

# New York City

## Resilience in Brownfield Reclamation

Final Report

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**NYC** Mayor's Office of  
Environmental  
Remediation

**NYC**<sup>TM</sup>

**BILL de BLASIO**  
**MAYOR**

**Daniel C. Walsh, Ph.D.**  
**Director**  
*Mayor's Office of Environmental Remediation*

Mayor's Office of Environmental Remediation, with support from TetraTech

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# Chapter 1: Program Introduction and Overview

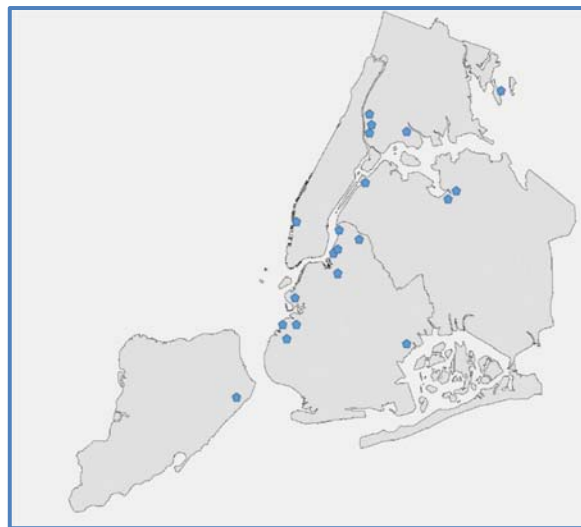
Rising sea levels and coastal storm surges associated with climate change pose a growing threat to coastal cities such as New York City. In the wake of Superstorm Sandy in 2012, the risks from climate change hazards becomes increasingly apparent. Likewise, the importance of efforts to reduce environmental and climate impacts grows more evident. In order to facilitate the development of measures to address these challenges during contaminated site (brownfield) remediation and new building construction, the NYC Mayor's Office of Environmental Remediation (OER) has developed the Climate Change Resilience Survey program to assess current practices through the lens of resilience, sustainability, and risk mitigation.

In the four years following Superstorm Sandy, OER surveyed flood resilience and sustainability practices on 20 development projects (Figure 1). The surveys evaluated what measures were being implemented, as well as identifying measures that could benefit similar projects. The 20 projects each enrolled in the NYC Voluntary Cleanup Program (NYC VCP), administered by OER, in order to perform site cleanup prior to commencing new building construction.

New building construction on brownfield properties, while challenging in unique ways, also present many opportunities. In the areas of resilience and sustainability, it is significantly more efficient and less

technically challenging to integrate resiliency and sustainability measures during the design and development stages of new building construction, rather than to retrofit a building after construction is complete.

Project-specific analyses were performed under contract to OER by TetraTech, and survey reports were developed and shared with project teams with the intent of promoting best practices for resilience and sustainability throughout the remediation and redevelopment process. The surveys covered a variety of new development end uses and building types across all five boroughs of New York City. All projects are located in current or projected future flood zones.



**Figure 1:** Survey site locations

Map credit: Kate Glass

This report is a compilation of the best practices identified while conducting these surveys. The report will serve as a tool to inform the remediation and development industries of ways to improve flood resilience and optimize implementation of sustainability measures.

## Intent and Evolution of the Resilience Surveys

As New York City continues to rebuild its formerly industrial neighborhoods, it is essential that resilience and sustainability concepts are integrated into new building design to reduce flooding vulnerability and carbon footprint. Since buildings tend to have long lifespans, current building practices, and the resulting newly constructed buildings, will have ramifications far into the future.

The Climate Change Resilience Surveys were developed to provide suggestions for improving resilience to developers of a subset of properties that had been enrolled in the NYC VCP that are especially vulnerable due to locations in flood-prone areas. Information regarding flooding, climate change and emergency response was incorporated into each survey for a final format that included suggestions, resources, and guidance on the following resiliency and sustainability topics:

- Building Resiliency
- Green Building
- Green Infrastructure
- Alternative Energy & Efficiency
- Green Remediation
- Culture of Sustainability
- Emergency Management

The surveys were conducted between March 2013 and March 2016. Figure 1 shows the location of the 20 sites that were assessed across the City's five boroughs.

The survey process was designed to adapt and to evolve as more specific information regarding climate change, resiliency, and sustainability became available. For example, the New York City Panel on Climate Change (NPCC) 2015 Report was released during the course of the project, and new data regarding future sea level rise and corresponding flooding projections were incorporated into the surveys. Likewise, deadlines regarding building energy efficiency incentives were updated as they changed and were incorporated into the surveys provided to the site developers.

The language and presentation of the surveys were designed to provide clear and concise explanations in accessible language over a broad array of topics to ensure usefulness to a broad audience that likely has varying levels of familiarity with resiliency and sustainability concepts. In many cases, the project-specific surveys were produced late in the building design phase. As such, the early undertaking of these evaluations, were intended to build long-term influence on developers' design practices and to identify best practices for presentation in this report.

## Overview of the NYC Voluntary Cleanup Program

OER established the NYC VCP in 2011 to ensure that vacant land with light to moderate levels of contamination—known as brownfields—can be cleaned up and redeveloped in a manner that protects public health and the environment. This landmark program—the first municipal program of its kind in the nation—has now engaged over 500 projects and is making land safer in New York communities,

bringing new businesses and jobs, and new affordable housing and open space on land that has been vacant for an average of over ten years. Most importantly, about 50% of these projects are located in historically disadvantaged neighborhoods, where this revitalization is needed most.

The NYC VCP is one of over 30 programs that OER has established to address issues around brownfields and their redevelopment, and to deliver the solutions envisioned in OneNYC. These include the most progressive programs in the country for community brownfield planning and engagement, transparency, and brownfield job training for disadvantaged citizens, and an innovative series of incentives including

soil recycling, city certification of clean land that symbolizes the city's confidence that the property is among the safest places to live and work, liability protection to lower development risk, and community directed grants to encourage developers to work with community based organizations.

The process that OER applies in the NYC VCP is swift and rigorous, with all projects resulting in high quality cleanups that meet State standards. Project are expedited by consolidating government and public review of cleanup plans into one parallel process that facilitates cleanup and development.

