NYC Green Infrastructure

2013 Annual Report

NYC Environmental Protection

Bill de Blasio
Mayor
Emily Lloyd
Commissioner

Emily Lloyd
Commissioner

Dear Friends:

In 2010, the New York City Department of Environmental Protection (DEP) began implementing a citywide Green Infrastructure Program to manage stormwater runoff that would otherwise discharge into the combined sewer system and contribute to combined sewer overflows (CSOs). Investing in green infrastructure is a cost-effective way to improve the quality of New York City's waterways while bringing multiple benefits to local communities, including improved air quality, increased shade, and cooler temperatures during the summer. Green infrastructure also enhances the aesthetics of New York City's neighborhoods and provides economic opportunities for green jobs.

Over the next 20 years, DEP will continue to implement innovative, cost-effective green infrastructure to manage one inch of stormwater runoff from 10 percent of impervious surfaces in combined sewer areas of the City. In March 2012, the City and the New York State Department of Environmental Conservation signed a historic agreement incorporating an adaptive management approach that uses green and cost-effective grey infrastructure to sustainably manage stormwater.

Since the release of DEP's second Green Infrastructure Annual Report in 2012, we have made steady progress in implementing the Green Infrastructure Program. The 2013 Annual Report documents the accomplishments of the past year, in which we:

- Committed $4.7 million through the Green Infrastructure Grant Program to design and construct green infrastructure on private property, for a total of $11.5 million in grant funding committed since 2011;
- Updated standard designs for the Right-of-way Bioswale, and received a New York City Public Design Commission Award for Excellence in Design;
- Worked with other City agencies to implement Area-wide contracts for the design and construction of green infrastructure in the City's right-of-way and on other public property;
- Met all green infrastructure milestones of the 2012 CSO Order on Consent, including completing construction of three Neighborhood Demonstration Areas, and commenced post-construction stormwater flow monitoring; and
- Launched the BioswaleCare Program to provide communities with tools for stewardship of green infrastructure in their neighborhoods.

We are excited to bring you the latest update on DEP's Green Infrastructure Program. I encourage you to read this report to learn more about our long-term commitment to improving the quality of New York's waterways and the health of its neighborhoods through the use of green infrastructure.

Sincerely,

Emily Lloyd
Commissioner

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Introduction

Right-of-way Bioswale, 62nd Drive, Queens

DEP's mission is to protect public health and the environment by supplying clean drinking water, collecting and treating wastewater, and reducing air, noise, and hazardous materials pollution. One of the ways that DEP carries out this mission is through the Green Infrastructure Program, which reduces combined sewer overflows (CSOs) by managing stormwater runoff with green infrastructure. Since the signing of the 2012 CSO Order on Consent ("the Order"[1]), DEP has significantly scaled up green infrastructure planning and implementation toward the goal of managing the equivalent of stormwater generated by one inch of precipitation from 10 percent of impervious surfaces citywide within combined sewer areas by 2030.[2]

DEP builds green infrastructure primarily to improve New York Harbor water quality, although these installations provide additional environmental, social and economic benefits. Environmental co-benefits of green infrastructure include carbon sequestration, urban heat island mitigation, reduced energy demand, improved air quality, and increased urban habitat for pollinators and other wildlife. Social co-benefits include opportunities for workforce development and improved quality of life, and economic co-benefits include reduced wastewater treatment needs. In 2013, DEP reviewed scientific literature and conducted monitoring and life cycle analyses to further investigate the benefits and costs of green infrastructure. DEP's upcoming research and development program will further study and quantify the benefits of green infrastructure. Through an adaptive management approach, DEP will use these findings to improve green infrastructure design, operations, and maintenance.

The 2013 Green Infrastructure Annual Report describes DEP's institutional and organizational steps to meet its goals; the strategy for widespread design and construction; progress toward program implementation; research and monitoring projects; and developments in DEP's adaptive management approach. This report builds upon the *2012 Green Infrastructure Annual Report*,[3] highlights the Green Infrastructure Program's major accomplishments in 2013, and sets goals for 2014.

Over the next 20 years, DEP is planning for $2.4 billion in public and private funding for targeted green infrastructure installations, and $2.9 billion in cost-effective grey infrastructure upgrades to reduce CSOs. DEP expects to fulfill the obligations of the Order largely by making a concerted effort in coordination with other City agencies to build green infrastructure in the public right-of-way and on other public property. By constructing thousands of green infrastructure practices over the next several years, in addition to cost-effective grey solutions, DEP's Green Infrastructure Program will continue to contribute to a greener, more sustainable city.

[1] Order on Consent (DEC Case No. CO2-20110512-25, modification to DEC Case No. CO2-20000107-8)

[2] See the NYC Green Infrastructure Plan, A Sustainable Strategy for Clean Waterways (2010), available at www.nyc.gov/html/dep/pdf/green_infrastructure/NYCGreenInfrastructurePlan_LowRes.pdf

[3] The *2012 Green Infrastructure Annual Report* is available at www.nyc.gov/html/dep/pdf/green_infrastructure/gi_annual_report_2013.pdf

2013 Major Accomplishments

1

Achieved Consent Order milestones for Neighborhood Demonstration Areas

The Order includes milestone dates to construct and monitor green infrastructure in three Neighborhood Demonstration Areas. DEP certified completion of the Jamaica Bay Neighborhood Demonstration Project in Brooklyn in December 2012. In spring 2013, DEP certified completion of the Newtown Creek Demonstration Project in Brooklyn and the Hutchinson River Demonstration Project in the Bronx, thereby achieving all three Order milestones on time.

2

Continued to implement the Area-wide green infrastructure strategy in Priority CSO Tributary Areas

In 2013, DEP continued to spearhead the full-scale implementation of Area-wide green infrastructure contracts in Priority CSO Tributary Areas ("Priority Areas") in collaboration with its partner agencies. DEP's three Area-wide design contracts continued in the Gowanus Canal, Newtown Creek, and Flushing Bay Priority Areas in 2013. The New York City Department of Parks and Recreation (DPR) continued two Area-wide contracts in Bronx River and Flushing Bay Priority Areas in 2013. In addition, the New York City Economic Development Corporation (EDC) and Department of Design and Construction (DDC) initiated nine new Area-wide design contracts in the Hutchinson River, Jamaica Bay, and Newtown Creek Priority Areas.

3

Continued construction of Right-of-way Bioswales and Stormwater Greenstreets in Priority CSO Tributary Areas

To date, DEP and partner agencies have constructed more than 200 Right-of-way Bioswales and Stormwater Greenstreets citywide.

4

Continued to grow the Green Infrastructure Grant Program

In 2013, DEP committed $4.7 million to 11 new grant recipients. In 2013, five grant projects completed construction, including a one-acre rooftop farm, three green roofs, and a community garden. To date, DEP has awarded $11.5 million for green infrastructure projects to 29 projects.

5

Advanced green infrastructure retrofits at New York City Housing Authority (NYCHA) developments

In 2013, DEP completed the design and bid the construction work for green infrastructure retrofits at the 50-acre Edenwald Houses property in the Hutchinson River Priority CSO Tributary Area in the Bronx. DEP anticipates construction at Edenwald will start in spring 2014, and conclude by fall 2016. In September 2013, DEP completed construction of green infrastructure practices at NYCHA's Seth Low Houses and Hope Gardens Houses in Brooklyn.

2013 Major Accomplishments

6

Constructed three green infrastructure schoolyard projects in Brooklyn.

DEP's partnership with the Trust for Public Land (TPL), which is a national not-for-profit open space conservation organization, the New York City Department of Education (DOE), and the New York City School Construction Authority (SCA) adds green infrastructure to "Schoolyards-to-Playgrounds" renovation projects. The TPL, with DEP, DOE, and SCA, constructed three green infrastructure playground projects at P.S. 261, P.S. 65, and J.H.S. 218 in Brooklyn.

7

Initiated development of a Project Tracking and Asset Management System

DEP's Office of Green Infrastructure designs, constructs and maintains a decentralized system of stormwater management assets. To manage this new system of public infrastructure effectively, DEP initiated the development of a Geographic Information System (GIS)-based tracking and asset management program in 2013. This system will enable DEP to track and report on the program's progress toward its goals, as well as to manage and monitor the operation and maintenance of its assets citywide. In addition, DEP hired two full-time staff to manage the tracking and asset management system. DEP anticipates launching the system in 2014.

8

Built upon the success of the first standard designs for Right-of-way Bioswales

As a part of DEP's adaptive management approach to green infrastructure, DEP's Office of Green Infrastructure updates standard designs as needed. Since August 2012, the first Right-of-way Bioswale standard designs have facilitated the standardization of design and construction of green infrastructure practices in right-of-way contracts. In July 2013, DEP and its partner agencies were honored at the 31st Annual Public Design Commission Awards for Excellence in Design. To build upon that accomplishment, in October 2013, DEP updated the standard designs for Right-of-way Bioswales. The standard designs are available at www.nyc.gov/dep/greeninfrastructure.

9

Expanded the Green Infrastructure Maintenance Program

In 2013, DPR and DEP continued to plan and implement the maintenance program for all green infrastructure in the public right-of-way. By the end of 2013, Brooklyn, the Bronx and Queens each had one fully staffed five-member green infrastructure maintenance crew. Additionally, DEP hired a full-time staff person to develop and manage the maintenance program.

10

Successfully worked to renew the Green Roof Property Tax Abatement for New York City.

In 2013, DEP worked with the Mayor's Office, the Office of Management and Budget, and the Departments of Buildings and Finance, as well as environmental advocates to extend the New York City Green Roof Tax Abatement (which expired in March 2013) for an additional five years. With some modifications, the property tax abatement continues the previous abatement that was intended to offset some of the costs associated with green roof installation.

Institutionalizing Green Infrastructure

Green roof at Bishop Loughlin High School, Brooklyn

Organizational Capacity

By the end of 2012, DEP's Office of Green Infrastructure (OGI) had 11 full time staff to implement the Green Infrastructure Program. In 2013, OGI added five more full time staff, bringing the total OGI staff headcount to 16, including engineers, planners, project managers, and administrative support staff. This section highlights two program areas that saw robust growth in 2013. DEP's Project Tracking and Asset Management system and its Maintenance Program will both provide increased capacity for managing the growing, decentralized set of green infrastructure assets. For more information on OGI's other programmatic areas, and its intra- and inter-agency partnerships, see the *2012 Green Infrastructure Annual Report*, which is available at DEP's website at nyc.gov/greeninfrastructure.

Project Tracking and Asset Management

In 2013, DEP initiated the development of a Geographic Information System (GIS)-based Project Tracking and Asset Management System capable of compiling, tracking, managing, mapping, reporting data, and providing asset management for thousands of decentralized green infrastructure assets.

DEP is required to submit quarterly and annual reports describing the status of the Green Infrastructure Program, and reporting on the Order milestone targets. The Project Tracking and Asset Management System will aid in this process by compiling, mapping and reporting data from thousands of decentralized green infrastructure assets throughout their life cycle. DEP is also responsible for ensuring the functionality of all green infrastructure assets throughout their useful life. The life cycle of each green infrastructure asset includes project initiation, site investigation, geotechnical investigation and design; construction and inspection; and operations and maintenance. DEP will utilize the Project Tracking and Asset Management System to manage and monitor operations and maintenance of all of the City's green infrastructure assets. DEP anticipates the system will be operational in 2014.

In the meantime, DEP has developed an interim asset management system to track all projects funded by the agency, including grant projects, Right-of-way Bioswales, Stormwater Greenstreets, and public property retrofits. DEP will ultimately utilize the Project Tracking and Asset Management System to track design, construction and maintenance information about each green infrastructure installation. DEP will review all tracking data regularly to sum waterbody application rates represented in this annual report.

Private investments in green infrastructure in New York City can be added to the Green Infrastructure Webmap, which is hosted on NYC Citymap by the New York City Department

of Technology and Telecommunications (DOITT[4]). Users can search for green infrastructure projects built on private property by address or by type of green infrastructure technology. DEP will populate the Green Infrastructure Webmap with public projects as they are completed. DEP continues to encourage individual property owners to add their projects to the Webmap, so that the true scale of the implementation effort in the City can be viewed by all.

Green Infrastructure Maintenance

Throughout 2013, DEP and the New York City Department of Parks & Recreation (DPR) continued to develop the Green Infrastructure Maintenance program, including the hiring of 15 right-of-way green infrastructure maintenance staff in Brooklyn, Queens, and the Bronx. As green infrastructure projects are completed through the Area-wide contracts, DEP will continuously evaluate the maintenance capacity of the existing crews and will add crews in each borough as needed. In planning for the large task of right-of-way maintenance, DEP and DPR account for neighborhood context, vegetation establishment, task efficiency and site density, as well as refine the frequency of maintenance visits. These and other parameters will be analyzed regularly and revised as field experience increases. In 2013, DEP also began planning for maintenance of green infrastructure built on other public properties, such as land under the jurisdiction of DPR, New York City Housing Authority (NYCHA), New York City Department of Transportation (DOT), and Metropolitan Transit Authority (MTA).

