Oysters from the Bay Ridge Flats Restoration Project.

GOAL 4

Improve water quality through measures that benefit natural habitats, support public recreation, and enhance waterfront and upland communities.

GOAL 4

IMPROVE WATER QUALITY

The waterways around New York sustain ecosystems and natural habitats for plants and animals. They provide for a range of recreational opportunities. They enhance the quality of life for New Yorkers and visitors alike. But the waterways can only continue to provide all of these benefits if advancements in water quality continue. Improved water quality is a desirable end in and of itself, as well as a means to many other objectives of *Vision 2020*.

Largely as a result of investment in public infrastructure, great progress has been made in water quality in New York Harbor. The 2009 *New York Harbor Water Quality Report* showed that the waterbodies surrounding the city are cleaner than they have been in 100 years. Of the 156 square miles on the New York side of the Harbor, 116 square miles, or approximately 75 percent of waters, are now clean enough for swimming. And nearly 30 square miles, or approximately 19 percent of the New York side of the Harbor, are classified for boating and recreational fishing. The city's smallest, most polluted tributaries—many of which support manufacturing and shipping—comprise less than 7 percent of the water area in the Harbor.

While advances in water quality have enhanced the health of the Harbor and led to an increase in public recreation, further improvements to water quality would provide even greater ecological value and additional public benefits. Continued improvements will require significant investment in cost-effective traditional infrastructure as well as new strategies for reducing pollution. These strategies, which the City has already begun to implement, include the use of green infrastructure to capture rainfall on typically impervious land areas—such as rooftops, parking lots, and streets—and efforts to restore natural systems that improve water quality, such as wetlands, submerged vegetation, and colonies of organisms that filter the water. As progress in water quality continues, the City will track improvements while increasing public awareness of conditions and suitable uses.

SOURCES OF WATER POLLUTION

The pollution in New York City's waterways comes from a variety of sources. One source is contaminated stormwater runoff. Stormwater runoff occurs when rain or snowmelt flows over impervious surfaces rather than seeping into the ground. Runoff can pick up oils, grease, sediment, bacteria, debris, litter, and other pollutants and flow into a storm sewer, a combined sewer, or directly into coastal waters.

Another major source of pollution is combined sewer overflows (CSOs), the discharge of a mix of untreated sewage and stormwater runoff into the waterways. Two-thirds of New York City's sewered areas have a combined sewer system that collects sewage and stormwater runoff from properties and streets together in the same lateral and interceptor sewers. When stormwater runoff enters the sewers during rainstorms, treatment plants can reach their capacity, and, as a result, mechanisms at interceptor sewers, called regulators, divert combined sewage and stormwater to the waterways. New York City's combined sewer system has 422 regulators that can discharge CSOs (see Figure 1, page 65).

Pollution in New York City's waterways also comes from chemical spills and leaching of chemicals from contaminated land within the city. Chemical spills—though now less prevalent than in the past because of better regulation—have over the years contaminated New York Harbor and its tributaries. Past industrial uses have left a legacy of contaminated sites along the waterfront, many of which have not yet been remediated.