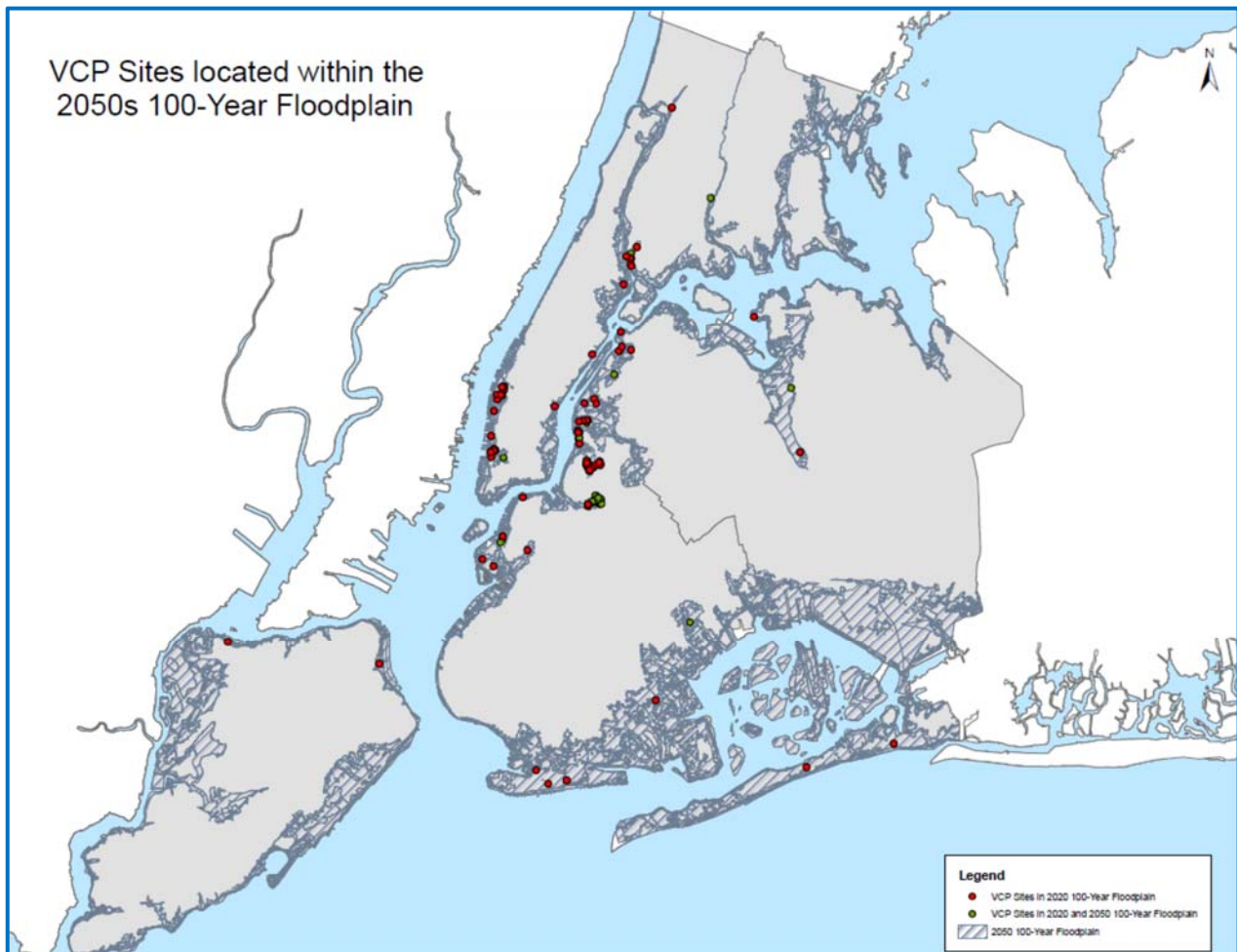


## Chapter 2: Building Resilience

Rising sea levels and increased storm frequency and intensity that are caused by climate change result in an increased risk and frequency of storm surges and potential for related flooding. Hurricanes, storm surges, flooding and other hazards related to climate change can be addressed in new

building construction with targeted resilience strategies. This chapter describes the most common techniques for proactively addressing flood risk.

Understanding flood risk factors is the first step in protecting a development from potential future damage from climate



**Figure 2:** Many projects enrolled in OER’s Voluntary Cleanup Program are located in the FEMA 100-year floodplain, and would benefit from proactive flood protection measures.

Map credit: Alysha Alfieri, OER



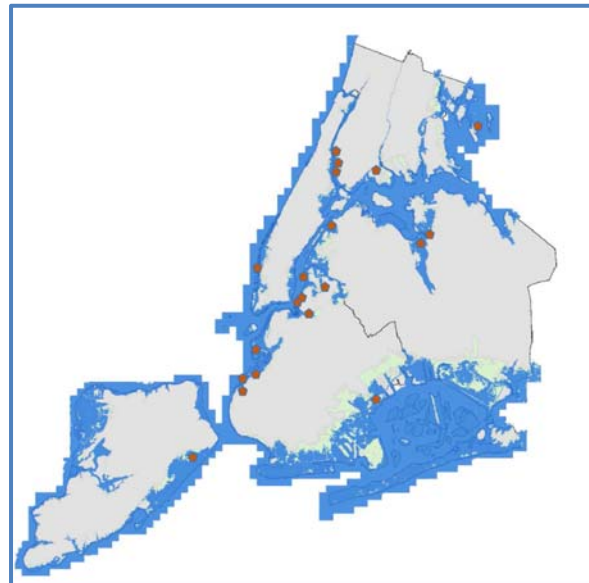
change. Once the types and magnitudes of risk are recognized, there are mitigation measures that may be implemented to reduce damage caused by climate change-related hazards. Each Climate Change Resilience Survey assessed a planned development for flood-related climate change risk factors. Additional information on select factors and example recommendations are provided in the following sections.

### Current Flood Risk

Federal Emergency Management Agency (FEMA) flood zone designations on Flood Insurance Rate Maps (FIRMs) can be used by property owners when making decisions regarding property protection and risk mitigation measure implementation. Figure 3 shows the locations of the development sites assessed in the surveys with respect to the flood zone as defined by FEMA.

FIRMs define the flood zone with respect to a base flood event and a base flood elevation. The base flood event is a flooding event that has a 1% chance annually of occurring, also known as the 100-year storm. The base flood elevation (BFE) is the elevation of land calculated to be flooded during a base flood event. The BFE is the calculated elevation of surface water resulting from a flood that has a 1.0-percent chance of occurring in any given year.

Areas at elevations equal to or lower than the BFE lie within the FIRM flood zone. During flood events in BFEs within New York City, there is the compounding hazard of coastal wave action and storm surge. Sites at or below the BFE are defined as being in flood zone A. Sites within zone A that are



**Figure 3:** The location of the survey sites in the 100 year (blue) and 500 year (green) flood zones.

Map Credit: Kate Glass

additionally vulnerable to wave action and storm surge are defined as being in flood zone V. Sites outside of zone A, but within areas that have a 0.2% chance annually of flooding (also known as a 500-year flooding event) are defined as being in flood zone X.

If a development site is located in a mapped flood zone, then knowledge of the Base Flood Elevation (BFE) is essential in designing resilient building features to address future flood hazard. A non-regulatory, interactive tool called the BFE Address Lookup Tool was used in the survey process to determine the BFE at survey site locations.

### Building to the BFE

Integrating site-specific knowledge of the BFE into a brownfield redevelopment project, property owners can reduce costs related to flood damage over the long term



by reducing the vulnerability of a building. Referencing a construction project to the site-specific BFE can be implemented in the following ways:

- Elevate the first finished floor of the building above the BFE.
- Elevate critical mechanical equipment, above the BFE. If hazardous materials or chemicals will be stored on-site, for example fuel oil for an emergency generator, these materials should also be stored above the BFE.
- Implement dry-flood proofing techniques below the BFE such as sealants, flood shields, or aquarium glass to resist water pressure and to keep floodwaters from entering the lower level of the building. Dry-flood proofing effectively waterproofs above-grade areas of the building that with the exception of a flooding event are dry and only in contact with the atmosphere.
- Implementing wet-flood proofing techniques below the BFE include installing openings or vents to allow floodwaters to flow between building walls to eliminate unequal pressure and prevent any structural damage. Wet-flood proofing effectively designs for partial inundation of lower levels.
- Install deployable flood gates and flood panels, especially for buildings that have garage entrances that may be flooded.

### **Elevation of Critical Equipment**

The survey of a Brooklyn development found that some flood resiliency techniques had been integrated into the development including the elevation of critical mechanical rooms and equipment; the cogeneration room, cooling towers, boiler room, emergency generator, and gas fired rooftop unit. However, the survey provided additional flood resiliency recommendations regarding the elevation of other critical equipment such as the electrical room, telecom room, plumbing room, gas meter room, and water and sewer room.

### **Future Flood Risk**

As climate change continues unabated and sea levels rise and storms grow in intensity, over time the areas vulnerable to flood risk will continue to grow and the BFE will increase. In short, this means that current zone X areas may become zone A areas. New York City has developed projections of future 100-year and 500-year flooding resulting from sea level rise and potential storm surge for the years 2020 and 2050. The New York City 2020 and 2050 maps are based on FEMA's Preliminary FIRM data and the New York Panel on Climate Change (NPCC)'s high estimate, or 90<sup>th</sup> percentile projections for sea level rise (11 inches and 31 inches, respectively).