Institutional Steps

Stormwater Performance Standard

DEP's stormwater performance standard ("Stormwater Rule"), enables the City to manage stormwater runoff more effectively, and to reduce the rate of runoff into the City's combined sewer systems from new development or major site expansions. Promulgated in July 2012,[5] the Stormwater Rule requires any new house or site connections to the City's combined sewer system to comply with stricter stormwater release rates, effectively requiring greater on-site detention. DEP's companion document, *Guidelines for the Design and Construction of Stormwater Management Systems*,[6] assists the development community and licensed professionals in the selection, planning, design, and construction of on-site stormwater management practices that comply with the Stormwater Rule.

The Stormwater Rule applies to new development or the alteration of an existing development in combined sewer areas of the City. For a new development, the stormwater release rate[7] is required to be 0.25 cubic feet per second (cfs) or 10 percent of the drainage plan allowable flow, whichever is greater.[8] If the allowable flow is less than 0.25 cfs, then the stormwater release rate shall be equal to the allowable flow. For alterations, the stormwater release rate for the altered area will be directly proportional to the ratio of the altered area to the total site area, and no new points of discharge will be permitted.[9]

DEP tracks new Site Connection Proposals (SCPs) and House Connection Proposals (HCPs) submitted to DEP that have been affected by the new release rate required under the Stormwater Rule.[10] Since the rule took effect, DEP has certified more than 1,600 SCPs/HCPs and, of that, more than 140 sites were affected by these more stringent requirements. Tables 1 and 2 present the breakdown of stormwater management system types employed by applicants affected by the rule. The total contributing drainage area reported for all sites is approximately 45

Site and House Connection Proposals Affected by Stormwater Performance Standard

Stormwater Management Type[1]	Status	
	Planned[2]	Constructed[3]
Blue Roof	56	10
Blue Roof/Tank Combination	1	0
Drywell	5	3
Perforated Pipe	7	0
Tank	82	6
Total	**151**	**19**

[1] Sites may contain more than one stormwater management system.
[2] Planned stormwater management projects are subject to change.
[3] Site/House Connection Proposals permitted and inspected by DEP.

Table 1: Site and House Connection proposals by project type.

Certified Site/House Connection Proposals by Borough	
Manhattan	38
Bronx	18
Brooklyn	57
Queens	30
Staten Island	0
Total	**143**

Table 2: Site and House Connection proposals by borough.

[4] The Green Infrastructure Webmap can be accessed under the green infrastructure "theme" at NYC Citymap's web page, www.maps.nyc.gov/doitt/nycitymap/, or by searching an address from DEP's Green Infrastructure web site at www.nyc.gov/greeninfrastructure.
[5] See Chapter 31 of Title 15 of the Rules of the City of New York Governing House/Site Connections to the Sewer System. (New York City, N.Y., Rules, Tit. 15, § 31)
[6] The Guidelines are available at DEP's website, at www.nyc.gov/html/dep/pdf/green_infrastructure/stormwater_guidelines_2012_final.pdf
[7] New York City, N.Y., Rules, Tit. 15, § 31-01(b)
[8] Allowable flow is defined as the storm flow from developments based on existing sewer design criteria that can be released into an existing storm or combined sewer.
[9] New York City, N.Y., Rules, Tit. 15, § 31-03(a)(2)
[10] DEP's tracking does not include SCP/HCPs certified by the Department of Buildings (DOB); hence, additional sites may be affected by the Stormwater Rule.

acres. It is important to note that these systems are primarily detention-based and designed to meet the reduced 0.25 cfs stormwater release rate. Since the Order requires that the City manage one inch of stormwater runoff, DEP will develop a methodology to apply the area managed per the Stormwater Rule towards the Order milestones and present these results in 2015.

Parking Lot Stormwater Pilot Program

First initiated in 2011, DEP's Parking Lot Stormwater Pilot program generates revenue for operation and maintenance of the City's wastewater system. The program applies a stormwater discharge fee to stand-alone parking lots that contribute runoff to the City's wastewater system, but that do not receive City water service. DEP's stormwater charge increased from $0.05 to $0.06 per square foot in 2013, to account for rate structure increases. The program billed 455 parking lot accounts in 2013, an increase of 75 from 380 accounts in 2012. DEP billed a total of $274,773 in FY11 and FY12. In 2013, DEP identified 143 additional stand-alone parking lots that will be billed a total of approximately $50,000 in 2014. Parking lot owners who implement green infrastructure practices are exempt from the stormwater discharge fee.

Green Roof Property Tax Abatement

Green roofs provide considerable benefits to New York City, but the expense of installation remains a barrier for many building and home owners. In 2013, DEP worked with the Mayor's Office, the Office of Management and Budget, and the Departments of Buildings and Finance, as well as environmental advocates to extend the New York City Green Roof Tax Abatement (which expired in March 2013) for an additional five years. With some modifications, the property tax abatement continues the previous abatement, which was intended to offset some of the costs associated with green roof installation. The tax abatement extension was signed by the Governor in 2013, and is expected to be adopted into the City Administrative code in 2014.

As part of the extension, the definition of a green roof now includes native and/or agricultural plant species, in response to increased public interest and enthusiasm for locally produced food crops. Besides stormwater retention, rooftop farms have the added benefit of providing local produce to New York City residents. To address green roofs with a growth medium of less than three inches (i.e., more typical green roofs without agricultural plant species), the abatement now includes the option of using controlled flow roof drains as an additional water holding mechanism,

Typical standalone parking lot

consistent with DEP's *Guidelines for the Design and Construction of Stormwater Management Systems*. Controlled flow roof drain systems provide temporary ponding on a rooftop surface and slowly release the ponded water. Adding controlled flow roof drains to green roof systems can enhance the retention and detention of stormwater.

Additionally, the tax abatement includes an increase to the value of the abatement from $4.50 to $5.23 per square foot, to continue offsetting construction costs by roughly the same value as the original tax abatement. And given that rooftop farms tend to be larger than typical green roofs, the abatement value cap was increased from $100,000 to $200,000 to allow rooftop farm projects to receive the full value of the abatement. Finally, based on the amount allocated for this abatement, the total annual amount available for applicants is $750,000 in the first year and $1 million in each subsequent year through March 15, 2018. The aggregate amount of abatements will be allocated by the New York City Department of Finance on a pro rata basis.

Green Infrastructure and Long-Term Control Plans

Right-of-way Bioswale, Central Avenue, Brooklyn

The Order requires that DEP undertake a comprehensive evaluation of CSO impacts on water quality, and an assessment of the highest attainable use for 10 waterbodies. Through this process, known as a Long-Term Control Plan (LTCP), DEP must identify appropriate CSO controls necessary to achieve waterbody-specific water quality standards. The Order also sets forth a schedule for the completion of the 10 LTCPs, and one citywide LTCP, between 2013 and 2017.[11] Each LTCP may include a mix of cost-effective green and/or grey infrastructure projects. In 2012, to prioritize waterbodies and to project waterbody-specific green infrastructure application rates, DEP identified multiple assessment metrics including but not limited to water quality standards, planned/constructed grey infrastructure investments, projected CSO volume reductions, and remaining CSO volumes. These metrics, shown in Table 3, are discussed in detail in the *2012 Green Infrastructure Annual Report*. DEP will continue to use these projected green infrastructure implementation targets in ongoing LTCP evaluations. However, if more detailed information is available at the time of the waterbody-specific LTCP development, these targets will be adjusted based on lessons learned during the design and construction of green infrastructure projects and area-wide construction contracts, which are described in the "Citywide Implementation" section.

[11] Pursuant to the 2005 CSO Order on Consent, DEP submitted a LTCP for Paerdegat Basin, which was approved by DEC in 2007.

DEP submitted a LTCP for Alley Creek in July 2013, and is currently working on the LTCPs for the Westchester Creek, Hutchinson River and Flushing Creek watersheds, to be completed and submitted to New York State Department of Environmental Conservation (DEC) in 2014. In the course of developing LTCPs, DEP creates hydraulic and hydrologic models[12] of the applicable watersheds in conjunction with green infrastructure targets to quantify the expected benefits from green infrastructure practices. For more detailed information on DEP's waterbody prioritization approach and the landside models used for green infrastructure implementation in CSO tributary areas, see the *2012 Green Infrastructure Annual Report.*

Neighborhood Demonstration Area Projects

The Order contains milestone dates, which DEP met in 2012 and 2013, for design, construction, and monitoring of three Neighborhood Demonstration Area Projects ("Demonstration Projects"). DEP has completed construction of green infrastructure within a total of 63 acres of tributary area in the Newtown Creek, Hutchinson River,[13]

[12] DEP uses InfoWorks for all watershed modeling. InfoWorks is a commercially available product that is used to analyze urban hydrology and hydraulics. The InfoWorks model is capable of using Geographic Information Systems (GIS) data, modeling continuous and event simulations, incorporating real time controls, modeling green and grey infrastructure, and performing water quality tracking within sewer systems.

[13] Both the Newtown Creek and Hutchinson River Neighborhood Demonstration Area Projects were funded under the Environmental Benefits Program (EBP). EBP projects are undertaken in connection with the settlement of an enforcement action by New York State and DEC for violations of New York State law and DEC regulations.

Waterbody	Combined Sewer Impervious Area (ac)	Application Rates Total Target[1]	
		Managed Acres	Percent of Managed Acres
Initial Phases			
Alley Creek	1,490	45	3%
Bronx River*	2,331	322	14%
Coney Island Creek	694	7	1%
Flushing Bay*	4,049	522	13%
Flushing Creek*	5,923	479	8%
Gowanus Canal*	1,387	162	12%
Hutchinson River*	1,128	158	14%
Jamaica Bay & CSO Tributaries*	7,891	675	9%
Newtown Creek*	4,524	593	13%
Westchester Creek*	3,480	487	14%
Total Waterbodies	**32,897**	**3450**	**10%**
Future Phases			
CITYWIDE (Total Waterbodies + East River/Open Waters + Paerdegat Basin)	**78,749**	**7,875**	**10%**

**Priority Waterbodies*

[1] Projected Green Infrastructure Implementation Rates based on the metrics used in 2012 assessments. These rates will be adjusted when information becomes available from Area-wide construction contracts.

Table 3: Waterbody-specific application rates and opportunities for green infrastructure implementation.

and Jamaica Bay CSO tributary areas, and is currently monitoring these practices to study the benefits of green infrastructure application on a neighborhood scale and using a variety of techniques. The Demonstration Projects will culminate in the submission of the *Post-Construction Monitoring Report* in August 2014. These results will be incorporated into the *2016 Performance Metrics Report*, which will model the CSO reductions enabled by green infrastructure projects. Pre-construction monitoring for all three Demonstration Projects started in fall 2011, and post-construction monitoring continued throughout 2013.

Rain garden, Hope Gardens Houses, Brooklyn

Construction of Right-of-way Bioswales as part of the Hutchinson River Green Infrastructure Demonstration Project was completed in April 2013 by DPR. There were 22 Right-of-way Bioswales installed within the 24-acre tributary area, and the design and construction costs were approximately $545,000. In the 23-acre Jamaica Bay Green Infrastructure Demonstration Project, DEP completed 31 right-of-way green infrastructure installations in 2012, and completed permeable pavement retrofit projects at NYCHA's Seth Low Houses in 2013. The total design and construction costs were approximately $1.3 million. In the 16-acre Newtown Creek Green Infrastructure Demonstration Project, DEP constructed 19 Right-of-way Bioswales, two rain gardens, and a subsurface storm chamber system on the site of NYCHA's Hope Gardens Houses. These projects were completed in 2013, and costs were approximately $1.4 million for design and construction. For more information on the Demonstration Projects, see the *2012 Green Infrastructure Annual Report.*

Citywide Implementation

Right-of-way Bioswale, Nostrand Avenue, Brooklyn

Area-wide Strategy: Priority Combined Sewer Tributary Areas

To meet the green infrastructure goals of the Order (as shown in Figure 1), DEP has been identifying Priority CSO Tributary Areas ("Priority Areas") based on several criteria. DEP looks closely at the annual CSO volume, frequency of CSO events, as well as outfalls that may be affected by Waterbody/Watershed Facility Plans (WWFPs[14]) or other system improvements in the future. DEP also notes outfalls in close proximity to existing and future public access locations. DEP will continue to review and expand the number of Priority Areas to ensure sufficient green infrastructure implementation toward the Order milestones. In 2013, DEP expanded the Priority Areas, which represents an additional 15,000 acres, bringing the total to 38,000 Priority Area acres. Figure 2 presents DEP's original and expanded Priority Areas.