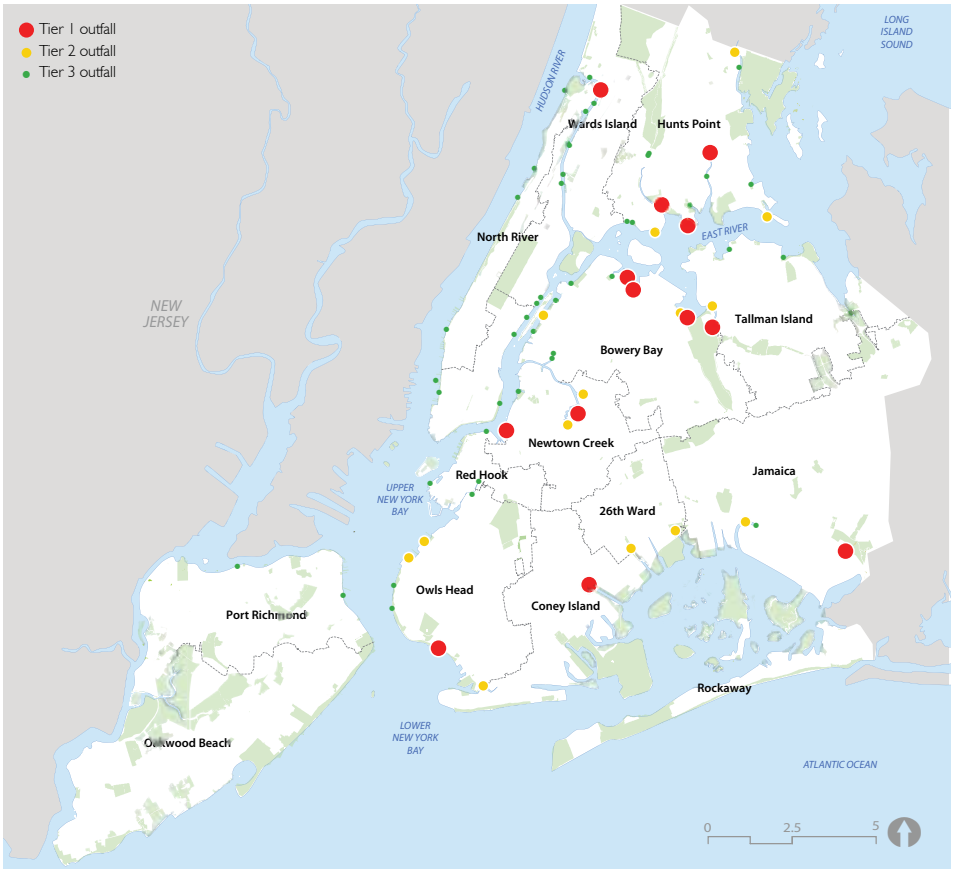
Pollution can also reach New York City's waterways from sources beyond city boundaries. For example, contaminants from past industrial practices along the Hudson River and other waterways are carried by currents into New York City's waterways. Air deposition of toxins from upwind coal-burning power plants has also compromised water quality here.

Water quality also depends on the strength of tidal flows and the mixing of surface and deep waters. Historic dredging, filling, or other changes to bathymetry (the shape of underwater terrain) have altered the hydrology within many of New York City's tributaries, in some cases limiting their ability to flush pollutants. For such areas, eliminating wastewater and CSO discharges alone would not result in significant improvements to water quality. These areas may require dredging and aeration to attain water quality goals.

HISTORY OF WATER QUALITY IMPROVEMENT IN THE CITY

Before the City began building wastewater treatment plants (WWTPs) in the 1890s, untreated sewage was conveyed out of crowded neighborhoods and directly into the Harbor. As the near-shore waters became too polluted to use except by industrial and maritime enterprises—and as residents began to clamor for clean waterways—the City took action. It built the first wastewater treatment plants and a network of large pipes to intercept sewers at their former discharge points and to convey wastewater to the plants. The plants remove contaminants from wastewater and discharge treated effluent into the Harbor, leaving behind treated sludge that is disposed of or reused elsewhere. Since the 1930s, New York City has been a national leader in the design and operation of wastewater treatment facilities, pioneering the use of modern treatment technology with the construction of the Coney Island Wastewater Treatment Plant in 1935. Three additional plants were constructed on

> "What is water quality? Part of it is aesthetic—if you can see the bottom there's appeal to getting into the water. But from a public health standpoint, there's a question of whether you can use the water safely."
>
> —Rob Buchanan, long-time rower and cofounder of the New York City Water Trail Association



NYC Department of Environmental Protection

Figure 1: Wastewater Treatment Plant Drainage Areas and Combined Sewer Overflow Outfalls, classified by tiers depending on the volume of annual discharge.

the East River by 1938, and two plants near Jamaica Bay were operating by 1942. Five plants were completed during the next 10 years. In 1967, the Newtown Creek plant became the city's 12th and largest plant.

Spurred by passage of the Clean Water Act in 1972, federal funding, and growing environmental awareness, New York City continued to upgrade and expand its wastewater treatment system in the last quarter of the 20th century. Between 1979 and 1995, the Coney Island and Owls Head plants were upgraded, and the City constructed the North River Wastewater Treatment Plant in Manhattan and the Red Hook plant in Brooklyn. Today New York produces, and its 14 WWTPs treat, more than 1.3 billion gallons of wastewater daily. The wastewater is collected through 7,400 miles of lateral sewers that flow downhill into large interceptor sewers, which lead directly to the plants, most of which are located on the waterfront. These WWTPs have the capacity to handle the city's wastewater on any dry-weather day.

