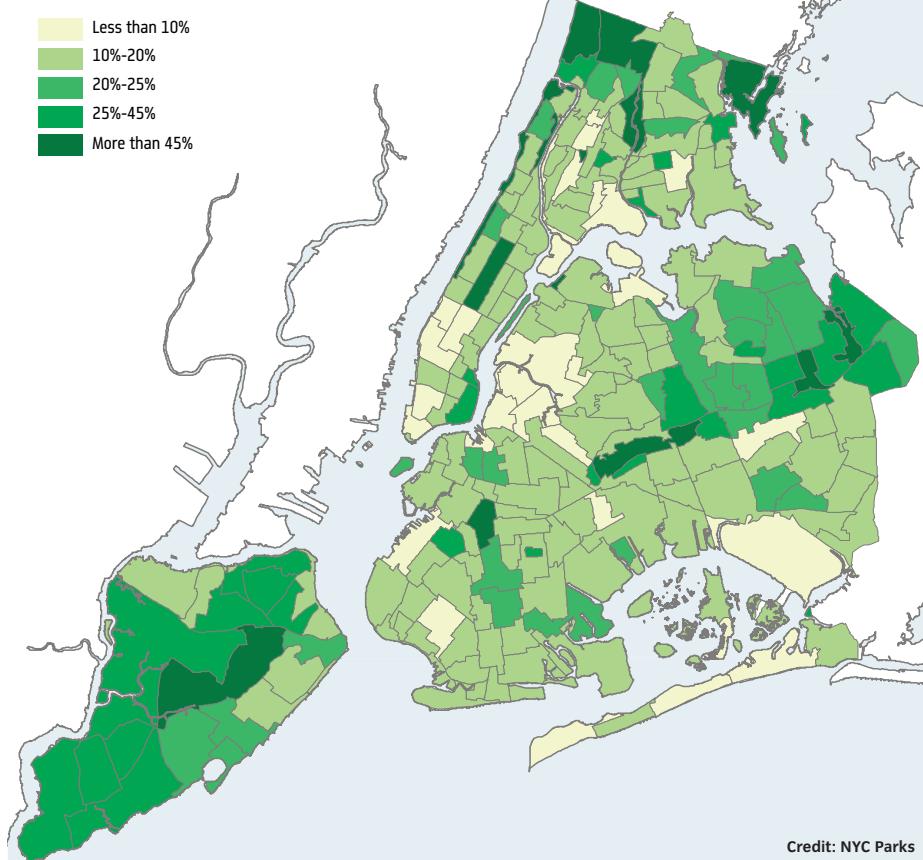
Public-Private Partnerships

New York City's parks system has experienced an incredible transformation over the past 30 years with the assistance of many partner organizations. This wide network of innovative partnerships has brought countless volunteers, much needed resources, and a shared advocacy for the city's green spaces. Hundreds of neighborhood Friends of Parks groups, many supported by Partnerships for Parks, have galvanized local interest and stewardship across the five boroughs.

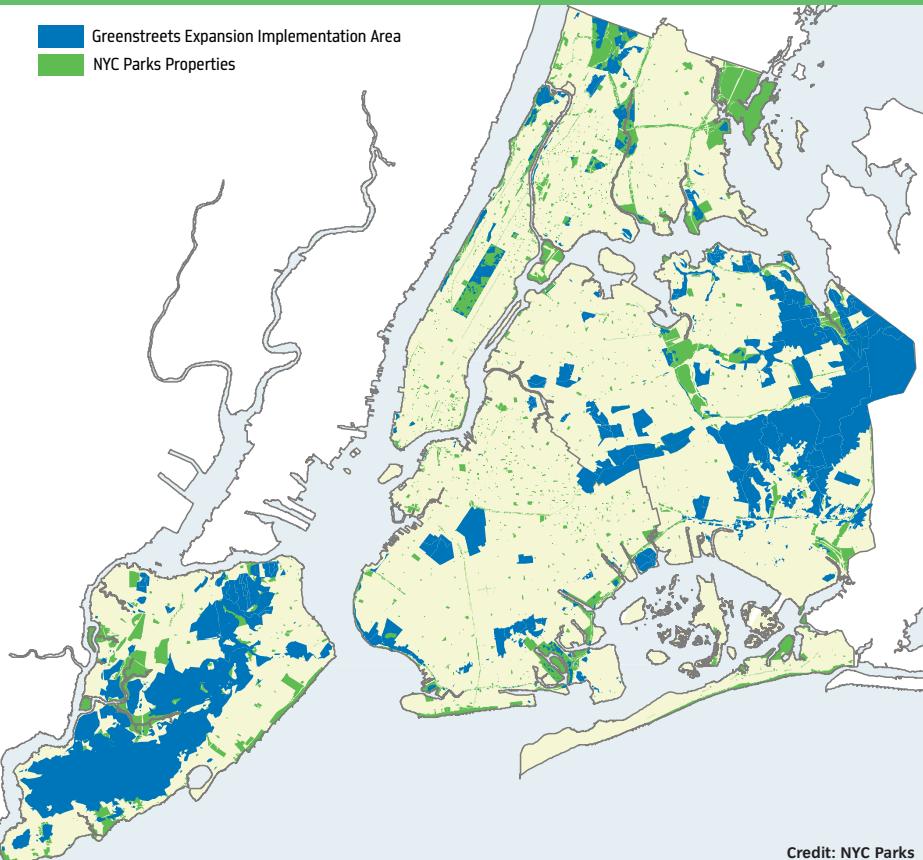
Organizations like the Central Park Conservancy, the Forest Park Trust, Prospect Park Alliance, the Greenbelt Conservancy, and the Bronx River Alliance have absorbed significant maintenance responsibility in specific parks and also raise millions of dollars for capital improvements. Other partners cast a citywide focus, such as the City Parks Foundation, with its commitment to expanding opportunities for cultural and recreational programming, and the Natural Areas Conservancy, a new organization developing a innovative model to manage natural areas in parks as one ecosystem.

such as Tibbetts Brook in the Bronx, also are connected to the City's combined sewer infrastructure and flow directly into the local wastewater treatment plant.