As part of the survey process, development site locations were evaluated against the 2020 and 2050 projections to determine potential future flood risk. Recommendations for mitigation measures were provided in survey reports to help reduce risks from future flood events. These measures largely reflect the

recommendations in “Building to BFE”, but reference a higher reference elevation utilizing the concept of freeboard. According to FEMA, “freeboard is a term used by FEMA’s National Flood Insurance Program (NFIP) to describe a factor of safety usually expressed in feet above the 1-percent-annual chance flood level” (BFE). FEMA notes that integration of freeboard into a building will also potentially reduce flood insurance premiums. The Design Flood Elevation (DFE) is defined as the BFE plus the designated amount of freeboard. Examples of measures that address estimated flood risk, beyond current FEMA Flood Projections include:

- Building to the DFE includes incremental space above the BFE, freeboard, to compensate for uncertainty related to flooding. Generally, New York City has adopted the New York State standard: add two feet of freeboard to base flood elevation for 1- and 2-family homes; add one foot to base flood elevation for most non-residential buildings. However, the freeboard used to reach the DFE varies depending on the zone (A or V) where a building will be built.
- Incorporate flood resistant building materials below the DFE (see Appendix G of the New York City Building Code).
- Elevate electrical system components such as fuses, circuit breakers, meters, switches, and outlets above the DFE.

### **Increasing Freeboard**

The survey of a development site located adjacent to the East River waterfront in Brooklyn indicated that currently the site is not located in a special flood hazard area and, thus, is not subject to flood related building code or insurance requirements. However, the survey noted that the subject property was in proximity of a special flood hazard area, approximately 115 feet away. It was recommended that the development consider building to the nearby BFEs plus freeboard as a precautionary measure, i.e. utilizing a DFE approach to reduce the risk of the lower level of the building flooding or being damaged by a flooding event that may be more likely under future, climate change induced conditions.

### **Unexpected Flood Risk**

Reviewing current and projected flood information is an important step before planning for any development site. This evaluation may identify unexpected flood risk, for example in low-lying areas that are not immediately evident as flood prone and which may under current conditions not be identified as lying below the BFE.

Though approximately one-and-a-half miles inland from the East River coast line, one of the Brooklyn development sites surveyed was identified to lie within an area currently susceptible to a 0.2 percent annual flood hazard (500-year flood risk). Due to climate change impacts that flood risk is projected to increase over time. By 2050, development in the area of Brooklyn where the site is located is projected to be below the 2050 BFE, or susceptible to a 1 percent annual flood hazard (100-year flood risk). Recognizing

these risks, current and future, and incorporating the flood resiliency recommendations provided in the survey into site and building design would reduce the vulnerability of the development to future flood hazard.

### **Local Clean Soil for Flood Resiliency Measures**

In addition to the building design choices discussed above, for larger projects and assemblages of projects, site topography can be used to increase resilience to flood hazards by raising grades in planned open areas or constructing flood mitigation berms.

Clean material (soil and sand) from local excavations can be obtained through the New York City Clean Soil Bank (CSB) (see Sustainable Materials Management, below). This City run Program provides an ideal option for raising grade and landscaping, lowering the cost of elevating the property or constructing flood mitigation structures.

The quality of CSB material is also vetted by the New York City Office of Environmental Remediation (OER). Use of CSB material also presents a much lower risk of introducing invasive species or their seeds to the landscape, as the material comes from deep native layers of excavations from within the City.

### **Salt Water Tolerant Landscaping**

Landscaped coastal areas can be planted with salt tolerant species to increase site resiliency to coastal flooding. Through the survey process, it was determined that a portion of a Brooklyn development was located within a coastal flood hazard area subject to salt water flooding and wave action. The audit recommended that landscaped areas be planted with salt tolerant trees, shrubs, grasses, and sedges to increase the overall resiliency of the site to the coastal flood hazard. Salt tolerant plants will not be permanently damaged by the salt water and will recover from the exposure.



## Chapter 3: Sustainable Materials Management

While administering the NYC VCP, OER has identified opportunities to use materials more sustainably, increasing efficiency and reducing environmental impact.

Novel materials exchanges have been established to promote local reuse of surplus material generated during a variety of construction activities, for example including excavation, roadway resurfacing, and building demolition. Local reuse drives down

material transportation distances and correspondingly, greenhouse gas (GHG) emissions. Also, as noted in Building Resilience (see above) the exchanges provide materials to construct flood-control structures. If structured properly, a material exchange may also reduce disposal and acquisition costs for both the generator of the unneeded material and the receiver of the repurposed waste material.

### NYC Clean Soil Bank

Site remediation often generates solid and hazardous waste that needs to be disposed



**Figure 4:** Material made available for reuse through the Clean Soil Bank such as this sandy excavation in Queens has been reviewed by OER and meets the highest remediation standards.

Photo credit: Horace Zhang, OER

of and/or treated at appropriately permitted facilities. However, projects with plans for deeper excavation also frequently generate clean native soil that must be excavated for subgrade structures, including basements or underground parking. Although this clean native material typically has very low contaminant levels well below applicable guidelines, it is currently largely underutilized as a resource.

In order to maximize the utilization of this clean native soil resource, both in terms of the end use and sheer volume, OER has established the NYC Clean Soil Bank (CSB). The CSB facilitates the transfer of clean soil from the generating site to sites that require clean material for backfilling or raising grade. The program operates without associated charges or fees for tipping, with the generator paying only for soil transport to receiving sites. Recycling of this valuable material through the CSB reduces long-haul transport of soil out of the city or into the city, reducing truck miles and associated energy use and air emissions.

The CSB also plays an important role in green remediation. Often, remediation requires removal of contaminated media greater than that which would be necessary for a specific building plan, i.e. hotspot removal. Conversely, this means that clean backfill material is needed to replace the contaminated material that was removed before construction of the building foundation can commence. Use of the clean native soil as a backfill for remedial excavation is an important way to green a remediation project (see also Green Remediation, below). Rather than import native materials from outside of the city

generated far from the building site, obtaining soil from a CSB generating site within the city, reduces truck miles and associated energy use and air emissions. Available clean soil can be used to backfill excavated hotspots on remediation sites, and as structural backfill or for clean capping, supporting green remediation under a variety of site conditions.

To date, 400,000 tons of soil have been reused via the Clean Soil Bank. The average Clean Soil Bank transfer has reduced trucking distance for soil disposal by about 40 miles per truckload. For a project that would otherwise need to dispose of 5,000 tons of clean native soil, this would be a savings of 10,000 miles. The total carbon emissions reduction for the Clean Soil Bank so far is 2,500 metric tons. The total cost savings is over \$30,000,000, including savings for both generating and receiving sites.

### **Asphalt Millings Bank**

The OER asphalt millings bank provides the opportunity to use recycled asphalt as



**Figure 5:** An asphalt millings stockpile in Queens.

Photo credit: Horace Zhang, OER



backfill or to raise grade on site. The asphalt millings are locally generated and can reduce construction costs and greenhouse gas emissions stemming from transport.

Asphalt millings should be considered when grading a site for a parking lot, or as non-structural backfill of an excavation that is well above the water table. The material is available at no cost to the recipient.

### **Salvage of Recyclable Materials**

Reusing existing structures or building materials takes advantage of embedded energy in existing structures, and can reduce the use of new virgin materials and the disposal of old materials. Some materials from on-site might be appropriate for reuse on-site or off-site, such as using reclaimed wood as part of a building's interior or recycled concrete crushed into an aggregate for fill. Other on-site materials, such as structural steel, might be appropriate for recycling.





## Chapter 4: Green Remediation

Development sites in urban areas, especially where former concentrations of industrial and commercial uses may have resulted in environmental impacts, often require some form of remediation to ensure that a property is cleaned up and redeveloped in a manner that protects human health and the environment. Green remediation is a holistic approach to remediation that considers the environmental impacts of construction activities and contamination management related to remedying a site and incorporates strategies that minimize those impacts.

Remedial action at a site can range from complete removal of contaminated soil with disposal and long-term treatment and management at an appropriate off-site facility to identification of levels of soil contamination that may be managed in place onsite, without removal and/or treatment implementing engineered barriers to prevent exposure to residual contaminants. Depending on the remedial strategy, the input of energy for excavation and transport will vary. Additionally, more excavation would also potentially result in a greater amount of contaminated dust released to the air. Onsite treatment may reduce contaminants, however some strategies are also highly energy intensive and would result in significant emissions.