The identification of Priority Areas enables DEP to focus resources on specific outfall tributary areas, to analyze all potential opportunities, to saturate these areas with green infrastructure as much as possible, and to achieve efficiencies in design and construction. This Area-wide strategy is made possible by DEP's standardized designs and procedures, which enable systematic implementation of green infrastructure. It also provides an opportunity to measure and evaluate the CSO benefits of Area-wide green infrastructure implementation at the outfall level.

DEP utilizes the Area-wide strategy for all public property retrofits, as described in more detail in the "Public Property Retrofits" section and in the *2012 Green Infrastructure Annual Report*. DEP has developed standard siting and design processes for right-of-way green infrastructure implementation, and works directly with its partner agencies on retrofit projects at public schools, public housing, parkland, and other City-owned property within the Priority Areas. DEP coordinates on a regular basis with partner agencies to review designs for new projects and to gather current capital plan information to identify opportunities to integrate green infrastructure into planned public projects.

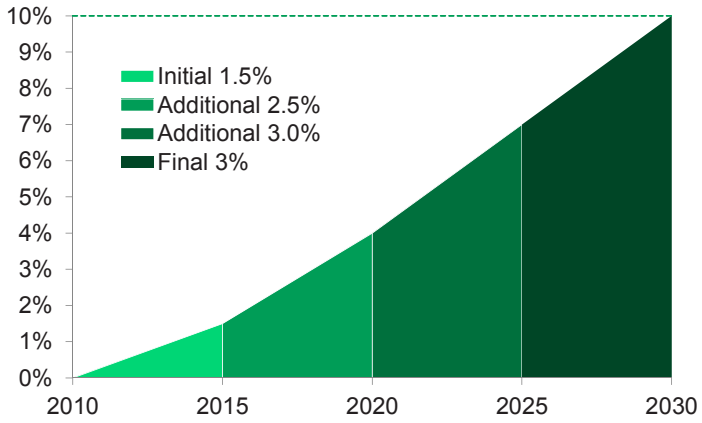


Figure 1: Milestone schedule for managing 10% of impervious surfaces in combined sewer areas with green infrastructure.

[14] For more information on Waterbody/Watershed Facility Plans, visit www.nyc.gov/html/dep/html/cso_long_term_control_plan/index.shtml

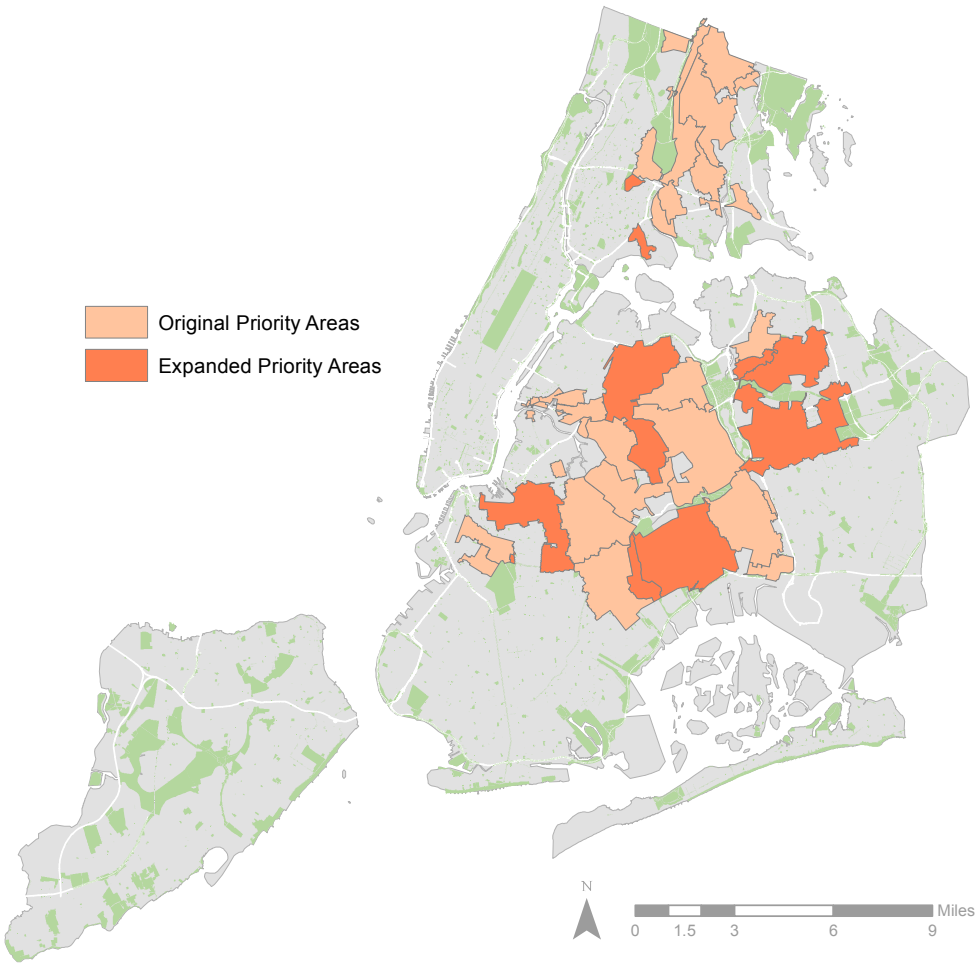


Figure 2: Original and Expanded Priority CSO Tributary Areas.

The Area-wide strategy and associated standardized procedures have enabled DEP to apply green infrastructure citywide at its current scale. However, there are several challenges that DEP faces during green infrastructure implementation. Some of these challenges, further described below, include existing urban street conditions, geologic and soil conditions (such as high bedrock or clay soils), high groundwater tables, and utility conflicts. DEP and partner agencies have made progress developing solutions to some of these obstacles and will continue to work to minimize them. However, in some cases there is no alternative but to remove sites with the above issues from consideration due to infeasibility.

Right-of-way Area-wide Contracts

DEP's right-of-way contracts continued to make up the majority of the Green Infrastructure Program's efforts and resources in 2013. DEP manages several of its own Area-wide design and construction contracts. Additionally, the New York City Economic Development Corporation (EDC), Department of Parks and Recreation (DPR), and Department of Design and Construction (DDC) manage several Area-wide contracts on behalf of DEP. EDC and DDC continued design through 2013, and anticipate that phased area-wide construction in the Priority Areas of Jamaica Bay, Newtown Creek, and Hutchinson River will begin during summer 2014. In spring 2013, DPR began constructing right-of-way green infrastructure installations in the Flushing Bay and Bronx River Priority Areas, and expects to complete construction in winter 2014.

In 2013, DEP (including OGI and the Bureau of Engineering, Design, and Construction) continued to design green infrastructure in the Gowanus Canal, Flushing Bay, Jamaica Bay, and Newtown Creek Priority Areas. DEP anticipates beginning phased construction in these areas in summer 2014. The case study on page 28 discusses one of the Flushing Bay Area-wide contracts in more detail.

To capture efficiencies in construction, and to minimize construction impacts on neighborhoods, DEP and partner agencies will bid out construction of approximately 200-

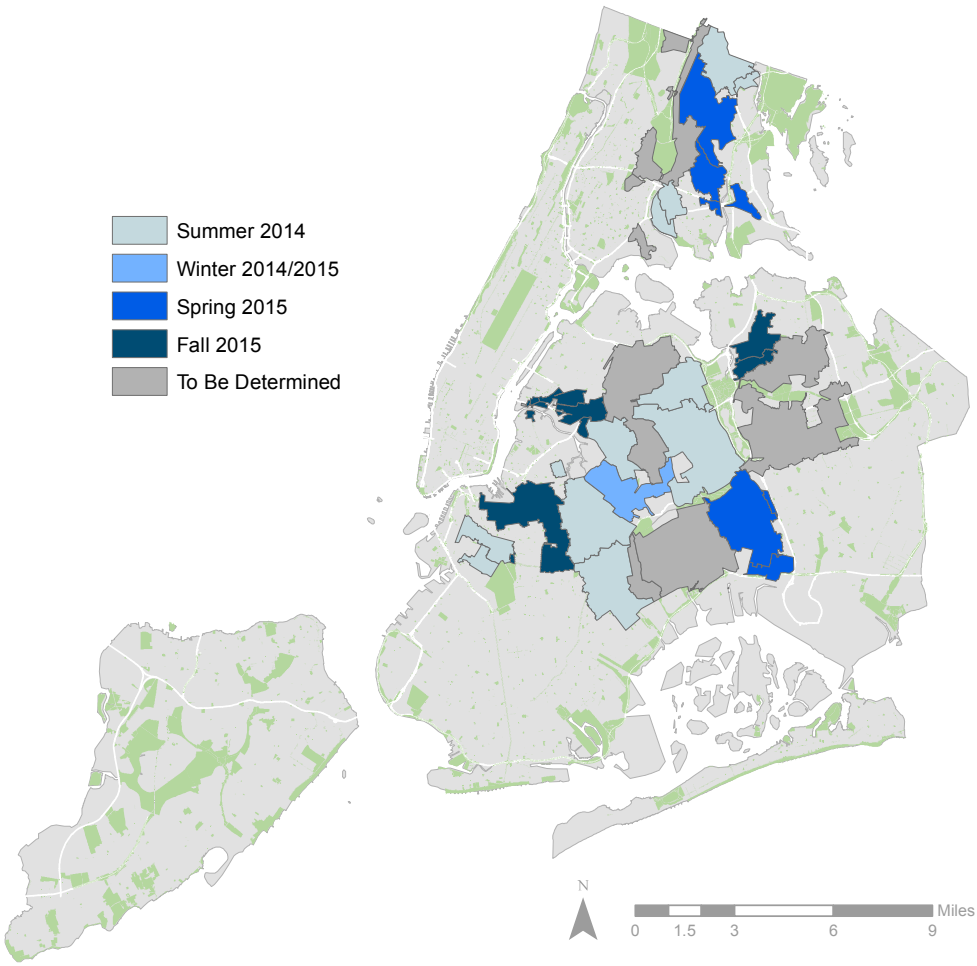


Figure 3: Projected construction start dates for Area-wide green infrastructure contracts.

300 Right-of-way Bioswales and Stormwater Greenstreets at a time. Depending on the total number of sites to be constructed, subsequent construction packages will be bid out until all sites are constructed. The typical construction timeline for 200-300 right-of-way sites is approximately six months. Anticipated Area-wide construction start dates are shown in Figure 3.

Standardized Right-of-Way Area-wide Design Procedure

As described in the *2012 Green Infrastructure Annual Report*, OGI developed standard designs for various types of Right-of-way Bioswales for use by engineers, architects, landscape architects, and other City agencies while preparing contract plans. These standards facilitate the design of green infrastructure practices in the right-of-way, streamlining the development of contract plans and drawings, and reducing the timeline and costs associated with design and approval processes. This standardization enables DEP to plan construction for thousands of Right-of-way Bioswales and Stormwater Greenstreets in Priority Areas.

In July 2013, DEP and its partner agencies accepted the New York City Public Design Commission's (PDC's) Excellence in Design Award for the standard designs. In October 2013, DEP completed additional green infrastructure standards in order to address a range of site conditions common throughout the Area-wide contract locations. Each Right-of-way Bioswale standard design features unique plant specifications and variations to include stormwater inlets and/or stone columns. Table 4 lists the calculated quantities of stormwater and impervious area managed for the typical types of Right-of-way Bioswale designs. The updated standard designs are available on DEP's website, www.nyc.gov/dep/greeninfrastructure.

Once DEP initiates an Area-wide contract for right-of-way green infrastructure, a series of steps are undertaken to select Potential, Preliminary and Final sites for Right-of-way Bioswales and Stormwater Greenstreets to further the design. These steps include a desktop hydrologic analysis, followed by a block-by-block site visit (or "walk-through")

by multiple City agencies including DOT, DPR, and DEP to determine the specific location. Siting criteria also include evaluations of traffic and pedestrian safety, mature street trees, bus stops and other important considerations in relation to the right-of-way zones, as shown in Figure 4. These existing urban conditions can eliminate hundreds of potential green infrastructure locations in the right-of-way of a Priority Area, and each neighborhood will vary widely in terms of available space for Right-of-way Bioswales and Stormwater Greenstreets. Each neighborhood will be evaluated thoroughly for all possible suitable locations per DOT, DPR, and DEP criteria. At the conclusion of the walk-throughs, all acceptable sites are considered Preliminary and will move toward a geotechnical investigation.

The geotechnical investigation and survey steps required by DEP have also been standardized to ensure that each site does not conflict with utilities and will allow water to infiltrate as designed. To date, thousands of borings and permeability tests have been conducted and, depending on the conditions, a large majority of them do not meet DEP's current criteria. These results are concerning and limit the amount of suitable locations; however, conservative evaluation is prudent at this early stage in the Green Infrastructure Program to ensure that all sites function as designed and do not cause a public concern. DEP will continually evaluate its geotechnical standards and make adjustments as more is learned about the performance and functionality of the green infrastructure (see "Research and Development Program"). Once the geotechnical reports are submitted and reviewed, DEP will allow a site to move forward to be surveyed or remove it from consideration due to unfavorable conditions for infiltration.