Tree Canopy by Neighborhood



Expanding the Greenstreets System



Also found in the city's natural areas—as well as in inland parks, along waterfront parks and beaches, and along streets—are trees, many of which are managed by DPR. These trees not only moderate temperatures; they also remove carbon dioxide and pollutants from the air, among other important functions. DPR's trees range from large canopy trees to street trees, which both enhance sidewalk environments and protect waterways by reducing stormwater runoff. DPR staff manage this urban forest by planting new trees and pruning existing trees to remove dead branches and increase light and air penetration. Since it was announced in PlaNYC in 2007, the City has planted nearly 760,000 trees as part of the Million-TreesNYC initiative. (See map: Tree Canopy by Neighborhood)

Greenstreets

DPR's green infrastructure includes natural areas that absorb stormwater and 2,500 Greenstreets, which transform parts of the city's asphalt areas into green landscapes. First constructed in 1996 as a joint project between DPR and the City's Department of Transportation (NYCDOT), Greenstreets have been built throughout the five boroughs in unused road areas, traffic islands, and industrial areas. Greenstreets beautify communities, improve air quality, reduce air temperatures, and enhance safety by shortening street-crossing distances and slowing traffic. (See map: Expanding the Greenstreets System)

In 2010, the unit that managed DPR's Greenstreets program became the Green Infrastructure Unit, solidifying its focus on active stormwater capture and using soil beds and other natural features to divert water. By using specially designed soils and plants in these areas, Greenstreets projects absorb runoff from an area 10 or more times their size. Created in partnership with the Department of Environmental Protection (DEP), new stormwater Greenstreet designs enhance cost-effective rainwater capture practices in priority areas of the city, as part of the NYC Green Infrastructure Plan. This work prevents runoff from entering the City's combined sewer system, which, in turn, lessens the frequency of combined sewer overflows (CSOs).

To manage these four categories of parks assets, DPR has a variety of administrative buildings from which staff run, build, and maintain this one-of-a-kind park system. These buildings include the agency's headquarters at the Arsenal in Central Park and other operations centers citywide. In addition to its administrative facilities, DPR also operates other facilities that support its operations and research activities. For example, the Greenbelt Native Plant Center,

a 13-acre greenhouse and seed bank, provides plant material for natural area restoration projects in the city.

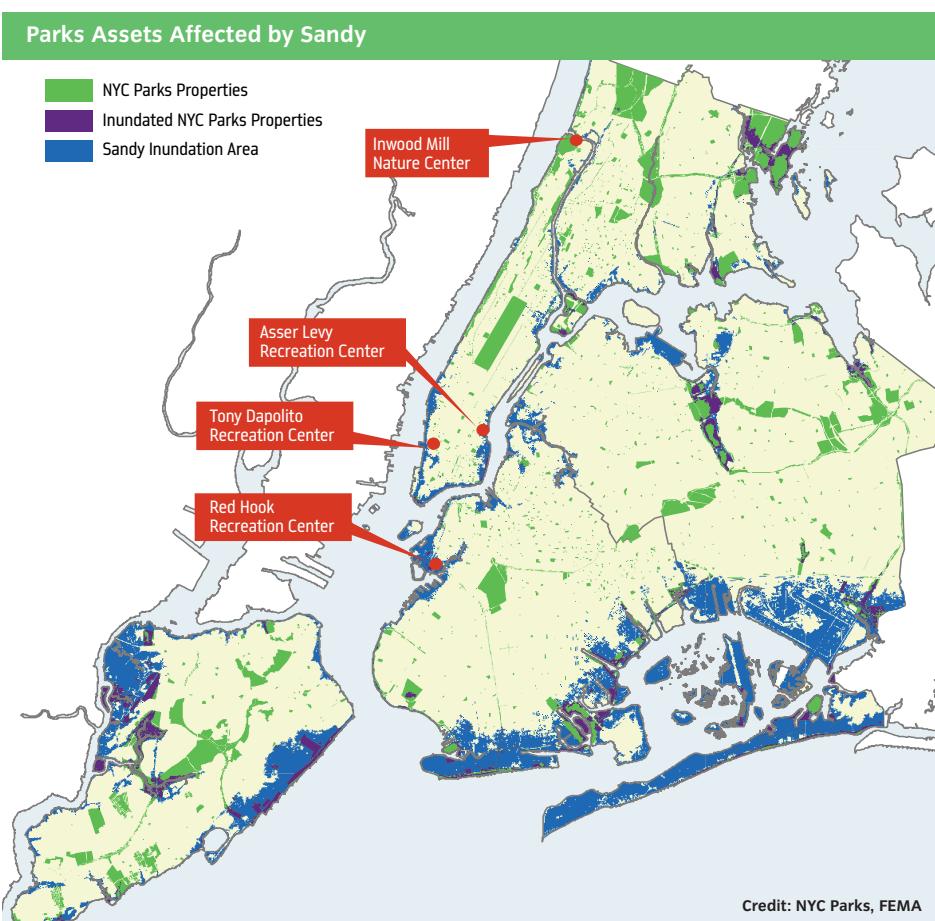
Finally, across the city, DPR supports its efforts through a wide variety of recreational, cultural, scientific, and educational programming. In 2013, DPR launched a Parks Fellowship and Conservation Corps, a new public service program that will expose and attract participants to career opportunities in DPR and the environmental field. The Conservation Corps will support DPR priority projects, provide valuable work experience across DPR divisions, and foster the next generation of leaders dedicated to protecting and enhancing the City's parks and natural resources.