These simplified hypothetical scenarios will inevitably be complicated by heterogeneous contamination, varying regulatory cleanup requirements, site-specific uses and development, variability in costs and

feasibility, etc. However, in general, each remedial action and construction alternative may be viewed from the lens of the environmental burden of energy and material inputs and related outputs. Green remediation concepts can be used to optimize the environmental column of a project's balance sheet, while continuing to protect human health and the environment, in the context of the other multiple considerations that a project requires.

The surveys evaluated Remedial Action Work Plans (RAWP) to identify opportunities to incorporate green remediation techniques. An overview of findings from the surveys are described in this chapter.

### Sustainability Statements

To encourage green remediation and sustainability in the cleanup process, OER has developed and integrated sustainability statements into the RAWP for each site. These Sustainability Statements allow developers to consider options for green and sustainable remediation measures before remediation activities begin. Sustainability Statements are designed to encourage many of the measures outlined in this chapter.

### In situ Remedial Action

Much of the cost and environmental footprint associated with remediation comes from moving contaminated material or water, such as sending contaminated soil to a landfill or pumping and treating groundwater. Several in situ remedial approaches have been developed that eliminate the need to move large volumes of material. Soil stabilization, in situ soil mixing of treatment reagents, soil vapor extraction,

and in situ thermal treatment are examples of processes that can reduce the amount of soil that requires removal and transport, followed by disposal in a landfill. Groundwater can also be treated with in situ remedies, such as in situ chemical oxidation, in situ bioremediation, and air sparging. In situ approaches can reduce energy use, reduce air emissions, preserve landfill capacity, and reduce cost. However, careful evaluation must be conducted, considering duration of operation of a specific in situ treatment technology, costs associated with long-term monitoring and reporting, and associated energy and material inputs.

### **Engineering Controls**

Engineering controls are physical controls used to contain, stabilize or monitor residual contamination not removed or treated in situ, and to eliminate potential exposure pathways to this contamination. Engineering Controls provide a variety of opportunities to integrate green remediation techniques into the remediation process. If the large majority of contamination identified at a site can be managed safely onsite without treatment or removal, through construction of engineering controls, the planned construction project would require little additional energy and materials for remedial work compared to general construction project needs.

### **Sub-Slab Vapor Management**

Contamination of subsurface soil and groundwater with volatile organic compounds can pose a risk if vapor intrusion into affected buildings introduces contaminated soil vapor into occupied

spaces. Often, although contaminant source areas may not be located within the property to be developed, soil vapors may migrate from offsite contaminant sources and via vapor intrusion enter into site buildings, requiring vapor management engineering controls to render the occupied space protective of human health and the environment.

Effective and efficient engineering controls used to prevent vapor intrusion involve construction of vapor barrier and passive venting systems beneath the slab of the building. It should be noted that installation of a vapor barrier is best completed prior to new building construction to be cost effective. However, this does not necessarily preclude installation in existing buildings should that be warranted and feasible. As a result, consideration of means to address possible future intrusion of soil vapors is necessary during building design and before construction. Water-proof vapor barriers can also protect buildings in the flood plain from water damage during high groundwater and flood events, and are often used to prevent water infiltration when a building is constructed at or into the local groundwater table.

### **Alternative Dust Suppression Techniques**

Minimizing soil disturbance can reduce the amount of dust generated. For extended periods of remediation, developers should consider covering exposed areas with vegetation, recycled concrete aggregate, stone or gravel. Dust control measures on roadways can also include tarps and gravel or recycled concrete aggregate. Synthetic geotextiles capable of biodegrading are an alternative for barriers such as tarps

designated for erosion and sediment control. Additionally, developers should consider using rain water collection systems as an alternative water supply for dust suppression to reduce or eliminate potable water use in water-intensive dust suppression.

### **Emissions Reductions**

Continual improvements in diesel engine and diesel engine emissions reduction technology over the years have resulted in newer engines that generate significantly lower emissions. Also, older engines can be retrofitted with pollution control devices to reduce emissions of particulate matter and

other air pollutants. Best-available technologies to control air pollution, and ultra-low sulfur diesel compatible engines are also now required for non-road diesel use in NYC. These interventions significantly reduce emissions of air pollutants such as sulfur oxides, nitrogen oxides, and particulate matter. Some equipment has been outfitted for use with biodiesel and can be requested on specific jobs where renewable fuels are preferred or specified. Reducing or eliminating idling time, for examples as dump trucks line up at a site for a major soil removal operation, can also reduce unnecessary air emissions and maintain compliance with the City's anti-idling regulations.



# Chapter 5: Green Building and Green Infrastructure

With remediation planning, building and site design provide many opportunities to incorporate green and resilient design principles. From building design and construction to landscaping, almost every aspect of the development presents an opportunity for green, resilient choices. The following green building practices were identified to be applicable to a wide variety of buildings and development types.

## 5-1 Green Building

### Building Systems

- **Heating, Cooling and Ventilation:** The selection of high-efficiency HVAC systems and the incorporation of individual temperature control can increase the overall efficiency of the building.
- **Lighting and Electrical:** The use of daylighting techniques or high efficiency lighting can reduce resource consumption. Energy sub-metering allows tenants to monitor their own energy consumption.
- **Water:** The selection and installation of low-flow fixtures and appliances can reduce the use of potable water. Installing grey water recycling systems can significantly reduce overall water consumption in a development.

### Building Envelope

Insulation selection and window selection and design can significantly impact the demand for heating and cooling and overall building efficiency. Additionally, small architectural details that provide passive lighting can impact building performance.

### Ventilation Systems

Residential buildings require a minimum ventilation air rate of 5 cubic feet per minute (cfm) per person plus 0.06 cfm/ft<sup>2</sup>, while commercial buildings require twice that rate. The survey for a development in the Bronx suggested that the proposed openings for light and ventilation may exceed building code requirements and may result in energy losses for heat, air conditioning, and humidity control. The surveys indicated that designed ventilation may exceed building code requirements and may result in unnecessary energy losses for heat, air conditioning, and humidity control. Higher energy efficiency can be achieved by optimizing ventilation systems to retain heat and control humidity efficiently. Demand control ventilation may be beneficial if there is a large occupancy in a space such as classrooms or meeting rooms.

### High Efficiency Lighting

Lighting control devices and high efficiency lighting can be implemented during the development stage or after the development has been completed. The purchase price of high efficiency lighting is higher than most incandescent lighting; however, the lifecycle cost is significantly lower. Lighting control devices may include occupancy sensors, daylighting availability,

time clocks, or photocells that control certain groups of lights independently. These control devices can be especially useful in community facilities that may not be occupied at all hours of the day.

### Sun Control Devices and Shading

The installation of sun control devices, such as an awning, on windows can counteract the higher solar heat gain during hot summer months and thus reduce cooling needs. These horizontal projections must be sized appropriately and may not be feasible for all building designs. Alternatives to horizontally projected shade devices include vertical shading, balcony shading, and windows inset towards the interior. Minor architectural extrusions strategically placed near windows can provide some shading, as well as visual interest.

### Cascading Roof Line

The audits of several residential redevelopment projects in Brooklyn and the Bronx identified opportunities to incorporate sun control. We found that cascading rooflines with private terraces provide opportunities for installing sun control devices to provide shading for windows below.

### White Roofs

White roofs, or cool roofs, are usually painted with a reflective material or simply painted white. Reflective white roofing alternatives include: white clay, concrete, or fiber cement tiles, which tend to have higher reflective values. The reflective roofing options usually are more costly upon installation than standard roofing, but can

save the owner money due to the products' increased longevity and durability because of decreased heat absorption. Spray-on white roofing applications are also available as an alternative to white roofing materials. White roof systems can reflect heat and can reduce net cooling requirements of a building by as much as 20%.



**Figure 6:** The cascading roofline on this OER E-designated site in Manhattan optimizes the sun exposure for maximum passive lighting potential.