Subsurface utility conflicts are also a challenge for DEP in implementing the right-of-way projects. After a few incidents where damage to water and sewer infrastructure was incurred due to the geotechnical investigations, DEP has addressed the problem with rigorous procedures, oversight and accountability in the field, and a Pre-Drilling Checklist. These steps will mitigate future interference and protect existing water mains, sewer and water service lines, sewer house connections, gas lines, and other subsurface utilities. For more details on the standardized design procedure for right-of-way green infrastructure, see the *2012 Green Infrastructure Annual Report*.

Right-of-way Bioswale Type	Calculated Volume of Stormwater Managed (ft^3)	Calculated Area Managed (ft^2)
Type I - Enhanced	400	4,800
Type I	360	4,320
Type II - Enhanced	300	3,600
Type II	270	3,240
Type III	180	2,160

Table 4: Standard Right-of-way Bioswale Calculated Volume and Impervious Area Managed.

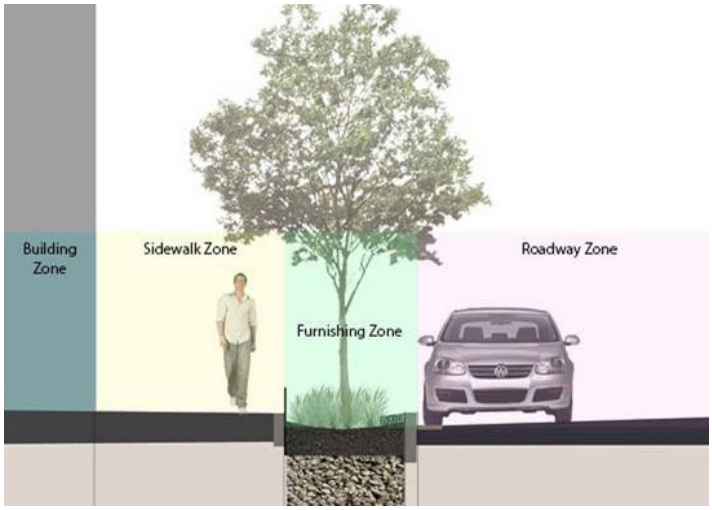


Figure 4: Public right-of-way zones. Image courtesy of NYCDOT.

Right-of-way Bioswale, Denton Place, Brooklyn

Public Outreach and Construction Notification

During the Area-wide site walk-throughs described above, DEP, agency partners, and design teams often meet local residents, homeowners, and business owners. In order to provide more information about the Green Infrastructure Program, DEP developed an informational brochure that describes the site selection and construction process for projects in the right-of-way. The brochure also includes frequently asked questions and answers, and explains the co-benefits of green infrastructure. Nearly 5,000 of these brochures were distributed throughout 2013.

In addition, DEP will distribute door hangers (shown in Figure 5 below) to notify abutting property owners in advance of green infrastructure construction projects. During construction in each contract area, DEP and its partner agencies will provide construction liaison staff to distribute the door hangers to adjacent property owners and to be present during construction. The contact information for the construction liaison will be affixed to the door hangers if the need to alert the City to a problem arises during construction.

Additionally, DEP continues to make presentations to elected officials and their staff, community boards, and other civic and environmental organizations about the Green Infrastructure Program, upcoming construction schedules, and final green infrastructure locations as an ongoing part of its outreach efforts.

Figure 5: Door hanger and Green Infrastructure brochure.

Public On-site Retrofit Projects

In 2013, DEP continued to assess all possible opportunities within Priority Areas to either initiate a new retrofit project or add funding for green infrastructure to current or new projects on City-owned property. DEP also continued to promote its public-private partnerships as a vehicle for green infrastructure implementation on City-owned property.

Over the course of the last year, DEP continued to work with DPR, NYCHA, New York City Health and Hospitals Corporation (HHC), Department of Cultural Affairs (DCA), School Construction Authority (SCA), Department of Education (DOE), and others to identify appropriate sites for green infrastructure retrofit projects that meet all partner agencies' programmatic goals.

In 2013, DEP completed construction of green infrastructure installations at NYCHA's Seth Low Houses and Hope Gardens Houses in Brooklyn, and completed the design of green infrastructure installations at the Edenwald Houses in the Bronx. DEP and NYCHA will also identify other green infrastructure retrofit opportunities within Priority Areas that will serve both to meet DEP's stormwater management goals, and to improve NYCHA property for the benefit of all their residents.

Feasibility, as well as suitability, are also challenges for implementing the public retrofit projects. As with the right-of-way projects, all public property retrofit sites must have suitable conditions for infiltration on the site. In addition, the sites must also be free of subsurface conflicts such as hazardous materials, underground vaults, or stormwater detention systems that already manage the site runoff. In these cases, the public properties prove infeasible or incompatible and DEP and the partner agencies cannot proceed with a design. When this occurs, DEP and the partner agency will consider other locations but this process of site selection can take much longer than expected and cause delays in the wide-scale implementation of these public property retrofits.

Public-Private Partnerships

Green Infrastructure Schoolyards

The "Schoolyards to Playgrounds" program, a PlaNYC 2030 initiative aimed at ensuring at all New Yorkers live within a 10-minute walk from a park, is a collaboration between the not-for-profit Trust for Public Land (TPL), DPR, DOE, and SCA to renovate school playgrounds and extended playground access to surrounding neighborhoods. In 2011, DEP joined TPL, SCA, and

FlexiPave™ installed in playground, Seth Low Houses, Brooklyn

Synthetic turf field, P.S. 65, East New York, Brooklyn

DOE, funding up to $5 million for construction of 10 green infrastructure public school playgrounds each year for the next four years. The partnership is a successful component of DEP's strategy to leverage public-private partnerships to improve public property using green infrastructure retrofits. By fall 2013, construction of the first three playgrounds was complete, and two playgrounds had completed designs. The case study on pages 30 and 31 details one of the completed playground projects. In 2013, the partnership identified eight additional playgrounds in Priority Areas for green infrastructure retrofits and started design. The partnership will continue to identify additional sites.

Green Infrastructure Grant Program

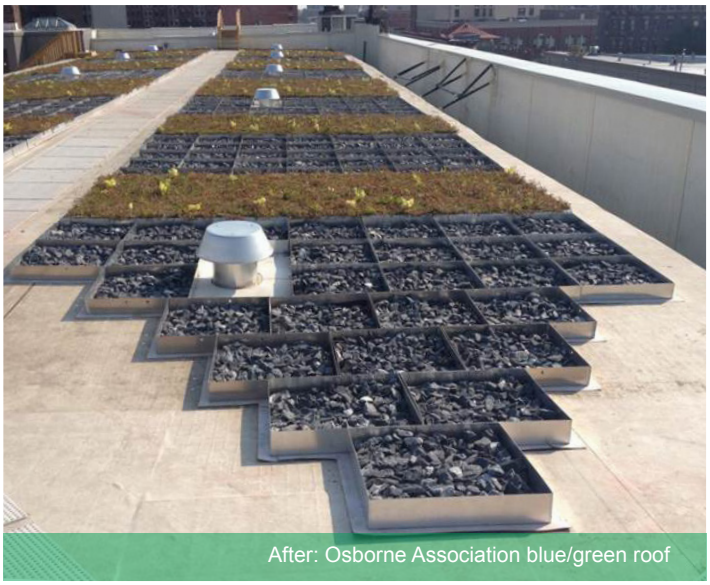
Since its introduction in 2011, the Grant Program has sought to strengthen public-private partnerships and public engagement in regards to the design, construction and maintenance of green infrastructure. The Green Infrastructure Grant Program has committed approximately $11.5 million to 29 private property owners to build green infrastructure projects in the combined sewer areas of New York City.

For the 2013 grant cycle, DEP improved its online application and submission processes, and conducted application workshops in Brooklyn, Queens and the Bronx. At the end of the application period, the inter-agency review committee, comprised of representatives from DPR, DOB, DDC, DEP and DEC, selected 11 projects and committed $4.7 million across four boroughs. Various types of green infrastructure will be constructed, including green roofs, rain gardens, and a rainwater harvesting system.

Several grant recipients from earlier cycles completed construction of their projects in 2013. A blue/green roof was completed by The Osborne Association in the Bronx, and green roofs were completed at both the Lenox Hill Neighborhood House in Manhattan and the Bishop Loughlin Memorial High School in Brooklyn. In addition, New York Restoration Project (NYRP) completed construction of a community garden that incorporates permeable pavement and bioretention. The case study on page 29 highlights the NYRP project at Gil Hodges Community Garden.

The Order requires the Green Infrastructure Grant Program to commit $3 million of Environmental Benefits Program (EBP) funds[15] to grant projects by 2015. By the end of 2013, DEP identified two additional grant projects for EBP grant funds in the Bronx and Brooklyn, bringing the total Grant EBP commitment to $2,013,548. DEP expects to meet the full $3 million EBP grant program commitment in 2014.

Before: Osborne Association roof. Photo by Osborne Association.



After: Osborne Association blue/green roof

Rain garden and permeable pavement, Queens College

[15] EBP Projects are undertaken by DEP in connection with the settlement of an enforcement action taken by New York State and DEC for violations of New York State law and DEC regulations.

Public Outreach and Engagement

DEP continues to educate and engage the public in the ongoing implementation of the Green Infrastructure Program. In spring 2013, DEP presented the *2012 Green Infrastructure Annual Report* and the *2012 Pilot Monitoring Report*[16] at the annual Green Infrastructure Citizens Group meeting. The Citizens Group comprises a wide range of members from community and environmental organizations as well as businesses, universities and water quality advocates. The Green Infrastructure Steering Committee continued to meet in 2013, and its scope expanded to include other agenda items beyond the work of the Office of Green Infrastructure. Steering Committee members now meet on a variety of DEP initiatives, such as resiliency planning and issues related to separately sewered areas.

DEP led a workshop at the Grow our Grassroots Summit organized by MillionTreesNYC (MTNYC) in 2013. DEP also made presentations at several conferences around the country, including the United States Environmental Protection Agency's Community Summit on Green Infrastructure, the International Low Impact Development (LID) Symposium, the Sustainable Communities Climate Leadership Academy, and the Water Environment Federation's Annual Technical Conference.

In 2013, DEP launched its new website design at www.nyc.gov/dep in 2013. As part of this update, DEP reorganized and added new content to the green infrastructure pages at www.nyc.gov/dep/greeninfrastructure. Users can now easily access more information on the Green Infrastructure Program, including the most common types of green infrastructure practices, and DEP's research and development program. Users can also view a map of the Priority Areas to learn if green infrastructure is coming to their neighborhood.

Also in 2013, DEP created an educational video on the Green Infrastructure Program. The video gives a brief explanation of the environmental challenges caused by combined sewer overflows while featuring green infrastructure technologies such as green roofs, rain gardens and permeable pavers. The video is available at DEP's YouTube page, at www.youtube.com/watch?v=zrhw2cMTpJs.

See the "Area-wide Contracts" section for further description of DEP's outreach materials used during design and construction for green infrastructure projects.

[16] DEP's *2012 Pilot Monitoring Report* is available at DEP's website at www.nyc.gov/html/dep/pdf/green_infrastructure/2012_green_infrastructure_pilot_monitoring_report.pdf

Stewardship

In spring 2013, DEP launched its new BioswaleCare Program in partnership with MTNYC. BioswaleCare provides free workshops and materials to participants interested in learning about environmental stewardship. DEP, NYCHA, and MTNYC hosted workshops for NYCHA residents in the three Neighborhood Demonstration Areas, and a fourth workshop with multiple Brooklyn churches. Participants in the 2013 events received hands-on training on the care of Right-of-way Bioswale and Stormwater Greenstreets and will have an opportunity to "adopt" or care for green infrastructure installations in their neighborhoods. In 2013, 77 community members participated in the BioswaleCare workshops. Future workshops will be announced on DEP's website.

BioswaleCare workshop, Bronx

BioswaleCare workshop, Brooklyn

Progress toward Implementation Goals

Blue/green roof trays, Osborne Association, Bronx

Built and Planned Green Infrastructure

DEP has built and funded numerous green infrastructure projects throughout the City's combined sewer area, both on private property and publicly owned property, including the public right-of-way. While the Order requires DEP to manage one inch of runoff on 10 percent of impervious surfaces in combined sewer areas citywide by 2030, DEP currently employs the Area-wide strategy, as described in previous sections, to target and saturate the Priority Areas. Table 5 indicates the equivalent acreage necessary to meet the 10 percent goal by 2030, and the 1.5 percent goal by 2015. The table also shows the amount of impervious area managed by green infrastructure to date and those acres to be managed by planned projects that are in development in 2014.