What Happened During Sandy

Sandy inundated over 5,700 acres of New York's park system and caused nearly \$800 million in damage. (See map: Parks Assets Affected by Sandy)

As described in Chapter 3 (*Coastal Protection*), the city's beaches bore the brunt of the storm's wave action, with significant impacts on the Rockaway Peninsula, Coney Island and adjacent areas of Southern Brooklyn, and along the East and South Shores of Staten Island. On the Rockaway Peninsula, storm surge pounded whole sections of the boardwalk, scattering them into the neighboring communities. Meanwhile, erosion displaced up to 3 million cubic yards of sand and maybe more. In some places, beachfronts retreated by as much as 70 feet. Sandy also pushed water over bulkheads on DPR-managed waterfront sites, damaging these critical coastal defenses and allowing waters to flood parts of the Belt Parkway in Brooklyn. In addition, Sandy damaged DPR's beachfront infrastructure and facilities, including public restrooms.

However, earlier beach nourishment projects (where sand was deposited on existing beaches to both elevate and widen them) also proved successful at city beaches. As a result, for example, the portion of Rockaway Beach at Beach 56th Street, which had well-maintained planted dunes, not only was able to partially resist Sandy's force but also was instrumental in protecting neighborhoods. By contrast, at Beach 94th Street, which had limited beach nourishment and dune maintenance, storm surge destroyed the wooden boardwalk and swept significant volumes of sand into the surrounding neighborhoods. Another successful nourishment project could be found at Plumb Beach in Southern Brooklyn, where, just before Sandy hit, the United States Army Corps of Engineers (USACE) had finished adding 120,000 cubic yards of clean, dredged sand. This intervention



kept Sandy's surge from potentially breaching a vulnerable section of the Belt Parkway.

Interestingly, not all waterfront parks in Sandy's path were impacted equally. The use of resilient materials and terraced grading helped protect Battery Park and Riverside Park. Revetments, armor stone edges that absorb and deflect waves, and salt-tolerant plantings helped Brooklyn Bridge Park escape with less damage than much of the area surrounding it. At

Governors Island, meanwhile, thanks to elevation and other flood-protective strategies, the site of a future park escaped largely unharmed.

However, flooding from storm surge did affect city marinas and piers, including the 79th Street Boat Basin in Manhattan, the World's Fair Marina in Queens, the Sheepshead Bay Piers in Brooklyn, and the Lemon Creek Marina on Staten Island. Docks, pilings, and piers were damaged, and buildings supporting these

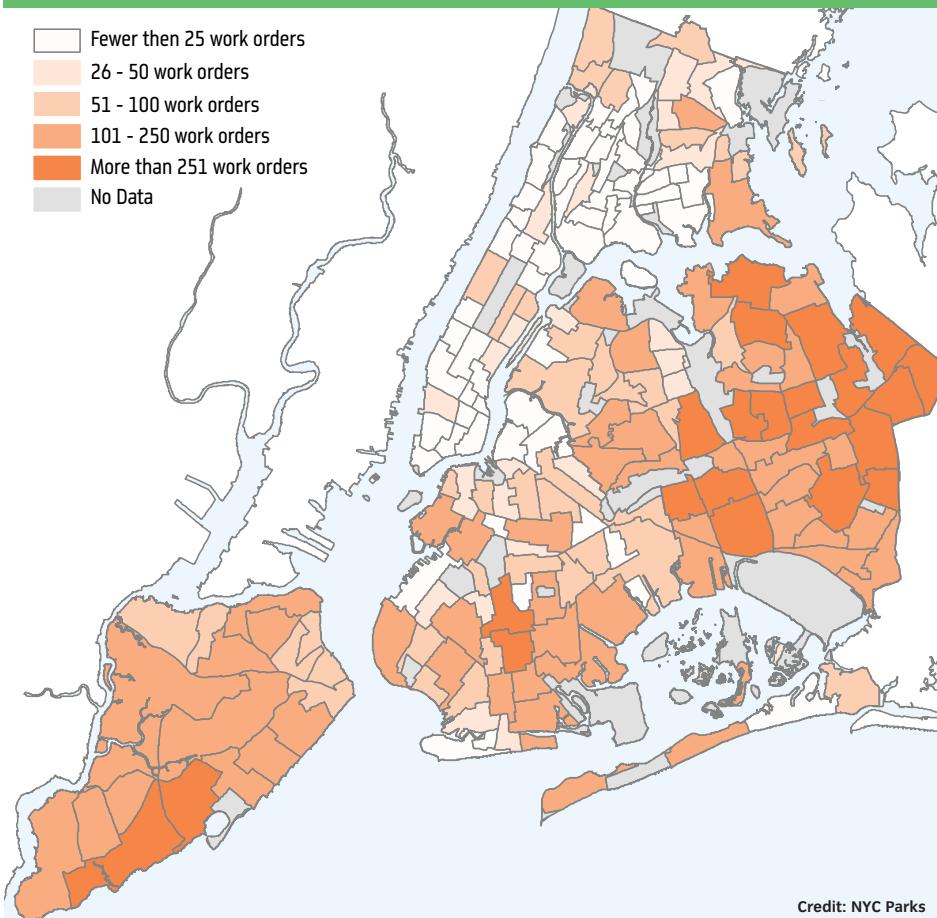
marinas were inundated, causing damage to equipment and electrical and plumbing systems.