Photo credit: Will Wong, OER



Installing alternative roofs can increase the energy performance and aesthetics of the development while also providing a beneficial decrease in the overall urban heat island effect, but not all roofs are amendable to green or blue roofing. For example, the proposed development plans for a Brooklyn recycling facility indicated that the facility's proposed pitched roofs would not be conducive to blue or green roof design (see Sustainable Stormwater Management & Green Infrastructure, below). The survey recommended that white roofs be installed on the repair garage, process building, office building and covered walkway of the facility to save energy and reduce building operating costs, especially in summer.

#### **Locally Sourced and Recycled Building Materials**

Locally sourced materials are building materials that have been extracted, harvested, recovered or manufactured within a region or the Leadership in Energy and Environmental Design (LEED)-designated 500-mile radius of a project site. By purchasing locally-sourced materials, projects support local native resources and local native ecology as well as reducing the footprint of material transportation, including greenhouse gas emissions such as carbon dioxide, nitrous oxide, sulfur oxide, and particulate matter which contribute to climate change, degradation of air quality, and ozone depletion. Locally-crafted, recycled products support local economic development and the reuse of products diverts these materials from landfilling. Through the Clean Soil Bank or Asphalt Millings Bank, development teams can

procure free locally sourced materials (see Sustainable Materials Management, above).

#### **Green Gymnasium Materials**

OER's RAWP template stipulates that "to the extent practical, energy efficient building materials, appliances and equipment will be utilized to complete the development." A surveyed site in Brooklyn included a space for a gymnasium and aquatic center. The site survey recommended that recycled rubber could serve as a versatile option for the gym floors and turf material.

## **5-2 Sustainable Stormwater Management & Green Infrastructure**

#### **Combined Sewage and Overflow (CSO)**

CSO areas are areas where storm water and sewage collection and transport systems are combined in one pipe. During storm events, storm water collected in the sewer system overwhelms capacity at sewage treatment plants and the excess is discharged untreated into local waterways. Priority CSO areas in NYC are areas where the combined discharges have greatest local impact on local water quality. On-site water retention above and beyond City requirements can help reduce the amount of storm water leaving a site and entering the system. Water retention can be increased through many green building and infrastructure techniques such as permeable pavement, green roofs, and rain barrels.

#### **Rain Detention and Retention**

The use of permeable or semi-permeable pavement, rain barrels, downspout planters

and bioswales can reduce stormwater runoff and ponding, as well as reduce the overall potable water used in the development.

### **On-site Water Retention**

Larger projects often present opportunities for efficient reuse of rainwater on site. The proposed development plans for a Queens site included a large landscaped area above the parking garage. The survey recommended installing a drip irrigation system that could utilize rainwater collected in rain barrels at the development. When sites are not located in a priority CSO area, rain barrels in conjunction with downspout planters placed beneath roof drainage can capture storm water and divert it away from the bodies of water.

### **Rain Barrels and Downspout Planters**

Urban watersheds are particularly sensitive to short intense rainstorms due to limited pervious area, resulting in large amounts of stormwater runoff. Rain barrels can be used to collect rain water from roofs for the purpose of irrigating landscaping and in the process, divert water from the sewer system. Rain barrels are connected to the downspout with an overflow mechanism to the sewer system, rain garden, a bioswale, or drip irrigation.

Downspout planters are placed along the downspout or at the end of the downspout to collect storm water, reducing entry into the sewer system.

### **Permeable Paving**

Permeable or semi-permeable pavement can be used on sites with unbuilt areas to increase the amount of storm water that is

retained onsite. Onsite retention may reduce stormwater runoff and combined sewer overflows and may help mitigate local flooding. This may have dual importance when a site is located in a flood hazard area. A review of a development in the Flatlands area of Brooklyn revealed that the property is located in a NYC priority combined sewer overflow area. Onsite stormwater retention in these priority areas is important in reducing overflows. The use of permeable pavement at the development in proposed open parking areas across the site, was recommended to reduce the amount of stormwater runoff that would need to be handled in the stormwater and sewer systems.

### **Blue Roofs**

Blue roofs provide rooftop water detention and are intended to increase water absorption and rain collection. Different types of blue roof detention technologies include check dam systems and tray and ballast systems.

### **Green Roofs**

Green roofs are partially or completely covered with vegetation over a waterproofing membrane, occasionally including components such as a root barrier, drainage or irrigation systems. Green roofs provide both reflection of heat and water retention and can provide agricultural or habitat space. According to the NYC Parks Department Green Roof Initiative, a green roof can increase the value of a property by an average of 5% when selling or renting to new tenants. The Parks Department also offers free classes to interested developers

at their facility on Randall’s Island; see Appendix 1 for further information.

### Urban Ecology

The selection of native species for landscape design generally results in landscaping that requires less resources for maintenance and also provides habitats for native species. These practices can be implemented anywhere at a site with planted spaces from landscaped recreational spaces to green roofs. Please see the NYC Parks Native Species Planting Guide linked in Appendix 1 for more information.

### Use of Landscaped Areas for Community Gardens

Community gardens and green space can dramatically increase the value of a

development. Though the ground level opportunities for a community garden on many sites are sometimes limited due to remedial action requirements, roof areas may offer the opportunity to incorporate garden space.

Community gardens and landscaped areas present a great opportunity to reduce materials management costs and implement sustainability best practices by using the NYC Clean Soil Bank (see Sustainable Materials Management above). Using local recycled clean soil from OER’s Clean Soil Bank lowers landscaping costs, and ensures that the material used for capping and landscaping meets cleanup standards.



**Figure 7:** The NYC Clean Soil Bank was able to provide capping for a garden in the Bronx that limited exposure to potentially contaminated historic fill, and laid the foundation for the addition of raised beds.

Photo credit: GrowNYC



## Chapter 6: Alternative Energy and Efficiency

Alternative energy sources can increase building efficiency and resiliency. Three of the options for renewable energy systems that have been demonstrated to have significant potential in New York City are solar panels, small-scale wind turbines, and geothermal energy. The Climate Change Resilience Surveys provided information on the feasibility of incorporating these energy systems to the survey sites.

### Solar Systems

Solar photovoltaic cells generate electricity for use in the building, or in times of surplus production can supply power back to the electricity grid. Photovoltaics are a versatile option that can be mounted on roofs or integrated into building materials. The cells can cut electricity costs, as well as providing power to New York City's electricity grid during peak demand times. Solar thermal technology is a clean and efficient way to supplement hot water generation requirements for a building without relying solely on fossil fuel energy for hot water systems. Typical solar thermal systems can supply 50-80% of hot water needs.

Although the area available for roof-mounted solar panel installation will depend on building orientation, shading from surrounding buildings, and particular site design, such as the pitch of the roof; there are opportunities to incorporate solar systems on most projects. Solar panels can potentially be installed on roofs and

### A Look at Future Technology

Manufacturing costs of photovoltaic cells has decreased over the last several decades, enabling more routine use of solar technologies on new and existing development. Emerging technologies include the ability to incorporate layers of printed solar cells onto glass and sprayed solar paint onto plastic surfaces. As these technologies develop, innovations such as these could be considered in future building designs.

additionally be utilized as shading devices over roofs and recreation areas. Additional options for installations could include double-paned windows with photovoltaic cells incorporated into the window or building-integrated photovoltaic cells, such as photovoltaic glass units that replace components of the facade.

### Small-Scale Wind Turbine

While wind power is unlikely to meet all energy demand for a property, small scale wind turbines mounted on rooftops can supplement a building's electricity supply. This is a viable option for properties with a demonstrable wind resource as well as sufficient space to install turbines. A New York State rebate program can reimburse up to 50% of installation costs.

### Geothermal Energy

New York City's geothermal resources have the possibility of providing heating and

cooling options, as well as reducing greenhouse gas emissions. Geothermal is currently most viable for large, newly constructed institutions and multi-family residences. Geothermal designs are also being recognized as a storm-resistant

resource that can provide heating and cooling without relying on New York City's power grid. Installation requires drilling deep into bedrock and involves a permitting process with New York State.