Investments in infrastructure have improved Harbor water quality not only by increasing the system's capacity, but also decreasing pollution caused by combined sewer overflows. Upgrades to wastewater treatment plants and sewers have allowed for the capture of a greater amount of overall CSO volume, from 30 percent in the 1980s to 73 percent today, and overflows are more dilute, with the percentage of sanitary waste decreasing from 30 percent in 1980 to 12 percent today.

The loss of heavily polluting industries on the waterfront has also contributed to improved water quality in New York Harbor. And the industries that remain have less of an impact on water quality due to stricter regulations. The Clean Water Act brought about better regulation of chemical use, storage, and disposal. New York State prevents leaks and spills at petroleum and chemical storage facilities through the Bulk Storage Program operated by the NYS Department of Environmental Conservation. Though the program has likely limited the occurrence of chemical dumping and spills, additional protections may still be needed, particularly in light of the rise in sea level and increased storms expected with climate change.

STRATEGIES TO IMPROVE WATER QUALITY

Making additional improvements to water quality requires a multifaceted approach. Continued investment in infrastructure must be coupled with new, innovative solutions to cleanse our waterways. To reduce levels of bacteria and nitrogen and to improve dissolved oxygen levels in the Harbor and its tributaries, the City will continue to build new infrastructure while optimizing the existing system to treat wastewater and reduce combined sewer overflows. In addition, the City proposes to maximize the use of green infrastructure and other source controls to capture rainfall on impervious areas. Providing green space, trees, and other amenities that capture stormwater will enhance communities and further the City's sustainability efforts. The City will also continue to restore natural systems, which capture and filter pollutants, cleaning water while also providing habitat, recreation, and climate-adaptation benefits.

Improving the City's Wastewater Treatment Systems

Building new infrastructure and optimizing the performance of the existing system to treat wastewater and reduce combined sewer overflows make up the largest portion of the City's multi-billion-dollar annual capital expenditure on water quality. The City is completing a $5 billion upgrade to the Newtown Creek WWTP, which has already met compliance with the Clean Water Act's monthly 85 percent pollutant-removal requirement. This is the first time that all 14 of the City's WWTPs are meeting this standard.

Over the next 10 years, the City will make significant improvements to wastewater treatment plants throughout the city to reduce nitrogen discharges. Upgrades at the 26th Ward, Coney Island, Jamaica, and Rockaway plants will reduce nitrogen discharges into Jamaica Bay by 50 percent, and improvements at the Bowery Bay, Tallman Island, Hunts Point, and Wards Island plants will reduce nitrogen discharges into the Upper East River by approximately 60 percent.

The City is also improving the ecology of waterbodies compromised by poor circulation and discharges from WWTPs, CSO outfalls, and storm sewers. These impaired tributaries include the Bronx River, Westchester Creek,

Understanding Water Quality

Waterbodies in New York City are classified by the New York State Department of Environmental Conservation (DEC) according to their best uses (see Figure 2, below). Classifications indicate whether water is a source of drinking water or suitable for other uses, such as swimming, boating, fishing, and shellfishing. Best uses are identified by taking into consideration the physical, chemical, and biological characteristics of the water body and its use and value for wildlife protection and recreational, industrial, and navigational purposes. For each classification, DEC sets standards for levels of fecal coliform (a type of bacteria) and dissolved oxygen. Bacteria concentrations are most important for human health, and are measured in the Harbor as indicator organisms to show the presence of sewage wastes in water and the possible presence of pathogenic (disease-producing) bacteria. Their presence suggests that swimming and eating shellfish might be a health risk. Dissolved oxygen concentration is a universal indicator of overall water quality. Dissolved oxygen is critical for respiration of most aquatic life forms; its presence in the water is most important for determining habitat and ecosystem conditions.