While the waterfront parks faced the most direct impacts, certain inland neighborhood recreational facilities sustained damage as well. In inundated areas, facilities such as the Asser Levy Recreation Center, the Tony Dapolito Recreation Center, the Inwood Nature Center, and the Red Hook Recreation Center suffered significant water damage to structural and mechanical systems, affecting in some cases the massive filtration plants supporting attached outdoor pools. As a result of this inundation, these centers were shut for four weeks.

Though Sandy flooded over 3,000 acres of natural areas, New York City's wetlands fared relatively well. For example, the salt marshes located in Jamaica Bay and its tributary systems remained largely clear of floating debris, with much of their vegetation surviving. By contrast, across the city, approximately 20,000 street and park trees were downed by Sandy's winds, resulting in weeks of emergency forestry work. In some areas, downed trees and limbs took down nearby utility lines, which disrupted power and telecommunications services. (See map: Street Tree Emergency Work Orders Post-Sandy)

With respect to Greenstreets, many performed well during Sandy. For example, the stormwater Greenstreet at Nashville Boulevard and Colfax Street in Queens absorbed water equivalent to 31 times its own area, including 1,300 gallons of rainwater falling directly on it and 39,000 gallons of runoff flowing in from surrounding streets—an amount estimated to represent 3,000 percent more water than a non-stormwater Greenstreet typically would hold. In the stormwater sites, little erosion or ponding was seen. While surge inundation killed some vegetation, generally, Greenstreets emerged from Sandy with minimal damage and plant loss.

Street Tree Emergency Work Orders Post-Sandy



Parks Assets Inundated and at Risk

NYC Parks	Citywide Total	Inundated by Sandy		2013 PWMS 100-Year Floodplain		Projected 2020s 100-Year Floodplain		Projected 2050s 100-Year Floodplain	
Park Properties (acres)*	24,200	5,700	24%	5,800	24%	6,600	27%	7,400	31%
Street Trees**	592,400	41,600	7%	35,990	6%	46,400	8%	61,100	10%
Natural Areas (acres)	9,900	3,000	30%	3,117	31%	3,300	33%	3,500	35%
Greenstreets (acres)	173	26	15%	26	15%	30	17%	40	23%

* not including areas located beyond NYC shoreline

** based on 2005-2006 Street Tree Census data

Risk Assessment: Impact of Climate Change on Parks

■ Major Risk ■ Moderate Risk ■ Minor Risk

Hazard	Scale of Impact			Comments
	Today	2020s	2050s	
Gradual				
Sea level rise				Risk in coastal areas for parks, Greenstreets, street trees, and natural areas
Increased precipitation				Could increase flooding in inland parks, natural areas and preserves, and roadways
Higher average temperature				Could increase stress on plantings, especially if coinciding with drought
Extreme Events				
Storm surge			■	Risk primarily for coastal parks (significant expansion in parks acreage in the floodplain by the 2050s), but could produce flooding in inland areas
Heavy downpour				Resulting flooding could cause street tree and forestry damage
Heat wave				Could increase stress on plantings
High winds				Street trees and forestry at risk, with indirect impacts on power lines and transportation

Key DPR operations and administrative facilities both within and beyond the inundation zone were impacted by Sandy. In Flushing Meadows Corona Park, areas of the park at lower elevations and closer to Flushing Bay were flooded, including the Olmsted Center, causing damage to office spaces, archived documents, and the computer

network. On the other hand, a facility within Sara D. Roosevelt Park in Manhattan, which assists in dispatching needed Parks resources in emergency situations, was equipped with a generator and continued operation despite widespread power loss in surrounding areas. (See table: *Parks Assets Inundated and at Risk*)



What Could Happen in the Future

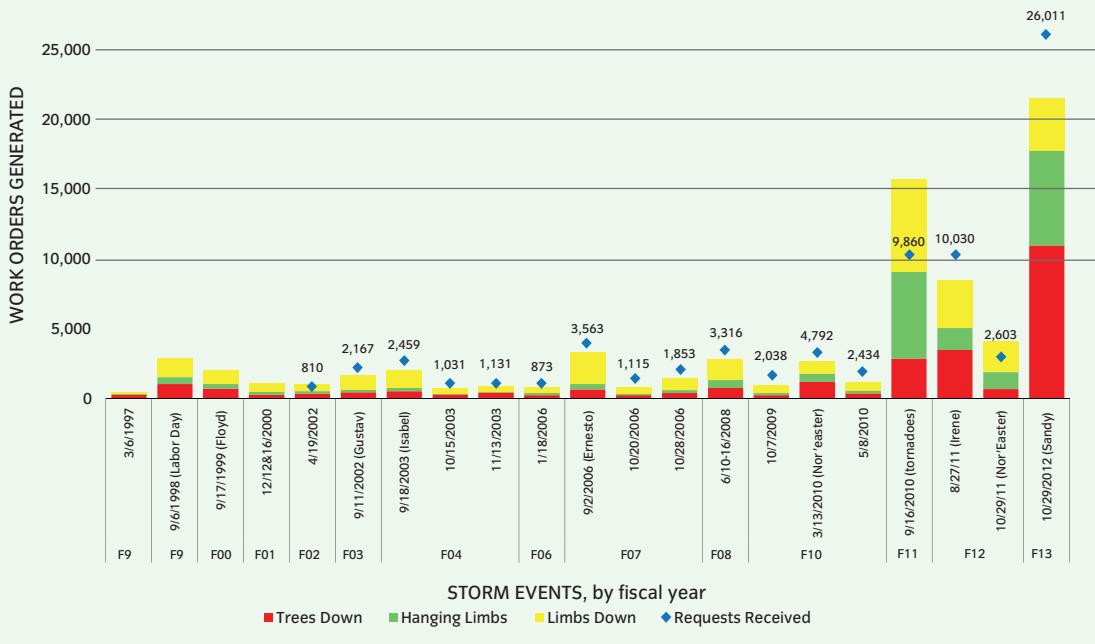
Going forward, the city's parks face a variety of risks related to climate change.