In Table 5, the "*2010-2013 Built*" column includes the impervious surfaces managed by green infrastructure assets completed between 2010 and 2013. Built green infrastructure assets include, but are not limited to, bioinfiltration practices (Right-of-way Bioswales, Stormwater Greenstreets, and rain gardens), permeable pavements, subsurface detention systems with infiltration capability, synthetic turf fields with infiltration capability, stormwater harvesting and reuse systems, blue roofs, and green roofs. Also see Figure 6 for a map of green infrastructure projects built between 2010 and 2013.

The "*2014 Planned*" column includes all green infrastructure projects that will be constructed, will be in construction, or will have an advanced design and progressing to final design by December 31, 2014. The total impervious surfaces managed by the 2010-2013 Built and 2014 Planned projects are summed in the final column, "*GI Built + Planned Percent of IACS Managed*" and shown as the percent impervious combined sewer tributary acres managed by green infrastructure.[17]

There are two totals represented in the table, one that includes the "Total Waterbodies" without East River/Open Waters, and a "Citywide" total that includes East River/Open Waters. The waterbodies included in East River/Open Waters watershed, namely the East River and Hudson River, already meet the existing water quality standards and are cleaner than they have been in a century. The tributary area to the East River/Open Waters watershed represents over half of the required acres to be managed to meet the citywide goal. While green infrastructure may be implemented there in the future, DEP is initially investing resources for green infrastructure in those CSO areas tributary to waterbodies that are not in compliance with the existing water quality standards, as described above

[17] At present, impervious area managed as a result of the Stormwater Rule is not included in Table 5. As noted in "Institutionalizing Green Infrastructure," NYC's Stormwater Rule is intended to reduce the stormwater flow rates to the combined sewer system. DEP will develop a methodology to apply the area managed per the Stormwater Rule towards the Order milestones and present these results in 2015.

Waterbody	Impervious Area within Combined Sewer Tributary, IACS (ac)	10% of IACS Tributary (ac)[1]	1.5% of IACS Tributary (ac)[1]	2010-2013 Built[2]		2014 Planned[3]		GI Built + Planned Percent of IACS Managed
				Number of Assets	IACS Managed (ac)	Number of Assets	IACS Managed (ac)	
Alley Creek	1,490	149	22	0	0.0	0	0.0	0.0%
Bronx River*	2,331	233	35	18	6.7	57	6.0	0.5%
Coney Island Creek	694	69	10	0	0.0	0	0.0	0.0%
Flushing Bay*	4,049	405	61	63	5.1	1649	131.9	3.4%
Flushing Creek*	5,923	592	89	14	2.3	2	3.3	0.1%
Gowanus Canal*	1,387	139	21	16	1.3	201	26.6	2.0%
Hutchinson River*	1,128	113	17	22	1.4	175	14.5	1.4%
Jamaica Bay & CSO Tributaries*	7,891	789	118	66	9.9	1682	139.7	1.9%
Newtown Creek*	4,524	452	68	22	2.1	2181	176.2	3.9%
Paerdegat Basin	4,725	473	71	1	0.0	3	0.1	0.0%
Westchester Creek*	3,480	348	52	1	0.1	0	0.0	0.0%
Total Waterbodies	**37,622**	**3,762**	**564**	**223**	**28.9**	**5,950**	**498.3**	**1.4%**
East River & Open Waters (ER/OW)	41,127	4,113	617	45	21.0	33	2.1	0.1%
Citywide (Total Watebodies plus ER/OW)	**78,749**	**7,875**	**1,181**	**268**	**50**	**5,983**	**500.4**	**0.7%**

** Priority waterbodies*
[1] Acreage shown to illustrate portions of citywide total, which may be adjusted as waterbody-specific LTCPs are developed.
[2] Green infrastructure projects built before December 31, 2013.
[3] Green infrastructure projects that will be constructed, will be in construction, or will have an advanced design and progressing to final design by December 31, 2014.

Table 5: Built and planned green infrastructure practices, by waterbody.

in the "Area-wide Strategy" section. By implementing the Green Infrastructure Program in this manner, DEP hopes to achieve real water quality benefits from the projects and either remove or limit the reliance on grey infrastructure in these areas.

For the "Total Waterbodies" summation, approximately 530 impervious acres are either currently being managed or are planned to be managed with green infrastructure by the end of 2014. This is equivalent to managing approximately 1.4 percent of 3,764 impervious acres, which represents the 10 percent goal for the Total Waterbodies. This is an enormous achievement given the Order's ambitious schedule and the need to establish appropriate contracting and budget approval processes in order to implement the Green Infrastructure Program. The Citywide total acres to be managed by the end of 2014 will be approximately 550 impervious acres. This is equivalent to 0.7 percent of 7,875 impervious acres, which represents the 10 percent citywide goal for 2030. The City is implementing the Green Infrastructure Program to meet the objective of cost-effective CSO control. It is possible, however, that achievements in CSO control through green infrastructure will vary across the City, depending on local conditions in each Priority Area. These conditions, and the challenges they present, are detailed in the "Citywide Implementation" section of this report.

Green Infrastructure Program Costs

The Green Infrastructure Program has budgeted over $730 million over the next 10 years. In the Order, DEP agreed to commit $187 million by 2015 to green infrastructure to show the agency's commitment toward mitigating CSOs using green practices. In addition, DEP set aside $5 million as Environmental Benefits Program (EBP) funding, which equals a $192 million total commitment for green infrastructure by 2015. At this time, DEP is planning to meet this commitment in full, and possibly exceed this amount, in terms of funds allocated to active design and construction projects.

Currently, there are 19 individual design teams covering 17 Priority Areas, all working on the same standardized design procedure in order to construct green infrastructure projects in 2014 and into the future. The site selection and design costs for this work are an estimated $84 million dollars for both right-of-way and public property retrofits. While implementation is still in the early stages, DEP is not yet certain how many sites will be constructed; siting success rates vary widely by area due to multiple field conditions, as described in the "Citywide Implementation" section. DEP is working to ensure that all costs stay competitive and that economies of scale are realized for all contracts. As an example, Table 6 shows DEP's revised estimated cost per Right-of-way Bioswale as of 2013, which is nearly

Project Phase	Average Cost
Design, Survey and Geotechnical Investigation	$6,000
Construction[1]	$17,000
Construction Management	$2,000
Total	**$25,000**

[1] Average construction cost is based on a typical 20' by 5' Right-of-way Bioswale.

Table 6: Average Right-of-way Bioswale costs in 2013.

Fiscal Year	Encumbered Capital Funding
FY12	$9,015,345
FY13	$15,943,969
TOTAL	**$24,959,314**

Fiscal Year	Approved FY 2015 Preliminary Four Year Plan
FY14	$296,334,525
FY15	$176,277,000
FY16	$6,494,000
FY17	$14,000,000
TOTAL	**$493,105,525**

Fiscal Year	Estimated Budget
FY18-FY23	**$213,885,161**
PROGRAM GRAND TOTAL[1]	**$731,950,000**

[1] Estimated total based the total encumbered, the Approved FY15 Preliminary Four Year Plan, and the Approved FY14 Executive Ten Year Capital Plan.

Table 7: Green Infrastructure capital program costs summary.

Fiscal Year	Expense Funding (Actual Expended)
FY12	$615,295
FY13	$3,269,689
TOTAL	$3,884,984

Fiscal Year	Approved and Proposed Expense Budget
FY14	$5,955,746
FY15	$7,940,987
FY16[1]	$8,802,455
FY17[1]	$8,291,631
TOTAL[1]	**$30,990,819**

[1] At the time of this publication, the OGI Expense Budget for FY16-FY17 has not been approved by the Mayor's Office of Management and Budget. Proposed costs are pending and should not be considered final.

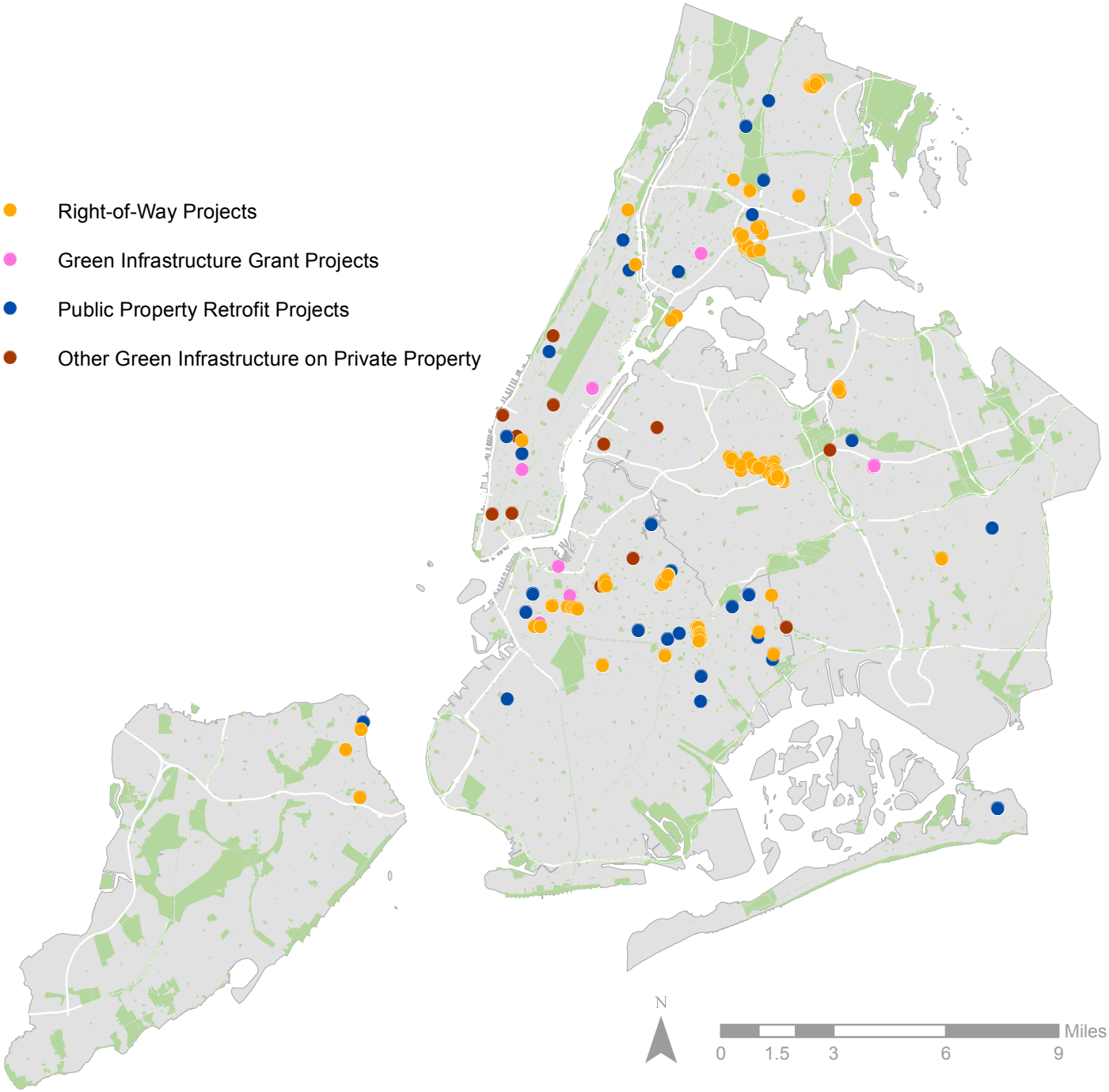
Table 8: Green Infrastructure expense program costs summary.

$10,000 less than the reported costs in the *2012 Green Infrastructure Annual Report*.

It should be noted that during Area-wide contracts, the site selection costs can represent a higher percentage of the total cost per location than typical construction projects. Site selection work is critical to the ultimate success of the Green Infrastructure Program to ensure each site functions properly. Therefore, DEP is conservatively requiring geotechnical investigations at most, but not all, proposed green infrastructure locations. As the program progresses, DEP will update these requirements as well as design and construction practices to keep costs reasonable and to ensure that all green infrastructure projects will be functional over the long term.

Table 7 shows the Approved FY15 Preliminary Four Year Plan through FY17, the estimated funding for FY18 through FY23, and the Approved Executive FY14 Ten Year Plan for the Green Infrastructure Program. Capital funding covers costs such as site selection, design, construction, and construction management for green infrastructure in the right-of-way and for all public property retrofits. This capital funding will support green infrastructure projects undertaken by DEP and agency partners, including the Area-wide contracts and smaller projects with other agencies. As shown in the table, DEP has almost $300 million budgeted in FY14. It is DEP's current estimate that approximately $170 million of that amount will be encumbered in FY14. While this is less than the budgeted amount, DEP has already made adjustments to reallocate the remaining funds in FY15 during the April 2014 budgeting process.