Figure 2: New York City Waterbody Classifications and Standards

Class	Best Usage of Waters	Fecal Coliform	Dissolved Oxygen (never-less-than)
SA	Shellfishing and all other recreation use	No standard	5.0 mg/L
SB, SC*	Bathing and other recreation use	Monthly geometric mean less than or equal to 200 cells/100mL from 5 or more samples	5.0 mg/L
I	Fishing or boating	Monthly geometric mean less than or equal to 2,000 cells/100mL from 5 or more samples	4.0 mg/L
SD	Fish survival	No standard	3.0 mg/L

* Other factors may limit the use of these waters for boating or bathing.

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and Hutchinson River in the Bronx; Flushing Bay and Creek, Bergen Basin, and Thurston Basin in Queens; Newtown Creek along the Queens/Brooklyn border; and the Gowanus Canal, Coney Island Creek, Paerdegat Basin, and Fresh Creek in Brooklyn.

In the Gowanus Canal, for instance, the City is addressing stagnant water, high nutrients, and odor through a multi-pronged improvement plan that includes reducing CSOs, repairing and upgrading the flushing tunnel that brings more oxygen-rich water from the Buttermilk Channel into the Canal, and installing a pumping station and interceptor sewer. High-level storm sewers within a 48-acre section of the Gowanus Canal drainage area are also being constructed to limit CSOs and alleviate street flooding. In addition, the City is dredging the head end of the Canal to remove sediments and improve tidal circulation. In total, these investments will lead to a 30 percent reduction in CSOs.

City efforts also focus on Newtown Creek. The City is developing the Newtown Creek Waterbody/Watershed Facility Plan and constructing an aeration system in the Lower English Kills section of Newtown Creek to improve dissolved oxygen levels on hot summer days. The aeration system will be extended to East Branch and Dutch Kills. In addition, separate sanitary and storm sewers within a 60-acre section of the Newtown Creek drainage area are being constructed. Finally, the City is cooperating with the Environmental Protection Agency and the NYS Department of Environmental Conservation in ongoing data collection and investigations for the Gowanus Canal and Newtown Creek Superfund cleanup efforts, which focus on contaminated sediments beneath these waterbodies.

NYC Green Infrastructure Plan

While continuing to invest in traditional, or grey, infrastructure, the City is implementing measures to maximize the use of green infrastructure and other source controls to reduce stormwater runoff from new and existing development. Unveiled by Mayor Bloomberg and the Department of Environmental Protection (DEP) in September 2010 and subject to regulatory negotiations and approvals, the *NYC Green Infrastructure Plan* marks a departure from conventional and expensive approaches to stormwater management. Under the current grey infrastructure plan, the City would invest $6.8 billion in infrastructure throughout

NYC Department of Environmental Protection

An enhanced tree pit, left, and swale, right, manage stormwater efficiently and also green neighborhoods.

The Benefits of Green Infrastructure

Green infrastructure encompasses cost-effective measures that collect and treat stormwater using natural, passive systems. These measures include blue roofs and green roofs, which use mechanical devices or vegetation to prevent roof water from draining too quickly and overwhelming storm sewers; porous pavement for parking lots that allows water to seep through it and be absorbed into the ground rather than running off into the sewer system; tree pits and streetside swales (ditches) that allow water to pool in underground holding areas until it can dissipate in the ground or be absorbed by plants; wetlands and swales for parks; and rain barrels in some residential areas. In addition to being more cost-effective, many of these green infrastructure strategies provide benefits that traditional grey infrastructure does not, such as cooling the city, reducing energy use, cleaning the air, and increasing property values.

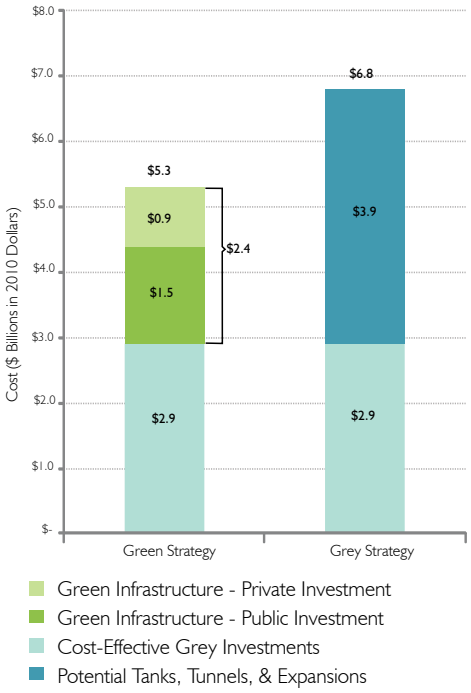

Figure 3: Comparison of the citywide cost of controlling CSOs through green and grey strategies (after 20 years).