Major Risks

The most significant risk to the parks system is flooding from coastal storms, which is likely to be exacerbated by projected sea level rise. This risk is significant even today, as illustrated by recently released flood maps from the Federal Emergency Management Agency (FEMA). According to these maps, called Preliminary Work maps (PWMS), over 5,800 acres (or 24 percent) of the city's parkland are in the 100-year floodplain, an area that has a 1 percent or greater chance of flooding in any given year. Over 230 DPR buildings are within the floodplain, including several key facilities such as the Greenbelt Native Plant Center and the Lyons Recreation Center on Staten Island.

According to the New York City Panel on Climate Change (NPCC), sea levels are expected to rise around New York City. By the 2020s, under high-end sea level rise projections, 6,600 acres (27 percent) of the city's parkland could lie in the 100-year floodplain, increasing to over 7,400 acres (or 31 percent) by the 2050s. An even more disturbing pattern

Forestry Storm Events



Credit: NYC Parks

holds true for DPR buildings, with the number in the floodplain forecast to grow even faster, rising to 301 buildings (an increase of 30 percent) by the 2020s and to almost 350 buildings (a 50 percent increase) by the 2050s. This increasing vulnerability to storm surge can be seen across DPR's portfolio, from its natural areas to its street trees to its Greenstreets—putting all these assets and the surrounding communities they protect at risk. (See map: Parks Assets in the Floodplain)

Other Risks

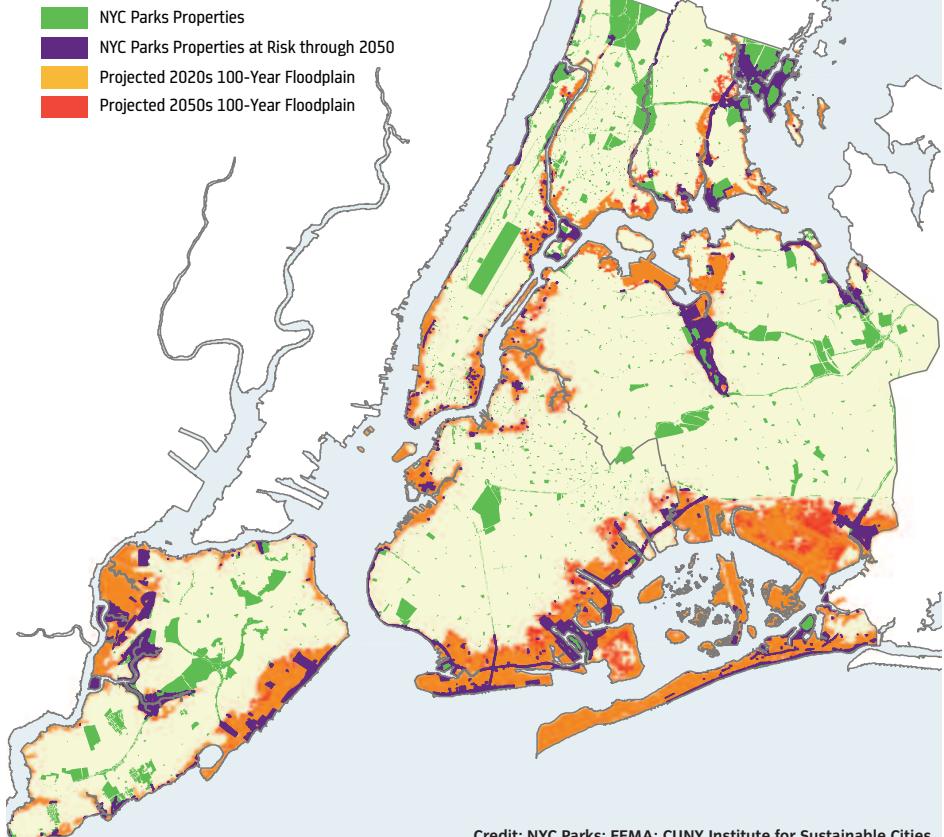
While surge from coastal storms poses the most significant climate-related risk to New York's parks in coming years, other extreme weather events also could impact DPR's system. With an estimated 2.5 million trees under DPR's jurisdiction, the city's urban forest is at great risk with the increasing frequency of the most intense storms with high winds, potentially impacting vital utility networks. Similarly, more frequent heavy downpours in New York could damage play surfaces and cause water quality impacts. (See graph: Forestry Storm Events)

Even without extreme weather events, chronic hazards also could impact New York's parks. For example, gradual sea level rise over time could lead to the loss of salt marsh habitats along the city's coastline, endangering plants and animals—a threat also posed by expected higher average temperatures and increased variability in precipitation. Additionally, sea level rise could lead to regular tidal flooding around New York City, especially in parks in South Queens, Alley Pond Park in northern Queens, and Pelham Bay Park in the Bronx.