## Chapter 7: Sustainability

Building a culture of sustainability is a critical step in ensuring that a new green building operates optimally. The Climate Change Resilience Surveys provided recommendations and examples for potential sustainable actions.

### Building a Culture of Sustainability

Building a culture of sustainability can take many forms, from information sharing to providing easy access to sustainable choices. Providing a sustainable occupancy guide that educates occupants to maximize energy efficiency and highlights sustainable features of the building may improve building energy performance and help residents to save money on electricity bills.

One simple way to build a culture of sustainability is to reduce paper use by encouraging digital communication. This reduction in paper use can begin during the remediation and development process through the NYC VCP's Paperless Voluntary Cleanup and Low-Energy Project Management Programs and continue through to building management and occupancy. Another way to make sustainable choices easier is to provide on-site parking spaces for ride sharing programs or plug-in spaces for electric vehicles.

Simple interventions can also contribute to the culture of sustainability. For example, designating a location within a building's recycling area for compost or electronic waste storage may positively impact

### Residential Composting in NYC

NYC provides organic collection in large residential buildings with 10 or more residential units. NYC Sanitation will provide free collection and transportation of organic waste, including food scraps, soiled paper and yard waste to regional composting facilities. Organic collection reduces waste sent to landfills and the compost can provide a source of renewable energy.

In addition to traditional recycling receptacles, developments can provide bins for composting food scraps and/or set aside designated space for compost storage. All receptacles should include instructive labels to teach occupants and visitors what can be recycled and composted.

residents' relationship to waste management.

### Bike Parking

Developments can encourage bicycle use by providing indoor and/or outdoor bicycle racks. One surveyed Brooklyn development was formerly home to the Brooklyn Bike Park, a free community bicycle course. The survey recommended that during the development of the one acre green space, a bike path to replace the former Brooklyn Bike Park be considered. The survey also recommended providing public bicycle parking for visitors in addition to the bicycle storage area now required by building code.





## Chapter 8: Emergency Management

During Hurricane Sandy, approximately 390,000 NYC electricity users lost power due to damage to overhead utilities. In heavily flooded areas, approximately 55,000 electricity users lost power, not because of damage to the utility system serving them, but because of damage to electrical equipment in their buildings. In many of these cases, these electricity users suffered much longer outages due to the extensive repairs needed to fix this equipment. Climate models predict increased frequency of extreme weather events like Hurricane Sandy. These extreme weather events have the potential to cause electrical grid disruptions with greater frequency.

The City continues to improve protocols for both residents and infrastructure management, preparing for a variety of disaster scenarios. With these precautionary measures in place, the time lost due to damages incurred and subsequent cleanup and repairs, as well as overall cost of recovery, would be reduced significantly from that following Hurricane Sandy. Though highly unpredictable, ideally, during future weather events damage and loss will be significantly less and afterwards, the city will resume its normal standard of functioning expeditiously.

Overall city recovery can be supported if individual developments are built and managed with resilient design, and these are able to recover quickly from extreme weather events. These buildings will not drain city resources during a recovery, and

may also contribute to recovery efforts. The Climate Change Resilience surveys assessed the RAWP and site design plans of the subject sites to identify and provide recommendations on emergency management related issues including the following:

- Designing and providing information on evacuation routes and emergency preparedness plans to residents and tenants.
- Planning for continuity of operations during and after an emergency.
- Integrating back up energy systems into building design in case of power outage.
- Integrating increased water storage capacity and access to potable water during power outages and emergencies.
- Including information on local shelters or providing space for communal shelters in the development plans.
- Planning for the operation of lavatory facilities during power outages.

This chapter presents additional information and examples of audit recommendations.

### Emergency Management during Remedial Action

Each cleanup plan developed under the oversight of OER includes an Extreme Storm Preparedness and Response Contingency Plan. The plan provides the remediation team tools to will undertake in the event of

emergency conditions caused by an extreme storm event. The steps include the following:

#### Extreme Storm Preparedness and Response Contingency Plan

- Storm Preparedness
- Storm Response
- Storm Response Reporting

Preparing in advance and implementing the storm response actions and coordinating with OER during and after the storm will ensure optimal management of sites that are in the process of conducting remediation when a storm disrupts operations.

#### Evacuation Routes and Emergency Preparedness Plans

Buildings should consider implementing tiered emergency responses for differing levels of emergencies. For example, a brownout or brief blackout may require occupants to temporarily take refuge in place, whereas a severe hurricane with prolonged power outages may require occupants to implement offsite evacuation strategies. Evacuation routes within the building should be designed with consideration of the use of graduated ramps for those who rely on wheelchair accessibility. Additionally, the development of an evacuation plan or implementing barriers or a mechanism to prevent parking garages and sub-grade building areas from flooding, should be considered. Parking garage entrances can be designed so that they can easily be reversed to exits in the case of an emergency. Both development employees and occupants should be

educated on evacuation plans and procedures.

#### Shelter Areas

Areas of refuge for building occupants offer space to congregate to reduce the overall energy needs during a state of emergency. Ideal areas for refuge would be well-insulated with a high-efficiency thermal envelope and have access to natural light and fresh air. Developers should consider designating a communal shelter area on an upper floor that would not be susceptible to flooding. Developers should also consider designating a secure locked room on an upper level floor for the storage of valuable merchandise or belongings of first floor residents and tenants. This will enable the store owners and residents occupying lower floors that may be vulnerable to flooding to safely store valuable items from potential flood damage.

#### Reaching a Wider Audience

The survey of a Brooklyn development determined that the site is located in a zone 2 hurricane evacuation zone and that the closest shelters are approximately 2 miles away. The survey recommended that building management post locations of the hurricane evacuation zone and local shelters, as well as the closest access routes to evacuate the area. It was suggested that due to the commercial use of the first floor, these postings could potentially reach a wider audience in the community.

## **Emergency Response Procedures for Industrial Sites**

The survey of a Brooklyn industrial development located close to the shoreline, determined that an on-site shelter area may not be appropriate given the close proximity to the water and its intended industrial use. The survey suggested that emergency response procedures be developed to ensure that grease and related liquids/solids associated with the facilities operations, are properly secured to prevent any releases into flood waters. Additionally, it was recommended that developers consider developing an evacuation plan or install

temporary barriers for parked trucks and trailers to prevent damage of these assets.

Thoughtful preparation, from the beginning of remediation through operation of the site, will have positive benefits ranging from protecting expensive equipment to preventing site contamination from leaving the site, to most importantly, protecting on-site workers and others in the vicinity of the site.



# Appendix 1: Overview of Cost-Saving and Funding Resources and Links

Resources and links for additional information, cost-saving programs and funding resources were provided throughout the reports. Below is a selection of the resources provided, please see the audits for links to additional information:

## Building Resiliency

- Estimate your flood risk and flood insurance premium: <http://www.floodsmart.gov>
- What is my base flood elevation address lookup table: <http://www.region2coastal.com/sandy/table>
- PlaNYC: <http://www.nyc.gov/html/planyc2030/html/theplan/climate-change.shtml>
- Flood resistant building materials: <http://www.fema.gov/national-flood-insurance-program-2/flood-resistant-material>
- Corrosion Protection in Coastal Areas: <http://www.fema.gov/media-library/assets/documents/3509?id=1721>
- Protecting Utilities: <http://www.fema.gov/media-library/assets/documents/3729?id=1750>

## Green Remediation

- NYC Office of Environmental Remediation, Clean Soil Bank Rules: [http://rules.cityofnewyork.us/sites/default/files/proposed\\_rules\\_pdf/p\\_oer\\_10\\_26\\_12\\_a.pdf](http://rules.cityofnewyork.us/sites/default/files/proposed_rules_pdf/p_oer_10_26_12_a.pdf)
- EPA Verified Idle Reduction Technology List: <http://www3.epa.gov/smartway/forpartners/technology.htm>