Table 8 shows the Green Infrastructure Program's approved and proposed expense budget through FY17. Expense funding includes DEP's operational costs, such as maintenance of green infrastructure, staffing, and other non-capitally eligible programmatic needs.



Public Property Retrofit Projects include all green infrastructure built on city-owned property.
Other Green Infrastructure on Private Property includes green roofs DEP tracks through the Green Roof Tax Abatement, the Green Infrastructure Web map, and the Department of Buildings permitting system. Private property subject to DEP's Stormwater Performance standard are tracked separately and are discussed in the "Institutionalizing Green Infrastructure" section of this report.

Figure 6: Built green infrastructure, 2010-2013.

Adaptive Management & Lessons Learned

Gil Hodges Community Garden, Denton Place, Brooklyn

Since the inception of the Green Infrastructure Program in January 2011, and through the early stages of implementation, DEP has increased its knowledge and understanding of the costs and benefits of green infrastructure. Reengineering stormwater management in New York City has posed serious challenges, but has also led to significant opportunities and increasing gains. The decentralized and diverse nature of green infrastructure systems demands non-traditional approaches to capital planning and streamlined processes to meet aggressive targets. As a result, DEP's adaptive management approach to green infrastructure implementation emphasizes the following strategies in the near term: identification of Priority Areas, area-wide design and construction, pilot and demonstration project monitoring, and research and development. As the implementation of the Green Infrastructure Program progresses, DEP expects to continue to take stock of lessons learned and modify the program accordingly to achieve cost-effective designs and installations, optimal performance over time, and overall water quality goals. This section of the report includes updates to DEP's Right-of-way Bioswale standard designs, an update on DEP's Pilot Monitoring effort, a description of DEP's current study on green infrastructure co-benefits, and DEP's upcoming research and development program. Once the Neighborhood Demonstration Area *Post-Construction Monitoring Report* is completed in August 2014, as described on page 8, the results will be incorporated into DEP's adaptive management approach along with the research and lessons learned described further below.

Updated Green Infrastructure Standards

In 2013, OGI made several revisions to the Right-of-way Bioswale standard designs in order to improve hydraulic capacity and performance, manage greater impervious area, increase durability, and create efficiencies in maintenance and construction. In order to increase

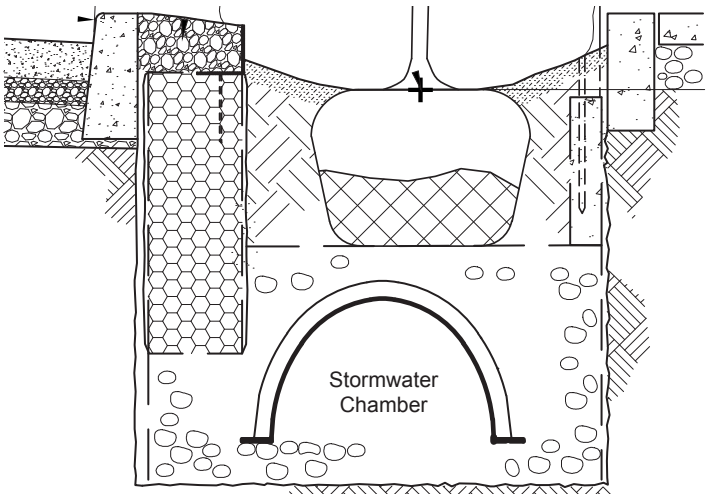


Figure 7: Right-of-way Bioswale stormwater chamber detail, *Standards for Green Infrastructure*, October 2013.

stormwater capacity, OGI added a stormwater chamber, which is a half-cylinder shaped structure installed in the broken stone layer that improves temporary storage of runoff underground and promotes infiltration. A stormwater chamber detail from the standard designs is shown in Figure 7. To improve performance, OGI increased space necessary for tree rooting, improved the grading of the depression, added a porous concrete strip between the inlet and outlet, increased the size of the stone column, and added plant species that reduce soil erosion. For increases in durability and maintenance efficiency, OGI improved the stabilization of the tree guard, improved the stone strip, selected plants for greater survival rates based on field observations, and replaced standard mulch with a jute mesh. The updated technical drawings for the Right-of-way Bioswale standard designs are available on DEP's website at www.nyc.gov/greeninfrastructure.

2013 Pilot Monitoring Program Update

The pilot implementation and monitoring program serves as the foundational element of DEP's adaptive management approach to implementing green infrastructure. Since 2010, more than 30 green infrastructure practices have been constructed and monitored as part of the citywide Pilot Program. These practices include right-of-way green infrastructure such as enhanced tree pits; rooftop practices such as blue roofs and green roofs; subsurface detention systems with open bottoms for infiltration; porous pavement; and bioretention facilities. The complete list of Pilot project sites is shown in Table 9.

DEP's monitoring efforts have primarily focused on the functionality of the green infrastructure practices and their impact on runoff rates and volumes, along with water and soil quality, and typical maintenance requirements. Monitoring activities largely involved remote monitoring

Green Infrastructure Application	Site	Green Infrastructure Project Type	Green Infrastructure Area (ft^2)[1]	Impervious Area Managed (ft^2)[2]
Right-of-way	Autumn Avenue	Enhanced Tree Pit	100	3,950
	Blake Avenue	Enhanced Tree Pit	100	2,180
	Ridgewood Avenue	Enhanced Tree Pit	100	4,420
		Street-Side Infiltration Swale	200	5,510
	Union Street	Enhanced Tree Pit	100	1,680
		Street-Side Infiltration Swale	200	2,230
	Eastern Parkway	Enhanced Tree Pit	100	19,880
	Howard Avenue	Street-Side Infiltration Swale	200	6,630
	99th Avenue	Street-Side Infiltration Swale	200	3,300
	North & South Conduit	Bioretention	7,400	81,870
	Shoelace Park	Bioretention	6,200	81,000
On-site	Bronx River Houses	Bioretention (5 areas)	3,300	18,570
		Blue Roof: Trays	1,100	1,100
		Subsurface Perforated Pipe System	2,700	13,600
		Subsurface Stormwater Chambers	800	3,950
	Canarsie Parking Lot	Bioretention (3 areas)	1,600	35,000
	Far Rockaway Parking Lot	Bioretention	2,300	9,720
		Porous Asphalt	6,400	6,400
		FilterPave	4,250	4,250
	Spring Creek Parking Lot	Wet Meadow	2,600	14,000
	Metropolitan Avenue	Blue Roof: Trays	10,680	10,680
		Blue Roof: Modified Inlet	5,250	5,250
		Blue Roof: Check Dams	5,890	5,890
	P.S. 118	Blue Roof: Check Dams	3,500	3,500
		Green Roof	3,500	3,500
		Total	**68,800**	**348,060**

[1] *Green Infrastructure Area* describes the footprint of the green infrastructure practice itself.
[2] *Impervious Area Managed* describes the amount of impervious area that drains to a green infrastructure practice.

Table 9: Stormwater Pilot projects.

equipment that measured water level or flows at a regular interval, supporting analysis of numerous storms at each site. Monitoring typically lasted a minimum of two years from the completion of construction at each site.

Monitoring analyses through 2013 demonstrated that all pilot green infrastructure types are providing effective stormwater management, particularly for storms with depths of one inch or less. In many cases, their performance between 2011 and 2013 was similar. Monitoring analyses indicate that:

- All green infrastructure practices have provided benefits for storms greater than one inch, with specific impacts varying based upon location and type.
- In many cases, bioretention practices have fully retained the volume of one-inch storms they receive.
- The performance of porous pavement varied depending on the type. Flexipave™, although providing 100 percent retention, has shown degradation in vehicle turning areas. On the other hand, porous asphalt is structurally sound and has retained more than 50 percent of runoff volumes for storms less than one inch.
- Green infrastructure practices designed primarily for detention, such as the subsurface systems and blue roofs, also retain substantial runoff volumes, supporting more effective stormwater control.
- Performance generally improved in vegetated systems (e.g., bioretention facilities and Spring Creek Wet Meadow) between 2011 and 2013, likely due to the growth and establishment of plants, which improve the infiltration and evapotranspiration of stormwater runoff.
- Performance monitoring and hydrant testing at inflow points have shown that simple curb cuts without localized depressions can bypass as much as 30 percent of incoming runoff. Localized depressions reduce bypass, but do not eliminate it entirely.
- Analysis of water quality data from enhanced tree pits and street-side infiltration swales suggests that pollutant concentrations from roadway runoff in New York City are similar to other urban areas.
- Soil analyses have shown that pollutant concentrations at the surface are typically higher than those six inches or one foot below ground surface, providing evidence of pollutant filtering. At times, these differences for pollutants like metals and diesel range organics were substantial.

At right-of-way locations, stormwater volume captured varies considerably with impervious area size and with storm depth. The impervious tributary area size that drains to each right-of-way practice affects the observed efficiency variation in the results for four of these sites over two and a half years. These results are shown in Figure 8.

Monitoring activities will be discontinued at several sites that have multiple years of performance data and have exhibited relatively consistent performance throughout

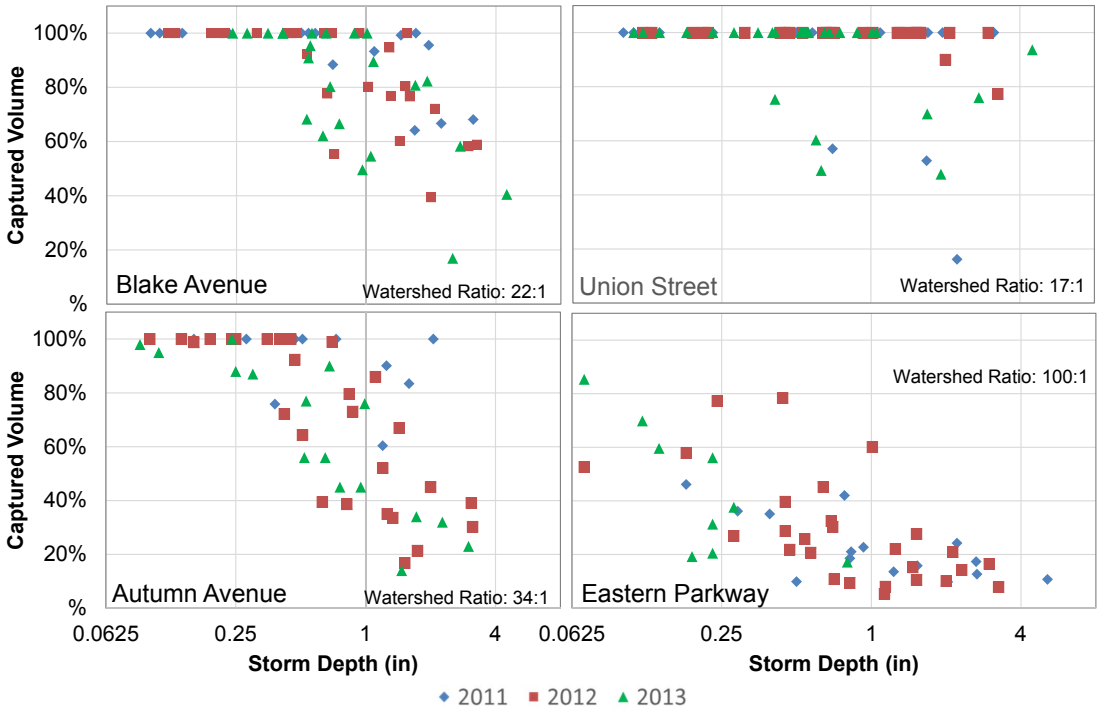


Figure 8: Stormwater volume captured varies with the ratio of drainage area to green infrastructure area ("watershed ratio").

that period. Further monitoring at these locations may be resumed in the future to further examine long-term performance. Monitoring data for these locations is included in the *2012 Pilot Monitoring Report*.

Green Infrastructure Co-Benefits Study

In support of the City's adaptive management approach to green infrastructure implementation, in 2013 DEP launched an effort to identify, characterize, and quantify the co-benefits of green infrastructure. These co-benefits consist of environmental, social, and economic benefits that extend beyond the direct stormwater control that green infrastructure provides. This preliminary co-benefits study examined the co-benefits listed below.

- Carbon sequestration: Carbon dioxide (CO_2) is taken up by woody vegetation and soil, helping the City meet its greenhouse gas reduction goals.
- Urban heat island mitigation: Vegetated areas are cooler than impervious surfaces such as pavement, and alleviate the elevated temperatures found in dense urban areas.
- Reduced energy demand: Through shading and improved insulation, green infrastructure can help reduce energy demands associated with heating and cooling.
- Urban habitat: Green infrastructure offers opportunities for improved soil health and urban habitat that supports pollinators and other beneficial wildlife.
- Improved air quality: Vegetation can help reduce the amount of pollutants in the air, indirectly mitigating impacts to public health.
- Improved quality of life: Green infrastructure beautifies neighborhoods and increases residents' access to green space.
- Reduced stormwater treatment impacts: By reducing the amount of stormwater entering the sewer system, green infrastructure supports energy, chemical, and cost savings at treatment plants.
- Green jobs: Design, construction and maintenance of green infrastructure support local jobs.