Meanwhile, associated changes in ocean temperature may affect the distribution of oysters and other aquatic life in New York Harbor, and also could affect commercial and

recreational fisheries in and around the city. Sea level rise and other chronic changes also could impact the water levels and chemistry of area freshwater ponds, harming the local ecology.

Parks Assets in the Floodplain



Credit: NYC Parks; FEMA; CUNY Institute for Sustainable Cities

INITIATIVES FOR INCREASING RESILIENCY IN PARKS

This chapter contains a series of initiatives that are designed to mitigate the impacts of climate change on New York's parks system. In many cases, these initiatives are both ready to proceed and have identified funding sources assigned to cover their costs. With respect to these initiatives, the City intends to proceed with them as quickly as practicable, upon the receipt of identified funding.

Meanwhile, in the case of certain other initiatives described in this chapter, though these initiatives may be ready to proceed, they still do not have specific sources of funding assigned to them. In Chapter 19 (*Funding*), the City describes additional funding sources, which, if secured, would be sufficient to fund the full first phase of projects and programs described in this document over a 10-year period. The City will work aggressively on securing this funding and any necessary third-party approvals required in connection therewith (i.e., from the Federal or State governments). However, until such time as these sources are secured, the City will only proceed with those initiatives for which it has adequate funding.

To protect parks and their surrounding neighborhoods, the City will work to upgrade and better prepare these parks—and related facilities—to withstand future extreme weather events as well as the chronic impacts of climate change. To this end, the City will seek to make parks more effective at absorbing and buffering the impacts of extreme events; will work to retrofit or harden parks and facilities, as well as wetlands and other natural areas; and will develop tools for comprehensive climate adaptation planning and design.

Strategy: Adapt parks and expand green infrastructure to shield adjacent communities from the impacts of extreme weather events

To protect parks themselves, together with surrounding neighborhoods, the City will seek to increase the capacity of its parks to absorb floodwaters (from storm surge and heavy precipitation) and to absorb the driving impact of surge-related wave action. The City also will seek to expand its green infrastructure citywide.

Initiative 1 Restore city beaches

Beaches play an important recreational role and also are an important component in the city's coastal defenses, but they cannot protect adjacent areas without being "nourished" (replenished with new sand to replace that lost to erosion) from time to time. Subject to available funding, the City, through DPR, will collaborate with Federal and State partners—including the USACE—to implement plans quickly to restore sand lost after extreme storm events and to conduct regular nourishment of beaches and regular monitoring to detect the early signs of erosion. The goal is launch this effort at city beaches such as Plumb Beach in Brooklyn and Orchard Beach in the Bronx by 2015 (see Chapter 3).

To restore the city's beaches following Sandy, DPR and the Department of Design and Construction, in cooperation with many other City, State, and Federal partners, conducted an expedited program of projects to provide new and elevated lifeguard stations and public bathrooms and improvements to other beachfront amenities in advance of Memorial Day 2013. DPR constructed 35 prefabricated modular buildings, to be used as comfort stations and lifeguard stations, in Rockaway, Coney Island, and Staten Island, informed by storm surge projections for the 500-year floodplain at a height ranging from 7 to 14 feet

above the existing grade to reduce the risk of flood damage and give a greater level of protection to these facilities. This impressive achievement comprised the first phase of restoring the city's beaches. In the coming months and years, DPR will continue its efforts to provide emergency sand nourishment and to expedite planning, evaluation, and design work for long-term plans to restore the city's beaches, boardwalks, and other beachfront amenities.

Initiative 2

Harden or otherwise modify shoreline parks and adjacent roadways to protect adjacent communities (See Coastal Protection Initiative 30)

Approximately 24 percent of DPR parks and other open spaces are in the 100-year floodplain on the PWMS, which is expected to expand as sea levels rise—including in areas where parks front residential and commercial districts. Subject to available funding, the City, through DPR, will study and identify mitigation strategies, including cost-effective ways to use its parks system to protect adjacent neighborhoods and the parks themselves. Strategies could include hardening or elevating park infrastructure, construction of levees or floodwalls to minimize flooding and attenuate waves, and using flood-tolerant materials in the construction of parks. The goal is to complete this study in 2014.

Initiative 3

Reinforce or redesign bulkheads in coastal parks (See Coastal Protection Initiative 6; see Coastal Protection Initiative 29)

The current portfolio of bulkheads and other waterfront structures in the city includes many aging or damaged assets that are at risk of failure, particularly during a major storm event. Many of these at-risk bulkheads can be found on DPR properties. Subject to available funding, the City, will inspect—as part of a new citywide waterfront inspection program—damaged bulkheads on parkland to develop a plan that will allow, over time, for their reconstruction, elevation, or replacement with living shorelines, where appropriate, that are both more resistant to storm damage and more accommodating of marine life. The goal is to launch this program in 2013. See Chapter 3 for more information on the City's plans for inspecting bulkheads and improving the resiliency of the coastline.

Initiative 4

Expand the City's Greenstreets, including for Jamaica Bay

Increased localized flooding is likely from more frequent heavy downpours in the future.