## Green Building

- Potential Reuses of Greywater and Reclaimed Wastewater in New York State: [http://www.dec.ny.gov/docs/water\\_pdf/waterresue.pdf](http://www.dec.ny.gov/docs/water_pdf/waterresue.pdf)
- New York City Department of Design and Construction, Construction & Demolition Waste Manual: <http://www.nyc.gov/html/ddc/downloads/pdf/waste.pdf>
- Energy Efficiency and Energy Cost Comparison of LEDs, CFLs, and Incandescent Light Bulbs: <http://www.designrecycleinc.com/led%20comp%20chart.html>
- Energy Performance Ratings for Windows, Doors and Skylights: <http://energy.gov/energysaver/articles/energy-performance-ratings-windows-doors-and-skylights>
- Energy Star Certified Products: [http://www.energystar.gov/index.cfm?fuseaction=find\\_a\\_product.showProductGroup&amp;pgw\\_code=W](http://www.energystar.gov/index.cfm?fuseaction=find_a_product.showProductGroup&amp;pgw_code=W)

## Green Infrastructure

- **Green Roof Tax Abatement:** A one-year tax abatement consists of \$4.50 per square foot of green roof with a maximum abatement of the lesser of \$100,000 or the building's tax liability. To be eligible at least 50% of eligible roof space must be covered by green roof. Applications must be submitted each year to the Department of Buildings (DOB) by March 15 for a tax abatement to be applied to the current fiscal year's property taxes. Applications submitted *after* March 15 will be eligible to have the tax abatement applied to the following Fiscal Year's taxes. (Fiscal year runs from July 1 to June 30.) Green roof tax abatement applications must be submitted and approved by the NYC DOB, prior to review and approval from the NYC Department of Finance. [http://www.nyc.gov/html/dob/html/sustainability/green\\_roofs.shtml](http://www.nyc.gov/html/dob/html/sustainability/green_roofs.shtml)
- **NYC °CoolRoofs:** A NYC Service initiative, in collaboration with the NYC Department of Buildings (DOB) to promote and facilitate the cooling of New York City's rooftops. Working with non-profits, City agencies, and building owners, NYC °CoolRoofs works with non-profits, city officials, and building owners to engage volunteers to apply white, reflective surfaces to NYC's rooftops. <http://www.nyc.gov/html/coolroofs/html/home/home.shtml>
- **Green Infrastructure Grants:** Green infrastructure grants are available for rain gardens, green roofs, and porous pavement on private property and are funded by NYC DEP. Applications are usually due in February and grant decisions are released in April/May. The grant funding must be spent within one year and must be used for design and construction costs (maintenance and education costs are not applicable for grant funding). The minimum funding for a green infrastructure grant is \$35,000 and the maximum funding is \$600,000. The Green Infrastructure Grant requirements include a restrictive twenty year covenant, requiring that the grant-funded project remain in place during that time. For more information on Green Infrastructure Grants, email [sustainability@dep.nyc.gov](mailto:sustainability@dep.nyc.gov) or [GIGrantProgram@dep.nyc.gov](mailto:GIGrantProgram@dep.nyc.gov) or see [http://www.nyc.gov/html/dep/html/stormwater/nyc\\_green\\_infrastructure\\_grant\\_program.shtml](http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_grant_program.shtml)

## Alternative Energy & Efficiency

- **NYSERDA Combined Heat and Power Program:** NYSERDA currently provides incentive for CHP systems installed in New York City. Visit their website for more info on eligibility. <http://www.nyserda.ny.gov/Energy-Efficiency-and-Renewable-Programs/Commercial-and-Industrial/CI-Programs/Combined-Heat-and-Power-Program.aspx>
- **NYC Solar Partnership:** NYC Solar's goal is to accelerate and encourage investments in solar energy throughout the City. NYC Solar Partnership can provide assistance with solar installation permits, technical information, and financing options. [www.nycsolarcity.com](http://www.nycsolarcity.com)
- **Photovoltaic Incentive Program:** Developers who install approved grid-connected photovoltaic (PV) systems to receive \$1.40 per watt. Install systems up to 50 kW, receive up to \$70,000 in incentives to install PV system on property. (Program Expires: 2023).



[http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2112-Solar-PV-Program-Financial-Incentives.aspx?sc\\_database=web](http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2112-Solar-PV-Program-Financial-Incentives.aspx?sc_database=web)

- **On-Site Small Wind Incentive Program:** New York State Wind Rebate Program pays up to 50% of the cost of installing small scale wind turbines up to 2 Mega-Watts. <http://www.nyserda.ny.gov/Funding-Opportunities/Current-Funding-Opportunities/PON-2439-On-Site-Wind-Turbine-Incentive-Program.aspx>
- **Solar, Wind & Biomass Energy Systems Exemption:** This program ensures that real property taxes will not increase as a result of installing renewable energy systems. (Program Expires: January 1, 2025) [http://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4\\_01/sec487.htm](http://www.tax.ny.gov/research/property/assess/manuals/vol4/pt1/sec4_01/sec487.htm)
- **NYCEEC Small Project Initiative:** NYCEEC provides financing for smaller energy efficiency or clean heat retrofit projects. To qualify, projects must provide three years of the building's financials and an energy audit or survey that identifies 15% energy savings or a comprehensive clean heat conversion, and agree to provide post-retrofit energy consumption information. [www.nyceec.com/apply](http://www.nyceec.com/apply)
- **NYCECC Green Mortgages:** NYCECC in conjunction with Fannie Mae and NYC Housing and Development Corporation has developed two green mortgage programs to provide loans to implement energy conservation and efficiency measures. Fannie Mae offers the Multifamily Property Improvements to Reduce Energy (M-PIRE) program and the NYC Housing and Development Corporation offers the Program for Energy Retrofit Loans (PERL). An assessment and energy audit (ASHRAE Level 2 audit) are performed to determine which energy efficiency measures can be implemented. <http://nyceec.com/get-a-loan/>
- **NYCEEC Direct Loans:** NYCEEC can provide loans directly to any building owner in New York City to finance energy efficiency retrofits, clean heat conversions, and installations of certain eligible on-site generation equipment, including CHP plants and solar PV when combined with other energy efficiency retrofits. NYCEEC can also provide direct loans in combination with an Energy Services Agreement (ESA), which provides energy efficient equipment through an Energy Services Company (ESCO) that finances the project with the resulting energy savings. <http://be-exchange.org/resources/source/35>
- **Consolidated Edison, Inc. (Con Edison) Multi-family Energy Program:** Buildings with 5-75 units are eligible for a Con Edison Green Team energy professional to evaluate your building's lighting and heating equipment and offer energy-saving recommendations. This program provides enrolled participants with free CFL light bulbs, water-saving devices, and energy-saving smart strips. Financial incentives are also available for certain energy efficiency upgrades and new HVAC systems. Con Edison-NYCEEC Multifamily Energy Efficiency Loan Program is available to finance the upgrades. [www.coned.com/energyefficiency/residential\\_multifamily.asp](http://www.coned.com/energyefficiency/residential_multifamily.asp)

## Culture of Sustainability

- **Alternative Fueling Infrastructure Tax Credit:** Income tax credits are available for 50% of up to \$5,000 of the cost of installing alternative fueling infrastructure. Alternative fueling infrastructure can include electric vehicle supply equipment or refueling stations, such as those for electric vehicles.
- [http://www.tax.ny.gov/pit/credits/alt\\_fuels\\_elec\\_vehicles.htm](http://www.tax.ny.gov/pit/credits/alt_fuels_elec_vehicles.htm)
- **NYC Compost Project:** <http://www1.nyc.gov/site/dsny/resources/initiatives/nyc-compost-project.page>

## Emergency Management

- **NYC My Emergency Plan:**  
[http://www.nyc.gov/html/oem/downloads/pdf/myemergencyplan\\_english.pdf](http://www.nyc.gov/html/oem/downloads/pdf/myemergencyplan_english.pdf)
- **Interactive Hurricane Evacuation Zone and Shelter Finder Map:**  
<http://nyc.gov/hurricanezones>