Green infrastructure practices examined through this co-benefits study include Right-of-way Bioswales, large bioretention areas, permeable pavement, constructed wetlands, blue roofs, and green roofs. The co-benefits study includes a literature review, field monitoring activities, a life cycle analysis of the environmental and economic costs of construction and maintenance, and the development of a calculation and comparison tool.

Vegetated green infrastructure supports habitat for pollinator species

Literature review

More than 100 references, predominantly peer reviewed journal articles, have been reviewed in support of the co-benefits analysis. This literature review covered studies specifically focused on green infrastructure practices, as well as research into the impacts of urban vegetation and other elements that contribute towards green infrastructure benefits. The available literature covers a combination of monitoring and modeling studies and includes some studies that have been conducted within New York City. A particular focus of the literature review was to support the development of quantifiable co-benefit metrics. For example, investigations into the carbon sequestration rates of vegetation and soil are supporting the calculation of the carbon sequestration benefits provided by a typical Right-of-way Bioswale. The literature review revealed wide variation in results for the co-benefits being studied, and suggests that further study is necessary. In 2014 DEP will begin an advanced analysis and study under the upcoming Research and Development program, discussed below.

Field monitoring study

Throughout 2013, field monitoring activities supplemented literature review findings by examining green infrastructure co-benefits locally within New York City. Preliminary findings suggest that more extensive research and site-specific work is needed in order to quantify these benefits and draw conclusions. DEP's upcoming research and development program will help to address some of these data gaps in monitoring and scientific literature. Monitoring activities included assessments of air and surface temperatures, time-lapse photography, vegetation health

and coverage assessments, observations of pollinator and wildlife, and soil analyses. To date, observations from these monitoring studies include:

- Vegetated green infrastructure surfaces can be substantially cooler than typical urban surfaces, helping to mitigate the urban heat island effect, but a variety of factors impact the realization of cooler air temperatures.
- Pollinators are present at green infrastructure with flowering vegetation, even when isolated in urban environments.
- Vegetation performance is variable and dependent upon several site-specific factors.
- Soil analyses indicate good soil microbial community health at green infrastructure practice locations.

Life Cycle Analysis

Construction documents and other records were examined for representative New York City green infrastructure installations in order to quantify the economic costs and environmental impacts associated with the manufacturing, transportation, construction, maintenance, and disposal of green infrastructure practices. Although a variety of environmental impacts are reported, the primary focus of this analysis was on CO_2 emissions due to green infrastructure implementation. For instance, a green roof utilizing a system of aluminum trays could have higher environmental costs than an extensive green roof, due to the higher CO_2 emissions typically associated with aluminum production.

Co-Benefit Calculator

DEP combined elements of the literature review, monitoring efforts and life cycle analyses into a single comparative tool for evaluation and planning purposes. This calculator tool identifies co-benefits associated with each type of green infrastructure and calculates environmental, social, and economic costs and benefits, allowing the user to compare the benefits and costs of different green infrastructure practices. The calculator's online interface is shown in Figure 9.

Some of the metrics used to compare these green infrastructure practices include removal of environmental pollutants such as CO_2, nitrogen, sulfur, particulate matter and ozone; and costs of construction and maintenance. For example, the calculator will enable DEP to compare the net CO_2 removed by a bioinfiltration practice against a green roof across the projects' entire life cycle, with the option to

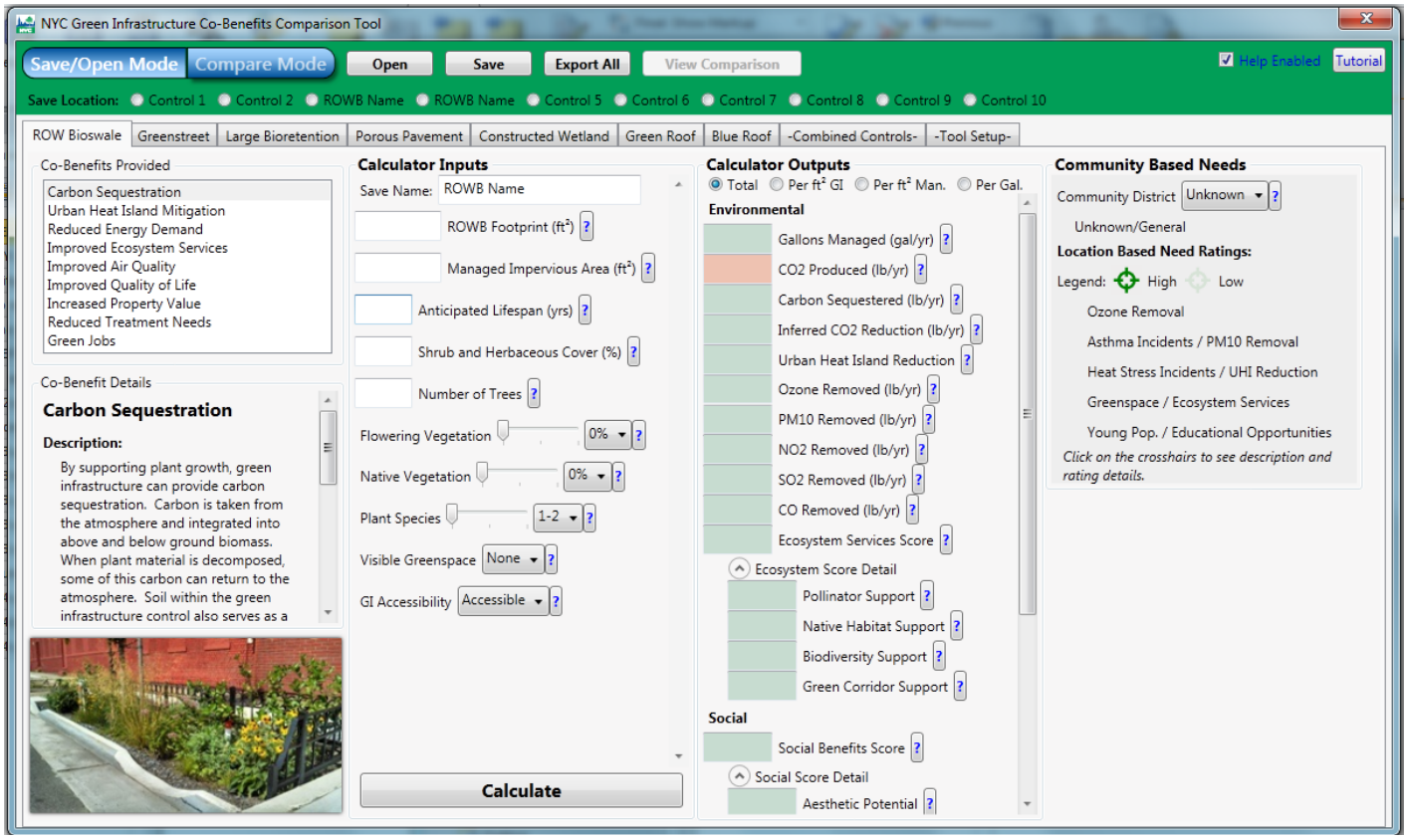


Figure 9: Co-benefit calculator interface.

normalize by square footage, impervious area managed or stormwater volume managed. DEP expects to make this tool publicly accessible on its website in 2014.

In total, this co-benefits analysis has provided DEP with valuable information and perspective on the comprehensive costs and benefits of green infrastructure implementation. Through examination of prior studies and conducting new analyses and field research, the full impact of green infrastructure within New York City can be better realized and understood by DEP, its partner agencies, and the public.

Green Infrastructure Research and Development Program

In addition to the monitoring initiatives discussed in the previous section, in 2013 DEP initiated a more comprehensive research and development program. DEP has dedicated $8 million over five years towards this effort.

This new research and development effort will evaluate DEP's Green Infrastructure Program to support long-term performance success, ensure cost-effectiveness of maintenance programs, and conduct cost-benefit analyses of various green infrastructure designs. In addition, the research and development program will support DEP's development of LTCPs and other water quality related compliance documents, fill data gaps DEP has identified through previous green infrastructure monitoring activities, and review DEP's current modeling framework for calculating co-benefits. DEP will then be able to incorporate these results into the overall green infrastructure implementation process.

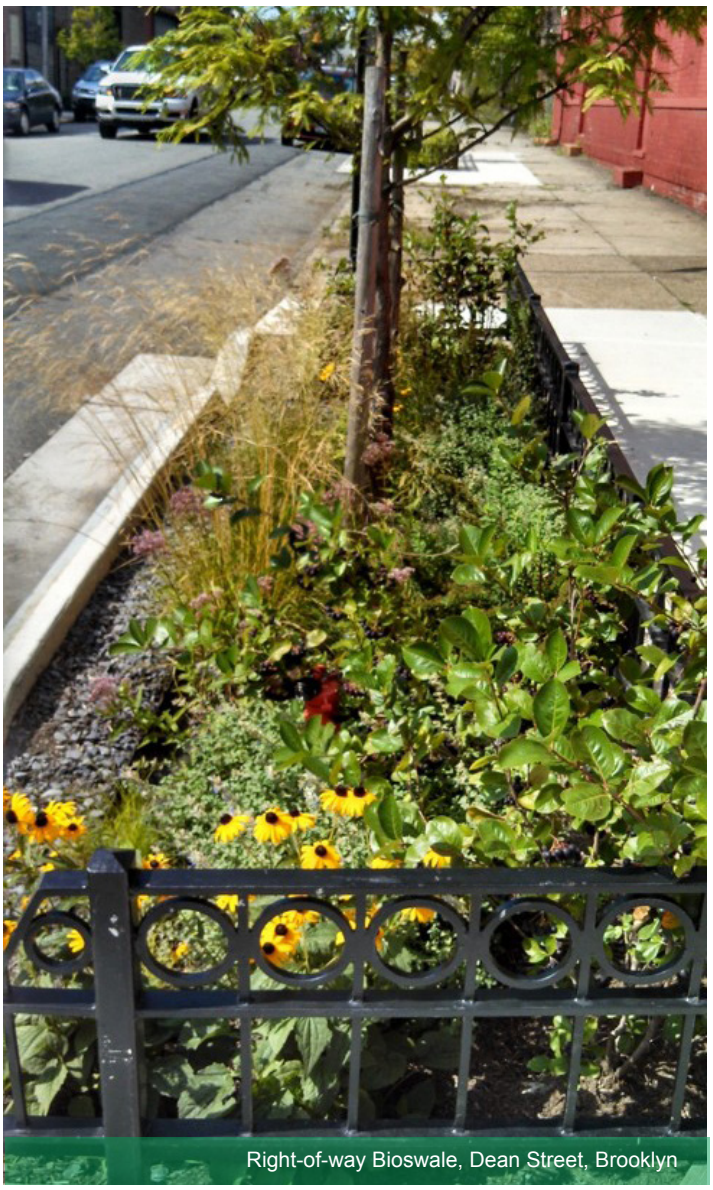
DEP's objectives for this research and development program are to evaluate and continue to expand DEP's monitoring program; develop and implement a Green Infrastructure Monitoring Protocol; evaluate the data collected and make recommendations for DEP's Green Infrastructure Program at multiple scales and in various conditions (e.g., land use, topography, etc.); analyze the costs of current and proposed green infrastructure designs; evaluate and advise on appropriate maintenance practices and protocols; and recommend additional tools or materials that can advance the performance of green infrastructure.

Right-of-way Bioswale, Junius Street, Brooklyn

Stormwater Greenstreet, Grove Street, Brooklyn

Examples of scientific data collection, analyses, and/or technical research that the research and development program may include but are not limited to:

- Quantify stormwater inflow, outflow, infiltration, and evapotranspiration
- Monitor engineered soil mixes for optimal infiltration rates, stormwater capacity, and plant growth
- Study stormwater lateral infiltration
- Monitor green roof and growing media types
- Assess performance and sediment removal
- Recommend optimal vegetation selection based on stormwater management and ecological goals
- Monitor multiple tree species' uptake/evapotranspiration
- Review and advise on maintenance practices, levels of effort, and thresholds for performance
- Evaluate design and construction costs for built green infrastructure practices
- Quantify potential green infrastructure co-benefits or sustainability metrics
- Review existing and new technologies that can maximize stormwater detention
- Review existing and develop new innovative modeling algorithms to capture the performance of green infrastructure elements at various spatial scales



Right-of-way Bioswale, Dean Street, Brooklyn

Case Study: Flushing Bay Area-wide Contract BB-008

Project Owner: NYC Department of Environmental Protection

Project Location: Queens

CSO Tributary Area: Flushing Bay, BB-008

Technologies: Right-of-way Bioswales, Stormwater Greenstreets

Gross Area: 1,190 acres

Right-of-way Impervious Area: 54.8 acres

Annual Storage Volume: Estimated 17,500,000 gallons managed

Status: In construction 2014-2016

Estimated Project Costs: $2.65 million (Site Selection and Design); $15 million (Construction Estimate)

BB-008 Priority CSO Tributary Area Location Map.