NYC Department of Environmental Protection

the city, paid for with New York City Municipal Water Finance Authority Bonds, which are repaid through residential and commercial water bills. The *NYC Green Infrastructure Plan*, on the other hand, proposes investing $2.9 billion in cost-effective grey infrastructure and $2.4 billion in green infrastructure—a total of $5.3 billion. Funding would include $900 million from new private development, bringing the total savings for the city's water customers to $2.4 billion (see Figure 3). Enhanced regulations and standards for onsite stormwater detention and infiltration will be incorporated into the designs for new construction projects.

The *NYC Green Infrastructure Plan* proposes to capture the first inch of rainfall on 10 percent of the impervious areas in CSO watersheds over the next 20 years. It recommends doing this by replacing the existing approach to reducing CSOs—which relies solely on traditional investments like holding tanks and tunnels—with a mix of cost-effective traditional infrastructure and green infrastructure. The City is constructing major storage facilities to reduce CSOs at Paerdegat Basin, Alley Creek, and Flushing Creek. The City is also launching a comprehensive citywide program to increase optimization of the existing system. The program includes drainage plans, the survey and rehabilitation of 149 miles of interceptor sewers, the inspection and repair of tide gates, and measures to prevent grease from obstructing the sewers.

Green infrastructure will be installed in the city's combined sewer drainage areas, including in the South Bronx, Flushing, northeastern and southeastern Queens, and the area around the Gowanus Canal. A number of pilot projects are already under way and being monitored by DEP at the Bronx River Houses; P.S. 118 in St. Albans, Queens; and a large highway median on North and South Conduit Avenues in Queens. Other steps to begin early implementation of the *NYC Green Infrastructure Plan* include establishing a Green Infrastructure Fund (to supply capital and maintenance funds for the incorporation of green infrastructure in planned capital projects) and the Green Infrastructure Task Force (an interagency group charged with incorporating stormwater management into roadway, sidewalk, and other capital projects, and providing for the maintenance of green infrastructure).

Bluebelts

The Staten Island Bluebelt is a leading example of how the City has been restoring natural areas to improve water quality. This program provides ecologically sound and cost-effective stormwater management for most of the South Shore of Staten Island by preserving and enhancing streams, ponds, and wetland areas so that they convey and store stormwater and filter pollutants from the water. At the same time, the Staten Island Bluebelt provides important community open spaces and diverse habitats. Since the inception of the program, the City has purchased approximately 325 acres of wetland and has spent more than $300 million building sewers on the South Shore plus $50 million for drainage improvements and wetland restoration. The current Bluebelt system drains 10,000 acres, comprised of 15 watersheds in southern Staten Island plus the Richmond Creek watershed. The Bluebelt system features special drainage facilities—52 of which are constructed and in operation—that protect natural wetland areas from uncontrolled storm sewer discharges. The Bluebelt strategy has saved the city tens of millions of dollars on traditional grey infrastructure.

The City is expanding the Staten Island Bluebelt into the mid-island area. The City is acquiring land for the New Creek Bluebelt, estimated to drain a watershed of 1,700 acres.



BioHabitats (3)

In pilot studies to improve water quality and create habitat in Jamaica Bay, eelgrass and mussels are being planted and monitored.

Land is also being acquired for two other mid-island Bluebelts—South Beach and Oakwood Beach. Together Bluebelt drainage systems will accept stormwater from a third of Staten Island's land area.

The City is also applying the Bluebelt concept in Queens and the Bronx. Wetlands and other natural features will be utilized for stormwater management at Baisley Pond Park and Springfield Park in Queens and at Van Cortlandt Lake in the Bronx. The Springfield Park project will direct stormwater through a system of stormwater management measures and open water in Springfield and Idlewild parks before discharging into Jamaica Bay.