Credit: Sage and Coombe Architects

Phase 1 Restoration, Rockaway Beach

INITIATIVES FOR INCREASING RESILIENCY IN PARKS

Subject to available funding, the City, through DPR and in partnership with DEP, will expand its efforts to build more and larger Greenstreets to absorb stormwater, mitigate local flooding, decrease urban heat island effect, increase pedestrian and traffic safety, and beautify neighborhoods. This will expand the installation of green infrastructure at appropriate locations in the City's streets, with approach modeled upon the NYC Green Infrastructure Plan, which improves water quality in combined sewer areas.

The first phase of this expansion would focus on fourteen neighborhoods with the greatest potential for improvement, areas that are not slated for CSO improvements through the NYC Green Infrastructure Plan, but could be well-suited for Greenstreets based on best available data showing low bedrock and ground water. The goal is to construct and maintain 1,600 Greenstreets at a high density to amplify impacts such as cooling and ecological health. This expansion would capture approximately 32 million cubic feet of stormwater per year by 2015, with a footprint of over 50 acres of increased green space. Thereafter, DPR will consider expansion of this strategy over a 10-year period, focusing on the remaining 20 percent of the city where new Greenstreets could provide myriad benefits.

An early priority for this effort will be the area surrounding Jamaica Bay, where DPR will collaborate with DEP and NYCDOT to reduce localized flooding and stormwater runoff, directly improving the health of the Bay. The goal is to begin pilot projects in and around Coney Island, Marine Park, the Rockaways, and Canarsie Park, including Greenstreets and parkland installations by 2014.

Strategy: Retrofit or harden park facilities to withstand the impacts of climate change

Even where parks-related facilities do not serve a protective function, they nonetheless offer vitally important amenities for the communities they serve. The City, therefore, will seek to protect these facilities from the impacts of climate change where possible and to enable them to bounce back quickly when impacts do occur.

Initiative 5: Fortify marinas and piers

Marinas and piers are valuable water-dependent facilities that are vulnerable to extreme weather events. Subject to available funding, the City, through DPR, will begin to address this vulnerability by increasing the resiliency of its fixed and floating structures at the 79th Street

Boat Basin in Manhattan, the World's Fair Marina in Queens, Lemon Creek Marina in Staten Island, and the Sheepshead Bay Piers in Brooklyn in 2013. This work will include increasing piling count and height, replacing deteriorated pilings, and installing steel hurricane straps on piers. Additionally, lighter floating docks will be replaced with heavy-duty, modular articulating docks, more robust wave screens, and icebreaker systems. Contingency plans also will be developed to accommodate bow-loading passenger ferries, in the event that these sites can aid in emergency transportation measures (see Chapter 10, *Transportation*). The goal is to complete these improvements by 2016.

Initiative 6 Relocate or increase the resiliency of playgrounds and athletic fields

The City's park network includes over 1,000 playgrounds and 800 athletic fields—over 256 acres of which were inundated during Sandy. Subject to available funding, the City, through DPR, will continue to assess whether facilities impacted by Sandy or otherwise impacted should be relocated or otherwise protected from future inundation. Based on these findings and subject to available funding, DPR then will adopt flood-mitigation tactics at these facilities (such as carpet-style synthetic turf and tiled safety surfacing) to allow for easier post-flood repair and cleanup. DPR also will install rain gardens and water collection systems around these facilities to reduce flooding in parks and the burden on stormwater systems during these extreme events. The goal is to complete the analysis of all sites by 2015.

Initiative 7 Protect mechanical systems at major park facilities and buildings

As with buildings citywide, many park facilities in flood-prone areas have mechanical systems that are vulnerable to inundation. Damage to these systems can, in turn, result in extended facility closures and costly repairs. Subject to available funding, the City, through DPR, therefore will begin the process of flood-proofing all of its mechanical, electrical, irrigation and critical systems in parks that are located in the 100-year floodplain. These protective measures could include elevating mechanical systems, or flood-proofing their enclosures—all consistent with strategies outlined in Chapter 4 (*Buildings*). Subject to available funding, this effort will begin with a DPR-led pilot program to test flood-proofing technologies to achieve maximum effectiveness in future capital projects. The goal is to commence this pilot program by 2015, at

which time DPR will identify and implement design strategies for five different facilities, targeting boilers; heating, ventilation, and air conditioning systems; pool filtration plants; and irrigation systems.

Initiative 8

Move or protect critical operations centers

Many DPR buildings, including operations centers and administrative buildings, are located in the 100-year floodplain and are, therefore, at risk of flooding. Subject to available funding, the City, through DPR, therefore, will strive to maintain critical operations at these centers during and immediately after extreme weather events. To this end, DPR will construct waterproof walls, berms, and pump systems powered with dual fuel generators, where possible, to protect these centers from flooding. DPR also will upgrade applicable telecommunication, utility, and computer systems in these centers so they can function as temporary reporting sites. These upgrades will occur pursuant to the availability of funding. The goal is to complete this project in five years.

Strategy: Protect wetlands, other natural areas, and the urban forest

Wetlands, streams, forests and other natural areas offer substantial sustainability and resiliency benefits. The protection and restoration of these natural areas is, therefore, of critical importance.

Initiative 9

Work with the Federal government to transform Jamaica Bay

One of the most significant opportunities in New York's history for the development, management, maintenance, and programming of an integrated set of wetlands and other natural areas for natural habitat and recreational use exists in and around Jamaica Bay. Through its groundbreaking partnership with the National Park Service, the City, through DPR, will seek to promote habitat preservation and flood protection as well as a variety of programs in the 10,000 acres of Federally and City-owned parks in and around Jamaica Bay. This program will offer educational, scientific, recreational, and other opportunities to visitors. The goal for this partnership is to lead large-scale bay restoration and green infrastructure projects, which, in addition to improving the Bay itself, also will protect the many adjacent neighborhoods in Brooklyn and Queens.