## Appendix 2: Climate Change Resiliency Checklist

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
<b>Building Resiliency</b>			
Consider flood-proofing areas of the building below the BFE or DFE.		X	X
Consider utilizing the 2020 and 2050 estimates when determining final DFEs for the development.	X	X	X
Discuss site designs with the local NFIP flood plain administrator.	X	X	X
Consider elevating the first finished floor, utilities, mechanical equipment and hazardous materials above the DFE.	X	X	X
Consider the incorporation of flood resistant building materials above the BFE.	X	X	X
Consider building to nearby BFEs plus freeboard, as a precautionary measure.	X	X	X
Consider installing backwater valves (also known as check valves) to prevent flooded sewer water from entering through the lower level plumbing.	X	X	X
Consider installing flood gates and flood panels especially at parking garage entrances.	X	X	X
Consider building to a higher standard, such as by increasing freeboard.	X	X	X
In LiMWA areas, consider plants that can withstand wave action and possibly buffer wave force.	X	X	X
In coastal areas, consider trees, shrubs, grasses, and sedges that can tolerate salt water.	X	X	X

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
<b>Green Remediation</b>			
Consider limiting the use of water spraying, but if water spraying is unavoidable, then consider set up of rain water collection systems to eliminate potable water use.	X	X	X
For extended periods of remediation, consider covering exposed areas with vegetation, recycled concrete aggregate, stone or gravel.	X	X	X
Consider means to address possible future intrusion of off-site soil vapors during building design and construction.	X	X	X
Consider installing manual override mechanism in toilets that allow the electronic flush valve to operate manually without power.	X	X	
Conduct any needed remedial action prior to building construction to properly sequence events to maximize cost effectiveness.	X	X	X
Consider salvaging uncontaminated materials for recycling, resale, donation, or reuse.	X	X	X
Consider alternative fuel choices, engine improvements, newer equipment, and/or reducing idle time to reduce emissions.	X	X	X
Consider using the NYC Clean Soil Bank to dispose of clean soil excavated from deep intervals or to acquire backfill, if needed	X	X	X
Consider in-situ and/or passive remedy options that offer adequate protectiveness.	X	X	X
Consider improving the characterization, i.e. delineation, of the impacted areas as a way to reduce remedy effort and cost.	X	X	X
Consider the designation of a recycling coordinator.	X	X	X
Prior to work, consider clearly identify recycling responsibilities and ownership of items, and if salvageable items are potentially available for resale.	X	X	X

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
<b>Green Infrastructure and Green Building</b>			
Consider utilizing secured rain barrels.	X	X	X
Consider replacing concrete with permeable pavers.	X	X	X
Consider implementing downspout planters.	X	X	X
Consider hiring a certified arborist or landscape architect during the early phases of the construction to develop a tree and plant preservation plan to determine which existing trees and plants will be preserved and maintained.	X	X	X
Consider developing a portion of the landscaping plots on roofs or other landscaped areas into community garden. Consider partnering with local schools and community groups.	X		
Consider insulated concrete form (ICF) walls.	X	X	X
Consider implementing lighting control devices.	X	X	X
Consider the addition of a faucet to improve water efficiency.	X	X	X
Consider the use of native plants and vegetation to add aesthetic value to and to reduce maintenance requirements.	X	X	X
Consider consulting with neighboring property owners on landscaping plans to allow for an ecological continuity of plants.	X	X	X
Consider conducting a blower door test.	X		
Consider selecting triple-pane glazed windows and fiberglass frames rather than double-paned glazed windows and aluminum-clad wood frame windows.	X	X	X
Consider the installation of a positive displacement or disc meter for the plumbing infrastructure.	X	X	X

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
Consider installing electrical sub-metering.	X	X	
Consider installation of a white roof, blue roof or green roof.	X	X	X
Consider conducting a visual building inspection for air leaks or a performing a basic building pressurization test to detect air leaks.	X	X	X
Consider decreasing the window to wall ratio (ideally less than 40%) by incorporating windowsills that extend from the floor.	X	X	
Consider materials with a Noise Reduction Coefficient value greater than 0.35 to absorb sufficient sound.	X	X	X
Consider integrating balcony shading techniques including retractable awnings.	X	X	
Ensure that building code specifications for ventilation are met, but are not excessive.	X	X	X
Consider specifying low-flow fixtures and appliances.	X	X	X
Consider the use of gray water in place of potable water when feasible.	X	X	X
Consider using utility steam for space heating and/or cooling and reusing at least 50% of the steam condensate produced.	X	X	X
Consider incorporating effective daylighting to reduce electric lighting use.	X	X	X
Design HVAC systems specifically for the building using DOE-2, eQuest, or equivalent tool.	X	X	X
Consider high-efficiency HVAC components and eliminate the use of window air conditioners.	X	X	X
Consider allowing tenants to have individual control of indoor temperatures and ventilation.	X	X	X
Consider integrating a rain garden or bioswale into site design.	X	X	X

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
<b>Alternative Energy/Efficiency</b>			
Consider applying for an ENERGY STAR certification and LEED certification.	X	X	X
Consider the use of energy efficient appliances.	X	X	X
Consider using Ultra-Low Sulfur No. 2 heating oil, biodiesel, natural gas, or steam instead of No. 6 or No. 4 heating oil.	X	X	X
Consider quantifying energy efficiencies during remediation and reporting those efficiencies in the Remedial Action Report.	X	X	X
Consider installing a of a small-scale ground-mounted wind turbine to supplement the supply of energy.	X	X	X
Consider the installation of solar panels.	X	X	X
Consider the installation of a geothermal well system.	X	X	X
Consider incorporating combined heat and power (CHP) and the NYSERDA incentives for CHP?	X	X	X
<b>Culture of Sustainability</b>			
Consider enrolling in NYC's organic collection in large residential buildings with 10 or more residential units. NYC Sanitation will provide free collection and transportation of organic waste, including food scraps, soiled paper and yard waste to regional composting facilities.	X		
Consider including recycling areas on each floor of the building and including receptacles for recycling and composting in the public open spaces of the development.	X	X	X
Consider installing RecycleNYC locked storage bins in a designated trash room or consider designating another room for electronic waste storage.	X	X	X



Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
Consider producing a sustainable occupancy guide, educating occupants on maximizing energy efficiency and highlighting sustainable features of the buildings.	X	X	X
Consider placing Quick Response (QR) code placards within the buildings to provide a digital alternative to a paper sustainable occupancy guide.	X	X	X
Consider including a bike path on large developments.	X	X	X
Consider providing public bicycle parking for visitors to occupants and/or retailers.	X	X	X
Consider encouraging the use of car sharing by designating specific spots in the parking garage.	X	X	X
Consider enrolling the in the Apartment Building Recycling Initiative (ABRI) free training program.	X		
Consider installing accessible drinking fountains including faucets for filling bottles		X	X
Consider means of encouraging stair use through building design	X	X	X
<b>Emergency Management</b>			
Consider posting the hurricane evacuation zone, locations of local shelters, as well as the closest access routes to evacuate the area.	X	X	X
Consider installing a generator.	X	X	X
Consider making plans to store fuel for a generator onsite. Ideally, this fuel would be stored in an area that is both safe for residents and at an elevation above the Design Flood Elevation (DFE).	X	X	X
Consider designating a communal shelter area on an upper floor that would not be conducive to flooding.	X	X	

Resilience & Sustainability Category Recommendation	Residential	Commercial	Industrial
Consider designating a secure locked room on a higher elevation floor for ground level retail and residents to store valuable merchandise or belongings during a potential flood event.	X	X	X
Consider developing emergency response procedures and an evacuation plan.	X	X	X
Consider implementing tiered emergency responses for differing levels of emergencies.	X	X	X
Consider designing parking garage entrances so that they can be reversed to exits in the case of an emergency.	X	X	X
Consider developing an evacuation plan or implementing barriers for parked trucks and trailers to prevent damage of these assets.			X
Consider the installation of a roof top water storage tower.	X	X	X
Consider utilizing lavatory faucet and toilet sensors with battery life and a manual override to operate for a period of at least two weeks without power	X	X	X





**BILL de BLASIO**  
**MAYOR**

**Daniel C. Walsh, Ph.D.**  
**Director**  
*Mayor's Office of Environmental Remediation*