Jamaica Bay Watershed Protection Plan

Jamaica Bay, one of the greatest natural resources in the New York metropolitan area, has been another area of concerted effort by the City. Over the last 150 years, wetlands around the Bay have been lost as a result of extensive filling operations; shorelines have been hardened and bulkheaded to stabilize and protect existing communities and infrastructure; deep channels have been dredged for navigation and fill, altering bottom contours and affecting flows; and natural tributaries have essentially disappeared, leaving behind deposits of silt and particulates from urban runoff. Since 2002, the City has made upgrades at the four WWTPs and associated sewer systems that surround the Bay. In addition, the City has invested $37.4 million to reclaim more than 440 acres of environmentally sensitive land adjoining Jamaica Bay, including the Pennsylvania and Fountain Avenue landfills. In 2007, the Department of Environmental Protection prepared the *Jamaica Bay Watershed Protection Plan*, which provides a comprehensive framework for improvements in water quality, ecological restoration, and the enhancement of valuable natural resources.

Under the plan, the City will continue to improve wastewater infrastructure in areas surrounding Jamaica Bay. In the Rockaways and other parts of Southeast Queens that are often subject to street flooding during heavy rains and high tides, the City is installing storm sewers to quickly convey stormwater runoff to points of discharge along the waterfront.

The *Jamaica Bay Watershed Protection Plan* laid the groundwork for restoration projects that are being piloted in and around the Bay to filter pollutants such as nitrogen, other nutrients, and particulate organic matter, and to provide shelter and habitat for fish and shellfish. Two oyster pilot studies are under way: the design and implementation of an oyster bed off Dubos Point, Queens, and the placement of oyster reef balls (man-made structures that create habitat) in Gerritsen Creek, Brooklyn. The oyster studies will evaluate whether climatic and environmental conditions in the Bay are suitable for oyster growth and reproduction. DEP is also undertaking a pilot study at Fresh Creek involving ribbed mussels. The study will monitor mussel growth to measure whether ribbed mussels are effective at removing nutrients and particulate organic matter from the water. Eelgrass, a type of submerged aquatic vegetation important for a number of fish and shellfish species, is being reintroduced in a pilot study to evaluate the potential for widespread restoration of eelgrass in the Bay. In another pilot study, DEP skimmer boats were used to harvest sea lettuce to improve water quality and environmental conditions in selected areas of Jamaica Bay. Finally, an algal turf scrubber is being piloted at the Rockaway WWTP. This mechanical device is used to harness the natural abilities of algae to remove pollutants from water; the harvested algae is processed into butanol, a high-quality fuel that can be put right into a gas tank.

To continue to improve overall water quality and mitigate marshland loss in Jamaica Bay, the City will restore wetlands and implement projects to improve ecological productivity. These projects include dredging the Bay and its tributaries, additional ecological restoration pilot projects, and remediation of nearly 100 acres of environmentally sensitive land adjoining the Bay. In June 2010 DEP launched an enhanced water-testing program in Jamaica Bay, increasing the number of sampling sites from 13 to 20 and expanding the monitoring parameters to include biotic and ecosystem measures such as the number of bird and animal species and the rate of growth or decline of wetlands, eelgrass beds, and other key habitat.

NYC Department of Parks & Recreation

William T. Davis Wildlife Refuge adjacent to Freshkills Park on Staten Island.

IMPLICATIONS OF WATER QUALITY FOR RECREATION

As water quality improves, recreational use of the waterways grows. Today, most areas in the Harbor are safe for recreation, and most of the time water quality is acceptable for recreation. However, recreational users must be aware that short-term spikes in bacteria levels may occur after heavy rains due to CSOs.

The City's 14 miles of designated bathing beaches are far from CSO outfalls or are in places with undisturbed shorelines and strong tidal flows. The City encourages people to use these beaches—which were able to accommodate 7.7 million visitors in 2009. The New York City Department of Health has a vigorous monitoring and advisory system to protect bathers at these beaches from pathogen infection, and this system is integrated with the City's 311 system and an email notification system to provide timely information to the public. The City does not recommend swimming or direct contact with the water outside those official areas.

Increasing Public Awareness

The City aims to increase public awareness of water quality and the risks of exposure to polluted water. To provide the public with information on CSOs, DEP is installing signs on the water side and land side of all 422 outfalls, and has recently upgraded its signs. The new signs are easier to read from a distance, have clearer warnings about CSOs, and have graphic images to clearly convey unambiguous warnings—understandable to English and non-English speakers alike. In addition, DEP is updating its website to provide timely information on water quality conditions.