Initiative 10

Increase the health and resiliency of natural areas, including Tibbetts Brook

Increased stormwater runoff mixed with sewage outflows poses a risk not just to the developed areas of the city but also to its natural areas. Subject to available funds, the City, through DPR and DEP, will restore freshwater streams and restore or construct wetlands to manage runoff and reduce the impacts of extreme weather events.

In particular, DPR will collaborate with DEP to make near-term progress toward the separation of Tibbetts Brook from the city's combined sewer system. This will reduce stormwater flow into the combined sewer system and provide wetland restoration in a cost-efficient manner. This effort will include property acquisition, conceptual design, and eventual construction. Successful separation would reduce CSO volumes into the Brook and the Harlem River by an estimated 140 million gallons per year, improving river water quality and freeing capacity at the Wards Island Wastewater Treatment Plant.

The goal is to develop conceptual designs and complete construction documents by 2015.

Initiative 11

Improve the health and resiliency of the city's urban forest

The city's forests and trees provide an array of health and environmental benefits. They are, though, vulnerable to a variety of climate change-related impacts, including storm surge, wind, and changes in average temperatures. Subject to available funding, the City, through DPR, will undertake a variety of efforts to protect trees—whether located in natural areas and parks, or along streets. Specifically, DPR will undertake three parallel efforts, all subject to available funding.

First, DPR will add to its forest management crews. Just one additional six-person crew would allow DPR, in partnership with the Natural Areas Conservancy, to expand active management of forests by 200 acres. Second, DPR will identify locations to expand tree beds, thereby giving tree roots more room to grow and reducing the high rate of tree mortality and failure during storms. Initially, DPR will target 5 percent of all planting locations for such expansion in connection with the City's existing MillionTreesNYC initiative. Finally, DPR will modify its regular tree inspection and pruning efforts to prioritize trees in areas vulnerable to extreme weather events. These pruning efforts will cover 80,000 street trees, 10,000 young

trees, and 20,000 park trees annually—a rate that will enable DPR to cycle through the entire citywide tree population every seven years. To launch this program, DPR will use existing funding to hire and train 10 foresters to perform tree risk assessment inspections and supervise pruning efforts. The goal is to launch this program in 2013.

Initiative 12

Increase growth of local plant material for restoration work

Nearly every landscape restoration project undertaken by DPR around the city requires locally sourced or native plant materials. Subject to available funding, the City, through DPR, therefore will make capital improvements and add additional staff to its Greenbelt Native Plant Center. The unprecedented volume of plants needed for post-Sandy restoration projects requires the timely production of a sufficient supply of the right local genetic stock of such plants. This program was launched in 2013.

Strategy: Develop tools for comprehensive climate adaptation planning and design

As weather experts expect conditions to evolve over a long period of time, the City aims to respond appropriately with resiliency measures for its park network. To that end, the City and its partners will seek to secure appropriate tools to monitor and measure conditions in the environment and the success of investments that it is making.

Initiative 13

Establish a center for resiliency and restoration efforts in the Jamaica Bay-Rockaway Parks

The joint City-Federal effort to transform Jamaica Bay into a national model has, as one of its centerpieces, a plan to create a new Science and Resilience Center at Jamaica Bay. The City, through DPR and in close collaboration with the National Park Service, will work with leading academic institutions to make this center a reality, with initial operations to begin in the fall of 2013.

The Science and Resilience Center at Jamaica Bay will serve a variety of key functions. First, the Center will facilitate decision-making by policy makers based on the latest scientific information developed by academic institutions. Second, the Center will address Jamaica Bay issues, such as water quality and ecological restoration. Third, the Center will seek to

ensure the broad dissemination of resiliency-related research and policymaking to governments and scientific institutions around the world. The goal is to launch the Center in 2013.

Initiative 14

Quantify the benefits of the city's ecosystems and green infrastructure

A lack of high-quality performance data could hamper the City's ability to make smart decisions about its green infrastructure. Subject to available funding, the City, through DPR and DEP, will commission studies on the impact of the city's green infrastructure and natural areas, seeking to quantify the program's impacts on air pollution, stormwater capture and flood control, the urban heat island effect, public health, and biodiversity. The City will adapt and employ tools developed by the US Forest Service for these studies, and will use the information to prioritize future projects. The goal is to launch this program in 2013.

Initiative 15

Create climate adaptation plans for all parks in the 100-year floodplain

Costly infrastructure and important natural elements throughout DPR's park system face significant risk due to future climate change. Subject to available funding, the City, through DPR, will map and catalogue all of the facilities, infrastructure, and plant communities in DPR's system within the city's 100-year floodplain, with the goal of developing adaptation plans. These plans will include detailed elevation information to understand how different parks may be impacted by extreme weather events. This information will inform DPR flood mitigation measures, including updates of DPR's 2010 report *High Performance Landscape Guidelines: 21st Century Parks for NYC*. The goal is to launch this program in 2013.

Initiative 16

Map the city's overhead utilities and street trees

The city's many street trees pose a risk to utility lines and other infrastructure. Better information, however, could help to manage this risk. Subject to available funding, the City, through DPR, will collaborate with local utilities to map the city's trees against its overhead utility networks by 2015. This mapping exercise is intended to help DPR and the owners of utility infrastructure to develop an effective vegetation management plan for those street trees. The goal is to launch this program in 2013.