This area of northern Queens, including East Elmhurst, Corona and North Corona, is served by combined sewers, which are tributary to the combined sewer outfall BB-008. During some rainstorms, this outfall can discharge combined sewer overflow to Flushing Bay. DEP identified BB-008 as a Priority Area in 2011 and in 2012 initiated an Area-wide contract to design and construct green infrastructure in the public right-of-way and on other City-owned properties within the area. The BB-008 Priority Area is shown in Figure 10.

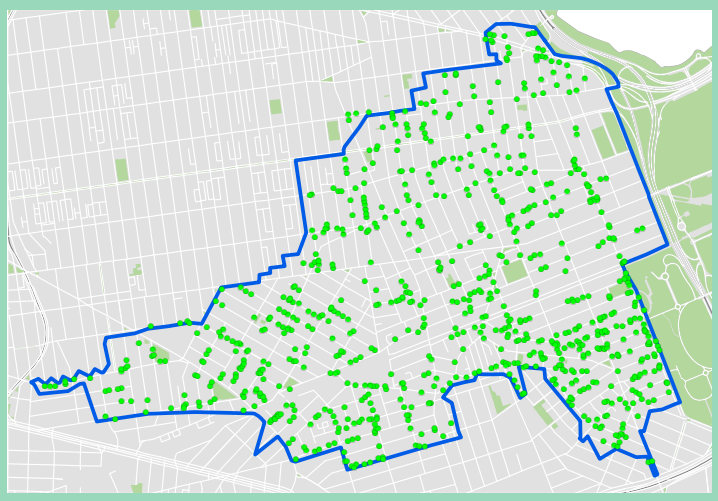


Figure 10: BB-008 contract area with Preliminary Right-of-way Bioswale locations.

Typically, DEP's standardized right-of-way green infrastructure design process evaluates a large number of Potential locations, then selects and finalizes a smaller number of feasible locations that meet all requirements. During spring and summer 2013, representatives from DEP, DPR and DOT visited each Potential green infrastructure location and rejected any sites conflicting with driveways, mature trees, and other clearance requirements. The remaining locations proceeded to geotechnical investigation as Preliminary sites.

From summer through winter 2013, DEP performed soil borings and permeability tests at Preliminary locations to determine the suitability of underlying soils. Based on these investigations, many of the sites will be reclassified as Final Right-of-way Bioswale or Stormwater Greenstreet locations. Figure 11 shows the approximate density and location of Preliminary sites in a representative portion of the BB-008 contract area. However, not all Preliminary sites will be constructed. After final design work and coordination with utility companies is complete, DEP will construct approximately 200-300 Right-of-way Bioswales and Stormwater Greenstreets at a time, to begin in summer 2014.

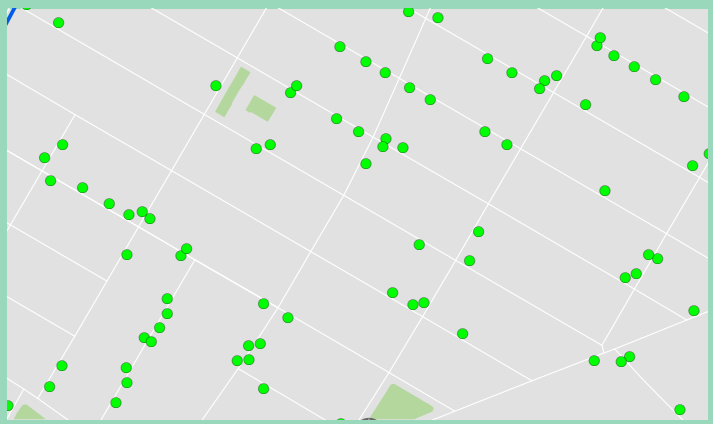


Figure 11: Representative section of BB-008 contract area. Not all sites shown will be constructed.

Case Study: New York Restoration Project's Gil Hodges Community Garden

Project Owner: New York Restoration Project, Inc.

Project Location: 534 Carroll Street, Brooklyn

CSO Tributary Area: Gowanus Canal, OH-007

Technologies: Rain Garden, Permeable Pavers, Right-of-Way Bioswale

Impervious Area: 6,333 square feet

Annual Storage Volume: 150,000 gallons managed

Status: Construction complete summer 2013

Grant Award: $328,871

Gil Hodges Community Garden location map.

New York Restoration Project's (NYRP) Gil Hodges Community Garden is located at a flood-prone intersection just a few blocks from the Gowanus Canal. It was designed by Yvi McEvilly, NYRP's Director of Design, and Stantec Consulting Inc., with help from EDesign Dynamics and Patrick Cullina, former High Line Vice President of Horticulture and Park Operations, and consulting from George Smith of The City College of New York.

Community members will be able to enjoy the garden's new fragrance walk, inspired by Jo Malone London, and a birch reading grove and patio that provide quiet getaways for passive recreation. The garden also has an outdoor classroom area complete with a blackboard, and a composting station and raised vegetable beds.

In addition, monitoring equipment has been installed in the Right-of-way Bioswale along Denton Place that will record data for three years and be analyzed by the City College of New York. This data will supply helpful information about how the Right-of-way Bioswale performs over time.

Founded by Bette Midler in 1995, New York Restoration Project is a not-for-profit organization dedicated to transforming open space in under-resourced communities to create a greener, more sustainable New York City. NYRP is the only New York City conservancy that works citywide, bringing private resources to spaces that lack adequate municipal support. DEP joined NYRP and Jo Malone London in September 2013 to cut the ribbon on the newly renovated community garden.

Before: Gil Hodges Community Garden, Brooklyn

After: Gil Hodges Community Garden, Brooklyn

Case Study: Green Infrastructure Playground at P.S. 261

Project Owner: NYC Department of Education

Project Location: 314 Pacific Street, Brooklyn

CSO Tributary Area: Gowanus Canal, RH-034

Technologies: Rain Garden, Permeable Pavers, Shade Trees, Synthetic Turf Field

Impervious Area: 23,000 square feet

Annual Storage Volume: 500,000 gallons managed

Status: Construction complete September 2013

Construction Costs: $604,000 (total project); $263,000 (green infrastructure)

P.S. 261 Playground location map.

As described in the "Public-Private Partnerships" section, DEP, TPL, SCA and DOE completed the first three green infrastructure playground retrofit projects in fall 2013. P.S. 261 in Cobble Hill, Brooklyn was the first playground to be completed. Located in the Gowanus Canal CSO Tributary Area, the project features a rain garden, a synthetic turf field, and permeable pavers and trees. Together, these green infrastructure practices capture the first inch of rainfall from more than 23,000 square feet of impervious area, managing more than 500,000 gallons of stormwater annually.

Early in the design process, geotechnical investigations were conducted to ensure that stormwater could infiltrate into the existing subsoil beneath the playground. In addition, TPL worked with a group of fourth grade P.S. 261 students in the 2011 school year to explore conceptual designs for the playground. The final location and size of each green infrastructure playground element is based on the needs of the school, the soil conditions, and the size of the impervious asphalt area to be managed. Throughout the design process, the hydraulic calculations and green infrastructure engineering were reviewed by engineers at DEP.

Designers divided the site into two smaller catchment areas, based on the existing grade of the site. The rain garden features a 12-inch soil layer designed to maximize

Before: P.S. 261 Playground. Photo by TPL.

After: P.S. 261 Playground. Photo by TPL.

Rain garden, P.S. 261

New paved ball field directs runoff to green infrastructure at P.S. 261

infiltration of stormwater into the soil beneath. The designers selected the rain garden plants for their water tolerance. The synthetic turf field features a pervious playing surface on top of 12 inches of gravel, which holds stormwater until it can infiltrate into the soils beneath. The permeable pavers are also installed over a gravel storage layer.

Playground construction at P.S. 261 began in spring 2013, and lasted approximately six months. When construction commenced, existing asphalt and play equipment were removed, and existing internal drains were capped. Next, excavation and placement of clean fill across the site ensured that stormwater will drain toward the new green infrastructure installations. New green infrastructure drainage components were then installed to carefully set grades. Next, new asphalt and permeable pavers were installed, followed by synthetic turf field layers, play equipment, and asphalt color seal designs; finally, soil, trees and plants were placed.

DEP's green infrastructure construction costs at P.S. 261 were approximately $263,000 out of a total construction budget of approximately $604,000. TPL raised a portion of this amount from private donors. New York City Councilmember Stephen Levin and SCA contributed funding as well. This mix of funding sources represents a successful public-private partnership, meeting the goals of all parties: educational opportunities, upgraded facilities, water quality improvement and other co-benefits, and increased access to public open space. The playground was officially opened with a ribbon-cutting ceremony held on September 13, 2013. Leadership from each partner agency, private donors, and the school attended, including P.S. 261 Principal Zipporiah Mills, students from P.S. 261, former DEP Commissioner Carter Strickland, New York City Schools Chancellor Dennis Walcott, Councilmember Stephen Levin, TPL New York State Director Marc Matsil, and Hideki Shirato, President and CEO of Mizuho Bank USA.

Ribbon cutting event, P.S. 261, Brooklyn

Ribbon cutting event, P.S. 261, Brooklyn

2014 Action Plan

1. DEP and partner agencies will begin construction in 10 Priority CSO Tributary Areas in the Bronx, Brooklyn and Queens, which will result in thousands of green infrastructure installations in the public right-of-way in 2014.

2. DEP will begin construction on green infrastructure practices at the Edenwald Houses, the largest New York City Housing Authority development in the Bronx. The project will manage 10.36 acres of impervious area and will be DEP's largest public property retrofit to date.

3. DEP will initiate up to 10 new green infrastructure playground projects in partnership with the Trust for Public Land (TPL), the New York City School Construction Authority (SCA), and New York City Department of Education (DOE).

4. DEP anticipates that up to 12 Green Infrastructure Grant Program projects will be completed this year. Also in 2014, DEP will expand the Grant Program by accepting application submissions multiple times throughout the year and developing a new "mini" grant program to incentivize smaller green infrastructure improvements.

5. DEP will continue to develop and expand its Green Infrastructure Maintenance Program. As the quantity of built green infrastructure practices grows, additional staff will be hired to support existing maintenance crews caring for green infrastructure in the right-of-way. The program will also develop maintenance protocols for green infrastructure constructed on City-owned property.

6. DEP will continue development of the Project Tracking and Asset Management System. This system will be used to track thousands of green infrastructure assets, and serve as the backbone for DEP's Green Infrastructure Maintenance Program.

2014 Action Plan

7 DEP will release the *Post-Construction Monitoring Report* on the three Neighborhood Demonstration Areas in August 2014. The results of this report will enhance DEP's understanding of the benefits of green infrastructure relative to runoff control and CSO reduction.

8 DEP will complete a report on green infrastructure co-benefits in 2014. DEP has used literature and monitoring data from different types of green infrastructure practices to identify and quantify the co-benefits of green infrastructure, including carbon sequestration, improved air quality, community benefits such as education and workforce development, as well as economic and lifecycle costs.

9 DEP will implement a five-year research and development program. A multi-disciplinary team will perform research and development services to assist the City in continuing to efficiently implement the Green Infrastructure Program.

10 DEP will build upon the success of the first year of the BioswaleCare program and offer more workshops to enhance community stewardship of green infrastructure.

11 In 2014, DEP will conduct an analysis of jobs supported by the Green Infrastructure Program in various labor sectors.

List of Acronyms

CSO	Combined Sewer Overflow
DCA	New York City Department of Cultural Affairs
DDC	New York City Department of Design and Construction
DEC	New York State Department of Environmental Conservation
DEP	New York City Department of Environmental Protection
DOB	New York City Department of Buildings
DOE	New York City Department of Education
DOITT	New York City Department of Technology and Telecommunications
DOT	New York City Department of Transportation
DPR	New York City Department of Parks and Recreation
EBP	Environmental Benefits Program
EDC	New York City Economic Development Corporation
GIS	Geographic Information System
HCP	House Connection Proposal
HHC	New York City Health and Hospital Corporation
LID	Low Impact Development
LTCP	Long-Term Control Plan
MTA	Metropolitan Transit Authority
MTNYC	MillionTreesNYC
NYCHA	New York City Housing Authority
NYRP	New York Restoration Project
OGI	Department of Environmental Protection's Office of Green Infrastructure
Order	2012 Amended Consent Order
PDC	New York City Public Design Commission
SCA	New York City School Construction Authority
SCP	Site Connection Proposal
TPL	Trust for Public Land
WWFP	Waterbody/Watershed Facility Plan

Environmental
Protection