Each year, with the publication of the *New York Harbor Water Quality Report,* commonly referred to as the Harbor Survey, the City routinely provides significantly more information on water quality (available to the public on DEP's website). In 1909 the Harbor Survey collected data on only five parameters and took samples from 12 sampling stations. Today, data is collected on more than 20 parameters and sampling is done at 85 stations. The Harbor Survey synthesizes the data collected from approximately 8,000 water samples. Going forward, the public will be able to obtain information on water conditions from an increased number of monitoring stations across the Harbor and sampling sites at the mouths of key tributaries.

In addition, data will be available from more robust monitoring in Jamaica Bay and the Hutchinson River. Finally, analysis of data and modeling of anticipated water quality improvements associated with *NYC Green Infrastructure Plan* projects will be forthcoming and made available in public reports associated with CSO Long Term Control Plans.

Improve Water Quality: Strategies and Projects

Improving water quality is an essential goal in and of itself that will further many of the other goals of *Vision 2020*. It will enhance the Blue Network by encouraging biodiversity and allowing natural areas to flourish. It will provide for water recreation. And the use of innovative stormwater strategies will help create greener, more livable neighborhoods as well as increase climate resilience.

To realize this goal, the City will pursue the following set of strategies over the next 10 years. While continuing to make improvements to grey infrastructure (such as wastewater treatment plants and sewer systems), the City will also invest in green infrastructure and other projects that utilize the ability of natural systems to absorb and filter water. Finally, the City will work to promote the safe enjoyment of New York's waterways through improved monitoring, notification systems, and education.

Vision 2020's 10-year strategies are complemented by the *New York City Waterfront Action Agenda*, a set of projects chosen for their ability to catalyze investment in waterfront enhancement. The City commits to initiating these projects over the next three years and will be tracking progress on an ongoing basis. For each project, the lead agency and implementation year are noted.

Together, these strategies and projects lay out a comprehensive vision for the waterfront and waterways and a plan of action to achieve that vision.

1. Build new cost-effective grey infrastructure and optimize existing systems to meet goals for water quality throughout the city.

VISION 2020 STRATEGIES

- Reduce nitrogen discharges through improvements to wastewater treatment plants.
- Improve pathogen and dissolved oxygen levels by reducing combined sewer overflows and other discharges, and improving aeration and flushing of constrained waterbodies.
- Optimize the existing sewer systems through improvements to drainage, interceptors, and tide gates.

ACTION AGENDA PROJECTS

- Continue major upgrades at wastewater treatment plants by investing $1.6 billion (projects listed on facing page).
- Build cost-effective grey infrastructure to manage CSOs and improve waterfront areas (projects listed on facing page).
- Launch comprehensive program to build on improvements to existing wastewater systems, including surveying and improving 136 miles of inceptor sewers; inspecting and repairing tide gates; and developing programs to prevent grease from obstructing sewers. (DEP, 2012)

2. Maximize the use of green infrastructure and other source controls to capture rainfall on impervious surfaces, helping reduce combined sewer overflows and other discharges.

VISION 2020 STRATEGIES

- Commence implementation of the *NYC Green Infrastructure Plan*, which provides an alternative approach to improving water quality through stormwater-management technologies, such as roadside swales and enhanced street tree pits, subject to regulatory approval.
- Build green-infrastructure demonstration projects on a variety of land uses.
- Develop a Green Infrastructure Fund to supply capital and maintenance funds for the incorporation of green infrastructure in planned capital projects.
- Establish the Green Infrastructure Task Force, an interagency partnership to incorporate stormwater management into roadway, sidewalk, and other capital projects and to provide for the maintenance of green infrastructure.
- Develop approved specifications for green infrastructure in commonly used applications.
- Streamline design and permitting processes for the incorporation of green infrastructure in public projects.
- Engage in watershed-level planning to develop annual spending plans for green infrastructure.

ACTION AGENDA PROJECTS

- Complete construction of and monitor green-infrastructure pilot projects that promote more efficient rainwater capture (projects listed on facing page).
- Capture the first inch of rainfall on 10 percent of impervious areas in combined sewer watersheds over 20 years by implementing green infrastructure in capital projects. (DEP/SCA/DCAS/DDC/DOB/DOE/DOT/DPR/EDC/HPD/Law Department/NYCHA/Mayor's Office/OMB/SBS/ TGI, 2011+)

3. Restore natural systems to improve ecological productivity, reduce pollution, and provide habitat, recreation, and climate-adaptation services.

VISION 2020 STRATEGIES

- Expand the Bluebelt in Staten Island, Queens, and the Bronx.
- Restore wetlands habitat in and around Jamaica Bay.
- Pilot additional ecological-restoration projects in Jamaica Bay.

ACTION AGENDA PROJECTS

- Mid-Island Bluebelt, Staten Island: Negotiate acquisition of 123 acres at New Creek, South Beach, and Oakwood Beach. (DEP, 2011)

4. Improve monitoring and public awareness of water quality.

VISION 2020 STRATEGIES

- Enhance water quality testing in Jamaica Bay, increasing the number of sampling sites, and monitoring combined sewer overflow (CSO) abatement measures in select tributaries.
- Refine DEP models to include new data on impervious cover and extending predictions to ambient water quality.
- Install signs on the water side and land side of all 422 CSO outfalls, using new signs that are clearer and easier to understand.
- Overhaul DEP's website notification system so that members of the public can check to see where CSOs are likely.

ACTION AGENDA PROJECTS

- Install new CSO outfall signs, enhance CSO website notification, and increase water quality sampling sites. (DEP, 2011)
- Develop comprehensive water use, navigation, and access policy. (Mayor's Office/ DEP/ DOHMH/ DPR/DCP/EDC, 2011)

Waterfront Action Agenda Projects to Improve Water Quality

Continue major upgrades at wastewater treatment plants by investing $1.6 billion:

- Jamaica Bay, Brooklyn/Queens: Complete installation of nitrogen-control technologies at wastewater treatment plants, reducing nitrogen by 50% over next 10 years. (DEP, 2013)
- Newtown Creek, Brooklyn/Queens: Upgrade Newtown Creek Wastewater Treatment Plant to attain Clean Water Act Secondary Treatment Standards and expand wet weather capacity to 700 million gallons. (DEP, 2013)
- Tallman Island, Bowery Bay, Wards Island, and Hunts Point: Make improvements at wastewater treatment plants, reducing nitrogen discharge into the East River by approximately 40%. (DEP, 2013)

New cost-effective grey infrastructure to manage CSOs and improve waterfront areas:

- Paerdegat Basin, Brooklyn and Alley Creek, Queens: Complete new CSO storage facilities. (DEP, 2011)
- Willets Point, Queens: Break ground on sanitary sewers and outfall controls. (EDC, 2013)
- Coney Island, Brooklyn: Complete design and begin construction of first phase of separate sanitary and storm sewer upgrades. (DEP, 2013)
- Newtown Creek, Brooklyn/Queens: Design and construct aeration system in Lower English Kills to meet DEC water quality criteria. (DEP, 2013)
- Newtown Creek, Brooklyn/Queens: Design and begin construction of separate sanitary and storm sewers within a 60-acre section of the drainage area. (DEP, 2013)
- Gowanus Canal, Brooklyn and Avenue V/Coney Island Creek, Brooklyn: Complete pump station and force main. (DEP, 2013)
- Gowanus Canal, Brooklyn: Complete the upgrade and reactivation of the flushing tunnel from Buttermilk Channel. (DEP, 2013)
- Gowanus, Brooklyn: Design and begin construction of the first phase of high-level storm sewers within a 48-acre drainage area to reduce CSOs in Gowanus Canal as well as street flooding and sewer backups in adjacent neighborhoods. (DEP, 2013)
- Gowanus, Brooklyn: Participate in ongoing reviews of remedial investigation results and feasibility study for EPA's cleanup of Gowanus Canal. (DEP, 2012)

Green infrastructure pilot projects (DEP, 2011):

- Bronx, Brooklyn, and Queens: Monitor effectiveness of constructed "blue roof" pilot projects to minimize runoff impacts.
- Brooklyn and Queens: Complete construction and install permeable pavement pilot projects at municipal parking lots.
- Queens: Monitor stormwater capture tree pits and street design pilot projects.
- Queens: Transform the North and South Conduit Avenues median into a natural water filter and bio-retention area.